County of Annapolis
NATURALLY ROOTED

Bridgetown
Source Water Protection Plan

Under the Guidance of
Bridgetown Source Water Protection
Advisory Committee

PREFACE

The Source Water Protection Plan (SWPP) was prepared by the Municipality of the County of Annapolis (MCA) under the guidance of Source Water Protection Advisory Committee (SWPAC). The objective of this document is to provide the approved actions that SWPAC has developed, which when implemented, will protect existing and future municipal drinking water sources.

For any questions about this document or Source Water Protection Area (SWPA), please contact the Municipality of the County of Annapolis staff at

902-532-2331,
swpp@annapoliscounty.ca, or go to
www.annapoliscounty.ca for more information.

Table of Contents

Tables

Figures

Appendices

ACRONYMS USED

ACWU	Annapolis County Water Utility
BMPs	Best Management Practices
DOT	Department of Transport
FEFLOW	Finite Element subsurface FLOW system
GCDWQ	Guidelines for Canadian Drinking Water Quality
MAC	Maximum Acceptable Concentration
MCA	Municipality of the County of Annapolis
MW	Monitoring Well
NSE	Nova Scotia Environment
NSTIR	Nova Scotia Transportation and Infrastructure Renewal
PW	Production Well
SCADA	Supervisory Control and Data Acquisition System
SWPAC	Source Water Protection Advisory Committee
SWPP	Source Water Protection Plan
TOT	Time Of Travel
TW	Test Well
USGS	United States Geological Survey
WHPA	Well Head Protection Area
WPA	Water Protection Area

DEFINITIONS

The units used in this report are metric: m (meters), mm (millimeters), km (kilometers), mg/L (milligrams per liter), L/min (Liters per minute) or m^3/day (cubic meters per day), with igpm (imperial gallons per minute) shown in brackets for yield estimates. Technical terms used are defined as follows.

Aquifer: An aquifer is an underground layer of water-bearing rock. Water-bearing rocks are permeable, meaning that they have openings that liquids and gases can pass through. Sedimentary rock such as sandstone, as well as sand and gravel, are examples of water-bearing rock. The top of the water level in an aquifer is called the water table.

Contaminant: Biological, chemical, physical, or radiological substance (ordinarily absent in the environment) which, in great concentrations, can adversely affect living organisms through air, water, soil, and food.

Chlorination: The method that serves as disinfection, taste and odor control in water and wastewater.

GUDI: GUDI (Groundwater Under Direct Influence of surface water) implies to short and direct pathway between surface water and a well.

FEFLOW: It is a computer program for simulating groundwater flow, used to determine the SWPA

Pesticide: A substance, usually synthetic although sometimes biological, used to kill or contain the activities of pests; includes herbicides (pesticides used to kill unwanted plants).

Permeability: The state or quality of a material or membrane that causes it to allow liquids to pass through.

Wellhead Protection Areas (WHPAs): Areas where water travels through the ground to a municipal well, i.e., 2, 5 and 25-year capture zones (or capture zones). The outer boundary of WHPA is the 25-year capture zone.

EXECUTIVE SUMMARY

Bridgetown located in north-central Annapolis County. From grassroots community projects to provincial government strategies and legislation, community of Bridgetown is working together to ensure safe and sustainable drinking water for generations to come. The protection and enhancement of drinking water sources are paramount for the successful growth of Nova Scotia.

The Source Water Protection Plan (SWPP)

Two documents support this plan:

1. Bridgetown Capture Zone Modelling: Technical Report (2010)
2. Town of Bridgetown Water Utility System Assessment Report, (2013)

The SWPP is not only a compilation of actions; it is the culmination of a process that has used a science-based approach as its foundation for identifying vulnerable areas and the risks posed to the municipal water system. The first stage of the document was the development of Terms of Reference and the work plan for the development of the Source Protection Plan. The second step is to identify a comprehensive drinking water strategy. The strategy outlines a multi-barrier approach to achieving this goal, and Nova Scotia Environment (NSE) has established a five-part guide to implementing source protection for water supplies. It includes an action plan for protecting the water supply through the implementation of a range of options and techniques known as the ABCs of source water protection.

ABCs

Use Table 4 (Page 12) to locate management options that address potential risks to the drinking water source for each.

NSE guidelines define the tools available for plan development and operation. The tools are:

- **A**cquisition of land
- **B**ylaws
- **B**est management practices
- **C**ontingency plans
- **D**esignation
- **E**ducation

Strategies

Strategies are grouped as:

- Management Plan
- Action Plan
- Monitoring Plan

The SWPP identifies strategies for protecting the well field. The SWPAC evaluated management options and ranked them by appropriateness and effectiveness for managing each risk as well as establishing an ongoing monitoring program. Most importantly, the SWPP provides the Municipality of the County of Annapolis (MCA) and the residents of the Bridgetown community with the necessary foundation, information, and agenda to support and carry out the province's ongoing commitment to protecting our precious drinking water source.

1.0 PLAN PURPOSE, OBJECTIVE, AND VISION

The most cost-effective way to ensure a safe source water supply is to prevent drinking water problems from developing in the first place. This is best achieved with an effective SWPP. The overall purpose of this SWPP is to manage land uses within the defined Well Head Protection Area (WHPA) to assure the continued supply of good quality water to the Bridgetown water supply system.

1.1 Plan objectives

The goal of the SWPP was achieved through the accomplishment of specific objectives:

1. Establish lines of protection, which will take the form of different initiatives for different types of contaminants. These initiatives will address vulnerable areas by identification of potential sources of pollutants and with possible mitigation measures for the SWPP. It includes physical isolation from ongoing potential contaminant sources, changes in practice, changes in the Land use By-Laws and Source Water Protection Area delineations and regulations, educating the public about responsible behavior within the boundaries of SWPA, and developing effective contingency plans to mitigate an incident if one does occur.
2. A Plan that is flexible and can be adapted or improved, if there are changes in contaminants (or activities of concern). It may be found that the current Land use By-Law within the defined protection zone does not have enough provisions to exclude activities that have the potential to impact water quality. Therefore, a management plan must address both existing and potential future land uses. It is essential to incorporate ongoing public and stakeholder input into the management plan, to design a well-integrated plan that builds upon existing programs and resources.
3. A management plan that allows the contamination sources to be efficiently and economically monitored. The degree of monitoring and management should depend on the locations of the potential contaminant sources and their proximity to the water source.

1.2 Vision

The overall vision of the Bridgetown SWPAC, in partnership with the public, NSE and MCA, is to protect the quantity and quality of present and future sources of drinking water in Bridgetown SWPA.

2.0 INTRODUCTION TO WELL FIELD

The town of Bridgetown groundwater supply became operable in May 2010 and consisted of three production wells (Well 1, Well 2 and Well 3) with variable speed pumps, one monitoring well (MW1), pump control chamber with hypo-chlorination disinfection equipment and water distribution system. The selection of Well 4's well field was based on the hydrogeological setting of the study area as determined by CBCL's 3D numerical model of the Well Field and surrounding area.

Wells, 1, 2, 3 and 4 were identified as Non-GUDI (Groundwater Under Direct Influence of source water), summarized in Table 1. Well 2 was taken out of production in March 2016 as it exhibited high concentrations of uranium.

Table 1 Bridgetown Well Field Development – SWPP

Well Identification	**Well 1**	**Well 2 (Not in Production)**	**Well 3**	**Well 4 (Not Operating until Dec 31, 18)**
Date Drilled	2009	2006	2006	2016
Depth (m)	121.9	106.7	106.7	122
Safe Yield (m^3/day)	655	114	655	982

Information presented in this report is based on the historical data provided by the County of Annapolis and the system assessment report completed by CBCL Limited (CBCL) in 2018 and 2013. The model was developed in 2010 and updated in 2017 to include Well 4 in the system, and its output was used as the basis for delineation of the SWPA at Well 4's field. More detail on the hydrogeology and summary of the Bridgetown Well Field is included in Appendix A.

3.0 PROCESS TO DEVELOP SOURCE WATER PROTECTION PLAN

NSE has published a five-part series of technical documents that provide detailed guidance for those who have to deliver effective source water protection plan and is available on their website. MCA has followed the suggested method including the five steps as follows:

- **Step One:** Form a Source Water Protection Advisory Committee
- **Step Two:** Delineate the Source Water Protection Area Boundary
- **Step Three:** Identify Potential Contaminants and Assess Risks
- **Step Four:** Develop and Adopt a Source Water Protection Management Plan and
- **Step Five:** Monitor and Evaluate the Plan

Table 2 Summary of SWPP Process

Step 1	The Annapolis County Water Utility (ACWU) formed an advisory committee to develop the SWPP. The Bridgetown SWPAC includes municipal councilors, the Director and Manager of Municipal Operations, residents of Bridgetown area and consultants (refer to Appendix B).
Step 2	The second step involved the delineation of source water protection area (depending on WHPA) and completed using groundwater model
Step 3	The third step is to identify and document potential sources of contamination and to assess the risk they pose to the source water supply. The intent of this is to provide the SWPAC with an understanding of the types of activities and associated contaminants.
Step 4	Step 4 includes the development of management options. The WHPA is often based on a combination of the most appropriate management practices for the source water supply area. Once the SWPAC has identified the range of options available to manage the drinking water supply, NSE can review the plan.
Step 5	One of the critical components of the SWPP is to monitor for water quality contaminants entering the SWPA. Both the SWPAC and MCA will need to continue to work with stakeholders to ensure that the management practices incorporated into the SWPP are contributing to the maintenance of water quality and quantity.

4.0 SOURCE WATER PROTECTION ADVISORY COMMITTEE

The first and most crucial step in developing the SWPP is to form a fully representative Advisory Committee. This step includes the formation, selection, and identification of responsibilities and objectives of the Source Water Protection Advisory Committee (SWPAC).

The mandate of the committee includes addressing issues such as:

- Identification of stakeholders
- Water quantity and quality concerns
- Actual and potential sources of contamination
- Management strategies
- The effectiveness of the SWPP.

The terms of reference provided in Appendix C define the roles and responsibilities of the SWPAC.

The committee will oversee the preparation and review of the following deliverables:

- Protection area boundary description
- Identification of contaminants and associated risks
- Source water management plan
- Set time frames for the completion of initiatives
- Implementation of the monitoring program
- Preparation of the draft SWPP
- Continuous evaluation of the effectiveness of the protection plan by the SWPAC, which is to meet on an annual basis

5.0 DELINEATION OF PROTECTED WATER AREA BOUNDARY

Using information on geology, precipitation, soil types, groundwater flow, and pumping well capability a computer model (FEFFLOW 5.2) of the Annapolis Valley flow system was created for the Bridgetown area (refer to Figure 3 and 4). Groundwater flow patterns served as a tool to delineate the SWPA. When travel times of 2 years, 5 years, and 25 years were entered into the model, a roughly circular zone (or capture zone) corresponding to each travel time was produced.

- the 2-year capture zone (Zone 1)
- the 5-year capture zone (Zone 2)
- the 25-year capture zone (Zone 3)

The outer boundary of the SWPA (Figures 2) for Wells 1 and 3 is the 25-year zone which intersects with the farmlands to the north, an orchard and several residential properties to the west, residential lots and a senior citizens' home to the south, and wooded area to the west (Figure 5 and 6). Well 4 is situated on the floor of Annapolis Valley, extending North from the Annapolis River to the foot of the North Mountain. Adjacent land uses are primarily agricultural or wooded and include several rural residential lots. The northwest corner of the property is bordered by a former Nova Scotia Transportation and Infrastructure Renewal (NSTIR) depot, used to store and service maintenance vehicles (Figure 5). Groundwater flow in the Valley is dominated by the regional topography, directing drainage down the Valley slopes and into the Valley plain where groundwater discharges to the Annapolis river or flows to the southwest as regional flow. The hydrogeological setting of the Bridgetown area has been described in detail in studies by CBCL.

There are private domestic water supplies located on adjacent properties to the south, west, and north of the Well 4. The closest wells are 300 m to the northwest of the site of the Well 4 production well. Some dwellings in the area use on-site sewage disposal systems and have heating oil storage tanks. Existing agricultural fields in the area are currently used to grow crops. The herbicides, fertilizers/ nitrates are used periodically on these fields.

6.0 HAZARD IDENTIFICATION AND RISK ASSESSMENT

As per NSE guidelines for developing the SWPP, Step 3 aims to identify known and suspected point sources of contaminants (that are released from a specific, known location) and non-point sources (diffuse in nature, difficult to locate and hard to identify the source) that may impact groundwater quality impact within the SWPA. It provides a qualified opinion on the level of risk to the underlying groundwater resource.

6.1 Potential Sources of Contamination

When assessing the level of risk of a potential contaminant, consideration was given to chemical and physical properties of the contaminant, the features of the aquifer materials, and overburden, material and its location within the SWPA. The risk ranking is based on the perceived severity of impact, should a significant release occur, and an estimate of the probability of such an occurrence.

Refer to Appendix D for a summary of how risk factors, including severity and likelihood, were calculated. Priority wise ranking was determined via consultation with the SWPAC. It considered such factors as the calculated Risk Factor and how readily the issue could be addressed.

Table 3 Potential Sources of Contaminants

Zone	Land Use and Activities of Primary Concern	Risk Score[1]	Risk Rank[2]	*Committee Rank*
Point Sources				
Exclusion	Well Control Building • Stand-by fuel for the generator	10	High	*High*
1	Abandoned wells? • The subsurface release of pathogens	12	High	*High*
	Roadway • Transport of fuel/chemicals/waste	9	High	*High*
	Vacant Lot • Dumping of fuel/chemicals/waste	9	High	*High*
2	Abandoned wells? • The subsurface release of pathogens	9	High	*High*
	Residential • Fuel oil tank (900 L) • Pest control/lawn care spraying • New Development	6	Medium	*Low*

Zone	Land Use and Activities of Primary Concern	Risk Score[1]	Risk Rank[2]	*Committee Rank*
	Roadway • Transport of fuel/chemicals/waste	6	Medium	*Medium*
	Vacant Lot • Dumping of fuel/chemicals/waste	6	Medium	*Medium*
	Private Organic Disposal Site • The ground surface release of pathogens	6	Medium	*Low*
3	Water Treatment Building / Reservoir	4	Low	*Low*
	Abandoned wells? • The subsurface release of pathogens	6	Medium	*High*
	Mountain Lea / Croskill • Large fuel oil tank (13,620 L)	5	Medium	*Low*
	Residential • Fuel oil tank (900 L) • Pest control /lawn care spraying • New Development	4	Low	*Low*
	Roadway • Transport of fuel/chemicals/waste	4	Low	*Low*
Non-Point Sources				
1	Agriculture • Potential manure and chemical spreading	9	High	*High*
	Woodlot • Pest control for silviculture • Fire suppression chemicals	8	High	*High*
	Roadway • Salt spreading	9	High	*Medium*[3]
2	Agriculture • Potential manure and chemical spreading	6	Medium	*Medium*
	Woodlot • Pest control for silviculture • Fire suppression chemicals	6	Medium	*Medium*
	Roadway • Salt spreading	6	Medium	*Medium*
3	Agriculture • Potential chemical spreading	4	Low	*Low*
	Woodlot • Pest control for silviculture • Fire suppression chemicals	4	Low	*Low*
	Roadway • Salt spreading	4	Low	*Low*

[1 and 2]Risk scores and ranks are computed in Appendix D

Chemical/ temporary fuel storage: The nature of the chemical will determine how it will react in the natural environment, and how much time it will take to degrade, however, some of these processes may take years to effectively reduce concentrations to levels that are no longer of concern. Other chemicals may be toxic at low concentrations, and may be persistent and mobile; therefore, it is essential to identify the potential risk of each distinct contaminant. The water treatment facility stores a liquid form of chlorine and temporary fuel storage may be a concern if the backup generator is required.

Abandoned wells: An abandoned private well located within the SWPA could pose a potential risk of groundwater contamination. Abandoned well can serve as a path for contaminants from the surface to the aquifer.

Roadway /Potential spills: There are unpaved access roads very close to the wells. If these roads are paved in the future and were salted, there would be a risk of salt infiltration to groundwater. The likelihood of the spills is also high because of the proximity of the roadway and the slope down to the Wells, raises concern. If a vehicle went off the road, it could impact Well 4.

Fuel oil tank storage/Heating oil tanks: There are residences in the SWPA, that might have heating oil tanks. Heating oil tanks commonly experience leaks due to many reasons, including aging or corroding tank and pipes, overfills or improper installation and maintenance. The volume of the residential spill is likely to be much smaller than a commercial fuel spill, but this type of contamination could go undetected, allowing infiltration to groundwater. The severity of this risk would vary depending on the proximity of the heating oil tank to the water supply.

Fire Suppressants: With wooded areas found throughout SWPA, fire is a risk. Fire suppressants foams used by first responders could reach the water supply through groundwater infiltration or surface runoff. The possible introduction of these chemicals is of greatest concern closest to the wells, but also of concern throughout the SWPA since these chemicals tend to be persistent and not degrade.

Herbicides/Pesticides: Agricultural areas are found throughout the SWPA, and the possible introduction of herbicides and pesticides into the subsurface is of greatest concern closest to

the wells. Pesticides and herbicides can be persistent and should be considered a potential risk throughout the SWPA. If herbicides or pesticides reach the aquifer, they are not easily removed by water treatment and could pose significant health risks.

Illegal Dumping: There are vacant lots in the SWPA, that may result in illegal dumping of domestic, industrial or waste or garbage with an array of potential contaminant sources.

7.0 MANAGEMENT PLAN

Step 4 of the NSE guidelines to develop a municipal SWPP focuses on the development and implementation of the management plan within the SWPA boundary. According to the identified potential sources of contaminants in Step 3 (NSE guidelines), Step 4 develops management options for those risks to water quality.

Steps for making the management plan:

- Set management goals and objectives
- Identify management options for issues identified in Step 3 (NSE guidelines)
- Develop a contingency plan
- Solicit input from stakeholders and the public
- Draft the management plan
- Update information

7.1 Goals and Objectives

The purpose of the Bridgetown SWPP is to protect the groundwater supply from contamination and keep it safe for current and future drinking water use. MCA should take all reasonable measures to achieve this goal as outlined in the Management Plan.

Objectives:

1. Educate stakeholders and the public as to value our groundwater source and what they can do to help keep it safe.
2. Adopt best management practices to avoid contamination of the water supply.
3. Develop contingency plans to limit contamination of the water supply by events such as contaminant spills or natural disasters.

7.2 Management options

The NSE guideline requires the assessment of source water protection management options. The following list of management options, with a general statement as to their effectiveness, cost, usefulness, and acceptability, is provided by NSE for the use of SWPP advisory committees:

A. **Acquisition of Land:** Typically, the most expensive option, but also the most effective, as it gives the Municipality direct control over the land usage and development.
B. **Best Management Practices (BMPs):** Methodologies used by residents and industry to define practical and effective means of protecting source water areas. In the case of the water utility and other institutions, such as NSTIR, BMPs may require education.
C. **By-Laws:** By-Laws are enacted under Municipal Planning Strategies and allow the municipality to restrict land usage and activities in sensitive areas.
D. **Contingency Planning:** Not all risks to the SWPA can be mitigated. Contingency Planning defines emergency response protocols, in case of dangerous contamination occurrence within the SWPA.
E. **Designation:** Protected Water Area (PWA), enforceable under the Nova Scotia Environment Act, Section 106. Regulations can be drafted that would enable the Municipality to define allowable activities within a protected area.
F. **Education and Stewardship:** The Municipality can work to develop and deliver educational materials to inform residents and landowners of the importance of protecting source waters, and to recommend practices for doing so.

7.3 Source Water Protection Management Recommendations

For each potential contaminant within the Bridgetown SWPA, the management options presented in the NSE guidelines were evaluated. Table 5 provides a summary of available management options.

The SWPAC is responsible for evaluating the application of these various management options to the identified potential contaminants within the SWPA, considering effectiveness, cost, maintenance, useful life, adverse effects, and public acceptability of each option, to develop suitable management options. Although specific management options are judged to be more effective than others for specific contaminant source activities, the SWPAC recognizes that the most effective initiatives would make use of two or more management options in a coordinated fashion. The rationale for the assigned priorities is presented in the sections that follow.

Table 4 Management Options

Ordinal	Committee Rank	Land Use and Activities of Primary Concern	Management Strategy	Actions
1	*High*	Well Control Building / Treatment Building • Stand-by fuel for the generator	Acquisition of Land; Best Management Practices; Well Field Monitoring; Emergency Response Plan.	1. Prepare Fuel Storage and Inspection Plan. 2. Prepare the Monitoring Plan. 3. Prepare Emergency Response Plan.
2	*High*	Abandoned wells? • The subsurface release of pathogens	Education and Stewardship; County Stewardship.	1. Complete Water Well Survey. 2. Voluntary inspection by County Public Works.
3	*High*	Vacant Lot • Dumping of fuel/chemicals/waste	NSTIR Stewardship; County Stewardship; Signage; Well Field Monitoring.	1. Post Signage. 2. Liaise with NSTIR. 3. Regular inspection by County Public Works. 4. Prepare the Monitoring Plan.
4	*High*	Agriculture • Potential manure and chemical spreading	Education; Best Management Practices; Well Field Monitoring.	1. Education and outreach. 2. Liaise with Nova Scotia Federation of Agriculture and encourage farmers to use existing Terms of Reference for Environmental Farm Plans. 3. Prepare the Monitoring Plan.
5	*High*	Roadway • Transport of fuel/chemicals/waste	Well Field Monitoring; Emergency Response Plan.	1. Post signage. 2. Prepare the Monitoring Plan. 3. Liaise with NSTIR and Bridgetown Fire Department. 4. Prepare Emergency Response Plan.
6	*High*	Woodlot • Pest control for silviculture • Fire suppression chemicals	Education; Best Management Practices; Emergency Response Plan.	1. Research government guidelines for Forest Management Plans. 2. Liaise with NSDNR / Emergency Services. 3. Prepare Emergency Response Plan.

Ordinal	Committee Rank	Land Use and Activities of Primary Concern	Management Strategy	Actions
7	*Medium*	Roadway Salt spreading	Well Field Monitoring.	1. Prepare the Monitoring Plan.
8	*Low*	Residential • Fuel oil tank (900 L) • Lawn care/pest control • New Development	Education; Best Management Practices; Well Field Monitoring.	1. Prepare information package and disseminate.
9	*Low*	Private Organic Disposal Site • The ground surface release of pathogens	Education; Best Management Practices; Well Field Monitoring.	1. Education and outreach. 2. Liaise with Nova Scotia Federation of Agriculture and encourage farmers to use existing Terms of Reference for Environmental Farm Plans. 3. Prepare the Monitoring Plan.
10	*Low*	Mountain Lea • Large fuel oil tank (13,620 L)	Education; Best Management Practices; Well Field Monitoring.	1. Education outreach by County Public Works.
11	*Low*	Animal Boarding / Assisted Living • Fuel oil tank (900 L) • Small on-site sewage disposal system • Lawn care / pest control	Land Acquisition.	1. Relocate / discontinue current land use. 2. Reassess after new land use established.

7.3.1 Chemical storage (e.g., chlorine, fuel for backup generator)

Best Management Practices: BMPs define practical and effective means of protecting source water that can be directly adopted and applied by water utilities. Concerning chemical storage, these may include:

- Limit chemical storage within the 90-day capture zone.
- Employ proper material storage, transport, and handling practices to reduce accidental releases to the environment.
- Make Material Safety Data Sheets (MSDSs) readily available.
- Provide appropriate awareness/preparedness training to operators and handlers.
- Have contingency and emergency response plans in place to address potentials spills.

Emergency Response Planning: MCA will prepare a contingency plan which will assist in response to an event that threatens the water supply. Contact information for emergency response personnel will be included in the contingency plan.

Well Field Monitoring: Well field monitoring can be in various forms, from the simple and relatively economical, such as mailing letters or fact sheets, to comprehensive programs such as training or site visits. This will involve educating municipal operators/maintenance crews about the SWPP and providing training/information on BMPs for chemical handling and storage.

7.3.2 Vacant Lot/Illegal Dumping

Education and Stewardship: Develop educational materials including water protection responsibilities, regulations, contingency plans, and BMPs. Include information on the potential impact of illegal dumping, spills and improper forest management. An education and outreach program would include written materials, community outreach, and special activities.

7.3.3 Agriculture (Pesticides/Herbicides/ Fertilizers and Manure Spreading)

Education and Stewardship:

- Liaise with Nova Scotia Federation of Agriculture and encourage farmers to use existing terms of reference for Environmental Farm Plans
- Review forestry management plan, practices, and policies annually.
- Support/provide awareness training for ACWU staff and other relevant organizations.
- Develop education materials including water protection responsibilities, regulations, contingency plans, and BMPs. Include information on the potential impact of pesticide usage.

Best Management Practices:

- Follow recommendations contained in NS agriculture Manure Management Guidelines and the Environment regulations Handbook for Nova Scotia Agriculture
- Avoid applying fertilizers or manure on frozen or snow-covered ground, excessively wet soils, exposed bedrock, or excessively sloped lands
- Make use of vegetated buffers to reduce herbicides/pesticides runoff
- Make use of natural, biological or organic forms of pest and weed controls where applicable.
- Rotate crops to reduce pest cycle.

7.3.4 Roadways (Transport fuels/ Salt Spreading)

Well Field Monitoring (Best Management Practices):

- Do not use road salt/dust suppression in 2-year WHPA, if it can be safely avoided.
- Do not use road salt on unpaved surfaces.
- Use only dust suppressants that are shown to be non-toxic.
- Provide appropriate application rates, especially within SWPA

- Employ proper material storage and handling practices and equipment selection to reduce accidental releases to the environment.
- If applying road salt, follow Environment Canada's BMPs for salt use on private roads, parking lots and sidewalks.

Emergency Response Planning: ACWU will prepare a contingency plan that will assist in response to an event that threatens the water supply. Emergency response measures and contact information for emergency response personnel will be included in the contingency plan. A top priority is the installation of physical barriers to protect the supply wells. It will also review and update or create incident response procedures for spills/releases on the municipal and surrounding property:

- petroleum hydrocarbon release from vehicles on access roads
- petroleum hydrocarbon release from temporary fuel storage/transport for generator

Education and Stewardship: Education and outreach policies are intended to increase public awareness of the benefits of drinking water source protection and encourage positive changes in behavior. ACWU will provide emergency response plans for petroleum hydrocarbon spills from vehicles and fuel for the backup generator.

7.3.5 Woodlot (Pest Control/Fire suppressants)

Education and Stewardship:

- Review the forestry management plan, practices, and policies annually.
- Assess whether an updated forestry assessment is warranted.
- Support/provide awareness training for the staff and landowners.
- Develop education materials including water protection responsibilities, regulations, contingency plans, and BMPs. Include information on the potential impact of improper forest management.

Best Management Practices: Should cutting occur, the following BMPs should be followed:

- Avoid clear-cutting. If clearing land is required, expose a smallest practical area of land for the shortest possible time.
- Limit the length and steepness of the designated slopes to reduce runoff volumes and velocity and install velocity lowering structures as needed.
- Do not allow camping or accommodation trailers or buildings in the SWPA

Emergency Response Plans: Identify likely forest fire responders (provincial and municipal) and advise them of the presence of the SWPP. Establish and agree upon Fire Response Plan, including fire-fighting protocols and incident response. Identify the avoidance of chemical fire suppressants as a BMP.

7.3.6 Fuel oil tank storage (Residential/ Mountain Lea)

Education and Stewardship: Education and outreach policies are intended to increase public awareness of the benefits of drinking water source protection and encourage positive changes in behavior. This includes:

- Proper signage showing the SWPA.
- Develop education materials including water protection responsibilities, regulations, contingency plans, and BMPs. Include information on the potential impact of improper installation of residential oil tanks or spills.

Best Management Practices

- Follow recommendations contained in the NSE homeowners guide to Heating Oil Tank Systems.
- Tanks must meet national construction standards at a minimum. Used or refurbished tanks have inherent risks and should not be installed.
- Oil tanks should be installed by a trained and experienced professional and by proper codes
- Oil tanks should be regularly inspected for rust, damage, and corrosion by heating service professional
- Immediately clean up any spills with the proper equipment and notify NSE and ACWU

8.0 IMPLEMENTATION PLAN

To bring about the desired level of well head protection, the SWPAC recommended several initiatives. Each one addresses one or more of the prioritized risks identified by the committee using one or more management options deemed most effective. These initiatives, including the individual actions they entail, estimated costs and suggested implementation dates, are listed in Table 5.

The SWPAC anticipates that MCA will elect to complete most of these initiatives with the assistance of the consultants. The costs presented in Table 5 represent the estimated costs of assistance. Where some of the recommended actions appear to be readily incorporated into the tasks usually assigned to ACWU staff, the cost reflects only the portion that would involve a consultant or outside contractor.

Table 5 Action Plan and Implementation Schedule

ACTION	COMPLETION DATE	ESTIMATED COST
1. Monitoring / Contingency / Emergency Response Planning		
(a) Review and update current municipal contingency plans towards the potential for reduction in water quality or quantity.	31-Mar-20	$3,000
(b) Review and update or create incident response procedures for spills/releases (refer to REMO) on the municipal and surrounding property: • petroleum hydrocarbon release from vehicles on access roads • petroleum hydrocarbon release from temporary fuel storage/transport for generator • discharge of chlorine in water treatment building • other spills/releases (e.g., illegal dumping/ private organic disposal) • liaise with Fire Department HAZMAT team	31-Mar-20	$5,000
(c) Prepare a Monitoring Plan to begin confirmatory sampling to ensure that no contaminants flow toward well field.	31-Mar-20	$5,000 to $50,000
(d) Liaise with NSTIR and identify likely forest fire responders to advise them of the presence of the SWPP. Establish and agree upon Fire Response Plan, including fire-fighting protocols and incident response. Identify the avoidance of chemical fire suppressants as a BMP.	31-Mar-20	$2,000
2. Well Head Protection		
(a) Protect Well Heads with bollards or equivalent.	31-Mar-20	$2,500/well

ACTION	COMPLETION DATE	ESTIMATED COST
(b) Post Signage on roadways at Entry and Exit to Source Water Area; post signage on abandoned NSTIR property.	31-Mar-20	$500/sign
(c) Complete Water Well Survey to check for abandoned wells and voluntary inspection by Bridgetown Utility	31-Mar-20	$7,000
(d) Inspect municipal wellheads and surrounding areas.	Monthly	Utility
(e) Relocate animal boarding facility.	31-Mar-19	County
(f) Review water supply quality and chemistry data annually to identify trends and concerns, if any, as part of the annual report to NSE.	Annually	$3,000/year
3. Education and Stewardship to Promote Best Management Practices		
(a) Educate Municipal operators/maintenance crews about SWPP. Provide training/reference information on: · BMPs for road salting · BMPs for dust suppression · BMPs for chlorine handling and storage · Emergency response plans for petroleum hydrocarbon spills from vehicles, fuel for the backup generator, or chlorine release.	31-Mar-21	$1,000
(b) Liaise with Nova Scotia Federation of Agriculture and encourage farmers to use existing Terms of Reference for Environmental Farm Plans.	31-Mar-21	$2,000 to $10,000
(c) Liaise with Nova Scotia Department of Natural Resources and review Forestry Management Plan, practices and policies annually.	Annually	$1,000/year
(d) Develop educational materials including BMPs for domestic septic systems and oil tanks. Include information on the potential impact of illegal dumping, organic disposal, lawn care/pest control, and spills.	31-Mar-23	$10,000
(e) Distribute educational materials to residents through various media.	31-Mar-24	County / Utility

9.0 MONITORING PLAN

9.1 Purpose

The purpose of the monitoring plan is to ensure that:

- The SWPP is regularly updated, and that it is meeting its objectives.
- Changes in the state of groundwater within the SWPA are evaluated.
- The SWPP remains current with changing conditions and priorities in the SWPA.

9.2 Ground Water Monitoring Parameters and Schedule

In coordination with the regulatory compliance monitoring required under Bridgetown's Approval to Operate and Approval to Withdraw water, a groundwater monitoring program will be implemented. The groundwater monitoring program considers the potential contaminants that were identified in Section 6.0. The monitoring schedule is outlined in Table 7, below.

Table 6 Source Water Protected Area Monitoring Parameters

Parameter	**Location**		
	Water Supply Well 1	Water Supply Well 3	Water Supply Well 4 (Not in operation until Dec 31, 2018)
Turbidity	Weekly	Weekly	Weekly
Chlorine residual	Weekly or continuous	Weekly or continuous	Weekly or continuous
pH (field)	Daily grab or continuous	Daily grab or continuous	Daily grab or continuous
Total Coliform and E. coli	weekly	weekly	weekly
Fluoride	Every two years	Every two years	Every two years
Arsenic, Antimony, Lead	Every 2 years	Every 2 years	Every 2 years
Total Trihalomethanes	Quarterly	Quarterly	Quarterly
Haloacetic acids	Quarterly	Quarterly	Quarterly
Volatile Organic Compounds	Every five years	Every five years	Every five years
Uranium, Pesticides, Herbicides	Annual	Annual	Annual

Recognized and established protocols for water quality sampling will be followed for all sampling programs and will be conducted by qualified personnel. Baseline data is available for many of

the testing parameters and will be used as a comparison over time to identify changes in the raw water quality.

9.3 Source Water Protection Zone Inspection

MCA will regularly (assumed at least monthly) visually inspect the well heads and complete the windshield survey of SWPA. On a minimum annual basis, the MCA will meet with SWPAC to identify any new or changing land uses or activities within the SWPA that may impact source water quality. Every 3 to 5 years, or more frequently if a concern is identified, MCA will complete a detailed survey of the properties and landowners within the SWPA.

Visual inspections and surveys, in addition to regular discussions with property owners, will assist in:

- assessing whether BMPs are being followed
- determining if additional educational efforts are required
- identifying problems that are not being adequately addressed and
- identifying activities that violate bylaws or regulations that have been put in place to protect water quality

9.4 Monitoring Records and Reporting

The ACWU will maintain records of ongoing monitoring, analyze results, document trends and changes in water quality, and report findings annually to the SWPAC and NSE.

9.5 Plan Review and Update

The SWPAC will review the SWPP annually and will update if necessary. Information gathered during the groundwater sampling, monitoring program, and the SWPA inspections will be considered during the plan review process. The review will include:

- analysis of monitoring results to evaluate the effectiveness of management options
- identification of any changes to risks in the area (including potential impacts from climate change)
- review of Action Plan and updating of action items completed over the year, adding new action items, as needed, and
- consideration of new legislation

10.0 TIMELINE & TARGETS

DATES	MEETINGS/ ACTVITIES	DETAILS
January 2010	Bridgetown capture zone modeling	Developed a groundwater flow model for delineation of SWPA and TOT
October and December 2016	Well 4 - Field exploration site	TW5 (Test Well) and TW6 drilled
October 5, 2017	SWPAC Meeting	Appointment and Election of the chair; overview of TOR
October 26, 2017	Tour of SWPA	
November 30, 2017	SWPAC Meeting	Hazard identification- activities within SWPA
January 4, 2017		Prioritized risks and discussed new site
February 1, 2018		Tabulated management options and passed a motion to add Well 4 site into the existing plan
April 5, 2018		Reviewed risk table and management options
April 19, 2018		Reviewed management strategies and action items
April 09, 2018		Revised draft action plan
May 3, 2018		Discussed visual panels and potential sources of contaminants for Well 4 Field site
September 4, 2018		Finalized landowners' letter and panels for the Landowners meeting
September 10, 2018	Landowners Meeting	
October 2, 2018	Review Panels for public meeting and review of Draft SWPP	
October 22, 2018	Public Meeting 1	
November 6, 2018	SWPAC Meeting	Reviewed public meeting comments and draft SWPP
November 22, 2018	SWPAC Meeting	Passed motion to present the draft plan v3 to COTW on Dec 11, 2018

References

- CBCL Limited. (2010). *Bridgetown Capture Zone Modelling: Technical Report.* Bridgetown: Terry w. Henninger Water Consulting.
- CBCL Limited. (2013). *Town of Bridgetown Water Utility System Assessment Report.* Town of Bridgetown: CBCL.
- CBCL Limited. (2016, March 1). Well Field Assessment - Summary and Recommendations. Bridgetown, Nova Scotia, Canada.
- CBCL Limited. (2017, January 09). Aquifer Testing Results- Bridgetown Well Field Development. Bridgetown, NS.
- CBCL Limited. (2018). *Bridgetown Water Supply: Water Withdrawl Application.*
- Nova Scotia Environment. (2002). *A Drinking Water Strategy for Nova Scotia: A Comprehensive Approach to the Management of Drinking Water*.
- Nova Scotia Environment. (2004). Developing a Municipal Source Water Protection Plan: A Guide for Water Utilities and Municipalities. Nova Scotia, Canada.
- Nova Scotia Environment. (2005). Best Management Practices/Forest Planning in Municipal Drinking Water Supply.

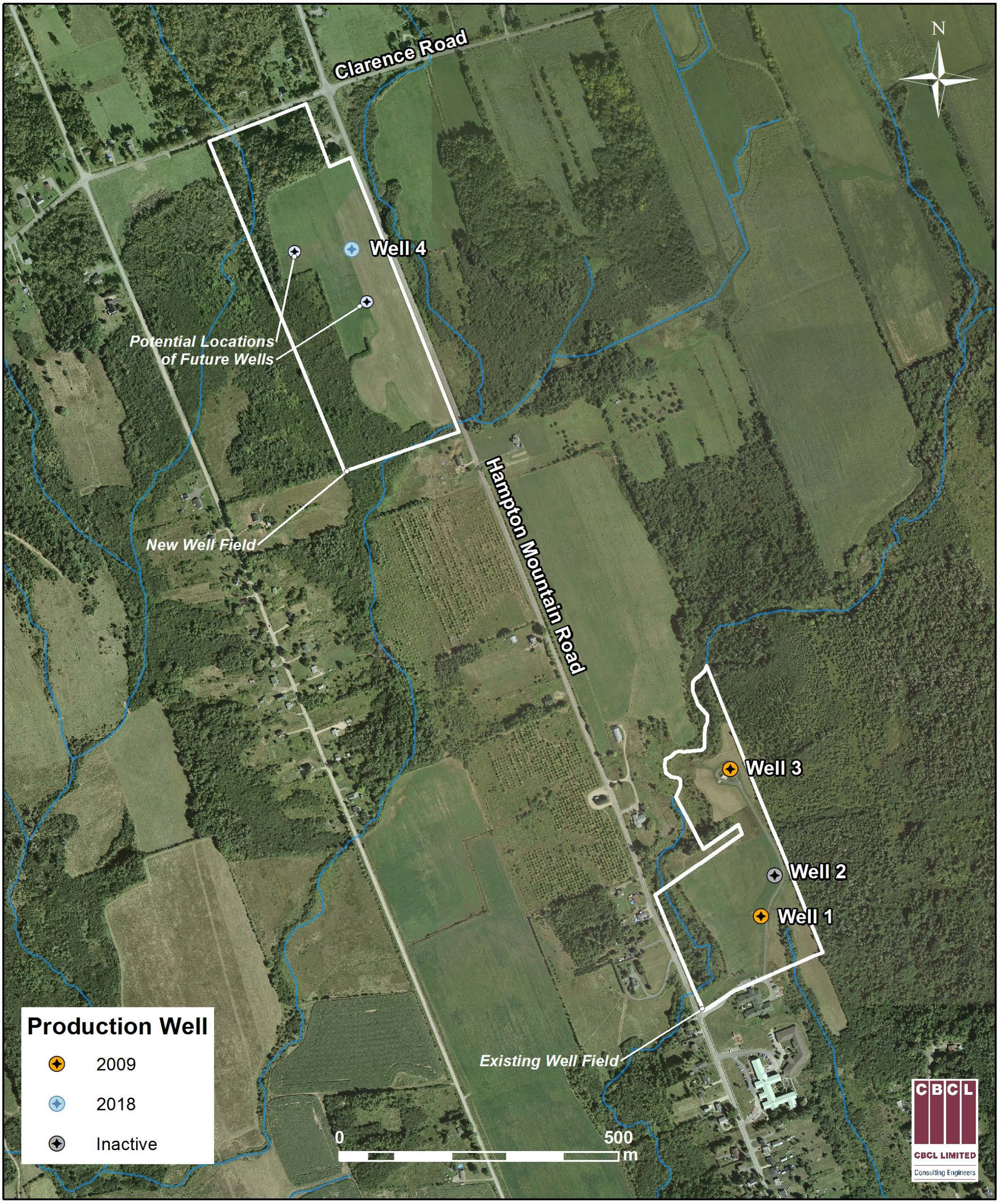

Figure 1 Location of the Bridgetown Well field

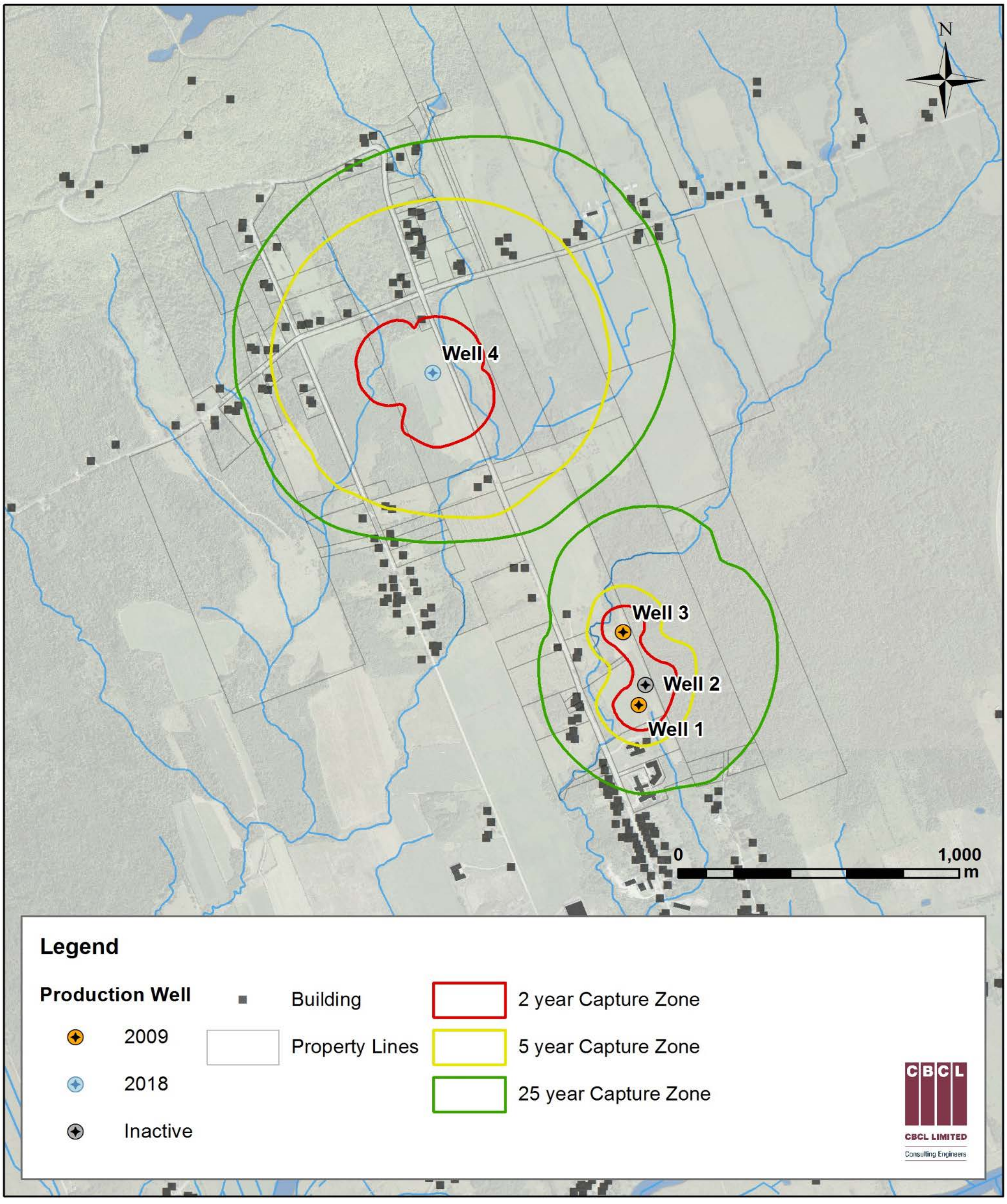

Figure 2 Well Head Protection Area of the Bridgetown Well Field

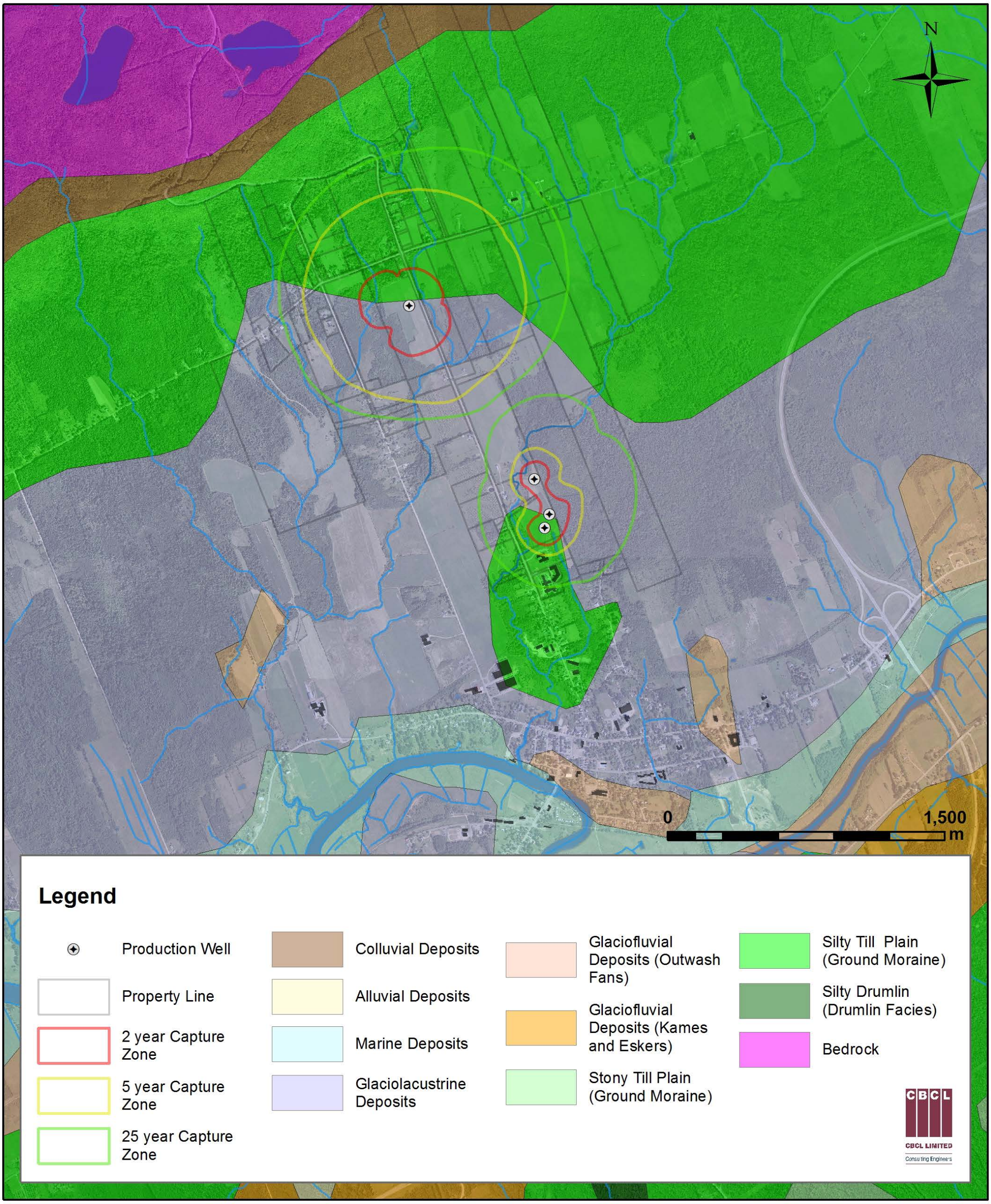

Figure 3 Surficial Geology of the Well Field

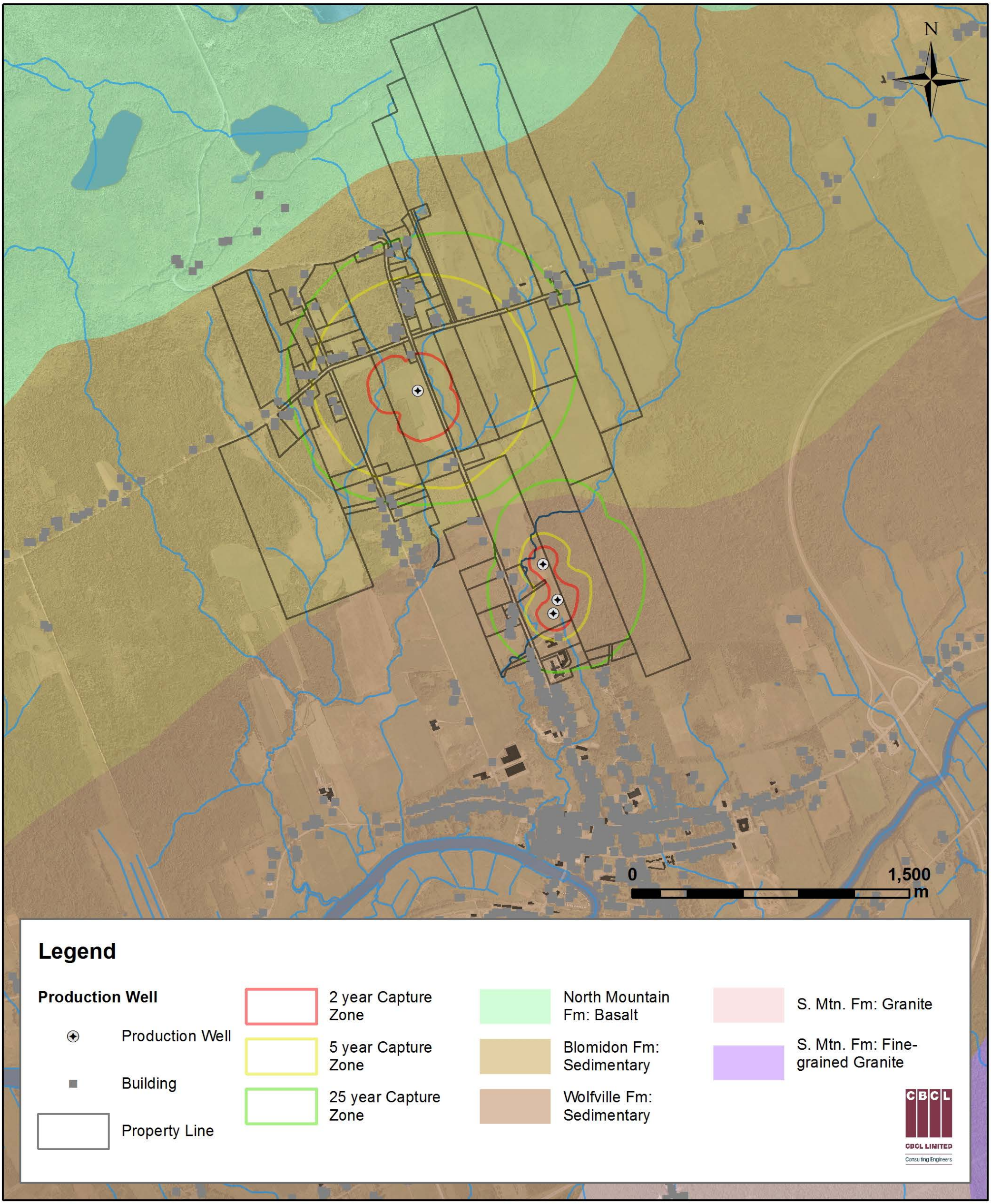

Figure 4 Bedrock Geology of the Well Field

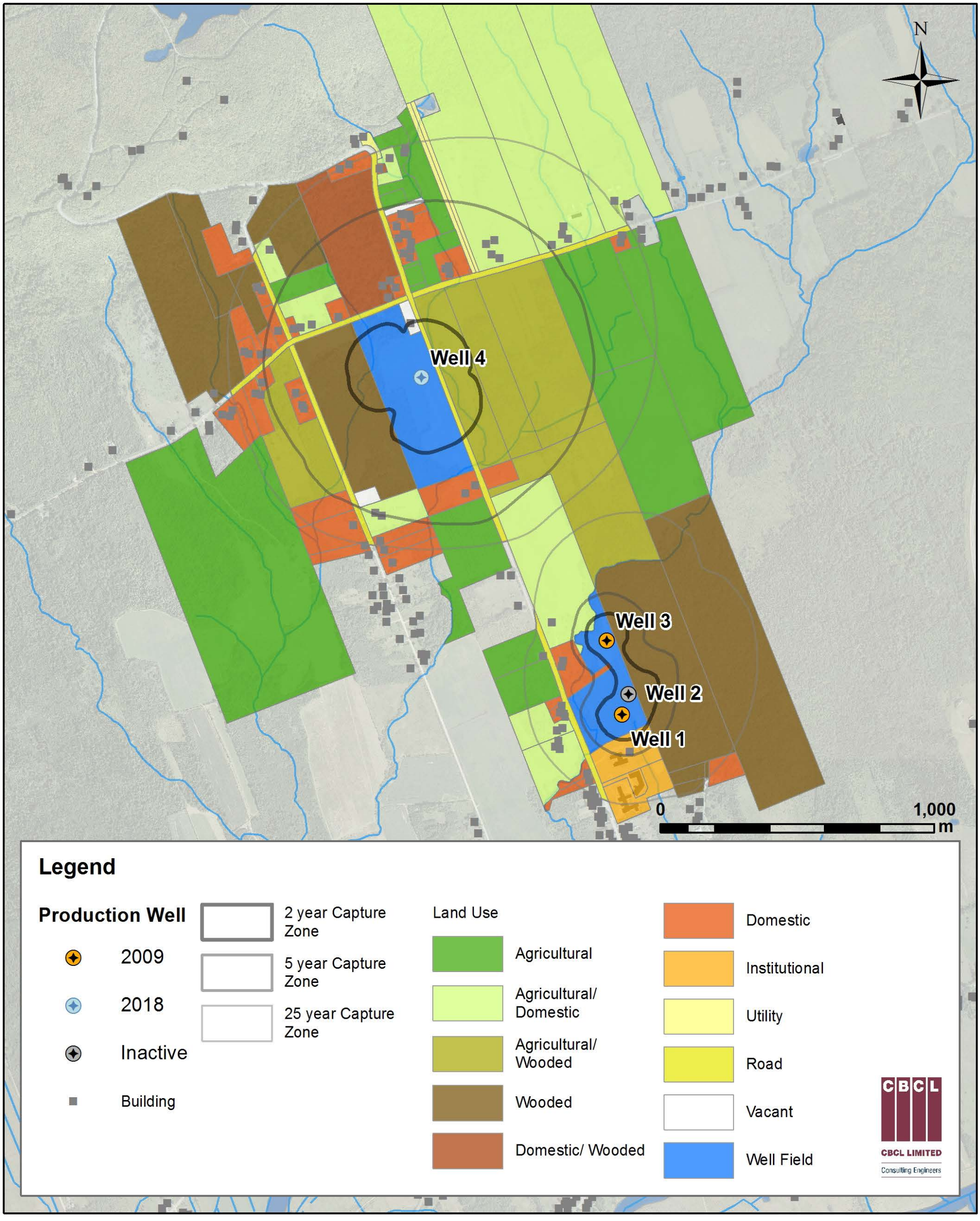

Figure 5 Land Use in the Well Head Protection Area

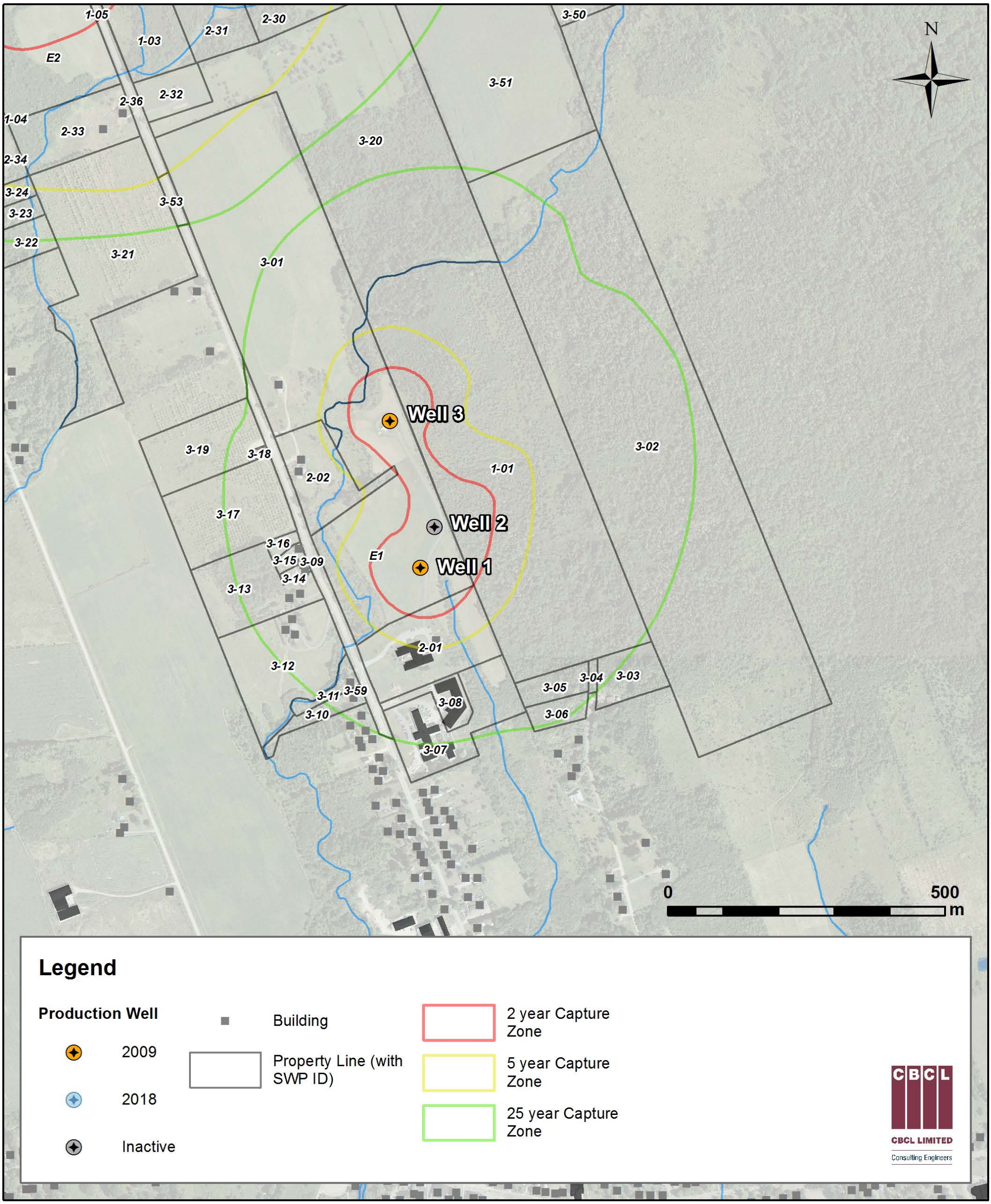

Figure 6 Property Ownership around Well 1, 2 and 3

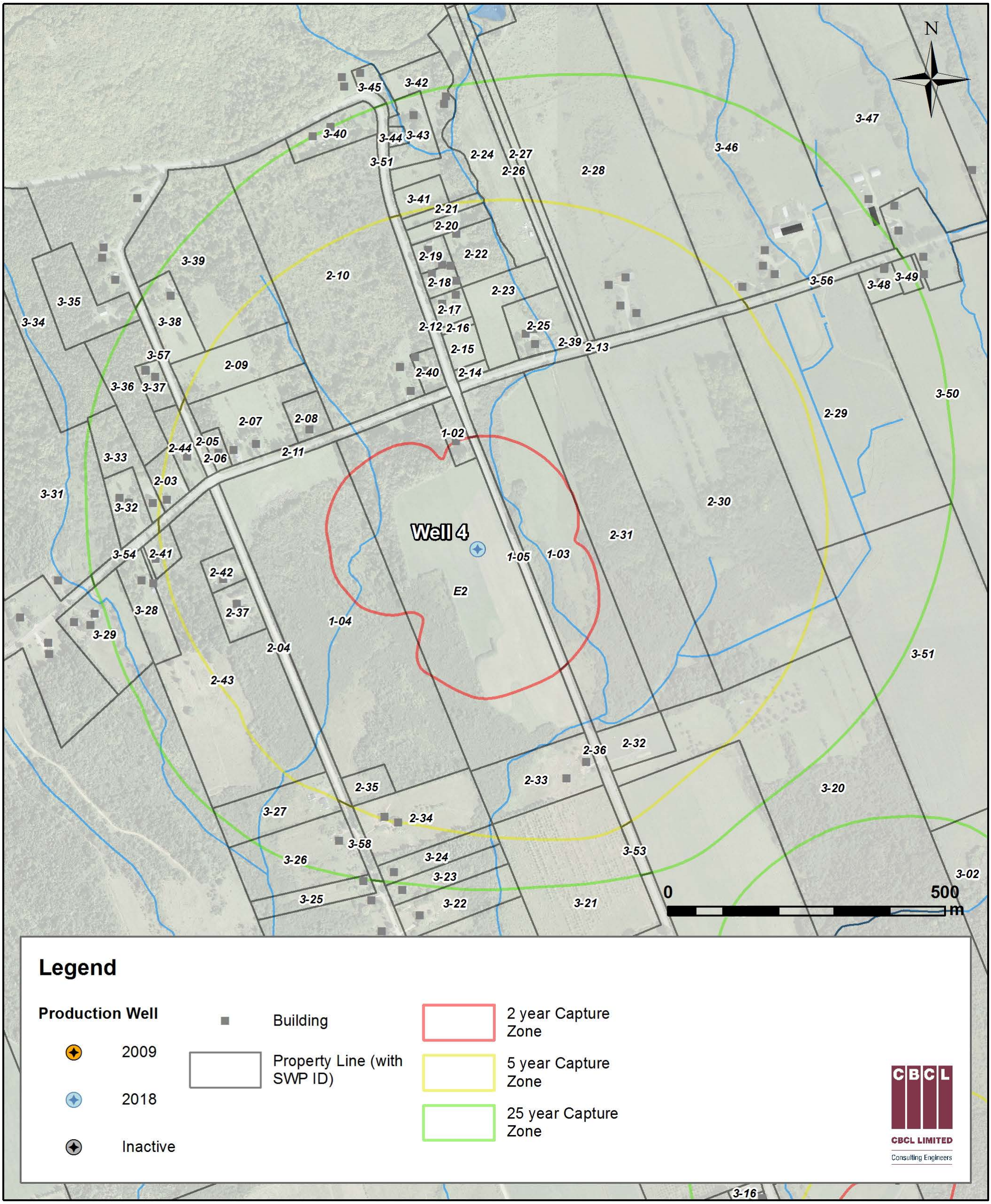

Figure 7 Property Ownership around Well 4

APPENDIX A: SUMMARY TO THE WELL FIELD SITE

The town of Bridgetown has been actively working on its water supply system since 2001. Following the introduction of treatment standards for municipal water systems by the Nova Scotia Environment in 2003, a system assessment report was completed by CBCL in 2004, and as an alternative to constructing a surface water treatment plant to comply with the NSE requirements, the council decided to pursue the groundwater option. Three test wells were constructed: Well 1, 2 and 3 were drilled to a depth of 91.5 m. In June 2007, uranium concentrations at Well 2 exceeded the Maximum Acceptable Concentration (MAC) of 20 µg/L. Elevated uranium concentrations led to an investigation of uranium removal technologies and costs.

Well 2 was pumped at a lower rate to minimize the effects of elevated uranium concentrations on the blended water supply. As Well 2 had a strong influence on uranium concentrations and provided a relatively low proportion of required demands, the well was taken out of production. The source of uranium in the study area is believed to be connected to the plutonic rock of the south mountain batholith, which was later incorporated into the Triassic material of Valley. Test Well, TW4 was sited adjacent to Well 1 to replicate its performance. Efforts to develop Well 4 at this location were abandoned in August 2016 after water quality samples showed concentrations of uranium were 19 to 41 µg/L (shown in Figure 2). A new test drilling site was selected, 1.2 km to the north of the existing well field and Well 4 was drilled on this new site on October 11, 2016. Selected sites seek to optimize well yield and water quality while minimizing the costs of transmission. The sites were furthermore selected to avoid potential sources of contamination, including urban infrastructure and surface water features. Well 4, will be tied into a force main on the adjacent Hampton Mountain Road, which will convey the water to the reservoir at the foot of North Mountain.

APPENDIX B: SOURCE WATER PROTECTION ADVISORY COMMITTEE

Chairperson – Horace Hurlburt

Vice Chairperson – Karen Jones

Councilor – Wayne Fowler

Councilor – Timothy Habinski

Citizen Member – Nancy McGrath

Citizen Member – Andrew Gilmour

NS Environment, Watershed Planner – Dawn MacNeill

CBCL Consultant – Colin Walker

Director of Municipal Operations, MCA – Stephen McInnis

Other Contacts

Greg Price, Manager of Municipal Operations, MCA

Shivani Gilhotra, Engineering Student Intern, MCA

APPENDIX C: TERMS OF REFERENCE

Bridgetown- Municipality of the County of Annapolis, Nova Scotia Source Water Protection Advisory Committee

1. Introduction

Provision of adequate and safe water supply to consumers is the top priority for the Province and the Municipality of the County of Annapolis. This is achieved through a multiple-barrier approach - a series of steps which together provide multiple layers of protection to ensure that safe water is delivered to the consumer in Nova Scotia the barriers defined in the Drinking Water Strategy are as follows:

- Keeping it Clean - ensure the water source is protected from contamination
- Making it Safe - provide the required treatment
- Proving it Safe - continuous testing and monitoring

Bridgetown is located within Districts 43 & 7 of the Municipality of the County of Annapolis (hereinafter referred to as the County). The community has a population of approximately 949 residents (2016 Census), and the wellhead protection area is approximately 170 acres. The community currently has a complete program of water treatment, testing and monitoring in full compliance with provincial and federal regulations to provide a finished product which meets or exceeds the Guidelines for Canadian Drinking Water Quality as published by Health Canada.

To satisfy the requirements of the multiple barriers approaches the community must develop a Source Water Protection Plan to ensure the source water remains clean. Nova Scotia Environment has clearly defined the steps in developing a Source Water Protection Plan, the first being the establishment of a Source Water Protection Advisory Committee. Before the establishment of the committee, a Terms of Reference must be developed. The purpose of the Terms of Reference is to define:

- the mandate of the committee;
- the composition;
- the roles and responsibilities of committee members;
- reporting hierarchy and operation; and
- Length of the term.
- The subsequent sections will detail the aforementioned.

2. Mandate

The Source Water Protection Advisory Committee hereinafter referred to as the Committee, is tasked with developing a source water protection plan and providing the Municipality of the County of Annapolis with direction on land use issues, water quality, levels and flows within the catchment area. This will include addressing issues such as:

a. Identification of stakeholders;
b. Water quantity and quality concerns;
c. Actual and potential sources of contamination;
d. Management strategies; and
e. The effectiveness of the Source Water Protection Plan.

In achieving their mandate, the Committee will undertake the following tasks:

i. review all activities within the catchment area and provide recommendations to the County;
ii. provide recommendations to the County on the development of land use by-laws to ensure the continued protection of the source water protection area;
iii. review all pertinent information and reports relating to water quality and quantity;
iv. liaise with government departments and agencies on all issues related to the source water protection area;
v. draft the SWP and recommend to Council; and
vi. Administer the development of education programs and best management practices for residents, stakeholders and other users with the source water protection area.

3. The composition of the Committee

The structure of the Committee must represent all members of the community. In achieving this, the first step is to identify stakeholders. For Bridgetown, the suggested composition of the Committee would include:

Voting Members

- Councilor
- Business member
- Resident/landowner
- Agriculture

Non-Voting Members

- County Director of Municipal Operations
- County Director of Community Services
- NS Environment member
- Consultant

4. Roles and Responsibilities

To develop and maintain an active committee, the roles and responsibilities must be clearly defined and agreed upon.

Voting Members

Councilor: It is the responsibility of the Councilor to represent the interests of the stakeholders served by the protection area

Business: Member will represent the interests of local business owners and their specific water quality/quantity concerns and needs. Member will also report on the number and nature of businesses within the protection area.

Residents/Land Owners: Residents and landowners represent the end-users of the water supply system and provide fundamental insight into any issues relating to day-to-day and seasonal issues that may be encountered. Additionally, these members will provide information on land use practices within the protection area that may impact water quality and quantity.

Agriculture: Represent agricultural members within the protection area and ensure that they are informed of any issues relating to farming and water protection. Additionally, the member is to notify the committee of agricultural activities occurring within the protection area.

Non-Voting Members

Municipal Staff (Public Works, Planning): Municipal staff will work with the Committee providing information and advising on topics relating to source water protection, watershed management, land use and the operation of the water treatment and distribution procedures and infrastructure. Staff will bring forth concerns relating to water quality and watershed management.

Nova Scotia Environment (NSE): NSE provides information and advice on topics related to source water protection and regulations.

Consultant: The Consultant will provide technical input as required.

5. Deliverables

The Committee will oversee the preparation and review of the following deliverables:

- Protection area boundary description and map
- Identification of contaminants and associated risks
- Source water management plan
- Implementation of the monitoring program
- Committee close-out report – at which point monitoring and SWPP updates will be completed by the Water Utility operators

6. Hierarchy and Operation

- The committee will appoint a Chair and Vice-Chair annually.
- The positions will be re-offered in the fourth quarter of each year.
- The Chair and Vice-Chair must be voting members.
- The Chair will be the spokesperson for the committee.
- The committee will strive to make decisions on a consensus-based approach whenever possible.
- The committee will meet as required and no less than once per year.
- The committee will prepare an annual report.
- The Terms of Reference may be modified by the County.

7. Term

There is no restriction on the number of years that a member may fulfill a role on the Committee. The Chair and Vice-Chair will serve a minimum of one year before the positions are re-offered.

APPENDIX D: RISK INDEX CALCULATIONS

Contaminant Mobility: Threats to source water are based more specifically on the behavior of each potential contaminant in groundwater. Some contaminants travel freely in groundwater, whereas others are slowed down or destroyed. Table D1 shows indices for contaminant mobility. Which break down quickly or are blocked by the aquifer material show poor mobility and are a threat only over shorter travel time. Materials which travel freely through aquifer material can be problematic over much longer travel times and distances.

Table D- 1 Mobility Index

Mobility Index	Description	Comment
2	Extremely low	Substance reacts rapidly in the environment setting
4	Low	Substance degrades readily or is filtered by aquifer material
5	Moderate	The substance is moderately attenuated by aquifer material
6	High	Substance moves at groundwater velocity

*Mobility index +1 for downhole/ subsurface release

PWA Zone: Source, water protection zones, are created based on the time of groundwater travel to the well. The well is at highest risk where travel times are short, closest to the well. Contaminants that are slowed down or rapidly degraded may reach the well if the travel time is minimal. Table D2 provides an index based on PWA zones. As contaminant mobility and travel time are directly related, the combined risk of these factors for a given property can be accounted for by subtracting the Mobility Index from the PWA zone index.

Table D- 2 Zone Index

Zone Index	Risk-based on proximity to wells	Comment
0	Very high	Wellfield/ exclusion zone
1	High	Properties intersecting 2 year time of travel
2	Moderate	Properties intersecting 5 year time of travel
3	Low	Properties intersecting 25 year time of travel

Human Toxicity: Potential contaminants pose varying levels of a threat when consumed in drinking water. Whereas some objectives are aesthetic, others may pose chronic or acute toxicity. An index relating to toxicity is shown in Table D3.

Table D- 3 Human Toxicity Index

Human Toxicity Index	Description	Comment
1	Low	Aesthetic/ nuisance concern
2	Moderate	Health-related parameter with chronic toxicity
3	High	Acute or short-term chronic toxicity

Risk Index: A composite Risk Index may be obtained as follows:

Risk Index = (Mobility Index - PWA Index) x (Human Toxicity Index)

As institutional land uses tend to produce greater volumes of sewage and require greater volumes of fuel to be stored on-site, the Risk Index is increased by 1.

Institutional Risk Index = (Mobility Index - PWA Index) x (Human Toxicity Index) + 1

Table B4 shows the Risk Index as calculated for potential contaminants that could be encountered in the Bridgetown PWA and Table B5 provides qualitative priority rankings based on the Risk Index.

Table D- 4 Summary of risk index calculations

Contaminant	Mobility Index	Zone Index	Human Toxicity Index	Risk Index	
				Low Volume Source[1]	High Volume Source[2]
Pathogens	4	1	3	9	10
	4	2	3	6	7
	4	3	3	3	4
Nitrate	6	1	1	5	6
	6	2	1	4	5
	6	3	1	3	4
Petroleum Hydrocarbons	5	1	2	8	9
	5	2	2	6	7
	5	3	2	4	5
Organochlorines	5	1	2	8	N/A
	5	2	2	6	
	5	3	2	4	
Heavy Metals	5	1	3	12	
	5	2	3	9	
	5	3	3	6	
Salt	6	1	1	5	
	6	2	1	4	
	6	3	1	3	
Fire Suppression Chemicals	5	1	2	8	
	5	2	2	6	
	5	3	2	4	
Liquid Chlorine	2	1	3	3	
	2	2	3	0	
	2	3	3	-3	

[1]Risk Index = (Mobility index – zone index) * human toxicity index

[2]Risk index = (Mobility – zone index) * Human toxicity index +1

N.B: All calculations assume material is released / spilled on ground surface

Table D- 5 Risk Index Calculations

Risk Index	Description
>7	High
5- 7	Medium
<5	Low

Table D- 6 Determination of risk index and risk rank for properties within WHPA

Land Use	Zone	Potential Contaminant Sources	Contaminant	Mobility Index	Zone Index	Human Toxicity Index	Calculated Risk Index[1]		Risk Rank
Well Control Building	Exclusion	Stand-by Fuel for Generator	Petroleum Hydrocarbons	5	0	2	**10**	10	High
		Liquid Chlorine for Disinfection	Excess Residual Free Chlorine	2	0	3	6		
Treatment Building & Reservoir	3	Stand-by Fuel for Generator	Petroleum Hydrocarbons	5	3	2	**4**	4	Low
		Liquid Chlorine for Disinfection	Excess Residual Free Chlorine	2	3	3	-3		
Any	2	Abandoned Well	Pathogens	5	2	3	**9**	9	High
	3	Abandoned Well	Pathogens	5	3	3	**6**	6	Medium
Mountain Lea[2] Senior's Centre	3	On-Site Sewage Disposal	Pathogens	4	3	3	4	5	Medium
			Nitrate	6	3	1	4		
		Fuel Oil	Petroleum Hydrocarbons	5	3	2	**5**		
Agriculture	1	Manure	Pathogens	4	1	3	**9**	9	High
			Nitrate	6	1	1	5		
		Pesticides, Herbicides, Fungicides	Organochlorines	5	1	2	8		
	2	Manure	Pathogens	4	2	3	**6**	6	Medium
			Nitrate	6	2	1	4		
		Pesticides, Herbicides, Fungicides	Organochlorines	5	2	2	**6**		
	3	Manure	Pathogens	4	3	3	3	4	Low
			Nitrate	6	3	1	3		
		Pesticides, Herbicides, Fungicides	Organochlorines	5	3	2	**4**		
Residential	2	On-Site Sewage Disposal	Pathogens	4	2	3	**6**	6	Medium

Land Use	Zone	Potential Contaminant Sources	Contaminant	Mobility Index	Zone Index	Human Toxicity Index	Calculated Risk Index[1]		Risk Rank
			Nitrate	6	2	1	4		
		Fuel Oil	Petroleum Hydrocarbons	5	2	2	**6**		
		Lawn Care	Organochlorines	5	2	2	**6**		
		Pest Control	Heavy Metals	5	2	2	**6**		
	3	On-Site Sewage Disposal	Pathogens	4	3	3	3	4	Low
			Nitrate	6	3	1	3		
		Fuel Oil	Petroleum Hydrocarbons	5	3	2	**4**		
		Lawn Care	Organochlorines	5	3	2	**4**		
		Pest Control	Heavy Metals	5	3	2	**4**		
Road	1	Salt Spreading	Salt	6	1	1	3	9	High
		Transport of Fuel / Chemicals / Waste	Petroleum Hydrocarbons	5	1	2	8		
			Industrial Chemicals	5	1	2	8		
			Sewage	4	1	3	**9**		
	2	Salt Spreading	Salt	6	2	1	3	6	Medium
		Transport of Fuel / Chemicals / Waste	Petroleum Hydrocarbons	5	2	2	**6**		
			Industrial Chemicals	5	2	2	**6**		
			Sewage	4	2	3	**6**		
	3	Salt Spreading	Salt	6	3	1	3	4	Low
		Transport of Fuel / Chemicals / Waste	Petroleum Hydrocarbons	5	3	2	**4**		
			Industrial Chemicals	5	3	2	**4**		
			Sewage	4	3	3	3		
Vacant Lot	1	Dumping on Ground Surface / Ditch	Petroleum Hydrocarbons	5	1	2	8	9	High
			Industrial Chemicals	5	1	2	8		
			Organochlorines	5	1	2	8		
			Heavy Metals	5	1	2	8		
			Pathogens	4	1	3	**9**		

Land Use	Zone	Potential Contaminant Sources	Contaminant	Mobility Index	Zone Index	Human Toxicity Index	Calculated Risk Index[1]		Risk Rank
	2		Petroleum Hydrocarbons	5	2	2	**6**	6	Medium
			Industrial Chemicals	5	2	2	**6**		
			Organochlorines	5	2	2	**6**		
			Heavy Metals	5	2	2	**6**		
			Pathogens	4	2	3	**6**		
	1		Petroleum Hydrocarbons	6	1	2	10	12	High
			Industrial Chemicals	6	1	2	10		
			Organochlorines	6	1	2	10		
			Heavy Metals	6	1	2	10		
Abandoned Wells		Downhole Waste Disposal	Pathogens	5	1	3	**12**		
	2		Petroleum Hydrocarbons	6	2	2	8	9	High
			Industrial Chemicals	6	2	2	8		
			Organochlorines	6	2	2	8		
			Heavy Metals	6	2	2	8		
			Pathogens	5	2	3	**9**		
	3		Petroleum Hydrocarbons	6	3	2	**6**	6	Medium
			Industrial Chemicals	6	3	2	**6**		
			Organochlorines	6	3	2	**6**		
			Heavy Metals	6	3	2	**6**		
			Pathogens	5	3	3	**6**		
Wood Lot	1	Silviculture	Organochlorines	5	1	2	**8**	8	High
		Forest Fire / Fire Suppression Chemicals	PFCs	5	1	2	**8**		
	2	Silviculture	Organochlorines	5	2	2	**6**	6	Medium
		Forest Fire / Fire Suppression Chemicals	[3]PFOS	5	2	2	**6**		

Land Use	Zone	Potential Contaminant Sources	Contaminant	Mobility Index	Zone Index	Human Toxicity Index	Calculated Risk Index[1]		Risk Rank
	3	Silviculture	Organochlorines	5	3	2	**4**	4	Low
		Forest Fire / Fire Suppression Chemicals	[3]PFOS	5	3	2	**4**		

APPENDIX E: PUBLIC MEETING COMMENTS

The following provides a summary of the comments and concerns that were received by Landowners and public in the two meetings:

Landowners Meeting (September 10, 2018)

- The change in the use and maintenance of septic systems - Normal use and proper maintenance (periodic removal of sludge) should not introduce any new requirements for landowners.
- How does the plan address overland flow from a property outside and into the WHPA? - vertical flow paths, the 20 ft thick silty unit in the area discussed in Chapter 5 and Appendix A
- The basis of Capture zones: Historical use of agricultural chemicals, the attenuation of varying contaminant types, and the samples collected as part of aquifer testing.
- Several landowners were worried about property values declining - Planners have noted that in Protected Water Areas land values tend to remain even or improve, due to the promise of high-quality land and groundwater provided by protective measures.

Public Meeting (October 22, 2018)

- Main concerns and questions were on quality of drinking water, cost of development and history of the well field and how it will affect the water rates.
- Long term results of the new well field i.e., Well 4
- Enforcement of carcass disposal by the regulatory authority