Water Resource Considerations in Small Point-Broad Cove-Blackhead-Adam’s Cove

An Assessment Report to Address Water Supply and Security Concerns Towards Climate Change Adaptation Planning for a Rural Community in Newfoundland and Labrador

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Important Notice

The following report was prepared exclusively for the municipal council of the town of Small Point-Broad Cove-Blackhead-Adam's Cove, Newfoundland by Matthew Schumacher. The quality of information, conclusions and estimates contained herein is consistent with the level of effort involved with evaluating the current water supply conditions in the community of Small Point-Broad Cove-Blackhead-Adam's Cove, NL at the time of assessment and based on: i) information available at the time of preparation, ii) data acquired from external sources and iii) the assumptions, conditions and qualifications set forth in this report. This report is intended to be used by the municipal Council for Small Point-Broad Cove-Blackhead-Adam's Cove to assist in any decision-making processes, policy development and for the benefit of their residents or towards any Climate Change Adaption Planning (CCAP). This report only provides an assessment of the current hydrological conditions in Small Point-Broad Cove-Blackhead-Adam's Cove at the time of study. There was no scientific study or investigations conducted to quantify or characterize the natural hydrological or hydrogeological conditions and any use of, or reliance on, this report by any third party is at that party's sole risk.

Executive Summary

In gathering data as part of a project investigating the potential impact of climate change on rural infrastructure and exploring the feasibility of conducting a Ph.D. project that would research water security, Matthew Schumacher visited the community of Small Point-Broad Cove-Blackhead-Adam's Cove in the summer of 2020. Through community engagement, a method used to involve residents in the study and to address local concerns, there were several discussions that expressed worry over the availability to have clean, drinkable water to meet current and future needs of residents.

Based on the feedback, Mr. Schumacher took this information to initiate a doctoral project through Memorial University that would examine water security in rural communities as part of Climate Change Adaption Planning (CCAP). After much consideration, the council for Small Point-Broad Cove-Blackhead-Adam's Cove approached Mr. Schumacher and enlist his services to address the concerns surround their water resources to assist in his data collection but also as an exercise to assess their current water supply situation. From August 2-13, 2021 Mr. Schumacher surveyed, explored and engaged the community to assess the town on matters relating to supplying residents with potable water. This evaluation included the documentation of local wells, reviewing the municipal water supply system, exploring the natural setting, and communicating with local residents.

This report explores how current and projected demographic trends, climate and water usage, along with local geologic conditions, to address the water demands to help Small Point-Broad Cove-Blackhead-Adam's Cove grow. However, it needs to be noted that this review is an assessment only, based on currently freely available data and general observation. A more thorough and complete study involving scientific research, by recognized experts, is needed and required to provide a complete and proper understanding of all the forces at play affecting a community's water supply.

Acknowledgments

Mr. Schumacher first came to the community as part of a research project investigating the effects of climate change on rural infrastructure that was initiated by Dr. Joseph Daraio, Professor in the Department of Engineering at Memorial University of Newfoundland, and through funding from the Harris Centre from their Thriving Regions Applied Research Fund. This assessment report would likely never have happened without this infrastructure project being created, therefore, appreciation and gratitude towards Dr. Daraio and the Harris Centre is warranted for addressing the climate change adaption needs of rural communities in Newfoundland and Labrador.

Mr. Schumacher would also like to acknowledge the welcoming and generous nature of the residents, Council, and staff of Small Point-Broad Cove-Blackhead-Adam's Cove. Upon visiting their community, he and his family were treated hospitably, received warmly, and had a wonderful time thanks to the gestures welcoming them to the community. The helpful assistance of staff and council to gather information made the assessment much easier to perform and recognition for this deserved.

Lastly, the support, and encouragement provided from Susan Rose cannot be understated. As a councillor for of Small Point-Broad Cove-Blackhead-Adam's Cove her concern about climate change and the future well-being of her community provided the spark that initiated this project. Her assistance was of tremendous importance in providing access and information of the town. Simply put, without her leadership and concerns about water resources within her community, this study addressing water security for the town may never have happened.

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1. Introduction

Canada is blessed with an abundance of fresh water; however, the management of potable water resources is, or is becoming, challenging for rural communities in the country, therefore, undertaking exercises to identify and address these concerns are ever more important (Vodden, 2020[1]), particularly with the threat of climate change looming. The province of Newfoundland and Labrador (NL) is expected to become warmer and wetter throughout the year from climate change (Finnis & Daraio, 2018[2]). The full impact of these future alterations on currently understood weather patterns is unknown, nor how resilient current infrastructure, including water supply systems, will be to these changes (Amponsah et al., 2019[3]).

Safeguarding a community's water resources from changes to its supply, quality, and hazards, while protecting the natural environmental systems that provide drinkable water, defines the concept of water security[4]. Water supply systems typically fall under the jurisdiction of municipal bodies, under the direction of provincial and federal legislation, leaving it to local governments to address water security concerns for their communities while also providing direction on climate change planning. Water security has become an emerging issue that can only be addressed at the community level and will require new innovative and strategic methods to tackle the expected increased and complex stresses on future supplies of potable water, especially in rural communities[5].

The town of Small Point-Broad Cove-Blackhead-Adam's Cove (SP-BC-BH-AC), a settlement located in the Baccalieu trail region on the Avalon peninsula in NL (Figure 1; Appendix A), is a small, rural community that is looking to proactively address their water security concerns. The council of SP-BC-BH-AC approached Matthew Schumacher, an environmental professional who visited their town as part of a research project with Memorial University of Newfoundland and Labrador (MUN) in 2020, to assist them in addressing their water security concerns. The objective for the community was to receive a brief assessment outlining the current conditions surrounding their water resources and offer some guidance towards climate change adaptation planning as it pertains to water supply options. The following report is produced to meet that objective and to assist the SP-BC-BH-AC council to assist in their efforts, policy development and decision-making processes.

[1] https://www.mun.ca/harriscentre/reports/water/Final_report_Vodden.pdf
[2] https://www.gov.nl.ca/ecc/files/publications-final-report-2018.pdf
[3] https://cdnsciencepub.com/doi/10.1139/cjce-2018-0563
[4] https://en.unesco.org/themes/water-security
[5] https://www.mun.ca/harriscentre/reports/15-16_report_Hanrahan_Water.pdf

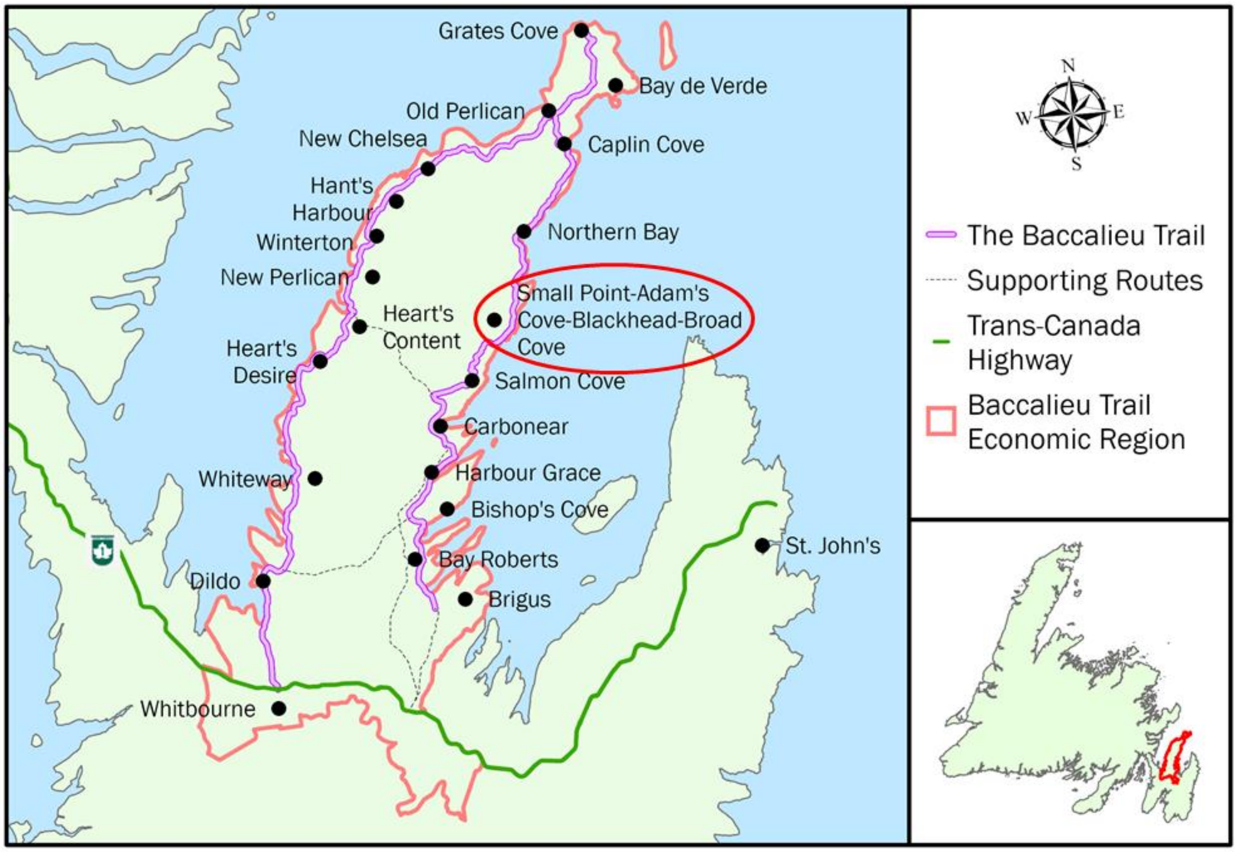


Figure 1: Communities of the Baccalieu Trail Economic Region with a highlight of the location of Small Point-Broad Cove-Blackhead-Adam's Cove (SP-BC-BH-AC).

2. Background Information

Community Demographics

According to the 2016 Canadian Census (Statistics Canada[6]), the community of SP-BC-BH-AC has a current population of 387 individuals (Table 1), which declined from 1996 – 2016 at an average rate of about 6 persons per year. The community has continually been decreasing in the number of residents since 1996, which is a trend that is disproportionate with the province or the country who both experienced gains in population since 2006 (Table 2).

A contributor to the loss of residents for the town would appear to be from a loss of youth in the community as half the residents would be greater that 54 years of age (Table 3), which is higher than the province or country. It can be assumed that SP-BC-BH-AC is a community of seasonal residents, or vacationers, as just over half of the buildings are occupied year-round (Table 4). The average income in the town is well below that of the province or country (Table 5).

With a decreasing population, only about half of the residents residing in the town year-round, and the ability to retain youth in the community, there are concerns about the long-term sustainability of the community. The decrease in population and lack of youth, could be attributed to a shortage of meaningful employment in the area. Any planning and decision making should focus on how to create economic opportunities and draw younger families to the area.

Table 1: Total Population of SP-BC-BH-AC, Newfoundland & Labrador, and Canada from 2001-2021[6]

TOTAL POPULATION

	2001	*2006*	*2011*	*2016*	*2021*
SP-AC-BH-BC	480	440	389	387	414
NL	512,930	505,470	507,270	519,720	510,550
Canada	30,007,095	31,612,895	32,852,325	35,151,730	36,991,981

Table 2: Percent change in Population of SP-BC-BH-AC, Newfoundland & Labrador, and Canada from 2001-2021[6]

PERCENT CHANGE IN POPULATION

	2001	*2006*	*2011*	*2016*	*2021*
SP-AC-BH-BC	-2.4	-8.8	-11.2	-0.5	7.0
NL	-7	-1.5	1.8	1	-1.8
Canada	4	5.4	5.9	5	5.2

[6] https://www12.statcan.gc.ca/datasets/index-eng.cfm

Table 3: Median age of the Populations of SP-BC-BH-AC, Newfoundland & Labrador, and Canada from 2001-2021[6]

MEDIAN AGE

	2001	2006	2011	2016	2021
SP-AC-BH-BC	44.2	46	51	54.4	60.4
NL	38.4	41.7	44	46	48.4
Canada	37.6	39.5	40.6	41.2	41.6

Table 4: Number of Dwellings Occupied by Residents in SP-BC-BH-AC, Newfoundland & Labrador, and Canada from 2001-2021[6]

TOTAL NUMBER & YEAR-ROUND OCCUPIED DWELLINGS

	2001			2006			2011			2016			2021		
	Total	All Year	% All Year	Total	All Year	% All Year	Total	All Year	% All Year	Total	All Year	% All Year	Total	All Year	% All Year
SP-AC-BH-BC	323	--	--	311	181	58%	308	172	56%	308	171	56%	327	200	61%
NL	227,570	--	--	235,958	197,245	84%	250,275	208,842	83%	265,739	218,673	82%	269,184	223,253	83%
Canada	12,548,588	--	--	13,576,855	12,435,520	92%	14,569,633	13,320,614	91%	15,412,443	14,072,079	91%	16,284,235	14,978,941	92%

Table 5: Average income of residents in SP-BC-BH-AC, Newfoundland & Labrador, and Canada from 2001-2021[6]

AVERAGE INCOME

	2001	2006	2011	2016	2021
SP-AC-BH-BC	15,016	19,656	24,615	35,353	37,000
NL	22,620	27,636	35,089	45,210	48,440
Canada	29,769	35,498	40,650	47,487	52,350

Current Climate Conditions

Weather and climate are two different subjects. Weather is the day-to-day interactions with our natural environment and can be highly variable in a short term, while climate looks at the long-term trends about weather over many years. Climate is simply the statistics of weather events. Traditionally, scientists, engineers and planners look at historic climate data over 30-year periods to determine what "normal" weather is for a given time. It is this data that is used to assist in the construction of buildings, infrastructure and plans to assess temperature ranges and precipitation amounts.

The climate of SP-BC-BH-AC can be described as a typical temperate environment under the direct influence of the ocean. This maritime effect would provide a generally wet setting that provides a slight cooling influence in the summer and enhanced warming in the winter. While there are no weather stations in SP-BC-BH-AC, climate data was obtained from the Federal Department of Natural Resources and Environment for the station at St. John's airport[7] as this station was deemed most relevant and representative for the community. The yearly temperature average has fluctuated between 4.7-5.5°C since 1941 while precipitation values have been steadily increasing from 1386.3 – 1534.2 mm total per year (Table 6).

Looking at the most recent normal data (Table 7, Figure 2), there is approximately a 20°C difference between the coldest months of January and February with the warmest months of July and August. The wet season would be found during the Fall months (Oct-Dec) with the preceding summer being dryer. Summer appears to be slowly getting warmer, winter is becoming slightly colder while receiving more precipitation throughout the year when looking at climate normal from 20 years prior (Table 8). While the actual effects of climate change are unknown, large scale computing is being performed to model and predict the expected weather by 2100.

Table 6: Average Temperature and Precipitation values from the Weather Station at St. John's Airport for Noted Climate Normals between 1941-2010[7]

Annual Values based on Climate Normals

	1941-1970	*1961-1990*	*1981-2010*
Daily Average (°C)	5.5	4.7	5.0
Daily Max Average (°C)	*N/A*	8.6	9.0
Daily Min Average(°C)	1.4	0.8	1.0
Total Precipitation (mm)	1386.3	1481.7	1534.2

Table 7: Monthly Climate Normal Data from the Weather Station at St. John's Airport for the period 1981-2010[7]

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Year*
Daily Average (°C)	-4.5	-4.9	-2.6	1.9	6.4	10.9	15.8	16.1	12.4	7.4	3	-1.5	5.0
Daily Average Max (°C)	-0.8	-1.1	1	5.6	11.1	15.8	20.7	20.5	16.5	10.8	6.4	1.8	9.0
Daily Average Min (°C)	-8.2	-8.6	-6.1	-1.9	1.7	5.9	10.9	11.6	8.2	3.9	-0.3	-4.7	1.0
Precipitation (mm)	149.2	129.5	142.2	122.9	102.6	97.6	91.6	100	129.6	156.2	148.1	164.8	1534.2

[7] https://climate.weather.gc.ca/climate_normals/index_e.html

Table 8: Monthly Climate Normal Data from the Weather Station at St. John's Airport for the period 1961-1990[7]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Average (°C)	-4.3	-5	-2.5	1.3	5.8	10.9	15.4	15.3	11.6	7	3.1	-1.7	4.7
Daily Average Max (°C)	-0.7	-1.4	1	4.8	10.3	15.8	20.2	19.5	15.6	10.6	6.2	1.5	8.6
Daily Average Min (°C)	-7.9	-8.7	-6	-2.2	1.3	5.9	10.5	11	7.5	3.4	-0.1	-5	0.8
Precipitation (mm)	147.8	133.6	126.7	110.4	100.9	96.9	77.9	121.8	125	151.7	144.7	144.2	1481.7

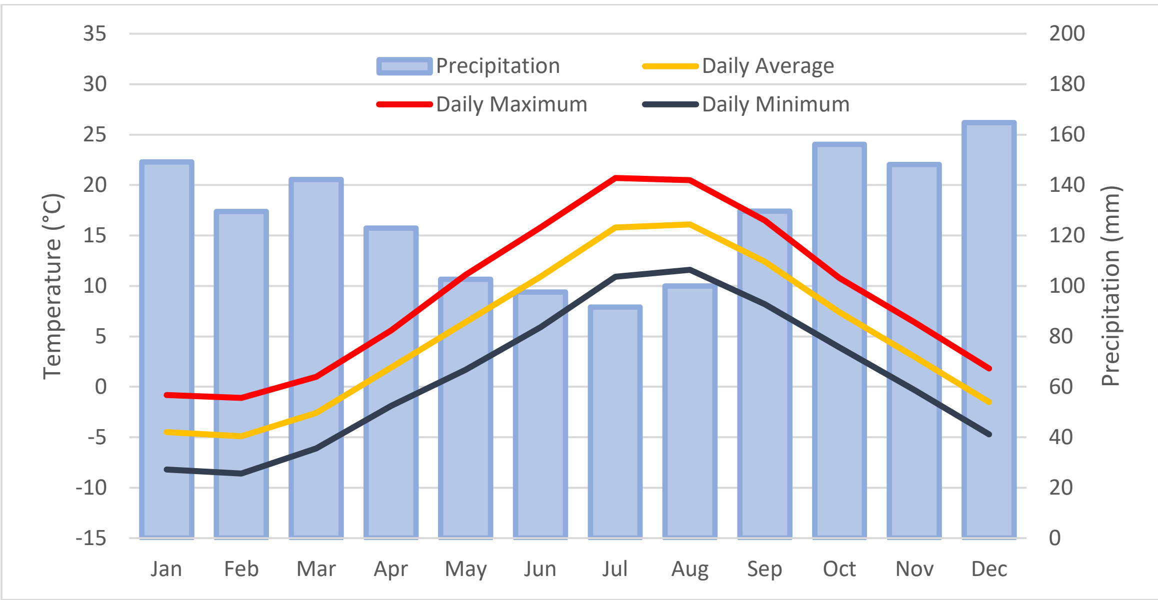


Figure 2: A Climatograph Displaying the Monthly Climate Normal Data from the Weather Station at St. John's Airport for the period 1981-2010[7]

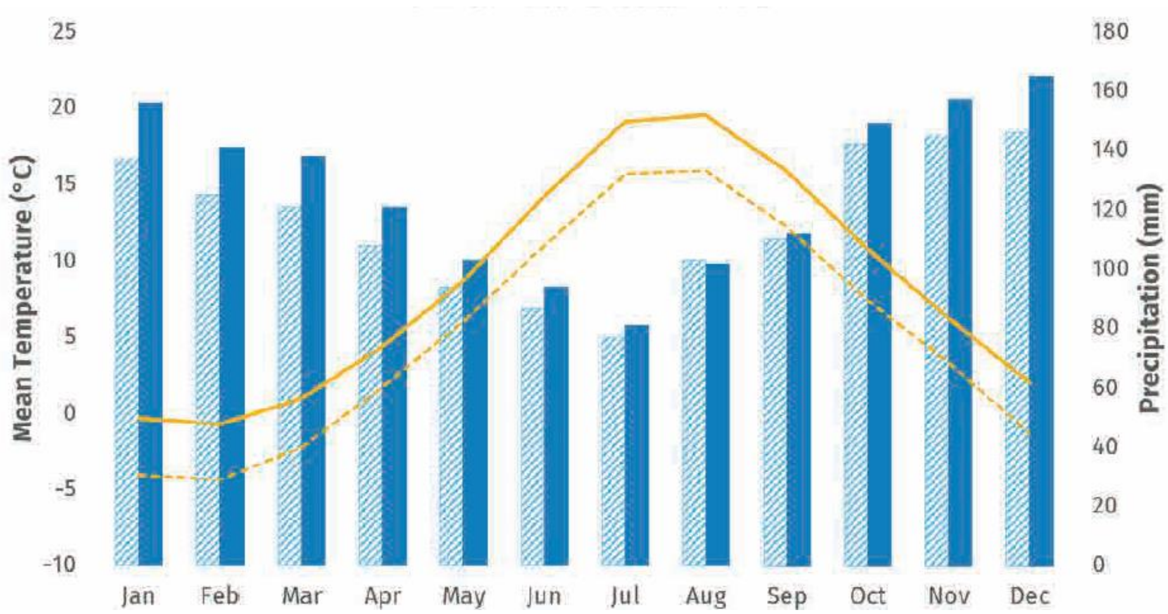


Figure 3: A Climatograph for the city of St. John's, NL created by the Climate Atlas of Canada[8] Illustrating the Shift from the Current Climate (*Hashed Features*) to Projected Climate Data (*Solid Features*)

Forecasted Climate Conditions

Predicting just how much the climate will change, and the direct impacts from the transformations in the weather by the year 2100, will continually evolve as more data and powerful computing methods are used. For example, the Department of Environment and Climate Change released a report in 2013 (Finnis, 2013[9]) outlining the projected impacts of climate change for the province only to provide an update 5 years later (Finnis & Daraio, 2018[10]). This is also why the International Panel on Climate Change (IPCC) releases an update on their reports approximately every 6 years, with the sixth assessment report being released in August 2021[11].

At the time of this report and using the findings of Finnis & Daraio (2018)[10] Newfoundland and Labrador is expected to experience an increase in the daily average temperature, by 1-6°C by 2100, with the biggest change in the winter. Global warming is often used synonymously with climate change; however, it should be noted that this is a misnomer because not every location will experience the same rate of warming and some locations will experience slight cooling. Heat waves are expected to be minimal.

[8] https://climateatlas.ca/sites/default/files/cityreports/StJohns-EN.pdf
[9] https://www.gov.nl.ca/ecc/files/publications-nl-climate-change-projections-full-technical-report.pdf
[10] https://www.gov.nl.ca/ecc/files/publications-final-report-2018.pdf
[11] https://www.ipcc.ch/assessment-report/ar6/

The amount of the average daily precipitation is also expected to increase (Figure 3) at about the rate of 0.5-1mm per day. While this change may seem minimal, when applied to a 90-day season that would be an extra 45-90mm. Rainfall events are expected to become more intense and the frequency of significant storms, such as a "100-year storm," will become more common, becoming closer to a "50-year storm." Due to the increase in temperature less snow is expected to fall and will be replaced by an increase in rain during winter months. Droughts are not expected to be an issue for Newfoundland and Labrador.

Bedrock Geology

The bedrock that underlies SP-BC-BH-AC (Appendix B) is mainly composed of folded sedimentary rock that are apart of the Signal Hill Group, and Connecting Point Group (King, 1988[12]; Myrow, 1995[13]). In the western portion of the community the Signal Hill Group is represented by only the Gibbett Hill formation, a 575-542 million year old sandstone that is a result of a delta (Hsu, 1972[14]). In contrast, the older Connecting Point Group formed in a deep marine environment and is made up two subgroups, the St. John's Group (565-550 Million years old) and the Conception Group (570-565 Million years old)[15].

The St. John's Group (Figure 4) covers most of the eastern limits and main study area of the town (Appendix B – blue units). This geologic group is represented by the Renews, Fermeuse and Trepassey formations, which composed of shales and sandstones.

The hard shales of the Conception Group (Appendix B – purple units). make up only a small portion of exposed bedrock in SP-BH-BC-AC and is made up of the Mistaken Point and Drook formations, the former unit being known internationally for its preserved fossils (King, 1990[16]).

The main feature of note with the bedrock geology locally is of the presence of a regional anticline, or an 'A' shaped structure, the result of tectonic forces long ago. The older Conception Group rock units make the point of this anticline with the other units flanking and angling away. An anticline allows for a glimpse into the possible older rock types that underlay younger bedrock, thanks to erosional proceses, that may otherwise be unknown at the surface.

[12] https://www.gov.nl.ca/iet/files/88-01.pdf
[13] Myrow, P (1995). "Neoproterozoic rocks of the Newfoundland Avalon Zone". Precambrian Research. 73: 123
[14] https://research.library.mun.ca/6931/
[15] https://www.gov.nl.ca/iet/files/mines-geoscience-publications-currentresearch-2001-obrien-s.pdf
[16] https://www.gov.nl.ca/iet/files/mines-geoscience-publications-report90-2.pdf

Figure 4: A localized anticlinal structure seen in exposed St. John's Group outcrops above a small beach along the coastline in Small Point

Figure 5: An area of Thin Till covered by vegetation and some bedrock outcropping along the coastline in Broad Cove

Surficial Geology

The localized landscape was sculpted by geologic processes that occurred when glaciers retreated out of the area, and other on-going erosional forces that continually shape the land, such as river and coastline processes. The geologically recent ice-age existed from approximately 100,000-10,000[17] years ago with glaciers leaving the Avalon peninsula around 10,000 years ago (Dyke, 2004[18]). These geologic activities leave behind loose sediment, ranging in size from clays to boulders as mixtures or uniform materials. The charting of the distribution of these deposits around SP-BC-BH-AC are found in Appendix C and was made from data available from the Province of Newfoundland and Labrador.

As glacier ice scraped the land, rock was grinded and transported away. The sediment left behind from the ice is collectively known as *till*, a deposit with a mixture of particles ranging in size from the super tiny (i.e., clay) to very large (i.e., boulders). When glaciers started to disappear their meltwater moved any debris that was caught in the flowing water and would settle out along with other similarly sized particles to create better *sorted* material compared to glacial till, typically being sand and gravel.

The surficial geology found around the community is mainly thin till (Figure 5), or a mixture of sediment being less than 2 metres in thickness. With the till unit being shallow, outcrops of bedrock are common and can be found throughout the town as well. The few brooks that run through the community will erode down to expose the local bedrock with pockets of gravel top boulders, being remnants of high flow events. The couple of sandy beaches present in SP-BC-BH-AC along the coastline are the result of erosion processes, the movement of sediment parallel to the shoreline from currents and deposited from the action of waves.

[17] https://www.britannica.com/science/Wisconsin-Glacial-Stage
[18] https://www.lakeheadu.ca/sites/default/files/uploads/53/outlines/2014-15/NECU5311/Dyke_2004_DeglaciationOutline.pdf

Hydrogeology

Hydrogeology is the geological science that studies water below the surface and interaction with the geological units. Groundwater moves under the influence of gravity and accumulates in underground geological reservoirs known as aquifers. Aquifers become replenished, or recharged, through precipitation and can be unconfined (no geologic factor to contain water in a defined space) or confined (geologic beds trap water within an aquifer). The height of water in a well for an unconfined aquifer is known as the water table while in a confined is referred to as its piezometric level.

Communities and residents access these storages of water through wells, either in the overlying sediment (generally referred to as *dug wells*) or through borings into bedrock (generally referred to as *drilled wells*). Commonly, residents of SP-BC-BH-AC refer to drilled wells as *artesian wells*, however, this term in hydrogeology refers to wells that penetrate confined aquifers (Figure 6) that have water rise above the aquifer unit due to natural pressure creating forces. It is unknown if the bedrock aquifers in the area exist with artesian conditions and this concept is addressed only to avoid confusion with any hydrogeologic work.

As aquifers are geologic bodies and often being composed of solid material, water gets stored in openings in the rock. The amount of total pore space found in each portion of material is known as the aquifer's *porosity*. The greater the porosity, the greater the storage potential for the aquifer. These pores can be openings between sand grains, fractures in rock or dissolution channels like caves (Figure 7) with the latter two known as secondary porosity as these openings were created after the rock was formed.

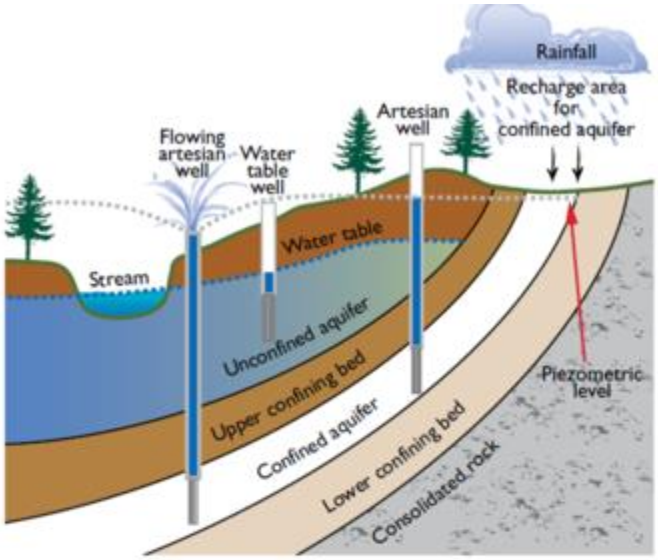


Figure 6: Geological and Local Surficial Controls that affect Artesian Conditions (USGS[19])

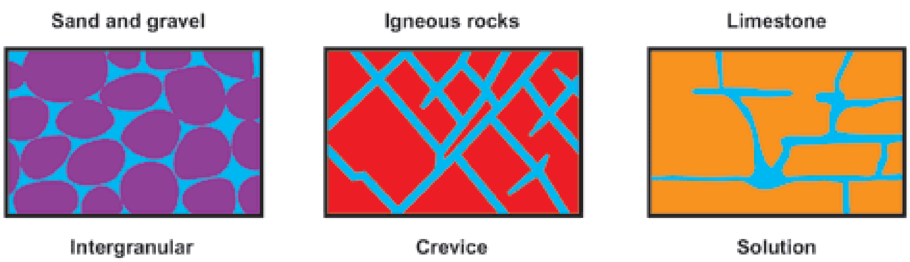


Figure 7: Porosity Types Found in Aquifers (Environment & Climate Change Canada[20])

While some aquifers can be highly porous, water may not move through them. Hydrogeologists distinguish aquifers based on their physical property being porous/unconsolidated (made of aggregate such as sand and gravel) and fractured aquifers (where groundwater moves through cracks, joints or fractures in otherwise solid rock)[20]. The degree to which the pores are interconnected, plentiful and sizable enough to allow water to move freely is known as its *permeability*[20]. Aquifers with high permeability can have water move through it at a rate of a metre per day while impermeable materials, such as clay and shale, can be a rate of a centimetre over a century.

[19] https://www.usgs.gov/special-topic/water-science-school/science/artesian-water-and-artesian-wells
[20] https://www.canada.ca/en/environment-climate-change/services/water-overview/sources/groundwater.html

Water Testing

The quality of water is a reference to the biological, chemical and physical characteristics found within a sample. Drinking water needs to be of a high quality to be considered safe to drink, or communities risk getting sick from contaminants found in the water. Testing of private water sources is the responsibility of the owner, however, any water supplied from a public must meet specific government standards known as the Guidelines for Canadian Drinking Water Quality (GCDWQ)[21] to be deemed safe for consumption and follow guidelines on how to monitor and report on public drinking water sources in the province[22]. Generally, the testing of water is every 2 years for chemical, and every 6 months for biological, contaminates.

The highest priority when concerned with drinking water is microbiological contaminants. This includes viruses, bacteria and other pathogens such as *giardia, cryptosporidium* and *Escherichia coli* (*E. coli*) that can cause illness and death if consumed. Daily monitoring, source water protection and chemical treatment (i.e. chlorine) are the main measures used to meet guideline requirements and to safeguard residents against microbiological contamination.

The second concern involves the chemical and physical parameters found within water. Some chemical elements, such as lead and cadmium, are toxic at low doses while others are safe but can be unpleasant to have in abundance (i.e., iron). Monitoring the levels of chemical contaminants needs to be continually done so measures can be implemented to reduce the concentration of any chemical contaminant, which can include well abandonment if no treatment option is available.

[21] https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table.html
[22] https://www.gov.nl.ca/ecc/waterres/regulations/policies/water-quality/

3. Water Supply Assessment

Domestic Water Supply Sources

Dug wells, drilled wells, and the municipal supply (which is sourced from a series of drilled wells) are the three different sources of water that is the source for domestic purposes in SP-BC-BH-AC. The Department of Environment, Climate Change and Municipalities requires a record of any new drilled well and maintains a database of these logs in the province. No record is required for the creation of a dug wells, therefore, no information about any dug well is available.

Data provided for this study showed that are records for sixty drilled wells in SP-BC-BH-AC, however, only about a quarter of them can be placed to a location (Appendix D). The actual number of drilled wells is expected to be greater due to the records starting in the 1970s with drilled wells be installed prior to that. The estimated number of dug wells is assumed to be the same as drilled wells[23] while the expected number of these wells is also assumed to be higher because their construction is much easier than their drilled counterpart and do not require any documentation.

No information that supports homes using any alternative source for a water supply, such as a lake or harvesting rainwater, was found.

Well Water

Dug Wells Tapping into Surficial Aquifers

Dug wells access aquifers that are close to the surface and can often have direct interaction with water sources found at the surface, such as rivers and lakes, but the source of recharge for these aquifers is mainly precipitation. The water found in dug wells would be considered soft and therefore expected to be low in TDS (total dissolved solids), hardness and heavy metals. However, given that these aquifers are close to the surface, they can be easily affected and potentially contaminated through flooding events and human activities. The location of dug wells should always take into consideration the position of potential sources of contaminants, such as septic fields, industrial sites, agricultural operations, landfills, and even cemeteries.

A dug well provides access to stored water below the surface into the overlying sediment above bedrock, occasionally referred to as overburden. For most of the community this material is glacial till (Appendix C) or can also be considered as loamy material when described as a soil. Silts and clays are found in this sediment and would lead to having a low porosity and

[23] Angela Buchanan, Manager (Acting) - Groundwater Water Resources Management Division, Department of Environment, Climate Change and Municipalities, Personal Communication, Feb 3, 2021

permeability when compared to an ideal aquifer made of sand. The eastern area of community's soil type has been classified as Turk's Cove[24] a highly acidic and imperfectly drained loam with water movement through the material being noted as slow[25], a reflection of the low porosity and permeability.

The average thickness of the overlying sediment is about 1 meter (3.3 feet) in the eastern, and habited part, of the community (Appendix E), which is fairly shallow. This limits the potential to store significant amounts of water, from snow melt and precipitation events, and can pose threats to supplying water in dry times if the aquifer does not tap into a surficial water source. Average production rates of dug wells in SP-BC-BH-AC are not precisely known, were guessed, and estimated to be about 15L/min (4 gal/min) based on the conversations made with locals.

The community's dug wells would appear to be below average when compared with other similar wells on the Avalon peninsula. The province hired a firm to explore the performance of wells in eastern Newfoundland. Their results[26] showed yields of dug wells ranging from 1.5 L/min (0.4 gal/min) to 227 L/min (60 gal/min) with half of wells studied having a value below 45 L/min (12 gal/min). These wells ranged in depth from 1.5 meters (m), or 5 feet, to 45.1m (148 feet) with an average of 17m (55.75 feet).

Drilled Wells and Bedrock Water

Based on discussions with community residents, the most preferred and known type of well in SP-BC-BH-AC is one that has been drilled into bedrock. From this conversation it would seem that the production of these wells are highly variable locally, ranging from 3.8 L/min (1 gal/min) up to 38 L/min (10 gal/min) but consensus seemed to be in the range of 7.5 -15 L/min (2-4 gal/min). This is in line with previous scientific studies. King (1990) published data on wells into the St. John's group having an average production of 26.2 L/min (7 gal/min) and ranging from 1 – 227.5 L/min (0.25 - 60 gal/min)[27] while the government hydrogeological study[26] presented an average of 20 L/min (5.3 gal/min) with half the wells performing at 9 L/min (2.4 gal/min) or less.

The generally low but highly variable yields of water from bedrock sources is a reflection on the geologic characteristics of the predominantly St. John's group. These rock types are compact, with no primary porosity and groundwater movement is limited to fractures in the rock as conduits[27]. The amount of flow is also dependant on how well the secondary porosity sources are interconnected. The more connections, the more potential for water flow. As a well is bored, the number of water producing fractures that is intercepted dictates the production of the well.

[24] https://sis.agr.gc.ca/cansis/publications/surveys/nf/nf3/index.html
[25] https://sis.agr.gc.ca/cansis/soils/nl/TKV/~~~~~/N/description.html
[26] https://www.gov.nl.ca/ecc/files/waterres-cycle-groundwater-hydro-hydrogeology-of-eastern-newfoundland.pdf
[27] https://www.gov.nl.ca/iet/files/mines-geoscience-publications-report90-2.pdf

Hitting a high flowing water vein comes down to a matter of luck when drilling a well and explains why two wells, metres apart, can have such a different in their production values. There is no known technology that can assist in targeting high producing fractures in bedrock.

Municipal Water Supply System

The number of households that are reliant on the town water supply is estimated to be 219, with the system experiencing daily chlorination monitoring and semi-annually testing for all other requirements[28]. The 2016 Census states there are 308 dwellings (Table 4) in SP-BC-BH-AC which leads to 71% of the community being dependant on the municipal supply, having only 8 total wells, 7 functional at the time of the assessment,[29] providing the sources of water for most of the community. Additional wells were attempted to be added and drilled, however, none of them produce at a rate suitable to be a source for a community distribution system. The water supply is at capacity for the current number of residents on the system and more water is needed.

This infrastructure for the entire water supply system is about 50 years old, being built around 1971, and concerns about its future were addressed by the Working Foreman for the community[29]. The line suppling water to the households are 1-inch galvanized steel and are buried but above the frost line[29]. It was implied that these pipes were not designed with any sort of contingencies to continue supply in case of water loss through a break in the line.

Water supply routes and storage tanks are filled with sediment and there are probable ongoing leaks that are buried causing a loss of water. Concerns about having enough water storage and supply for use of fire suppression, such as through the few hydrants in the community, while also continuing to allocate sufficient water to dependent residents exists. There are also the well houses themselves, which host the pumps, tanks and other supporting equipment in providing water to the community.

Municipal Well Houses

Upon inspection of the municipal well houses in the town (Figure 8), it became clear that they are a reflection from the time of their construction. They come across as being poorly designed and seemed to be constructed in haste. Ventilation and drainage are inadequate inside the structures with mould and standing water (Figure 9) being found inside several buildings. The placement of water filled objects (i.e., pipes, tanks, lines, etc.) are near electrical panels, non-GFCI outlets and other electrical equipment posing electric shock risks. While the well houses do have chlorination tanks, with the presence of commercially available sodium hypochlorite, or bleach, being used as

[28] Susan Kelleher, Town Clerk for SP-BC-BH-AC, personal communication, Sept 9, 2021
[29] Neil Piercey, Working Foreman for SP-BC-BH-AC, personal communication, Aug 10, 2021

part of water treatment requirements, is not stored properly, safety data sheets (MSDS/SDS) information does not appear to be available on-site, nor does every building contain an eye wash or shower station in case of an accident. The presence of mould, standing water, electrical shorting/shock risks and chemical handling procedures provides a significant health and safety risk to any individual working in these places.

Figure 8: Outside of one of the well houses within the community of SP-BC-BH-AC

The location of the large storage tanks are often adjacent to the wall and waterlines that access to any infrastructure behind them is impossible. If there is equipment that needs servicing in these areas, complicated and inventive solutions need to created or potentially, the tanks will need to be drained, posing a potential loss to this stored water. Heating is done with an electrically powered ceiling unit that appears undersized for the space for each well house. With no insolation in the building and the walls being constructed of plywood, any heat generated would be quickly lost. This would be expensive to operate, in terms of energy and financial, to sustain a warm environment in the building, especially in the cold winter, when maintaining unfrozen water is important for dependant residents.

Figure 9: The Interior of one well house in the Community

There are no backup energy sources available for the well houses which in times of a power outage those on the municipal supply would lose access to water. The use of numerous pressure tanks in well houses (Figure 9) is an expensive, troublesome and inefficient way to distribute water to the community when more effective and cost-effective methods exist, such as a variable speed well pump, seems to be favoured by the maintenance team. These buildings, and the equipment within, are generally constructed in an inefficient manner that if they were to be addressed, fixed and properly designed, the long-term savings from these repairs would save the town money and likely pay for themselves in a short period of time.

Surface Water Bodies

Large reserves of water that accessible at the surface, such as lakes, can act as supplies of water for the community. There are two large ponds found within the municipal boundaries (Appendix A) that could be potential sources of water. Blackhead pond and the larger Broad Cove Pond have been considered in the past to act as community reservoirs, with the latter seen as the best option. However, this idea was cancelled due to it being seen as too expensive at the time[30].

[30] Susan Rose, Town Councillor for SP-BC-BH-AC, personal communication, August, 2021

Another option could see the desalination of ocean water but the infrastructure and energy required would be quite excessive.

Water Quality Issues

Groundwater quality is determined from the interaction of water with bedrock and overburden. The provincial report[31] on the hydrogeology of eastern Newfoundland shows that parameters of surficial water sources that generally exceed the GCDWQ include colour, pH, turbidity, iron, lead and manganese. Meanwhile, the chemical limits of bedrock-based water that exceed the GCDWQ within the study area include colour, pH, turbidity, TDS, chloride, arsenic, barium, cadmium, iron, lead, manganese, mercury and selenium. Wells that are located near roadways and the coastline can also be susceptible to high sodium and chloride levels due to salt leaching into the water.

As for the water quality index for the community, government reports accessed through the provincial Water Resources Portal[32] generally show water quality to be considered very good to excellent. However, there are a few cases where arsenic and turbidity levels were exceeded (Well #1 – Reg Bursey well) as well as boil water advisories due to the disinfection system being down. The source water and methods in place to monitor the drinking water for SP-BC-BH-AC are sufficient to ensure safe drinking water, as long as chlorination of the water is taking place.

Through conversations among residents, community members are concerned about arsenic, iron and manganese being in their home water supply. Arsenic, a carcinogen, cannot be simply removed from water and requires specialized, and often expensive, equipment. Consumption of arsenic in water is the health risk, therefore, a reverse osmosis unit in the kitchen to supply drinking water to a house is recommended. There is no risk of inhalation during showers[33] and larger, household removal systems are not needed.

High levels of iron and manganese are often found associated with each other and enters water as it is leached from soil and rock[34]. These two elements can discolour plumbing fixtures and can be seen staining storage tanks in the local well houses (Figure 9). Removal options at the residence level vary among ion exchange (i.e., water softening, greensand), oxidizing or carbon filters, and reverse osmosis units but their effectiveness will vary and may be expensive for small household

[31] https://www.gov.nl.ca/ecc/files/waterres-cycle-groundwater-hydro-hydrogeology-of-eastern-newfoundland.pdf
[32] https://maps.gov.nl.ca/water/reports/viewreport.aspx?COMMUNITY_NAME=Small+Point-Adam%27s+Cove-Blackhead-Broad+Cove
[33] https://www.canada.ca/en/health-canada/services/healthy-living/your-health/environment/arsenic-drinking-water.html
[34] https://www.gov.nl.ca/iet/files/mines-geoscience-publications-report90-2.pdf

water systems[35]. Greensand systems seem to be the most common and easiest solution to remove iron, manganese as well as hydrogen sulfide from well water[36].

ADDENDUM

This report was first presented to the Council of SP-BC-BH-AC in October, 2021, for their review and consideration. Upon learning of some of the concerns address in the preceding section, the Council has already acted to undertake, mitigate and improve upon the issues raised in this report. The Town considers the security of the well houses a top priority and are currently addressing the concerns for the benefit of the residents and personnel of SP-BC-BH-AC.

[35] https://www.rdn.bc.ca/cms/wpattachments/wpID2284atID3808.pdf
[36] https://wcwc.ca/wp-content/uploads/2020/07/NESC-Tech-Brief_Iron-and-Manganese-Removal.pdf

4. Future Considerations

Through conversations among community residents, staff, and leaders, it became clear that there is a desire to see the town of SP-BC-BH-AC grow and prosper. Increases in acceptable industry, commercial operations, and population numbers, notably though the attraction of youth and young families, are seen as the key contributors to local progress. However, this is currently not occurring in the community as the population has been dropping for at least past two decades (Tables 1 & 2) and the inability to retain youth (Table 3). Having more local job opportunities would expect to keep younger people in the area and increase income (Table 5). A factor that limits the creation of economic opportunities and a higher residential capacity in SP-BC-BH-AC is locally believed to be due to a poor availability of water. Thus, moving forward for the community involves securing water resources to meet the wanted demands for a town that is seeking growth.

Municipal Plan

An official plan is a document that will help guide local officials and inform residents about policies that are to be identified and established by a municipal council for the betterment of their community. Any effective planning strategy will need to consider current demographic trends, climate change and in the case of water security, an understanding of the available water resources. For SP-BC-BH-AC a plan does exist being established in 2011[37] which was to guide community growth and development until 2021. Topics such as climate change, groundwater supply for subdivisions and well head protection areas are covered in this document to address concerns with development. It is also noted that there was no mention of property tax in the 2011 plan; however, Council has since initiated a property tax and separate water tax since the creation of this document. Exploring the use of taxes and user fees for users of the municipal water supply can help to offset current and future expenses and is recommended that these taxes be outlined in any future Municipal Plan.

If addressing the future needs and sustainability of the water needs is a priority for the community, then a review of the current plan should be considered so that a new, updated plan can be made. This evaluation should explore how well the municipal plan has been followed by the community, and to update it to ensure measures that will focus on protecting the town's water security through climate change adaptation planning. An example would be to ensure there are no uses or activities that can damage a water supply within a well head protection area as well to investigate coastline erosion rates to identify where structures would be under threat from the

[37] https://www.gov.nl.ca/ecc/files/registry-community-small-point-broad-cove-blackhead-adams-cove-files-small-point-broad-cove-blackhead-adams-cove-mp.pdf

expected increase in land loss along the coast. Means to ensure compliance to the plan would also need to be investigated and discussed.

The assured supply and availability of potable water to houses into the future is an important issue with residents and drinking water has a potential threat with climate change. If water security is a topic to be addressed, then new goals will have to be added to the plan so that direction can be provided to Council. Following the *7 Steps to Assess Climate Change Vulnerability in Your Community* toolkit, available from Municipalities Newfoundland and Labrador[38] (MNL), is a good resource to start in climate change adaptation planning and includes a chapter on drinking water.

Potential Sources of Water for a Community's Needs

Broad Cove Pond

The official plan for SP-BC-BH-AC states that there has been prior thought given to the use of Broad Cove Pond (BCP) as a source for local water. Using BCP as a water supply is highly encouraged and it is recommended to reinvestigate this idea. While the actual amount of water stored in BCP is unknown, it is assumed that its capacity is more than sufficient to meet the on-going needs for SP-BC-BH-AC. Climate change is expected to bring more precipitation which should adequately keep the pond recharged with water with enough storage potential to keep water available during any dry spells.

BCP has an environmental protection status within the limits of SP-BC-BH-AC, however, this water body is shared with the town of Kingston as well, which does not have the same designation applied, according to the official plan for SP-BC-BH-AC. Protecting source waters is an important first step for any municipality, therefore, preventing any future development or activities that can threaten the water quality, such as nutrient pollution (eutrophication) or petrochemical contamination from the use of motorized vehicles, will be vital. Residents would also be able to continually monitor the state of this water supply source and any actions that pose a risk to its quality will raise alarms.

If BCP is to be explored as a water source, it would be recommended to approach the community leaders of Kingston to apply a similar designation around the water source and even include their community to benefit from a municipality supplied water source. Including Kingston would increase the number of users benefitting from safe water as well sharing the costs in operating the system. The expected cost to create the infrastructure needed to use BCP as a water source is expected to be in the range of $10-15 million. This is an estimated guess based

[38] https://municipalnl.ca/

on a recent reservoir project in Sylvan Lake, AB - a community of about 15,000 - expected to cost $10 million[39].

The investment into using BCP, or even Blackhead Pond, as a reservoir would be expected to include the creation of a centralized location for the treatment and distribution of water and in replacing the aging current infrastructure. This, in turn, would address concerns raised about the current conditions of the municipal supply system, the multiple well houses and capacity to meet supply for future demands. Therefore, reaching out to other levels of government, along with having MNL as a partner, will be encouraged to explore applicable infrastructure funding programs to assist the community in funding such a project.

Continued Use of Wells

If the establishment of BCP as a community water source cannot be achieved, then the dependence on wells to provide domestic water will continue. Wells provide the water for the municipal system as well as for houses not tied to the local water supply network. It appears that the community is at a limit for water availability and often the response for more water is to drill more wells. It is understandable why individuals would look to drill more wells as the water is viewed as being generally safe, readily available and a continuous supply. This is untrue and this type of reasoning can lead to problems as bedrock water can have quality concerns as well as having the well go dry.

Over pumping of an aquifer depletes the amount of water stored in it, causing the water table to drop and can go below the reach of a pump. Well pumps can also compete against each other for water when their area of influence overlaps which can lead to water supply shortages. Thus, it is important to extract groundwater at a sustainable level suitable, so the aquifer is not drained.

According to a government report on the hydrogeology for eastern NL[40], through several tests conducted on aquifers, the average safe yield rate of water from the bedrock is 22 L/min (5.8 gal/min) while 63 L/min (16.6 gal/min) from glacial till. This of course can vary based on local conditions, however, using these numbers and the average water use for a Canadian of 330L of water a day[41] then water pumped at the safe rate of 22L/min can provide enough water for 96 people per day, or at 63L/min would be 274 people per day, without causing any harm to the aquifer. The potential for the mass extraction of water for a community would be better served through surficial aquifers than drilled, if possible.

[39] https://www.sylvanlakenews.com/news/new-water-reservoir-has-large-price-tag/
[40] https://www.gov.nl.ca/ecc/files/waterres-cycle-groundwater-hydro-hydrogeology-of-eastern-newfoundland.pdf
[41] https://www.mcgill.ca/waterislife/waterathome/how-much-are-we-using

Unfortunately for SP-BC-BH-AC there is not a significant amount of glacial till overlying bedrock to act as a surficial aquifer. Dug wells would be strongly encouraged to be investigated first as a water supply to a single household. This can be easily down by hiring a hydrogeologist or by digging a test pit and monitoring the amount of water in it. There is also the uncertainty of how climate change will affect these wells and their supply throughout a year, therefore, study into this would be highly recommended and encouraged.

If drilling a well is the only option available to supplying water, then the user will have to temper their expectation on water availability if their well is within the study area (Appendix A). The best yielding drilled wells will likely be in the Gibbett Hill Formation, or Signal Hill Group of rocks (Appendix B), in the western part of the town limits, however, there appears to be a very limited number of accommodations in that part of the community. The further a drilled well goes down, the greater the probability for higher yield rates but also so does the chance of encountering salt water, which will make the water unusable for consumption.

Alternative Sources of Domestic Water

With water supply a concern for residents in SP-BC-BH-AC, alternative sources of water to supplement a household's needs should be explored. One possible option is rainwater harvesting, which is an ideal option at the household scale. Collecting and storing rainwater can be used to offset demand from a municipal supply or well through a hybrid system and can also assist in mitigating excess stormwater on a property[42]. However, challenges do exist for capturing rainwater in rural Newfoundland as storage of the water in winter would require extra energy to prevent ice from forming and shallow bedrock would generally require above ground shelter of the tanks.

Contamination Threats

Flooding Events

With the climate projected to become, on average, warmer and wetter from past normals (Tables 6-8; Figures 2 & 3) it is reasonable to expect changes in the frequency of storms events that will creating flooding conditions. The presence of water at the surface provides a means for contaminates to enter a well. The pooling of water can pick up undesirable chemicals, bacteria and viruses and transport them along flow paths. If a wellhead was installed incorrectly, or not sealed off, overland water can enter a well directly through these openings. Dug wells are

[42] https://www.crd.bc.ca/education/stormwater-wastewater-septic/green-stormwater-infrastructure/rainwater-harvesting

generally viewed as being more susceptible as these wells may not be fully sealed off at the ground and they interact directly with surficial water sources.

The prime example of the risk of contamination into wells from a flooding event would be the Walkerton Water Crisis of 2000. Over 2000 people fell ill and seven people died in Walkerton, Ontario after one of the three municipal wells were contaminated with bacteria including *E. Coli,* spreading to the entire municipal water supply due improperly treated water. The bacteria entered the water supply after heavy rains caused manure from a farm to runoff into a nearby well, which would have been prevented if the water had been treated properly. A report[43] published by the commission to investigate the events that caused the crisis recommended a multi-barrier approach to ensure safe drinking water. This includes source water protection and having a secure water supply network for a community, generally overseen by the local government, to monitor, treat and distribute safe water for domestic use to all it's residents.

As a source water protection consideration, it is encouraged for SP-BC-BH-AC to review previous and current land uses in the community to see if there were, or are, any activities that could provide sources of chemical and microbiological contamination to water sources. It is also recommended for the community to investigate the feasibility of providing a water supply to as many residents as possible to ensure a continuous source of safe drinking water.

Saltwater Intrusion

Wells that are located near the coastline, or close to a roadway, are at risk of being contaminated with salt water. The salting of motorways in the winter creates deposits of salt along roads which then leach into aquifer systems. Wells located near roadways can become contaminated with salt from years of road salting. In some communities where wells are near roadways they apply only sand along these stretches to minimize the risk to these wells while providing traction in icy conditions for drivers.

For wells near the shore, saltwater can enter the wells from ocean surges, overdrawing of groundwater and sea level rise. Surges are only a threat to wells located close to the shoreline and are not properly sealed off from surficial runoff. However, the overextraction of water from aquifers plus forecasted rise in ocean waters from climate change provide the greatest risks to well water being contaminated by saltwater.

Fresh water is less dense than saltwater and will "float" on top of it. With sea level rise ocean water creates a wedge that would push the fresh water inland and would fill any wells with saline water (Figure 10). Preparing and planning for climate change is the best way to mitigate against any future wells from being developed in areas that would be affected from sea level rise. Any

[43] http://www.archives.gov.on.ca/en/e_records/walkerton/index.html

wells that currently exist in these areas will eventually succumb to saltwater intrusion and should be continually tested to ensure the water is safe for consumption.

Wells can also be impacted by sea water by over-pumping. As water is drawn into a well through a pump, it will pull any underlying saltwater with it. If this extraction occurs too frequently or at excessive rates, salt water can enter a well (Figure 10). With local wells drilled into the local bedrock, that penetrate well below the average sea level, and the presence of fractures in the rock that act as conduits for water, there is a real risk of saltwater contamination for coastal drilled wells from over-pumping and sea level rise. To avoid saltwater intrusion from overdrawing, pumps should not exceed the safe yield rate, which can be determined through aquifer testing from a qualified hydrogeologist.

Figure 10: An Illustration Displaying Sources of Saltwater Intrusion into Wells[44]

Surface Water Contamination

If a surface freshwater body is to be used as a water source for a resident or community then monitoring of that resource will need to occur. Contaminants from industrial, agricultural and residential activities can enter these bodies through overland and groundwater flows. One effect of from this process, also known as eutrophication (Figure 11), creates a build up of nutrients, which coupled with warmer weather, creates conditions for excessive plant and algae growth in water[45] and kills of aquatic life. This can lead to blue-green algae blooms, which really is a special type of bacteria known as *cyanobacteria*, and the introduction of several toxins, collectively known as *cyanotoxins*, into the water body. If the levels of these toxins exceed the

[44] https://blogs.egu.eu/network/gfgd/2018/02/12/saltwater-intrusion-causes-impacts-and-mitigation/
[45] https://www.nature.com/scitable/knowledge/library/eutrophication-causes-consequences-and-controls-in-aquatic-102364466/

allowable limits and cannot be reduced through treatment, then the water will have to be discarded as a source[46].

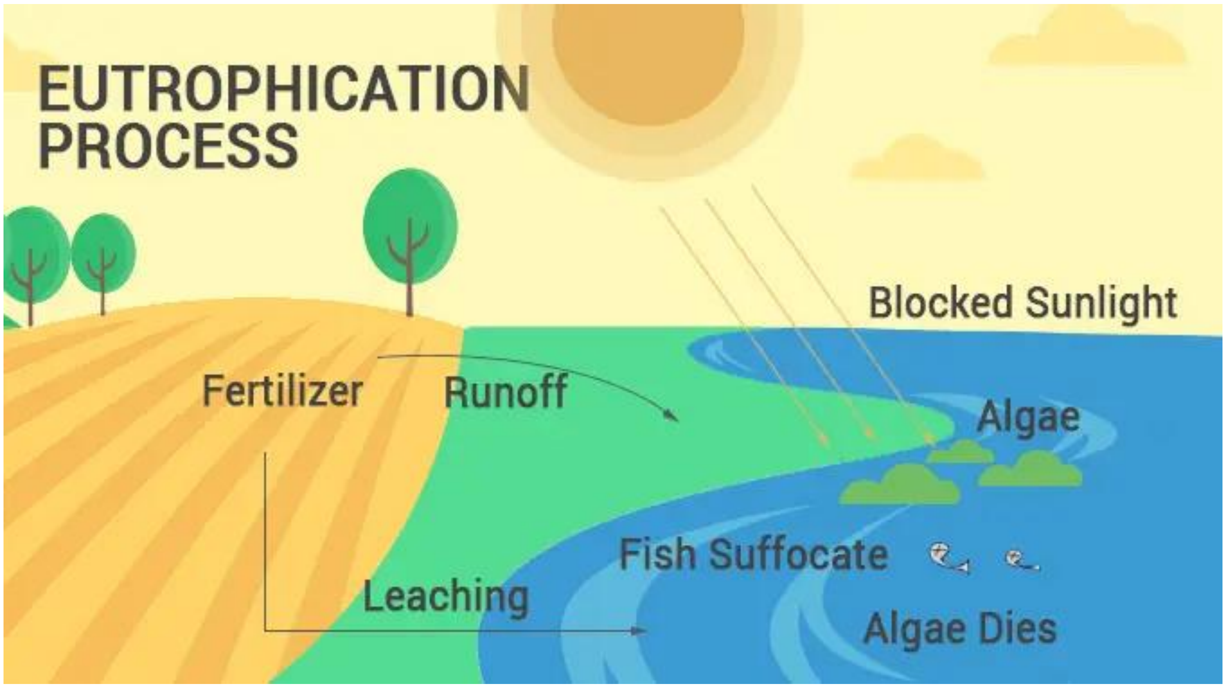


Figure 11: A Diagram Illustrating the Concept of Eutrophication[47]

Climate change is expected to increase the frequency and extent of blue-green algae outbreaks[48] as the prolonged warmer weather will also enhance the conditions needed to spark a bloom. While there is nothing that can be done locally to slow down the effects of global climate change, efforts can be made at a local scale to limit its impact.

If the residents or the community wishes to explore any surface water body as a potential water source, such as Broad Cove Pond, then protection of these bodies from the excessive introduction of nutrients from human activities will need to be considered by Council. This would include introducing and enforcing protective land use zoning to safeguard source waters and even purchasing lands to hold in public trust. Efforts to inform and educate people of any introduced protective measures, including posting signage (Figure 12), to protect water sources to help mediate the impacts from changes this policy will bring to limit contamination risks.

[46] https://www.gov.nl.ca/ecc/waterres/quality/background/bgalgae/
[47] https://earthhow.com/eutrophication-causes-process-examples/
[48] https://www.epa.gov/nutrientpollution/climate-change-and-harmful-algal-blooms

Figure 12: An Example of Signage used to Inform People of a Protected Surficial Water Source used by the City of Halifax[49]

Water Conservation Approaches

One consideration to address the stressed water supply of a community is the encouragement to use less water in our daily use. According to the government of NL, the average water usage per capita by a resident of their province is 628L/day with nearly two thirds of that being for the toilet and bathing[50]. Educating the community on applying conservational methods towards household water usage would be of great assistance to ensuring enough water in the municipal or natural supply systems.

Conserving water in the household can be done by installing water sustainable devices as well as changing personal behaviours and opinions on water usage. Equipment such as toilets, faucets, shower heads dishwashers and washing machines are designed to use water as efficiently and effectively as possible. Avoiding leaving the tap running to wash vegetables, brushing teeth or dethawing frozen items are examples of to minimize the wasteful use of water. Applying water conservational methods in multiple households within the community would lower the demand making more water available to other potential users. Even the promotion of water friendly landscaping and the use of rain barrels can assist in the conservation of water at home.

[49] https://globalnews.ca/news/7185802/blue-green-algae-found-in-lake-major-water-supply/
[50] https://www.gov.nl.ca/ecc/waterres/waste/water-conservation

Council, and the town, can actively promote and encourage these uses by having community activities to promote and educate residents. These events can have giveaways and prizes, potentially sourced from sponsors, applicable to the information being shared. Partnering with a special interest group or commercial partner to create an incentive program to provide rebates or financial incentives for residents to replace wasteful or old inefficient house fittings can also be explored. These are just a few ideas on activities that could be done to engage the community on water conservation and to minimize any financial challenges that would come with repairs.

Another conservational method that could be adopted by residents is the integration of a greywater recycling system. What these arrangements allow is that fresh water coming into a house is used for consumption, cooking and sanitary purposes with any usable wastewater from these sources being reclaimed to be used for usages that do not need clean water, such as toilet flushing. There are government guidelines and considerations when using a greywater system, notably they can be expensive to install and require some management and maintenance to avoid any health issues [51].

[51] https://www.canada.ca/content/dam/canada/health-canada/migration/healthy-canadians/publications/healthy-living-vie-saine/water-reclaimed-recyclee-eau/alt/reclaimed-water-eaux-recyclees-eng.pdf

5. Summary

From August 2-13, 2021, Matthew Schumacher, a professional with expertise in surficial geology and water resources, as well as being a prospective Ph.D. student from Memorial University of Newfoundland and Labrador, surveyed, explored and engaged the community of Small Point-Broad Cove-Blackhead-Adam's Cove to assess the town on current and future water supply issues. Mr. Schumacher discovered that the town is experiencing difficulties in attracting new residents and businesses with the lack of available water being viewed as the limiting factor. Residents expressed concern over having enough water to meet their needs while also being of a quality that is safe to consume. In investigating the current conditions of the community, Mr. Schumacher found:

Community Water Supply Assessment

- Concerns regarding how climate change will impact the community and affect future water sources
- Records for only 60 drilled wells and an unknown number of dug wells, which is assumed to be equal to the of drilled wells
- Based on communications with residents, production of wells in the community varies and drilled wells appear to be limited in how much water they can produce
- The town provides water for 71% of its residents, all sourced from drilled wells
- The municipal water supply system is need of upgrades while well houses need to be repaired to address concerns related to operational costs and health and safety of staff
- No surficial water body is currently used as a water source, however, using Broad Cove Pond as a supply was once explored
- Concerns around iron, manganese and arsenic in the water

To address what was discovered regarding the current concerns and issues surrounding the supply of potable water in the community, Mr. Schumacher has made the following suggestions:

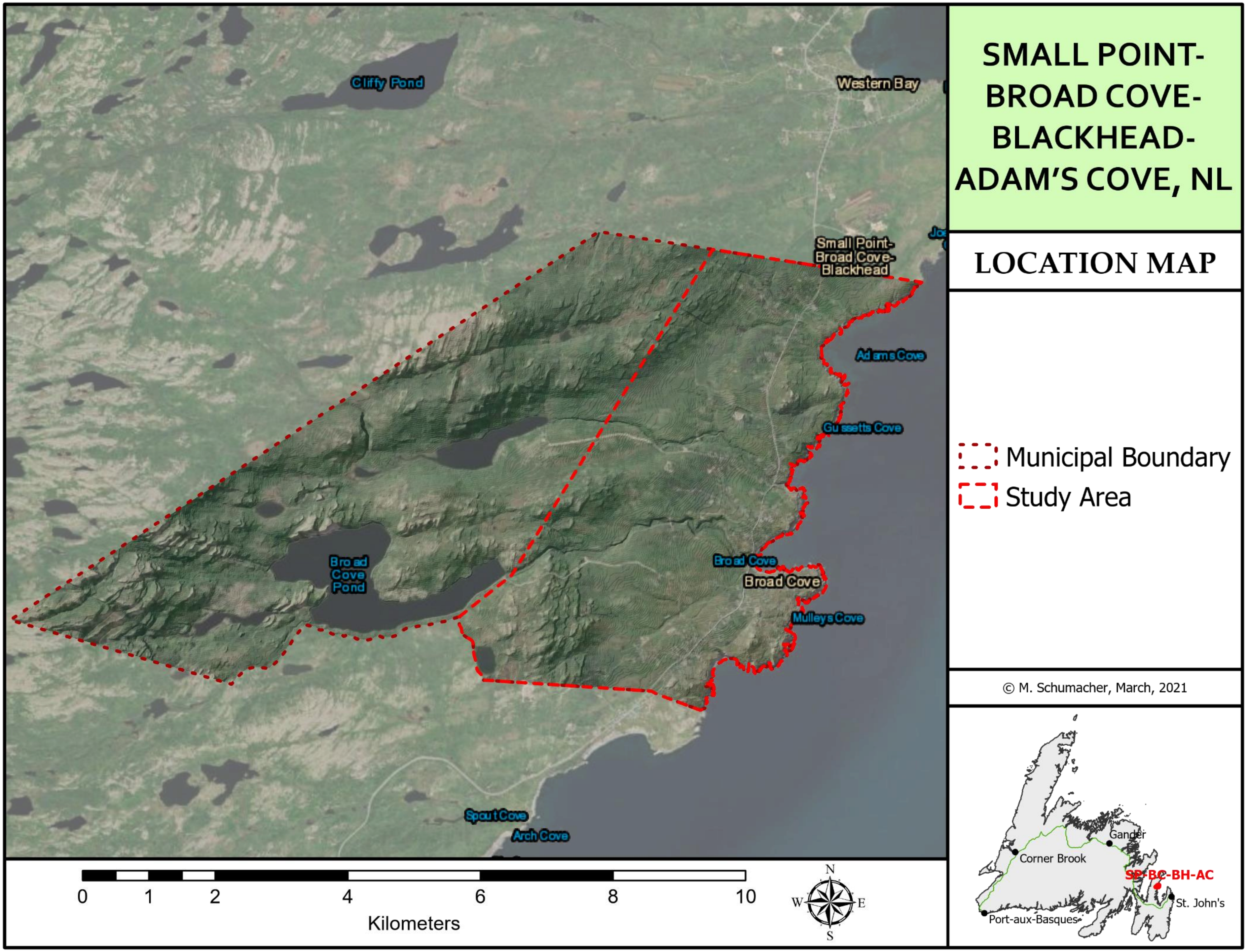
Future Recommendations

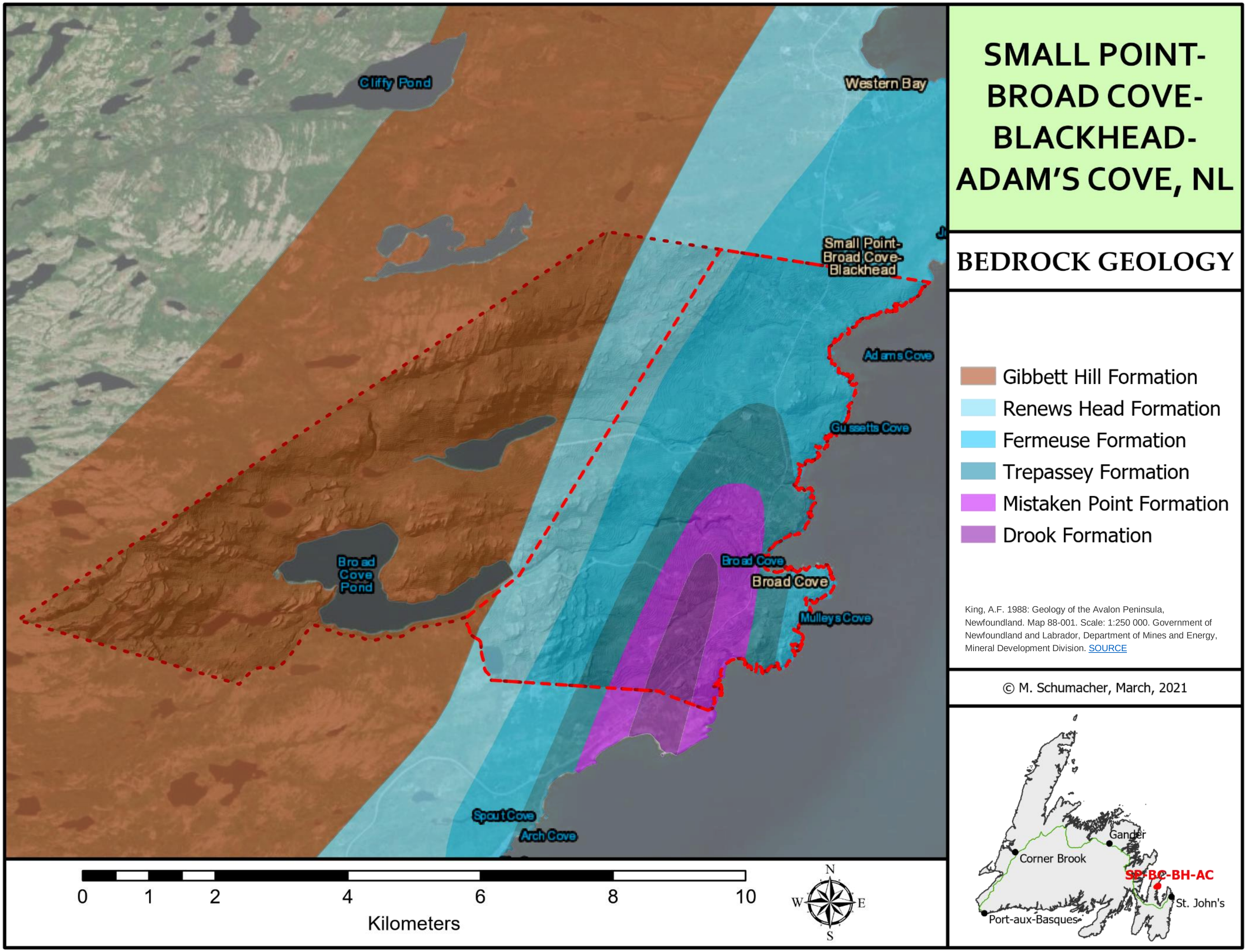
- Update the official town plan to help guide policy development and decision making to include a focus on water security for the community
- Review rate of property taxes and user fees on municipal water usage to help offset costs with the maintenance and upgrading of the system

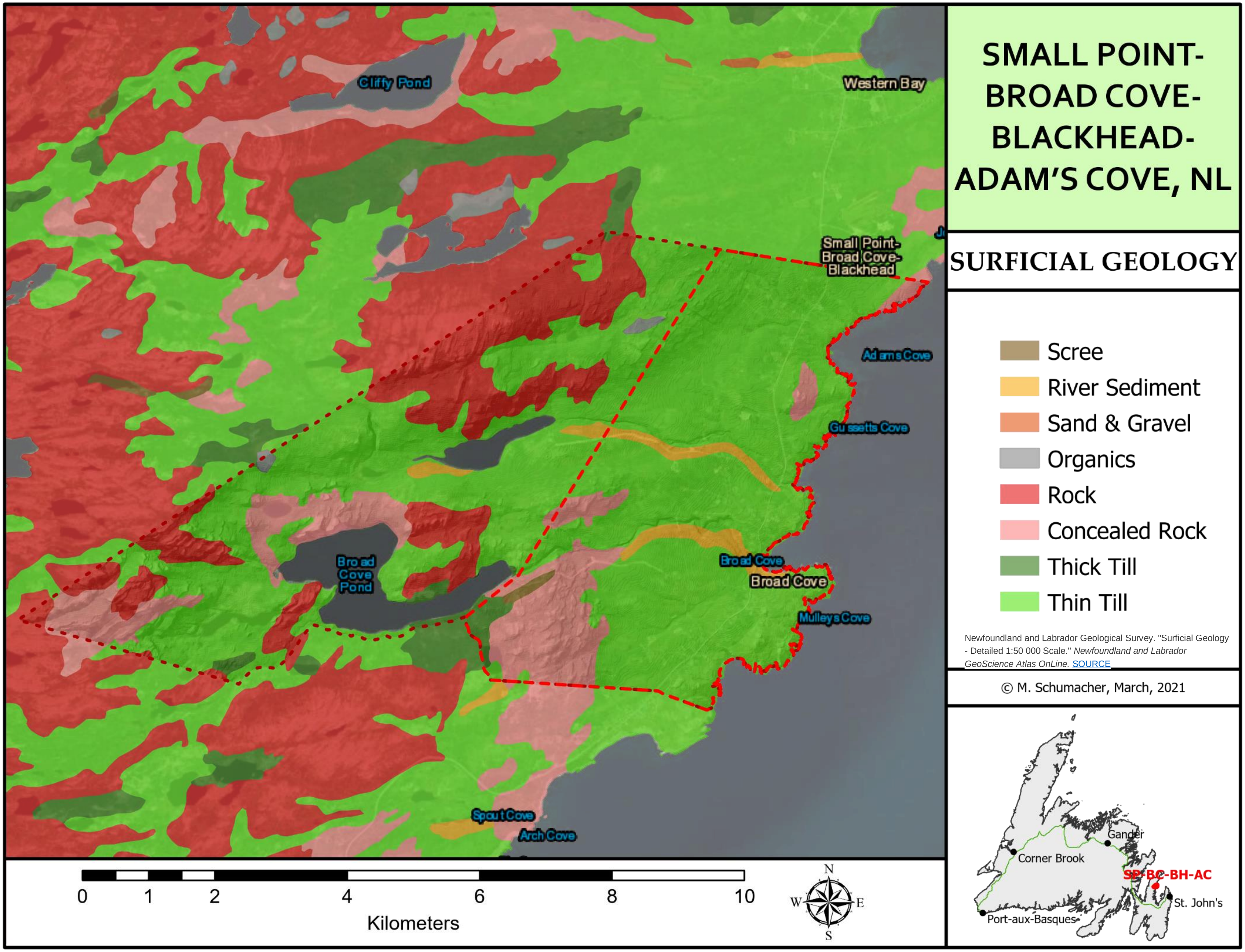
- To explore the possibility of using Broad Cove Pond (or Blackhead Pond) as the main water source for the community through a municipal supply system, in conjunction with the community of Kingston
- If Broad Cove Pond is to be explored as a water supply, create protective measures to safeguard source water from contamination and nutrient pollution
- Upgrade and repair the current municipal supply system to address infrastructure concerns and ideally, create a centralized location for distribution to help manage expenses
- If dependency on well water is to continue, tapping into surficial aquifers is likely to yield better production rates than drilled wells, where geological conditions are ideal
- Investigate into current and past activities occurring in well head protection areas to identify potential contamination sources in water supplies as part of source water protection
- Investigate the impact of climate change on future water supply, especially on dug wells given their production potential
- Investigate threat of saltwater intrusion, especially as it relates to climate change, on current and future wells
- Inform community on implementing water conservation measures in the household

If these recommendations are considered and explored, it will be a start for the town of SP-BC-BH-AC addressing water security as an important community issue. In conducting most of these proposals, it is imperative that a qualified individual using scientific methods be used to gather data for fact-based decision making. A licensed professional geoscientist (P.Geo) specializing in hydrogeology would be necessary to provide the applicable expertise along with exploring a partnership with Memorial University as an excellent research based graduate student project.

6. Appendices


SMALL POINT-BROAD COVE-BLACKHEAD-ADAM'S COVE, NL
LOCATION MAP
Municipal Boundary
Study Area
© M. Schumacher, March, 2021
Cliffy Pond
Western Bay
Small Point-Broad Cove-Blackhead
Adams Cove
Gussetts Cove
Broad Cove
Broad Cove Pond
Mulleys Cove
Spout Cove
Arch Cove
0
1
2
4
6
8
10
Kilometers
N
S
E
W
Gander
Corner Brook
SP-BC-BH-AC
St. John's
Port-aux-Basques


SMALL POINT-
BROAD COVE-
BLACKHEAD-
ADAM'S COVE, NL
BEDROCK GEOLOGY
Gibbett Hill Formation
Renews Head Formation
Fermeuse Formation
Trepassey Formation
Mistaken Point Formation
Drook Formation
King, A.F. 1988: Geology of the Avalon Peninsula, Newfoundland. Map 88-001. Scale: 1:250 000. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division. SOURCE
© M. Schumacher, March, 2021
Cliffy Pond
Western Bay
Small Point-Broad Cove-Blackhead
Adams Cove
Gussetts Cove
Broad Cove Pond
Broad Cove
Mulleys Cove
Spout Cove
Arch Cove
0 1 2 4 6 8 10
Kilometers
N
W
E
S
Gander
Corner Brook
SP-BC-BH-AC
St. John's
Port-aux-Basques


SMALL POINT-BROAD COVE-BLACKHEAD-ADAM'S COVE, NL
SURFICIAL GEOLOGY
Scree
River Sediment
Sand & Gravel
Organics
Rock
Concealed Rock
Thick Till
Thin Till
Newfoundland and Labrador Geological Survey. "Surficial Geology - Detailed 1:50 000 Scale." Newfoundland and Labrador GeoScience Atlas OnLine. SOURCE
© M. Schumacher, March, 2021
Cliffy Pond
Western Bay
Small Point-Broad Cove-Blackhead
Adams Cove
Gussetts Cove
Broad Cove
Broad Cove
Broad Cove Pond
Mulleys Cove
Spout Cove
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0
1
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Kilometers
N
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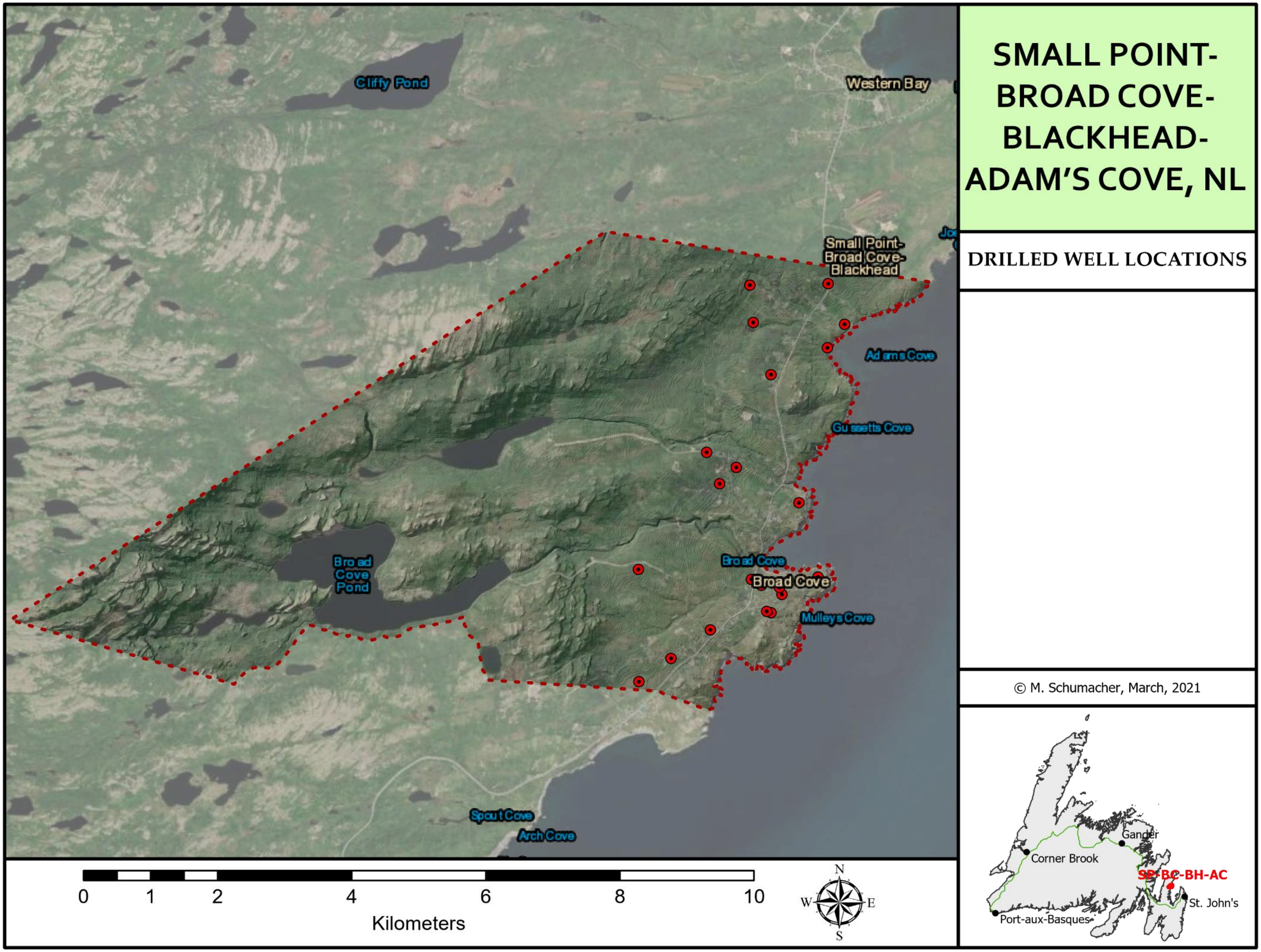
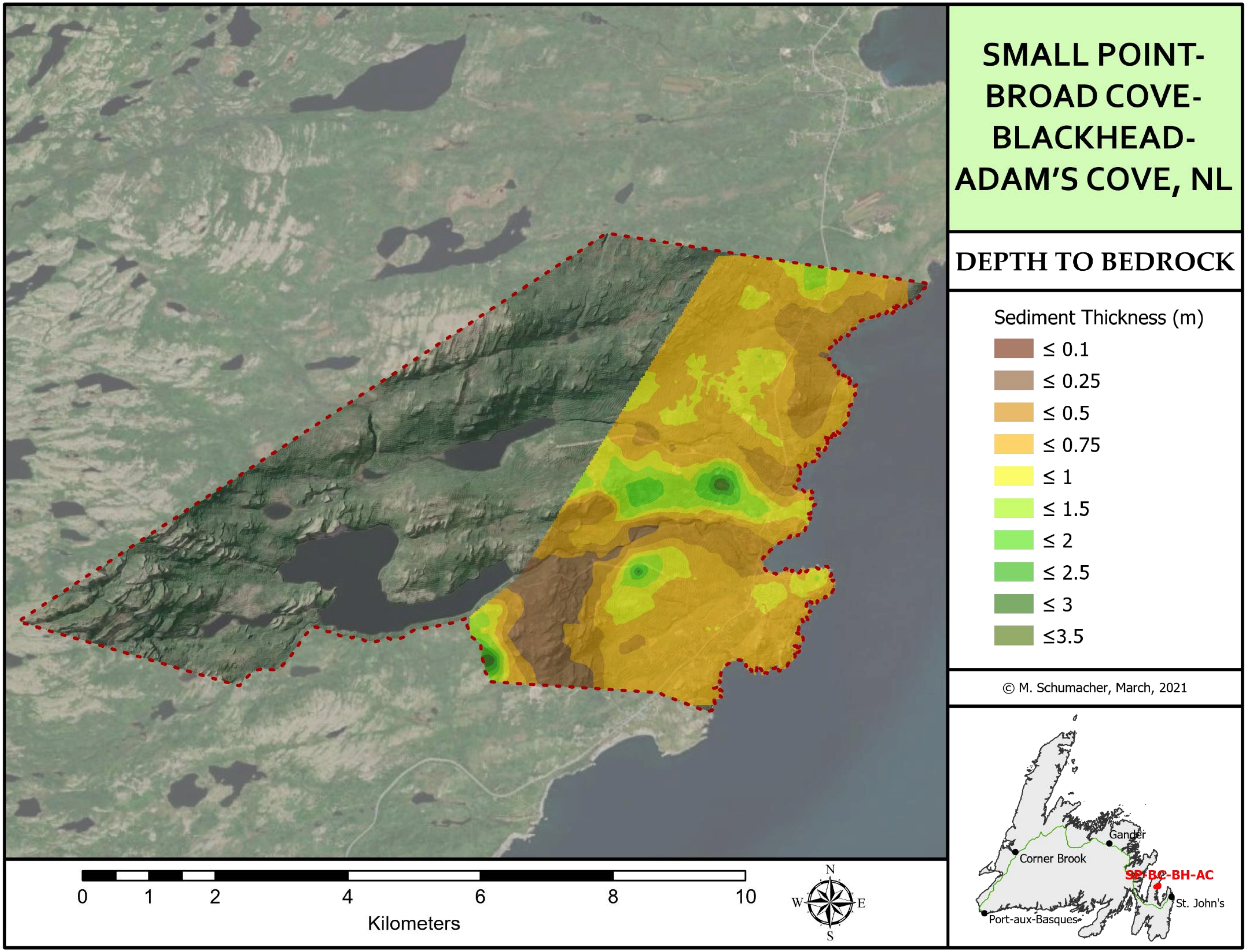
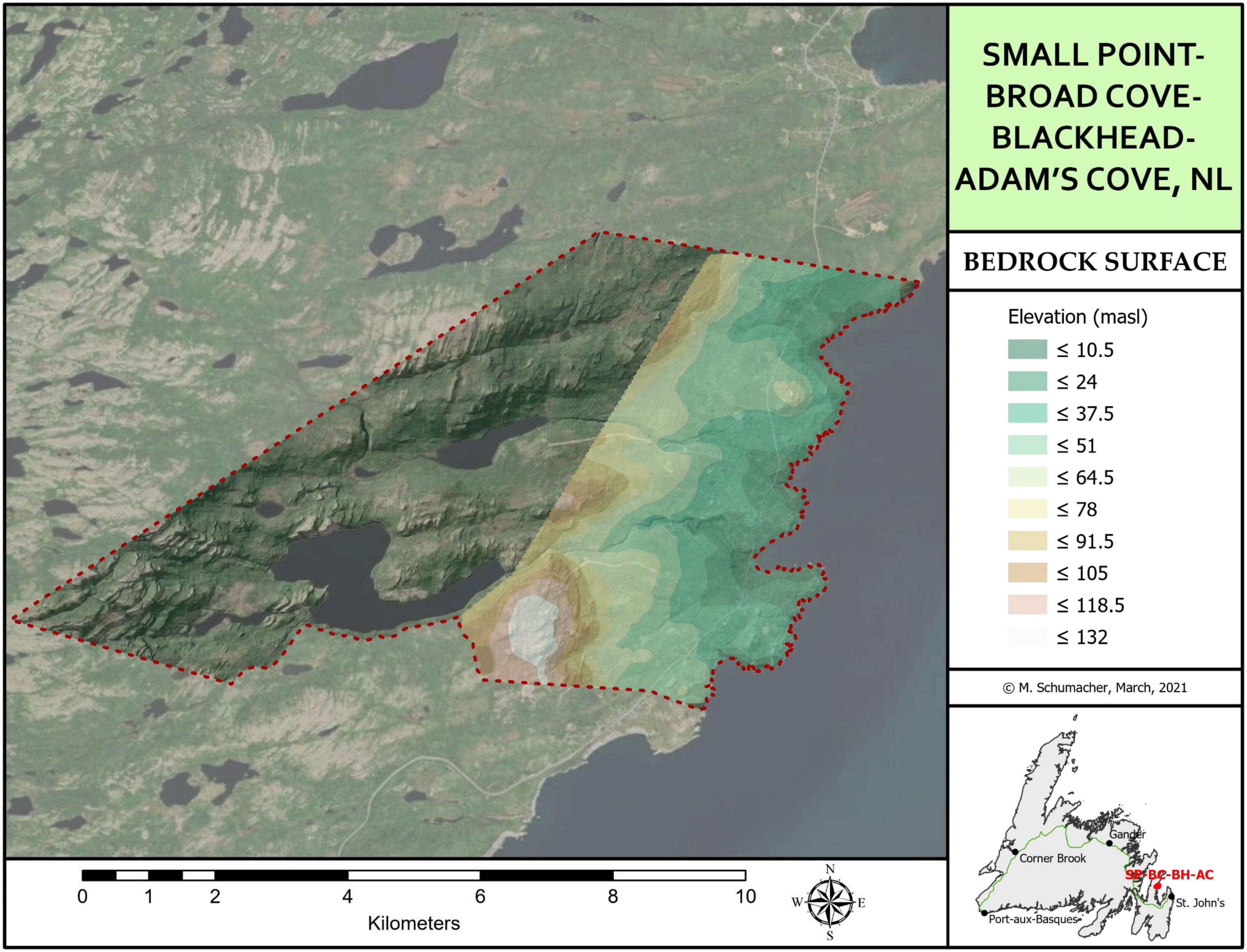
Gander
Corner Brook
SP-BC-BH-AC
St. John's
Port-aux-Basques


SMALL POINT-BROAD COVE-BLACKHEAD-ADAM'S COVE, NL
DRILLED WELL LOCATIONS
© M. Schumacher, March, 2021
Cliffy Pond
Western Bay
Small Point-Broad Cove-Blackhead
Adams Cove
Gussetts Cove
Broad Cove Pond
Broad Cove
Mulleys Cove
Spout Cove
Arch Cove
0 1 2 4 6 8 10
Kilometers
N S W E
Gander
Corner Brook
SP-BC-BH-AC
St. John's
Port-aux-Basques


SMALL POINT-
BROAD COVE-
BLACKHEAD-
ADAM'S COVE, NL
DEPTH TO BEDROCK
Sediment Thickness (m)
≤ 0.1
≤ 0.25
≤ 0.5
≤ 0.75
≤ 1
≤ 1.5
≤ 2
≤ 2.5
≤ 3
≤3.5
© M. Schumacher, March, 2021
0 1 2 4 6 8 10
Kilometers
N
W
E
S
Gander
Corner Brook
SP-BC-BH-AC
St. John's
Port-aux-Basques


SMALL POINT-
BROAD COVE-
BLACKHEAD-
ADAM'S COVE, NL
BEDROCK SURFACE
Elevation (masl)
≤ 10.5
≤ 24
≤ 37.5
≤ 51
≤ 64.5
≤ 78
≤ 91.5
≤ 105
≤ 118.5
≤ 132
© M. Schumacher, March, 2021
0
1
2
4
6
8
10
Kilometers
N
E
S
W
Gander
Corner Brook
SP-BC-BH-AC
St. John's
Port-aux-Basques