Halifax Water
Halifax Regional Water Commission

FIVE ISLAND SMALL SYSTEM WELLHEAD

SOURCE WATER PROTECTION PLAN

November 2010

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1.0 Introduction

Halifax Water is responsible for monitoring and managing all activities that may impact water quality on eleven distinct source water supplies, in order to meet the needs of customers throughout the Halifax Regional Municipality. The following document serves as the Source Water Protection Plan (SWPP) for the Five Island Small System, which uses groundwater as its drinking water source to serve nine residential customers and one commercial customer. The SWPP outlines: the current management of the wellhead protection area; risk assessment; and the management plan and monitoring program.

2.0 Description of the Five Island Water Supply Area

The following provides a brief overview of ownership and activities inside the Five Island Source Water Area.

2.0.01 Ownership and Location

The Five Island Small System is located off St. Margaret's Bay Road (Route 3), 1.1km west/northwest of Five Island Lake (and Route 3) and ~0.3km south of Highway 103. The water supply well is located at Latitude N 44°40.793', Longitude W 63°49.394'. This system supplies water to 9 residential customers and one commercial customer (Trecan Combustion Limited).

The water supply system was originally constructed in 1993, under the management of the Municipality of Halifax County to supply water to homes whose wells were at risk of contamination by discharge from a salvage yard that was located 800m down gradient from the current well. The Five Island Small System was managed by Halifax Regional Municipality County from 1993 until 1996, when the Halifax Regional Water Commission (Halifax Water) assumed operation of the system.

2.0.02 Water Supply and Treatment Facility

The small system consists of one 15.2 cm diameter drilled well at an elevation of 97m, 50m deep. A well rehabilitation was completed in November 2009, where 12.2m of 15cm diameter plastic well casing was installed with an annular seal, to prevent surface water intrusion and water migration within the space between the well casing wall and the borehole.

The facility treats the water supply using a chlorine disinfection system via sodium hypochlorite addition. An aeration system is also in place for the removal of radionucliides. There are three above-ground 4,545 L polyethylene water storage tanks and a secondary pumping system. The distribution system delivers treated water to Halifax Water customers via 100 mm diameter PVC piping.

2.0.03 Wellhead Protection Area Delineation

A wellhead protection area (WHPA) is the surface and subsurface area surrounding a water well supplying a public water system, through which contaminants are likely to move toward, and reach, such water well (USEPA, 1987). There are a number of approaches for delineating a WHPA, differing in their degree of complexity and relative precision. Methods range from assigning an Arbitrary Fixed Radius (AFR) to the use of three dimensional modelling techniques (e.g., MODFLOW).

The most practical and economical approach for delineating a WHPA is one that simplifies the groundwater flow system, while still reflecting the respective geological and hydrologic characteristics (Paradis et al., 2007). A hybrid approach involving a combination of flow mapping and analytical techniques has been recommended as

providing a reasonable representation of groundwater movement and well susceptibility to contamination, especially in fractured flow bedrock systems (USEPA, 1991; Paradis et al., 2007). The zone of capture and time of travel radii associated with the Five Island (Appendix A) wellhead were delineated using local geological characteristics, surficial features, and groundwater movement calculations assuming uniform flow conditions.

a) Geological Setting

The surficial geology in the Five Island/Hubley area is categorized as granite till veneer (Stea and Hemsworth, 1978; Finck and Graves, 1987), and classified in the Nova Scotia Soil Survey as being mainly Rockland, with areas categorized as Gibraltar Series (MacDougall et al., 1963). These soils are shallow, stony, with a sandy loam texture. Thickness of these glacial deposits is reported to range generally from 1m to 10m, averaging approximately 3m, with areas of exposed and glacially scoured bedrock.

These glacial deposits are not considered to contain major aquifers in the Hubley area. However, where the saturation thickness is greater than approximately 6m in groundwater discharge areas (i.e., bedrock hollows), sufficient water supplies of good quality water can be obtained from properly constructed wells for domestic purposes. The topography is primarily granite bedrock controlled; bedrock in this region is mapped as the Halifax Peninsula Leucomonzogranite (MacDonald and Horne, 1987). This igneous rock is light to whitish grey, pinkish to orangish-grey in colour, and is medium to coarse grained. All groundwater stored and flowing in the granitic rocks of the Hubley area is through fractured bedrock.

b) Well Head Protection Time of Travel Zones

Time of travel as a delineation criterion is based on the maximum time for a groundwater contaminant to reach a well (EPA, 1987). A series of protection zones based on increasing travel times were identified based on guidelines suggested by Nova Scotia Environment and the Ontario Ministry of the Environment (Appendix A: Figure A8). For details regarding the hydrogeological assumptions and calculations, please refer to Appendix A: Well Head Protection Delineation.

Using the guidelines, along with the calculated "moderate" groundwater velocity (Appendix A: Table A2), the overall WHPA was defined as the recharge area surrounding the water supply well, which has been divided into three time of travel zones (Table 1, below). Zone 1 (radius of approximately 125 m from the well head) represents up to a 2 year groundwater travel time zone, where both microbial and chemical contamination in this area would present the highest risk to the water supply.

The water supply is considered to be less susceptible to microbial contamination in Zone 2, representing 2 to 5 year travel time (~125 to 300 m radius from well) due to expected declines in microorganism survival; however, risks associated with chemical contamination still present a risk to source water quality.

In Zone 3, which covers the remainder of the recharge zone, the main contaminants of potential concern would be chemicals that could travel long distances to the well head and would exhibit little to no natural attenuation.

Consideration will also be given to the recharge area as a whole, as the overburden is thin, permeable, and discontinuous. In the event of a contamination event occurring anywhere within the recharge area, there is the potential for surface run-off to provide a contaminant transport mechanism to down-gradient areas that exhibit permeability within the travel time zones of immediate concern.

In addition to the time of travel zones noted above, NSE also recommends that a "well site control zone" be established to protect the wellhead from daily activities of the water utility, and any other potential risks, including vandalism. The well site control zone is recommended to be a minimum of 30 m in radius surrounding the wellhead.

Table 1: WHPA zones for the Five Island water supply area

WHPA Zone	Associated Risk	Time of Travel Distance
Zone 1: Up to 2 year travel time	Area of maximum risk to well; great care should be taken in this area in the handling of all potential contaminants. This zone is used to protect against microbial and chemical contamination; bacteria and viruses from animal and human waste, as well as hazardous chemicals are a concern in this zone	0 to 125 m
Zone 2: 2 to 5 year travel time	This zone is used to protect against all chemical contaminants (e.g., petroleum, and persistent, mobile contaminants) as biological contaminants are less of a concern due to survival expectancies.	125 to 300 m
Zone 3: 5 to 20 year travel time*	This zone is used to protect against persistent, mobile chemical contaminants (e.g., chlorinated solvents, nitrates)	300 to 1200 m*

* due to the location of the groundwater divide, the time of travel distance was limited to 1200m up gradient of the water supply well, which represents a travel time of approximately 20 years. Normally, Zone 3 would represent 5 to 25 years of travel time.

2.0.04 Current Land Use in the Five Island Well Head Area

The land uses within each delineated time of travel zone are outline below.

a) Zone 1

Zone 1 (Appendix A) covers an area of approximately 5 ha (12.4 acres); most of the land area within zone 1 is currently undeveloped and forested, including all land in this zone upgradient of the water supply well. Down-gradient of the water supply well, about 0.4 ha of an industrial development property, Trecan Combustion Ltd, is located within this zone. Trecan Combustion specializes in the design, manufacturing, and installation of industrial combustion and incineration systems.

b) Zone 2

Zone 2 (Appendix A) covers an area of approximately 23 ha (56.6 acres) beyond the land area associated with Zone 1. The area up gradient of the well head is mainly undeveloped forested land which encompasses approximately 0.3 km of Highway 103. Down-gradient of the water supply well, there are two private residences and two commercial businesses (Trecan Combustion Ltd. and Alcad Logistics & Services Ltd.) in this zone.

c) Zone 3

The remainder of the groundwater recharge area associated with the Five Island well head is within this zone. Zone 3 (Appendix A) covers an area of approximately 107 ha (277 acres) beyond that represented by Zones 1 and 2. This zone is primarily characterized by a residential subdivision located up gradient of highway 103, which encompasses approximately 108 residential properties.

2.0.05 Land Use Planning

The Five Island WHPA is located within HRM's Planning Districts 1 and 3 (St. Margaret's Bay) Land Use By-Law Area. The three land use by-law zones in the Five Island well head area are MRR-1 (Mixed Rural Residential), I-1 (General Industrial), and R-1 (Single Unit Dwelling). WHPA Zones 1 and 2 contain MRR-1 and I-1 by-law areas, while WHPA Zone 3 contains by-law areas MRR-1 and R-1. Please refer to Appendix B for the accompanying map of the by-law area locations. All land areas within the WHPA are privately owned, of which Halifax Water does not currently own any property parcels.

a) MRR-1 (Mixed Rural Residential)

This zone allows for residential, commercial, resource and community uses. Residential uses include single and multiple unit dwellings, day care facilities, home businesses, and boat houses. Allowable commercial developments include bed and breakfast establishments, as well as shops and stores (e.g., grocery/convenience, antique/craft, medical clinics, services). Agricultural, forestry, and fishery support uses, along with institutional and open spaces are also permitted.

b) The I-1 (General Industrial)

This by-law area located in the WHPA is currently owned and occupied by Trecan Combustion Ltd. By-law regulations in this area allow for any manufacturing, processing, or assembly operation that is not an obnoxious forestry industry over 300 square feet. Office and retail use accessory to any permitted development is also included. Composting operations are also permitted in this area. All other uses are also allowable, with the exception of mobile home parks, multi-unit dwellings, and senior citizen housing over 20 units. Other uses not permitted in this area include: commercial entertainment, campgrounds, intensive agriculture, extractive facilities, sawmill/industrial mills related to forestry over 3,000 square feet, salvage yards, and construction/demolition materials operations.

c) R-1 (Single Unit Dwelling)

This zone allows for single-unit dwellings, day-care facilities, and home businesses including bed and breakfast facilities. Open space uses are also permitted.

By-law details and regulations can be found on-line:
http://www.halifax.ca/planning/documents/PlanningDdistricts1and3_LUB.pdf

3.0 Risk Identification and Assessment

The following section describes activities within the WHPA, potential risks and contaminants, as well as activities conducted to date to protect the water supply area. Many of the risks remain high as the WHPA is not currently designated, and Halifax Water does not own any of the lands within the WHPA.

The aquifer in the Five Island well head area can be considered to be unconfined due to the thin and discontinuous overburden. Available sampling records indicate that raw groundwater quality at Five Island has been consistent from 2002 to present, and all parameters analyzed fall within the respective Guidelines for Canadian Drinking Water Quality as determined by Health Canada, indicating that the current groundwater supply exhibits excellent water quality characteristics. However, activities within the well head area can still present a risk to the future quality of the water supply. Potential risks associated with land uses in the WHPA are outlined below.

3.0.01 Forestry

Approximately 41 ha of undeveloped privately owned forested land lies within the WHPA zones, where 5 ha falls within zone 1 and 18 ha falls within zone 2, with the remaining 18 ha located in zone 3. Due to the proximity to the well head and shallow soils, Halifax Water considers these areas very important as a water gathering and filtration gallery. The maintenance of healthy vegetative cover is vital to the functionality of this area. Presently, there is no known forestry or land development activities scheduled for this area; however the risk remains high as there are no regulations restricting these types of activities from happening within the WHPA. Halifax Water will continue to monitor the WHPA for activities that may pose a risk

to the safety and security of the water treatment/pumping facility and distribution system and respond accordingly.

3.0.02 Mining and Agriculture

To Halifax Water's knowledge no mining or agricultural developments have taken place or are planned within the WHPA. However, the water quality risks associated with these activities are high and presents a concern to Halifax Water should they take place. Land-use planning bylaws do not identify the WHPA zones or any requirements to consult with Halifax Water. Halifax Water will continue to monitor WHPA zones for activities that may pose a risk to the safety and security of the water treatment/pumping facility and distribution system and respond accordingly.

3.0.03 Recreation

Halifax Water's ability to monitor and restrict recreational activities on the Five Island WHPA zones is limited, as Halifax Water does not own any of the lands on which the plant sits or have the governing ability to do so on the surrounding area. Therefore, Halifax Water can only assume that recreational activities that pose a risk may be taking place within the WHPA. No known recreational trails or destinations have been observed by Halifax Water staff or reported by concerned customers. Halifax Water has gated the access road and posted signage in the immediate area making users aware of the treatment plant. Halifax Water will continue to monitor the WHPA zones for activities that may pose a risk to the safety and security of the water treatment/pumping facility and distribution system and respond accordingly.

3.0.04 Public Roads and Highways

The east-bound lane of Highway 103 is within Zone 2 of the WHPA. Highway 103 is 0.3 km up-gradient of the well head and poses a risk by way of contaminants leaching through to the shallow groundwater aquifer. Contaminant concerns associated with roadways include accidental spills from traffic accidents and the accumulation of road de-icing salts that could migrate to the water table and impact groundwater quality.

A traffic accident on Route 3 occurring down gradient from the well head, and located beyond the recharge null-point may pose less of a risk to the aquifer. However, hydrogeological tests have not been done to determine hydrologic connection between this area and the well head; therefore, it is assumed the well may be at risk.

Road de-icing salts applied on Highway 103 or Route 3 may increase groundwater chloride concentrations over time; Halifax Water monitors total chloride concentrations in the treated water three times per year, and raw water annually, as part of the compliance raw water monitoring program. From this program, if chlorides are found to be above the acceptable levels, recommendations can be made to the Department of Transportation Infrastructure and Renewal and HRM, or Halifax Water can adjust its treatment process to remedy the situation.

3.0.05 Controlled Access

The access road to the facility crosses a private residential property; a grant of easement was issued in March of 1988, to allow for the installation of the well and pumping station, and subsequent access to the facility.

For security purposes, Halifax Water maintains a locked gate at the access road to the treatment facility, limiting unauthorized vehicle access. In the spring of 2009, nearby construction activity took place; Halifax Water was concerned that the use of heavy equipment on the access road, combined with spring thaw, would potentially damage the water main located directly below. A letter was sent to the property owner informing them of the water main location, and requested that every precaution be made to prevent road breakage from occurring. The security gate was also temporarily removed by the contractors during construction activity. The gate has since been moved and upgraded.

Halifax Water will continue to monitor WHPA for activities that may pose a risk to the safety and security of the water treatment/pumping facility and distribution system and respond accordingly.

3.0.06 Land-use Planning

The Five Island WHPA zones fall within HRM's District 1 and 3 (St. Margaret's Bay Region). Unfortunately, the risk of water quality impairment is considered to be very high as the regions by laws do not identify the water treatment facility or the WHPA. The region is comprised of three by law zones, MRR-1 (Mixed Rural Residential), I-1 (General Industrial), and R-1 (Single Unit Dwelling), which allows for a wide variety of developments. Halifax Water plans to investigate potential amendment possibilities of the HRM regions by-laws to include the WHPA for future development purposes.

3.0.07 Residential

There are currently two homes located within Zone 2 of the WHPA; as septic systems and furnace oil tanks may not be adequately maintained, the residential area is included as a concern. One of the homes within the WHPA has a heating oil tank, stored outside, that appears to be in good condition. However, heating oil tanks have an inherent risk of failing if improperly installed or maintained. Also, any spill during fuel transfer is a potential source of contamination. The second home presents no threat as it uses an electric hot water heat boiler system.

Home heating oil tanks that are exposed to weather, not installed properly, or shifted at their base from frost action, can cause environmental problems. Even though the single residential oil storage tank appears to be in good condition, it is unknown if it has a stable base or if there is a protective shield over line connections which are a current requirement of insurance companies (this tank was viewed from the property line). This tank is also exposed to weather, which may limit its operating time.

Both homes rely on septic systems for domestic wastewater treatment; wastewater could impact the ground water supply if the system was improperly installed, if

wrong materials enter the system, if there is surface damage to the drainage field, or if contaminants leach from the field to groundwater through bedrock fissures. These homes are located beyond the estimated 2 yr time of travel zone, which minimizes the risk of microbial contamination reaching the water supply well should a failure occur. However, pathogenic microorganisms could move more quickly than anticipated by the time of travel estimates due to the fractured bedrock nature of the aquifer, or if surface-groundwater interactions take place.

Additional potential concerns associated with residential areas include the use of fertilizers, household products, driveway/road salt, and other chemicals. However, it is expected that the quantity of lawn and garden products potentially used at this home is very small and does not pose a substantial risk to the quality of the raw water.

Residences located in the subdivision located up-gradient of Highway 103 also rely on septic systems for the treatment of domestic wastewater. This subdivision has been recently developed (circa 2000 to present) and the on-site waste treatment systems would therefore required to be constructed in compliance with NSE's On-Site Sewage Disposal Regulations. Due to the long travel time required for groundwater from this subdivision to reach the water supply well, microbial contamination risk associated with this area can be considered to be minimal. However, many of these homes would likely rely on oil-fired heat; risks from tank spills or failure could pose a risk to the water supply well due to the potential persistence and movement of petroleum products in a fractured bedrock aquifer. Another concern is the potential use of household chemicals associated with the subdivision residences; persistent, mobile chemicals could present a long-term risk to source water quality (e.g., nitrate, chloride, petroleum products, some pesticides and solvents) if used in great enough quantities over the groundwater recharge area.

3.0.08 Commercial

A storage yard for a metal fabrication company on St. Margaret's Bay Road, Trecan Combustion Ltd., falls within all three zones of the WHPA. Heavy equipment and some fuels are stored on site that could impact the water supply in the event of a spill or improper storage.

A second commercial business falls within Zone 2 of the WHPA, Alcad Logistics & Services Ltd., is a wood pallet re-fabrication and distribution facility.

These businesses also have on-site waste systems to treat domestic wastewater. Fuel storage and on-site septic treatment present the same concerns as outlined for the residential properties within Zone 2, above.

3.0.09 Treatment Facility

The production well, treatment, and storage system are currently housed within a locked building; access to the system is limited to approved Halifax Water personnel. There is no fuel or hazardous chemical storage located on-site. Raw water is

disinfected via sodium hypochlorite, which is transported and transferred to the system application reservoir in small quantities (~8 L) on an "as needed" basis.

3.0.10 Chemicals

Halifax Water does not support the use of chemicals on any of its source water areas including the Five Island WHPA other than for water treatment purposes. Currently the risk of chemical contamination is considered to be high, primarily due to the fact that the lands within the WHPA are not owned by Halifax Water or protected by legislation. Halifax Water will investigate the potential of amending municipal by-laws or purchasing lands within Zone 1 of the WHPA.

3.0.11 Emergencies

In the event of an emergency, Halifax Water's *Emergency Response Manual* must be followed. A copy of the manual and emergency-contact list can be found at Halifax Water's main office located at 450 Cowie Hill Road in Halifax. Emergencies that pose the greatest threat to water quality in the Five Island WHPA are accidental spills associated with highway accidents or residential/business activities, natural disasters such as hurricanes or fires, and malicious intent.

a) Accidents and Spills

Due to the proximity of residential and industrial areas along with transportation routes, the threat of an accidental chemical emergency remains high. First Responders are responsible for responding to an accident or spills occurring on the roadways. The local RCMP office out of Timberlea has been contacted and made aware of the Five Island Source Water Area; a map and contact information has been provided to the detachment. In the event of an emergency, Halifax Water will cooperate with First Responders; however, Halifax Water's *Emergency Response Manual* will be followed.

b) Natural Disasters

The geology of the area, shallow soil with exposed bedrock, in combination with the existing poor vegetative cover place the source water area at risk of natural disasters such as fire, insect, disease and wind damage. Currently Halifax Water does not own any of the lands within the Five Island source water area and rely heavily on public reporting. Signage is placed along the treatment plant road identifying the plant and who to contact in case of an emergency. As well a map of the source water area is located at the Waverly NSDNR office which is responsible for responding to forest fires in the area.

Forest fire reporting protocol and procedures fall under the provincial forest fire protection regulations. In addition, the NSDNR hotline (1-800-565-2224) is to be included in new signage scheduled for the Source Water Area in 2010.

In the case of a fire occurring within the water-treatment plant, Halifax Water's *Emergency Response Manual* will be followed. A copy of

the manual can be found at the main office located at 450 Cowie Hill Road in Halifax.

c) Malicious Intent

Security at Halifax Water is taken very seriously. Access is restricted to the well head and treatment facility, regular patrols are performed, and a water-sampling program has also been developed and implemented to ensure the safety of HRM's drinking water. Halifax Water has completed an industry-developed risk assessment for its facilities and its security measures. The procedures were designed based on this assessment to reduce the probability, increase the likelihood of detection, and lessen the impact of event.

3.1 Contaminants and Risk

Table 2 identifies the known and potential activities that take place within the WHPA and summarizes the potential contaminants involved, point or non-point source pollutant and potential impact.

Table 2: Summary of current and potential activities within the wellhead protection area.

Activity	Potential Contaminant	Point Source	Non-Point Source	Potential Impact	WHPA Zone Affected
Forestry operations: harvesting, silviculture, road maintenance and construction.	Fuel, hydraulic fluid, sedimentation of streams	X		Oil, fuel or hydraulic spill would likely be limited to immediate area as there are usually limited quantities of these fluids, unless there was direct discharge to stream. Sedimentation of stream may occur if culvert fails and road is washed away. Exposure of acid bearing slate could impact lake PH-levels. BMP does typically help control impact from road construction and maintenance.	1, 2, 3
Recreation:, OHV's, pedestrian activities	Fuel, sedimentation of streams, garbage		X	Fuel in streams and lakes, stream-bank erosion and sedimentation of streams from OHV use. Pedestrian activity is light impact and sometimes results in garbage left behind.	
Roads: Route 3 and Highway 103	Hazardous chemical spill, hydrocarbons, vehicle fluids, road salts		X	Spill on Highway 103 or Route 3 within the WHPA, or beyond, may affect ground water supplies depending on hydrogeology in the area.	2, 3
Land-use planning, Halifax Regional Municipality: commercial business, residential, agrcuture	Automotive fluids and exposure of soils. Commercial and residential chemicals used in lawn and septic care. Septic field failure, overflowing septic tanks as a result of going un-pumped, furnace oil tank failure, other petroleum products.		X	Hydrocarbons seeping to ground water table. If septic system fails, possible source for bacteria and nitrates to enter ground water supply. Currently there is zero risk of agricultural contamination as the activities associated with it have not yet been established inside the WHPA	1, 2, 3
Chemicals: forestry, caustics, commercial, residential	Biocide, fungicide, insecticide, herbicide, diesel	X		Forestry, residential and commercial use	1, 2, 3
Natural disaster: Fire, Wind, Insects	Chemicals, pathogens, turbidity		X	Soil erosion, increased turbidity.	1, 2, 3
Malicious intent	Terrorism, vandalism, sabotage	X		Total shutdown of water-treatment plant and long-term damage to the water supply.	1, 2

3.2 Identified Issues Prioritized

Table 3 shows the scale of problem and priority ranking associated with known and potential activities within the WHPA. Issues of priority concern are potential fuel spills and septic system failures.

Table 3: Scale of current and potential problems and priority rank of activities within the wellhead protection area.

Activity	Contamination Issue	Scale of Problem*	Priority Rank**
Forestry operations: harvesting, silviculture, road maintenance, construction.	1) Fuel and hydraulic fluid 2) Sedimentation of streams 3) Exposure of acid bearing slate	1) 5 2) 5 3) 3	1) 1 2) 1 3) 1
Recreation: OHV's, pedestrian activities	1) Fuel, sedimentation 2) Garbage	1) 5 2) 5	1) 4 2) 4
Public roads and highways	1) Fuel, automotive fluids, dangerous goods 2) Road salting	1) 4	1) 1
Trecan Combustion Ltd and Alcad Logistics & Services Ltd.	1) Fuels 2) Chemicals 3) Septic field failure	1) 4 2) 4 3) 3	1) 1 2) 1 3) 2
Residential areas	1) Septic field failure 2) Furnace oil tank failure 3) Chemicals	1) 3 2) 3 3) 5	1) 2 2) 2 3) 1
Agriculture	1) Manure fertilization 2) Pesticides	1) 5 2) 5	1) 2 2) 2
Chemicals:	1) Forestry 2) Residential 3) Commercial	1) 3 2) 3 3) 3	1) 1 2) 1 3) 1
Natural disaster	1) Fire	1) 2	1) 1
Malicious intent	1) Hazardous materials	1) 4	1) 2

**Scale of Problem rank: 1=severe, 3=moderate, 5=minimal*
***Priority rank: 1=high, 3=moderate, 5=low*

4.0 Management Plan

As the Five Island WHPA is not a designated water supply area, the goal of the source water protection program is to gain support and cooperation via stewardship and awareness initiatives. The source water protection program is mainly comprised of public communication and awareness, promotion of best management practices, contingency planning, and water quality monitoring.

The source water protection strategy, which includes the implementation strategy, along with contingency and emergency measures, is presented below. The Source Water Protection Plan is reviewed annually to ensure proper implementation is being followed. A major review is conducted every five years to evaluate and make necessary changes to the plan.

4.1 Implementation Strategy

Halifax Water considers watershed management to be the first step in the multiple barrier approach to water quality management. Halifax Water has set objectives for the strategy implementation, including land acquisition, BMP's, conducting patrols and enforcement, as well as a guided sampling program. Halifax Water and the NSE have agreed to

implementation timelines. Halifax Water will inform the NSE of any required changes to those timelines.

4.1.01 Land Acquisition Program

Halifax Water has found the most effective management tool is ownership; therefore, as they arise, Halifax Water will continue to investigate all opportunities to purchase private lands within the WHPA with priority given to lands that fall within Zone 1. By owning the lands, Halifax Water is able to control all activities conducted on them

4.1.02 Best Management Practices

Halifax Water has developed and implemented BMP's for activities that include forestry, aggregate removal, recreational, heavy equipment, and various other activities (Appendix C) with water quality in mind. It is a requirement for people working on company or crown lands managed by Halifax Water to follow the BMP's. Halifax Water will make available and promote its BMP's via public communication and awareness efforts, as outlined in section 5.1.03, below.

4.1.03 Public Communication and Awareness

Halifax Water's communication and awareness program is an effective way to inform the public about watershed news.

Currently, there are regulatory signs posted in the WHPA advising that trespassing and hunting activities are not permitted. To enhance and maintain awareness about the WHPA, Halifax Water is investigating the posting of public awareness signage along Route 3 at the wellhead access location to indicate that area users are in a well head area. Public awareness signage, if feasible at this location, is expected to be completed by August 2010.

The WHPA resident(s) and business are responsible for the condition of their fuel storage tanks; most insurance companies require that tanks be replaced every 10 years and measures taken to protect tank from the elements. The WHPA resident and business are also responsible for the condition and functioning of their respective septic systems so that they do not fail and discharge domestic wastewater contaminants on the surface or allow leaching to shallow groundwater.

Halifax Water is not responsible for the condition of the septic systems and fuel storage tanks within the WHPA; however, it would be prudent that the residents in the WHPA are informed of the environmental issues associated with fuel spills or septic system failure, and ways they can avoid such a problem.

As there are both industrial and residential activities within the WHPA area, Halifax Water will prepare an information package for the customers and

stakeholders. The objective of the communication will be to inform them that they are located within a WHPA, outline the potential impacts of fuel spills, septic treatment failure, and other detrimental activities on water supplies, and outline preventative measures they can take to avoid such occurrences. Public communication and outreach will be developed in early 2010 with the intent to encourage cooperation between Halifax Water, customers, and stakeholders to ensure quality drinking water supplies.

4.1.04 Watershed Committee

Halifax Water is currently investigating the potential need for a WHPA advisory board as there is not one currently in place for Five Island WHPA. If it is determined that a board would be useful to have in place, Halifax Water will accordingly develop and facilitate an advisory committee comprised of water users and stakeholders in the WHPA.

4.1.05 Regulations and By Laws

Halifax Water continually investigates new opportunities for provincial legislation and local bylaws to be strengthened or created to enhance the protection of drinking water. The Five Island WHPA is currently not designated as a protected drinking water supply, but is subject to the rules and regulations under the NS Environment Act and municipal by laws. Halifax Water works with the local authorities to enforce and enhance acts, regulations, and by laws that are applicable within the water supply areas.

4.1.06 Controlled Access

Halifax Water maintains fences, gates, barriers and signs to limit the access to watershed lands including the Five Island treatment plant. Halifax Water will continue to monitor these areas and, when required, hire private security companies to be on-site during high-traffic times. Halifax Water encourages local users to report illegal activities using the information provided on signs throughout the watersheds.

4.1.07 Public Roads and Highways

For all public roads and highways that fall within the WHPA, Halifax Water maintains open communication with HRM and TIR staff and an updated list.

4.1.08 Emergencies

For all emergencies that fall within the WHPA, Halifax Water maintains open communication with the first responders responsible for the area and provides them with an update contact list.

4.1.09 Chemicals

Halifax Water will investigate contacting local government; make them aware of the WHPA, and to further investigate restricting the use of chemicals for certain uses.

4.2 Contingency Planning (Mitigation, Preparedness, and Response)

4.2.01 Public Communication and Reporting

The mitigation of risks to the raw water supply will be primarily through education and awareness in the WHPA. Halifax Water will continue to make the users and stakeholders aware of the WHPA via signage, newsletters or fact sheets, and website links.

4.2.02 Land Use Planning Communication

Halifax Water maintains regular and open communication with HRM and TIR to exchange information regarding potential developments or scheduled events in the water supply area that could pose a threat to source water quality.

4.2.03 Five Island Treatment System and Operations

Halifax Water has plant operations staff dedicated to maintenance of the treatment plant facility on at least a weekly basis in order to keep systems operating and treating water to meet guidelines. There is currently a contingency plan in place which falls under the Halifax Water *Emergency Response Manual* if there is a mechanical failure at the treatment facility that prevents water from being supplied, or if there are problems found with the raw water supply. A copy of the manual can be found at the Halifax Water main office located at 450 Cowie Hill Road in Halifax.

The continued monitoring of the raw water (see Section 6.0 Raw Water Monitoring) according to the Water Quality Sampling and Permit Compliance Manual also contributes to Halifax Water's ability to detect impact.

The Supervisory Control and Data Acquisition system (SCADA) monitors the mechanics of the treatment process. If a problem is detected, a message is relayed to Halifax Water Plant Operations staff via cell phones for personnel to correct the mechanical problem.

4.2.04 Controlled Access

The Five Island well head and treatment system is housed within a locked facility only accessible by approved Halifax Water personnel. Halifax Water also maintains a gate which limits vehicular access to the wellhead and treatment facility location. Halifax Water will continue to monitor these areas and, when required, enhance security measures as needed. Halifax Water encourages local users to report illegal activities using the information provided on signs in the immediate well head area.

4.2.05 Public Roadways

Highway 103 Route 3 are both considered low to moderate risk to the water supply; the roadways are mainly located beyond Zone 2 of the WHPA in areas of flat topography and low regional hydraulic gradient. Currently, there

are no mitigative measures in place. In the event of an emergency as a result of a spill or accident, Halifax Water's *Emergency Response Manual* will be followed. A copy of the manual can be found at Halifax Water's main office located at 450 Cowie Hill Road in Halifax.

4.2.06 Land Use Planning and By Laws

Currently, one of the biggest threats to the water supply is the lack of provincial and municipal legislation restricting activities within the WHPA. Halifax Water will consult with HRM and provincial government bodies to create awareness of groundwater quality concerns to consider during the planning and permit application processes.

4.2.07 Chemicals

If a deleterious chemical enters the Five Island water supply, as a result of Halifax Water operations or otherwise, Halifax Water's *Emergency Response Manual* will be followed. A copy of the manual can be found at Halifax Water's main office located at 450 Cowie Hill Road in Halifax.

4.2.08 Emergencies

Residents with concerns or an emergency can contact their respective municipal office/first responders (911) or Halifax Water (902-490-6940) to report the incident so Halifax Water can activate its emergency-response plan.

In case of an emergency, the Halifax Water emergency-response plan must be followed. A copy of the manual, and an up-to-date contact list and map, are kept at A copy of the manual can be found at Halifax Water's main office located at 450 Cowie Hill Road in Halifax.

4.2.09 Back Up Emergency Supply

In the event of raw water contamination (non-pathogen) or power failure, two in-house water tanks can supply customers by gravity feed for an approximately 24 hour period, after which treated water would be transported in to supplement the system.

Emergency procedures are in place for shutting down the Five Island Water Supply Plant, public notification, customer restrictions, emergency plant start-up, etc., of which all treatment plant operators and engineering staff are fully aware. These procedures are located at Halifax Water's main office at 450 Cowie Hill Road in Halifax.

5.0 Monitoring Program

Halifax Water monitors the immediate Five Island WHPA (Zone 1); however, there is no WHPA legislation in place to ensure the protection of the WHPA. Presently the monitoring program consists of posting signs, encouraging the public to report any illegal or suspicious activities to Halifax Water, and conducting raw water

sampling. Halifax Water will revise the monitoring program as new challenges surface.

Halifax Water currently follows the Water Quality Sampling and Permit Compliance Manual that details sampling and reporting procedures for each of the systems HRWC manages. In addition to the requirements for maintaining operating permits, HRWC must meet provincial regulations that specify quality standards for water produced, as well as meet or exceed the Guidelines for Canadian Drinking Water Quality (GCDWQ).

Specific to raw water monitoring, Halifax Water's Compliance Inspectors undertake regular sampling at each of its raw water supplies. At the Five Island water supply, sampling and testing is conducted annually for all parameters listed in the GCDWQ. Additional samples are collected twice per year for PCB's, pH and turbidity. Raw water quality sampling program at Five Island is outlined in Table 4, below).

Table 4: Raw Water Monitoring Program Conducted at the Five Island Small System

Timing	Parameters
2nd Week of September	GCDWQ Water Quality Parameters
Last Week of May and November	Turbidity pH
2nd Week of December and June	PCBs

The GCDWQ sampling covers a broad spectrum of both public health related and aesthetic water quality parameters, as outlined by Health Canada. Details can be found via Health Canada's website:
http://www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/guide/index-eng.php

Turbidity: is a visual property of water, a measurement of light scattered and absorbed due to the presence of suspended material (e.g., organic or inorganic particles). Turbidity itself is has no health effects; however, high levels of turbidity may indicate the presence of pathogens, and can interfere with disinfection. Increases in turbidity, especially following rainfall events, may also indicate surface water intrusion into the groundwater supply.

pH level: is an indicator of the acidity, or alkalinity, of the water source. pH levels affects the taste of water, as well as the solubility of many minerals, metals, and other chemicals. The monitoring program is intended to establish baseline conditions and track changes in pH; changes in pH could indicate a shift in groundwater quality due to changes in recharge area characteristics.

Water monitoring results will be regularly examined by Halifax Water to determine if there are changes or degradation in raw water quality; this evaluation will be used to determine if remedial action is needed in the WHPA, or if changes in the monitoring protocol are required.

PCBs: stands for Polychlorinated Biphenyls, a class of organic compounds that were widely used in transformers, capacitors, coolants, and other industrial materials. PCBs can cause a number health effects, including cancer. Monitoring for PCBs at the Five Island small system is reflective of the salvage yard contamination event that occurred 800 m down gradient of the well head, to ensure there has been no migration to the wellhead. To date, PCBs have not been detected in the groundwater supply.

6.0 Evaluation and Updating

An assessment of the management plan is performed annually, evaluating the assumptions, known risks, suitability of monitoring program, and review monitoring results, to identify if any changes should be made. Halifax Water evaluates the source water protection plan at the end of the fiscal year (March 31) in any year, to identify any new risks in the water supply area or lessons learned over the previous year.

Updates that may be required in the protection plan are then initiated and completed by the team responsible for small water supply systems. In addition, the Superintendent of Plant Operations is responsible to oversee the investigation of events that have potential to impact the source water, and document findings. The source water protection plan is then updated accordingly.

7.0 Acknowledgements

Halifax Water would like to thank its diverse staff for its professional support in the Source Water Protection Program; in particular, Carl Yates, Reid Campbell, Dave Duggan, Barry Geddes and Terra Jamieson. Having people involved who believe in a goal and follow it through help create a positive learning and working experience for all those involved in the process.

8.0 References

Fetter, C.W. 2001. Applied Hydrogeology. 4th Ed. Prentice-Hall, Inc. Upper Saddle River, NJ. 598 pp.

Finck, P.W., and R.M. Graves. 1987. Glacial Geology of Halifax and Sambro Area, Map 87-2. Scale 1: 50,000. Nova Scotia Department of Mines and Energy.

MacDonald, M.A., and R.J. Horne. 1987. Geological Map of the Halifax and Sambro Area, Map 87-6. Scale 1: 50,000. Nova Scotia Department of Mines and Energy.

MacDougall, J.I., D.B. Cann, and J.D. Hilchey. 1963. Soil Survey of Halifax County Nova Scotia. Report No. 13, Nova Scotia Soil Survey, Truro, NS.

Ministry of the Environment for the Province of Ontario.2001. Protocol – Delineation of Wellhead Protection Areas for Municipal Protection Areas for Municipal Groundwater Supply Wells under Direct Influence of Surface Water.
http://www.ene.gov.on.ca/en/publications.water (accessed Sept. 2009)

Paradis, D., R. Martel, G. Karanta, R. Lefebvre, Y. Michaud, R. Therrien, M. Nastev. Comparative Study of Methods for WHPA Delineation. Ground Water. 45:158-167.

U.S. Environmental Protection Agency (USEPA). 1987. Guidelines for Delineation of Wellhead Protection Areas. Office of Ground-Water Protection, U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency (USEPA). 1991. Delineation of Wellhead Protection Areas in Fractured Rocks. Wisconsin Geological and Natural History Survey. Ground Water Protection Division, Office of Ground Water and Drinking Water, U.S. Environmental Protection Agency.

Stea, R.R., and D. Hemsworth. 1980. Pleistocene Geology - Central Nova Scotia. Sheet 4. Government of Canada and the Province of Nova Scotia