Halifax Water
Halifax Regional Water Commission

SILVER SANDS SMALL SYSTEM WELLHEAD

SOURCE WATER PROTECTION PLAN

December 2011

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1. 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 Silver Sands Small System, which uses groundwater as its drinking water source to serve approximately 40 customers. The SWPP outlines the description and management of the wellhead protection area, risk assessment, and the management plan and monitoring program.

2. DESCRIPTION OF THE SILVER SANDS WATER SUPPLY AREA

The following provides a brief overview of ownership and activities inside the Silver Sands Water Supply Area.

2.1. Ownership and Location

The Silver Sands Small System is located at 11 Dyke Road in the Eastern Passage/Cow Bay area, at Latitude N 44o37'29.19", and Longitude W 63o26'45.188". This system supplies water to approximately 40 residential customers in the Silver Sands subdivision.

The water supply and distribution system was originally developed and owned by the Silver Sands Water Utility. Ownership was acquired by Halifax Water in 1998.

2.2. Water Supply and Treatment Facility

The existing water supply consists of a 15.2 cm diameter drilled well at an elevation of 23 m, 88 m deep. A well rehabilitation was completed in July 2008, where 18.2 m of 15 cm PVC 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. An additional well, the Spruce Drive Small System Well, was drilled adjacent to the treatment facility in September 2009; this well is intended to serve as an additional water supply should the pumping capacity of the primary well be exceeded.

The facility treats the water supply with pressure greensand filters (iron removal), chlorine disinfection via sodium hypochlorite addition, and caustic soda to adjust the pH. The distribution system delivers treated water to Halifax Water customers via 100mm diameter PVC 38mm polyethylene piping.

2.3. 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 zones associated with the Silver Sands (Appendix A) wellhead were delineated using local geological characteristics, surficial features, and groundwater movement calculations assuming uniform flow conditions.

2.3.1. Geological Setting

The topography is primarily metamorphic rock of the Meguma group (Keppie, 2000); the immediate wellhead area is underlain by the Halifax Formation. The bedrock makes contact with the Goldenville Formation located approximately 300m northwest of the Silver Sands subdivision. The Halifax formation consists of slates, siltstone, and minor sandstone. The Goldenville formation is mainly characterized by sandstone turbidites and slate. All groundwater stored and flowing in the aquifer of the Cow Bay area is through fractured bedrock.

The surficial geology in the Silver Sands area is categorized by two different glacial till deposits (Stea and Dickie, 1977); the region east of Cow Bay Road has been classified as Quartzite till, while the western region is classified as Lawrencetown till. Quartzite till is comprised of approximately 80% sand, 15% silt, and 5% clay, and is described as a loose, cobbly silt-sand. The Quartzite till overburden is ground moraine with an average 3 m thickness, with a maximum thickness of 20m. Lawrencetown till is a moderately compact clay till made up of 25% sand, 50% silt, and 25% clay. These surficial deposits have an average thickness of 8 m and are characterized by ground moraines and drumlins that can be 25 to 35 m thick.

According to the Nova Scotia Soil Survey (MacDougall et al., 1963), soils in this area are mainly from the Bridgewater, Aspotogan, and Rockland Series. Thickness is estimated from 0.5–5 m. Some areas include exposed bedrock and thicker till deposits (>5 m) of locally derived till. The Bridgewater series, located immediately up-gradient from the wellhead, are a medium textured shaley loam. Aspotogan soils are moderately coarse textured gravelly sandy loam that are generally shallow and stony. Rockland areas have bedrock exposed on at least 60% of the land surface, or the till is extremely shallow or stony. Sediments were deposited by ice and derived from sub glacial erosion (map sourced from http://www.gov.ns.ca/natr/meb/data/mg/ofm/pdf/ofm_2011-012_d447_dp.pdf).

2.3.2. Wellhead 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 A4). For details regarding the hydrogeological assumptions and calculations, please refer to Appendix A: Wellhead Protection Delineation.

Using the guidelines, along with the calculated 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 outlined in

Table 1, page 9. Zone 1 (radius of approximately 500 m from the wellhead) 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 (~500 to 1200 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 wellhead 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 Silver Sands Water Supply Area.

WHPA Zone	Associated Risk	Time of Travel Distance
Zone 1: Up to 2 year travel time	This is a zone of maximum risk to the well. Great care should be taken here in the handling of all potential contaminants. This zone is defined to protect against microbial and chemical contamination. Bacteria and viruses from animal and human waste and hazardous chemicals are a concern in this zone.	0 to 500 m
Zone 2: 2 to 5 year travel time	This zone is delineated to protect against all chemical contaminants (e.g., petroleum, and persistent, mobile contaminants) as biological contaminants are less of a concern due to their survival expectancies.	500 to 1200 m
Zone 3: 5 to 10 year travel time*	This zone is used to protect against persistent, mobile chemical contaminants (e.g., chlorinated solvents, and nitrates).	1200 to 2500 m*

* Due to the location of the groundwater divide, the time of travel distance was limited to 2500m up-gradient of the water supply well, which represents a travel time of approximately 10 years. Normally, Zone 3 would represent 5 to 25 years of travel time.

2.4. Current Land Use in the Silver Sands Wellhead Area

The entire WHPA covers approximately 298 ha of land area; around 220 ha of the WHPA area is currently undeveloped. The land uses within each delineated time of travel zone are outlined below.

2.4.1. Zone 1

Zone 1(Appendix A) covers an area of approximately 51 ha (126 acres); most of the land area within Zone 1 is residential, and includes the Silver Sands subdivision. There is a storage yard containing building materials located approximately 150 m down-gradient, and an automotive repair shop within 100 m up-gradient, of the water supply well. Approximately 2 km of public roadways (portions of Dyke Rd, Cow Bay Rd, Spruce Dr, and Silver Crt) are also located within the Zone 1 area.

2.4.2. Zone 2

Zone 2 (Appendix A) covers an area of approximately 115 ha (284 acres) beyond the land area associated with Zone 1. Of this area, approximately 35% (~40 ha) is residential development. Approximately 1.3 km of public roadways are also located within this zone.

2.4.3. Zone 3

The remainder of the groundwater recharge area associated with the Silver Sands wellhead is within this zone. Zone 3 (Appendix A) covers an area of approximately 132 ha (326 acres) beyond that represented by Zones 1 and 2. Approximately 5% of this area is residentially developed (~6.5 ha); the remaining land base is currently undeveloped and forested.

2.5. Land Use and Planning

The Silver Sands WHPA is located within HRM's Eastern Passage/Cow Bay Land Use By-Law Area. There are six By-law zones located within the WHPA: Rural Area (RA), Local Service (I-3), Floodplain (FP), Environmental Conservation (EC), Protected Area (PA), and Comprehensive Development District (CDD). Zone 1 contains CDD, FP, and RA; Zone 2 contains FP, RA, I-3, EC, and PA; Zone 3 is PA, RA, and FP. Please refer to Appendix B for the accompanying land use by-law map. The permitted activities within each By-law zone are described below.

2.5.1. RA (Rural Area)

Rural Area allows for single unit dwellings and existing mobile dwellings, bed and breakfasts or home business uses, and open space uses. Forestry, agriculture, and fishing uses are also permitted.

2.5.2. I-3 (Local Service)

Local service allows for equipment sale/rental outlets, auto repair/body shops, trade contractive services and shops, trucking/landscaping/excavating and paving services, and cement work services/manufacturing. Residential uses are also permitted that include single unit, mobile, and two unit dwellings, along with bed and breakfast establishments.

2.5.3. EC (Environmental Conservation)

Environmental Conservation is restricted to conservation and passive recreation uses, as well as historic sites and monuments.

2.5.4. FP (Floodplain)

Floodplain permitted uses includes forestry and agriculture (involving no buildings), passive recreation, historic sites and monuments, public parks/playgrounds, and conservation uses.

2.5.5. PA (Protected Area)

Protected Area only allows for development related to scientific study and education (involving new buildings), trails, boardwalks or walkways, and conservation uses.

2.5.6. CDD (Comprehensive Development District)

Comprehensive Development District uses are limited to residential, local commercial, community facilities and/or parks in association with residential uses, which comprise a development of five or more acres. Major commercial uses and any industrial uses are specifically prohibited. No development permit shall be issued in this area except in accordance with development agreement provisions.

More By-law details and regulations can be found on-line:

http://www.halifax.ca/planning/documents/EasternPassageCowBay_LUB.pdf

3. 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 under provincial legislation, and Halifax Water does not own any of the lands within the WHPA, with the exception of the property parcel associated with the well and treatment facility.

Sampling records indicate that raw groundwater quality at Silver Sands has been consistent since the well rehabilitation in 2008, and most parameters analyzed fall within the respective Guidelines for Canadian Drinking Water Quality as determined by Health Canada, indicating that the current groundwater supply exhibits good water quality characteristics. However, elevated concentrations were measured for iron, manganese, and turbidity.

Close attention should be paid to the aquifer in the Silver Sands wellhead area as it may be vulnerable to surface water interactions due to the shallow, discontinuous overburden, and evidence of groundwater turbidity concentrations that routinely exceed 1.0 NTU.

Potential risks identified and assessed in association with land use activities in the WHPA are outlined in the following subsections.

3.1. Forestry

Approximately 220 ha of undeveloped privately owned forested land lies within the WHPA zones, whereby approximately 13 ha fall within Zone 1, 75 ha fall within Zone 2, and the remaining 132 ha fall within Zone 3. Due to the proximity to the wellhead and shallow soils, Halifax Water considers these areas very important as a water gathering and filtration gallery. The maintenance of healthy vegetative cover is important to the functionality of this area. Presently, there is no known forestry or land development

activities scheduled for the undeveloped areas, however, the risk of disturbance is high as there are no regulations restricting these types of activities within approximately 80% of 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.

3.2. Mining, and Pits and Quarries

To Halifax Water's knowledge, no mining developments have taken place or are planned within the WHPA. However, mining activities may be permitted under the *Mineral Resources Act. 1990, c. 18, s. 1,* unless the Minister directs restriction of mining activity as per subsection 21(1)[1] of the *Act.*

The water quality risks associated with mining, and pits and quarry activities include high water usage affecting groundwater quantity, chemical pollution, alteration of hydrology, acid rock drainage, and heavy metal contamination. Such risks are high and present a concern to Halifax Water should they take place. 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.

3.3. Recreation

Halifax Water's ability to monitor and restrict recreational activities in the Silver Sands WHPA zones is limited. Halifax Water only owns the property parcel on which the treatment facility sits, and does not have governing authority over the surrounding area. Therefore, Halifax Water cannot monitor activities in the surrounding area and can only assume the recreational activities that pose a risk are taking place within the WHPA.

Halifax Water has gated the access road and posted signage in the immediate area making users aware of the treatment plant. However, there has been evidence of trespassing on Halifax Water property. 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.

3.4. Public Roads and Highways

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[1] Subsection 72(1) of the Act additionally states: For the purposes of subsection 21(1) of the Mineral Resources Act. 1990, c. 18, s. 1. the Minister may direct that any lands within an area designated by the Minister are restricted from any or all prospecting, exploration, development or mining with respect to the minerals specified in the direction and for such time as the Minister may specify.

Furthermore, Subsections 11 and 13 of the Hebb, Milipsigate and Minamkeak Lake Watershed Protected Water Area Regulations, NS Reg 113/2006, <http://canlii.ca/t/lczh> retrieved on 2011/11/24 provide regulations associated with mining, and pits and quarries. Note: this case is in reference to a designated watershed not a designated wellhead area.

Portions of Cow Bay Road, Dyke Road, and other residential streets intersect Zones 1 and 2 of the WHPA. These roadways are located up-gradient of the wellhead, and are considered to carry a potential contamination risk. Contaminant concerns associated with roadways include accidental spills from traffic accidents and the accumulation of road de-icing salts that could migrate to the shallow water table and impact groundwater quality.

3.4.1. Road de-icing

Road de-icing salts applied on public roads and highways may increase groundwater chloride concentrations over time. Road de-icing application standards for the Nova Scotia Department of Transportation and Infrastructure Renewal (TIR) are found in the department's Highway Maintenance Standards (July, 2009), Chapter 6: Snow and Ice Control, pp. 98-107 found here: http://gov.ns.ca/tran/publications/Highway%20Maintenance%20Standards%20Manual.pdf. The TIR Standards states "[t]he use of salt in environmentally sensitive areas is strictly prohibited" (p. 98). If the WHPA is defined as an environmentally sensitive area, salt should not be applied in this area.

Halifax Water is investigating where road de-icing salt is being applied by TIR and by HRM within the WHPA. If de-icing salt is being applied by TIR, further investigation will be conducted to determine whether the WHPA may be defined as an environmentally sensitive area with respect to TIR's Standards to justify the cessation of de-icing salt being applied.

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 TIR and to HRM regarding road de-icing salt applications. The risks of chloride concentrations attributed to Halifax Water's use of chloride in its water treatment process, may be remedied with adjustments to the concentration levels.

3.5. Controlled Access Roads

For security purposes, Halifax Water maintains a locked gate at the access road to the treatment and pumping facility, limiting unauthorized vehicle access. There are currently no security measures in place to limit pedestrian access to the property; there has been evidence of trespasses onto Halifax Water's private property at this location. 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.

3.6. Land Use and Planning

The Silver Sands WHPA zones fall within HRM's Eastern Passage/Cow Bay Land Use By-law area. Unfortunately, the risk of water quality impairment is considered to be very

high as the region's By-laws do not identify the water supply and treatment facility or the risks associated with permitting certain land use activities within the WHPA.

There are six By-law zones located within the WHPA: Rural Area (RA), Local Service (I-3), Floodplain (FP), Environmental Conservation (EC), Protected Area (PA), and Comprehensive Development District (CDD).

The PA zone covers approximately 57 ha (19%) of the WHPA, where 8.2 ha fall in WHPA Zone 2, and the remaining portion in Zone 3. The PA zone in the WHPA is part of the Nelson Conservation Area – land that was donated to the province and designated an Eastern Habitat Joint Venture land securement area. This area is protected under the *Wildlife Act* as a significant habitat. An additional 4.7 ha (1.5%) in WHPA Zone 2 is zoned as EC. The PA and EC zones do not allow for infilling, excavation, alteration of grade, or removal of vegetation.

The RA, I-3, FP, and CDD zones in this By-law, covering approximately 263 ha (79%) of the WHPA, present the greatest potential for risk to water quality because they allow for a wide range of development.[2] Halifax Water is exploring options to amend existing or develop new HRM by-laws that consider the WHPA.

Assessments of the risks associated with the permitted land use activities are described below:

3.6.1. Residential

Approximately 70% (~35 ha) of land in Zone 1 of the WHPA is currently developed residential, with the potential for an additional 3% (10 ha), through RA and CDD zoning By-laws. Within Zone 2, 29% (32 ha) of land in the area closest to the wellhead is residentially developed, with the potential for another 30% (33 ha) through RA and I-3 zoning By-laws. In Zone 3, residential properties cover approximately 4% (5 ha) of this Zone with the possibility of another 56% (74 ha) becoming a residentially developed area through the RA zoning By-law. A total of 24% (72 ha) of the WHPA is residentially developed, with potential for 39% (117 ha) more residential development.

Residential areas present among the highest risk factors for source water contamination due to the following factors:

On-site Septic Systems

Properties located in the WHPA rely on on-site septic systems for the treatment of domestic wastewater. Due to the close proximity and short

[2] The Municipal Planning Strategy Generalized Future Land Use Map for Eastern Passage/Cow Bay shows lot lines through Cow Bay Lake (aka Cow Bay Pond). There is cause for concern if this area is to be infilled and developed due the potential for subsequent flooding and possible loss of groundwater recharge. However, in 2007 the result of the following Case, *Silver Sands Realty Ltd. v. Nova Scotia* (Attorney General), 2007 NSSC 291 (CanLII), <http://canlii.ca/t/1tg1d> retrieved on 2011-11-16, was granted an order dismissing the case for permitting development of the water areas of the property, arguing that Cow Bay Lake remain the property of the Crown as per the *Water Act* and subsequently the *Environment Act*.

groundwater travel times to reach the water supply well, microbial contamination risk associated with this area is considered to be high. Wastewater can impact the ground water supply if septic systems are improperly installed or maintained, deleterious materials enter the system, there is surface damage to the drainage field, or contaminants leach from the septic system to groundwater through bedrock fissures.

Home Heating Fuel
Many homes in this area rely on oil-fired heat. Tank spills or failure could pose a risk to the water supply well, regardless of the WHPA Zone, due to the potential persistence and movement of petroleum products in a fractured bedrock aquifer. Home heating oil tanks that are exposed to weather, are not installed or maintained properly, or have shifted at their base from frost action have the potential to leak, causing serious environmental problems and property damage.

Household Chemicals
Another concern is the potential use of household chemicals associated with the subdivision residences; persistent, mobile chemicals (e.g., fertilizers, private road and driveway de-icing agents, petroleum products, pesticides, solvents, and other chemicals) could present a long-term risk to source water quality if repeatedly used in great enough quantities over the groundwater recharge area.

3.6.2. Agriculture

Where agriculture activities are permitted in By-law Zone RA, there is a potential risk to the WHPA due to leachate from manure piles, and farmland pesticide and fertilizer application runoff potentially seeping into the groundwater. Currently the By-law states that "no barn, stable, feedlot, or manure pile shall be located closer than…300 feet from any watercourse or potable water supply except for water supplies on the same lot." Given the Wellhead Protection Time of Travel Zones calculations in the WHPA, described in section 2.3.2 on page 7, there are potential risks beyond the 300 foot buffer. Additional agricultural use risk factors include greenhouse operations due to potential runoff containing pesticides and chemical fertilizers.

The HRM By-laws do not identify the WHPA zones or any requirements to consult with Halifax Water. Halifax Water will continue to monitor the area and is investigating options to amend existing or develop new by-laws that consider the WHPA with respect to agriculture uses.

Under section 106 of the *Environment Act* \ SNS 1994-95, c 1, HRWC also could request an area surrounding the wellhead be designated a protected water area which could incorporate specifications on agriculture activity. An example of Nova Scotia provincial legislation restricting agriculture practices and use of their byproducts in a protected watershed is Lake George Watershed Protected Water Area Regulations, NS Reg 197/2006, <http://canlii.ca/t/lczd> retrieved on 2011/11/25

3.6.3. Commercial

In Zone 1 of the WHPA within the CDD By-law Zone there are two properties engaged in commercial activity that could potentially pose risks. In Zone 2 of the WHPA, the I-3 By-law Zone permitted uses pose risks due to Local Service Uses such as auto repair and body shops (associated with existing dwellings) being permitted in this area. The risk assessments are described below.

Storage Yard

There is currently property owned by Silver Sands Realty located approximately 150 m down gradient of the wellhead, within Zone 1 of the WHPA, and within the CDD and RA By-law zones. Currently the property supports a storage yard for building materials, such as gravel, wood, and pipe and a warehouse. Potential risks associated with these property uses are dependent on the materials stored on-site, whether there is an on-site septic system or fuel storage present and what other land use function occurs on the property.

Automotive Repair Shop

In Zone 1, within the CDD By-law Zone, there is an automotive repair shop located within 100 m up-gradient of the wellhead. Risks associated with the shop and associated residences include potentially hazardous materials stored on site, fuel storage, as well as on-site septic. Since both properties are in close proximity to the wellhead, they potentially pose high risks for source water contamination.

3.6.4. 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 adjusted for pH using caustic soda, and polyphosphate is also added for sequestering; the water is disinfected via sodium hypochlorite prior to distribution. Chemicals are transported and transferred to the system in small quantities on an "as needed" basis.

3.6.5. Chemicals

Halifax Water does not support the use of chemicals on any of its source water areas, including the Silver Sands WHPA, other than for water treatment purposes. Currently the risk of chemical contamination as outlined in section 2.3.2 on page 7 is considered to be high, 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 increasing legislative restrictions or purchasing lands within the WHPA.

"Halifax Regional Municipality By-Law P-800 Respecting the Regulation of Pesticides, Herbicides and Insecticides" is a regional municipal by-law that regulates the use of pesticides on residential and municipal properties throughout HRM. The By-law

prohibits the outdoor application of any pesticide on these properties unless they are identified as "Permitted Pesticides." Permitted applications may be granted by HRM if required for public health purposes. By-law details and regulations can be found on-line: http://www.halifax.ca/legislation/bylaws/hrm/blp-800.pdf.

3.6.6. 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 Silver Sands WHPA are accidental spills associated with highway accidents or residential/business activities, natural disasters such as hurricanes, fires, wind, insects, and flooding, and malicious intent. The emergency 911 number is to be included on all signage placed in the Source Water Area to indicate who should be called in an emergency situation.

Accidents and Spills

Due to the proximity of residential and industrial areas along the transportation routes which dissect WHPA Zones 1 and 2, the threat of an accidental chemical emergency is high. In the event of an emergency involving accidents and spills, Halifax Water will follow its emergency response protocols and continue operations during the emergency, as described in its *Emergency Response Manual,* and cooperate with first responders, who are responsible for responding to accidents and spills occurring on the roadways. Signage is placed along the treatment plant road identifying the plant and the contact information in the event of an emergency, in addition to the 911 number.

Natural Disasters

The areas consisting of shallow soils and exposed bedrock place the source water area at risk of natural disasters such as fire, insect, disease and wind damage. Additionally, if the Cow Bay Lake area were to be infilled, combined with the effects of rising sea levels associated with Climate Change, flooding is a concern in the WHPA.

Currently Halifax Water owns only the property on which the wells and treatment plant are located within the source water area and relies heavily on public reporting. Signage is placed along the treatment plant road identifying the plant and contact information in the event of an emergency.

Fire

Forest fire reporting protocols and procedures fall under the provincial forest fire protection regulations. 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. In addition, the NSDNR hotline (1-800-565-2224) and emergency 911 number is to be included on all signage in the Source Water Area.

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.

Flooding
If Cow Bay Lake were to be infilled, as Silver Sands realty requested in the Case: *Silver Sands Realty Ltd. v. Nova Scotia* (Attorney General), 2007 NSSC 291, the potential risk for flooding in the area, downgradient from the wellhead, is worth assessing. Through the HRM planning consultation process and by applying the wetland management guidance provided by the Nova Scotia Wetland Conservation Policy, September 2011 found online at http://www.gov.ns.ca/nse/wetland/docs/Nova.Scotia.Wetland.Conservation.Policy.pdf, the impact and risk could be diverted.

Malicious Intent
Security at Halifax Water is taken very seriously. Halifax Water has completed an industry-developed risk assessment for its facilities and security measures. The procedures were designed based on this assessment to reduce the probability, increase the likelihood of detection, and lessen the impact of an event. A water sampling program has been developed and implemented to ensure the safety of HRM's drinking water.

Vehicle access to the treatment plant is currently restricted via a locked gate. Halifax Water staff frequent the plant for operational and security purposes and report on any concerns that may arise to the proper authorities. The area is also posted with emergency contact and no trespassing signs. Halifax Water is considering the installation of a security fence around the treatment plant to further limit access.

Halifax Water is exploring additional emergency response options including being among the first to be advised as per the Emergency Management Office (EMO NS) Emergency Response Guidelines, when an emergency event has the potential to affect the WHPA.

3.7. Risk Activity Potential and Contaminants

Table 2 identifies the current activities known to pose risks within the WHPA and summarizes the potential contaminants involved, point or non-point source pollutant and potential impact.

Table 2: Summary of Risk Activities and Potential Contaminants Within WHPA.

Risk 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, acid rock runoff	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. BMPs 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.	1, 2, 3
Public Roads: vehicles traveling on Dyke Road, Cow Bay Road and Spruce Drive	Hazardous chemical or fuel spills, vehicle fluids, road salts		X	Spill on roads within the WHPA may affect ground water supplies depending on hydrogeology in the area. Chloride from the application of road salt for deicing during winter months may also migrate to the groundwater supply.	1, 2, 3
Land Use Planning: residential, resource development	Chemicals, pathogens, fuels, removal of vegetation and soils, acidic rock	X	X	Loss of infiltration area, increased affects/risk of impacts due to residential or resource development: fuel spills, septic failure, use of chemicals, increased run-off, erosion and sedimentation due to development activity and acid rock drainage.	1, 2, 3
Residential: heating oil tanks, household products, auto leaks in driveways, on-site septic systems, lawn and garden products	Fuel, fertilizers and other household chemicals, domestic wastewater	X	X	Hydrocarbon contamination can impact ground water supplies both in the short to long term. Household and lawn and garden products, if used in great enough quantities could also negatively impact the source water supply. Failure of septic systems can lead to fecal, phosphorus and nitrate contamination of the water supply.	1, 2, 3

Risk Activity	Potential Contaminant	Point Source	Non-Point Source	Potential Impact	WHPA Zone Affected
Commercial: Storage yard, potential for small businesses	Fuel, chemicals, domestic wastewater	X		Depending on the commercial activities, fuel, chemicals, and domestic wastewater could pose risks as outlined for the residential risks above.	1
Agriculture: Livestock and crop management	Manure piles, chemical fertilizer and pesticide use and, nutrients	X	X	Leachate from agricultural activities has the potential to contaminate groundwater; the level of risk is dependent upon the proximity of the contaminant (e.g., chemicals versus E. coli) to the wellhead.	1, 2, 3
Mining, Pits and Quarries: Chemicals, vegetation and soil removal, and blasting	Chemical pollution, acidic rock, and heavy metal contamination	X		Chemical pollution, acid rock drainage and heavy metal contamination could pose risks as outlined in Table 1 and sec. 3.2. Mining and pits and quarries may alter hydrology and affect groundwater levels.	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, Flooding	Chemicals, pathogens, turbidity		X	Soil erosion, increased turbidity in groundwater, chemical/pathogen contamination. The risk of flooding is also a risk factor due to the impacts of Climate Change and the potential interest in infilling Cow Bay Lake.	1, 2, 3
Malicious Intent	Terrorism, vandalism, sabotage	X		Total shutdown of water treatment/pumping facility and long-term damage to the water supply.	1, 2, 3

3.8. Identified Risks Prioritized

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

Table 3: Scale and Rank of Problems/Activities Within WHPA.

Risk Activity	Contamination Issue	Scale of Problem*	Priority Rank**
Resource development: • Agriculture • Forestry	Fuel and auto/hydraulic fluid	5	2
	Sedimentation of streams	5	2
	Use of chemicals or fertilizers	5	1
Recreation: • OHV's • Pedestrian activities	Fuel	5	1
	Sedimentation due to soil erosion	5	5
	Garbage	5	4
Public roads and highways	Fuel spills	3	1
	Auto fluids	3	2
	Dangerous goods	5	1
	De-icing	3	4
Residential: • Heating oil tanks • Household and lawn and garden products and activity • Auto leaks in driveways • Chicken pen • On-site septic.	Septic systems	1	1
	Leaking fuel tanks & auto leaks	3	2
	Household chemical products	4	2
	Sediment runoff	3	2
	De-icing	3	4
Commercial	Fuel leaks/spills	4	1
	Septic systems	4	1
	Chemicals	4	1
Natural Disaster	Fire	2	1
	Extreme weather	2	2
	Insect	4	2
	Disease	4	2
	Flooding	2	1
Malicious Intent	Hazardous materials	5	2
	Vandalism	3	1

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

4. MANAGEMENT PLAN

As the Silver Sands WHPA is not a provincially designated protected water supply area, the goal of this 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 and 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.

4.1.1. 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.

4.1.2. Best Management Practices

Halifax Water has developed and implemented BMPs 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 BMPs. Best Management Practices for the agriculture industry are being developed to mitigate the effects of these activities should they be permitted. Halifax Water will make available and promote its BMPs via public communication and awareness efforts, as outlined in section 4.1.3, below.

4.1.3. Public Communication, Education and Awareness

Halifax Water's communication and education and awareness program is an effective way to inform the public about water supply area news and protection strategies.

As the Silver Sands WHPA is not provincially designated as a protected area, public communication, education and awareness, are key components in Halifax Water's source water protection strategy. Currently, Halifax Water's communication and awareness program includes: posting information and

regulatory signage, conducting educational seminars, developing source water protection publications (e.g., newsletters, public notifications, and reports), publishing website information, and placing advertisements in periodicals.

The objective of the communication in the water supply area is to inform users of the location of the WHPA, outline the potential impacts of detrimental activities on the water supply, and outline measures they can take to avoid such occurrences. Public communication, education and awareness outreach will continue to be developed with the intent to encourage cooperation between Halifax Water, customers, and stakeholders to ensure quality drinking water supplies.

The WHPA resident(s) and businesses are responsible for the condition of their fuel storage tanks; most insurance companies require that tanks be replaced every ten years and measures taken to protect the 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 into shallow groundwater.

Halifax Water is not responsible for the condition of septic systems and fuel storage tanks within the WHPA; however, it would be prudent for residents in the WHPA to be informed of the environmental issues associated with fuel spills or septic system failure, and how to avoid such problems.

Considering there are both industrial and residential activities within the WHPA, 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 that can be taken to avoid such occurrences. Public communication, education and awareness will be developed in 2012 with the intent to encourage cooperation between Halifax Water, customers, and stakeholders to ensure quality drinking water supplies.

4.1.4. Watershed Advisory Board

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

4.1.5. Regulations and By-laws

Halifax Water continually investigates new opportunities for provincial legislation and local by-laws to be strengthened or created to enhance the protection of drinking water. The Silver Sands WHPA is currently not designated as a protected drinking water supply, but is subject to applicable provincial and

federal legislation 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.

4.1.6. Controlled Access

Halifax Water maintains signs and a gate to limit the access to the Silver Sands treatment plant. Halifax Water will continue to monitor these areas and, when required, enhance security measures as required. Halifax Water encourages local water supply area users to report illegal activities using the information provided on signs posted throughout the water supply area.

4.1.7. 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.

4.1.8. Chemicals

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

4.1.9. Emergencies

For all emergencies that fall within the WHPA, Halifax Water maintains open communication with the first responders responsible for the area.

4.2. Contingency Planning (Mitigation, Preparedness and Response)

4.2.1. Public Communication, Education, Awareness 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 raise awareness about the WHPA to users and stakeholders via signage, newsletters, factsheets, and website links.

4.2.2. Land Use and Planning Communication

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

4.2.3. Silver Sands Treatment System and Operations

Halifax Water has plant operations staff dedicated to the maintenance of the treatment plant facility, on at least a weekly basis, to ensure systems are 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.

4.2.4. Controlled Access

The Silver Sands pumping 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 wellhead area.

4.2.5. Public Roadways

Public roads located within the WHPA are considered to be a moderate risk to the water supply due to the close proximity to the wellhead; the roadways are mainly located within Zone 1 of the WHPA in areas of thin to discontinuous overburden. In the event of an emergency resulting from a spill or an 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. Emergency contact information is posted on signage located at the main entrance to the water treatment plant. Halifax Water is exploring additional emergency response options including being among the first to be advised as per the Emergency Management Office (EMO NS) Emergency Response Guidelines, when an emergency event has the potential to affect the WHPA.

4.2.6. 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.

4.2.7. Chemicals

If a deleterious chemical enters the Silver Sands 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. Emergency contact information is posted on signage located at the main entrance to the water treatment plant.

4.2.8. 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, can be found at Halifax Water's main office located at 450 Cowie Hill Road in Halifax.

Halifax Water is exploring additional emergency response options including being among the first to be advised as per the Emergency Management Office (EMO NS) Emergency Response Guidelines, when an emergency event has the potential to affect the WHPA.

4.2.9. 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 approximate 24 hours, after which treated water would be transported in to supplement the system.

Emergency procedures are in place for shutting down the Silver Sands Water Supply Plant, which includes 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. MONITORING AND EVALUATION PROGRAM

Halifax Water monitors the immediate Silver Sands WHPA (Zone 1); however, there is no WHPA legislation in place to ensure the protection of the WHPA. Currently 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).

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.

5.1. Raw Water Monitoring

The sampling and analyses requirements specific to raw water monitoring for Silver Sands are derived from various sources including the Silver Sands Water Treatment Facility, Nova Scotia Environment, Approval to Operator (2008-061151-DIR-090101-A), January 1, 2009. Halifax Water's Compliance Inspectors undertake regular sampling of raw water at the Silver Sands water supply as specified in permits approved by NSE.

Halifax Water's Drinking Water Quality Sampling and Permit Compliance Manual, March 2011, describes the raw water monitoring program procedures for quality assurance and compliance. Under the compliance scope sampling and testing is conducted annually for all parameters listed in the GCDWQ; and additional samples are collected twice per year for pH, turbidity, iron, and manganese.

Additionally, under the small systems process control program scope, sampling is done throughout the treatment process to monitor its effectiveness. Sampling is typically done by plant operators, with analyses being done in the plant lab. The Silver Sands Treatment Facility is visited at least twice a week for operational or quality assurance purposes to undertake process checks, carry out minor or routine maintenance, refill chemical tanks, check the physical condition of the facility, and to conduct water tests. Details on the raw water quality sampling program for both compliance and process control purposes at Silver Sands are outlined in Table 4, below.

Table 4: Silver Sands Small System Raw Water Monitoring Program

Sampling Scope	**Timing**	**Parameters**
Compliance :	2nd Week of September	GCDWQ* (HW Package) Water Quality Parameters
	Last Week of May and November (Combined and each well)	Turbidity (lab)
		pH (lab)
	2nd Week of December and June	Manganese
		Iron
Process	WQA minimum twice per week or whenever the plant	pH iron

Sampling Scope	Timing	Parameters
Control:	is visited: control sample tests to maintain water quality assurance.	turbidity

*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

The data collected is entered into the WaterTrax database, a procurement application service for managing water quality data, analyses, and reporting purposes. An annual report is required on all water supply systems to summarize chemical analyses.

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 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 affect 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 whether there are changes or degradation in raw water quality. This evaluation will be used to determine whether remedial action is needed in the WHPA, or changes in the monitoring protocol are required.

Manganese: is also commonly found in local groundwater sources due to soil and geological conditions. Drinking water with high concentrations of manganese can cause black staining, have a metallic taste, have an undesirable odour, and contribute to microbial growth and turbidity.

Iron: can be found at elevated concentrations in local groundwater sources due to the weathering of soil and iron-bearing rock. The presence of iron in drinking water may result in poor-taste, staining, and promote the growth of certain microorganisms in water distribution systems.

5.2. 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.

6. 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 Anna McCarron. 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.

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APPENDIX A: WELL HEAD PROTECTION AREA DELINEATION

A1. Local Stratigraphy and Potentiometric Surface

Local well log and GIS data were used to examine water table features, depth to bedrock, and surface elevation surrounding the Silver Sands wellhead (Figure A1). As the regional water table appears to closely follow the surficial topography, groundwater divides would be located at the topographical high points, and at the water body locations.

Figure A1. Map of surficial topography of the area surrounding the Silver Sands small system. The static water table elevations associated with available well log data are indicated; the general regional groundwater flow during pumping upgradient from the well are denoted by arrows.

A2. Hydrogeological Estimates and Groundwater Movement

The protocols below are based on information obtained from the Ministry of the Environment for the Province of Ontario (2001), U.S. Environmental Protection Agency (1987; 1991) and peer-reviewed literature (Fetter, 2001; Paradis et al., 2007).

A capture zone refers to the underground area that encompasses groundwater travelling towards a given well; the amount of time it takes for the water to reach a well is called the time of travel (Ontario MOE, 2009). Therefore, the land surface area associated with a given time of travel zones can assist in establishing well head protection areas based on the length of time it would take a groundwater contaminant to reach a water supply well from a given distance. The water table in the Silver Sands area closely follows the surficial topography; both static water levels from locally available well log data and 1:10,000 topographical contours were used to delineate the recharge area in order to identify the total zone of capture for the Silver Sands water supply well head. Groundwater velocity calculates were used to establish time of travel estimates. Details regarding the methodologies used and results are outlined below.

A3. Pump Test Analyses

The well at Silver Sands is 86 m deep, 152 mm in diameter, has 20.7 m of total casing, and a static water level of 10 m the top of the casing. A 72 hour pump test was carried out by Jacques Whitford Limited in August 2008, as part of an ongoing GUDI assessment for the Silver Sands production well. Analysis of the time-drawdown and recovery results indicates an apparent transimissivity (T) of 2.4 m^2/day, a well hydraulic conductivity of 0.035 m/d. The pumping well had a theoretical 100 d sustainable yield of 115 m^3/d.

A4. Distance to Down Gradient Recharge Boundary

The recharge distance downgradient of the water supply well (X) was calculated using the down-gradient null point equation assuming uniform flow. Downgradient recharge distance was calculated using the apparent transmissivity, regional hydraulic gradient, and assumed pump rate. The pump rate is assumed to be 40 m^3/d, which is representative of the flow rate required to support the current water supply users. The recharge distance were calculated from the data reported in the available pump test results, using the local hydraulic conductivity (K) and assumed borehole depth below casing (X_1), or using the reported apparent/aquifer transmissivity values (X_2) which would incorporate both the k and b components.

From the assumptions and calculation estimates obtained, a mean down gradient distance of ~220 m was identified as the down gradient recharge boundary (Table A1). The details, equations, and assumptions are reported below.

Equations Used:

$$X_1 = \frac{Q}{(2*\pi*K*b*i)} \qquad \text{(Eq 1)}$$

$$X_2 = \frac{Q}{(2*\pi*T*i)} \quad \text{(Eq 2)}$$

and:

$$T = k * b \quad \text{(Eq 3)}$$

Where:

Q = Well Pumping Rate

K = hydraulic conductivity

T = Transmissivity

b = screened interval (in this case, the interval between the bottom of the well casing to end of the borehole, 37.8 m)

i = hydraulic gradient (static)

Table A1. Downgradient water table drawdown distance to null point at Silver Sands, based on available data and assumptions.

T (m^2/d)	Q (m^3/d)	K (m/d)	b (m)	i (unitless)	X_1 (m)	X_2 (m)
2.4	40	0.035	86	0.011	195	241

A5. Upgradient Recharge Area

The upgradient recharge area was identified based on the physical geological characteristics of the region. Generally, the recharge area in the upgradient direction can be described as the total area contributing water to a well, back to the groundwater divide. The asymptotic recharge radius (Y) can be calculated by the following equation, assuming uniform flow:

$$Y = \frac{Q}{2Ti} \quad \text{(Eq. 4)}$$

Assuming the current pump rate (40 m^3/d) and apparent and aquifer T, the mean Y was estimated to be about 758 m. As the water table appears to closely mimic the surficial topography, a 1500 m recharge diameter perpendicular to the regional ground water flow direction appears reasonable given the regional contours and surficial water features(Figure A1).

A6. Groundwater Movement in Well Head Area

In the case of an unconfined aquifer, the Thiem equation (Fetter, 2001) can be used to describe steady-state radial groundwater flow:

$$Q = \frac{K*\pi*(b_2^2 - b_1^2)}{\ln(\frac{r_2}{r_1})} \quad \text{(Eq 5)}$$

Where:

Q = pumping rate

K = hydraulic conductivity

b_1 = water table elevation at distance r_1 from the pumping well

b_2 = water table elevation at distance r_2 from the pumping well

A schematic demonstrating steady radial groundwater flow using the Thiem method is presented in Figure A2.

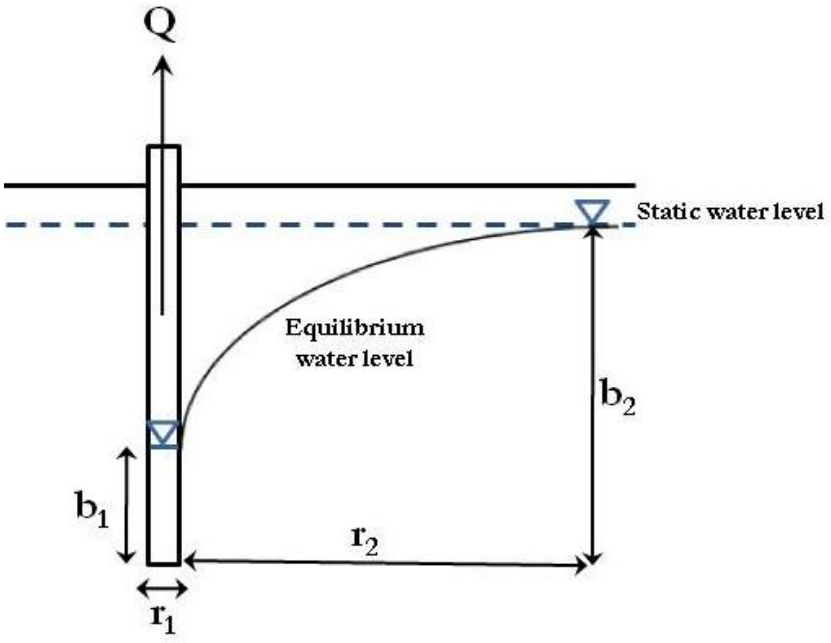

Figure A2. Equilibrium drawdown in an unconfined aquifer according to the Thiem Method

The pump test drawdown data under steady state conditions, b_1 (equal to 27 m of drawdown), was assumed based on the pumping test analysis results obtained from Jacques Whitford Limited. The theoretical distance drawdown curve using the Thiem method is illustrated in Figure A3, below.

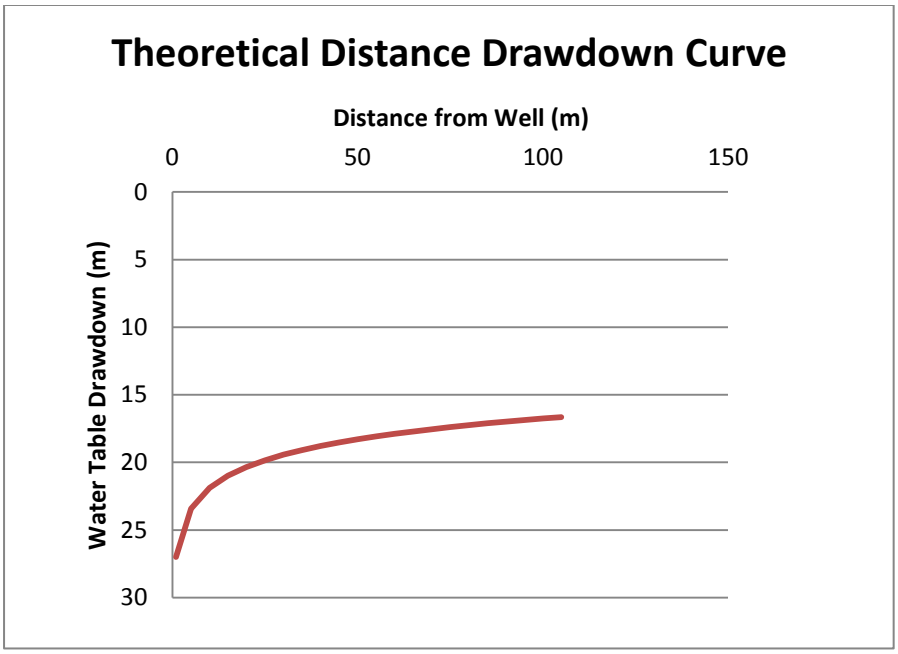

Figure A3. Theoretical distance drawdown curve assuming Q of 40 m^3/d, T=2.4 m^2/d, r_1=0.152 m, and b_1=27 m of drawdown.

The mean slope from the theoretical distance drawdown curve, was found to be 0.8. The mean slope of the drawdown is equivalent to the local hydraulic gradient under pumping conditions, i_p. To calculate potential time of travel zones, groundwater velocity (V) was calculated as:

$$V = \frac{Ki_p}{n} \qquad \text{(Eq 6)}$$

Where:

V = groundwater velocity under pumping conditions

K = hydraulic conductivity

n = porosity of the aquifer

Aquifer porosity (n) was assumed to be 0.04, generally consistent with fractured crystalline bedrock, along with the Theim-derived i_p value to calculate the time of ground water travel for the Silver Sands well head area (Table A2).

Table A2. Groundwater velocity estimates for the Silver Sands water supply area, under pumping conditions. Time of travel distances were calculated to the approximate extent of the upgradient groundwater divide.

Assumptions	V (m/d)	Time (y)	Time (d)	Distance (m)

Q = 40 m^3/d	0.69	1	365	252
n=0.04		2	730	504
		3	1095	755
		5	1825	1259
		10	3650	2518

Figure A4. Estimation of Time of Travel Zones and Recharge Area for the Silver Sands Water Supply Well Head Area.

APPENDIX B: HALIFAX REGIONAL MUNICIPALITY LAND USE BY-LAW ZONES IN THE SILVER SANDS WELL HEAD AREA

Halifax Water

Best Management Practices

For

Halifax Water, and

Crown Managed Lands

April 2010

Compiled By:

Halifax Water

Supported by:

Elmsdale Lumber Company Ltd.

Department of Natural Resources

Pockwock Watershed Management Committee

Lake Major Watershed Advisory Board

Bennery Lake Watershed Advisory Board

Table of Contents

1.0 Introduction

Halifax Water is responsible for managing many activities on its watersheds. As a means of better managing these activities, Halifax Water has developed and implemented the following Best Management Practices (BMPs) to guide activities on Company and Crown managed lands, as supported by Elmsdale Lumber Company, the Pockwock Watershed Management Committee, the Lake Major Watershed Advisory Board, the Bennery Lake Watershed Management Committee and the Department of Natural Resources. For all other watershed lands, these BMPs are meant to be used for educational and awareness purposes. The following BMPs are not considered a complete collection but will continue to evolve to improve outcomes. In addition, these BMPs are not meant to replace existing legislation that governs activities on the watersheds. Furthermore, persons operating on the watersheds, regardless if it is designated as a Protected Water Area or not, should be familiar with current legislation that apply to the activities they are carrying out. A list of applicable legislation sited throughout these BMPs is listed in Appendix 1.

2.0 Definitions

1. ***Watershed* – For the** simplicity of this document, Halifax Water defines well head areas and surface water supply areas collectively under the term *"watershed"*.
2. ***3-Point Contact*** – A combination of 2 hands and one foot or 2 feet and 1 hand.
3. ***Company lands*** –Lands privately owned by Halifax Water.
4. ***Crown managed lands*** – Crown lands managed alone by Halifax Water or jointly by Halifax Water and NSDNR.
5. ***Chicot*** – Standing dead trees.
6. ***Special Management Zone*** (SMZ) – Special Management Zone as defined by the Department of Natural Resource
7. ***Lodged or Spring Trees*** – Trees that have become unsafe while operations are being conducted on the block. For example trees that are leaning against another tree for support or trees whose tops have broken and become lodged in other standing timber.
8. ***Grubbing*** – The removal of vegetative or organic matter by machine exposing bare mineral soil.
9. ***Overburden*** – Vegetative or organic matter which covers bare mineral soil.
10. ***Cultural Heritage Zone*** – An area that has been positively identified or having potential cultural or heritage significance by a trained expert. For example a trapper's cabin, grave stones.
11. ***Fording*** – Traversing of a machine through a watercourse, water body, and wetland as defined under the Environment Act.
12. ***Rip Rap*** – Clean, washed angular aggregate greater than 4 inches in size. Usually used around culverts or for erosion control purposes. The material must be free of sulphide bearing or acid slate.
13. ***Shelterwood Management*** – The practice of removing 30-50% of the stand basal area to create light conditions suitable for growth conditions. This harvest technique favours long lived tree species that are shade-tolerant., NSDNR Forest Research Report, *"Regeneration Following White Pine Shelterwood Cuts in Shelburne Co., NS."* March 1995.
14. **Selection Management –** With respect to *Uneven-aged Management* it is "the practice of leaving 3 or more height classes on site with a minimum height difference of 3m between classes, and one height class greater than 10m." Association for Sustainable Forestry, *"Selection Management."* October 2009.
15. **Variable Retention Management –** The practice of leaving as much hardwood and shade-tolerant species as operationally possible in the identified harvest block. The residual standing trees would be in addition to the *'Wildlife Habitat and Watercourses Protection Regulations'*.
16. **Clear Cut Management –** The total removal of all tree species with in an identified harvest block while meeting the minimum *'Wildlife Habitat and Watercourses Protection Regulations'*.
17. **Travel Corridor** – Solid linear feature that is used to physically break up larger harvest blocks into smaller harvest blocks.

3.0 Heavy Equipment

- Use 3-point contact for mounting and dismounting equipment. Check for hazards prior to dismounting and ensure handles and footholds are intact.
- Hard hats, safety boots and highly visible clothing or straps must be worn at all times. When working in a fully enclosed cab, exception may be given to hard hats.
- Lunch, fueling and maintenance areas will be kept clean and all garbage removed from the watershed on a daily basis. Deposit refuse, garbage, and tires in an approved waste disposal site.
- Be aware of all persons or vehicles around you. When you see a person or vehicle approaching, immediately stop operating your machine and lower the blade or boom to the ground, make eye contact, and signal for safe passage.
- Be aware of potential overhead danger such as a chicot, large dead branches and power lines.
- Shut machine down during times of repairs or maintenance.
- Ensure the blade or boom is always down and emergency brake is on when operator is out of the machine.
- While inside the HRM core, the HRM noise by-law will be applied and followed.
- During breaks and non working hours, park heavy equipment at least 30m from a defined stream channel or flowing water (e.g., where water is flowing in the ditch, etc.) and 60m from a well head location.

3.01 Fueling and Fluid Disposal

- No fuel bulk storage stations may exceed 450 litres unless approved by Halifax Water or NSDNR.
- All Halifax Water authorized fuel storage tanks must be fully contained.
- An emergency plan must be located on site and known to all users.
- All fuel tanks must conform to the Transportation of Dangerous Goods (TDG) Regulations.
- During transport, ensure all fluid containers, including jerry cans, are leak-free and secured to avoid damage and spills.
- All fuel containers, including jerry cans, must be marked clearly identifying their contents.
- Vehicles specifically designed for delivering fuel/fluids must be escorted at all times.
- Pumping devices for all fuel tanks must have automatic shut-off valve and be attended at all times while in use; no gravity fed pumps allowed.
- Designated fueling areas must be at least 30m from a defined stream channel or flowing water (e.g., where water is flowing in the ditch, etc.) and 60m from a well head location.
- All fuel tanks must have a 10 pound 6A80BC serviceable fire extinguisher available at all times.
- All fuel stations must maintain a complete spill kit which will include a plug and dyke kit. Chainsaw fueling stations will maintain gas and oil absorbing material which will be placed under saws when refueling and oiling.

- All motorized equipment must have an appropriate sized spill kit located on board.
- Do not smoke while refueling equipment.
- Fuel equipment on bare-mineral, stable, level ground.
- Prior to beginning work, all fluid maintenance must be completed.
- Dispose of waste fluid at an approved government facility.

3.02 Maintenance and Inspections

- When performing equipment maintenance and inspections, ensure that:
  - Machinery is parked on bare-mineral, stable, level ground.
  - Parking brake is on.
  - Blade or boom is in contact with ground.
  - Machine/energy is off; hydraulics and pneumatics are off and in zero energy state.
  - Operator inspects for and repairs all fluid leaks.
  - Operator inspects all electrical components and repairs any damaged or loose parts.
- When welding:
  - Machine must be 10m from a refueling area, and parked on bare-mineral soil.
  - A 20lb serviceable 6A80BC fire extinguisher is available.
  - Fuel caps must be in place and combustibles must be cleaned up prior to welding or grinding.
  - A fire watch must be implemented, that will continue for 15 minutes after welding is complete
  - A welding mask and gloves must be worn.
- Remove flammable debris from equipment daily.
- No welding or grinding is permitted during high to extreme fire conditions.
- Machinery and tools showing above normal leaking fuels or other fluids will cease operation immediately and fluids contained. Repairs are to be made or machinery moved from watershed. Report spills as per Emergency Spill Regulations.

3.03 Floating Equipment

- Check with provincial or local authorities for weight, height, length, and timing restrictions on deliveries.
- Do not use defective tie downs to secure machinery.
- Check load security prior to entering onto a public highway as well as routinely throughout the duration of the trip.
- Check for loose debris prior to transporting.
- Be aware of all persons in the vicinity of the float when lowering; make eye contact to ensure person(s) see you and are aware of the potential danger.

4.0 Communication

- ”Active Operation” signs or similar worded signs must be posted in work area to advise people of heavy equipment operating. The signs must be posted in plain sight so as to allow for adequate warning time.
- Use private contractors channel within the operating block to maintain contact of location throughout area.
- Calling frequency depends on traffic on the road. Increase calling frequency as vehicles approach one another.
- Identify location by kilometer markers and be clear about direction. Do not use “nick names” to identify location as this could cause confusion amongst workers in area.
- Vehicles carrying flammable liquids or chemicals hazardous to water quality, and exceed the minimum TDG requirements, that do not have communication capabilities must be escorted to and from the drop off/ pickup point by a vehicle that has communication capabilities.

5.0 Gates

- Only authorized Halifax Water staff will be permitted to duplicate gate keys that fall under Halifax Water control.
- Only authorized Halifax Water staff will be permitted to issue gate keys that fall under Halifax Water control. A key issuance sheet must be completed by Halifax Water Staff and signed by both Halifax Water Staff and the party(s) receiving the key(s). A copy will be given to the receiving party(s) and the original be kept on file at Halifax Water. Once the key(s) has been returned to Halifax Water the key issuance sheet will be completed as returned, a copy will be issued to the returning party and the original will be kept on file at Halifax Water
- A master list of key holders will be kept by Halifax Water.
- A key issuance is considered written authorization. A key issuance form must be completed and kept on file with Halifax Water.
- Gates must be locked at all times unless authorized by Halifax Water.
- Authorized users must report any illegal activities or unauthorized personnel behind Halifax Water controlled gates to Halifax Water staff immediately or when within communication range.

6.0 Emergency Response and Reporting

- In the event of any emergency on watershed lands Halifax Water is to be contacted immediately as well as the emergency responders responsible.
- The Halifax Water Emergency Response Plan manual, dated December 2006, will be the guiding document for Halifax Water staff. The ERP manual can be found at Halifax Water's main office located at 450 Cowie Hill Road, Halifax.

6.01 Fire Prevention and Reporting

- In case of a fire on watershed lands, immediately contact:

HALIFAX WATER **490-6940**

(24 hour contact line))

FOREST FIRE EMERGENCY 24 HOUR LINE **1-800-565-2224**

FIRE CONTROL (Shubenacadie office) **1-902-758-2232**

- Person(s) reporting a fire must provide location, size, estimated time, name and contact information of person reporting.
- For designated watersheds, fire season is dependent on the applicable watershed regulations. For the Pockwock PWA the fire season is from **April 1st to Oct 31st o**f each year while the Lake Major and Bennery Lake PWA fire season is from **April 15th to Oct 15th** of each year. For all other watershed lands that fall outside of a designated PWA, the fire season depends on the provincial fire season for that area. **(legal requirement)**
- All operators are to be aware of where the fire equipment is stored.
- No open fires are permitted on Company lands unless otherwise authorized by Halifax Water. For all other watershed lands follow the applicable watershed regulations pertaining to fire restrictions or contact Halifax Water or your local NSDNR office.
- During fire season, smoking shall only take place on bare mineral soil; all precautions must be taken to ensure the cigarette or cigar has been extinguished.
- During fire season, all motorized equipment is required to have applicable firefighting equipment as per the Nova Scotia Fire Protection Act. The fire plan must be on site during fire season.
- During fire season, while conducting operational activities fire indices must be checked daily and followed. A daily log must be kept.
- During high to extreme fire hazard conditions only operations conducted on bare mineral soil shall take place. Written permission to operate must first be obtained and a fire watch must be conducted daily 30 minutes after operations have ceased.
- Move equipment to mineral soil and shut off master switch at the end of each working day.

- Remove all accumulation of flammable material from equipment daily.
- No equipment shall operate within 300m of a forest or woodlands without an adequate device for arresting sparks. **(legal requirement)**
- Chainsaws must be equipped with spark arresters.
- Do not start chainsaws within 3m of a fueling area.
- Chainsaw must have a 0.5kg (1 lb) pouch fire extinguisher or 5kg (10 lb) extinguisher.

6.02 Petroleum and Chemical Spill Response and Reporting

- In the case of a petroleum or chemical spill on watershed lands, immediately contact:

HALIFAX WATER **490-6940**

(24 hour contact line))

COAST GUARD ..... **1-800 565-1633 or 426-6030**

ENVIRONMENTAL EMERGENCIES 24 HOUR LINE **426-6200**

- One hundred (100) litres (22.2 gallons) of fuel or used oil constitutes a reportable spill to government agencies. ALL-SIZED SPILLS must be reported to Halifax Water. See appendix 2 for a complete list of reportable toxins.
- Person(s) reporting a petroleum or chemical spill must provide location, estimated quantity, time, substance, if known; name and contact information of person reporting.
- Halifax Water will maintain, at all pumping station locations, a supply of oil absorbent material to be used in the event of an oil spill to create an oil boom around the intake of the pumping station and/or absorb oil on the water supply surface.
- All Halifax Water employees, Department of Natural Resources staff, and contractors working on watershed lands must report any overturned engine-equipped machines, such as trucks, skidders and tractors, to Halifax Water immediately. They must also report any foreign substance on the surface of the water supply or land that could pollute the water.
- When a petroleum or chemical spill has been reported to Halifax Water, the applicable treatment plant operator and Director of Water Services will be contacted as well as the **COAST GUARD/ENVIRONMENTAL EMERGENCIES** immediately.

7.0 Road Construction and Maintenance

7.01 Road Planning

- Applicable permits and approvals must be obtained prior to operations beginning and on site at all times.
- Where possible, use existing roads as they usually provide the best long term access. When using existing roads, reconstruct only to the extent necessary to provide adequate drainage and safety.
- Avoid areas that require large cuts and fills, in order to reduce construction costs and soil erosion.
- Plan road systems that will minimize the number, width, and length of roads in order to limit the total area disturbed and loss of productive ground.
- Where possible, locate roads on high ground and along ridges to reduce erosion and prevent sedimentation of streams. Avoid locating roads along the sides of hills with greater than 30% slope.
- Identify landings, loading areas, meeting places, turn-a-rounds and potential gravel pits during road layout.
- Plan turnouts for opposing traffic at one kilometer intervals along single lane roads and turnarounds at the ends of all roads.
- Attempt to locate roads parallel to the natural drainage system to minimize the number of watercourse and stream crossings.
- Maintain a belt of undisturbed vegetation between the road and a stream or lake to allow silt carried by runoff from the road to be collected in the undisturbed area. Vegetative widths: Slope of land <30% = 30m buffer, Slope of land >30% = 40m buffer.
- Ensure all merchantable right-of-way (ROW) wood is delivered to a mill facility.
- Where possible, avoid hilly terrain (<10% if possible), erodible soils, bedrock and shallow soils when locating roads and crossings.
- Select crossings well in advance of operations to avoid delays in receiving approvals.
- Plan crossings at right angles to prevent any redirection of the flow in the water course.
- Plan crossing at the narrowest spot possible with no braided channels or obstructions.
- Ensure all Special Management Zones (SMZs) and crossings that may require special mitigation techniques have been addressed (e.g., visual buffer or slope dependant).

7.02 Road Layout

- Road layout will be completed using a GPS hand held unit or a compass accompanied by photo and map showing a minimum:
    - Harvest boundaries
    - Special Management Zones
    - Waterways and water bodies

- Roads
- Property Boundaries
- Significant areas such as wetlands, heritage sites, and wildlife values

- Ribbon layout:
  - Three (3) ribbons indicate the end of a road
  - Two (2) ribbons indicate a corner in the road or block
- Blue ribbon marked will be used to mark road centre line location as well as skid trails into or between harvest blocks that have not already roaded.
- Ensure the ribbons are tied in a manner that is clearly visible to the operator during anytime of the year.
- If an alteration to the road location is required, remove old ribbons so as not to create confusion of the correct road ribbons to follow.
- If operations do not start up within a year of completing road layout, the site is to be revisited and the lines are to be refreshed where needed. Halifax Water and NSDNR are to be notified once completed.

7.03 ROW Clearing and Road Construction

- Applicable permits and approvals must be obtained prior to operations beginning and on site at all times.
- Road construction shall only take place from **June 1 to September 30** of each year as per applicable watershed regulations (Bennery Lake, Lake Major, and Pockwock). For all other Company and Crown managed lands outside of a designated watershed where road construction is required, approval will only be granted to those situations where there is little to no risk of the water supply being affected. **(legal requirement)**
- "Active Operation" signs or similar worded signs must be posted in work area to advise people of heavy equipment operating. The signs must be posted in plain sight so as to allow for adequate warning time.
- Cut landings and pile wood away from drainages to avoid obstructing water.
- Trees must be never be felled into a watercourse.
- No landings or wood piling areas are to be located within a SMZ, riparian area or within 30m of a watercourse.
- Ditches, water bars, off-take ditches, cross drains and settling ponds must be a minimum of 30m from any watercourse.
- Where ditches are required, construct them in a manner to divert water into the green belt.
- Cut down chicots that are closer than one treelength from the road edge.
- Do not leave lodged or spring trees.
- ROW width outside of a SMZ must not exceed 30m from standing timber to standing timber unless otherwise approved by Halifax Water or NSDNR. The exception to the rule is ROW that run through a harvest block.

- ROW width inside a SMZ or riparian zones must not exceed 20m from standing timber to standing timber unless otherwise approved by Halifax Water or NSDNR.
- No grubbing shall take place within a cultural heritage zone without the approval of Halifax Water or NSDNR.
- Post safety signs as required, such as: slow, stop, blind curve, steep hill, narrow bridge, and kilometer markers.
- Contractors working must attend a minimum of one start up meeting per year to review the requirements specific to the applicable watershed as per the contractor start up agenda.
- Slash and stumps created from ROW clearing and road construction must be used in a manner that minimizes the roadside debris (e.g., construction of roadbeds, turn-a-rounds, back filling of borrow pits) unless otherwise approved by Halifax Water or NSDNR.
- Where possible, construct roads and landings away from areas of advanced regeneration.
- Stop operations if a potential value that has not been previously identified is encountered (e.g., stream, stick nest, cabin, grave site). Immediately notify Halifax Water or NSDNR to be advised on how and where to resume operations.
- Cross drainage culverts will be a minimum diameter of 300mm (12inches).
- All watercourse crossings will be calculated using the 100 hundred year event (Q100).
- The travel surface on all forest access roads (Class-D = 3m) will be covered to a thickness of 10cm to 15cm with 5cm (2inch) gravel, free of contaminants, in order to reduce erosion and potential sedimentation from the road surface.
- Ensure a copy of the most recently approved map is on site at all times showing the location during operations. The old versions are to be destroyed.
- The construction of loop roads is not permitted without the permission of Halifax Water or NSDNR.
- The use of explosives must be authorized by Halifax Water and carried out by a certified explosives specialist.
- Once operations are completed, leave all existing roads, ditches and culverts in the same or better condition as prior to operations.

7.04 Erosion Control

- Use erosion control techniques (i.e., straw bales, filter cloth, seeding, silt fences, ditch dams, etc.) to prevent foreign material from entering the water. Install erosion control measures prior to working near streams.
- Seeding and mulching on "sensitive" areas with high sedimentation potential such as bridge approaches or cut and fill areas within 30m of streams are especially important.
- Use clean rip rap to line all bridge and culvert faces above the high water mark to protect against erosion during periods of high water. Rip rap must be free of acidic bearing slate.
- Avoid operating equipment on unstable slopes, stream banks or soft ground. Use straw, hay or clean crushed stone to stabilize banks or slopes to prevent soil from falling into stream.

- Continuously monitor and conduct routine maintenance as required on erosion and sediment control measures during and after road construction operations.
- Ensure that drainage features are fully functional prior to spring or fall runoff.
- Where erosion is anticipated on steeper sections or near culverts/bridges consider using surfacing material (gravel and rocks) to reduce erosion and potentially extend the operating season.
- Diversion ditches must be at least 30m away from a water body or watercourse. Where slope is greater than 10%, a diversion ditch is required every 30m into the green belt.
- No grubbing shall take place within 30m of any water body or watercourse to prevent sedimentation.
- Minimize grubbing within a SMZ to reduce the disturbance of the overburden unless otherwise approved by Halifax Water or NSDNR.
- Vehicle traffic should be restricted on soft roads during the wet season of the year and during heavy rains when road surface is rutting.
- Avoid skidding or forwarding on truck roads unless conditions are such that the road profile will be maintained.
- For roads with a slope of 10% or less, avoid having water run in a ditch for greater than 300m to minimize erosion.
- For roads with a slope of greater than 10%, avoid having water run in a ditch for greater then 30m to minimize erosion.
- When construction lasts more than one day, exposed soils must be stabilized at the end of each day.

7.05 Water Crossing Installation

- Applicable permits and approvals must be obtained prior to operations beginning and on site at all times.
- All watercourse crossings requiring approval for installation must be completed by person(s) who have successfully completed the NS Watercourse Alteration Certification Program, who is to remain on site to supervise the installation. Person(s) responsible for the installation must be able to provide proof of successfully completing taking the course.
- All permanent bridge and culvert installations must be completed between **June 1 and September 30** of each year. Temporary bridges can be installed year round; however, the installer must comply with the Water Course Alteration Certification Program, manufacturer instructions, and obtain approval from Nova Scotia Environment (NSE), Halifax Water and NSDNR. Exception to the rule is the emergency repair of any water course structure as a result of a wash out or failure.
- "Active Operation" signs or similar worded signs must be posted in work area to advise people of heavy equipment operating. The signs must be posted in plain sight so as to allow for adequate warning time.
- Minimize soil disturbance near streams.
- No in-water work is allowed unless approved by NSE.

- ☐ Ensure no fluids, debris or soils enter the water. Allow free flow of water at all times to allow fish passage. Temporary obstruction maybe allowed with the approval of NSE if there is no other means of water crossing installation, such as cofferdam or dam and pump option.
- ☐ No fording through water bodies or water courses of any kind is permitted unless approved by NSE.
- ☐ If a sediment control plan is required for the crossing, have the plan on site at all times.
- ☐ Ensure a copy of the most recently approved map is on site at all times showing the location during operations. The old versions are to be destroyed.
- ☐ Equipment must be clean and free of debris prior to work beginning.
- ☐ Equipment must be mechanically sound ensuring no fluid leaks of any kind prior and during water crossing installation.
- ☐ No merchantable wood may be used in a crossing without approval by Halifax Water or NSDNR.
- ☐ Where possible, build crossing at right angles to the stream to build more stable crossings and prevent changes in the water flow.
- ☐ Avoid wetlands, sensitive and unique areas where possible when choosing a water crossing.
- ☐ No beaver dams are to be removed unless approved by Halifax Water or NSDNR.
- ☐ When constructing bridge cribbing use geo-textile and clean fill to prevent sedimentation.
- ☐ Remove all leftover debris or building material from the site.
- ☐ Culvert(s) must be imbedded 20% of the culvert diameter into stream bed. **(legal requirement)**
- ☐ Ensure slope of road shoulder at the culvert is 2:1 or less to maintain stability. **(legal requirement)**
- ☐ Whenever possible use open bottom culverts or bridges for fish bearing streams. If closed bottom culverts must be used, ensure free fish passage. **(legal requirement)**
- ☐ When installing closed bottom culverts the slope gradient must not exceed 0.5%. If the slope is greater than 0.5% then an open bottom culvert or bridge must be installed to ensure fish passage and water flow. Align structure with the channel to ensure water flows freely. **(legal requirement)**
- ☐ When installing culverts, backfill with earth or gravel and pack material. For culverts greater then 600mm (24inches), pack backfill material to at least half the diameter of the culvert using a tamping machine. **(legal requirement)**
- ☐ Cover culvert with a minimum of 30cm (12 inches) of gravel leaving a 2:1 slope at each end. Culvert ends must extend a minimum of 30cm out from the end of the culvert to the toe of the finished banks. **(legal requirement)**
- ☐ When installing bridges and open bottom culverts, cribbing and footings must be 30cm back from the high water mark. Do not excavate below the normal high water mark. **(legal requirement)**
- ☐ No multiple culvert installations are permitted unless approved by NSE, Halifax Water or NSDNR.

- No chemically treated wood is allowed for the construction of water crossing structures. It is recommended that untreated hemlock, tamarack/juniper, or cedar, pre-cast concrete, corrosion resistant steel, or plastic be used.
- After construction is complete, re-vegetate disturbed soils located within 30m of water bodies, outside the travel surface.
- Regularly inspect and clean culverts when necessary to avoid washouts and ponding from occurring on the upstream side of the culvert. A routine culvert inspection and maintenance program can avoid costly repairs and reduce negative water quality impacts.
- Where possible, adjust the height of the bridge deck so that it is slightly higher than the road approaches, preventing road surface water from running onto the bridge and into the stream.
- Bridge decking (permanent/temporary) must be entirely closed with outside a minimum of 15cm x 15cm (6inch x 6inch) bumpers installed to catch vehicle and water runoff. Decking and bumpers must be kept clean to reduce negative water quality impacts.
- Ensure all end corners of the bridges are well marked with reflective bridge markers.
- Regularly inspect and maintain bridges for structural repairs and to remove any debris which may clog the opening and hinder stream flow.

7.06 Water Crossing Removal

- Applicable permits and approvals must be obtained prior to operations beginning and on site at all times.
- No in water-work is allowed unless approved by NSE.
- Ensure no fluids, debris or soils enter the water. Allow free flow of water at all times to allow fish passage. Temporary obstruction may be allowed with the approval of NSE if there is no other means of water crossing installation, such as cofferdam or dam and pump option.
- Stabilize approaches once crossing has been removed (e.g., seeding, rip rap).
- Minimize disturbance to greenbelt (riparian zone)
- Ensure construction material has been removed from site once crossings completely removed
- Machines must be cleaned and leak free prior to crossing removal.
- All crossings that are to be removed must be removed during dry conditions. During wet periods (rain, snow melt) removal will be suspended until the ground around the removal location has dried up.
- Ensure a copy of the most recently approved map is on site at all times showing the location during operations. The old versions are to be destroyed.
- Ensure short term and long term erosion measures are put in place during and after removal to maintain bank stability and prevent sedimentation.
- Safety measures must be taken to notify users of removal and to proceed with caution. Place barriers and warning signs in plain view to allow for adequate warning time.

7.07 Gravel Pits

- Applicable permits and approvals must be obtained prior to operations beginning and on site at all times.
- Pit extraction can only take place from June 1 to September 30 of each year or as approved by NSE, Halifax Water or NSDNR.
- Ensure the pit boundaries are clearly identified prior to cutting and excavating to eliminate excess exposure of bare-mineral soil.
- Remove trees within 5m of the extraction face.
- Organic overburden and trees must be piled so as to be used for site remediation once pit operations have been completed.
- The use of explosives must be authorized by NSE, Halifax Water, or NSDNR and carried out by a certified explosives specialist.
- During Gravel pit extraction, no aggregate is to be removed within 10m of the road bed edge and property boundary lines.
- There is to be no aggregate removal allowed within a SMZ or riparian zone or 30m of a watercourse or water body.
- Excavation faces must be sloped and stabilized to prevent erosion during and after extraction has been completed. Once excavation has been completed all pit faces must be sloped 3:1 to prevent erosion and reduce safety concerns.
- During extraction, the water table must remain 1.5m below the lowest extraction point to avoid the area from filling up with water.
- Drainage of the excavation area will be designed to prevent sedimentation from entering a water body or water course.

7.08 Road Upgrade and Maintenance

- Contact Halifax Water before conducting any emergency repairs on roads if water crossings are involved.
- "Active Operation" signs or similar worded signs must be posted in work area to advise people of heavy equipment operating. The signs must be posted in plain sight so as to allow for adequate warning time.
- No chemical application for the purpose of controlling vegetation is allowed unless approved by NSE, Halifax Water or NSDNR.
- Ensure no material is deposited on bridge decking or over the ends of culverts during grading operations.
- Grade road surfaces only as often as necessary to maintain a stable running surface and retain the original surface drainage.
- Avoid grading sections of road where it is not required. Grading creates a source of sediment from the newly disturbed surface. Raise the grader blade where grading is not necessary.

- While grading, bring loose material back towards the centre of the road to prevent the creation of windrows along the edge of the road that may channel runoff and erode slopes.
- Shape road to allow for proper drainage and runoff
- Wing back snow during plowing operations to minimize spring saturation and erosion of the road. Ensure the plowed road surface does not appear wider than the actual road.
- During hauling operations, road and weather conditions will be monitored to ensure proper maintenance measures are in place and being followed (eg. sanding/plowing). By doing so will minimize road repairs and lessen sediment runoff.
- Sand is the preferred winter maintenance tool; however salt may be used as a last resort, and only in areas that are considered to be a safety concern. For example, on roads with hilly terrain. Permission must first be obtained from Halifax Water or NSDNR

8.0 Forest Management Planning

- Halifax Water considers forest management planning to be an important tool in watershed management for the improvement of water quality.
- It is Halifax Water's goal to manage the forested watersheds with the support of NSDNR to have no more than 50% of the forested watershed less than 50 years of age while supporting the provincial *Environmental Goals and Sustainable Prosperity Act* 12% protected areas target.
- The maximum annual harvest area (AHA) is recommended to not exceed 1% of the forested watershed. However if market or weather conditions do not allow the 1% AHA to be reached, a maximum AHA of 2% is recommended to be harvested in the following year. It is not recommended that the maximum 2% AHA be exceeded in any one year. Exception to this rule maybe given in the event of an unplanned natural disaster such as a fire or wind storm damage. If harvesting is required for the protection of water quality, it is recommended that up to 6% of the watershed may be harvested annually for a period of no more than 3 years; after which, harvesting must return to 1% or less over the next 6 years.
- Additional to the *'Wildlife Habitat and Watercourses Protection Regulations'* Halifax Water considers forest management planning that take into consideration natural disturbance patterns, the re-establishment of the Acadian Forest, and climate change, while maintaining the highest priority in protecting water quality.
- Typical harvest blocks are not to exceed 10 hectares. Special exemption for salvage operations of wind, insect, disease, and fire damaged sites can be approved by Halifax Water or the applicable watershed advisory board where there is a threat to water quality.
- In addition to salvage operation, special block size exemption maybe given to harvest systems that improve forest stand health such as Hardwood, Selection and Shelterwood Management.
- Adhere to the harvest adjacency rule of 10 years or 2m for softwood and 3m for hardwood, whichever comes first, before considering the next harvest treatment.
- For harvest blocks exceeding the 10 hectare size limit and do not meet special block size exemption conditions or do not meet the adjacency rule, a block separation or travel corridor must be used. The corridor is meant to break up the larger block into smaller blocks less than 10 hectares. The corridors must continually run between blocks and be at least 50m wide.
- For Wildlife Tree retention, priority will be given to disease-free, long-lived, deep rooted species. Preferences in order, are;
    - American White Ash, Red Oak, Yellow Birch, Sugar Maple, Iron Wood, American Beech, White Pine, Red Pine, Eastern Hemlock, Red Spruce, Red Maple, White Birch, Black Spruce, White Spruce, Balsam Fir.
- Other values will be considered during forest management planning, in areas such as cultural heritage sites, wildlife habitat (e.g., deer wintering areas), and Species at Risk (e.g., lichens, flying squirrels, etc.).
- Identify the area to be harvested, including the location of water bodies and sensitive area such as wetlands and high erosion hazard areas (e.g., thin soils) within the harvest area.
- During forest management planning, Halifax Water must consider using harvesting techniques that do not require the use of chemicals as a post treatment to control hardwood

and unwanted vegetative species as Halifax Water does not support their use. In lieu of chemicals the following practices are applied:

- Where forest stands would best benefit from the variable retention management system, Halifax Water will promote leaving as much standing hardwood and shade-tolerant species as operationally possible. The intention is to reduce clear cut management methods within the watersheds and promote leaving as much overhead canopy as possible.
- Where forest stands would best benefit from Hardwood, Selection, and Shelterwood management systems, Halifax Water will promote leaving shade-tolerant, long lived, deep-rooted species that leave a uniform canopy over the landscape.

- Time harvesting activities to minimize environmental impacts. For example, typically harvesting activities should occur during the drier summer months, or if needed will occur during the winter months when the ground is frozen and/or there is a snow pack.
- Consider timing restrictions around other values such as tourism season (June 15 to Oct.15 of each year).
- The width of any water course within a watershed will have a riparian zone greater or equal to the Provincial minimum standard of 20m from high water mark; however, depending on depth to water table, soil conditions, slope, etc., the riparian zone may be increased to protect the integrity of the riparian area.
- All lake shore riparian zones widths will be no less then 60m from high water mark; however, depending on depth to water table, soil conditions, slope, etc., the riparian zone may be increased to protect the integrity of the riparian area.
- Consider potential water quality impacts and risk of erosion and sedimentation in the selection of silvicultural and regeneration systems (e.g., variable retention harvest, shelterwood, hardwood selection) in order to plan forwarding routes and trails.
- Consider the additional contributions from harvesting or roads to any known existing water quality impairments or problems in watersheds of concern. For example, acid bearing slate in the Bennery Lake Watershed.
- Ensure all contracts and agreements are in place prior to operations commencing (e.g., land owner, stumpage, service agreements etc.).
- Use silvicultural practices that promote native natural species.

9.0 Forest Operations

9.01 Block Layout

- Block layout will be completed using a GPS hand held unit or a compass accompanied by photo and map showing a minimum:
  - Harvest boundaries
  - Special Management Zones
  - Waterways and water bodies
  - Roads
  - Property boundaries
  - Significant areas such as wetlands, heritage sites, and wildlife values
- Ribbon layout:
  - The tails of the ribbons indicate the inside of the operating area and will be facing the operator
  - Three (3) ribbons indicate the end of a road
  - Two (2) ribbons indicate a corner in the road or block
- Solid pink ribbon pr pink ribbon marked with "Cut Block Boundary" or "Boundary Layout" will be used to mark the harvest area boundaries during block layout. Pink ribbon with black stripes will be used to mark out buffer and significant areas (water course/ heritage zones).
- Blue ribbon marked will be used to mark skid trails into or between harvest blocks that have not already roaded.
- Orange ribbon will be used to mark sample points for forestry data collection during silvilculture or harvesting operations (e.g. stem count or volume count).
- Ensure the ribbons are tied in a manner that is clearly visible to the operator during anytime of the year.
- If an alteration to the boundary location is required, remove old ribbons so as not to create confusion of the correct boundary ribbons to follow.
- If operations do not start up within a year of completing the block layout, the site is to be revisited and the lines are to be refreshed where needed. Halifax Water and NSDNR to be notified once completed.

9.02 Harvesting

- Applicable permits and approvals must be obtained prior to operations beginning and on site at all times.
- Ensure harvest areas, all applicable leave areas, and riparian zones are flagged off as according to the *'Wildlife Habitat and Watercourses Protection Regulations'* or any applicable watershed regulations and company policies.
- Ensure a copy of the most recently approved map showing the location is on site at all times during operations. The old versions are to be destroyed.

- The harvesting machine(s) must have a copy of the most recently approved map on board showing a minimum:
  - Harvest boundaries
  - Special Management Zones
  - Water ways and water bodies
  - Roads
  - Property Boundaries
  - Significant areas such as wetlands, heritage sites, and wildlife values
- In addition to the most recently approved map, it is highly recommended that the harvesting machine have a GPS on board that reflects the approved map boundaries.
- "Active Operation" signs or similar worded signs must be posted in work area to advise people of heavy equipment operating. The signs must be posted in plain sight so as to allow for adequate warning time.
- Do not pile wood on top of culverts in order to avoid obstruction or damage.
- No cutting or other works are to take place within the designated riparian zone of any lake, river, wetland, or stream (including seasonal streams) without special approval from NSE, Halifax Water or NSDNR.
- Do not fall trees into any watercourse.
- All water bodies and watercourses must be kept free of debris generated from forest operations. No slash accumulations resulting from the operation is to be left on roads so that vehicle traffic is impeded. All ditch-lines are to be functional post harvesting.
- The Stump height BMP is as follows:
  - For trees with a diameter of 30cm or less, measured as the outside diameter at the point of cutting, the maximum stump height allowed is 30cm. For trees with a greater outside diameter than 30cm, the maximum stump height must not be greater than its' measured outside diameter. Regardless of the diameter, no tree may be felled so that its' stump height is greater than 60cm. Special exemption maybe given by Halifax Water or NSDNR for reasons such as safety; for example, the cleanup of wind damaged sites.
- All merchantable timber harvested must be moved to roadside in a timely fashion for trucking purposes.
- Ensure all merchantable timber within the harvest block as identified in the forest management plan is harvested with the exception of leave areas, riparian zones and wildlife trees.
- While felling trees along a harvest boundary ensure the boundary ribbons are left intact.
- While felling trees along a property boundary ensure the boundary markers and blazes are left intact and do not fall trees into adjacent property.
- Do not fall trees over block boundary lines.
- Ensure no lodged or spring trees are left in the harvest area.
- Protect advanced growth and residuals.

- Stop operations if a potential value that has not been identified is encountered (e.g. stream, stick nest, cabin) and notify Halifax Water or NSDNR immediately. Halifax Water or NSDNR will advise on how to resume.
- Do not use roads if rutting of the road surface, sedimentation of streams or damage to culverts is likely to occur.
- If, in the opinion of Halifax Water or NSDNR, forest operations are causing excessive damage to the natural forest environment that may result in erosion or other unnatural disturbances, the operation will be ordered discontinued until the situation has been corrected.
- Cut down chicots that are closer than one tree length from the edge of the road.
- When using a chainsaw, operators must meet Occupational Health and Safety Guidelines. When operating a chainsaw, the operator must wear appropriate chainsaw safety pants, hard hat, protective eye wear, ear protection, gloves and safety boots at all times. **(legal requirement)**
- Chainsaws must be equipped with an operable chain catcher and chain break.
- When harvesting using a chainsaw, all chicots must be removed from the block for safety reasons.
- No camping, accommodation trailers or buildings are to be brought into the watershed area.
- Contractors must attend a minimum of one start up meeting per year to review the requirements specific to the applicable watershed as per the contractor start up agenda**.**
- The contractor engaged in forest operations in the watershed will be responsible for the conduct of all his employees and agents with respect to law, regulations and guidelines pertaining to activities on watershed lands.
- Any deviance on the part of the contractor or employees of the contractor from these working conditions will be immediately corrected as directed by Halifax Water.
- Leave known recognized recreational trails (i.e. hiking, walking) in as good as or better condition than found, and clear off debris.
- If the harvesting operation occurs in the vicinity of identified recreational trails (HRM) or residential areas (closer then 100m) , ensure the club and/or residents are aware of the operation and post warning signs at each end of the trail/road within 100m of the operation. The signs are to remain in place during the length of the operation until all wood is removed.
- Skidders and forwarders are to travel in the same path as the felling and processing machines to minimize site disturbance and damage to residual stems.
- No extraction trails may be located within a plantation without first obtaining permission from Halifax Water or NSDNR.
- No motorized equipment may travel through/over a watercourse unless an appropriate crossing structure is in place.
- To reduce the risk of wood being left behind, place a skid log under roadside piles. This will reduce the number of logs laying in wet/frozen conditions.
- Harvested trees must be utilized to the fullest extent; however, if form and length do not allow for ideal utilization, the minimum top diameters are defined as:

- Minimum top diameter of 7.5cm (3inch) for Red Spruce, Black Spruce, White Spruce, Tamarack.
- Minimum top diameter of 16cm (6inch) for Hardwood, White Pine, Red Pine.
- Discretion must be used when measuring for top diameter as form could be a deciding factor of where the tree must be topped. Both the roadside piles and in bush tops will be inspected by Halifax Water or NSDNR to ensure quality topping practices are being conducted.

9.03 Grinding and Chipping

- Applicable permits and approvals must be obtained prior to operations beginning and on site at all times.
- No chipping or grinding of wood products is to be conducted within 60m of a watercourse.
- "Active Operation" signs or similar worded signs must be posted in work area to advise people of heavy equipment operating. The signs must be posted in plain sight so as to allow for adequate warning time.
- No stock piling of woodchips within 60m of a watercourse
- Chipping debris created from the chipping process must be cleaned off road surfaces on a regular basis so as not to impede vehicular passage.
- Once operations have been completed, chipping debris must be completely cleaned off of road surfaces and spread out to a maximum thickness of 30cm within the block boundary.

9.04 Loading and Hauling

- Applicable permits and approvals must be obtained prior to operations beginning and on site at all times.
- "Active Operation" signs or similar worded signs must be posted in work area to advise people of heavy equipment operating. The signs must be posted in plain sight so as to allow for adequate warning time.
- Ensure all tie down cables, chains, and chip van covers are working accordingly and replace any damaged ones immediately.
- Ensure all wood is centered between the pickets for safe loading.
- Ensure the truck driver has checked both sides of the load prior to leaving the block.
- Truckers must not tie down next to another truck loading.
- Check for loose debris prior to transporting.
- Check load security prior to entering onto a public highway as well as routinely throughout the duration of the trip.
- The loader operator must thoroughly search through the snow to ensure no merchantable wood is left behind.
- If merchantable wood cannot be loaded because it is frozen to the ground, Halifax Water or NSDNR must be notified.

10.0 Silviculture

10.01 General

- Applicable permits and approvals must be obtained prior to operations beginning and on site at all times.
- All water bodies and watercourses must be kept free of debris from silviculture operations. No slash resulting from the operation is to be left on roads, and felled saplings near culvert inlets are to be removed.
- Do not use roads if rutting of the road surface, sedimentation of streams, or damage to culverts is likely to occur.
- Lunch, fueling and maintenance areas will be kept clean and all garbage removed from the watershed on a daily basis. A gas and oil absorbing material will be placed under saws when refueling and oiling. Report spills as per the Emergency Spill Regulations.
- Designated fueling areas must be at least 30m from a defined stream channel or flowing water (i.e., where water is flowing in the ditch, etc.).
- Fuel containers (Jerry cans) when transported in vehicles are to be leak-free and secured to avoid damage and spills.
- All fuel containers (Jerry cans) must be marked clearly identifying their contents.
- Machinery and tools showing above normal leaking fuels or other fluids will cease operation immediately and fluids contained. Repairs are to be made or machinery removed from watershed.
- All vehicles on the forest operation will have an appropriately sized spill kit and required firefighting equipment on board.
- No camping, accommodation trailers or buildings are to be brought into the watershed area.
- Be aware of wildlife habitat features, such as cavity trees or nests, and protect these from disturbance during silviculture operations.
- No chemicals are allowed for herbicide, pesticide, biocide, or fungicide purposes unless otherwise approved by NSE, Halifax Water or NSDNR.
- The contractor engaged in forest operations in the watershed will be responsible for the conduct of all his employees and agents with respect to law, regulations and guidelines pertaining to activities on watershed lands.
- If forest operations are causing excessive damage to the natural forest environment that may result in erosion or other unnatural disturbances, the operation will be ordered discontinued until the situation has been corrected.
- Any deviance on the part of the contractor or employees of the contractor from these working conditions will be immediately corrected.

10.02 Regeneration Assessment

- Regeneration Assessments for initial post-harvest treatment (natural establishment/ planting) will be completed by Halifax Water or NSDNR two years after harvesting operations have been completed.

- Regeneration Assessments will be completed as per the 'Nova Scotia's *Forest Sustainability Regulations'*.

10.03 Planting

- Halifax Water prefers to promote the re-growth of native species to the harvest area through natural regeneration. Planting of native species will be used as an alternative if regeneration assessments show inadequate restocking through natural regeneration.
- Halifax Water does not promote the planting of non-native species, however, if conditions warrant, approval must be given by Halifax Water or NSDNR.
- Planting will be completed as per the *'Nova Scotia's Forest Sustainability Regulations'*.

10.04 Spacing

- Halifax Water's silviculture program includes a spacing program which targets healthy immature stands. Spacing is only conducted on stands that warrant it as per the *'Nova Scotia's Forest Sustainability Regulations'*.

10.05 Chemical Use

- As per applicable watershed regulations.
- Halifax Water does not support the use of chemicals on any watershed lands.

11.0 Recreation

- Halifax Water does not promote its lands or watersheds as open to the public for recreational activities; rather it takes the approach of "user-beware".
- Halifax Water tolerates the use of low impact recreational activities on its lands and watersheds unless otherwise posted. Low impact watershed activities include hiking, mountain biking, and cross country skiing as long as they does not impair water quality or impede on the systems in place to conduct watershed management.
- In addition to the applicable Protected Water Area regulations, no motorized vehicles are allowed on Halifax Water lands without written authorization. The written authorization must be carried on the authorized vehicle(s) at all times. A penalty may be issued to those who do not comply.
- No open fires are allowed, including camp fires, on Company lands without written permission being first obtained from Halifax Water. The written permission must be carried on the person(s) conducting the fire activity. A penalty may be issued to those who do not comply.
- There will be no cutting of wood allowed for recreational, personal or commercial purposes without the written authorization of Halifax Water or NSDNR. The written permission must be carried on the person(s) doing so. A penalty may be issued to those who do not comply.
- Hunting and fishing activities must comply with provincial and watershed regulations unless otherwise posted.
- Boating, canoeing, and kayaking must comply with provincial and watershed regulations unless otherwise posted.
- Swimming must comply with provincial and watershed regulations unless otherwise posted.

Appendix 1 – Applicable Legislation

- **Applicable Municipal By-laws that may affect Halifax Watersheds:**
  - Halifax Regional Municipality By-laws regions. Listed below are those By-Law regions that directly influence activities on Halifax Water watershed lands in addition to the Protected Water Area regulations:
    - Cole Harbour/ Westphal
    - North Preston/ Lake Major/ Lake Loon/ Cheery Brook/ East Preston
    - Lake Echo/ Porter/s Lake
    - Shubenacadie Lakes
    - St. Margaret's Bay
    - Beaver Bank/ Hammonds Plans/ Upper Sackville

    For more information please visit the website www.halifax.ca or contact (902) 490-4210.

  - East Hants Municipality By-laws for Commercial Zones:
    - East Hants – Zones within the Pockwock PWA
    - East Hants – Zones outside of the PWA, but still within the Pockwock Watershed; specifically:
      - 8.10.7 Special Requirements for the Pockwock Watershed
        a) No open storage shall be located within the Pockwock watershed area as identified on the official zoning mapping.
        b) No hazardous materials shall be stored within the Pockwock watershed area as identified on the official zoning mapping.

    For more information please visit the website www.easthants.ca or contact (902) 758-2715.

- ***Provincial Act and Regulations:***
  - *Lake Major Watershed Protected Water Area Designation and Regulations*
  - *Pockwock Lake Watershed Protected Water Area Designation and Regulations*
  - *Bennery Lake Watershed Protected Water Area Designation and Regulations*
  - *Halifax Regional Water Commission Act*
  - *Provincial Forest Protection Regulations*
  - *Wildlife Habitat and Watercourses Protection Regulations*
  - *Nova Scotia's Forest Sustainability Regulations*
  - *Emergency Spill Regulations*
  - *Used Oil Regulations*
  - *Transportation of Dangerous Goods Regulations*

The above Acts and Regulations may be viewed on line for the most recent versions.

Appendix 2 – List of Reportable Toxins

Item No.	TDGA Class	Description of Contaminant	Amount Spilled
1.	1	Explosives	any amount
2.	2.1	Compressed gas (flammable)	100 L
3.	2.2	Compressed gas (non-corrosive, non-flammable)	100 L
4.	2.3	Compressed gas (toxic)	any amount
5.	2.4	Compressed gas (corrosive)	any amount
6.	**3**	**Flammable liquids**	**100 L**
7.	4.1	Flammable solids	25 kg
8.	4.2	Spontaneously combustible solids	25 kg
9.	4.3	Water-reactant solids	25 kg
10.	5.1	Oxidizing substances	50 L or 50 kg
11.	5.2	Organic peroxides	1 L or 1 kg
12.	6.1	Poisonous substances	5 L or 5 kg
13.	6.2	Infectious substances	any amount
14.	7	Radioactive substances	any amount
15.	8	Corrosive substances	5 L or 5 kg
16.	9.1 (in part)	Miscellaneous products or substances, excluding PCB mixtures	50 L or 50 kg
17.	9.1 (in part)	PCB mixtures of 50 or more parts per million	0.5 L or 0.5 kg
18.	9.2	Environmentally hazardous substances	1 L or 1 kg
19.	9.3	Dangerous wastes	5 L or 5 kg

20.	none	Asbestos waste, as defined in the Asbestos Waste Management Regulations	50 kg
21.	**none**	**Used oil, as defined in the Used Oil Regulations**	**100 L**
22.	none	Contaminated used oil, as defined in the Used Oil Regulations	5 L
23.	none	A pesticide in concentrated form	5 L or 5 kg
24.	none	A pesticide in diluted form	70 L
25.	none	Unauthorized sewage discharge into fresh water or sensitive marine water	100 L
26.	none	Ozone-depleting substances, as defined in Ozone Layer Protection Regulations	25 kg