SOURCE WATER PROTECTION PLAN

Cape Breton Regional Municipality

Gardiner Mines

BASED ON: DEVELOPING A MUNICIPAL SOURCE WATER PROTECTION PLAN: A GUIDE FOR WATER UTILITIES AND MUNICIPALITIES, STEPS 1 – 5, NOVA SCOTIA ENVIRONMENT 2009

CBRM Water Utility
2014

1.0 Introduction

In October 2002, the Province of Nova Scotia released A *Drinking Water Strategy for Nova Scotia.* This describes a multiple-barrier approach to clean, safe drinking water for Nova Scotians. Nova Scotia's multiple barrier approach has three lines of defence:

• **Keeping Clean Water Clean** - select the highest quality sources of water and protect these sources to prevent contamination.

• **Making It Safe** - treat water to remove natural and manmade impurities.

• **Proving It's Safe** - consistently monitor water quality and take swift, corrective action when deficiencies are identified.

One step to **Keeping Clean Water Clean** is the development of a source water protection plan (SWPP). Nova Scotia Environment (NSE) describes a SWPP as:

> An approach to managing drinking water supplies based on (1) the formation of an advisory committee to guide the development of the plan, (2) an inventory of land-uses and activities within the source water supply area, (3) determination of existing and potential threats to the drinking water supply, (4) the development of management strategies designed to reduce and eliminate threats to the drinking water supply, and (5) contingency planning and a monitoring program to evaluate the effectiveness of the overall plan.

The source water protection approach encourages collaboration with all stakeholders within the source water supply area.

Although water is a renewable resource, there are limits to its quality and quantity. The quality of our drinking water sources is threatened by land development, runoff from agricultural, commercial, and industrial sites, and aging wastewater infrastructure, to name a few. To protect our source water we must manage the human activity that creates these threats. Protecting source water makes good sense in three ways. It makes good public health sense, good economic sense, and good environmental sense. Protecting drinking water sources also protects the water resource for many uses.

The development of a SWPP became a requirement for municipal drinking water facilities in Nova Scotia in 2002.

This document will describe the municipal drinking water system for the Gardiner Mines area of the Cape Breton Regional Municipality (CBRM), delineate the source waters, identify risks to the source water and management options selected to reduce these risks, and outline a monitoring plan.

2.0 Drinking Water System Description

ADI Limited (2009a) provides the following history of the system:

An initial domestic well in the Mackies Lane area is reported to have served several homes prior to 1991. A new replacement well was drilled in November 1991 by the County of Cape Breton. The work at that time included the installation of a pumping well, concrete pumping chamber and distribution system. In July of 2007, a new production well was drilled by the CBRM to address complaints of low water pressure and dirty water. At that time all of the equipment in the existing pumping chamber was replaced, including the pump, storage tanks and chlorine injector. The equipment was moved to a new above-ground pump house, constructed on top of the old pumping chamber.

Figure 1. Gardiner Mines well drilled July 2007 on Mackie Lane cul-de-sac.

Figure 2. Abandoning old well October 2008, new treatment building in background.

The Gardiner Mines system pumps groundwater from the well and disinfects it within the pump house, using sodium hypochlorite. The treatment system includes a skid mounted, automatic switch over unit for chlorine injection, and comes equipped with back pressure valves, flow monitors and flow checkers that are configured to automatically sense when one pump is not pumping and will start the second. Chlorine residuals are recorded on a continuous basis and monitored once per day by personnel from the CBRM Water Utility. In 2011 CBRM added two water treatment systems to filter manganese and other substances from the raw water.

The customers are supplied through a 50 mm diameter water main for distribution to Strang's Lane (nine customers) and Centerville Road (four customers). The remaining customer on Mackies Lane, a two unit dwelling, is supplied by a separate 19 mm service from the pump chamber.

Figure 3. Fourteen Gardiner Mines water account customers shown in blue.

According to ADI (2009) the 2007 pump test resulted in a theoretical 20-year safe yield of 57 Lpm (82 m^3/day), with an operational safe yield of 37.8 Lpm (54 m^3/day or 10 USGPM). Average daily consumption in 2010 was 5.25 m^3/day, well below the theoretical value, and less than 10 per cent of the 20-year safe yield. Maintaining this low demand minimizes drawdown which might interfere with nearby domestic wells. It also reduces the chance of interfering with surrounding contaminant sources, such as mine waste, septic systems, poorly constructed wells, and mine waters.

Figure 4. Centerville Road customers left and Strang Road customers right.

3.0 Source Water Protection Committee

The first step in developing a SWPP is to form a representative Advisory Committee. The process should be consensus-driven and contingent on the collaboration of all stakeholders.

CBRM attempted to establish a source water protection committee for this well; however, there was no interest in the community. CBRM hoped the source water protection committee for the New Waterford water supply would be able to prepare a plan, but the committee members were not familiar with the Gardiner Mines system. CBRM therefore drafted a plan and is placing it on our website, inviting comments and discussion, and offering to meet with residents if they wish. SWPP are “living” documents, needing to be regularly updated. Residents will always be able contact CBRM to discuss concerns or gaps with the SWPP and activities identified in it.

4.0 Delineation

A fundamental concept of source water protection and management is the identification and delineation of the zones requiring safeguards and the appropriate level of protection for each zone.

It is important to define or delineate your source water protection area for the following reasons:

• to know exactly what land area you will be dealing with, and, therefore the hydrogeological, ecological and hydrological factors that interact with the source water.

• to determine what land owners will be affected by the SWPP, and what activities and land-uses you must concentrate on in the SWPP.

By clearly identifying what area supplies water to your source, you will be better able to provide adequate protection for it.

Groundwater Delineation

The source water protection area surrounding the well or well field where groundwater is to be protected is called the wellhead protection area (WHPA). The protection area includes all or part of the area that contributes groundwater to the well field and is typically divided into several smaller zones that are used to manage different types of contaminants.

The WHPA is divided into zones based on the time it takes groundwater to travel to the well. The different zones reflect the fact that different types of contaminants in groundwater will persist for different lengths of time, migrate at different rates, and pose different health risks. Zones that are closer to the well require a higher level of protection because there is a shorter distance to travel before groundwater reaches the well and, therefore, less time to respond to contamination events and less opportunity for contaminants to be diluted or removed by the aquifer.

Zone 1: represents the 0-1 year time of travel. This zone is intended to protect the water supply from microbial contaminants (e.g. bacteria and viruses), which have the potential to produce disease in humans, and chemical contaminants. This is the immediate zone of influence around the wells.

Zone 2: represents the 1-5 years time of travel. This zone is intended to protect the water supply from all chemical contaminants. The time delay for this zone is based on a time allowance considered sufficient for comparatively reactive chemicals to be diminished to concentrations that are no longer of concern. The intent of the 1-5 years travel time will either allow an opportunity for the reactive chemicals to break down/be absorbed by the aquifer or provide ample time to track plume migration to determine the level of intervention required to mitigate the contamination (if any intervention is needed).

Zone 3: represents the 5-25 years time of travel zone. This zone is intended to protect the water supply from persistent, mobile chemical contaminants. This level of protection is required for contaminants which are persistent and mobile in groundwater as they can last for decades and travel several kilometers in an aquifer. A significant period of time is required for the concentration of these contaminants to diminish to levels that are not of concern or provide ample time to track plume migration to determine the level of intervention required to mitigate the contamination (if any intervention is needed).

In 2007, ADI Limited (ADI) delineated a source water protection area for the community well in Gardiner Mines. Zones were estimated using the 5 and 10 year time-of-travel capture zones using the USEPA calculated fixed radius method. The method is based on simple hydrogeologic principles and requires limited input data. There is no detailed hydrogeological assessment completed on the aquifer supplying the well to determine

groundwater flow direction and lateral/vertical components of flow velocity. The method assumes a cylindrical cone of depression and does not account for anisotropy in the system, which may elongate the plume in a particular direction. The method tends to over-predict the size of the capture zone in the down-gradient direction and under-predict the size in the up-gradient direction. The calculations accounted for:

- A pumping rate for the well averaging 15,200 Lpd with a maximum permitted withdrawal of 40,000 Lpd
- A total depth of well exposed to the aquifer of 30 metres
- An aquifer fracture porosity ranging between 0.5 and 5%.

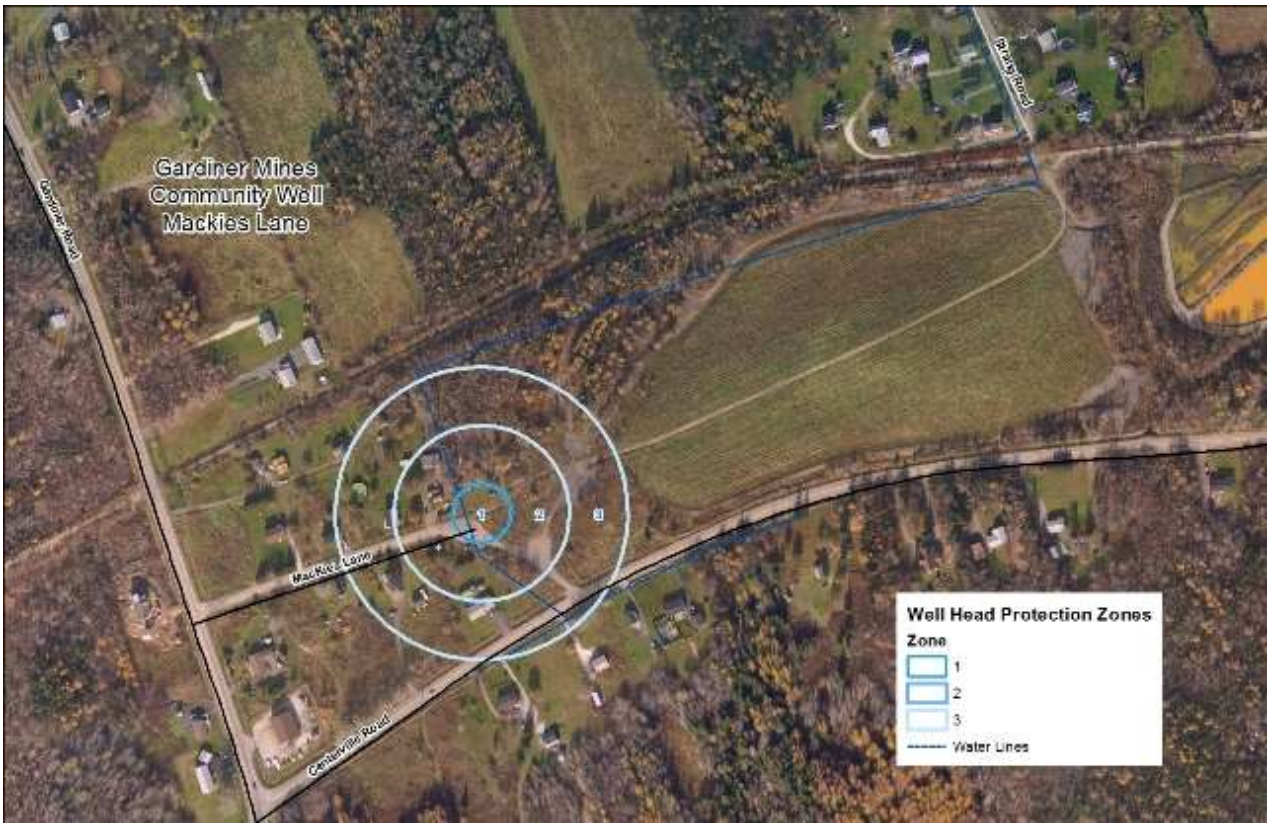

Figure 5. Well head protection zones and approximate water line locations.

The radii of arbitrarily selected 5 and 10 year time-of-travel capture zones were estimated to be 60 and 100 metres, respectively. The extent of these zones is relatively low, due primarily to the low withdrawal rate. Using this approach, Zone 1 immediately around the well head (assuming a time of travel of 1 year) would have an estimated radius of 20 metres; zone 2, 60.96 metres; and zone 3, 91.44 metres.

At present, Zone 1 is not fenced to restrict access. No monitoring wells have been installed to detect the first signs of any contaminant movement out of Zones 2 or 3 toward the Production Well.

5.0 Risk Identification

Step Three in the process recommended by NSE for implementing a SWPP identify potential contaminants and assess risk.

What Are the Risks to Source Water?

• **Microbial contaminants**, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.

• **Inorganic contaminants**, such as salts and metals, which can occur naturally or result from urban storm water runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming.

• **Pesticides and herbicides**, which may come from a variety of sources such as agriculture, storm water runoff, and residential uses.

• **Organic chemical contaminants**, including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also, come from gas stations, urban storm water runoff, and septic systems.

• **Radioactive contaminants**, which can be naturally occurring or be the result of oil and gas production and mining activities.

• **Sediment** is associated with the weathering of soil and rock. Human development can cause sedimentation, primarily through soil erosion. Sediment can seriously harm the quality of source water.

• **Nutrients**, such as nitrates and phosphorus can be generated by human activity, and cause **eutrophication**, whereby excessive plant growth depletes oxygen levels in water.

Box 1. Description of the types of contaminants that can threaten source water

Current concerns in the Gardiner Mines source water protection area are residential properties, roads, and historical mine workings. Zone 1, with 1260 m^2, has 580 m^2 of undeveloped land, 360 m^2 of road way, and 320 m^2 of remediated pit head. ECBC owns 4200 m^2 of Zone 2, which is 40 per cent of the 10,420 $m^{2\ total}$ area. Zone 3 contains 14,590 m^2, of which over 75 percent is developed or in the remediated pit head area.

5.1 Residential

The production well is within a residential area. All homes are on septic systems and expected to have oil tanks. As well, there are some homes with private wells. Many of the homes also have sheds and barns. It is unknown whether these contain chemicals such as lawn care products. ADI (2008) listed risks of residential uses:

There are a total of six dwellings on Mackies Lane and several shed/barn type buildings. The structure closest to the Production Well has three sheds and one large barn structure currently being used as a dog kennel and two 909 litre petroleum above ground storage tanks (ASTs). The structure on the south side has a propane tank.

Three homes on Centreville Road opposite the Production Well have 909 litre ASTs. The closest home to the Production Well is positioned on Centreville Road to the southeast, which has a 909 L AST.

Zone 1 contains no buildings, but one quarter of its area is part of a residential property used for storage of vehicles and other items. Although almost 40 percent of the area of Zone 2 consists of residential lots, two homes just touch the zone. The 2008 photography indicates there are four sheds (one is indicated as a barn on a 2002 subdivision plan) and one swimming pool in Zone 2. There are three homes, four sheds, a residential garage and one swimming pool in Zone 3.

ADI reported in 2009 that the absence of bacteria in the well water indicated there is no impact from adjacent septic fields to the south and west. CBRM Water Utility recognizes however that this can change. All dwellings within the protection zones appear on 1981 or 1985 subdivision plans, meaning the septic fields are at least 25 years old.

5.2 Roads

The production well is located on Mackies Lane, a cul-de-sac, which consumes about 30 per cent of the zone. Figure 1 shows a Jersey barrier installed to protect the well head from damage by snow removal equipment. About 10 percent of Zone 2 and Zone 3 are paved or graveled for traffic. As shown in Figure 5, a portion of Centerville Road is located within zone 3. These roads are both paved, with winter maintenance by the Province. NSTIR uses salt to control ice.

Figure 6. Gardiner Mines well, stone dump in background.

5.3 Historical Mine Workings

The abandoned pit head and associated mine waste rock from the No. 25 colliery is positioned adjacent and immediately east of the Production Well. The covered waste rock pile can be seen in Figure 5 and in the background of Figure 6. ADI (2009b) reported that water quality problems with the original (pre-1991) well were suggested to be a result of proximity to the mine stone dump.

The surface facilities have been removed; the approximate extent of subsurface infrastructure is shown in Figure 7. The surface stone tip, where waste rock from the mining operation was permanently stored, covers some 5.6 hectares east of the Production Well. Waste rock was dumped above grade, over natural ground surface. The waste rock material was determined to be acid producing and shallow ground waters were impacted by the waste pile.

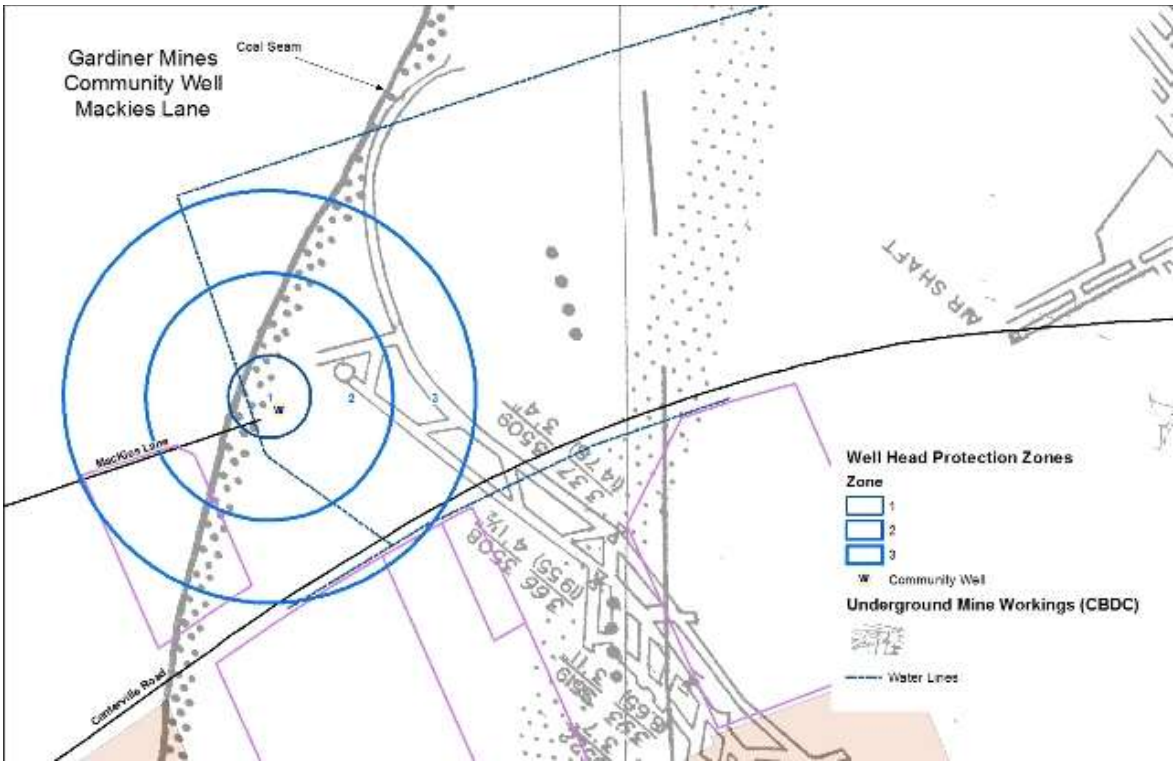

Figure 7. Approximate location of underground mine workings and coal seam.

Areas of the site had also been used for dumping garbage including automobile parts, household appliances, furniture and other domestic refuse.

The mine site remained largely unchanged over 40 years following the mine closure. The stone tip was capped in 2005 with approximately a metre of fill material and vegetated. Settling ponds, which can be seen in Figures 3 and 5, now collect flow from three artesian wells discharging mine water. The lack of detectable hydrocarbons indicates there is no impact from the flooded mine workings to the east. Water quality

has remained relatively stable since then. Enterprise Cape Breton Corporation (ECBC) continues to monitor water flowing from the passive wetland treatment system seen at the right hand edge of Figure 5.

ADI (2009b) notes that the 2007 well is just 90 metres west of the former mine entrance, but a water sample taken 71 hours into the initial pump test indicated excellent water quality, with all measured chemical parameters within the Guidelines for Canadian Water Quality (2007) except manganese at 0.48 mg/l.

5.4 Accidents

The wellhead is not enclosed in a structure. The proximity of the wellhead to Mackies Lane poses a risk of automobile accidents. The barriers shown in Figure 6 and the gate and boulders placed by ECBC shown in Figure 8 have greatly reduced the amount of vehicle traffic near the well.

Figure 8. Gate and boulders placed by ECBC

Land Uses and their Relative Risk to Source Water

Least risk

1. Land surrounding reservoir/well, owned by water utility/municipality
2. Permanent open space dedicated to passive recreation
3. Woodlands and managed forests

1. Field crops: pasture, hay, grains, vegetables
2. Low-density residential: lots greater than 2 acres
3. Churches, municipal buildings

1. Institutional uses
2. Medium-density residential: 0.5 to 1.0 acre lot sizes
3. Commercial uses with limited hazardous material storage or underground chemical or fuel storage

1. Agricultural production: dairy, livestock, nurseries, orchards,
2. Golf courses, quarries
3. High-density housing: lots smaller than 0.5 acre

1. Retail commercial: gasoline, farm equipment, automotive, dry cleaners, photo labs, machine shops, furniture strippers
2. Industrial: all forms of manufacturing and processing
3. Underground chemical and fuel storage
4. Waste disposal: pits, dumps, ponds, lagoons, landfills

Greatest risk

Box 2. Land Uses and the Relative Risk to Source Water ranked from least to greatest risk.

Table 1 presents the assessment of risks for the Gardiner Mines community well. Mine tailings and mine water are identified as the largest potential issue and given priority in the Water Utility's source water protection efforts.

Contamination Issue	Activity\Cause	Scale of Problem*	Priority Rank**
chemicals	Mine tailings and mine water	2	1
oil	Oil tank leak	3	2
bacteriological	Onsite septic system leakage	3	3
Salt/sand	Road winter maintenance	3	3

* Scale: 1 = Severe, 3 = Moderate, 5 = Minimal ** Rank: 1 = High, 3 = Moderate, 5 = Low

Table 1. Risk assessment matrix for Gardiner Mines community well.

6.0 Source Water Protection Management Options

Step 4 in the process recommended by NSE for implementing a SWPP: develop a SWPP.

Matching management options to issues that affect source water quality (**Step Three**) is a critical step in the development of a SWPP. Available management options and their use by CBRM in the protection of the Gardiner Mines community well are described below.

Acquisition of Land: Land acquisition gives direct ownership and control of the source water protection area to the utility or municipality. This is a preferred option because of its obvious benefits. The purchase of land may include all lands within the source water protection area, or may be confined only to land areas that play a critical role in protecting the water source.

Bylaws: Land-use planning through the use of municipal planning strategies and zoning is a very powerful tool to ensure that potential contaminant threats or activities are sited away from the water source. Developing bylaws is subject to mandatory public consultation requirements.

Best Management Practices (BMPs): Once individuals and industries understand they may be part of the problem, they also understand they can be part of the solution. BMPs are a good way to introduce a change in the way businesses, industry and individuals treat the environment.

Contingency Planning: An emergency response plan provides a blueprint for action in the event of a dangerous contamination occurrence within the source water protection area. All utilities or municipalities must have a contingency plan in place for their source water protection areas.

Designation: Formal designation as a Protected Water Area, under Section 106 of the Nova Scotia Environment Act, is a mechanism for utilities or municipalities to develop regulations for activities that have the potential to impair source water quality. Regulations will apply to the source water protection area defined by the utility or municipality and advisory committee. Designation is subject to mandatory public consultation requirements.

Education and Stewardship: Few people will make changes without understanding what changes need to be made, why change is needed, how to make the change, and how the change will affect the individual. Educating people and communities on the importance of source water protection will help introduce a change in behavior and begin a move toward environmental stewardship. Educating the people who live and work within source water protection areas creates a sense of ownership and shared responsibility for the protection of the water resource.

6.1 Residential

As described in section 5.1, the Production Well is within a residential area. Homes have oil tanks and onsite septic systems. CBRM will provide information to home owners on oil tank and septic tank maintenance. A useful approach in other jurisdictions has been an inspection of septic systems, wells, and oil tanks by educational staff. In some jurisdictions, financial incentives have been provided for septic system, oil tank or well maintenance or upgrades. CBRM may consider this option in the future.

Signs can be erected near the wellhead to remind residents of the well. As well, CBRM planning staff hopes to introduce wellhead protection zoning during the annual winter amendments of 2012-2013, following discussion with interested residents within the well head area.

6.2 Roads

There is no signage on Mackies Lane to warn road maintenance staff that a community well is present. A sign on the pump house should alert resident and drivers alike that they are public water supply and should strive to “Please help keep it clean”. The road is maintained by NSTIR who do use salt for de-icing. CBRM will meet with provincial staff to discuss other options for winter maintenance.

6.3 Historical Mine Workings

As described in section 5.3, the waste rock pile has been capped and revegetated. ECBC have a passive treatment system down the hill from the well where they sample the mine water coming from the former Gardiner #25 mine as it comes to surface. CBRM Water Utility staff will keep in regular contact with ECBC staff to discuss monitoring results and notification in case ECBC detects contamination. ECBC staff have been transferred to PWGSC, but are still monitoring the site.

It should be noted that the well is constructed with 24.4 metres of sealed casing to prevent contamination from surface water.

6.4 Accidents

The wellhead is not enclosed in a structure. The Jersey barriers shown in Figure 1 were installed to reduce the risk of accidents following a collision in 2007 that damaged the pitless adapter. An emergency response plan, including an operations manual, has been compiled and remains on-site within the facility. It will be reviewed to ensure it captures scenarios related to a contamination or loss of the source water.

7.0 Source Water Protection Monitoring and Review

Step Five in the process recommended by NSE for developing a SWPP is Develop a Monitoring Program to Evaluate the Effectiveness of the plan.

Source water protection monitoring is a process that reviews the performance of the SWPP. This typically involves monitoring the quality of source waters to evaluate changes in the state or health of the water supply area. The plan may not be meeting its objectives if water quality is deteriorating in the water supply or the identified management options (such as BMPs) are not being followed. A municipality or utility should be able to link deterioration in water quality to one or more of the risks identified source water protection plan.

This complements, but is different from the monitoring completed by a utility or municipality on its raw water to meet regulatory requirements (i.e. regulatory compliance monitoring). Raw water quality monitoring may be on a much more frequent basis depending on the source of supply, risk of contamination, type of treatment and similar factors.

As well, SWPPs need to be regularly reviewed to ensure new land uses or activities are included (or, conversely, the cessation of land uses/activities), any changes to the water supply infrastructure (e.g. construction of a new well), or the introduction of new legislation. The monitoring and evaluation program for the SWPP will help assure the plan remains current with changing conditions and priorities in the water supply area.

Regulatory Compliance Monitoring

Groundwater: Under the requirements of the Environment Act, the Activities Designation Regulations and the Water and Wastewater Facilities and Public Drinking Water Supplies Regulations, the Utility samples raw water from the groundwater well before it enters the treatment process. Raw water is tested for microbiological (E. coli and total coliforms), physical (turbidity and pH) and chemical (example pesticides and metals) quality.

Water Supply Area Monitoring

In addition to testing the distribution water for bacteria, CBRM also tests the raw water weekly to ensure there is no E. coli or coliform bacteria in the well water.

SWPP Review and Update

The Water Utility will regularly review and update the SWPP. This will include:

- review of monitoring results for information on the effectiveness of management options;
- identification of any changed risks in the area (e.g. new businesses in area or increased recreational use) and corresponding update to the plan;

- identification of changes to the water system infrastructure (e.g. a new well) and corresponding update to the plan.

	2014				2015
Management Strategy	**Jan - Mar**	**Apr - Jun**	**Jul - Sep**	**Oct - Dec**	**Jan -Mar**
Develop and distribute draft plan to landowners\residents (on website)					
Develop contingency/ EMO plans for spills\accidents					
Work with ACAP CB to create community awareness (schools)					
Work with CBRM Planning Department on zoning boundaries					
Establish signage at access roads					
Put source water protection materials on the CBRM web site					
Review water samples for bacteria, chemicals, and minerals (road salt)					
Review and update SWPP					
Work with ACAP CB on home assessments?					

Table 2. Gardiner Mines well head SWPP implementation schedule

8.0 References

ADI Limited, 2008. *Cape Breton Regional Municipality Source Water Protection Planning Gardiner Mines Production Well Report L4012-081.7,* prepared for CBRM Water Utility February 2008, 24 pages.

ADI Limited, 2009a. *Cape Breton Regional Municipality Centerville Water Assessment ADI Limited Report L4012-121.1,* prepared for CBRM Water Utility March 2009, 13 pages plus appendices.

ADI Limited, 2009b. *Cape Breton Regional Municipality Municipal Water Supply GUDI Assessment 2007 Production Well Gardiner Mines ADI Limited Report L4012-123.1,* prepared for CBRM Water Utility August 2009, 6 pages plus appendix.