SOURCE WATER PROTECTION PLAN

Cape Breton Regional Municipality

Floral Heights

CBRM Water Utility
2013

1.0 Introduction

In October 2002, the Province of Nova Scotia released the *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.

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 Floral Heights area of the Cape Breton Regional Municipality (CBRM), delineate the source water area, 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

The Floral Heights area is supplied drinking water by groundwater, from one well located at 54 Waterville Drive, Howie Center, on PID 15795107, a 4162 square metre lot owned by CBRM. According to ADI Limited, 2006, the well was pump tested and a report submitted to NSE requesting water rights withdrawal in January, 1997. Pumping commenced in April, 1997. The well is 61.5 metres (202 feet) deep with 16 metres (52 feet) of casing.

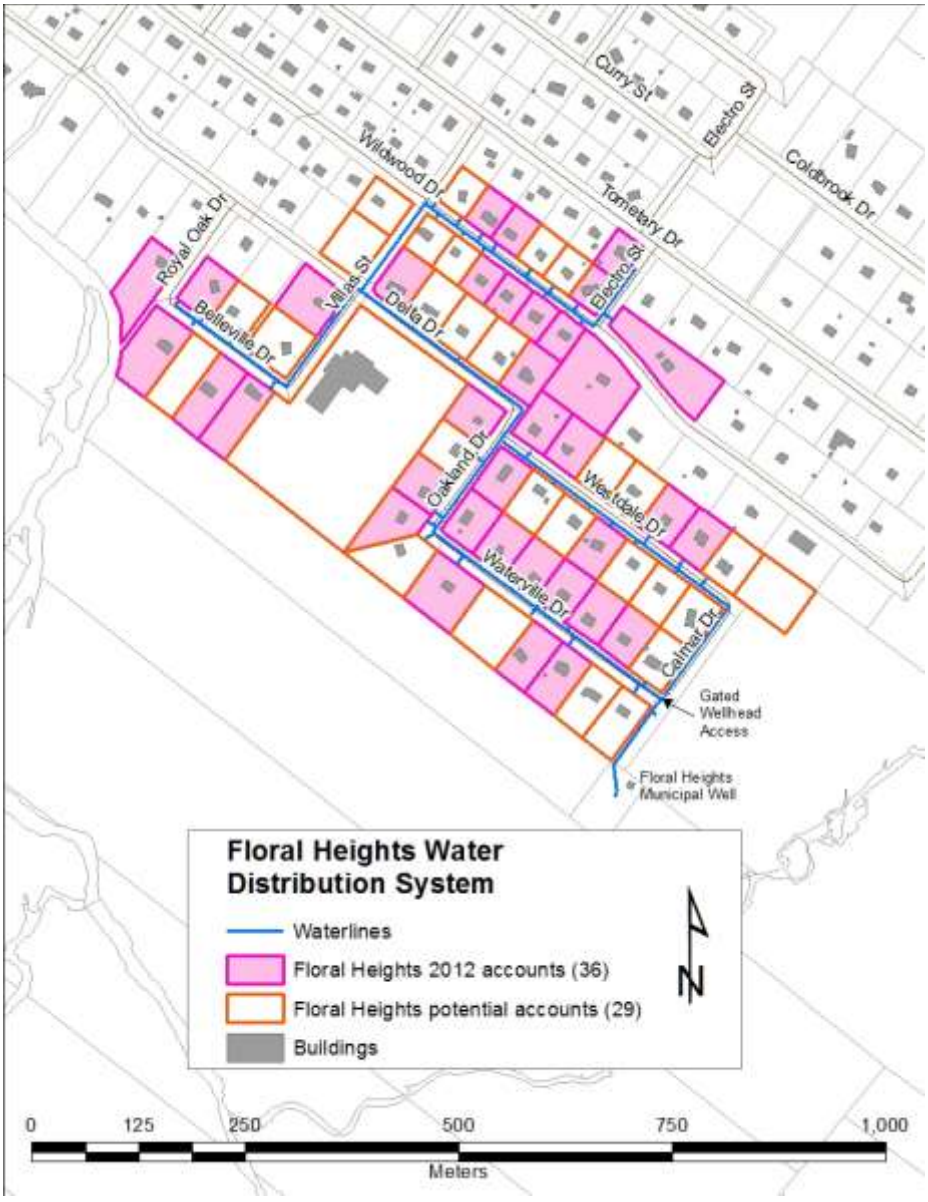


Figure 1. Location of well, transmission lines and customer properties.

The 1996 72 hour constant rate pump test indicated a 20-year safe yield of 426 m^3/day and an operational safe yield of 524 m^3/day. Water is distributed through 2.1 kilometres of 150mm water mains. Figure 1 shows the waterlines, well head, and water customer properties.

Figure 2. Waterville Drive and Westdale Drive.

The Floral Heights well pumps over 5000 gallons (an average of 23 m^3 in 2011) a day to the 36 homes which opted to connect to the distribution system following an event which contaminated private wells in the area. There are 55 single unit dwellings, four two unit dwellings, and an elementary school within reach of the distribution system. The fact that only 34 single unit homes and two of the two unit dwellings asked to be connected is probably related to the fact that not all private wells had contaminated water. It has been the experience in CBRM that people will not join a municipal system until they have problems with their water. CBRM has the capacity to accept the school as a water customer but Nova Scotia Supply and Services has not asked to be connected.

The treatment system was upgraded under approval number 2007-05164 to include an automatic chlorination switch over unit. The SCADA system reports flow information to the Sydney Water Treatment Plant. Another alarm notifies operators in Sydney of a power failure at the Floral Heights station.

Figure 3. Floral Heights well head February 2008 (left) and March 2011 (right)

Customers complained frequently about dirty water, often due to visible manganese in the distribution water, caused by the addition of chlorine. In 2010 three Greensand Plus pressure filters were added and a building was constructed over the concrete tank. It is now easier to maintain adequate chlorine residual. A continuous turbidity meter was added in January 2009 to monitor turbidity entering the distribution system. Other improvements were a second chlorination pump, an alarm system alerting a failed chlorination process, continuous residual chlorine monitoring, and daily monitoring of chlorine residuals and pH in treated water.

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 - residents, business owners, municipal staff, and provincial representatives.

CBRM attempted to establish a source water protection committee for this well. CBRM staff approached two well-informed customers of the water system: a hydrogeologist and an administrator in a well-known environmental organization. They were not able to volunteer for committee participation. The Sydney well field SWP committee was approached to prepare a plan, but felt it was outside their area of concern. CBRM therefore drafted a plan and will send copies to residents, inviting comments and discussion, and offering to meet with residents if they wish. The SWPP will then be finalized. It is noted SWPPs are “living” documents, needing to be regularly updated. Residents will always be able to 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.

Wellhead protection zones are normally 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. The NSE website provides the following explanations for three zones of protection:

Zone 1: represents the 0-2 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 - (2 to 5 year travel time). 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. Chemical may be persistent, such as chlorinated solvents, nitrates, or road salt or non-persistent, like petroleum hydrocarbons. The 2 to 5 year 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 – (5 to 25 year travel time). 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 2004, ADI Limited did not have access to long term pumping data for the Floral Heights well and could not calculate travel times. They delineated three zones shown in Figure 4:

Zone 1 – **Well Head:** representing the most sensitive area immediately around the well head, which requires the greatest amount of protection. This was delineated at a 100 metre radius from the wellhead which gives a one day residence time.

Zone 2 – **Zone of Influence:** encompassing the extent of the drawdown cone developed in the bedrock aquifer during operational pumping of the production well; an area in which contamination of the well is still of high concern, but within which certain activities are permitted.

Zone 3 – **Zone of Contribution:** which defines the area through which rainwater infiltrates into the aquifer and groundwater flows toward and through the well field, i.e. the groundwater watershed; the least sensitive zone.

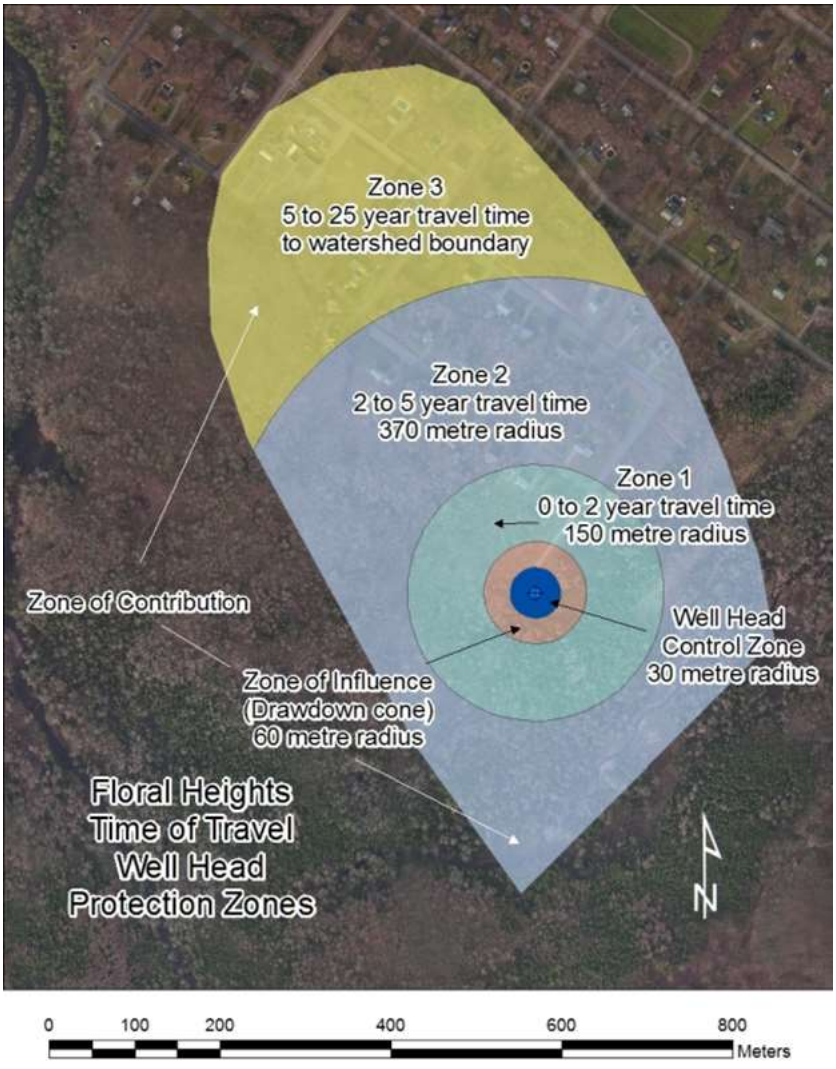
Figure 4. 2004 Floral Heights well head protection zones with 2008 photography.

To determine the time of travel zones, ADI relied on the initial pump testing undertaken on the well and coupled it with a conservative approach to maximize the areal extents. It assumed that Dutch Brook would form a major boundary, thereby limiting the influence of the drawdown cone to the north of the channel.

In 2012, the original consultants, now with EXP, were provided with SCADA flow data and asked to provide time of travel estimates for revised well head protection zones. The data was complicated by a a major leak in 2011, which resulted in an average flow of 31.6 US gallons per minutes (gpm) or 120 liters per minute (lpm). This was reduced to 47 lpm when the leak was fixed. The consultants also found that seasonal changes in water levels were two to three times greater than changes induced by pumping, adding to the difficulty in defining a dewatering cone.

As no detailed hydrological studies were available for the Lower Morien Aquifer providing Floral Heights water, the consultants used a range of values for gradient, hydraulic conductivity, and fracture porosity. The range of inputs naturally provide a wide range of possible water velocities and travel times. Based on dating the water in the aquifer at almost 11,000 years old, long resident times in the flow system were indicated. The conservative calculations indicated the drawdown extends out some 56 metres from the well.

Given the small amount of water being drawn by the Floral Height system and uncertainties in the exact values for the inputs, EXP suggested the following options as shown in Figure 5:



Well Head – arbitrary as defined by NSE at 30 metre radius

Zone 1 (USEPA approach) Zone of Influence at 60 metre radius (6 to 56 day time of travel)
Zone 1 (NSE approach) 0 to 2 year travel time at 150 metres out from the well (using lower velocity range).

Zone 2 (USEPA approach) Zone of Contribution at the watershed divide (0.5 to 6 year time of travel)
Zone 2 (NSE approach) 0 to 2 year travel time at 370 metres out from the well (using lower velocity range).

Zone 3 (NSE approach) out to the watershed boundary.

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

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.

As can be seen in Figure 4, most of Zone 1, with an area of 31,400 m^2, is heavily treed, except for the access road and the well itself. The lot around the well head and the access road are owned by CBRM and cover 5000 m^2 or 16 percent of Zone 1. 0. The area southeast of the access road is owned by the family that developed the subdivisions and could still be developed. With the exception of the small undeveloped corner of a residential lot, the remaining untouched forested land is on large parcels which have no road access and are unlikely to be developed, although the wood may be harvested at any time.

Zone 2, 224,800 m^2 in area, includes Dutch Brook and is about two-thirds forested. Developed residential lots make up almost 30 percent of the Zone and streets and their easements make up the remainder. There are 22 homes in Zone 2, 13 of them being customers of the water utility. Of the homes in the Zone, 19 are single unit (12 are customers) and three are two unit

dwellings (one is a customer). Most of these homes were built in the early 1990s, meaning the septic systems are 20 years old. Homeowners connected to the municipal water system because their wells were contaminated by bacteria from a failed septic tank at the elementary school. These residential wells may continue to be a source of groundwater contamination if they were not properly abandoned. Similarly, if the homes are heated with oil, leaking fuel oil tanks would be a source of groundwater contamination.

The parts of four paved streets, their easements, and the access road to the well field total over 14,000 m^2 in Zone 2. The streets are owned and maintained by the provincial department of Transportation and Infrastructure Renewal. Salt is used as part of winter maintenance, but water samples indicate there are no elevation chloride or sulphate levels. The access road to the well head is plowed, but sand only is used for traction control and very rarely, at that.

Zone 3, with 132,400 m^2, is about one-third forested. Developed residential lots cover 52,000 m^2 or about 40 percent of Zone 3. There are 17 homes, ten of which receive municipal water, and one school in Zone 3. The school, parking lot, and school yard cover 18,000 m^2. Parked and idling vehicles and fuel oil may be a risk for the groundwater. There are 8425 m^2 of public street in this zone.

Figure 5. Well Head Protection Zones 2 and 3 showing water customer parcels in red.

Figure 6. View of access road and Waterville Drive from the gate.

Figure 7. Mountainview Elementary School

Contamination Issue	Activity\Cause	Scale of Problem*	Priority Rank**
Bacterial contamination	Failed septic systems	unknown	1
Hydrocarbons	Leaking fuel tank, home or vehicle	unknown	2
Salts, metals, and chemicals	Urban street and lot runoff	4	3
Pesticides and herbicides	Urban lot runoff	5	4
Nutrients	Urban lot runoff	5	4

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

Table 1. Risk assessment matrix proposed by CBRM

6.0 Source Water Protection Management Options

Step 4 in the process recommended by NSE for implementing a source water protection plan: 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 Floral Heights 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.

CBRM requested the legal department to purchase the lot around the well head and the parcel used as an access road. CBRM legal department is currently researching why the transfers have not been properly recorded in Property on Line. There were plans to purchase another parcel adjacent to the well and the CBRM legal department is investigating that as well.

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.

There is currently no land use zoning in the area of the Floral Heights community well; however, CBRM will be pursuing it. The CBRM Planning Department reviewed a suggested list of uses for each well head protection zone and will use the list as a guide to develop land use zoning for the Floral Heights well head protection area.

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.

BMPs for lawn and garden care have been prepared by CBRM and should be distributed to residents of Floral Heights. As well, many Nova Scotians do not properly maintain their septic systems or their drilled wells. CBRM Water Utility will consider education for Floral Heights residents on maintenance procedures for wells and septic systems.

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.

An emergency response plan, including an operations manual, has been compiled and remains on-site within the facility. CBRM Water Utility will review the emergency response plan to ensure it covers scenarios related to the contamination of the community well.

To improve contingency planning, CBRM will evaluate options for further work delineating the time of travel zones. NSE guidance recommends 2 year, 2-5, and 5-25 year time of travel zones be delineated. Updating to the 2 year and 2-5 year, and confirming the 5 year, will improve CBRM's understanding of the greatest risks and ability to plan for emergencies.

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.
At this time, CBRM intends to focus its efforts on management options other than designation.

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 behaviour 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.

The CBRM Water Utility and the CBRM Wastewater Operations both contract ACAP Cape Breton to provide education programs to schools and the general public. A focused program for Floral Heights will be considered – topics mentioned above include maintenance procedures for wells and septic systems.

As well, 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.

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 a Source Water Protection 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

CBRM takes weekly raw water samples to test for the presence of E. coli and will continue to do so. The Water Utility wanted to maintain a well of a homeowner who receives water from the community well and is at some distance from the community well as a monitoring well. However, NSE required all former private wells be abandoned and this was not an option. The Water Utility will continue to consider options for further raw water monitoring in the area of the community well.

SWPP Review and Update

The CBRM 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 plan to landowners\residents					
Review existing contingency/ EMO plans for spills\accidents related to the source water					
Work with ACAP CB to create community awareness					
Work with CBRM Planning Department on zoning boundaries					
Establish signage at access roads (done)					
Put source water protection materials on the CBRM web site					
Review water samples for bacteria, chemicals, and minerals (road salt)					
Review and update SWPP					
Consider options with ACAP CB on home assessments for septic systems, private wells and oil tanks					
Continue to look for options for further raw water monitoring.					
Evaluate options for further work delineating the time of travel zones (done 2013)					

Table 2. Floral Heights SWPP implementation schedule

8.0 References

ADI Limited, 2000. *Proposed Acceptable Land Use Activities for the Protection of the Floral Heights Well Field, Project No. 24-4012-001.1,* prepared for the CBRM water Utility February 2000, 24 pages.

ADI Limited, 2006. *Municipal Water Supply Production Well GUDI Assessment- Floral Heights ADI Limited Report (24) 4012-045.1,* prepared for CBRM Water Utility April 2006.

ADI Limited, 2008. *Cape Breton Regional Municipality Floral Heights Water Assessment ADI Limited Report L4012-121.1,* prepared for CBRM Water Utility December 2008, 12 pages plus appendices.