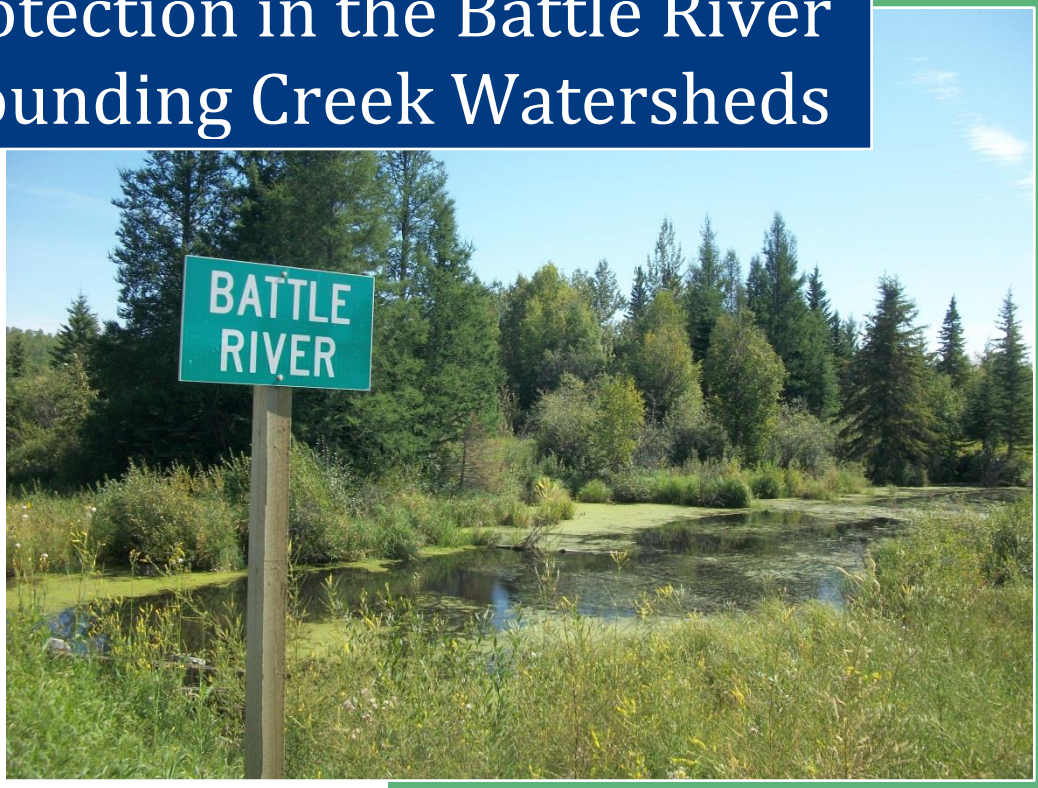
Watershed Management Plan:
Water Quality Component

BATTLE RIVER
WATERSHED ALLIANCE

Understanding the Policy Context for Source Water Protection in the Battle River and Sounding Creek Watersheds



Sarah Skinner

BRWA Watershed Planning Coordinator

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Front Cover: Battle River at the outlet of Battle Lake – the headwaters of the Battle River

Back Cover: Hills north of Consort, AB (Sounding Creek watershed)

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List of Acronyms

AAFC	Agriculture and Agri-Food Canada
AANDC	Aboriginal Affairs and Northern Development Canada (formerly INAC)
AUMA	Alberta Urban Municipalities Association
BMPs	beneficial management practices
BRWA	Battle River Watershed Alliance
CCME	Canadian Council of Ministers of the Environment
EPA	United States Environmental Protection Agency
EPEA	Environmental Protection and Enhancement Act (Alberta)
ESRD	Alberta Environment and Sustainable Resource Development
GOA	Government of Alberta
INAC	Indian and Northern Affairs Canada (now AANDC)
WMP	Watershed Management Planning (Process)

1 Background

Under *Water for Life: Alberta's Strategy for Sustainability* (Government of Alberta [GOA], 2003), the Battle River Watershed Alliance (BRWA) is the Watershed Planning and Advisory Council for the Battle River and Sounding Creek watersheds within Alberta. Figure 1 shows a map of the BRWA's planning boundaries.

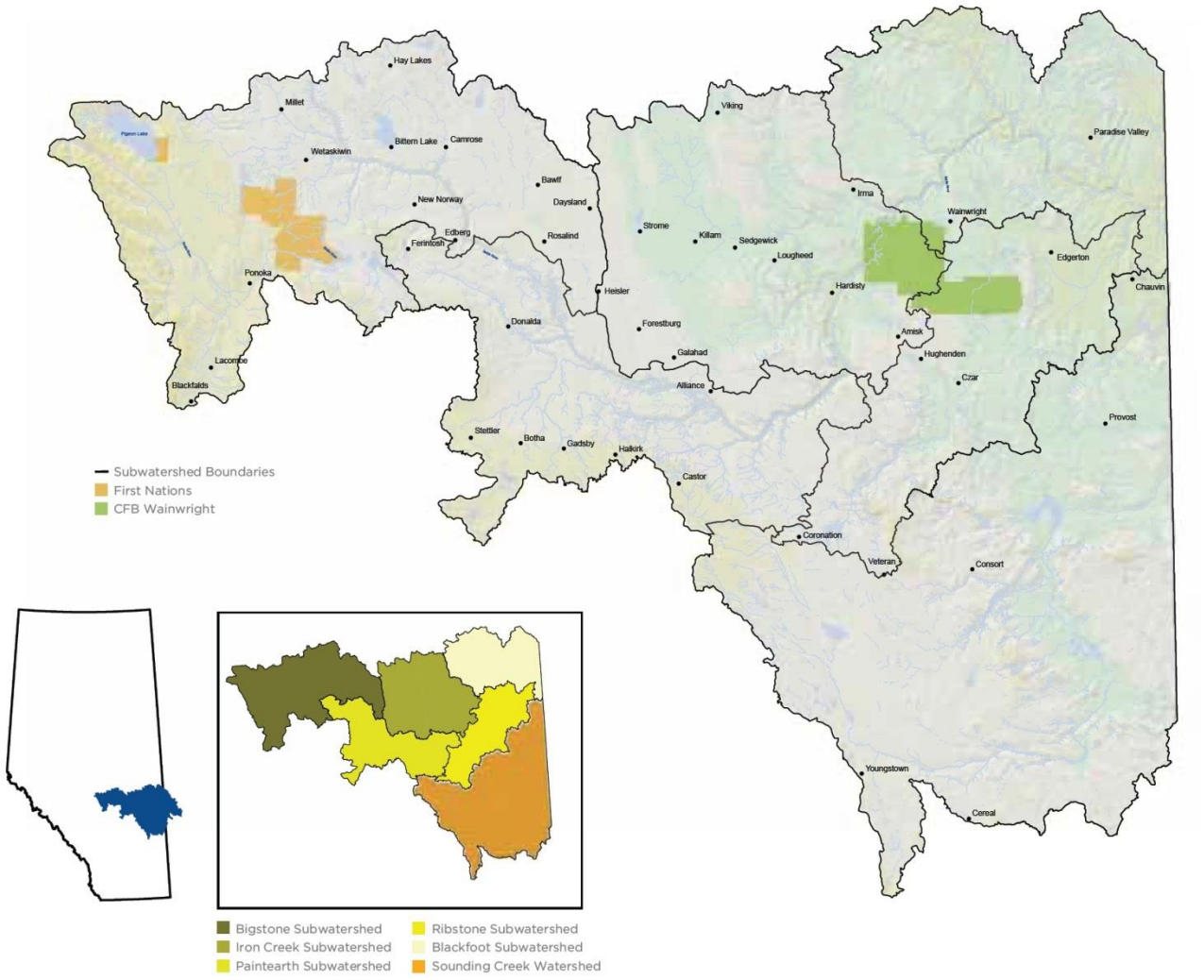

Figure 1: Battle River and Sounding Creek Watersheds within Alberta (BRWA planning boundaries)

In 2011, the BRWA completed its first State of the Watershed Report (BRWA, 2011). With the completion of this report, the BRWA has now shifted into its watershed management planning (WMP) process. This work is guided by the BRWA's WMP Terms of Reference (BRWA, 2012).

As outlined in the WMP Terms of Reference, various "watershed management components" have been identified as key issue areas to be addressed through the WMP process. These are outlined in Figure 2. Source water protection has been identified as one of these components.

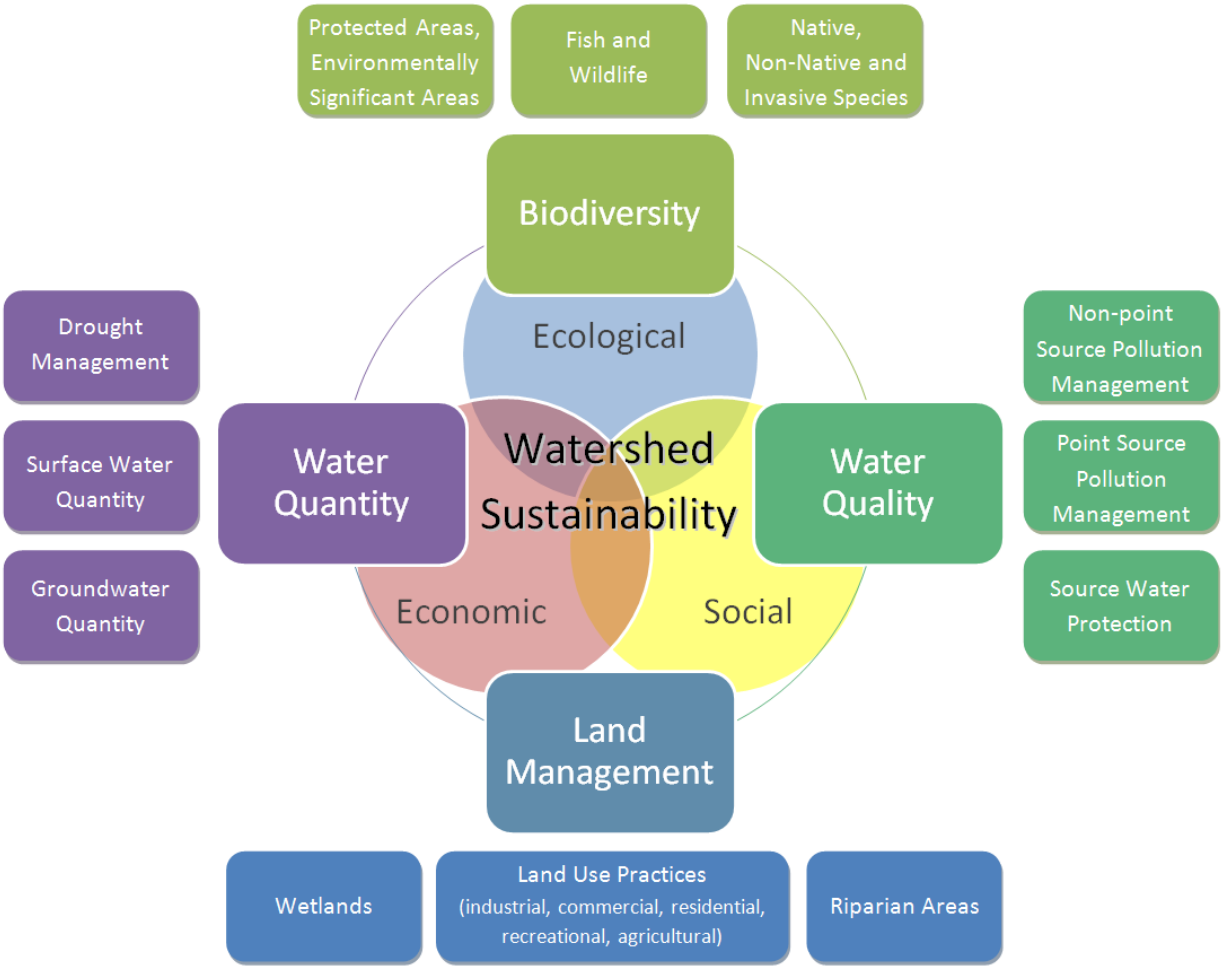

Figure 2: Watershed management components of the BRWA's WMP process

Figure 3 outlines the planning process the BRWA will undertake to develop management recommendations for each watershed management component. Key outcomes of this process include a background research report, policy advice, and implementation guidelines (BRWA, 2012).

Figure 3: Watershed management planning process for each watershed management component

The purpose of this report is to outline the current knowledge base for source water protection, the policy context in which it takes place in Alberta and Canada, and current and emerging source water protection management options. This research will then inform the development of source water protection policy advice and implementation guidelines for the Battle River and Sounding Creek watersheds in Alberta.

Source water protection is closely tied to other watershed management components that focus on addressing water quality and quantity challenges. In particular, the BRWA has already developed policy advice and implementation guidelines for the drought management and non-point source pollution management components of the WMP process (BRWA, 2013a, 2013b, 2013c, 2013d). Recommendations developed as part of those components will be taken into consideration in this source water protection work.

2 Source Water Protection: Defined

Three key goals of Alberta's *Water for Life* Strategy are: 1) the provision of safe, secure drinking water supplies, 2) the provision of reliable, quality water supplies for a sustainable economy, and 3) the maintenance and protection of aquatic ecosystems (GOA, 2003). Source water protection helps to achieve all three of these goals.

Source water protection is one component of a multi-barrier approach to drinking water protection (Canadian Council of Ministers of the Environment [CCME], 2002; CCME, 2004). See Figure 1 for an overview of the various components of this multi-barrier, "source-to-tap" approach to drinking water protection.

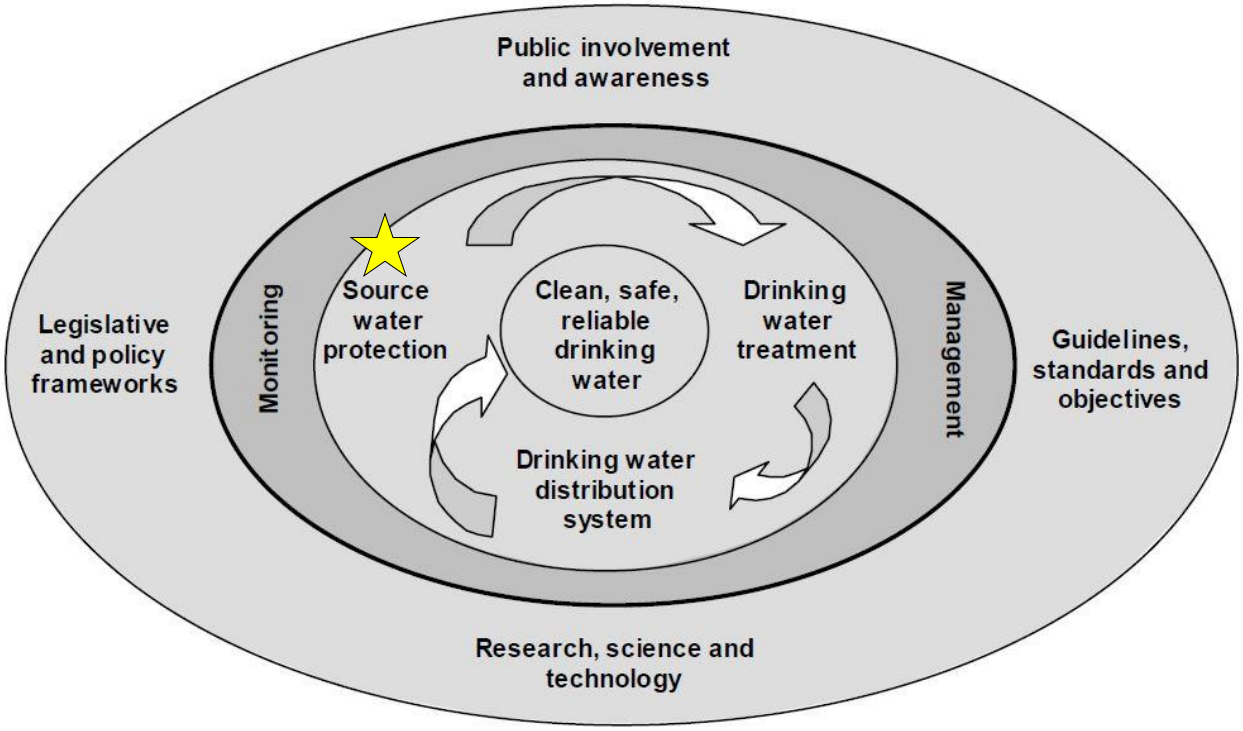

Figure 4. The Multi-Barrier Approach to Drinking Water Protection (CCME, 2002)

Source water protection typically focuses solely on the protection of the *quality* of *drinking* water sources. Alberta Environment defines source water protection as "the prevention of pollution of the lakes, reservoirs, rivers, streams, and groundwater that serve as sources of drinking water" (Alberta Environment, 2008). However, the BRWA recognizes that water is essential for many purposes, including the provision of human needs as well as the maintenance of healthy aquatic and terrestrial ecosystems within our watersheds. We also recognize that the protection of water *quantity* is a necessary component of source water protection (de Loë & Murray, 2012). As such, our definition of source water protection encompasses the protection of both the quantity and quality of ground and surface water sources used for a variety of purposes. Protection of drinking water sources is the main focus of this report and subsequent policy

> *Our definition of source water protection encompasses the protection of both the quantity and quality of ground and surface water sources used for a variety of purposes.*

advice and implementation guidelines. The broader protection of our water sources will be addressed further in other WMP components.

Integral to the concept of source water protection is the understanding that the provision of safe, secure water supplies begins with the protection of these water supplies at their source – that is, the surface and ground water systems from which we draw our water. In order to protect the quality and quantity of water within an aquifer and/or river system, management of the surrounding watershed must be addressed. This includes actions taking place in the countryside as well as within rural and urban communities. The implementation of a source water protection plan thus ensures not only the provision of safe and secure water supplies for people, but also supports the overall health of the watershed and the terrestrial and aquatic ecosystems within it.

A healthy environment provides a strong foundation on which to build healthy communities and economies. For example, through source water protection, public health risks associated with poor source-water quality may be reduced and drinking water treatment costs minimized. In an agricultural landscape, safe and secure water supplies contribute to viable agricultural operations.

Source water protection involves reducing risks to local water sources by: 1) identifying existing and potential risks to source water quantity and quality, and 2) developing and implementing plans and strategies to minimize, control, or prevent those risks. Source water protection plans may include specific goals for water quality improvement, where deemed necessary.

Other components of source water protection include:

- A clear understanding of watershed and aquifer characteristics and boundaries (including groundwater recharge and discharge areas),
- An inventory of land uses taking place in the watershed and associated pollutants, and potential avenues through which those pollutants may enter source water, and
- Vulnerability and risk assessments to understand the degree to which land uses and pollutant sources may impact source water in particular regions of the watershed.

3 Source Water Protection in the Battle River and Sounding Creek Watersheds

Approximately 122,700 people live in the Battle River and Sounding Creek watersheds of Alberta. About 70% of these people live in communities within these watersheds, while the remaining 30% live in rural areas.

Of the 84,000 urban watershed residents (people living in any city, town, village or hamlet), about 42% receive their drinking water from regional water lines from the North Saskatchewan River and Red Deer River. About 28%, comprising the communities of Bittern Lake, Ohaton, Camrose and Wainwright, receive their water from the Battle River. Wetaskiwin and Gwynne, comprising about 15% of the watersheds' urban population, receive their water from Coal Lake. Another 15% of the urban population receives their water from groundwater sources.

The majority of the rural population of the Battle River and Sounding Creek watersheds relies on groundwater sources for their drinking water. The remainder may use water from local surface water sources or have their drinking water brought in from other sources.

In general, about 35% of watershed residents rely on groundwater sources for their drinking water, 35% rely on surface water sources located within the Battle River and Sounding Creek

watersheds, and 30% rely on inter-basin transfers from the Red Deer River and North Saskatchewan River.

In addition to drinking water, people within the Battle River and Sounding Creek watersheds rely on water for a number of other purposes, including various residential uses, irrigation, livestock watering, and business/industrial uses. While this report and subsequent recommendations focus on drinking water, it is recognized that source water protection supports the broad protection of water for a variety of social, economic and ecological purposes.

A key goal of this source water protection project is to address the diverse source water protection needs of rural and urban water users within the Battle River and Sounding Creek watersheds in Alberta.

4 Source Water Protection: Media Coverage

In order to gain a greater understanding of how source water protection is portrayed in the media, the BRWA conducted a media scan of newspapers to find articles of relevance to this topic. As a result of this media scan, 40 media articles were identified for the years 2003-2013. Descriptions of all these articles are available in the BRWA's source water protection information database (BRWA, 2014).

Based on this media scan, it was found that media articles related to source water protection focus on both the quantity and quality of drinking water supplies. 19 articles mentioned water quantity, while 17 mentioned water quality. Drinking water sources were focused on to a lesser degree. While many articles described the drinking water source(s) of concern to a superficial degree (for example, specifying that water would come to a small town via a water line from a larger community), few articles described the actual water source in any detail (for example, describing the lake, river, or groundwater aquifer from which the community received its water).

Related to the quality of drinking water supplies, articles from within the Battle River watershed often focused on the main urban centres. In particular, many articles discussed the City of Camrose and the 2006 upgrade of the Camrose water treatment plant. Comments about how the quality of source water impacts water treatment measures were included in a few of these articles.

Related to the quantity of drinking water supplies, media articles from within the Battle River and Sounding Creek watersheds often focused on the efforts of communities to obtain adequate water supplies for their community. These efforts often involved tying into regional water lines. In the case of Wetaskiwin, articles primarily discussed the necessity of water use restrictions due to the limited supply of water available from Coal Lake, where the City draws its municipal water. In the case of the Sounding Creek watershed, water supply (or lack thereof) was very much tied to economic development and the health and sustainability of communities in that region.

Perhaps the most widely covered Canadian media stories related to source water protection are those linked to the contamination of community drinking water supplies, such as what was experienced in Walkerton, Ontario in 2000 and North Battleford, Saskatchewan in 2001. Both of these events raised the profile of drinking water safety in Canada and led to inquiries into the circumstances surrounding these events, the adequacy and effectiveness of actions taken by municipal, provincial, utilities and health district officials, and the adequacy of existing

regulations, guidelines, policies, practices and procedures. A key recommendation arising out of the Walkerton Inquiry was that an increased emphasis should be placed on a multi-barrier approach to drinking water protection, of which source water protection is an important first step. Ontario's *Clean Water Act*, which became law in 2006, enacts this multi-barrier approach to drinking water protection. Source water protection plans have now been developed by all Conservation Authorities within the province (34 out of 36 of which are still awaiting final approval by the provincial government). In Saskatchewan, source water protection planning is now under the jurisdiction of the Saskatchewan Water Security Agency, and source water protection plans have been developed for most of the major watersheds in the southern portion of the province. The contamination of drinking water in Walkerton and North Battleford has played an important role in raising awareness about the importance of source water protection and spurring people on to action.

5 Components of Source Water Protection Planning

In 2004, the Canadian Council of Ministers of the Environment (CCME) released *From Source to Tap: Guidance on the Multi-Barrier Approach to Safe Drinking Water* (CCME, 2004). This report highlights the importance of source water protection and outlines the various components of source water protection planning. These components are outlined in Figure 5. In Canada, source water protection planning has taken various forms, but many planning processes have taken these broad components into account. In addition, some have suggested additional components to be considered in source water protection planning.

Drawing from various national and international examples of source water protection planning processes, the following section outlines 5 broad components that may be included in source water protection planning, including:

- Establishing Source Water Protection Lead Agency/Agencies and Working Committee(s)
- Delineating watershed/aquifer boundary and planning area
- Completing a Source Water Risk Assessment:
    - Watershed characterization (land use, water quantity, water quality, water sources and systems)
    - Identifying potential threats to source water and assessing risk
- Developing and implementing a source water protection plan
- Reviewing plan progress and evaluating effectiveness of management actions

These 5 components are described in greater detail in the following sections.

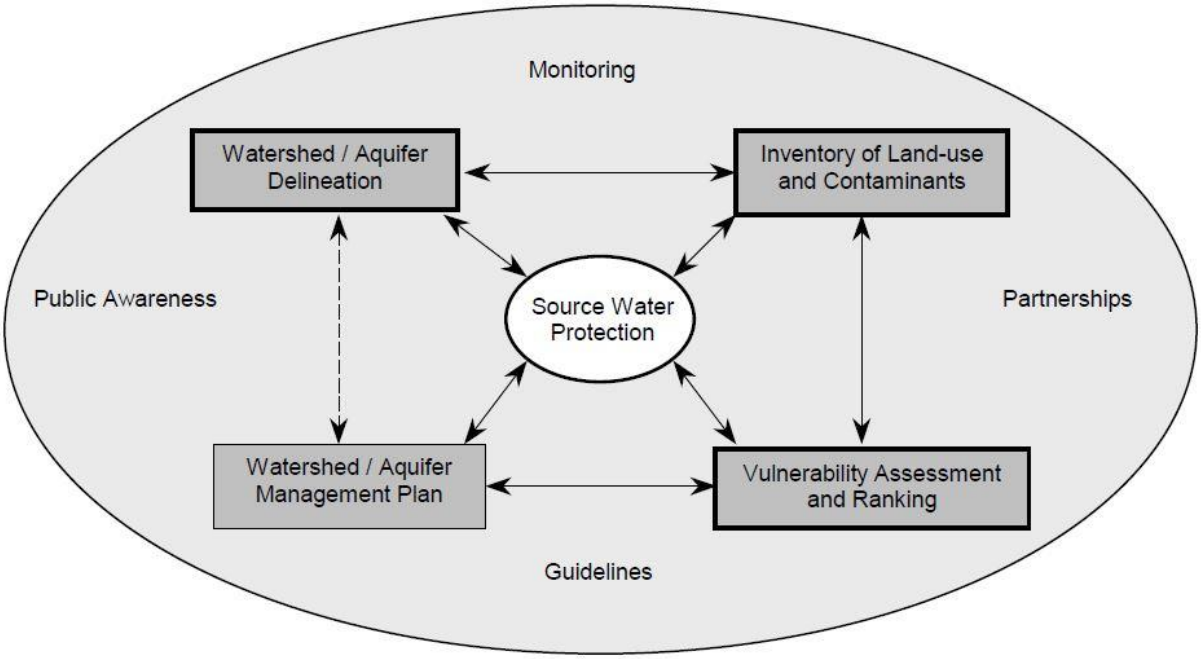

Figure 5: Components of Source Water Protection Planning (CCME, 2004)

5.1 Establish Source Water Protection Lead Agency and Working Committee(s)

Various source water protection planning processes take as their first step the formation of organizing bodies to administer and carry out source water protection planning efforts. This often takes the form of a lead agency and working committee(s).

Ontario and Nova Scotia provide two examples of provinces that have developed a specific structure for establishing organizing bodies for source water protection. In Ontario, Source Protection Authorities (often synonymous with the province's Conservation Authorities) administer source water protection for their geographic area. Under the direction of the Source Protection Authority for a given region, a multi-stakeholder Source Protection Committee is then formed to lead the development of a source protection plan for that region. In Nova Scotia, municipalities and/or water utilities act as the lead agencies for source water protection planning. For a given municipality, a Source Water Protection Advisory Committee is then formed to lead the development of a source water protection plan for that community.

In a broad sense, the role of the lead agency is to facilitate source water protection planning efforts in their region. The role of a working committee is to lead the development of a source water protection plan for their community or region. Working committees should be multi-stakeholder groups that are representative of the various groups present in the planning area. In addition, it is important to clearly define the roles and responsibilities of the working committee. In Ontario, for example, these roles and responsibilities are formally laid out in a Terms of Reference for the planning process.

Local Context

Rural and urban municipalities should play a central role in the development and implementation of source water protection plans in their jurisdictions. The BRWA is well-positioned to support and facilitate this work in the Battle River and Sounding Creek watersheds of Alberta.

Working committees may be formed to lead the development of source water protection plans for different regions of the Battle River and Sounding Creek watersheds. Key stakeholder groups that should be involved on these working committees include: municipalities, local water utilities, content experts, urban and rural residents and landowners, provincial government, agricultural managers and practitioners, oil and gas industry representatives, and environmental and community organizations.

5.2 Delineate Watershed/Aquifer Boundary and Planning Area

For surface water, the source water protection planning boundary ideally includes the entire watershed upstream of the source intake, and especially those areas that regularly contribute water to the mainstem (also referred to as the effective drainage area). For groundwater, the planning boundary ideally includes the entirety of the aquifer system(s) providing drinking water to a particular region. However, working at a watershed/aquifer scale has important implications for collaboration across multiple social and political jurisdictions. Source water protection planning for one community, taking into consideration the entire watershed upstream of that community, may necessitate the involvement of various public, private and civil society actors. For example, in the Battle River watershed, a source water protection plan for the City of Camrose may strive for a collaborative approach between the four counties and three major communities located upstream, in addition to a variety of additional actors operating in the planning area. While this degree of collaboration may be desirable, it may not be practical. As suggested by Ferreyra, de Loë, and Kreutzwiser (2006), "meaningful scales" for collaboration on land and water issues may not include the watershed scale. As a result, they suggest that rather than forcing watershed-based governance structures, it may be valuable to explore ways of linking watershed imperatives with existing socially and politically meaningful scales.

Jurisdictional considerations aside, Agriculture and Agri-Food Canada (AAFC) has developed an online watershed delineation tool that may be used to quickly and easily delineate watershed boundaries based on any user-specified outlet location. These watershed boundaries may then be downloaded as a standard GIS shapefile. The tool automatically calculates various watershed characteristics, such as watershed size (area), longest flow path, stream density, and elevation change from source to outlet. It also allows the user to view topographic relief, contributing and non-contributing areas, and the location of Water Survey of Canada gauging stations within the delineated watershed. This is a valuable tool that may be used to delineate watershed boundaries for source water protection planning (AAFC, 2013).

Local Context

Within the Battle River and Sounding Creek watersheds, source water protection is relevant across the entire landscape. However, to develop a singular source water protection plan for the entire area may not be the most effective approach. As described above, regional source water protection plans may present jurisdictional challenges. It will be important to consider the most meaningful and effective scales at which source water protection plans should be developed for ground and surface water systems within the Battle River and Sounding Creek watersheds.

As described above, the source water protection planning boundary for a surface water system ideally includes the entire watershed upstream of the source intake. Three major communities in the Battle River watershed rely on surface water for their drinking water supply: Wetaskiwin (which also supplies water to Gwynne), Camrose (which also supplies water to Ohaton and Bittern Lake), and Wainwright. See Figures 6-8 (below) for maps of the watershed areas upstream of the water intake locations of these municipalities. Non-contributing areas are shown in pink. All other areas within the watershed are expected to contribute runoff to the Battle River during a flood with a return period of two years (also referred to as the effective drainage area). Because these areas regularly contribute water to the Battle River, they are especially critical to the maintenance of water quality and should be the focus of source water protection planning efforts.

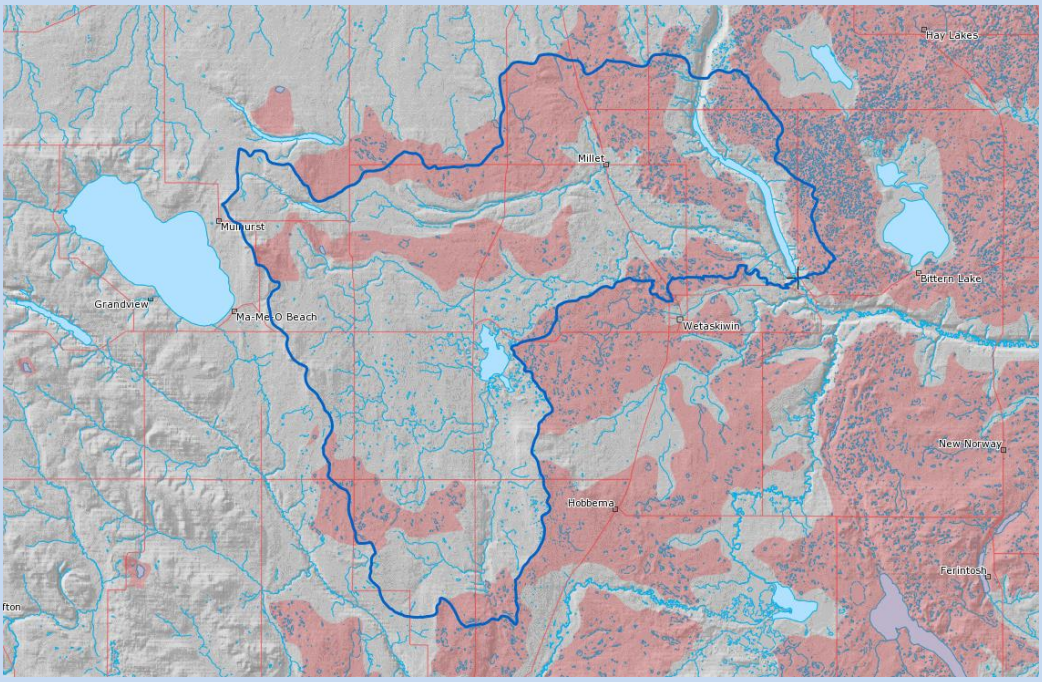

Figure 6: Watershed area upstream of the City of Wetaskiwin's water intake, showing the non-contributing areas in pink (AAFC, 2013)

Local Context (continued from previous page)

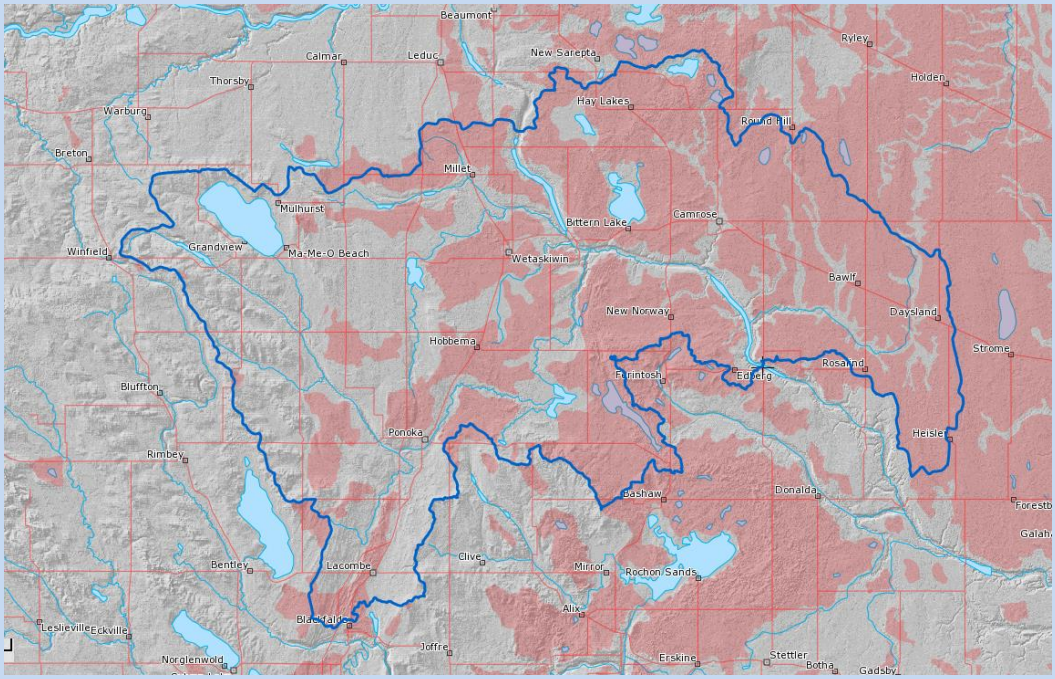

Figure 7: Watershed area upstream of the City of Camrose's water intake, showing the non-contributing areas in pink (AAFC, 2013)

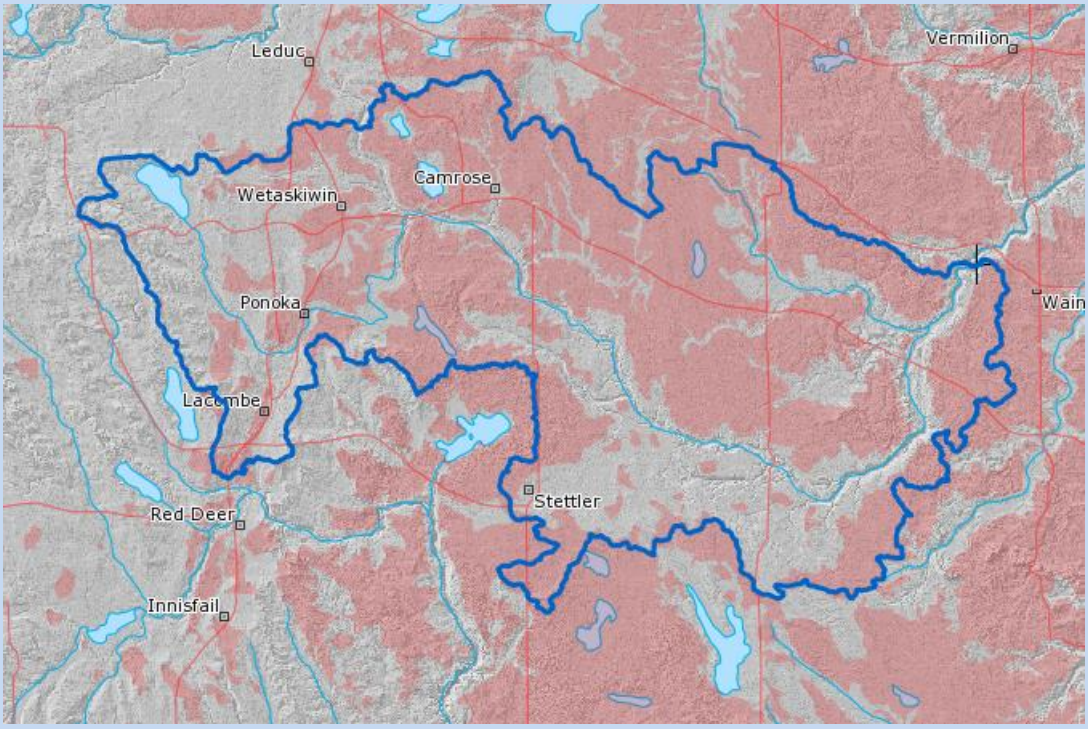

Figure 8: Watershed area upstream of the Town of Wainwright's water intake, showing the non-contributing areas in pink (AAFC, 2013)

Local Context (continued from previous page)

Because there is some overlap in the watershed boundaries shown above, source water protection plans may be nested within one another. For example, because the watershed area upstream of the Town of Wainwright includes the watershed areas of both Camrose and Wetaskiwin, source water protection plans for these communities could be integrated as sub-regional plans into a broader source water protection plan for Wainwright.

The above maps illustrate the ideal scale at which source water protection planning should occur for the communities of Wetaskiwin, Camrose and Wainwright. However, groundwater protection must also be considered.

Determining appropriate scales at which groundwater systems may be integrated into source water protection planning efforts is difficult, due to limited knowledge of groundwater systems in east-central Alberta and the fact that groundwater aquifers may not be confined to the boundaries of the watershed. Despite these limitations, what is known is that 35% of the population of the Battle River and Sounding Creek watersheds in Alberta relies on groundwater supplies. As such, groundwater considerations should be included as an integral component of source water protection plans developed for the watershed areas upstream of Wetaskiwin, Camrose, and Wainwright. Ground and surface source water protection planning should also be undertaken for the Sounding Creek watershed and the portion of the Battle River watershed located downstream of Wainwright's intake. See Figure 9 for an overview of the potential source water protection planning boundaries for the Battle River and Sounding Creek watersheds in Alberta.

As described above, the effective drainage area of these watersheds is critical to water quality maintenance within the Battle River and Sounding Creek. As such, management of this area should be the focus of source water protection planning efforts for surface water systems. Management of groundwater systems should be based on aquifer vulnerability throughout the watershed, significant groundwater recharge and discharge areas, and private and public wellhead locations.

Local Context (continued from previous page)

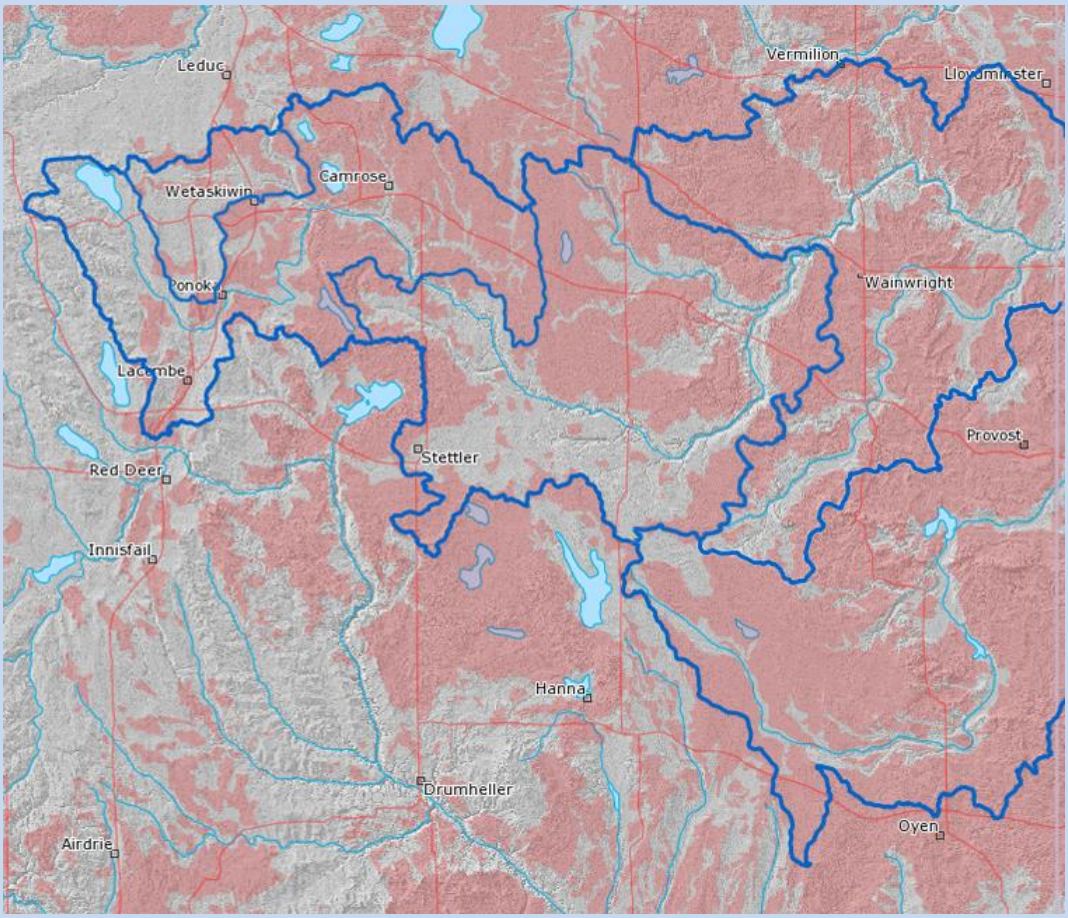

Figure 9: Potential source water protection planning boundaries for the Battle River and Sounding Creek watersheds in Alberta, showing the non-contributing areas in pink (AAFC, 2013)

In short, source water protection planning for both ground and surface water sources should be undertaken for the entirety of the Battle River and Sounding Creek watersheds. While this report and subsequent recommendations focus on source water protection within Alberta, the BRWA recognizes that the Battle River and Sounding Creek watersheds continue into Saskatchewan, and that it is essential to undertake source water protection planning efforts for the Saskatchewan portion of these watersheds as well. See Figure 10 for a map of these watersheds in their entirety.

Local Context (continued from previous page)

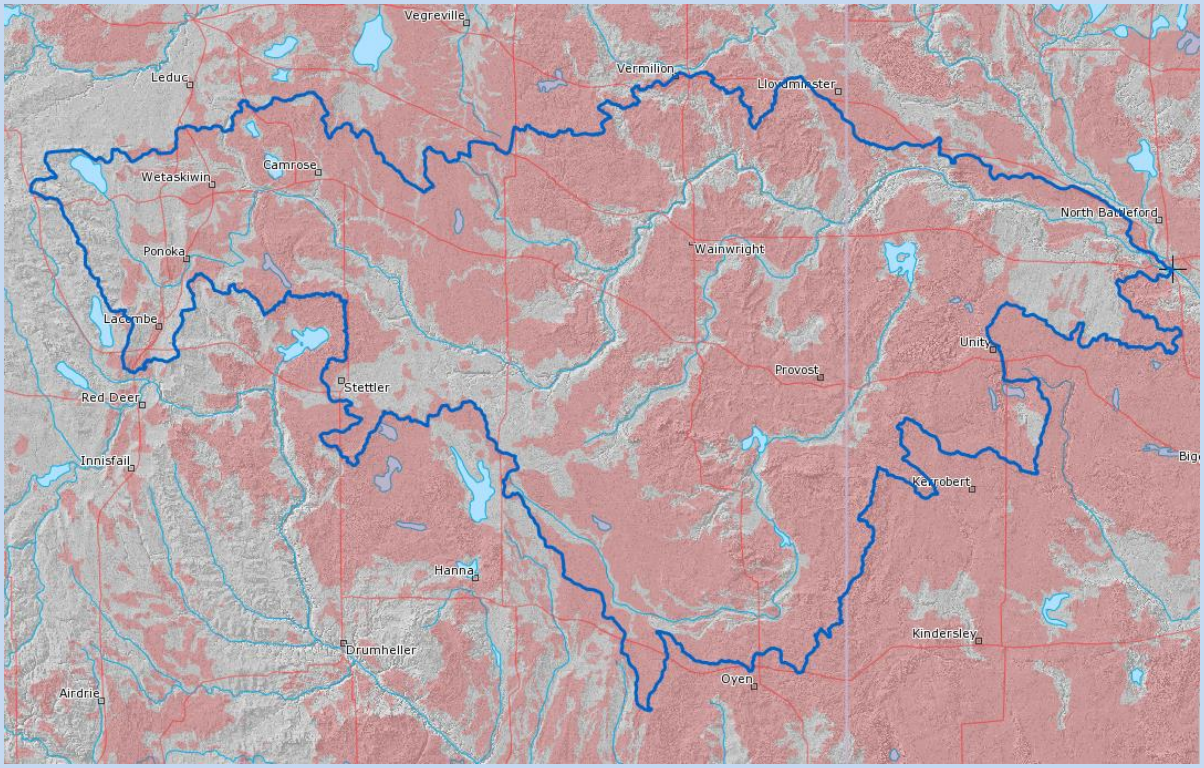

Figure 10: Battle River and Sounding Creek watersheds, showing the non-contributing areas in pink (AAFC, 2013)

5.3 Complete a Source Water Risk Assessment

5.3.1 Watershed Characterization

Natural Features and Land Use

In order to evaluate risks to source waters, it is critical to have a good understanding of the planning region, including the natural characteristics of the area as well as the various land uses and activities taking place within the region. Land use mapping is useful in understanding the geographic distribution of these activities across a landscape. Natural characteristics and land use factors that may be of relevance to source water protection planning in the Battle River and Sounding Creek watersheds include:

- natural regions and subregions,
- vegetative land cover,
- effective drainage area of the watershed,
- environmentally significant areas, parks, and protected areas,
- distribution and density of oil and gas wells, gravel mines, water wells, and freshwater springs,
- distribution of surface water and groundwater licenses and registrations and volume of water allocated,
- linear developments (roads, powerlines, pipelines, etc.),
- urban development (area covered, land uses, stormwater management practices, etc.),
- agricultural land uses and associated management practices,
- industrial and commercial land uses,
- population density and distribution, and
- waste water treatment facilities.

Water Quantity and Quality

Also critical to the assessment of risks to source waters is an understanding of the degree to which water quality is affected by contaminant loadings (and associated land uses) from different geographic regions of the watershed. Surface water quality monitoring (especially of tributary streams entering the river mainstem) is essential to determining where contaminant loadings are currently entering the system and identifying potential contaminants of concern in the future. Key contaminants of concern may also be identified through analysis of water quality monitoring data gathered at water treatment plant raw water intakes. Groundwater monitoring is also essential to understanding groundwater quality dynamics throughout the watershed and potential sources of contamination.

In addition, it is important to understand the quantity of surface and ground water present in a particular region, in order to ensure that the withdrawal of water supplies does not adversely impact the long term sustainability of the water source. In the case of groundwater, it is important to identify groundwater recharge and discharge areas, recharge rates, and groundwater areas vulnerable to contamination.

Drinking Water Sources and Systems

In some cases, a source water protection plan may only look at a single drinking water source (such as the water source for a particular community). However, some source water protection plans may take into account multiple drinking water sources (surface and/or groundwater) within a particular geographic area. Whatever the case, it is important to identify these water sources

and compile detailed information on the systems through which this water is distributed. Aboriginal Affairs and Northern Development Canada (AANDC, 2013) has outlined a number of important considerations to include in an inventory of surface and groundwater sources and systems (described below).

In the case of surface water, it is important to consider:

- the location of the source water, and whether or not a backup source is available
- intake location, date of construction, frequency of intake inspection
- whether or not:
    - intake is screened
    - an intake protection zone is in place
    - a backup intake is available
- population served by source water
- whether or not raw water is monitored (and if it is, what parameters are monitored, and how frequently?)
- water treatment type

In the case of groundwater, it is important to consider:

- well details, including: well depth, whether water is from a confined or unconfined aquifer, depth to bedrock, depth of casing
- whether or not:
    - wellhead seal is secure and in good condition
    - wellhead access is controlled (via well house, fence, locked cap, or otherwise)
    - wellhead is enclosed by a well house
        - if not, is there a permanent grass buffer at least 3 meters around well?
    - surface water pools around well
    - well casing extends at least 0.3 meters above ground
    - there is fuel storage in the well house
    - a wellhead protection zone is in place

Local Context

The *State of the Battle River and Sounding Creek Watersheds Report*, developed by the BRWA in 2011, provides important baseline data for evaluating current land uses and water quantity and quality considerations within the Alberta portions of the Battle River and Sounding Creek watersheds. Subwatershed-specific data and maps have been developed for a number of indicators of watershed health. This data may be utilized to evaluate potential contaminants and risks to ground and surface source waters in these watersheds.

Land use data available for the Battle River and Sounding Creek watersheds in Alberta includes: land cover (vegetation type), dams and weirs, linear development, environmentally significant areas, parks and protected areas, oil and gas wells and pipelines, water wells, and fresh water springs.

In Alberta, Long-Term River Network (LTRN) sites are used to monitor water quality on Alberta's major rivers. Two LTRN monitoring stations are located on the Battle River. Additional water quality monitoring has also taken place on an irregular basis at 11 other sites spaced out along the entire Alberta length of the Battle River. However, monitoring of tributary streams has been fairly limited to-date.

Alberta Environment and Sustainable Resource Development (ESRD) maintains a detailed inventory of water licences and registrations in the Battle River and Sounding Creek watersheds, which provides a clear picture of the total volume of surface and groundwater allocated in these watersheds. Less well known is the portion of this water that is actually used (some people may not use their entire allocation) and the portion that is consumed (taken from the system and not returned). An *Approved Water Management Plan for the Battle River Basin (Alberta)* has been developed by ESRD, which defines a water allocation limit for surface water licences in the Battle River watershed (ESRD, 2014). Currently, there is no plan in place to regulate the total volume of groundwater that may be allocated in the Battle River and Sounding Creek watersheds. More work is required to determine a sustainable groundwater withdrawal rate based on groundwater availability and recharge rates.

ESRD also maintains a basic inventory of drinking water sources for most communities within the Battle River and Sounding Creek watersheds. Detailed information on water intakes, well characteristics, etc. would have to be gathered from all the municipalities located within these watersheds.

5.3.2 Identify Potential Threats to Source Water and Assess Risk

Based on the current understanding of the planning area (including land use, water quantity, water quality, and drinking water sources and systems), a risk assessment is undertaken to evaluate potential risks to source waters. Various approaches may be utilized to complete source water risk assessments. The concept of a "risk matrix" is utilized in AANDC's First Nations On-Reserve Source Water Protection Plan Guide and Template (AANDC, 2013) and the GOA's Drinking Water Safety Plan Template (GOA, n.d.(a)). As such, the risk matrix approach is presented here as a potential template for assessing risks to source waters in the Battle River and Sounding Creek watersheds. The Bowtie Method is an alternative risk assessment tool that may be used, and is described in section 5.3.3.

A source water risk assessment based on the risk matrix model involves identifying potential risks to the quality and quantity of source waters and then evaluating: 1) the likelihood of the risk occurring and 2) the impact or severity of the risk if it were to occur.

Potential contamination sources may be numerous, but key considerations include:

- waste water treatment plants, sewage lagoons, sewage outfall locations, and private septic systems,
- unmaintained or abandoned groundwater wells developed for drinking water, oil and gas exploration and extraction, research/monitoring, etc.
- landfills and other waste deposits
- agricultural land uses
- erosion, flooding and other natural factors
- industrial and commercial land uses
- urban development and associated stormwater runoff

Ontario's *Clean Water Act* contains detailed tables of drinking water threats that may be useful in identifying potential contamination risks (Government of Ontario, 2009a). A list of expected source risks is also included in the GOA's Drinking Water Safety Plan template (GOA, n.d.(a)). In general, both Alberta and Ontario have identified four broad categories of hazards that may impact water quality (GOA, 2012a; Government of Ontario, 2011):

- Biological: bacterial, viral, and parasitic organisms such as E. coli, giardia, and cryptosporidium;
- Chemical: including toxic spills, heavy metals, and dissolved gases;
- Physical: sediments that may carry microbiological hazards and interfere with water treatment; and
- Radiological: naturally occurring chemicals such as radon or uranium, which occur most frequently in groundwater.

Other important considerations related to risks to source water include:

- potential impact of drought on water supply
- potential impact of climate change on water supply
- the extent of ground and surface water allocations in the watershed and potential effect of current and future water use on water supply
- connectivity between ground and surface water, and the potential for surface water to contaminate groundwater (and vice versa)
- vulnerable areas *(see text box below for details)*

Vulnerable Areas

In Ontario, assessment reports conducted prior to the development of source water protection plans must identify risks related to four types of vulnerable areas: wellhead protection areas (WHPAs), intake protection zones (IPZs), highly vulnerable aquifers (HVAs), and significant groundwater recharge areas (SGRAs). A detailed description of the process for delineating these zones is provided in the Technical Rules: Assessment Report of Ontario's *Clean Water Act* (Government of Ontario, 2009b).

In Alberta, a provincial aquifer vulnerability index has been developed to assess the vulnerability of aquifers to surface contaminants. Figure 11 shows the aquifer vulnerability index for the Battle River and Sounding Creek watersheds of Alberta.

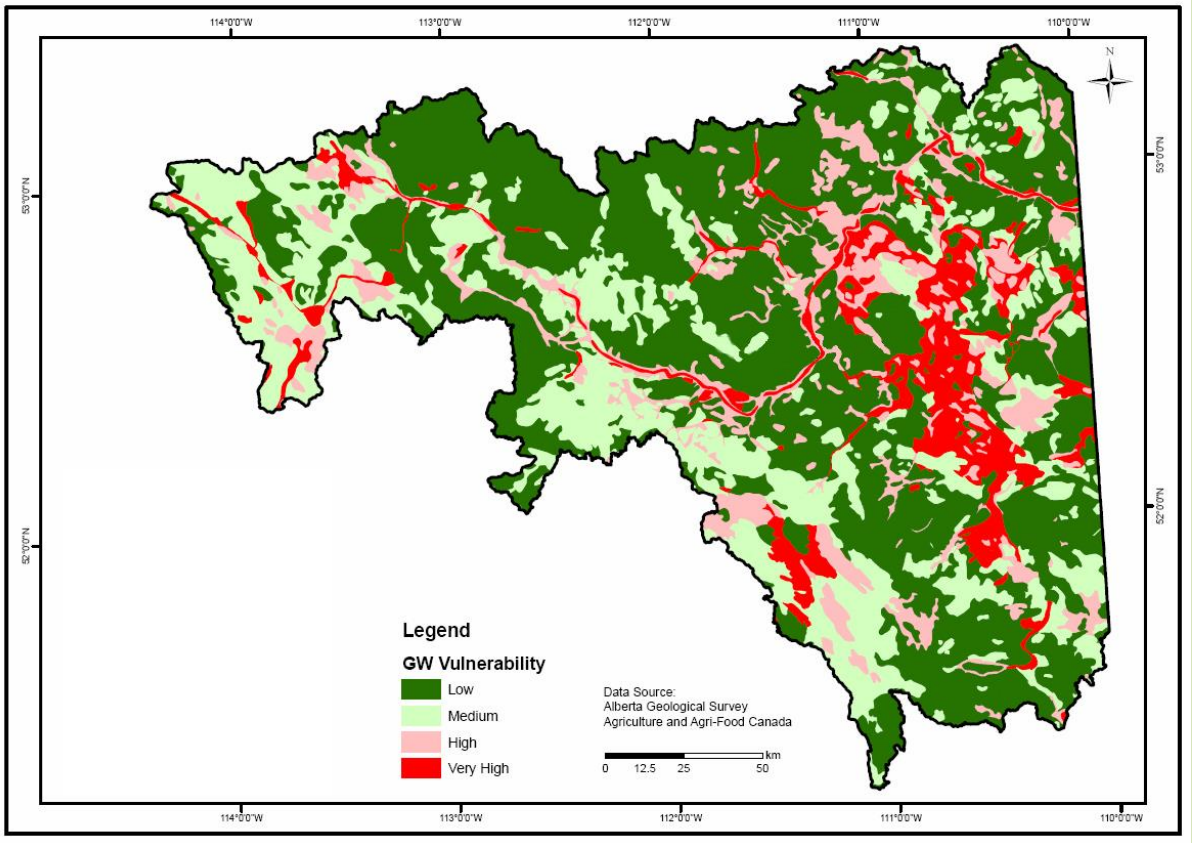

Figure 11: Aquifer Vulnerability Index for the Battle River and Sounding Creek Watersheds in Alberta

It is important to consider geographic areas of concern related to each potential risk or contaminant source in order to target management actions accordingly.

Once potential risks and contamination sources have been inventoried and associated geographic areas of concern identified, risk scores may be assigned using the risk matrix. The first step in developing a risk matrix is to assign a numerical value to represent the likelihood of each drinking water risk occurring. Second, a numerical value is assigned to represent the impact of each risk if it were to occur. Tables 1 and 2 outline a range of "likelihood of occurrence" and

"impact of occurrence" values, based on the values used in AANDC's First Nations On-Reserve Source Water Protection Plan Guide and Template (AANDC, 2013) and the GOA's Drinking Water Safety Plan Template (GOA, n.d.(a)).

Table 1: Likelihood of Occurrence for Drinking Water Risks (values taken from AANDC, 2013 and GOA, n.d. (a))

Likelihood	Value (AANDC)	Value (GOA)
Most Unlikely Extremely small chance of occurring in the next 4-5 years	1	1
Unlikely It is possible (but not likely) to occur in the next 4-5 years	2	2
Possible Just as likely as not to occur in the next 4-5 years	3	4
Probable It is expected to occur in the next 4-5 years but there is a small chance it may not	4	8
Almost Certain Confident that it will occur at least once in the next 4-5 years	5	16

Table 2: Impact of Occurrence for Drinking Water Risks (values taken from AANDC, 2013 and GOA, n.d. (a))

Impact	Value (AANDC)	Value (GOA)
Insignificant No health risk; water system interruption less than 8 hours	1	1
Minor Short-term or localized non-compliance; non-health related (e.g. aesthetic) or interruption 8-12 hours	2	2
Moderate Widespread aesthetic issues or long term non-compliance; non-health related or interruption 12-24 hours	3	4
Severe Potential illness or interruption 24-48 hours	4	8
Catastrophic Actual illness or potential long term health effects or interruption greater than 48 hours	5	16

The overall risk assessment score is then calculated by multiplying the "likelihood" score by the "impact" score (Likelihood x Impact = Risk Assessment Score). The risk matrix is built based on all possible risk assessment scores (as illustrated in Table 3) and is used to determine the relative risk of each potential threat to source water that has been identified. Risks may be ranked or prioritized from highest risk (score of 25) to lowest risk (score of 1), and management actions determined accordingly.

While a single risk assessment score is typically assigned for each identified risk, EPCOR utilized two scores in their Source Water Protection Plan (EPCOR, 2012). Using their own risk matrix, they assigned an "inherent risk" score to each of their identified source water threats to represent the risk present without any controls applied (such as water treatment and watershed management). They also assigned a "residual risk" score for each identified source water threat to represent the risk present under normal water treatment operations and continued watershed management work. The difference between these two scores then becomes a measure of the effectiveness of drinking water protection controls currently in place.

Table 3: Risk Matrix, based on AANDC "likelihood" and "impact" values (AANDC, 2013)

		Impact of Occurrence				
	Score	Insignificant	Minor	Moderate	Severe	Catastrophic
Likelihood of Occurrence	Most Unlikely	1	2	3	4	5
	Unlikely	2	4	6	8	10
	Possible	3	6	9	12	15
	Probable	4	8	12	16	20
	Almost Certain	5	10	15	20	25

	Low Risk		Moderate Risk		High Risk

5.3.3 The Bowtie Method: An Alternative Risk Assessment Tool

In addition to the risk assessment tool presented above, a number of other risk assessment tools may be used to assess risks to source waters. The Bowtie Method is presented here for the sake of comparison. See Figure 12 for a visual representation of the various components of this method.

The Bowtie Method consists of a single diagram that is used to visualize the risk, or *hazard*, with which you are dealing. If numerous *hazards* exist, several bowtie diagrams may be utilized. The first step in the Bowtie Method is to identify the overarching *hazard* with which you are dealing. In the case of source water protection, the *hazard* would be the presence of surface and groundwater contaminants within the Battle River and Sounding Creek watersheds.

The next step is to identify the *top event*, which is the moment when control is lost over the *hazard*. For source water protection, the *top event* would be when contaminants enter surface and/or groundwater systems in quantities that are harmful to the overall health and sustainability of the watershed and the people who live there. Next, *threats* and *consequences* are identified. A *threat* is anything that will cause the *top event*, and a *consequence* is what happens as a result of the *top event*. *Threats* and *consequences* provide an overview of the various negative scenarios that may arise as a result of the *hazard*.

Barriers/controls (actions that may prevent *threats* and *consequences*) are then identified for each *threat* and *consequence*. As illustrated in Figure 12, you may indicate the effectiveness of various *barriers/controls* (from "very good" to "very poor") by colour-coding them in the bowtie diagram. In the context of source water protection, *barriers/controls* form the basis for

developing a Source Water Protection Plan aimed at preventing contaminants from entering surface and groundwater systems in harmful quantities. *Barriers/controls* may fail. The Bowtie Method takes this into consideration through the identification of *escalation factors* (that is, anything that may cause a *barrier/control* to fail). B*arriers/controls* are then identified for each *escalation factor* in order to manage these factors.

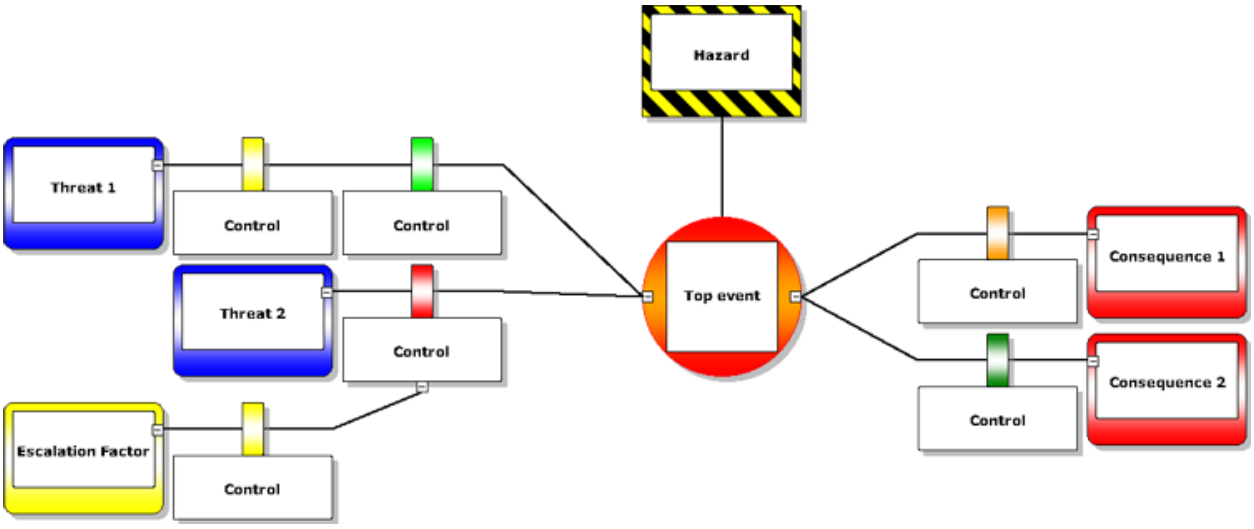

Figure 12: The Bowtie Method (CGE Risk Management Solutions, n.d.)

Local Context

No source water risk assessments have been undertaken to-date within the Battle River and Sounding Creek watersheds in Alberta. However, ESRD now requires that all communities regulated under the *Environmental Protection and Enhancement Act* (EPEA) must complete Drinking Water Safety Plans, which must include a source water risk assessment of that community's drinking water source. Source water protection plans developed at the watershed scale may support the development of these Drinking Water Safety Plans, and vice versa.

Indian and Northern Affairs Canada (INAC; now AANDC) completed a national assessment of First Nations water and waste water systems in 2011 (INAC, 2011a). The Alberta regional assessment looked at various risks to these systems for each of the 44 First Nations in Alberta. These assessments may provide useful information to support source water risk assessments in these communities. Four First Nations located in the Battle River watershed were assessed as having a medium water system risk level, which indicates that these systems have deficiencies that pose a medium risk to water quality and human health. These systems may not require immediate attention, but the deficiencies should be addressed in order to prevent future issues. The other First Nations group located in the watershed was assessed as having a high water system risk level, indicating that the water system has major deficiencies that pose a high risk to water quality and should be addressed immediately (INAC, 2011b).

5.4 Develop and Implement a Source Water Protection Plan

Developing a source water protection plan is really about identifying management actions that may be taken to minimize the risks to source water identified in the risk assessment. For potential contamination sources identified as being high risk, immediate actions may be required in order to ensure that the risk to source waters is reduced. For potential contamination sources identified as being of low or moderate risk, management actions may be focused on ensuring that those sources never become a more significant threat to source waters. Management actions may also include a focus on education, outreach and incentive programs designed to bring attention to potential risks to source water and encourage actions that minimize these risks.

Once management actions are identified for each identified risk, an implementation strategy should be developed to ensure that these actions are completed. For each management action, the implementation strategy should outline the stakeholders required to complete the action, the timeline within which the action should be completed, and resources (monetary or otherwise) required to implement the action.

Local Context

To-date, no source water protection plans have been completed in the Battle River and Sounding Creek watersheds in Alberta. However, one has been completed for the Saskatchewan portion of the North Saskatchewan River watershed (including the Battle River watershed) (Saskatchewan Watershed Authority, 2008). However, this plan is more akin to a watershed management plan, as it does not include a source water risk assessment.

5.5 Review Plan Progress and Evaluate Effectiveness of Management Actions

Once a source water protection plan is completed, it should be reviewed on a regular basis (every 5 years) and updated as necessary. This review should evaluate progress in implementing the management actions laid out in the plan and identify any additional resources required to support plan implementation. Management actions that have been implemented should be evaluated for their effectiveness in minimizing risks to source water.

Source water protection monitoring and evaluation options are not well defined in academic research or in practice. In order to address this issue, the Water Policy and Governance Group, a multi-university, collaborative research team based at the University of Waterloo, undertook to explore options for evaluating source water protection policies in Ontario (Murray and Roth, 2012). While their report focuses on the specific context of source water protection planning in Ontario, their findings may be applied across Canada. In particular, they note that evaluation of environmental policies is challenging due to the fact that natural systems may be slow to react to change, and may react differently at different geographic scales. As such, the impact of source water protection actions may only be observed over the long term or at certain geographic scales. Despite this challenge, indicators of success may still be developed for each management action outlined in the source water protection plan, based on:

- the nature of the management action (regulatory or non-regulatory),
- the nature of the threat to which the management action is applied, and
- the context in which the management action is applied (geographic scale and type of action – municipal, agricultural, industrial, etc.)

- whether the management action is proactive/preventative (contamination risk has not yet been observed) or reactive (contamination of source water has been observed and must be minimized)

Murray and Roth (2012) set out five different evaluation models that may be utilized in source water protection plan evaluation. These models are outlined below:

1) Goal Based Evaluation Model

This model involves setting planning goals/objectives and then evaluating the degree to which these goals are achieved.

2) Effects Evaluation Model

This model examines the anticipated and unanticipated effects of management actions and determines if these effects were beneficial or detrimental.

Note: Goal Based and Effects Models may not be suited to evaluating the impacts of more complex source water protection actions such as land use planning policies, due to their limited capacity to take local conditions and context into consideration. As such, they may be best suited to determining the impact of management actions that are easier to evaluate, such as the impact of education and outreach initiatives.

3) Process Evaluation Model

This model builds upon the goal based evaluation model by examining the effectiveness, efficiency, and impact of policies and management actions, as well as the process through which they were developed.

4) Participatory Evaluation Model

This model does not have a set evaluation approach, but rather seeks to involve stakeholders in developing their own context-specific evaluation method(s).

5) Systems Evaluation Model

This is perhaps the most comprehensive evaluation model, as it considers the unique ecological, social, economic and institutional conditions and context within which policies and management actions are applied, and evaluates the impact of these policies and actions within that specific context. This model requires intensive data collection and analysis (particularly for environmental indicators) in order to determine the impact of management actions on a particular landscape.

Note: Because of the complex nature of social and ecological systems, it may be difficult to determine whether observed changes are occurring as a result of planning exercises and management actions or due to other factors (regardless of which evaluation model is used). Special care must be taken to identify clear cause and effect linkages between management actions and observed changes.

Local Context

Baseline data and continued monitoring of key water quantity, water quality, and land use parameters in the Battle River and Sounding Creek watersheds will support evaluation of the long-term ecological impacts of source water protection actions. However, it must be expected that these impacts may only be observed over the long-term or at certain geographic scales, depending on the type of management action and how broadly the action is implemented within the watershed.

Collecting data on various social, economic and/or institutional indicators may be another means of evaluating the success of some management actions. For example, one management action may be to encourage agricultural beneficial management practices (BMPs) aimed at reducing nutrient loading to surface water systems. Water quality monitoring may be utilized to measure the direct impact of these actions on water quality, although changes may not be observed right away, and may only be observed at certain scales. An alternative measure of success that could be evaluated more easily and within a shorter timeframe might be to determine the number of BMPs that have been implemented within a particular region.

6 Current Management Context

6.1 Canada

The following section outlines source water protection actions currently taking place in Alberta, select provinces, and nation-wide.

6.1.1 Alberta

In Alberta, source water protection falls under the province's *Water for Life Strategy* and related water and watershed management planning initiatives. Source water protection requirements are also found in a number of acts and regulations of the Government of Alberta (GOA), including the EPEA, the Alberta Safety Code for private sewage systems, the Water Act, and the Public Health Act (GOA, n.d.(b)). In addition, water quality management frameworks developed as part of the province's regional planning initiatives will provide key guidance for the management of surface and ground water quality in Alberta. In particular, these frameworks will strive to maintain water quality within an acceptable range through identifying water quality indicators, establishing triggers and limits for those indicators, and determining management responses to be used when those triggers and limits are exceeded (GOA, 2012b).

In 2009, Alberta Environment developed a report entitled "Alberta Environment's Drinking Water Program: A 'Source to Tap, Multi-Barrier' Approach" (GOA, 2009). This report states that "drinking water source protection is the equivalent of, or a component of, a watershed management plan that focuses on water quality" and that source water protection is a key component of a source-to-tap approach to drinking water protection (p. 9). The Alberta Urban Municipalities Association (AUMA) has also recognized the important role source water protection plays in achieving *Water for Life*'s goals of safe, secure drinking water and reliable quality water supplies for a sustainable economy (AUMA, 2012).

A number of watershed planning efforts are currently underway in the Battle River and Sounding Creek watersheds of Alberta. The Battle River Watershed Alliance, as the designated Watershed Planning and Advisory Council for the Battle River and Sounding Creek watersheds in Alberta, is currently developing a Watershed Management Plan focused on water quality, water quantity, land management and biodiversity. ESRD recently developed an *Approved Water Management Plan for the Battle River Basin (Alberta)*, which supports the responsible management of water allocations within the Battle River watershed, including surface water and groundwater that is hydrologically connected to surface water (ESRD, 2014). There is currently no plan in place to manage surface water or groundwater allocations in the Sounding Creek watershed. Regional watershed planning efforts are being undertaken in the headwaters region of the Battle River watershed. The Pigeon Lake Watershed Association is currently developing a watershed management plan for the Pigeon Lake watershed, and the Battle Lake Watershed Synergy Group recently undertook a Watershed Development Planning Pilot Project for the Battle Lake watershed. It is important to build upon these planning initiatives in order to ensure source water protection in the Battle River's headwaters.

Related to the management of drinking water systems, ESRD now requires that all drinking water systems regulated under the EPEA complete Drinking Water Safety Plans. These Safety Plans must include a comprehensive "source-to-tap" risk assessment (GOA, 2012c). Several resources and tools have been developed by ESRD to support the development of these Plans, including a Drinking Water Safety Plan Training Course, *A Guidance Framework For the Production of Drinking Water Safety Plans*, and a Drinking Water Safety Plan template (GOA, n.d.(a)). AUMA has expressed support for the GOA's approach to Drinking Water Safety Plans and has also requested the continuation of tools and resources to support implementation of these plans (AUMA, 2012). The GOA has also developed a drinking water and wastewater guidebook for municipalities entitled *Taking Care of Your Drinking Water and Wastewater: A Guide for Members of Municipal Councils* (GOA, 2012a), which is loosely based on a similar report developed by the Government of Ontario (see section 6.1.4 for more information on that report).

Groundwater management is a key component of source water protection. The GOA has developed a Groundwater Observation Well Network (GOWN), which consists of a GOA-owned network of groundwater monitoring wells located in various aquifers throughout the province. Most of these wells continually monitor groundwater levels, and many of the wells are periodically sampled for water quality analysis. The GOA has also developed a "Working Well" program, which is designed to provide water well owners with the information and tools they need to properly care for their wells. This information sharing is facilitated through Working Well workshops which are held on a regular basis across the province, as well as through a variety of paper resources, including a number of fact sheets and the *Water Wells That Last* workbook (GOA, 2013). Alberta Health Services also provides services to private land owners. They may advice home owners on the safety of their well, cistern or dugout water and discuss treatment options if necessary. Chemical water testing of untreated groundwater is also available through the Provincial Laboratory of Public Health and Alberta Centre for Toxicology. Water testing supplies and shipping information are available through local Community Health Centres. At a regional scale, regional groundwater assessments have been completed for each of the 16 counties, municipal districts and Special Areas located within the Battle River and Sounding Creek watersheds. These reports provide important information on surficial and bedrock formations and aquifers, groundwater recharge and discharge areas, and more. In addition to this

work, a detailed groundwater atlas has been developed for the Edmonton-Calgary corridor (Barker et al., 2011).

Alberta Agriculture and Rural Development (ARD) has a number of extension materials related to rural water supplies and farm water analysis, treatment and management (ARD, n.d.(a); ARD, n.d.(b); ARD, n.d.(c)). They also have an online "Rural Water Quality Information Tool" designed to help people assess the quality and suitability of raw water sources for privately owned and operated water supplies (ARD, n.d.(d)).

Within the private sector, EPCOR has developed a source water protection plan for Edmonton's drinking water system (EPCOR, 2012). This plan adheres closely to the source water protection planning components recommended by the CCME (CCME, 2002; CCME, 2004).

A major water supply initiative in the Sounding Creek watershed is the Special Areas Water Supply Project. A number of reports were completed in 2004 and 2005 to evaluate the feasibility of this project (Alberta Environmental Protection, 1992: AMEC, 2004; Golder, 2005). In 2011, the GOA announced that they would be undertaking a three-year Environmental Impact Assessment of the proposed project (GOA, 2011). Since then, discussions have continued related to the scope and logistics of the project. The proposed scope of the project involves utilizing water pipelines to divert 2.5 cubic meters per second from the Red Deer River to the headwaters of Sounding and Berry Creeks. From there, the water would flow through open creek channels to supply water to farmers and ranchers in the region. Water would also be stored in two proposed reservoir sites, one at the existing Lehman reservoir southwest of Coronation and another north of Oyen on Sounding Creek. It is estimated that public consultations and environmental assessments for the project will be completed by the end of 2015 (Passifiume, 2012).

6.1.2 Saskatchewan

Source Water Protection Plans have been completed for many watersheds in the southern portion of Saskatchewan. While these plans do not include source water risk assessments, they do include many recommendations of relevance to source water protection. The source water protection plan developed for the aquifers surrounding the City of Yorkton, SK provides one example of integrating groundwater considerations into source water protection planning efforts (Saskatchewan Watershed Authority [SWA], 2006). The Saskatchewan portions of the Battle River and Sounding Creek watersheds are included in the source water protection plan developed for the North Saskatchewan River watershed (SWA, 2008).

6.1.3 Nova Scotia

In Nova Scotia, source water protection is guided by *Water for Life: Nova Scotia's Water Resource Management Strategy* (Government of Nova Scotia, 2010). The provincial government requires that all municipalities and water utilities seeking approval for the construction and operation of water treatment and distribution facilities must develop a Source Water Protection Plan for their drinking water source area. The Government of Nova Scotia has developed a guide to support water utilities and municipalities in developing these plans (Nova Scotia Environment, 2004). Several municipalities have already completed plans based on these guidelines. The guide outlines 5 steps in developing source water protection plans, which are as follows:

1) Form a Source Water Protection Advisory Committee
2) Delineate the Source Water Protection Area Boundary

3) Identify Potential Contaminants and Assess Risks
4) Develop and Adopt a Source Water Protection Management Plan
5) Monitor and Evaluate the Plan

The government of Nova Scotia has also developed educational resources on water conservation and management of both public and private drinking water supplies (Government of Nova Scotia, 2013a; Government of Nova Scotia, 2013b).

6.1.4 Ontario

Source water protection planning was initiated in Ontario after the drinking water system of the town of Walkerton was contaminated with E. coli in 2000, resulting in thousands of illnesses and several deaths. This incident served as the catalyst for an in-depth review of drinking water safety in the province (Walkerton Inquiry) and the development of a multi-barrier approach to source water protection.

The *Clean Water Act* governs source water protection in Ontario, requiring that local communities identify existing and potential threats to their water supply and then implement actions to address those threats (Government of Ontario, 2006). This is accomplished through a well-defined process for developing source water protection plans based on sound science. The four stages of this process are as follows:

1) Formation of Source Protection Areas, Source Protection Authorities (SPAs), and local source protection committees throughout the province.
    - Ontario's 36 Conservation Authorities have been designated as SPAs. As such, Source Protection Areas follow the boundaries of these Conservation Authorities. There are also two additional non-conservation authority SPAs.
2) Preparation of an "Assessment Report", which seeks to understand surface and ground water characteristics and identify drinking water issues and threats in vulnerable areas within the planning boundary.
    - All Conservation Authorities have now completed assessment reports which have been approved by the provincial government.
3) Setting out policies and risk management strategies in a Source Protection Plan.
    - All Conservation Authorities have now completed Source Protection Plans. Two Conservation Authorities have had these plans approved by the provincial government. The remaining plans are "proposed" plans, meaning that they have undergone two public consultation periods and are awaiting final approval from the Ontario Ministry of the Environment.
4) Implementation of the Source Protection Plan

The *Clean Water Act* also introduced the Ontario Drinking Water Stewardship Program, which provides financial assistance to farmers, landowners and business owners who undertake actions to reduce threats to drinking water sources.

The Government of Ontario has released a number of other reports related to source water protection. In 2004, the Government of Ontario released *Watershed-Based Source Protection Planning, Science-based Decision-making for Protecting Ontario's Drinking Water Resources: A Threats Assessment Framework* (Government of Ontario, 2004). This report provides a detailed description of Ontario's source protection planning process, as well as a number of

recommendations for management actions related to private surface and ground water systems, private sewage disposal systems, aquifer vulnerability, pathogens, natural areas, water quantity issues, and more. More recently, the Government of Ontario released *Taking Care of Your Drinking Water: A Guide for Members of Municipal Councils* (Government of Ontario, 2011). This report provides municipalities with important information on a number of drinking water management topics.

6.1.5 Canada-Wide

The CCME has released two companion reports outlining the "multi-barrier approach" to drinking water protection. The first report, *From Source to Tap: The multi-barrier approach to safe drinking water*, was released in 2002 and provides a broad overview of the elements of a multi-barrier approach to safe drinking water (CCME, 2002). The second report, *From Source to Tap: Guidance on the Multi-barrier Approach to Safe Drinking Water*, provides technical guidance to drinking water system owners and operators and gives municipal, provincial, and federal levels of government a structure for the implementation of a multi-barrier approach to drinking water protection (CCME, 2004).

The Water Policy and Governance Group (a research team based at the University of Guelph) has completed several reports as part of the Canadian Water Network project on *Governance for Watershed-Based Sound Water Protection in Canada: A National Assessment*. Two reports of particular interest are *Tools and Approaches for Source Water Protection in Canada*, which provides an overview of source water protection related activities currently taking place across Canada, and *Governance for Source Water Protection in Canada: Synthesis Report*, which discusses opportunities and challenges for source water protection governance in Canada.

In 2011, Indian and Northern Affairs Canada (INAC; now AANDC) completed a national assessment of First Nations water and wastewater systems, which included regional assessments of most of Canada's provinces and territories (INAC, 2011a). The Alberta regional assessment included participation from 44 First Nations across Alberta. Individual community reports were completed for each First Nations, which were then summarized in the regional assessment report. The regional assessment report provides an overview of the risk associated with the various components of First Nations water and wastewater systems in Alberta, including risks associated with source waters (INAC, 2011b). More recently, AANDC has developed a *First Nations On-Reserve Source Water Protection Plan: Guide and Template* report, which provides valuable tools to support First Nations in developing source water protection plans for their communities (AANDC, 2013). This Guide has been piloted in Siksika First Nation, Alberta. Related to First Nations groundwater management, Health Canada has developed a "Toolkit for Individual Wells for First Nations" to support First Nations in protecting their water wells (Health Canada, 2011).

6.2 International

It is beyond the scope of this report to provide an in-depth review of international policies related to source water protection. However, the following sections provide a few examples of international policies and resources that may be applicable to source water protection in Alberta.

6.2.1 United States

In the United States, the Safe Drinking Water Act requires that all states develop programs to conduct state-wide source water assessments. These programs must be approved by the United

States Environmental Protection Agency (EPA). For areas where there are few or no alternatives to groundwater as a drinking water source, the EPA's Sole Source Aquifer Protection Program also plays an important role in groundwater protection (EPA, 2012a).

Source water assessments are structured similarly to other source water protection planning processes outlined in this report. The four main steps include:

1) Delineating the source water assessment area,
2) Conducting an inventory of potential sources of contamination,
3) Determining the susceptibility of the water supply to contamination,
4) Notifying and involving the public, and
5) Implementing management measures, and
6) Developing contingency planning strategies (EPA, 2002; EPA 2012b).

The EPA's *State Source Water Assessment and Protection Programs: Final Guidance* document provides overarching guidance to support the development of source water assessments (EPA, 1997). A variety of Delineation Tools, Potential Contaminant Source Inventory Tools and Susceptibility Determination Tools have also been compiled to support this work (EPA, 2012c; EPA, 2012d; EPA, 2012e) Additional source water protection resources available through the EPA are outlined in an annotated bibliography developed in 2003 (EPA, 2003). Source water protection is also supported through a number of local, state and federal funding programs (EPA, 2013).

Perhaps the most well-known U.S. example of source water protection undertaken by an urban municipality is the story of New York City and their investment in the Catskill/Delaware watersheds in upstate New York (EPA, 1996). In 1989, the EPA's Surface Water Treatment Rule (issued under the federal Safe Drinking Water Act), required filtration of all surface water supplies to protect against microbial contamination of drinking water. This requirement could be waived if the water treatment system processes provide safe water and the watershed is actively protected to ensure that safety into the future. New York City chose to forego the filtration requirement and instead partner with the EPA, environmental groups, New York State and local communities to implement watershed protection actions in the Catskill/Delaware watersheds from which the city receives its drinking water. In doing so, they were able to forego the construction of a multi-billion dollar filtration plant. Specific watershed protection actions implemented include: targeted land acquisition to protect sensitive lands and key reservoirs and waterways; regulations specifying acceptable land uses and practices; water quality monitoring; and investment in partnership programs to ensure the watershed was developed in an environmentally sustainable manner that protects water quality. This project encouraged the EPA to begin developing tools and reorienting existing programs to support this watershed approach on a national scale.

6.2.2 International Organizations

The strategy of undertaking watershed management as a means of drinking water protection is gaining traction on a global scale. One example of this is a recent publication by the World Resources Institute entitled *Natural Infrastructure: Investing in Forested Landscapes for Source Water Protection in the United States* (World Resources Institute, 2013). This report "provides comprehensive guidance to help water utilities, municipalities, businesses, land management organizations, and other decision makers better manage their water systems by securing forests and other ecosystems" (Gartner & Mulligan, 2013).

The World Health Organization (WHO) and International Water Association have developed training materials for the development of Water Safety Plans (WHO and IWA 2012a, WHO and IWA 2012b). These resources may provide additional considerations and insights to support the development of municipal Drinking Water Safety Plans in Alberta.

7 Next Steps and Further Research

This report has provided on overview of the policy context for source water protection within Alberta and Canada. The BRWA will use this information to develop policy advice and implementation guidelines for source water protection in the Battle River and Sounding Creek watersheds of Alberta.

The main data gap identified in this report is the need for a greater understanding of groundwater resources in east-central Alberta. Research such as that conducted for the Edmonton-Calgary Corridor should be conducted for the rest of Alberta (Barker et al., 2011). In particular, the boundaries of groundwater aquifers should be delineated and research undertaken to determine groundwater recharge and discharge areas and rates in the Battle River and Sounding Creek watersheds.

Also essential for effective source water protection planning in the Battle River and Sounding Creek watersheds of Alberta is data-sharing. The designated lead agency for this planning work must have adequate access to data in order to gain an in-depth understanding of the planning area and develop appropriate management recommendations.

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At the Battle River Watershed Alliance we desire to live, work and play in a watershed that sustains all life by using sound knowledge, wisdom and wise actions to preserve our watershed for future generations.

Battle River Watershed Alliance
Gateway Centre
4825 51 Street
Camrose Alberta
T4V 1R9
1 888 672 0276
www.battleriverwatershed.ca

Connecting People to Place for Action