



**SUMMER VILLAGE
OF GHOST LAKE**

Presented To
Mustafa Hashimi
Chief Administrative Officer

Climate Resilient Groundwater Implementation Plan





MORRISON HERSHFIELD

September 29, 2023

MH 2300276

Summer Village of Ghost Lake
c/o Mustafa Hashimi
Chief Administrative Officer
via email: admin@ghostlake.ca

Dear Mustafa:

Re: Climate Resilient Groundwater Implementation Plan

Please find following the final implementation plan. This plan reflects the findings of the hydrogeological assessment plus input received at the community workshop. Thank you for the opportunity to support your community realize as sustainable, climate resilient future.

Sincerely,
Morrison Hershfield Limited

Forest Pearson, P.Eng.,
Geological Engineer

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ACKNOWLEDGEMENTS

Land Acknowledgement

The Summer Village of Ghost Lake respectfully acknowledges that our community is located on the traditional lands of the Stoney Nakoda peoples of the Chiniki, Bearspaw and Wesley Bands, the Tsuut'ina, the Niitsitapi (Blackfoot) peoples of Siksika, Piikani and Kainai Band.

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MCCAC was established in 2009 as a partnership initiative between the Alberta Municipalities, Rural Municipalities of Alberta, and the Government of Alberta. They provide municipalities, schools, and non-profit community related organizations with support, technical assistance, and funding programs to implement energy efficiency and renewable energy projects that reduce greenhouse gas emissions and energy costs while increasing community resilience.

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1. INTRODUCTION

Morrison Hershfield Limited (MH) was retained by the Summer Village of Ghost Lake (SVGL) to conduct a Climate Resilient Groundwater Assessment and Implementation Plan. This document builds on the Climate Adaptation Plan (Morrison Hershfield 2022) and the Hydrogeological Assessment completed in 2023. The SVGL is located between the northern shore of the Ghost Lake Reservoir and the Bow Valley Trail within the Municipal District of Bighorn No. 8. Ghost Lake is approximately 60 km west of the City of Calgary, and 24 km west of Cochrane, Alberta.



1.1 Objectives

The purpose of this implementation plan is to build on the analysis and recommendations contained in the Climate Resilience and Adaptation Plan (2022). Specifically further analysis and engagement completed throughout this project provides context-specific, evidence-based actions to protect the quality and quantity of SVGL's potable groundwater resources, even in the face of future climate uncertainty, as well as a roadmap to implement these actions in a manner that respects the unique capacity and resource challenges faced by a small community.

The Summer Village of Ghost Lake will work to ensure that residents have continued access to safe and reliable drinking water in the context of climate change.

The Climate Resilient Groundwater Implementation Plan:

- Provide recommended actions based on the results of the hydrogeological assessment and community engagement conducted,
- Offer three sets of implementation recommendations for both the municipality and the residents, community members, and stakeholders, and
- Deliver the implementation plans recommended as Action W.1 and W.2 from the Climate Adaptation Plan (2022).

This project work and resulting implementation plan outlines a community education and participation program to continuously educate the community on potential surface and groundwater impacts and encourage community members to report potential impacts to groundwater water.

1.2 Process

The analysis and recommendations in the Climate Adaptation Plan provided direction for this project. The process to complete an Implementation Plan is illustrated in Figure 1 based on resources from the Local Governments for Sustainability Network (ICLEI). The scope of this work was defined in the project proposal and the assessment of risks and opportunities that took place during the hydrogeological assessment. This implementation plan is inspired from the Climate Adaptation Plan (2022) but include more specifics based on the assessment findings from this project. The resulting implementation plan is in this document.



Figure 1: Climate Resilience Planning Process from ICLEI

The Hydrogeological Assessment process involved background research on existing documents, on-site water quality testing, development of a conceptual hydrogeological model, interviews with residents and other stakeholders, and engagement sessions with residents. Publicly available water well reports, geological maps and reports, topographical mapping, water quality data, and provincial reports were used to complete the background desktop research. Together this data supported the creation of the conceptual hydrogeological model.

Throughout the project process residents and other stakeholders were engaged. This included a hybrid community engagement session with 10 participants once the data was collected, in preparation for writing the Implementation Plan. In addition, interviews with six community members were conducted as part of the water sample collection program to collect information on their local knowledge, experience, challenges, and interests in their groundwater supply. Other stakeholders like the SVGL council, the municipal district of Big Horn, and the Nature and Environment Lake Society (NELS) were also consulted to gain different insights into the local conditions. Overall, water quality and quantity has been good with some concern over future water quantity if more development happens or TransAlta changes the Ghost Lake reservoir water level requirements. There is also a history of older water wells being “grandfathered in” that may not meet current well design requirements. Together this process of data collection and community

engagement has given a more holistic perspective that guides a feasible and stakeholder supported implementation plan.

1.3 Climate Change

Climate change refers to long term shifts in atmospheric conditions such as temperature and weather systems (IPCC, 2001). These changes are mainly driven by the addition of greenhouse gases by human activity into the atmosphere (IPCC, 2001). While these greenhouse gases are vital to life on earth the increase in trapped heat in the atmosphere is leading to an increase in average global temperatures and shifts in weather systems.

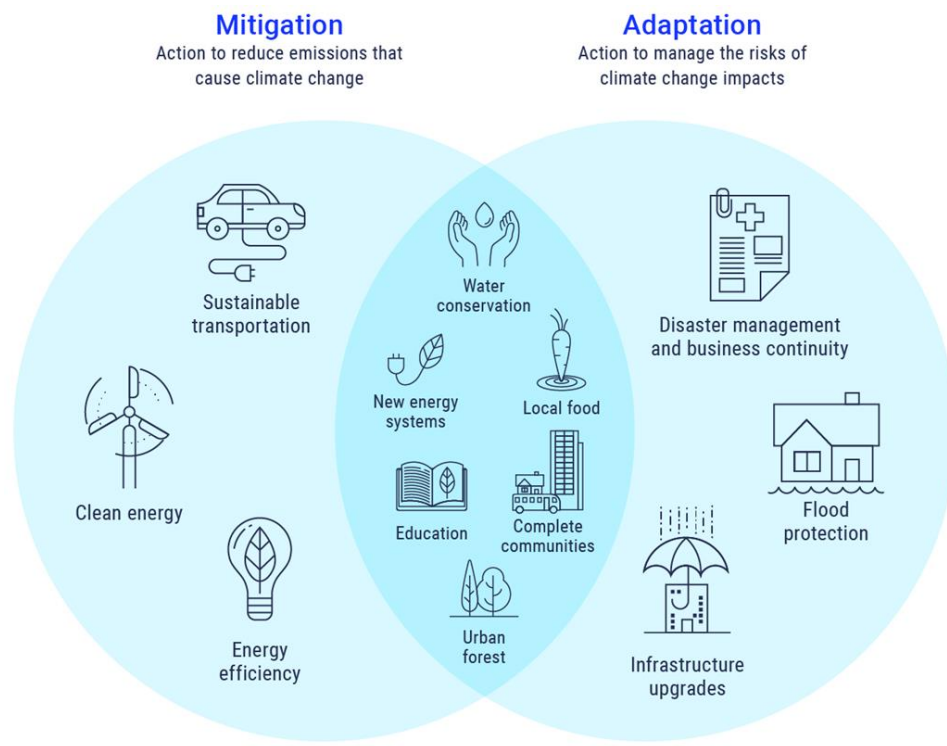


Figure 2: Climate Change Adaptation and Mitigation (Sauchyn et al., 2020)

Community responses to climate change fall generally into two broad categories: mitigation (reducing our inputs to climate change) and adaptation (responding to impacts caused by a changing climate). This is illustrated in Figure 12. Climate resilience refers to the planning for the future effects of climate change, in this case ensuring safe and reliable drinking water for the residents of the SVGL.

Historic and existing greenhouse gas emissions have already resulted in observed changes to our climate resulting in impacts that we must respond to (Canadian Institute for Climate Choices, 2020). Examples of climate change hazards include but are not limited to increases in wildfire events, increases in flooding frequency and intensity, more intense droughts and water scarcity issues, more severe and frequent storm systems, human health impacts, and a loss in biodiversity (IPCC, 2022).

Specifically, with climate change, spring snow melt will arrive earlier, and more precipitation will fall as rain and not snow. Along with earlier spring runoff and rain instead of snow, scientists expect the Bow River could have drier late summer months and increasing variability in precipitation from year to year. They also project that the Bow River basin will experience more frequent and severe intensive storms that could potentially cause flooding (Alberta WaterPortal Society, 2022). Fortunately, the Ghost Lake dam, regulates the water surface level of Ghost Lake and will help create managed water levels in the face of more variable inflows. This regulation can be seen as a climate change adaptation tool. In addition, more intense rainstorms can increase the risk of localized contamination of wells. Similarly, warmer temperatures and increased precipitation in the spring months could lead to more flooding, with a quicker snowmelt also playing a role. These factors create the need for more frequent water quality testing and well head protection.

1.4 Hydrological Assessment Overview

The goal of the project is to ensure that residents have access to safe and reliable drinking water in the context of climate change. A significant part of this was completing and assessment and documentation of current groundwater conditions. SVGL has two main sources of groundwater; shallow wells in sand and gravel, and deeper wells in bedrock. While it was hard to distinguish any trends between the two, both supplies are impacted when the reservoir is low. The Ghost Lake reservoir is used to provide hydropower therefore the water levels are typically kept between the elevations (mASL) of 1191.1m and 1191.7m.

During the well water quality survey, six homes were visited. Overall, the well water was found to be hard, mineralized, and bacteria free. None of this is cause for concern and is consistent with previous studies. There also did not seem to be a difference between the water quality in shallow and deep wells, or Brazeau (non-marine sandstone) and Wapiabi (marine shale or sandstone with siltstone) areas. It should be noted that one sample had nitrate above the Canadian health guideline (10mg/L) and that is likely related to the septic system.

In general, the development density of well and septic services is high, and the protection of water services falls mainly on residents to test and maintain their private wells. Citizens raised the concern that within increased urbanization and a development trend to larger, year-round residences that there will be increased pressure on groundwater. This concern is valid because the community density is very high for on-site water and in-ground septic disposal. In particular, larger, year-round homes will produces more wastewater, which will be a threat to groundwater quality. This has been considered throughout the process of the creation of the implementation plan.

Overall, this study shows that the groundwater supply in SVGL is good and should have good climate resilience in comparison to the surface water. However, shallow wells are more vulnerable to surface contamination (including nitrates from septic systems) and water level fluctuations. With that in mind the information on current well and septic systems is not complete in details. Therefore, implementing a program to collect additional data on existing infrastructure and a robust monitoring program will help ensure the groundwater stays resilient.

1.4.1 Conceptual Modeling Results

The hydrogeological model was developed based on interpretation of information that was available which included surficial geological mapping and cross sections. The model attempts to explain major patterns of groundwater, major aquifers and aquitards, the typical horizontal and vertical groundwater velocities, groundwater geochemistry and age, and the anthropogenic and ecological interactions and dependencies. Figure 3 shows a cross-section of the modeling results.

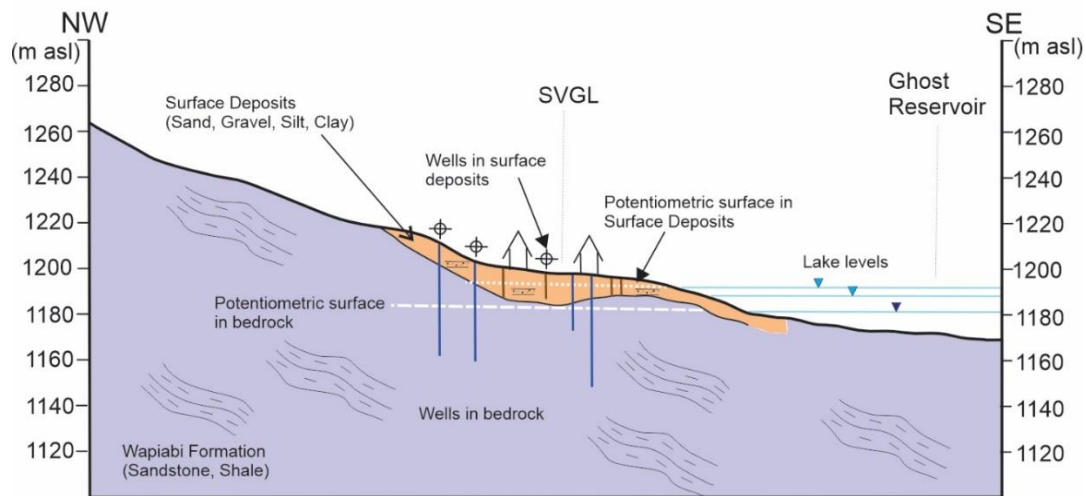


Figure 3: SVGL Conceptual Groundwater Model

2. IMPLEMENTATION PLAN

2.1 Overview

Three key planning documents informed the development of the Summer Village of Ghost Lake's Climate Resilient Groundwater Implementation Plan. Their relation to each other in the planning hierarchy can be seen in Figure 4.

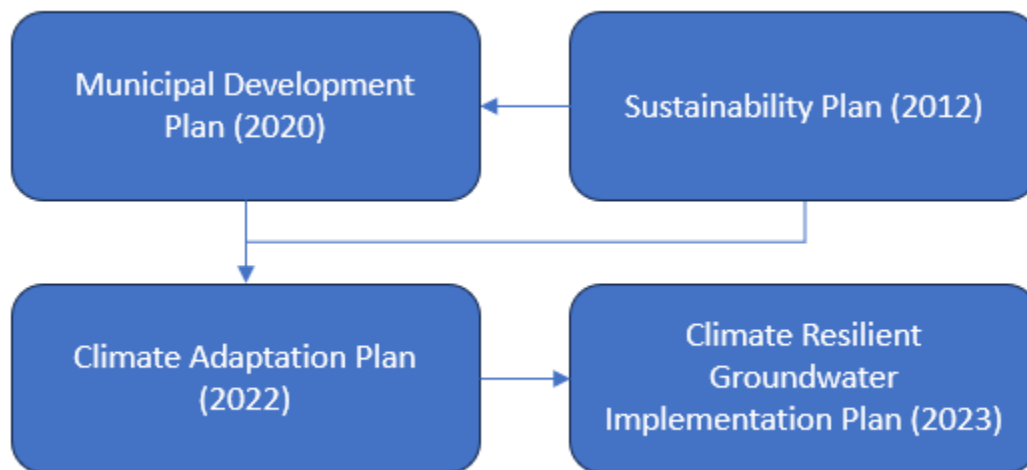


Figure 4: SVGL Planning Context

This implementation plan is primarily based on the priority actions around water quantity and quality highlighted in the Climate Adaptation Plan (2022). The hydrogeological assessment and community engagement results completed in 2023 also helped inform the following implementation plan actions. The outcome of this plan is to ensure that SVGL residents have continued access to safe and reliable drinking water in the context of climate change. The assessment work illustrates that groundwater is relatively more resilient the face of climate change relative to surface water supplies. Thus, good stewardship of the community's groundwater is a prudent climate change adaptation measure.

The following implementation plan in many regards parallels [Alberta's Source Water Protection Planning guidelines](#), but does not constitute a full Source Water Protection Plan (SWP). These types of plans are typically for the protection of a single point source of municipal water such as municipal well or surface water intake, whereas the SVGL obtain water from a collection of privately-owned wells. Notwithstanding, should SVGL choose to develop and implement a full SWP plan at some point in the future, many of the actions recommended in this Implementation will be foundational to a SWP plan and comprise components of such a plan.



2.1.1 Actioning the Resilient Groundwater Plan

While this implementation plan is being presented to the Summer Village council, water wells are primarily the responsibility of homeowners, not the municipality. Therefore, the following implementation plan actions is divided into actions for the municipality and homeowners to take. This also reiterates the importance of a community education program to ensure the groundwater continues to be resilient within considerations of new development and climate change.

Note that for the municipality to implement many of these actions, given the small size of the organization, it will require an increase in capacity and resources.

- To ensure implementation, it is recommended that an individual at SVGL be identified as Implementation Plan Coordinator to ensure the actions Plan's actions are being implemented and that the Plan is evaluated every five years.
- Evaluate opportunities to further regulate water and wastewater systems. Specifically, it appears that section 4.7.6 empowers the Municipality to approve water and wastewater systems. An example maybe for increased requirements for around wastewater management and treatment linked to development permits.

A schedule and frequency are identified for each action. Some actions are one-time, others are annual, on-going or event driven. Appendix A provides a summary of the plan elements for both the municipality and for homeowners, including the implementation frequency.

2.1.2 Plan Evaluation

The actions recommended in this Plan provide a path forward for the Summer Village of Ghost Lake (SVGL) to respond to groundwater concerns and increase community climate change resilience. This Plan and its implementation should be evaluated regularly; it is recommended that implementation is assessed on an annual basis to help understand where to prioritize future resources. An evaluation of this Plan should occur at least every five years, using the most up to date data available. Through the ongoing monitoring and evaluation process, SVGL can assess what has been achieved, what challenges have arisen, what lessons have been learned, and what new actions need to be added to the prioritized list of actions.

2.2 Information Gathering

Understanding the groundwater resources is the first step to building resilience. The hydrogeological assessment is a foundation, but site-specific information is needed to further protect this important resource. Especially when considering that many of the water wells and private wastewater infrastructure is old and may not meet current guidelines. This information gathering can be focal actions for the early years of the Implementation Plan but warrant continual maintenance of the information as the community grows and changes.

Actions are numbered with relevant details listed below and separated into municipal and household level actions. Ensuring all the relevant information has been collected with better support the success of the subsequent two sections for the implementation of a water monitoring and community education program.

2.2.1 Municipal Level Actions

1. Obtain and review 2016 inventory (*One time*)

According to the Transalta agreement, an aquifer study was completed in 2016 which included a well inventory and site visits to private wells in the community. This inventory should be obtained from the Province and reviewed. Information contained in the study can be used to help SVGL build their well inventory. Building off of existing data is a good place to start in creating and maintain a record of water wells and septic fields in SVGL.

- Add data from the 2016 inventory report to updated community inventory of water wells (see below).

2. Build an inventory of community water wells (*Once with continual update*)

The location of the community wells and details of the wells' completion and depths is incomplete. Knowing the exact location of all the wells and their well head vulnerability is an important first step in building the groundwater resilience. Ideally this inventory consists of a map with coordinates and identifier of each well, details on the well completion at surface, depth, water level and water quality information. Drilling records exist for some wells, but they are often incomplete and should be verified. As the wells themselves are responsibility of the homeowners, it will rely on voluntary participation by residents, however the SVGL can conduct and coordinate the inventory. Building the inventory can be time consuming and thus a stepwise approach is recommended as follows. The inventory should be continuously updated as new wells are drilled and/or wells are refurbished.

- Step 1.** Complete an inventory of the number and location of wells in SVGL. Collect coordinates of every well in the community. This can be done with a hand-held GPS through a door-to-door survey. Photographs should be collected as part of the survey. Well details can be collected at the same time, if resources allow (see Step 2 below.)
- Step 2.** Gather details on wells ie. depth, well head completion, water demand, age and size of house, usage of house, issues with quantity and quality of water etc. This

information can be collected through an on-site, coordinated survey with property owners. An example survey form is provided in Appendix C. The survey would involve individual well site visits. A key piece of information to be collected in this step is the wellhead completion and its risk to surface water flooding—is the well completed above grade with a pitless adapter, is it inside or under a building, or in a well pit? Ideally, total depth and static water level information can be gathered, however this may require use of a contractor with capabilities for opening water wells and collecting such measurements. It is unlikely that all information will be gathered for all wells, but the more information that can be collected, the better the community will be able to protect the groundwater resource.

- **Step 3.** Gather water quality results. Request homeowners share their water quality testing results. It may be necessary to keep location specific results confidential, but general trends and findings can be important to overall protection of the groundwater. Consolidated results will be important to inform future assessment of the groundwater resource.

3. **Build a community inventory of septic systems.** *(Once with continual update)*

Knowing exactly where septic systems are located and the status of those fields is an important step to managing the risk to groundwater. Ideally this inventory consists of a map with coordinates and identifier of each septic system, details on its construction, age and maintenance. As the septic themselves are responsibility of the homeowners, it will rely on voluntary participation by residents, however the SVGL can conduct and coordinate the inventory. Building the inventory can be time consuming and thus a stepwise approach is recommended as follows. The inventory should be continuously updated as new systems are constructed and/or are refurbished/replaced.

- **Step 1.** Complete an inventory of the number of septic systems in SVGL. Collect coordinates of every septic system in the community. This can be done with a hand-held GPS through a door-to-door survey. Photographs should be collected as part of the survey. System details can be collected at the same time, if resources allow (see Step 2 below.)
- **Step 2.** Gather details on the septic system ie. field construction, age, size, tank details, etc. This information can be collected through an on-site, coordinated survey with property owners. An example survey form is provided in Appendix C. The survey would involve individual homes. Understand the age and maintenance of the system is a key goal of the survey. Many septic systems are aging and not maintained, resulting in reduced treatment effectiveness. A contractor experienced in septic system maintained may help in gathering the onsite information. It is unlikely that all information will be gathered for all wells, but the more information that can be collected, the better the community will be able to protect the groundwater resource.

4. Update hydrogeological assessment (*One time*)

A key data gap in the hydrogeological assessment is an understanding of shallow versus deep water wells. Specifically, are water levels and water quality systematically different between the two aquifers. This information will be important to help understand if one is more resilient (or at risk) to climate change relative to the other.

- Once information of the community's water wells and water quality is gathered, update the hydrogeological assessment with respect to differences in water level, water availability (quantity) and water quality between the shallow and deep water-wells. This update should be done towards the end of the implementation plan cycle (e.g. year 4)

2.2.2 Household Level Actions

1. Contribute to water well knowledge in the Village. (*Once with updates if there are changes*)

The location of the community's wells and details of the wells' completion and depths is incomplete. Knowing the exact location of all the wells and their well head vulnerability is an important first step in protecting homeowner's groundwater resources. Ideally this means contributing to the development of a map with coordinates and identifier of each well, details on the well completion at surface, depth, water level and water quality information. Drilling records exist for some wells, but they are often incomplete and information should be verified. As the wells themselves are responsibility of the homeowners and thus this inventory will rely on voluntary participation by residents. Homeowner can help by participating in the well survey, providing access to their wells and sharing information. If there are new wells, or wells are upgraded, or there is new water quality information, this should be shared with the Village as it becomes available.

- **Step 1.** Find your well and share location with SVGL. Identify the location of the well, show it to the Village representative and share photographs. Ultimately, GPS coordinate of the well are needed.
- **Step 2.** Gather and share information on your well with SVGL. If you have a drilling record, or records of maintenance, share it with the Village. Participate in the well survey and share your knowledge. Provide access to well to the researchers if possible.
- **Step 3.** Share water quality monitoring results with SVGL (*on going*). If you have water quality testing results, share them with the Village. If you get new testing done, share that data as well. If you discover a health-related water quality issue, it is important you let your community know so collectively residents can take action to protect the community's water supply.
- **Step 4.** Share information if new well built. If you build a new water well, or substantively upgrade an existing well, ensure it is built to modern guidelines to help protect your water supply. Share the well construction information with the Village so the community can work together to help protect your investment.

2. **Share location of your septic system with SVGL or if new septic system built.** (*Once with updates if there are changes*)

Knowing exactly where septic systems are located and the status of those fields is an important step to managing risks to your groundwater. Ideally this means contributing to the development of a map with coordinates and identifier of each septic system, details on its construction, age and maintenance. As the septic themselves are responsibility of the homeowners, it will rely on voluntary participation by residents. Homeowner can help by participating in the septic system survey, providing access to their property and sharing information. If there are new septic systems, or systems are upgraded, this should be shared with the Village as it becomes available.

- Step 1.** Find your septic system and share location with SVGL. Identify the location of the tank and field, show it to the Village representative and share photographs. Ultimately, GPS coordinate of the system is needed.
- Step 2.** Gather and share information on your septic system with SVGL. If you have a construction record, or records of maintenance, share it with the Village. Participate in the septic system survey and share your knowledge. Provide access to septic system to the researchers if possible.

2.3 Surface and Groundwater Monitoring

The following section outlines the actions needed to develop a water monitoring plan. These actions align with and support Action W.1 in the Climate Adaption Plan (MH, 2022).

Action W. 1 → Develop a program to monitor surface and groundwater quality following wildfire or storm events to confirm water quality is not impacted, and to mitigate contamination due to debris or contamination.

With increasing concern over greater impacts on groundwater quality and quantity it is important that a program coordinate monitoring of the groundwater situation, especially associated with extreme weather events. This means both:

- Routine testing of water quality by homeowners and sharing of results to help build collective awareness if potential issues are identified so the community can work together to protect and enhance the resilience of the resource.
- Weather event-related surveillance, including visual inspection for well-head flooding risk, and water level and water quality monitoring by homeowners after events occur.

This will work to evaluate the potential impact on water quality following major events and help identify future mitigation measures to reduce contamination risk and maintain water quality. It is important to keep in mind that currently residents are responsible for their own wells and septic systems, the municipality has limited control. Thus, residents need to collaborate to collectively protect this important community resource. Actions are numbered with relevant details listed below and separated into community and household level actions:

2.3.1 Municipal Level Actions

Monitoring is the responsibility of homeowners; however, SVLG can facilitate monitoring, coordinate sampling, share information & resources, and provide recommendations for monitoring. Several of these actions are recommended to be conducted as an annual “campaign” and also continuously through on-line resources and information hosted by the municipality:

1. **Encourage homeowners to test their water quality regularly** (*Annually and continuously*)

Homeowners should test for bacteria twice per year and test for chemical and trace metals every three years. Alberta Health Services Environmental Public Health will test samples at no cost to homeowners. See Homeowner Monitoring Actions #2 and #3 below for details.

- Provide community members with information on how often to sample their water supplies and how to contact Environmental Public Health for bottles and analysis.

2. Communicate and encourage residents to sample wells after significant events with localized flooding (*After an extreme weather event and continuously*)

Communicate with residents they should inspect their wells and conduct water quality testing after an extreme weather event that results in localized flooding. This could be after a storm event or after a rapid spring melt. The Village should conduct a visual survey to identify areas of significant surface water ponding or water accumulation. Residents that are adjacent should be notified and encouraged to sample their well water.

- Conduct visual survey of community during/after an extreme wither event with localized flooding to identify areas of surfacer water accumulation and ponding, especially in proximity of known water wells. Wells without an above grade stickup will be at greater risk.
- Encourage residents to sample well water after significant weather events.

3. Communicate anticipated seasonal low water levels (*Annually*)

Flood mitigation operations of the Ghost Lake dam results in seasonal low water levels that may affect residents' water wells. Residents should prepare for these seasonal low levels and monitor their wells for low water and/or water quality effects. Water quality testing at this time of year may also be prudent.

4. Consider coordinating an annual water well sampling events (*Annually*)

Consider coordinating an annual sample event to facilitate/make it easier for residents to get their water tested. The cost of a contractor could be shared by participants for the coordination, collection and delivery of samples to Environmental Public Health. Although this could have a cost to homeowners, it may make it easier to get the sampling completed. Community members should also encourage everyone to share their results with the community.

- Coordinate an annual well water testing event, consider use of a contractor to facilitate the testing.
- Encourage residents to share their water quality testing results.

5. Develop a water quality database (*Continuously*)

Understanding of groundwater quality trends is incomplete. Collecting more information on groundwater quality, especially associated with location and depth of wells, will be important to further understanding the groundwater resilience. It will also be important for detecting changes or long-term impacts to water quality. As the water wells themselves are responsibility of the homeowners, it will rely on voluntary participation by residents, however the SVGL can solicit sharing of quarter quality results and provide a central repository for the data. At minimum, it could be as simple as a digital folder storing testing reports which could be access in future studies. The Village may need to store this data securely to

protect confidentiality concerns of residents, if identified. The database should be continuously updated as new results are collected.

- Develop a water quality data repository system.
- Encourage residents to share their water quality testing results.

2.3.2 Household Level Actions

1. **Inspect well head after a weather event** (*After an extreme weather event*)

Visually inspect the well head for risk of flooding after an extreme weather event. This could be after a storm event or after a rapid spring melt. Wells heads located below ground in a well pit or flush with the ground are particularly vulnerable.

- Visually inspect the well head after an extreme rain event or rapid snow melt, for signs of well flooding or inundation.
- Wells with a well pit should be visually inspected each spring at the peak of snowmelt for signs of meltwater entering the well pit.

2. **Conduct biannual bacteria testing** (*Twice a year*)

Alberta Health Services Environmental Public Health recommends sampling for bacteria analysis twice per year.

- It is recommended sampling be done twice per year, ideally associated with weather events, freshet and/or low lake levels. For more information on sampling, see:

<https://myhealth.alberta.ca/Alberta/Pages/Testing-Your-Drinking-Water-in-Alberta.aspx>.

Sample bottles can be obtained from:

Cochrane Community Health Centre
60 Grande Boulevard , Cochrane, Alberta T4C 0S4
Telephone: 403-851-6002

- If an issue is found, notify SVGL and share the results so the community can work together to protect the groundwater resource.

3. Sample water for chemical and trace metal testing (Once every three years)

- Alberta Health Services Environmental Public Health recommends sampling for chemical and trace metals every three years.
- It is recommended sampling be once every three years, ideally associated with weather events, freshet and/or low lake levels. For more information on sampling, see:

<https://myhealth.alberta.ca/Alberta/Pages/Testing-Your-Drinking-Water-in-Alberta.aspx>.

Sample bottles can be obtained from:

Cochrane Community Health Centre
60 Grande Boulevard , Cochrane, Alberta T4C 0S4
Telephone: 403-851-6002

- Request analytical results be provided by Environmental Public Health. Sharing water quality sample results with the SVGL will allow the data to be added to the community database. Having this data over time will help identify any trends and build knowledge of groundwater. In addition, if an immediate health concern is identified in the water quality, notify SVGL so the community can work together to protect the groundwater resource.

2.4 Community Education Program

The following section outlines the actions to create and implement a community education program. These actions align with and support Action W.2 in the Climate Adaptation Plan (MH, 2022).

Action W. 2 → Develop a community education and participation program to educate the community on potential surface and groundwater impacts and encourage community members to report potential impacts observed on surface water.

It is critical that residents are educated and involved in the process of protecting groundwater resilience in the SVGL. Residents should understand potential impacts on groundwater and actively engage in reducing potential impacts to the community's shared groundwater supply.

2.4.1 Municipal Level Actions

1. Build community awareness of the Climate Resilient Groundwater Implementation Plan (*Once, annually, and continuously*)

Engage residents and make them aware of this plan, and their role in protecting groundwater. Multiple methods are recommended to continuously raise awareness and engagement in the plan, including:

- Share the plan with residents. Post the plan on the SVGL website and send communication to residents making them aware of the plan and where they can view it.
- Circulate the 2-page plan summary (Appendix B) to residents. This can be both electronically and physical mailout to residents.
- Include awareness building in annual community newsletter(s) and at annual community events. This can be making residents aware of the importance of the community groundwater, how they can help and where to find this plan.

2. Develop a webpage of resources (*One time*)

Create webpage of educational resources that is easily accessible by the community. This will reduce the effort needed to find resources and improve overall well water knowledge. Consider sharing the list of resources on well water education and maintenance through a variety of channels such as newsletters, SVGL website, posters, word of mouth, etc.

- Compile a list of relevant resources on well water resilience and private septic system maintenance on the SVGL website. Some good relevant resources include:
 - Resources Alberta's excellent Working Well website (<https://www.alberta.ca/working-well-resources>), including video links

- Fact sheets from the *Working Well* website (<https://open.alberta.ca/publications/working-well-clean-water-well-protected-2022>)
- Links to Alberta Health water testing webpage (<https://myhealth.alberta.ca/Alberta/Pages/Testing-Your-Drinking-Water-in-Alberta.aspx>)
- Link to the document Wells that Last (<https://open.alberta.ca/publications/9781460143414>)
- Homeowner resources from the Onsite Waste Water Management Association (<https://wcowma.com/home-owners/>)

Distribute links the educational materials to the community via email or mail.

3. Host a *Working Well* community workshop (Once every three to five years)

The *Working Well* program is a collaborative effort led by Alberta Environment and Protected Areas (EPA). The goals of the program are to raise awareness of the property owners' responsibility of private wells, educate residents on how wells work and proper maintenance, and have owners adopt recommended well water management practices.

The program offers free, approximately three-hour workshops offered in person and virtually. Municipalities and community groups are encouraged to host it. The workshop covers a variety of topics including how your well works, common well water problems, taking samples, and shocking your well. See <https://www.alberta.ca/working-well-overview#jumplinks-2> for details and registration.

Coordinate with neighboring MD of Bighorn to jointly host a workshop is a minimum number of participants are required to host the workshop. To organize a workshop, contact:

Kristina Dembinski (kdembinski@sagewoodcommunications.ca)
Sagewood Communications Solutions Ltd.
780-718-5023

2.4.2 Household Level Actions

1. Read this plan (Once)

A first step is becoming familiar with this plan, learning what you can do, how water wells work and the importance of groundwater resilience in the face of climate change. Become aware of your role and responsibility as a property owner for protecting this important community resource.

2. Visit resources on the *Working Well* website (Once or annually)

Learn about how wells work and the importance of groundwater resilience in the face of climate change. Understanding how water wells work, the connection between the land surface of the community and the groundwater, and how homeowners can help protect

this resource. It is especially important that SVGL residents learn about wells and keep up to date on maintenance guidelines as it is the responsibility of the property owner.

- Review the resources on the *Working Well* website at <https://www.alberta.ca/working-well-resources>. This includes a number of fact sheets and useful YouTube videos.

3. Talk to your neighbor about working together to protect groundwater (*Continually*)

- Share your groundwater and septic management learnings and knowledge with your neighbors. Talk about working together to protect your groundwater supply.

4. Participate in community education events (*Annually*)

- Join community events that include groundwater resilience topics. Seek opportunities to learn more and share your experience with your community.
- Participate in the Working Well workshop when hosted locally or in the nearby communities to learn more about caring for and protecting your water supply. Visit <https://www.alberta.ca/working-well-overview> for more information on the Working Well program.

3. SUMMARY

This Resilient Groundwater Implementation Plan takes into consideration information collected during the Climate Adaptation Plan (2022) creation, hydrogeological assessment (2023), and the feedback from community members during this project. Key highlights from the assessment and community engagement program are synthesized and shared at the beginning of this document such as the concern around how lake levels and new development will affect water quantity. Overall, the assessment shows groundwater is an important, relatively more climate change resilient water supply option that is worth protecting to enhance community climate change resilience. The assessment shows good water quality in the region that can be maintained with the actions laid out in the implementation plan. However, development density is high within Summer Village of Ghost Lake, and with increased urbanization within the community and conversion of properties to year-round usage, there will be increased threat to groundwater and its quality.

Ultimately, there responsibility for use and protection of on-site water and wastewater (i.e. water wells and septic systems) lies with homeowners. The municipality can play a role in coordination, knowledge share and education. Thus, this implementation plan presents actions for both Homeowners and the Municipality. Actions are broken down in the three broad areas:

1. Information Gathering
2. Surface and Groundwater Monitoring
3. Community Education

Within each area, the actions have been broken down into clear tangible steps that are reasonably achievable for a small community and for homeowners. By creating an updated water well and septic field database, consistently monitoring ground and surface water, and keeping residents up to date with current best practice recommendations, the region can continue to have a resilient source of groundwater in the context of new development and climate change.

4. CLOSURE

The Summer Village of Ghost Lake retained Morrison Hershfield to conduct the work described in this report, and this report has been prepared solely for this purpose.

This document, the information it contains, the information and basis on which it relies, and factors associated with implementation of suggestions contained in this report are subject to changes that are beyond the control of the author. The information provided by others is believed to be accurate and may not have been verified.

Morrison Hershfield does not accept responsibility for the use of this report for any purpose other than that stated above and does not accept responsibility to any third party for the use, in whole or in part, of the contents of this document. This report should be understood in its entirety, since sections taken out of context could lead to misinterpretation.

We trust the information presented in this report meets Client's requirements. If you have any questions or need addition details, please do not hesitate to contact one of the undersigned.

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APPENDIX A: Implementation Plan Schedule



Climate Resilient Implementation Plan Schedule – Municipal Actions*

Summer Village Ghost Lake

Continuous Implementation		
 <p>Information Gathering</p> <ul style="list-style-type: none"> <input type="checkbox"/> Update inventory of community water wells as new wells are built or upgraded. <input type="checkbox"/> Update community inventory of septic systems as they are built, upgraded and/or replaced 	 <p>Surface & Groundwater Monitoring</p> <ul style="list-style-type: none"> <input type="checkbox"/> Encourage homeowner to test their water quality regularly. <input type="checkbox"/> Communicate and encourage residents to sample wells after significant weather events with localized flooding. <input type="checkbox"/> Maintain a water quality database 	 <p>Community Education Program</p> <ul style="list-style-type: none"> <input type="checkbox"/> Build awareness of Climate Resilient Groundwater Implementation Plan on Village website
Open Time	Annually	Intermittent
<p>Information Gathering</p> <ul style="list-style-type: none"> <input type="checkbox"/> Obtain and review 2016 well inventory. <input type="checkbox"/> Build community water well inventory. <input type="checkbox"/> Build community inventory of septic systems. <input type="checkbox"/> Update hydrogeological assessment (year 4 or 5 of the plan). <p style="background-color: #27ae60; color: white; padding: 2px;">Community Education Program</p> <ul style="list-style-type: none"> <input type="checkbox"/> Build awareness of this Implementation Plan: post on website, circulate 2-page plan summary. <input type="checkbox"/> Develop webpage of resources. 	<p>Surface & Groundwater Monitoring</p> <ul style="list-style-type: none"> <input type="checkbox"/> Encourage homeowner to test their water quality regularly. <input type="checkbox"/> Consider coordinating an annual water well sampling event. <p style="background-color: #27ae60; color: white; padding: 2px;">Community Education Program</p> <ul style="list-style-type: none"> <input type="checkbox"/> Build awareness of Climate Resilient Groundwater Implementation Plan through annual newsletter and community events. 	<p>Surface & Groundwater Monitoring</p> <ul style="list-style-type: none"> <input type="checkbox"/> Conduct visual inspection for localized flooding after extreme weather event and rapid snow melt. <input type="checkbox"/> Encourage residents to sample wells after significant weather events with localized flooding. <p style="background-color: #27ae60; color: white; padding: 2px;">Community Education Program</p> <ul style="list-style-type: none"> <input type="checkbox"/> Host a Working Well community workshop every 3 to 5 years.

* Implementation of municipal actions is subject to increased capacity.

Climate Resilient Implementation Plan Schedule – Homeowner Actions

Summer Village Ghost Lake

Continuous Implementation

- Talk to your neighbors about working together to protect your groundwater

Open Time

Information Gathering



- Contribute to the community's water well knowledge (*share your well records and monitoring results*)
- Share location of your septic system with SVGL.

Community Education Program



- Read this Plan.
- Visit and review resources on *Working Well* website.

Annually

Surface & Groundwater Monitoring



- Inspect well head after rapid spring snowmelt.
- Conduct biannual bacterial testing of water.

Community Education Program



- Re-visit and review resources on *Working Well* website.
- Participate in community education events.

Intermittent

Surface and Groundwater Monitoring



- Inspect well head after an extreme weather event.
- Sample water for chemical and trace metals (*once every 3 years*)

Community Education Program



- Participate in such as *Working Well* workshops when offered.

APPENDIX B: Project Summary



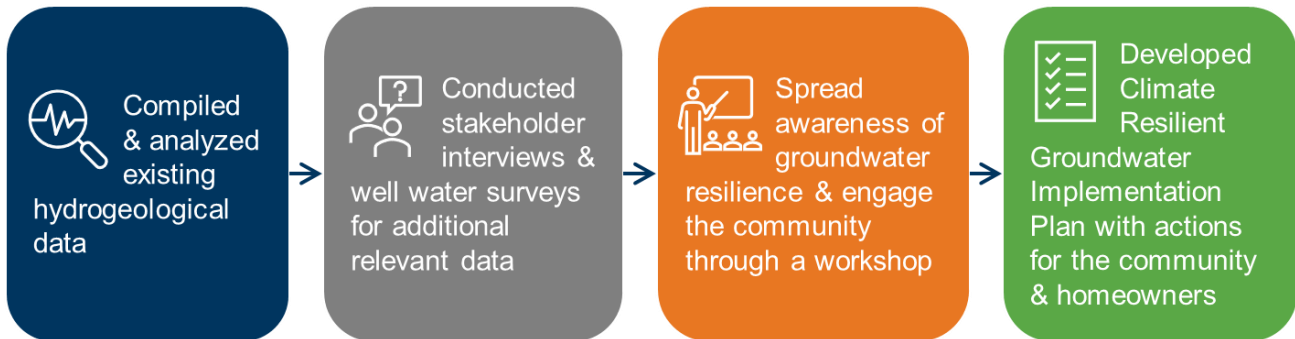
Summer Village of Ghost Lake Climate Resilient Groundwater Assessment & Implementation Plan

Project Purpose

This project was completed as a recommendation from the Summer Village Climate Change Risk Assessment completed in 2022. This project specifically addresses groundwater resilience and provides a pragmatic plan for the community and homeowners to ensure they have access to good quantity and quality of drinking water in the face of climate change. The project had three main components:

1. Conduct further research on the groundwater (hydrogeology) of the area
2. Engage and build awareness around groundwater with residents
3. Develop the Climate Resilient Groundwater Implementation Plan

Process – Project Steps



Key Learnings

- Overall, the groundwater tends to be more climate change resilient than surface water sources. The water supply currently meets SVGL needs, but the community should work together to keep it that way.
- The community density is quite high for onsite water and wastewater services, and the community should be realistic about options for increasing development/redevelopment.
- Well water quantity is affected by the Ghost Lake reservoir levels, with shallower wells closer to the lake being more susceptible. However, the reservoir also helps mitigate water levels by stabilizing water levels within a regulated range.
- The community is engaged and raised concerns over impacts of new development density on groundwater.
- Many wells and septic systems are old and may not meet modern guidelines. Wells may be completed below ground (in well pits) and therefore more at risk of surface contamination.
- To better protect the groundwater, more information should be collected on well locations, well details and septic system locations.

Scope of the Implementation Plan

The Climate Resilient Groundwater Implementation Plan focuses on actions the municipality and individual homeowners can do because on-site wells and septic systems on private property are the responsibility of the owner. The following page provides an overview of plan elements that should be undertaken to ensure the SVGL maintains good drinking water for everyone in the face of climate change.



Climate Resilient Groundwater Implementation Plan Overview

	Municipal Actions*	Homeowner Actions
Information Gathering 	1→ Obtain and review 2016 inventory. 2→ Build inventory of community's water wells. 3→ Build inventory of community's septic systems. 4→ Update hydrogeological assessment.	1→ Contribute to water well knowledge in the Village. 2→ Contribute location your septic system to community inventory.
Surface & Groundwater Monitoring 	1→ Encourage homeowners to test water quality regularly. 2→ Communicate and encourage residents to sample wells after significant events with localized flooding. 3→ Consider coordinating an annual water well sampling events. 4→ Develop a water quality database.	1→ Inspect well head after a weather event. 2→ Conduct biannual bacteria testing. 3→ Sample water for chemical and trace metal testing.
Community Education 	1→ Build community awareness of the Climate Resilient Groundwater Implementation Plan. 2→ Develop a webpage of resources. 3→ Host a <i>Working Well</i> community workshop.	1→ Read the Plan. 2→ Visit resources on the <i>Working Well</i> website. 3→ Talk to your neighbor about working together to protect groundwater. 4→ Participate in community education events.

* Implementation of municipal actions are subject to increased capacity.

APPENDIX C: Example Well and Septic System Survey Forms



Well Survey

Address/Lot Number: _____

UTM Coordinates, Easting: _____ Northing: _____

Date: _____ Field Technician: _____

Site Description

Location of well on property

Potential Source of Contamination (animals, oil tanks, septic pits, etc)

Topography and Drainage

Well and Septic System Questions

1. Is this a fairly standard well and septic system? If not, describe:

2. Water Quantity. How much water do you use? Any problems with quantity?

3. Water Quality. Taste? Colour? Odour? Hardness? Staining on Fixtures? Corrosion? Scaling?
Any sickness from the water?

4. Number of residents:

5. Any babies? Children?

6. Is the property used year-round or seasonally?

7. Any prior investigations or repairs?

8. Any testing of the water? When? Parameter tested? Results?

Well Survey

THE WELL

1. Location on Property: _____

2. Type: Dug Overburden

Drilled Bedrock

3. Is there a Well Record? (Obtain to get answers to the following questions)

4. Installation Date: _____

5. Total Depth: _____

6. Pump Rate: _____

7. Screened Interval (or depth of casing): _____

8. Diameter (measure if possible): _____

9. Static Water Level (measure if possible, note reference point and height of casing):

10. Type of Pump (jet pump in basement, submersible in well? How deep is it set?):

INSPECTION OF WELL

1. Take Photo

2. Measure Diameter: _____

3. Measure Casing Height Above Ground: _____

4. Measure Depth to Water Level Below Casing Top: _____

5. Measure Depth to Bottom of Well: _____

6. Note Problems (no cap, short casing, voids around well, poor drainage):

WATER TREATMENT SYSTEM

1. Is there a treatment system? Where? _____

2. Type:
Particle/Cartridge Filter (for solids) / Softener (for hardness) / Carbon Filter (for chemicals) /
Reverse Osmosis (for salinity) / Iron or Greensand Filter (for iron, sulphur, manganese) /
Ultraviolet (for bacteria) / Other: _____

3. Date of Installation: _____

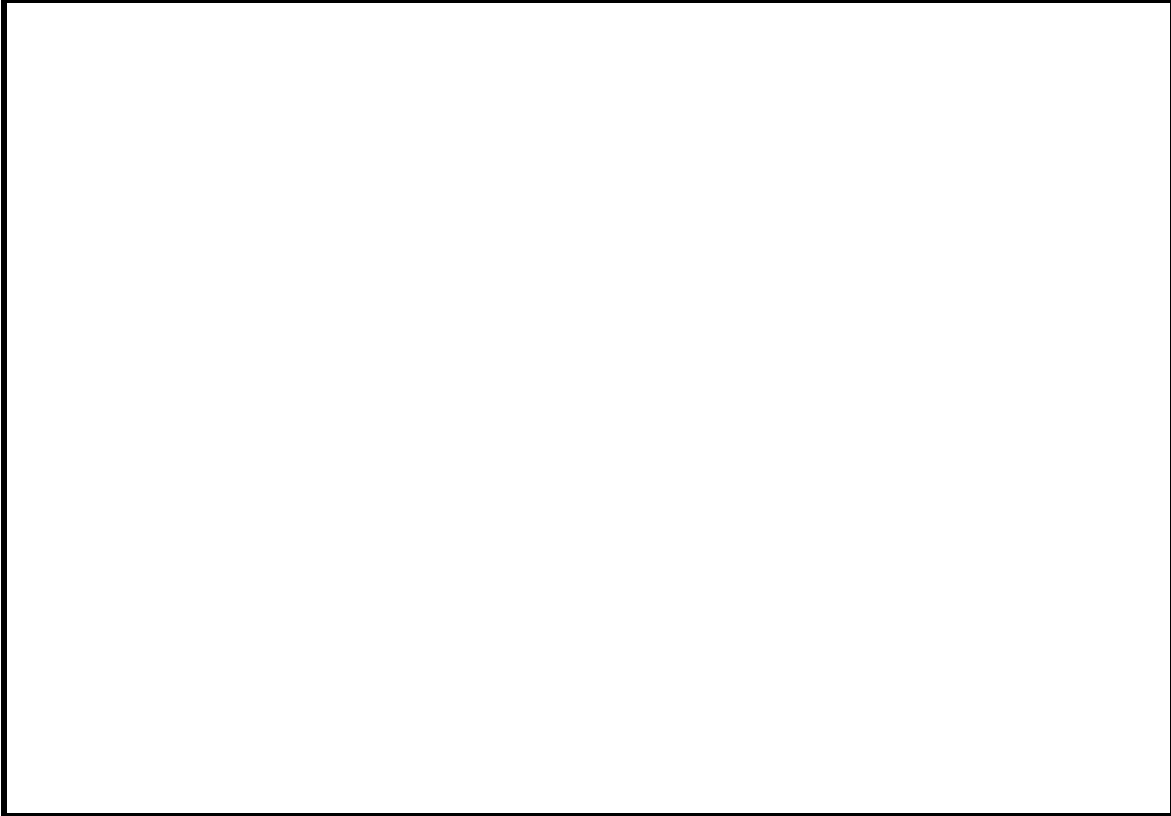
4. Services: Entire House
 Kitchen Faucet Only

5. Is there a place where we can sample the water upstream of the treatment system?

Well Survey

SKETCH

1. Well
2. Septic System
3. Topography
4. House
5. Driveway
6. North arrow and nearest road
7. Contaminant sources (fuel tanks, farmers fields, livestock, etc.)



Septic System Survey

Address/Lot Number: _____

UTM Coordinates, Easting: _____ Northing: _____

Date: _____ Field Technician: _____

Site Description

Location of septic tank and field on property

Topography and Drainage

Septic System Questions

Septic with field or Holding Tank: _____

Year constructed: _____

Last pump out date? _____

Is tank hatch visible and accessible?

System description (materials, volume, compartments, pump, plumbing):

Bed area (dimension):

Land use of bed area (for example grass, parking, driveway, garden, etc)

Riser pipes accessible?

Any problems with it (breakout, odour, flooding)?

PLUMBING

1. Any problems with plumbing?

2. Copper or plastic pipe? Lead solder if copper pipe?

3. Any water hammer effect, or gas (methane) in the pipes?

4. Is there a cistern, or reservoir for balancing supply and peak demand?

Septic System Survey

SKETCH

1. Well
2. Septic System
3. Topography
4. House
5. Driveway
6. North arrow and nearest road
7. Contaminant sources (fuel tanks, farmers fields, livestock, etc.)

