Health-Regulated Public Water Supply Guide

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DEFINITIONS

Aquifer: a rock or soil formation that can yield significant amount of groundwater to wells or springs. Aquifers are classified into two main categories: confined and unconfined. Confined aquifers are characterized by an overlying layer of impervious rock or clay that restricts water seepage, while unconfined aquifers are situated within permeable soils that are influenced by atmospheric conditions.

Backflow device: a device that works to prevent backflow of water into a potable water system, thus protecting potable water from potential contamination. Common backflow preventers or devices include air gaps, vacuum breakers, dual check valves, double check valves and reduced pressure valve assemblies.

Bacteria: single-celled microorganisms naturally found in lakes, rivers, and streams. While most bacteria pose no threat to humans, some types commonly found in the intestinal tracts of warm-blooded animals can cause illness and disease.

Challenge testing: a study conducted to determine pathogen removal or reduction efficiency for a membrane module or cartridge filter for a particular organism, particulate or surrogate.

Chlorine residual: the amount of chlorine measured after it has reacted with impurities present in water after a certain period of time.

Cistern: a container usually made of fibreglass, cement or polyethylene plastic used to store potable water.

Confined aquifer: an aquifer in which the groundwater is restricted under pressure by an overlying confining layer.

Cross connection: any physical connection or potential connection or arrangement whereby the public water supply is directly or indirectly connected with any other water supply system, sewer, drain, storage reservoir, plumbing fixture, or other waste or liquid capable of contaminating the public water supply as a result of backflow.

Cryptosporidium**:** microorganisms commonly found in lakes and rivers that can cause gastrointestinal illness with symptoms like diarrhea, nausea, and abdominal cramps. Only one species, *Cryptosporidium parvum*, infects humans. *Cryptosporidium* forms spores or egg-like cells called oocysts, which can survive outside the body for long periods and are highly resistant to chlorine-based disinfectants. *Cryptosporidium* oocysts *are* excreted from the body through the feces of infected humans or animals.

Distribution system: that portion of the public water supply system, including water pipes, storage reservoirs, valves, hydrants, water treatment devices and associated components that are designed or used to convey water for drinking or personal hygiene purposes to a service connection or water access outlets (fixture) located within places identified in subsection 3(1) of *The Health Hazard Regulations* and are not connected to a waterworks or distribution system that another agency regulates.

Escherichia coli (E. coli)**:** a coliform group of bacteria commonly found in the intestines of both humans and animals. While many strains of *E. coli* are not harmful, its presence in drinking water can indicate the presence of fecal matter. This raises concern about the potential presence of harmful bacteria, viruses, and parasites in drinking water.

Free chlorine: the portion of the total chlorine present in water which is not combined with ammonia, nitrogen compounds, or other compounds and is available for the inactivation of harmful or disease-causing organisms. Free chlorine is a measure used to determine the potability of water.

Giardia*:** a type of protozoan parasite potentially found in water and other media. *Giardia* is protected by an outer shell called a cyst that enables it to survive outside the body for extended periods. Additionally, this cyst makes it resistant to chlorine disinfection. ***Giardia lamblia is a parasite that lives in the small intestines of humans and other animals and belongs to the *Giardia* genus.

Groundwater under the Direct Influence of Surface Water (GUDI): any water beneath the surface of the ground (e.g., a well) which may be subject to surface water contamination. GUDI is considered to be surface water.

Inactivation: the killing or rendering of microorganisms incapable of reproducing and thus preventing their ability to cause illness.

Local authority: the Saskatchewan Health Authority (SHA).

Log reduction: the reduction in the concentration of a microorganism such as bacteria, protozoa (e.g., *Cryptosporidium, Giardia lamblia* etc.) and viruses in drinking water by a factor of 10. This is measured in logarithmic units or logs and shows how effective a water treatment system is in removing or inactivating microorganisms. For instance, a 1-log reduction indicates that 90% of microorganisms have been eliminated or inactivated from the initial concentration. Similarly, a 2-log, 3-log, and 4-log reduction corresponds to the removal or inactivation of 99%, 99.9%, and 99.99% of microorganisms removed or inactivated from the initial concentrations, respectively. To ensure safe drinking water, public water supplies must meet specific log reduction requirements depending on the treatment method used and the level of risk the source water poses.

Log reduction credits: the number of credits assigned to a specific treatment process (such as filtration, chlorine disinfection, ultraviolet disinfection, etc.) expressed in log units for the removal or inactivation of a specific microorganism or group of microorganisms. For example, a log reduction of 99.9% will be assigned a 3-log reduction credit.

Multi-barrier approach: a comprehensive system that involves various procedures, processes, and tools to prevent or minimize drinking water contamination from the source to the tap, thereby reducing risks to public health.

National Sanitation Foundation (NSF): an organization accredited by the American National Standards Institute (ANSI) that develops standards for treating and delivering safe drinking water. Their focus is on guidelines for water treatment components to ensure reliability and safety of potable water.

Pathogens: microorganisms such as bacteria, viruses, *Cryptosporidium* and *Giardia lamblia*, which can cause human illness. Pathogens are disease-causing organisms.

Personal hygiene purposes: the usage of water for bathing and showering excluding oral hygiene purposes.

Potable: water that is safe or fit for human consumption.

Premises: places or locations listed in clause 3(1)(a) of *The Health Hazard Regulations*. These include parcels of land together with structures like cottages, trailers, cabins, and stores that have an ownership title, deed, or long-term lease agreement. In this guide, the term "premises" refers to individual properties like long-term leased lots or privately owned campgrounds that offer itinerant accommodations.

Protozoa: a diverse group of microorganisms (usually single-celled) found mainly in freshwater. The majority of protozoa pose no threat to human health. However, certain enteric protozoa can cause diseases and have been linked to outbreaks resulting from drinking water. In Canada, the two primary protozoa of concern are *Giardia* and *Cryptosporidium*.

Public water supply: as per section 3 of *The Health Hazard Regulations*:

3(1) Subject to subsection (2), a supply of water that is intended to be used for drinking or personal hygiene purposes and:

- (a) is provided at any of the following places:
  - (i) a facility as defined in *The Child Care Act, 2014*;
  - (ii) a mental health approved home as defined in *The Mental Health Services Act*;
  - (iii) a facility designated as a hospital or a health centre pursuant to *The Facility Designation Regulations;*
  - (iv) a personal care home as defined in *The Personal Care Homes Act*;
  - (v) a care facility as defined in *The Residential Services Act, 2019*;
  - (vi) a facility designated as a special-care home pursuant to *The Facility Designation Regulations;*
  - (vii) any facility, establishment, business or premises that is required to be licensed by any regulations pursuant to *The Public Health Act, 1994*;
  - (viii) a school or an independent school, as defined in *The Education Act, 1995*;
  - (ix) a recreational area;
  - (x) a special event;
  - (xi) a wayside area;
  - (xii) an itinerant use accommodation as defined in *The Public Accommodation Regulations*;
  - (xiii) a multi-dwelling unit owned by the Saskatchewan Housing Corporation;
- (b) is a well or other supply of water intended for public use that is not connected to a distribution system; or
- (c) is provided from a distribution system that:
  - (i) is connected to at least three but less than 15 service connections; and
  - (ii) receives water directly from a surface water source, ground water source or other raw water source.

(2) Subsection (1) does not apply to:

- (a) commercially bottled water;
- (b) a supply of water that is a waterworks within the meaning of *The Environmental Management and Protection Act, 2010*. As per section 17 of *The Waterworks and Sewage Works Regulations*, these include municipal waterworks, municipal wells connected to a distribution system, pipelines directly connected to a municipal waterworks, regardless of the volume of water supplied or number of service connections, and pipelines not otherwise directly connected to a municipal waterworks or distribution system, serving 15 or more service connections, as well as

other public waterworks with a design flow exceeding 18 cubic meters in any 24-hour period;

(b.1) a supply of water to which section 9.1 applies; (limited-scope water pipeline)

(c) a supply of water to which subsection 10(1) applies; (delivery by bulk tank) or

(d) a supply of water that, for the purposes of section 15 of the Act, is posted as being not potable water.

Recharge: the process by which groundwater is replenished.

Secondary disinfection: a process used to ensure that the disinfection residual is maintained in a distribution system to protect the water from the growth of microorganisms and control biofilm formation.

Service connection: a connection between a distribution system and premises. For example, when determining the number of service connections per section 3(1)(c) of *The Health Hazard Regulations*, the SHA will determine if the distribution system connects to a premises as defined above. Leased sites are considered service connections, whereas itinerant-use campsites are not. Neither are individual facilities (e.g., swimming pools) located within a larger area of land (e.g., campground), provided the same individual or organization owns them.

Source water: water in its natural state before any sort of treatment.

Total chlorine: the remaining chlorine concentration after taking into consideration the water's chlorine demand. The chlorine demand for water is the amount of chlorine that reacts with organic materials and other compounds present in water, making it unavailable for disinfection. However, total chlorine is made up of both combined chlorine and free chlorine.

Total coliforms: a large group (or collection) of related bacteria commonly found in the intestines of humans and animals. Total coliforms may not likely cause illness, but their presence in drinking water may indicate contamination by disease-causing microorganisms.

Turbidity: refers to the level of relative cloudiness or clarity of water and is usually expressed in nephelometric turbidity units (NTU). Water from surface sources like rivers, streams, and lakes generally have higher turbidity levels than groundwater. Some surface water sources exhibit high turbidity levels during periods of high rainfall or snow melt (e.g., spring runoff). The level of turbidity in water can vary from less than 1 NTU to over 1,000 NTU. When the turbidity reaches 5 NTU, the water becomes visibly cloudy, and at 25 NTU, it becomes murky.

Unconfined or semi-confined aquifer: an aquifer in which the groundwater either does not have confining layer between it and the surface (upper boundary is the water table) or is bounded by layers of materials which do not serve as an effective barrier to water migration.

Viruses: microscopic organisms that require a host cell to reproduce. They are host-specific and typically do not infect humans unless they are enteric viruses. Enteric viruses are excreted in feces and some in urine and can contaminate water sources. These viruses can infect humans and animals by reproducing in the gastrointestinal tract.

PURPOSE

The Health Hazard Regulations (the regulations), pursuant to *The Public Health Act 1994,* require owners and operators of public water supplies to provide users with water suitable for drinking or personal hygiene purposes. Poorly constructed and operated public water supplies may constitute a health hazard and pose a risk of severe illness to users.

This guideline is intended to assist owners and operators of public water supplies by providing clear directions and outlining the minimum requirements for new, altered, renovated, and existing water supplies. It will also specify the compliance requirements for public water supplies regulated by the Saskatchewan Health Authority (SHA). The Provincial Drinking Water Quality Standards and Objectives are based on *Health Canada's Guidelines for Canadian Drinking Water Quality*, as updated from time to time, and serve as the foundation for assessing drinking water quality. They cover various aspects such as bacteriological standards, disinfection levels, turbidity, and chemical parameters related to health and toxicity. Each substance in drinking water is assigned either a maximum acceptable concentration (MAC) level or an aesthetic objective (AO). If a substance exceeds a MAC level, posing a risk to human health, it is considered a contaminant. These standards and objectives apply to SHA-regulated public water supplies. While standards (such as MACs) are mandatory, public water supplies should aim to achieve water quality objectives beyond the minimum requirements. AOs are non-mandatory. Furthermore, this guide has been developed to ensure that public water supplies follow the multi-barrier approach set by the Canadian Council of Ministers of the Environment (CCME) and Health Canada. Implementing this approach guarantees that safe drinking water is delivered from the source to the tap and meets all necessary treatment standards and criteria.

This guideline also covers the design of new public water supplies or extensions, replacements as well as operational requirements for SHA-regulated public water supplies. The guide is not intended to be a detailed engineering manual. However, it addresses certain aspects of the design and operations of public water supplies to safeguard the public and protect the environment. Owners and operators of public water supplies should engage qualified professionals when constructing or modifying a system. Designers must comply with good engineering practices and supply supporting evidence where required. The owner or operator of a public water supply is responsible for ensuring the water supplied as drinking water is suitable for human consumption regardless of any approval issued by the SHA.

SCOPE

The regulation of public water supplies in Saskatchewan is a shared responsibility between the Water Security Agency (WSA) and the SHA. The SHA oversees public water supplies as defined in the regulations that are not considered waterworks within the meaning of *The Environmental Management and Protection Act, 2010* and according to *The Waterworks and Sewage Works Regulations.* The division of regulatory responsibility is based on various design considerations including daily design flow rates and the number of service connections.

The Ministry of Environment regulates water in industrial sites, while Indigenous Services Canada (ISC) oversees public water supplies on First Nations lands.

This guideline **applies specifically** to SHA-regulated public water supplies. The following are systems to which this guideline applies:

- a public water supply that supplies water intended to be used for drinking or personal hygiene purposes and is provided at one of the defined places (refer to the definition of public water supply on page 5).
- a well or other supply of water intended for public use that is not connected to a distribution system; or is provided from a distribution system that:
  (a) is connected to at least three but less than 15 service connections; and
  (b) receives water directly from a surface, groundwater, or other raw water sources.

This guideline **does not apply** to a supply of water that is a waterworks within the meaning of *The Environmental Management and Protection Act, 2010*.

This guideline also **does not apply** to water supply systems within individual private homes and commercial and industrial facilities that are not defined as regulated (e.g., work camps).

Note:
To find contact information for the Water Security Agency (WSA) and the Saskatchewan Health Authority (SHA), please visit the websites listed below:
https://www.wsask.ca/about/office-locations/
https://www.saskatchewan.ca/residents/health/public-health/public-health-offices

Regulatory Framework for Public Water Supplies

Owners or operators of public water supplies must obtain written approval from the local authority before establishing, extending, renovating, or altering a public water supply as required by section 5 of the regulations, which states:

- **Approval re public water supplies**
  5(1) No person shall establish, extend, renovate, or alter a public water supply unless the owner or operator has obtained written approval from the local authority.

Section 6 of the regulations outlines the duties that owners and operators of public water supplies must fulfill:

- **Duties of owners and operators of public water supplies**
  6(1) the owner or operator of a public water supply shall:
    (a) ensure that the water is potable at the place where it is delivered for use;
    (b) locate, construct, and operate the public water supply in a manner that will:
      (i) reduce the potential of contamination of the water source; and
      (ii) prevent water contamination within the distribution system, including any place where water is collected, stored, or treated.

Regarding section 8 of the regulations, it is the responsibility of the SHA to ensure the continued safety of public water supplies as follows:

- **Treatment of public water supply**
  (8) If a local authority suspects that a public water supply constitutes a health hazard, the local authority may require the owner or operator to provide ongoing treatment of the kind and to the extent required by the local authority.

Note:
Section 6 of the regulations establishes sampling requirements and frequencies of sampling analysis to which owners or operators of public water supplies must adhere.

1 OVERVIEW

1.1 SOURCE WATER

One of the most critical decisions in establishing a public water supply is choosing a safe water source at a suitable location. Although there may be limited options for source water, there may be opportunities to optimize the available options.

Public water supplies may rely on any, or a combination of, applicable source water types below:

- Surface water – rivers, lakes, and streams.
- Groundwater under the direct influence of surface water (GUDI), such as a shallow well which, may be subject to surface water contamination.
- Groundwater not under the direct influence of surface water (non-GUDI), such as wells accessing groundwater from confined aquifers.
- Other raw water sources.
- Hauled treated water – water obtained from other regulated water systems and stored onsite, e.g., by means of cisterns.

Groundwater in Saskatchewan may require some level of treatment to make it safe for human consumption, as it can be contaminated by both natural and human sources. Surface water supplies, including GUDI, always require treatment due to the increased potential for pathogens. The source water type and quality will dictate the minimum treatment requirements to ensure water is potable at the points of use. For blended supplies, the minimum treatment requirements shall be based on the highest-risk water source. A water source must be assessed to determine if the supply is sufficient to meet the demand.

> ***Note:***
> *Project proponents or owners of public water supplies should contact the WSA to ensure appropriate approvals are received for the source water withdrawals where applicable. This webpage provides an overview of the requirements for obtaining a ground and surface water rights licence and approval for constructing and operating related works:*
> https://www.wsask.ca/permits-approvals/regulatory-information/domestic-purpose-water-use/

1.1.1 Surface Water

Public water supplies that rely on surface water or groundwater under the direct influence of surface water (GUDI) are particularly susceptible to contamination by disease-causing organisms (i.e., pathogens) such as bacteria, viruses, and protozoa. Consumption of water containing these pathogens can cause severe illness or even death. Drinking water supplies must be protected from potential sources of contamination as much as possible, both in the immediate area where water is extracted and throughout the watershed.

Contamination can result from various human activities, including:

- **Agricultural runoff:** Pesticides, fertilizers, and other chemicals used in farming can enter water bodies, leading to contamination.
- **Industrial discharges:** Factories and manufacturing plants often release pollutants into rivers, lakes, and other water bodies, affecting water quality.
- **Urban development:** Construction, sewage systems, and stormwater runoff can introduce harmful substances into water bodies.
- **Waste disposal:** Improper disposal of garbage, hazardous materials, and sewage can contaminate water sources.
- **Deforestation:** Clearing forests disrupts natural water cycles and exposes soil to erosion, leading to sediment runoff.
- **Mining operations:** Mining activities release heavy metals and other pollutants into nearby water bodies.
- **Oil spills:** Oil spills from industries or storage facilities can contaminate water sources.

Additionally, natural factors such as:

- **Animal activities:** Beaver lodges and other wildlife behaviors can impact water quality.
- **Weather events:** Flooding, torrential rainfall, and spring snowmelt can transport contaminants into water bodies.
- **Erosion and landslides:** Soil erosion and landslides contribute sediment and pollutants to rivers and lakes.

1.1.2 Groundwater

Groundwater is extracted by drilling a well or digging a hole (i.e., bored well) to penetrate an aquifer. By using a pump, water can be drawn up for use. Groundwater can travel long distances before reaching a well and, in doing so, can come in contact with minerals, chemicals and other hazardous substances or contaminants. Notably, due to the different layers of sand and rocks that the water will travel through, a natural process of filtration occurs and can, over time, improve the quality of groundwater and aid pathogen removal.

In Saskatchewan, the quality of groundwater varies significantly. Shallow aquifers are more susceptible to contamination from local land use, resulting in nitrate and microbial contamination. Meanwhile, some groundwater sources are connected beneath the ground to nearby surface waters, as in the case of a well drilled close to a river or lake, which may be subject to the risk of pathogenic contamination. This is referred to as groundwater under the direct influence of surface water (GUDI). Deep aquifers tend to have higher levels of total dissolved solids than shallow aquifers.

Despite many groundwater supplies in Saskatchewan not meeting *Canadian* Drinking *Water Quality Guidelines* for specific parameters like total dissolved solids, hardness and levels of manganese, arsenic, uranium, selenium and iron, owners and operators of public water supplies can treat source water to meet a desired level of quality. Regular testing and water quality monitoring are needed to detect any issues and take appropriate measures to ensure safe drinking water.

1.1.2.1 Wells

Groundwater wells can be assessed as low, medium, or high risk based on their potential for containing pathogens. Low-risk wells are considered to be secure; unlikely to be under the influence of surface water and properly constructed. Medium-risk wells may be a secure source of drinking water, while high-risk wells are not considered to be secure sources of drinking water. To determine the risk level of a well, it is important to conduct an assessment (refer to **Appendix A**). This form is utilized by Public Health Inspectors (PHIs) and includes all the required information for a well assessment.

The WSA is responsible for administering the approval process for the construction and operation of wells and the right to use groundwater under *The Water Security Agency Act.* According to *The Ground Water Regulations* under the Act*,* regardless of the use, well drillers are required to register their rigs, follow regulatory requirements for the construction of the well, and submit a water well drillers report to the WSA. Water use (private or public) exceeding 5,000 cubic meters per year requires a Water Rights Licence. The WSA issues permits to Conduct Ground Water Investigations, Water Rights Licences, and Approvals to Construct and Operate Works. Conditions of a Water Rights License may include requirements to install metering and report annual water use.

New wells that are part of a public water supply must be constructed to prevent the entry of surface water, dirt, or other materials in the casing; and not be located in a pit or basement. Well designers should maintain a proper separation distance between the well and any possible sources of contamination. In addition, the reliable yield of the source should be adequate to supply the design's maximum day demand and the intake structure should be able to withdraw from multiple levels of the water source. Intakes must be accessible in all seasons of usage and be suitably anchored.

After construction, new wells need to be disinfected and tested to meet acceptable bacteriological quality requirements before usage for human consumption. For more detailed information on shock chlorination of wells, refer to the document on the Saskatchewan.ca website – Shock Disinfection (High-Level Chlorine Well Disinfection). High-level chlorine disinfection is the preferred option; however, if proper equipment (e.g., a 1360-litre [300-gallon] tank) is not available, then low-level disinfection (see Low-Level Well Disinfection Fact Sheet) may be adequate.

1.1.2.1.1 Well Protection from Contamination

If a well is not adequately maintained, it could be subject to contamination, which can deteriorate the water quality and render it unfit for human consumption. Wells must be protected from potential microbial and chemical contamination sources such as onsite wastewater systems (e.g., septic systems), livestock yards, pesticides, manure/fertilizers, and fuel storage facilities.

For shallow and poorly constructed wells close to surface waters or subject to flooding, well owners will require proper treatment to ensure water is safe for consumption. Protecting the well may not be enough to prevent contamination, and alternative water sources may be necessary.

1.1.2.1.2 Proper Well Construction

Properly constructed wells help to prevent the risk of contamination. The following should be considered during the design and construction of wells:

- Proper casing and seals to prevent contaminants entering from the ground surface;
- Well casing and cap to extend above the ground surface approximately 0.6 – 0.9 m (i.e., 2 – 3 ft.);
- Proper grading around the well head with bentonite clay soil sloped to drain surface water away from the well; and
- Installation of a watertight vermin-proof well cap to prevent the entrance of vermin or bugs into the well.

1.1.2.1.3 Proper Well Siting and Setbacks

The location of a well can significantly impact the water quality and performance. All water wells should be located:

- In a well-drained area (easily accessible for cleaning, repairs, sampling, and treatment) and protected from unauthorized access or vehicular damage.
- Considering any future land use developments for the site. Well installers or owners should ensure that wells are not built within localized depressions or low-lying areas subject to seasonal flooding.
- With the minimum separation distances between wells and the following private sewage works based on the *Saskatchewan Onsite Wastewater Disposal Guide (2018)*:
    - Septic tanks, package sewage treatment plants, or holding tanks should be located no less than 9 m (i.e., 30 ft.) from a water source.
    - Absorption fields, chamber systems, and mounds should be located no less than 15 m (i.e., 50 ft.) from a water source.
    - Open discharge systems and jet-type disposals should be located no less than 45 m (i.e., 150 ft.) from a water source.
    - Private sewage lagoons should be located no less than 90 m (i.e., 300 ft.) from a water source.

1.1.2.1.4 Well Maintenance

Routine maintenance is necessary to ensure the efficient operation of wells and preserve the well's water quality and structural integrity.

Well maintenance should include the following:

- Regular visual inspections to ensure that the vermin-proof well cap is watertight and secure, protecting the well from unauthorized access, vermin, insects, bugs, and debris which can contaminate water quality.
- Backflow devices installed on points of use and other potential contaminant sources and inspected/tested periodically to ensure they are operating correctly.
- Chlorine disinfection of the well, water lines and any equipment placed into the well.
- Shock chlorination to control bacterial growth, which is required:
    - Immediately upon completion of well construction;
    - After major repairs are carried out on wells, pumps, or distribution systems; and,
    - After any contamination event or unsatisfactory bacteriological water quality test.
- Routine shock chlorination (low-level chlorine well disinfection) should be used as semi-annual maintenance for existing wells and is applied as part of the start-up procedure for newly constructed wells.

Note:

- *Operators must inform SHA about any repairs, maintenance, or service disruptions that may affect their public water supply systems. It is recommended that operators have an emergency response/preparedness plan that clearly outlines the required actions to be taken in case of potential incidents.*
- *Low-level chlorination could affect the turbidity of water because of oxidized iron and/or manganese. Therefore, removing oxidized iron and/or manganese particles through pre-treatment methods such as filtration is advisable to minimize the potential adverse effects of low-level chlorination. Another option is to optimize chlorination by adjusting chlorine dosage, contact time, or pH levels. This will help ensure that turbidity is not impacted by chlorination.*
- *Information on the ground water approval process can be found online at https://www.wsask.ca/permits-approvals/regulatory-information/ground-water-approval-process/*
- *For more detailed information on well construction and maintenance, refer to the document "Saskatchewan Guide to Private Well and Water Management," which is available on the Saskatchewan.ca website.*

1.2 Water Treatment Facilities and Pump Houses

Buildings housing water treatment equipment and pumps must be designed to maintain the sanitary quality of the water and to prevent unauthorized entry. Interior finishes shall be durable and easily cleaned. Subsurface pits and other inaccessible installations should be avoided. No pumping station or water treatment plant should be subject to flooding. Provisions should be made for a standby pump and backup power should be considered since power failures often result in distribution system pressure loss. This can allow contaminants in the soil to enter the distribution system.

The floor of any building or room housing water treatment equipment and/or pumps shall be designed to direct drainage to a floor drain or sump. Floor drains must be constructed according to the National Plumbing Code of Canada and connected to a sanitary sewer or approved private sewage works. Piping systems within pumping stations and water treatment facilities shall be designed to avoid cross-connections between potable water and any source of contamination.

Except for small facilities with no treatment or distribution system, all public water supplies should have a water meter installed sufficient to measure the volume of water treated. This is a good practice, even if not required by regulations, as it helps with water conservation by increasing awareness of water usage, monitoring system performance, and detecting leaks or other issues that may lead to water loss. Water treatment facilities should be designed to include sampling points that allow water to be sampled before and after all treatment units. Furthermore, keeping a record book in the pump house to record daily readings of various required parameters is recommended.

Note:
To ensure optimal safety and quality, water treatment facilities should utilize water treatment equipment certified by NSF.

2 CISTERNS

Cisterns are containers usually made of fibreglass, cement or polyethylene plastic used to store potable water. Bulk water haulers should fill cisterns with water delivered from a municipal water supply or an SHA-approved source.

Cisterns are used in public water supplies for multiple purposes. These include:

- Supplementing low-yield wells that are insufficient to meet the water demands of users.
- Providing an alternative water source to address poor water quality that is difficult and costly to treat, such as high levels of sulphur, iron, or arsenic in the source water. Cisterns can also act as an alternative water source when there are no available natural water sources.
- Serving as buffers during emergencies or temporary disruptions in water supply, for instance, when maintenance or repairs are being carried out on a public water supply system.

2.1 CONSTRUCTION REQUIREMENTS FOR CISTERNS

- Cisterns shall be constructed in accordance with the *Canadian Standards Association (CAN)-B126 Series 13 for Water Cisterns*. Cisterns must be constructed from materials that will not be subject to decay, deformation, corrosion, or cause diffusion of any contaminants that will impact the potability or aesthetic characteristics of the water.
- Cisterns are to be watertight and protected from insects and rodents with no significant defects or damage to maintain water quality and enable adequate disinfection and cleaning.
- All components of the cistern (including flanges, gaskets, housing etc.) shall conform to the *NSF/ANSI 61-2016 Drinking Water System Components - Health Effects* or an equivalent system approved by SHA.
- Coatings applied inside a cistern to ensure potable water does not directly come into contact with the interior of the tank shall be certified to the NSF/ANSI 61 standard.
- The top surfaces of cisterns shall be self-draining to prevent water accumulation over the cistern's top.
- All joints, connections or other access points into the cistern must be sealed and watertight.
- Public water supplies using cisterns should install a lock around the access hatch or a fence to prevent unauthorized access.

Note:
Sizing a cistern requires careful consideration. If you oversize a cistern, it can impact the water quality in the cistern and pipes because the chlorine disinfection residual responsible for controlling bacterial growth will gradually dissipate and result in bacterial growth and biofilm development.

2.2 Cistern Installation and Maintenance

- Cisterns should be installed in an area that is easily accessible for the bulk water hauler, allows for adequate maintenance and cleaning purposes, and is a safe distance away from potential contamination sources. Underground cisterns can become contaminated from various sources such as onsite wastewater soil treatment fields, chemical storage areas, and animal pens.
- Depending on the circumstances, cisterns can be installed underground or above ground.
  - Underground cisterns should be located below the frost line (approximately 1.8 m or 6 ft.), or the cistern should be appropriately insulated. Adequate bedding (materials and quantity determined by the manufacturer or supplier) should be provided during placement to support the cistern properly. Care should be taken during placement to limit the potential for groundwater infiltration, hydraulic uplift, and surface water ponding above the underground cistern.
  - Above ground cisterns and their components should also be adequately insulated to prevent freezing. NSF/ANSI 61-certified protective coatings or linings applied to the inside of above ground cisterns and regular inspection of installed protective coatings are essential to protect against bacterial growth. Maintaining residual chlorine levels in above ground cisterns can be challenging, particularly if they are opaque. This is because ultraviolet radiation from the sun quickly degrades chlorine.
- Cisterns should be installed according to manufacturers' specifications.
- Cisterns are to be well maintained, clean and in a good sanitary condition and should be inspected regularly to ensure the integrity of the cisterns, piping, and other components.
- To ensure proper disinfection of water stored in cisterns, a minimum total chlorine residual of 0.5 mg/L must be maintained at all times. Owners and operators of public water supplies will need to use a suitable chlorine test kit to confirm chlorine concentrations. Chlorine concentrations must be tested daily at a minimum.
- Bulk water haulers should be delivering water with sufficient chlorine residual. Periodic addition of chlorine may be necessary to maintain the recommended chlorine residual and prevent bacterial growth.
- Cisterns connected to a distribution system must maintain a free available chlorine residual of at least 0.1 mg/L and 0.5 mg/L total chlorine in the distribution line measured at any point of use.

> ***Note:***
> *Cisterns installed underground should maintain a minimum setback distance of 3m (10ft) from a septic tank as per the requirements of the Saskatchewan Onsite Wastewater Disposal Guide.*

2.3 Cleaning and Disinfection of Cisterns

2.3.1 Cleaning of Cisterns

The cleaning procedure for cisterns is as follows:

- Drain the stored water in the cistern completely. Do NOT use sewage haulers to pump out water from the drinking water cistern.

- Use a pressure washer with mild food-grade detergent to wash and remove all dirt from the interior surfaces of the cistern. Adhere strictly to the manufacturer's recommendations when cleaning the inside of cisterns with protective coatings or linings.
  ***Important**: All cisterns are considered confined spaces which can pose a severe danger to humans and animals due to insufficient oxygen or dangerous concentrations of hazardous gases that could result in death. Only authorized persons adequately trained in confined space entry/procedures and properly equipped with air testing devices, ventilation and rescue equipment should be allowed to perform maintenance on a cistern. Refer to The Occupational Health and Safety Regulations, 2020 on the Saskatchewan.ca webpage for guidelines on confined space entry procedures.*
- Closely examine all seals, surfaces, and the cistern floor for any signs of leaks or cracks.
- Rinse all the inside surfaces of the cistern with potable water to remove the remaining dirt, debris, and any detergent residue.
- Discard all rinse water.
- Follow the procedure for the disinfection of cisterns.

Cisterns should be cleaned:

- The first time it is put into service after installation;
- Immediately after any contamination or suspected contamination incident (e.g., water quality test results are considered unsatisfactory, exposure of filled or empty cistern either through open/unsealed cover, infiltration of floodwater into the cistern, etc.);
- After maintenance or repairs on the cistern due to prolonged periods of inactivity, such as in seasonal campgrounds before the start of the season; and,
- During annual maintenance to remove any sediment buildup at the bottom of the tank.

2.3.2 Disinfection of Cisterns

- Disconnect all water treatment devices from the cistern.
- Commence filling the cistern with potable water.
- Add chlorine to the cistern to achieve 50 mg/L chlorine solution strength.
  - If using unscented household bleach (5% chlorine), add 1 L of unscented household bleach to every 1000 L (220 imp gal.) of water the cistern can hold. Add the bleach as you fill-up the cistern so that it mixes well with the water.
  - If using industrial-strength chlorine (12%), add 420 mL of industrial strength sodium hypochlorite for every 1000 L (220 imp gal.) of water the cistern can hold. Also, add the bleach as you fill-up the cistern so that it mixes well with the water.
- Continue adding potable water to the cistern until it is full.
- Run every tap connected to the water distribution system until you can smell chlorine, and then close the tap.
- Leave the chlorinated water in the cistern and the distribution system for at least 6 hours. Water MUST NOT BE CONSUMED during this process, and provision for alternative drinking water should be made available.
- After 6 hours, drain and properly dispose of the chlorinated water from the cistern. Flush the cistern and distribution system with potable water.
- Fill the cistern with potable water.
- Test the water in the cistern and the distribution system (if applicable) for bacteria. If there are no bacteria in the water sample, then the water is considered fit for drinking.

Note:

- *Collecting water samples from the point of use for bacteriological analysis is recommended.*
- *Chlorinated water must not be discharged into natural waterways.*
- *An effective method for public water supply operators to discharge chlorinated water is to store it in a holding tank until the residual chlorine decays before releasing it into a sanitary stormwater sewer.*

3 BULK WATER HAULING

Water shortages due to unforeseen circumstances, including power/pump failures or an unsatisfactory water quality test result, may require a short-term alternate potable water supply for users. Bulk water hauling may be an acceptable temporary solution for water shortages; however, it should only be considered a short-term solution. In remote locations with inconsistent power supply or where access to a communal water supply system is not practicable, bulk water hauling can be deemed a longer-term solution to water shortage issues. Bulk water hauling could contaminate the public water supply when not carried out under normal sanitary conditions.

Bulk water haulers operating in Saskatchewan must comply with the provisions in section 10 of the regulations. Bulk water hauling vehicles and associated equipment must be designed, operated, and maintained in a sanitary manner to ensure that supplied water is potable at the point of delivery. Water haulers may also be subject to specific water sampling and reporting requirements at the request of the SHA.

3.1 GENERAL REQUIREMENTS

Potable bulk water must be obtained from an approved source, such as:

- a municipal water supply; and,
- a water source approved by the SHA.

3.1.1 Bulk Water Hauling Tank & Equipment Requirements

- Bulk water hauling tank
  - Bulk tanks for hauling potable water must meet *NSF/ANSI Standard 61 or equivalent standards for food or water-grade containers*.
  - The interior of bulk water tanks should be made of or coated with food-grade contact materials resistant to corrosion, such as stainless steel, fibreglass plastic, food-grade epoxy liner etc.
  - Water tank hatches and other openings (apart from fittings for water entry/discharge) should be completely covered and sealed with tightly fitted coverings, permanently mounted food-grade gaskets, or screw/clamp fastenings.
  - The tank should be vented downwards to allow air to replace discarded water.
  - A drain in the tank bottom should be provided for the complete discharge of water during sanitation procedures.
  - Bulk water tanks used for hauling potable water should display clearly visible labels indicating water use for drinking purposes only.
- Equipment Requirements
  - Hoses, nozzles, water pumps and other equipment used in the transporting and delivering potable water should be made of food-grade materials.
  - Hoses and nozzles, when not in use, should be fitted with threaded or clamped caps to prevent them from contamination. A tight, clean storage compartment can be used as a substitute for those caps, provided the hoses are always stored within the compartment.

3.2 Operational Requirements

Owners/operators of bulk water hauling vehicles must ensure that water tanks and equipment are regularly cleaned and disinfected. They must ensure that appropriate and adequate measures are implemented to protect the water and its source, bulk water tank, and all other equipment from contamination during filling, storage, transportation, and delivery.

- Bulk water hauling tanks and equipment must be disinfected (as described in the document "*Disinfection Guideline for Bulk Water Haulers*" available at Saskatchewan.ca website.
- Appropriate backflow prevention devices shall be in place at all times when the bulk water vehicle is attached to the water supply system during refilling, thereby protecting the water supply system during tank refilling.
- Maintain an activity logbook in the water hauling vehicle and make it available to a Public Health Inspector (PHI) upon request. The logbook records shall include the date, time and location of each water fill, water delivery, the volume of water delivered, equipment cleaning and disinfection, bacteriological test results and comments regarding any issues with the water supply or vehicle and equipment.
- Chlorine should be added to the water in the tank in an amount sufficient to achieve 1.0 mg/L of total chlorine. Thus, this ensures adequate water disinfection in the tank to achieve at least 0.1 mg/L of free chlorine residual at the point of delivery. Each water-hauling vehicle shall have a suitable chlorine test kit for accurately measuring chlorine residual to within 0.01 mg/L tolerance.
- Conduct daily visual inspections to ensure access/fill hatch seals are in good condition and provide proper sealing.
- Submit water samples at intervals prescribed by the SHA PHIs.
- Allow regular inspections by SHA PHIs. PHIs may inspect facilities, vehicles, and equipment used by the bulk water haulers and their records to ensure compliance with guideline requirements.
- Establish and implement a written procedure for emergency disinfection of equipment in the event of contamination and make it available to a PHI upon request.

3.3 Procedure for Emergency Disinfection of Bulk Water Truck Equipment

If bulk water truck equipment (such as hoses, nozzles, etc.) gets contaminated due to falling on the ground, it can be disinfected on-site in an emergency. This can help save significant time compared to travelling back to the base station for equipment disinfection.

Below is an on-site procedure for emergency disinfection of bulk water truck equipment:

1. Run the potable water from the bulk water hauling tank through the contaminated equipment to remove visible dirt.
2. Fill a plastic container (at least 8 litres) with potable water from the hauling water tank and rinse contaminated equipment thoroughly.
3. Discard water and thoroughly rinse the plastic container with potable water from the bulk water hauling tank.
4. Fill up a plastic container with potable water from the bulk water hauling tank to completely immerse the contaminated equipment.
5. Add chlorine bleach to obtain a 200 mg/L solution – approximately 5 ml (1 tsp) per litre of water.

6. Completely immerse the contaminated equipment and allow for a contact time of at least 2 minutes, and then remove the equipment which is now ready to be used.

Note:
Appropriate personal protective equipment must be worn when handling chlorine bleach. When handling and adding chlorine, follow the manufacturer's safety guidelines.

4 APPROVAL FOR NEW PUBLIC WATER SUPPLIES

4.1 SUBMISSION REQUIREMENTS

As per subsection 5(1) of the regulations, no person shall establish, extend, renovate, or alter a public water supply unless they have submitted a complete application and received approval from the local authority. Contact your local SHA PHI for more information about obtaining the necessary approval for your water supply.

No public water supply shall be put into operation until the local authority has approved the water quality, water treatment and construction of the system. Unless otherwise required by the local authority, a complete application to establish, extend, renovate, or alter a public water supply shall contain the following information:

1. Administrative information
   (a) contact information and locations;
   (b) general description of the public water supply system;
2. General information on the public water supply system
   (a) a plan/map to show where the system is located;
   (b) a brief description of the system's future demands and design flow rates;
3. New water source technical data
   (a) information that indicates the source water quantity is sufficient (as applicable);
      (i) ground water: well log, pump test, hydrogeological report; or
      (ii) surface water: water license;
   (b) results of water quality tests, as determined by SHA;
   (c) location of any nearby utilities, including sanitary sewers, storm sewers, and onsite sewage treatment and disposal systems;
4. New public water supplies infrastructure technical data
   (a) proposed treatment/treatment unit and technical data (e.g., sizes, maximum flow rates, volumes etc.) for each treatment unit proposed if applicable;
   (b) a description of the operations of the equipment;
   (c) technical information from equipment suppliers;
   (d) a description of the waste streams discharged from the water treatment plant, if any, and possible impact;
5. Water piping and storage system technical data
   (a) information on water supply, storage, transmission, pumping and distribution works;
6. Water supply system diagrams
   (a) water supply system diagrams to scale or indicate length, sizes etc.
   (b) additional sheets may be required and attached if necessary.
7. Cleaning and maintenance schedule
   (a) treatment components;
   (b) distribution lines; and
   (c) water treatment building.

The information shall be submitted on an acceptable version of the application form which can be obtained from the public health inspection offices - https://www.saskatchewan.ca/residents/health/public-health/public-health-inspectors. Additionally, you can refer to **Appendix B** for the general format for the application form for approval of public water supply systems. **All applications submitted by a professional engineer must be signed and sealed**.

4.2 WATER QUALITY

Public water supply owners or operators shall submit water quality test results from an accredited laboratory to the local authority for analysis, **and approval for system use will be based on meeting acceptable results** for:

(i) bacteria (Total Coliform and/or E. coli and/or Fecal coliform);

(ii) general chemicals (Bicarbonate, calcium, carbonate, chloride, conductivity, fluoride, iron, magnesium, manganese, nitrate, pH, potassium, sodium, sulphate, total alkalinity, total hardness, TDS, turbidity); and,

(iii) health and toxicity chemicals (aluminum, arsenic, barium, boron, cadmium, chromium, copper, lead, selenium, uranium, and zinc).

The local authority may require public water supply operators to conduct additional water quality testing, such as testing for UV transmittance or the presence of pesticides, herbicides, and biocides, depending on the circumstance.

When determining the suitability of water quality for health risks, the local authority will consider the most current edition of the *Health Canada's Guidelines for Canadian Drinking Water Quality* and the *Saskatchewan Drinking Water Quality Standards and Objectives* to ensure that the finished water quality parameters from the public water supplies meet the acceptable level of risk contained within the guideline documents. The Health Canada's *Guidelines for Canadian Drinking Water Quality* sets a maximum allowable concentration (MAC), which is typically a health-based numerical water quality objective. This is used by the local authority in conjunction with the *Saskatchewan Drinking Water Quality Standards and Objectives* to evaluate the risk level of drinking water from public water supplies with regard to chemical constituents while considering other factors. The finished water quality from the water supply systems shall be adequate for the intended purposes.

4.3 TRANSMISSION AND DISTRIBUTION

All distribution lines should be sized based on hydraulic requirements for future demands and pressure, considering whether the distribution system provides fire protection. The system should provide at least 140 kPa (20 psi) at ground level at all points in the water distribution system. Watermains should typically be 15 cm (6 inches) in diameter or greater where fire protection is provided. Water service lines are water lines that connect to distribution mains and are available in various sizes, such as ¾, 1, 1 ½, 2, 3, 4, 6 inches etc. These lines are carefully assessed for their impact on the distribution system and shall not exceed the size of the mains. Pipe materials shall meet the requirements of a relevant standard (NSF 61, AWWA C906).

Watermain valves should be provided to isolate reasonably sized sections of the system for repair or maintenance. Where applicable, the valves should be placed on property lines to make them easier to locate.

Watermains should be looped wherever economically feasible to minimize contamination risks and service disruption during the repair of breaks or when flushing. However, if dead ends or low points are present, flush-outs or hydrants must be provided for flushing. In addition, measures must be taken to prevent freezing watermains and services if the system is intended for year-round use.

4.3.1 Backflow Prevention Devices

Persons responsible for designing and building public water systems must take steps to prevent potential cross-connections. Cross-connection of watermains with any non-potable water sources is not recommended.

Backflow prevention devices may be required under the provisions of the National Plumbing Code of Canada. When required to install backflow prevention devices, public water supply system operators shall ensure that the latest CSA standard (CSA-B64.10) is followed and complies with the National Plumbing Code of Canada and Saskatchewan's *Plumbing Code Regulations* to ensure safety of the public water systems. Five plumbing authorities in Saskatchewan regulate plumbing in different areas. These authorities include the cities of Lloydminster, Regina, and Saskatoon, as well as the Global Transportation Hub (GTH). For the rest of the province, plumbing regulations are overseen by the Technical Safety Authority of Saskatchewan (TSASK).

If you are an owner or operator of a public water supply, it is your responsibility to purchase, install, and test backflow prevention devices and assemblies. The plumbing authority responsible for your area will inspect to ensure that any required backflow prevention or cross-control device, as per the National Plumbing Code of Canada, has been installed correctly. Operators are responsible for checking with their local bylaw offices and water utility regarding additional requirements for installing backflow prevention when performing plumbing works that may exceed plumbing code requirements.

4.4 Operations and Infrastructure Requirements

Manuals detailing the installation and operation of all devices should be provided to the operator and made available to the SHA upon their request. The operator is responsible for ensuring that all treatment equipment is operated and maintained as the manufacturer recommends.

Public water supply owners and installers are responsible for ensuring that all new and repaired tanks, water mains, wells, etc., are disinfected (and pressure tested when applicable) before use. This should be done according to the AWWA Standards, considered best practice, or any other equivalent methods approved by the local authority.

Operators and owners must inform the local authority of any maintenance or repairs affecting water service delivery. Additionally, they should submit an emergency response plan for their water system to the local authority for review and approval.

4.5 COORDINATION OF REGULATORS

If the local authority receives an application for a public water system that is correctly regulated under the regulations but is likely to be captured under *The Waterworks and Sewage Works Regulations* and eventually be turned over to the WSA, the local authority will:

- advise the designer or owner at the application stage that if the system expands, it may be regulated by the WSA, and then the owner will have to comply with WSA's regulatory requirements;
- provide WSA contact details to the designer or owner to obtain their requirements. This will ensure that they are aware of changes in regulatory requirements if the system should expand in the future; and,
- continue to work closely with the local WSA Environment Officer so that both agencies are aware of all projects in the area in case future regulatory responsibility for them needs to change.

5 Treatment Standard for Existing Public Water Supply

Unless otherwise approved by the local authority, the minimum treatment for an existing public water supply shall be:

5.1 Groundwater Supply

- No treatment for a groundwater supply at low risk of pathogens that is not connected to a water distribution system, is properly constructed (unlikely under the direct influence of surface water, non-GUDI) and has a history of acceptable water quality to the local authority.
- Chlorination for a groundwater supply at risk of pathogens that is not connected to a water distribution system but is of poor construction (likely under the direct influence of surface water, GUDI) or has a history of unacceptable water quality.
- Chlorination for a ground water supply at risk of pathogens that is connected to a water distribution system.

5.2 Surface Water Supply

- Chlorination and filtration of a type capable of 3-log reduction for both *Cryptosporidium* oocysts and *Giardia* cysts for a surface water supply.
- Filtration of a type that will prevent water turbidity levels from each filter exceeding 1 NTU (Nephelometric Turbidity Units).

Note:

- *Treatment objectives for E. coli, fecal coliform, and total coliform can be easily achieved with disinfection processes like chlorination or UV light and can also be reduced through filtration.*

6 Treatment Standard for New Public Water Supply

Public water supply project owners must consult SHA before construction to ensure that the level of treatment is considered appropriate. The level of treatment to which any raw water source is subjected depends on the source water type, surface or groundwater supply and the water system design (e.g., distribution). Treatment requirements reduce the presence of disease-causing organisms (pathogens like bacteria, protozoa, viruses etc.) and associated health risks to an acceptable or tolerable level and shall apply to all new, failed, significantly altered, or high-risk (as determined by SHA) public water supplies.

The raw water quality and its variability, the necessary treatment objectives (both health-related and aesthetic), costs, operational requirements and other factors need to be carefully considered. The minimum treatment for a new public water supply intended to be used for drinking water shall comply with the following requirements based on the *Guidelines for Canadian Drinking Water Quality*:

6.1 Groundwater Supply

- If a groundwater supply has a low risk of containing pathogens, is not connected to a water distribution system, is unlikely under the direct influence of surface water (non-GUDI), is properly constructed, and has a history of acceptable water quality that satisfies the local authority, then no treatment is necessary.
- Disinfection and filtration are required if turbidity exceeds 1 NTU (Nephelometric Turbidity Units) for a groundwater supply at risk of pathogens that is not connected to a water distribution system but is of poor construction and likely under the direct influence of surface water (GUDI). The minimum treatment targets are 3-log (99.9%) reductions for *Cryptosporidium* oocysts and 3-log (99.9%) reductions for *Giardia* cysts, and 4-log (99.99%) virus inactivation.
- Disinfection capable of 4-log inactivation of viruses and filtration is required if turbidity exceeds 1 NTU, for groundwater at risk of pathogens with a history of unacceptable bacteriological water quality.

Note:

- *Pre-filtration with an absolute 1µm filter or less (such as NSF/ANSI 53 or 58 certified for cyst removal or reduction) in combination with free chlorine disinfection can achieve the minimum log reduction targets of 3-log reduction of Cryptosporidium & Giardia and 4-log reduction of viruses.*
- *Public water supplies determined to be at risk of being potentially GUDI shall provide treatment equivalent to that required if the source were surface water.*

6.2 Surface Water Supply

- Treatment:
  - Disinfection and filtration of a type capable of 3-log reductions for *Cryptosporidium* oocysts and 3-log reductions for *Giardia* cysts, includes;
  - Disinfection capable of producing 4-log virus inactivation, and;

- Filtration of a type that will prevent water turbidity levels from each filter from exceeding 1 NTU (Nephelometric Turbidity Units), OR
- Health Canada's filtration exclusion criteria.

Filtration of a surface water source or GUDI *may not be necessary* if all of the following conditions are met:
i) Overall inactivation is met using a minimum of two disinfectants:
- ultraviolet irradiation or ozone to inactivate cysts/oocysts;
- chlorine (free chlorine) to inactivate viruses; and,
- Chlorine or chloramines to maintain a residual in the distribution system.

Disinfection should reliably achieve at least a 99% (2-log) reduction of *Cryptosporidium* oocysts, a 99.9% (3-log) reduction of *Giardia lamblia* cysts and a 99.99% (4-log) reduction of viruses. If mean source water cyst/oocyst levels are greater than 10/1000 L, more than 99% (2-log) reduction of *Cryptosporidium* oocysts and 99.9% (3-log) reduction of *Giardia lamblia* cysts should be achieved.

Background levels for *Giardia lamblia* cysts and *Cryptosporidium* oocysts in the source water should be established by monitoring as described in the most recent *Guidelines for Canadian Drinking Water Quality: Guideline Technical Document for Enteric Protozoa (Giardia and Cryptosporidium)* or more frequently during periods of expected highest levels of rainfall or spring runoffs.

ii) Prior to the point where the disinfectant is applied, the number of *E. coli* bacteria in the source water does not exceed 20/100 mL (or, if *E. coli* data are not available, the number of total coliform bacteria does not exceed 100/100 mL) in at least 90% of the weekly samples from the previous 6 months.

iii) Average daily source water turbidity levels measured at equal intervals (at least every 4 hours), immediately prior to where the disinfectant is applied, are around 1.0 NTU (Nephelometric Turbidity Units) but do not exceed 5.0 NTU (Nephelometric Turbidity Units) for more than 2 days in a 12-month period. Source water turbidity also does not show evidence of protecting microbiological contaminants.

Below is a summary of the minimum treatment options required to ensure the safety and quality of drinking water in public water supply systems.

Table 1: Summary of Minimum Treatment Options for Health-Regulated Public Water Supply Systems

Source | Usage	Non-Potable				Oral Consumption			
Quality Concern?	None	Bacteria[1]	Protozoa[2]	Chemical[3]	None	Bacteria[1]	Protozoa[2]	Chemical[3]
Surface Water[7] (or GUDI)	NR[4]	NR[4]	NR[4]	NR[4]	T2, D1[6]	T2, D2	T3, D2	R1
Ground Water (or non-GUDI)	NR[4]	NR[4]	NR[4]	NR[4]	NT	T2, D2	GUDI[8]	R1
Distribution System	NR[4]	NR[4]	NR[4]	NR[4]	D3	D3	D3	NT
Treatment								
D1	Chlorination or other disinfection methods							
D2	4-log inactivation of viruses							
D3	Secondary disinfection							
T1	Filtration for aesthetic purposes should be considered in cases where turbidity is high.							
T2	Processes (e.g., Filtration) effective for maintaining a turbidity less than 1.0 NTU. In some cases (i.e., with some groundwater) the water may not require treatment to maintain the turbidity below 1.0 NTU							
T3[5]	3-log *Cryptosporidium*, 3-log *Giardia*							
R1	Treatment effective at lowering the level of chemical to below the acceptable level as determined through risk assessment							
NR/NT	No treatment requirements							
Notes								
* All significant distribution systems require secondary disinfection. Primary and secondary disinfection are often completely separate treatment processes and provide different outcomes. The former is intended to provide disinfection before the water is delivered to the first consumer and the latter ensures maintenance of a disinfectant residual throughout the distribution system.								
* In all instances, the local authority (SHA) would evaluate whether a higher level of treatment is needed for the system.								
* When more than one treatment option results from the table, the highest level should be selected. E.g., Groundwater where both bacteria and protozoa are suspected and the water will be used for human consumption would require T2, D2. In addition, the requirements are additive. E.g., Oral consumption of surface water from a distribution system where protozoa and chemicals are present would be T3, D2, R1, and D3.								
1	Bacterial concerns are identified via bacteriological testing or the presence of poor infrastructure. Bacterial indicators can also be used to indicate the presence of viruses.							
2	Protozoa concerns are identified by a wellhead or watershed assessment based on the discretion of the local authority. In most cases it is safe to assume that protozoa are present in surface water and high risk potentially GUDI wells.							
3	Chemical concerns are identified by testing for health and toxicity testing, which may be required by the local authority. This category encompasses all chemical-related health concerns (e.g., arsenic, selenium, lead, etc.)							
4	When a water system is posted as being non-potable no requirements can be placed on its quality, operations, etc.							
5	Raw water monitoring (E. *Coli*) of 1/month for 24 months or 2/month for 12 months can be used to determine if additional treatment is required. See Long Term 2 Enhanced Surface Water Treatment Rule: A quick reference guide for schedule 4 systems. If the E. *Coli* limit is exceeded, Cryptosporidium testing is required for 12 to 24 months. If any *Cryptosporidium* is discovered, up to 5.5 log inactivation of *Cryptosporidium* is necessary.							
6	Situation is highly unlikely to occur. Significant information should be collected and analyzed prior to believing that this is the case.							
7	Generally, surface water can be assumed to contain, bacteria, viruses, and protozoa.							
8	Groundwater that falls in this category would be considered under the direct influence of surface water and surface water treatment requirements should apply for new systems.							

Note:

- ***Owners of public water systems are advised to seek professional design assistance for meeting complex water supply systems requirements.***
- *Treatment objectives are achieved using a multi-barrier approach of at least two treatment processes.*
- *Bacteriological standards (i.e., for groundwater and surface water) include:*
    - *Total coliform levels of* ***zero organisms per 100 mL (0/100 mL)****; and,*
    - *E. coli levels of* ***zero organisms per 100 mL (0/100 mL)****.*
- *It is recommended that filtration be carried out before disinfection to improve the effectiveness of disinfection and reduce disinfection byproducts.*
- *Consideration should also be given to the disinfection of groundwater supplies capable of 4-log inactivation of viruses during the construction or renovation of existing works for sources vulnerable to contamination by viruses (such as enteric viruses, which have been detected even in well-secured aquifers).*
- *4-log virus inactivation credit can be achieved through:*
    - *filtration (pre-treatment as recommended by ultraviolet equipment manufacturers) and NSF/ANSI 55 Class A Ultraviolet Water Treatment Systems;*
    - *chlorine disinfection system;*
    - *equivalent treatment system approved by the local health authority.*

6.3 Distribution System

If a distribution system is in place, it is essential to implement secondary disinfection to maintain a minimum free chlorine disinfection residual level of 0.1 mg/L throughout the distribution lines. This will prevent microbial growth and decrease biofilm formation as the water flows through the system.

A target free chlorine residual of 0.3 - 0.5 mg/L should be maintained at the end of the distribution system to ensure that fluctuations in the system never result in free chlorine residuals below 0.1 mg/L. Secondary disinfection may not be needed if the operator can prove to the local authority that multiple water samples from representative locations within the water supply system consistently meet acceptable quality standards.

7 Design Criteria for Typical Water Treatment Units

It is important to consult with a licensed professional engineer or qualified person to identify the appropriate treatment technologies for your public water supply. The following information describes the usage of typical water treatment units. Where the design criteria are given, these may be used as typical values and designers are responsible to ensure that the proposed system will function as desired.

- Filtration:
    - Slow Sand Filtration: Filtration rate between 0.04 to 0.42 m/h (0.01 to 0.14 gpm/ft^2).
    - Rapid Sand (Gravity or Pressure Filtration): Filtration rate between 5 to 12.5 m/h (1.7 to 4.2 gpm/ft^2) with a backwash rate of between 37 and 56 m/h (12-19 gpm/ft^2).
    - Membrane Filtration: A professional engineer must design larger public water supplies. Smaller Point-of-Use (POU) or Point-of-Entry (POE) units shall be certified to an appropriate ANSI/NSF standard (e.g., standard 58 establishes minimum requirements for the certification of POU reverse osmosis filter systems)
    - Cartridge Filtration Systems:
        - ✓ Should be designed to manufacturer's specifications.
        - ✓ Should be certified to ANSI/NSF standard 53 for health-related contaminant reduction such as lead, cysts, volatile organic compounds (VOC's) etc.
        - ✓ Should include more than one cartridge and be graded to a final cartridge that is 1 micron (µm) absolute which removes 99.9% microbes such as *Cryptosporidium* and *Giardia*.
    - Filtration Media:
        - ✓ Manganese Greensand (used for removing iron, manganese, hydrogen sulphide, arsenic etc.): Requires continuous or periodic application of potassium permanganate for the regeneration of greensand.
        - ✓ Anthracite Coal: Typical filter media used for turbidity and suspended solids removal in water, commonly used in combination with filter sand. (Important: does not remove chlorine, taste & odour like activated carbon).
        - ✓ Filter Sand (a variety of types/sizes is available with silica sand commonly used): Typical filter media used for removing suspended particles in water.
        - ✓ Garnet: Typical filter media used for removing fine particulates in water.
- Granular Activated Carbon Contactors:
    - Typical design based on 5 to 25 minutes empty bed contact time (EBCT).
    - Should be located near the end of treatment but before chlorination.
    - May be used at filtration rate of 5 to 12.5 m/h (1.7 to 4.2 gpm/ft^2).
- Chlorine Disinfection for Virus Inactivation:
    - Unless your water supply system is required to disinfect and meet a chlorine contact time, a minimum contact time (T) (T equals storage volume divided by peak hourly flow), and minimum level of free chlorine residual (C) are required to produce a CT (product of C and T) of 30 min. mg/L capable of adequately inactivating viruses and bacteria.

***Important**: It is highly recommended to hire a professional engineer to submit an application for a public water supply that requires meeting a chlorine disinfection contact time.*

7.1 Log Reduction Objectives for Various Source Water Types

Different treatment technologies are available for achieving the potable drinking water requirements for public water supplies. The issuing official assigns these technologies log reduction credits for *Cryptosporidium*, *Giardia lamblia* and viruses. The log reduction credits assigned are based on fully operational treatment processes. The recommended log reduction credit criteria assigned are specific to each treatment technology, including the design, operations, and monitoring criteria essential for the treatment performance.

Below is the table for the recommended log reduction objectives based on the various types of source water:

Table 2: Summary of Recommended Log Reduction Objectives for various Source Water

Source Water	***Cryptosporidium* Oocysts**	***Giardia Lamblia* Cysts**	**Viruses**
Groundwater – properly constructed well at low risk of pathogens (unlikely under the influence of surface waters, i.e., non-GUDI)	0	0	0
Groundwater – poorly constructed well at risk of pathogens (GUDI)	3.0 Log	3.0 Log	4.0 Log
Surface Water	3.0 Log	3.0 Log	4.0 Log

System designers can ensure that public water supplies meet the necessary standards for removing pathogens by adding up log reduction credits for each treatment technology used in a treatment train. They can then compare this total to the recommended minimum log reduction for the specific source water type and pathogen listed in the summary table.

Depending on the unique conditions of the water source and identified risks, designers may need to increase the level of treatment to achieve higher levels of pathogen log reduction.

7.2 Log Reduction Credits for Filtration and Disinfection Systems

7.2.1 Pathogen Log Reduction Credits for Filtration

Filtration systems remove particulate matter from water through porous or non-porous media and should be designed and operated effectively to reduce turbidity levels as low as reasonably achievable. The log reduction credits for filtration systems are based on the manufacturer's claims, testing and validation of various filtration technologies, and continuous use in a treatment train.

Turbidity objectives are also specified in the assigned log reduction credit criteria for the different filtration technologies. The Guidelines for Canadian Drinking Water Quality: Guideline Technical Document for Turbidity guides the filtration technologies, performances, and log reduction credits. Tables 3 and 4 below outline the maximum recommended log reduction credits assigned to different filtration technologies that meet the design and operational criteria and the effluent turbidity objectives. The treatment technologies in table 3 can achieve varying degrees of *Cryptosporidium* and *Giardia* inactivation or removals when appropriately operated as follows:

Table 3: Log Reduction Credits for Different Filtration Technologies

Technology	*Cryptosporidium* Credit	*Giardia* Credit[c]	Virus Credit
Conventional Filtration[a]	3.0 Log	3.0 Log	2.0 Log
Direct Filtration[a]	2.5 Log	2.5 Log	1.0 Log
Slow Sand Filtration[a]	3.0 Log	3.0 Log	2.0 Log
Diatomaceous earth Filtration[a]	3.0 Log	3.0 Log	1.0 Log
Cartridge Filtration (1µm absolute stage, certified to NSF Standard 53)	Removal efficiency demonstrated through challenge testing[d] or through NSF Standard 53 products certified for cyst reduction claims for 2-Log maximum credit and 2.5-Log when filters are used in series.	Removal efficiency demonstrated through challenge testing[d] or through NSF Standard 53 products certified for cyst reduction claims for 2-Log maximum credit and 2.5-Log when filters are used in series.	No credit
Microfiltration	Removal efficiency demonstrated through challenge testing[d]	Removal efficiency demonstrated through challenge testing[d]	No credit
Ultrafiltration, Nanofiltration, and Reverse osmosis	Removal efficiency demonstrated through challenge testing[d]	Removal efficiency demonstrated through challenge testing[d]	Removal efficiency is demonstrated through challenge testing[d]

a) Conventional/direct/slow sand/diatomaceous earth filtration should be followed by free chlorination to obtain additional virus credit.
b) Micro- and ultrafiltration should be followed by free chlorination for the inactivation of viruses.
c) Depending on (oo)cyst levels in source water, additional treatment is required using UV light, ozone, chlorine, or chlorine dioxide.
d) Certification by ANSI or NSF for treatment objectives can be used as a surrogate to determine this.

<u>Note:</u>

- *The technology log removal credits are based on optimized equipment. Optimized equipment performs adequate turbidity removal, which has been related to filter effluent turbidity. The credits discussed above are only valid if the following turbidity levels in the below table are achieved.*

Table 4: Turbidity Requirements for Filtration

Technology	Turbidity requirement
Conventional Filtration (turbidity after each filter ≤0.3 NTU)	≤ **0.3 NTU** in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 1.0 NTU at any time.
Direct Filtration (turbidity after each filter ≤0.3 NTU)	≤ **0.3 NTU** in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 1.0 NTU at any time.
Slow Sand or Diatomaceous earth filtration (turbidity after each filter ≤ 1.0 NTU)	≤ **1.0 NTU** in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 3.0 NTU at any time.
Microfiltration, Ultrafiltration, Nanofiltration, Cartridge filtration and Reverse osmosis (turbidity after each filter ≤ 0.1 NTU)	Less than or equal to **0.1 NTU** in at least 99% of the measurements made, or at least 99% of the time each calendar month, and shall not exceed 0.3 NTU at any time. If membrane filtration (**membrane filtration unit** or **an individual filter cartridge**) is the sole treatment technology employed, 99% of turbidity measurements per filter operation period or per month is recommended and shall not exceed 0.1 NTU at any time. Additionally, some form of virus inactivation should follow the filtration process.

Note:

- *Conventional filtration is defined as a treatment train containing the following optimized and functioning processes: coagulation-flocculation-sedimentation-filtration.*
- *Direct filtration is defined as a treatment train containing the following optimized and functioning processes: coagulation-flocculation-filtration.*
- *Cartridge filters certified to remove cysts can be assigned a maximum of 2-log credit for Giardia and Cryptosporidium removal. Cartridge filters that each are certified to remove cysts and used in series receive a maximum of 2.5-log credits for Giardia and Cryptosporidium removal for the complete cartridge treatment train. According to the EPA's Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), individual bag or cartridge filters can receive up to a 2.0-log credit for Cryptosporidium treatment, while filters operated in series can receive up to a 2.5-log credit.*
- *The cartridge filtration process is specifically tested and confirmed by an independent agency for at least 2.5-log inactivation of Cryptosporidium oocysts or surrogate particles conforming to ANSI/NSF Standard 53 criteria for low-flow systems. Cartridge filters can handle higher source water turbidity if additional pre-treatment is provided.*

7.3 CHLORINE DISINFECTION

Free residual chlorination is the most commonly practiced method of disinfection. Sufficient disinfection of a water supply requires a free chlorine residual that can reduce or inactivate microorganisms over time. This relationship can be described using the concept of CT value, which stands for the product of the free chlorine concentration (C) in mg/L and the time (T) in minutes. A chlorine CT value of 30 min. mg/L is typically deemed adequate. More detailed information on CT value can be found in the section below.

Some "protozoa" microorganisms like *Giardia lamblia* or *Cryptosporidium parvum* require higher CT values for disinfection. These organisms are common in surface water and can be present in GUDI wells. Water characteristics like pH, ammonia, presence of organic compounds, temperature, bacteriological quality, and other factors will be required to accurately determine the CT value. Assistance from a water treatment professional may be needed. As the pH levels increase, the effectiveness of chlorine in disinfection decreases. This means that a higher CT value is needed to achieve sufficient disinfection. Storage tanks that allow water to flow in and out of the tank often do not provide the necessary contact time for disinfection.

The capacity of chlorination equipment must maintain adequate chlorine residuals when maximum flow rates coincide with anticipated maximum chlorine demands. The equipment must also operate accurately over the entire anticipated flow rate. When using chlorine gas, it is essential for operators to adhere to all occupational health and safety requirements. Consult with Saskatchewan Occupational Health and Safety through the Saskatchewan.ca webpage: https://www.saskatchewan.ca/business/safety-in-the-workplace/hazards-and-prevention/chemicals-dangerous-goods-and-hazardous-substances for support and information if you will be operating a chlorine gas room.
When using powdered chlorine, it is important to follow the instructions provided by the manufacturer and to review the product information and material safety data sheets. Where methods of disinfection other than chlorination are employed, contact time and disinfectant concentrations must be sufficient to provide adequate disinfection. It should be possible to confirm the disinfectant's dosage to the water.

If a distribution system is present, the water quality following any treatment and disinfection must produce a minimum free chlorine residual of 0.1 mg/L or a total chlorine residual of 0.5 mg/L throughout the distribution system.

Additional facilities such as standby equipment, flow pacing to regulate the speed of dosing pump, residual monitoring, automated recording and controlling equipment, and alarms should be provided to ensure reliable, effective, and continuous disinfection.

Note:

- *No person shall use a chemical to treat water that is to be used in a public water supply unless it is a type that is acceptable to the local authority. All chemicals shall meet the appropriate ANSI/AWWA standards, ANSI/NSF Standard 60 or other standards considered equivalent by the local authority.*
- *Chlorination treatment equipment certified to NSF/ANSI 61: Drinking Water System Components or NSF/ANSI 53 Water Treatment Devices should be installed.*
- *Owners/operators of public water supplies should provide a chlorine test kit (DPD) suitable for measuring free and total chlorine residual over a range of 0 to 2.0 mg/L for use during chlorine disinfection. Test kits with either a scale or digital readout are far better (when appropriately maintained and calibrated occasionally) than those which rely on the visual colour comparison, particularly for measurements below 0.5 mg/L, and should be utilized.*
- *A continuous chlorine analyzer equipped with an alarm system is recommended to ensure that the chlorine residual entering the distribution system is maintained.*

7.4 PATHOGEN LOG REDUCTION CREDITS FOR CHEMICAL DISINFECTION

Chlorine, chloramine, chlorine dioxide and ozone are common chemical disinfectants used to inactivate pathogenic microorganisms in water. The choice of an appropriate chemical disinfectant should be based on its efficiency in reducing or inactivating pathogens and the potential for generating disinfection by-products formed when the disinfection chemicals react with the naturally occurring organic matter in the source water or the distribution system. The presence of organic matter, pH of the water and temperature, and disinfectant type or dose are several factors that influence the formation of disinfection byproducts in water supply systems.

Generally, disinfection should be carried out after filtration to minimize the formation of harmful disinfection by-products. The effectiveness of disinfection chemicals can be determined based on the knowledge of the level of the disinfectant chemical (e.g., chlorine level, chlorine dioxide, ozone etc.), temperature, pH and contact time. This is referred to as the CT value (i.e., Concentration x Time), where CT is the product of the residual concentration of the disinfection chemical (C) measured in mg/L during peak hourly flow and the contact time (T) measured in minutes.

$$\boldsymbol{CT\ calculated\ = C\ (Concentration, mg/L)\ x\ T\ (Time, minutes)}$$

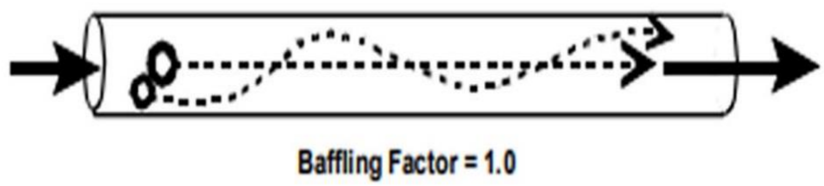
In performing CT calculations, the below design/operational parameters will need to be estimated for the source water to be disinfected:

- Minimum water temperature
- Maximum pH of the water
- The minimum free disinfectant residual for the water supply system
- Peak Hourly Flow Rate (Q) based on the flow meter records, design flow rate, maximum loading rates to filters etc.
- The volume of the reservoir or tank (i.e., depending on the shape or configuration) at the normal operating level

- Baffling Factors (BFs) for the effective storage volume

The baffling factor (BF) helps estimate the contact time of a storage basin, pipe or unit process based on the volume and flow rate. Considering flow through a pipe (plug flow), the difference between a particle's longest and shortest path is negligible (Figure 1).

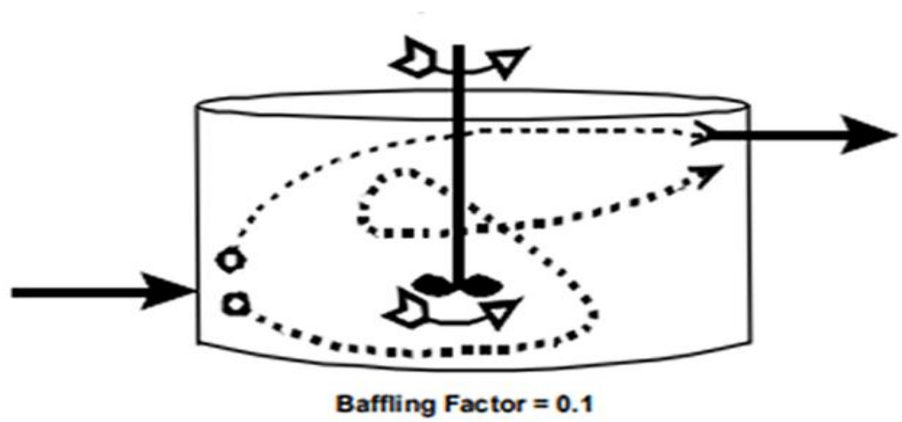
Figure 1: Flow in a pipe (Plug flow)



Source: Figure from LT1ESWTR Disinfection Profiling and Benchmarking Technical Guidance Manual

However, in an unbaffled basin (mixed flow), some portion of the flow may take a direct path from the inlet to the outlet, resulting in microorganisms in that path only contacting the disinfectant for a relatively short time (Figure 2).

Figure 2: Unbaffled Basin Flow



Source: Figure from LT1ESWTR Disinfection Profiling and Benchmarking Technical Guidance Manual

The below summary of the theoretical baffling conditions and storage basins is based on *US EPA Disinfection Profiling and Benchmarking: Technical Guidance Manual* and should be applied to various water storage system configurations:

Table 5: Baffling Factors

Baffling Factor	Baffling Condition	Baffling Description
0.1	Unbaffled (Mixed flow)	No baffles, agitated basin, very low length to width ratio, high inlet, and outlet flow velocities.
0.3	Poor	Single or multiple unbaffled inlets and outlets, no intra-basin baffles.
0.5	Average	Baffled inlet or outlet with some intra-basin baffles.
0.7	Superior	Perforated inlet baffle, serpentine or perforated intra-basin baffles, outlet weir, or perforated launders.
1.0	Perfect (Plug flow)	Very high length to width ratio (i.e., pipeline flow), perforated inlet, outlet, and intra-basin baffles.

7.4.1 Example of a CT Calculation for a Pipeline (Plug) Flow

The example below illustrates how to calculate CT and determine if a chemical disinfection system can receive credit for providing a 4-log virus inactivation using a plug flow system.

Example:

The XYZ public water supply system serves three commercial businesses, a gas station, and a public eatery. The water supply comes from a single GUDI well situated on the property, which is operated by a pressure-activated switch. According to the manufacturer's specifications, the well pump has a capacity of 6 gallons per minute (imperial). A drum of prepared hypochlorite solution is injected into the well water using an injection pump inside the well house for disinfection. The designer or operator is interested in determining the level of virus inactivation provided by the disinfection system.

Solution:

- To determine the level of virus inactivation achieved through disinfection, the designer or operator needs to calculate the CT value of the hypochlorination system. The designer or operator must determine the contact time (T) based on the size of the system's components and measure the disinfectant residual concentration (C) at or before the first service connection.
- Based on the manufacturer's information, the designer or operator knows that the well pump has a capacity of 6 gallons per minute, which is the maximum flow that can pass through the water system. To calculate the system's contact time (in minutes), the operator divides the system's volume (in gallons) by the maximum flow. Additionally, the designer or operator knows that a 120-foot 3-inch pipe connects the well house to the first service connection. To obtain the volume in gallons for the pipe, the designer or operator must calculate the volume in cubic feet.

The diameter of the pipe is 3 inches (or 3/12 ft).

The area of the pipe is [π x (diameter^2)]/4, where π = 3.14 and hence the area of the pipe = [3.142 X (3/12)^2] /4 sq. ft = 0.049 sq. ft.

The volume of the pipe in cubic ft = 120 ft x (0.049 sq. ft) = 5.88 cubic ft, which equals 5.88 cubic ft x 6.229 gals/ cubic ft = 36.63 gals.

The contact time, T, in the pipe = [V/Q] x BF; where V is the volume of pipe, Q is the maximum flow (i.e., well pump capacity) and BF is the baffling factor (i.e., 1.0 for plug flow, obtained from Table 5)

T = [36.63 gals/ 6 gals per mins] x 1.0 = 6.11 mins.

The designer or operator measures the chlorine residual of the first service connection, which is 0.5 mg/L. The calculated CT provided by the system is as follows:

$CT_{Calculated}$ = 0.5 mg/L x 6.11 mins = **3.06 mg/L.min**.

The designer or operator measured the temperature of the water and found it to be 15°C, and the pH of well water was 7.8. Using Table C7 from the Appendix C, which provides CT values for inactivation of viruses with free chlorine, the designer or operator determined that at a water temperature of 15°C and well water pH of 7.8, the **$CT_{Required}$** to provide **4-**log inactivation of viruses **is 4 mg/L.min**.

Since the CT provided by the system ($CT_{Calculated}$) is less than the $CT_{Required}$**,** XYZ public water supply system does not meet the necessary standards for disinfection to achieve 4-log virus inactivation. Therefore, it cannot be assigned pathogen log credits for virus inactivation. To achieve an adequate level of disinfection through hypochlorination, the designer or operator must increase the effective contact time and potentially boost the chlorine residual. This will ensure that the CT of the system equals or surpasses the CT necessary to accomplish 4-log virus inactivation.

Note:

If you have any further inquiries, it is recommended that you seek the advice of a qualified person, a water treatment plant professional or a professional engineer with technical expertise.

Chlorine, chlorine dioxide, and ozone can effectively inactivate Giardia but not Cryptosporidium under certain conditions. For example, temperature, pH, residual, contact time and other factors influence the amount of inactivation that occurs.

The maximum pathogen log reduction credit assigned to Cryptosporidium oocysts, Giardia cysts and viruses by chemical disinfection is determined through CT calculations and is based on the disinfection process being in full operation and meeting the recommended pathogen log reduction credits.

$CT_{Required}$ *values are set out in the CT tables (refer to* ***Appendix C*** *for the CT log inactivation tables for free chlorine, chlorine dioxide and ozone). These values are used to determine the appropriate level of disinfection required to meet the criteria for the recommended pathogen credits assigned to chemical disinfection. For the recommended pathogen log reduction credits for disinfection, the following criteria should be noted:*

a) The dosage for the chemical disinfectant should be sufficient for the disinfection of the raw water source.

b) The minimum frequency of sampling and testing for disinfectant residual should be at least once every 24 hours or on a more frequent basis as may be determined by the local authority.

c) To ensure the achievement of the pathogen log reduction credits assigned, the $CT_{Calculated}$ *shall be greater than or equal to the* $CT_{Required}$*. Where the* $CT_{Required}$ *is greater than* $CT_{Calculated}$*, public water supply system operators will need additional chemical disinfection contact time to ensure achievement of the recommended pathogen log inactivation.*

7.5 Ultraviolet (UV) Disinfection Systems

In contrast to chemical disinfection, UV disinfection does not leave a residual in the water. As a result, UV disinfection does not lead to the formation of harmful disinfection by-products (i.e., as seen in chemical disinfection). UV disinfection is highly effective for the inactivation of harmful microorganisms such as *Cryptosporidium* and *Giardia*, provided that the correct dose of UV radiation is applied.

The UV dose depends on UV intensity, flow rate and the UV transmittance to ensure adequate disinfection of pathogens. The UV dose table for *Cryptosporidium* oocyst, *Giardia* cyst and virus inactivation credits based on US EPA's Ultraviolet Disinfection Guidance Manual for the

Final Long Term 2 Enhanced Surface Water Treatment Rule (UVDGM) (USEPA, November 2006) is as follows:

Table 6: UV Dose Requirements (mJ/cm2 i.e., millijoules per centimeter squared)

Target Pathogens	**Log Inactivation Credits**							
	0.5	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**
Cryptosporidium	1.6	2.5	3.9	5.8	8.5	12	15	22
Giardia	1.5	2.1	3.0	5.2	7.7	11	15	22
Virus	39	58	79	100	121	143	163	186

UV reactor validation is used to define the operational conditions under which certain pathogenic organisms of concern are inactivated for a specific UV reactor model and manufacturer and is a method for determining the operational conditions under which a UV reactor produces a specific UV dose.

From the UV dose requirement table, the dose required for virus inactivation is relatively high at 100 mJ/cm^2 for 2-log inactivation and 186 mJ/cm^2 for 4-log inactivation which the standard NSF/ANSI 55 Class A Ultraviolet Water Treatment Systems (i.e., rated 40 mJ/cm^2) cannot inactivate. Thus, public water supplies may choose to use a combination of UV light for its effectiveness in inactivating *Cryptosporidium* and *Giardia* and then chlorine disinfection for its effectiveness for virus inactivation and residuals in distribution systems.

Though UV disinfection has many advantages as a primary means of disinfection, public water supplies system operators and owners need to be put into consideration the following disadvantages when opting for UV disinfection systems:

- UV disinfection leaves no residual in water. Where a distribution system disinfection residual is required, a chemical disinfectant will need to be added to the water.
- Very high turbidity and organic matter content in water may shield organisms, thereby protecting these organisms from being exposed to UV light for inactivation. For this reason, public water supplies are expected to apply UV disinfection after filtration, in which case the turbidity and organic matter contents have been significantly reduced.
- UV disinfection is not very effective in virus inactivation and will require a combination of chemical disinfection.

- The use of UV light in water treatment may be a source of various potential safety concerns, such as exposure of skin and eyes to UV light, burns from equipment or hot lamps and exposure to mercury from broken lamps. Adequate safety measures must be put in place and strictly implemented to address such potential safety issues.

> ***Note:***
> - Ultraviolet *disinfection can provide a 3-log inactivation of Cryptosporidium and Giardia, but only if appropriately operated and a turbidity level of 1.0 NTU or less is recommended. However, chlorination is still required for a functional ultraviolet system to ensure virus inactivation.*
> - *It* is *crucial to follow the manufacturer's instructions when installing and operating ultraviolet disinfection systems.*
> - *UV systems may not provide sufficient disinfection in regions with unstable or intermittent power supply.*

7.6 Pathogen Log Reduction Credit Assignment Scenarios

See below typical examples that illustrate how credits are assigned based on source water types and the treatment processes used for filtration and disinfection.

Scenario 1:

XYZ public water supply utilizes a non-GUDI groundwater well (determined to be at low risk of containing pathogens) as the source water type with a standpipe not connected to any distribution system. This groundwater well is properly constructed and receives no sort of treatment. What pathogen log reduction credit should be assigned to this system?

The minimum recommended and assigned pathogen log reduction credit for scenario 1 based on the treatment technologies applied is as below:

Table 7: Pathogen Log Reduction Credit Assignment for Scenario 1

Criteria	***Cryptosporidium* Oocysts**	***Giardia* Cysts**	**Viruses**
Recommended Minimum Pathogen Log Reduction (i.e., for non-GUDI/groundwater well at low risk of pathogens)	0	0	0
Log Credits for Treatment Technology(ies) Applied	0	0	0
Pathogen Log Reduction Credit Assigned (Total)	**0**	**0**	**0**

For the low risk or non-GUDI groundwater well in scenario 1, the recommended log reduction objectives for *Cryptosporidium*, *Giardia*, and viruses are all zero (refer to Table 2 for the summary of recommended objectives for different source waters). This implies that no treatment is necessary.

Scenario 2

XYZ public water system uses surface water and has installed an NSF/ANSI Standard 55 Class A ultraviolet water disinfection system, cartridge filtration (2 x 1µm absolute stage filter in series), and an automatic chlorination system for treatment. This public water supply system is connected to a distribution system. Do the treatment technologies applied by XYZ public water supplies meet the log reduction credit required for the local authority's approval of the drinking water system?

Table 8: Pathogen Log Reduction Credit Assignment for Scenario 2

Criteria	***Cryptosporidium* Oocysts**	***Giardia* Cysts**	**Viruses**
Recommended Minimum Pathogen Log Reduction (i.e., for surface water)	3.0 Log	3.0 Log	4.0 Log
Log Credits for Treatment Technology(ies) Applied			
• Cartridge filtration	2.5 Log	2.5 Log	0
• Ultraviolet Disinfection	4.0 Log	4.0 Log	0.5 Log
• Chlorination (Primary)	0	0	4.0 Log
Pathogen Log Reduction Credit Assigned (Total)	**6.5 Log**	**6.5 Log**	**4.5 Log**

The pathogen log reduction credit assignment criteria for scenario 2 is as follows:

1. Cartridge filtration:
    a. The pathogen removal efficiency for C*ryptosporidium* oocysts and *Giardia* cysts credits is demonstrated through challenge testing or through certification by ANSI/NSF standards. Cartridge filters certified to remove cysts and used in series can receive a maximum of 2.5-log credits for *Giardia* and *Cryptosporidium* removal for the complete cartridge treatment train.
    b. No virus reduction credit assigned to cartridge filtration.
    c. The filter effluent turbidity must be continuously monitored and recorded for each filter and when using a combination of filters, the combined filter effluent turbidity.
    d. For each filter, the effluent turbidity should be equal or less than 0.1 NTU in at least 99% of the turbidity measurements per filter operation period or per month.
2. Ultraviolet Disinfection:
    a. Specific ultraviolet equipment or reactor model are operated within its validated or certified operating conditions.
    b. Ultraviolet equipment or reactors are operated in such a way that a continuous ultraviolet dose is maintained throughout the life of the ultraviolet lamps which is at least the minimum recommended ultraviolet dose utilized in the certification standard or validation protocol for the pathogen log reduction targeted.
3. Chlorination:
    a. Chlorine disinfectant dosages are appropriately adjusted based on the raw water quality variations.

b. Chlorine disinfectant residual sampling and testing are conducted through continuous monitoring equipment near a location in the water system where the intended contact time has been achieved.
c. $CT_{Calculated}$ at all times must be equal or greater than the $CT_{Required}$ to be able to achieve the pathogen log reduction credits assigned.

Note:

- *The most common chemical disinfectant used for primary disinfection is free chlorine because it is widely available, relatively inexpensive, and provides a residual that can be used to maintain water quality in distribution systems.*
- *A moderate chlorine concentration of 0.5 mg/L with 15-min contact time can achieve greater than 4-log virus inactivation at 20°C (refer to Page 8: Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Enteric Viruses)*
- *Secondary disinfection does not qualify for log-inactivation credits.*

In scenario 2, the pathogen log reduction credits obtained from the treatment technologies used by XYZ public water supplies meet the minimum requirements for the source water. The local authority will approve each treatment process as long as it meets the relevant log reduction credit criteria.

Scenario 3

XYZ water treatment facility relies on multiple raw water sources - surface water, a groundwater well at low risk of containing pathogens and a backup groundwater well at risk of containing pathogens. XYZ water treatment facility employed the use of conventional filtration and chlorination to treat these raw water sources. Will these treatment technologies meet the local authority's requirements for approving the water treatment facility?

Table 9: Pathogen Log Reduction Credit Assignment for Scenario 3

Criteria	***Cryptosporidium* Oocysts**	***Giardia* Cysts**	**Viruses**
Recommended Minimum Pathogen Log Reduction (i.e., for surface water and GUDI wells)	3.0 Log	3.0 Log	4.0 Log
Log Credits for Treatment Technology(ies) Applied			
• Conventional filtration	3.0 Log	3.0 Log	2.0 Log
• Chlorination (Primary)	0	0	2.0 Log
Pathogen Log Reduction Credit Assigned (Total)	**3.0 Log**	**3.0 Log**	**4.0 Log**

For scenario 3, where we have a combination of multiple raw water sources, the minimum treatment requirements shall be based on the highest-risk source water, the surface water (i.e., equivalent with groundwater well at risk of containing pathogens).

The pathogen log reduction credit assignment criteria for scenario 3 is as follows:

1. Conventional Filtration:
    a. A chemical coagulant (e.g., aluminum sulphate or alum) is always used during treatment operations. Chemical dosages are monitored and appropriately adjusted based on the raw water quality variations.
    b. Effective backwash procedures are sustained during operations to ensure that filter effluent turbidity objectives are always met.
    c. For each filter, filter effluent turbidity is less than or equal to 0.3 NTU in at least 95% of the measurements each calendar month and shall not exceed 1.0 NTU at any time.
2. Chlorination:
    a. Chlorine disinfectant dosages are appropriately adjusted based on the raw water quality variations.
    b. Chlorine disinfectant residual sampling and testing are conducted through continuous monitoring equipment near a location in the water system where the intended contact time has been achieved.
    c. $CT_{\text{Calculated}}$ at all times must be equal or greater than the CT_{Required} to be able to achieve the pathogen log reduction credits assigned.

Both treatment technologies that XYZ water treatment facility applied (i.e., for scenario 3) were adequate for the recommended minimum pathogen log reduction credit for the highest-risk source water. Approval by the local authority will also depend on each treatment process meeting the applicable log reduction credit assignment criteria.

8 FREQUENCIES OF TESTING AND MONITORING

1. Unless otherwise approved by the local authority, during chlorination, the owner or operator shall conduct and record daily tests for chlorine, pH, water temperature, turbidity, and any other test that the local authority requires.
2. The local authority shall direct the owner or operator of a public water supply to submit samples for monitoring the water quality to an accredited laboratory.
3. Unless otherwise required by the local authority the frequency of sample submission shall be as follows:

(a) Bacteriological Analysis

The below minimum frequencies are contained within *The Health Hazard Regulations*:

(i) in the case of a public water supply that is operated throughout the year, once every three months; and

(ii) in the case of a public water supply that is operated on a seasonal basis, once per year, with the sample being taken at a time specified by the local authority.

> ***Note:***
>
> *Whatever sampling frequency is required, owners or operators of public water supplies are required to send in a sample for bacteriological analysis whenever environmental conditions (e.g., excess rain, flooding, etc.) have occurred that may have impacted on the water supply. Hence, there may be a need for the local authority to consider the following:*
>
> - *Increasing the sampling requirements for locations with a history of unacceptable bacteriological results.*
> - *Having a raw well source sampled in case more than one unacceptable bacteriological test result occurs and less than 4-log virus inactivation or reduction is present.*

(b) General Chemicals Analysis (formerly called Major Ion Analysis)

The minimum frequencies, as contained within the regulations, are as below:

(i) in the case of a ground water supply, at least once in every 365 days; and

(ii) in the case of a surface water supply, at least once in every 730 days.

(c) Health and Toxicity Analysis

Health and toxicity analysis is required when establishing a new water supply or when directed by the SHA.

> ***Note:***
>
> *The local authority may require the owners or operators of a public water supply to submit samples for analysis other than those mentioned in subsection 3(a) and 3(b) if the local authority suspects that the public water supply may be subject to contamination that would not be identified in those types of analysis.*

9 OPERATIONAL RECORDS AND RESPONSE TO SYSTEM FAILURES

The following daily records shall be maintained by the owner or operator of a public water system:

(a) chlorine residuals (if applicable);
(b) water quality test results;
(c) chemicals applied and concentrations (if applicable);
(d) water system maintenance (full description of maintenance with dates and times);
(e) unusual events, such as heavy rainfall, snowmelts;
(f) treatment failures;
(g) water meter readings, if applicable; and
(h) any other results that are required by the local authority.

The owners or operators of public water supplies shall maintain for a period of five (5) years, the required water quality and treatment targets and shall make this available to the local authority upon request.

The owner or operator of a public water supply shall:

(a) immediately notify the local authority (i.e. a public health inspector through the local public health inspection offices at https://www.saskatchewan.ca/residents/health/public-health/public-health-inspectors) of any event or situation that may affect the safety of that public water supply including:
    (i) any malfunction of treatment equipment that could affect the safety of that public water supply;
    (ii) any breakdown or contamination of the distribution system;
    (iii) any matter that may affect the safety or suitability of the source water for that public water supply;
    (iv) any laboratory water test results from that public water supply that indicate the presence of *E. coli* or fecal coliforms.
(b) followed up by immediately taking appropriate action to prevent the usage of the water supply for drinking or personal hygiene purposes until the safety of the water is confirmed. This complies with subsection 6(1) of the regulations, which requires the owner or operator of a public water supply to ensure that the water is potable at the place it is delivered.

10 WATER ADVISORIES

10.1 PRECAUTIONARY DRINKING WATER ADVISORIES (PDWAS)

PDWAs are issued by a Public Health Officer when there is a possibility that problems may exist with the public water supply, although an immediate health threat has not been identified (e.g., lack of minimum treatment). PDWAs are issued as a precautionary measure when the water quality in a public water supply system cannot be verified. The advisory remains in effect until water quality meets regulatory standards.

10.2 EMERGENCY BOIL WATER ORDER (EBWOS)

EBWOs are issued by a designated MHO when a threat to the public health exists (e.g., presence of *E. coli* in the water). Water from the supply and distribution system must be boiled for at least one minute at a rolling boil before use to ensure it is bacteriologically safe. An EBWO will remain in effect until the owner or operator of the public water supply complies with the requirements outlined in the EBWO, which include taking necessary actions or making improvements to ensure a safe water supply as determined by laboratory testing.

11 SEASONAL PUBLIC WATER SUPPLIES

11.1 START-UP AND SHUTDOWN PROCEDURES

Seasonal systems are unique because they operate only for a specific portion of the year. Typically, these systems operate during the summer and shut down during winter. During the winter, the treatment and distribution systems are drained to prevent freezing, as many distribution lines may be shallowly buried above the frost line. Any stagnant water that remains in the system for some time may be susceptible to microbial growth. It is vital to ensure that a seasonal system is appropriately started in the spring and shut down in the fall to protect consumers.

This guideline section is developed to standardize seasonal public water supply start-up and shutdown procedures. It is intended for use when a health-regulated public water supply begins operation after being shut down for more than seven (7) days. This guideline is not intended for situations where a depressurization event occurs due to a pump failure, power outage, line break, etc. unless the system continues to be out of service for seven (7) days.

> ***Note:***
> ***Appendix D*** *offers a helpful start-up and shutdown checklist for groundwater wells and surface waters to ensure proper procedures are followed.*

11.1.1 Start-Up Procedures

Operators of seasonal water systems should begin preparing their water systems several weeks before serving customers. These guidelines generally require evaluating, repairing, disinfecting, and testing each system. This guidance is provided as information only and may not be applicable or complete in all cases.

1. Operators of seasonal systems should notify their respective Public Health Inspection Office of their intention to begin operation and the tentative start date for supplying customers with drinking water. The Public Health Inspector may have specific actions for the operator to complete, for example, if consumers are present during the start-up period before receiving bacteriological sample results, a PDWA may be issued, which advises consumers to boil their water before drinking.
2. Examine the electrical system before activation and follow appropriate precautions for working with electricity.
3. All water quality test equipment should be confirmed as operating properly and calibrated where possible. Reagents should be checked for expiry, and a new supply should be obtained if required. A supply of bacteriological sampling bottles should be obtained.
4. All components of the water system (source, treatment, and distribution) should be inspected by the operator.
    a. Groundwater Wells: If applicable, ensure the well casing and cover are in good condition. Remove the lid for the well and remove any debris that may have entered the casing during the off-season. If your well is in a well pit, do not enter without following confined entry procedures. Information on confined space procedures can be obtained from the Saskatchewan Ministry of Labour Relations and Workplace Safety (https://www.saskatchewan.ca/labour-relations-workplace-safety) or several safety consultants.
    b. Buildings: Buildings associated with the water source, treatment, or distribution, such as a well house should be thoroughly cleaned of all leaves, dust, etc. Buildings should not be used as storage areas for yard equipment, gas cans, paint cans or other miscellaneous items.
    c. Storage Tanks: All storage tanks should be drained, inspected, desludged and repaired, if necessary. Any deficiencies should be noted and repaired.
    d. Treatment System: The treatment system and source should be activated and optimized. Chemical feed solutions should be mixed, and feeder rates should be verified. Clean all required components, such as injection ports, foot valves, static mixers, etc. Inspect and test all backflow connection valves. Distribution System: If applicable, open all hydrants, blow-off and faucets, and run water through the entire water system.
    e. Exercise all valves (i.e., operate at least one complete cycle until valves operate freely with little resistance).
5. Flush and disinfect all the sources, pressure tanks, storage tanks and distribution lines.
    a. Groundwater Wells and Wet Wells: Disinfection should proceed as outlined in the Low-Level Disinfection Fact Sheet.
    b. Storage Tanks: Storage tanks should be disinfected using full storage or surface application methods.

i. The full storage method involves adding a chlorine solution to the tank and holding it for 24 hours. At the end of the 24 hours, the total chlorine residual should be greater than 10 mg/L. If not, add more chlorine and wait another 24 hours. Repeat if necessary. The highly chlorinated water should not be disposed of into surface water, private sewage system or communal sewage system (unless permission of the owner has been obtained).

Table 10: Required Chlorine to Produce 10 mg/L of Chlorine Solution (Imperial unit)

Tank Volume (Imp. Gallons)	Household bleach 5% Chlorine (mL)	Sodium Hypochlorite 12% Chlorine (mL)
100	90	38
500	450	190
750	675	285
1000	900	380

Table 11: Required Chlorine to Produce 10 mg/L of Chlorine Solution (Metric unit)

Tank Volume (Litre)	Household bleach 5% Chlorine (mL)	Sodium Hypochlorite 12% Chlorine (mL)
100	20	9
500	100	42
750	150	63
1000	200	84

ii. The surface application method requires spraying a 200 mg/L chlorine solution on all exposed surfaces. To prepare a 200 mg/L chlorine solution, pour 75 millilitres (mL) of household bleach (which contains approximately 5% chlorine) or 30 mL of Sodium Hypochlorite (which contains approximately 12% chlorine) into 18 litres (4 gallons) of water. Add enough chlorine in the tank drains to ensure that when the drain is filled with water, the concentration is at least 10 mg/l. After 30 minutes, rinse the tank. The highly chlorinated water should not be disposed of into surface water, private sewage system or communal sewage system (unless permission of the owner has been obtained). All confined space entry requirements and other occupational health and safety concerns should be examined before applying chlorine in a confined space. Operators should utilize proper ventilation or breathing equipment.

c. Distribution System: If applicable, monitor chlorine residual at the far extents of the distribution system to ensure that sufficient chlorine is maintained in the distribution system. If disinfected separately, the distribution system should be super-chlorinated with water of at least 100 mg/L total chlorine, and the superchlorinated water should remain in the lines for at least 3 hours. Alternatively, a total chlorine concentration of 25 mg/L for 24 hours is sufficient. No consumers should have access to water during this time. The highly chlorinated water should not be disposed of into surface water, private sewage system or communal sewage system (unless permission of the owner has been obtained).

d. Treatment Units: Treatment units such as softeners, reverse osmosis (RO) systems, carbon filters, etc., may be damaged by high chlorine levels and should be bypassed during the disinfection process.

   e. In-Home Plumbing: Treatment units such as softeners, RO Systems, carbon filters, etc., may be damaged by high chlorine levels and should be bypassed during the disinfection process. Hot water tanks should be shut off. Remove faucet devices such as filters, screens, and aerators to avoid clogging these devices.

6. Collect bacteriological sample(s): Take one sample. Where a distribution system is present, the sample should be taken from a representative location in the distribution system. Submit the sample for analysis. The system can be used for human consumption if the testing results are acceptable. Regardless of the result from the first sample, the local Public Health Inspector may request a second bacteriological sample to be submitted before considering the water potable.

Note:

- *The bacteriological sampling completed during the start-up period will be counted towards the annual requirement of one bacteriological sample. At least one additional sample taken later in the operating season is recommended and may be required by the local Public Health Inspector. Water flow through all parts of the system must be maintained after the bacteriological sampling to prevent areas of stagnant water, which may allow bacterial growth.*
- *Before shock chlorinating the system, it is essential to flush it to remove as much material as possible.*
    - *For pressure and storage tanks: Fill and empty them repeatedly until the water runs clear.*
    - *Water treatment equipment: Follow supplier instructions.*
    - *Piping system: Bypass water treatment equipment and flush each outlet one by one, starting with the outlet closest to the water source. Turn the outlet to full flow and flush until the water runs clear. Flush hot and cold-water outlets separately.*
- *All valves should be exercised to ensure they are in good working order.*
- *Ensure that there are no cross connections which could introduce contaminants into the treated water system.*
- *Dechlorination using sodium thiosulphate is commonly used to remove chlorine from highly chlorinated water before disposal. 10 g of sodium thiosulphate crystals can neutralize 1,000 litres of water that contains 5 mg/L (ppm) of free chlorine. Other dechlorination methods include activated carbon and powdered ascorbic acid. While exposing chlorinated water to sunlight can reduce the chlorine content, it is not as effective as dechlorination methods.*

11.1.2 Shutdown Procedures

When the water system is shut down for the season, it must be inspected and protected until the following season. Several steps can be taken at the season's end to minimize the work required at the beginning of the next season.

1. Inspect the system.
    a. Wells: Ensure the well casing and cap is in good condition. Inspect the interior of the well for debris and cracks.
    b. Surface water supply: If possible, surface water intake pipes should be brought ashore during winter. Remember to cover/cap to prevent any contamination.
    c. Treatment Plant: Valves should be exercised.
    d. Distribution System: Valves should be exercised.

2. Drain all components.
    a. Pumphouse, Pumps and Treatment System: Any storage tanks and pressure tanks should be drained. Water should be drained or blown out of all pumping, treatment, and storage equipment.
    b. Distribution System: Drain the distribution system if it is susceptible to freezing. Do not leave taps open during the off-season, and never use anti-freeze in the water system.
3. Clean all components, such as the storage tanks and ensure that openings to all components are sealed to prevent the entry of rodents, insects, or other contaminants.
4. Shut down and protect the source water supply system. Turn off the power supply, if possible. Protect sensitive components from freezing using Styrofoam, if possible, as fibreglass insulation may attract rodents.

Note:
At no time should a foreign liquid such as anti-freeze be used for winterizing any part of a drinking water system.

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APPENDICES

APPENDIX A:

WELL RISK CATEGORIZATION ASSESSMENT FORM

PRELIMINARY ASSESSMENT WORKSHEET

Preliminary assessment of groundwater sources to determine sources that are secure.

System Name:

Source Name: ***Population Served:***

Inspector: ***Date:***

Instructions

In Column A: Circle the applicable points. Total this column for the current risk score.

In Column B: Place maximum potential increase in points available if the operator can provide more information (make unknowns known) or complete remedial action (repair wells construction deficiencies) or operate & maintain the well successfully (complete testing, record-keeping as required). Points in this column are not available where the box is grayed out.

Part	***Item***	***A***	***B***
1)	**Type of Structure** (select one)		
	· Well · Spring · Infiltration Gallery/Horizontal Well	10 5 0	
2)	**Historical Pathogenic Organism Contamination** (select one)		
	· Historical or suspected outbreak of Giardia or other pathogenic organisms associated with surface water, with current system configuration · No history or suspected outbreak of Giardia or other pathogenic organism	-50 0	
3)	**Historical Microbial Contamination[1] of in the past three years** (Complete a & b)		
	a) Total Coliforms (select one) · No Positives & all samples submitted · One Positive & all samples submitted · Two Positives or more & all samples submitted · Two or more positives & not all samples submitted · No history or Not all samples submitted b) Fecal Coliforms/E. Coli (select one) · No Positives & all samples submitted · One Positive & all samples submitted · Two Positives or more & all samples submitted · Two or more positives & not all samples submitted · No history or Not all samples submitted	 15 10 0 0 0 20 10 0 0 0	
4)	**Water Quality** (select one)		
	· There is a noticeable change in the appearance (colour/cloudiness) or quality of the water shortly after a heavy rainfall or snow melt (as determined by interviewing the well owner and/or visual inspection of the well) · There is not a noticeable change in the appearance or quality of the water shortly after a heavy rainfall or snow melt	-50 0	

5)	**Land Use**		
	Horizontal distance between a source of contamination[2] and the well head is (select one): · Greater than 300 m (1000 ft) · 60 to 300 m (200 ft to 1000) · Less than 60 m (<200 ft)	10 5 0	
6)	**Hydrogeological Features** (Complete a, b or c)		
	a) Well in Unconfined Aquifer or unknown Horizontal Distance between surface water[3] and the source is (select one): · Greater than 60 m (>200 feet) · 30 to 60 m (100 to 200 feet) · 15 to 30 m (25 to 100 feet) · Less than 15 m (<25 feet) or unknown Water level in well (when pumping) is (select one): · Significantly higher than typical level nearest surface water · Not significantly higher than typical level nearest surface water b) Bedrock Well Horizontal Distance between surface water[3] and the source is (select one): · Greater than 150 m (>500 feet) · 75 to 150 m (250 to 500 feet) · 30 to 75 m (100 to 250 feet) · Less than 30 m (<100 feet) or unknown c) Well in Confined Aquifer Horizontal Distance between surface water[3] and the source is (select one): · Greater than 15 m (>25 feet) · Less than 15 m (<25 feet) or unknown	20 10 5 0 5 0 20 10 5 0 20 10	
7)	**Well Construction** (Complete a, b, c and d)		
	a) Casing (select one) · Cased properly[4], and annular space is sealed with an impermeable material such as concrete; and seal is not with an unacceptable or non-intact material; and casing construction is not unknown · Cased improperly (e.g., wood), or unknown b) Well Cap (select one) · Has a well cap securely attached, and is securely attached; and well casing appears to not have cracks or unsealed joints · Improper cap c) Casing height (select one) · Extends greater than 60 cm above the ground surface · Less than 60 cm above the ground surface d) Well Discharge pipe (select one) · Well discharge pipe is constructed in a manner that does not allow surface runoff or infiltrating surface water into the well (e.g., pit less adaptor and a sealed discharge pipe exit) · Surface water could enter well due to poor well discharge pipe construction	0 -20 0 -20 0 -20 0 -20	

8)	**Well Screen Construction** (Complete either a or b)		
	a) In wells tapping unconfined, semi-confined aquifers, or bedrock aquifers (or where the aquifer type is unknown), depth below land surface to top of perforated interval or screen is (select one):		
	· Greater than 60 m (>100 feet)	15	
	· 30 to 60 m (50 to 100 feet)	10	
	· 15 to 30 m (25 to 49 feet)	5	
	· 0 to 15 m (0 to 24 feet)	0	
	· Unknown	0	
	b) In wells tapping a confined aquifer		
	· All wells in a confined aquifer	15	
9)	**Well Intake Construction** (Complete either a or b)		
	a) In wells tapping unconfined or semi-confined aquifers or bedrock aquifers (or where the aquifer type is unknown), depth to static water level below land surface is (select one):		
	· Greater than 60 m (100 feet)	15	
	· 30 to 60 m (50 to 100 feet)	10	
	· 15 to 30 m (25 to 49 feet)	5	
	· 0 to 15 m (0 to 24 feet)	0	
	· Unknown	0	
	· Intake open to the atmosphere[5]	-20	
	· Leaks in source collector allowing entry of surface water	-40	
	b) In wells tapping confined aquifers, depth to static water level below land surface is (select one):		
	· Greater than 5 m (15 feet)	15	
	· 0 to 5 m (0 to 14 feet)	0	
	· Unknown	0	
	· Intake open to the atmosphere[5]	-20	
	· Leaks in source collector allowing entry of surface water	-40	
10)	**Well Maintenance** (Complete a, b, c & d)		
	a) Record Keeping (over last five years)		
	· Completed and maintained as required	0	
	· Not completed as required.	-10	
	b) Onsite testing (if required)		
	· Completed as required (or not required)	0	
	· Not Complete as required	-10	
	c) Shock Chlorination of Well (averaged over last three years)		
	· Twice per year (once per year seasonal system)	0	
	· Once per year	-5	
	· Less than once per year or unknown	-10	
	d) Reporting of events (over last three years)		
	· Completed or not required	0	
	· Event occurred that should have been reported	-10	

11)	**Consumer Characteristics** (Complete a, b, & c)		
	a) Number of patrons/customers/employees served each day (select one) · 1 to 25 people · 26 to 100 people · More than 100 people b) Primarily serves Infants, Elderly, Immuno-compromised and/or Immuno-suppressed · Yes · No c) Type of user (select one) · Primarily permanent residents (e.g., residential developments) · Primarily the same consumers while open (e.g., private cabins) · Primarily transient users (e.g., campgrounds, restaurants)	0 -5 -10 -20 0 0 -5 -10	
12)	**Water Use Characteristics** (Complete a & b)		
	a) Water used for · Non-contact hygienic purposes (e.g., toilet flushing, watering) · Contact hygienic purposes (e.g., showering) · Drinking purposes b) Water System operated for · Less than 60 days per year · More than 60 days per year	20 10 0 10 0	
	Sub-Totals	____ **A**	____ **B**
	Current Score (A): ____________________ **Secure Well / Medium Risk / High Risk** **Potential Score (A+B):** ______________________ **Deferred: Yes / No**		

PRELIMINARY ASSESSMENT DETERMINATION

- Secure Well (A≥70 points): Well is classed as a secure groundwater source.
- Medium Risk: (55<A<70 points): Well may be potentially GUDI or otherwise a high risk
  - Deferred (A+B≥70): Well may be considered low risk if additional information is collected or deficiencies are corrected.
- High Risk (A <56 Points): Well is classed as potentially GUDI or otherwise a high risk
  - Deferred (A+B≥56): Well may be considered low or medium risk if additional information is collected or deficiencies are corrected.

Notes:

1) *If a microbiological positive test was determined to be due to sampling error and not due to contamination, it should not be considered a positive for this analysis.*

2) *A source of contamination includes septic systems (holding tanks not included), landfill, manure storage or application, livestock, wildlife, and other microbial contamination sources but does not include surface water. Other contamination sources such as chemical storage and fuel storage are a risk to water safety however, outside of the scope of this assessment.*

3) *Surface water includes at a minimum all perennial surface waters including:*
   - *Lakes, streams, ponds, creeks, rivers, ditches, drains, etc.*
   - *Intermittent surface water such as ponds, streams, ditches, drains, etc.*
   - *Wastewater treatment lagoons*
   - *Other natural or manmade lagoons, ponds, or reservoirs*
     For determining distances between the surface water and the groundwater source, measurements should be made from the annual high-water level.

4) *Proper casings include:*
   - *Casings made from plastic, steel, or fibreglass. Concrete could also be used for certain situations although this is discouraged.*
   - *Casings that are continuous and watertight from the top to the screen*

5) *Intake open to the atmosphere can include an improperly constructed collection system from a spring system where water that has been exposed to the atmosphere may be collected. This does not include the ability to visibly observe water in the well if the well cap/lid is removed.*

General

- *Owners of poorly constructed wells should be advised to make improvements even if this assessment does not result in a medium or high risk.*

- *Where individuals, such as immune-compromised, youth and the elderly, are present, a conservative approach should be taken when completing the assessment.*

Form Completion Examples:

1) *If there has been one positive total coliform but not all samples were submitted, Column A = 0, Column B = +10.*
2) *If there has been zero positive total coliform but not all samples were submitted, Column A = 0, Column B = +15.*
3) *If the Casing height is less than 60 cm above the ground surface, Column A = -20, Column B = +20.*
4) *For Section 8, if it is uncertain if the well is in a confined or unconfined aquifer, complete part (a). If the depth is 16 metres, column A would be 5 and column B would be +10.*

APPENDIX B:

GENERAL APPLICATION FORM FOR APPROVAL OF PUBLIC WATER SUPPLIES

This form and guideline detail the information to be submitted by any person wishing to establish, extend, renovate, or alter a public water supply. This application form has been prepared in accordance with Section 5 of *The Health Hazard Regulations, 2002.*

If you are applying for an **approval to establish, extend, renovate or alter** a public water supply, the application must be completed and forwarded to your designated Public Health Inspection Office at least one month prior to the planned construction of a new or significantly altered public water supply.

Overall Review of the Public Water Supply System

The applicant wishing to the establish, extend, renovate, or alter a public water supply shall ensure that all information with respect to the source of the water supply and the design of the water supply system that are part of the public water supply and distribution system has been submitted. Manufacturer's technical information on equipment design and operations should be attached to the application. Further information may be requested by the Saskatchewan Health Authority if it is believed that the submitted information is not sufficient.

Section I - Administrative Information

1. Premises name: (in full)

____

Location of water supply system: Legal land description or GPS____________

RM or City/Town:____________________

2. Owner's Name: ______________________________
   Mailing Address:______________________________
   Email Address: ______________________________

   City/Town:____________Prov. /State:________________Postal Code: __________
3. Operator's Name: ___________Telephone:_______________(h)_______________(w)
   ______________(c)
4. Emergency Contact

Name:______________________Telephone:_______________(h)_____________(w)
________________________(c)
Name:______________________Telephone:_______________(h)_____________(w)
________________________(c)

5. Construction application additional details

Name of Consultant/Engineer/Designer/Supplier: __________________________

Mailing Address/Postal Code: ____

Estimated cost of project $ _____________ Phone Number: _________________

Section II - Water Supply System General Information

1. What is the source of water? ☐ New or ☐ Existing

❑ Water Hauler (name) ________________________

❑ Dugout

❑ Lake

❑ Spring

❑ Well

❑ Cistern (water source)

❑ River

❑ Other: ____________

2. Facilities Served (check all apply):

- ❑ Non-Potable
- ❑ Campground
- ❑ Urban Municipal Well
- ❑ Rural Municipal Well
- ❑ Trailer Park
- ❑ Daycare
- ❑ School
- ❑ Outfitter
- ❑ Food Processor Licensed
- ❑ Food Distributor
- ❑ Recreational Area
- ❑ Residential
- ❑ Personal Care Home
- ❑ Wayside Area
- ❑ Food Processor (Other)
- ❑ Group Home
- ❑ Special Care Home
- ❑ Hospital
- ❑ Hotel/Motel
- ❑ Special Event
- ❑ Public Eating Establishment
- ❑ B&B/Vacation Farms
- ❑ Water Haulers
- ❑ Limited Scope Pipeline
- ❑ Other

Describe the type of usage (e.g., 15 hotel rooms, 5 seasonal cabins, etc.)

____

____

____

____

3. If the source is a well or spring, please fill out the following table.

Well information	**Well # ______**	**Well # ______**
Water Rights License No		
Well Name/number		
Water usage (e.g., year-round, seasonal, backup, etc.)		
Well Type (i.e., construction method: artesian, drilled, dug, driven, sand point, bored)		
Casing type (concrete, fibreglass, metal, wood, plastic, other)		
Pump Type (e.g., centrifugal, hand, jet, submersible)		
Well completion depth (m)		
Water depth (m)		
Location (e.g., Legal Description Sec-Twp- Rge-Mer or description)		
Well Drilling Contractor		
Date Well Came into Production (Month/Year)		
Does casing extend 60 cm above ground? (Yes, no, unsure)		
Watertight well lid and screen vent(s)? (Yes, no, unsure)		
Production Rate (L/s)		
Land slope and characteristics surrounding well (e.g., sloped away, in a depression, etc.)		

If available, attach a well driller's report or log (may be available from the Water Security Agency, Phone: 866-727-5420)

4. Sampling Requirements (Refer to section 8 of the regulations)

Bacteriological: Frequency___________(i.e., Month, Week, Year)
Major Ion: Frequency___________(i.e., Month, Week, Year)
Other: _____________________ Frequency___________(i.e., Month, Week, Year)

5. What water treatment units are proposed? (Attach additional technical information, if available.) (Check the boxes for each treatment that is or will be used)

- ❑ Aeration
- ❑ Coagulation/Flocculation
- ❑ Softening
- ❑ Algae Control
- ❑ Iron Removal
- ❑ Distillation
- ❑ Other:
  - Sedimentation
  - Oxidation (chemical)
  - ___________________

Filtration
- ❑ Biological Filtration (SS)
- ❑ High-Rate Sand
- ❑ Cartridge
- ❑ Reverse Osmosis
- ❑ Other ________________
  - Diatomaceous Earth (DE)
  - Activated Carbon Contactor

6. Is Disinfection being provided?

   - ❑ Calcium Hypochlorite
   - ❑ Sodium Hypochlorite
   - ❑ Ultraviolet Light
   - ❑ Other

7. Is a distribution system present? ☐Yes ☐ No

   If yes, number of service connections: ______________________

8. Approximate maximum number of people served by this water supply (under maximum conditions): __________________________

9. What are the flow rates for the plant?

Flows	**Average Daily Flow**	**Maximum Daily Flow**	**Plant Service Flow Rate**
Current (N/A if new PW supply)			
Design			

Facilities are: ☐ Year-round ☐ Seasonal –

Month Opening Date:____

Month Closing Date: ____

10. Please describe the piping system, if present, that conveys raw water from the source to the water treatment plant.

____

____

____

11. Backflow Prevention

If proposed, do truck fill stations have backflow prevention devices? ☐ Yes ☐ No
Is there backflow prevention installed to prevent water from flowing back to the well?
☐ Yes ☐ No

Type of Backflow Prevention

- ❑ Vacuum breaker
- ❑ Reduced pressure valve
- ❑ Double check valve (DCV)
- ❑ Testable DCV
- ❑ Single check valve
- ❑ Other:_______

Describe location of each valve: ____

____

____

12. Water Metering

Please list all flow monitoring locations:
Location: ____________________ Imperial Gallons/ Cubic Meters/ Other: _____________
Location: ____________________ Imperial Gallons/ Cubic Meters/ Other: _____________

13. Describe the proposed usage of the water from the proposed system:

- ❑ Drinking
- ❑ Cooking
- ❑ Irrigation
- ❑ Domestic (toilet flushing, etc.)
- ❑ Fire Suppression / prevention
- ❑ Personal Hygiene
- ❑ Agricultural Use (e.g., livestock watering, chemical mixing)
- ❑ Commercial Use
- ❑ Other

14. Provide the existing water quality. (Please attach water quality report to the application)

15. Description of the works

Brief description of the works to be constructed, altered or decommissioned

Section III - Water Supply System Diagrams

Site Plan – Please provide a diagram that indicates the proposed and/or existing source water location(s) on the site plan below with respect to the following items (if applicable): property lines, sewage and waste disposal systems, location of underground storage, all intermittent, natural and artificial bodies of water, other wells including abandoned wells, access roads, structures, livestock areas other areas that may be potential sources of contamination. Attach copies of professional drawings if available.

Flow Diagram – Please provide a flow diagram of the proposed and existing water system below and indicate the following items (if applicable): all equipment and treatment devices, detailed equipment plan indicating all types of treatment devices and operational equipment, including their intended use, water distribution lines, and hydrants/flushouts, and their connections to all water users. Be sure to indicate the direction path of flow through the system. Attach copies of professional drawings if available.

Signature

I certify that I am familiar with the information contained in this application, and that to the best of my knowledge and belief, this information is true, complete, and accurate.

Printed Name of Person Signing	Title
Address	Postal Code
Telephone Number	Email Address
Date of Application	Signature

APPENDIX C:

CT LOG INACTIVATION TABLES FOR FREE CHLORINE, CHLORINE DIOXIDE AND OZONE

Table C - 1: CT Values (min.mg/L) for Inactivation of Giardia lamblia Cysts by Free Chlorine at 0.5 °C or Lower

Free Chlorine Concentration (mg/L)	pH ≤ 6 Log Inactivation						pH = 6.5 Log Inactivation						pH = 7.0 Log Inactivation						pH = 7.5 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤ 0.4	23	46	69	91	114	137	27	54	82	109	136	163	33	65	98	130	163	195	40	79	119	158	198	237
0.6	24	47	71	94	118	141	28	56	84	112	140	168	33	67	100	133	167	200	40	80	120	159	199	239
0.8	24	48	73	97	121	145	29	57	86	115	143	172	34	68	103	137	171	205	41	82	123	164	205	246
1	25	49	74	99	123	148	29	59	88	117	147	176	35	70	105	140	175	210	42	84	127	169	211	253
1.2	25	51	76	101	127	152	30	60	90	120	150	180	36	72	108	143	179	215	43	86	130	173	216	259
1.4	26	52	78	103	129	155	31	61	92	123	153	184	37	74	111	147	184	221	44	89	133	177	222	266
1.6	26	52	79	105	131	157	32	63	95	126	158	189	38	75	113	151	188	226	46	91	137	182	228	273
1.8	27	54	81	108	135	162	32	64	97	129	161	193	39	77	116	154	193	231	47	93	140	186	233	279
2	28	55	83	110	138	165	33	66	99	131	164	197	39	79	118	157	197	236	48	95	143	191	238	286
2.2	28	56	85	113	141	169	34	67	101	134	168	201	40	81	121	161	202	242	50	99	149	198	248	297
2.4	29	57	86	115	143	172	34	68	103	137	171	205	41	82	124	165	206	247	50	99	149	199	248	298
2.6	29	58	88	117	146	175	35	70	105	139	174	209	42	84	126	168	210	252	51	101	152	203	253	304
2.8	30	59	89	119	148	178	36	71	107	142	178	213	43	86	129	171	214	257	52	103	155	207	258	310
3	30	60	91	121	151	181	36	72	109	145	181	217	44	87	131	174	218	261	53	105	158	211	263	316

Free Chlorine Concentration (mg/L)	pH = 8.0 Log Inactivation						pH = 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤ 0.4	46	92	139	185	231	277	55	110	165	219	274	329	65	130	195	260	325	390
0.6	48	95	143	191	238	286	57	114	171	228	285	342	68	136	204	271	339	407
0.8	49	98	148	197	246	295	59	118	177	236	295	354	70	141	211	281	352	422
1	51	101	152	203	253	304	61	122	183	243	304	365	73	146	219	291	364	437
1.2	52	104	157	209	261	313	63	125	188	251	313	376	75	150	226	301	376	451
1.4	54	107	161	214	268	321	65	129	194	258	232	387	77	155	232	309	387	464
1.6	55	110	165	219	274	329	66	132	199	265	331	397	80	159	239	318	398	477
1.8	56	113	169	225	282	338	68	136	204	271	339	407	82	163	245	326	408	489
2	58	115	172	231	288	346	70	139	209	278	348	417	83	167	250	333	417	500
2.2	59	118	177	235	294	353	71	142	213	284	355	426	85	170	256	341	426	511
2.4	60	120	181	241	301	361	73	145	218	290	363	435	87	174	261	348	435	522
2.6	61	123	184	245	307	368	74	148	222	296	370	444	89	178	267	355	444	533
2.8	63	125	188	250	313	375	75	151	226	301	377	452	91	181	272	362	453	543
3	64	127	191	255	318	382	77	153	230	307	383	460	92	184	276	368	460	552

Source: USEPA (1991) Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources

Table C - 2: CT Values (min.mg/L) for Inactivation of Giardia lamblia Cysts by Free Chlorine at 5 °C

Free Chlorine Concentration (mg/L)	pH ≤ 6						pH = 6.5						pH = 7.0						pH = 7.5					
	Log Inactivation						Log Inactivation						Log Inactivation						Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤ 0.4	16	32	49	65	81	97	20	39	59	78	98	117	23	46	70	93	116	139	28	55	83	111	138	166
0.6	17	33	50	67	83	100	20	40	60	80	100	120	24	48	72	95	119	143	29	57	86	114	143	171
0.8	17	34	53	69	86	103	20	41	61	81	102	122	24	49	73	97	122	146	29	58	88	117	146	175
1	18	35	53	70	88	105	21	42	63	83	104	125	25	50	75	99	124	149	30	60	90	119	149	179
1.2	18	36	54	71	89	107	21	42	64	85	106	127	25	51	76	101	127	152	31	61	92	122	153	183
1.4	18	36	55	73	91	109	22	43	65	87	108	130	26	52	78	103	129	155	31	62	94	125	156	187
1.6	19	37	56	74	93	111	22	44	66	88	110	132	26	53	79	105	132	158	32	64	96	128	160	192
1.8	19	38	57	76	95	114	23	45	68	90	113	135	27	54	81	108	135	162	33	65	98	131	163	196
2	19	39	58	77	97	116	23	46	69	92	115	138	28	55	83	110	138	165	33	67	100	133	167	200
2.2	20	39	59	79	98	118	23	47	70	93	117	140	28	56	85	113	141	169	34	68	102	136	170	204
2.4	20	40	60	80	100	120	24	48	72	95	119	143	29	57	86	115	143	172	35	70	105	139	174	209
2.6	20	41	61	81	102	122	24	49	73	97	122	146	29	58	88	117	146	175	36	71	107	142	178	213
2.8	21	41	62	83	103	124	25	49	74	99	123	148	30	59	89	119	148	178	36	72	109	145	181	217
3	21	42	63	84	105	126	25	50	76	101	126	151	30	61	91	121	152	182	37	74	111	147	184	221

Free Chlorine Concentration (mg/L)	pH = 8.0						pH = 8.5						pH ≤ 9.0					
	Log Inactivation						Log Inactivation						Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤ 0.4	33	66	99	132	165	198	39	79	118	157	197	236	47	93	140	186	233	279
0.6	34	68	102	136	170	204	41	81	122	163	203	244	49	97	146	194	243	291
0.8	35	70	105	140	175	210	42	84	126	168	210	252	50	100	151	201	251	301
1	36	72	108	144	180	216	43	87	130	173	217	260	52	104	156	208	260	312
1.2	37	74	111	147	184	221	45	89	134	178	223	267	53	107	160	213	267	320
1.4	38	76	114	151	189	227	46	91	137	183	228	274	55	110	165	219	274	329
1.6	39	77	116	155	193	232	47	94	141	187	234	281	56	112	169	225	281	337
1.8	40	79	119	159	198	238	48	96	144	191	239	287	58	115	173	230	288	345
2	41	81	122	162	203	243	49	98	147	196	245	294	59	118	177	235	294	353
2.2	41	83	124	165	207	248	50	100	150	200	250	300	60	120	181	241	301	361
2.4	42	84	127	169	211	253	51	102	153	204	255	306	61	123	184	245	307	368
2.6	43	86	129	172	215	258	52	104	156	208	260	312	63	125	188	250	313	375
2.8	44	88	132	175	219	263	53	106	159	212	265	318	64	127	191	255	318	382
3	45	89	134	179	223	268	54	108	162	216	270	324	65	130	195	259	324	389

Source: USEPA (1991) Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources

Table C - 3: CT Values (min.mg/L) for Inactivation of Giardia lamblia Cysts by Free Chlorine at 10°C

Free Chlorine Concentration (mg/L)	pH ≤ 6 Log Inactivation						pH = 6.5 Log Inactivation						pH = 7.0 Log Inactivation						pH = 7.5 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤ 0.4	12	24	37	49	61	73	15	29	44	59	73	88	17	35	52	69	87	104	21	42	63	83	104	125
0.6	13	25	38	50	63	75	15	30	45	60	75	90	18	36	54	71	89	107	21	43	64	85	107	128
0.8	13	26	39	52	65	78	15	31	46	61	77	92	18	37	55	73	92	110	22	44	66	87	109	131
1	13	26	40	53	66	79	16	31	47	63	78	94	19	37	56	75	93	112	22	45	67	89	112	134
1.2	13	27	40	53	67	80	16	32	48	63	79	95	19	38	57	76	95	114	23	46	69	91	114	137
1.4	14	27	41	55	68	82	16	33	49	65	82	98	19	39	58	77	97	116	23	47	70	93	117	140
1.6	14	28	42	55	69	83	17	33	50	66	83	99	20	40	60	79	99	119	24	48	72	96	120	144
1.8	14	29	43	57	72	86	17	34	51	67	84	101	20	41	61	81	102	122	25	49	74	98	123	147
2	15	29	44	58	73	87	17	35	52	69	87	104	21	41	62	83	103	124	25	50	75	100	125	150
2.2	15	30	45	59	74	89	18	35	53	70	88	105	21	42	64	85	106	127	26	51	77	102	128	153
2.4	15	30	45	60	75	90	18	36	54	71	89	107	22	43	65	86	108	129	26	52	79	105	131	157
2.6	15	31	46	61	77	92	18	37	55	73	92	110	22	44	66	87	109	131	27	53	80	107	133	160
2.8	16	31	47	62	78	93	19	37	56	74	93	111	22	45	67	89	112	134	27	54	82	109	136	163
3	16	32	48	63	79	95	19	38	57	75	94	113	23	46	69	91	114	137	28	55	83	111	138	166

Free Chlorine Concentration (mg/L)	pH = 8.0 Log Inactivation						pH = 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤ 0.4	25	50	75	99	124	149	30	59	89	118	148	177	35	70	105	139	174	209
0.6	26	51	77	102	128	153	31	61	92	122	153	183	36	73	109	145	182	218
0.8	26	53	79	105	132	158	32	63	95	126	158	189	38	75	113	151	188	226
1	27	54	81	108	135	162	33	65	98	130	163	195	39	78	117	156	195	234
1.2	28	55	83	111	138	166	33	67	100	133	167	200	40	80	120	160	200	240
1.4	28	57	85	113	142	170	34	69	103	137	172	206	41	82	124	165	206	247
1.6	29	58	87	116	145	174	35	70	106	141	176	211	42	84	127	169	211	253
1.8	30	60	90	119	149	179	36	72	108	143	179	215	43	86	130	173	216	259
2	30	61	91	121	152	182	37	74	111	147	184	221	44	88	133	177	221	265
2.2	31	62	93	124	155	186	38	75	113	150	188	225	45	90	136	181	226	271
2.4	32	63	95	127	158	190	38	77	115	153	192	230	46	92	138	184	230	276
2.6	32	65	97	129	162	194	39	78	117	156	195	234	47	94	141	187	234	281
2.8	33	66	99	131	164	197	40	80	120	159	199	239	48	96	144	191	239	287
3	34	67	101	134	168	201	41	81	122	162	203	243	49	97	146	195	243	292

Source: USEPA (1991) Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources

Table C - 4: CT Values (min.mg/L) for Inactivation of Giardia lamblia Cysts by Free Chlorine at 15°C

Free Chlorine Concentration (mg/L)	pH ≤ 6						pH = 6.5						pH = 7.0						pH = 7.5					
	Log Inactivation						Log Inactivation						Log Inactivation						Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤ 0.4	8	16	25	33	41	49	10	20	30	39	49	59	12	23	35	47	58	70	14	28	42	55	69	83
0.6	8	17	25	33	42	50	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86
0.8	9	17	26	35	43	52	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88
1	9	18	27	35	44	53	11	21	32	42	53	63	13	25	38	50	63	75	15	30	45	60	75	90
1.2	9	18	27	36	45	54	11	21	32	43	53	64	13	25	38	51	63	76	15	31	46	61	77	92
1.4	9	18	28	37	46	55	11	22	33	43	54	65	13	26	39	52	65	78	16	31	47	63	78	94
1.6	10	19	28	37	47	56	11	22	33	44	55	66	13	26	40	53	66	79	16	32	48	64	80	96
1.8	10	19	29	38	48	57	11	23	34	45	57	68	14	27	41	54	68	81	16	33	49	65	82	98
2	10	19	29	39	48	58	12	23	35	46	58	69	14	28	42	55	69	83	17	33	50	67	83	100
2.2	10	20	30	39	49	59	12	23	35	47	58	70	14	28	43	57	71	85	17	34	51	68	85	102
2.4	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86	18	35	53	70	88	105
2.6	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88	18	36	54	71	89	107
2.8	10	21	31	41	52	62	12	25	37	49	62	74	15	30	45	59	74	89	18	36	55	73	91	109
3	11	21	32	42	53	63	13	25	38	51	63	76	15	30	46	61	76	91	19	37	56	74	93	111

Free Chlorine Concentration (mg/L)	pH = 8.0						pH = 8.5						pH ≤ 9.0					
	Log Inactivation						Log Inactivation						Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤ 0.4	17	33	50	66	83	99	20	39	59	79	98	118	23	47	70	93	117	140
0.6	17	34	51	68	85	102	20	41	61	81	102	122	24	49	73	97	122	146
0.8	18	35	53	70	88	105	21	42	63	84	105	126	25	50	76	101	126	151
1	18	36	54	72	90	108	22	43	65	87	108	130	26	52	78	104	130	156
1.2	19	37	56	74	93	111	22	45	67	89	112	134	27	53	80	107	133	160
1.4	19	38	57	76	95	114	23	46	69	91	114	137	28	55	83	110	138	165
1.6	19	39	58	77	97	116	24	47	71	94	118	141	28	56	85	113	141	169
1.8	20	40	60	79	99	119	24	48	72	96	120	144	29	58	87	115	144	173
2	20	41	61	81	102	122	25	49	74	98	123	147	30	59	89	118	148	177
2.2	21	41	62	83	103	124	25	50	75	100	125	150	30	60	91	121	151	181
2.4	21	42	64	85	106	127	26	51	77	102	128	153	31	61	92	123	153	184
2.6	22	43	65	86	108	129	26	52	78	104	130	156	31	63	94	125	157	188
2.8	22	44	66	88	110	132	27	53	80	106	133	159	32	64	96	127	159	191
3	22	45	67	89	112	134	27	54	81	108	135	162	33	65	98	130	163	195

Source: USEPA (1991) Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources

Table C - 5: CT Values (min.mg/L) for Inactivation of Giardia lamblia Cysts by Free Chlorine at 20°C

Free Chlorine Concentration (mg/L)	pH ≤ 6 Log Inactivation						pH = 6.5 Log Inactivation						pH = 7.0 Log Inactivation						pH = 7.5 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤ 0.4	6	12	18	24	30	36	7	15	22	29	37	44	9	17	26	35	43	52	10	21	31	41	52	62
0.6	6	13	19	25	32	38	8	15	23	30	38	45	9	18	27	36	45	54	11	21	32	43	53	64
0.8	7	13	20	26	33	39	8	15	23	31	38	46	9	18	28	37	46	55	11	22	33	44	55	66
1	7	13	20	26	33	39	8	16	24	31	39	47	9	19	28	37	47	56	11	22	34	45	56	67
1.2	7	13	20	27	33	40	8	16	24	32	40	48	10	19	29	38	48	57	12	23	35	46	58	69
1.4	7	14	21	27	34	41	8	16	25	33	41	49	10	19	29	39	48	58	12	23	35	47	58	70
1.6	7	14	21	28	35	42	8	17	25	33	42	50	10	20	30	39	49	59	12	24	36	48	60	72
1.8	7	14	22	29	36	43	9	17	26	34	43	51	10	20	31	41	51	61	12	25	37	49	62	74
2	7	15	22	29	37	44	9	17	26	35	43	52	10	21	31	41	52	62	13	25	38	50	63	75
2.2	7	15	22	29	37	44	9	18	27	35	44	53	11	21	32	42	53	63	13	26	39	51	64	77
2.4	8	15	23	30	38	45	9	18	27	36	45	54	11	22	33	43	54	65	13	26	39	52	65	78
2.6	8	15	23	31	38	46	9	18	28	37	46	55	11	22	33	44	55	66	13	27	40	53	67	80
2.8	8	16	24	31	39	47	9	19	28	37	47	56	11	22	34	45	56	67	14	27	41	54	68	81
3	8	16	24	31	39	47	10	19	29	38	48	57	11	23	34	45	57	68	14	28	42	55	69	83

Free Chlorine Concentration (mg/L)	pH = 8.0 Log Inactivation						pH = 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤ 0.4	12	25	37	49	62	74	15	30	45	59	74	89	18	35	53	70	88	105
0.6	13	26	39	51	64	77	15	31	46	61	77	92	18	36	55	73	91	109
0.8	13	26	40	53	66	79	16	32	48	63	79	95	19	38	57	75	94	113
1	14	27	41	54	68	81	16	33	49	65	82	98	20	39	59	78	98	117
1.2	14	28	42	55	69	83	17	33	50	67	83	100	20	40	60	80	100	120
1.4	14	28	43	57	71	85	17	34	52	69	86	103	21	41	62	82	103	123
1.6	15	29	44	58	73	87	18	35	53	70	88	105	21	42	63	84	105	126
1.8	15	30	45	59	74	89	18	36	54	72	90	108	22	43	65	86	108	129
2	15	30	46	61	76	91	18	37	55	73	92	110	22	44	66	88	110	132
2.2	16	31	47	62	78	93	19	38	57	75	94	113	23	45	68	90	113	135
2.4	16	32	48	63	79	95	19	38	58	77	96	115	23	46	69	92	115	138
2.6	16	32	49	65	81	97	20	39	59	78	98	117	24	47	71	94	118	141
2.8	17	33	50	66	83	99	20	40	60	79	99	119	24	48	72	95	119	143
3	17	34	51	67	84	101	20	41	61	81	102	122	24	49	73	97	122	146

Source: USEPA (1991) Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources

Table C - 6: CT Values (min.mg/L) for Inactivation of Giardia lamblia Cysts by Free Chlorine at 25°C

Free Chlorine Concentration (mg/L)	pH ≤ 6						pH = 6.5						pH = 7.0						pH = 7.5					
	Log Inactivation						Log Inactivation						Log Inactivation						Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤ 0.4	4	8	12	16	20	24	5	10	15	19	24	29	6	12	18	23	29	35	7	14	21	28	35	42
0.6	4	8	13	17	21	25	5	10	15	20	25	30	6	12	18	24	30	36	7	14	22	29	36	43
0.8	4	9	13	17	22	26	5	10	16	21	26	31	6	12	19	25	31	37	7	15	22	29	37	44
1	4	9	13	17	22	26	5	10	16	21	26	31	6	12	19	25	31	37	8	15	23	30	38	45
1.2	5	9	14	18	23	27	5	11	16	21	27	32	6	13	19	25	32	38	8	15	23	31	38	46
1.4	5	9	14	18	23	27	6	11	17	22	28	33	7	13	20	26	33	39	8	16	24	31	39	47
1.6	5	9	14	19	23	28	6	11	17	22	28	33	7	13	20	27	33	40	8	16	24	32	40	48
1.8	5	10	15	19	24	29	6	11	17	23	28	34	7	14	21	27	34	41	8	16	25	33	41	49
2	5	10	15	19	24	29	6	12	18	23	29	35	7	14	21	27	34	41	8	17	25	33	42	50
2.2	5	10	15	20	25	30	6	12	18	23	29	35	7	14	21	28	35	42	9	17	26	34	43	51
2.4	5	10	15	20	25	30	6	12	18	24	30	36	7	14	22	29	36	43	9	17	26	35	43	52
2.6	5	10	16	21	26	31	6	12	19	25	31	37	7	15	22	29	37	44	9	18	27	35	44	53
2.8	5	10	16	21	26	31	6	12	19	25	31	37	8	15	23	30	38	45	9	18	27	36	45	54
3	5	11	16	21	27	32	6	13	19	25	32	38	8	15	23	31	38	46	9	18	28	37	46	55

Free Chlorine Concentration (mg/L)	pH = 8.0						pH = 8.5						pH ≤ 9.0					
	Log Inactivation						Log Inactivation						Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤ 0.4	8	17	25	33	42	50	10	20	30	39	49	59	12	23	35	47	58	70
0.6	9	17	26	34	43	51	10	20	31	41	51	61	12	24	37	49	61	73
0.8	9	18	27	35	44	53	11	21	32	42	53	63	13	25	38	50	63	75
1	9	18	27	36	45	54	11	22	33	43	54	65	13	26	39	52	65	78
1.2	9	18	28	37	46	55	11	22	34	45	56	67	13	27	40	53	67	80
1.4	10	19	29	38	48	57	12	23	35	46	58	69	14	27	41	55	68	82
1.6	10	19	29	39	48	58	12	23	35	47	58	70	14	28	42	56	70	84
1.8	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86
2	10	20	31	41	51	61	12	25	37	49	62	74	15	29	44	59	73	88
2.2	10	21	31	41	52	62	13	25	38	50	63	75	15	30	45	60	75	90
2.4	11	21	32	42	53	63	13	26	39	51	64	77	15	31	46	61	77	92
2.6	11	22	33	43	54	65	13	26	39	52	65	78	16	31	47	63	78	94
2.8	11	22	33	44	55	66	13	27	40	53	67	80	16	32	48	64	80	96
3	11	22	34	45	56	67	14	27	41	54	68	81	16	32	49	65	81	97

Source: USEPA (1991) Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources

Table C - 7: CT Values (min.mg/L) for Inactivation of Viruses by Free Chlorine

Temperature (°C)	Log Inactivation					
	2		3		4	
	pH Range		pH Range		pH Range	
	6 to 9	10	6 to 9	10	6 to 9	10
0.5	6	45	9	66	12	90
5	4	30	6	44	8	60
10	3	22	4	33	6	45
15	2	15	3	22	4	30
20	1	11	2	16	3	22
25	1	7	1	11	2	15

Source: USEPA (1991) Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources

Table C - 8: CT Values (min.mg/L) for Inactivation of Giardia lamblia Cysts by Chlorine Dioxide

Log Inactivation (min.mg/L)	Temperature (°C)					
	≤1	5	10	15	20	25
0.5	10	4.3	4	3.2	2.5	2
1	21	8.7	7.7	6.3	5	3.7
1.5	32	13	12	10	7.5	5.5
2	42	17	15	13	10	7.3
2.5	52	22	19	16	13	9
3	63	26	23	19	15	11

Source: USEPA (1991) Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources

Table C - 9: CT Values (min.mg/L) for Inactivation of Viruses by Chlorine Dioxide

Log Inactivation (min.mg/L)	Temperature (°C)					
	≤1	5	10	15	20	25
2	8.4	5.6	4.2	2.8	2.1	1.4
3	25.6	17.1	12.8	8.6	6.4	4.3
4	50.1	33.4	25.1	16.7	12.5	8.4

Source: USEPA (1991) Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources

Table C - 10: CT Values (min.mg/L) for Inactivation of Cryptosporidium Oocysts by Ozone

Log Inactivation (min.mg/L)	Temperature (°C)									
	≤0.5	1	2	3	5	7	10	15	20	25
0.5	12	12	10	9.5	7.9	6.5	4.9	3.1	2	1.2
1	24	23	21	19	16	13	9.9	6.2	3.9	2.5
1.5	36	35	31	29	24	20	15	9.3	5.9	3.7
2	48	46	42	38	32	26	20	12	7.8	4.9
2.5	60	58	52	48	40	33	25	16	9.8	6.2
3	72	69	63	57	47	39	30	19	12	7.4

Source: (2006) Code of Federal Regulations, 40 CFR 141.720

Table C - 11: CT Values (min.mg/L) for Inactivation of Giardia lamblia Cysts by Ozone

Log Inactivation (min.mg/L)	Temperature (°C)					
	≤1	5	10	15	20	25
0.5	0.48	0.32	0.23	0.16	0.12	0.08
1	0.97	0.63	0.48	0.32	0.24	0.16
1.5	1.5	0.95	0.72	0.48	0.36	0.24
2	1.9	1.3	0.95	0.63	0.48	0.32
2.5	2.4	1.6	1.2	0.79	0.6	0.4
3	2.9	1.9	1.43	0.95	0.72	0.48

Source: USEPA (1991) Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources

Table C - 12: CT Values (min.mg/L) for Inactivation of Viruses by Ozone

Log Inactivation (min.mg/L)	Temperature (°C)					
	≤1	5	10	15	20	25
2	0.9	0.6	0.5	0.3	0.25	0.15
3	1.4	0.9	0.8	0.5	0.4	0.25
4	1.8	1.2	1	0.6	0.5	0.3

Source: USEPA (1991) Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources

APPENDIX D:

SMALL GROUNDWATER AND SURFACE WATER SYSTEM START-UP AND SHUTDOWN SELF-INSPECTION CHECKLIST

Appendix D1: Small Groundwater System Start-up or Shutdown Self-Inspection List

Location: **Date Submitted:**
Operator Name:

Administrative

Has the local Public Health Inspector been contacted? (For Start-up situations, ensure that the Public Health Inspector is contacted prior to providing water from the waterworks to consumers.)	Yes: _____ No: _____ Date:
Is the chlorine test kit working (calibrated or verified by standards) and are the reagents fresh (check expiry date)?	Yes: _____ No: _____ Date:
Have chlorine solutions greater than 12 months old (6 months old for open containers) been discarded and a new supply obtained?	Yes: _____ No: _____ Date:

Well Source and Pumphouse

Is the pumphouse locked and secured?	Yes: _____ No: _____ Date:
Are all chemicals (other than disinfectants) stored away from the well?	Yes: _____ No: _____ Date:
Is there any sign of animal activity inside the well house or within the immediate area of the well? (Look for droppings, chewed papers or nesting materials)	Yes: _____ No: _____ Date:
Is the well cap free of openings that would allow insects to enter the well?	Yes: _____ No: _____ Date:
Is the area surrounding the well built up and sloped away from the well?	Yes: _____ No: _____ Date:
Is the well protected from tampering?	Yes: _____ No: _____ Date:
If used, is the water meter working? Meter Reading: _________________	Yes: _____ No: _____ Date:
What is the static water level of the well? Depth from top of casing: __________ Ft or M (Ensure to disinfect probe before monitoring)	Yes: _____ No: _____ Date:
Has the well been shock chlorinated (low level)?	Yes: _____ No: _____ Date:

Has the well been flushed (at least 4 well volumes per day)?	Yes: _____ No: _____ Date:

Chlorination

Is the chlorinator dosing the water adequately? (This can be determined by checking the chlorine residual at the far extents of the distribution system, if present, on a number of consecutive days)	Yes: _____ No: _____ Date:
Has the chlorine injector and foot valve been serviced?	Yes: _____ No: _____ Date:
Has the chlorine pump been calibrated?	Yes: _____ No: _____ Date:

Pressure Tanks

If used, do the air/water level controls function properly?	Yes: _____ No: _____ Date:
During start-up make sure that pressure tanks are pressurized.	Yes: _____ No: _____ Date:

Storage Tanks

Has the tank been drained prior to shutdown?	Yes: _____ No: _____ Date:
Has the tank been inspected to determine if it requires cleaning? If the tank has a layer of deposition, has it been cleaned?	Yes: _____ No: _____ Date:
If an exterior hatch is present, is it locked?	Yes: _____ No: _____ Date:
Are the tank vents and overflow properly screened?	Yes: _____ No: _____ Date:
Are animals (birds, bats, gophers) kept out of the storage tank?	Yes: _____ No: _____ Date:
Are the water level controls operating properly?	Yes: _____ No: _____ Date:

Treatment Components

Have all treatment components been drained during extended shutdown periods?	Yes: _____ No: _____ Date:
Have all chemical feed tanks been cleaned, and the unused chemical properly disposed of (for shutdown) or remixed (for start-up)?	Yes: _____ No: _____ Date:
Have the required bacteriological samples and other tested been submitted?	Yes: _____ No: _____ Date:
Refer to advice from your manufacturer on proper storage methods for equipment, chemicals, or filter media.	Yes: _____ No: _____ Date:

Mechanical & Electrical

If you have a backup generator, is the fuel and generator stored so any fuel leaks will be captured in a containment area?	Yes: _____ No: _____ Date:
Is the main power to the pumps and treatment equipment off during start-up and shutdown maintenance procedures? (In most cases, the power should be left off during extended shutdown periods.)	Yes: _____ No: _____ Date:
Have all pumps and motors been inspected to determine if maintenance is required, and maintenance performed if required?	Yes: _____ No: _____ Date:

Distribution System (If present)

Are there any distribution lines visible on the surface when the location of distribution lines is walked?	Yes: _____ No: _____ Date:
Has each valve in the distribution system been located, and exercised (closed and re-opened)?	Yes: _____ No: _____ Date:
Are all outdoor hose bibs provided with backflow prevention devices?	Yes: _____ No: _____ Date:
Have all cross-connection devices been tested, if possible, and replaced, if required?	Yes: _____ No: _____ Date:
If a sewage dump station is present, are any water lines present that can reach the sewer pad (this should not be possible)?	Yes: _____ No: _____ Date:
Has the distribution system been superchlorinated?	Yes: _____ No: _____ Date:

This guidance is provided as information only and may not be applicable or complete in all cases.

Appendix D2: Small Surface Water System Start-up or Shutdown Self-Inspection List

Location:	**Date Submitted:**
Operator Name:	
Administrative	
Has the local Public Health Inspector been contacted? (For Start-up situations, ensure that the Public Health Inspector is contacted prior to providing water from the waterworks to consumers.)	Yes: _____ No: _____ Date:
Is the chlorine test kit working (calibrated or verified by standards) and are the reagents fresh (check expiry date)?	Yes: _____ No: _____ Date:
Have chlorine solutions greater than 12 months old (6 months old for open containers) been discarded?	Yes: _____ No: _____ Date:
Pumphouse	
Is the pumphouse, if present, locked and secured?	Yes: _____ No: _____ Date:
Is there any sign of animal activity inside the pump house or within the immediate area of the well? (Look for droppings, chewed papers or nesting materials)	Yes: _____ No: _____ Date:
If used, is the water meter working? Meter Reading: ____________	Yes: _____ No: _____ Date:
Chlorination	
Is the chlorinator dosing the water adequately? (This can be determined by checking the chlorine residual at the far extents of the distribution system, if present, on a number of consecutive days)	Yes: _____ No: _____ Date:
Has the chlorine injector and foot valve been serviced?	Yes: _____ No: _____ Date:
Has the chlorine pump been calibrated?	Yes: _____ No: _____ Date:
During start-up make sure that pressure tanks are pressurized.	Yes: _____ No: _____ Date:
Storage Tanks	
Has the tank been drained prior to shutdown?	Yes: _____ No: _____ Date:

Has the tank been inspected to determine if it requires cleaning? If the tank has a layer of deposition, has it been cleaned?	Yes: _____ No: _____ Date:
If an exterior hatch is present, is it locked?	Yes: _____ No: _____ Date:
Are the tank vents and overflow properly screened?	Yes: _____ No: _____ Date:
Are animals (birds, bats, gophers) kept out of the storage tank?	Yes: _____ No: _____ Date:
Are the water level controls operating properly?	Yes: _____ No: _____ Date:

Treatment Components

Have all treatment components been drained during extended shutdown periods?	Yes: _____ No: _____ Date:
Have all chemical feed tanks been cleaned, and the unused chemical properly disposed of (for shutdown) or remixed (for start-up)?	Yes: _____ No: _____ Date:
Have the required bacteriological samples and other tested been submitted?	Yes: _____ No: _____ Date:
Refer to advice from your manufacturer on proper storage methods for equipment, chemicals, or filter media.	Yes: _____ No: _____ Date:

Mechanical & Electrical

If you have a backup generator, is the fuel and generator stored so any fuel leaks will be captured in a containment area?	Yes: _____ No: _____ Date:
Is the main power to the pumps and treatment equipment off during start-up and shutdown maintenance procedures? (In most cases, the power should be left off during extended shutdown periods.)	Yes: _____ No: _____ Date:
Have all pumps and motors been inspected to determine if maintenance is required, and maintenance performed if required?	Yes: _____ No: _____ Date:

Distribution System (If present)

Are there any distribution lines visible on the surface when the location of distribution lines is walked?	Yes: _____ No: _____ Date:

Has each valve in the distribution system been located, and exercised (closed and re-opened)?	Yes: _____ No: _____ Date:
Are all outdoor hose bibs provided with backflow prevention devices?	Yes: _____ No: _____ Date:
Have all cross-connection devices been tested, if possible, and replaced, if required?	Yes: _____ No: _____ Date:
If a sewage dump station is present, are any water lines present that can reach the sewer pad (this should not be possible)?	Yes: _____ No: _____ Date:
Has the distribution system been superchlorinated?	Yes: _____ No: _____ Date:

This guidance is provided as information only and may not be applicable or complete in all cases.