Canadian Guidance Document for Managing Drinking Water Systems

A Risk Assessment / Risk Management Approach

Prepared for Health Canada

by:

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1. Preamble

Much is written in many fields of activity, including in the activity of drinking water supply, about risk assessment and risk management. Mingled with the term risk, and often used interchangeably, is the term hazard. It is appropriate to establish a common understanding of what it is that is encompassed by these terms.

- a **hazard** is a biological, chemical, physical or radiological agent that has the potential to cause harm;
- a **hazardous event** is an incident or situation that can lead to the presence of a hazard (i.e., what can happen and how); and
- **risk** is the likelihood of identified hazards causing harm in exposed populations in a specified time frame, including the magnitude of that harm or the consequences.

Risk assessment is therefore an orderly methodology of identifying potential hazards or hazardous events that may affect the desired outcomes of a given activity or process and evaluating their significance. **Risk management** is an orderly methodology of determining what measures should be instituted to prevent the occurrence of significant risks or (conjunctively) responding to those risks should they occur in order to return the process to the desired outcomes as soon as possible.

Across Canada there are many management tools, regulatory and non-regulatory, to assist managers in the operation and maintenance of their drinking water facilities. Larger municipalities often have a multi-disciplinary team and the relevant resources to ensure their staff are following prescribed and formalized operating procedures and work instructions and methods in the management of their water supply systems. In smaller municipalities and at the local level, i.e. on-site systems, there are tools available but these are not often as formalized as those used by the larger centralized systems.

The World Health Organization (WHO), in the publication of its 2004 Guidelines, recommends the establishment of a *Water Safety Plan* for every water system - whether a municipal system or not (i.e., the safety plan is applicable in principle to stand-alone systems, seasonal camp grounds, as well as industrial water plants). The *Bonn Charter for Safe Drinking Water* (developed over several years by drinking water regulators, drinking water service providers and drinking water professionals from around the world through the International Water Association) also speaks to the need for integrated water safety plans based on a risk assessment and risk management process from the catchment (source) to the tap. The Federal-Provincial-Territorial Committee on Drinking Water (FPTCDW) and the Canadian Council of Ministers of the Environment (CCME), have developed a risk-based “Source to Tap” multi-barrier approach to managing drinking water systems in Canada.

The application of risk assessment and risk management principles to drinking water systems is a common sense procedure, and in Canada it is sometimes applied first by the provincial or territorial governments in establishing general and sometimes specific requirements for water treatment plants. It is also applied by the water utilities themselves in the conduct of their operations and activities. Larger municipalities will often have a dedicated process for the application of these principles. The proposed Ontario Drinking Water Quality Management Standard (DWQMS) will require all water utilities in Ontario to develop operational plans. The

Ontario Standard uses as a base the ISO 9001 quality management standard and the Hazard Analysis and Critical Control Points methodology (HACCP), a process originally developed for the food industry to assure food safety and quality. Some progressive Canadian municipalities have already adopted the ISO 9001 standard and HACCP methodologies to their water supply operations. These standards and management systems however, require considerable training, costs, and may be too sophisticated for the small, remote, or non-municipal systems.

Although rudimentary risk assessment and risk management principles are often applied to drinking water systems, the approach and key hazard information is often not formalized or collated into one comprehensive procedure that can be understood and followed by those responsible for the operation and maintenance of the system. The intent of this document is to provide guidance for a step-wise methodology useable by all drinking water system operators (e.g., individual home owners, institutions, truck stops, northern and remote communities, as well as small and large municipalities) to ensure that they have adequately determined the risks and know how to manage those risks within their system. The aim of this document is to ensure managers follow a systematic process based on science that is recorded and documented and, as necessary, verified and validated. This is an iterative process to ensure that the hazards and hazardous events identified have not changed, or that there is not a more appropriate risk management strategy that could be followed. There must be follow-up actions to ensure this iterative process is successful and that opportunities for continuous improvement are acted upon. Although we often assume we know all the hazards and hazardous events, and the consequent risks associated with our drinking water systems, it is surprising to discover the number of things that are identified as being deficient if we follow a systematic process as to:

- What kind of system we have;
- Where the water comes from;
- How it is treated;
- How it is distributed; and
- Its final use(s).

If followed, this guidance document will force users to look at what they are currently doing and what they should be doing to protect human health.

This document is a “guidance” document only. It is not a tool to measure compliance but one to assure due diligence by linking science-based risk management to site-specific operational activities.

The document is intended to outline a simple protocol, based on HACCP and other risk assessment / risk management approaches for managers of all drinking water systems to follow. It can be used in conjunction with existing formalized management processes (HACCP, ISO, Water Safety Plans, etc.) that address large complex systems, or equally, can be applied to small systems or one aspect or feature of any drinking water system.

2. Introduction

The varying structures of Canada's drinking water supply systems and the complexity of the regulatory and policy framework within which they act are complicating factors in the application of risk assessment and risk management models. Drinking water service managers also may not have complete responsibility for the entire system from source to tap, and are likely to be subject to programs and policies of senior levels of government that are not in themselves integrated.

Drinking water services in Canada (for the most part, owned and operated by municipal governments) are subject to regulations from the two senior levels of government. The objective of the regulations is to provide and ensure safe potable water to all customers within the service's jurisdiction. Traditionally water services function through a number of separate components – e.g., water access/withdrawal, water treatment and water distribution. Water quantity and quality are facets of each of these components. They are or may be regulated by different components of a single government department, or different departments, or a different level of government. Several models for service delivery are in place at the municipal level. Water systems may be divided between departments of a city administration or Regional government systems. For example: the local (constituent) municipalities may manage the local distribution system, while the upper tier regional government may own, operate and manage the treatment facility and the trunk distribution system. Provincial and federal departments are responsible, through overlapping constitutional authorities[1], for the protection of the source water and wastewater discharge points. In addition, a number of federal and provincial government agencies are also purveyors of water – e.g., those who operate parks, correctional institutions, border crossings, ports and airports. Of particular interest, First Nations communities under Indian and Northern Affairs Canada (INAC) own and operate their water treatment and distribution systems but the systems are paid for by INAC. Health Canada is responsible for ensuring safe water on First Nations' lands. In some cases a First Nations' Band provides water to a municipality and in others they receive it from a municipality. Lack of clear interdepartmental responsibilities and accountabilities (within a municipality) can also create another layer of confusion. The result is the potential for errors and oversights that in the extreme can create a situation as devastating as the waterborne emergencies of Walkerton or North Battleford. Woven into this complex web are the various pieces of legislation, best management practices, standards and guidelines available to water managers.

The "Source to Tap" framework provides formalized procedures that can be implemented to aid managers in source to tap protection. The framework, available through both the CCME and the Health Canada website, outlines the opportunities for water managers to implement a multi-barrier approach to protect water from the source (ground or surface water) to tap. It endorses the use of approaches like HACCP, ISO and Water Safety Plans; however it does not assist the operator in determining crucial monitoring and control points in the system from source through treatment through distribution to the user's tap. This is where a national guidance document on risk assessment and risk management, such as that followed by the food processing industry's

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[1] Protection of water sources is sometimes exercised at the municipal level through land use-planning and zoning, for example to protect aquifer recharge areas, or to control watersheds. Unfortunately though for most municipal systems, the watershed is normally outside the geographic boundaries of their municipal jurisdiction.

critical points assessment is warranted for Canada. As applied in the food industry, it is known as *Hazard Analysis and Critical Control Points (HACCP).* However, the HACCP approach has to be adapted to suit the drinking water supply service sector to take into account the multi-barrier approach already common in these services.

Drinking water system operators should be prepared to reflect their actual operations amongst the following suggested basic elements of a risk assessment / risk management plan. These are not the only situations, so care should be taken to include your site-specific needs.

Source water elements

- surface water sources (could include rain harvesting and reclaimed wastewater), and
- ground water sources.

Intake and/or transmission elements

- lake or river bed intakes or well heads,
- connections to neighbouring water supply systems, and
- transmission pipes from intakes or connections to treatment plants

Treatment plant elements

- chemical dosing facilities,
- flocculation and coagulation units,
- post treatment disinfection, and
- on-site storage and reservoirs

Storage and distribution elements

- piped distribution systems (i.e., all distribution is carried out by piped systems), and
- truck distribution systems (i.e., distribution by truck with or without interim storage).

Customer elements

- interactions with others - e.g. domestic and commercial, industrial and institutional customers or neighbouring municipalities. Generally a municipality supplies water to the property line of a property owner. ~~and that is where their plan would end~~. (The property owner should consider developing a risk assessment and risk management plan if the distribution of water is extensive within the property such as a large industrial or institutional property).
- customers can also be considered as sources of potential hazards (e.g. with building management activities or point-of-entry treatment, or in the industrial and commercial sector particulaly there may be potential back flows, and system cross connections that could impact the safety of the water in the distribution system before the point of delivery.

The current guidance document has been developed through review of relevant existing guidance material both in Canada and in other countries, and through consultation with staff of selected municipalities across Canada. It will be further refined as it is used and new insights are gained.

3. Prerequisites for getting started

Before developing a comprehensive management plan[2] there are a number of prerequisites and programs that need to be developed and available to water supply system managers. These are:

1. A proactive staff and management;
2. A reporting structure within the organization;
3. An understanding of all pertinent legal requirements;
4. Training programs to ensure operator competency;
5. Up-to-date operational manuals for equipment and processes; and
6. A preventative maintenance and breakdown response program for all equipment used in the system.

3.1 Basic Steps

Once the prerequisites are in place, there are a number of initial steps that are necessary before developing the risk assessment / risk management plan. The information gathered in these initial steps is crucial for developing an effective management plan for the water system.

1. Assemble the team that will be responsible for developing and implementing your specific risk assessment and risk management plan;
2. Identify the product that you are delivering and the goals for that product[3];
3. Identify the intended use(s) of the product;
4. Construct schematics and flow charts to assist each team member's understanding of the drinking water system from source to point of delivery to the client and specifically identify each process step;
5. Take a tour of the entire system to identify component parts and confirm the flow charts;
6. Ensure all team members are engaged in the development process and undertake regular discussion sessions to reflect upon and refine your plan(s);
7. Record all the information gathered for review and potential revision.

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[2] It may be possible to have an overall plan for the entire system from source to the point of delivery to the client or it may be desirable to have individual plans to address each component of the overall system. This will depend on the infrastructural or institutional complexity of the system and the nature of the team set up to develop and oversee the plan.

[3] The product is dependent on the system that is to be evaluated – it may be raw water if the end of the system is the treatment plant, or it would be potable water if the end of the system is the client. The goals may address quality, quantity or continuity of service.

Let's break this down further!

1. **Assemble the team that will be responsible for developing and implementing your specific risk assessment and risk management plan(s).**

   - A team should be assembled that is familiar with the product and the specific processes. The team's goal and each member's responsibilities in reaching that goal must be clearly defined;
   - The team should have expertise in public health issues, process controls and knowledge of the types of drinking water safety hazards and hazard events that may be encountered;
     - Specialist external support, scientific or technical expertise may be necessary. External expertise may include engineers, microbiologists, chemists, toxicologists, statistical process control experts (to determine process capability) and other experts familiar with risk assessment and risk management strategies.
   - The team should have the authority to implement any necessary changes to ensure safe drinking water is being produced;
   - The team should include people who are directly involved with the daily operations such as operational staff, line supervisors, etc.;
   - There should be sufficient people on the team to allow for a multi-disciplinary approach, but not so many that the team has difficulty making decisions (for small water systems there might be two or three members but in a larger service, a multi-disciplinary team should be formed) in either case, personnel from neighbouring services might be included;
   - The team leader must be familiar with all areas of the operation while the various resource groups that are drawn from specific operational areas provide information and assistance specific to that operational area.

2. **Identify the product that you are delivering and the goals for that product.**

   - The product[4] should be described by the team (i.e. source of supply, physical and chemical characteristics, process and treatment steps, storage and distribution);
   - Identify and determine the quality, quantity and the potential for long term quality and quantity control over the product.

3. **Identify the intended use(s) of the product.**

   This step requires a description of the intended use of the product and includes the following:

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[4] To repeat footnote 3, the product is dependent on the system that is to be evaluated – it may be raw water if the end of the system being assessed is the treatment plant, or it would be potable water if the end of the system is delivery to the client. The goals may address quality, quantity or continuity of service.

- How the -water be will used if not for potable/drinking purposes.
- Who is the drinking water intended for? Users or customers with their specific needs as a population should be identified (i.e. kidney dialysis patients, vulnerable groups, etc.)
- What consumer instructions are there for the use of the drinking water?
- How are these instructions communicated to the consumers?

4. **Construct schematics and flow charts to assist each team members' understanding of the system (eg. from source to point of delivery to the client) and specifically identify each process step**
   (The schematics and flow charts developed will be used to aid in the development of the risk assessment / risk management plan for the drinking water system).

   - This step requires a schematic or flow chart of the general characteristics of the water source, through the operational processes to providing drinking water to the consumers;
   - The flow chart must include all process steps, all inputs (such as treatment chemicals, filtration materials, and energy) and outputs (such as finished water and residues) and should include the start and finish of responsibilities for the water purveyor;
   - The schematic or flow chart should include all components of the water system that have the potential to change the qualities/quantities of the product;
   - For example the components of the water system could include (but not be limited to):
     - source waters,
     - pumping stations,
     - water treatment processes,
     - transmission systems,
     - mains distribution systems,
     - local distribution systems to the client's property

   An example of a drinking water supply system schematic and a flow chart are presented in Annex 1.

5. **Take a tour of the entire system to identify component parts and confirm the schematic and flow charts.**

   - Verify that the schematic and flow charts are complete and accurate;
   - Assure that each team member is familiar with each step in the system.

6. **Ensure all team members are engaged in the development of the risk assessment / risk management plans.**

   - There should be regular meetings to review and update the plans as required;
   - No one should assume that everyone and everything is known or functioning properly.

7. **Establish a system and be prepared to record all the information gathered for review and potential revision.**

   - Documenting the risk assessment / risk management plan is an essential part of the process and contributes to due diligence;

- Tables for the compilation of data are suggested in the rest of this chapter, and form the basis for the proposed summary Risk Assessment / Risk Management Template which will be the core feature of the Plan.

An example of the summary Risk Assessment / Risk Management Template is shown in Annex 4 following the discussion below.

4 Developing the Risk Assessment / Risk Management Plan

Using the information and the ideas from the initial steps completed above, the team can now develop a risk assessment / risk management plan. The plan should reflect also the multi-barrier approach to safe drinking water which requires that hazards be addressed as soon as possible in the system and that back up measures be put in place in the case of failure. The steps outlined below will lead the team through the process of identifying existing or potential hazards for the drinking water system, determining the hazards that are or could be significant, and developing a plan for managing the water system to ensure any health risk from a significant hazard is reduced to an acceptable level. In the multi-barrier approach, there are two or more control points, the last one sequentially is defined as the critical control point since there is no further barrier. This step is one of information gathering and preparation of data management systems. Control points can or should have a number of characteristics: there must be an opportunity to make an intervention that would change the level of hazard or hazardous event, there must be an opportunity to measure the hazard or hazardous event (and ideally, the measurement should be measurable in real time), and the effect of the control action taken should be measurable.

Tables and procedures are required to provide a structured approach for determining and recording:

- the hazards or the potential for hazardous events within the elements or process steps of your system,
- if the hazards are significant,
- whether the element or process step is a control point or a critical point within the system,
- if it is a contol point or a critical control point, the activities that need to be in place to ensure the water remains safe, and
- for recording the corrective actions taken that may have been taken in the operation of the system and reporting them.

These are presented as four separate tables that are sequentially expanded (with some repetition of columns for linkage purposes) to include the additional data and to better explain the steps of the process. Annex 4 contains the combined tables that would be completed to form part of your risk assessment / risk management plan. It is expected that the information gathered would become part of an electronic database, that would be linked to other data bases of operational activities and monitoring results that would be subject to the periodic review of the plan.

4.1 Potential hazards and hazardous events should be identified and considered

All potential hazards and hazardous events, large and small, should be identified, recognized as important and prioritized. A significant hazard or hazardous event is one that must be prevented, eliminated or reduced to acceptable levels to produce safe drinking water. A hazard may be biological, chemical, physical or radiological in nature and can cause drinking water to be unsafe. A **hazardous event** is an incident or situation that can lead to the presence of a hazard (i.e., what can happen and how) – hazardous events can be natural (e.g., extreme weather situations such as floods or geological – earthquakes, etc.) or technological (within the system such as equipment failure, or external such as a power grid failure). The analysis of hazards and hazardous events requires the assessment of two factors, i.e., the likelihood that the hazard or event will occur and the severity of consequences if it does occur. Hazard analysis also involves identification and establishment of preventive measures for control. All hazards and hazardous events, their significance, and control measures should be documented. Someone on your team should be able to assist in identifying potential problems in your own system.

Hazards or hazardous events that involve low consequence severity or that are not likely to occur, while being identified, should not be considered in the plan until after the significant hazards or hazardous events have been managed. There are likely to be other hazards or events that will not be readily identified until after you start to work through your plan and rigorously review it. Each plan will be site specific according to your water system.

4.1.1 Types of Hazards

Biological Hazards

Because of their ability to quickly cause widespread severe illness, disease-causing (pathogenic) microorganisms pose the greatest risk to customers. Consequently, as drinking water supply services work to control all drinking water related risks, measures to control biological risks should <u>not be compromised</u>. Controlling biological risks may often require a balance between public health protection and chemical usage, for example in the usage of chlorine and the creation of disinfection byproducts. Waterborne biological hazards include bacterial, viral and parasitic organisms. These organisms are commonly associated with faecal wastes from humans and other animals, and some can occur naturally in the environment. Although most bacteria are not pathogenic, pathogens such as *E.coli* O157, *Legionella*, *Salmonella typhi,* and *Shigella* are commonly associated with waterborne disease. Viruses of concern include, but are not limited to, Hepatitis A and Norovirus. Protozoa of concern include *Giardia* and *Cryptosporidium;* both are common contaminants in natural bodies of surface water. Most waterborne pathogens are removed or inactivated by appropriate control measures such as: ultraviolet light treatment, chlorine dosing and chemically assisted filtration. Post-treatment control measures may include: backflow prevention programs, inspection programs or cleaning and flushing of pipes to remove biofilms.

Chemical Hazards

Chemical contaminants may be naturally occurring or may be added or created during the processing of water. Harmful chemicals at high levels have been associated with acute cases of waterborne illnesses and can be responsible for chronic illness at lower levels of exposure. Chemical hazards in drinking water may come from the source water or occur in the treatment and distribution system. They include but are not limited to: toxic spills, naturally occurring minerals, heavy metals, dissolved gases (e.g. radon), pesticides, fertilizers, endocrine disruptors, personal care products and pharmceutical residuals, cyanotoxins, flocculants, coagulants, lubricants, copper, iron, zinc, and lead from pipes and fittings. Chemical hazards can be avoided or managed by implementing appropriate control measures such as source management, dosing equipment controls, treatment processes and process optimization.

Physical Hazards

Physical hazards can result from contamination and/or poor procedures at different points in the chain from source to customer. Sediments are the most common physical hazard associated with drinking water and are of concern as they may carry with them microbiological hazards and interfere with disinfection system efficacy. Monitoring turbidity levels is an essential precursor activity to control measures in the treatment system. Control measures at the source can include grass strips on all water/land interfaces. Other physical hazards include biofilms, pipe materials or sloughed metal. Some of the control measures for physical hazards include but again are not limited to: cleaning and maintenance of mains, replacing unlined pipes and fittings, and chemically assisted filtration (coagulation and flocculation).

Radiological Hazards

Radiological hazards may arise from man-made or natural sources, with naturally occurring chemicals (uranium, radon, etc.) most frequently being found in groundwater. If there is the potential for the accidental release of man-made radiologicals, such as tritium or other radionuclides, these sources should also be considered. With accidental releases, surface waters are generally at a greater risk.

4.2 How to determine if there is a significant hazard

The following Table provides a structure for recording the identified hazards or the potential for hazardous events within the elements or process steps of your system and for determining if the hazards are significant. **Annexes 1 and 2** provide examples that may be included in the first two columns of Table 1.

It is normal that only a small percentage of the hazards or hazardous events will be characterized as significant hazards or hazardous events (see Section 4.3 below). Some planners may choose at this point of the Plan, while keeping the original Table 1 as a reference point subject to review periodically, to select only the significant hazards and hazardous events to proceed to Table 2 which will address whether or not there is a contol point or a critical control point in respect of the hazard or event.

Table 1 is provided as a means of combining the assessments made to this point.

Table 1 – Determination of a Significant Hazard or Hazardous Event based on Risk Factor Assessment

Element or process step	Potential hazard or hazardous event	Description of the likelihood and consequence of the Hazard or Hazardous Event.	Available control measures	Likelihood rating	Consequence rating	Combined risk assessment	Determination as a significant hazard or hazardous event (Yes/No)

Column 1: Identifies the **Element or process step** – e.g., water source, treatment plant, etc.(See Annex 1)
Column 2: Describes the **Potential hazard or hazardous event** – e.g., protozoa, power grid failure, etc.(See Annex 2)
Column 3: Gives a **Description of the likelihood and consequence of the hazard or hazardous event** – e.g., following severe rainstorms, the source water is likely to be contaminated by contaminated runoff from adjacent farms with protozoa present, etc.
Column 4: Describes any **Available control measures** – e.g., implementation of grass strips along all water courses, switch to alternative water sources during and following the event, etc.
Column 5: Estimates the **Likelihood rating** – e.g., low, medium, high etc. (See section 4.3).
Column 6: Estimates the **Consequence rating** – e.g., low, medium, high etc. (See section 4.3).
Column 7: Provides the **Combined risk assessment** – e.g., low, medium, high etc. (See section 4.3).
Column 8: Indicates whether the **Potential hazard or hazardous event** is considered **a significant hazard or hazardous event (Yes/No)**.

4.3 How to determine what the significance of the hazard or hazardous event and the consequent risk?

Risk is considered to be the probability/likelihood of a hazard or hazardous event occurring, multiplied by some indicator of the consequence if it occurs, i.e. RISK = FREQUENCY x CONSEQUENCE. Frequency and Consequences are almost always expressed by a system of numerical weighting factors. Some events or hazards are more likely to occur, others less likely (likelihood/probability of occurrence) and some of the events or hazards will have low severity consequences and other potentially high severity. Typically high likelihood / high consequence events are given priority, and low likelihood / low consequence events are not prioritized for management actions until the high priority events are managed. The team performing the analysis will rely on site-specific knowledge of the water system from source to the point of delivery in order to characterize the significance of the risk.

An example of a numerical risk-rating scheme is presented in Table 1A.

Table 1A – Possible Rating Scheme for Likelihood and Consequence Factors[5]

Likelihood of Occurrence	Rating	Consequence of Occurrence	Rating
Has not occurred	1	Limited Public exposure, little or no health risk	1
Rare (Hazard has occurred but as 5 or 10 year events)	2	Limited Public exposure, minor health risk	2
Possible (hazard occurs on a yearly basis)	3	Public at Risk, minor discomfort	3
Occasional (hazard occurs on a monthly basis)	4	Public at Risk, potential for major illness	4
Frequent (hazard occurs on a weekly basis or less)	5	Multiple deaths or widespread major illness.	5

Likelihood is determined by "how often' or "how likely" a hazard or a hazardous event occurs. It must take into account hazards that have occurred in the past and their likelihood of re-occurrence and must also predict the likelihood of hazards and events that have not occurred to date. Emergency events and predictable events should also be considered.

Consequence looks at the severity of the results of the hazard/hazardous event and the seriousness or intensity of the impact of the hazard. When dealing with impact we are concerned with human health only. The consequence of an event can be affected by the concentration of contaminants present and their nature, the duration of the exposure (in time) and the geographical area of the exposure or the number of persons exposed. Sensitivity of the exposed population may also be a factor in determining consequence.

Multiplying the derived likelihood ratings with derived consequence ratings from the above table is a simple way of producing a risk rating: e.g., a likelihood rating of 2 multiplied by a consequence rating of 4 would give a risk rating of 2 x 4 = 8, which would be ranked higher than an event with a likelihood of 1 and a consequence of 5 and a risk rating of 1 x 5 = 5. However this does not address well the variations in likelihood and consequence. Alternatively, accelerated rating scales (1, 3, 5, 7, and 9 instead of 1, 2, 3, 4 and 5) or even exponential or log scales might be chosen to give greater emphasis to high likelihood and high consequence events.

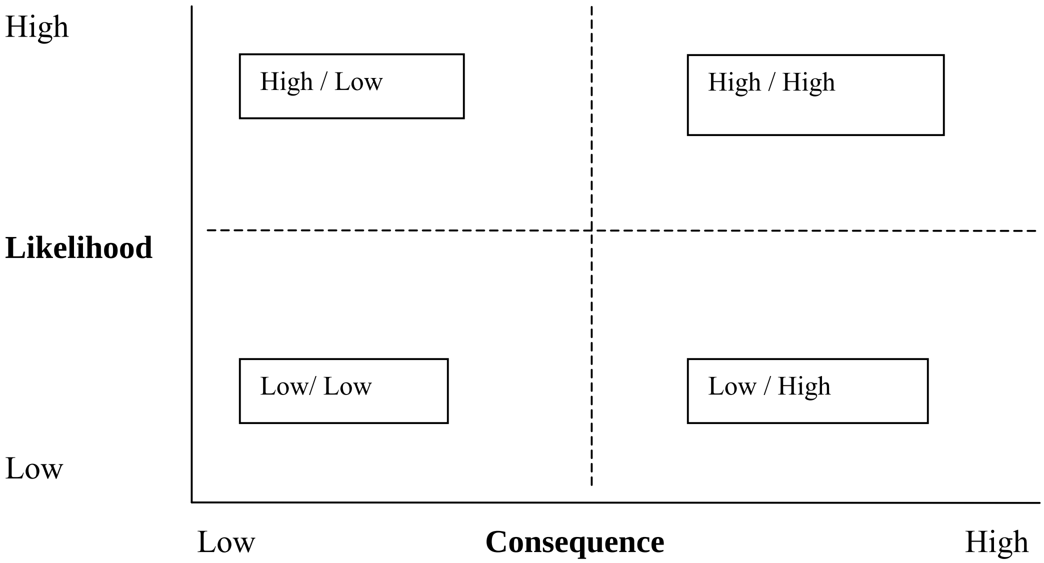
Other numerical methods of assessing the risk of a hazard or hazardous event are available from various sources and could be explored by the team. Two of these are shown in Annex 3.

For very simple, small water systems, it may be sufficient to use initially a four quadrant schematic approach as illustrated below in Diagram 1 below.

Hazards or hazardous events with a high / high hazards should be tackled first.

[5] Assumes an equal rating system.

Diagram 1 – Simplified Risk Rating Schematic



To prepare the plan there should be someone on the team to assist you in determining the risk model you will follow to assess and determine the risk. In all cases the methodology should be documented, as should be the assessments made.

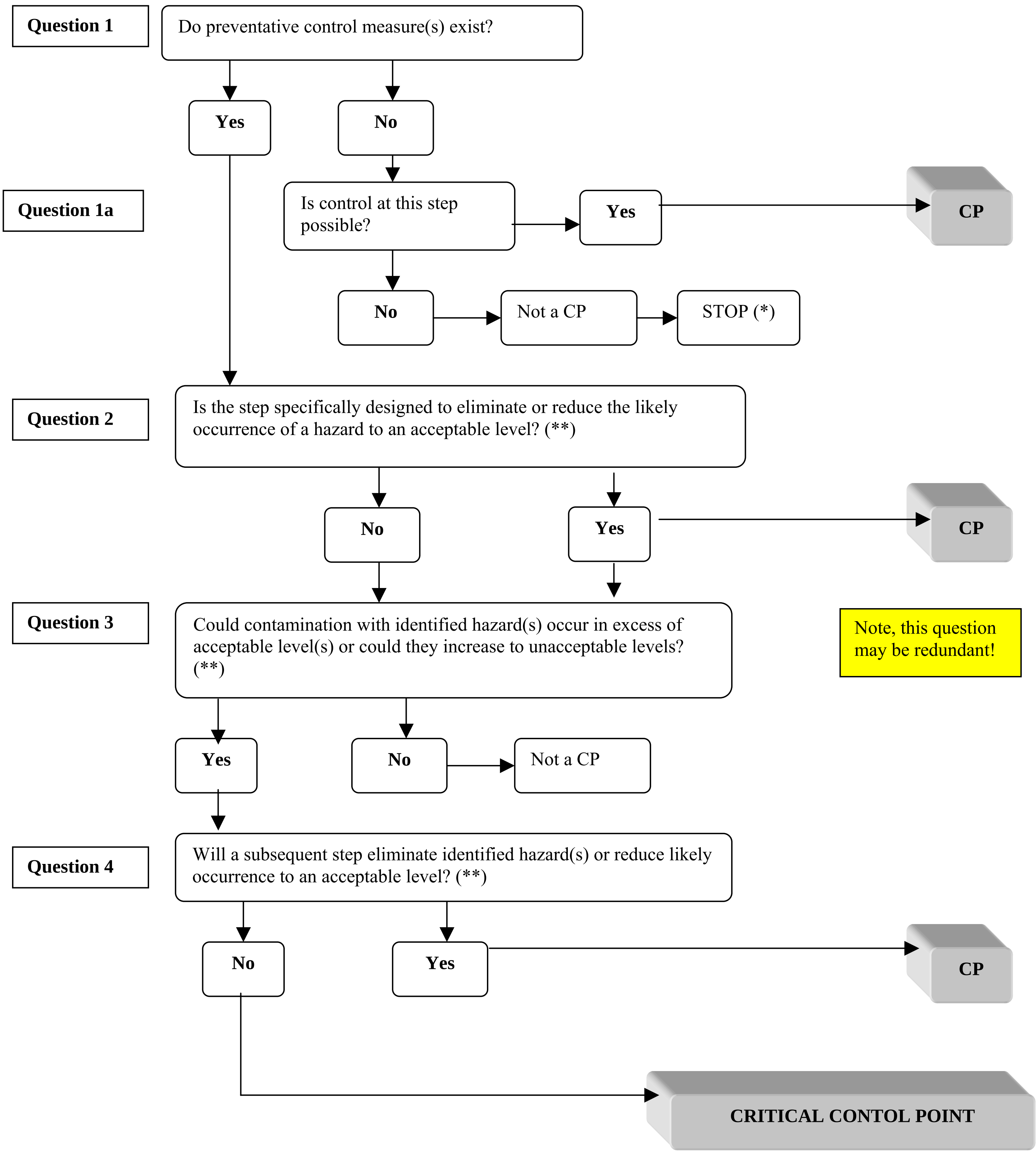
4.4 Identify Control Points (CPs) and Critical Control Points (CCPs)

A control point is any point, step, or procedure at which a biological, physical, chemical, or radiological hazard can be controlled. If these control points do not relate to water safety, they are not included in the plan. Ideally in a risk management plan based on multi-barrier approach, there will be several control points that might address any particular hazard or hazardous event – for example, pre-treatment disinfection of raw water is a control point, as is the treatment process itself, and post-treatment disinfection. A Critical Control Point (CCP) is sequentially the last step within your process that can be used to correct or prevent the development or occurrence of a hazard or a hazardous event. In respect to the handling of water from source through to delivery to the client, there are many hazards and hazardous events and potentially many points at which they can be controlled, but very few are actually critical control points. Control points and critical control points must be carefully developed and documented. The following questions are helpful in deciding which steps should be designated as CPs and which as CCPs. These questions are included in Table 2 as part of the process suggested for determining CPs and CCPs. They also appear as a “decision tree”[6] in Diagram 2 below.

1. Do preventative control measures exist or is there some prerequisite program that is in place e.g. equipment maintenance program?
2. Is the step specifically designed to eliminate or reduce the likely occurrence of a hazard to an acceptable level?
3. Could contamination with identified hazards occur in excess of acceptable levels or could they increase- to unacceptable levels?
4. Will a subsequent step eliminate identified hazards or reduce their likely occurrences to an acceptable level?

[6] The Decision Tree shown in Diagram 2 is adapted from one provided by NSF International.

Diagram 2 - An example of a Decision Tree used in HACCP models to Identify CPs and CCPs for identified steps with hazards and hazardous events



This step can be combined into a table to record the determination of the critical control points relevant only to process steps in which a significant hazard is identified The Table would have the following columns:

Table 2 - Determination of Control Points and Critical Control Points

(from Table 1)			*(from Diagram 2)*						
Element or process step	**Potential hazard or hazardous event**	**Significant hazard or hazardous event (Yes / No)**	**Q 1**	**Q 1a**	**Q 2**	**Q 3**	**Q 4**	**Control Point (Yes / No)**	**Critical Control Point (Yes / No)**

Table 2a is used to determine if the Element or Process Step is a CCP.

Table 2a – Conditions for Establishing Critical Control Points

Question 1	**Question 1a**	**Question 2**	**Question 3**	**Question 4**	**Control Point (Yes / No)**	**Critical Control Point (Yes / No)**
No	Yes	-	-	-	Yes	-
Yes	-	Yes	-	-	Yes	-
Yes	-	No	Yes	Yes	Yes	-
Yes	-	No	Yes	No	-	Yes

4.5 Establish Critical Limits and Monitoring Procedures For Control Points (CPs) and Critical Control Points (CCPs)

4.5.1 Critical Control Limits

For each CP and CCP in the system, the team must establish the critical limits and establish a monitoring procedure. Monitoring provides alerts to the risk management system and for operational control programs in general.

Critical limits are the boundaries of safety for each CP and CCP according to your system. They can be numerical or descriptive limits and will be based on applicable regulatory limits, best practice guidelines and the cumulative knowledge of the team on the site-specific system capability and available responses.

Critical limits can be established for a variety of points (critical and non-critical alike) within the system and can include but are not limited to watershed/wellhead protection, source water intake location, chlorine contact time, chemical dosage, filter performance, turbidity, pH, and available disinfectant.

Critical limits although derived from existing regulatory standards and guidelines, scientific literature, experimental studies, and consultation with experts must, however, also take into account operational capabilities to measure the variable for which the limit is established (acceptable operational deviations +/-). Verification activities within plan reviews should check the operational capacity.

Each CP and CCP should have one or more corrective measures that can be implemented to prevent, eliminate, or reduce the hazard to an acceptable level. If a critical limit at a CCP is exceeded, then the significant hazard is no longer controlled and emergency measures must be taken to protect public health.

If a critical limit is incorrectly assigned, it means that the production of safe water may be compromised.

Critical limits must be clearly expressed in your plan. Numerical critical limits such as chlorine residuals must be indicated as a maximum (value not to exceed), minimum (value that must be exceeded), or range with clearly defined upper and lower values.

System managers may also wish to set "operational limits" that are more stringent than the critical limits in order to allow for corrective actions to take place before the critical limit is exceeded, hence preventing consumer exposure to a hazard or a regulatory non-compliance.

Where customer/consumer preferences and acceptability are an issue (e.g., taste, odour or colour), then aesthetic water quality and appropriate limits may also be considered in the plan, provided that public health and regulated limits are not compromised.

4.5.2 Procedures To Monitor CPs and CCPs

Having identified the critical limits for the CPs and CCPs, the team now has to establish monitoring procedures for each CP and CCP.

The three main purposes of monitoring are to:

- track system performance so trends indicating a loss of control can be recognized and corrective action can be taken to bring the process back into control before a *CRITICAL LIMIT IS EXCEEDED*;
- indicate when a loss of control and a deviation have actually occurred, and corrective action must be taken; and
- provide written documents for use in verification or revision of the plan (accountability).

All critical limits must have an associated monitoring activity to ensure that the critical limit is met at all times. The appropriate type of monitoring will depend on the nature of the limit - numerical or descriptive.

Monitoring of CCPs and ensuring the critical limit is not exceeded can be accomplished by observation (usually for qualitative critical limits) or by measurement (usually for quantitative critical limits). The results must be recorded and signed by the person doing the monitoring. The most appropriate employees for such assignments are often those directly associated with the element and the operation within it.

The table for these activities includes columns for the critical limits and monitoring activities (Table 3). Monitoring activities describe or provide instructions on how to monitor the limits achieved at the step. There should be a link to records of the monitoring activities (i.e., recorded monitoring data including the signature of the monitoring official and the date and time of monitoring –this is essential for the review procedures.

Table 3 – Critical Limits and Monitoring Activities for CPs and CCPs

(from Table 1)			*(from Table 2)*		Critical Limits (use appropriate units)	Monitoring Activities
Element or process step	Potential hazard or hazardous event	Significant hazard or hazardous event (Yes / No)	Control Point (Yes / No)	Critical Control Point (Yes / No)		

Column 6: Identifies the **Critical Limits** – e.g., ≤5 mg/l; ≤1.0 NTU, etc.
Column 7: Describes the **Monitoring Activities** – e.g., check critical limits daily, etc.

4.6 Establish Corrective Actions and Reporting

4.6.1 Corrective Actions

There must be a corrective action and reporting plan in place to:

- Specify the immediate and long term (external and internal communications) actions required to correct the problem;
- Assign responsibilities;
- Correct where possible, the cause of the deviation and ensure that the critical control point is under control or where not possible, initiate emergency procedures to protect public health (e.g., provide a boil water warning).

The primary focus for the application of this principle is the correction of the condition that led to exceeding a critical limit. More frequent monitoring may be temporarily required to ensure that exceedance of the established critical limit does not continue when the operation is resumed.

3.2.4.1 Reporting

Reporting of all corrective actions taken is required to ensure an accurate record is available of any deviations from the elements of the risk management plan including the critical levels for each CCP, and to assure that corrective action has been taken when necessary. The reporting element requires:

- Submitting an incident report to the designated authority within the utilityto indicate that you have responded; and

- Maintaining records of corrective actions taken.

The table for these activities includes a column for the corrective actions and reporting elements (Table 4).

Table 4 – Corrective Actions and Reporting for CPs and CCPs.

(from Table 1)			*(from Table 2)*		*(from Table 3)*		Corrective Action	Report
Element or process step	**Possible hazard or hazardous event**	**Significant hazard or hazardous event (Yes / No)**	**Control Point (Yes / No)**	**Critical Control Point (Yes / No)**	**Critical Limits (use appropriate units)**	**Monitoring Activities**		

Column 8: Identifies the **Corrective Actions** to be taken – e.g., increased disinfection dosage according to procedure XX, etc.
Column 9: Details the **Report** – e.g., corrective action taken, monitoring enhanced for 3 days, and report filed as Incident Report XX, etc.

Corrective action and reporting records should include signatures of the staff who took the action or who made the report.

5 Establish Procedures to Verify the Plan Works and is Valid

5.1 Review and Verification

Review and verification is the process of applying methods, procedures, tests and other evaluations, in addition to monitoring to determine adherence to the plan.

The plan must have procedures designed to ensure regular reviews and verification of its contents once it is implemented. This means that the team must be allowed and prepared to meet on a regular basis, to carry out reviews of the operations of the system, to compare the reviews against the provisions of the plan and also to undertake iterative reviews of the plan itself. The team must have the authority to recommend and make changes to the plan as required.

Review and verification procedures may include:

- Establishment of appropriate review and verification inspection schedules;
- Review of the plan;
- Review of the flow chart produced for the overall activity to ensure that it is up to date, accurate and is a true representation of the system;
- Review of CP and CCP records;
- Review of process deviations and their resolutions;
- Visual inspection of operations to determine if CPs and CCPs are under control;

- Random sample collection and analysis;
- Review of critical limits to verify that they are adequate to control hazards;
- Review of written record of verification inspections which certify compliance with the plan or deviations from the plan and the corrective actions taken;
- Review of the plan for validation or recommendation for change, including on-site review and verification of flow charts and CPs and CCPs;
- Review of modifications proposed for the plan.

The periodic review and verification of the Risk Assessment / Risk Management Plan and the conditions of the system should be recorded and an indication shown that the appropriate records have been established and maintained (see the next step). No illustrative Table is proposed for these actions, but they could be recorded in an additional column in Table 4. This column is included in the summary Templates proposed in Annex 4. The periodic review and verification enables the continuous improvement of the plan as well as the ongoing assurance of safe drinking water. This process can and ideally should include external experts who can present a fresh perspective of the operations being reviewed and verified.

The **first phase** of the review and verification process is the scientific or technical review of the critical limits at CPs and CCPs and should ensure they are satisfactory in the light of current regulations, standards or best practices, including available technology. A review of the critical limits is also necessary to verify that the limits are adequate to control the significant hazards or hazardous events.

The **second phase** of the review and verification process ensures that the plan is functioning effectively. This phase requires that the data sets and information set out in the plan are collected and recorded in accordance with the plan and an examination of alternative control measures. It is an audit of the activities included within the plan.

5.2 Validation

Following the review and verification activities, the organization should undertake a formal process to validate the plan to ensure that it is appropriate to current conditions and requirements and is functioning as effectively as possible[7]. This can be done internally or externally using independent audits or other review procedures.

Validation follows verification of the critical limits and the operation of the plan as prepared. It includes a documented on-site review and examination of all flow charts and CCPs in the plan and may result in modifications to the plan as necessary. The validation process may include members of the review and verification team, but should also include non-members too.

It is crucial that data be reviewed on a regular basis and action taken to adjust the plan if required. The actions needed and taken must be clearly articulated and a member of the validation team must review the action documentation and sign the documentation if the recommended actions have been taken.

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7 "Effectively as possible" implies a cost/benefit analysis of any change to the control measures, monitoring activites, etc. that must take into account the acceptability of risk to the utility, to its stakeholders including the regulator.

6 Documentation and Record Keeping

All components of the plan have to be documented in order to show conformance with the plan. In some instances the documentation may form the basis for demonstrating regulatory compliance and establish due diligence for the provision of safe drinking water.

Record keeping requires the maintenance of records generated during the operation of the plan. The record keeping associated with plan procedures, including the application of signatures by the plan operators ultimately makes the system work.

Record keeping must include:

- Historical records (the hazard analysis, CP and CCP determination, information and data collected on critical limits, schedule and type of monitoring, sampling plans, corrective action plans, preventative measures, schedule and types of verification, validation schedule, and sample records);
- Specific records of operations (CP and CCP monitoring, corrective actions and preventive measures, and verification activities);
- Other records important to an effective plan system (supplier certification, personnel training, equipment calibration, product of purchasing specifications, and distribution records).
- Critical documents relating to the plan and its operation must be on site or available for use and reference by all staff.

7 Implementation and Application of the Risk Assessement/Risk Management Plan

Once established, the Risk Assessment / Risk Management Plan should be implemented by the management of the organization and applied to all elements of the water system. In order to do this it is recommended that:

- A senior member of the organization's management group be designated as leader of the planning and verification team,
- Adequate resources be allocated to implement and operate the plan, and support the team and the review processes,
- All employees of the organization be fully apprised of the plan and their roles within it,
- The planning and verification team report periodically to the organization's management group.

There will be a great deal of variability in the combination of these elements depending on the size of the system and the geographic area covered. For example: groundwater systems may have more than one aquifer source; systems primarily relying on surface water may well have wells as water sources for some parts of the service area; and some systems may partially import treated water to supplement their own water sources, etc.

8 Summary of Process

In the development and implementation of your plan you will have to develop flow charts (see example in Annex 1) of all elements and processes of your system from source to the point of delivery to the customer. In conjunction with these flow charts you may utilize the Tables already described and Diagram 2 to assist in identifying the control points and critical control points. For each part of your system you will need to develop templates that you should use and can be referred to in a glance when monitoring and reporting on your plan's success. These are referred to as Application Templates. An example of these, constructed from the essential information in particular columns of the recommended Tables is shown in Annex 4 (it is presumed in offering a partial template drawn from the Tables that the rest of the information in the Tables is retained for reference purposes). For ease of presentation in this document only, the example template is broken up into three components. In practice it would be appropriate to keep them in a single spreadsheet.

Each Application Template (plus supporting Tables) should provide a comprehensive but summary record of the analysis of hazards in the referenced element of the drinking water supply service operated. The Templates comprises a number of columns and rows. Footnotes can be inserted in the cells of each Template as appropriate, to refer to additional information (e.g. regulations, laboratory practices, operational manuals, other policies and procedures, etc.).

The following provides a review of Section 3 on how to complete the Tables and the Templates in Annex 4.

The Introduction

Each Template should be accompanied by an introductory section generally describing the elements or processes being assessed and reported on, and should identify persons responsible for the operation of the element or process and other administrative details.

The Tables and the Template

Suggested columns are as follows:

1. Identified activities in the elements or processes of the service operated or features of the service operated for which a hazard or a hazardous event may be presumed or expected.

2. What are the potential hazards or hazardous events associated with the activity or feature that are significant for drinking water safety? - These may not be limited to the potential introduction of contaminants.

3. Describe broadly the likelihood and consequence of the hazard or hazardous event

4. What control measures to prevent, eliminate, or reduce the hazards or hazardous events to acceptable levels are available and could be applied? (Note: this could include a description of control measures available to other organizations, but not to your own.).

5. How likely is the hazard or hazardous event, i.e, what is the likelihood rating?

6. What are the likely consequences of the hazard or hazardous event, i.e., what is the consequence rating?

7. Determine the combined Risk Rating = Frequency x Consequence

8. Is the risk significant? i.e., use tthe combination of frequency and consequence determines whether the hazard or hazardous event is significant or not for your situation.

The results of the decision tree analysis (Diagram 2) which comprise the yes/no answers to the following questions should be entered in the "Q" sub-columns:

9. Q1: Do control preventative measure(s) exist?
10. Q1a: Is control at this step possible if modified?
11. Q2: Is the step specifically designed to eliminate or reduce the likely occurrence of a hazard to an acceptable level?
12. Q3: Could contamination with identified hazard(s) occur in excess of acceptable level(s) or could these increase to unacceptable levels?
13. Q4: Will a subsequent step eliminate identified hazard(s) or reduce likely occurrence to an acceptable level?

14. Does this activity or feature represent or require a Control Point (Yes or No)? The responses to the previous suggested questions relative to the activity or feature will determine whether the activity or feature should be considered as a Control Point or not.

15. Does this activity or feature represent or require a Critical Control Point (Yes or No)?

16. What are the critical limits of measurable values, if any, that are applicable to the control measures available?

17. What are the monitoring and/or control measures applicable that will demonstrate the critical control point is under control?

18. What corrective actions (written procedures to be followed when a deviation occurs) should or could be taken?

19. What reports have been submitted on the application of corrective actions to ensure compliance with the plan?

20. What review and verification actions have been undertaken of the plan in respect of this step and what were the results.
21. What are the records and documents generated during the operation of the plan?

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www.who.un

Annex 1

Flows and Schematics of drinking water supply systems

There are five essential elements or components of any drinking water supply system as shown in Figure A1-1 below[8]:

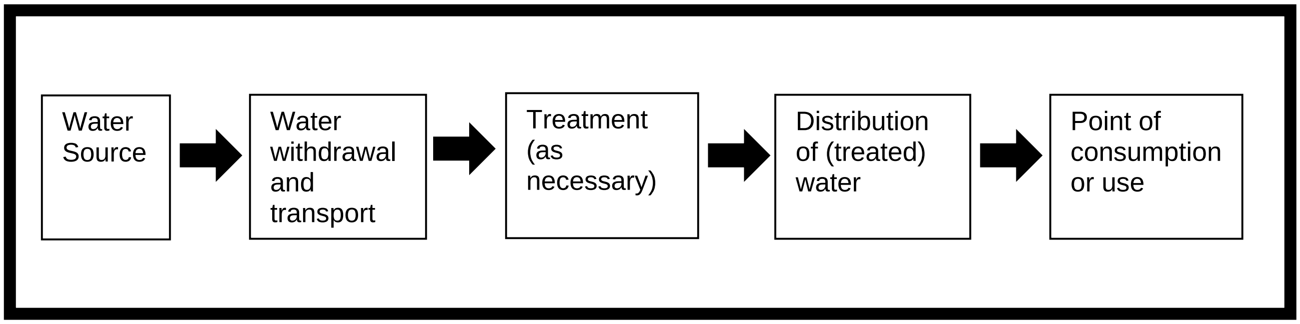


Figure A1-1 — Basic components and elements of a drinking water supply system

These components can be recognized as elements of a central water supply system as may be found in communities ranging from villages to cities and even regional water supply systems supplying several communities in a given geographic area. In this case the distribution system will include a broader distribution system of treated water mains connected to serviced buildings within the community. Figure A1.illustrates such a system, and notes that there may be connections between such a system and other systems which may be undertaken for a series of operational or security reasons.

The components can equally be recognized as elements of a typical on-site system such as those found in private water supply systems of rural residences and buildings. These may have a well, a pump, piping to connect the well to the building, possibly some sort of point-of-entry or point-of-use treatment system such as a water softener or filter, and a plumbing system connected to a series of taps located in the building or in some cases to a stand pipe for common use within a village.

Table A1-1 provides examples of the elements or processes of a typical drinking water supply system including the typical activities or features of those elements or processes.

Figure A1-3, provides an example of a typical flow chart for a drinking water system.

[8] Figures A1-1 and A1-22 and much of the text are drawn from the proposed ISO Standard CD 24512, *Service activities relating to drinking water and wastewater – Guidelines for the assessment of drinking water services and the management of utilities*. Figure A1 was contributed by Canada, Figure A2 by Japan.

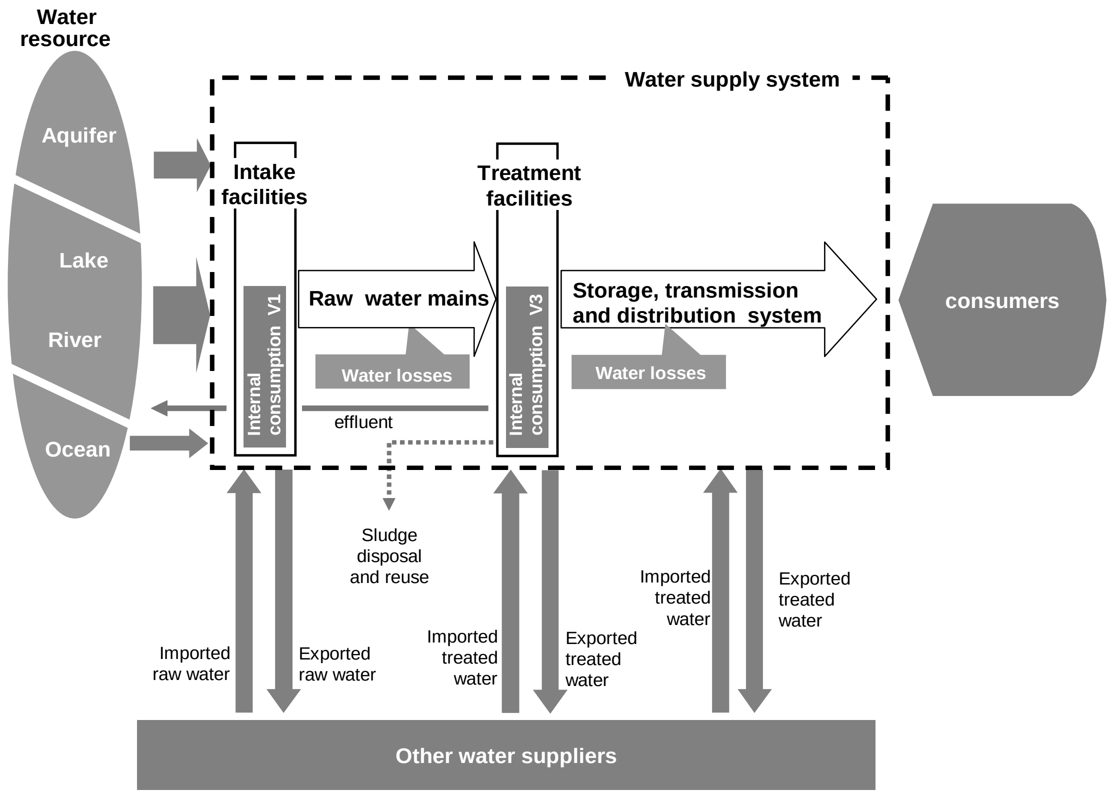


Figure A1-2 — Schematic of a typical centralized service drinking water supply system

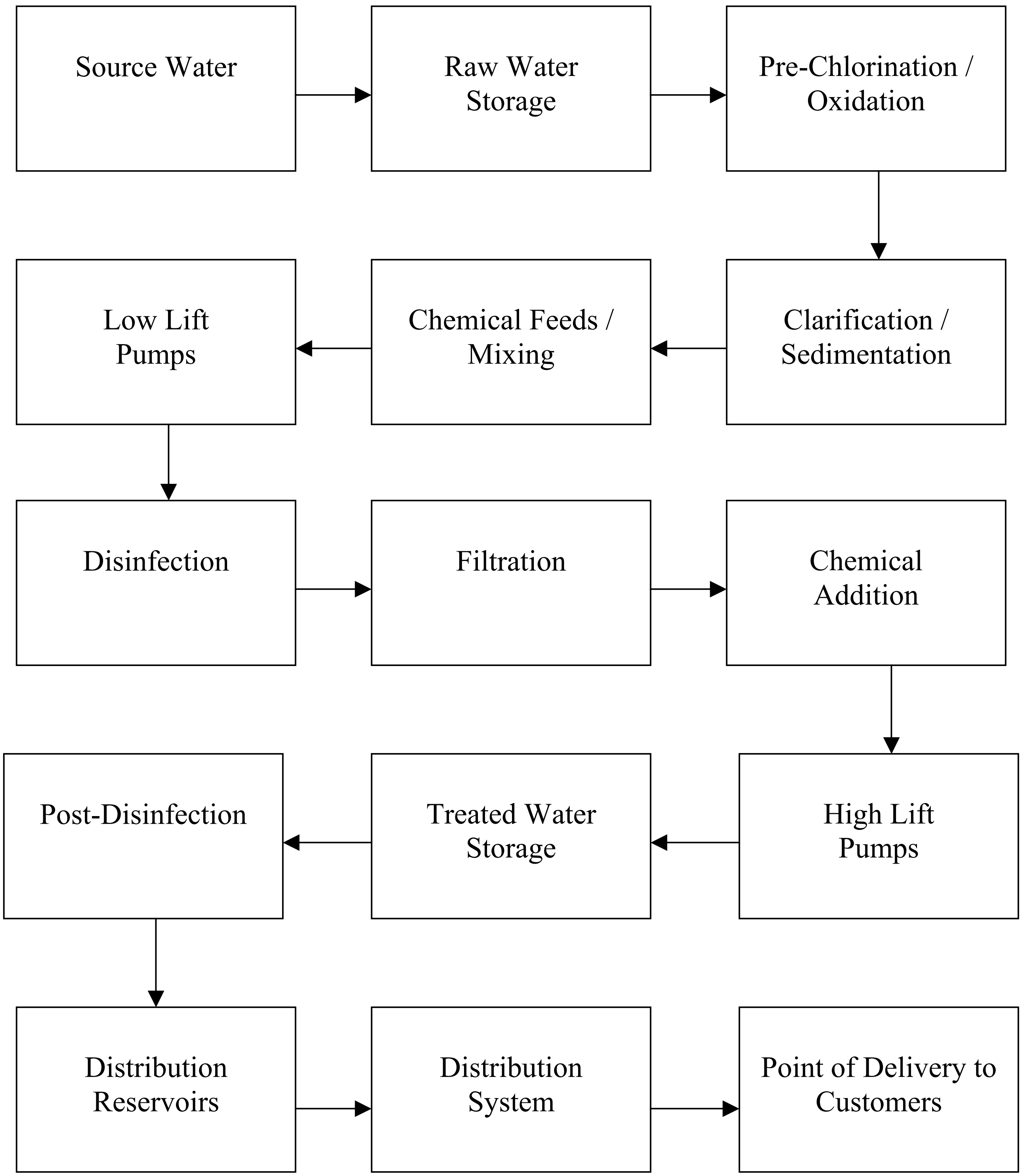
Table A1-1 below provides examples of the elements or processes of a typical drinking water supply system including the typical activities or features of those elements or processes.

Table A1-1 - Examples of The Elements or Processes of a Typical Drinking Water Supply System and Typical Activities or Features of the Elements or Processes.

Elements or Processes	Typical Activities or Features of the Elements or Processes
Source Water	Watershed and Well head protection, Runoff Events, Monitoring
Raw Water Storage	Pre-sedimentation
Pre-Chlorination/Oxidation	Chlorine/Permanganate addition, Aeration
Low Lift Pumps	Pump house, Pumps, Screens, Pipelines
Chemical Feeds/Mixing	Coagulants, Polymer aids, Activated Carbon, Rapid Mix
Clarification/Sedimentation	Floc formation, Settling
Disinfection	Mid-stage Chlorination or Ozone
Filtration	Sand Filters, Deep Bed Filters, GAC Filters, Membranes
Chemical Addition	Other Chemicals: Fluoride, Phosphate, Ammonia, pH correction
Post-Disinfection	Chlorine, Chlorine dioxide or Chloramines and/or UV Light
Treated Water Storage	Onsite Reservoirs, Monitoring
High Lift Pumps	Pump house, Pumps, Transmission Mains
Distribution Reservoirs	Multiple Field Reservoirs, Re-chlorination Points
Distribution System	Mains, Hydrants, Pumping Stations, Valves, Cross-connections
Customers	Service Connections, Meters, Truck fills

Figure A1-3 below, provides an example of a typical flow chart for a drinking water system.

Figure A1-3 - Flow Chart of a Drinking Water System



Annex 2

Table A2-1 provides a list of hazards or hazardous events typically associated to the elements or processes of a drinking water system.

Table A2-1 - List of Potential Hazards or Hazardous Events Related to Drinking Water Systems' Elements or Processes likely to result in Health Risks.

Elements or Processes of a Drinking Water System	Potential Hazards or Hazardous Events
Source Water - Surface water	On-site septic systems – microbial hazards Domestic waste dumping– microbial hazards Land spreading of manure– microbial hazards Feedlot runoff– microbial hazards Municipal sewage effluent– microbial hazards, heavy metals, pharmaceutical residuals Municipal landfills – chemical leachates Industrial activities – chemical spills Leaking pipelines – chemical spills Pesticide use – chemical contamination Road salt use and storage – chemical contamination Petroleum refineries – oil and chemical spills Highway/Railway accidents and spills – chemical spills Recreational activities – oil and microbial releases Natural events – flooding, droughts, etc.
Source Water - Groundwater	On-site septic systems – microbial hazards Domestic waste dumping – microbial hazards Municipal landfills – chemical leachates Graveyards – microbial and virus hazards Land spreading of manure – microbial hazards Intensive livestock activities– microbial hazards Gas service stations – hydrocarbon contamination Industrial plants – chemical spills Leaking pipelines – hydrocarbon contamination Sludge disposal areas at petrol refineries – hydrocarbon contamination Highway/Railway accidents and spills – chemical spills Road salts use and storage – chemical spills
Raw Water	Raw water pump stations – pumping failure Raw water pipelines – microbial growth and biofilms Raw water reservoir storage– microbial growth and biofilms Pre-oxidation – disinfection byproducts

Elements or Processes of a Drinking Water System	Potential Hazards or Hazardous Events
Treatment Systems	Water optimization - failure Carbon dosing - failure Alum dosing -failure Filtration - failure Coagulation, flocculation and sedimentation – biofilm growth Inlet flow control – failure pH correction – inappropriate levels Disinfection – over dosage Reservoir storage - contamination
Storage and Distribution - Distribution Systems	Reservoirs – security control failure Pump stations – security control failure Distribution transmission mains – geological faults Distribution water mains – geological faults Re-chlorination points – under or over dosages Main breaks – contamination of mains Cross connections – microbial contamination
Storage and Distribution – Other Water Delivery Systems	Tank truck storage – loss of sterile conditions Tank truck previous use - contamination Cisterns - contamination Unauthorized haulers – inappropriate equipment
Customer Elements	Backflow device failures – contamination Customers systems – lead/copper/zinc/antimony from solder, brass fittings, service lines, internal plumbing Fire sprinkler systems – cross contamination Leaking underground storage tanks - contamination Hot water heating systems – cross contamination

Annex 3

Other examples of risk assessment and prioritization factors and methods

Example 1: WHO Matrix

The World Health Organization has proposed the following risk scoring matrix for likelihood and consequence factors[9].

Example of a simple risk-scoring matrix for ranking risks

	Severity of Consequence				
Likelihood	**Insignificant**	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	2	3	4	5	6
Likely	1	2	3	4	5
Moderately likely	-	2	3	3	4
Unlikely	-	1	2	2	3
Rare	-	-	-	1	2

The indicated priority levels 1 to 6 are in ascending order of priority, ie. the higher the number, the greater the risk.

Examples of definitions of likelihood and severity of consequence categories that can be used in risk scoring.

Item	**Definition**
Likelihood categories	
Almost certain	Once per day
Likely	Once per week
Moderately likely	Once per month
Unlikely	Once per year
Rare	Once every five years
Severity categories	
Catastrophic	Potentially lethal to a large population
Major	Potentially lethal to a small population
Moderate	Potentially harmful to a large population
Minor	Potentially harmful to a small population
Insignificant	No impact or not detectable

9 Tables 4.2 and 4.3 respectively of Chapter 4 – Water Safety Plans - 2004 WHO Guidelines for Safe Drinking Water.

Example 2: Other possible rating criteria

The Ontario Clean Water Agency proposed the following as examples of rating criteria that might be developed by teams to address various alternative rating factors, again the rating applied is in ascending order, i.e. the higher the number the more significant the likelihood or consequence.

Likelihood Criteria:

Probability of Occurrence
1. Once in 50 years,
2. Once in 20 years,
3. Once in 5 years,
4. Once a year,
5. Once in 3 months.

Consequence Criteria:

Severity and Duration of Environmental Impact
1. Local short-term impact with no serious ecosystem damage or regulatory non-conformance,
2. Widespread impact with no serious ecosystem damage and no regulatory non-conformance,
3. Serious impact limited to local ecosystem with possible minor or regulatory non-conformance,
4. Widespread, serious impact, regulatory non-conformance, remediation can be achieved in less than 1 year,
5. Same as No. 4 but remediation requires 1 year or more.

Severity of Health or Safety Impact to Employees or the Public
1. Discomfort or irritation up to 5 persons,
2. Widespread discomfort or irritation,
3. Injury or illness (not critical) up to 5 persons,
4. Widespread injury or illness (not critical),
5. Critical illness or injury or death to one or more persons.

Consumer/Public Concern
1. Low level of concern,
2. Intermittent interest and concern,
3. Sustained, widespread concerns usually including media and client concerns.

Corporate Strategic/Economic Concern (including cost)
1. Cost less than 5% of annual facility budget and no lasting impact on client relations,
2. Cost 5 - 10% of annual facility budget and no lasting impact on client relations,
3. Significant impact on client relations,
4. Critical to continued service to community.

Annex 4

Risk Analysis and Risk Management Template

The following overall template as shown, is created by combining the four Tables set out in Section 4 for all hazards and hazardous events.

Some utilities have found it convenient to split the template into two portions – The Risk Analysis portion and the Risk Management portion.

The first, the Risk Analysis, portion simply combines Tables 1 and 2 and results in a template that when completed, lists all elements and all potential hazards or hazardous events, and records the risk assessment (i.e., likelihood of occurrence and consequence analysis) to determine if the hazard or hazardous event is significant or not. The Risk Analysis portion is retained for periodic review to determine if the significance of the hazards or hazardous events have changed in character over time, which would result in their reclassification as significant or not significant.

The second, the Risk Management portion, takes the information for the significant hazards or hazardous events from Tables 1 and 2, and proceeds by adding Tables 3 and 4, to establish whether or not there is a CCP, sets out the control limits and corrective actions, and provides for monitoring and reporting.

The advantage of making this split may be minor administratively, but it recognizes that there maybe many hazards or hazardous events that are not significant, and allows the risk management resources and efforts to be concentrated on the significant hazards or hazardous events.

RISK ANALYSIS / RISK MANAGEMENT TEMPLATE (PART 1)

Risk Analysis Portion							
(from Table 1)				*(from Table 2)*			
Element or Process Step*)*	**Hazard or hazardous event**	**Description of the likelihood and consequence of the hazard or hazardous event**	**Available Control Measures**	**Likelihood Rating**	**Consequence Rating**	**Combined Risk Assessment**	**Significant hazard or hazardous event (Yes/No)**

TEMPLATE (PART 2)
(continues from Part 1).

Risk Management Portion												
(from Table 3)							*(from Table 4)*					
Q 1	**Q 1a**	**Q 2**	**Q 3**	**Q 4**	**Control Point (Yes / No)**	**Critical Control Point (Yes / No)**	**Critical Control Limits (use appropriate units)**	**Monitoring Activities**	**Corrective Actions**	**Reports**	**Verification**	**Records**

Annex 5

Example of information that would be included in a Risk Assessment / Risk Management Template – Port Perry, ON

The template reproduced below shows some relevant data in respect to hazards or hazardous events whether or not they are significant and whether or not there is a control point or critical control point. It is drawn from the municipality of Port Perry, ON.

[Note: it is anticipated that the final edition of the guidance document will contain additional examples of steps, hazards and control and critical control points.]

RISK ANALYSIS / RISK MANAGEMENT TEMPLATE (PART 1)

Risk Analysis Portion							
(from Table 1)				*(from Table 2)*			
Element or Process Step)	**Hazard or hazardous event**	**Description of the likelihood and consequence of the hazard or hazardous event**	**Available Control Measures**	**Likelihood Rating**	**Consequence Rating**	**Combined Risk Assessment**	**Significant hazard or hazardous event (Yes/No)**
Taking of Raw Groundwater	Biological Hazard High Bacteria levels, E-coli, etc	Likelihood: Rare (Hazard has occurred but as 5 or 10 years events) Consequence: Multiple death or widespread major illness	Weekly sampling but no method of control	2	5	10	Yes
Disinfection with Sodium Hypochlorite	Biological Hazard E.Coli	Likelihood: Has not occurred Consequence: Multiple death or widespread major illness	On Line analyzers with auto shutdown of well pumps at 1.0 mg/L	1	5	5*	Yes

TEMPLATE (PART 2)

(continues from Part 1).

Risk Management Portion													
(from Table 3)							*(from Table 4)*						
Q 1	**Q 1a**	**Q 2**	**Q 3**	**Q 4**	**Control Point (Yes / No)**	**Critical Control Point (Yes / No)**	**Critical Control Limits (use appropriate units)**	**Monitoring Activities**	**Corrective Actions**	**Reports**	**Verification**	**Records**
No	Yes	No	Yes	Yes, (disin-fection)	Yes							
Yes	No	Yes	Yes	No		Yes	1.0 mg/L at analyzer	On Line analyzer with radio alarms	Manual test of analyzer, backflush system, service chemical pump	Daily manual sample checked against analyzer, 3 month calibration of analyzer.	Form 35-01 Port Perry Well Log Report, Logbook	

Notes:

* Although significant Risk Level may be low due to frequency, due to the severity of the consequence, attention must be given to this activity and the safety barriers in place.

** Because the hazard of high bacteria levels in raw water is eliminated in a future step (disinfection), the actual activity of taking ground water is a CP, not a CCP, but the final disinfection element would be a CCP.