



DECISION TREE FOR RESPONDING TO A TURBIDITY EVENT IN UNFILTERED DRINKING WATER

Version 2, Post-Consultation Draft
January 2013

1 Objective and Scope

To provide decision makers with a means of planning for future turbidity events in unfiltered drinking water, and rapidly responding to acute turbidity events. The goal is for decision makers to have the ability to take proactive measures against potential health risk from pathogens **before** there is a threat to public health.

This document is not intended to provide guidance for the process of determining if a drinking water system is in compliance with provincial treatment objectives or to be used as an alternative to providing appropriate treatment.

2 Introduction

Turbidity (“cloudiness” in layman’s terms) is a water quality issue. It is caused by suspended organic and colloidal matter; such as, clay, silt, finely divided organic and inorganic matter, bacteria, protozoa, and other microscopic organisms. Events such as sedimentation from road surfaces, higher surface runoff peak flows, landslides, and debris flows increase turbidity. Turbidity, in and of itself, does not necessarily pose a threat to human health, but it can be an indicator of the potential presence of human pathogens. Additionally, turbidity has the potential to disrupt or overload drinking water disinfection processes, such as Ultraviolet (UV) light and chlorination, to the point that they may no longer effectively deactivate pathogens.

The *Decision Tree for Responding to a Turbidity Event in Unfiltered Drinking Water* (Decision Tree) provides the standard operating procedure to be followed by System Operators, in consultation with their local Health Authority [Drinking Water Officer (DWO)], when assessing turbidity events pertaining to unfiltered* surface water or ground water at risk of containing pathogens (GARP). This tool can be used by decision makers to plan for future turbidity events when developing emergency

* For information about what to do in the case of a turbidity event related to filtered water, please speak to the local Drinking Water Officer immediately.

response plans. In addition, it can be used as a means of rapidly assessing an unanticipated turbidity event.

The decision tree outlines the steps for evaluating the health risks associated with the turbidity event, and the appropriate course of action. Appendix A contains expanded explanations for each step within the Decision Tree. Appendix B contains turbidity-related risk factors that should be considered when determining the appropriate course of action.

3 Filtration

As per section 6 of the *Drinking Water Protection Act*, water systems must provide potable water to all users. This is an important responsibility that water suppliers undertake. The Ministry of Health developed the following documents to set out minimum performance targets for treating surface water and GARP, which are considered to pose increased risk to human health:

- [Drinking Water Treatment Objectives \(Microbiological\) for Surface Water Supplies in British Columbia \(Version 1.1, November 2012\)](#)
- [Guidance Document for Determining Ground Water at Risk of Containing Pathogens \(GARP\) including Ground Water Under Direct Influence of Surface Water \(GWUDI\) \(Version 1, April 2012\)](#).
- *Drinking Water Treatment Objectives (Microbiological) for Ground Water Supplies in British Columbia (under development)*

These documents endorse the recommendations from the [Guidelines for Canadian Drinking Water Quality](#) which state that systems using surface water or GARP sources should use filtration and one form of disinfection. A second form of disinfection may be considered in lieu of filtration if certain criteria are met.* The filtration exclusion criteria can be found in the *Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia*. Should a water system qualify for an exemption, it is important to remember that these criteria need to be reassessed on an on-going basis to confirm continued validity. It should not be considered a permanent exemption as source water quality can change with alterations in watershed conditions.

If turbidity is an on-going issue for a water system, the filtration exemption should be re-evaluated. The decision tree is only to be used for isolated incidents or as an interim solution for systems that are in the process of adding filtration (with consultation from their local DWO).

4 Communication

The emergency response plan should be consulted and followed when a turbidity event occurs. It is important for the Water Supplier and the DWO to maintain open dialogue during any emergency situation. Ideally, the two parties should reach agreement regarding the degree of any potential health risks associated with a turbidity event and its related considerations (set out in Appendix B). Furthermore, there should be agreement on the appropriate public communication and/or water quality monitoring strategy. The DWO has the discretion to make a decision and request or order the Water Supplier to comply if:

- There is no agreement
- The Water Supplier does not provide information about the nature of the turbidity event
- The Water Supplier does not voluntarily take the appropriate action

* If a system does not use filtration and does not meet the filtration exclusion criteria, it is not in compliance with the *Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia*. In this situation, system operators should consult with the local DWO about the steps that need to be taken in order to be compliant.

When a notice regarding turbidity is issued, the risk event(s) underlying the turbidity should be communicated to the public and the strength of any scientific evidence presented. For example, if a Boil Water Notice (BWN) is issued, the notice should specify if sampling evidence indicates the presence of potential indicator organisms or if the BWN is based on other available (or lack of available) evidence or information. This may change over the course of an event as in the case of a BWN being issued, but upon further testing, new data may allow the water supplier to rescind the BWN. It is the responsibility of the water supplier to provide the scientific evidence that the drinking water is safe for human consumption. A DWO has the discretion to order the issuance of a BWN should there be a failure on the part of the water supplier to provide the information that is needed to assess the health risk posed by the turbid drinking water.

5 Definitions

Boil Water Notice (BWN) – Notice provided to water users to boil their water before any use that may involve ingestion of the water. A BWN infers that an adverse microbiological health risk exists if the water is ingested. A BWN is issued by the system operator at their own discretion or on request or order by the local health authority via the DWO. Consultative agreement between the operator and the DWO is the preferred approach. The DWO should verify that the BWN has been issued to users of the system.

Drinking Water Officer (DWO) – DWO refers to an Environmental Health Officers (or other qualified individuals) that is delegated by the local Medical Health Officer to administer the *Drinking Water Protection Act* and Regulation within a specific geographic area. The DWO is responsible for enforcing drinking water legislation, ensuring water systems are operating within the parameters of their permits, and providing advice/orders during events that have potential to adversely affect public health.

Filtration – A treatment process approved by the Issuing Official (i.e., DWO or MHO - a person authorized under the Drinking Water Protection Regulations to issue a construction permit, operating permit or other permit required under the *Drinking Water Protection Act*) for the removal of particulate matter, has been granted removal credits for pathogens and is operating as expected.

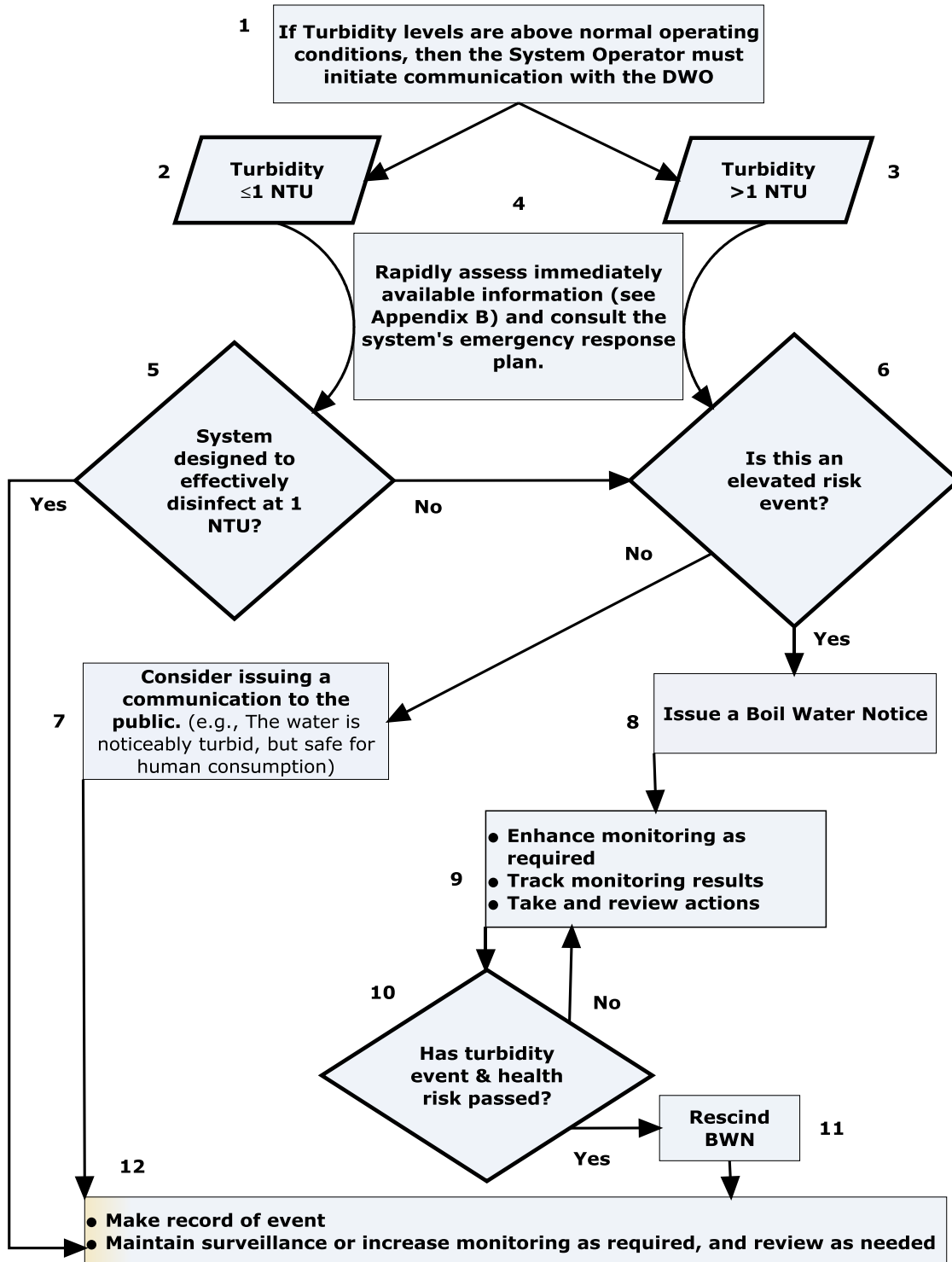
GARP – Ground Water at Risk of Containing Pathogens – For more information, please see the Ministry of Health document: *Guidance Document for Determining Ground Water at Risk of Containing Pathogens (GARP) including Ground Water Under Direct Influence of Surface Water (GWUDI) (Version 1, April 2012)*.

Medical Health Officer (MHO) – A medical doctor that is appointed under the authority of the *Public Health Act* to advise and report on local public health issues within a health authority. The MHO is responsible for fulfilling the role of a DWO unless the MHO delegates this responsibility to another qualified individual.

Nephelometric Turbidity Unit (NTU) – This is the unit of measurement that is used for evaluating the level of turbidity (suspended and colloidal particles and/or microscopic organisms) in water.

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(This applies to unfiltered surface water and ground water at risk of containing pathogens and should be considered for incorporation into such water system's Standard Operating Procedure)



Appendix A. Expanded Notes for the Decision Tree

The following notes provide an expanded explanation for each box in the Decision Tree. The numbering below corresponds to the numbering of the decision tree boxes.

Box 1. In the case that a system operator identifies a turbidity spike above normal operating conditions, that system operator should first determine if it is possible to remove the source of the turbidity from the system (e.g., switch to an alternate source). The system operator must notify the DWO of a turbidity event immediately. The level of the measured turbidity will determine which box the system operator, with consultation from the DWO, should proceed to from this point:

- Less than or equal to 1 Nephelometric Turbidity Units (NTU), move to Box 2
- Greater than 1 NTU, move to Box 3

Box 2. This box applies when the turbidity level is ≤ 1 NTU. Generally, cases of turbidity that measure ≤ 1 NTU are not associated with adverse health effects when treatment by disinfection is provided. There are, however, some circumstances in which this condition may not apply. For example, if the water system is designed to operate at an extremely low NTU (e.g., 0.25) than it may become overwhelmed at a measurement above that level even if it is still below 1 NTU (e.g., 0.99 NTU). It is important to investigate all turbidity spikes regardless if the measurement is ≤ 1 NTU. From here, investigators should proceed to Box 4.

Box 3. This box applies when turbidity levels are >1 NTU. Turbidity spikes above this threshold should be investigated because turbidity levels >1 NTU are associated with a greater probability of adverse health effects. The actual health risk may depend on a number of factors that include the parameters under which the system is designed to operate. Other factors to consider include identifying the source of the turbidity to assess the potential for pathogens harmful to human health (e.g., organic vs. inorganic material) and whether harmful pathogens have been identified through bacteriological water monitoring during previous similar turbidity events. From here, investigators should proceed to Box 4.

Box 4. Assessment: Each of boxes 2 and 3 moves through Box 4. This is the stage in which stakeholders rapidly assess the situation for the purpose of decision-making. Additionally, decision makers may consult with the system's emergency response plan for prescribed actions. Monitoring and water testing takes time – to wait for results before taking action could put the public at risk for adverse health effects. Only evidence that is immediately available should be considered in this step. Appendix B contains potential risk factors that should be considered during the assessment. Once assessment information is gathered, continue on to Box 5 for measurements of ≤ 1 NTU or Box 6 for measurements >1 NTU to make decisions about the safety of the water and corresponding actions.

Box 5. Decision: *Disinfection sufficient?* - If the water system is designed to provide disinfection up to 1 NTU, adjust disinfection and maintain surveillance or increase monitoring as required. Proceed to Box 12 and review as needed. Documented evidence must be available to demonstrate that disinfection at this level of turbidity is effective. If historical evidence demonstrates disinfection could be insufficient at this level, or no data is available, continue to Box 6 for further investigation.

Box 6. Decision: *Is this an elevated risk event?* – This box applies to a turbidity event when the level is >1 NTU or if there is evidence indicating that disinfection is insufficient for turbidity spikes ≤1 NTU. The information assessed in Box 4 is used to determine the risk level of the turbidity event. The DWO has the discretion to default to a determination of elevated risk should the Water Supplier not provide compelling evidence to the contrary (as per Appendix B).

Proceed to Box 8 and issue a BWN if:

- The emergency response plan prescribes this action in this circumstance,
- Risk factors of concern demonstrate an adverse risk to human health,
- Historical evidence indicates a relationship between adverse health effects and similar turbidity events, or
- There is no compelling documented evidence (current or historical) of a low level of risk

In some circumstances, a BWN may not be necessary. For example, the treatment system is designed to effectively disinfect at the measured turbidity level (e.g., measured at 3.0 NTU and designed to effectively disinfect up to 3.5 NTU), or there is documented evidence of an acceptable low level of risk (i.e., historically, similar turbidity events have not been related to adverse health effects). It is the responsibility of the water supplier to provide compelling evidence to the DWO that either of these situations applies. Under these circumstances, decision makers can increase disinfection processes as required and continue to Box 7.

Box 7. Issue a communication to the public: A public communication may be issued to notify users that the water is turbid, but there is a low risk of adverse health effects. This communication should explain the reason (e.g., water line flushing, harmless algae bloom, etc.) for the turbidity as well as provide contact information should they have any further questions. The decision to issue a communication (as well as the form of communication – informal notice or formal advisory) should be jointly agreed upon by the Water Supplier and the local DWO. This is not a requirement, but something to consider for mitigating concerns in consumers. Proceed to Box 12.

Box 8. Issue Boil Water Notice: Issue a BWN with the guidance of the Water Supplier’s emergency response plan. A BWN is issued by the system operator and the DWO should verify that the users of the system have received the notice. Proceed to Box 9.

Box 9. Evaluation: When a BWN is issued, it is important to increase/enhance monitoring as required and track the results of monitoring. This may include bacteriological or other water tests. This is done to determine when the event of concern has passed. If possible, the water supplier should undertake actions that can mitigate the turbidity. It is also important to review decisions on an ongoing basis to ensure that the Water Supplier has taken appropriate action. Continue to Box 10.

Box 10. Decision: This box provides two options:

- If monitoring demonstrates continuing elevated risk, stay on the BWN and continue monitoring (proceed back to Box 9)
- If monitoring demonstrates that the turbidity event and elevated health risk has passed, rescind the BWN (proceed to Box 11)

Box 11. Rescind BWN: When conditions have returned to normal (i.e., the health risk is no longer elevated), the BWN may be rescinded. The DWO should provide oversight to the process of rescinding the BWN by the Water Supplier to ensure that users of the system are notified. Proceed to Box 12.

Box 12. Record turbidity events, causes, and actions taken so they can be reviewed in case of a future similar event. At this stage, the system should be back to normal operating conditions; although, there may be increased monitoring during and after the turbidity event (i.e., post-treatment bacteriological testing, distribution system bacteriological testing, operational parameters, disinfectant residuals, illness among users and possibly other parameters).

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Appendix B. Turbidity-related Risk Factors: Considerations for health risk assessment*

Source Water

1. Has there been contamination or a spill in which there is likely to be human pathogens? For example:
 - Sewage
 - Animal waste
 - Any substance likely to contain fecal material (e.g., agricultural run-off)
2. Are there recent changes in the hydrological characteristics of the watershed due to factors such as ground disturbances (e.g., mining, road work or other development projects), or vegetative cover disruptions (e.g., mountain pine beetle or planting/harvesting)?
3. Has precipitation been abnormally intense and/or have there been anomalies in precipitation (e.g., the amount and timing of rain, snow, or snowmelt)?

Treatment System

1. Has the turbidity level exceeded the level for which the system has been designed or validated (e.g., system designed to operate effectively for turbidity levels ≤ 3.5 NTU but the current turbidity level is 4 NTU)?
2. Have there been failures in the treatment train? For example:
 - Power outage
 - Existing treatment outcomes from chemical disinfection cannot be maintained (e.g., loss of chlorine residual)
 - Decrease in UV dose or lamp failure
 - Decrease in UV transmittance (the amount of light passing through the water)
3. Is there a lack of multiple barriers in place? Since one form of disinfection is not capable of addressing all pathogens, multiple treatment barriers (e.g., UV and chlorination) minimize risks to the water system. Treatment systems employing a single disinfection method (e.g., chlorination or UV only) do not address all pathogens of concern, and this may place the water system at elevated risk during turbidity events.

Other Considerations

1. Is there evidence of pathogens in the distribution system?
2. Is there evidence of illness related to the current event?
3. Has there been a history of health concerns under similar turbidity conditions? Or, is there lack of evidence to the contrary? There should be documented historical evidence demonstrating a lack of elevated health risk; otherwise, all involved parties should consider a precautionary approach and issue a BWN.

* There is the possibility that some of these questions may not be applicable to all systems. Should the answer to any of these questions be 'yes,' it is possible that the water is not safe for human consumption.