



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

April 2013

1. Objective

The *Decision Tree for Responding to a Turbidity Event in Unfiltered Drinking Water* (decision tree) is intended to provide water supply system operators and health authority drinking water officers (DWOs) with a tool to help:

- Plan for future turbidity events in unfiltered drinking water from systems meeting the filtration exemption criteria.
- Provide quick response to acute turbidity events.

This tool will help decision makers take proactive measures to mitigate potential health risks from pathogens **before** there is a threat to public health. The decision tree applies to unfiltered¹ surface water and groundwater at risk of containing pathogens and should be incorporated into a water supply system's standard operating procedure.

The decision tree is not intended to provide guidance for 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 is caused by suspended organic and colloidal matter - such as: clay, silt, finely divided organic and inorganic matter, bacteria, protozoa, and other microscopic organisms. Turbidity can increase following events, such as, landslides, higher surface runoff, peak flows, debris flows, or road sedimentation due to construction. Turbidity does not necessarily pose a threat to human health, but it can be an indicator of the potential presence of human pathogens. It also has the potential to disrupt or overload drinking water disinfection processes, such as ultraviolet (UV) light and chlorination, to the point that they no longer effectively deactivate pathogens.

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.

¹ 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.

3. Filtration

Under section 6 of the *Drinking Water Protection Act*, water supply systems must provide potable water to all users. This is an important responsibility. The Ministry of Health developed the following documents to set out minimum performance targets for treating surface water and groundwater at risk of containing pathogens (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 \(GARP\)](#), (Version 2, November 2015).
- [Drinking Water Treatment Objectives \(Microbiological\) for Ground Water Supplies in British Columbia](#) (Version 1, November 2015).
 - 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 met². The filtration exemption criteria can be found in the *Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia* and the *Drinking Water Treatment Objectives (Microbiological) for Ground 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.

4. Communication and decision-making

- Under section 10 of the *Drinking Water Protection Act*, water suppliers must have a written emergency response and contingency plan that includes a strategy for communication with users of the system. Response to a turbidity event should be part of this plan.
- It is important for water system operators and DWOs to maintain open dialogue during any emergency situation. The two parties should reach agreement regarding the degree of potential health risk associated with a turbidity event and its related considerations (set out in appendix B). There should be agreement on the appropriate public communication and/or water quality monitoring strategy. In circumstances where there is no agreement, the DWO has the authority to request or order the water system operator to comply.
- When a notice regarding turbidity is issued, the risk event(s) underlying the turbidity should be communicated to the public, as well as the scientific evidence. 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. The situation may change over the course of an event, and further testing and 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 authority to order the issuance of

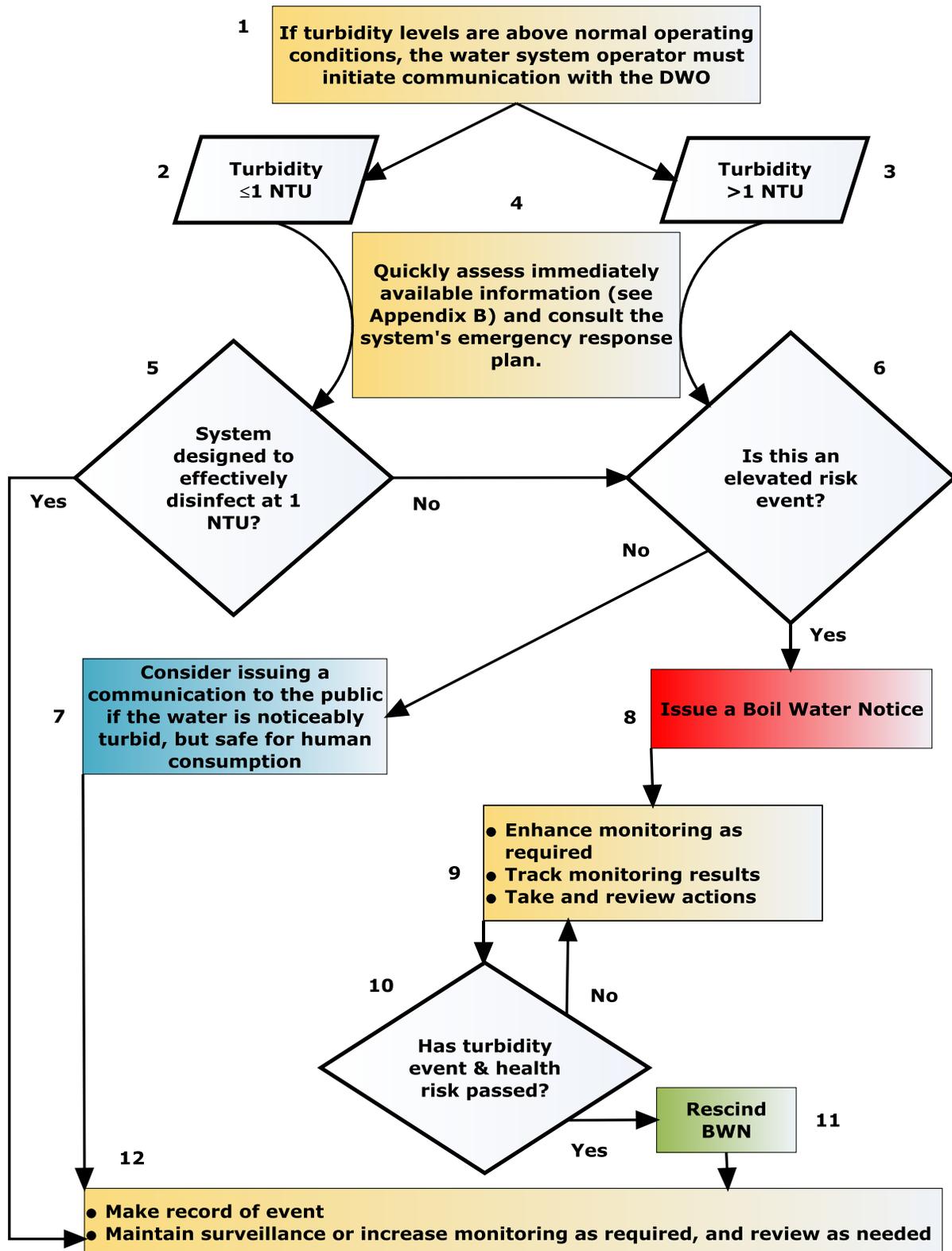
² If a system does not use filtration and does not meet the filtration exemption criteria, it is not in compliance with the *Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia* or the *Drinking Water Treatment Objectives (Microbiological) for Ground Water 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.

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 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)** –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. The local medical health officer is appointed as the DWO. The medical health officer has the authority to designate the duties of a DWO to environmental health officers. Generally, it is these designated environmental health officers that perform the front-line DWO duties.
- **Filtration** – A treatment process for the removal of particulate matter that has been approved by the issuing official (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). The filtration system has been granted removal credits for pathogens and is operating as expected.
- **GARP** – Groundwater 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 \(GARP\)](#) (Version 2, November 2015).
- **Medical Health Officer (MHO)** – A physician appointed under 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.

Decision Tree for Responding to a Turbidity Event in Unfiltered Drinking Water



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 in 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 quickly assess the situation for the purpose of decision-making. 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 system operator not provide compelling evidence to the contrary (as per Appendix B).

Box 7. 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 strong 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 (e.g., historically, similar turbidity events have not been related to adverse health effects). It is the responsibility of the water supplier to provide solid 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 8. 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 system operator and the DWO. This is not a requirement, but something to consider for mitigating concerns in consumers. Proceed to box 12.

Box 9. Issue Boil Water Notice: Issue a BWN with the guidance of the water system operator's emergency response and contingency 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 10. 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 system operator has taken appropriate action. Continue to box 10.

Box 11. 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 12. 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 system operator to ensure that users of the system are notified. Proceed to box 12.

Box 13. 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 (e.g., post-treatment bacteriological testing, distribution system bacteriological testing, operational parameters, disinfectant residuals, illness among users and possibly other parameters).

APPENDIX B: TURBIDITY-RELATED RISK FACTORS: CONSIDERATIONS FOR HEALTH RISK ASSESSMENT ³

1. 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 weather (e.g., the amount and timing of rain, snow or snowmelt)?

2. 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. Other Considerations

1. Is there evidence of indicator organisms 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.

³ There is the possibility that some of these questions may not be applicable to all systems. Additionally, this is not an exhaustive list of risk factors. Should the answer to any of these questions be 'yes,' it is possible that the water is not safe for human consumption.