

Turbidity



This information sheet is intended to assist the waterworks owner, manager or operator in understanding turbidity and the related requirements of *The Water Regulations, 2002*.

What is Turbidity?

When applied to the treatment of drinking water, it describes the relative clarity of the water, ranging from perfectly clear and transparent to cloudy, hazy or opaque. Turbidity in water is caused by suspended matter such as clay, silt, finely divided organic and inorganic matter, coloured organic compounds, algae and other microscopic organisms.

How is Turbidity Measured?

Turbidity is determined using an instrument that transmits a beam of light into a water sample, by measuring the amount of light scattered at right angles to the beam using a photoelectric sensor. There are a number of ways in which turbidity can be measured. A nephelometric turbidity meter which meets the American Water Works Association / American Public Health Association method 2130B and the United States Environmental Protection Agency method 180.1 and Great Lakes Instrument Method 2 are considered acceptable ways to measure turbidity. The preferred unit of turbidity measurement is the Nephelometric Turbidity Unit (NTU). Nephelometric turbidity meters (nephelometers) are available as portable units, desktop instruments as well as in a form that allows continuous measurement. Larger water treatment plants often use instrumentation that will provide continuous measurement and as outlined below, this is required for certain waterworks.

Other means of measuring turbidity which gives readings in Jackson Turbidity Units (JTU) or Formazin Turbidity Units (FTU) are not equivalent or accepted by Saskatchewan Environment (SE). According to standard measurements, the sensitivity of nephelometers is such that turbidity differences of 0.02 Nephelometric Turbidity Units (NTU) can be determined. Performing a turbidity test is a simple procedure and once understood, can be performed in a few minutes.

Electronic particle counters are now available that are capable of accurately counting and recording the number of particles as a function of size. Although there is a relationship between particle counts and turbidity (in samples less than 1.0 NTU) a firm correlation or a simple conversion factor relating the two methods does not exist because of the different way in which the methods work. Water quality related standards for the particle counting technique have not been developed. Therefore particle counters are not considered a replacement for nephelometers.

In terms of instrument calibration, operators should use secondary standards to ensure accuracy. Instrument accuracy should be verified and recorded once a month using secondary standards. These monthly checks should be used to trigger calibration with primary standards if the instrument is deemed to be greater than 10 per cent error. Calibration using the 4-point calibration kits available from instrument manufacturers should be conducted every three months regardless of the results of the secondary standard checks. In addition, once a year the calibration of turbidity meters should be verified by the instrument manufacturer.

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Why is Turbidity Important in Drinking Water Treatment?

Waterborne disease-causing organisms such as bacteria, viruses, *Giardia* and *Cryptosporidium* often attach themselves to particles in raw water. The ability of particles suspended in water to protect attached organisms from disinfection is the most important health-related effect of turbidity. Turbidity has been shown through scientific studies to be correlated with the contamination of water supplies (typically surface water supplies) with *Giardia* and *Cryptosporidium*. Excessive turbidity is often associated with unacceptable tastes, odours and colours in water and may represent a health concern where heavy metal ions, pesticides or waterborne disease causing organisms may attach to the suspended particles. As a result of the potential impact to health, turbidity measurement is important in gauging the performance of a water treatment system.

Is Monitoring Turbidity Important?

Drinking water has to be monitored by routine bacteriological analysis as highly “turbid” treated water may contain disease-causing organisms. But what does the operator do between the submission of routine bacteriological samples? Monitoring turbidity on a daily or continual basis is a simple and effective way to identify deteriorating water quality, before a problem occurs. A sudden increase in the turbidity of the treated water off of each filter or entering the distribution system at the clearwell will alert the operator of potential problems with the water treatment process. Turbidity may provide guidance to the operator in changing or optimizing water treatment chemical dosage rates and overall plant operating conditions. A fully equipped conventional surface water treatment plant using coagulation, flocculation, settling and filtration processes should be able to consistently produce water which meets Environment’s regulatory requirements.

What are the Benefits of Routine Turbidity Measurement?

- quick, inexpensive and simple means of observing water quality and determining if treatment operations are operating efficiently or requires change;
- when used regularly, can save unnecessary overfeeding of expensive water treatment chemicals;
- can be used to identify and isolate distribution system problems and confirm if flushing is required;
- can be used to monitor filter backwashing, reduce waste of treated water for backwashing filters and lower overall operational costs; and
- monitor filter operations and optimize filter runs.

What are the Drinking Water Quality Standards for Turbidity?

New turbidity standards for water used or intended for human consumptive use (potable water) were adopted by *The Water Regulations, 2002*. Compliance with turbidity standards is immediate for newly constructed waterworks and water treatment processes undergoing significant alterations. Existing waterworks producing water for human consumptive use will be required to meet the standards outlined below by no later than December 5, 2008 for systems serving a population of less than 5,000 and by no later than December 5, 2006 for systems serving a population of 5,000 or more.

Source/Treatment	Routine Standard	Continuous Monitoring Time and Duration Maximum	Absolute Maximum
Surface Water ^{1,2} : Chemically Assisted Filtration – When monthly source water average turbidity is 1.5 NTU or more	Less than 0.3 NTU, 95% of discrete measurements or 95% of the time if continuous monitoring is employed, each calendar month	Not to exceed 0.3 for more than 12 consecutive hours if continuous monitoring is employed	Never to exceed 1.0 NTU
Surface Water ^{1,2} : Chemically Assisted Filtration – When monthly source water average turbidity is less than 1.5 NTU	Less than 0.2 NTU, 95% of discrete measurements or 95% of the time if continuous monitoring is employed, each calendar month	Not to exceed 0.2 for more than 12 consecutive hours if continuous monitoring is employed	Never to exceed 1.0 NTU
Surface Water ^{1,2} : Membrane Filtration	Less than 0.1 NTU, 95% of discrete measurements or 95% of the time if continuous monitoring is employed, each calendar month	No standard stated	Never to exceed 0.3 NTU
Surface Water ^{1,2} : Slow Sand or Diatomaceous Earth Filtration	Less than 1.0 NTU, 95% of discrete measurements or 95% of the time if continuous monitoring is employed, each calendar month	Not to exceed 1.0 for more than 12 consecutive hours if continuous monitoring is employed	Never to exceed 3.0 NTU
Groundwater ³	Less than 1.0 NTU, 95% of discrete measurements or 95% of the time if continuous monitoring is employed, each calendar month	No standard stated	No standard stated - see Permit

¹ Includes surface water and groundwater under the direct influence of surface water. ² Turbidity value measured from each filter effluent. ³ Turbidity value for water entering the distribution system. Other turbidity requirements may apply for novel water treatment technologies.

In terms of a practical example for a small surface water treatment plant using chemically assisted filtration with a source water quality of 1.5 NTU or more at which turbidity is to be measured each day at each filter, the following will apply:

- treated water measured at least once a day from each filter must not be more than 0.3 NTU on more than one occasion in a calendar month for each filter (or no more than once out of every 20 consecutive samples for each filter); and
- treated water turbidity measured from each filter must never exceed 1.0 NTU.

Turbidity in the distribution system should also be monitored, particularly at the same times and location that bacteriological samples are submitted. Turbidity in the distribution system should be kept as low as possible.

What are the Requirements for Monitoring for Turbidity?

How often a waterworks operator must monitor for turbidity depends on the type of raw water used and the number of people served by the waterworks.

Table 2: On-Site Turbidity Monitoring Requirements (Minimum)

Population	Groundwater Source	Surface Water and Blended Source
0-100	1 per day	1 per day
101-500	1 per day	1 per day
501-2,000	1-2 per day	1-2 per day
2,001-5,000	2 per day	4 per day
5,001-15,000	3 per day	Continuous
15,001-50,000	4 per day	Continuous
>50,000	Continuous	Continuous

What Happens if Turbidity Standards are Exceeded?

If turbidity standards are exceeded, a problem or upset with the water treatment process is indicated. These problems must be reported as soon as possible to the Environmental Project Officer (EPO) who normally inspects the waterworks. The EPO will provide guidance to help diagnose and obtain assistance in solving the problem. In some instances, if a significant problem or upset is indicated, a Precautionary Drinking Water Advisory may be issued. If the problem is encountered after regular business hours, the upset should be reported by calling 1-800-667-7525.

Are There Any Waterworks that are Exempt from the Requirements for Turbidity?

Turbidity related water quality and monitoring requirements are outlined on the permit to operate a waterworks issued by Environment. Certain "Human Consumptive Use" waterworks will not be required to monitor for turbidity, including most pipelines that obtain water from a municipal or other waterworks regulated under *The Water Regulations, 2002* and some systems served directly by pipelines. However, municipal systems which obtain water from a pipeline and store this water in a reservoir(s) may be required to monitor for turbidity and ensure that the water meets the turbidity requirements where specifically outlined in the "Permit to Operate". Waterworks systems classified as "Hygienic Use Systems" are exempt from the turbidity related water quality standards and monitoring requirements for turbidity. For further information on works specifically exempted from turbidity water quality standards and/or monitoring, please contact the EPO who regularly inspects the waterworks.

Is More Information on Turbidity Available?

Additional information on turbidity control is available from engineering consultants or from the EPO who regularly inspects the waterworks. Additional information on turbidity measurement is available from instrument manufacturers, suppliers and from the EPO who regularly inspects the waterworks.