Guidance Document:

Potential GWI Sources—Microscopic Particulate Analysis

GWI-MPA

August 2003

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The Surface Water Treatment Rule

The federal Surface Water Treatment Rule (SWTR) regulations were promulgated in 1989 as part of the Safe Drinking Water Act Amendments. In 1993, the Washington State Board of Health adopted regulations (Part 6 of WAC 246-290) that are as stringent as the federal SWTR.

The SWTR affects all Group A public water systems that use:

- Surface water sources or
- Groundwater sources under the direct influence of surface water (GWI).

The SWTR is based on the assumption that all surface water and GWI sources are at risk of microbiological (bacteriological, viral, and protozoal) contamination, and that the pre-SWTR drinking water requirements were insufficient to protect against the risk of waterborne disease outbreaks.

For most affected systems, the SWTR requires both filtration and disinfection to control microbiological contamination and to provide adequate protection from waterborne disease-causing organisms such as *Giardia lamblia*.

Water systems are required to achieve at least 99.9% removal and/or inactivation of *Giardia lamblia* cysts and at least 99.99% removal and/or inactivation of viruses. To accomplish this, systems must filter (unless certain source quality and site-specific conditions are met), disinfect, and be operated by qualified personnel.

Definition of GWI Source

The SWTR defines **groundwater under the direct influence of surface water** as:

> *Any water beneath the surface of the ground with:*
>
> 1. *Significant occurrence of insects or other macroorganisms, algae or large-diameter pathogens such as* Giardia lamblia*, or*
> 2. *Significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions.*

Under the direct influence of surface water means that the groundwater source is located close enough to nearby surface water, such as a river, stream, lake, or pond to receive direct surface water recharge. Since a portion of the groundwater source's recharge is from surface water, the groundwater source is considered at risk to contamination from microbial pathogens such as *Giardia lamblia,* which are not normally found in true groundwaters, but are often found in surface water.

Sources most likely to be under the direct influence of surface water are:

- Infiltration galleries and Ranney wells.
- Springs.
- Shallow wells located near surface water.

Definition of a potential GWI source

Potential GWI sources are defined as infiltration galleries, Ranney wells, and springs. Potential GWI sources also include wells that withdraw water from less than 50 feet below the ground surface and that are located within 200 feet of surface water (WAC 246-290-010). Other susceptible sources may be considered potential GWI sources based upon poor water quality, substandard construction, or public health concerns.

DOH Drinking Water staff, local health department staff, sanitary surveyors, and other field personnel often identify potential GWI sources while conducting field work. DOH also conducts records reviews to identify potential GWI sources. Once a source is identified as a potential GWI source, field confirmation is conducted to make sure the potential GWI source fits the regulatory definition. If the regulatory definition is appropriate, DOH designates the source as a potential GWI source.

Definition of associated surface water

All surface waters within 200 feet of the potential GWI source are identified as associated surface water and must be monitored. In general, surface water is defined as water open to the atmosphere and subject to surface runoff, including perennial (year-round) rivers, streams, and creeks as well as lakes, ponds and wetlands. Intermittent streams and natural and man-made surface impoundments that receive runoff are also included in the definition of surface water. Isolated bodies of water that form in low-lying areas during the rainy season solely as a result of the water table rising to the surface are not considered surface water. If there is a question as to whether a particular body of water will be considered surface water in the context of this guidance, the deciding factor will be whether channelized drainage contributes water to the body; that is, a particular body of water will be considered surface water if channelized drainage contributes water to it.

Definition and designation of hydraulic connection to surface water

Hydraulic connection to surface water means that water provided by a well (through pumping) or a spring (through pumping or by gravity-flow) is actually coming from the nearby, associated surface water, and that the time it takes for the surface water to reach the potential GWI source is sufficiently short for pathogens to survive the trip. Any contamination present in the surface water can travel through the subsurface soil and emerge in water drawn from the well or spring. This is how *Giardia lamblia*, *Cryptosporidium*, viruses, and other microbial organisms contaminate what appear to be groundwater sources.

In general, the closer a groundwater source is to surface water, the greater the likelihood of a hydraulic connection. Because of the nearness of a potential GWI source to surface water, hydraulic connectivity must be evaluated. The purveyor may also presume hydraulic connectivity and bypass the evaluation.

The groundwater in hydraulic connection with surface water designation triggers required installation of disinfection per WAC 246-290-451. In addition, microscopic particulate analysis (MPA) samples must be collected to look specifically for organisms typically found in surface water, such as algae, *Giardia lamblia*, and viruses. The MPA method may require a year or more to complete because a number of MPA samples may need to be collected.

As long as the source remains involved in the MPA method, the GWI determination process is considered underway, and a final designation is not made until this method is completed.

When a determination of hydraulic connection with surface water has been established (either conclusively or by presumption), the department notifies the purveyor, and provides time frames for taking the first two MPA samples as well as a list of laboratories that perform MPA analyses. At this point, per WAC 246-290-640(4)(a), the purveyor is required to submit an Action Plan that includes confirmation of the MPA sampling schedule, identification of the laboratory that has been selected to conduct the analyses, and a strategy for achieving disinfection. The installation or upgrade of disinfection treatment must be completed within 120 days after the second MPA result is known. (In some cases, a designation of GWI is made after the first MPA result.)

Microscopic Particulate Analysis Method

Overview

Microscopic Particulate Analysis (MPA) tests are conducted according to EPA's *Consensus Method for Determining Groundwaters Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (MPA)* (www.doh.wa.gov/ehp/dw/GWI.htm). The method was developed through a collaborative effort of microbiologists and laboratories from around the country.

MPA is intended to identify organisms that occur only in surface waters and whose presence in groundwater clearly indicates that at least some surface water has been mixed with it. The parameters that are believed to be indicators of surface water contamination of groundwater include *Giardia lamblia* cysts, *Coccidia*, diatoms, algae, insects/larvae, rotifers, and chlorophyll-containing plant debris. A more detailed discussion of these parameters is available in EPA's *Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources* (March, 1991 edition).

The EPA Consensus Method discusses the theory behind and limitations of the MPA tests. The absence of surface water indicators does not necessarily mean that the source is pathogen-free. Conversely, a positive MPA result does not necessarily signify the presence of specific pathogens. Thus, MPA sample results are not the sole factor in determining surface water influence, and a single high score or multiple medium scores are considered with other factors (indicated below) to make a final GWI determination. However, surface water is considerably more susceptible to contamination than groundwater, so it is generally assumed that even if the potential GWI source does not appear to be contaminated at the time of MPA sample collection, it may become contaminated at any time in the future. Likewise, if macroscopic surface water indicators are found in a groundwater source, then the conclusion is that microscopic-sized pathogens can also show up at any time.

Sanitary surveys and other site inspections of the source are used to evaluate other factors contributing to the risk of surface water influencing the microbiological quality of the source. These include factors such as:

- Source design and construction
- Surrounding geology, geography, and topography
- The type of surface water body or runoff
- Water levels, permanence or intermittence, volume, distance from the source, water quality, flow rate, and relative direction of flow
- Incidences of documented water contamination
- Operational procedures such as pumping rates, drawdown curves, etc.
- Customer complaints regarding water quality or water-related infectious illness.

Monitoring locations

Selection of the optimum sample site is critical to the success of the MPA sampling effort, and Department of Health input and approval is required.

The sampling point at the potential GWI source must be located as close as possible to the actual water supply source (the well head, spring collection box, etc.).

The MPA sample must be collected prior to distribution (including pipes, valves, pressure tanks, and reservoirs) and prior to treatment (including filtration, disinfection, and other physical or chemical treatment processes).

A sample tap at the source (at the well head or spring collection box) is the best sample location. The department may require installation of such a tap to accommodate MPA sample collection.

Monitoring frequency and timeframe

MPA samples may be collected as soon as hydraulic connection to surface water has been designated and the department has approved an MPA sampling plan (required as part of the Action Plan). In general, samples are collected at times that correspond to the greatest potential impact of surface water on the potential GWI source. EPA guidance suggests that MPA samples be collected until at least two sets of results are in the same risk category of low, moderate, or high (described in more detail below).

To optimize the detection of direct surface water influence, MPA samples are typically collected during both wet and dry periods. The purpose of collecting both wet-period and dry-period samples is to analyze water that is most likely to contain indicator organisms typical of surface water, if any exist, at times when conditions for transport to the potential GWI source are optimal. Information about time lags or trends derived from graphical and statistical analyses—such as from water quality monitoring data or a hydrogeologic investigation—will be used, if available, to refine optimal MPA sample collection times.

The wet-period sample is collected when the flow of surface water toward the potential GWI source is expected to be high due to a naturally steepened hydraulic gradient. Typically, the wet-period sample is planned to be collected when soils are freshly saturated and surface water flows are peaking or are at a very high level, such as during the winter and spring months.

The dry-period sample is collected when drawdown in the well is excessive due to maximum demand and a high pumping rate that also induces a steepened hydraulic gradient. Typically, a dry-period sample will be collected after a long, relatively dry (rain-free) period when soils are dry, surface water flow is at a low level, and the static (non-pumping) groundwater level is at a low point, such as during the late summer months. The groundwater level may be at a low point also because of high demand and pumping rates.

It is not always necessary to collect both wet-period and dry-period samples. In some cases, two wet-period samples may be sufficient. An example is when a spring flows into storage or a distribution system by gravity only (even during the dry season) and is not actively pumped. Because the spring is not pumped, the hydraulic gradient is not artificially steepened. By contrast, the steepened hydraulic gradient resulting from the seasonal increase in precipitation during the wet months would establish optimal conditions for transport of indicator organisms from the surface

water to the potential GWI spring source. In this and similar cases, wet-season samples would be collected both in early winter when surface water levels are beginning to peak and again in late spring before they begin to decline.

In most cases, a minimum of two MPA samples are collected during any given year—when water flow and water quality conditions are expected to be optimal for transport of surface water indicator organisms—until it is possible for the department to make a determination about the influence of surface water on the potential GWI source. It is possible for the first MPA sample to indicate direct influence of surface water, in which case the source is designated GWI, no further MPA testing is required, and the SWTR requirements apply.

Monitoring equipment

The equipment needed to collect an MPA sample is highly specialized and is provided by a laboratory capable of conducting microscopic particulate analyses. Appendix A contains a list of such labs.

In general, the equipment consists of hosing, a pressure regulator, a flow meter, control valves, and a high volume filter. The equipment is used to collect samples of the raw source water before any blending, disinfection or other treatment. The laboratory that does the sample analysis typically provides the monitoring equipment, the filter, a shipping container, refrigerant packs, sanitary gloves, plastic bags, field data worksheets, and sample collection instructions.

Sample collection and handling

In general, a large volume of water (typically 500-1,000 gallons) is pumped through a 10-inch, one-micrometer polypropylene filter under a specified pressure (10 psi) and flow rate (one gallon per minute). The filtering process typically takes about 24 hours. A low-pressure discharge (hose or drain) for disposal of water during the MPA test period is also required. Typically about 1,000 gallons of water is wasted over a 24-hour period.

When filtering is completed, the filter is sealed in a plastic bag, packed in a cooled container, and sent via overnight courier to an analytical laboratory. The maximum holding time is 48 hours because the sample must be analyzed at the laboratory within 96 hours of the beginning of sample collection.

Pressure required

A pump at the source must be able to provide sufficient pressure to force water through the MPA filter. The minimum pressure to operate the MPA test equipment is typically 10 psi (pounds per square inch). If pressure is inadequate at the sampling location, a portable or auxiliary pump must be provided to supply the needed sampling pressure. Adequate pressure must be provided regardless of the remoteness of the source.

Sample handling

It is critical for the sampler to be careful when handling the filter to make sure it does not become contaminated. For example, sanitary gloves (often provided by the lab with the sample collection equipment) must be used and the filter must not be laid down anywhere other than inside its protective plastic shipping bag.

Custody documentation

It is critical that the chain-of-custody form (provided by the laboratory) be completed while the MPA test is in progress, so that no details are left to memory. This form legally documents the custody, control, and integrity of the filter during transport from the field to the lab. It records custody of the sample (names, locations, dates, and times) from the collection point to the laboratory. The chain of custody must remain unbroken from the time the filter is removed from its protective, sealed plastic bag (in as-manufactured, unused condition) to when it is analyzed at the laboratory.

Laboratory analysis

The MPA filters are analyzed at a laboratory in accordance with EPA's *Consensus Method for Determining Groundwaters Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (MPA).* The laboratory concentrates the filtered water and examines it microscopically for organisms typically found in surface water.

Any observed bio-indicators are quantitatively equated to a relative risk score. The risk scores are used to determine whether the potential GWI source is under the direct influence of surface water. If several consecutive MPA test results' risk scores are inconclusive, additional filter samples must be collected and analyzed specifically for *Giardia lamblia* and *Cryptosporidium* using an additional Immuno-Fluorescent Assay (IFA) technique.

Sample collection and laboratory coordination

Appendix A contains a list of laboratories that provide MPA services. It is imperative that the laboratory be contacted and coordinated with prior to planning collection of a MPA sample. It is necessary to consider the timing of the sample collection event, especially the starting and ending times.

A MPA sample must be analyzed at the laboratory within 96 hours of the water having been run through the filter. Within this 96-hour period, there is a maximum holding time of 48 hours. The laboratory requires at least 12 hours to analyze the sample. Thus, taking into account the time needed to collect the sample (typically 24 hours), package it up and deliver it to the lab (possibly another 24 hours), plus the 12 hours needed by the lab for sample analysis, it is typically best to set up the equipment and start the MPA sample process on a Sunday or Monday morning, to be completed the following Monday or Tuesday morning (24 hours later). The sample filter should then be promptly shipped by overnight delivery to the laboratory (Monday or Tuesday night for delivery on Tuesday or Wednesday morning).

These timing issues must be well coordinated, not only for the convenience of whomever sets up the equipment, collects the sample, and ships it to the laboratory, but also for the laboratory staff to complete the analysis according to the required procedure. Planning is critical so as not to waste time or an MPA sample. Laboratories typically will not analyze a sample received late relative to a planned analysis time period.

Record keeping

The person who collected the MPA sample should keep a copy of the chain-of-custody form that accompanies the MPA sample at all times, plus a copy of the MPA result provided by the lab (next section).

MPA Result

Upon receipt of an MPA sample, the laboratory applies the *Consensus Method for Determining Groundwaters Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (MPA)* developed by EPA. Application of this method results in relative risk factors (scores) that the department uses to determine the degree of risk associated with influence by surface water.

The laboratory will send a report of the MPA results to the purveyor. The purveyor must send a copy of each MPA result to the DOH GWI Program Lead as soon as the laboratory provides it. (The purveyor may also arrange to have the laboratory send the result directly to the department.) The report will indicate a low, moderate, or high-risk score. The department will interpret the result and determine whether additional MPA samples must be collected or whether the source is directly influenced by surface water.

MPA Risk Scores and Ratings

The department applies the following relative risk factors:

- High risk – A lab-provided MPA result equal to or greater than 20.
- Moderate risk - A result equal to or greater than 10 and equal to or less than 19.
- Low risk – A result equal to or less than 9.

The MPA Interpretation Process Flow Chart (Appendix B) illustrates the department's decision-making process based on MPA sample results.

When MPA samples indicate a high risk, the source is designated GWI and SWTR requirements apply.

When MPA samples indicate a low risk, the source is designated groundwater (with or without disinfection requirements, depending on whether the potential GWI source was determined or presumed to be in hydraulic connection with surface water, and depending on the federal Ground Water Rule, when in effect).

When MPA samples indicate moderate risk, a limited number of additional MPA samples are required that eventually enable the department to make a designation of either GWI or groundwater. For example, if a series of four MPA samples results in a scattering of low, moderate, and high results, the timing of sample collection, source water quality monitoring data, and other factors will be evaluated to determine a process for final evaluation of the source.

The minimum number of MPA samples that may need to be collected is one. The maximum is 10 (two per year for five years).

Immuno-Fluorescent Assay (IFA) Samples

As shown on the MPA Interpretation Process Flow Chart (Appendix B), the second MPA test result may indicate a need for a sample to be Split for *Giardia/Crypto*. This split sample must be analyzed using the Immuno-Fluorescent Assay (IFA) method, which tests specifically for the presence of *Giardia lamblia* cysts and *Cryptosporidium* oocysts. When an IFA sample must be collected, the

MPA sample collection procedure is performed two days in a row. The first filter is submitted to the laboratory for analysis using the MPA method, and the second filter is submitted for analysis using the IFA method. No special action is required of the sample collector except for extra diligent coordination with the laboratory to ensure ample time for the subsequent pair of analyses.

If an IFA sample shows the presence of *Giardia lamblia* cysts or *Cryptosporidium* oocysts, then the sample is assigned an equivalent MPA score of 20. Because it is considered to pose high risk to public health, the source is immediately designated a GWI source, and SWTR requirements are applied.

Outcome of MPA Results

DOH analysis of MPA results. The department uses the results of the MPA samples to determine whether the source is directly influenced by surface water. As explained above, each MPA sample result relates to a relative risk factor, indicating the degree of risk to which the source is directly influenced by surface water. The department uses the flowchart titled MPA Interpretation Process (Appendix B) to interpret the MPA sample results with regard to source designation as GWI or groundwater.

If the first MPA sample result is a high-risk score (equal to 20 or higher) and the sample is valid, then the second MPA sample is not required, the source is designated GWI, and SWTR regulations apply. If the purveyor can justify in writing that an MPA sample result is invalid (for example, due to improper collection technique, unsuitable sample location, etc.) and the department concurs, this data point may be omitted, but additional samples may be required.

Designation of groundwater with hydraulic connection

Regardless of the MPA results, the determination of hydraulic connection requires the purveyor to install disinfection for the source within 120 days of the second MPA sample result or determination of hydraulic connectivity, unless an alternate schedule is justified and negotiated via a Bilateral Compliance Agreement. The 120-day timeframe begins after the first MPA sample result, if it is equal to or greater than 20.

If the source is designated groundwater (with hydraulic connection to surface water) based on the MPA sampling process, it is subject to groundwater source monitoring requirements.

Designation of GWI

If the source is designated GWI, it becomes subject to the full requirements of the SWTR. Water systems with GWI sources must achieve at least 99.9% removal or inactivation of *Giardia lamblia* cysts and at least 99.99% removal or inactivation of viruses. To accomplish this, systems must do all of the following:

- Filter, unless certain source quality and site-specific conditions are met.
- Disinfect.
- Be operated by qualified personnel.

Systems with GWI sources have several compliance options to choose from, including:

- Modifying (reconstructing) the source to eliminate direct surface water influence.
- Developing an alternate DOH-approved source (for example, developing a true groundwater source or purchasing from a nearby approved public water system).
- Attempting to meet the source quality and site-specific criteria to remain unfiltered (available to Group A Community water systems only per WAC 246-290-639(6) and (7)).

- Installing filtration or a limited alternative to filtration.

The department will work closely with the purveyor to determine the best option.

For more information

Department of Health, Office of Drinking Water

- Donna Freier, GWI Program Lead, (360) 586-5179 or donna.freier@doh.wa.gov
- Regional Office GWI Program contacts:
  Eastern Regional Office, Jeff Johnson (509) 456-2797
  Northwest Regional Office, Derek Pell (253) 395-6763
  Southwest Regional Office, John Blacklaw (360) 664-8951
- Website: http://www.doh.wa.gov/ehp/dw/. Provides access to publications on *Cryptosporidium* and other contaminants, information on how to hire an engineer, and many other resources. Also includes links to other sites such as the federal Environmental Protection Agency (EPA) and the American Water Works Association (AWWA.)
- Toll-free number: 1-800-521-0323

US Environmental Protection Agency
Safe Drinking Water Hotline 1-800-426-4791

Appendix A: Laboratories that Provide MPA Services

Organization: NORTHERN TESTING LABORATORY, INC.
Contact: Heather Reynolds
Address: 3330 Industrial Avenue
City: Fairbanks State: AK Zip 99701
Phone: (907) 456-3116 Fax: (907) 456-3125
Turn Around Time: 5 days
Kit: $50.00
Lab Cost: $400.00

Organization: AQUATIC CONSULTING & TESTING INC.
Contact: Frederick A. Amalfi, PhD.
Address: 1525 West University Drive, Suite 106
City: Tempe State: AZ Zip 85281
Phone: (480) 921-8044 Fax: (480) 921-0049
Turn Around Time: 2 -3 weeks
Kit cost included in Lab Cost
Lab Cost: $350.00

Organization: BIOVIR LABORATORIES
Contact: Nancy Drews
Address: 685 Stone Road
City: Benicia State: CA Zip 94510
Phone: (800) 442-7342 Fax: (717) 747-1751
Turn Around Time: 2-3 weeks
Kit: $50.00
Lab Cost: $360.00

Organization: CH DIAGNOSTIC & CONSULTING SERVICE, INC.
Contact: Keith W. Hancock
Address: 214 SE 19th Street
City: Loveland State: CO Zip 80537
Phone: (970) 667-9789 Fax: (970) 667-9719
Turn Around Time: 10 days
Kit $75.00
Lab Cost: $195.00

Organization: TAMPA BRANCH LABORATORY
Contact: Lea A. Heberlein-Larson
Address: 3602 Spectrum Blvd.
City: Tampa State: FL Zip 33612
Phone: (813) 974-8070 Fax: (813) 974-5776
Turn Around Time: 2 weeks
Kit $0.00
Lab Cost: $375.00

Organization: ANALYTICAL LABORATORIES, INC.
Contact: Robert Voermans
Address: 1804 N 33rd St
City: Boise State: ID Zip 83703
Phone: (208) 342-5515 Fax: (208) 342-5591
Turn Around Time:
Kit Call for quote
Lab Cost: Call for quote

Organization: ANALYTICAL SERVICES, INC
Contact: Attn: Sampling Receiving
Address: 130 Allen Brook Lane
City: Williston State: VT Zip 05495
Phone: (800) 723-4432 Fax: (802) 878-6765
Turn Around Time: 10 days
Kit $90.00
Lab Cost: $350.00

Organization: CLANCY ENVIRONMENTAL CONSULTANTS
Contact: Tim Clancy
Address: 2 Mapleville Depot
City: St. Albans State: VT Zip: 05478
Phone: (802) 527-2460 Fax: (802) 524-3909
Turn Around Time: 15 days
Kit $35.00
Lab Cost: $360.00

Organization: EDM LABORATORY AND CONSULTING SERVICES
Contact: Michele Eisenstein
Address: 28 Bridge St., Unit 2
City: Morrisville State: VT Zip 05661
Phone: (802) 888-1517 Fax:
Turn Around Time: 1 week
Kit $0.00
Lab Cost: $310.00

Organization: UDDER HEALTH SYSTEMS
Contact: Allan Britten, DVM, MPVM
Address: 6401 Old Guide Road
City: Bellingham State: WA Zip 98226
Phone: (360) 398-7617 Fax: (360) 398-7617
Turn Around Time: 5-10 days
Kit $85.00
Lab Cost: $350.00

Appendix B: Flow Chart of the MPA Interpretation Process