Revised December 2008

Monthly Reporting Requirements

Surface Water (SW) and Groundwater under the Direct Influence of Surface Water (GWUDI) Water Treatment Plants

Department of the Environment
Water Supply Program

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THE SURFACE WATER MONTHLY OPERATING REPORT (SWMOR)

GENERAL INSTRUCTIONS

1. **Read these instructions carefully. Keep these instructions for reference.**

2. **This information applies to public water systems that treat either surface water or groundwater under the direct influence of surface water (GWUDI).** Systems that purchase treated surface water from a wholesale supplier and do not have any treatment plants do not use this form.

3. **All testing needed to complete the report must be conducted using the laboratory methods listed in Appendix 1.**

   The term "MDE" means the Maryland Department of the Environment.

4. The term "surface water" means surface water sources or ground water sources under the direct influence of surface water.

5. Each page of the report must contain the name of the water system, the PWSID number, the name or number of the plant submitting the report, and the month and year that the plant collected the data.

6. The individual with primary responsibility for plant operations must sign and date the first page and initial all other pages of the form. This individual is usually the chief operator, the plant superintendent, the water production supervisor, or other person with similar authority, and he or she must be certified in the appropriate treatment plant classification.

7. The form contains no room for comments or general remarks. Please submit any general information on a separate sheet of paper.

8. **Federal regulations:** Surface Water Treatment Rule (SWTR)-June 29, 1989; Interim Enhanced Surface Water Treatment Rule (IESWTR)-December 16, 1998; Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR)- January 14, 2002; Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)- January 4, 2006.

9. **SYSTEMS THAT VIOLATE ANY OF THE TREATMENT TECHNIQUE REQUIREMENTS MUST NOTIFY THE MDE's WATER SUPPLY PROGRAM BY THE END OF THE NEXT BUSINESS DAY. Call (410) 537-3706, and in Maryland, 800-633-6101 (ext. 3706) during business hours. To report emergency incidents and Tier 1 violations during off-hours, call 1-866-MDE-GOTO (1-866-633-4686). See Appendix 6 for more details.**

PAGE 1 OF THE SWMOR

SYSTEM DATA

PWSID No.:

Enter the water system's seven-digit PWSID (Public Water System Identification) number.

Report for the Month of:

Enter the month and the year that the plant collected the data. For example, January 2009.

PUBLIC WATER SYSTEM NAME:

Enter the name of the public water system.

PLANT NAME OR NUMBER:

If the water system has more than one treatment plant, enter the name of the treatment plant that collected the data. You may leave this line blank if the water system only has one treatment plant.

Operator's Signature:

The certified operator or superintendent responsible for the day-to-day operation of the treatment plant must **sign** the form.

Certificate No. and Classification:

Enter the certificate number and the water treatment classification of the operator signing the form. For example, T4-1234.

Date:

Enter the date that the operator signs the form.

TREATMENT PLANT PERFORMANCE

(1) Total number of turbidity readings:

Record the number of filtered water turbidity readings taken for the month. This number must include, at minimum, readings taken every 4 hours; however, a turbidity recording frequency of once every minute is recommended for determining plant optimization. See page 3 of the MOR form, **Finished Water Turbidity.** If a continuous recording turbidimeter becomes inoperable, grab samples collected every four hours may be substituted for continuous monitoring. If this happens, however, systems serving a population of 10,000 or more must replace or repair the turbidimeter within 5 days. Systems serving fewer than 10,000 people must repair or replace the turbidimeter within 14 days.

(2) Number of readings above the turbidity standard

Record the number of readings above 0.3 NTU or 1.0NTU as appropriate on the corresponding line. 0.3 NTU is the 95th percentile turbidity level for most systems; 1.0 NTU is the 95th percentile turbidity level for systems that are unfiltered, or use diatomaceous earth, slow sand, or other alternative filtration as determined by MDE. (Note: Plants may round turbidity readings to the nearest 0.1 NTU. For example, 0.34 NTU rounds down to 0.3 NTU but 0.35 NTU rounds up to 0.4 NTU. Therefore, count only the readings that were 0.35 NTU and above when completing this line.)

(3) 95th percentile turbidity level

The MDE strongly encourages utilities to maintain turbidities as low as possible. The 95th percentile turbidity level is 0.3 NTU for conventional or direct filtration surface water treatment plants. System s that are unfiltered or use diatomaceous earth, slow sand, or other alternative filtration as determined by MDE are allowed a 95th percentile turbidity level turbidity of 1.0 NTU.

(4) Percentage of readings above this limit:

Divide the **"Number of readings above 95th percentile turbidity level** " by the **"Total number of turbidity reading**s" and then multiply by 100. For example, for a plant operating under a 0.3 NTU turbidity limit, if 180 readings were taken and 6 of these readings were above 0.3 NTU, the calculation would be:

$$\frac{6}{180} \text{ x } 100\% = 3.3\%$$

Round the percentage to the nearest 0.1%, i.e. 5.04% rounds to 5.0% and 5.05% rounds to 5.1%.

(Note: Plants should use the data on Page 1 of the MOR form to determine if notification of MDE or the public is required. See page 8 of this guidance manual, **"COMPLIANCE DETERMINATION**", for guidance.)

(5) Number of 4-hour periods when plant was off-line:

Count the number of complete 4-hour periods in the month during which the plant was not on-line.

(6) Number of 4-hour periods when plant was on-line but turbidity data was not collected:

Count the number of 4-hour periods in the month that the plant was on-line but turbidity data was not collected.

(7) Number of days with readings above maximum turbidity level:

Most systems may not exceed 1 NTU at any time; systems that are unfiltered or use diatomaceous earth, slow sand, or alternative filtration as determined by MDE may not exceed 5 NTU as specified in the SWTR. Record the number of calendar days that one or more readings were above 1 NTU or 5 NTU as appropriate on the corresponding lines.

(Note: Plants may round turbidity readings to the nearest 0.1 NTU, i.e., 1.04 NTU rounds to 1.0 NTU and 1.05 NTU rounds to 1.1 NTU. Therefore, count only the readings that were 1.05 NTU and above when completing this line.)

Finished Water Data (as measured at the point of entry (POE))

(8) Minimum, Maximum, and Average turbidity reading

The Maximum filtered water turbidity reading that was recorded during the month must be reported. Reporting of Minimum and Average turbidity values is helpful but optional. For systems with more than one filter, this is the maximum of the plant's combined effluent turbidity measurements, not an individual filter's effluent turbidity. POE turbidity readings may be taken before or after post filter chemical addition.

(9)) Minimum, Maximum, and Average chlorine residual

The Minimum finished water (point of entry) chlorine reading that was recorded during the month must be reported. Reporting of Average and Maximum chlorine residual values is helpful but optional.

This data, also contained on Page 3 of the monthly report, should be entered on Page 1 for summary purposes.

(10) Exception Report(s) for Individual Filter Monitoring Required

For systems serving 10,000 people or more, if no two consecutive individual filter effluent turbidity readings taken fifteen minutes apart exceeded 0.5 NTU during the month, check "None". For systems serving fewer than 10,000 people, if no two consecutive individual filter effluent turbidity readings taken fifteen minutes apart exceeded 1.0 NTU during the month, check "None". Otherwise, please refer to the section in this guidance document regarding page 4 of the SWMOR, and check the appropriate reporting requirement. Options include:

1) None
2) Report to MDE
3) Filter Self-Assessment
4) CPE

Note: MDE should be contacted as soon as operators are aware that a filter exception has occurred.

(11) Exception Report(s) for Individual Filter Monitoring Submitted

If you checked "None" for item 10, check "None" for item 11 also. Otherwise, please refer to the section in this guidance document regarding page 4 of the SWMOR, and check the appropriate reporting requirement.

CT Determination

Please refer to Appendices 3 and 4 of this document for guidance in calculating required CT and actual plant CT. CT is the product of disinfectant residual (mg/L) and the estimated post disinfection detention time. Adequate CT should be an indicator of effective inactivation of bacteria, Giardia, and viruses.

In general, if CT is adequate for required *Giardia lamblia* cyst inactivation, it is also adequate for required inactivation of bacteria and viruses. All surface water systems are required to achieve a total of 99.9% or 3.0 log removal and or inactivation of *Giardia lamblia* cysts. Conventional filtration plants are assumed to achieve 2.5 log *Giardia* cyst removal through the filtration process and must achieve an additional 0.5 log inactivation from the disinfection process. Direct filtration, slow sand filtration, and alternative filtration technologies achieve 2.0 log *Giardia* cyst removal through the filtration process and must achieve an additional 1.0 log inactivation of *Giardia* cysts from the disinfection process. Unfiltered plants must achieve 3.0 log inactivation from the disinfection process.

Adequacy of CT can be verified in one of two ways. CT can be calculated and recorded daily using values of maximum plant flow rate, minimum disinfection residual, pH and water temperature. Otherwise, plant personal may choose to determine the maximum plant flow rate, minimum disinfection residual, maximum pH and minimum water temperature at which adequate CT will be achieved. Then, adequacy of CT can be verified daily simply by ensuring that none of these four parameters fell outside of the acceptable range. **Minimum requirement: Ensure that required CT was met daily at the plant's maximum flow rate and lowest disinfectant residual.**

(12) Number of days with a low CT for more than 4.0 consecutive hours:

If **"CT actual/CT required**" was 1.0 or greater on all days during the month, enter "0" on this line. If **"CT actual/CT required**" was less than 1.0 for more than 4.0 consecutive hours, enter the number of days during the month that this occurred.

(13) Number of days when plant was on-line and adequacy of CT was not verified

Look at the "**Raw Water (MGD**)", "**Chlorine Residual**", "**pH**" and "**Temp**". Count the number of calendar days that the plant was on-line but did not collect the data needed to demonstrate compliance with the disinfection requirements.

(Note: Unless a plant pumps no raw water during the day, maximum flow rate and minimum chlorine residual must be recorded daily and used to ensure adequate CT; water temperature and pH must also be recorded at least once daily if these parameters could cause required CT to not be met.)

(14) Minimum disinfectant residual required leaving the plant:

If the system uses free chlorine in the distribution system, select “0.2 mg/L free chlorine”. If the system injects ammonia at the plant, select “0.5 mg/L total chlorine”.

(Note: Most systems need to provide a much higher residual than the allowable minimum to maintain an acceptable residual throughout the distribution system.)

(15) Minimum disinfectant residual detected at the point of entry

Record the lowest point-of-entry disinfectant residual measured during the month. **Note: if the point-of-entry free chlorine residual is < 0.2 mg/L at anytime (or total chlorine < 0.5 mg/L for systems that use chloramines), you must notify MDE as soon as possible, but no later than the end of the next business day.**

Water systems that serve more than 3300 persons are required to continuously monitor the chlorine residual entering the distribution system. Water systems serving 3300 or fewer may collect grab samples as described below. (Note: Unless a plant pumps no treated water to distribution during the day, it must test the disinfectant residual entering the distribution system.) If a chlorine analyzer is inoperable, the system may substitute grab samples collected every four hours for continuous monitoring. The chlorine analyzer must be replaced or repaired within 5 days.

System size by population	Samples/Day
500 or fewer	1
501 to 1,000	2
1,001 to 2,500	3
2,501 to 3,300	4

Plants should conduct these tests at the outlet of the clearwell or at the service pump discharge header. However, any location characteristic of the water entering the distribution system is acceptable.

(16) Maximum number of consecutive hours when residual was below 0.2 mg/L (or 0.5 mg/L if using chloramines)

If none of the entries in the "**Minimum Chlorine Residual**" column on the page 3 of the form is below the 0.2 mg/L (or 0.5 mg/L for chloramines), enter "0" on this line. If any entry in the "**Minimum Chlorine Residual**" column is below 0.2 mg/L (or 0.5mg/L for chloramines), record the number of hours that passed before a residual of 0.2 mg/L (or 0.5mg/L for chloramines) or higher was measured and recorded. If the residual dropped below 0.2 mg/L (or 0.5mg/L for chloramines) for more than 4.0 hours on more than one occasion, enter the maximum number of consecutive hours during which this occurred.

(17) For systems with population>3,300: Number of days when disinfectant residual leaving the plant was not continuously monitored:

If the continuous chlorine monitor monitored and recorded residual at all times that water was produced, enter “0”. Otherwise, enter the number of days that the recorder was not monitoring or not recording; this should never exceed “5”.

DISTRIBUTION SYSTEM

(18) Minimum disinfectant residual required in distribution system:

If the system uses chlorine only as a disinfectant, check **"free chlorine = 0.1 mg/L."** Free Chlorine Residual monitoring is required. If the system uses chloramines (injects ammonia and chlorine), check **"total chlorine =0.5 mg/L."** Total chlorine residual monitoring is required.

(19) Total number of tests this month:

Record the number of times disinfectant residual was monitored in the distribution system during the month. Unless the system uses chloramines, it must test for free (not total) chlorine when monitoring the distribution system. See Appendix 1 for the acceptable laboratory methods. The minimum number of tests required depends on the population served by the entire system:

1) All systems must monitor and record the disinfectant residual each time they collect a bacteriological sample.
2) A system that treats surface water should check the residual in the distribution system at least once daily. Distribution residuals should be measured at representative locations throughout the distribution system. Sampling locations should be shown on the system's bacteriological sample site plan.

(Note: A system's bacteriological sample site plan should identify the "residual sampling sites" in addition to the "bacteriological sampling sites" used for coliform monitoring. Although a system may monitor the residual at other locations, it must complete the report based only on samples collected at sites shown on the sample site plan.)

(20) Minimum disinfectant residual value measured:

Record the lowest free chorine residual of all samples collected in the distribution system. If chloramines are used, record the lowest total chlorine residual.

(21) Number of readings with low residual:

Record the number of distribution system chlorine residual sample sites where the free chlorine residual was not detectable (i.e. below 0.1mg/L).

(22) Number of low readings with HPC > 500/ml:

Record the number of times a low residual was measured in the distribution system and the bacteriological sample collected at the same site and at the same time had an HPC > 500/ml.

(23) Percentage of readings with a low residual this month:

If at least 0.1 mg/L free chlorine residual was detected at all sites tested, enter "0". Otherwise, calculate the "V" value as follows: $V= (c+d+e)/(a+b) \times 100$, where:

a=total number of instances where the residual disinfectant concentration is measured;
b=number of instances where the residual disinfectant concentration is not measured but heterotrophic bacteria plate count (HPC) is measured;
c=number of instances where the residual disinfectant concentration is measured but not detected and no HPC is measured;
d=number of instances where no residual disinfectant concentration is detected and where HPC>500/ml;
e=Number of instances where the residual disinfectant concentration is not measured and HPC is >500/ml.

Enter the calculated V value for item #23.

(24) Percentage of readings with a low residual last month:

Enter item 23 from the previous month's MOR.

COMPLIANCE DETERMINATION

Answer each of the six questions; check in the appropriate column: "Yes" or "No." When answering the questions, refer to the data entered above on page 1 of the form.

If the answer to a question is "Yes," provide the dates that the system informed the MDE and the customers. Whenever possible, the system should include a copy of the customer notice when submitting its Monthly Operating Report.

Note: Systems that have violated any of the treatment technique requirements must inform the MDE as soon as possible, and no later than the end of the next business day. Please call the MDE at (410) 537-3706 during regular business hours or 1-866-MDE-GOTO during off-hours and verbally report the violation.

PAGE 2 and 3 OF THE SWMOR

GENERAL INFORMATION

RAW WATER

Record the number of inches of rainfall for each day that it rains and the number of hours the plant operated. Record turbidity of the raw water in the **"Turb NTU"** column. Also record Alkalinity, water temperature, and any other applicable raw water quality parameters such as iron and manganese. See Appendix 1 for the acceptable laboratory methods.

(Note: Plants may round raw water turbidity values to the nearest 1 NTU, i.e., 12.4 NTU rounds to 12 NTU and 112.5 NTU rounds to 113 NTU.)

CHEMICAL ADDITION

Record the volume or weight of each chemical additive fed each day. "#/day" is short for "pounds per day". The column titles on the form should be customized to show all chemical additives that are added to water that is delivered to the distribution system. Also, alternate units such as ounces, gallons, or grams per day may be used instead of pounds ("#") if desired. Calculate the expected average concentration of chemical, in mg/L, based on the chemical concentration of the additive, the volume of chemical added and total daily plant flow. Enter these values in the columns titled "mg/L". "Pre" chemicals are added prior to filtration; "post" chemicals are added after filtration.

Page 3: TREATMENT PROCESS PARAMETERS

Max Settled Turb NTU:

Record the maximum turbidity value recorded at the sedimentation basin or clarifier effluent, prior to the filters.

FINISHED WATER

Monitor water quality parameters that are affected by treatment, at the point of entry, and record data.

Cl2-Point of Entry: Number of Readings and Minimum Residual

Record the number of daily chlorine readings taken at the point-of-entry and the lowest residual detected. Required frequency for chlorine monitoring at the point-of-entry varies based on population as follows:

25- 500	1 grab sample per day
501-1000	2 grab samples per day
1000-2500	3 grab samples per day
2501-3300	4 grab samples per day
>3300	continuous chlorine residual monitoring and recording required

If the plant treated no water on a specific day, "Finished Water" cells should be left blank. See Appendix 1 for the acceptable laboratory methods. The plant may collect the residual data at any location in the plant where the quality is representative of the water entering the distribution system. Common sampling sites include the clearwell outlet line and the service pump discharge line.

Systems serving more than 3,300 persons must equip 9 lant with continuous disinfectant residual monitoring equipment. The continuous analyzer must sample the plant effluent at least once every 30 minutes. Plants using continuous analyzers to monitor the disinfectant residual must take the data from the recorder chart. The analyzer must be calibrated at least once each month to verify its continued accuracy. See Appendix 2 for more information on the calibration requirements of continuous chlorine residual monitors and recorders. A plant which experiences a failure in the continuous monitoring equipment may collect "grab samples" at the required frequency (see above) for no more than 5 working days.

FINISHED WATER TURBIDITY

Turbidity must be continuously monitored at the point-of-entry and recorded at least once every four hours that the plant operates. The frequency of recorded readings must be no more than every fifteen minutes and no less than every four hours that the plant operates, and the same frequency should be used every month. Enter the daily average and maximum of the recorded readings in the appropriate columns. Enter the total number of monthly readings that will be used to determine compliance in the "Total" column. Enter the number of these turbidity readings that are below the 95th percentile value of 0.3 NTU for most plants or below 1 NTU for unfiltered, DE, slow sand, or alternative filtration plants in the appropriate column. Enter the number of "four hour" readings that are below the maximum allowable turbidity level of 1 NTU for most plants or below 5 NTU for unfiltered or DE plants in the appropriate column. Plants using continuous turbidity analyzers may take the turbidity data from the recorder chart. However, the turbidity monitor must be calibrated at least once each quarter and checked at least weekly to verify its continued accuracy. See Appendix 2 for more information on the calibration requirements of continuous turbidity monitors and recorders. Alternately, plants with continuous analyzers may choose to use the results of grab samples for compliance purposes instead. Plants should collect the finished water turbidity data at the filter outlet header or the clearwell inlet line. However, MDE occasionally approves other sampling sites such as the clearwell outlet line or the service pump discharge line.

DISTRIBUTION

Record the daily minimum, maximum and average of distribution system chlorine residual measurements taken in the distribution system.

(Note: Plants may round turbidity readings to the nearest 0.1 NTU. For example, 0.54 NTU rounds to 0.5 NTU and 0.55 NTU rounds to 0.6 NTU. Similarly, 1.04 NTU rounds to 1.0 NTU and 1.05 NTU rounds to 1.1 NTU. Plants should avoid rounding turbidity readings below 0.1 NTU, especially those values below 0.05 NTU.).

FLOW DATA

Raw Water (MGD)

Record the amount of water withdrawn for treatment in the **"Raw Water (MGD**)" column. (Do not record the meter reading. Record the total amount of water produced during the day.) If the plant treated no water on a specific day, enter "0" in this column or leave that cell blank.

(Note: If a plant treats no water during the day, it may leave the **"RAW WATER ANALYSES**," **"FINISHED WATER DATA**" and **"Turbidit**y" columns for that day blank.)

Finished Water (MGD)

Record the amount of treated water discharged to the distribution system in the **"Finished Water (MGD**)" column. (Do not record the meter reading. Record the total amount of water pumped to the distribution system during the day.) If the plant pumped no water to distribution on a specific day, enter "0" in this column.

(Note: If a plant pumps no treated water to distribution during the day, it may leave the **"Minimum Residua**l" column for that day blank.)

Backwash Water

Record the amount of water used for backwashing. Calculate the percentage of the total water withdrawn from the source (raw water) that was used for backwashing.

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INDIVIDUAL FILTERS

Which systems are required to monitor individual filters?

Systems that provide conventional or direct filtration treatment must monitor individual filters.

The filtration requirements of the IESWTR (effective January 2002) apply to public water systems (PWSs) that use surface water or GWUDI, serve 10,000 or more people, and are required to filter under the SWTR. The filtration requirements of the LT1ESWTR (effective January 2005) apply to PWSs that use surface water or GWUDI, serve fewer than 10,000, and are required to filter under the SWTR. Systems with two or fewer filters that serve fewer than 10,000 may monitor combined effluent turbidity in lieu of monitoring the effluent from each individual filter.

What are the monitoring requirements for individual filters?

Systems must continuously measure the effluent turbidity of each individual filter using a method approved by EPA, and must record the results at least every 15 minutes. Individual filter turbidity monitoring once every 1 minute is recommended for determining plant optimization. If there is a failure in the continuous turbidity monitoring equipment, the system must conduct grab sampling every four hours in lieu of continuous monitoring until the turbidimeter is repaired or replaced. Systems serving ≥10,000 must repair or replace the turbidimeter within five (5) working days following the failure of the equipment. Systems serving <10,000 must repair or replace the turbidimeter within fourteen (14) working days following the failure of the equipment. Failure to comply with these requirements is a monitoring violation.

What are the reporting and recordkeeping requirements for individual filter monitoring?

Systems required to monitor individual filters must maintain the results of this monitoring for at least three years. Within 10 days after the end of each month, these systems must make a report to MDE that they have conducted individual filter monitoring. Systems are strongly encouraged to submit all data on page 4 of the report form every month. At minimum, they must report individual filter turbidity measurements to MDE if the measurements demonstrate any of the following exceedance conditions:

1) Any individual filter that has a measured turbidity level greater than 1.0 NTU in two consecutive measurements taken 15 minutes apart;
2) Any individual filter that has a measured turbidity level of greater than 0.5 NTU in two consecutive measurements taken 15 minutes apart after the first four hours of continuous filter operation after the filter has been backwashed or otherwise taken offline. (Note: only water systems serving ≥ 10,0000 are required to report this condition.)
3) Any individual filter that has a measured turbidity level greater than 2.0 NTU during each of two consecutive months.

For these cases, the system must report the filter number, the turbidity measurement, and the date(s) on which the exceedance occurred. The system must either identify and report an obvious reason for the exceedance or produce a filter profile for the filter within 7 days of the exceedance and report that the profile has been produced. Information on filter profiles is included in the next section of this document.

What are the reporting and recordkeeping requirements for addressing individual filter exceedances in consecutive months?

1) For an individual filter that has a turbidity of greater than 1.0 NTU in two consecutive measurements taken 15 minutes apart at any time during each of three consecutive months, the system must conduct a self-assessment of the filter within 14 days of the exceedance and report that the self-assessment was conducted in the monthly report. The self-assessment must consist of at least the following components: i) assessment of filter performance, ii) development of a filter profile, iii) identification and prioritization of factors limiting filter performance, iv) assessment of the applicability of corrections, and v) preparation of a filter self-assessment report.

2) For any individual filter that has a turbidity greater than 2.0 NTU in two consecutive measurements taken 15 minutes apart at any time in each of two consecutive months, the system must arrange for a comprehensive performance evaluation (CPE) by MDE, or a third party approved by MDE no later than 30 days following the exceedance for systems serving ≥ 10,000 and no later than 60 days following the exceedence for systems serving < 10,000. The CPE must be completed and submitted to the State no later than 90 days following the exceedance for systems serving ≥ 10,000 and no later than 120 days following the exceedance for systems serving < 10,000.

INDIVIDUAL FILTER DATA

PWS ID No.:

Enter the water system's seven-digit PWS ID number.

System Name:

Enter the name of the public water system.

Plant Name or Number:

If the water system has more than one treatment plant, enter the name of the treatment plant that collected the data. You may leave this line blank if the water system only has one treatment plant.

Month/Year:

Enter the month and the year that the plant collected the data.

Individual filter data:

In each "Max" column, enter the maximum filter turbidity recorded in readings taken every 15 minutes at the effluent to that filter during the day. Enter the number of 4-hour periods during which the filter was is service that day (maximum of 6).

Note: Individual filter turbidities must be recorded in 15- minute intervals in the logs maintained at the water treatment plant. Electronic data files may be utilized by water systems with turbidimeters that record data to computers or SCADA systems. Electronic data files must record filter #, time, and turbidity level, and be saved on a weekly basis. Large utilities may elect to have daily data files.

SUMMARY AND COMPLIANCE ACTIONS

Were there any periods when 15 minutes turbidity values were not recorded? Check "Yes" or "No"

Was turbidity >0.5 NTU in two or more consecutive 15 minute readings? (This question is for systems serving ≥10,000 only.) Check "Yes" or "No". If yes, attach a report to the form indicating the filter number, the turbidity measurements, and the date(s) on which the exceedances occurred. If there is an obvious reason for abnormal filter performance, also include a written explanation of this reason. Otherwise, if the system is not able to identify an obvious reason for abnormal filter performance, complete a filter profile within 7 days of the exceedance and submit a copy to MDE. A filter profile is a graphical representation of a individual filter's 15 minute turbidity readings recorded during the 24-hours in which the exception occurred. Indicate special circumstances such as backwashing events, chemical feed rate changes and plant flow rate changes on the graph.

Was turbidity >1.0 NTU in two or more consecutive 15 minute readings? Check "Yes" or "No".

Did this occur in both the previous two months at the same filter? Check "Yes" or "No". If yes, attach a report to the form indicating the filter number, the turbidity measurements, and the date(s) on which the exceedances occurred. Complete an individual filter self assessment within 14 days of the exceedance. Report that the individual filter self assessment was conducted. An individual filter assessment is an evaluation of the design and condition of a filter to determine the reliability of the filter's performance. This includes the following components: i) development of a filter profile, ii) determination of hydraulic loading conditions, iii) evaluation of actual condition and placement of the media, iv) description of backwashing practices, v) evaluation of condition of support media/underdrains; and vi) determining the condition and operation of filter rate-of-flow controllers and filter valving..

Was turbidity >2.0 NTU in two or more consecutive 15 minute readings? Check "Yes" or "No".

Did this occur in the previous month at the same filter? Check "Yes" or "No". If yes, attach a report to the form indicating the filter number, the turbidity measurements, and the date(s) on which the exceedances occurred. Arrange for completion of a comprehensive performance evaluation (CPE) by MDE or a third party approved by MDE no later than 30 days following the exceedance for systems serving ≥10,000 and no later than 60 days following the exceedance for systems serving <10,000.

Filter Profile Exception Reports: Check "No" if the answer was "No" to all questions above. Check "Yes" if exception report is required.

Filter Self-Assessment Exception Report: Check "No" if the answer was "No" to all questions above. Check "Yes" if exception report is required.

Request for Compliance CPE: Check "No" if the answer was "No" to all questions above. Check "Yes" if exception report is required.

APPENDIX 1

ACCEPTABLE LABORATORY PROCEDURES

Surface water treatment plants must monitor the turbidity, pH, temperature, and disinfectant residual to properly complete the Surface Water Monthly Operating Reports (SWMORs). To meet state and federal requirements, plants must use the laboratory methods shown in the following table when conducting these tests.

TABLE 1-1
ACCEPTABLE LABORATORY METHODS FOR ANALYSES

Parameter	Minimum Accuracy *(1)*	Acceptable Method(s) *(2)*
Temperature	± 0.5	C Thermometric (SM 2550)
pH	± 0.1 pH unit	Electrometric (SM 4500-H^+) Electrometric (EPA 150.1&2)
Turbidity	± 0.05 NTU	Nephelometric (SM 2130 B) Nephelometric (EPA 180.1) Great Lakes Instruments Method 2
Free Chlorine	±0.1 mg/L	Amperometric, Titration (SM 4500-Cl D) DPD Ferrous, Titration (SM 4500-Cl F) DPD, Colorimetric *(4)* (SM 4500-Cl G) Syringaldizine (FACTS) (SM 4500-Cl H)

Table continues on the next page.

TABLE 1-1 (cont.)
ACCEPTABLE LABORATORY METHODS FOR ANALYSES

Parameter	Minimum Accuracy *(1)*	Acceptable Method(s) *(2)*
Chloramine	± 0.1 mg/L	Amperometric, Titration (SM 4500-Cl D)
		DPD Ferrous, Titration (SM 4500-Cl F)
		DPD, Colorimetric *(4)* (SM 4500-Cl G)
Chlorine Dioxide	± 0.05 mg/L	Amperometric, Titration (SM 4500-ClO_2 C)
		Amperometric, Titration (SM 4500-ClO_2 E)
		DPD-Glycine *(5)* (SM 4500-ClO_2 D)
Ozone	± 0.02 mg/L	Indigo Method (SM 4500-O_3 B)
MIOX	± 0.1 mg/L	See Note *(*6) below

Notes: ***(1)*** Minimum accuracy needed to comply with MDE requirements. The values shown may be different from the values contained in Standard Methods or EPA procedures.

(2) SM - Standard Methods, 19th Edition; EPA - EPA Methods

(3) This is not a complete list of all commercially available test kits nor an endorsement of any specific product.

(4) Color comparator test kits, such as Hach's color wheels and LaMotte's Octet comparator, are not acceptable for in-plant testing. These test kits may be used for distribution testing although more sophisticated colorimetric meters are recommended.

(5) The DPD-Glycine method for chlorine dioxide may be used to measure the ClO_2 residual at the point of application or the residual leaving the plant. It may not be used to measure the residual at the end of any disinfection zone.

(6) In the absence of recommendations by EPA, MIOX residuals may be measured using any of the acceptable methods for free chlorine.

APPENDIX 2

CALIBRATION OF CONTINUOUS TURBIDITY AND CHLORINE RESIDUAL MONITORS

Rules Affected:

Systems that treat surface water or ground water which is under the direct influence of surface water must monitor the turbidity and disinfectant residual of their treated water. Certain systems must use continuous monitors to comply with these requirements. Others may choose to use this technology to meet the requirements even when its use is not mandatory. Continuous monitors are used for two purposes: (1) process control, and (2) compliance monitoring.

"Process control" monitors are used only to improve the performance of a treatment plant. The data collected from these instruments is not reported to the MDE. Individual filter turbidity monitors, particle counters, and streaming current detectors are all examples of process control instruments.

Compliance monitors are instruments that collect data used for compliance determinations. These instruments include the turbidity monitors on the filter effluent header and the chlorine residual monitors located at the plant discharge. Any monitor used to determine if the system meets a treatment technique requirement of the Surface Water Treatment Rule is a compliance monitor.

MDE regulations require periodic calibration of continuous monitors used to collect compliance data. Turbidity monitors must be calibrated weekly. Continuous chlorine residual monitors must be calibrated at least once each month. However, manufacturer's calibration procedures are often time-consuming, multi-step methods. Consequently, the MDE will allow plant operators to utilize the following procedures to check the calibration of the on-line monitors.

Weekly Calibration Check for Continuous Turbidity Monitors and Recorders

1. Record the turbidity reading shown on the on-line monitor.

2. Collect a sample from the inlet or outlet of the on-line monitor.

3. If a continuous recorder is used, compare the value reported by the recorder with the value reported by the monitor.
   (a) If the values differ by more than 0.05 NTU, adjust the recorder.
   (b) If the values differ by 0.05 NTU or less, no adjustment of the recorder is needed.

4. Check the calibration of the bench scale turbidity meter with a secondary standard.

5. Measure and record the turbidity of the sample collected from the on-line monitor.

Appendix 2: Calibration of Continuous Turbidity and Chlorine Residual Monitors (cont.)
Weekly Calibration Check for Continuous Turbidity Monitors and Recorders (cont.)

6. Compare the turbidity readings from the two instruments.
   (a) If the values differ by no more than 0.10 NTU, complete calibration of the units is not required.
   (b) If the values differ by more than 0.10 NTU:
      (i) follow the manufacturer's instructions and recalibrate both the on-line and bench turbidimeters using primary turbidity standards.
      (ii) repeat steps 1-6. If the values still differ by more than 0.10 NTU, contact the instrument manufacturer for further instructions.

Monthly Calibration Check for Continuous Chlorine Residual Monitors and Recorders

1. Record the chlorine residual reading shown on the on-line monitor.

2. Collect a sample from the inlet of the on-line monitor.

3. If a continuous recorder is used, compare the value reported by the recorder with the value reported by the monitor.
   (a) If the values differ by more than 0.10 mg/L, adjust the recorder.
   (b) If the values differ by 0.10 mg/L or less, no adjustment of the recorder is needed.

4. Measure and record the chlorine residual of the sample collected from the on-line monitor using an USEPA-approved manual method (see Quarterly Calibration below).

5. Compare the two chlorine residual readings.
   (a) If the values differ by no more than 0.10 mg/L, recalibration of the on-line monitor is not required.
   (b) If the values differ by more than 0.10 mg/L:
      (i) follow the manufacturer's instructions and recalibrate the on-line chlorine residual monitor.
      (ii) repeat steps 1-5. If the values still differ by more than 0.10 mg/L, contact the instrument manufacturer for further instructions.

Quarterly Calibration of Continuous Monitors

At least once every three months, the plant operator(s) must follow manufacturer's instructions and completely calibrate its continuous monitors.

1. Continuous turbidity monitors must be calibrated using primary turbidity standards.

2. Continuous chlorine residual monitors must be calibrated using a chlorine solution of known concentration. The concentration of the “known” must be determined by an USEPA-approved titration (DPD-Ferrous, etc.), colorimetric (HACH DR100, etc.) or spectrophotometric (HACH DR2000, etc.) method. Color wheel test kits are not suitable for the quarterly calibration.

APPENDIX 3
DETERMINING THE VALUE OF REQUIRED CT (CT_{REQD})

CT = Disinfection residual (mg/L) x Detention time (minutes)

Plants use CT calculations to check the adequacy of the disinfection process under actual operating conditions to inactivate Bacteria, *Giardia lamblia* cysts, and viruses.

In general, if CT is adequate for required *Giardia lamblia* cyst inactivation, it is also adequate for required inactivation of bacteria and viruses. All surface water systems are required to achieve a total of 99.9% or 3.0 log removal and or inactivation of *Giardia lamblia* cysts. Conventional filtration plants are assumed to achieve 2.5 log *Giardia* cyst removal through the filtration process and must achieve an additional 0.5 log inactivation from the disinfection process. Direct filtration, slow sand filtration, and alternative filtration technologies achieve 2.0 log *Giardia* cyst removal through the filtration process and must achieve an additional 1.0 log inactivation of *Giardia* cysts from the disinfection process. Unfiltered plants must achieve 3.0 log inactivation from the disinfection process.

Plant personnel must determine the required CT (or CT_{req}) for each disinfection zone i.e. each segment of the treatment process with the same flow rate, disinfection residual, pH, and water temperature.

.Finding CT_{req} for *Giardia* When Using Free Chlorine

Procedure:

1. Go to the "**CT Values for Inactivation of *Giardia Cysts* by Free Chlorine**" Tables in Appendix 5.

2. Find the CT table for the temperature which is equal to (or slightly below) the actual temperature of the water. For example, if the temperature is 19°C, use the 15°C table (Appendix 4).

3. Go to the section of the table for the pH which is equal to (or slightly above) the actual pH of the water. For example, if the pH is 7.2, use the pH=7.5 section.

4. Find the column for the log inactivation needed. For example, if the plant is required to provide a 0.5-log *Giardia* inactivation, use the 0.5-log column.

5. Look at the far left side of the table and find the chlorine concentration which is equal to (or slightly above) the actual free chlorine concentration at the end of the contact pipe or effluent from the vessel. For example, if the chlorine concentration is 1.1 mg/L, use the 1.2 mg/L row.

6. The value shown at the intersection of the concentration row and the inactivation column is the value of CT_{req}.

Example: For a plant that is using free chlorine as the disinfectant and is required to achieve a 0.5-log inactivation of *Giardi*a, find the value of CT_{req} for a water temperature of 11°C, a pH of 8.2, and a residual of 2.5 mg/L.

Answer: Using the 10°C *Giardia* Inactivation Table for Free Chlorine, look under the pH=8.5 section and the 0.5-log inactivation column. Across the 2.6 mg/L row, find that the CT_{req} is 39.

IMPORTANT NOTES

1. NO *GIARDIA* DISINFECTION CREDIT IS ALLOWED FOR FREE CHLORINE IF THE pH IN THE DISINFECTION ZONE IS ABOVE 9.0.

.**Finding CT_{req} for *Giardia* When Using Chlorine Dioxide, Ozone, or Chloramines:** This procedure is similar to the procedure for determining CT_{req} using free chlorine. The CT tables for these disinfection methods can be found at the end of Appendix 5.

See Appendix 4 to determine CT. Each plant must verify daily that CT/ CTreq ≥1.

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APPENDIX 4

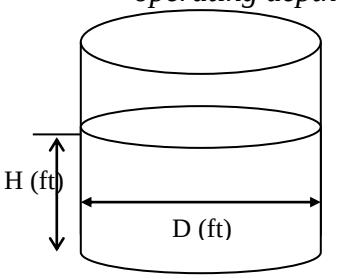
DETERMINING ACTUAL CT

To verify adequacy of CT, plant personnel must ensure that the actual CT achieved at a water treatment plant is greater than the required CT (CT_{REQD}: See Apendix 3). Plant CT is the sum of the CT values calculated for each disinfection zone in the treatment process as well as any distribution system piping, tanks, or reservoirs that are located before the first customer. For each zone, CT= the disinfection residual (mg/L) x the detention time (minutes).

Calculating Detention Time: Approximate detention time can be calculated based on plant flow rate (gallons per minute) and the effective volume of all post-disinfection piping and basins (at minimum operating depth). To determine the effective volume of a basin, multiply the actual volume of water that is in the basin at its lowest operating depth by the appropriate baffling factor from the table below.

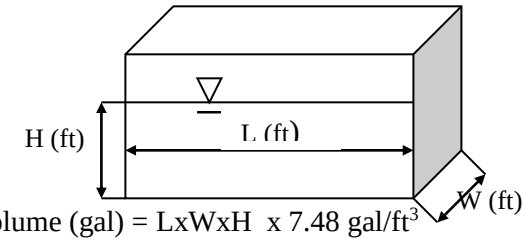
Examples of actual volume calculations:

Tank at lowest operating depth



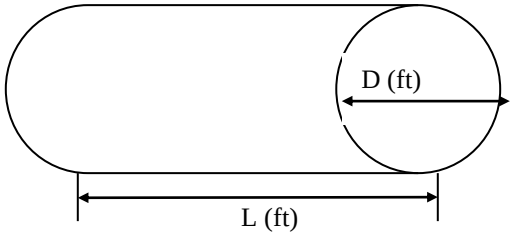
Volume (gal) = $\pi(D/2)^2H$ x 7.48 gal/ft^3

Basin at lowest operating depth



Volume (gal) = LxWxH x 7.48 gal/ft^3

Pipeline



Volume (gal) = $\pi(D/2)^2L$ x 7.48 gal/ft^3

Baffling factors for determining effective volume

Baffling Condition	Factor	Baffling Description
Unbaffled	0.1	None; agitated basin, high inlet and outlet flow velocities, variable water level.
Poor	0.3	Single or multiple unbaffled inlets and outlets, no intra-basin baffles.
Average	0.5	Baffled inlet or outlet with some intra-basin baffles.
Superior	0.7	Perforated inlet baffle, serpentine or perforated intra-basin baffles, outlet weir or perforated weir.
Excellent	0.9	Serpentine baffling throughout basin.
Perfect (plug flow)	1.0	Pipeline flow.
*Based on hydraulic detention time at minimum operating depth		

To calculate plant CT:

effective volume = actual volume x baffling factor (see table above)

detention time (minutes) = effective volume (gallons) ÷ plant flow rate (gallons per minute)

CT (mg/L●min) for one disinfection zone = free chlorine residual (mg/L) x detention time (minutes)

CT (mg/L●min) = sum of CT for each disinfection zone prior to the first customer

Is CT/ $CT_{REQD} \geq 1$? If so, CT is adequate.

APPENDIX 5

CT TABLES

This appendix contains the *Giardia lamblia* CT tables for free chlorine, chlorine dioxide, ozone, and chloramine. The information used to generate the tables and associated notes was derived from the following documents:

U.S. Environmental Protection Agency, *Optimizing Water Treatment Plant Performance Using the Composite Correction Program,,* Office of Research and Development Technology Transfer and Support Division National Risk Management Research Laboratory, Cincinnati, OH, 1998 Edition, revised 2004. Table D-1

U.S. Environmental Protection Agency, *Guidance Manual: Disinfection Profiling and Benchmarking* Appendix C, August 1999. "Source: AWWA, 1991. Modified by linear interpolation between 5ºC increments." Tables C-8, C-10, and C-12.

Appendix 5: CT Values for Inactivation of *Giardia Cysts* by Free Chlorine at 0.5 ºC or Lower (32.9 ºF or lower)

Chlorine Concentration	pH ≤ 6.0 Log Inactivation						pH ≤ 6.5 Log Inactivation						pH ≤ 7.0 Log Inactivation						pH ≤ 7.5 Log Inactivation					
(mg/L)	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
≤0.4	23	46	69	91	114	137	27	54	82	109	136	163	33	65	98	130	163	195	40	79	119	158	198	237
0.6	24	47	71	94	118	141	28	56	84	112	140	168	33	67	100	133	167	200	40	80	120	159	199	239
0.8	24	48	73	97	121	145	29	57	86	115	143	172	34	68	103	137	171	205	41	82	123	164	205	246
1	25	49	74	99	123	148	29	59	88	117	147	176	35	70	105	140	175	210	42	84	127	169	211	253
1.2	25	51	76	101	127	152	30	60	90	120	150	180	36	72	108	143	179	215	43	86	130	173	216	259
1.4	26	52	78	103	129	155	31	61	92	123	153	184	37	74	111	147	184	221	44	89	133	177	222	266
1.6	26	52	79	105	131	157	32	63	95	126	158	189	38	75	113	151	188	226	46	91	137	182	228	273
1.8	27	54	81	108	135	162	32	64	97	129	161	193	39	77	116	154	193	231	47	93	140	186	233	279
2	28	55	83	110	138	165	33	66	99	131	164	197	39	79	118	157	197	236	48	95	143	191	238	286
2.2	28	56	85	113	141	169	34	67	101	134	168	201	40	81	121	161	202	242	50	99	149	198	248	297
2.4	29	57	86	115	143	172	34	68	103	137	171	205	41	82	124	165	206	247	50	99	149	199	248	298
2.6	29	58	88	117	146	175	35	70	105	139	175	209	42	84	126	168	210	252	51	101	152	203	253	304
2.8	30	59	89	119	148	178	36	71	107	142	178	213	43	86	129	171	214	257	52	103	155	207	258	310
3	30	60	91	121	151	181	36	72	109	145	181	217	44	87	131	174	218	261	53	105	158	211	263	316

Chlorine Concentration	pH ≤ 8.0 Log Inactivation						pH ≤ 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
(mg/L)	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
≤0.4	46	92	139	185	231	277	55	110	165	219	274	329	65	130	195	260	325	390
0.6	48	95	143	191	238	286	57	114	171	228	285	342	68	136	204	271	339	407
0.8	49	98	148	197	246	295	59	118	177	236	295	354	70	141	211	281	352	422
1	51	101	152	203	253	304	61	122	183	243	304	365	73	146	219	291	364	437
1.2	52	104	157	209	261	313	63	125	188	251	313	376	75	150	226	301	376	451
1.4	54	107	161	214	268	321	65	129	194	258	323	387	77	155	232	309	387	464
1.6	55	110	165	219	274	329	66	132	199	265	331	397	80	159	239	318	398	477
1.8	56	113	169	225	282	338	68	136	204	271	339	407	82	163	245	326	408	489
2	58	115	173	231	288	346	70	139	209	278	348	417	83	167	250	333	417	500
2.2	59	118	177	235	294	353	71	142	213	284	355	426	85	170	256	341	426	511
2.4	60	120	181	241	301	361	73	145	219	290	363	435	87	174	261	348	435	522
2.6	61	123	184	245	307	368	74	148	222	296	370	444	89	178	267	355	444	533
2.8	63	125	188	250	313	375	75	151	226	301	377	452	91	181	272	362	453	543
3	64	127	191	255	318	382	77	153	230	307	383	460	92	184	276	368	460	552

Note: CT 99.9= CT for 3-log inactivation

Appendix 5: CT Values for Inactivation of *Giardia Cysts* by Free Chlorine at 5 ºC (41 ºF)

Chlorine Concentration (mg/L)	pH ≤ 6.0 Log Inactivation						pH ≤ 6.5 Log Inactivation						pH ≤ 7.0 Log Inactivation						pH ≤ 7.5 Log Inactivation					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
≤0.4	16	32	49	65	81	97	20	39	59	78	98	117	23	46	70	93	116	139	28	55	83	111	138	166
0.6	17	33	50	67	83	100	20	40	60	80	100	120	24	48	72	95	119	143	29	57	86	114	143	171
0.8	17	34	52	69	86	103	20	41	61	81	102	122	24	49	73	97	122	146	29	58	88	117	146	175
1	18	35	53	70	88	105	21	42	63	83	104	125	25	50	75	99	124	149	30	60	90	119	149	179
1.2	18	36	54	71	89	107	21	42	64	85	106	127	25	51	76	101	127	152	31	61	92	122	153	183
1.4	18	36	55	73	91	109	22	43	65	87	108	130	26	52	78	103	129	155	31	62	94	125	156	187
1.6	19	37	56	74	93	111	22	44	66	88	110	132	26	53	79	105	132	158	32	64	96	128	160	192
1.8	19	38	57	76	95	114	23	45	68	90	113	135	27	54	87	108	135	162	33	65	98	131	163	196
2	19	39	58	77	97	116	23	46	69	92	115	138	28	55	83	110	138	165	33	67	100	133	167	200
2.2	20	39	59	79	98	118	23	47	70	93	117	140	28	56	85	113	141	169	34	68	102	136	170	204
2.4	20	40	60	80	100	120	24	48	72	95	119	143	29	57	86	115	143	172	35	70	105	139	174	209
2.6	20	41	61	81	102	122	24	49	73	97	122	146	29	58	88	117	146	175	36	71	107	142	178	213
2.8	21	41	62	83	103	124	25	49	74	99	123	148	30	59	89	119	148	178	36	72	109	145	181	217
3	21	42	63	84	105	126	25	50	76	101	126	151	30	61	91	121	152	182	37	74	111	147	184	221

Chlorine Concentration (mg/L)	pH ≤ 8.0 Log Inactivation						pH ≤ 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
≤0.4	33	66	99	132	165	198	39	79	118	157	197	236	47	93	140	186	233	279
0.6	34	68	102	136	170	204	41	81	122	163	203	244	49	97	146	194	243	291
0.8	35	70	105	140	175	210	42	84	126	168	210	252	50	100	151	201	251	301
1	36	72	108	144	180	216	43	87	130	173	217	260	52	104	156	208	260	312
1.2	37	74	111	147	184	221	45	89	134	178	223	267	53	107	160	213	267	320
1.4	38	76	114	151	189	227	46	91	137	183	228	274	55	110	165	219	274	329
1.6	39	77	116	155	193	232	47	94	141	187	234	281	56	112	169	225	281	337
1.8	40	79	119	159	198	238	48	96	144	191	239	287	58	115	173	230	288	345
2	41	81	122	162	203	243	49	95	147	196	245	294	59	118	177	235	294	353
2.2	41	83	124	165	207	248	50	100	150	200	250	300	60	120	181	241	301	361
2.4	42	84	127	169	211	253	51	102	153	204	255	306	61	123	184	245	307	368
2.6	43	86	129	172	215	258	52	104	156	208	260	312	63	125	188	250	313	375
2.8	44	88	132	175	219	263	53	106	159	212	265	318	64	127	191	255	318	382
3	45	89	134	179	223	268	54	108	162	216	270	324	65	130	195	259	324	389

Note: CT 99.9= CT for 3-log inactivation

Appendix 5: CT Values for Inactivation of *Giardia Cysts* by Free Chlorine at 10 ºC (50 ºF)

Chlorine Concentration (mg/L)	pH ≤ 6.0 Log Inactivation						pH ≤ 6.5 Log Inactivation						pH ≤ 7.0 Log Inactivation						pH ≤ 7.5 Log Inactivation					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
≤0.4	12	24	37	49	61	73	15	29	44	59	73	88	17	35	52	69	87	104	21	42	63	83	104	125
0.6	13	19	25	32	38	8	15	23	30	38	45	9	18	27	36	45	54	11	21	32	43	53	64	
0.8	13	26	39	52	65	78	15	31	46	61	77	92	18	37	55	73	92	110	22	44	66	87	109	131
1	13	26	40	53	66	79	16	31	47	63	78	94	19	37	56	75	93	112	22	45	67	89	112	134
1.2	13	27	40	53	67	80	16	32	48	63	79	95	19	38	57	76	95	114	23	46	69	91	114	137
1.4	14	27	41	55	68	82	16	33	50	66	83	99	20	40	60	79	99	119	24	48	72	96	120	144
1.6	14	28	42	55	69	83	17	33	50	66	83	99	20	40	60	79	99	119	24	48	72	96	120	144
1.8	14	29	43	57	72	86	17	34	51	67	84	101	20	41	61	81	102	122	25	49	74	98	123	147
2	15	29	44	58	73	87	17	35	52	69	87	104	21	41	62	83	103	124	25	50	75	100	125	150
2.2	15	30	45	59	74	89	18	35	53	70	88	105	21	42	64	85	106	127	26	51	77	102	128	153
2.4	15	30	45	60	75	90	18	36	54	71	89	107	22	43	65	86	108	129	26	52	79	105	131	157
2.6	15	31	46	61	77	92	18	37	55	73	92	110	22	44	66	87	109	131	27	53	80	107	133	160
2.8	16	31	47	62	78	93	19	37	56	74	93	111	22	45	67	89	112	134	27	54	82	109	136	163
3	16	32	48	63	79	95	19	38	57	75	94	113	23	46	69	91	114	137	28	55	83	111	138	166

Chlorine Concentration (mg/L)	pH ≤ 8.0 Log Inactivation						pH ≤ 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
≤0.4	25	50	75	99	124	149	30	59	89	118	148	177	35	70	105	139	174	209
0.6	26	51	77	102	128	153	31	61	92	122	153	183	36	73	109	145	182	218
0.8	26	53	79	105	132	158	32	63	95	126	158	189	38	75	113	151	188	226
1	27	54	81	108	135	162	33	65	98	130	163	195	39	78	117	156	195	234
1.2	28	57	85	113	142	170	34	69	103	137	172	206	41	82	124	165	206	247
1.4	28	57	85	113	142	170	34	69	103	137	172	206	41	82	124	165	206	247
1.6	29	58	87	116	145	174	35	70	106	141	176	211	42	84	127	169	211	243
1.8	30	60	90	119	149	179	36	72	108	143	179	215	43	86	130	173	216	259
2	30	61	91	121	152	182	37	74	111	147	184	221	44	88	133	177	221	265
2.2	31	62	93	124	155	186	38	75	113	150	188	225	45	90	136	181	226	271
2.4	32	63	95	127	158	190	38	77	115	153	192	230	46	92	138	184	230	276
2.6	32	65	97	129	162	194	39	78	117	156	195	234	47	94	141	187	234	281
2.8	33	66	99	131	164	197	40	80	120	159	199	239	48	96	144	191	239	287
3	34	67	101	134	168	201	41	81	122	162	203	243	49	97	146	195	243	292

Note: CT 99.9= CT for 3-log inactivation

Appendix 5: CT Values for Inactivation of *Giardia Cysts* by Free Chlorine at 15 ºC (59 ºF)

Chlorine Concentration (mg/L)	pH ≤ 6.0 Log Inactivation						pH ≤ 6.5 Log Inactivation						pH ≤ 7.0 Log Inactivation						pH ≤ 7.5 Log Inactivation					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
≤0.4		16	25	33	41	49	1	20	30	39	49	59	12	23	35	47	58	70	14	28	42	55	69	83
0.6	8	17	25	33	42	50	1	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86
0.8	9	17	26	35	43	52	1	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88
1	9	18	27	35	44	53	11	21	32	42	53	63	13	25	38	50	63	75	15	30	45	60	75	90
1.2	9	18	27	36	45	54	11	21	32	43	53	64	13	25	38	51	63	76	15	31	46	61	77	92
1.4	9	18	28	37	46	55	11	22	33	43	54	65	13	26	39	52	65	78	16	31	47	63	78	94
1.6	9	19	28	37	47	56	11	22	33	44	55	66	13	26	40	53	66	79	16	32	48	64	80	96
1.8	10	19	29	38	48	57	11	23	34	45	57	68	14	27	41	54	68	81	16	33	49	65	82	98
2	10	19	29	39	48	58	12	23	35	46	58	69	14	28	42	55	69	83	17	33	50	67	83	100
2.2	10	20	30	39	49	59	12	23	35	47	58	70	14	28	43	57	71	85	17	34	51	68	85	102
2.4	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86	18	35	53	70	88	105
2.6	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88	18	36	54	71	59	107
2.8	10	21	31	41	52	62	12	25	37	49	62	74	15	30	45	59	74	89	18	36	55	73	91	109
3	11	21	32	42	53	63	13	25	38	51	63	76	15	30	46	61	76	91	19	37	56	74	93	111

Chlorine Concentration (mg/L)	pH ≤ 8.0 Log Inactivation						pH ≤ 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
≤0.4	17	33	50	66	83	99	20	39	59	79	98	118	23	47	70	93	117	140
0.6	17	34	51	68	85	102	20	41	61	81	102	122	24	49	73	97	122	146
0.8	18	35	53	70	88	105	21	42	63	84	105	126	25	50	76	101	126	151
1	18	36	54	72	90	108	22	43	65	87	108	130	26	52	78	104	130	156
1.2	19	37	56	74	93	111	22	45	67	89	112	134	27	53	80	107	133	160
1.4	19	38	57	76	95	114	23	46	69	91	114	137	28	55	83	110	138	165
1.6	19	39	58	77	97	116	24	47	71	94	118	141	28	56	85	113	141	169
1.8	20	40	60	79	99	119	24	48	72	96	120	144	29	58	87	115	144	173
2	20	41	61	81	102	122	25	49	74	98	123	147	30	59	89	118	148	177
2.2	21	41	62	83	103	124	25	50	75	100	125	150	30	60	91	121	151	181
2.4	21	42	64	85	106	127	26	51	77	102	128	153	31	61	92	123	153	184
2.6	22	43	65	86	108	129	26	52	78	104	130	156	31	63	94	125	157	188
2.8	22	44	66	88	110	132	27	53	80	106	133	159	32	64	96	127	159	191
3	22	45	67	89	112	134	27	54	81	108	135	162	33	65	98	130	163	195

Note: CT 99.9= CT for 3-log inactivation

Appendix 5: CT Values for Inactivation of *Giardia Cysts* by Free Chlorine at 20 ºC (68 ºF)

Chlorine Concentration (mg/L)	pH ≤ 6.0 Log Inactivation						pH ≤ 6.5 Log Inactivation						pH ≤ 7.0 Log Inactivation						pH ≤ 7.5 Log Inactivation					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
≤0.4	6	12	18	24	30	36	7	15	22	29	37	44	9	17	26	35	43	52	10	21	31	41	52	62
0.6	6	13	19	25	32	38	8	15	23	30	38	45	9	18	27	36	45	54	11	21	32	43	53	64
0.8	7	13	20	26	33	39	8	15	23	31	38	46	9	18	28	37	46	55	11	22	33	44	55	66
1	7	13	20	26	33	39	8	16	24	31	39	47	9	19	28	37	47	56	11	22	34	45	56	67
1.2	7	13	20	27	33	40	8	16	24	32	40	48	10	19	29	38	48	57	12	23	35	46	58	69
1.4	7	14	21	27	34	41	8	16	25	33	41	49	10	19	29	39	48	58	12	23	35	47	58	70
1.6	7	14	21	28	35	42	8	17	25	33	42	50	10	20	30	39	49	59	12	24	36	48	60	72
1.8	7	14	22	29	36	43	9	17	26	34	43	51	10	20	31	41	51	61	21	25	37	49	62	74
2	7	15	22	29	37	44	9	17	26	35	43	52	10	21	31	41	52	62	13	25	38	50	63	75
2.2	7	15	22	29	37	44	9	18	27	35	44	53	11	21	32	42	53	63	13	26	39	51	64	77
2.4	8	15	23	30	38	45	9	18	27	36	45	54	11	22	33	43	54	65	13	26	39	52	65	78
2.6	8	15	23	31	38	46	9	18	28	37	46	55	11	22	33	44	55	66	13	27	40	53	67	80
2.8	8	16	24	31	39	41	9	19	28	37	47	56	11	22	34	45	56	67	14	27	41	54	68	81
3	8	16	24	31	39	47	10	19	29	38	48	57	11	23	34	45	57	68	14	28	42	55	69	83

Chlorine Concentration (mg/L)	pH ≤ 8.0 Log Inactivation						pH ≤ 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
≤0.4	12	25	37	49	62	74	15	30	45	59	74	89	18	35	53	70	88	105
0.6	13	26	39	51	64	77	15	31	46	61	77	92	18	36	55	73	91	109
0.8	13	26	40	53	66	79	16	32	48	63	79	95	19	38	57	75	94	113
1	14	27	41	54	68	81	16	33	49	65	82	98	20	39	59	78	98	117
1.2	14	28	42	55	69	83	17	33	50	67	83	100	20	40	60	80	100	120
1.4	14	28	43	57	71	85	17	34	52	69	86	103	21	41	62	82	103	123
1.6	15	29	44	58	73	87	18	35	53	70	88	105	21	42	63	84	105	126
1.8	15	30	45	59	74	89	18	36	54	72	90	108	22	43	65	86	108	129
2	15	30	46	61	76	91	18	37	55	73	92	110	22	44	66	88	110	132
2.2	16	31	47	62	78	93	19	38	57	75	94	113	23	45	68	90	113	135
2.4	16	32	48	63	79	95	19	38	58	77	96	115	23	46	69	92	115	138
2.6	16	32	49	65	81	97	20	39	59	78	98	117	24	47	71	94	118	141
2.8	17	33	50	66	83	99	20	40	60	79	99	119	24	48	72	95	119	143
3	17	34	51	67	84	101	20	41	61	81	102	122	24	49	73	97	122	146

Note: CT 99.9= CT for 3-log inactivation

Appendix 5: CT Values for Inactivation of *Giardia Cysts* by Free Chlorine at 25 ºC (77 ºF)

Chlorine Concentration (mg/L)	pH ≤ 6.0 Log Inactivation						pH ≤ 6.5 Log Inactivation						pH ≤ 7.0 Log Inactivation						pH ≤ 7.5 Log Inactivation					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
≤0.4	4	8	12	16	20	24	5	10	15	19	24	29	6	12	18	23	29	35	7	14	21	28	35	42
0.6	4	8	13	17	21	25	5	10	15	20	25	30	6	12	18	24	30	36	7	14	22	29	36	43
0.8	4	9	13	17	22	26	5	10	16	21	26	31	6	12	19	25	31	37	7	15	22	29	37	44
1	4	9	13	17	22	26	5	10	16	21	26	31	6	12	19	25	31	37	8	15	23	30	38	45
1.2	5	9	14	18	23	27	5	11	16	21	27	32	6	13	19	25	32	38	8	15	23	31	38	46
1.4	5	9	14	18	23	27	6	11	17	22	28	33	7	13	20	26	33	39	8	16	24	31	39	47
1.6	5	9	14	19	23	28	6	11	17	22	28	33	7	13	20	27	33	40	8	16	24	32	40	48
1.8	5	10	15	19	24	29	6	11	17	23	28	34	7	14	21	27	34	41	8	16	25	33	41	49
2	5	10	15	19	24	29	6	12	18	23	29	35	7	14	21	27	34	41	8	17	25	33	42	50
2.2	5	10	15	20	25	30	6	12	18	23	29	35	7	14	21	28	35	42	9	17	26	34	43	51
2.4	5	10	15	20	25	30	6	12	18	24	30	36	7	14	22	29	36	43	9	17	26	35	43	52
2.6	5	10	16	21	26	31	6	12	19	25	31	37	7	15	22	29	37	44	9	18	27	35	44	53
2.8	5	10	16	21	26	31	6	12	19	25	31	37	7	15	22	29	37	44	9	18	27	36	45	54
3	5	10	16	21	26	31	6	12	19	25	31	37	8	15	23	30	38	45	9	18	28	37	46	55

Chlorine Concentration (mg/L)	pH ≤ 8.0 Log Inactivation						pH ≤ 8.5 Log Inactivation						pH ≤ 9.0 Log Inactivation					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
≤0.4	8	17	25	33	42	50	10	20	30	39	49	59	12	23	35	47	58	70
0.6	9	17	26	34	43	51	11	20	31	41	51	61	12	24	37	49	61	73
0.8	9	18	27	35	44	53	11	21	32	42	53	63	13	25	38	50	63	75
1	9	18	27	36	45	54	11	22	33	43	54	65	13	26	39	52	65	78
1.2	9	18	28	37	46	55	11	22	34	45	56	67	13	27	40	53	67	80
1.4	10	19	29	38	48	547	12	23	35	46	58	69	14	27	41	55	68	82
1.6	10	19	29	39	48	58	12	23	35	47	58	70	14	28	42	56	70	84
1.8	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86
2	10	20	31	41	51	61	12	25	37	49	62	74	15	29	44	59	73	88
2.2	10	21	31	41	52	62	13	25	38	50	63	75	15	30	45	60	75	90
2.4	11	21	32	42	53	63	13	26	39	51	64	77	15	31	46	61	77	92
2.6	11	22	33	43	54	65	13	26	39	52	65	78	16	31	47	63	78	94
2.8	11	22	33	44	55	66	13	27	40	53	67	80	16	32	48	64	80	96
3	11	22	34	45	56	67	14	27	41	54	68	81	16	32	49	65	81	97

Note: CT 99.9= CT for 3-log inactivation

Appendix 5: CT Values for Inactivation of *Giardia Cysts* by Chlorine Dioxide, pH 6.0-9.0

	Temperature																							
Inactivation (log)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0.5	10.0	8.6	7.2	5.7	4.3	4.2	4.2	4.1	4.1	4.0	3.8	3.7	3.5	3.4	3.2	3.1	2.9	2.8	2.6	2.5	2.4	2.3	2.2	2.1	2.0
1	21.0	17.9	14.9	11.8	8.7	8.5	8.3	8.1	7.9	7.7	7.4	7.1	6.9	6.6	6.3	6.0	5.8	5.5	5.3	5.0	4.7	4.5	4.2	4.0	3.7
1.5	32.0	27.3	22.5	17.8	13.0	12.8	12.6	12.4	12.2	12.0	11.6	11.2	10.8	10.4	10.0	9.5	9.0	8.5	8.0	7.5	7.1	6.7	6.3	5.9	5.5
2	42.0	35.8	29.5	23.3	17.0	16.6	16.2	15.8	15.4	15.0	14.6	14.2	13.8	13.4	13.0	12.4	11.8	11.2	10.6	10.0	9.5	8.9	8.4	7.8	7.3
2.5	52.0	44.5	37.0	29.5	22.0	21.4	20.8	20.2	19.6	19.0	18.4	17.8	17.2	16.6	16.0	15.4	14.8	14.2	13.6	13.0	12.2	11.4	10.6	9.8	9.0
3	63.0	53.8	44.5	35.3	26.0	25.4	24.8	24.2	23.6	23.0	22.2	21.4	20.6	19.8	19.0	18.2	17.4	16.6	15.8	15.0	14.2	13.4	12.6	11.8	11.0

CT Values for Inactivation of *Giardia Cysts* by Ozone

	Temperature																							
Inactivation (log)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0.5	0.48	0.44	0.40	0.36	0.32	0.30	0.28	0.27	0.25	0.23	0.22	0.20	0.19	0.17	0.16	0.15	0.14	0.14	0.13	0.12	0.11	0.10	0.10	0.09	0.08
1	0.97	0.89	0.80	0.72	0.63	0.60	0.57	0.54	0.51	0.48	0.45	0.42	0.38	0.35	0.32	0.30	0.29	0.27	0.26	0.24	0.22	0.21	0.19	0.18	0.16
1.5	1.5	1.36	1.23	1.09	0.95	0.90	0.86	0.81	0.77	0.72	0.67	0.62	0.58	0.53	0.48	0.46	0.43	0.41	0.38	0.36	0.34	0.31	0.29	0.26	0.24
2	1.90	1.75	1.60	1.45	1.30	1.23	1.116	1.09	1.02	0.95	0.89	0.82	0.76	0.69	0.63	0.60	0.57	0.54	0.51	0.48	0.45	0.42	0.38	0.35	0.32
2.5	2.40	2.20	2.00	1.80	1.60	1.52	1.44	1.36	1.28	1.20	1.12	1.04	0.95	0.87	0.79	0.75	0.71	0.68	0.64	0.60	0.56	0.52	0.48	0.44	0.40
3	2.90	2.65	2.40	2.15	1.90	1.81	1.71	1.62	1.52	1.43	1.33	1.24	1.14	1.05	0.95	0.90	0.86	0.81	0.77	0.72	0.67	0.62	0.58	0.53	0.48

CT Values for Inactivation of *Giardia Cysts* by Chloramine, pH 6.0-9.0

	Temperature																							
Inactivation (log)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0.5	635	568	500	433	365	354	343	332	321	310	298	286	274	262	250	237	224	211	198	185	173	161	149	137	125
1	1270	1136	1003	869	735	711	687	663	639	615	592	569	546	523	500	474	448	422	396	370	346	322	298	274	250
1.5	1900	1700	1500	1300	1100	1066	1032	998	964	930	894	858	822	786	750	710	670	630	590	550	515	480	445	410	375
2	2535	2269	2003	1736	1470	1422	1374	1326	1278	1230	1184	1138	1092	1046	1000	947	894	841	788	735	688	641	594	547	500
2.5	3170	2835	2500	2165	1830	1772	1714	1656	1598	1540	1482	1424	1366	1308	1250	1183	1116	1049	982	915	857	799	741	683	625
3	3800	3400	3000	2600	2200	2130	2060	1990	1920	1850	1780	1710	1640	1570	1500	1420	1340	1260	1180	1100	1030	960	890	820	750

NOTE: NO DISINFECTION CREDIT IS ALLOWED FOR CHLORINE DIOXIDE, OZONE, OR CHLORAMINE IF THE pH IN THE DISINFECTION ZONE IS BELOW OR ABOVE THE LIMITS SHOWN IN THE CT TABLES

APPENDIX 6

MDE NOTIFICATION REQUIREMENTS FOR TREATMENT TECHNIQUE VIOLATIONS

Systems that violate any of the treatment technique requirements must notify the MDE's Water Supply Program as soon as possible and no later than the end of the next business day.

PUBLIC NOTICE REQUIREMENTS FOR TREATMENT TECHNIQUE VIOLATIONS

A public water system must notify the MDE, Water Supply Program if it violates any technique requirement of the Surface Water Treatment Rule, Interim Enhanced Surface Water Treatment Rule or Long Term 1 Enhanced Surface Water Treatment Rule, if applicable. These include:

1. Turbidity violation from a single exceedance of maximum allowable turbidity level (1.0 NTU for conventional treatment plants, 5 NTU for unfiltered or D.E. filtration plants). This may require immediate public notice.
2. Turbidity violation of the 95th percentile turbidity standard (0.3 NTU for conventional filtration plants, 1 NTU for unfiltered or D.E. filtration plants): This may require public notification within 30 days.
3. Free chlorine residual below 0.2 mg/L at the Point-of-Entry. If this condition persists for more than four hours, public notification may be required within 30 days.

For All Treatment Technique Violations

The water system should call MDE at one of the following numbers as soon as possible to report violations or possible violations.

(410) 537-3706
MDE, Water Supply Program: regular business hours

1-866-633-4626 (1-866-MDE-GOTO)
MEMA emergency line: off-hours

(410) 537-3157
MDE Water Supply Program fax

The system must notify the MDE by the end of the next business day following the violation to avoid a reporting violation.