



# NEW YORK STATE DEPARTMENT OF HEALTH

Bureau of Water Supply Protection

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## FACT SHEET

### Microbial Log Removal/Inactivation Rule Requirements and Credits for Various Types of Drinking Water Treatment Processes

#### PURPOSE

This fact sheet was prepared to summarize the microbial log removal/inactivation requirements under the various USEPA rules and to consolidate the numerous log inactivation and removal treatment credit tables that exist in different rules and guidance documents. This document is applicable to community and non-community public water systems.

#### DESIGN REQUIREMENTS

General design and plan approval requirements for public water systems are delineated in Subpart 5-1.22 of the New York State Sanitary Code, and minimum treatment requirements are delineated in Subpart 5-1.30. The design professional must select an arrangement of treatment components based on the applicability of these code requirements and the treatment credits summarized in this document. Once the appropriate treatment is determined the design standards for the treatment system are as follows:

- NYS Sanitary Code Appendix 5-A (Recommended Standards for Water Works, 2003 edition). Although the 2007 edition of the Recommended Standards for Water Works has not yet been incorporated as Appendix 5-A, it is available on line at [www.10statesstandards.com](http://www.10statesstandards.com) and it may be used for water system design.
- All applicable New York State Fire Prevention and Building Codes. Available at [www.dos.state.ny.us/code/lc-codes.html](http://www.dos.state.ny.us/code/lc-codes.html)

#### DEFINITIONS

**CT** means the product of the disinfectant residual Concentration (prior to the first user), C, in the water in milligrams per liter (mg/l), and the contact time, T, in minutes, that the water is in contact with the disinfectant:

CT= RESIDUAL at or before 1st user (mg/l) x CONTACT TIME (minutes)  
Baffling factors must be considered when calculating CT (see Table 6)

**Inactivation** for this document means the reproductive sterilization or the destruction of organisms through disinfection.

**Removal** for this document means the physical removal of organisms usually through filtration.

## **SUMMARY of RULES**

- **The Surface Water Treatment Rule (SWTR)** promulgated in 1989 required all public water supply systems using surface water or ground water under the direct influence of surface water (GWUDI) sources to provide a 3 log or 99.9% *Giardia* removal/inactivation and a 4 log (99.99) enteric virus removal/inactivation.
- **The Interim Enhanced Surface Water Treatment Rule (IESWTR)** promulgated in 1998 added a 2 log removal/inactivation of *Cryptosporidium* requirement for water supply systems with a population equal to or more than 10,000 using surface water sources or GWUDI sources.
- **The Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR)** promulgated in 2002 added a 2 log removal/inactivation of *Cryptosporidium* requirement for water supply systems with a population less than 10,000 using surface water sources or GWUDI sources.
- **The Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)** promulgated in 2006 added that all public water systems with surface water sources or GWUDI sources, depending on the source water quality, provide additional treatment (filtration and/or disinfection) for a total of 3 log through a 5.5 log removal/inactivation of *Cryptosporidium*. The additional level of treatment if required under LT2ESWTR is dependent on the amount of *Cryptosporidium* in the source water and those requirements are detailed in the LT2ESWTR bin classification table (See Table 2). The USEPA has provided what is called the microbial tool box (See Table 10) outlining what additional treatment is acceptable for meeting the LT2ESWTR *Cryptosporidium* removal / inactivation requirements.
- **The Ground Water Rule (GWR)** promulgated in 2006 requires systems with ground water sources at risk of microbial contamination to take corrective action to protect consumers from harmful bacteria and viruses. Monitoring is a key element of this risk-targeted approach. Triggered source water monitoring is used to determine if fecal contamination is present in the ground water source. Triggered source water monitoring is required for any ground water system (GWS) that has a positive total coliform result under the Total Coliform Rule (TCR) routine sampling and does not provide and monitor for 4-log treatment of viruses. Based on the results of the triggered monitoring the system may need to provide additional treatment to achieve a 4 log inactivation of viruses.

See **Table 1: Summary of Rule Requirements**  
**Table 2: LT2ESWTR Bin Classification Table**  
**Table 3: Chlorine Disinfectant-*Giardia* Inactivation**  
**Tables 4A-4D: Chemical Disinfectants-Virus Inactivation**  
**Table 5: Chlorine Dioxide & Ozone Disinfectant-*Giardia* Inactivation**  
**Table 6: Baffling Factors for Chemical Disinfectants**  
**Table 7: UV Dose Requirements for *Cryptosporidium*, *Giardia*, & Virus Inactivation**  
**Table 8: Virus Removal Credits for Filtration**  
**Table 9: Filtration Spectrum**  
**Table 10: Microbial Toolbox Summary**

# Tables

**Table 1**

**Summary of Rule Requirements**

Pathogen	Log removal / inactivation requirements for Various Rules				
	SWTR	IESWTR	LT1ESWTR	LT2ESWTR	GWR
Virus	4 log	4 log (no Change from SWTR)	4 log (no Change from SWTR)	4 log (no Change from SWTR)	4 log (if Triggered)
Giardia lamblia	3 log	3 log (no Change from SWTR)	3 log (no Change from SWTR)	3 log (no Change from SWTR)	N/A
Cryptosporidium	N/A	2 log (Sys. Population $\geq 10,000$ )	2 log (Sys.Pop. $< 10,000$ )	0 to 3 log additional dependent on Bin Class	N/A

**Table 2**

**LT2ESWTR Bin Classification Table**

If source water Cryptosporidium concentration for filtered systems is in oocyst/L	And the system uses the following filtration treatment, then additional treatment requirements				
	Bin classification is...	Conventional Filtration Treatment	Direct Filtration	Slow sand or diatomaceous earth	Alternative filtration technologies
<0.075	1	No additional treatment	No additional treatment	No additional treatment	No additional treatment
$\geq 0.075$ and $< 1.0$	2	1.0 log treatment	1.5 log treatment	1.0 log treatment	At least 4.0 log total
$\geq 1.0$ and $< 3.0$	3	2.0 log treatment	2.5 log treatment	2.0 log treatment	At least 5.0 log total
$\geq 3.0$	4	2.5 log treatment	3.0 log treatment	2.5 log treatment	At least 5.5 log total

From: <http://www.epa.gov/ogwdw000/disinfection/lt2/compliance.html>

**Table 3**

**Chlorine Disinfectant-*Giardia* Inactivation**

These CT values achieve greater than a 99.99 percent inactivation of viruses. CT values between the indicated pH values may be determined by linear interpolation. CT values between the indicated temperatures of different tables may be determined by linear interpolation. If no interpolation is used, use the CT<sub>99.9</sub> value at the lower temperature, and at the higher pH.

**CT VALUES\* FOR 3-LOG INACTIVATION  
OF GIARDIA CYSTS BY FREE CHLORINE**

Chlorine Concentration (mg/L)	Temperature <=0.5°C							Temperature =5°C							Temperature = 10°C						
	pH							pH							pH						
	<=6.0	6.5	7.0	7.5	8.0	8.5	9.0	<=6.0	6.5	7.0	7.5	8.0	8.5	9.0	<=6.0	6.5	7.0	7.5	8.0	8.5	9.0
<=0.4	137	183	195	237	277	329	390	97	117	139	168	198	236	279	73	88	104	125	149	177	209
0.6	141	188	200	239	286	342	407	100	120	143	171	204	244	291	75	90	107	128	153	183	218
0.8	145	172	205	246	295	354	422	103	122	146	175	210	252	301	78	92	110	131	158	189	226
1.0	148	178	210	253	304	365	437	105	125	149	179	216	260	312	79	94	112	134	162	195	234
1.2	152	180	215	259	313	376	451	107	127	152	183	221	267	320	80	95	114	137	166	200	240
1.4	155	184	221	266	321	387	464	109	130	155	187	227	274	329	82	98	116	140	170	206	247
1.6	157	189	226	273	329	397	477	111	132	158	192	232	281	337	83	99	119	144	174	211	253
1.8	162	193	231	279	338	407	489	114	135	162	196	238	287	345	86	101	122	147	179	215	259
2.0	165	197	236	286	346	417	500	116	138	165	200	243	294	353	87	104	124	150	182	221	265
2.2	169	201	242	297	353	426	511	118	140	169	204	248	300	361	89	105	127	153	186	225	271
2.4	172	205	247	298	361	435	522	120	143	172	209	253	306	368	90	107	129	157	190	230	276
2.6	175	209	252	304	368	444	533	122	146	175	213	258	312	375	92	110	131	160	194	234	281
2.8	178	213	257	310	375	452	543	124	148	178	217	263	318	382	93	111	134	163	197	239	287
3.0	181	217	261	316	382	460	552	126	151	182	221	268	324	389	95	113	137	166	201	243	292

Chlorine Concentration (mg/L)	Temperature = 15°C							Temperature = 20°C							Temperature = 25°C						
	pH							pH							pH						
	<=6.0	6.5	7.0	7.5	8.0	8.5	9.0	<=6.0	6.5	7.0	7.5	8.0	8.5	9.0	<=6.0	6.5	7.0	7.5	8.0	8.5	9.0
<=0.4	49	59	70	83	99	118	140	38	44	52	62	74	89	105	24	29	35	42	50	59	70
0.6	50	60	72	86	102	122	146	38	45	54	64	77	92	109	25	30	36	43	51	61	73
0.8	52	61	73	88	105	126	151	39	46	55	66	79	95	113	26	31	37	44	53	63	75
1.0	53	63	75	90	108	130	156	39	47	56	67	81	98	117	26	31	37	45	54	65	78
1.2	54	64	76	92	111	134	160	40	48	57	69	83	100	120	27	32	38	46	55	67	80
1.4	55	65	78	94	114	137	165	41	49	58	70	85	103	123	27	33	39	47	57	69	82
1.6	56	66	79	96	116	141	169	42	50	59	72	87	105	126	28	33	40	48	58	70	84
1.8	57	68	81	98	119	144	173	43	51	61	74	89	108	129	29	34	41	49	60	72	86
2.0	58	69	83	100	122	147	177	44	52	62	75	91	110	132	29	35	41	50	61	74	88
2.2	59	70	85	102	124	150	181	44	53	63	77	93	113	135	30	35	42	51	62	75	90
2.4	60	72	86	105	127	153	184	45	54	65	78	95	115	138	30	36	43	52	63	77	92
2.6	61	73	88	107	129	156	188	46	55	66	80	97	117	141	31	37	44	53	65	78	94
2.8	62	74	89	109	132	159	191	47	56	67	81	99	119	143	31	37	45	54	66	80	96
3.0	63	76	91	111	134	162	195	47	57	68	83	101	122	146	32	38	46	55	67	81	97

\*Although units did not appear in the original tables, units are min-mg/L.

From: EPA Guidance Manual LT1ESWTR Disinfection Profiling and Benchmarking, May 2003

## Tables 4A-4D

### Chemical Disinfectants-Virus Inactivation

Where CT = Residual at or prior to first user (mg/l) x Contact Time (Minutes)

Interpolation between temperature and CT values is acceptable

**Table 4A: CT values for inactivation of viruses by free chlorine, pH 6 – 9**

Log inactivation	1°C	5°C	10°C	15°C	20°C	25°C
2	5.8	4.0	3.0	2.0	1.0	1.0
3	8.7	6.0	4.0	3.0	2.0	1.0
3.5	<i>10.2</i>	<i>7.0</i>	<i>5.0</i>	<i>3.5</i>	<i>2.5</i>	<i>1.5</i>
4	11.6	8.0	6.0	4.0	3.0	2.0

*Italic values have been interpolated*

**Table 4B: CT values for inactivation of viruses by chloramine, pH 6 – 9**

Log inactivation	1°C	5°C	10°C	15°C	20°C	25°C
2	1243	857	643	428	321	214
3	2063	1423	1067	712	534	356
4	2883	1988	1491	994	746	497

**Table 4C: CT values for inactivation of viruses by chlorine dioxide, pH 6 – 9**

Log inactivation	1°C	5°C	10°C	15°C	20°C	25°C
2	8.4	5.6	4.2	2.8	2.1	1.4
3	25.6	17.1	12.8	8.6	6.4	4.3
4	50.1	33.4	25.1	16.7	12.5	8.4

**Table 4D: CT values for inactivation of viruses by ozone, pH 6 – 9**

Log inactivation	1°C	5°C	10°C	15°C	20°C	25°C
2	0.9	0.6	0.5	0.3	0.25	0.15
3	1.4	0.9	0.8	0.5	0.40	0.25
4	1.8	1.2	1.0	0.6	0.50	0.30

From EPA Guidance Manual Disinfection Profiling and Benchmarking, August 1999

## Table 5

### Chlorine Dioxide & Ozone Disinfectant-*Giardia* Inactivation

Interpolation between temperature values is acceptable

**CT Values (CT<sub>99.9</sub>) for 99.9 Percent Inactivation of *Giardia Lamblia* Cysts**

**by Chlorine Dioxide and Ozone<sup>1,2</sup>**

	Degrees Celsius					
	<=1	5	10	15	20	>=25
Chlorine dioxide	63	26	23	19	15	11
Ozone	2.9	1.9	1.4	0.95	0.72	0.48

1. These CT values achieve greater than a 99.99 percent inactivation of viruses. CT values between the indicated pH values may be determined by linear interpolation. If no interpolation is used, use the CT<sub>99.9</sub> value at the lower temperature for determining CT<sub>99.9</sub> values between indicated temperatures.

2. The use of these alternative disinfectants shall be approved in accordance with the provisions of section 5-1.22 of this Section.

Data from NYS Sanitary Code Part 5 Subpart 5-1 table 14 G

**Table 6**  
**Baffling Factors for Chemical Disinfectants**

Baffling Condition	T10/T*	Baffling Description
Unbaffled (mixed flow)	0.1	None, agitated basin, very low length to width ratio, high inlet and outlet flow velocities. Can be approximately achieved in flash mix tank
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 launders
Perfect (plug flow)	1.0	Very high length to width ratio (pipeline flow), perforated inlet, outlet, and intra-basin baffles

T10 = Detention Time (Mins) of Segment \* Baffling Factor

From EPA Guidance Manual Disinfection Profiling and Benchmarking, August 1999

**Table 7**  
**UV Dose Requirements for *Cryptosporidium*, *Giardia*, & Virus Inactivation**  
***Cryptosporidium*, *Giardia* and Virus log inactivation values for UV**

Log Credit	<i>Cryptosporidium</i> Dose mJ/cm <sup>2</sup>	<i>Giardia</i> Dose mJ/cm <sup>2</sup>	Virus Dose mJ/cm <sup>2</sup>
0.5	1.6	1.5	39
1.0	2.5	2.1	58
1.5	3.9	3.0	79
2.0	5.8	5.2	100
2.5	8.5	7.7	121
3.0	12	11	143
3.5	15	15	163
4.0	22	22	186

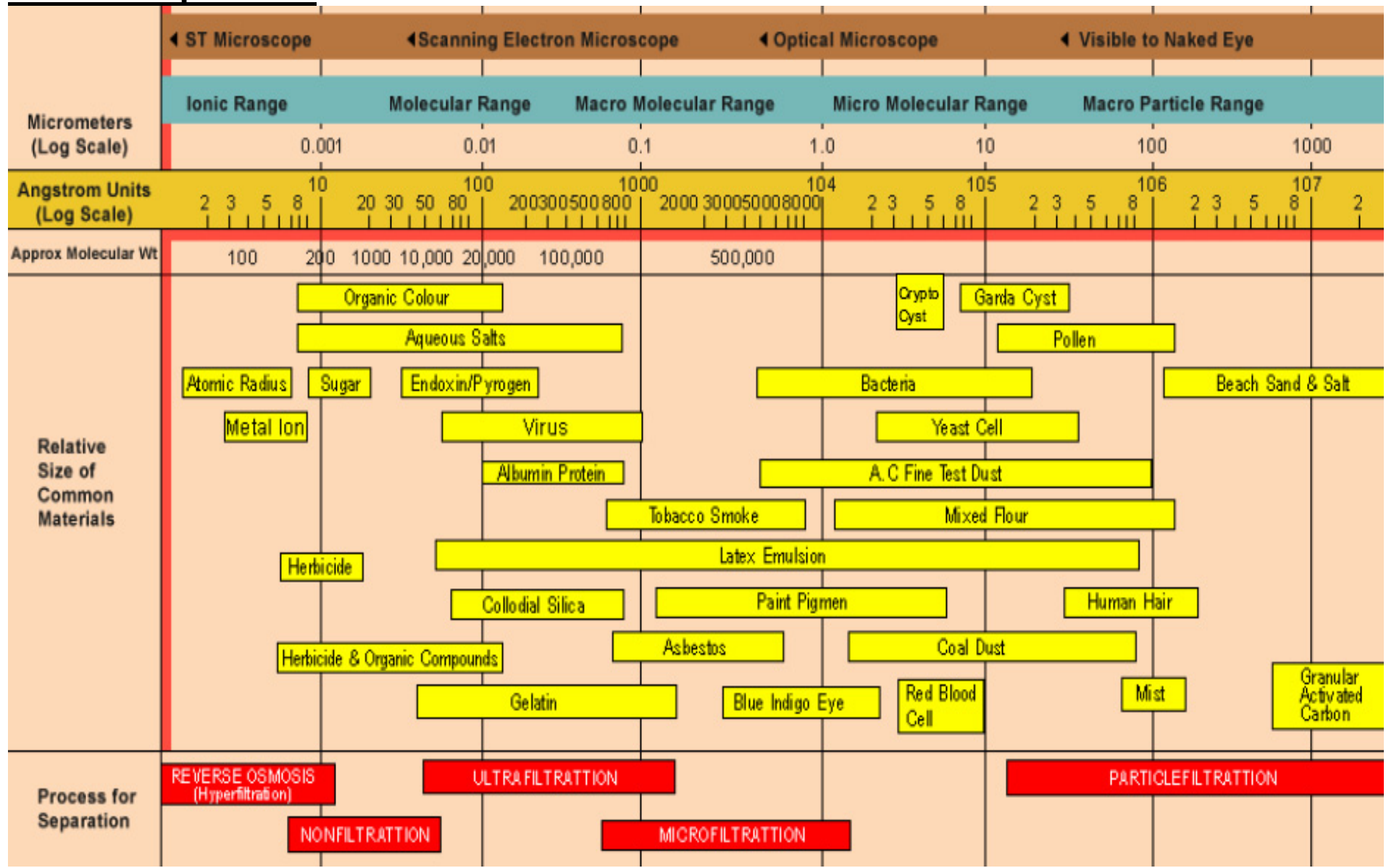
From 40 CFR 141.720 (d) (1) and EPA UV Guidance Manual Nov. 2006

**Table 8**  
**Virus Removal Credits for Filtration**

Typical Log Removal Credits	Viruses
Conventional	2
Direct	1
Slow Sand	2
Diatomaceous Earth Filtration	1
Alternative (membranes, bag filters, cartridges)	Systems must demonstrate to the State by pilot study or other means that the alternative filtration technology provides the required log removal and inactivation

Data from: EPA Guidance Manual LT1ESWTR Disinfection Profiling and Benchmarking, May 2003

**Table 9**  
**Filtration Spectrum:**



From <http://www.liquidfiltration-products.com/LiquidFiltration/Osmonicsfiltraspec.html>

# Table 10

## Microbial Toolbox Summary:

The table shows the applicable log removal/inactivation of *Cryptosporidium* credits for various common types of water treatment and environmental factors. Some of these filtration credits may generally apply to *Giardia Lamblia* also since it is a larger pathogen and less resistant to chemical disinfection.

### Options, Treatment Credits and Criteria

From 71 CFR 777 and LT2ESWTR Implementation Guidance, August 2007

<b>Toolbox Option</b>	<i>Cryptosporidium</i> treatment credit with design and implementation criteria
<b>Source Protection and Management Toolbox Options</b>	
<b><u>(1) Watershed control program</u></b>	0.5-log credit for state-approved program comprising required elements, annual program status report to state, and regular watershed survey. Unfiltered systems are not eligible for credit. Specific criteria are in § 141.716(a).
<b><u>(2) Alternative source/ intake management</u></b>	No prescribed credit. Systems may conduct simultaneous monitoring for treatment bin classification at alternative intake locations or under alternative intake management strategies. Specific criteria are in § 141.716(b).
<b>Pre Filtration Toolbox Options</b>	
<b><u>(3) Presedimentation basin with coagulation</u></b>	0.5-log credit during any month that presedimentation basins achieve a monthly mean reduction of 0.5-log or greater in turbidity or alternative state-approved performance criteria. To be eligible, basins must be operated continuously with coagulant addition and all plant flow must pass through basins. Specific criteria are in § 141.717(a).
<b><u>(4) Two-stage lime softening</u></b>	0.5-log credit for two-stage softening where chemical addition and hardness precipitation occur in both stages. All plant flow must pass through both stages. Single-stage softening is credited as equivalent to conventional treatment. Specific criteria are in § 141.717(b).
<b><u>(5) Bank filtration</u></b>	0.5-log credit for 25-foot setback; 1.0-log credit for 50-foot setback; aquifer must be unconsolidated sand containing at least 10 percent fines; average turbidity in wells must be less than 1 NTU. Systems using wells followed by filtration when conducting source water monitoring must sample the well to determine bin classification and are not eligible for additional credit. Specific criteria are in § 141.717(c).
<b>Treatment Performance Toolbox Options</b>	
<b><u>(6) Combined filter performance</u></b>	0.5-log credit for combined filter effluent turbidity less than or equal to 0.15 NTU in at least 95 percent of measurements each month. Specific criteria are in § 141.718(a).



**(7) Individual filter performance**

0.5-log credit (in addition to 0.5-log combined filter performance credit) if individual filter effluent turbidity is less than or equal to 0.15 NTU in at least 95 percent of samples each month in each filter and is never greater than 0.3 NTU in two consecutive measurements in any filter.

Specific criteria are in § 141.718(b).

**(8) Demonstration of performance**

Credit awarded to unit process or treatment train based on a demonstration to the state with a state-approved protocol.

Specific criteria are in § 141.718(c).

**Additional Filtration Toolbox Options**

**(9) Bag or cartridge filters (individual filters)**

Up to 2-log credit based on the removal efficiency demonstrated during challenge testing with a 1.0-log factor of safety.

Specific criteria are in § 141.719(a).

**(10) Bag or cartridge filters (in series)**

Up to 2.5-log credit based on the removal efficiency demonstrated during challenge testing with a 0.5-log factor of safety. Specific criteria are in § 141.719(a).

*Series may include any pretreatment filter if final filter is 1 micron absolute rated (Comment added by DOH).*

**(11) Membrane filtration**

Log credit equivalent to removal efficiency demonstrated in challenge test for device if supported by direct integrity testing.

Specific criteria are in § 141.719(b).

**(12) Second stage filtration**

0.5-log credit for second separate granular media filtration stage if treatment train includes coagulation prior to first filter.

Specific criteria are in § 141.719(c).

**(13) Slow sand filters**

2.5-log credit as a secondary filtration step; 3.0-log credit as a primary filtration process. No prior chlorination for either option.

Specific criteria are in § 141.719(d).

**Inactivation Toolbox Options**

**(14) Chlorine dioxide**

Log credit based on measured CT in relation to CT table.

Specific criteria in § 141.720(b).

**(15) Ozone**

Log credit based on measured CT in relation to CT table.

Specific criteria in § 141.720(b).

**(16) UV**

Log credit based on validated UV dose in relation to UV dose table; reactor validation testing required to establish UV dose and associated operating conditions.

Specific criteria in § 141.720(d).