Essentials of Surface Water Treatment (Part 2)

Oregon Health Authority
Drinking Water Services
www.healthoregon.org/dws

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Overview of 2-Part Course:

Part 1:
- ✓ Background of Surface Water Treatment Rules
- ✓ Filtration
- ✓ Disinfection
- ✓ Operations

Part 2:
1. Review of Part 1
2. Reporting Requirements w/Exercises #4 - #6
3. Emerging Issues
4. Resources for Operators

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Background of Surface Water Treatment Rules

- 1989: SWTR required most SW and GWUDI (Groundwater Under Direct Influence) systems to filter.
- States required to identify GWUDI sources.
- Required 3-log (99.9%) *Giardia* and 4-log (99.99%) virus removal.
- CF/DF: 95% of turbidity readings ≤ 0.5 NTU; all < 5 NTU
- Slow sand/DE/alt: 95% of turbidity readings ≤ 1 NTU; all < 5 NTU
- Required detectable disinfectant residual.
- Did not address *Cryptosporidium*.

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Background (continued)

- 1998 Interim Enhanced Surface Water Treatment Rule (IESWTR)
- Addressed concerns about *Crypto* (required 2-log removal)
- CF/DF: Lowered turbidity standard to 95% of readings ≤ 0.3 NTU, all readings <1 NTU for systems with population ≥10,000.
- Required Individual Filter Effluent (IFE) turbidimeters

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Background (continued)

- 2002 Long-Term 1 Enhanced Surface Water Treatment Rule (LT1)

  -Extended 0.3 NTU requirement to systems with <10,000 population.

- 2006: LT2 requires additional *Crypto* treatment for systems with ≥ 0.075 oocysts/L in their source water.
  - So far only one water system is required to install additional treatment in Oregon.

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Filtration Types:

- Conventional & Direct (Rapid Rate)
  - Backwashing
- Slow sand
  - Scraping/harrowing
  - Ripening (24-hr filter-to-waste)
- Membrane
  - Backwash
  - Chemical cleaning
- Cartridge/bag
  - Discard/replace used filters

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Disinfection Requirements for Surface Water

- Surface Water Treatment Rule (SWTR) requires 3-log reduction of *Giardia* using a combination of **disinfection** and **filtration**
- 2.0 to 2.5-log removal is achieved through **filtration**
- 0.5 to 1.0-log inactivation is achieved through **disinfection**
- Determines which column of EPA tables used to calculate CTs (0.5 or 1.0-log)

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What are CT's?

- It's a way to determine if disinfection is adequate
- **CT** = Chlorine **C**oncentration x Contact **T**ime
- Do not confuse "CT" and "Contact Time"

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How do we calculate CT's?

- We use the EPA tables to determine the CTs needed to inactivate *Giardia* ($CT_{required}$)
  - We need to know pH, temperature, and free chlorine residual at the first user in order to use the EPA tables.
- Then we compare that with the CTs achieved in our water system (CT_{actual})
- CT_{actual} must be equal to or greater than $CT_{required}$

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Tracer Studies and Contact Time:

- Used to determine contact time (T) which is used in calculating CT's
- Determines the time that chlorine is in contact with the water from the point of injection to the point where it is measured (sometimes referred to as the "CT segment")
  - May be at or before the 1st user
  - May be more than one CT segment
- Estimates of contact time are not allowed for calculating CT's for surface water!
  - ***The degree of short-circuiting is only approximately known until a tracer study is conducted.***

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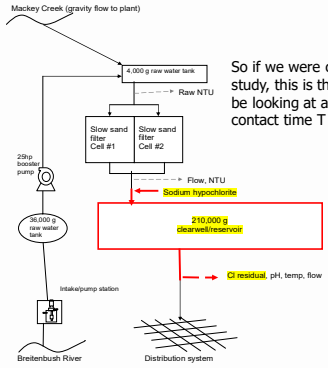
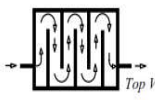


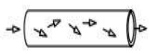
So if we were conducting a tracer study, this is the segment we would be looking at and determining the contact time T for.

11

The shorter the path, the shorter the contact time (T)



Superior Circulation
Baffling Efficiency = 70%
Top View



Perfect Circulation
Baffling Efficiency = 100%
Plug flow through a length of pipe

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Tracer studies (continued):

- Must redo if peak hour demand flow increases more than 10% of the maximum flow used during the tracer study
- Community water systems with populations <10,000 and non-profit non-community systems can use the circuit rider to perform a tracer study
- Must submit a proposal to DWS for approval prior to conducting the tracer study (even if using the circuit rider).

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Operations & Maintenance Manual

Keep written procedures on:

- Instrument calibration methods and frequency
- Data handling/reporting
- Chemical dosage determinations
- Filter operation and cleaning
- CT determinations
- Responding to abnormal conditions (emergency response plan)

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REPORTING REQUIREMENTS

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Overview

- How to fill out the monthly SWTR operating reports
  - How often to record turbidities
  - Highest turbidity of the day
  - Peak hourly demand flow
  - CT calculations
- Common mistakes
- What to do when things go wrong

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How to fill out the monthly SWTR reports

- There are 4 forms:
  - Conventional/Direct
  - Slow Sand / Membrane / DE / Unfiltered
  - Cartridge
  - UV (if used for *Giardia* credit)
- Must use correct form because each has questions that must be answered that are specific to the filtration type

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How to fill out the monthly SWTR reports

Forms have places to report:

- Turbidity
- Peak Hourly Flow
- CT calculations
- Log inactivation requirement (0.5 or 1.0-log, CF/DF only)

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Turbidity

- Record how often?
  - Conventional and direct: every 4 hours
  - SSF, DE & Alternative: daily
- Report CFE turbidities
- Answer questions about IFEs
- Highest turbidity of the day (can be between the 4 hour readings)

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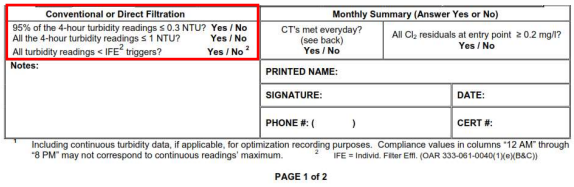

Conventional or Direct Filtration	Monthly Summary (Answer Yes or No)	
95% of the 4-hour turbidity readings ≤ 0.3 NTU? Yes / No All the 4-hour turbidity readings ≤ 1 NTU? Yes / No All turbidity readings < IFE[2] triggers? Yes / No [2]	CT's met everyday? (see back) Yes / No	All Cl_2 residuals at entry point ≥ 0.2 mg/l? Yes / No
Notes:	PRINTED NAME:	
	SIGNATURE:	DATE:
	PHONE #: ( )	CERT #:

[1] Including continuous turbidity data, if applicable, for optimization recording purposes. Compliance values in columns "12 AM" through "8 PM" may not correspond to continuous readings' maximum. [2] IFE = Individ. Filter Eff. (OAR 333-061-0040(1)(e)(B&C))

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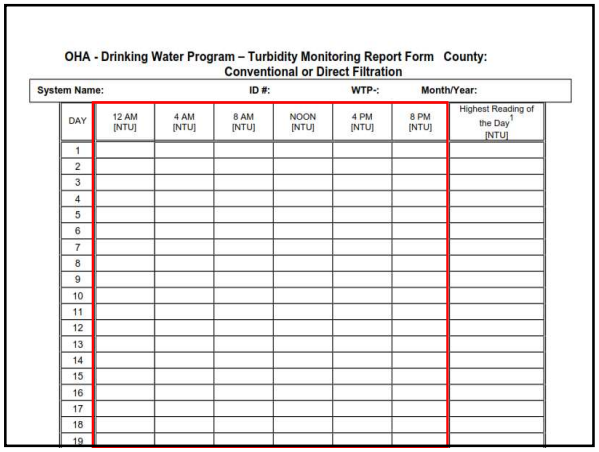

OHA - Drinking Water Program – Turbidity Monitoring Report Form County:
Conventional or Direct Filtration

System Name: ID #: WTP-: Month/Year:

DAY	12 AM [NTU]	4 AM [NTU]	8 AM [NTU]	NOON [NTU]	4 PM [NTU]	8 PM [NTU]	Highest Reading of the Day[1] [NTU]
1							
2							
3							
4							
5							
6							
7							
8							
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10							
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12							
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19							

20

Peak hourly flow

- Report the Peak Hourly Flow
  - greatest volume of water passing through the system during any one hour in a consecutive 24 hr period
- Not the same as Peak Instantaneous Flow
- Report demand flow: flow leaving the clearwell, not plant flow (in most cases)

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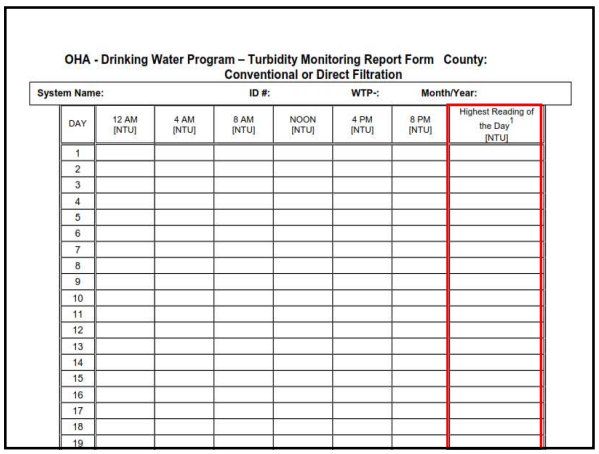

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Method for determining peak hourly demand flow

- On a daily basis, use the best available operational data to identify the hour within the 24 hr period that had the highest demand flow
- For the hour of highest demand flow:
  - Calculate the average flow rate within the one hour period (i.e., add the flow rates and divide by the number of data points).
  - Use as many data points as possible, preferably no less than four data points taken at 15 minute intervals

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Method for determining peak hourly demand flow (continued)

- For systems that only have a flow totalizer, spot check throughout the day to determine the time of peak demand
- Once that time has been identified (e.g., 8am or 9pm for residential; mid-day for industrial), then record how much water is used during that hour each day and divide by 60 minutes to get a peak hour demand

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OHA - Drinking Water Program – Surface Water Quality Data Form - *Giardia* Inactivation

System Name: **ID #:** **WTP-:** **Month/Year:** **Log Requirement (Circle One): 0.5 / 1.0**

Date / Time	Minimum Cl_2 Residual at 1st User (C) [3]	Contact Time (T)	Actual CT	Temp	pH	Required CT	CT Met? [3]	Peak Hourly Demand Flow
	[ppm or mg/L]	[minutes]	C X T	[° C]		Use tables	Yes / No	[GPM]
1 /								
2 /								
3 /								
4 /								
5 /								
6 /								
7 /								
8 /								
9 /								
10 /								
11 /								
12 /								
13 /								
14 /								
15 /								

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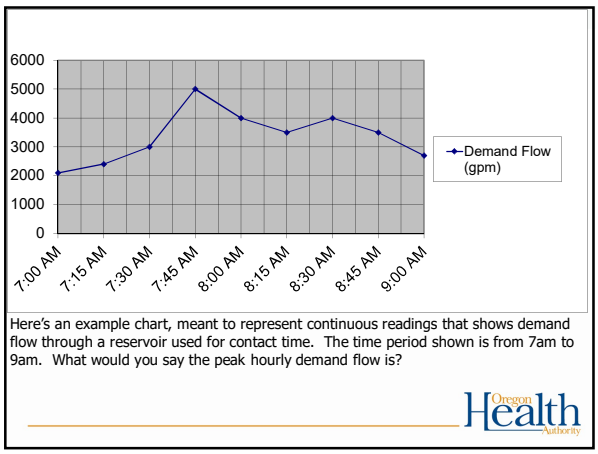

Here's an example chart, meant to represent continuous readings that shows demand flow through a reservoir used for contact time. The time period shown is from 7am to 9am. What would you say the peak hourly demand flow is?

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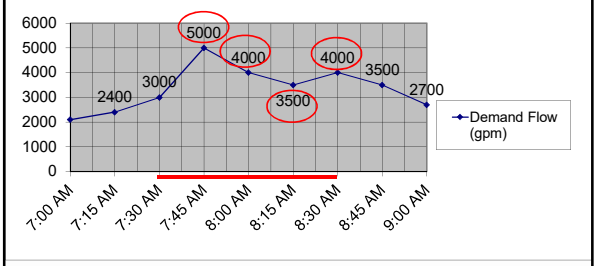

Again, the peak hourly demand flow is the hour within the 24-hr period of the highest demand flow. The red line represents the span of 1 hour: **7:30 am to 8:30 am – the peak hour.** The avg. of the 4 data points equals **4125 gpm - the peak hourly demand flow.**

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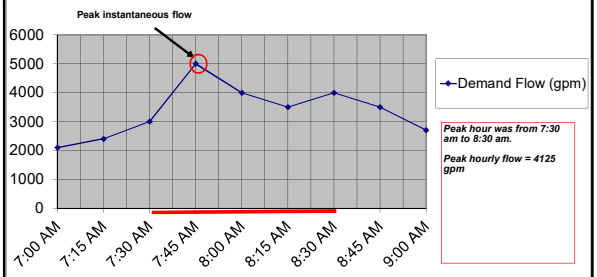

The highest flow point, **5000 gpm, is the peak instantaneous flow**, not the peak hourly demand flow.

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Exercise #4

- Calculate peak hourly demand flow based on continuous flow rate data

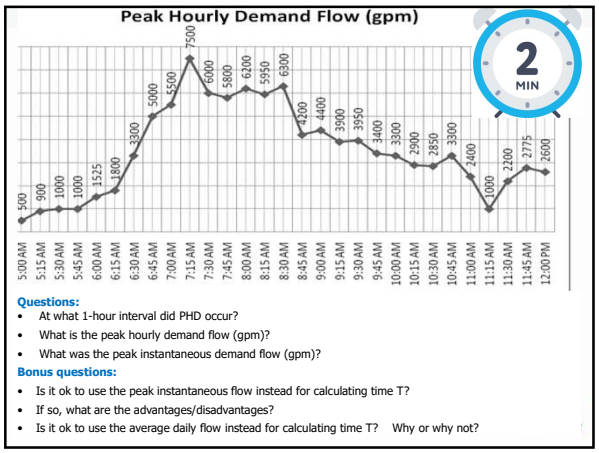
Questions:

- At what 1-hour interval did PHD occur?
- What is the peak hourly demand flow (gpm)?
- What was the peak instantaneous demand flow (gpm)?

Bonus questions:

- Is it ok to use the peak instantaneous flow instead for calculating time T?
- If so, what are the advantages/disadvantages?
- Is it ok to use the average daily flow instead for calculating time T? Why or why not?

30



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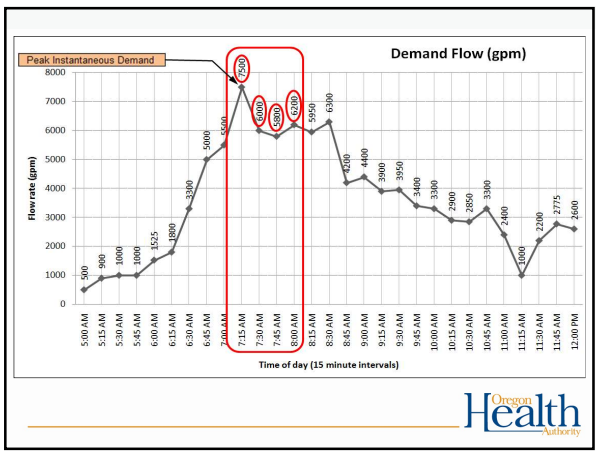
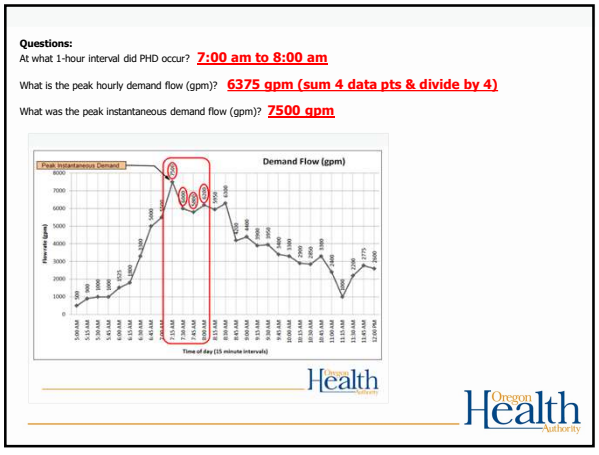


32



Questions:

At what 1-hour interval did PHD occur? **7:00 am to 8:00 am**

What is the peak hourly demand flow (gpm)? **6375 gpm (sum 4 data pts & divide by 4)**

What was the peak instantaneous demand flow (gpm)? **7500 gpm**

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- Example of calculate a running hourly average by averaging the previous 4 data points every 15 minutes.

Time (min)	Demand Flow (gpm)	Running Hourly Average Flow (gpm)
5:00 AM	500	
5:15 AM	900	
5:30 AM	1000	
5:45 AM	1000	850.0
6:00 AM	1525	1,106.3
6:15 AM	1800	1,331.3
6:30 AM	3300	1,906.3
6:45 AM	5000	2,906.3
7:00 AM	5500	3,900.0
7:15 AM	7500	5,325.0
7:30 AM	6000	6,000.0
7:45 AM	5800	6,200.0
8:00 AM	6200	6,375.0 <= Peak Hour Demand

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Exercise #4: Calculating Peak Hourly Demand Flow

Bonus questions:

Is it ok to use the peak instantaneous flow instead for calculating time T?

Yes - it's more conservative

If so, what are the advantages/disadvantages?

Advantage - easy to determine.

Disadvantage - may exceed tracer study flow by more than 10%

Is it ok to use the average daily flow instead for calculating time T?

No

Why or why not?

Averaging the whole day would not be conservative enough (it would not account for sustained period of high flow which is when it is important for CTs to be met)

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How to use the EPA CT tables to figure out $CT_{required}$

- There are six EPA CT tables based on temp
- Find the correct table based on your water temperature in degrees Celsius.
  - °C = 5/9 x (°F – 32)
- If water temp is between values, then round down
  - Example: for water temp of 12°C, use the 10°C table
  - *Even if the water temp is 14.9°C, round down to 10°C*
- *Water gets more viscous the colder it gets and chemical reactions take longer, so rounding temp down is more conservative.*

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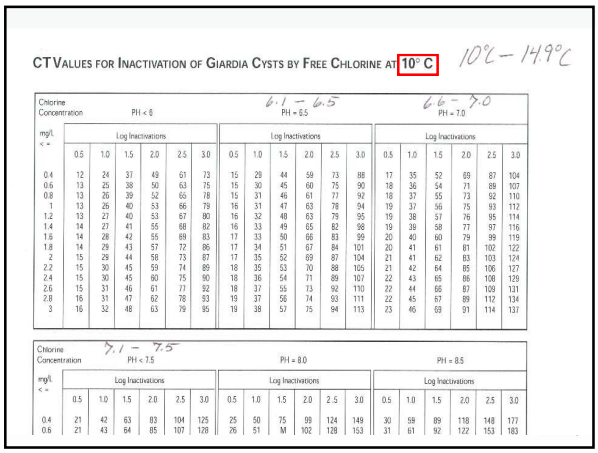
CT VALUES FOR INACTIVATION OF GIARDIA CYSTS BY FREE CHLORINE AT 10° C

10°C – 14.9°C

Chlorine Concentration mg/L <=	pH <= 6.0 Log Inactivations						pH = 6.5 Log Inactivations						pH = 7.0 Log Inactivations					
	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
0.6	13	25	38	50	63	75	15	30	45	60	75	90	18	36	54	71	89	107
0.8	13	26	39	52	65	78	15	31	46	61	77	92	18	37	55	73	92	110
1	13	26	40	53	66	79	16	31	47	63	78	94	19	37	56	75	93	112
1.2	13	27	40	53	67	80	16	32	48	63	79	95	19	38	57	76	95	114
1.4	14	27	41	55	68	82	16	33	49	65	82	98	19	39	58	77	97	116
1.6	14	28	42	55	69	83	17	33	50	66	83	99	20	40	60	79	99	119
1.8	14	29	43	57	72	86	17	34	51	67	84	101	20	41	61	81	102	122
2	15	29	44	58	73	87	17	35	52	69	87	104	21	41	62	83	103	124
2.2	15	30	45	59	74	89	18	35	53	70	88	105	21	42	64	85	106	127
2.4	15	30	45	60	75	90	18	36	54	71	89	107	22	43	65	86	108	129
2.6	15	31	46	61	77	92	18	37	55	73	92	110	22	44	66	87	109	131
2.8	16	31	47	62	78	93	19	37	56	74	93	111	22	45	67	89	112	134
3	16	32	48	63	79	95	19	38	57	75	94	113	23	46	69	91	114	137

Chlorine Concentration mg/L <=	pH <= 7.5 Log Inactivations						pH = 8.0 Log Inactivations						pH = 8.5 Log Inactivations					
	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	21	42	63	83	104	125	25	50	75	99	124	149	30	59	89	118	148	177
0.6	21	43	64	85	107	128	26	51	M	102	128	153	31	61	92	122	153	183

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How to use the EPA CT tables (cont.)

- There are 7 sections for pH on each table
- Find the section that corresponds to your water's pH level
- If your pH is between the choices, then round up to the higher pH
  - Example: if pH of water is 6.8, use the pH 7.0 section

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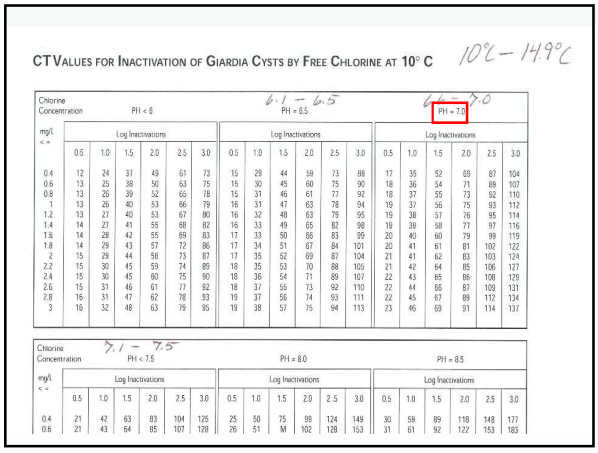
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0.4	12	24	37	49	61	73	15	29	44	59	73	88	17	35	52	69	87	104
0.6	13	25	38	50	63	75	15	30	45	60	75	90	18	36	54	71	89	107
0.8	13	26	39	52	65	78	15	31	46	61	77	92	18	37	55	73	92	110
1	13	26	40	53	66	79	16	31	47	63	78	94	19	37	56	75	93	112
1.2	13	27	40	53	67	80	16	32	48	63	79	95	19	38	57	76	95	114
1.4	14	27	41	55	68	82	16	33	49	65	82	98	19	39	58	77	97	116
1.6	14	28	42	55	69	83	17	33	50	66	83	99	20	40	60	79	99	119
1.8	14	29	43	57	72	86	17	34	51	67	84	101	20	41	61	81	102	122
2	15	29	44	58	73	87	17	35	52	69	87	104	21	41	62	83	103	124
2.2	15	30	45	59	74	89	18	35	53	70	88	105	21	42	64	85	106	127
2.4	15	30	45	60	75	90	18	36	54	71	89	107	22	43	65	86	108	129
2.6	15	31	46	61	77	92	18	37	55	73	92	110	22	44	66	87	109	131
2.8	16	31	47	62	78	93	19	37	56	74	93	111	22	45	67	89	112	134
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How to use the EPA CT tables (cont.)

- Use the 0.5 log inactivation column if your plant is rated at 2.5 log removal for *Giardia*
- All others use the 1.0 log inactivation column
- Note: unfiltered surface water must achieve the 3-log inactivation through disinfection

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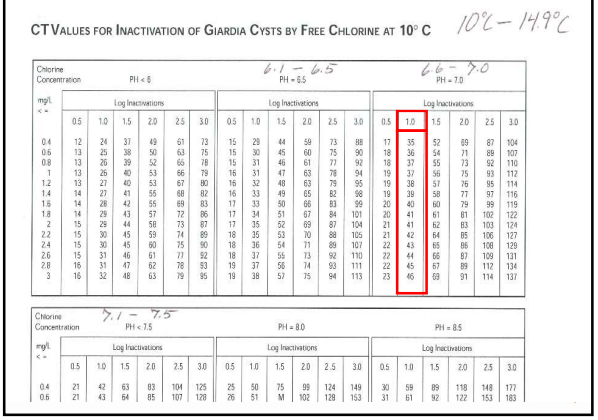
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1.2	13	27	40	53	67	80	16	32	48	63	79	95	19	38	57	76	95	114
1.4	14	27	41	55	68	82	16	33	49	65	82	98	19	39	58	77	97	116
1.6	14	28	42	55	69	83	17	33	50	66	83	99	20	40	60	79	99	119
1.8	14	29	43	57	72	86	17	34	51	67	84	101	20	41	61	81	102	122
2	15	29	44	58	73	87	17	35	52	69	87	104	21	41	62	83	103	124
2.2	15	30	45	59	74	89	18	35	53	70	88	105	21	42	64	85	106	127
2.4	15	30	45	60	75	90	18	36	54	71	89	107	22	43	65	86	108	129
2.6	15	31	46	61	77	92	18	37	55	73	92	110	22	44	66	87	109	131
2.8	16	31	47	62	78	93	19	37	56	74	93	111	22	45	67	89	112	134
3	16	32	48	63	79	95	19	38	57	75	94	113	23	46	69	91	114	137

Chlorine Concentration mg/L <=	pH <= 7.5 Log Inactivations						pH = 8.0 Log Inactivations						pH = 8.5 Log Inactivations					
	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	21	42	63	83	104	125	25	50	75	99	124	149	30	59	89	118	148	177
0.6	21	43	64	85	107	128	26	51	M	102	128	153	31	61	92	122	153	183

41

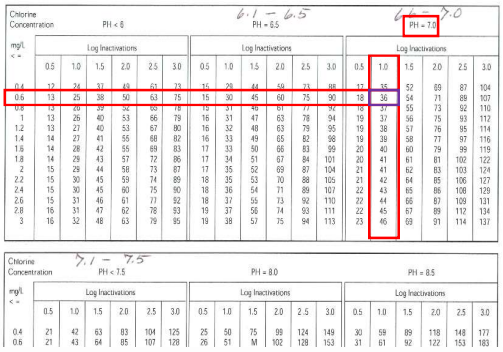
How to use the EPA CT tables (cont.)

- Match your free chlorine residual on the far left column
- If in between, then round up
  - Rounding chlorine residual up is more conservative because as chlorine residual increases at a given pH, more CT is required
- The point where it intersects with the log inactivation column is the $CT_{required}$
  - Example: free chlorine residual is 0.6 ppm

42

CT VALUES FOR INACTIVATION OF GIARDIA CYSTS BY FREE CHLORINE AT 10° C

10°C – 14.9°C



43

In review:

- temp of 12°C,
- pH of 6.8,
- free chlorine residual of 0.6
  - $CT_{required}$ = **36**
- Remember…
  - $CT_{achieved}$ must be > $CT_{required}$

(CT achieved = chlorine concentration x contact time)

44

15 Minute Break

45

15 Minute Break

- 10 minutes left

46

15 Minute Break

- 5 minutes left

47

Exercise #5

- Using EPA CT tables to calculate CTs required

48

Exercise #5

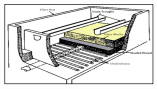
- There are six EPA CT tables based on temp

Appendix Table 4-1.
CT Values for Inactivation of Giardia Cysts by Free Chlorine at 0.5° C

Chlorine Concentration	pH ≤ 6						pH = 6.5						pH = 7.0					
mg/L	Log Inactivations						Log Inactivations						Log Inactivations					
	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
0.6	24	47	71	94	118	141	28	56	84	112	140	168	33	67	100	133	167	200
0.8	24	48	73	97	121	145	29	57	86	115	143	172	34	68	103	137	171	205
1	25	49	74	99	123	148	29	59	88	117	147	176	35	70	105	140	175	210
1.2	25	51	76	101	127	152	30	60	90	120	150	180	36	72	108	143	179	215
1.4	26	52	78	103	129	155	31	61	92	123	153	184	37	74	111	147	184	221
1.6	26	52	79	105	131	157	32	63	95	126	158	189	38	75	113	150	188	226
1.8	27	54	81	108	135	162	32	64	97	129	161	193	39	77	116	154	193	231
2	28	55	83	110	138	165	33	66	99	131	164	197	39	79	118	157	197	236
2.2	28	56	85	113	141	169	34	67	101	134	168	201	40	81	121	161	202	242
2.4	29	57	86	115	143	172	34	68	103	137	171	205	41	82	124	165	206	247
2.6	29	58	88	117	146	175	35	70	105	139	174	209	42	84	126	168	210	252
2.8	30	59	89	119	148	178	36	71	107	142	178	213	43	86	129	171	214	257
3	30	60	91	121	151	181	36	82	109	145	181	217	44	87	131	174	218	261

Exercise #5: Using EPA CT tables to calculate CTs required

Example #1: Conventional filter plant (2.5-log)

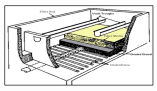


Example #2: Slow sand filter plant (2-log)

Example #3: Membrane filter plant (2.5-log)

CT parameters measured at the first user are provided below

Example #1: Conventional filter plant (2.5-log)
- Temperature: 10° C
- pH: 7.0
- Free chlorine residual: 0.8 ppm
- Contact time T: 100 minutes

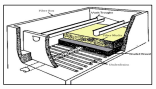


Example #2: Slow sand filter plant (2-log)
- Temperature: 16° C
- pH: 6.6
- Free chlorine residual: 0.5 ppm
- Contact time T: 46 minutes

Example #3: Membrane filter plant (2.5-log)
- Temperature: 8° C
- pH: 7.3
- Free chlorine residual: 1.3 ppm
- Contact time T: 100 minutes

Directions: Use the data provided in the examples to determine the CTs required for giardia inactivation at the treatment plant for that day

Example #1: Conventional filter plant (2.5-log)
- Temperature: 10° C
- pH: 7.0
- Free chlorine residual: 0.8 ppm
- Contact time T: 100 minutes

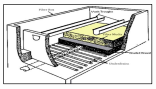


Example #2: Slow sand filter plant (2-log)
- Temperature: 16° C
- pH: 6.6
- Free chlorine residual: 0.5 ppm
- Contact time T: 46 minutes

Example #3: Membrane filter plant (2.5-log)
- Temperature: 8° C
- pH: 7.3
- Free chlorine residual: 1.3 ppm
- Contact time T: 100 minutes

Answer 3 questions for each example…

1. What are the CTs required for that day?
2. What was the CT achieved?
3. Were CTs met?



Example #1: Conventional filter plant (2.5-log)

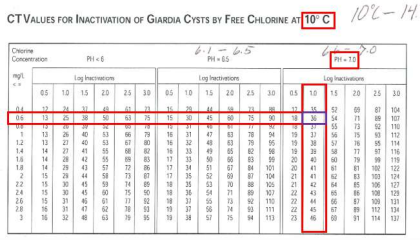
Example #2: Slow sand filter plant (2-log)

Example #3: Membrane filter plant (2.5-log)

Exercise #5

- Remember to set the bar high for $CT_{required}$

CT Values for Inactivation of Giardia Cysts by Free Chlorine at 10° C



Exercise #5

Avoid common mistakes for $CT_{required}$…

– Must round down for temperature
– Must round up for pH
– Must round up for free chlorine residual

55

Exercise #5: Use EPA CT tables to calculate CTs required

Example #1: Conventional filter plant (2.5-log)
•Temperature: 10° C
•pH: 7.0
•Free chlorine residual: 0.8 ppm
•Contact time T: 100 minutes

Example #2: Slow sand filter plant (2-log)
•Temperature: 16° C
•pH: 6.6
•Free chlorine residual: 0.5 ppm
•Contact time T: 46 minutes

Example #3: Membrane filter plant (2.5-log)
•Temperature: 8° C
•pH: 7.3
•Free chlorine residual: 1.3 ppm
•Contact time T: 100 minutes

For each example:

1. What are the CTs required for that day?
2. What was the CT achieved?
3. Were CTs met?

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Exercise #5: Use EPA CT tables to calculate CTs required

Example #1: Conventional filter plant (2.5-log)
•Temperature: 10° C
•pH: 7.0
•Free chlorine residual: 0.8 ppm
•Contact time T: 100 minutes

Example #2: Slow sand filter plant (2-log)
•Temperature: 16° C
•pH: 6.6
•Free chlorine residual: 0.5 ppm
•Contact time T: 46 minutes

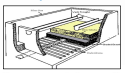
Example #3: Membrane filter plant (2.5-log)
•Temperature: 8° C
•pH: 7.3
•Free chlorine residual: 1.3 ppm
•Contact time T: 100 minutes

For each example:

1. What are the CTs required for that day?
2. What was the CT achieved?
3. Were CTs met?

57

Example #1: Conventional Filter Plant (2.5-log)



CT Required = 18

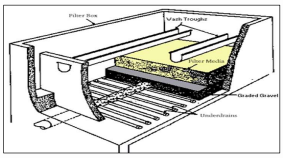
Temp = 10° C
pH = 7.0
Residual = 0.8 ppm

APPENDIX TABLE 4-3.
CT VALUES FOR INACTIVATION OF GIARDIA CYSTS BY FREE CHLORINE AT 10° C

Chlorine Concentration mg/L < =	PH < 6						PH = 6.5						PH = 7.0					
	Log Inactivations						Log Inactivations						Log Inactivations					
	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
0.6	12	25	38	50	63	75	15	30	45	60	75	90	17	36	54	71	89	107
0.8	13	26	39	52	65	78	15	31	46	61	77	92	18	37	55	73	92	110
1	13	26	40	53	66	79	16	31	47	63	78	94	19	37	56	75	93	112
1.2	13	27	40	53	67	80	16	32	48	63	79	95	19	38	57	76	95	114
1.4	14	27	41	55	68	82	16	33	49	65	82	98	19	39	58	77	97	116
1.6	14	28	42	55	69	83	17	33	50	66	83	99	20	40	60	79	99	119
1.8	14	29	43	57	72	86	17	34	51	67	84	101	20	41	61	81	102	122
2	15	29	44	58	73	87	17	35	52	69	87	104	21	41	62	83	103	124
2.2	15	30	45	59	74	89	18	35	53	70	88	105	21	42	64	85	106	127
2.4	15	30	45	60	75	90	18	36	54	71	89	107	22	43	65	86	108	129
2.6	15	31	46	61	77	92	18	37	55	73	92	110	22	44	66	87	109	131
2.8	16	31	47	62	78	93	19	37	56	74	93	111	22	45	67	89	112	134
3	16	32	48	63	79	95	19	38	57	75	94	113	23	46	69	91	114	137

58

Example #1: Conventional Filter Plant (2.5-log)



Temp = 10° C
pH = 7.0
Residual = 0.8 ppm
Contact Time = 100 min

1. What are the CTs required for that day? **18 (EPA Table)**
2. What was the CT achieved? **80 (0.8 ppm x 100 min)**
3. Were CTs met? **Yes (CT achieved > CT required)**

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Example #2: Slow Sand Filter Plant (2.0-log)

CT Required = 24

Temp = 16° C
pH = 6.6
Residual = 0.5 ppm

APPENDIX TABLE 4-4.
CT VALUES FOR INACTIVATION OF GIARDIA CYSTS BY FREE CHLORINE AT 15° C

Chlorine Concentration mg/L < =	PH < 6						PH = 6.5						PH = 7.0					
	Log Inactivations						Log Inactivations						Log Inactivations					
	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	9	16	25	33	41	49	10	20	30	39	49	59	12	23	35	47	58	70
0.6	8	17	25	33	42	50	10	20	30	40	50	60	12	24	36	48	60	72
0.8	9	17	26	35	43	52	10	20	31	41	51	61	12	24	37	49	61	73
1	9	18	27	35	44	53	11	21	32	42	53	63	13	25	38	50	63	75
1.2	9	18	27	36	45	54	11	21	32	43	53	64	13	25	38	51	63	76
1.4	9	18	28	37	46	55	11	22	33	43	54	65	13	26	39	52	65	78
1.6	9	19	28	37	47	56	11	22	33	44	55	66	13	26	40	53	66	79
1.8	10	19	29	38	48	57	11	23	34	45	57	68	14	27	41	54	68	81
2	10	19	29	39	49	58	12	23	35	46	58	69	14	28	42	55	69	83
2.2	10	20	30	39	50	59	12	23	35	47	58	70	14	28	43	57	71	85
2.4	10	20	30	40	51	60	12	24	36	48	60	72	14	29	43	57	72	86
2.6	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88
2.8	10	21	31	41	52	62	12	25	37	49	62	74	15	30	45	59	74	89
3	11	21	32	42	53	63	13	25	38	51	63	76	15	30	46	61	76	91

60

Example #2: Slow Sand Filter Plant (2.0-log)

Temp = 16° C
pH = 6.6
Residual = 0.5 ppm
Contact Time = 46 min

1. What are the CTs required for that day? **24 (EPA Table)**
2. What was the CT achieved? **23 (0.5 ppm x 46 min)**
3. Were CTs met? **No (CT achieved < CT required)**

61

Exercise #5: Using EPA CT tables to calculate CTs required

Directions: Use the data provided in the examples below to determine the CTs required for giardia inactivation at the treatment plant for that day

Example #1: Conventional filter plant (2.5-log)

CT parameters measured at the 1st user as follows:
- Temperature: 10° C
- pH: 7.0
- Free chlorine residual: 0.8 ppm
- Contact time T: 100 minutes

What are the CTs required for that day? **18**
What was the CT achieved? **80**
Were CTs met? **Yes**

Example #2: Slow sand filter plant (2-log)

CT parameters measured at the 1st user as follows:
- Temperature: 16° C
- pH: 6.6
- Free chlorine residual: 0.5 ppm
- Contact time T: 46 minutes

What are the CTs required for that day? **24**
What was the CT achieved? **23**
Were CTs met? **No**

Example #3: Membrane filter plant (2.5-log)

CT parameters measured at the 1st user as follows:
- Temperature: 8° C
- pH: 7.3
- Free chlorine residual: 1.3 ppm
- Contact time T: 100 minutes

What are the CTs required for that day? **31**
What was the CT achieved? **130**
Were CTs met? **Yes**

64

Example #3: Membrane Filter Plant (2.5-log)

CT Required = 31

Temp = 8° C
pH = 7.3
Residual = 1.3 ppm

APPENDIX TABLE 4-2.
CT VALUES FOR INACTIVATION OF GIARDIA CYSTS BY FREE CHLORINE AT 5.0° C

Chlorine Concentration mg/L < =	pH < 7.5						pH = 8.0						pH = 8.5					
	Log Inactivations						Log Inactivations						Log Inactivations					
	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	28	55	83	111	138	166	33	66	99	132	165	198	39	79	118	157	197	236
0.6	29	57	86	114	143	171	34	68	102	136	170	204	41	81	122	163	203	244
0.8	29	58	88	117	146	175	35	70	105	140	175	210	42	84	126	168	210	252
1	30	60	90	119	149	179	36	72	108	144	180	216	43	87	130	173	217	260
1.2	31	61	92	122	153	183	37	74	111	147	184	221	45	89	134	178	223	267
1.4	31	62	94	125	156	187	38	76	114	151	189	227	46	91	137	183	228	274
1.6	32	64	96	128	160	192	39	77	116	155	193	232	47	94	141	187	234	281
1.8	33	65	98	131	163	196	40	79	119	159	198	238	48	96	144	191	239	287
2	33	67	100	133	167	200	41	81	122	162	203	243	49	98	147	196	245	294
2.2	34	68	102	136	170	204	41	83	124	165	207	248	50	100	150	200	250	300
2.4	35	70	105	139	174	209	42	84	127	169	211	253	51	102	153	204	255	306
2.6	36	71	107	142	178	213	43	86	129	172	215	258	52	104	156	208	260	312
2.8	36	72	109	145	181	217	44	88	132	175	219	263	53	106	159	212	265	318
3	37	74	111	147	184	221	45	89	134	179	223	268	54	108	162	216	270	324

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Bonus: Use the data provided below to determine the CTs required for virus inactivation at the treatment plant for that day

CT parameters measured at the 1st user as follows:
- Temperature: 10° C
- pH: 7.0

Table A-7. CT Values for Inactivation of Viruses by Free Chlorine[1]

	Log Inactivation					
	2.0-log		3.0-log		4.0-log	
Temperature (C)	pH=< 6-9	10	6-9	10	6-9	10
0.5	6	45	9	66	12	90
5	4	30	6	44	8	60
10	3	22	4	33	6	45
15	2	15	3	22	4	30
20	1	11	2	16	3	22
25	1	7	1	11	2	15

1. What log inactivation is required for viruses in surface water?
2. What are the CTs required for viruses that day?
3. Assuming a contact time T of 30 minutes, what free chlorine concentration is needed to meet the CT required above?
4. What does this tell you about meeting the CT requirements for viruses compared to meeting the CT requirements for giardia?

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Example #3: Membrane Filter Plant (2.5-log)

Temp = 8° C
pH = 7.3
Residual = 1.3 ppm
Contact Time = 100 min

1. What are the CTs required for that day? **31 (EPA Table)**
2. What was the CT achieved? **130 (1.3 ppm x 100 min)**
3. Were CTs met? **Yes (CT achieved > CT required)**

63

Bonus: Use the data provided in the examples below to determine the CTs required for virus inactivation at the treatment plant for that day

CT parameters measured at the 1st user as follows:
- Temperature: 10° C
- pH: 7.0

Table A-7. CT Values for Inactivation of Viruses by Free Chlorine[1]

	Log Inactivation					
	2.0-log		3.0-log		4.0-log	
Temperature (C)	pH=< 6-9	10	6-9	10	6-9	10
0.5	6	45	9	66	12	90
5	4	30	6	44	8	60
10	3	22	4	33	6	45
15	2	15	3	22	4	30
20	1	11	2	16	3	22
25	1	7	1	11	2	15

1. What log inactivation is required for viruses in surface water? **4.0-log**
2. What are the CTs required for viruses that day? **6**
3. Assuming a contact time T of 30 minutes, what free chlorine concentration is needed to meet the CT required above? **0.2 ppm**
4. What does this tell you about meeting the CT requirements for viruses compared to meeting the CT requirements for giardia? **If you meet CT requirements for giardia, then you automatically meet them for viruses (i.e. it takes more CTs to inactivate Giardia than it does for viruses)**

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Filling out the monthly surface water quality report form

OHA - Drinking Water Program – Surface Water Quality Data Form - *Giardia* Inactivation

System Name: ID #: WTP-: Month/Year: Log Requirement (Circle One): 0.5 / 1.0

Date / Time	Minimum Cl_2 Residual at 1st User (C) [2]	Contact Time (T)	Actual CT	Temp	pH	Required CT	CT Met? [3]	Peak Hourly Demand Flow
	[ppm or mg/L]	[minutes]	C X T	[° C]		Use tables	Yes / No	[GPM]
1 /								
2 /								
3 /								
4 /								
5 /								
6 /								
7 /								
8 /								
9 /								
10 /								
11 /								
12 /								
13 /								
14 /								
15 /								
16 /								
17 /								
18 /								
19 /								

So here's our reporting form (available for download on our website…)
Every day you must calculate the CTs required using the tables and record it on this form.
So let's enter our data from the example into the form starting w/ temp…

67

Filling out the monthly surface water quality report form

Picking up where we left off when determining required CT, these same parameters will be used to fill out the monthly surface water quality form.
- temp of 12°C,
- pH of 6.8,
- free chlorine residual of 0.6
- $CT_{required}$ = 36

68

Filling out the monthly surface water quality report form

Picking up where we left off when determining required CT, these same parameters will be used to fill out the monthly surface water quality form.
- temp of 12°C,
- pH of 6.8,
- free chlorine residual of 0.6
- $CT_{required}$ = 36

Yet to be determined is...
- CT_{actual} = contact time x chlorine residual
- Contact time
- Peak hour demand flow
- Turbidity data

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OHA - Drinking Water Program – Surface Water Quality Data Form - *Giardia* Inactivation

System Name: ID #: WTP-: Month/Year: Log Requirement (Circle One): 0.5 / 1.0

Date / Time	Minimum Cl_2 Residual at 1st User (C) [2]	Contact Time (T)	Actual CT	Temp	pH	Required CT	CT Met? [3]	Peak Hourly Demand Flow
	[ppm or mg/L]	[minutes]	C X T	[° C]		Use tables	Yes / No	[GPM]
1 /				12				
2 /								
3 /								
4 /								
5 /								
6 /								
7 /								
8 /								
9 /								
10 /								
11 /								
12 /								
13 /								
14 /								
15 /								
16 /								
17 /								
18 /								
19 /								

Here's where we enter temp

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OHA - Drinking Water Program – Surface Water Quality Data Form - *Giardia* Inactivation

System Name: ID #: WTP-: Month/Year: Log Requirement (Circle One): 0.5 / 1.0

Date / Time	Minimum Cl_2 Residual at 1st User (C) [2]	Contact Time (T)	Actual CT	Temp	pH	Required CT	CT Met? [3]	Peak Hourly Demand Flow
	[ppm or mg/L]	[minutes]	C X T	[° C]		Use tables	Yes / No	[GPM]
1 /				12	6.8			
2 /								
3 /								
4 /								
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18 /								
19 /								

Here's where we enter pH

71

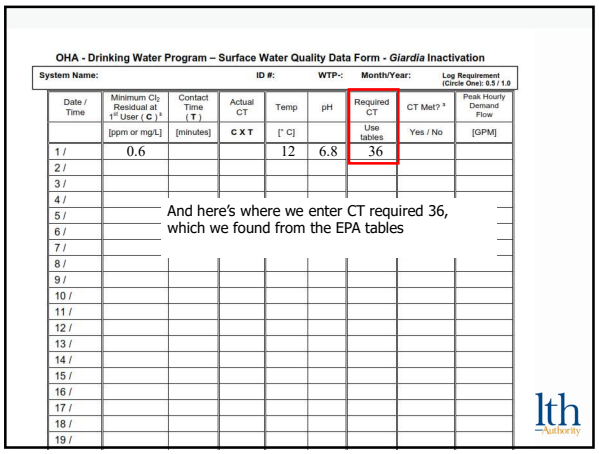
OHA - Drinking Water Program – Surface Water Quality Data Form - *Giardia* Inactivation

System Name: ID #: WTP-: Month/Year: Log Requirement (Circle One): 0.5 / 1.0

Date / Time	Minimum Cl_2 Residual at 1st User (C) [2]	Contact Time (T)	Actual CT	Temp	pH	Required CT	CT Met? [3]	Peak Hourly Demand Flow
	[ppm or mg/L]	[minutes]	C X T	[° C]		Use tables	Yes / No	[GPM]
1 /	0.6			12	6.8			
2 /								
3 /								
4 /								
5 /								
6 /								
7 /								
8 /								
9 /								
10 /								
11 /								
12 /								
13 /								
14 /								
15 /								
16 /								
17 /								
18 /								
19 /								

Here's where we enter free chlorine residual

72



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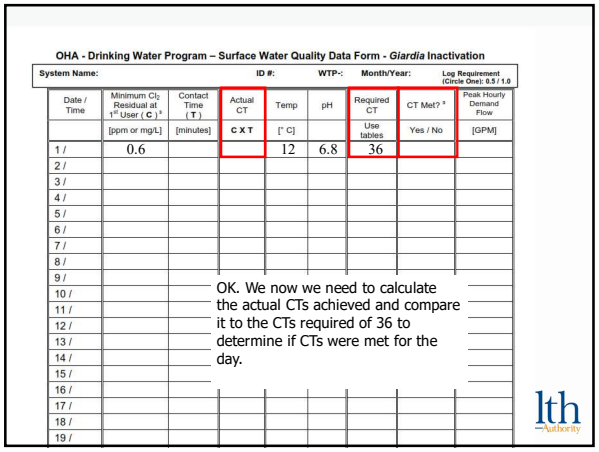

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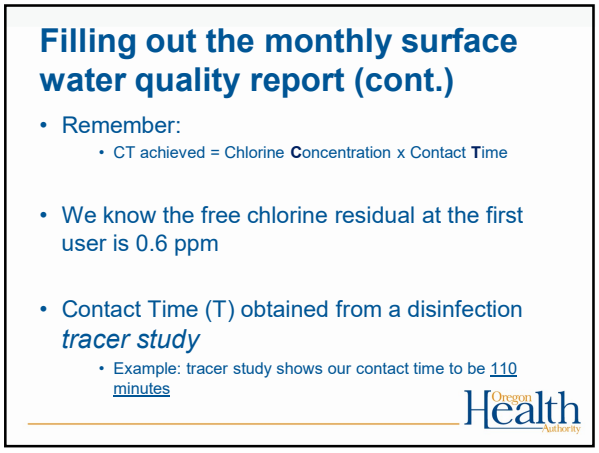

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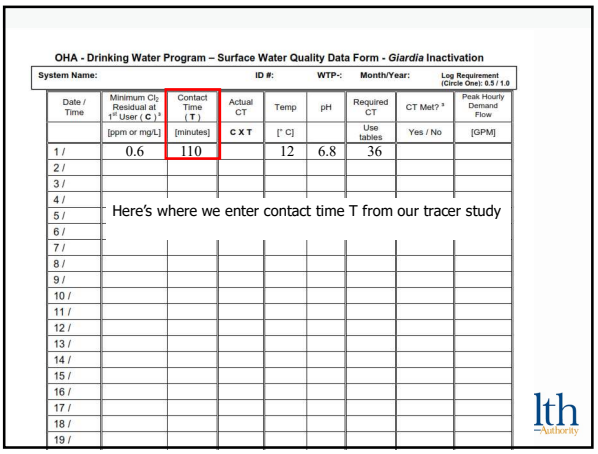

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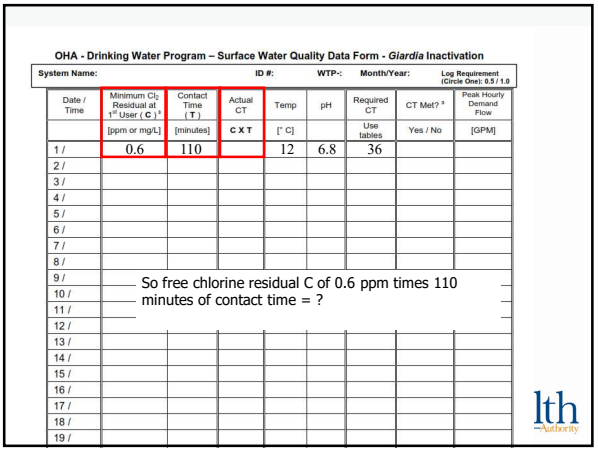

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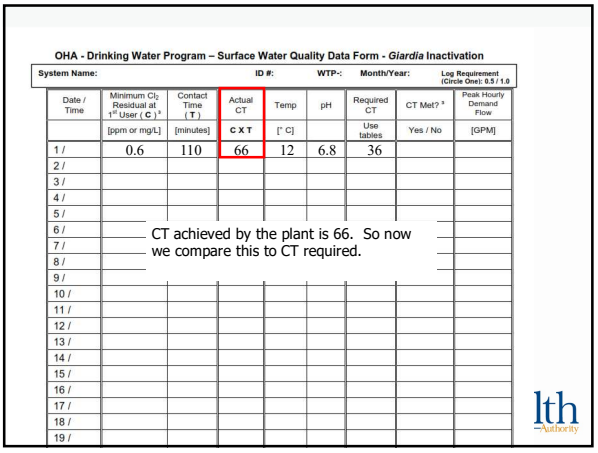
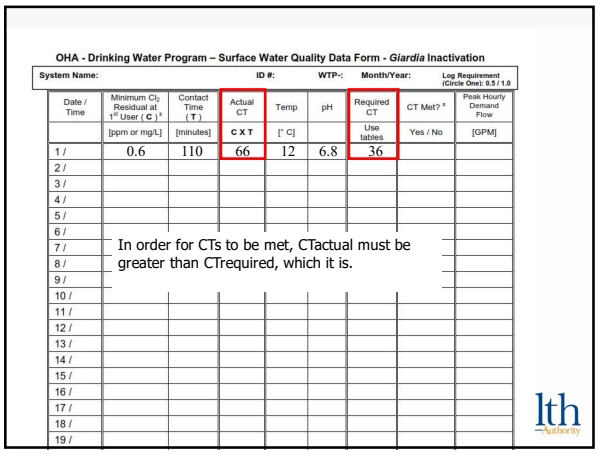


78

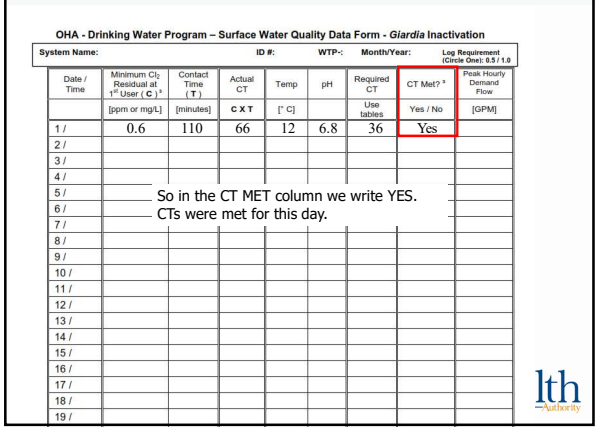

OHA - Drinking Water Program – Surface Water Quality Data Form - *Giardia* Inactivation

System Name: ID #: WTP-: Month/Year: Log Requirement (Circle One): 0.5 / 1.0

Date / Time	Minimum Cl_2 Residual at 1st User (C) [1]	Contact Time (T)	Actual CT	Temp	pH	Required CT	CT Met? [2]	Peak Hourly Demand Flow
	[ppm or mg/L]	[minutes]	C X T	[° C]		Use tables	Yes / No	[GPM]
1 /	0.6	110	66	12	6.8	36		
2 /								
3 /								
4 /								
5 /								
6 /								
7 /								
8 /								
9 /								
10 /								
11 /								
12 /								
13 /								
14 /								
15 /								
16 /								
17 /								
18 /								
19 /								

In order for CTs to be met, CTactual must be greater than CTrequired, which it is.

79


OHA - Drinking Water Program – Surface Water Quality Data Form - *Giardia* Inactivation

System Name: ID #: WTP-: Month/Year: Log Requirement (Circle One): 0.5 / 1.0

Date / Time	Minimum Cl_2 Residual at 1st User (C) [1]	Contact Time (T)	Actual CT	Temp	pH	Required CT	CT Met? [2]	Peak Hourly Demand Flow
	[ppm or mg/L]	[minutes]	C X T	[° C]		Use tables	Yes / No	[GPM]
1 /	0.6	110	66	12	6.8	36	Yes	
2 /								
3 /								
4 /								
5 /								
6 /								
7 /								
8 /								
9 /								
10 /								
11 /								
12 /								
13 /								
14 /								
15 /								
16 /								
17 /								
18 /								
19 /								

So in the CT MET column we write YES. CTs were met for this day.

80

Common mistakes:

- Rounding errors:
  - Must round down for temperature
  - Must round up for pH
  - Must round up for free chlorine residual
- Bad formulas in excel spreadsheets:
  - Make sure you understand your formula
  - Wilkes Equation not allowed, must use Regression Equation

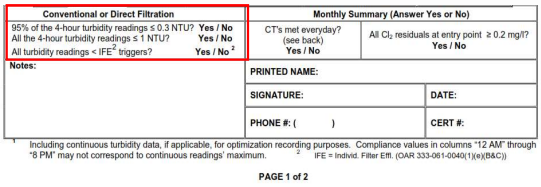
81

Common mistakes (continued):

- Not calculating CT's daily
  - Don't wait until the end of the month to do the calculations because if you discover you didn't meet CT's, it's too late!
- If adjusting contact time according to flow rate, use the demand flow, not the plant flow.
- Failure to answer questions at bottom of form correctly (or at all)
- Always answering "Yes" to the questions at the bottom of the form without actually looking at the numbers

82

Conventional or Direct: Answer all the yes/no questions



Conventional or Direct Filtration	Monthly Summary (Answer Yes or No)	
95% of the 4-hour turbidity readings ≤ 0.3 NTU? Yes / No All the 4-hour turbidity readings ≤ 1 NTU? Yes / No All turbidity readings < IFE[2] triggers? Yes / No [2]	CT's met everyday? (see back) Yes / No	All Cl_2 residuals at entry point ≥ 0.2 mg/l? Yes / No
Notes:	PRINTED NAME:	
	SIGNATURE:	DATE:
	PHONE #: ( )	CERT #:

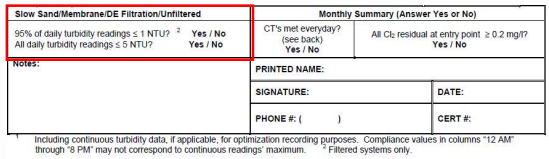
[1] Including continuous turbidity data, if applicable, for optimization recording purposes. Compliance values in columns "12 AM" through "8 PM" may not correspond to continuous readings' maximum. [2] IFE = Individ. Filter Eff. (OAR 333-061-0040(1)(e)(B&C))

PAGE 1 of 2

83

Slow Sand/Membrane/DE/Unfiltered

Answer all the yes/no questions



Slow Sand/Membrane/DE Filtration/Unfiltered	Monthly Summary (Answer Yes or No)	
95% of daily turbidity readings ≤ 1 NTU? [2] Yes / No All daily turbidity readings ≤ 5 NTU? Yes / No	CT's met everyday? (see back) Yes / No	All Cl_2 residual at entry point ≥ 0.2 mg/l? Yes / No
Notes:	PRINTED NAME:	
	SIGNATURE:	DATE:
	PHONE #: ( )	CERT #:

[1] Including continuous turbidity data, if applicable, for optimization recording purposes. Compliance values in columns "12 AM" through "8 PM" may not correspond to continuous readings' maximum. [2] Filtered systems only.

PAGE 1 of 2

84

Cartridge/Bag

Answer all the yes/no questions

Cartridge Filtration	Monthly Summary (Answer Yes or No)	
95% of daily turbidity readings ≤ 1 NTU? Yes / No All daily turbidity readings ≤ 5 NTU? Yes / No	CT's met everyday? (see back) Yes / No	All Cl_2 residual at entry point ≥ 0.2 mg/l? Yes / No
Notes: PSI = pounds per square inch PSID = pounds per square inch difference (before filter – after filter) PSID When to Change Filter = Manufacturer's recommendation; may need to look in manual for manufacturer's specifications when to change the filter, at what PSID.	PRINTED NAME:	
	SIGNATURE:	DATE:
	PHONE #: ( )	CERT #:

[1] Including continuous turbidity data, if applicable, for optimization recording purposes. Compliance values in "Daily Turbidity Reading" Column may not correspond to continuous readings' maximum.

PAGE 1 of 2

85

Everyone needs to fill out the CT section!

Cartridge Filtration	Monthly Summary (Answer Yes or No)	
95% of daily turbidity readings ≤ 1 NTU? Yes / No All daily turbidity readings ≤ 5 NTU? Yes / No	CT's met everyday? (see back) Yes / No	All Cl_2 residual at entry point ≥ 0.2 mg/l? Yes / No
Notes: PSI = pounds per square inch PSID = pounds per square inch difference (before filter – after filter) PSID When to Change Filter = Manufacturer's recommendation; may need to look in manual for manufacturer's specifications when to change the filter, at what PSID.	PRINTED NAME:	
	SIGNATURE:	DATE:
	PHONE #: ( )	CERT #:

[1] Including continuous turbidity data, if applicable, for optimization recording purposes. Compliance values in "Daily Turbidity Reading" Column may not correspond to continuous readings' maximum.

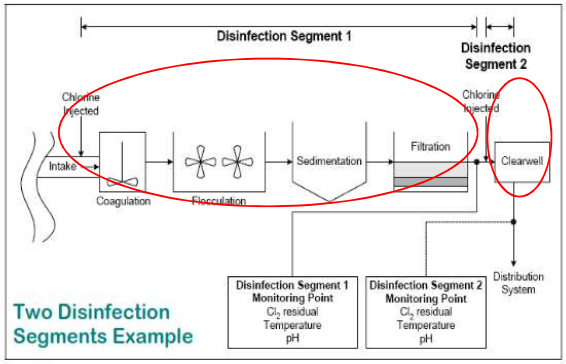
PAGE 1 of 2

86

Multiple CT segments

- A "CT segment" is the point between which chlorine is injected and free chlorine residual is measured
- Treatment plants can have multiple CT segments (i.e. multiple chlorine injection points)

87



Total inactivation = ∑ log inactivation from each disinfection segment

88

Multiple CT segments

- Multiple CT segments can be added together in order to meet CTs
- Do not add contact times "T" together!
  - Why? Chlorine, temp, pH may change throughout the process

89

Multiple CT segments (cont.)

- Must calculate log inactivation ratios for each segment and add ratios together
  - Inactivation ratio = $\frac{C1T1_{actual}}{CT1_{reqd}} + \frac{C2T2_{actual}}{CT2_{reqd}}$
- Modify reporting form: add column for log inactivation ratios (sum must be >1)
  - Not to be confused with 1-log inactivation
- Contact your regulator for further assistance

90

What to do when things go wrong:

Such as:

- Treatment interruptions
- CTs not met
- Turbidity exceeds regulatory limits

What to do:

- Call your regulatory contact at the drinking water program

91

In Summary:

- In order to verify adequate disinfection is taking place, we need to calculate CT achieved (CT_{actual})
- EPA reviewed many disinfection studies in order to create CT Tables that specify minimum CT requirements needed to achieve specific log reduction levels for *Giardia* ($CT_{required}$)
- CT_{actual} must be equal to or greater than $CT_{required}$

92

Things you should do:

- Check how T is calculated at your plant
- Do all treatment plant operators understand it?
- Review spreadsheet equation for CTs (if applicable)
- Write an SOP for CT determination
- Arrange for a tracer study if necessary

93

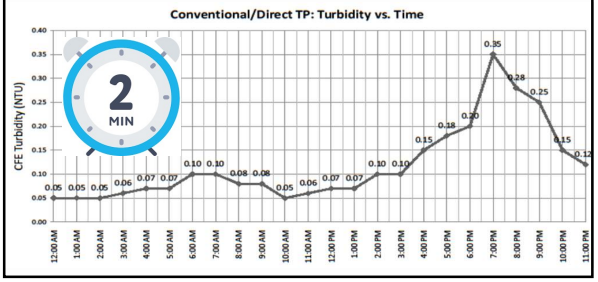
Exercise #6 – Example 1

- Filling out the monthly surface water quality operating report for a 2.5-log conventional filtration plant

94

Example #1: Conventional or direct filter plant - Turbidity

- Use the data in the graph to record the 4-hour daily turbidities on the first day of the month of the Conventional/Direct Filtration monthly reporting form.
- What number should be entered in the "Highest Reading of the Day (NTU)" column?_____



95

Example #1: Conventional or direct filter plant - Turbidity

- Use the data in the graph to record the 4-hour daily turbidities on the first day of the month of the Conventional/Direct Filtration monthly reporting form.
- What number should be entered in the "Highest Reading of the Day (NTU)" column? **0.35 NTU**

OHA - Drinking Water Program – Turbidity Monitoring Report Form County:
Conventional or Direct Filtration

System Name: ID #:
WTP-: Month/Year:

DAY	12 AM (NTU)	4 AM (NTU)	8 AM (NTU)	NOON (NTU)	4 PM (NTU)	8 PM (NTU)	Highest Reading of the Day[1] (NTU)
1	0.05	0.07	0.08	0.07	0.15	0.28	0.35
2							
3							
4							
5							

96

Example #1: Conventional or direct filter plant - Turbidity

- Let's say your plant runs 24 hours a day and you have turbidity readings filled in for every 4-hour interval for all 31 days of the month. How many readings could you have that were > 0.3 NTU? (Hint: 95% of readings should be ≤ 0.3 NTU)_____
- What should you do if you answer "no" to the turbidity question "All readings ≤ 1 NTU?" on the bottom of the form? _____
  a) Call the state
  b) Issue a boil water notice
  c) Issue a public notice within 30 days
  d) Both a & c

- What should you do if you answer "no" to the turbidity question "All readings < IFE triggers?" on the bottom of the form?_____
  a) Call the state
  b) Issue a boil water notice
  c) Issue a public notice within 30 days
  d) Both a & c

97

Example #1: Conventional or direct filter plant - Turbidity

- Let's say your plant runs 24 hours a day and you have turbidity readings filled in for every 4-hour interval for all 31 days of the month. How many readings could you have that were > 0.3 NTU? (Hint: 95% of readings should be ≤ 0.3 NTU) **9**
  (6 readings/day x 31 days = 186 readings total. 5% x 186 = 9.3)
- What should you do if you answer "no" to the turbidity question "All readings ≤ 1 NTU?" on the bottom of the form? **a**
  a) Call the state
  b) Issue a boil water notice
  c) Issue a public notice within 30 days
  d) Both a & c
- What should you do if you answer "no" to the turbidity question "All readings < IFE triggers?" on the bottom of the form? **a**
  a) Call the state
  b) Issue a boil water notice
  c) Issue a public notice within 30 days
  d) Both a & c

98

Example #1: Conventional or direct filter plant - Disinfection

- Use the following parameters to calculate the CTs achieved at a 2.5-log conventional plant and fill it in on the form on first day of the month:
  - Free chlorine residual: 0.6 ppm
  - Contact time: 100 minutes
  - Peak hourly demand: 2000 gpm
- Use the following parameters to calculate the CTs required using the EPA tables from Exercise 5 and fill it in on the form:
  - Temp: 12°C
  - pH: 7.2

99

Example #1: Conventional or direct filter plant – Disinfection

- Use the following parameters to calculate the CTs achieved at a 2.5-log conventional plant and fill it in on the form on first day of the month:
  - Free chlorine residual: 0.6 ppm
  - Contact time: 100 minutes
  - Peak hourly demand: 2000 gpm
- Use the following parameters to calculate the CTs required using the EPA tables from Exercise 5 and fill it in on the form:
  - Temp: 12°C
  - pH: 7.2

OHA - Drinking Water Program – Surface Water Quality Data Form - *Giardia* Inactivation

System Name: WTP-:	Month/Year:	Log Requirement (Circle One): 0.5 / 1.0 / 1.5 / 2.0 / 2.5 / 3.0	ID #:

Date / Time	Minimum Cl_2 Residual at 1st User (C)	Contact Time (T)	Actual CT	Temp	pH	Required CT	CT Met? [3]	Peak Hourly Demand Flow
	[ppm or mg/L]	[minutes]	C x T	[° C]		Use tables	Yes / No	[GPM]
1 /	0.6	100	60	12	7.2	21	Yes	2000
2 /								
3 /								
4 /								
5 /								

100

Example #1: Conventional or direct filter plant - Disinfection

- Let's say the Peak Hourly Demand Flow for the day was 2000 gpm. If the Peak Hourly Demand Flow during the tracer study was 1750 gpm, is this a problem? Why or why not?
- What should you do if you answer "no" to either of the CT questions on the turbidity side of form?
- "CTs met at all times?"
  a) Call the state
  b) Issue a boil water notice
  c) Issue a public notice within 30 days
  d) Both a & c
- "Residual at EP ≥ 0.2 ppm at all times?"
  a) Call the state
  b) Issue a boil water notice
  c) Issue a public notice within 30 days
  d) Both a & c

101

Example #1: Conventional or direct filter plant - Disinfection

- Let's say the Peak Hourly Demand Flow for the day was 2000 gpm. If the Peak Hourly Demand Flow during the tracer study was 1750 gpm, is this a problem? Why or why not? **Yes this is a problem – flow cannot exceed 10% of tracer study flow. 10% x 1750 gpm = 175 gpm. 1750 + 175 = 1925 gpm. Therefore flow cannot be >1925 gpm or else a new tracer study is needed.**
- What should you do if you answer "no" to either of the CT questions on the turbidity side of form?
- "CTs met at all times?" **a**
  a) Call the state
  b) Issue a boil water notice
  c) Issue a public notice within 30 days
  d) Both a & c
- "Residual at EP ≥ 0.2 ppm at all times?" **a**
  a) Call the state
  b) Issue a boil water notice
  c) Issue a public notice within 30 days
  d) Both a & c

102

Exercise #6 – Example 2

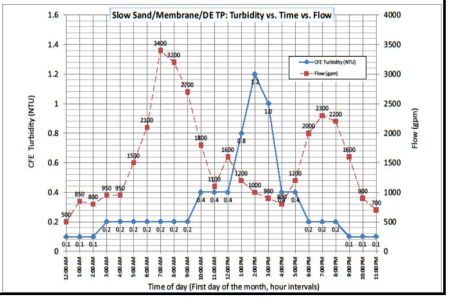
- Filling out the monthly surface water quality operating report for a 2.0-log slow sand plant

103

Example #2: Slow sand filter plant - Turbidity

- Use the data in the graph to record the daily combined filter effluent turbidity on the first day of the month of the slow sand monthly reporting form. Which column should it be reported in and why?
- What number should be entered in the "Highest Reading of the Day (NTU)" column?

2 MIN



104

Example #2: Slow sand filter plant - Turbidity

- Use the data in the graph to record the daily combined filter effluent turbidity on the first day of the month of the slow sand monthly reporting form. Which column should it be reported in and why? **Any of the columns is fine to use. Most people use the column that is closest to the time they observed the turbidity**
- What number should be entered in the "Highest Reading of the Day (NTU)" column? **1.2 NTU**

OHA - Drinking Water Program – Turbidity Monitoring Report Form County:
Slow Sand, Membrane, Diatomaceous Earth Filtration, or Unfiltered Systems

System Name: ID #:
WTP-: Month/Year:

DAY	12 AM [NTU]	4 AM [NTU]	8 AM [NTU]	NOON [NTU]	4 PM [NTU]	8 PM [NTU]	Highest Reading of the Day [1] [NTU]
1			0.2				1.2
2							
3							
4							
5							

105

Example #2: Slow sand filter plant - Turbidity

- Let's say your plant runs everyday and you have turbidity readings filled in once a day for all 31 days of the month. How many readings could you have that were > 1 NTU and still meet the requirement of 95% of readings being ≤ 1 NTU?
- What should you do if you answer "no" to the turbidity question "All readings ≤ 5 NTU?" on the bottom of the form?
  a) Call the state
  b) Issue a boil water notice
  c) Issue a public notice within 30 days
  d) Both a & c

2 MIN

106

Example #2: Slow sand filter plant - Turbidity

- Let's say your plant runs everyday and you have turbidity readings filled in once a day for all 31 days of the month. How many readings could you have that were > 1 NTU and still meet the requirement of 95% of readings being ≤ 1 NTU? **1 out of the 31 readings total. 5% x 31 = 1.6**
- What should you do if you answer "no" to the turbidity question "All readings ≤ 5 NTU?" on the bottom of the form? **a**
  a) Call the state
  b) Issue a boil water notice
  c) Issue a public notice within 30 days
  d) Both a & c

107

Example #2: Slow sand filter plant - Disinfection

- Use the following parameters to calculate the CTs achieved at a 2.0-log slow sand plant and fill it in on the form on first day of the month:
  - Free chlorine residual: 0.3 ppm
  - Contact time: 60 minutes
- Use the chart to calculate peak hour demand.
- Use the following parameters to calculate the CTs required using the EPA tables from Exercise 5 and fill it in on the form:
  - Temp: 9°C
  - pH: 7.8
- Are CTs met for this day?

5 MIN

108

Example #2: Slow sand filter plant - Disinfection

- Use the following parameters to calculate the CTs achieved at a 2.0-log slow sand plant and fill it in on the form on first day of the month:
  - Free chlorine residual: 0.3 ppm
  - Contact time: 60 minutes
  - **Peak hourly demand: 3300 gpm**
- Use the following parameters to calculate the CTs required using the EPA tables from Exercise 5 and fill it in on the form:
  - Temp: 9°C
  - pH: 7.8
- Are CTs met for this day - **No - CT achieved (18) is < CT required (66)**

OHA - Drinking Water Program – Surface Water Quality Data Form - *Giardia* Inactivation

System Name: ID #:

WTP: Month/Year: Log Requirement (Circle One): 0.5 / 1.0

Date / Time	Minimum Cl_2 Residual at t^{xx} User (C)	Contact Time (T)	Actual CT	Temp	pH	Required CT	CT Met?	Peak Hourly Demand Flow
	[ppm or mg/L]	[minutes]	C x T	[° C]		Use tables	Yes / No	[GPM]
1 /	0.3	60	18	9	7.8	66	No	3300
2 /								
3 /								
4 /								
5 /								

109

Example #2: Slow sand filter plant - Disinfection

- What should you do if you answer "no" to either of the CT questions on the turbidity side of form?
- "CTs met at all times?"
  a) Call the state
  b) Issue a boil water notice
  c) Issue a public notice within 30 days
  d) Both a & c
- "Residual at EP ≥ 0.2 ppm at all times?"
  a) Call the state
  b) Issue a boil water notice
  c) Issue a public notice within 30 days
  d) Both a & c

111

Example #2: Slow sand filter plant - Disinfection

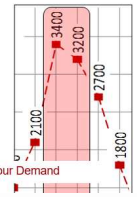
- How was peak hour demand calculated using only flow readings taken every hour?
- Tabulate the chart data and calculate a running hourly average using 2 consecutive flow readings for every hour.

What number should be entered in the "Peak Hourly Demand Flow" column? **3300 gpm.**

Average of flows between 7 am and 8 am.

Exercise #6, Example #2 Slow Sand - Peak Hour Demand Determination

Time	Flow Reading (gpm)	Running hourly average of demand flow readings (gpm)
12:00 AM	500	
1:00 AM	850	675
2:00 AM	800	825
3:00 AM	950	875
4:00 AM	950	950
5:00 AM	1500	1225
6:00 AM	2100	1800
7:00 AM	3400	2750
8:00 AM	3200	3300 <= Peak Hour Demand
9:00 AM	2700	2950

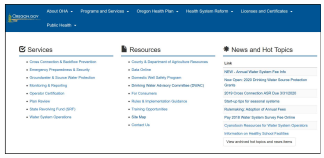


110

Emerging Issues

- Climate change and water supply
- Cyanobacteria (Harmful Algal Blooms)
- www.healthoregon.org/dws

News & "Hot Topics"



114

Climate Change and Water Supply

- Earlier and heavier snowpack runoff
- Increasing variability of storm frequency and intensity
- Weather extremes already evident
- Increased variability in water quality; can affect both surface and groundwater systems.
- Changes in rainfall patterns affect all systems
- Rising sea levels could lead to salt water intrusion or flooding

115

Cyanobacteria

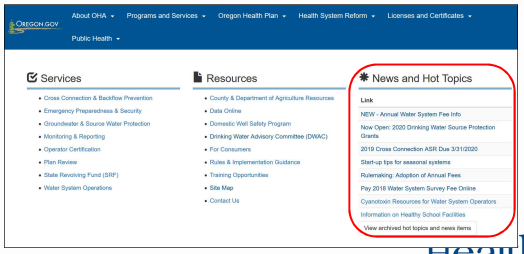
- Produce toxins that can be harmful
- Occur in warm, slow moving water
- Increasing in frequency and duration
  - happening more or better reporting?
  - more people, more nutrients, warmer water
- Resources for operators on-line at:

www.healthoregon.org/dwcyanotoxins

116

www.healthoregon.org/dws

- News
- Hot Topics



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Tools & Resources

- For surface water systems: www.healthoregon.org/dws

Click on "Water System Operations" on left-side menu list, then "Surface Water Treatment"

  - Monthly Surface Water Quality Report form template
  - Tracer Study form

- Surface Water Treatment Rule guidance manual, Appendix C: Determination of Disinfectant Contact Time

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Tools & Resources (continued)

- EPA Rules http://water.epa.gov/lawsregs/rulesregs/sdwa/currentregulations.cfm
- AWWA http://www.pnws-awwa.org/
- OAWU http://www.oawu.net/
- Circuit Rider http://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/Operations/Pages/circuitrider.aspx
- ORWARN http://www.orwarn.org/

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RESOURCES FOR OPERATORS

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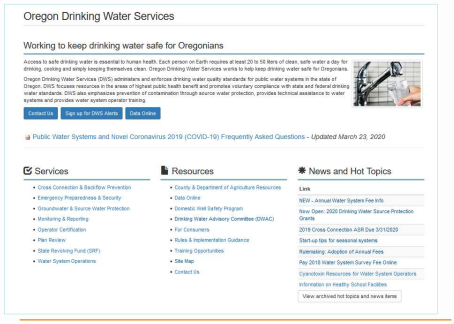
Information Available Online

www.healthoregon.org/dws



Information By Subject

"Data Online" (data specific to each water system)

Contact Us

News and Hot Topics

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Information By Subject

Services

- Cross Connection & Backflow Prevention
- Emergency Preparedness & Security
- Groundwater & Source Water Protection
- Monitoring & Reporting
- Operator Certification
- Plan Review
- State Revolving Fund (SRF)
- Water System Operations

Resources

- County & Department of Agriculture Resources
- Data Online
- Domestic Well Safety Program
- Drinking Water Advisory Committee (DWAC)

9. Water System Operations
   - **Surface Water Treatment**
   - Public Notice Resources
   - Fact Sheets & Best Practices
   - Outstanding Performance
   - Circuit Rider Program
   - Pipeline Newsletter

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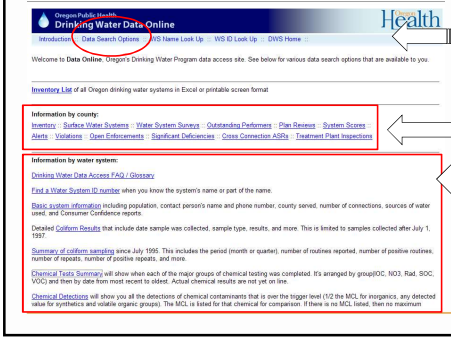
Drinking Water Data Online

https://yourwater.oregon.gov/

Many data search options are available



Data Search Options

Info by County

Info by Water System

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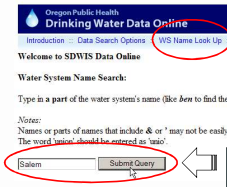
Find Your Water System

WS Name Look Up



1. Select WS Name Look Up
2. Enter water system name (e.g., "Salem")
3. Click Submit Query

Note: You also could have used WS ID Look Up and entered the ID# for Salem (00731)

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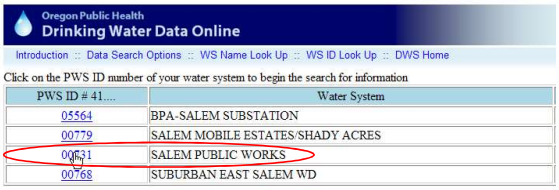
Select Your Water System

Select the Water System by Clicking on the PWS ID#



PWS ID # 41....	Water System
05564	BPA-SALEM SUBSTATION
00779	SALEM MOBILE ESTATES/SHADY ACRES
00731	SALEM PUBLIC WORKS
00768	SUBURBAN EAST SALEM WD

https://yourwater.oregon.gov/inventory.php?pwsno=00731

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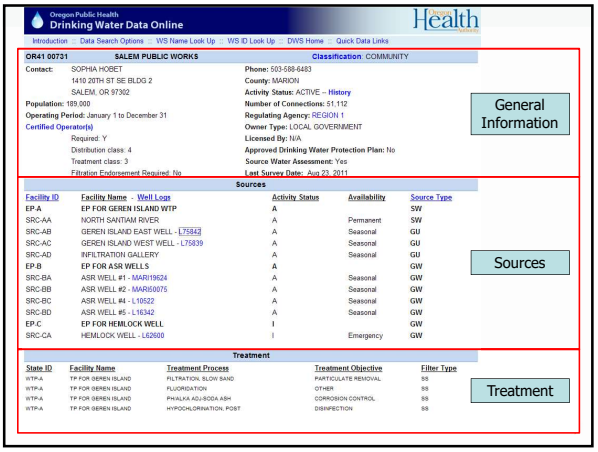
Drinking Water Data Online



General Information

Sources

Treatment

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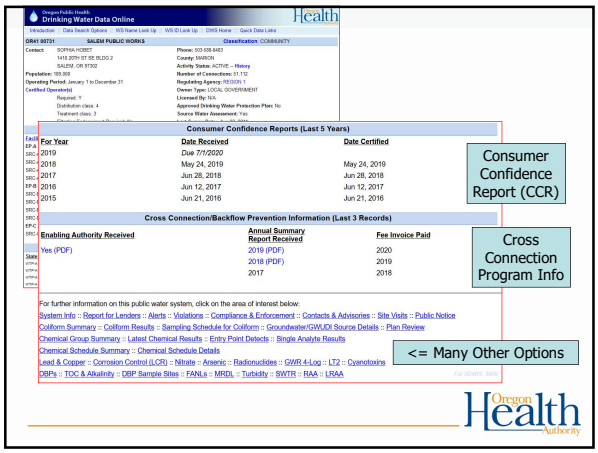

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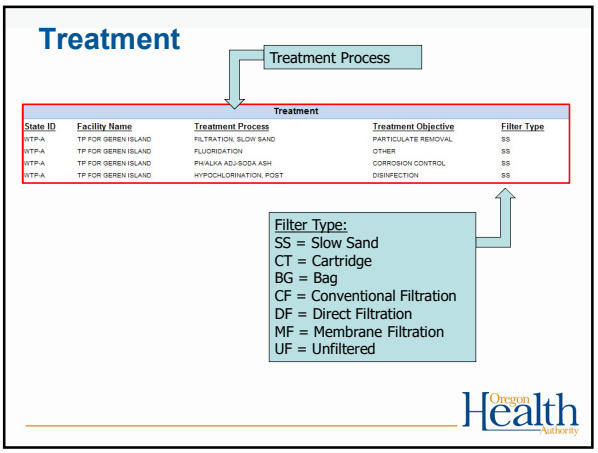

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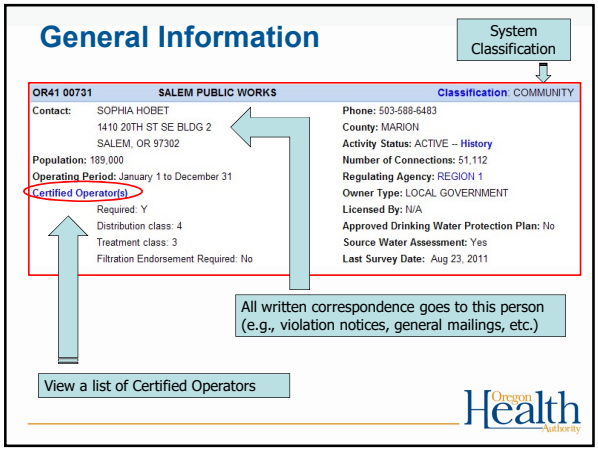

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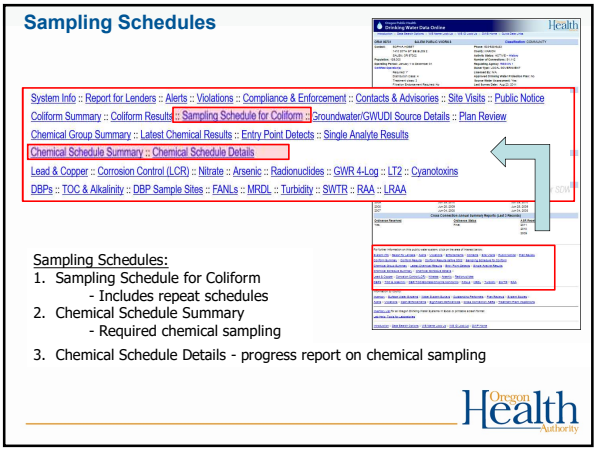

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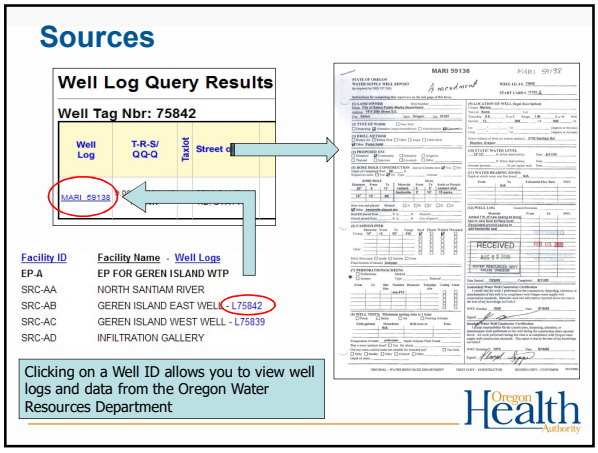

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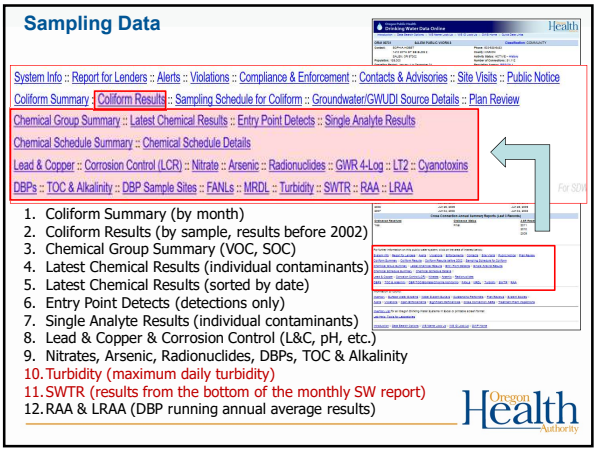

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Alerts, Contacts, Advisories & Site Visits

System Info :: Report for Lenders :: Alerts :: Violations :: Compliance & Enforcement :: Contacts & Advisories :: Site Visits :: Public Notice
Coliform Summary :: Coliform Results :: Sampling Schedule for Coliform :: Groundwater/GWUDI Source Details :: Plan Review
Chemical Group Summary :: Latest Chemical Results :: Entry Point Detects :: Single Analyte Results
Chemical Schedule Summary :: Chemical Schedule Details
Lead & Copper :: Corrosion Control (LCR) :: Nitrate :: Arsenic :: Radionuclides :: GWR 4-Log :: LT2 :: Cyanotoxins
DBPs :: TOC & Alkalinity :: DBP Sample Sites :: FANLs :: MRDL :: Turbidity :: SWTR :: RAA :: LRAA

1. Alerts - Sample results that require State/County/Dept of Ag staff to respond
2. Contacts – Document alert follow-ups and other significant correspondence
3. Advisories – boil water notice advisories, etc.
4. Site Visits – Document surveys and treatment plant inspections

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Violations, Enforcements & Public Notices

System Info :: Report for Lenders :: Alerts :: Violations :: Compliance & Enforcement :: Contacts & Advisories :: Site Visits :: Public Notice
Coliform Summary :: Coliform Results :: Sampling Schedule for Coliform :: Groundwater/GWUDI Source Details :: Plan Review
Chemical Group Summary :: Latest Chemical Results :: Entry Point Detects :: Single Analyte Results
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Lead & Copper :: Corrosion Control (LCR) :: Nitrate :: Arsenic :: Radionuclides :: GWR 4-Log :: LT2 :: Cyanotoxins
DBPs :: TOC & Alkalinity :: DBP Sample Sites :: FANLs :: MRDL :: Turbidity :: SWTR :: RAA :: LRAA

1. Violations
   - Also shows related enforcement actions
   - Systems should strive to see "Returned to Compliance" or "RTC"
   - System score should be less than 11 and as close to 0 as possible
2. Enforcements
   View pdf copies of original Administrative Orders and Bilateral Compliance Agreements as well as their status
3. Public Notice
   - Notices required
   - Notices delivered

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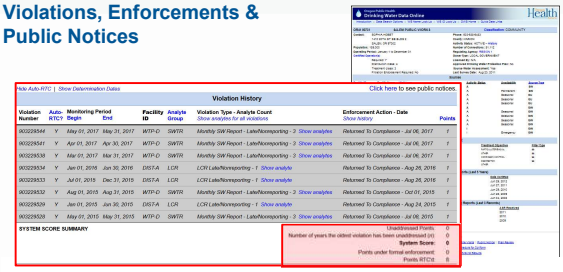
Violations, Enforcements & Public Notices



1. Violations
   - Systems should strive to see "Returned to Compliance" or "RTC"
   - System score should be less than 11 and as close to 0 as possible

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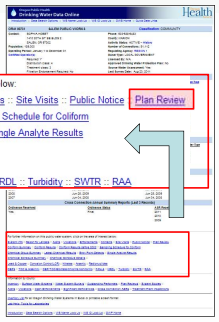
Plan Review Information



For further information on this public water system, click on the area of interest below:
System Info :: Report for Lenders :: Alerts :: Violations :: Enforcements :: Contacts :: Site Visits :: Public Notice :: Plan Review
Coliform Summary :: Coliform Results :: Coliform Results before 2002 :: Sampling Schedule for Coliform
Chemical Group Summary :: Latest Chemical Results :: Entry Point Detects :: Single Analyte Results
Chemical Schedule Summary :: Chemical Schedule Details ::
Lead & Copper :: Corrosion Control(LCR) :: Nitrates :: Arsenic :: Radionuclides
DBPs :: TOC & Alkalinity :: DBP/TOC/Bromate/Chlorine Monitoring :: FANLs :: MRDL :: Turbidity :: SWTR :: RAA

1. Project ID and Name
2. Date Plans Received
3. Date Preliminary Approval was Granted (no conditions)
4. Date Conditional Approval was Granted (required items not shown on submitted plans)
5. Date Abandoned (project was not completed)
6. Final Approval Date (approval for use)
7. Reviewer (initials of State staff engineer reviewing the plans)

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System Info & Report For Lenders

For further information on this public water system, click on the area of interest below:
System Info :: Report for Lenders :: Alerts :: Violations :: Enforcements :: Contacts :: Site Visits :: Public Notice :: Plan Review
Coliform Summary :: Coliform Results :: Coliform Results before 2002 :: Sampling Schedule for Coliform
Chemical Group Summary :: Latest Chemical Results :: Entry Point Detects :: Single Analyte Results
Chemical Schedule Summary :: Chemical Schedule Details ::
Lead & Copper :: Corrosion Control(LCR) :: Nitrates :: Arsenic :: Radionuclides
DBPs :: TOC & Alkalinity :: DBP/TOC/Bromate/Chlorine Monitoring :: FANLs :: MRDL :: Turbidity :: SWTR :: RAA

1. System Info
   - Main water system information page (already covered)
2. Report for Lenders
   - Provides proof that the water supply is under regulatory oversight
   - Satisfies lending institutions

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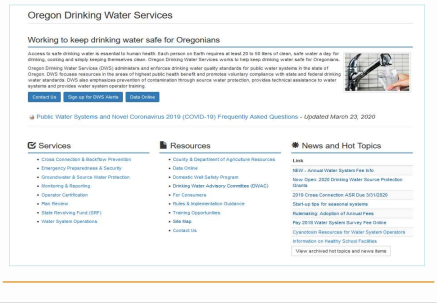
Information Available Online

www.healthoregon.org/dws/
https://yourwater.oregon.gov/



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End of Part 2

- 0.3 CEU certificates for Part 2 will be e-mailed to you soon.
- If you missed Part 1, you can receive an additional 0.3 CEU certificate.
- Register for Part 1 under “Free Training Resources” at www.healthoregon.org/swt

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QUESTIONS?

- E-mail questions to: DWS.SurfaceWater@dhsoha.state.or.us
- Call your technical services contact at the State.
- State Drinking Water Services
  - General Info: (971) 673-0405

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Thank you!

- Please remember to provide your feedback today.

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