Review of Inactivation by Disinfection for SDWA Primacy Agencies

USEPA Office of Groundwater and Drinking Water

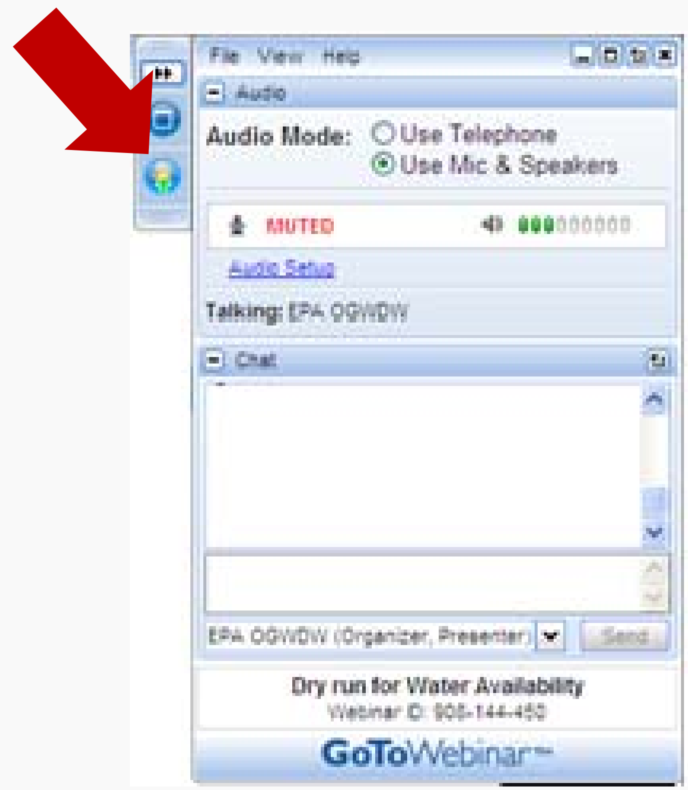
Need Technical Assistance?
Call GoToWebinar Support:
U.S. and Canada: **1-800-263-6317**

Connecting to the Audio

- Dial-in using your telephone
  - Number: (415) 363-0078
  - Conference Code: 657-257-290

If You Need Help

- Raise your hand
  - Someone will contact you via chat to help
- Ask a question at the bottom of your GoToWebinar window



Maximizing Your Screen

- For a full screen view hit F5 or full screen icon in bottom right
- To return to the regular view, hit F5 again or regular screen icon
  - You need to be in “regular” view to submit text questions
- Hitting Control+H will also give you a larger view

Questions and Answers

- You can submit questions/comments anytime during the presentation
- Just use the question and answer pane that is located on your screen
- The speakers will address as many questions as possible at the end of the presentations.

Polls

- Polls will be launched during breaks throughout the presentation
- Please be sure to respond to the polls
- You will not be able to view the presenter’s screen until the poll is closed by a webinar organizer

Acknowledgements

EPA appreciates the assistance of today's speakers in developing and presenting today's webinar.

Speakers

Michael J. Finn, P.E.

Michael Finn is an Environmental Engineer with the Environmental Protection Agency's Office of Groundwater and Drinking Water, Drinking Water Protection Branch. He joined EPA in 2001 to work on the development of the Long Term 2 Enhanced Surface Water Treatment Rule, the Stage 2 Disinfection By Products Rule and the Groundwater Rule and the related guidance documents. He is currently working with States and public water systems on the implementation of those rules as well as water availability, water efficiency and energy efficiency in public water systems.

Samuel A.L. Perry, P.E.

Sam Perry is a water treatment engineer with the Washington State Department of Health where he has worked for the past 10 years. Prior to working for the DOH, Sam worked for several years in consulting engineering. Sam earned his Masters in Civil Engineering from the University of Washington and BS in Civil and Environmental Engineering from the University of California, Davis where he graduated with high honors. He has written a number of papers and conference proceedings on water treatment issues and received recognition of his work from AWWA.

Speakers

Vanessa Wike

Vanessa Wike has a BS in Geology from Virginia Tech as well as a BS and MS in Civil Engineering from the University of Alaska. She has worked for the Department of Environmental Conservation for just over 20 years, mostly doing water and wastewater work.

Jennifer Bunton, P.E.

Jennifer Bunton is a senior environmental engineer with the Iowa Department of Natural Resources. She is a licensed professional engineer and has been with the department for more than 15 years. Jennifer has been involved in all aspects of the public drinking water program, including construction permitting, compliance, capacity development, and the Area Wide Optimization Program.

Speakers

Craig Corder, P.E.

Craig Corder has a BS in Civil Engineering and is a registered professional engineer in Arkansas. Craig has been employed at the Arkansas Department of Health and working in the drinking water program since 1988. Craig currently supervises District 1, the Area Wide Optimization Program, and the Cross Connection Control Program.

Disclaimer

Neither the United States Government nor any of its employees, contractors, or their employees make any warranty, expressed or implied, or assumes any legal liability or responsibility for any third parties' use of or the results of such use of any information, apparatus, product, or process discussed in this guidance manual, or represents that its use by such party would not infringe on privately owned rights. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

The examples included in this presentation are intended for discussion purposes only. While EPA has made every effort to ensure the accuracy of the discussion in this presentation, the obligations of the regulated community are determined by statutes, regulations, or other legally binding requirements. In the event of a conflict between the discussion in this presentation and any statute or regulation, this presentation would not be controlling.

Overview

- Introduction-Inactivation Requirements-Chemical Disinfection
  - Michael Finn, OGWDW, U.S. EPA Headquarters
- Introduction-Inactivation with UV
  - Sam Perry, Washington State Department of Health
- Alaska-Status Component Inspection Project
  - Vanessa Wike, Alaska Division of Environmental Health
- Evaluating CT –Iowa's Experience
  - Jennifer Bunton, Iowa Department of Natural Resources
- Arkansas
  - Craig Corder, Arkansas Department of Health
- Questions and Answers

Goals of the Webinar

- Review the regulatory requirements for microbial inactivation, CT for chemical disinfectants and inactivation by UV.
- Discuss review and verification of inactivation calculations as part of oversight activities.
- Present state primacy programs for review and verification of inactivation requirements.

Inactivation Requirements (CFR 141)

- Filtered surface water systems (and GWUDI) must provide :
  - 3 log *Giardia*, 4 log virus and 2 log *Cryptosporidium* treatment through a combination of removal and inactivation.
  - Systems meeting filtration performance requirements are providing up to 2.5 log *Giardia*, 2 log virus and 2 log *Cryptosporidium* removal (conventional plants).
  - Membrane systems- removal credit based on membrane type and demonstration-most do not provide or cannot meet integrity testing requirements for > 2 log virus removal.
- Remaining treatment requirements must be met through inactivation.

Inactivation Requirements

- Unfiltered surface water systems must provide 3 log *Giardia*, 4 log virus and at least 2 log *Cryptosporidium* treatment through inactivation.
- Unfiltered systems must use two disinfectants and must use ozone, chlorine dioxide or UV for *Cryptosporidium* inactivation.
- Ground water systems
  - May be required to provide 4 log virus treatment if fecal contamination (or significant deficiency) is identified.
  - State may allow system to meet 4 log virus treatment through inactivation.

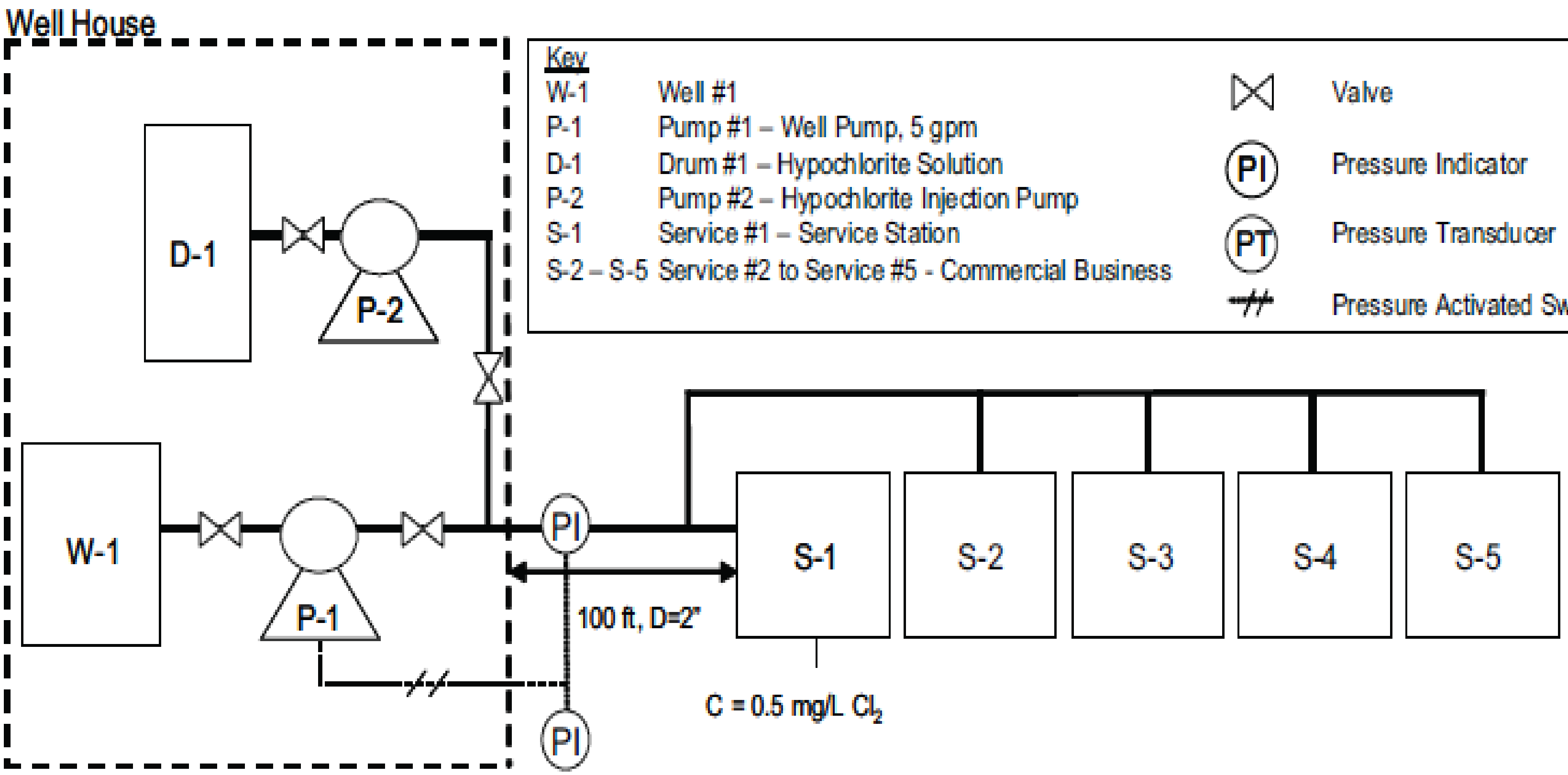
Inactivation Requirements-Chemical Disinfection

- Systems using chemical disinfectants meet their inactivation requirements using the CT concept where
  - C= residual disinfectant concentration (mg/L).
  - T= Contact time-measured from the point of application to the point of residual measurement (minutes).
- CT is determined prior to or at the first customer.
- CT determined is compared to CT tables to determine inactivation requirements were met.
- CT tables for chlorine, chlorine dioxide, chloramine and ozone
  - *Giardia*-CFR 141. 74 and SWTR Guidance Manual
  - Virus- SWTR Guidance Manual and GWR Sanitary Survey Guidance Manual.

CT Example- GW System

Figure E.1 – Redwood Road Water System

Key			
W-1	Well #1	⋈	Valve
P-1	Pump #1 – Well Pump, 5 gpm		
D-1	Drum #1 – Hypochlorite Solution	PI	Pressure Indicator
P-2	Pump #2 – Hypochlorite Injection Pump		
S-1	Service #1 – Service Station	PT	Pressure Transducer
S-2 – S-5	Service #2 to Service #5 - Commercial Business		Pressure Activated Switch



Note: Figures not drawn to scale

CT Example- GW System

- The volume of the pipe in gallons is 2.2 cubic feet X 7.48 gallons/cubic foot=16.4gallons
- The contact T in the pipe is 16.4 gallons ÷ 5gpm=3.3 minutes
- The chlorine residual measured at the service station is 0.5 mg/l
- So the CT provided is 0.5 mg/L X 3.3 minutes=1.6 mg/L-minutes
- The water temperature is measured as 10^{o}C and the last chemical analysis found a pH of 7.5
- From the CT table, the CT required for 4 log virus inactivation for that temperature and pH is 6 mg/L minutes
- So the system is not providing 4 log virus inactivation (ratio of CT required/CT achieved must be 1.0 or more)

Inactivation-CT values

CT Values for a 4 -log Inactivation of Viruses by Free Chlorine [1,2]

	CT for a 4- log Inactivation of Viruses (mg/L-minutes)	
Temperature o C	pH =6-9	pH=10
0.5	12	90
5	8	60
10	6	45
15	4	30
20	3	22
25	2	15

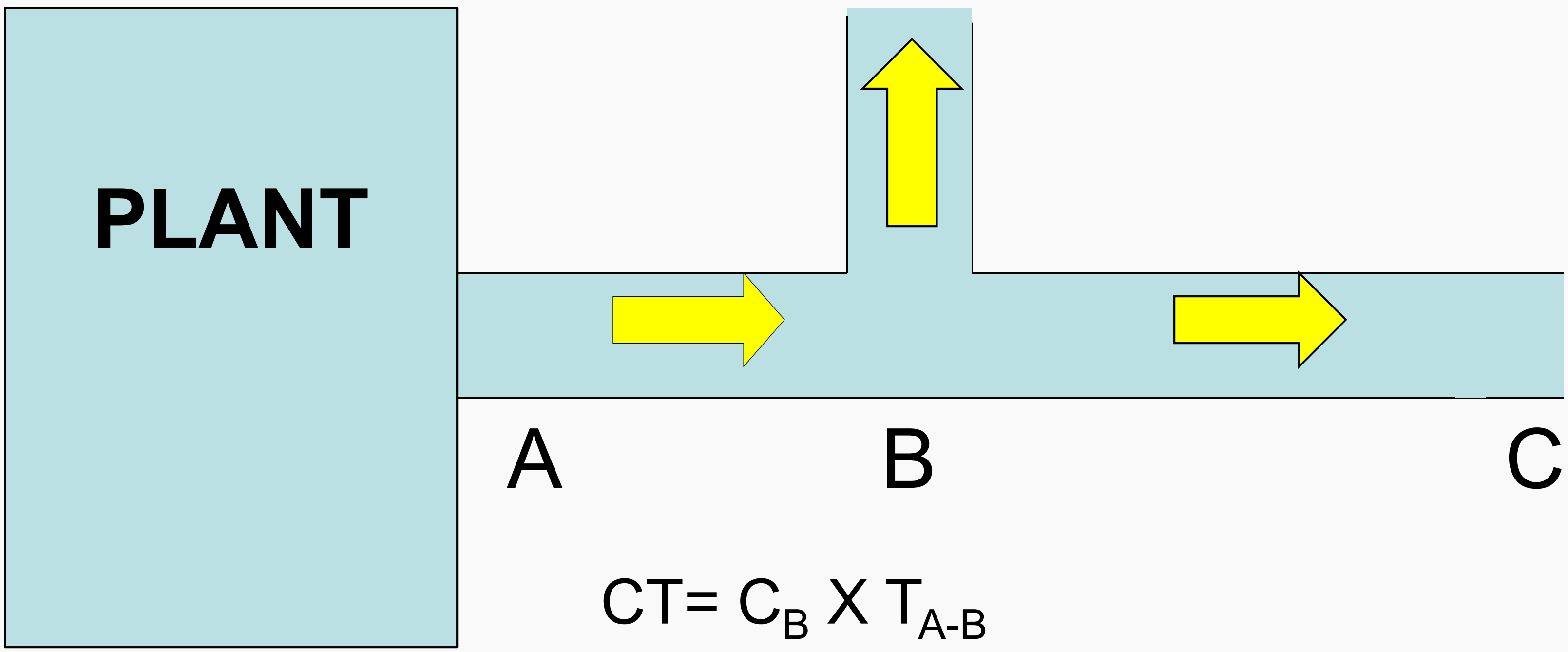
[1] Adapted from Table E-7, Appendix E, Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources,1990.
[2] Basis for values given in Appendix F, Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources, 1990.

Inactivation Requirements-Measuring C and T

- Cannot take inactivation credit at a point if C is not measured at that point.
- Can take credit on a segment or unit process but must measure leaving the process.
- C measured with an approved method (CFR 141.74 (a) (2)),instruments are calibrated/checked, reagents are correct and not outdated.
- T is determined at peak hourly flow leaving the plant or measured across a segment or unit process.

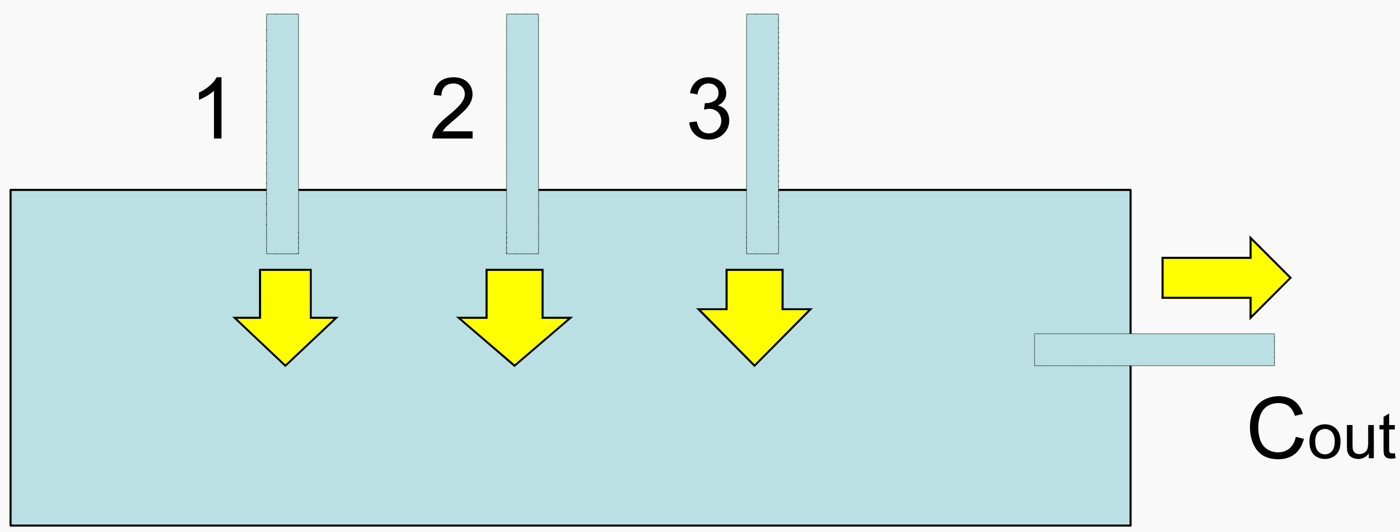
Inactivation Requirements-Measuring C and T

- Except for plug flow (pipe) contact time, T, is less than volume÷flow due to short circuiting/non-uniform flow paths.
- T should be measured (tracer tests) or use a conservative baffling factor, T_{10}/T. (see SWTR or GWR SS guidance).
- Baffling factor is related to the geometry and baffling of the basin or process.
- Conservative approaches for small systems- use lowest available temperature, highest pH to do CT checks, set minimum residual.
- Conservative approaches w/o tracer study or obvious baffling that improves contact time-use a T_{10}/T of 0.1 to verify system meets CT under all conditions.



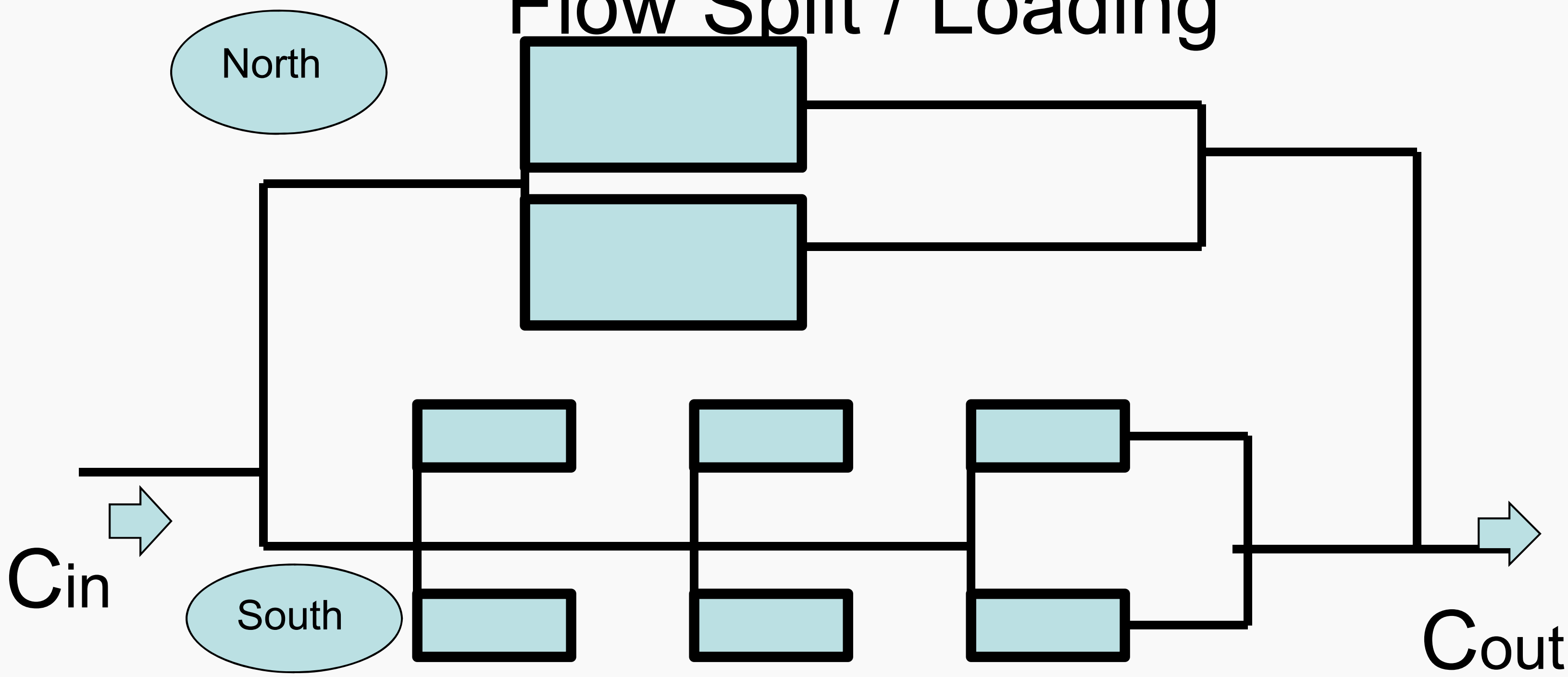
$$CT = C_B \times T_{A\text{-}B}$$

Multiple Inlets or Outlets



T from 1 to C_{out} ≠ T from 3 to C_{out}

Flow Split / Loading



$T_{north} \neq T_{south}$?

Inactivation Requirements-Sanitary Surveys, Plan Review-What Has Changed?

- Points of injection or residual measurement
- Plant flows or hydraulics
- New/modified treatment processes
- Water conditions temperature, pH, raw/influent turbidity
- Water conditions outside the range of CT tables-pH, temperature

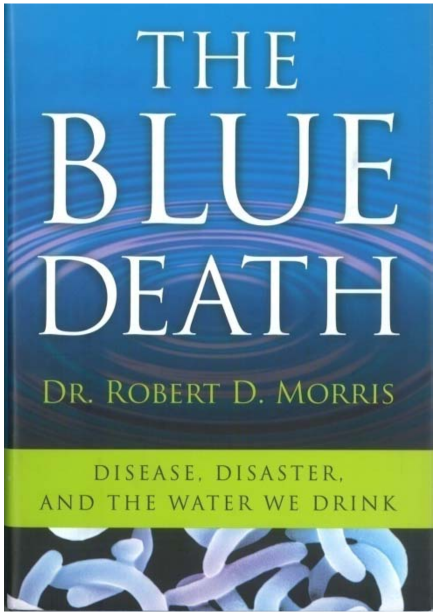
UV Operations and Reporting
A State Perspective

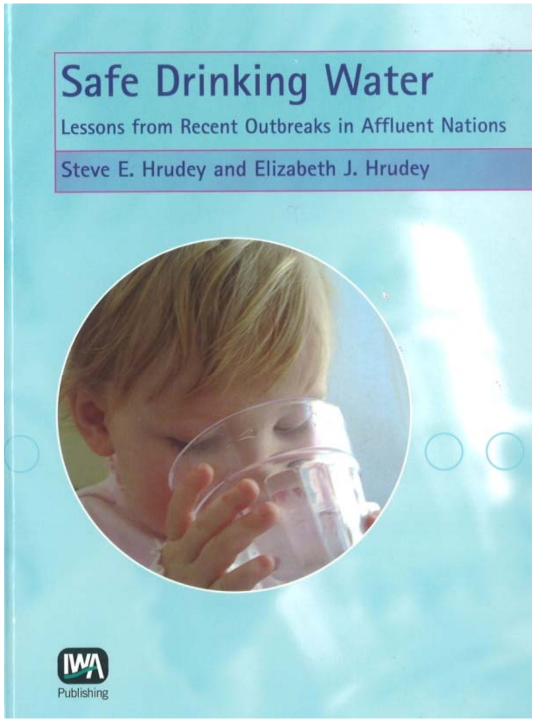
Sam Perry
Water Treatment Engineer

PUBLIC HEALTH
ALWAYS WORKING FOR A SAFER AND
HEALTHIER WASHINGTON

Mission

To protect the *health* of the people of Washington State by ensuring safe and reliable drinking water.

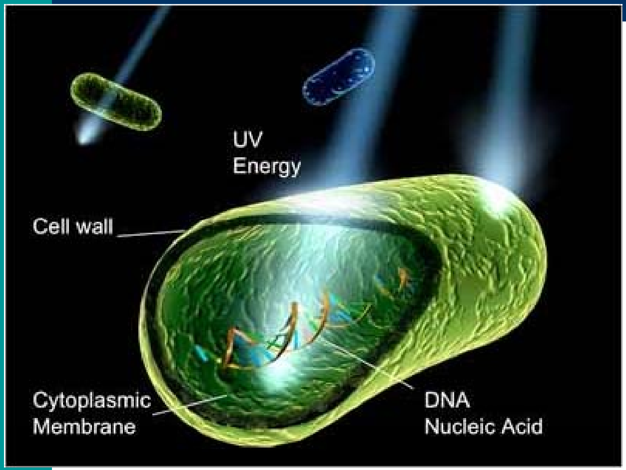




Overview

- UV Disinfection Basics
- UV Control Strategies
- UV Monitoring and Reporting
  - Parameters and Format
  - Examples

UV Disinfection Basics



- Dose = I x T
  - Time – Dependent upon flow, reactor geometry, particle path
  - I – Measured by a sensor; Dependent upon UVT, Lamp Age/Power/Fouling
  - Dose = mW/cm^2 x sec
  - Dose = mJ/cm^2

CONTROL STRATEGIES

Sensor/Intensity Setpoint Approach

- Developed from DVGW W294 and ONORM Standards
- Typically used for smaller reactors <1 mgd; Low pressure lamps
- UV Sensor is key to operational control
- Flow rate, number of lamps & sensor readings set control boundaries

Dose Control Approach

- Integrates flow, sensor reading and UVT into an equation or equations
- Most common approach in the US
- Used for larger reactors >1 mgd

$$RED = 0.148 \times UVA^{-2.519} \times (S/S_o)^{0.166} \times (1/Q)^{0.409}$$

REACTOR MONITORING AND REPORTING

Reactor Monitoring

- LT2ESWTR (40 CFR 141.720(d)(3))
  - Systems must monitor their UV reactors … monitoring must include:
    - UV intensity (as measured by a UV sensor)
    - Flow rate
    - Lamp status
    - And other parameters ….
  - Systems must verify calibration of UV sensors . . .

Monthly Operations Report

- Examples in Chapter 6 of the EPA UV Disinfection Guidance Manual
- Reports vary depending upon reactor type
  - Dose control vs. Setpoint control
- Dose control report includes
  - Monthly summary report for UV disinfection
  - Daily operations report for each reactor
  - Monthly sensor check summary
  - Weekly UVT monitor checks (*Not required for setpoint control*).

Monthly Summary Report

Monthly Summary							
			Off Spec Data *				
Reactor	Total Run Time (hrs)	Total Production (MG)	Off Spec Events (#)	Total Off Spec Volume (MG)	% Total Volume In Spec	Total Off Spec Time (min)	% Total Time In Spec
Train 1							
UV-R1	0	0.0	0	0.0000	100.0000%	0	100.0000%
UV-R2	0	0.0	0	0.0000	100.0000%	0	100.0000%
UV-R3	0	0.0	0	0.0000	100.0000%	0	100.0000%
UV-R4	0	0.0	0	0.0000	100.0000%	0	100.0000%
UV-R5	0	0.0	0	0.0000	100.0000%	0	100.0000%
UV-R6	0	0.0	0	0.0000	100.0000%	0	100.0000%
UV-R7	0	0.0	0	0.0000	100.0000%	0	100.0000%
Train 2							
UV-R8	232	156.3	0	0.0000	100.0000%	0	100.0000%
UV-R9	489	314.6	0	0.0000	100.0000%	0	100.0000%
UV-R10	688	451.2	0	0.0000	100.0000%	0	100.0000%
UV-R11	645	438.1	0	0.0000	100.0000%	0	100.0000%
UV-R12	704	450.9	1	0.0234	99.9990%	2	99.9955%
UV-R13	638	416.4	1	0.0338	99.9985%	3	99.9933%
UV-R14							
Total	3396	2227	2	0.0572		5	

Compliance Certification

Total In Spec Water (% of Total Production Time)**	100.00%	*(Required = 95% Daily, 99% Monthly)*
Total In Spec Water (% of Total Production Volume)	100.00%	
Reactors Operational During Reporting Period		
Total Sensors Requiring Calibration	36	
Total Sensors Calibrated	36	
% Of Requried Sensors Calibrated	100%	
Meets Requirements (>95% of Time Daily) (Y/N)	Yes	
Meets Requirements (>99% of Time Monthly) (Y/N)	Yes	

UV Reactor - Daily Report

Operational Data									Dosage Data at Mininmum UV Dose Per Day										Off Spec Data						UV Dose Adequacy Determination		
			Flow			UV Transmittance							Lamp Sensor Output														
Day	Run Time (hrs)	Total Production (MG)	Min (mgd)	Ave (mgd)	Max (mgd)	Min (%)	Ave (%)	Max (%)	Flow (mgd)	Minimum Calculated RED (Dose) (mJ/cm2)	UVT (%)	Lamp Power (%)	1	2	3	4	5	6	Flow >18.4 (Y/N)	Total Time Flow Off-Spec (min)	UVT <90.0% (Y/N)	Total Time UVT Off-Spec (min)	Lamp Hours >5,000 (Y/N)	Total Time Lamp Hours Off-Spec (min)	MS2 RED < Required Dose (Y/N)	If yes, how many times (# events)	If yes, total time (min)
1	19.0	12.4	13.1	15.8	16.7	95.4	96.1	97.3	15.9	65.4	95.4	60	70	45	54	47	50	58	N		N		N		N		
2	15.0	4.5	15.2	16.2	16.8	95.8	96.1	96.4	16.2	66.1	95.8	60	68	65	53	65	49	57	N		N		N		N		
3	22.0	15.1	14.0	15.9	16.8	95.9	96.2	96.5	16.5	70.0	95.9	60	75	66	56	66	49	61	N		N		N		N		
4	22.0	15.9	13.1	15.9	17.1	95.6	96.1	96.4	16.9	61.9	95.6	60	69	47	52	47	45	57	N		N		N		N		
5	24.0	15.8	15.1	15.8	17.4	95.8	96.2	96.5	16.9	62.8	95.8	60	68	46	51	46	44	57	N		N		N		N		
6	24.0	15.8	13.1	15.8	16.8	95.8	96.2	96.5	16.5	61.0	95.8	60	64	45	48	44	41	54	N		N		N		N		
7	24.0	15.9	15.0	15.9	16.8	95.7	96.1	96.4	16.5	59.5	95.8	60	62	44	46	43	39	52	N		N		N		N		
8	24.0	16.0	13.0	16.0	16.8	95.7	96.0	96.4	16.7	53.4	95.7	60	57	38	42	40	35	48	N		N		N		N		
9	24.0	15.9	12.9	15.9	16.6	95.7	96.1	96.4	16.3	50.4	95.7	60	53	36	39	37	30	44	N		N		N		N		
10	18.0	11.5	14.9	15.8	16.5	95.7	96.0	96.4	16.2	49.7	95.7	60	52	36	38	36	29	43	N		N		N		N		
11	24.0	15.7	12.7	15.9	16.5	94.6	96.1	96.5	15.6	65.1	94.6	60	79	51	60	50	52	65	N		N		N		N		
12	24.0	15.9	13.1	15.9	17.1	94.7	95.8	99.0	16.9	62.9	95.3	60	75	47	57	47	49	62	N		N		N		N		
13	24.0	16.1	13.2	16.1	17.1	94.9	95.8	96.3	17.0	63.1	95.4	60	75	49	56	47	48	61	N		N		N		N		
14	24.0	15.5	12.1	15.5	16.8	94.4	95.8	96.5	15.8	57.8	94.4	60	75	47	55	47	47	60	N		N		N		N		
15	24.0	16.4	12.8	16.4	17.5	95.3	95.8	96.3	17.0	58.6	95.3	60	69	39	51	44	43	57	N		N		N		N		
16	19.0	13.0	8.0	16.2	17.6	94.8	95.8	97.6	16.3	55.2	95.6	60	69	45	50	44	42	55	N		N		N		N		
17	19.0	12.9	12.2	16.1	17.1	95.3	95.8	97.6	16.8	53.7	95.4	60	62	41	45	41	37	50	N		N		N		N		
18	24.0	15.8	13.1	15.8	17.1	95.6	96.0	96.7	16.9	54.6	95.6	60	63	40	45	41	37	50	N		N		N		N		
19	24.0	15.8	13.0	15.8	17.0	95.1	96.0	96.4	16.9	46.6	95.1	60	57	39	40	37	33	46	N		N		N		N		
20	24.0	14.8	11.8	14.8	16.0	95.3	95.9	96.5	16.0	49.6	95.3	60	56	39	39	36	32	45	N		N		N		N		
21	24.0	14.3	12.1	14.3	15.5	95.6	96.1	96.4	15.4	51.9	95.6	60	53	39	37	35	31	43	N		N		N		N		
22	15.0	8.7	12.7	14.9	15.5	95.8	96.1	96.3	15.2	53.6	95.9	60	52	38	36	34	30	42	N		N		N		N		
23	24.0	15.4	14.0	15.4	17.2	95.4	96.0	96.3	17.1	63.6	95.4	60	74	47	57	49	49	63	N		N		N		N		
24	18.0	13.0	11.2	16.4	17.2	95.5	96.0	97.8	16.6	66.4	95.5	60	74	47	57	49	49	63	N		N		N		N		
25	20.0	13.1	12.6	16.6	17.3	95.1	95.8	97.7	17.2	59.8	95.1	60	72	46	56	48	48	61	N		N		N		N		
26	24.0	16.1	13.2	16.1	16.8	95.8	96.1	96.5	16.6	70.0	95.8	60	75	48	57	49	49	62	N		N		N		N		
27	24.0	16.1	13.2	16.1	16.8	95.8	96.1	96.5	16.6	67.8	95.8	60	73	47	55	47	47	61	N		N		N		N		
28	24.0	16.4	13.7	16.4	16.9	95.8	96.1	96.4	16.6	66.7	95.8	60	72	43	55	47	47	60	N		N		N		N		
29	24.0	16.1	15.4	16.1	16.8	94.1	96.3	96.7	16.1	53.1	94.1	60	72	45	55	46	46	57	N		N		N		N		
30	24.0	16.2	11.1	16.2	17.2	95.9	96.4	96.7	17.0	63.1	95.9	60	70	47	53	45	43	54	N		N		N		N		
31	21.0	14.9	13.4	16.4	17.1	95.3	96.3	97.9	16.7	60.1	95.3	60	71	46	54	46	44	56	N		N		N		N		
Min	15	5	8.0	14.3	15.5	94.1	95.8	96.3	15.2	46.6	94.1	60	52	36	36	34	29	42		0		0		0		0	0
Max	24	16	15.4	16.6	17.6	95.9	96.4	99.0	17.2	70.0	95.9	60	79	66	60	66	52	65		0		0		0		0	0
Total	688	451.2																		0		0		0		0	0

Sensor Checks

Washington Department of Health
UV Treatment Monthly Sensor Report

Washington State Department of Health

Water System Name: **Cedar Treatment Facility**
County: **King**
Water System ID#: **77050Y** Source #: **S-01**
Source Name: **Cedar**
Month/Year: **Feb-10**

Report Submitted by: Jim West
WTPO Certificate #: 10553
Telephone #: 425 255 7238
Signature: Jim West

Reactor UV-R1

Reactor #

Sensor	Serial Number		Sensor Readings		% Difference	Lamp Hours	Date
	Operational	Reference	Operational	Reference			
1	110204894012	170303916006	14.63	12.90	13.4	3681	2/25/2010
2	290503560002	170303916006	12.41	10.70	16.0	1297	2/25/2010
3	020503902001	170303916006	13.14	12.40	6.0	3681	2/25/2010
4	190603897008	170303916006	12.28	11.14	10.2	3681	2/25/2010
5	110204894012	170303916006	14.74	12.94	13.9	193	2/25/2010
6	190603897008	170303916006	13.46	12.44	8.2	3681	2/25/2010

Reactor UV-R2

Sensors/Reactor

Sensor	Serial Number		Sensor Readings		% Difference	Lamp Hours	Date
	Operational	Reference	Operational	Reference			
1	190603897006	170303916006	15.11	13.64	10.8	3188	2/25/2010
2	050603203005	170303916006	11.43	10.62	7.6	3188	2/25/2010
3	020503902005	170303916006	13.44	12.74	5.5	505	2/25/2010
4	190603897004	170303916006	11.96	11.70	2.2	3187	2/25/2010
5	190603897006	170303916006	13.07	11.69	[illegible]	2118	2/25/2010
6	190603897007	170303916006	15.79	13.58	16.3	505	2/25/2010

Reactor UV-R3

Sensor	Serial Number		Sensor Readings		% Difference	Lamp Hours	Date
	Operational	Reference	Operational	Reference			
1	19060396300[illegible]	170303916006	15.79	13.84	14.1	3163	2/25/2010
2	290503504003	170303916006	13.02	11.19	16.4	15	2/25/2010
3	290503504004	170303916006	13.34	12.26	8.8	3163	2/25/2010
4	190603963011	170303916006	9.77	9.75	0.2	3163	2/25/2010
5	19060396300[illegible]	170303916006	13.92	12.20	14.1	727	2/25/2010
6	1906039630[illegible]1	170303916006	13.58	12.90	5.3	3163	2/25/2010

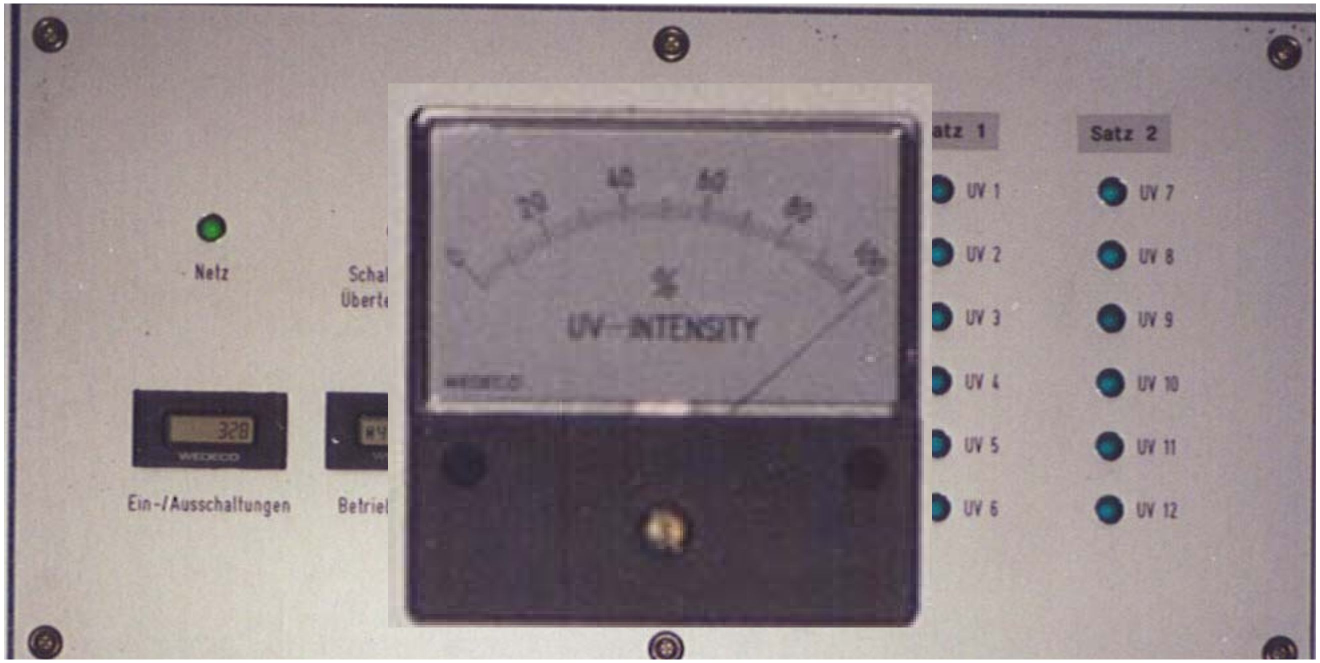
Reactor UV-R4

Difference (%)
10.4 to 16.0

Sensor	Serial Number		Sensor Readings		% Difference	Lamp Hours	Date
	Operational	Reference	Operational	Reference			
1	190603963002	170303916006	13.58	1[illegible].03	12.9	885	2/25/2010
2	290503560001	170303916006	11.57	1[illegible].48	10.4	3512	2/25/2010
3	290503504002	170303916006	12.49	1[illegible].77	16.0	885	2/25/2010
4	190603963004	170303916006	12.39	1[illegible]13	11.3	885	2/25/2010
5	190603963002	170303916006	8.00	7.[illegible]5	13.5	885	2/25/2010
6	190603963004	170303916006	15.11	13.4[illegible]	12.4	885	2/25/2010

February 2010 DOH Report .xls, Sensor Report

UV Sensors – Reality



For more examples read: Wright et al. (2010) Design and Performance Guidelines for UV Sensor Systems. Water Research Foundation

| UVTon-line(%) - UVTbench(%) | ≤ 2% UVT

On-Line Reading (%) [A]	Grab Sample Result (%) [B]	Difference (%) (| [A] - [B] |)
96.6	98.3	1.8%
96.4	97.3	0.9%
96.0	97.4	1.5%
96.3	98.2	1.9%
96.6	96.6	0.0%

	5.0			
	6.0			

UVT Monitoring – Reality

Operational Safety Factor

- See Section 3.4.2 of the UVDGM
- Recommends increasing applied dose by 10-20 percent above that required
- Reality may warrant a larger operational safety factor

Uncertainty of Operations

- Sources of Error
  - Flow (U_Q) – Usually within 5% (5.5.1)
  - UV Absorbance (U_{UVA}) – UVT can vary by 2% (See UVDGM 6.4.1.2).
  - Sensor (U_S) – ($S_{duty}/S_{ref} \leq 1.20$)

$$U_{op} = \sqrt{U_Q^2 + U_{UVA}^2 + U_S^2}$$

Changed Site Conditions

- Changes to the physical system – Hydraulics, upstream treatment, lamps, and sensors.
- Changes to the source water – New source, changes in watershed, algae growth, and iron from lake turnover.
- Reactor Start-up – Warm-up in place, flow-to-waste, or recycle loop.

Resources for State Staff

- ASDWA Treatment Forums –
  - Contact Anthony Derosa - aderosa@asdwa.org
- AWWA Standard F110 – UV Disinfection Systems for Drinking Water (2012)
- EPA UV Disinfection Guidance Manual (2006) – Chapter 6 (Monitoring & Reporting)
- Other States
  - AK, CA, IA, NC, NY, TX, UT and Others
- UV Professionals
- Water Research Foundation Reports
- WSDOH Water System Design Manual – Appendix I

For More Information

- Sam Perry

  (253) 395-6755

  sam.perry@doh.wa.gov

Questions?

Next Speaker

PUBLIC HEALTH
ALWAYS WORKING FOR A SAFER AND
HEALTHIER WASHINGTON

STATE OF ALASKA
Department of
Environmental Conservation

Vanessa Wike, P.E.

Statewide Engineering Coordinator
Drinking Water Program
Division of Environmental Health

555 CORDOVA STREET
ANCHORAGE, ALASKA 99501

PHONE: (907) 269-7696
Email: vanessa.wike@alaska.gov

Status Component Inspection Project

Goal: To inspect the inactivation and filtration components of SWT systems and assign treatment credits in accordance with SWTR/LT1/LT2.

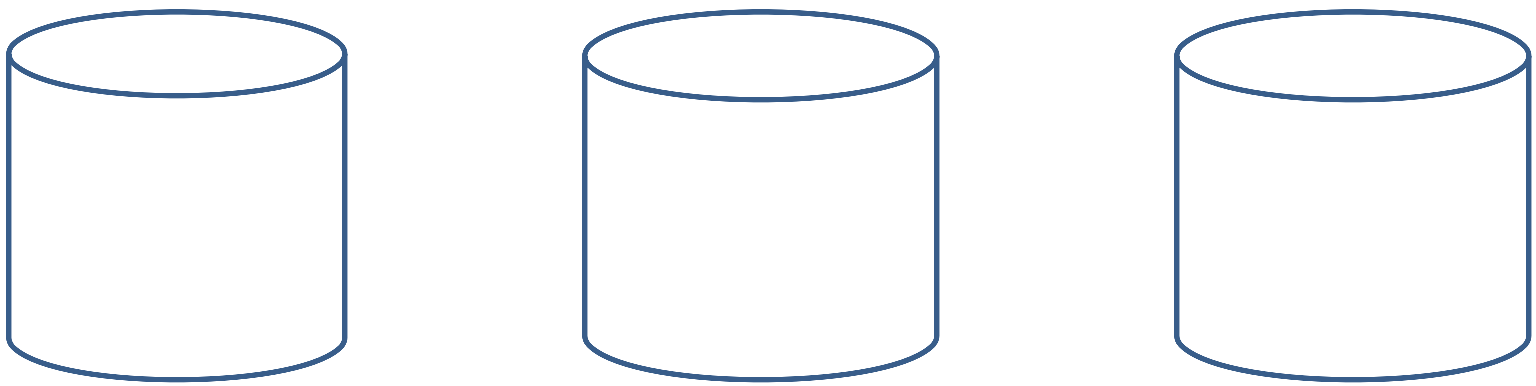
- Inspections began in 2010.
- Forms and processes were developed and re-developed and re-developed.
- Approximately 170 federal recognized public water systems treating for surface water.
- Approximately 133 systems have been inspected.

Storage & Disinfection Tanks for CT

Tank # or Name ___________
Volume _______________gal
Height _________________ ft
Diameter _______________ ft
Minimum Level __________ft
Baffle Factor ______________
Assigned by?______________
Max hourly flow____________
Water Type? Raw___________
Filtered _______Potable _____

Tank # or Name ___________
Volume _______________gal
Height _________________ ft
Diameter _______________ ft
Minimum Level __________ft
Baffle Factor ______________
Assigned by?______________
Max hourly flow____________
Water Type? Raw___________
Filtered _______Potable _____

Tank # or Name ___________
Volume _______________gal
Height _________________ ft
Diameter _______________ ft
Minimum Level __________ft
Baffle Factor ______________
Assigned by?______________
Max hourly flow____________
Water Type? Raw___________
Filtered _______Potable _____



On the above schematic please indicate the location of the following:

- Piping between tanks
- Piping within tanks
- Indicate if used for:
  CT or storage only
- Overflow level
- Baffle configuration
- Inlet
- Outlet
- Internal walls
- Sample Taps

Plug Flow: Length__________ Diam __________
Volume ________________ gal

Comments____
____
____
____

PWS Name/ID ____________________________________

State of Alaska Department of Environmental Conservation

Drinking Water Program

PUBLIC WATER SYSTEM
TREATMENT STATUS SUMMARY

SYSTEM INFORMATION: Alakanuk WS (270362), Alakanuk, AK
Inspection Date: March 15, 2011

Population Served Community / NonTransient Non Community / Transient	**570 / 0 / 0**
Filtration Type	**Conventional**
Max Filtration Flow Rate (gpm)	**75**
Filter Operation	**Continuous**
Number of Filters in Service	**2**
Filter to Waste	**Yes**
Inactivation Type	**Chlorine**
Peak Hourly Flow (gpm)	**114**
***Total CT Water Storage (gal)**	**63000**
***CT Baffle Factor**	**0.1**
***Total Inactivation (CT) Ratio at Visit (actual minutes /required minutes, should be greater than 1.0 for adequate inactivation)** 4.6 (C), 7.63 (pH), 0.32 (mg/l),	**1.4468085106**
* CT calculations apply to systems using chlorine or ozone for disinfection of *Giardia* or viruses.	
Master Meter Date Verified	**March 15, 2011**

Comments

System was not treating water during visit, due to frozen raw water line. Improvements need to be made to the safety controls for Fluoride injection system.

Disinfection requirements are: Minimum storage tank volume= 105,000 gal, minimum temperature= 5°C, minimum free chlorine residual= 0.3 mg/L, maximum pH= 7.5, peak hourly flow= 114 gpm

TREATMENT CREDITS

Filtration Credit – *Giardia*	**2.5 log**	*minimum 2 log required for filtration only*
Filtration Credit – *Cryptosporidium*	**2.5 log**	*minimum 2 log required for filtration only*
Total Inactivation Credit – Virus	**4 log**	*minimum 2 log required*
Total Inactivation Credit – *Giardia*	**0.5 log**	*minimum 0.5 log required for inactivation only*

State of Alaska Department of Environmental Conservation
Drinking Water Program

PUBLIC WATER SYSTEM
TREATMENT STATUS SUMMARY

SYSTEM INFORMATION: Kotlik WS (272004), Kotlik, AK
Inspection Date: March 16, 2011

Population Served Community / NonTransient Non Community / Transient	591 / 0 / 0
Filtration Type	Conventional
Max Filtration Flow Rate (gpm)	50
Filter Operation	Continuous
Number of Filters in Service	2
Filter to Waste	Yes
Inactivation Type	Chlorine
Peak Hourly Flow (gpm)	55
***Total CT Water Storage (gal)**	62000
***CT Baffle Factor**	0.1
***Total Inactivation (CT) Ratio at Visit (actual minutes /required minutes, should be greater than 1.0 for adequate inactivation)** 11 (C), 7 (pH), 0.15 (mg/l),	1.12
* CT calculations apply to systems using chlorine or ozone for disinfection of *Giardia* or viruses.	
Master Meter Date Verified	March 16, 2011

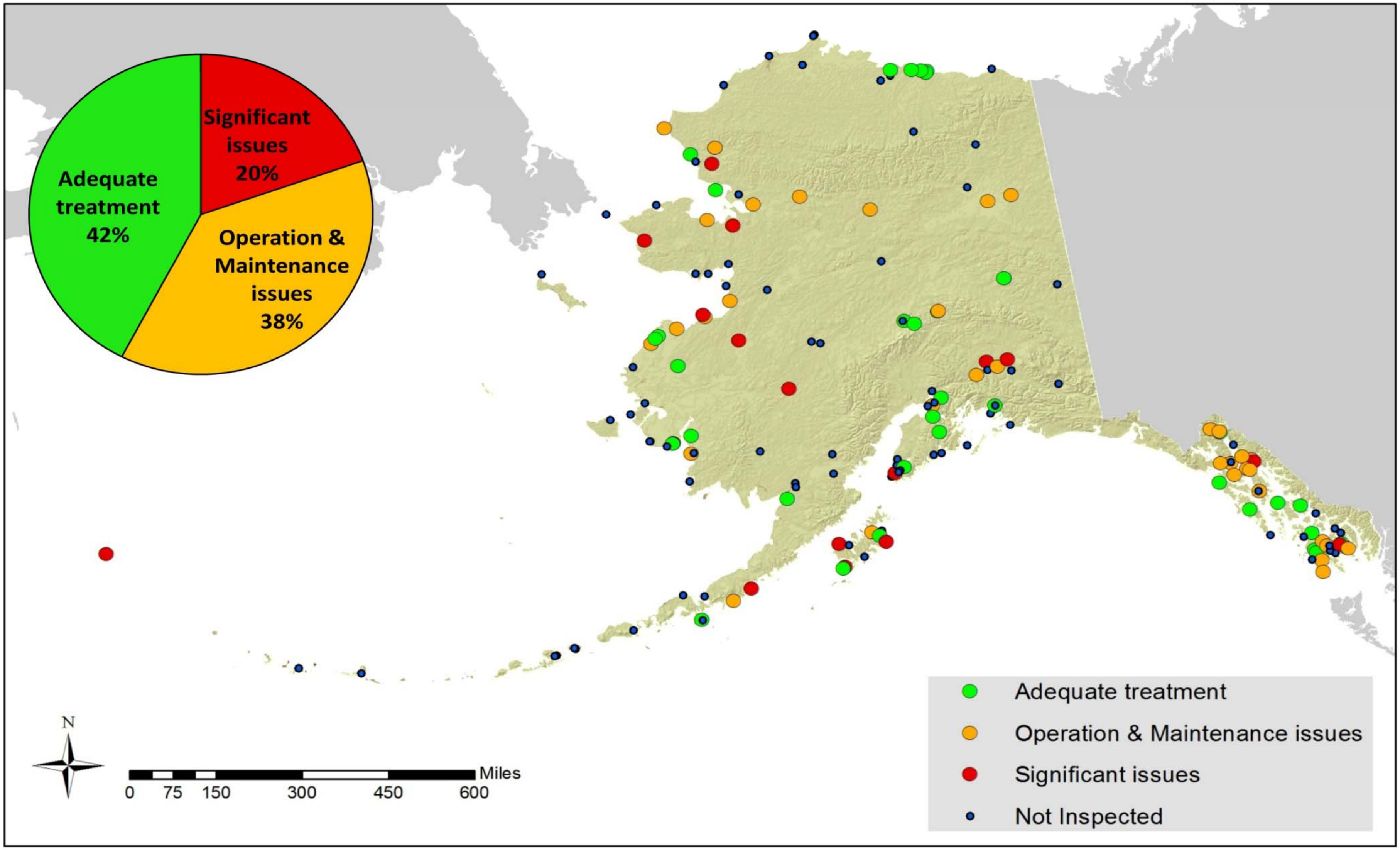
Comments

Disinfection requirements are: Minimum storage tank volume= 45,000 gal, minimum temperature= 10°C, minimum free chlorine residual= 0.2 mg/L, maximum pH= 7.0, peak hourly flow= 55 gpm

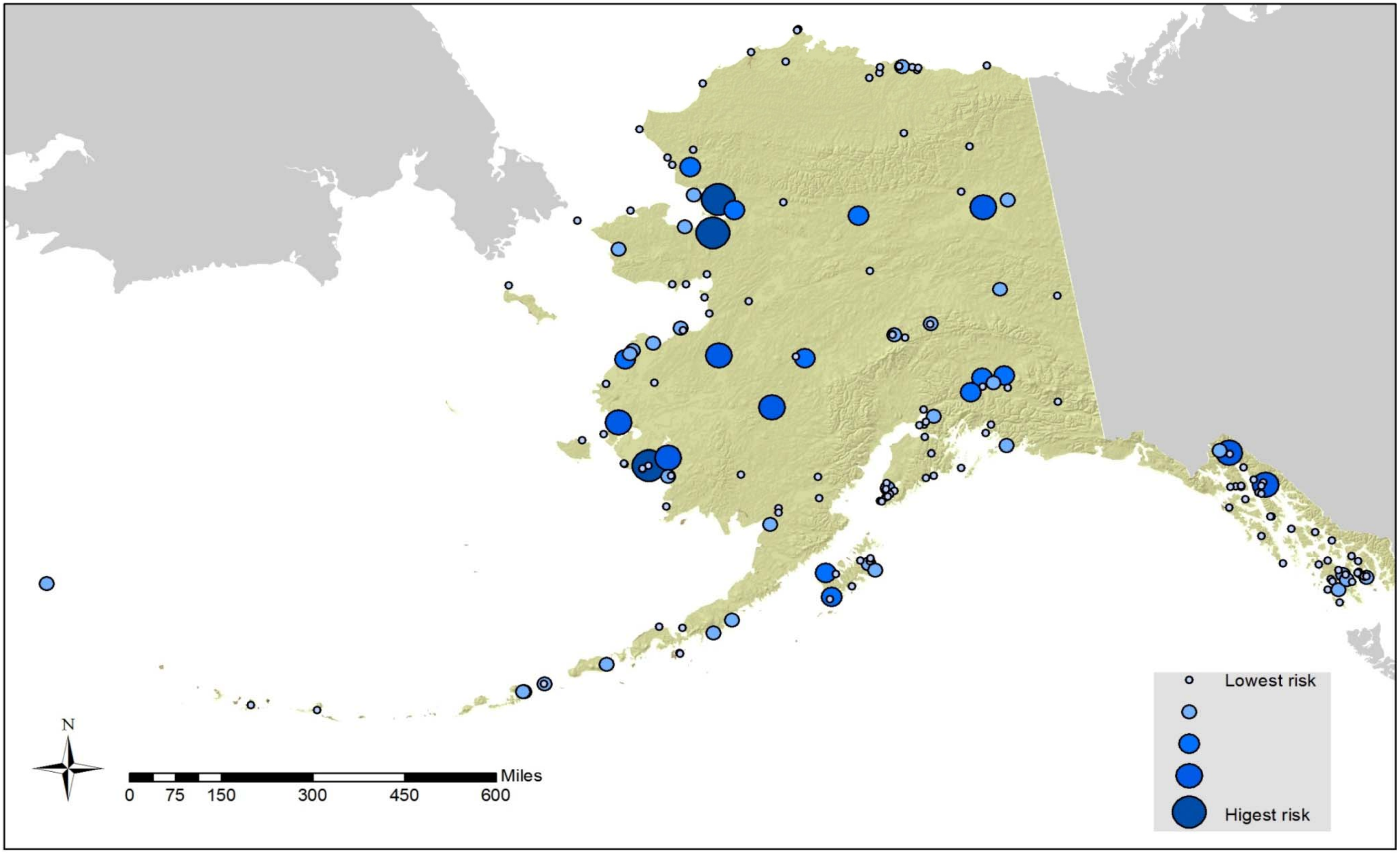
TREATMENT CREDITS

Filtration Credit – *Giardia*	**2.5 log**	*minimum 2 log required for filtration only*
Filtration Credit – *Cryptosporidium*	**2.5 log**	*minimum 2 log required for filtration only*
Total Inactivation Credit – Virus	**4 log**	*minimum 2 log required*
Total Inactivation Credit – *Giardia*	**0.5 log**	*minimum 0.5 log required for inactivation only*

Status Component Inspection Project



Status Component Inspection Project



Status Component Inspection Project

Chlorine Inactivation Findings

(in order of significance)

- **Chlorine sampling locations** not adequate.
  - Inadequate chlorine sampling point(s).
    - Injection point chlorine = chlorine residual for CT.
- **Design flows** for contact time (peak hourly) difficult to confirm/measure/calculate.
- **Baffle factor** was based on design assumptions. Some baffles have deteriorated with time. Tank inspections don't match record drawings.
- **Chlorine feed rate** remains constant. Raw water characteristics not compensated for in chlorine use.
- **Chlorine sampling** logs exhibit amazing consistency.

STATE OF ALASKA
Department of
Environmental Conservation

Vanessa Wike, P.E.

Statewide Engineering Coordinator
Drinking Water Program
Division of Environmental Health

555 CORDOVA STREET
ANCHORAGE, ALASKA 99501

PHONE: (907) 269-7696
Email: vanessa.wike@alaska.gov

Evaluating CT: Iowa’s Experience

Jennifer Bunton, P.E.

Iowa Department of Natural Resources

How Do We Evaluate CT in Iowa?

- Most CT evaluations performed in the 1990s
  - Evaluations approved by IDNR engineers or EPA R7
  - Approval letters tailored to CT study-specifics, such as clear well low water levels, pH, high service pump ratings, minimum chlorine residual, etc. All approvals not created equal!
  - As new plants/clear wells come online, we should be receiving CT studies

How Do We Evaluate CT in Iowa?

- Plant operators report minimum chlorine residual and CT ratio at the end of each month
  - This assumes that
    - All assumptions used in the original CT study are still correct,
    - The operator knows what these are, and
    - The IDNR field staff conducting sanitary surveys every three years are verifying that assumptions are still correct and the operator knows how to calculate CT

Sounds Great… What's the Problem?

- During CPEs, we started noticing that CT was frequently not being calculated correctly
  - Lime softening plants with pH 9.5-9.8 leaving the plant, using CT tables that only go to pH of 9
  - Plants using initial chlorine residual instead of the residual leaving the clear well to calculate CT (no sampling tap after clear well prior to first customer)
  - Plants using highest residual of the day to calculate CT, instead of the lowest residual
  - Plants with CT studies for chlorine dioxide have switched to chlorine years ago, haven't notified IDNR or modified CT equation
  - Over time, disinfectant monitoring points have changed, but the operator hasn't notified IDNR or re-evaluated the CT equation to account for it

Sounds Great… What's the Problem?

- Also, difficult to locate the original CT approval letters in our files
  - Many paper files have disappeared over time, or been microfiched and located elsewhere
- As new plants and basins have come online, IDNR has not done a good job of ensuring new CT studies are conducted
- Some operators know the original CT parameters and assumptions…
- Some just assume that the equation in the spreadsheet is correct because it was there when they arrived
- Some field inspectors have a good handle on CT and know what to ask the operator about, while some don't

What Did We Decide to Do About It?

- In 2009, made a plan to visit each SW system (33 total) to verify that original CT assumptions still held true and that CT calculation was correct
- Any plants/basins without approved CT studies would be required to conduct and submit CT evaluations for approval
- Develop a CT template that could be used to record the assumptions for each system so that field staff could evaluate for changes during sanitary surveys and verify the calculation was being performed correctly

What Did We Decide to Do About It?

- Include the template with the operating permit so that the state and the operator would always have an updated copy of the CT parameters
- Obtain copies of old CT studies and approval letters and store them electronically with any updates in a central location that can be accessed by field and central office staff

What Has Happened to Date?

- A team visited four systems to evaluate CT and learned that:
  - It took a considerable amount of time to locate the old CT documents and read them to prepare for the visit
  - One of the four still met original assumptions and was calculating correctly
- We included a presentation on CT at a workshop and got a positive response (and found out another system was not calculating correctly)

What Has Happened to Date?

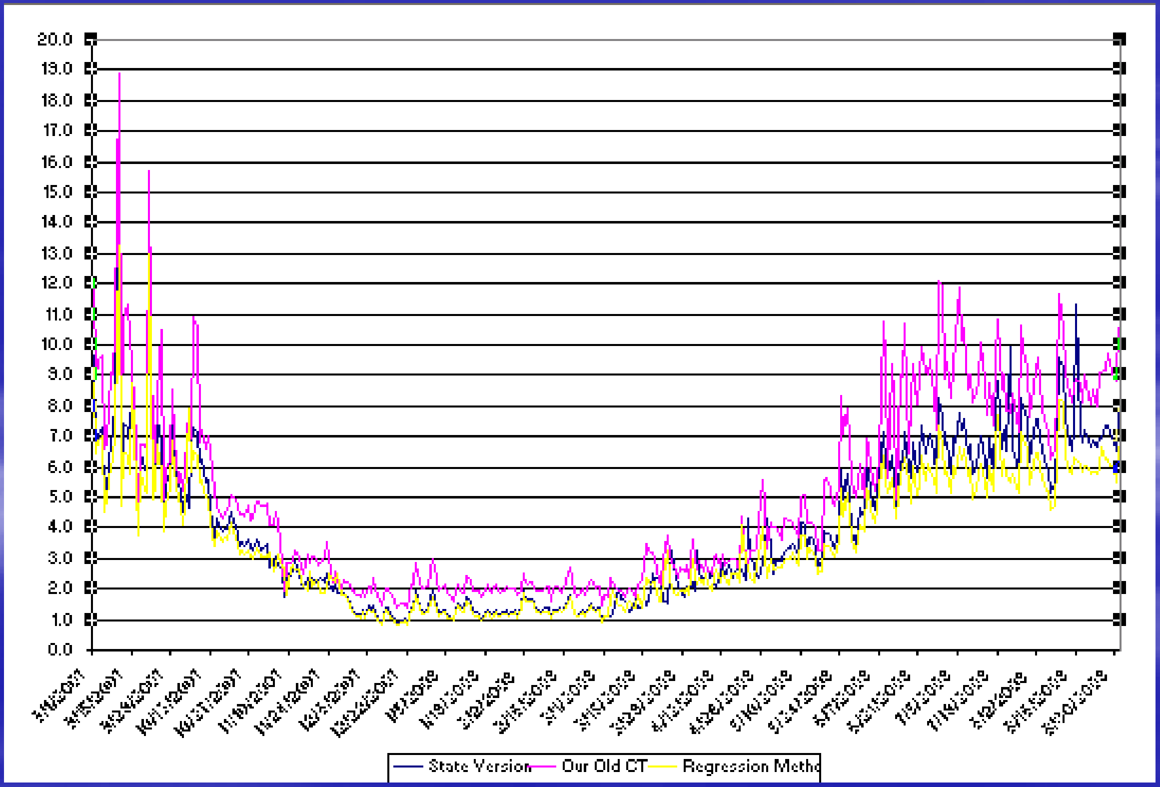
- Due to staff cutbacks, it has not been possible to continue CT evaluation visits, so we know there are still problems
- IDNR optimization program staff attended workshop on conducting tracer studies
- Staff initiated development of the template to record specific CT parameters for each system

What Do We Hope to Do Next?

- Considering hiring a contractor to
  - Conduct tracer studies at plants that need them,
  - Evaluate CT at plants with approved studies to ensure assumptions are still valid and calculation is being performed correctly
  - Provide IDNR with CT parameters so these can be recorded with the operating permit and verified during sanitary surveys on a periodic basis
- Transfer all CT studies and approvals to electronic format and store in a central location for easy viewing and updating
- Continue to educate field and central office staff so that they can assist operators in ensuring that CT is calculated correctly and disinfection barrier is maintained

Questions?

- jennifer.bunton@dnr.iowa.gov
- 515/725-0298



ARKANSAS

Craig Corder, P.E.
Engineer Supervisor
Arkansas Dept. of Health

Arkansas PWS Information

- ~ 1,091 Public Water Systems
- ~ 98 Surface Source Systems
- ~ 327 Surface Purchase Systems
- ~ 563 Ground Source Systems
- ~ 103 Ground Purchase Systems

- ~ 141 WTP's with CT Requirements

- ~ 80 Community Surface WTP's
- ~ 25 Non – Community Surface WTP's
- ~ 36 Groundwater WTP's using CT for GWR Compliance

Arkansas - Historical

- When CT first required for surface water treatment plants, most plants assigned worst case conditions. (chorine is good and more chlorine is better)
- A few plants were assigned seasonal criteria or daily calculations generally due to lack of contact time.
- + Easy to implement
- + Easy for operators
- - Generally higher than needed for CT chlorine residual - problem when DBP requirements come in effect.
- - Operators have poor understand of CT calculations.

Arkansas - Historical

- Where to get the "T" in CT?
- Anywhere after chlorine is added and prior to first customer other than treatment plant.
  - Raw water transmission mains
  - flocculation basins
  - sedimentation basins
  - filters
  - clearwells or storage tanks
  - piping or transmission mains
- Must sample "CT" parameters at end of volume used

Arkansas - Current

- Some plants still using worst case conditions, but due to DBP issues,
  - Many plants now using seasonal conditions (warm water – cold water) or doing daily calculations.
  - Few plants are doing pre-chlorination, most have moved chlorine fed to after sedimentation or after filtration
  - Some plants have split chlorine feeds, a little pre-filter chlorine and a lot post-filter.
  - Many plants have built clearwells or baffled existing clearwells to get more "CT" time.

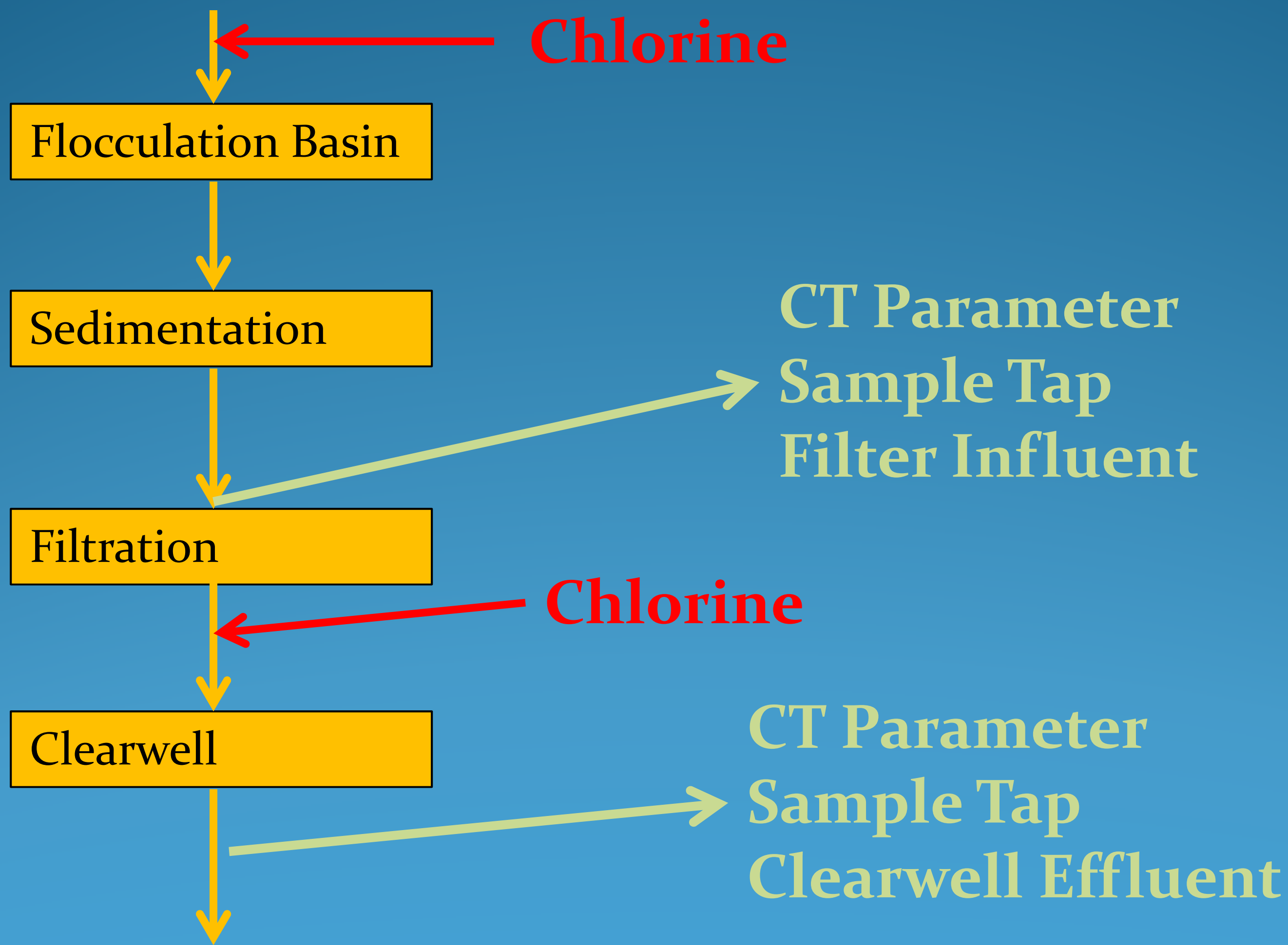
Arkansas - Issues

- Conflicting regulations: CT versus DBP versus TCR
- Poor operator understanding of CT - may change chlorine feed point or CT monitoring point without consideration of CT
- Some plants need capital improvements $$$
- CT Monitoring and Reporting Issues – CT not correctly monitored or reported.
- ADH staff turnover – quality of sanitary surveys, plan review, inspections, technical assistance.

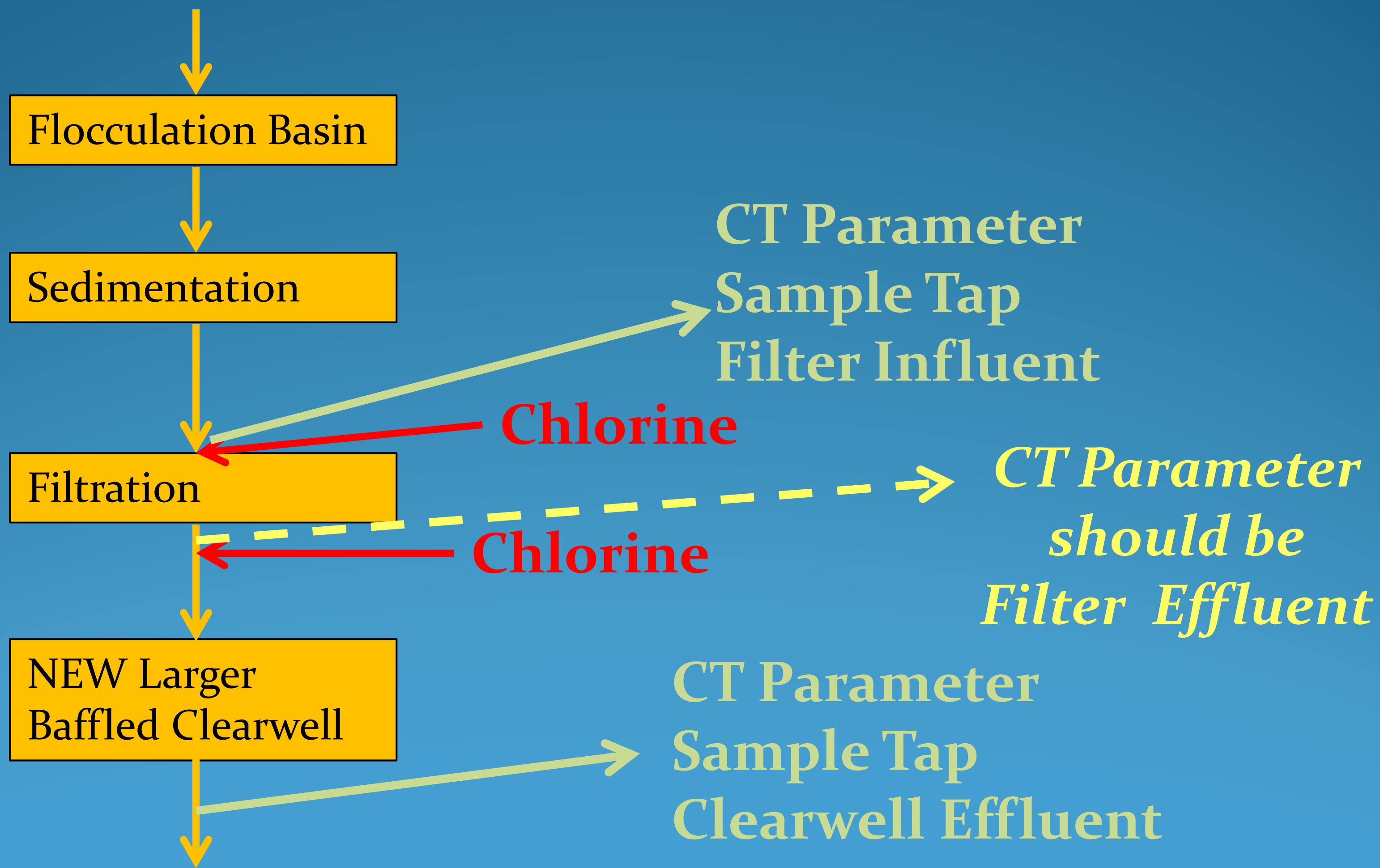
Arkansas – Surveys and ?

- Sanitary survey of surface plants conducted every 2 years
- SWTR evaluation of surface plants suppose to be done every 4 years
- Disinfection Profiles have been done on most surface plants
- Technical Assistance by ADH
- Comprehensive Performance Evaluations
- Data Audits

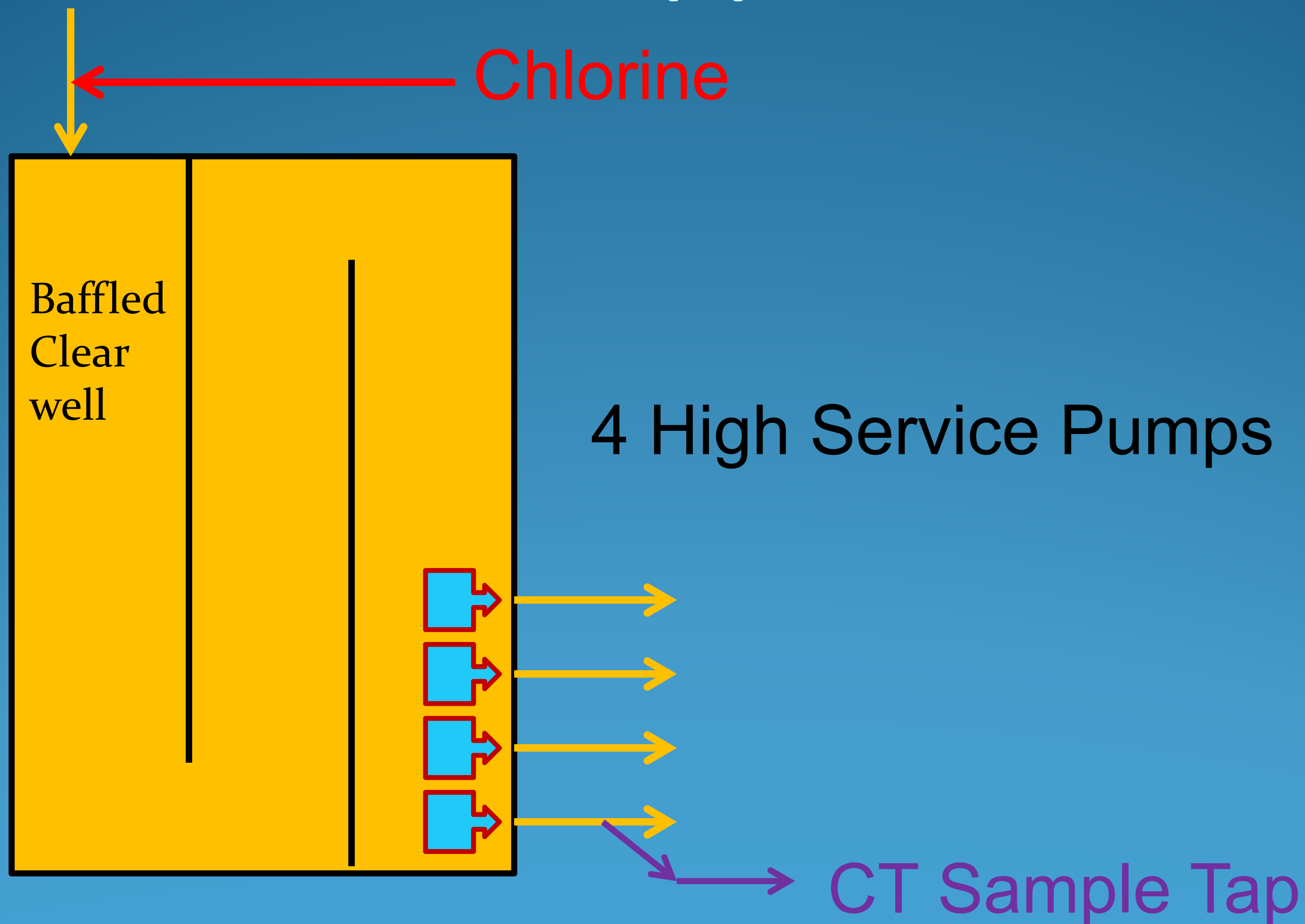
Pre DBP plant



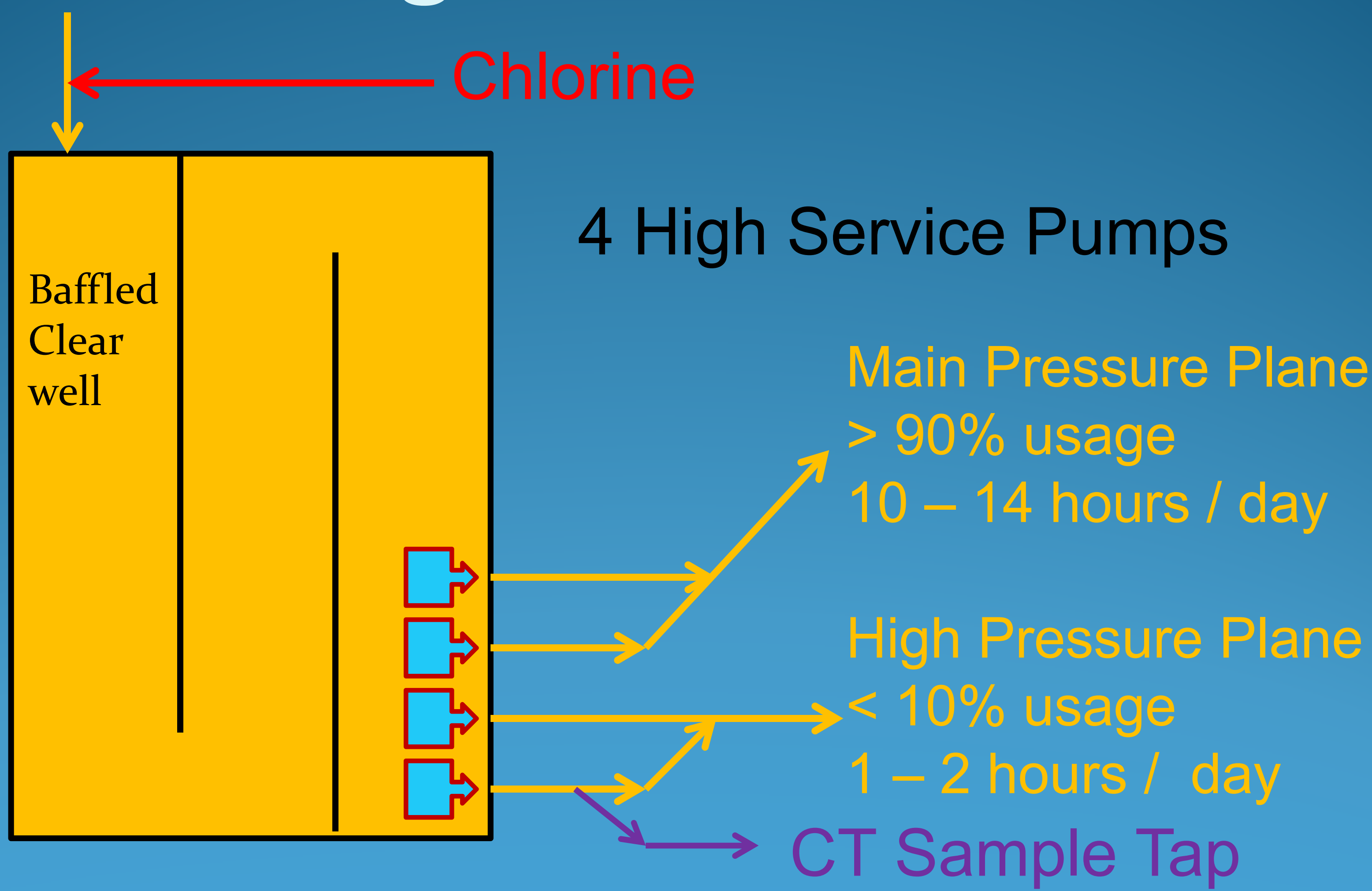
Post DBP plant



Plan Review - Approved



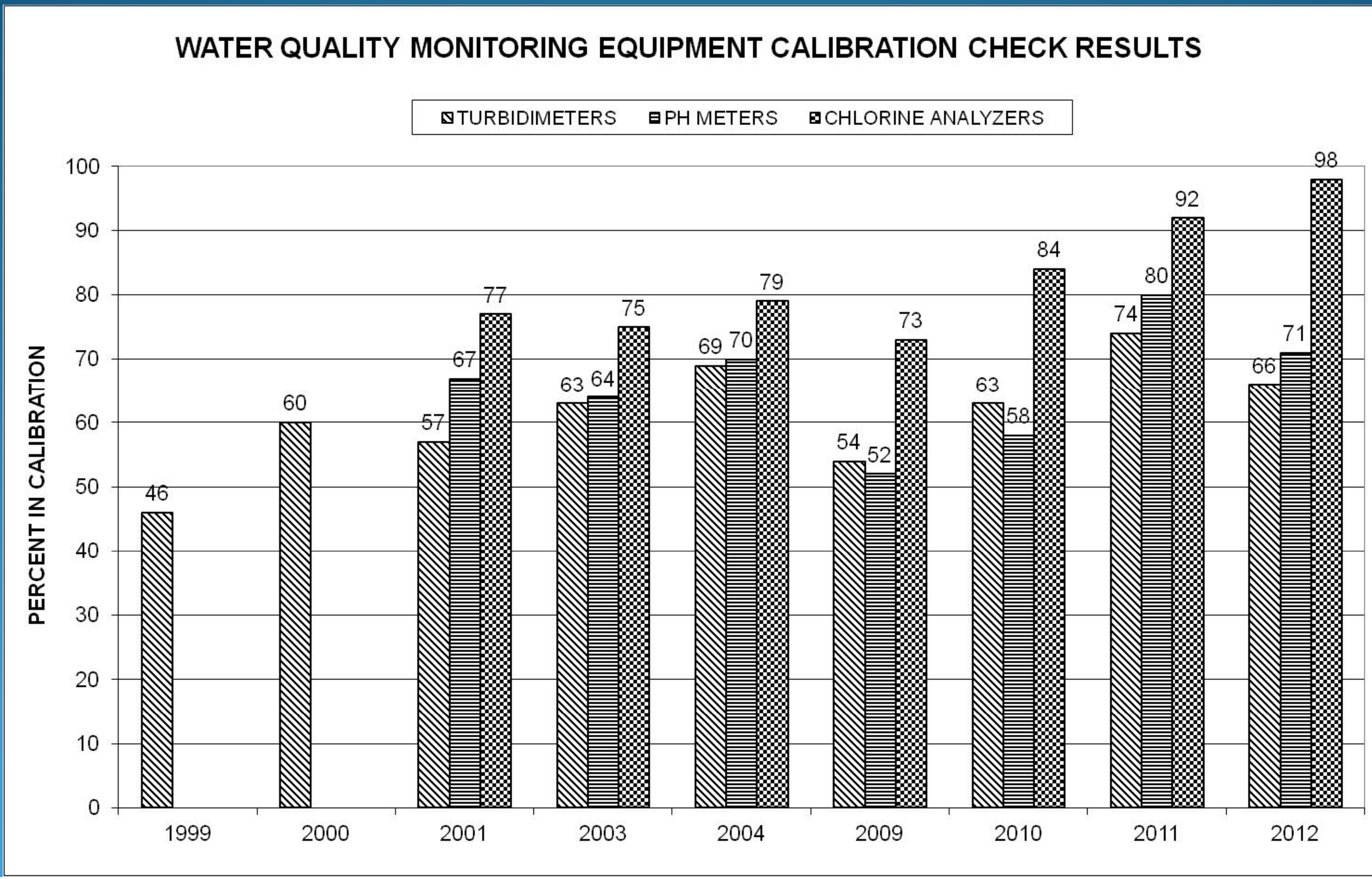
CPE Findings – CT not accurate



Equipment Calibration Checks

- Started doing CPE's in 1997, started finding problems with turbidimeter calibration
- Used summer intern to go to SWTP's and check calibration some years
- Taught series of classes on Turbidimeter calibration
- District Staff suppose to follow up on equipment significantly out of calibration

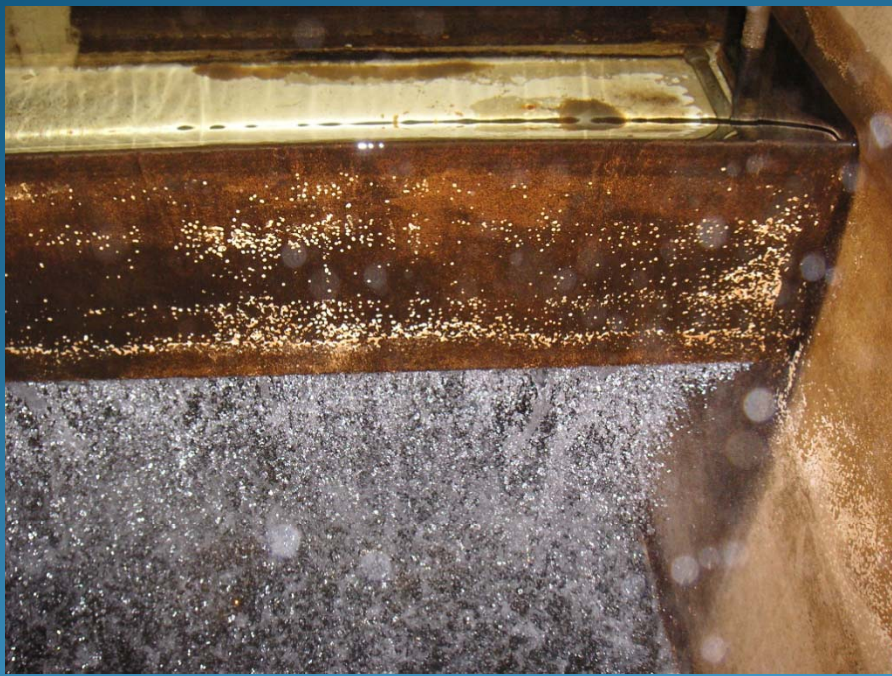
Equipment Calibration Checks



Data Audits

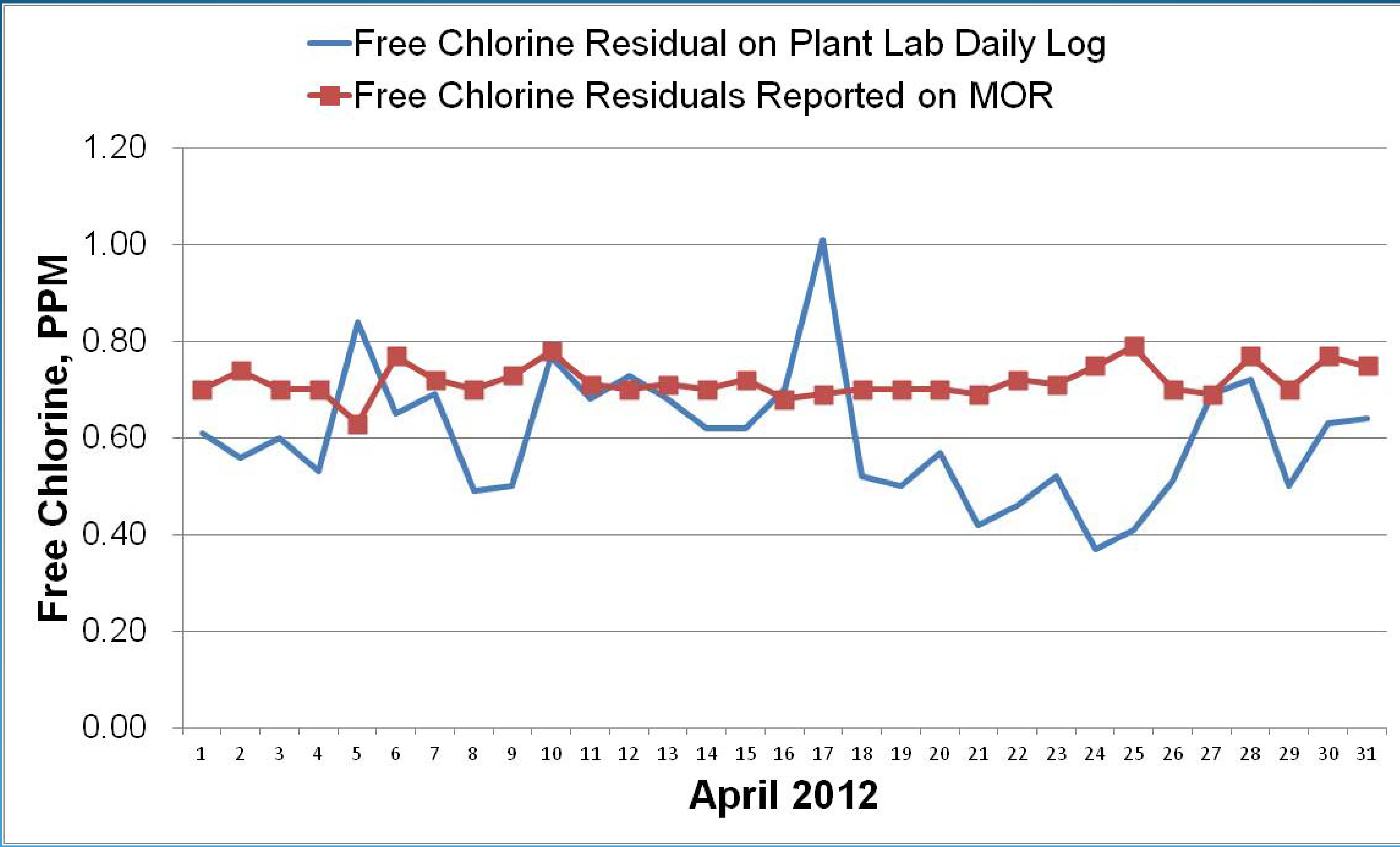
- 3 – 4 people, one day in WTP
- Check Turbidity and CT monitoring and reporting
- Check equipment calibration
- Find exact sample taps / locations
- Follow data through from sample through daily logs, plant worksheets, SCADA, to MOR submitted to ADH, and to historical record storage
- Does data on MOR submitted to ADH appear to be accurate and representative of WTP performance?

Data Audits



- Computer with all historical data – Blue Screen of Death
- 2 of 4 IFE turbidimeters not working
- At least 3 filter control valves not working
- System sited for multiple significant deficiencies

Data Audits



Free Chlorine Residual on Plant Lab Daily Log
Free Chlorine Residuals Reported on MOR
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Free Chlorine, PPM
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
April 2012

QUESTIONS?

Finn.michael@epa.gov
202-564-5261