



# **Comparing** EPA SWTR Baffling Factors to Full Scale Tracer Study Empirical Data

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# Surface Water Treatment Rule (SWTR)

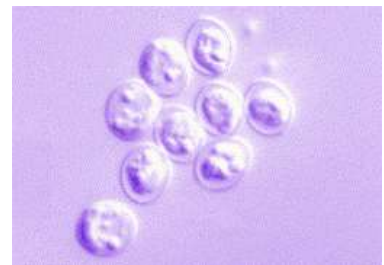
- At least 99.9% (3-log) removal/inactivation of *Giardia lamblia*
- At least 99.99% (4-log) removal/inactivation of viruses
- At least 99% (2-log) removal/inactivation of *Cryptosporidium*



<https://msu.edu>



<https://www.cdc.gov/dotw/rotavirus/index.html>



<http://www.wales.nhs.uk/sitesplus>

## **CT** Requirement

$$CT = C \times T$$

$C$  = concentration of free chlorine (mg/L)

$T$  = disinfection contact time (minutes)

$$\text{Log Inactivation} = \frac{CT_{\text{achieved}}}{CT_{\text{required}}}$$

$CT_{\text{achieved}}$  = Empirically measured CT

$CT_{\text{required}}$  = CT required by the EPA

# Definitions

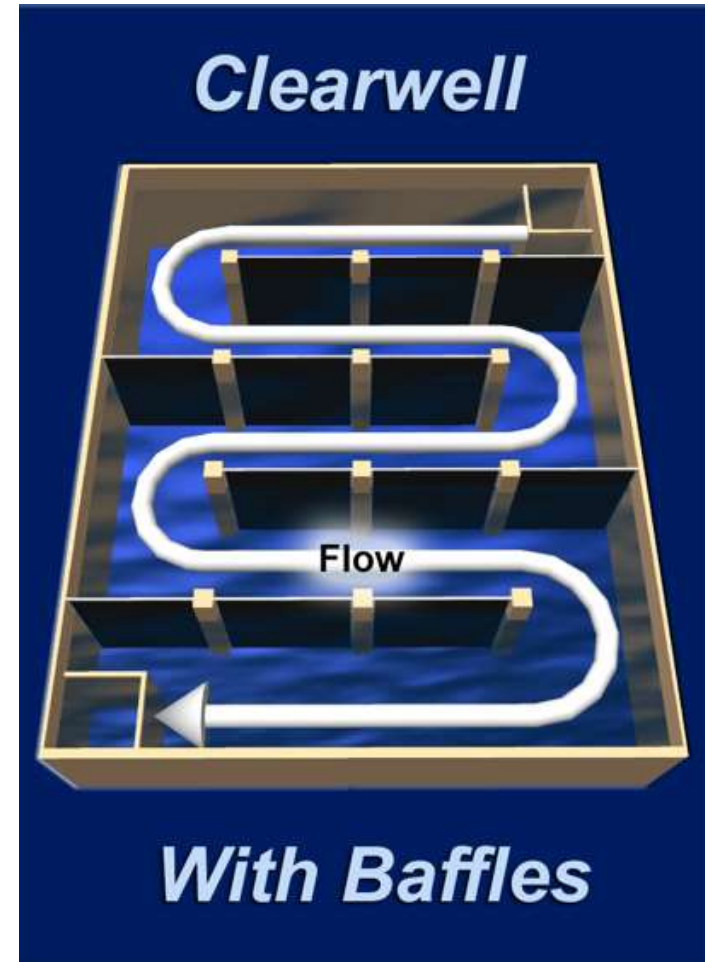
## Detention Time ( $T_{10}$ ):

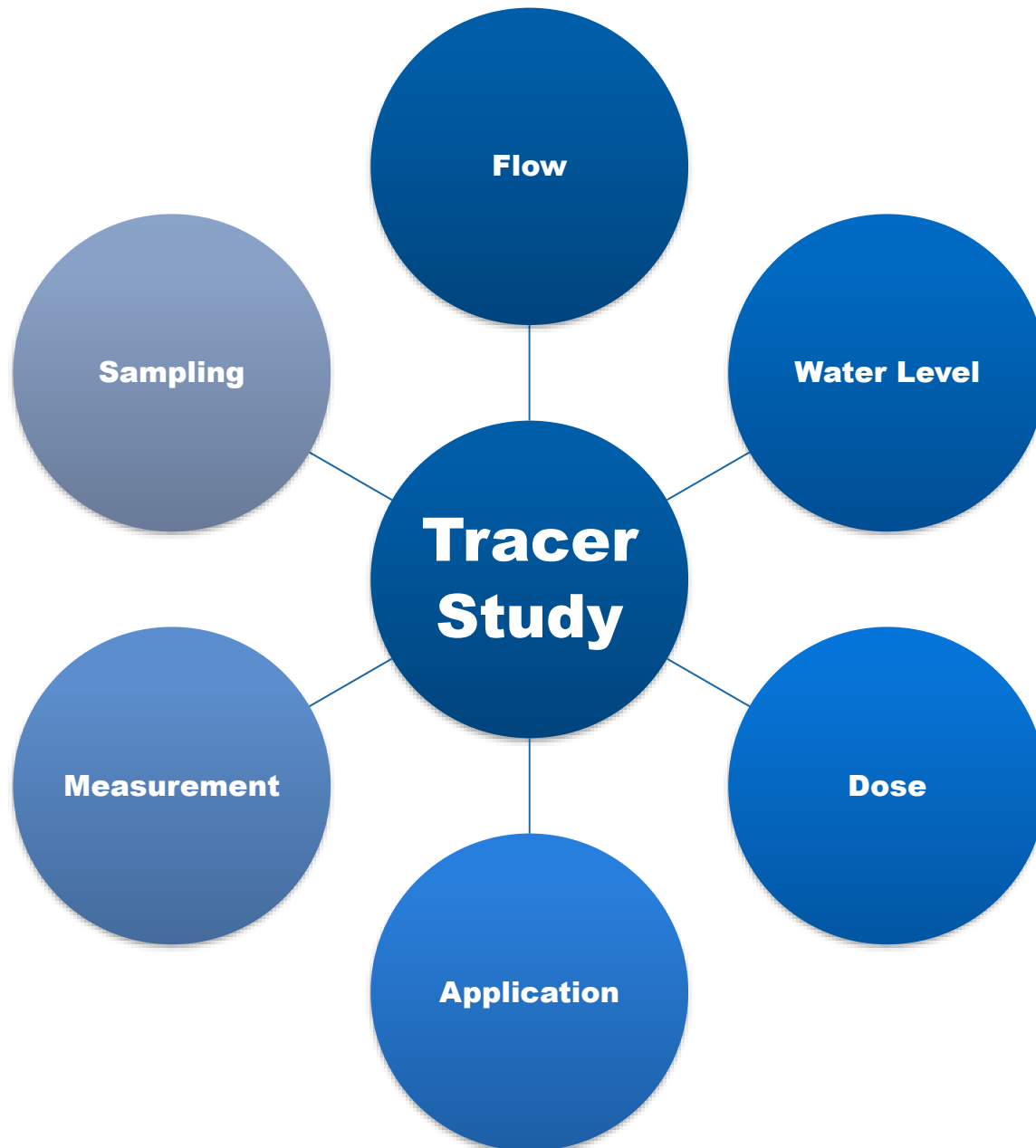
- Time at which 10% of water passes through basin
- Used to calculate CT

## Baffling Factor:

- The degree of short circuiting that occurs within a basin

$$BF = \frac{T_{Theoretical}}{T_{10}}$$





# Data Collection



## **Data** Analysis

**Plot conductivity against time on  $\log_{10}$  scale**



**Determine  $R^2$**



**Estimate  $T_{10}$**

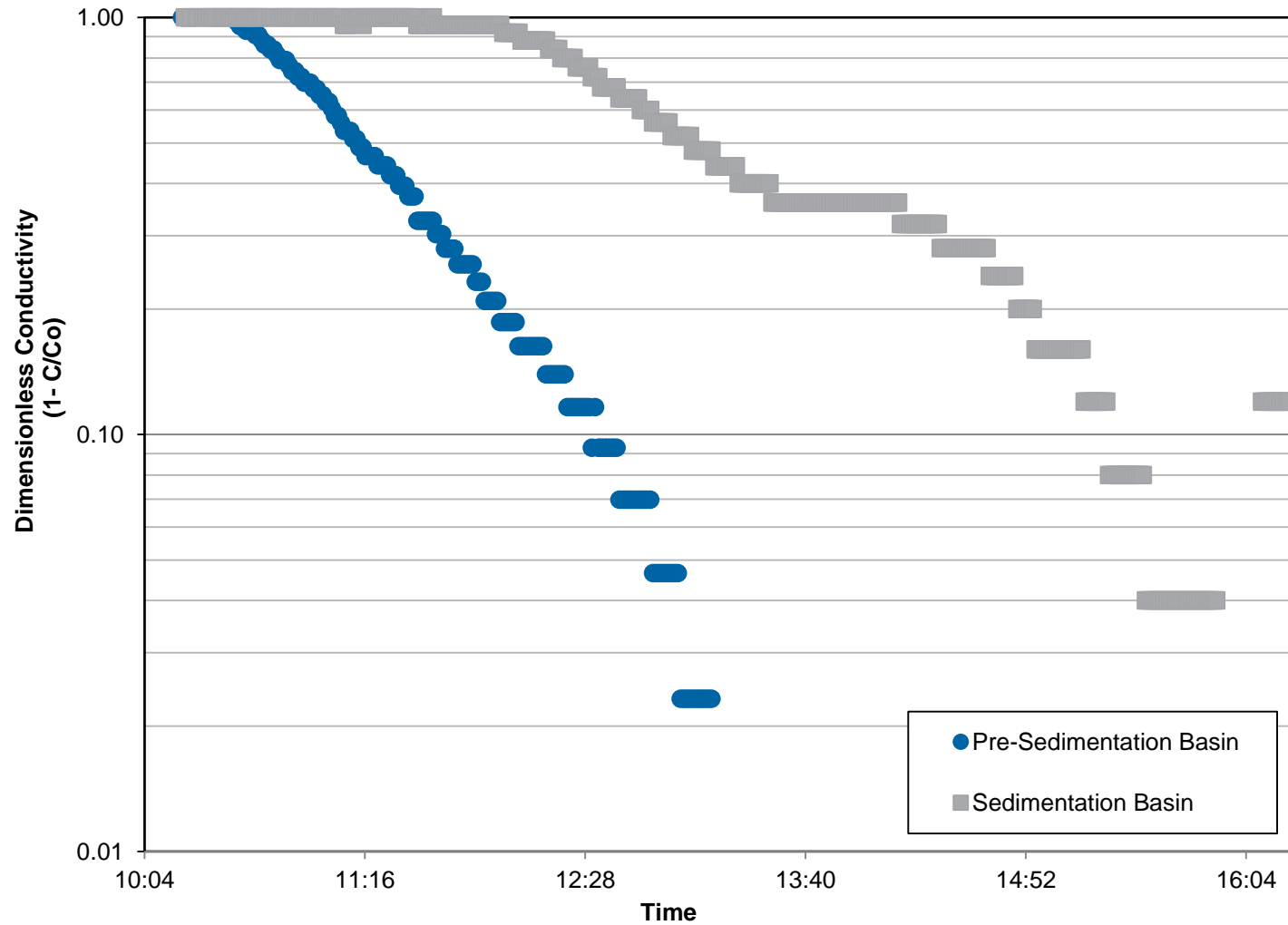


**Calculate baffling factor**



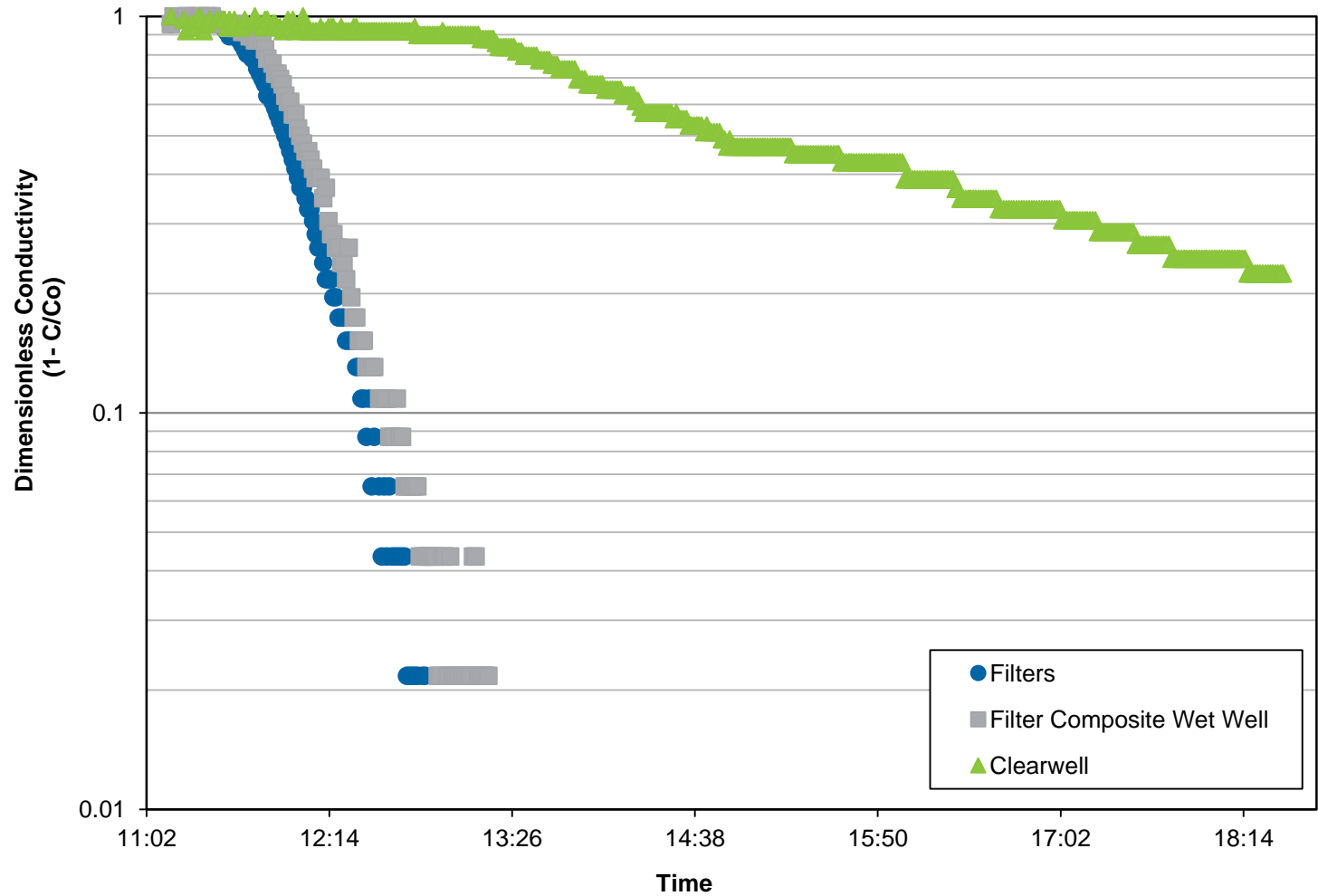
**Compare to EPA SWTR baffling factors**

# Data Analysis – Pre-Filtration





# Data Analysis – Post-Filtration



# Results – PLANT A

Plant Segment	T10 (min)	Volume of Section (gal)	Theoretical Time (min)	BF	EPA BF
<b>Plant Flow Rate: 8.02 MGD or 5569 gpm</b>					
Raw Water Wet Well to Mixed Water (Acti-flo Influent)	5	33,950	5.3	0.8	1
Acti-flo Inlet to Filter Top	22	201,971	31.6	0.6	0.7
<b>Plant Flow Rate: 8.2MGD or 5625 gpm</b>					
Filter Top Channel inlet to Filter Effluent Combined Header	33	354,407	65.5	0.5	0.7
Filter Effluent Header to Clearwell Influent	33	273,849	45.4	0.7	0.2-1
Clearwell Influent to Plant Effluent	111	1,208,749	132.6	0.5	0.5

# Results – PLANT B

Plant Segment	T10 (min)	Volume of Section (gal)	Theoretical Time (min)	BF	EPA BF
<b>Pre Filtration: Flow Rate = 7.6 MGD or 5278 gpm</b>					
Raw Water Mixer to Sedimentation Basin Inlet	24	334,453	63.4	0.4	0.2-0.4
Sedimentation Basin Inlet to Filter Top	87	1,898,963	359.8	0.2	0.3
<b>Post Filtration: Flow Rate = 6.5 MGD or 4514 gpm</b>					
Filter Top to Filter Composite	21	178,263	33.8	0.6	0.7
Filter Composite to Clearwell Influent	10	184,322	40.8	0.2	0.1-0.3
Clearwell Influent to Sendout	66	1,422,438	315.1	0.2	0.1

# Results – PLANT C

Plant Segment	T10 (min)	Volume of Section (gal)	Theoretical Time (min)	BF	EPA BF
<b>Plant Flow Rate = 5.0 MGD or 3,472 gpm</b>					
Raw Water Wet Well to Basin Inlet	40	144,738	42	1.0	0.3-1
Basin Inlet to Filter Top	62	407,151	117.26	0.5	0.3-0.5
Filter Top Channel inlet to Filter Composite	41	209,511	60.34	0.7	0.7
Transfer Pump to Plant Sendout	480	8,032,451	2313.35	0.2	0.1

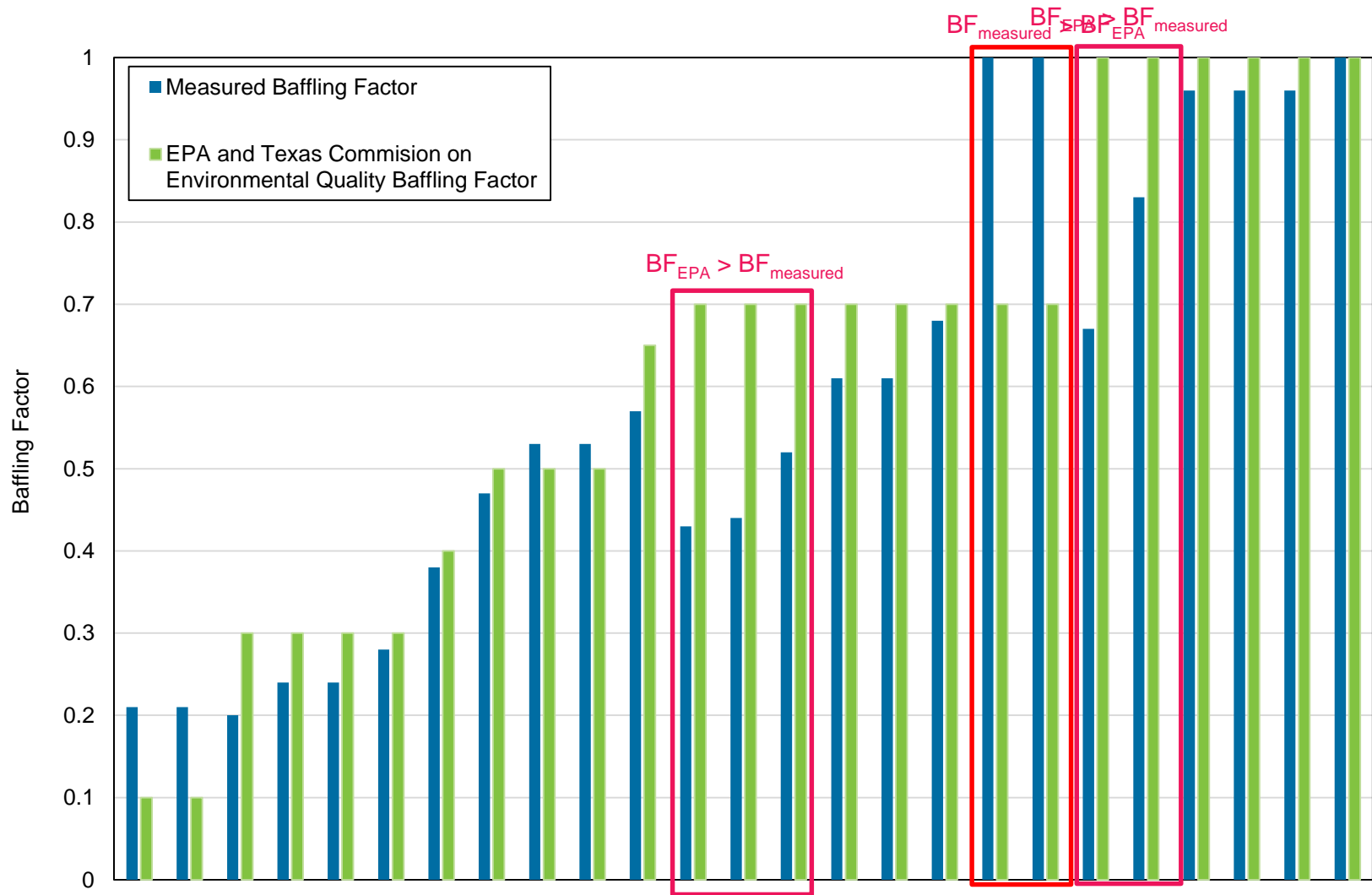
# Results – PLANT D

Plant Segment	T10 (min)	Volume of Section (gal)	Theoretical Time (min)	BF	EPA BF
<b>Plant Flow Rate = 16.0 MGD or 11111.1 gpm</b>					
Lab Channel to Sedimentation Basin Inlet	12.0	137,000	12.3	1.0	1.0
Basin Inlet to Basin Outlet	22.5	884,494	79.6	0.2	0.3
Basin Outlet to Filter Top	3.0	39,336	3.5	1.0	1.0
Filter Top to Filter Comp	33.0	1,074,182	96.7	0.4	0.7
Filter Comp to Plant Effluent	103.0	1,973,334	177.6	0.6	0.6-0.65

# Results – PLANT E

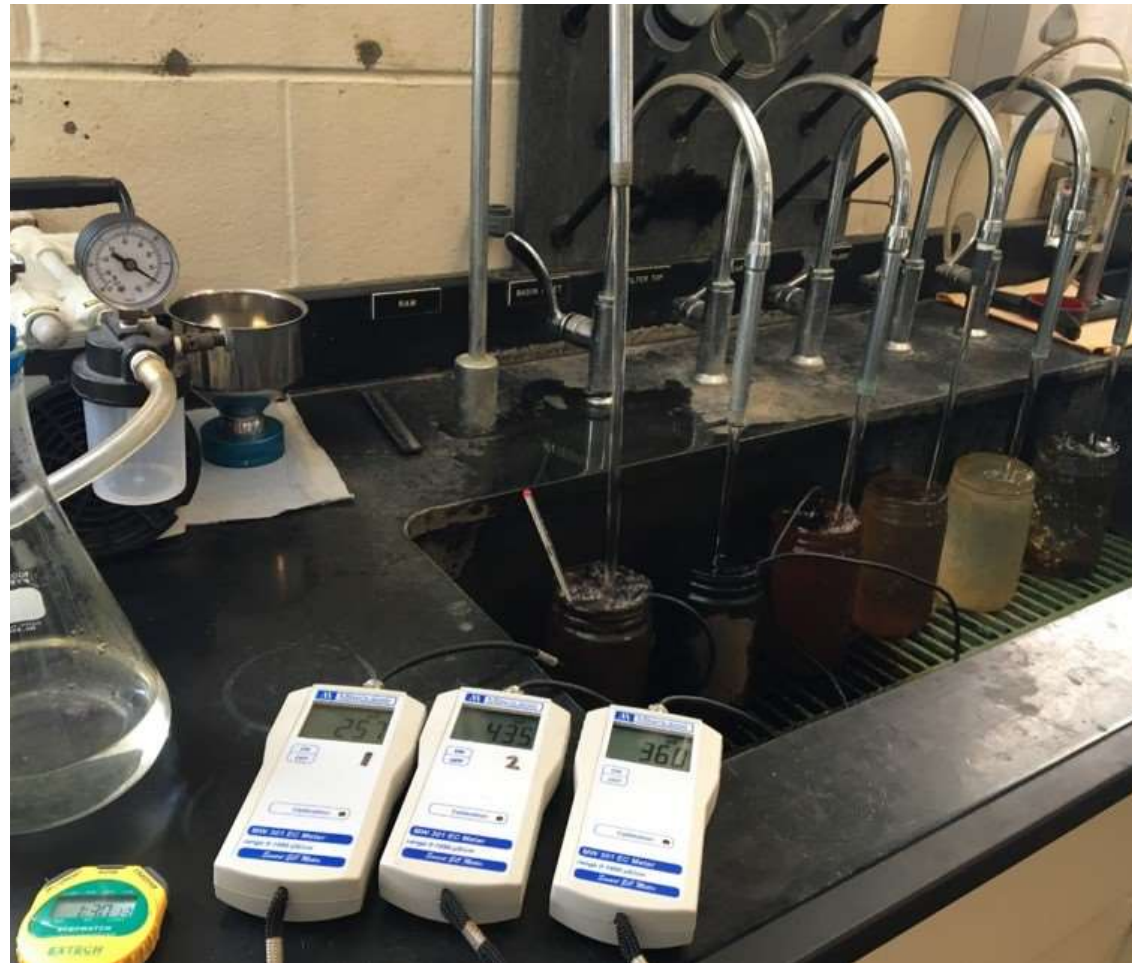
Plant Segment	T <sub>10</sub> (min)	Volume of Section (gal)	Theoretical Time (min)	BF	EPA BF
<b>Plant Flow Rate = 8.0 MGD or 5555.5 gpm</b>					
Basin Inlet to Filter Top	37.0	735,872	132.5	0.3	0.3
Filter Top to Filter Comp	24.5	319,098	57.4	0.4	0.7
Filter Comp to Plant Transfer	18.5	218,141	39.3	0.5	0.5
Plant Transfer to Tank #1 Inlet	19.0	92,593	16.7	1.0	1.0
Tank #1 Inlet to Tank #1 Outlet	110.0	592,178	106.6	1.0	0.7
Tank #2 Inlet to Tank #2 Outlet	110.0	592,178	106.6	1.0	0.7

# Results - Summarized



# Summary

1. SWTR
2. CT Requirement
3. Baffling Factors
4. Tracer Study
5. Data Analysis
6. Results





# References

Environmental Protection Agency. (1999, August). Disinfection Profiling and Benchmarking Guidance Manual. Retrieved April 2013

Texas Commission on Environmental Quality. (2004, April 1). Selection of Baffling Factors and Operating Conditions for “T10” Calculations. Retrieved April 2013

United States, Environmental Protection Agency, Office of Drinking Water. (1991). *Guidance manual for compliance with the filtration and disinfection requirements for public water systems using surface water sources*. Washington, D.C.: U.S. Environmental Protection Agency

# Questions

