Disinfection By-Products (DBPs)

2021 November 2

Monitoring requirements, what are DBP's, how are they reduced

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Outline

- What are DBPs?
  - Formed as products or reactions between disinfectants and organic matter (primarily dissolved; DOC) in the water
  - DBPs of concern are toxic at sufficient exposures
- If present, how are DBPs reduced?
  - Reduce concentrations of reactants and/or DOC
  - Reduce time that reactants and DOC are in contact
  - TTHM can be volatilized (HAA5 cannot significantly)
- Field examples …
- Monitoring requirements
  - Standard monitoring
  - IDSE
  - Stage 2
  - IDSE vs Stage 2

Questions…

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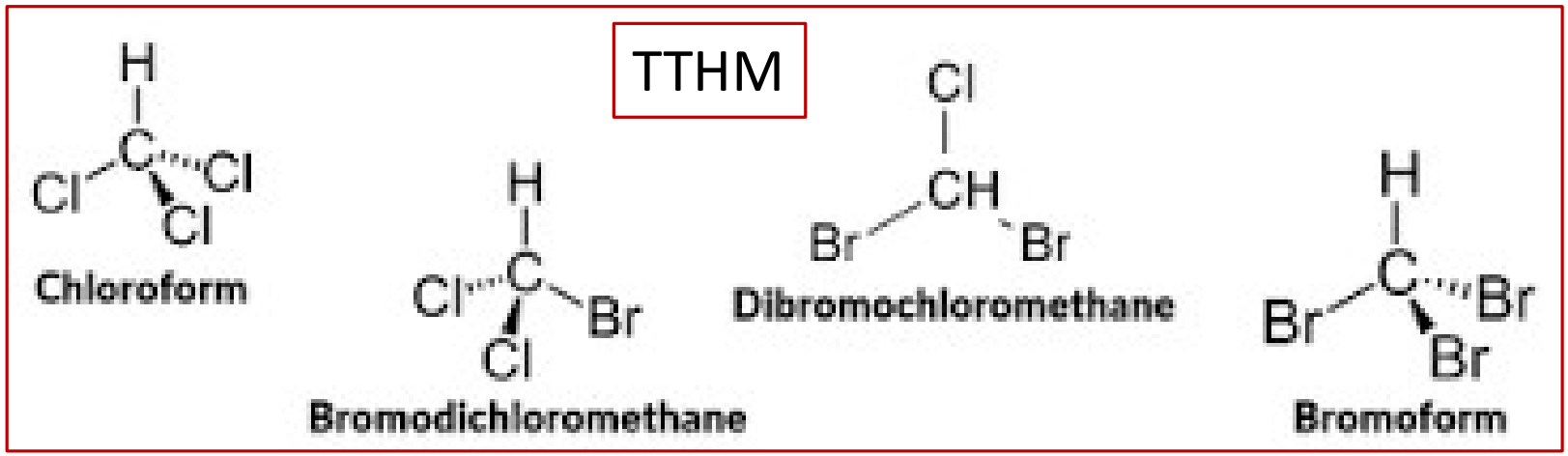
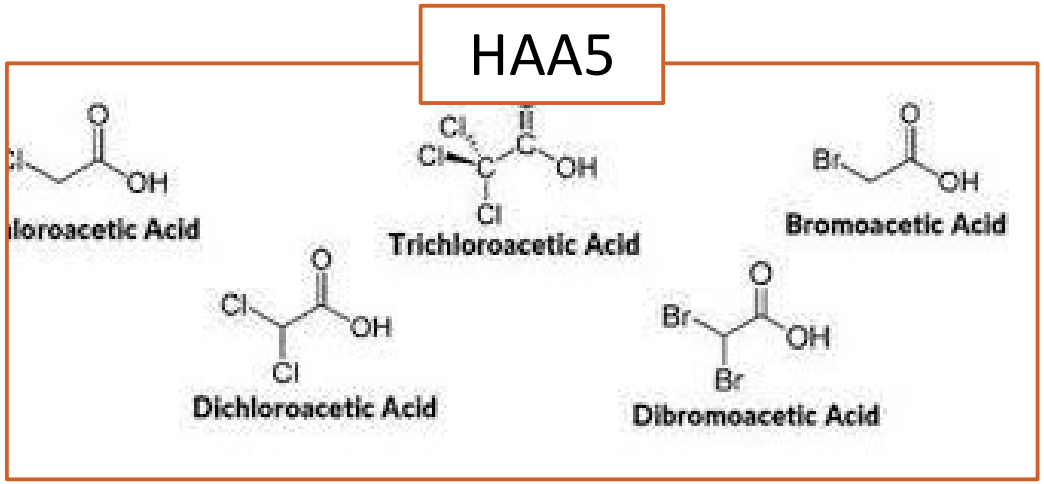
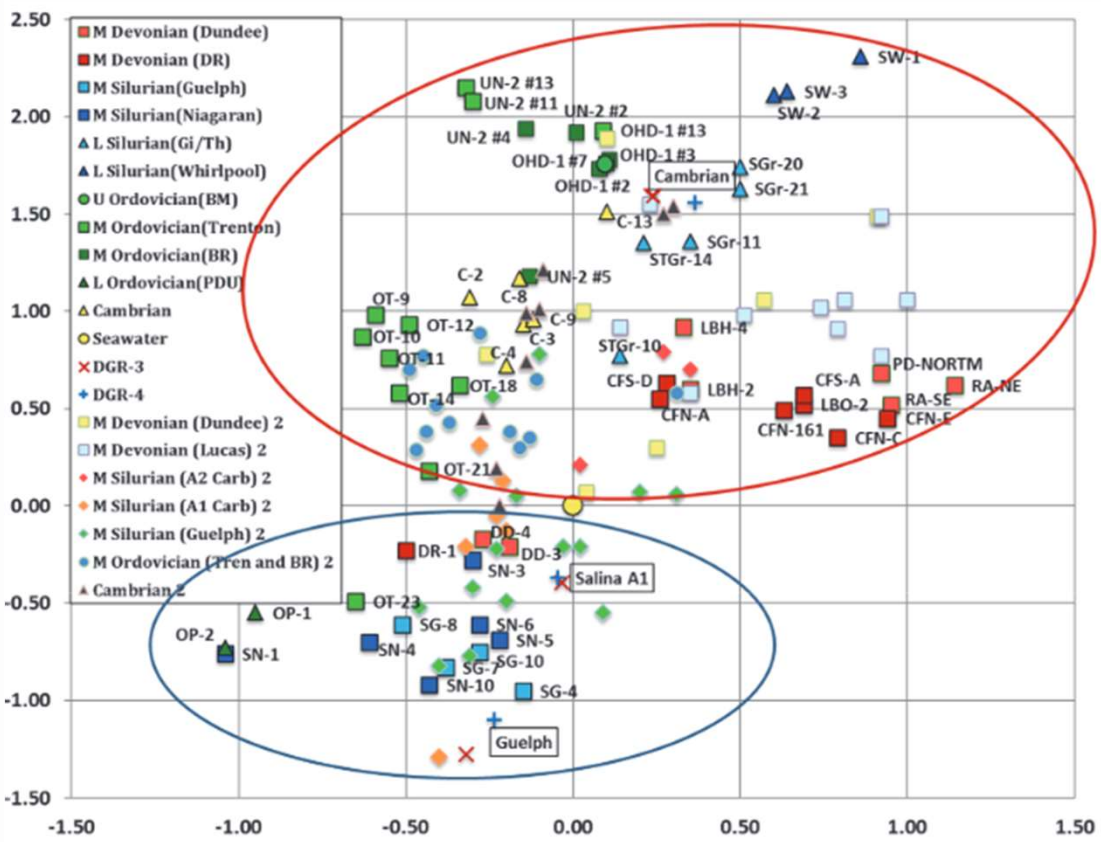
What are DBPs?

- Reaction products between oxidizing disinfectants and substances in the water
- DBPs of concern are toxic at sufficient exposures
- Specifically, regulations require monitoring for total trihalomethanes (TTHM) and haloacetic acids (HAA5) (and bromates if appropriate).





Why bromodichloromethane?

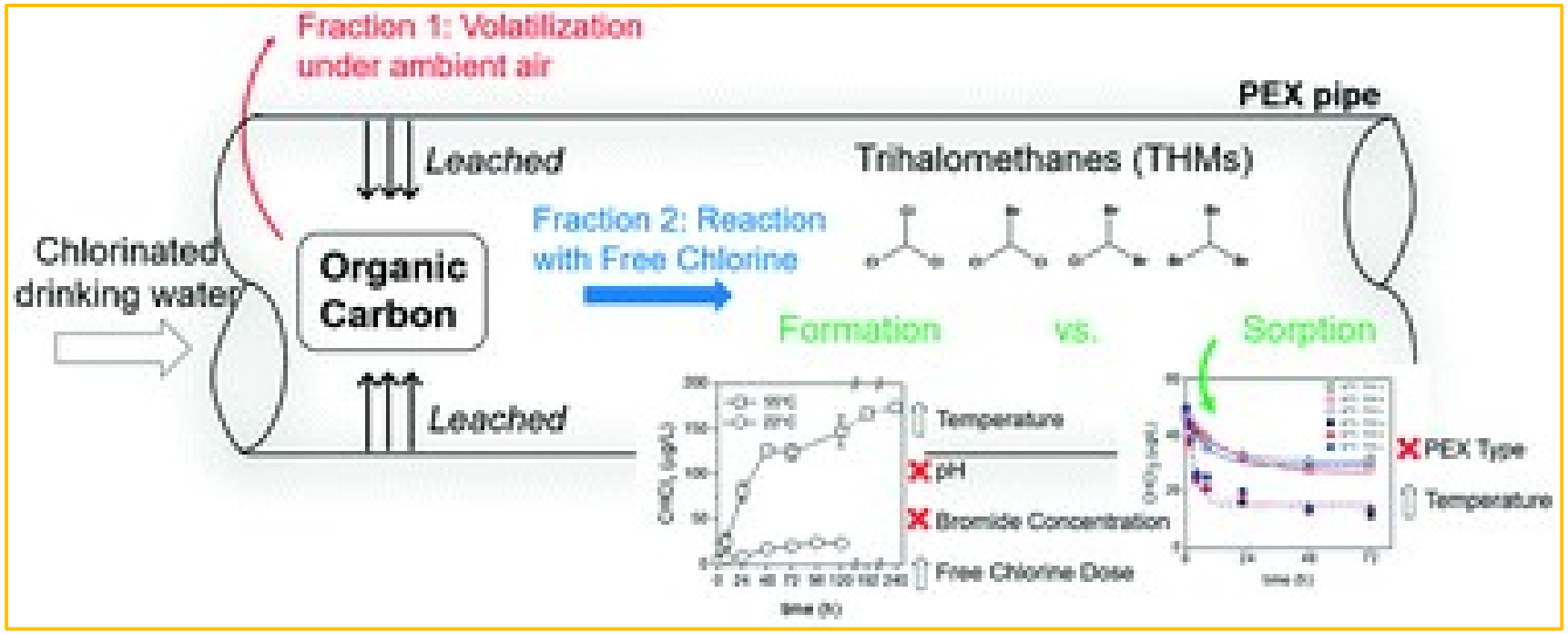


Chlorine/bromine isotope ratios from Great Lakes region bedrock (https://www.nwmo.ca/~/media/Site/Reports/2016/01/07/12/53/NWMOTR20152 0_Chlorine-and-Bromine-Isotopic-Analyses-of-Groundwaters-DGR3-and-DGR4_R0b.ashx?la=en)

How are DBPs Reduced (avoided)?

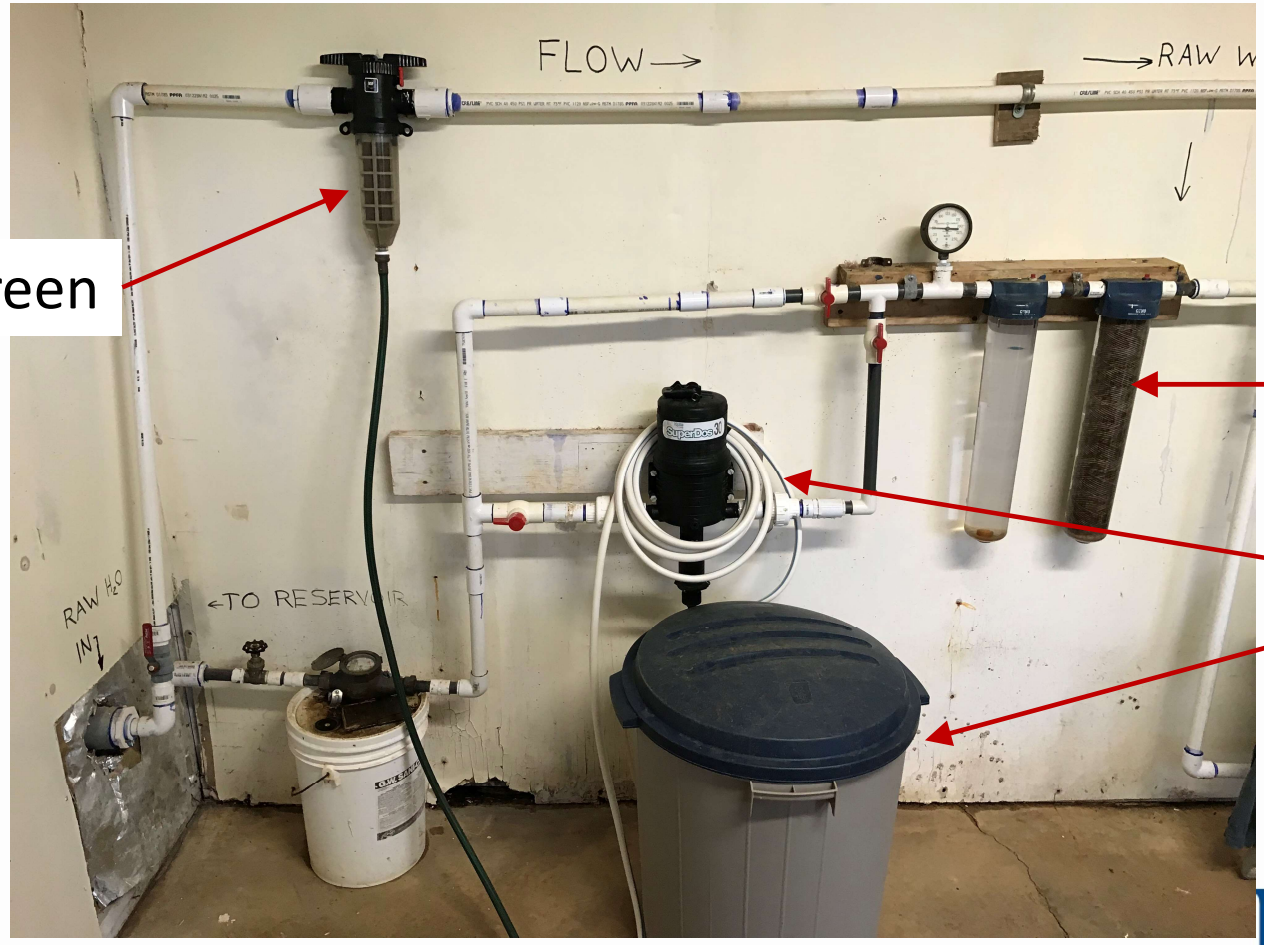
- Reduce reactants' concentrations (remove DOC, use less disinfectant)
- Reduce time in contact (minimize water age)
  - Is this practical?
  - Lower volume of water in contact chamber (clear well)
  - Flush distribution lines
  - Get treatment credit from other tech (e.g. UV)
- Injection point – where disinfectant added relative to contact chamber
- Aerate water to volatilize TTHMs (unlikely to help w HAA5s)
- Clean the contact chamber, mains, etc.

One possible reason for sustained DBPs



Field Examples: 1

- Coast Range PWS w creek source and large concrete tank



Pre-screen

Former filter

Chlorinator

Day tank

Field Examples: 1 con't

- Storage tank (50,000 gallons); Population 25, 19 connections
- 25 x 250 gpd results in hydraulic residence time of ~8 days

Field Examples: 1 con't

- Knock-out tank at intake, pre-screen, string-wound filter, erosion chlorinator, massive storage tank
- No known maintenance on tank, roof opening (below)
- Water demand small proportional to storage tank volume and variable use, especially seasonally
- Slow sand filter built 2011, not finished or used (!)

July 2021 →

Nov 2019 →

TTHM (mg/L) MCL = 0.080	HAA5 (mg/L) MCL = 0.060
0.0926000	--
--	0.1140000
--	0.1130000
0.0999000	--
ND	--
0.0531000	--
--	0.0718000
0.0658000	--
--	0.0690000
0.0630000	--
--	0.0829000
0.0912000	--
--	0.0318000
0.0834000	--
0.0079600	--
--	0.0069100
0.0064300	--
--	0.0052200
0.0750000	--
--	0.0293000
--	0.0563000
0.0867000	--
0.0440000	--
--	0.0715000
0.0440000	--
--	0.0700000
0.0465000	--
--	0.0919000

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Field Examples: 1 con't

- What do we do? Simplest to most complicated…
- Reduce contact time
  - Tank volume excessive…reduce water level
    - The tank has an outlet at the floor level (can completely drain)
  - Add a smaller tank downstream and dose before that tank
- Remove TOC/DOC
  - Clean the storage tank
  - Clean the knock-out tank at intake (done?)
  - Use slow sand filter (yet to happen)
  - Add activated carbon (PWS's choice)
  - Lower disinfectant concentration
- More technical
  - Add UV for *Crypto* & *Giardia*
  - Add UV with 186 mJ/cm^2 for viruses

Field Example: 2

- DBP violations only in the last year
- SW, conventional treatment, experienced operator

Sample ID	Sample Date	Receive Date	Sample Point	Location	TTHM (mg/L) MCL = 0.080	HAA5 (mg/L) MCL = 0.060	Bromate (mg/L)
107092604-D	07/09/21	07/13/21	2DBP-01	#27-TOOL BARN	0.1170000	--	--
107092604	07/09/21	07/21/21	2DBP-01	#27-TOOL BARN	--	0.0305000	--
104131801-D	04/13/21	05/06/21	2DBP-01	#27-TOOL BARN	0.0572000	0.0506000	--
101041703-D	01/04/21	01/14/21	2DBP-01	#27-TOOL BARN	--	0.1010000	--
101041703	01/04/21	01/22/21	2DBP-01	#27-TOOL BARN	0.0720000	--	--
011020603-D	11/02/20	11/12/20	2DBP-01	#27-TOOL BARN	--	0.0897000	--
011020603	11/02/20	11/23/20	2DBP-01	#27-TOOL BARN	0.0505000	--	--
008101601-D	08/10/20	08/17/20	2DBP-01	#27-TOOL BARN	0.0921000	--	--
008101601	08/10/20	08/24/20	2DBP-01	#27-TOOL BARN	--	0.0492000	--
907100602-D	07/10/19	08/30/19	2DBP-01	#27-TOOL BARN	0.0353000	0.0212000	--
808153501-D	08/15/18	08/31/18	2DBP-01	#27-TOOL BARN	0.0519000	0.0309000	--
708022901-D	08/02/17	08/18/17	2DBP-01	#27-TOOL BARN	0.0662000	0.0282000	--

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Field Example: 2 con't

Contact reports:

- The operator explained that water usage is low causing the water age to be much older due to recent shutdown. The system will start implementing strategies to reduced the amount of aged water in the system by increasing flushing to weekly and changing the storage tank levels. The system will also determine if chlorine dosages can be lowered and still meet the required CT.
- The system is now looking at changing the disinfection of the system, exploring using UV. The system was also given the OEL reporting form to fill out.
- They have started flushing monthly, reduced the reservoir levels and reduced the chlorine dosage. The HAA5 levels have been reducing, but there is still problems with the TTHM levels. The system is going to clean the tanks, install and auto-flush system, and **move to post-chlorination instead of pre-chlorination**.

And the moment you've all been waiting for…
Monitoring Requirements !

IDSE = *Initial Distribution System Evaluation* per 333-061-0036(4)(b)

- NTNC water systems serving less than 10,000 people are exempt
- Water suppliers adding a disinfectant must complete an IDSE by:
  - conducting either standard monitoring (explained on next slide) or
  - a system specific study.
- Water suppliers must consult with the Authority after completing the IDSE to identify compliance monitoring locations prior to developing a monitoring plan.
- Samples collected to conduct an IDSE will not be used for the purpose of determining compliance with MCLs. Each location is sampled for TTHM and HAA5 (aka "dual sample sites").

Stage 2 = create a "Compliance Monitoring Plan;" or maybe EPA assigned a 40/30 waiver or very small system waiver

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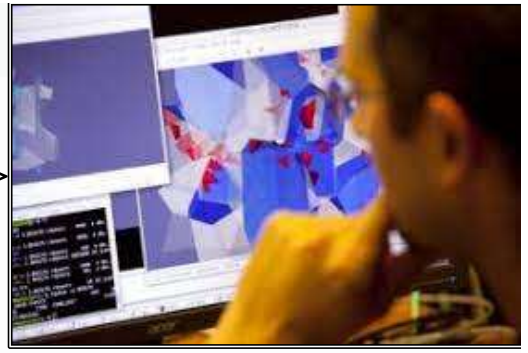
IDSE Tasks

<OR>



- Standard Monitoring Plan – 1 year duration
  - A schematic of the distribution system (including distribution system water sources, entry points, and storage facilities), with notes indicating the locations and dates of all "projected" standard monitoring;
  - An explanation of standard monitoring location selection, and a summary of data relied on to justify the selection; and
  - The population served and source water classification for the water system.
- System Specific Study
  - Existing site data
  - Hydraulic modeling

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Monitoring for IDSE

IDSE "Standard monitoring" sampling by PWS size

Table 16

Source water type	Population and category	Monitoring periods and frequency of sampling	Distribution system monitoring locations				
			Total per monitoring period	Near entry points	Average residence time	High TTHM locations	High HAA5 locations
Ground-water:	< 500 purchasing water systems	one (during peak historical month)[1]	2	1		1	
	< 500 non-purchasing water systems	one (during peak historical month)[1]	2			1	1
	500-9,999	four (every 90 days)	2			1	1

IDSE report **within 90 days** of completing "standard monitoring." Conundrum: when are there enough data to decide on locations?

Routine Monitoring (after IDSE)

Table 17

Source water type	Population	Monitoring frequency [1]	Distribution system monitoring location		
			Total per monitoring period [2]	Highest TTHM locations	Highest HAA5 locations
Surface water systems or GWUDI	< 500	per year	2	1	1
	500-3,300	per quarter	2	1	1
	3,301-9,999	per quarter	2	1	1
Groundwater	< 500	per year	2	1	1
	500-9,999	per year	2	1	1

Red circled "2" is the "dual" sample, and two locations each event. One location for TTHM, and one location for HAA5 (they sometimes are the same location if the PWS is <500).

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Stage 2: Where All are Now
OHA Website Info…

GW <500…1 "sample" per year (sample means a container for TTHM and a container for HAA5; aka "dual")

)

[4] *Groundwater systems < 500 must take individual TTHM and HAA5 samples (instead of a dual sample set) at the locations with the highest TTHM and HAA5 concentrations, respectively. However, if the highest TTHM and HAA5 concentrations occur at the same location, you can collect a dual sample set at one locations per monitoring period* (see https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/DRINKINGWATER/RULES/STAGE2/Pages/monitoring.aspx)

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Stage 2 *vs* IDSE

Hey small systems, check it out! ☞

- Stage 2 requires "Compliance monitoring plan" to contain monitoring locations, the same locations proposed in the water system's IDSE report (if one exists) or match any modifications made by the state (see "DBP Sample Sites" in Data Online)

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

- Maybe change locations if:
  - significant changes in treatment,
  - distribution system operations and layout, or
  - other factors that may affect TTHM or HAA5 formation
- Changes might alter monitoring locations if the above bullets alter where different-from-IDSE highs for TTHM or HAA5 are anticipated (a rare occurrence)
- Sample dates are same as IDSE…or if new data/exceptions would change to when high concentrations would occur.

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Stage 2: TTHM Monitoring Sites Without Previous DBP Data

Use other knowledge about system to identify probable high TTHM and high HAA5 locations. Consider the following:

- Geographic distribution of monitoring sites
- Sites already used for compliance with other rules (e.g. RTCR)
- Site accessibility

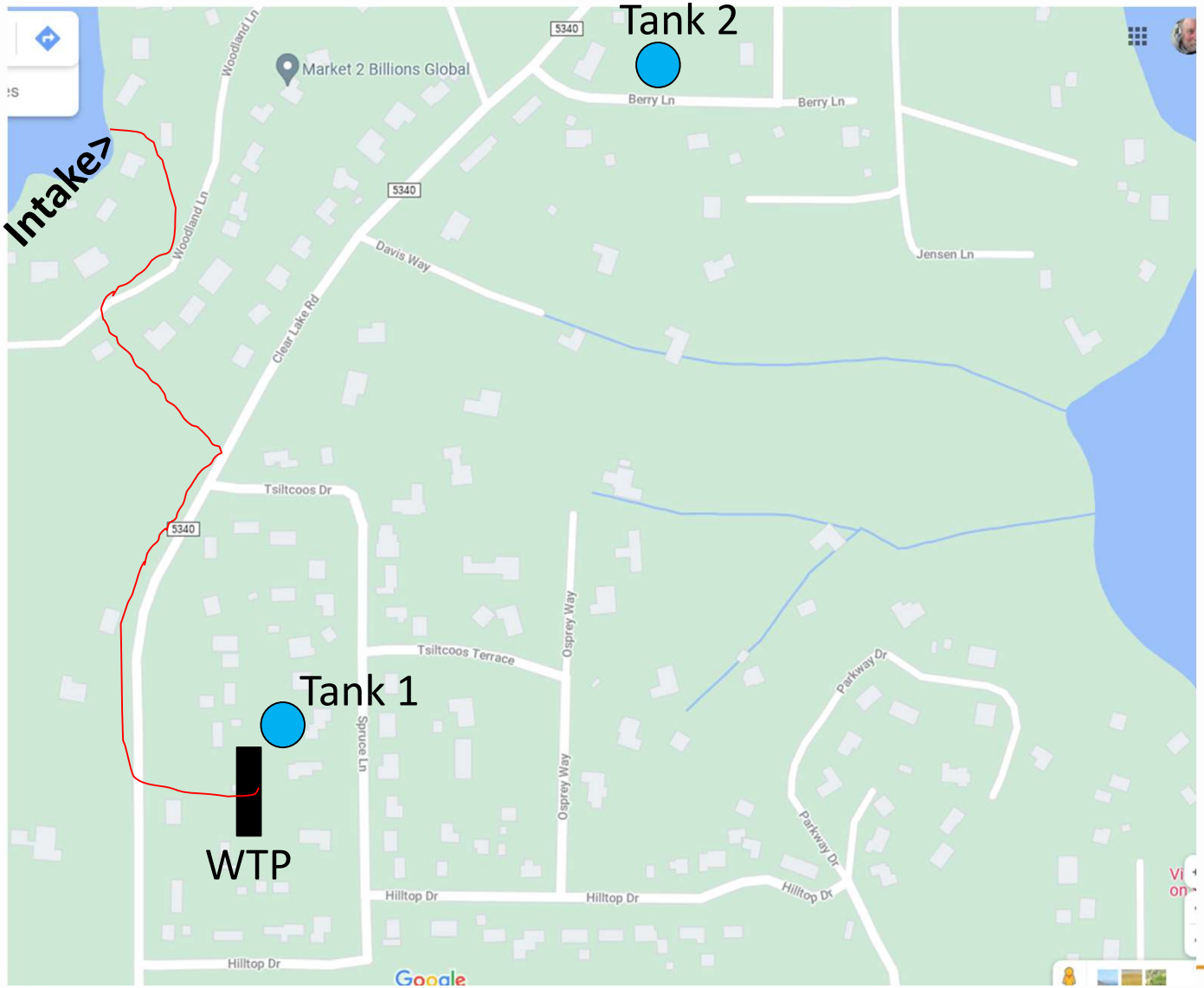
Characteristics of High TTHM Monitoring Sites:

- Highest residence time (older water)
- Highest pH
- Not at the very end of a dead-end line, and not looped
- Low flows (e.g. lightly developed)
- Downstream of storage facilities, esp. ones with a common inlet/outlet
- Low residual concentration (indicates likely advanced residence time)
- Immediately after booster chlorination

Stage 2: HAA5 Monitoring Sites Without Previous DBP Data

- To genuinely know where to monitor for maxima…
  acquire data, data, data
- Locations of maximums can be highly variable
- Relatively close to point of disinfection (tho not immediately after)
- In areas with disinfectant residual consistently above 0.2 mg/L for chlorine or 0.5 mg/L for chloramine
- In mixing zones where water from different sources combines within the distribution system
- Downstream of storage tanks
- At sufficiently small systems, the majority of ground water PWSs, selecting HAA5 sampling locations is guess-work

Where would you sample?



All building outlines are served water, and no others.

Chlorination is used at WTP.

Population is 471

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Partner Question Examples:

1. Compliance following an exceedance including monitoring, public notice, and the LRAA?

2. For very short distribution systems (<500 ft) why does an IDSE not use the EP instead of the 1st user?

3. Why do some groundwater systems have a schedule with two different sites and some only one? Could a system with two required sites get reduced to one site? If so, when and how?

Partner Question 1:

Compliance following an exceedance including monitoring, public notice, and the LRAA?

- Monitoring - Sampling frequency change to quarterly, same number of samples (1 set of dual, even if the “other” DBP group was ND)
- Public notice (PN) - every 3 months until MCL violation resolved, including the LRAA value because quarterly monitoring has begun. When ongoing, the PN is for the subsequent quarter, not the past quarter. This even applies even when the latest data are below MCLs, yet the LRAA is above. If treatment is installed and working, they may forego PN.
- LRAA - calculated by DWS if on quarterly schedule, though it is useful if the PWS also calculates the value. If on annual or every 3 years, then quarterly monitoring is required. “If any sample exceeds the MCL, you are not immediately in violation. You must begin increased monitoring immediately (monitor quarterly at each location).”

Partner Question 2:

For very short distribution systems (<500 ft) why does an IDSE not use the EP instead of the 1st user?

- TTHMs typically are higher further from the point of disinfection, at the far end of distribution.
- HAA5s may be highest near the point of disinfection, though at this scale, HAA5s might be highest anywhere.

Partner Question 3:

Why do some groundwater systems have a schedule with two different sites and some only one? Could a system with two required sites get reduced to one site? If so, when and how?

- If sufficient data exist demonstrating TTHM and HAA5 maxima at different locations, then 2 sample sites exist.

- A system having 2 sites could be reduced to 1 site if the data support that change. The data would have to demonstrate that a change has occurred such that both TTHM and HAA5 maxima are now occurring at the same location.

Your expectations moving forward:

- _____ [fill in the blank]

- Share today's conversation
  - Review at your next staff meeting
  - Send tough situations to…to…your state contact or to info.drinkingwater@dhsoha.state.or.us

- Participate in… _____

- Look for and direct the next generation...

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