AN OVERVIEW OF FINDINGS IN UCMR 4

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AGENDA

- UCMR 4 Overview
- Comparison databases
- Occurrence observations in UCMR 4
- DBP indicators in source waters
- Implications and conclusions

BRIEF HISTORY OF UNREGULATED CONTAMINANT MONITORING RULES

- Every 5 years
- No more than 30 compounds per UCMR
- Traditionally mostly organics (emerging contaminants)
- But there have often been some inorganics mixed in.
  (nitrate was part of UCMR 1…)
- UCMR 3 had a lot of metals plus ClO_3/ClO_2
  (and Mn and Ge were added for small systems)
- UCMR 4 includes Mn, Ge and source water Br and TOC

OTHER RELEVANT COMPARISON DATABASES

- The Information Collection Rule, aka ICR (1997) included Br and TOC for source waters and HAA9 for DS.
  - Fewer systems (~300 serving >100K population)
  - More frequent source testing (monthly)

- UCMR 3 (2013-15) included Mn and Ge for small systems only.
  - ~800 systems
  - Only systems serving < 10K population

UCMR 4 OVERVIEW

- 2018-2020 monitoring
- ~2300 surface water and ~2500 ground water systems
- ~35,000 samples overall for entry points when done
- ~ 20,000 samples overall for source waters when done
- 30 contaminants (2 inorganics, 3 cyanotoxins, 25 organics) for EP or MR plus TOC/Br for sources
- Most of the organics are MOSTLY “boring”

CYANOTOXINS ARE GENERALLY NOT DETECTED

Cyanotoxin	# of samples	% positive	# of PWS	% PWS positive	Max Value and 2nd Highest (ug/L)	MRL (ug/L)
Total Microcystins	23443	0.03%	2376	0.29%	0.79 (0.44)	0.3
Cylindrospermopsin	23757	0.05%	2379	0.46%	0.88 (0.41)	0.09
Anatoxin-a	23757	0.46%	2379	1.43%	13 (0.41)	0.03

There is no regulatory guidance yet for anatoxin-a, even though it is the most commonly detected cyanotoxin.

MOST OF THE ORGANICS ARE EVEN MORE BORING

Contaminant	MRL (µg/L)	Reference Conc (µg/L)	Total number of results	% of samples with results ≥ MRL	Total number of PWSs with results	% of PWSs with results ≥MRL	Max Value (2nd highest) (ug/L)
1-butanol	2.0	700	26,935	0.90%	4,191	3.96%	102 (100)
o-toluidine	0.007	NA	26,777	0.41%	4,212	1.85%	0.38 (0.15)
quinoline	**0.02**	**0.01 / 1[1]**	**26,726**	**0.27%**	**4,206**	**1.07%**	**1.5 (0.44)**
2-methoxyethanol	0.4	NA	26,938	0.21%	4,191	1.10%	63 (16)
2-propen-1-ol	0.5	35	26,937	0.10%	4,191	0.45%	1.7 (1.5)
Alpha-HCH	**0.01**	**0.006 / 0.6[1]**	**26,555**	**0.08%**	**4,187**	**0.50%**	**0.067 (0.031)**
total permethrin	0.04	3.344 / 334.4[1]	26,562	0.05%	4,186	0.26%	0.21 (0.16)
Others (8)			~26,500	<0.05%	~4186	<0.25	0.21 (0.06)

SO THAT LEAVES THE INORGANICS AND DBPS

- About ¾ of systems have reported data already.
- Overall patterns of occurrence are unlikely to change (data released in April is similar).

	% of samples with hits				% of PWS with hits			
	0119	**0519**	**1019**	**0120**	**0119**	**0519**	**1019**	**0120**
germanium	7.0%	7.4%	8.0%	7.6%	12.3%	12.6%	12.6%	12.4%
manganese	69%	68%	70%	70%	83%	85%	88%	88%
HAA5 (regulated)	97%	97%	97%	97%	98%	98%	98%	98%
HAA6Br	95%	95%	95%	95%	97%	97%	96%	97%
HAA9	97%	97%	97%	97%	98%	98%	98%	100%
~ Total chemistry	4500	9000	18000	22000	1100	1900	3200	3700
~ Total DBPs	7000	15000	30000	37000	1100	1900	3200	3600

CAN WE COMPARE UCMR 4 WITH UCMR 3 DATA?

- UCMR 3 included only a small set of samples.
- UCMR 3 included only small systems (<10K pop).
- Reporting limits were different (1 ug/L for both in UCMR 3 and 0.4 ug/L (Mn) and 0.3 ug/L (Ge) in UCMR 4).
- Lets first review the UCMR 3 data.

UCMR 3 Mn and Ge DATA (SMALL SYSTEMS)

Statistic	Mn Overall	Mn GW sources	Mn SW sources	Ge Overall	Ge GW sources	Ge SW sources
Mean	17	22	9	<1	<1	<1
Median	1.7	2.2	1.4	<1	<1	<1
Maximum	3550	3550	1400	13	13	1.1
95th percentile	68	97	28	<1	<1	<1
90th percentile	29	46	14	<1	<1	<1
10th percentile	<1	<1	<1	<1	<1	<1
Total samples	5935	3564	2019	5935	3564	2019

- 800 small water systems (representing ~6000 samples)
- Higher reporting limits than UCMR 4
- Semi-annual (GW) or quarterly (SW) monitoring

Data in ug/L

UCMR 3 DATA (SMALL SYSTEMS) OBSERVATIONS

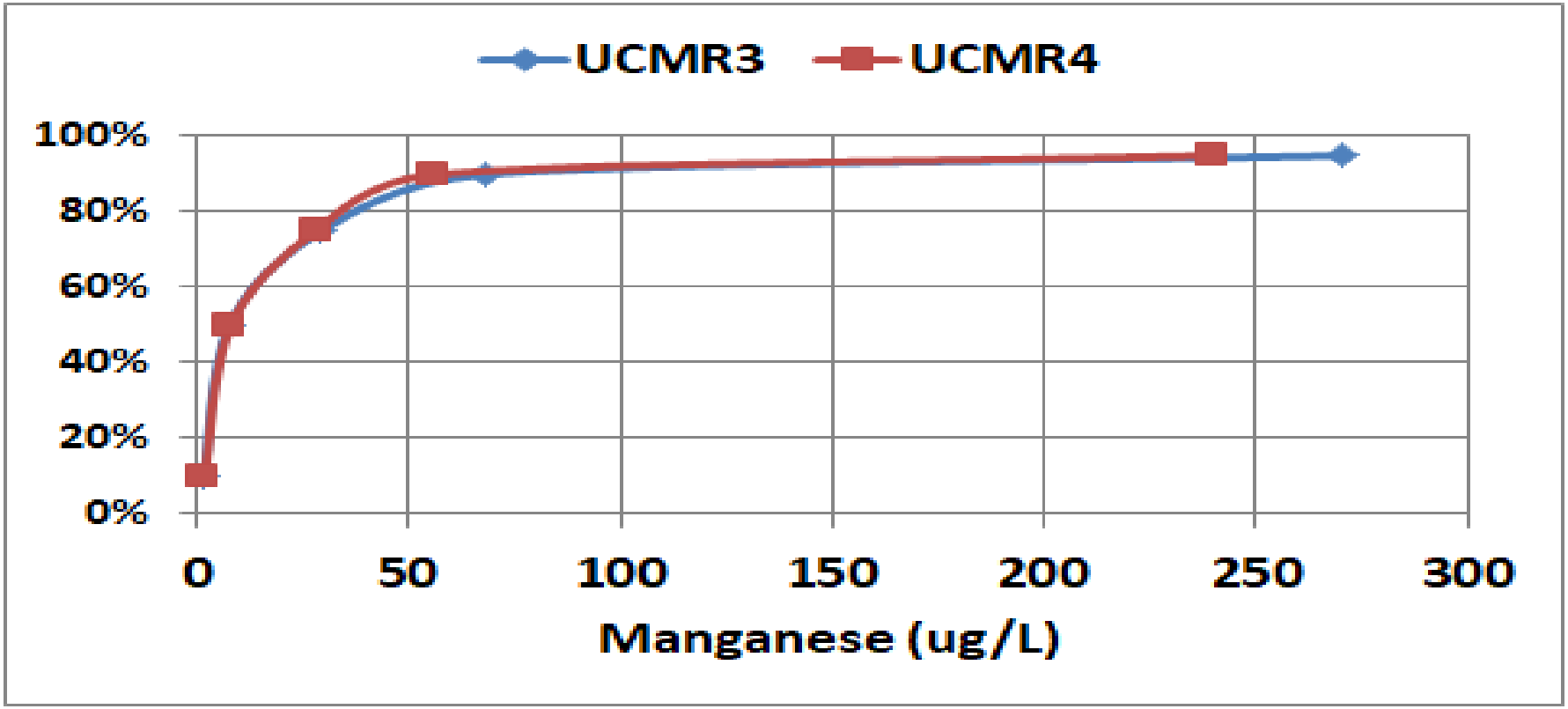
- Sites with GW sources were higher than sites with SW sources (duh!).
- Mn occasionally exceeded the SMCL.
- There were some VERY high Mn sites present.
- Mn could vary significantly at the same site, suggesting that it's perhaps not all a source water issue.
- Ge was pretty much a non-issue.

GE and MN- a DEEPER DIVE COMPARING THE UCMR 3 AND UCMR 4

	Manganese		Germanium	
	UCMR 3	UCMR 4	UCMR 3	UCMR 4
% Hits	60%	70%	1%	8%
Median	1.7	1.8	<1	<0.3
95th percentile	68	56	<1	0.5
99th percentile	271	240	<1	1.3
MRL	1	0.4	1	0.3

- Results are actually comparable if one corrects for the greater sensitivity used in UCMR 4.
- Although germanium appears to be much more frequently detected in UCMR 4, 98% of samples are <1 ug/L.

PROBABILITY PLOT COMPARISON
UCMR 3 vs UCMR 4 for MANGANESE



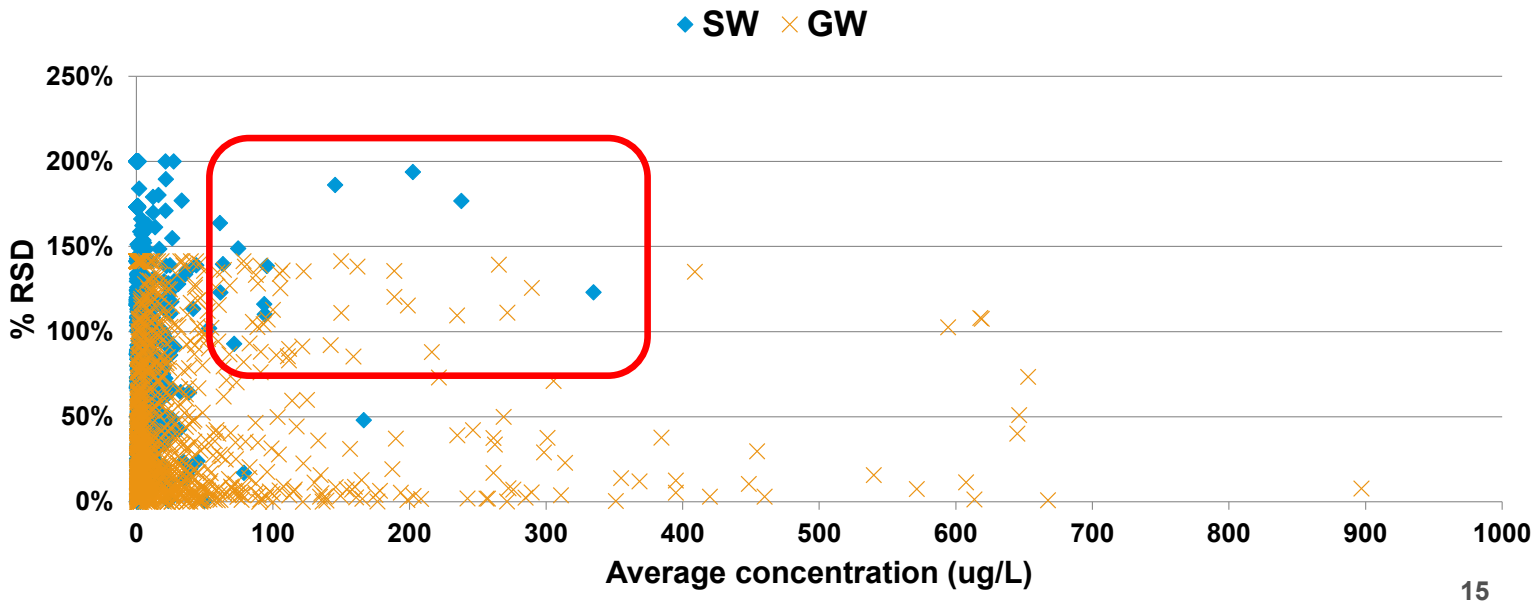
MANGANESE: % of SAMPLES/SYSTEMS ABOVE DIFFERENT THRESHOLDS as of APRIL 2020

	% of samples	% of PWS
N	27194	4211
50 ppb SMCL	3.9%	12%(495)
120 ppb Canadian Guideline	1.6%	5.3%(224)
300 ppb HAL	0.5%	1.9% (79)

At the SMCL or even slightly higher levels, there are a number of systems that would be impacted if EPA or states imposed a primary standard.

OTHER OBSERVATIONS on UCMR 4 MN DATA

- One can't easily tease out the influence of source waters versus permanganate treatment, but high %RSD and high average concentrations in some SW plants make it possible it's not just source influences (devil's in the details).



SWITCHING THE FOCUS TO SOURCE WATERS

- Source water bromide and TOC act as precursors for HAA species, which is the main reason they were included in UCMR 4.

- There has been literature showing bromide influences from anthropogenic sources like power plants, and potential impacts on DBPs. However WRF project 4711 (2020) suggests that bromide levels have not really changed over an extended period of time.

ICR DATA (1997)

Statistic	TOC (mg/L)	Bromide (ug/L)
Mean	2.8	69
Median	2.4	36
Maximum	27.5	2230
90th percentile	5.3	160
10th percentile	<0.35	<10
Total samples	7504	7959

- 296 water systems (representing 500 treatment plants)
- Lower reporting limits than UCMR 4

From: Information Collection Rule Data Analysis (AWWARF 2002)

OVERALL SOURCE WATER MEASUREMENTS COMPARISON

Statistic	ICR TOC (mg/L)	UCMR 4 TOC (mg/L)	ICR Bromide (ug/L)	UCMR 4 Bromide (ug/L)
Mean	2.8	1.3	69	136
Median	2.4	<1	36	38
Maximum	27.5	57	2230	73000
90th percentile	5.3	4.0	160	193
10th percentile	<0.35	<1	<10	<20
Total samples	7504	15127	7959	15225

WHY ARE THE ICR AND UCMR RESULTS SO DIFFERENT?

- Mainly because its different sample sets.
  - ICR was only 100K+ systems
  - UCMR 4 includes a lot more GW; = lower TOC
- Changes in source waters over time?
  - More saline sources? < TOC, higher Bromide
- Bromide results are not all that different overall.

LARGE SYSTEM SOURCE WATER MEASUREMENTS

Statistic	ICR TOC (mg/L)	UCMR 4 TOC (mg/L)	ICR Bromide (ug/L)	UCMR 4 Bromide (ug/L)
Mean	2.8	1.8	69	151
Median	2.4	1.2	36	40
Maximum	27.5	27.6	2230	50020
90th percentile	5.3	4.7	160	230
10th percentile	<0.35	<1	<10	<20
Total samples	7504	2333	7959	2336

Luckily, one can just pull the subset of large systems from UCMR 4, and that confirms changes in source waters for both TOC and Bromide.

UCMR 4 LARGE SYSTEM (>100K) SW vs GW

Statistic	SW TOC (mg/L)	GW TOC (mg/L)	SW Bromide (ug/L)	GW Bromide (ug/L)
Median	2.9	<1	30	57
Maximum	16	27.6	3130	10100
90th percentile	6.1	1.6	160	274
10th percentile	1.4	<1	<20	<20
Total samples	1013	1260	1013	1260

As expected, TOC is higher in SW systems , whereas bromide is higher in GW systems.

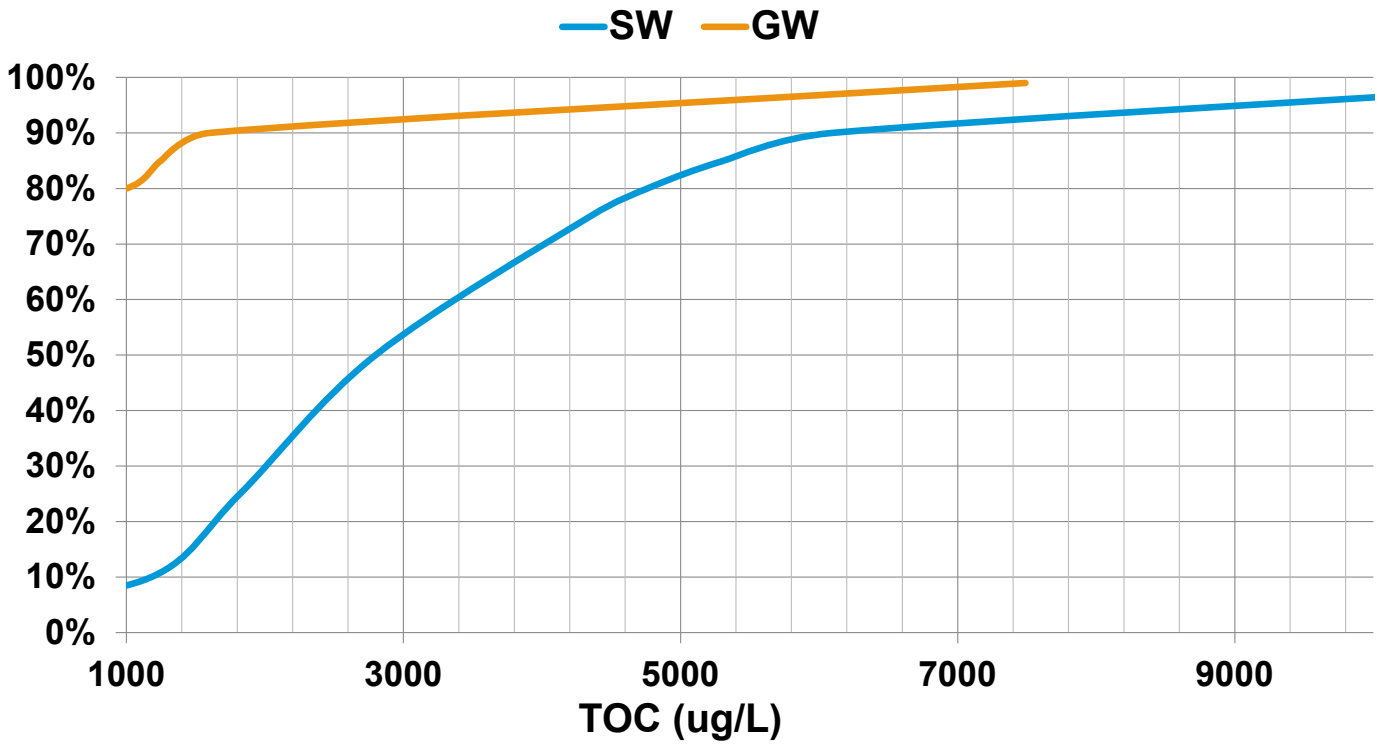
WHY HAVE BOTH TOC AND BROMIDE CHANGED IN LARGE SYSTEM SOURCE WATERS?

- TOC likely reasons for decrease?
  - Systems changed sources to minimize DBP formation potential?
  - Climate change impacts?

- Bromide likely reasons for changes in 90th percentile?
  - Climate change?
  - More saline water sources?
  - Coal ash impact?

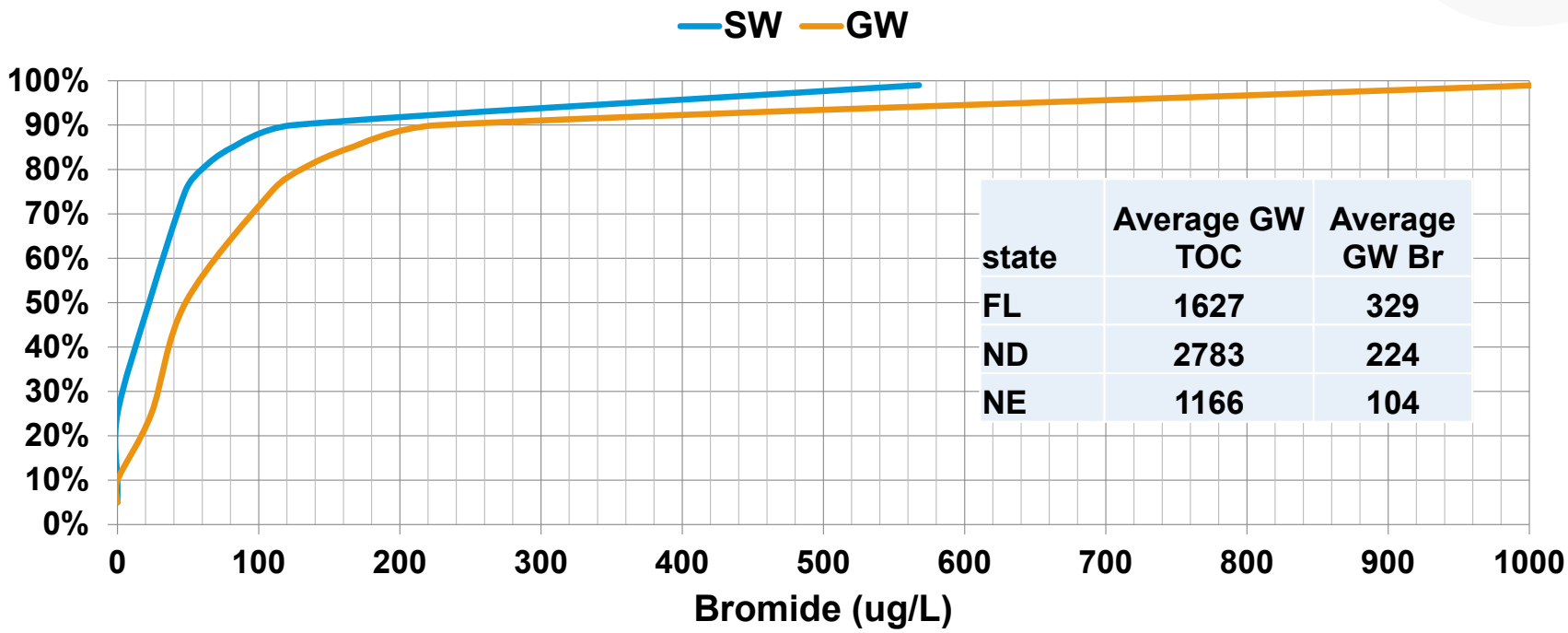
This is obviously worth exploring more because of the DBP implications but is not the focus here (and its still speculative).

GW vs SW TOC- ALL UCMR 4 SAMPLES



Although, as expected, TOC is much higher in SW systems than GW systems, nearly 10% of GW samples have TOC > 3000 ug/L, which could lead to measureable DBPs.

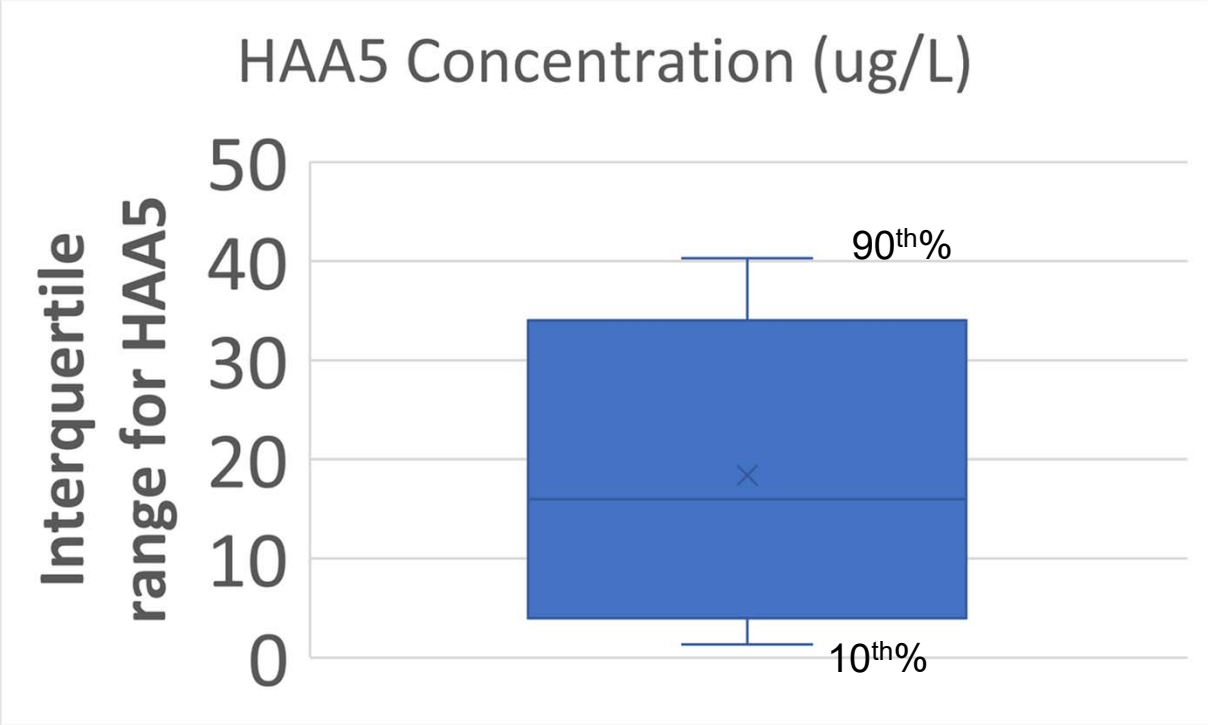
GW vs SW BROMIDE- ALL UCMR 4 SAMPLES



state	Average GW TOC	Average GW Br
FL	1627	329
ND	2783	224
NE	1166	104

Br levels in GW systems are generally higher than SW, but won't have as big an effect on DBPs because of lower TOC levels. FL, ND, and NE all are likely to have Brominated HAA in GW systems.

COMPLIANCE WITH HAA STANDARDS REMAINS GOOD

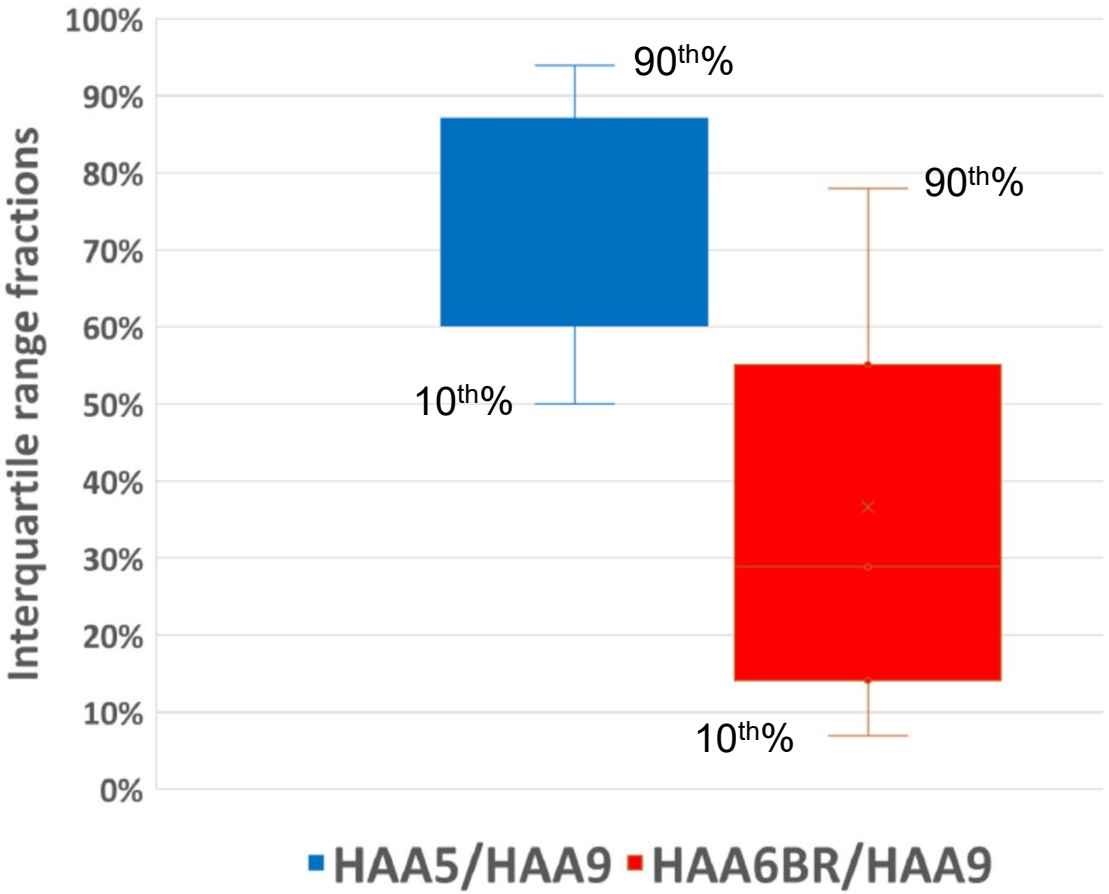


Only 2% of HAA5 exceed the 60 ppb MCL

95% of HAA5 results are below 50 ppb.

There are still a few “tails”, with HAA values as high as 460 ppb

MORE ABOUT THE HAAs



HAA5 accounts for 75% (median) to 87% (75th percentile) of HAA9, indicating that HAA5 is a good surrogate for overall HAA.

Brominated HAAs account for 29% (median) to 55% (75th percentile) of HAA9, indicating that chlorinated HAAs are still the dominant species.

CONCLUSIONS

- Significant occurrence of Mn at levels above the SMCL in UCMR 4 suggest the possibility of regulation.
- GW systems are more susceptible to high levels of manganese, but it can be a SW system issue also.
- DBP precursor concentrations appear to have changed in the last 20+ years (post ICR) and the cause needs to be determined, along with the implications for DBPs.
- Most of the organic results and cyanotoxins do not seem to raise any regulatory issues (although quinoline is interesting)

QUESTIONS?