MTBE and Other VOCs in Drinking Water in the Northeast and Mid-Atlantic Regions

A cooperative study with the USEPA Office of Ground Water & Drinking Water

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U.S. Department of the Interior
U.S. Geological Survey

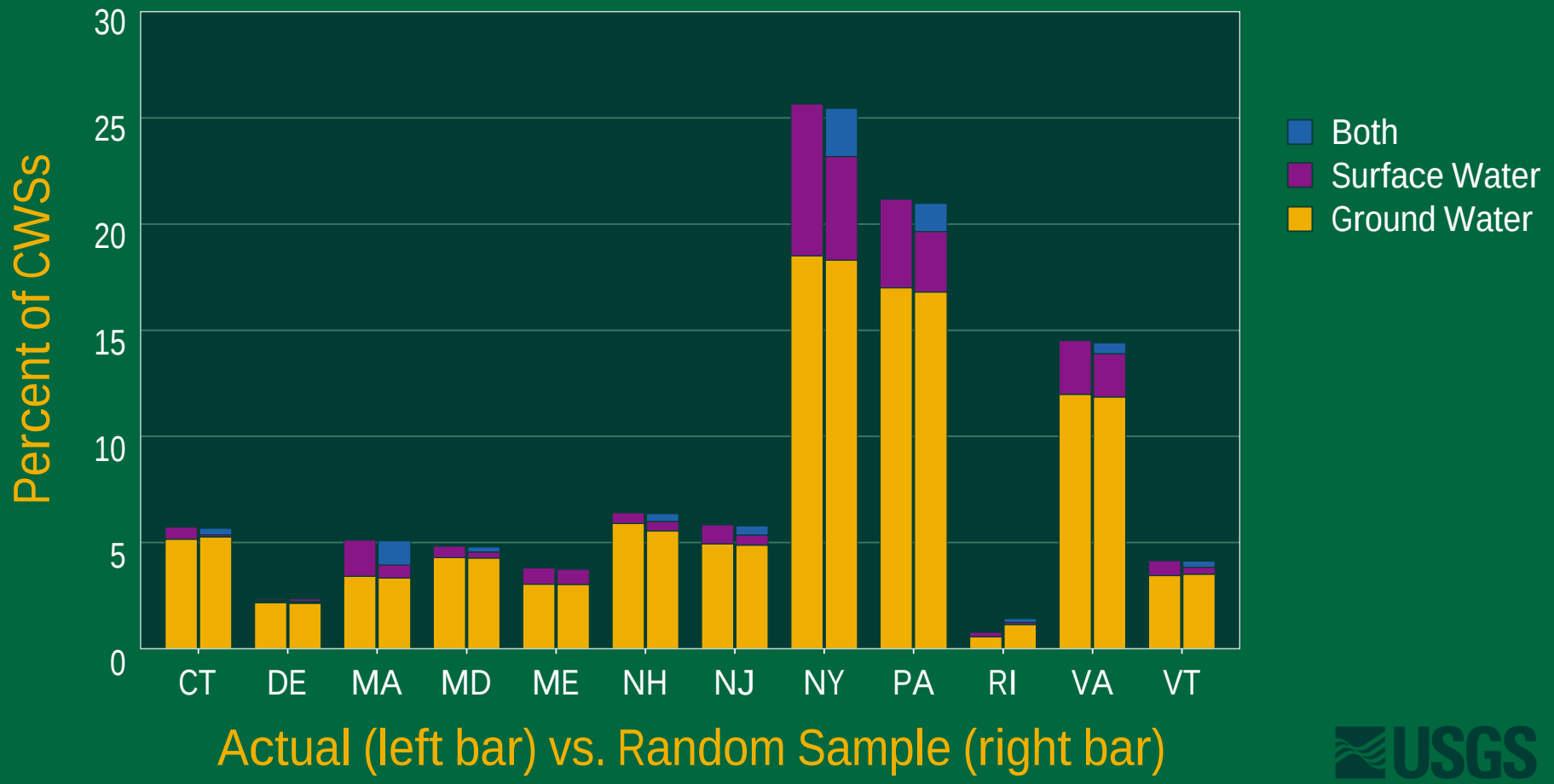
Study Design

- Only community water systems (CWSs)
- Representative 20-percent sample
- Stratified-random selection by source of water, size of system, and State
- Data for 1993-98 SDWA compliance monitoring

USGS

Distribution of CWSs

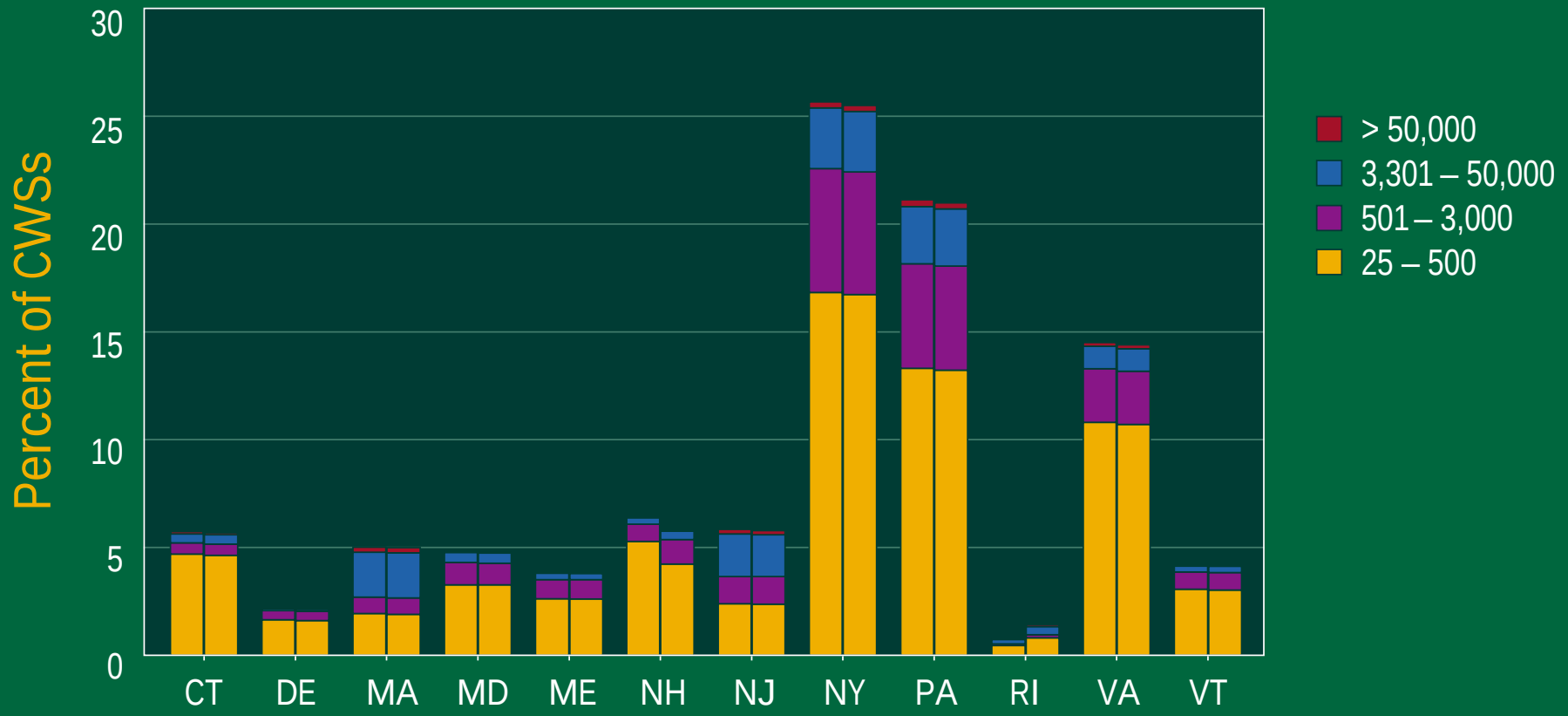
by Source of Water



USGS

Distribution of CWSs

by Population Served

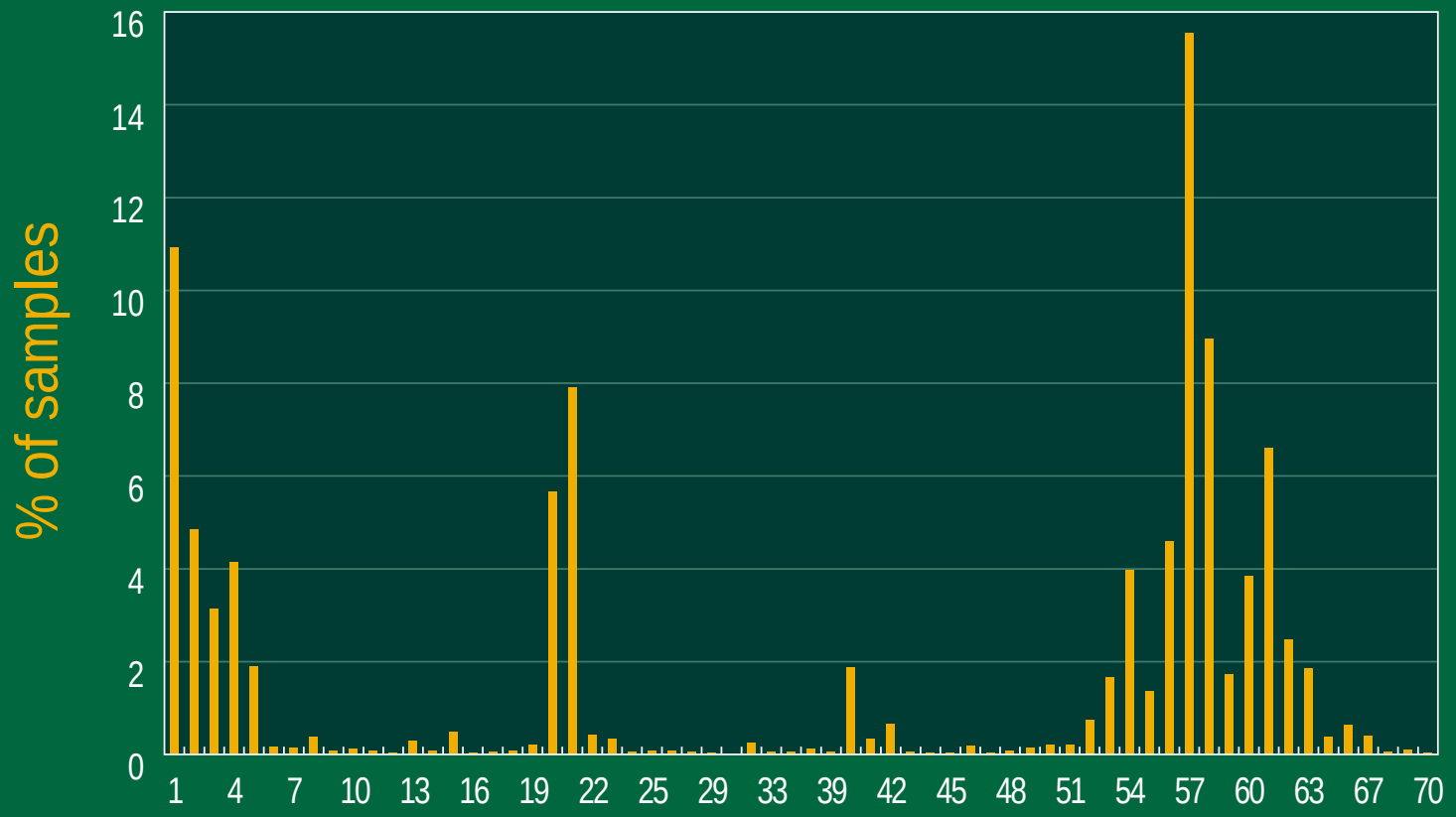


Actual (left bar) vs. Random Sample (right bar)

USGS

VOC Analytes per Sample

21,635 Samples from 2,110 CWSs



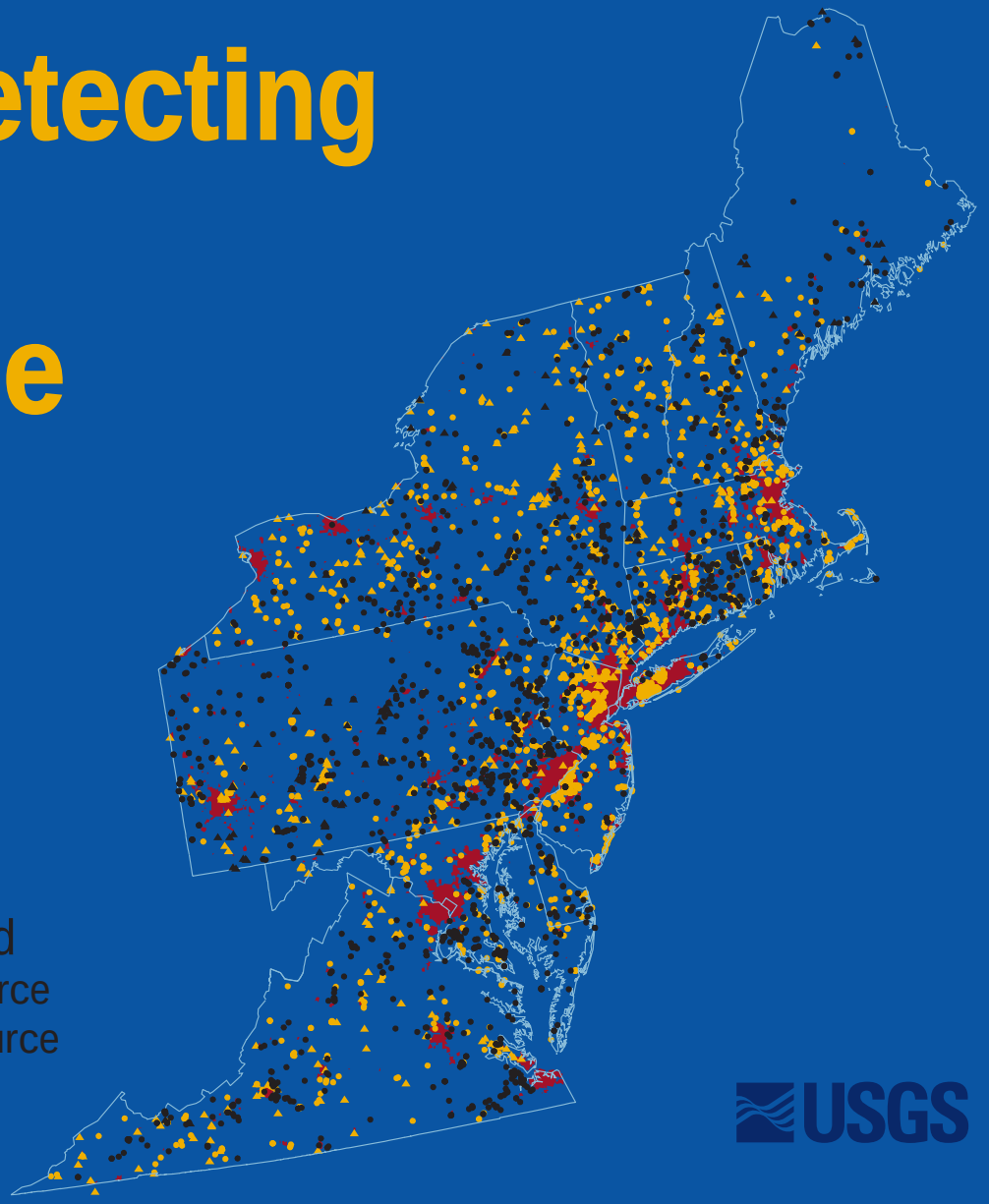
USGS

Probability of detecting VOCs is related to urban land use

% of CWSs with VOCs

— 67% in urban areas

— 42% in rural areas



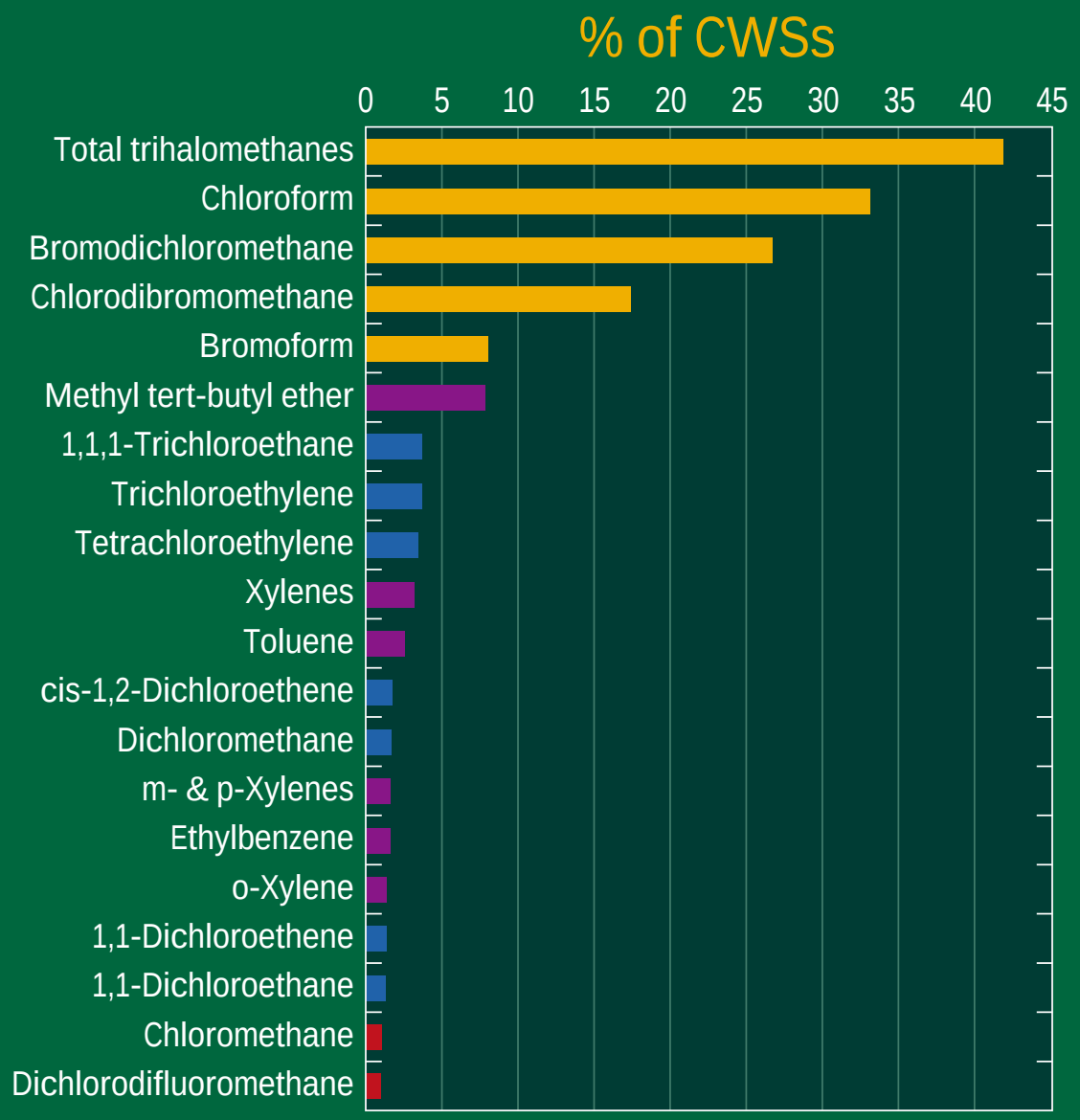
VOCs detected
- ● Ground-water source
- ▲ Surface-water source

VOCs not detected
- ● Ground-water source
- ▲ Surface-water source

■ Urban areas (pop. > 1,000 people/mi²)

USGS

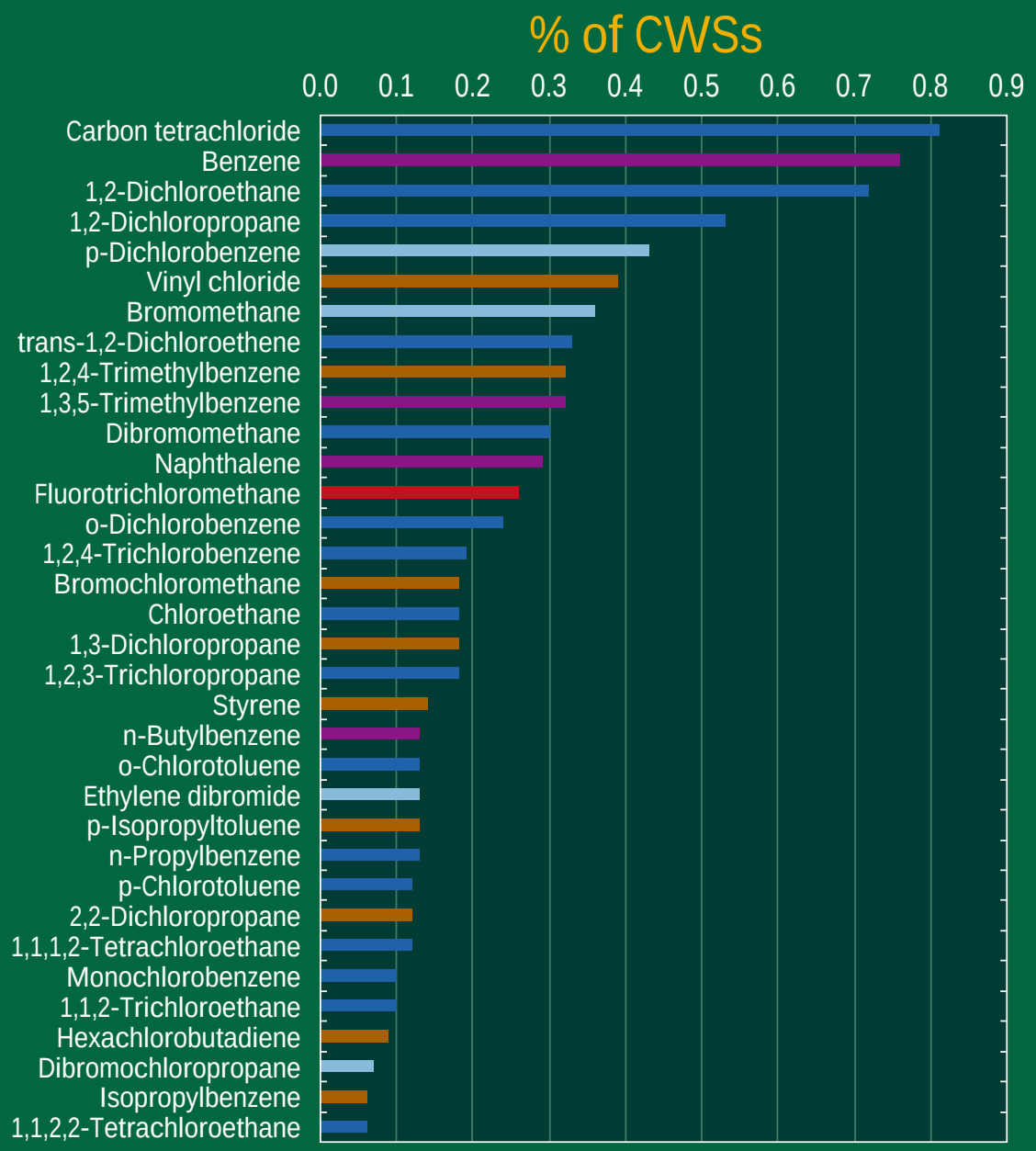
Frequency of VOC Detection ≥ 1.0 µg/L



- Disinfectant by-product
- Gasoline component
- Solvent
- Refrigerant

USGS

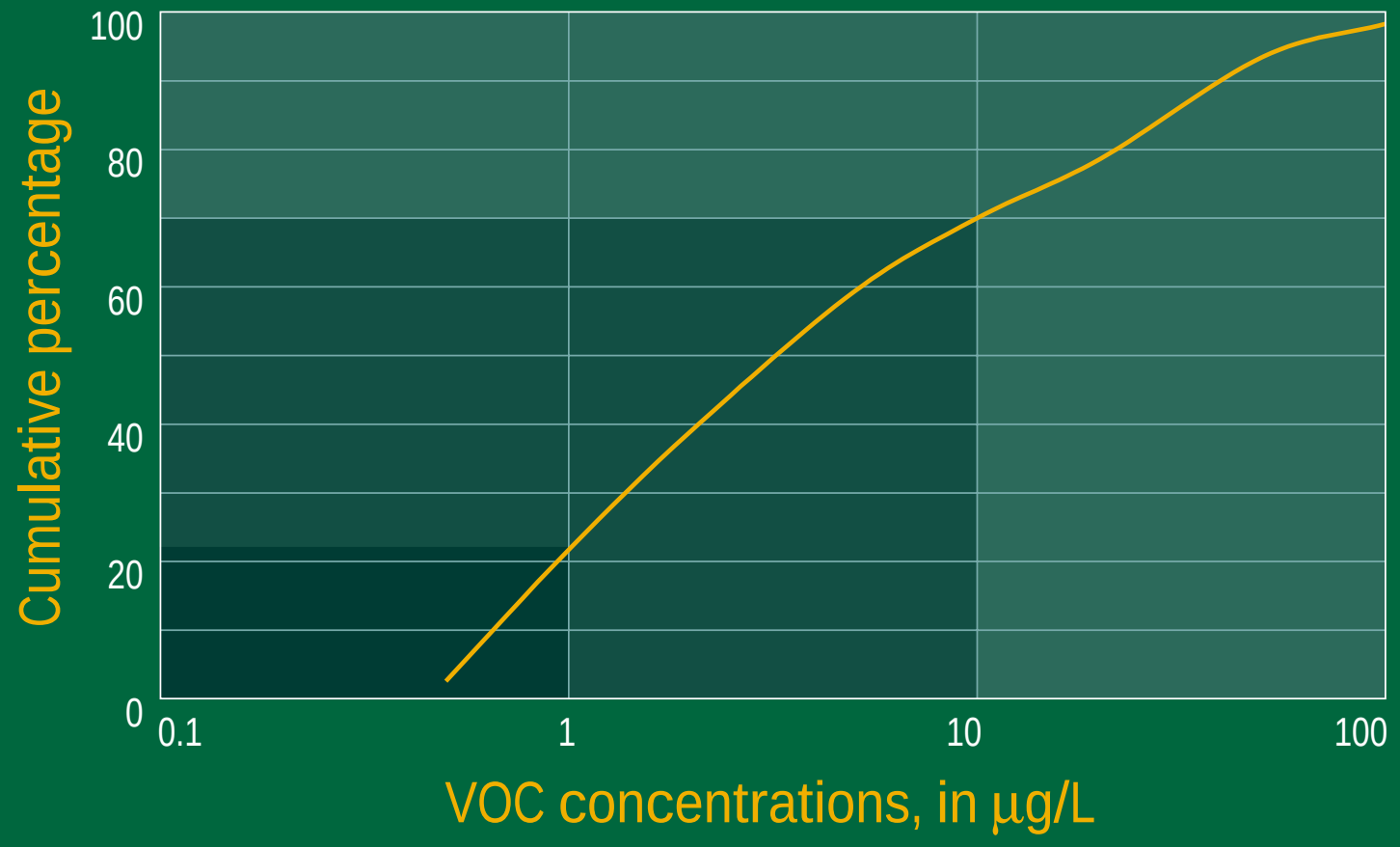
Frequency of VOC Detection ≥ 1.0 µg/L



- Solvent
- Gasoline component
- Organic synthesis compound
- Fumigant
- Refrigerant

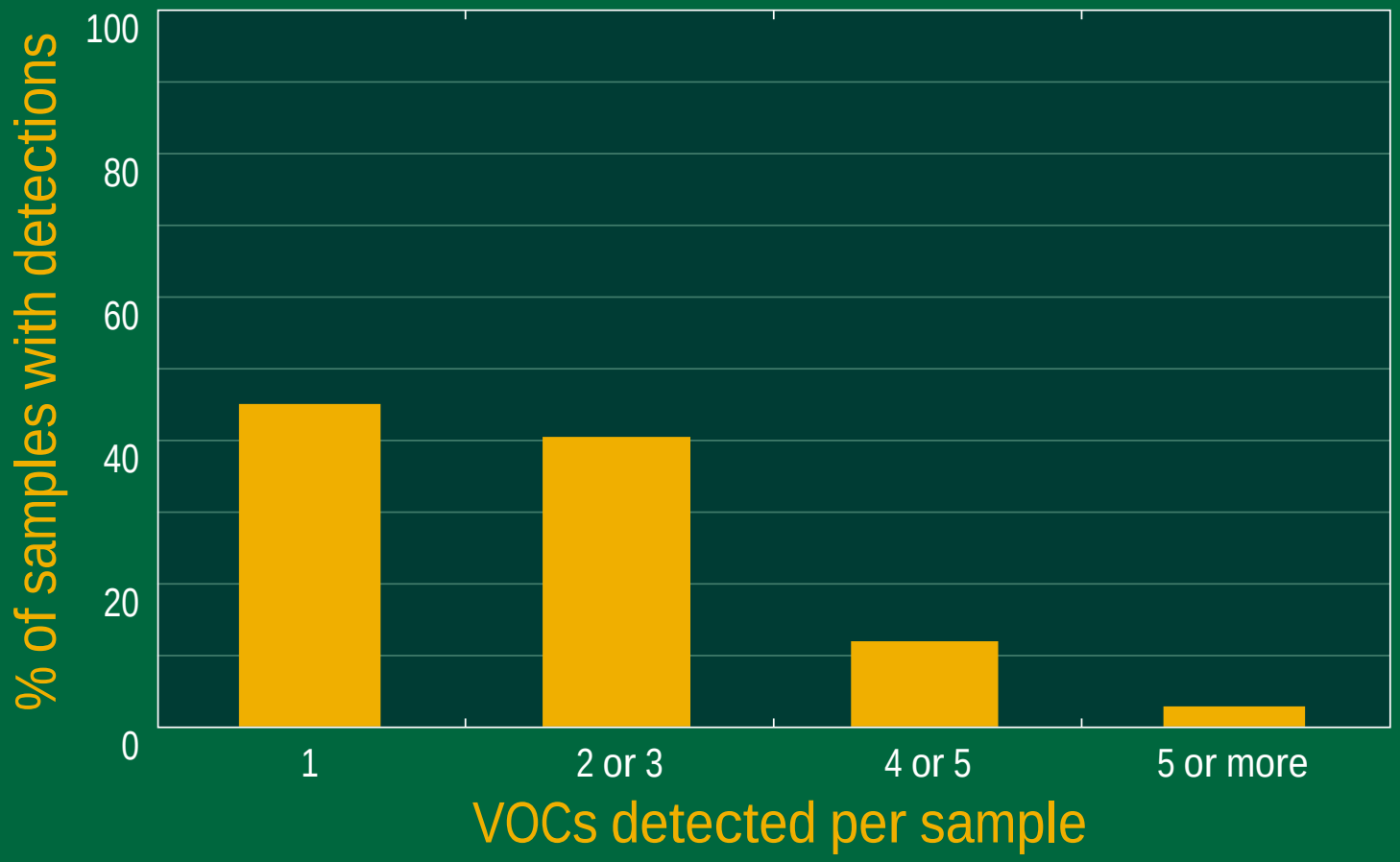
USGS

Cumulative Distribution of VOC Concentrations



USGS

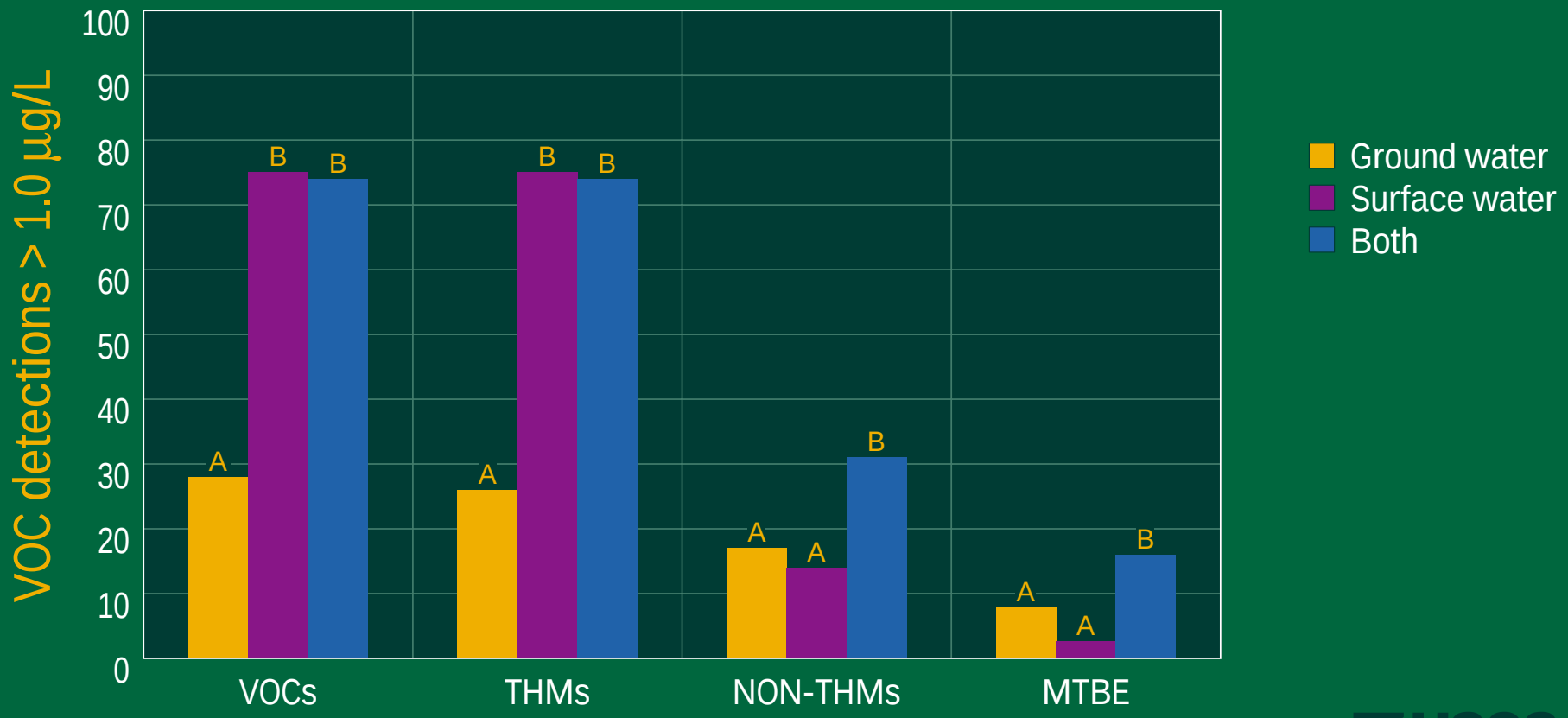
Frequency of VOC Co-Occurrence in Drinking Water



USGS

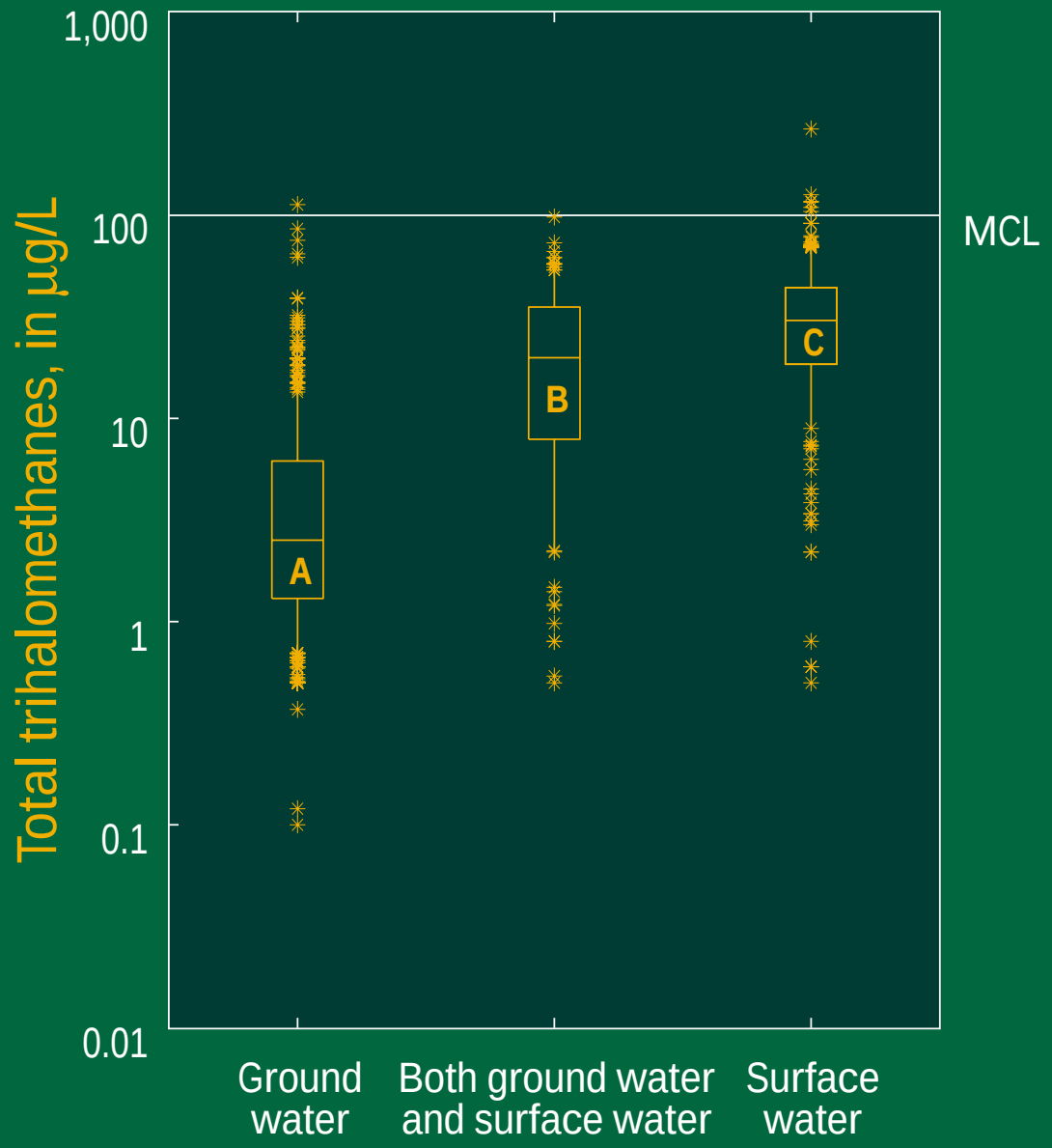
VOC Detections

Varied by Source of Water



USGS

Total Trihalomethane Concentrations Compared by Source



$p<0.0001$

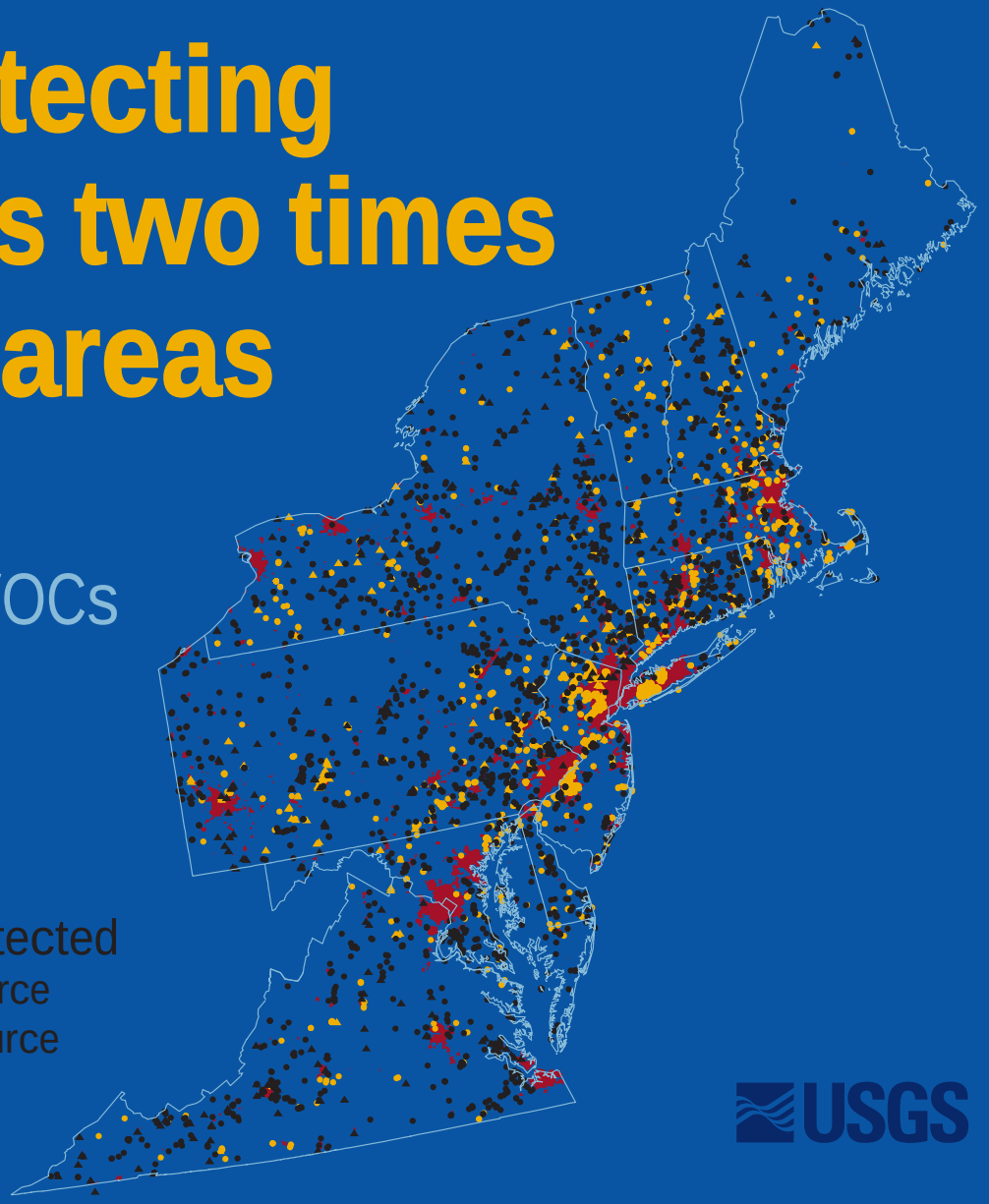
USGS

Probability of detecting non-THM VOCs is two times greater in urban areas

% of CWSs with non-THM VOCs

— 46% in urban areas

— 22% in rural areas



non-THMs detected
- Ground-water source
- Surface-water source

non-THMs not detected
- Ground-water source
- Surface-water source

Urban areas (pop. > 1,000 people/mi²)

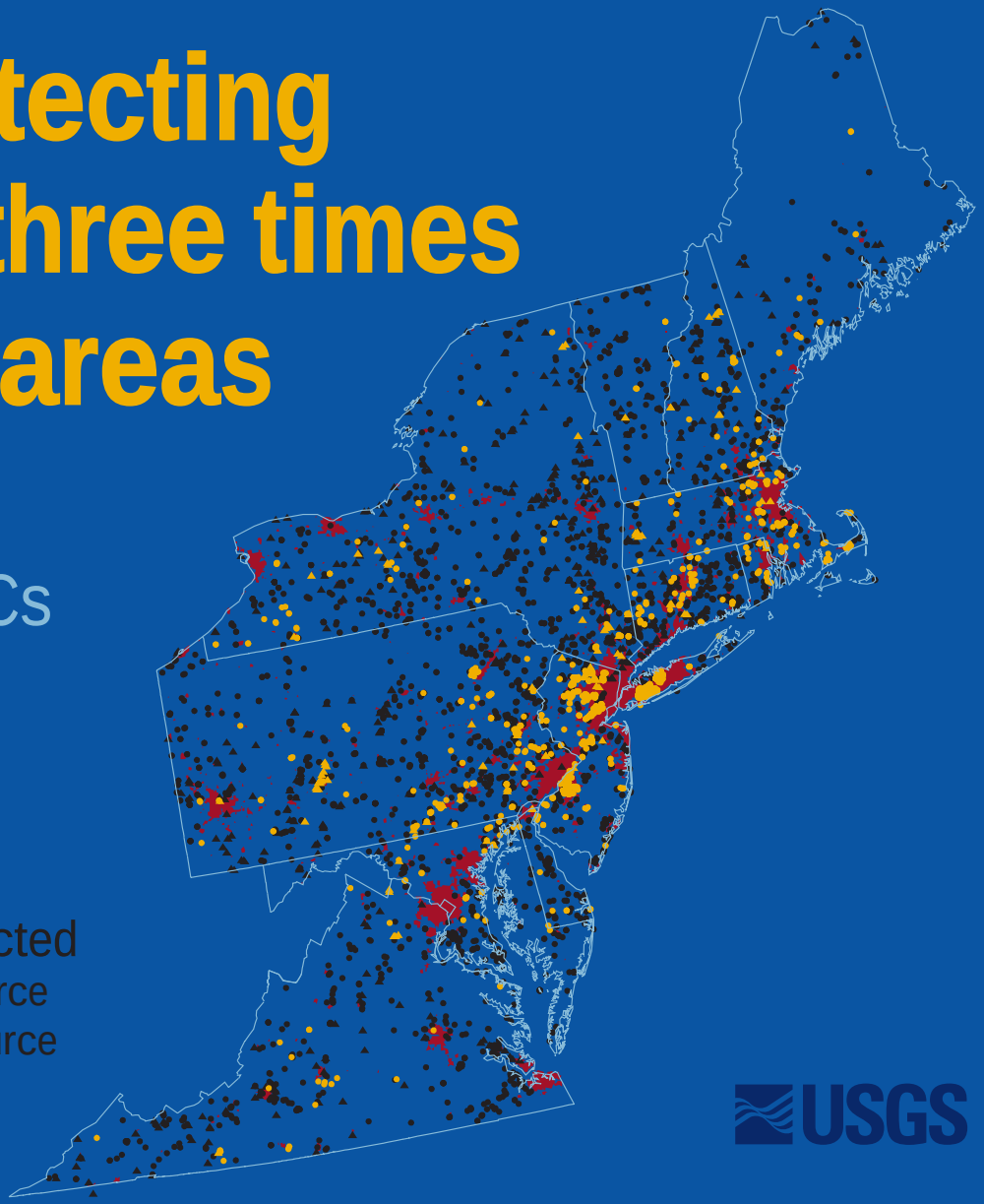
USGS

Probability of detecting solvent VOCs is three times greater in urban areas

% of CWSs with solvent VOCs

— 33% in urban areas

— 11% in rural areas



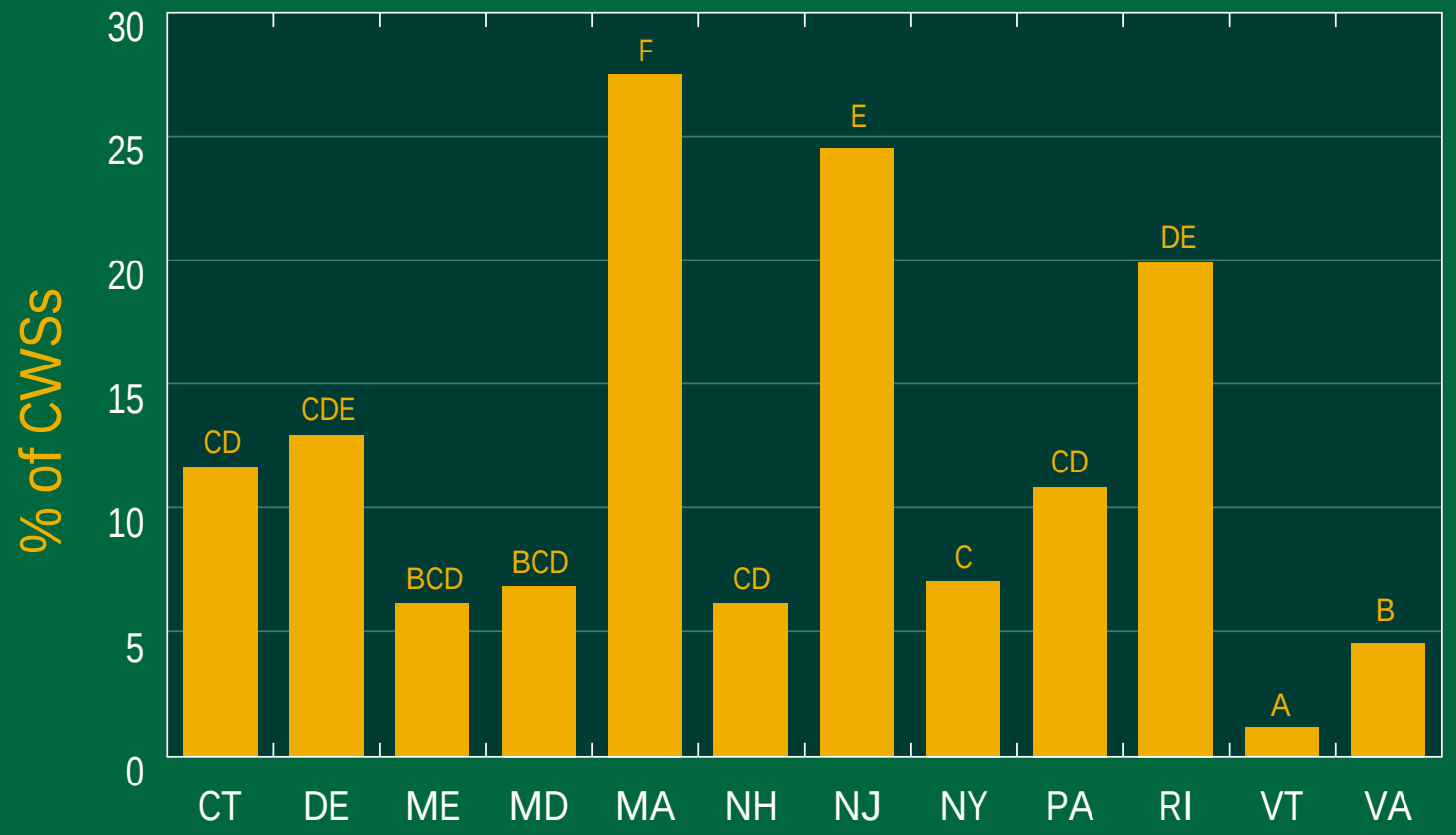
Solvents detected
- Ground-water source
- Surface-water source

Solvents not detected
- Ground-water source
- Surface-water source

- Urban areas (pop. > 1,000 people/mi²)

USGS

Frequency of Detection of Solvents ≥ 1.0 µg/L



$p<0.0001$

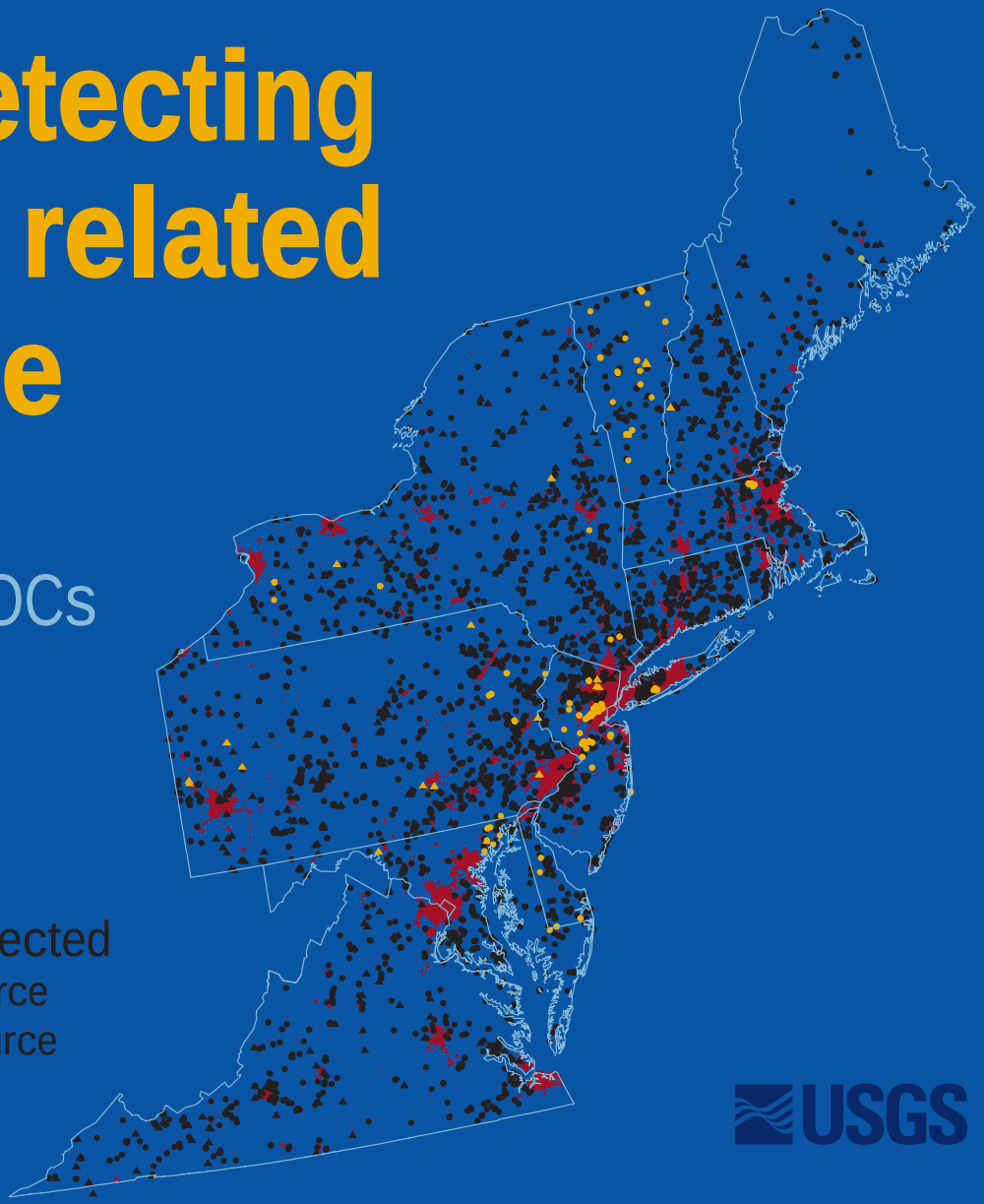
USGS

Probability of detecting fumigants is not related to urban land use

% of CWSs with fumigant VOCs

— 4% in urban areas

— 3% in rural areas



Fumigants detected
- Ground-water source
- Surface-water source

Fumigants not detected
- Ground-water source
- Surface-water source

Urban areas (pop. > 1,000 people/mi^2)

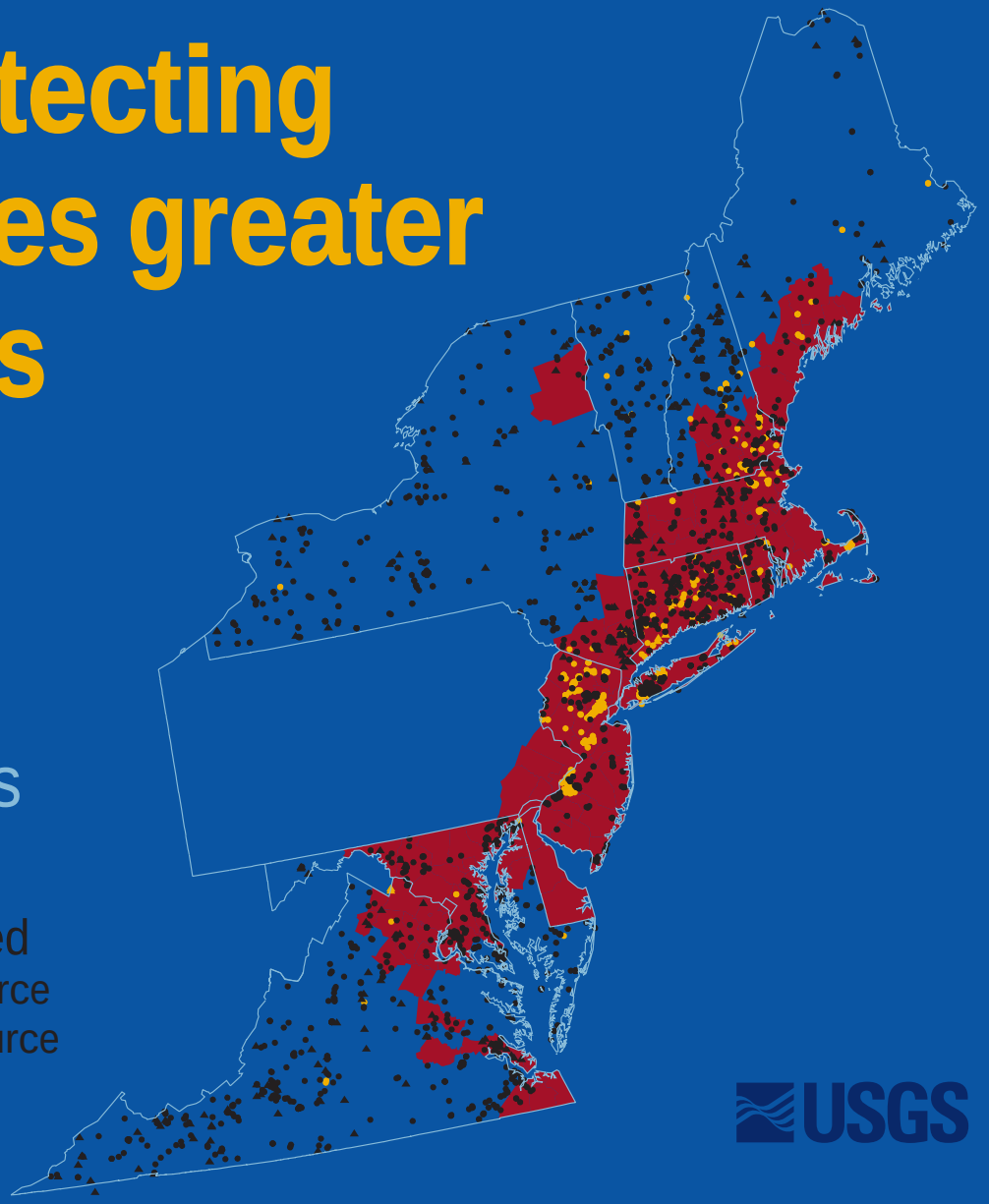
USGS

Probability of detecting MTBE is five times greater in RFG/OXY areas

% of CWSs with MTBE:

— 16% in RFG/OXY areas

— 3% out of RFG/OXY areas



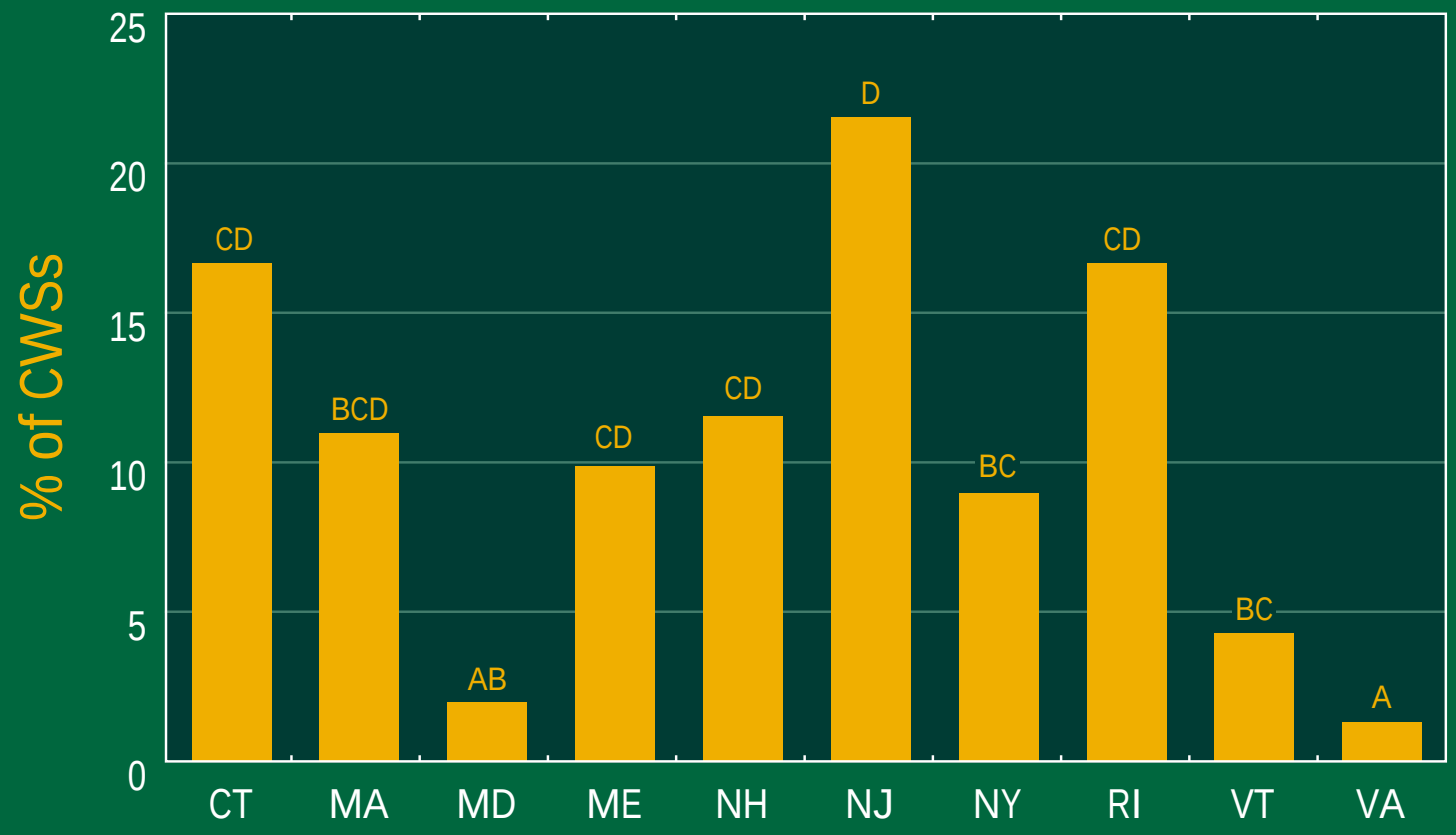
MTBE detected
- ● Ground-water source
- ▲ Surface-water source

MTBE not detected
- ● Ground-water source
- ▲ Surface-water source

■ RFG/OXY areas

USGS

Frequency of Detection of MTBE ≥ 1.0 µg/L



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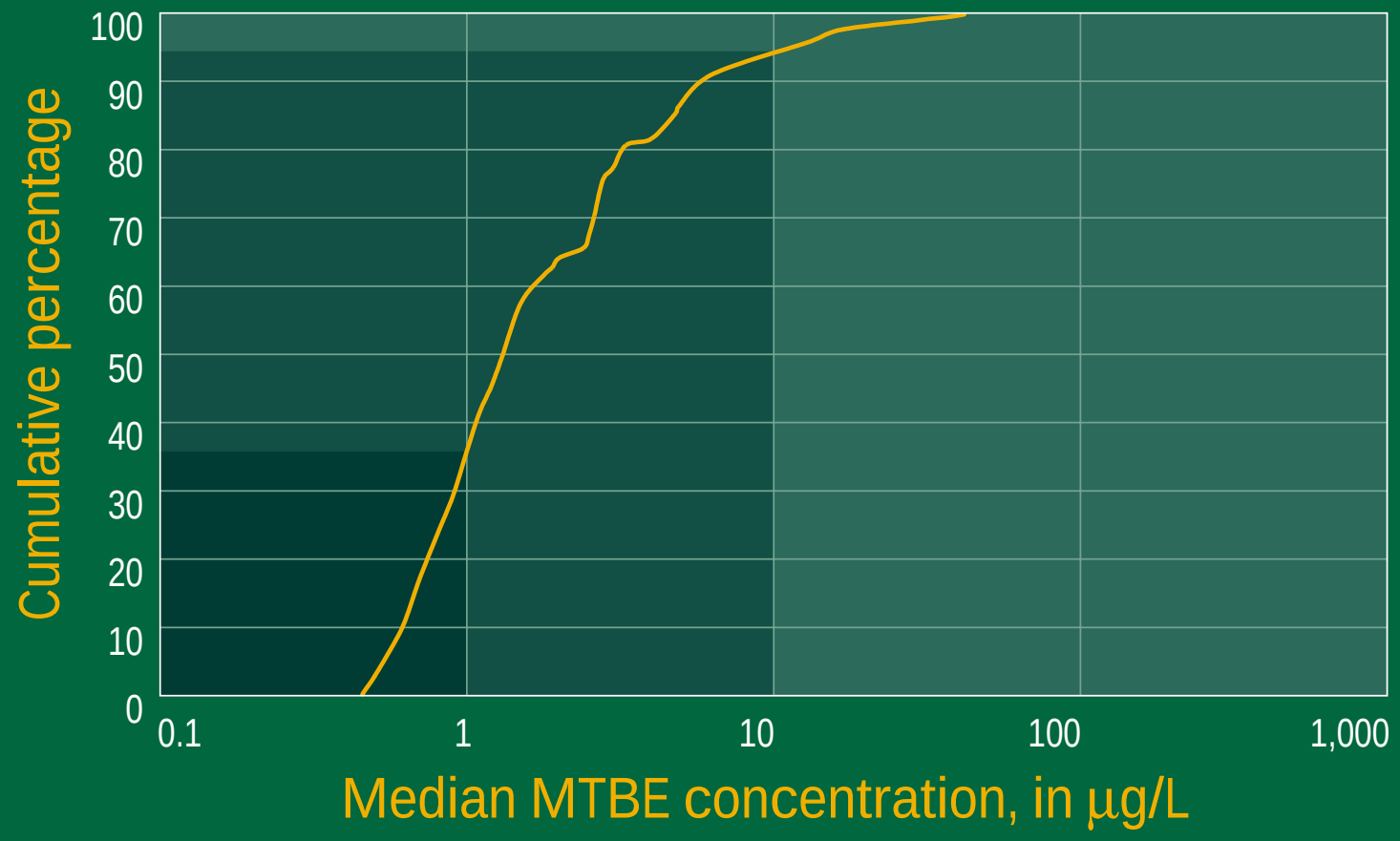
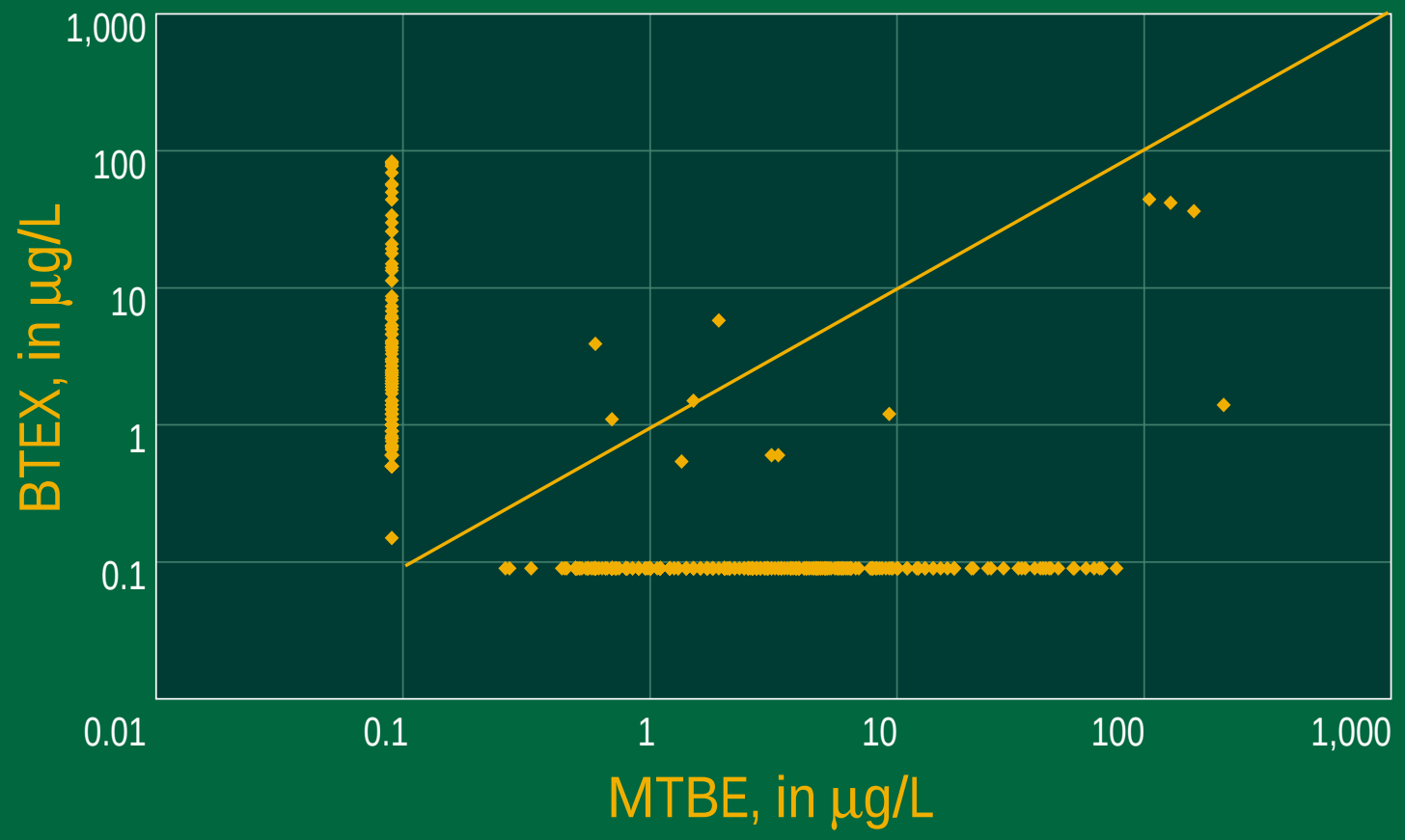
USGS

Cumulative Distribution of Median MTBE Concentrations



USGS

Concentrations of MTBE and BTEX in Drinking-Water Samples



p<0.0001

USGS

Population Served by Sampled CWSs with Detections (in million people)

	at any conc.	at 1.0 µg/L	MCL/HA/DWA
VOCs	8.8	8.7	2.6
THMs	8.6	8.4	0.9
Non-THMs	5.3	4.5	1.7
MTBE	2.3	2.0	0.05

USGS

Estimated Population Served in 12-State Area Potentially Exposed

(in million people)

	at any conc.	at 1.0 µg/L
VOCs	52.5 – 53.6	51.7 – 52.8
THMs	53.2 – 53.6	51.8 – 52.6
Non-THMs	31.1 – 32.0	26.5 – 27.4
MTBE	18.6 – 19.8	17.1 – 18.7

USGS

Conclusions

- 64 of 84 VOC analytes detected in drinking water
  - THMs>>MTBE>1,1,1-TCA, TCE, PCE> BTEX
- 45 % of CWSs reported one or more VOC
  - detections 2X more often in urban areas
- 70 % of all detections < 10 μg/L
- Population exposed to VOCs: ~9 million by sampled CWSs, ~52 -54 million projected

USGS

Conclusions (continued)

- MTBE detected: 8.9 % of CWSs @ any conc.
  7.8 % of CWSs @ 1.0 µg/L
  0.8 % of CWSs @ 20 µg/L
- MTBE detected 5X more often in RFG/OXY areas
- MTBE detected in ground & surface water
  - most often in larger CWSs with both sources (urban)
- MTBE does not co-occur with BTEX
- Population exposed: ~2.3 million sampled,
  ~19 million projected

USGS