

Case Study: Local Limits Development for the Brightwater Wastewater Treatment Plant

King County Industrial Waste Program
Seattle, Washington

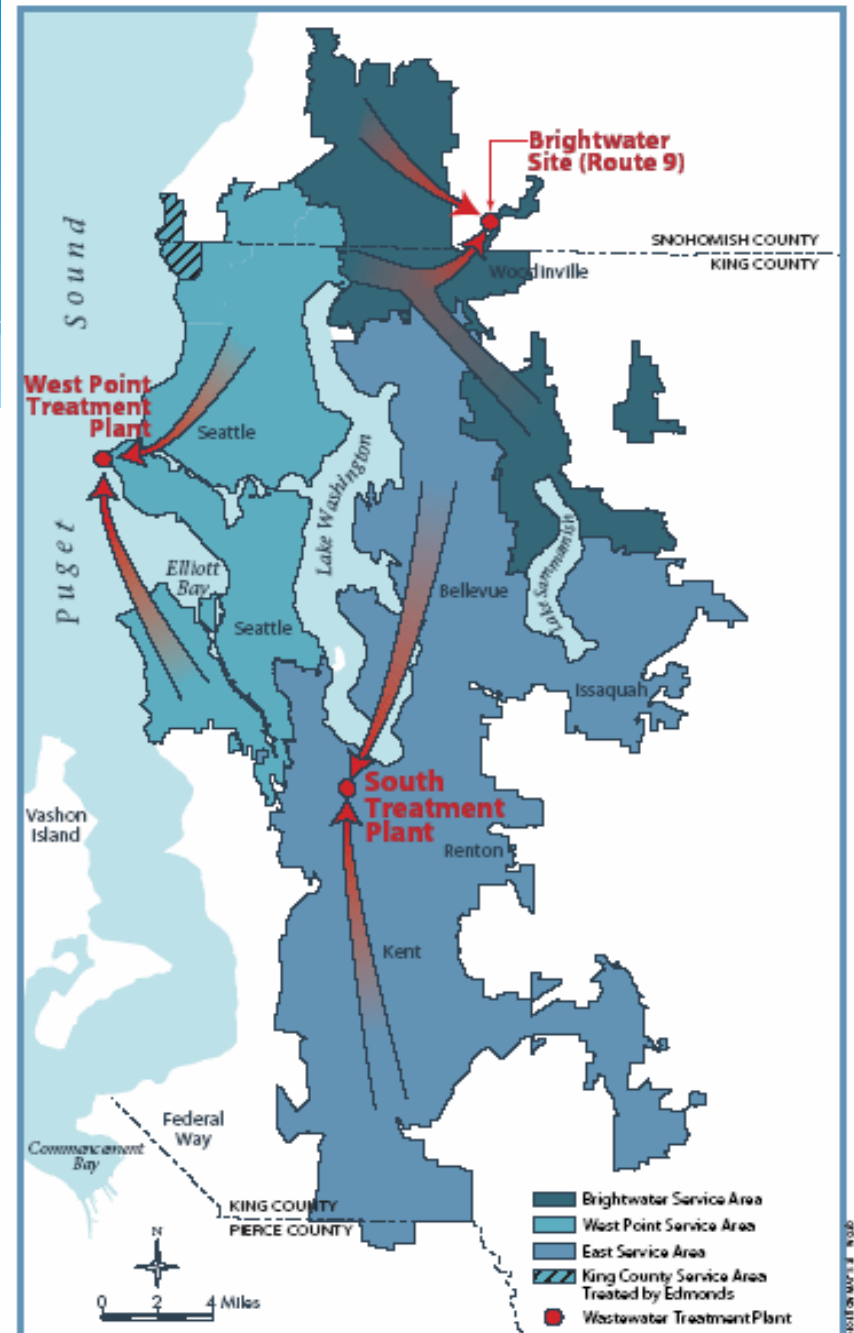
Pretreatment Objectives

- Protect worker health & safety
- Prevent interference with operation of treatment plants
- Prevent pass-through to the environment
- Recycle biosolids/ Reclaim Water



King County Wastewater System

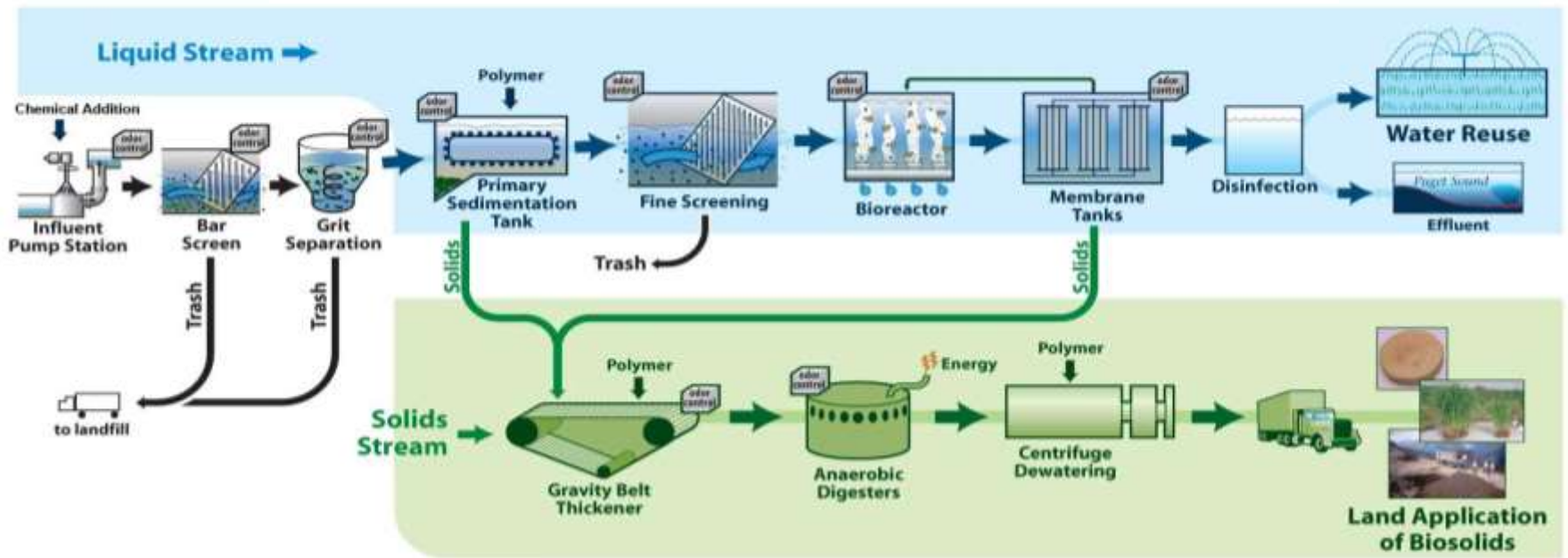
- 1.5 million people over 415 square miles
- 34 local sewer agencies
- About 180 million gallons of wastewater treated every day
- Three regional and two local treatment plants
- About 650 businesses approved to send industrial wastewater into the sewer





Treatment Plant Processes

- Membrane bioreactor treatment technology
- Biosolids production via anaerobic digestion
- State-of-the-art odor control system
- Reclaimed water availability



Local Limits Study Design



- Quarterly sampling for two calendar years (2015 & 2016)
- Three locations in Brightwater service area that represent domestic/commercial (uncontrollable) sources
- Sampling influent/effluent at Brightwater treatment plant
- Simultaneous sampling at Brightwater treatment plant and at the service area sites (paired dataset)
- Use of flow-proportioned sampling

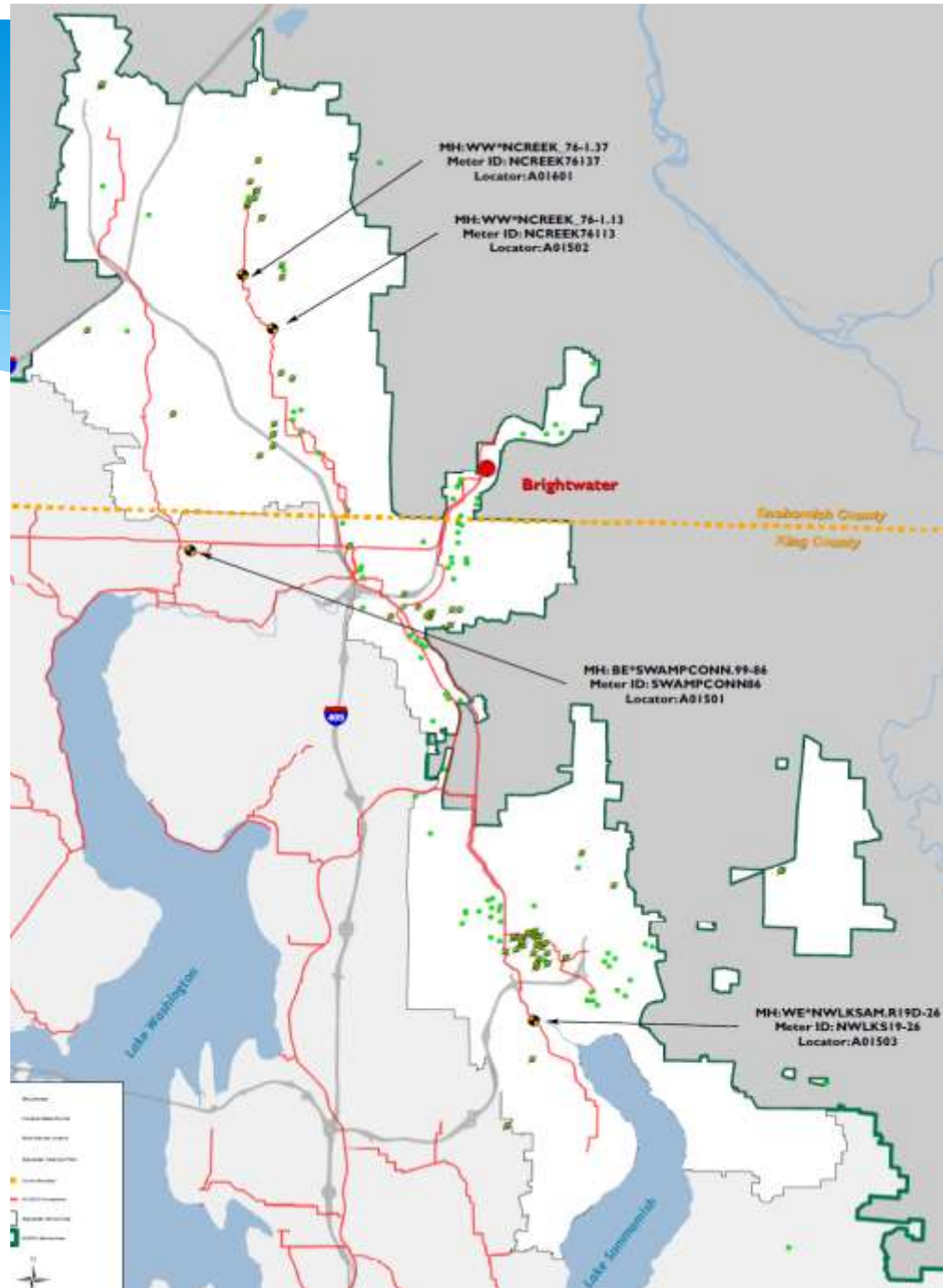
Service Area

Sampling

Swamp Creek

North Creek

NW Lake Sammamish



Analytes

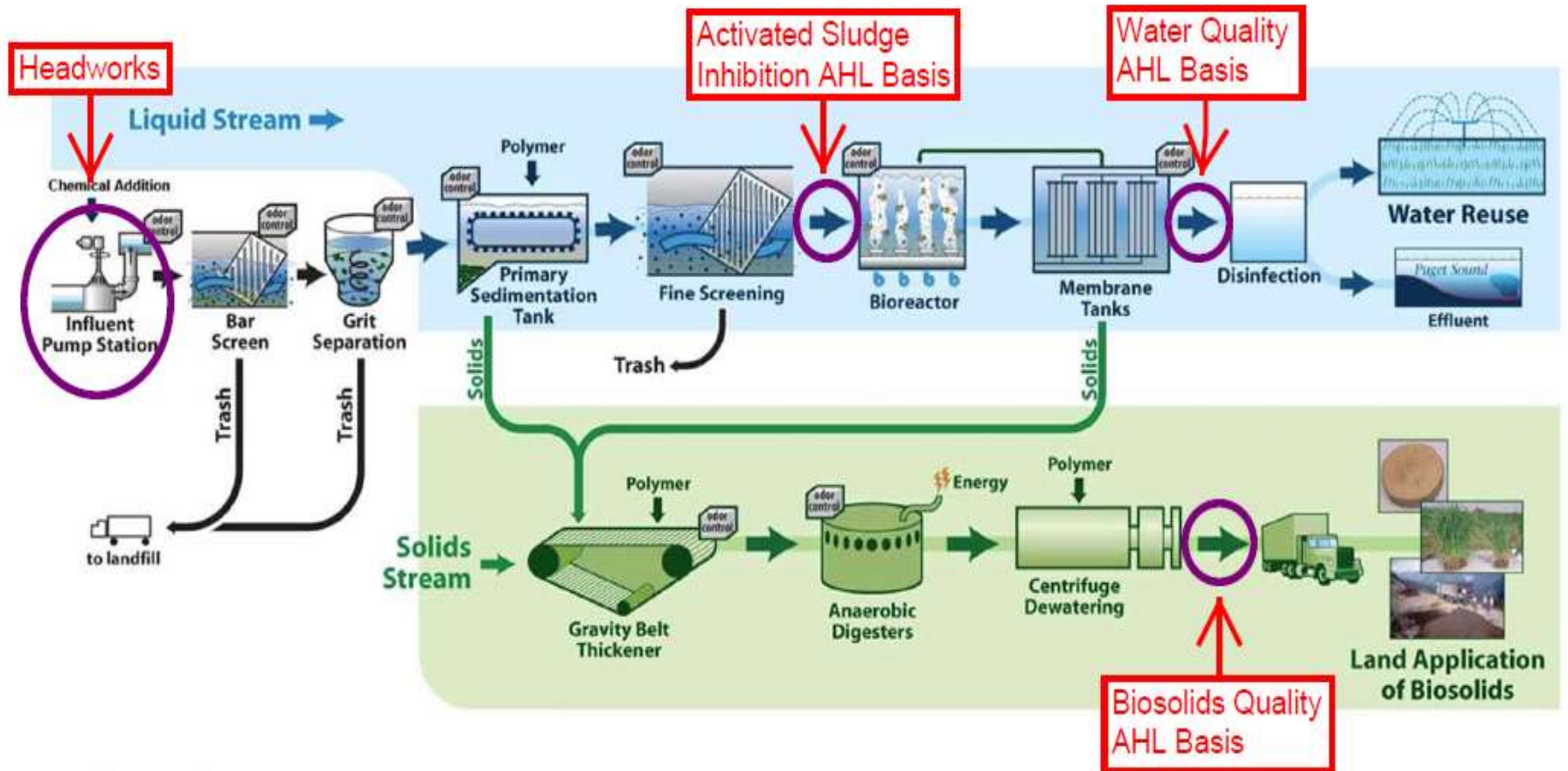
- Current Local Limits Metals:
As, Cd, Cr, Cu, Pb, Hg, Ni, Ag,
Zn
- Extra Metals: Molybdenum &
Selenium
- Total Cyanide
- Biochemical Oxygen Demand
- Total Suspended Solids



How Are Local Limits Calculated?

- * Determine the Relevant Environmental Criteria: Activated Sludge Inhibition, Biosolids Quality, NPDES Discharge Limits, Etc.
- * Determine Removal Efficiency for a Given Parameter and Work Backwards From Environmental Criterion to Determine Allowable Headworks Loading (AHL)
- * Find the Most Stringent AHL for a Given Parameter to Determine Maximum Allowable Headworks Loading (MAHL)
- * Remove Loadings from Uncontrollable Sources (i.e., Residential and Commercial)
- * Remaining Loading (Minus Safety Factor) is Allocated to Industrial Users – Maximum Allowable Industrial Loading (MAIL)

Allowable Headworks Loading (AHL) Determination



What Data Do You Need to Collect?

- Treatment Plant Influent and Effluent Chemistry
- Treatment Plant Daily Flow Rate
- Treatment Plant Biosolids Production Data
- Service Area Chemistry from Domestic/Commercial Sub-Basin(s)
- Estimate of Daily Flow Rate from Industrial Users (in Aggregate)
- Chemistry of Receiving Water
- Treatment Plant NPDES Permit Conditions (mixing zone, etc.)

Which Environmental Standards Should You Use?

- Activated Sludge Inhibition
 - Literature Value (2004 EPA Local Limits Guidance)
 - Highest Concentration Where Inhibition Did Not Occur
 - Use Only for Clear Connection Between a Chemical Concentration and Treatment Plant Upset
- Water Quality Standards (Freshwater or Marine)
 - Acute
 - Chronic
 - Human Health (Carcinogenic and Non-Carcinogenic)
- Biosolids Quality Standards

The Allowable Headworks Loading (AHL) Equations

$$\text{AHL}_{\text{inhib}} = (8.34)(C_{\text{inhib}})(Q_{\text{WWTP}})(1-\text{SF})$$

(Note: Assumes No Primary Removal)

$$\text{AHL}_{\text{NPDES}} = \frac{(8.34)(C_{\text{NPDES}} - C_{\text{rw}})(Q_{\text{WWTP}})(1-\text{SF})}{(1-R_{\text{WWTP}})}$$

$$\text{AHL}_{\text{bsldstd}} = \frac{(C_{\text{bsldstd}})(\text{SL}_{\text{bsld}})(2000)(1-\text{SF})}{(R_{\text{WWTP}})(10^6)}$$

C_{bsldstd} : Concentration - biosolids standard (mg/kg)

C_{inhib} : Concentration - activated sludge inhibition (mg/L)

C_{NPDES} : Concentration - NPDES permit limit w/mixing zone (mg/L)

C_{rw} : Concentration - receiving water - Puget Sound (mg/L)

Q_{WWTP} : Wastewater treatment plant average flow (MGD)

R_{WWTP} : Removal efficiency - wastewater treatment plant (as decimal)

SF: Safety factor (as decimal)

SL_{bsld} : Solids loading - biosolids (dry tons/day)

Information for Local Limits Calculations

- ❑ Brightwater Treatment Plant – 2015 & 2016 Average Flow: 17.55 MGD
- ❑ Brightwater Treatment Plant – 2015 & 2016 Average Biosolids Production: 9.22 dry tons/day
- ❑ Industrial User Average Flow: 0.30 MGD [from permit maximum discharge limit from 12 metal finishers (40CFR433) and one electronic component manufacturer (40CFR469). Food processors and other industrial users considered along with uncontrollable sources.]
- ❑ Safety Factor: 10%

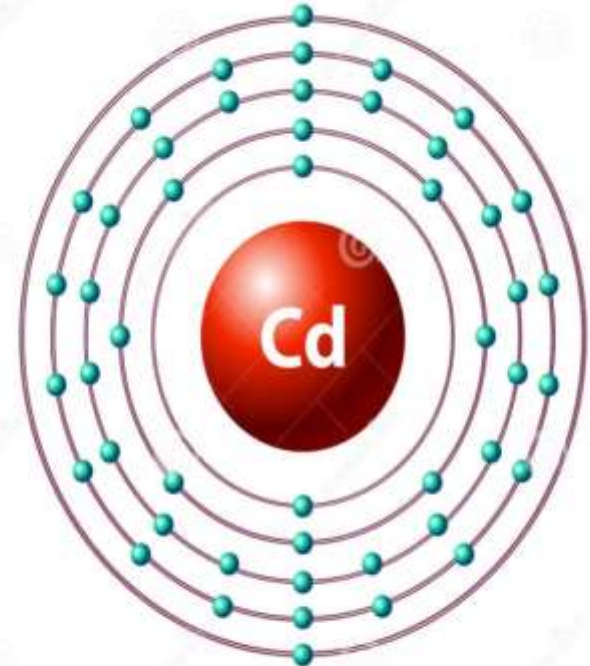
Results of Local Limits Calculations

	Total Metals										
	As	Cd	Cr	Cu	Pb	Hg	Mo	Ni	Se	Ag	Zn
Allowable Headworks Loadings - BWTP											
Removal Efficiencies, %	24.4%	77.3%	77.6%	81.4%	87.1%	98.2%	36.4%	54.4%	63.9%	93.6%	62.2%
Activated Sludge Inhibition, lb/day	13	132	132	132	132	13	-	132	-	-	40
NPDES Permit - Marine Acute WQ, lb/day	1,357	2,798	75,064	355	24,660	1,515	-	2,444	12,164	447	3,586
NPDES Permit - Marine Chronic WQ, lb/day	1,494	1,323	7,246	466	2,038	45	-	554	6,386	-	6,928
NPDES Permit - Human Health WQ - Carcinogen, lb/day	475	-	-	288,093	-	320	-	13,524	13,689	-	250,835
NPDES Permit - Human Health WQ - Non-Carcinogen, lb/day	375	-	-	227,345	-	253	-	10,673	10,803	-	197,943
Washington State Biosolids Quality Standards, lb/day	2.79	0.84	-	30.58	5.72	0.29	3.42	12.81	2.60	-	74.71
Maximum Allowable Headworks Loading (MAHL), lb/day	2.79	0.84	131.74	30.58	5.72	0.29	3.42	12.81	2.60	446.51	39.52
Domestic/Non-Controllable Source Loading, lb/day	0.13	0.02	0.20	5.87	0.17	0.01	0.15	0.37	0.10	0.03	16.10
Maximum Allowable Industrial Loading (MAIL), lb/day	2.65	0.82	131.53	24.72	5.55	0.28	3.27	12.44	2.50	446.48	23.42
Calculated Local Limit Concentration, mg/L	1.06	0.33	52.57	9.88	2.22	0.11	1.31	4.97	1.00	178.4	9.36
Current Local Limit Concentration, mg/L	1.0	0.5	2.75	3.0	2.0	0.1	-	2.5	-	1.0	5.0
Is Calculated Limit Less Than (<) Current Limit?	No	Yes	No	No	No	No	NA	No	NA	No	No

So What's Up with Cadmium?

- * MAHL is 0.84 lb/day, but domestic/commercial is only 0.02 lb/day
- * High removal efficiency (77%) and low biosolids standard (39 mg/kg) are drivers
- * 0.30 MGD industrial flow estimate too conservative for cadmium
- * Per code and public rule, pretreatment program also has mass limits (0.024 lb/day) for each Brightwater industrial user
- * For 13 metal-bearing industrial users, aggregate cadmium allocation (0.312 lb/day) is less than MAIL (0.82 lb/day)

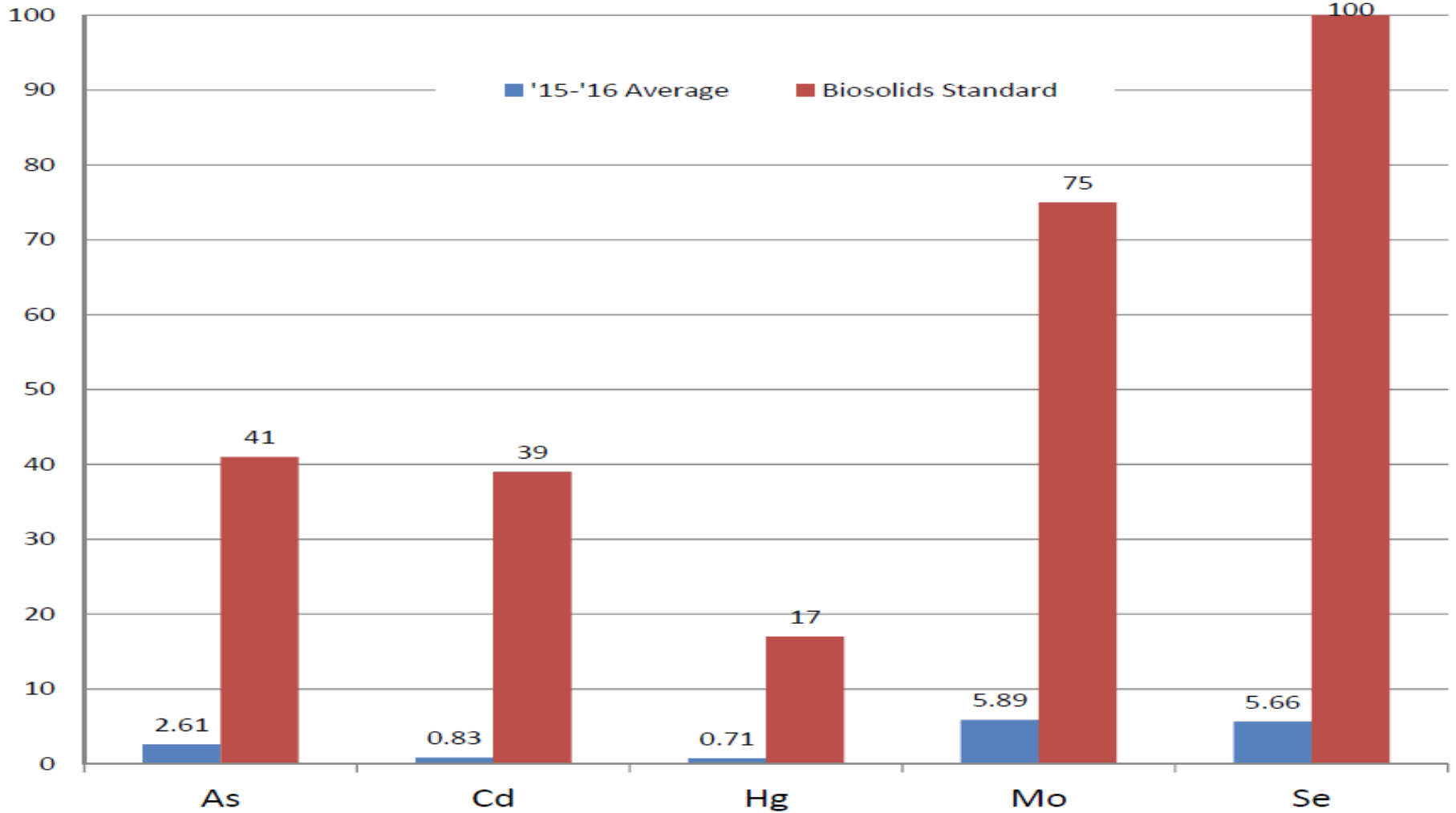
48 **Cadmium** Cd



Atomic mass: 112.41

Electron configuration: 2, 8, 18, 18, 2

Brightwater Biosolids Quality (mg/kg-dry)



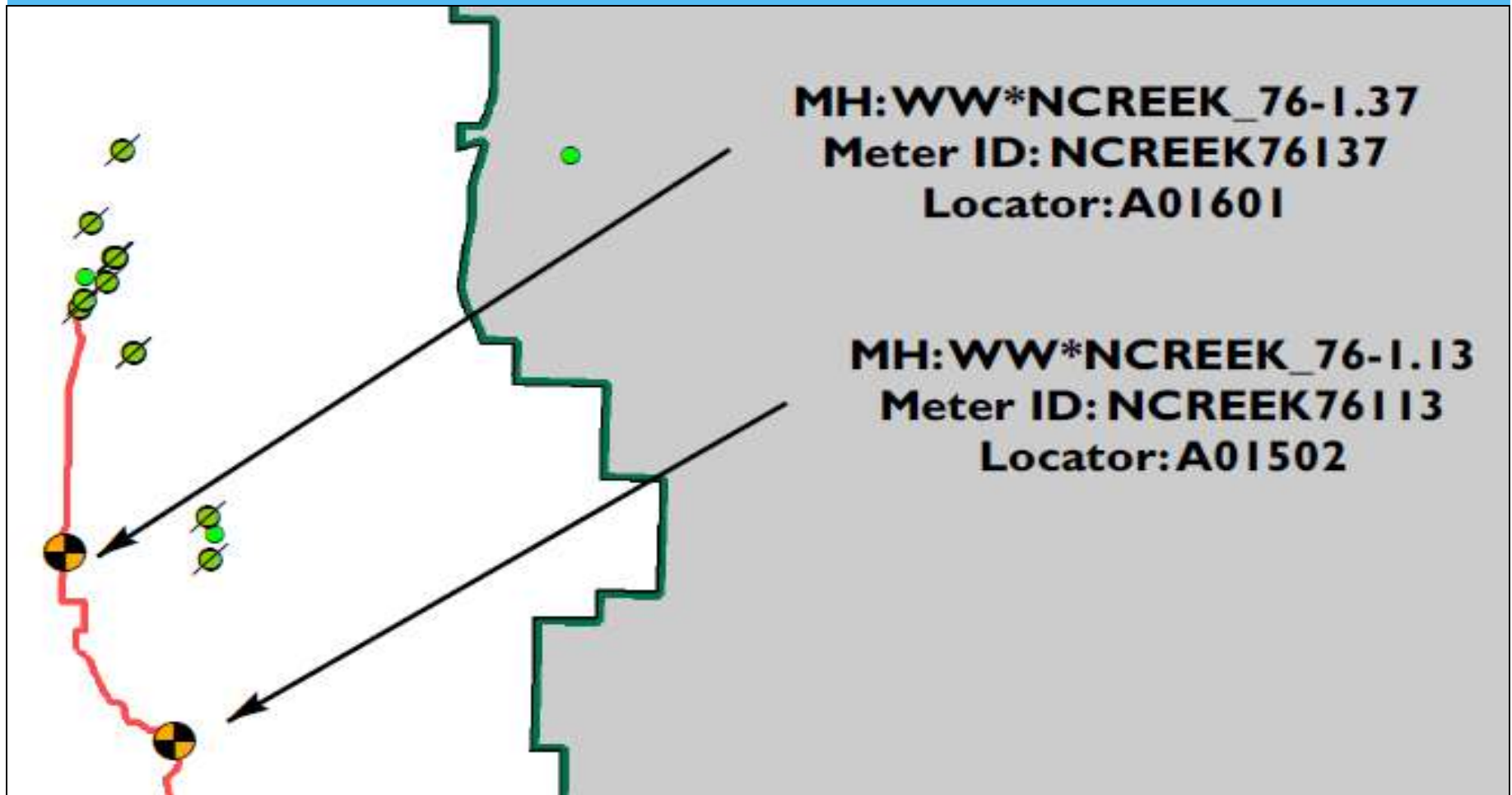
Local Limits Recommendations

- Sampling of Domestic/Commercial Sewers – Know where the industrial users are and don't forget the dentists
- Use low-level analytical methods for domestic/commercial sampling
- Get legal authority to also apply mass-based limits in a hybrid approach (i.e., issue permits with concentration and mass restrictions)
- If you are doing flow-proportioned sampling, conduct a few preliminary sampling rounds to work out the bugs.

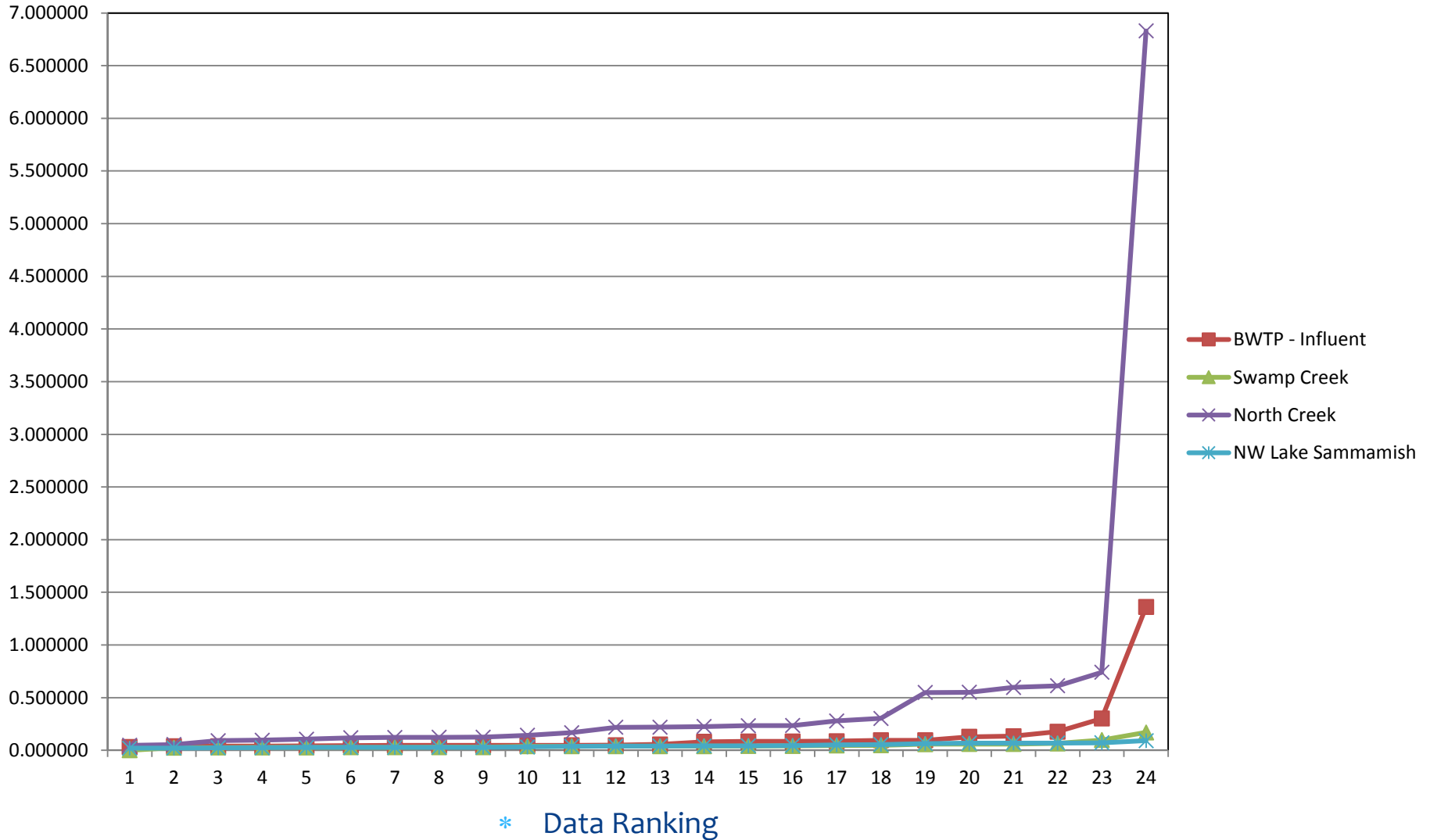
Beyond Local Limits

- Use of Local Limits Data to Identify Sources

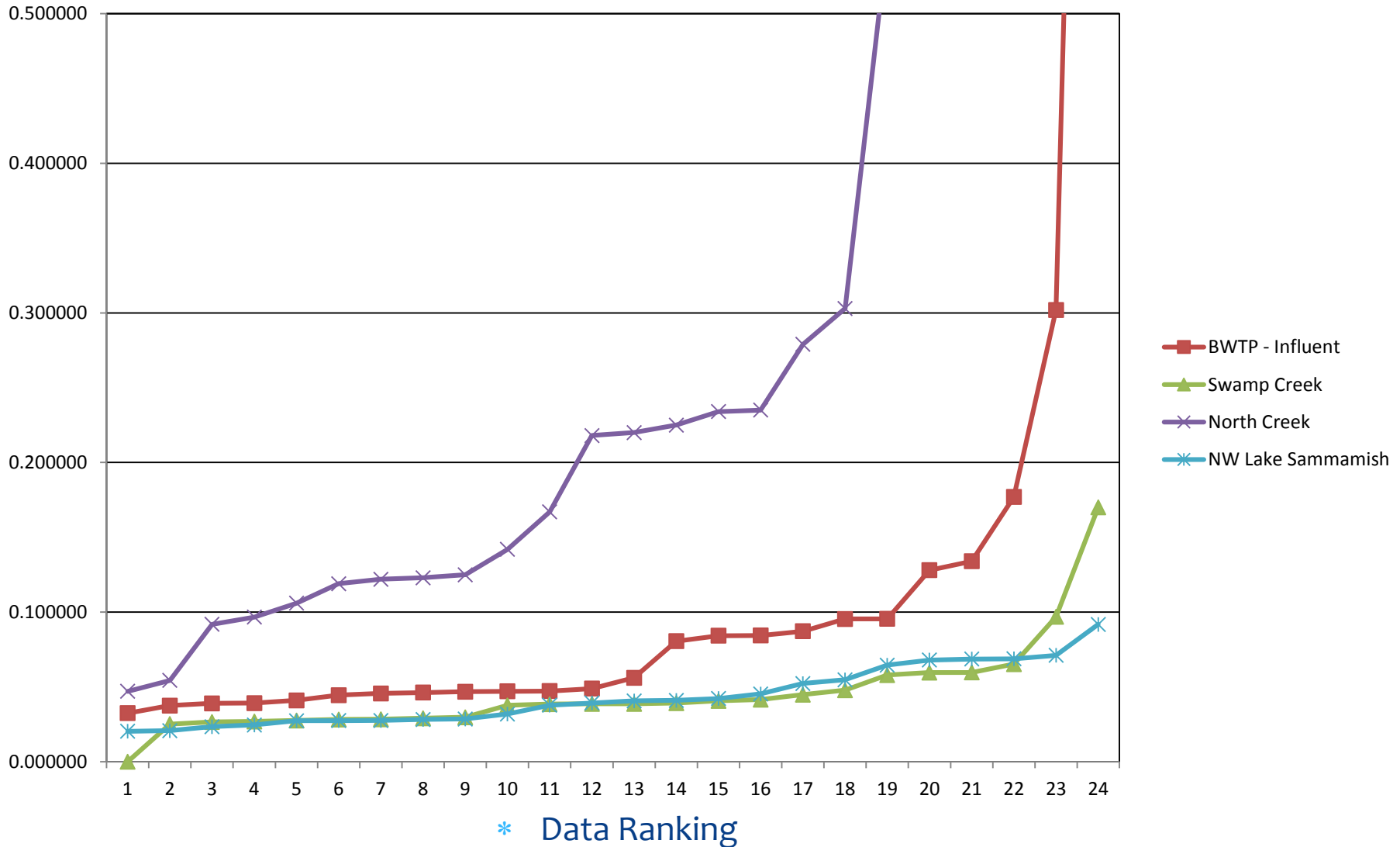
Why Should We Care About Dental Facilities?



Total Mercury ($\mu\text{g/L}$)



Total Mercury ($\mu\text{g/L}$)



Acknowledgements

- KCIW Sampling and Monitoring Team – For Making Good “Real World” Decisions
- KCIW Sampling Lead, Tim Coffey – For Being the “De Facto Project Manager” for the Project
- WTD Flow Monitoring Group – For Keeping the Flow Meters Calibrated
- Curt McCormick – For His Local Limits Course

Thank You

Bruce Tiffany
King County Industrial Waste Program
Seattle, Washington

Phone: 206-477-5441

E-mail: bruce.tiffany@kingcounty.gov

Web: www.kingcounty.gov/IndustrialWaste