

Cost of DBP Mitigation Associated with Bromide Discharges from Power Plants



Extent of Problem – Plants with wet scrubbers

- 118 coal-fired power plants identified as currently having wet scrubbers
- Of those, 57 discharge to watersheds supplying WTPs
- 96 WTPs are downstream of those 57 coal-fired power plants



Extent of Problem - Plants that may have wet scrubbers

- 225 coal-fired power plants in the U.S. have wet scrubbers or are likely to add wet scrubbers that discharge to rivers supplying potable water treatment plants
- 24 states have impacted WTPs
- 257 WTPs are downstream of those 225 plants



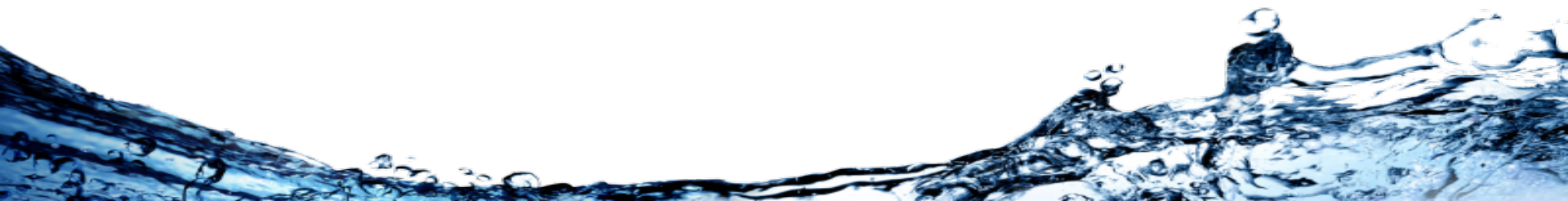
Extent of Problem – Plants that could have wet scrubbers

- An additional 182 coal-fired power plants in the U.S. have not identified how they will comply with MATS
- 96 of those plants are upstream of WTPs
- 573 total WTPs potentially impacted
- Potentially impacted WTPs distributed across 33 states

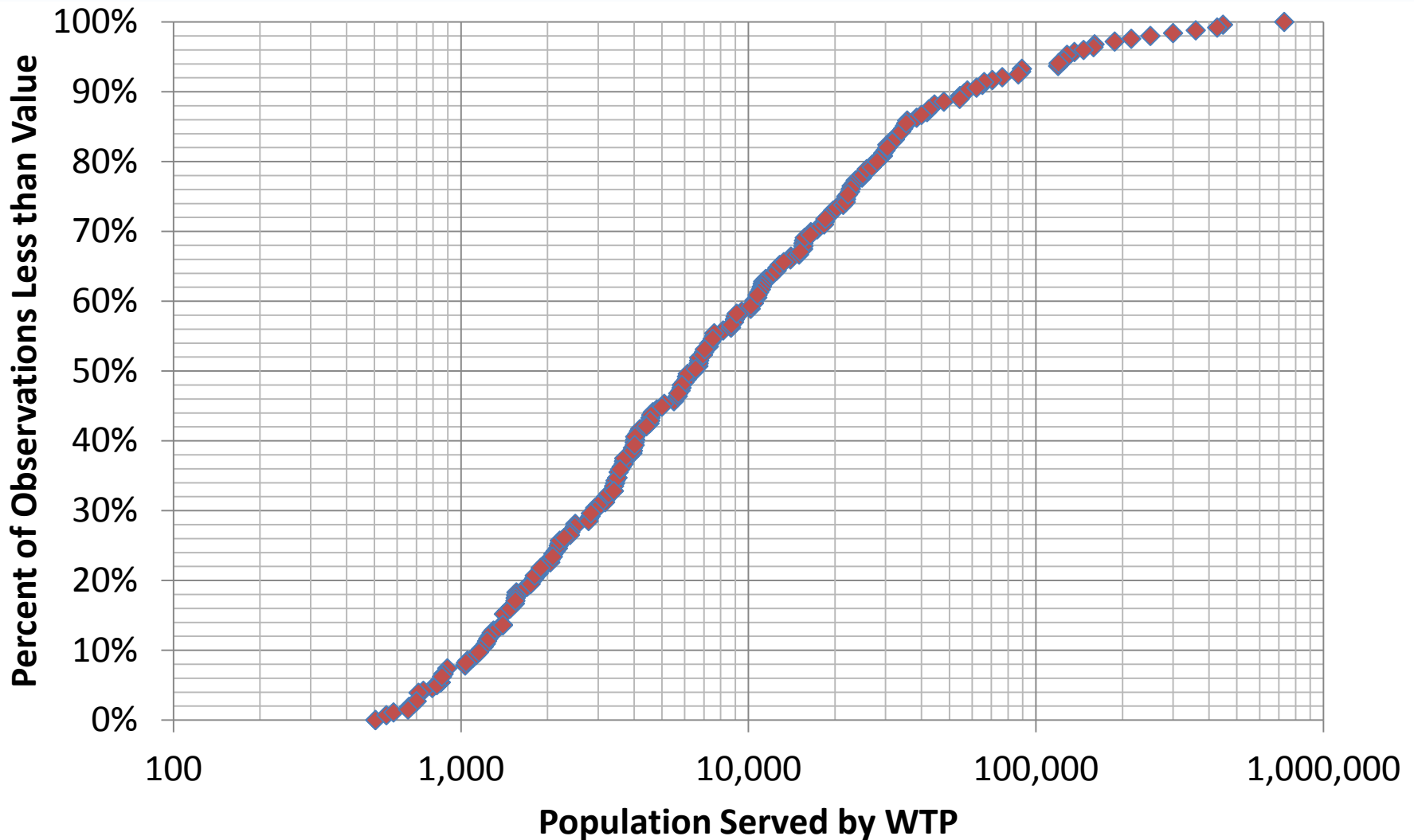


DBP Mitigation

- Three technologies examined
 - Chloramination to reduce extent of DBP formation
 - Granular activated carbon (GAC) contactors to remove DBP organic precursors
 - Ion exchange (IX) to remove bromide prior to chlorination
- Costs developed for three plant sizes using EPA cost curves and/or manufacturer data



Pop. Served by Impacted WTPs (257 plants)



Estimated Plant Capacities

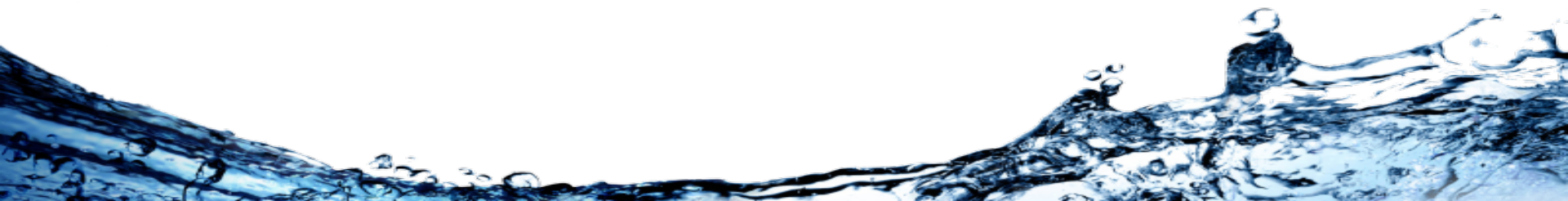
- Capacity estimated using per capita data collected from WaterSense database
 - Per capita values previously utilized in NPDES discharge costing
- WTP rated capacity values*:
 - Pop. <50,000 = 323 gpcd
 - Pop. 50,000 – 100,000 = 266 gpcd
 - Pop. >100,000 = 283 gpcd

* Gallon per capita per day



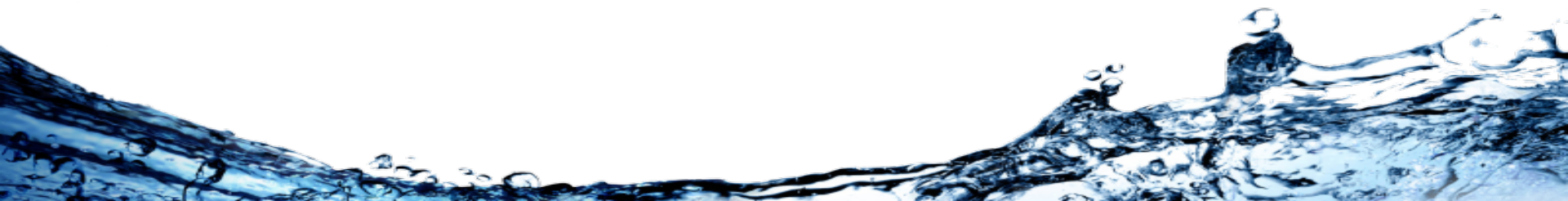
Plant Sizes Used for Costing

- 1.0 mgd
= 3,096 service pop. (31st percentile)
- 10 mgd
= 30,960 service pop. (83rd percentile)
- 50 mgd
= 176,678 service pop. (97th percentile)



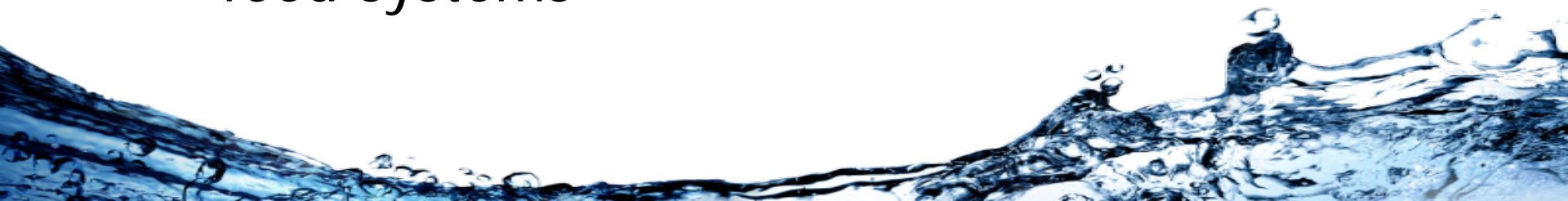
Cost Estimating Methodology

- Costs based on 1979 EPA cost curves, as appropriate
 - Costs escalated to 2015 dollars using ENR index
 - O&M costs based on current U.S. average power rate (\$0.0671/kWh) and U.S. average water treatment plant operator wage (\$20.56/hr)



Cost Estimating Methodology

- Chloramination
 - Assumed that the following would be added:
 - Additional chlorinators
 - Chlorine contact basin
 - Aqua ammonia feed
 - Total chlorine analyzer
 - Cost for additional chlorinators estimated by using $\frac{1}{2}$ of the EPA cost curve for chlorine feed systems



Cost Estimating Methodology

- GAC Contactors

- Assumed that the following would be added:
 - GAC pressure contactors (15 min. empty bed contact time)
 - In-plant pumping
- Cost for initial carbon charge added on top of EPA cost (EPA cost curves do not include cost of carbon)
- O&M carbon replacement cost based on 3 month replacement schedule



Cost Estimating Methodology

- IX Cost
 - IX System Costs provided by Calgon
 - Assumed \$2.73 Million per 3,500 gallon per minute module
 - O&M costs estimated at \$75/acre-foot
 - Costs for in-plant pumping added to Calgon costs



Capital Costs

Rated System Capacity (MGD)*	Capital Cost		
	Chloramination	GAC	IX
1	\$409,971	\$1,361,575	\$5,166,593
10	\$1,318,002	\$8,418,436	\$10,492,535
50	\$4,209,566	\$39,413,519	\$51,530,265

* Million gallons per day



Annualized Capital Costs

(20 years at 3%)

Rated System Capacity (MGD)*	Annualized Capital Cost		
	Chloramination	GAC	IX
1	\$27,556	\$91,519	\$347,276
10	\$88,590	\$565,851	\$705,263
50	\$282,949	\$2,649,208	\$3,463,643

* Million gallons per day



Annual O&M Costs

Rated System Capacity (MGD)*	Annual O&M Costs		
	Chloramination	GAC	IX
1	\$8,837	\$282,161	\$174,220
10	\$29,853	\$2,282,330	\$1,045,776
50	\$116,704	\$11,135,421	\$5,184,468

* Million gallons per day

A decorative graphic at the bottom of the slide showing a dynamic splash of water with bubbles and droplets, rendered in shades of blue and white.

Total Annual Costs

Rated System Capacity (MGD)*	Total Annual Costs		
	Chloramination	GAC	IX
1	\$36,393	\$373,681	\$521,496
10	\$118,444	\$2,848,181	\$1,751,039
50	\$399,653	\$13,784,628	\$8,648,111

* Million gallons per day



Predicted Monthly Rate Increases

	Chloramination	GAC	IX
1 MGD	\$3.23	\$33.16	\$46.33
10 MGD	\$1.10	\$25.28	\$15.54
50 MGD	\$0.77	\$26.70	\$16.75



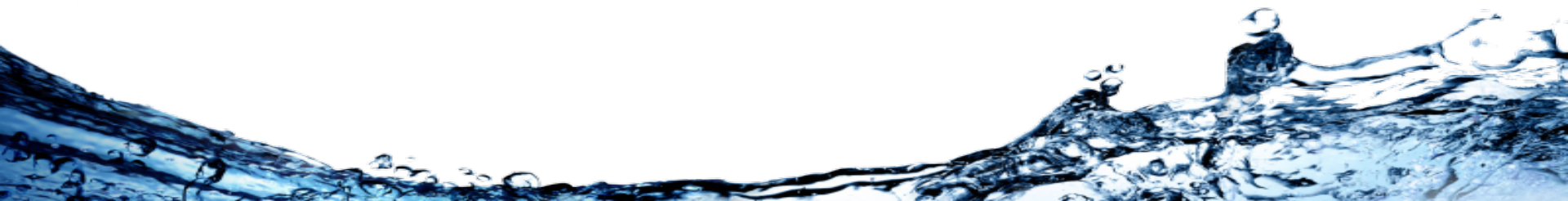
Total Unit Costs

Rated System Capacity (MGD)*	Total Annual Unit Costs (\$/yr per MGD WTP Capacity)		
	Chloramination	GAC	IX
1	\$36,393	\$373,681	\$521,496
10	\$11,844	\$284,818	\$175,104
50	\$7,993	\$275,693	\$172,962

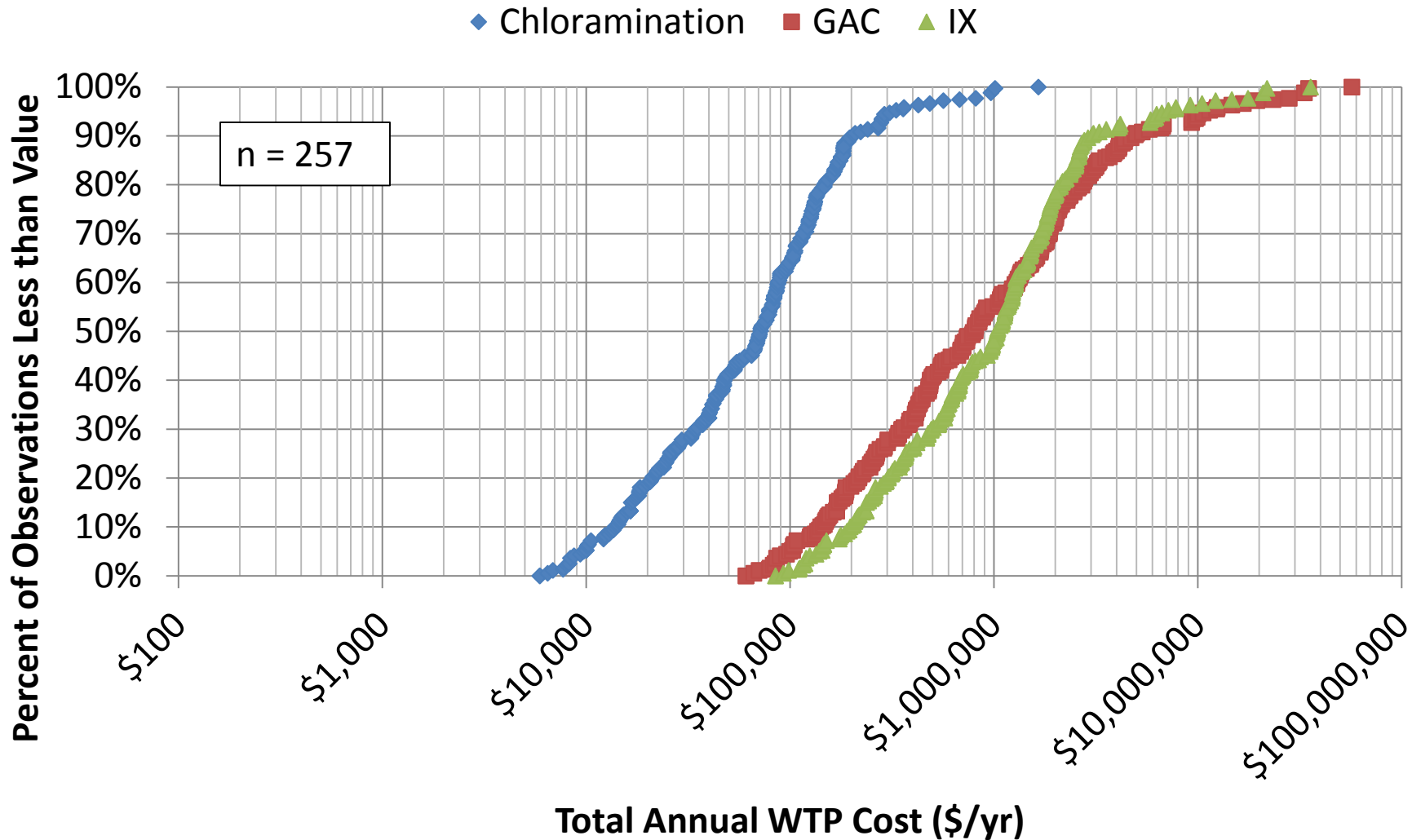
* Million gallons per day



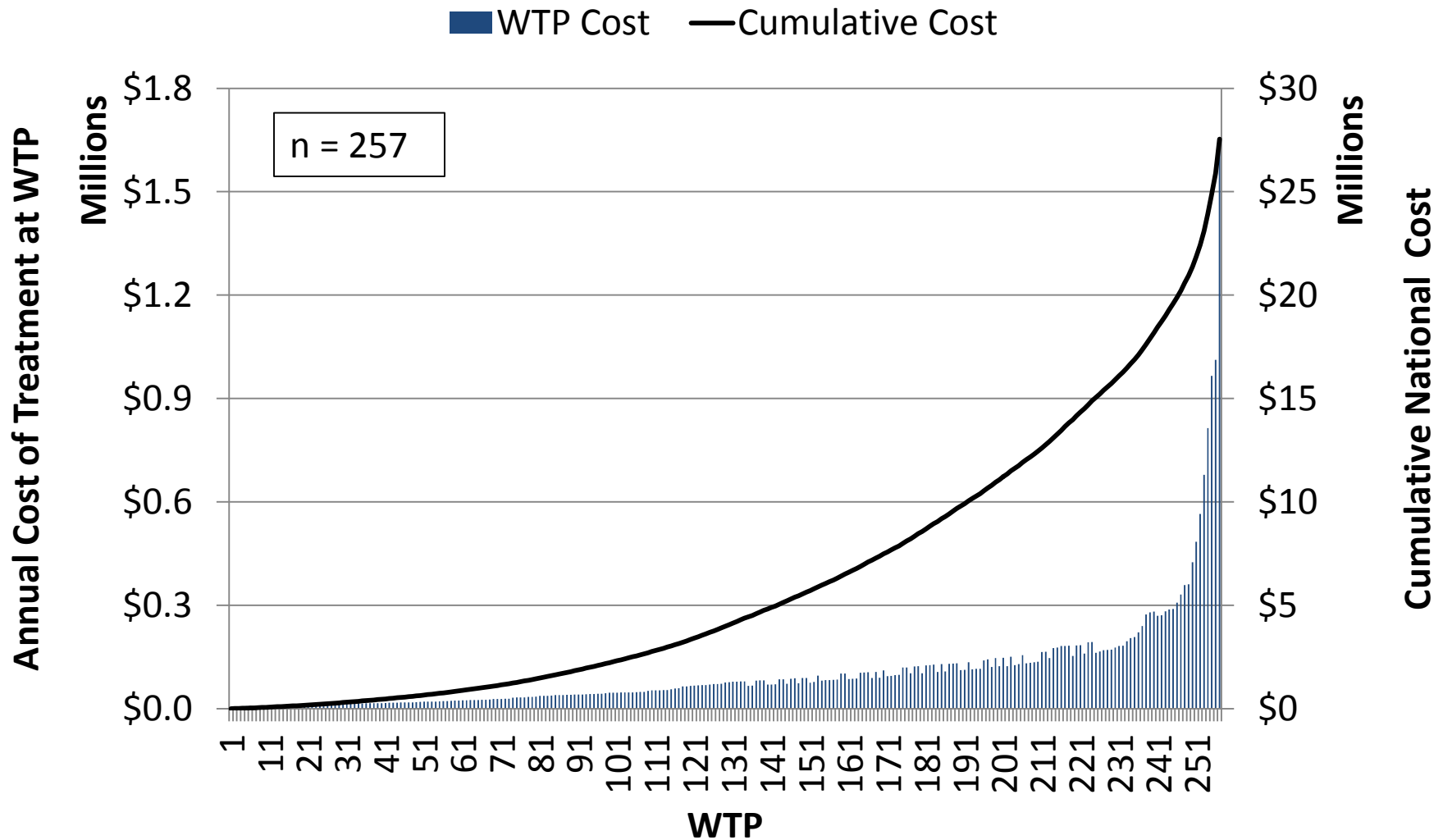
Cost estimates for WTPs likely to be impacted (257 WTPs)



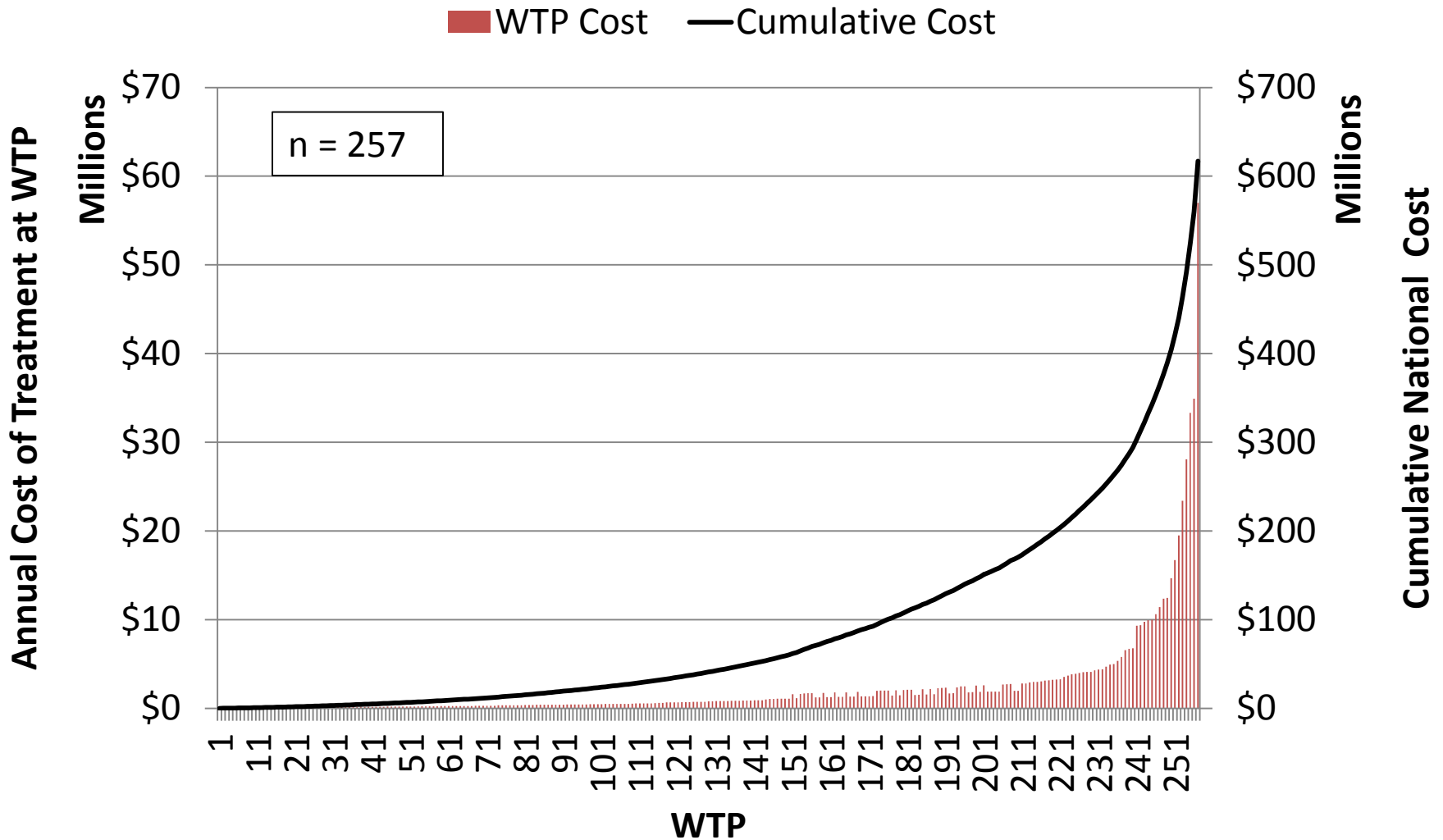
Distribution of Annual Costs



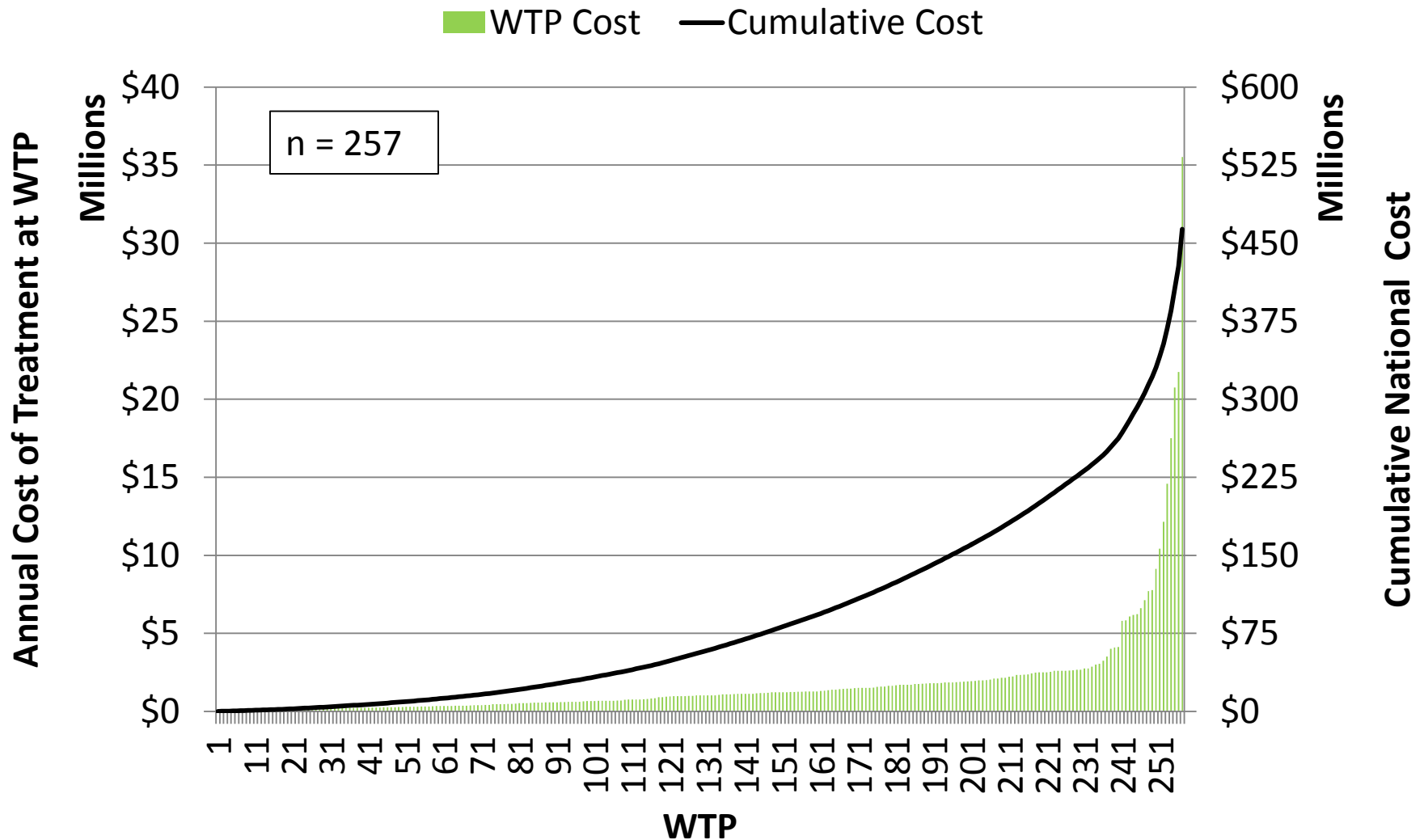
Cost of Chloramination



Cost of GAC



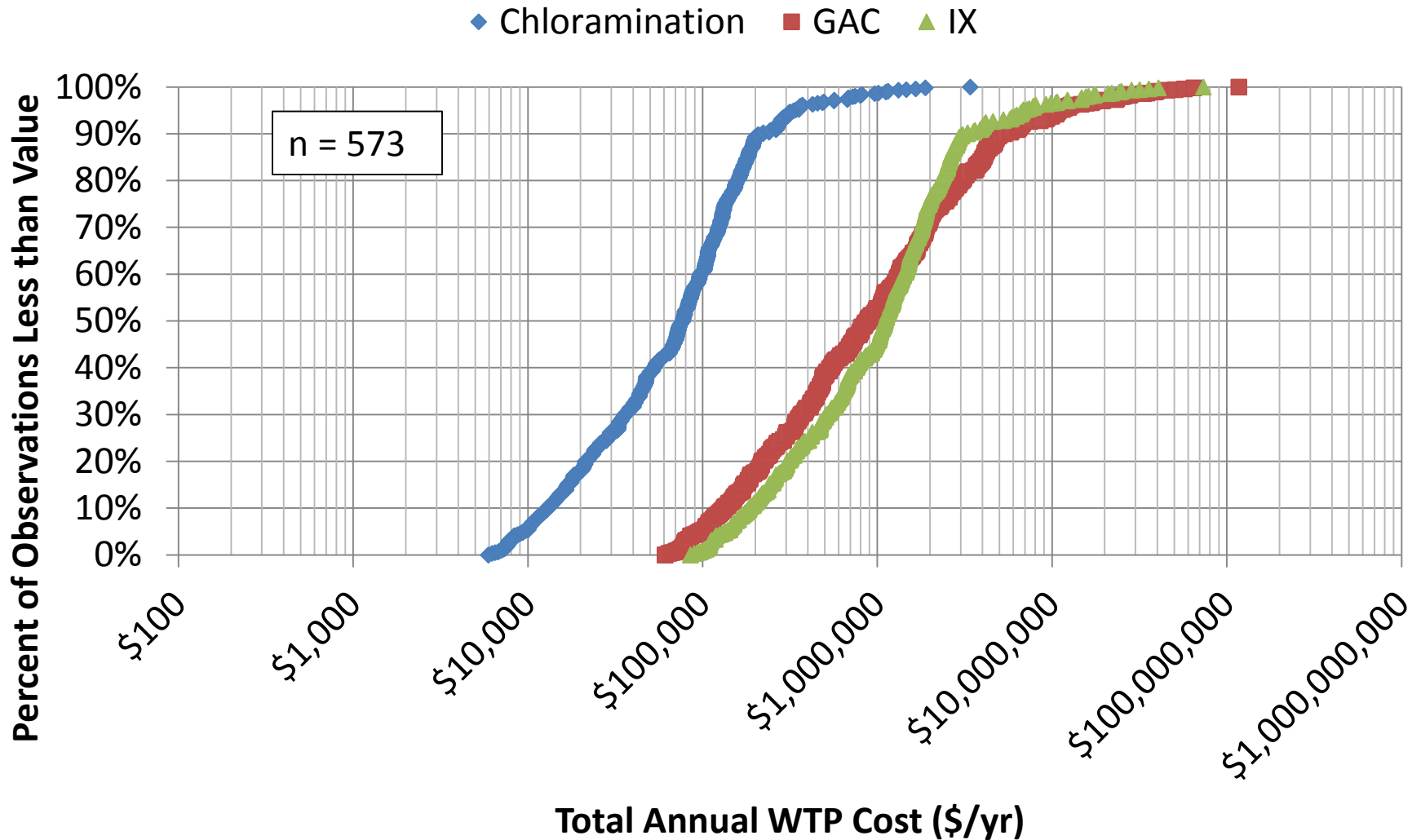
Cost of IX



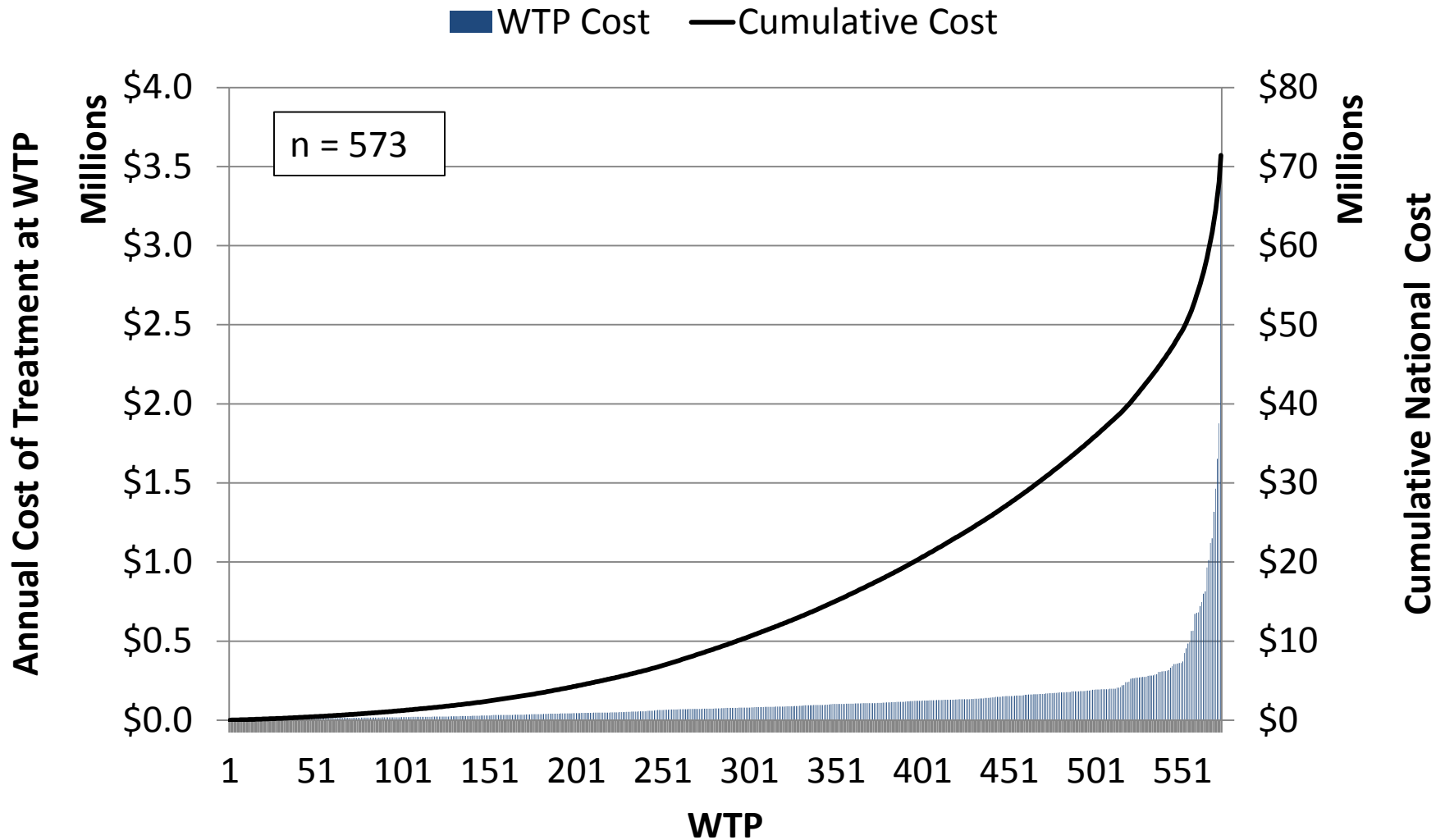
**Cost estimates for all WTPs that
may be affected (573 WTPs)**



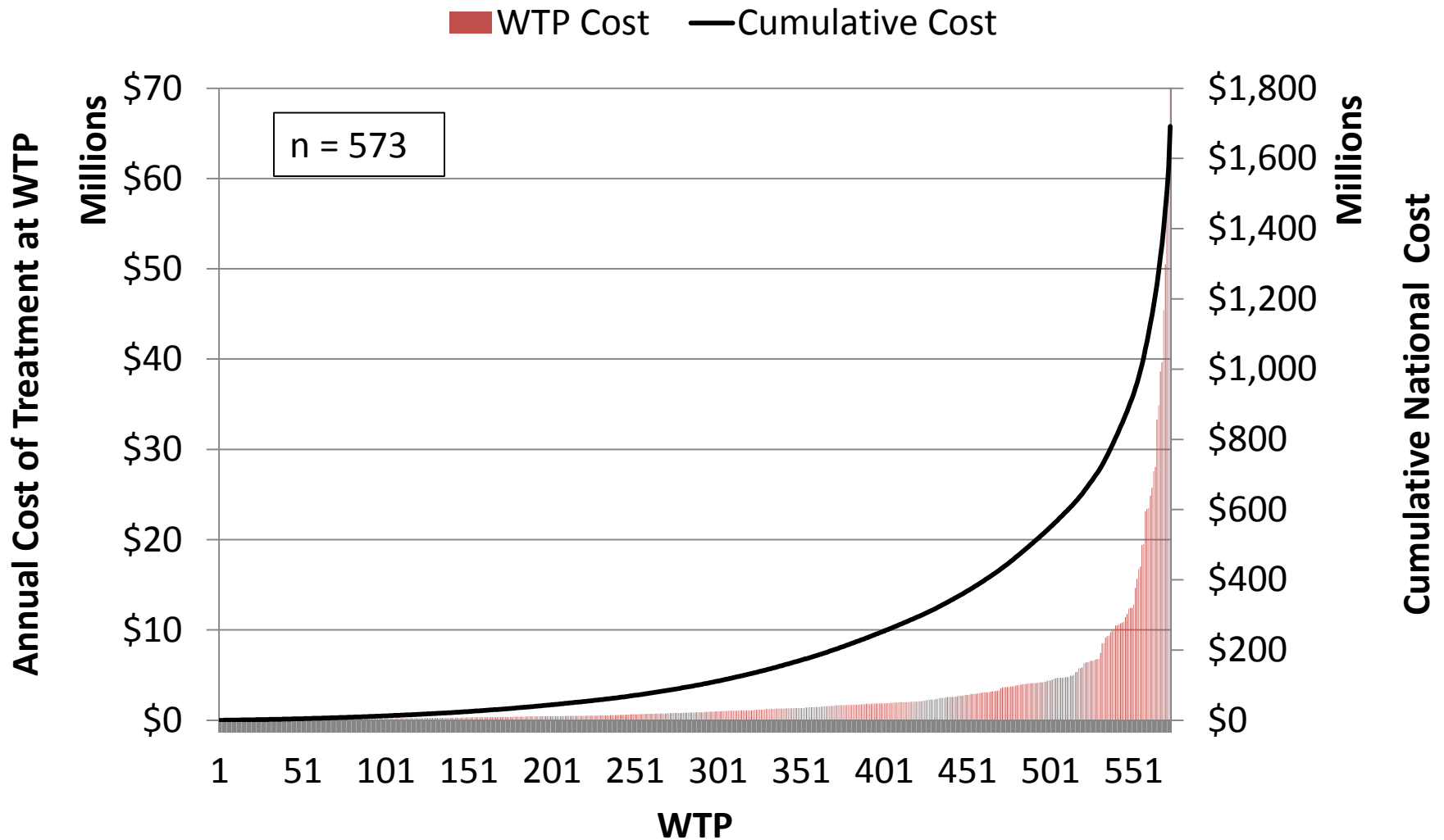
Distribution of Annual Costs



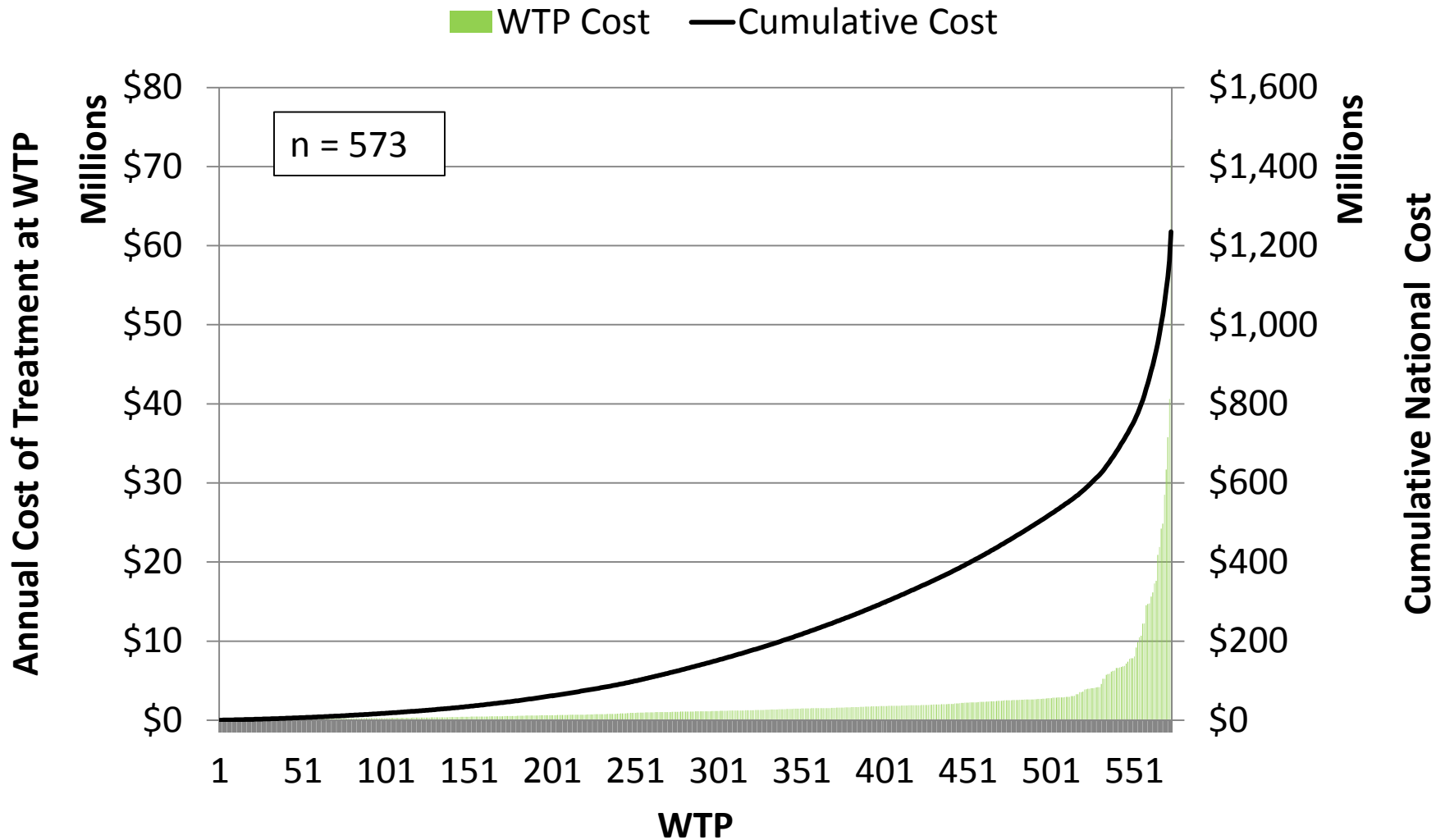
Cost of Chloramination



Cost of GAC

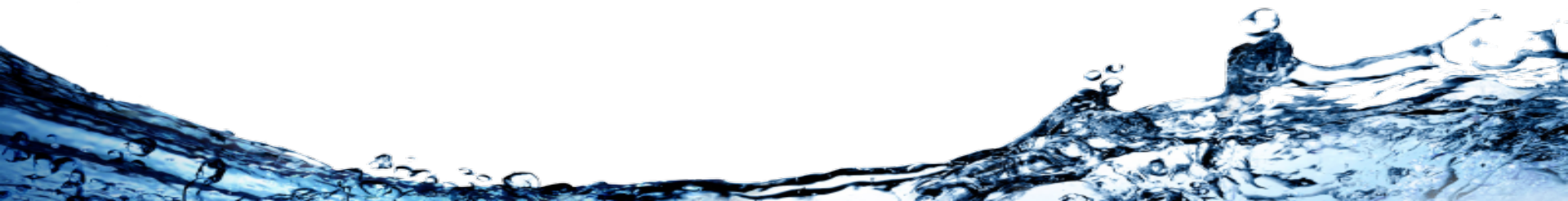


Cost of IX



Estimate of National Cost

- Assumed distribution of total cost
 - 20% of WTPs use chloramination
 - 60% of WTPs use GAC
 - 20% of WTPs use IX



Estimate of National Annual Cost

Total National Annual Cost	Percent of Plants Requiring Additional Treatment		
	100%	50%	25%
WTPs likely to be impacted (257 WTPs)	\$469,046,029	\$234,523,015	\$117,261,507
WTPs that may be impacted (573 WTPs)	\$1,275,987,110	\$637,993,555	\$318,996,778

