



# Removing and Destroying PFAS at Minnesota Municipal Water Resource Recovery Facilities is Unaffordable

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## Evaluation of Current Alternatives and Estimated Cost Curves for PFAS Removal and Destruction from Municipal Wastewater, Biosolids, Landfill Leachate, and Compost Contact Water

Prepared for:  
Minnesota Pollution Control Agency



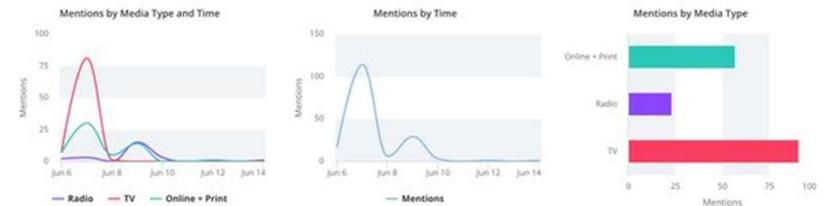
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### PFAS Wastewater Cleanup Report Launch 6 June 2023

#### Mention Analytics



|  |  |   |   |
|--|--|---|---|
| Total National TV Audience<br>1,416,108    | Total National TV Publicity<br>USD \$305,609 | Total Local TV Audience<br>1,416,108            | Total Local TV Publicity<br>USD \$305,609 |
| Total Radio Audience<br>1,460,590          |  | Total Publicity Value<br>USD \$3,105            |   |
| Total Online + Print Audience<br>7,509,145 |  | Total Online + Print Publicity<br>USD \$170,672 |   |

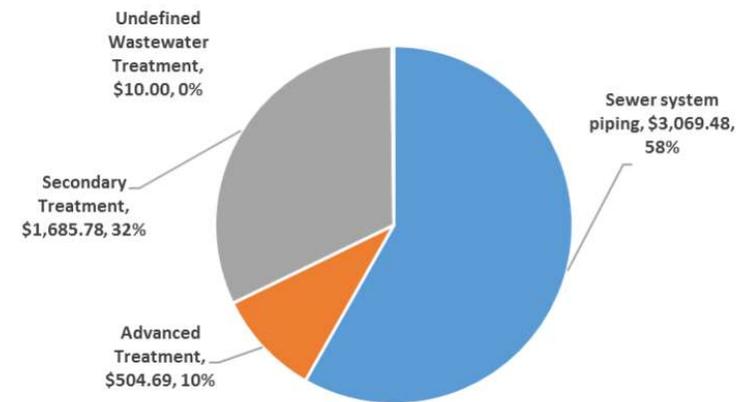
Study reached 7.5  
Million people in  
Wisconsin and MN!

**TLDR:**  
Removing and Destroying PFAS at  
Minnesota Municipal Water  
Wastewater Facilities is  
Unaffordable

# How much money are we talking?

**Table ES-2 Summary of estimated 20-year costs for managing PFAS in targeted waste streams in Minnesota<sup>[1]</sup>**

| Waste Stream                               | Estimated Number of Facilities                  | Range of Flows   | Estimated 20-year costs for Minnesota (Millions of USD) <sup>[2]</sup> |
|--|---|--|--|
| Municipal WRRF effluent <sup>[3]</sup>     | 283   | 0.1–300 MGD  | \$12,000–\$25,000  |
| Municipal WRRF biosolids <sup>[4]</sup>    | 1 regional facility, plus 50 on-site facilities | 50 dry tons of wastewater solids per day (dtpd) regional facility, on-site for 1–10 dtpd | \$1,600–\$3,300  |
| Mixed MSW landfill leachate <sup>[5]</sup> | 24  | 1–100 gpm  | \$77–\$160   |
| Compost contact water <sup>[6]</sup>       | 9   | 1–100 gpm  | \$28–\$60  |



**MN needs \$5.3 Billion needs to just maintain current wastewater infrastructure**

# Study Questions

1) How do you treat and destroy PFAS in wastewater and biosolids?

2) What are the costs?

3) Are the costs affordable?

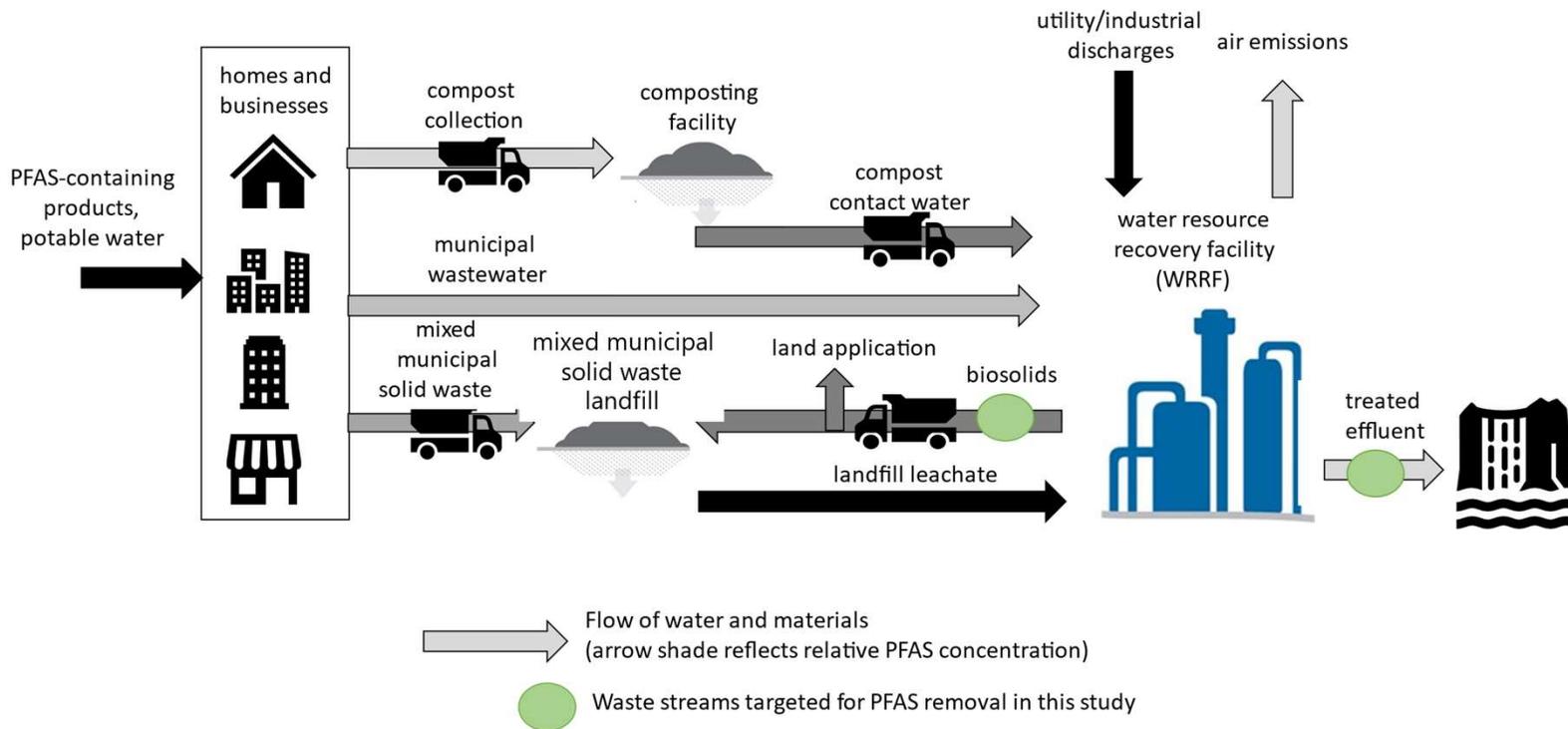
1) With currently available technologies

2) To low levels (e.g. non-detect)



# Municipal PFAS Use, Disposal, and Targeted Municipal Waste Media

municipal PFAS cycle



## Target PFAS

|                  |
|------------------|
| <b>PFBA</b>      |
| <b>PFBS</b>      |
| <b>PFHxS</b>     |
| <b>PFOA</b>      |
| <b>PFOS</b>      |
| <b>PFOSA</b>     |
| <b>6:2 FTS</b>   |
| <b>N-EtFOSAA</b> |
| <b>N-MeFOSAA</b> |

# Why are PFAS so expensive to treat?

- PFAS are bad for engineers
  - Slippery
  - Indestructible
  - Cannot biodegrade
  - Partition weirdly
  - Have low treatment targets
  - Are always present

You can buy bulk PFAS for \$50-1000 per pound

Phosphorus can be treated at \$40-60 per pound

|                                     |         |        |         |
|-------------------------------------|---------|--------|---------|
| Municipal WRRF facility size        | 0.1 MGD | 1 MGD  | 10 MGD  |
|                                     | \$18.1M | \$6.8M | \$2.7M  |
| Municipal WRRF biosolids production |         | 1 DPTD | 10 DPTD |
|                                     |         | \$2.7M | \$1.0M  |
| Municipal landfill facility size    | 1 GPM   | 10 GPM | 100 GPM |
|                                     | \$12M   | \$1.4M | \$0.40M |
| Composting facility size            | 1 GPM   | 10 GPM | 100 GPM |
|                                     | \$39M   | \$4.5M | \$1.3M  |

# On why engineers are Debbie downers

Google Scholar search results for "PFAS treatment" showing approximately 38,800 results. A callout box highlights the text: "So much high quality PFAS treatment research at the lab and pilot scale!!!".

Articles About 38,800 results (0.08 sec)

So much high quality PFAS treatment research at the lab and pilot scale!!!

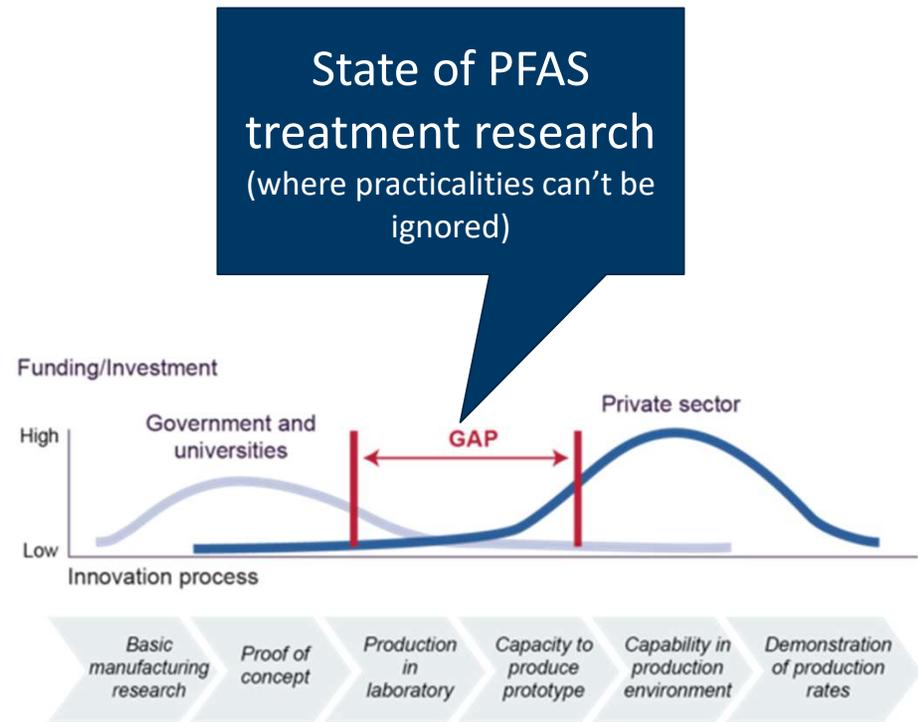
... compounds: A critical review of environmental ..., 2017 - Elsevier for PFOA and PFOS in ... and PFOS ... situate treatment methods and the ... sions

... hologies for PFAS contaminated ... anagement, 2020 - Elsevier ... nated soil due to PFAS binding to ... e challenging in treating PFAS (...

... ovement of poly-and ... r treat ... plants

... plants (... PFAS precursors and ... ultra-short chain PFAS in WWTPs. Most WWTPs exhibited low removal efficiencies for PFAS... ☆ Save 59 Cite Cited by 133 Related articles All 4 versions

Physico-chemical processes for the treatment of per- and polyfluoroalkyl substances (PFAS): A review BN Nzeribe, M Crimi ... Critical Reviews in ..., 2019 - Taylor & Francis ... physico-chemical treatment processes for PFAS ... treatment technologies for PFAS destruction. For example, Vecitis, Park, Cheng, Mader, & Hoffmann (2009) summarized the treatment ... ☆ Save 59 Cite Cited by 157 Related articles All 5 versions



Source: GAO adapted from Executive Office of the President. | GAO-21-202

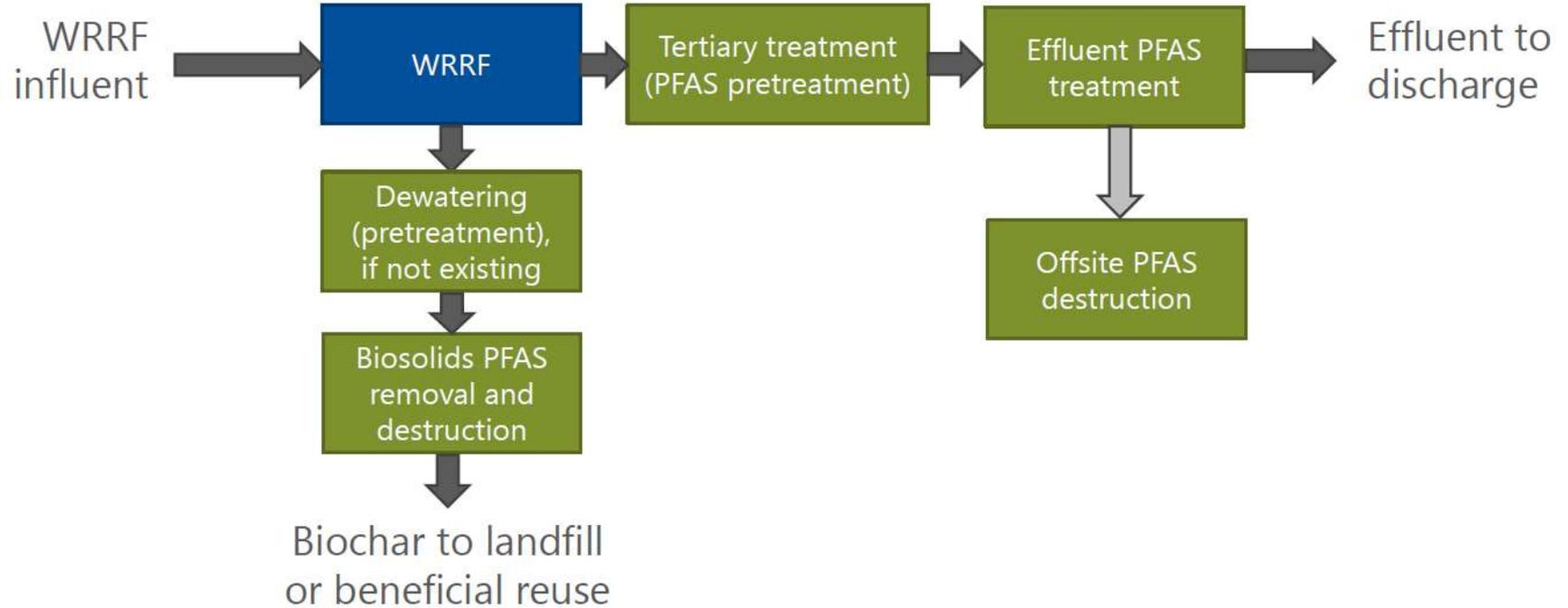
# Assembled Alternatives Passing to Preliminary Design

| Waste Stream           | Liquid Separation Process | Sorption Separation Process 1 | Sorption Separation Process 2 | Destruction Process |
|------------------------|---------------------------|-------------------------------|-------------------------------|---------------------|
| Municipal Wastewater   |                           | GAC                           |                               | HTI/reactivation    |
|                        |                           | AIX                           |                               | HTI                 |
|                        |                           | GAC                           | AIX                           | HTI/reactivation    |
|                        | RO                        | GAC                           | AIX                           | HTI/reactivation    |
| Municipal WW Biosolids |                           |                               |                               | SCWO                |
|                        |                           |                               |                               | Pyrolysis + TO      |

**None of these technologies currently in use in Minnesota for targeted waste streams.**

RO = RO membrane separation, GAC = granular activated carbon, AIX = single-use anion exchange, HTI = high-temperature incineration, SCWO = supercritical water oxidation, TO = thermal oxidation

# Wastewater flow diagram to treat PFAS



# What do these technologies look like?



Metro plant would need >450 of these 60,000 lb GAC vessels

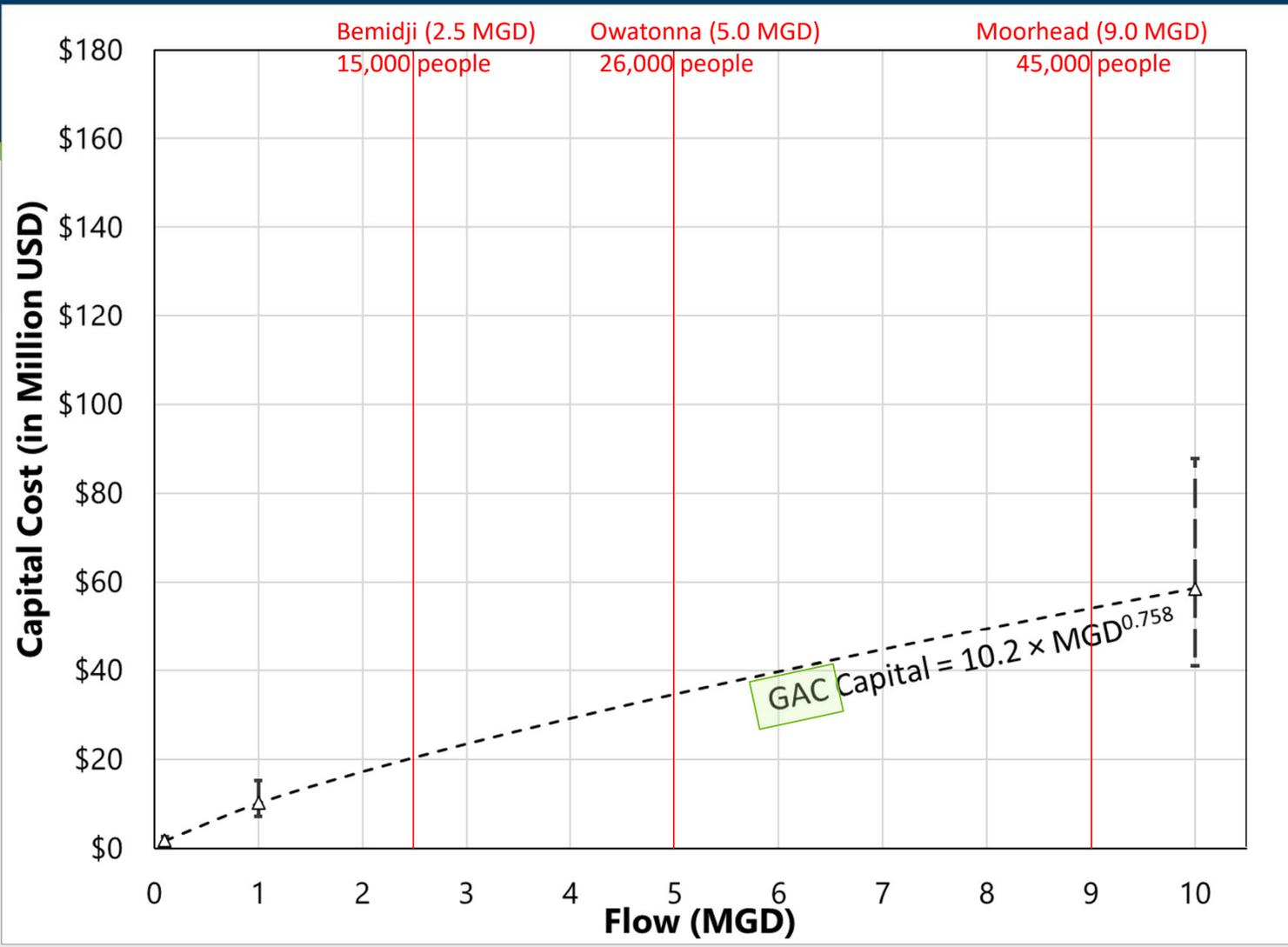


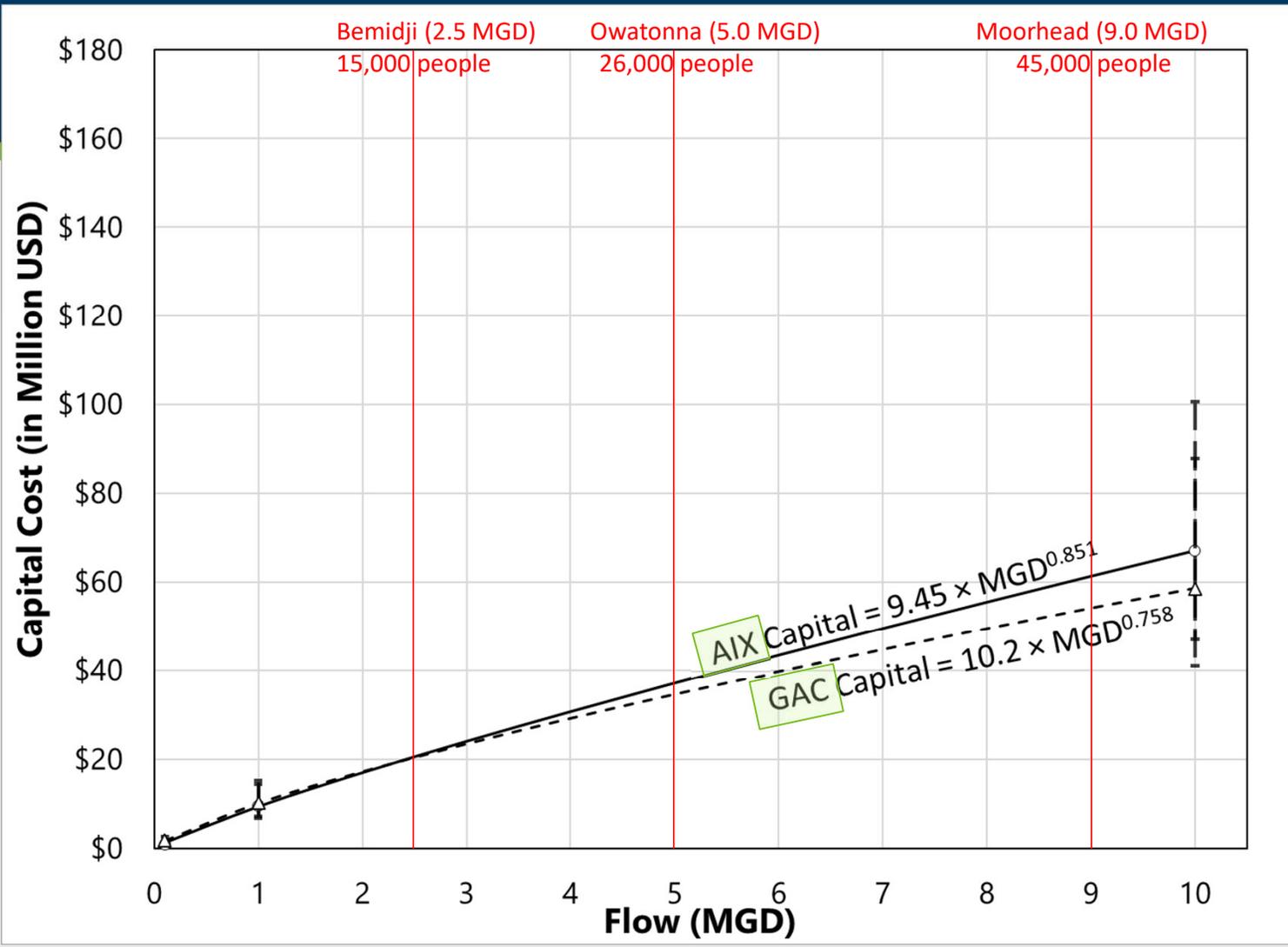
Pyrolysis/gasification facility

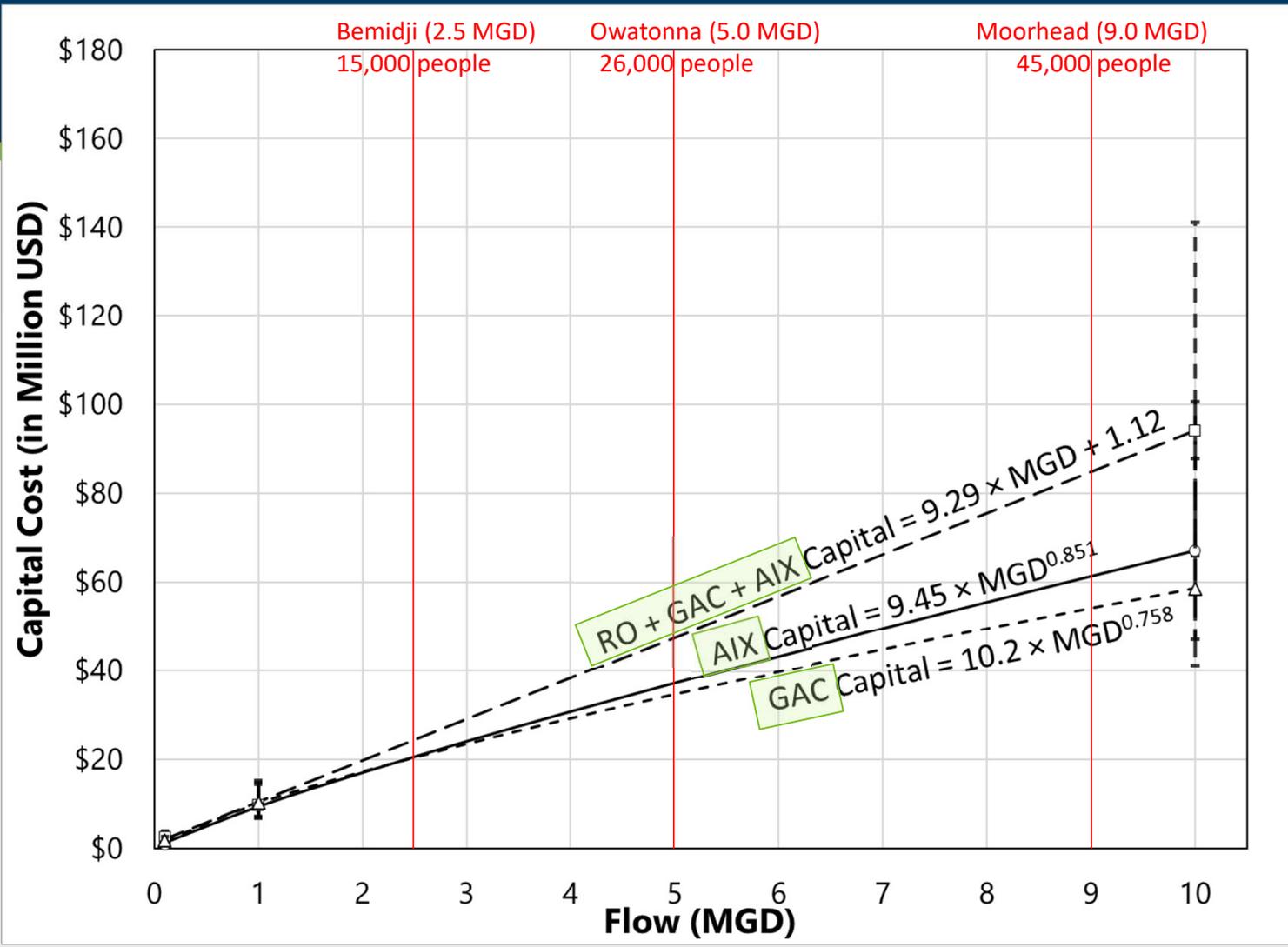


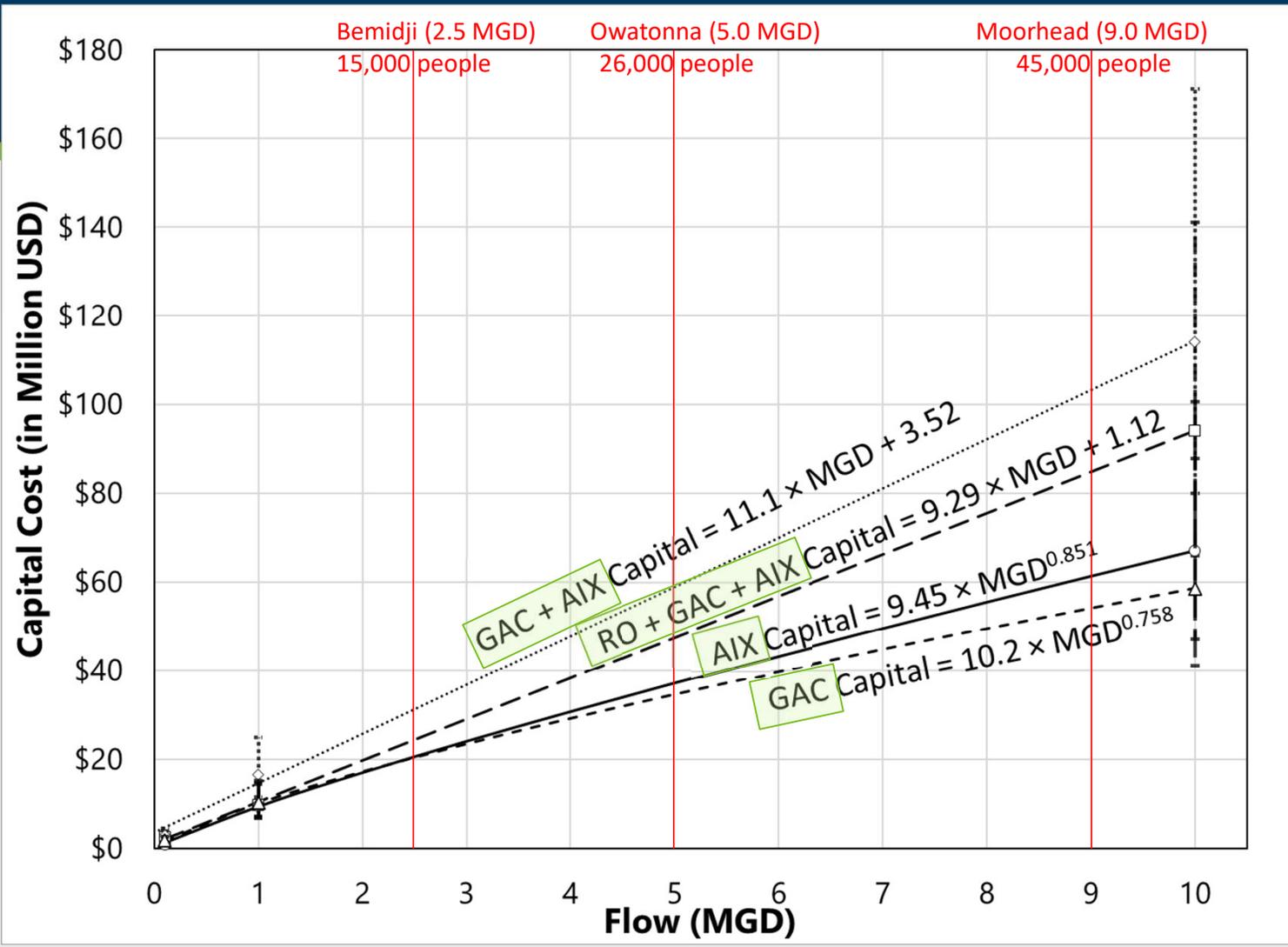
60,000 ton/year high-temp incineration for sorption media from liquid treatment (For about 130 MGD from WRRFs)

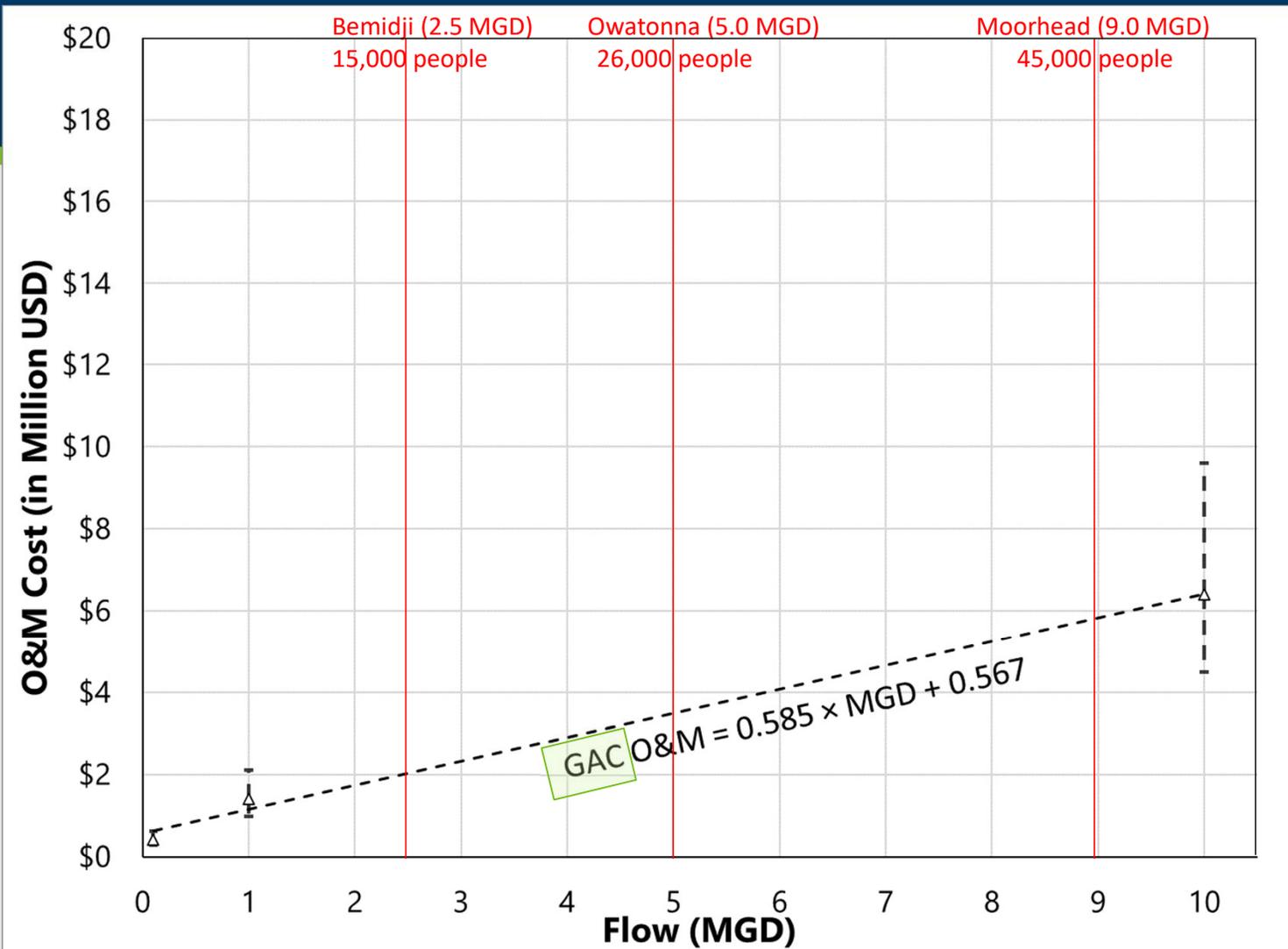
6/29/2023

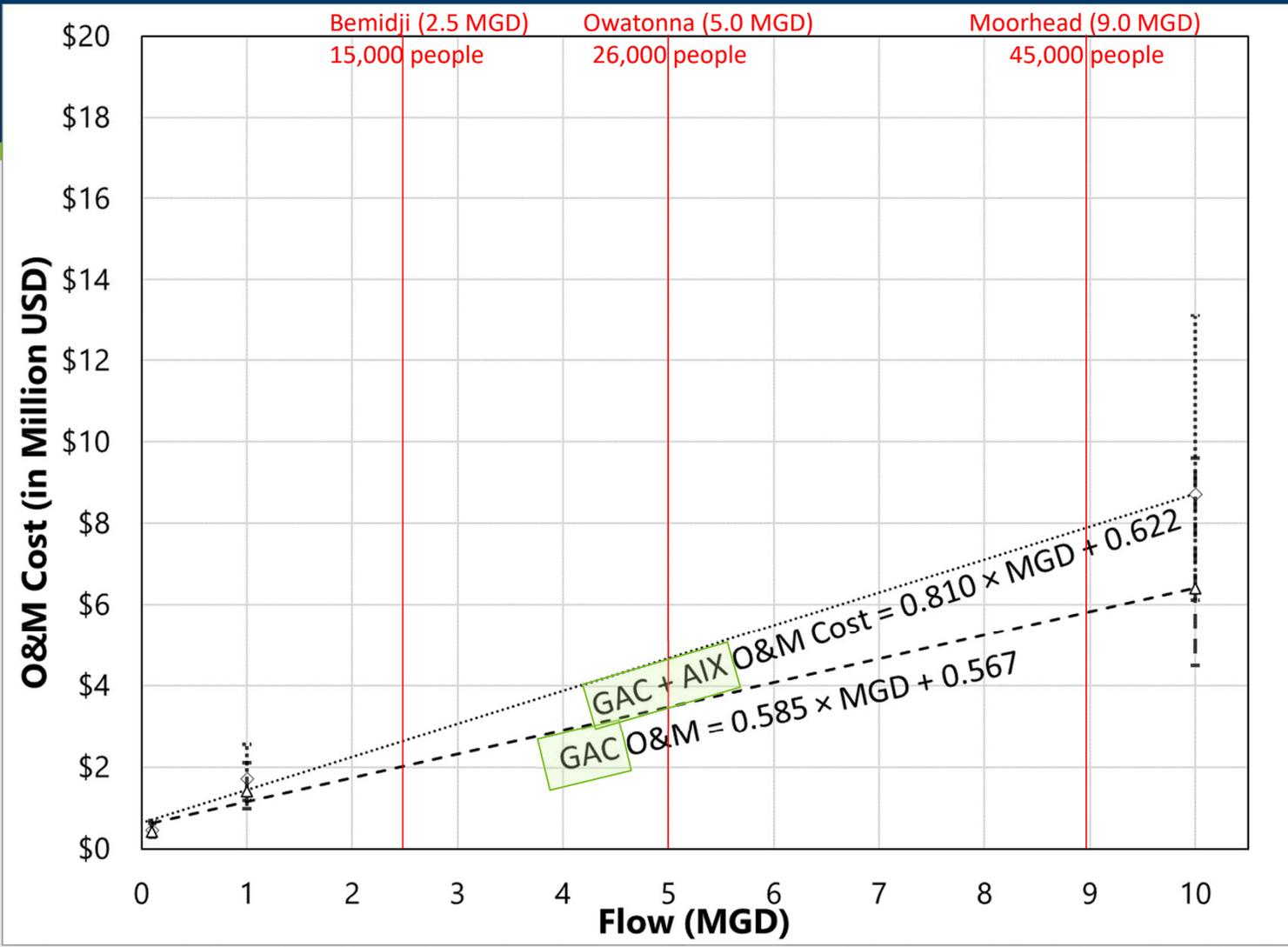


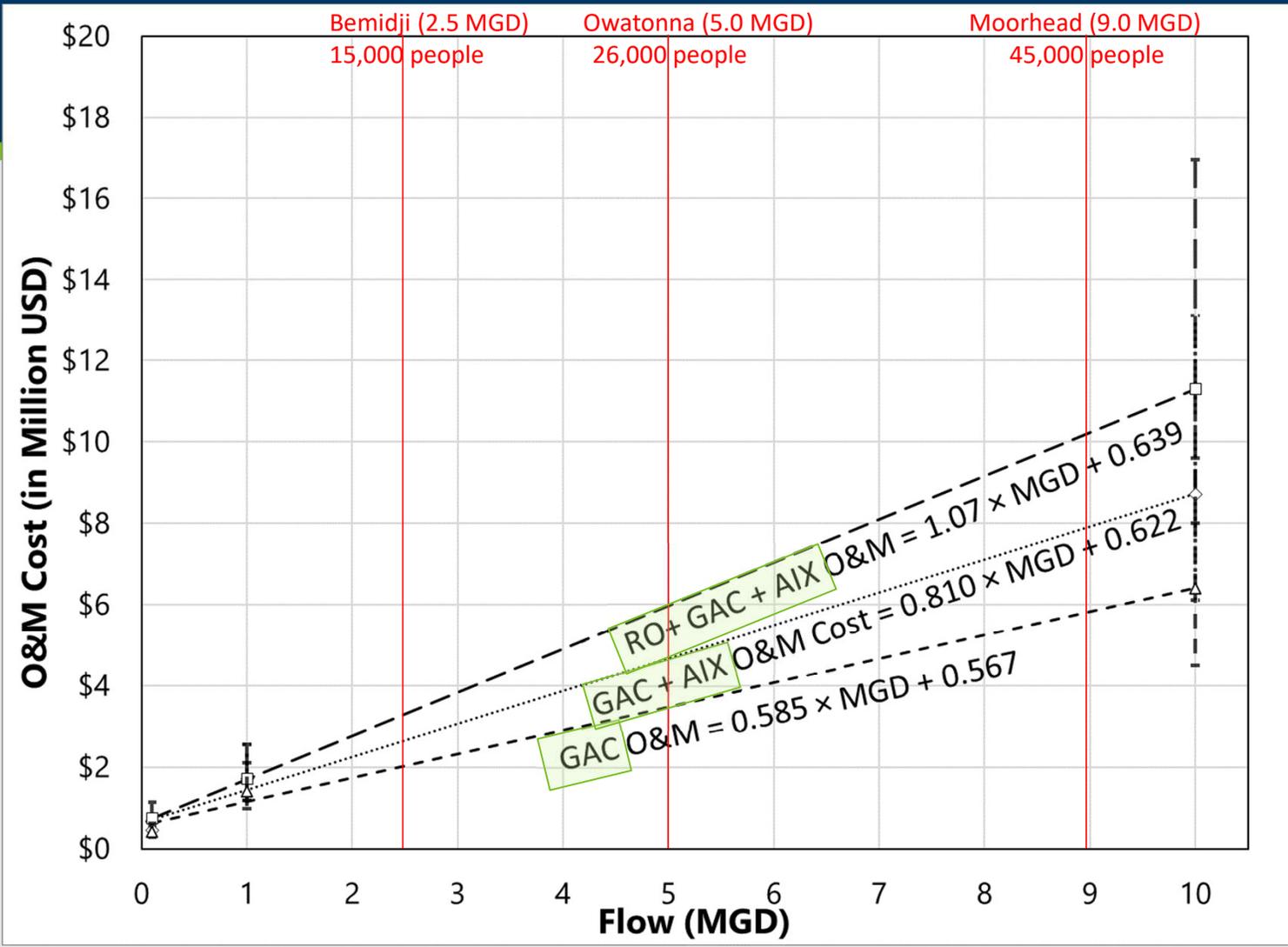


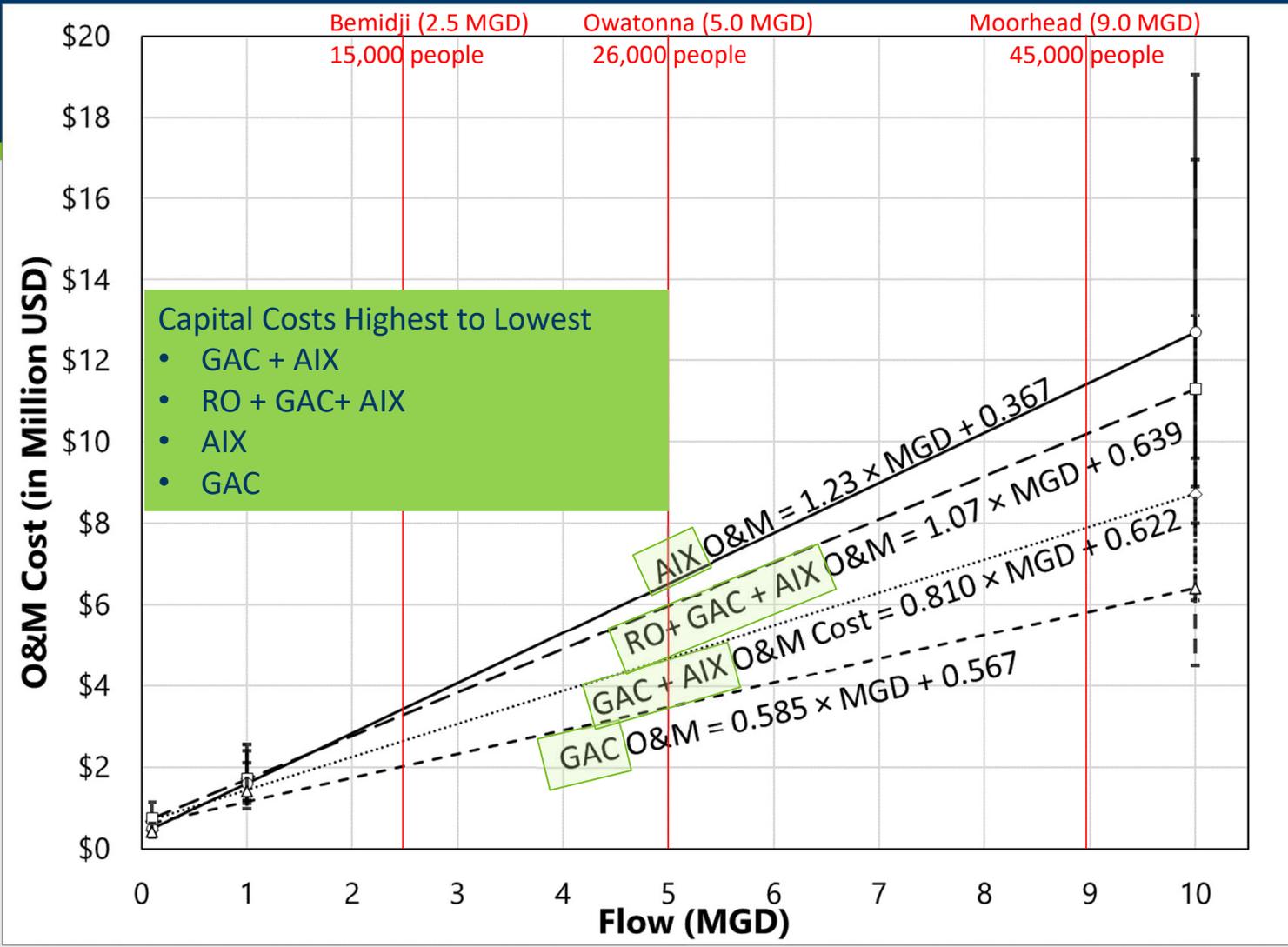




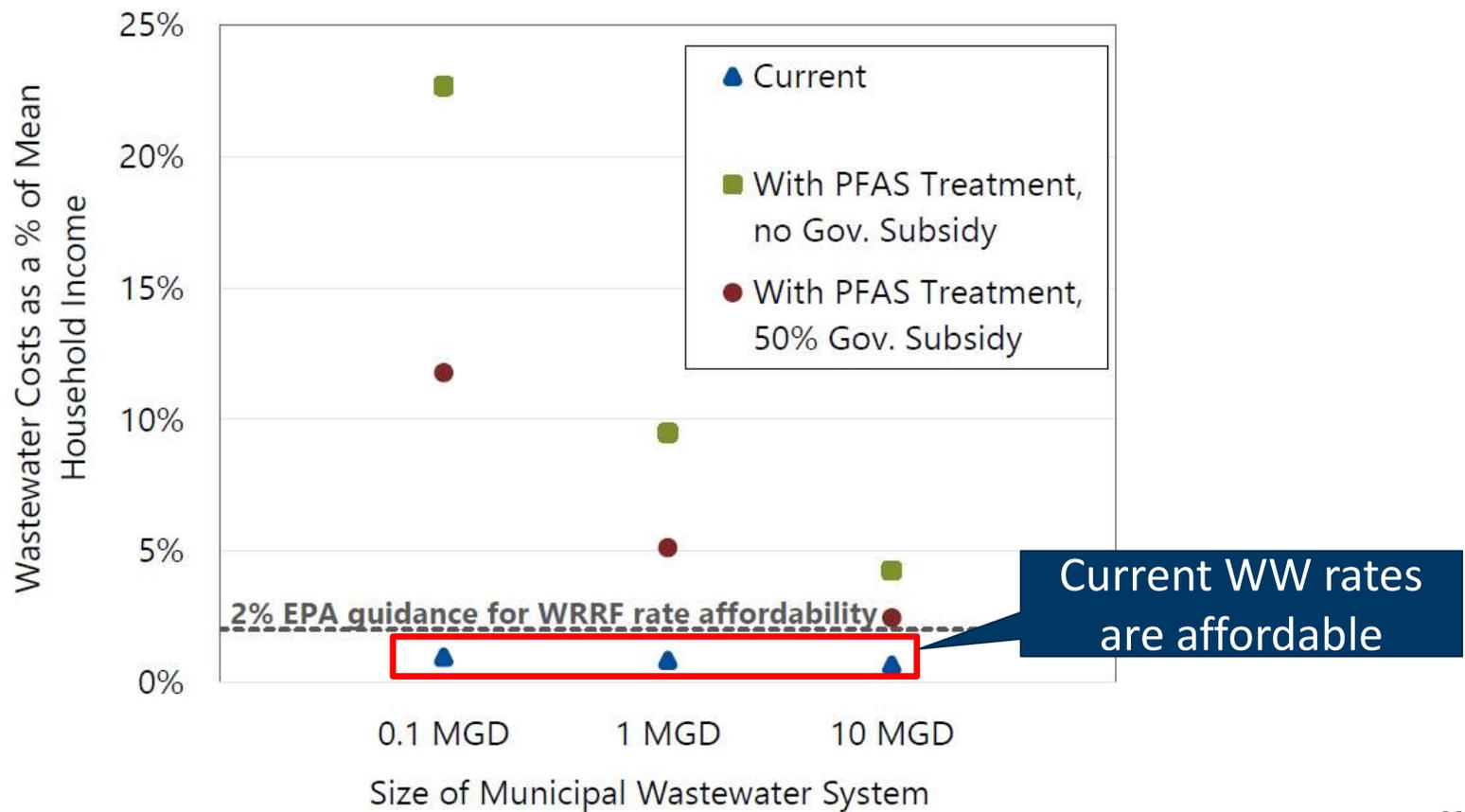








# Are these Wastewater treatment and destruction costs affordable?



# What about biosolids and PFAS?



# PFAS Source Reduction is the key

- Minnesota legislature passed a non-essential PFAS Ban!
- MPCA working on source reduction measures
  - Statewide PFAS sampling efforts
  - Funding of source reduction efforts

