

# Investigation of Post-Filter Treatment DBP Alternatives

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# Presentation Outline

Plant Background & DBP History

Description of Pilot Efforts

Bench scale

Pilot Scale

Discussion of Pilot Results

Conclusion

# Roche Harbor Background



**San Juan Island – NW  
Washington**

**~400 Residential  
Connections**

**Large Resort**

**New Package Plant**

**350 gpm capacity**

**200 gpm normal  
operation**

# Source Background

Shallow Surface Impoundment

Low Turbidity

High Organics and Color

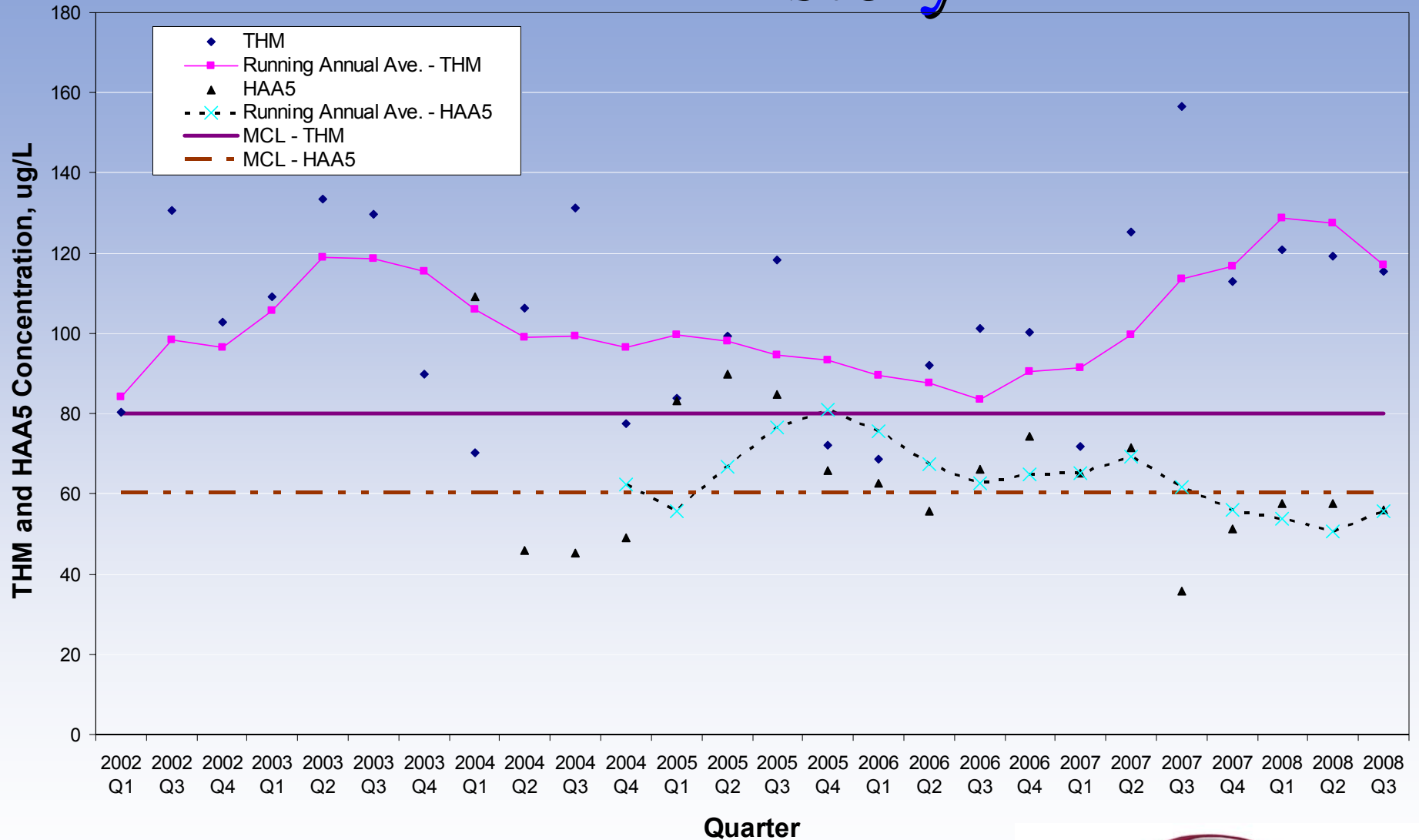
High TOC – 8-15 mg/L

Alkalinity - 60-120 mg/L as  $\text{CaCO}_3$

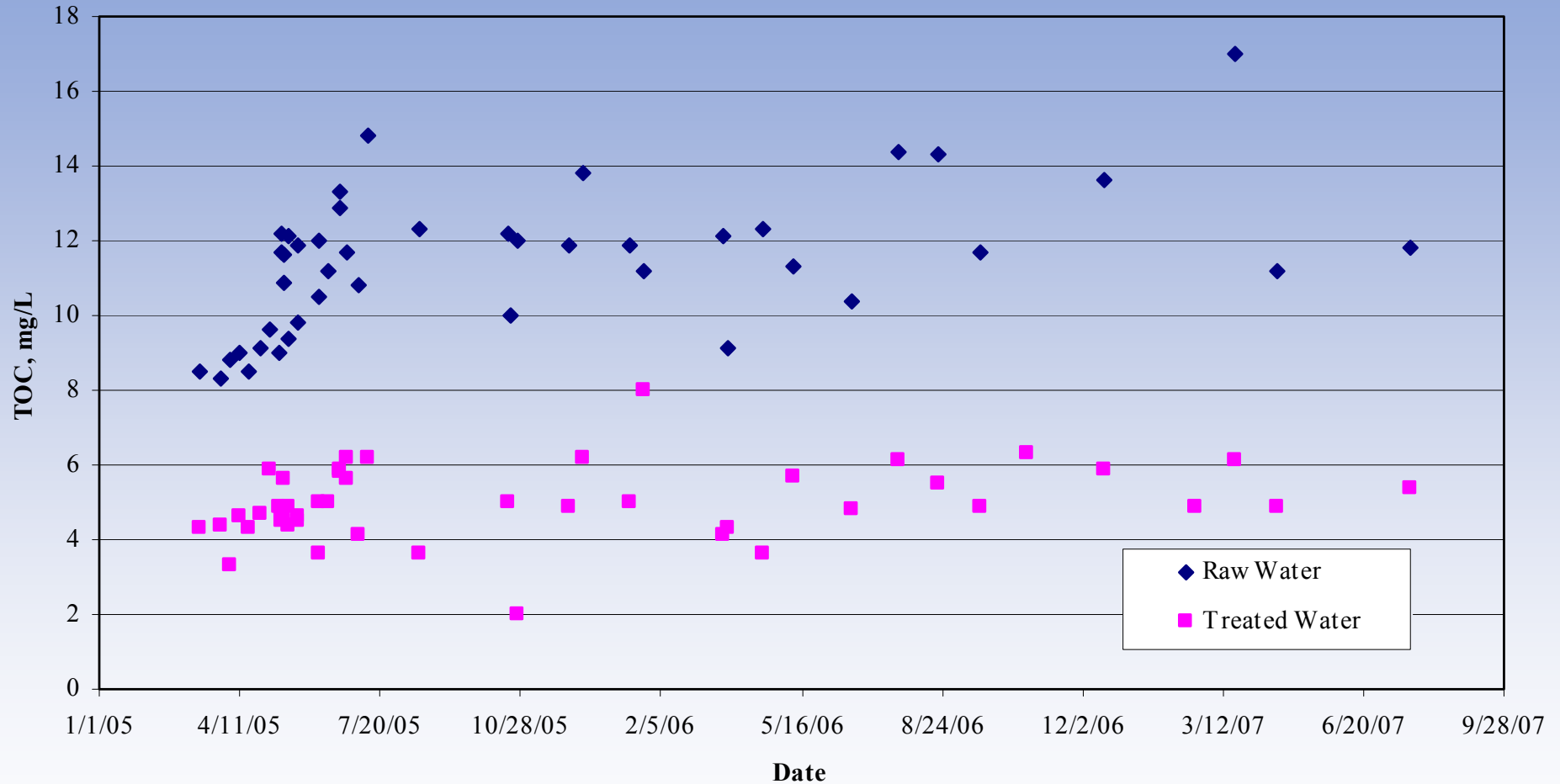
40% TOC Reduction Required by Stage 1 D/DBP



# DBP History



# TOC Removal Through Filtration



# TOC Removal History

Raw Water Average TOC – 11.4 mg/L as  
CaCO<sub>3</sub>

Filtered Water Average TOC – 5.0 mg/L as  
CaCO<sub>3</sub>

~56% Removal of TOC Through Filtration

Filter Optimization Probably Not the Answer

# Other Considerations

Multiple taste and odor complaints

In 2005, Roche Harbor installed  $\text{KMnO}_4$  feed near Briggs Lake.

Little Effect on DBPs



# Purpose of Pilot Study

Investigate carbon (GAC) and ozone as potential post-treatment options to treat DBPs.

Develop DBP measuring surrogate for Roche Harbor use.

Provide design parameters for full scale facility.

# Carbon Study – 2 Step Process

1. Initial powdered carbon bench work

Will carbon work?

2. GAC column exposure study

Cost effective?

Design parameters?

# Bench Scale Carbon Study

GAC pulverized in coffee mill –  
3 types of carbon tested

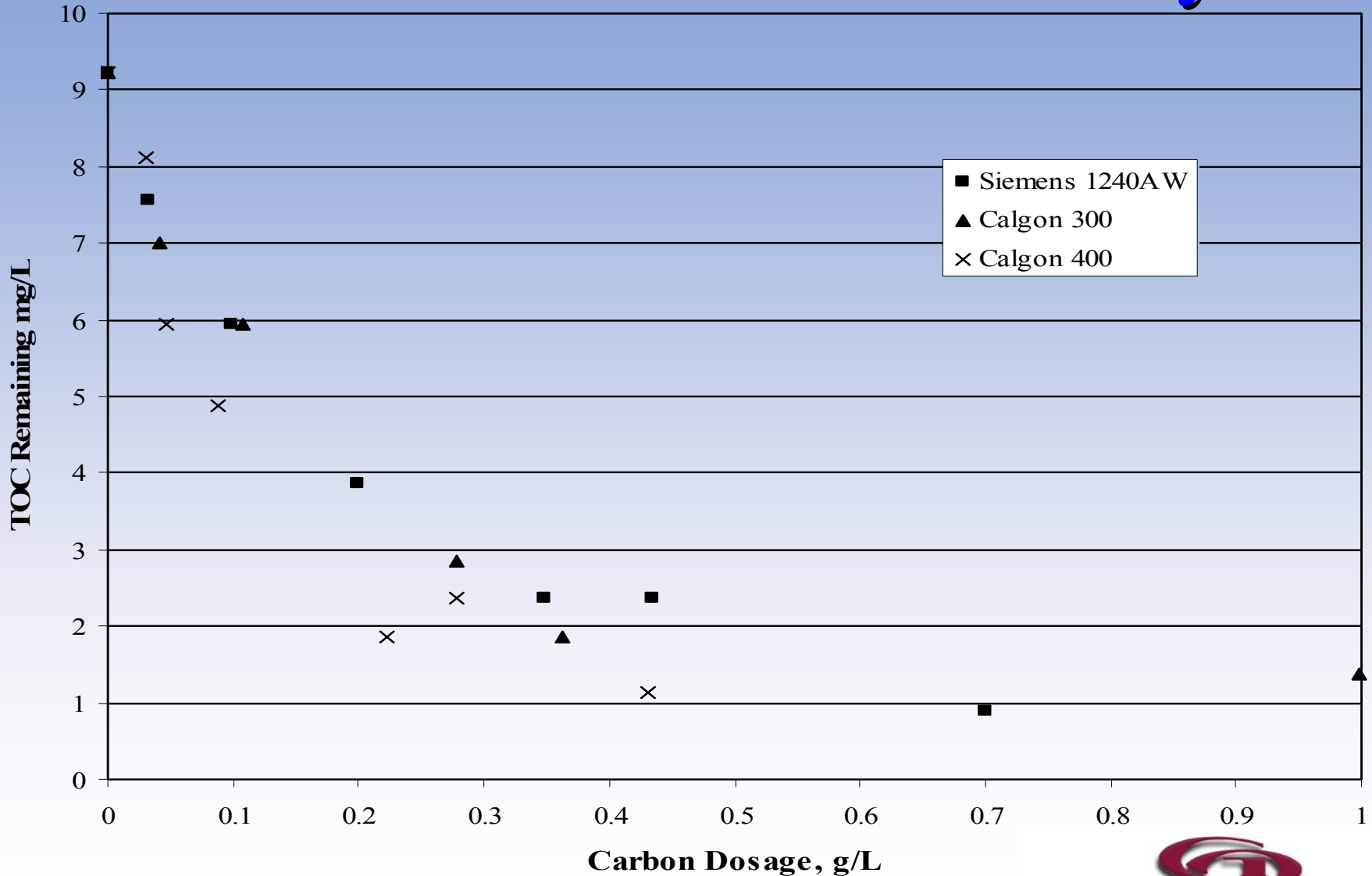
Powdered carbon added to  
filtered water at varying doses

Vacuum filtered after 10 minute  
contact time

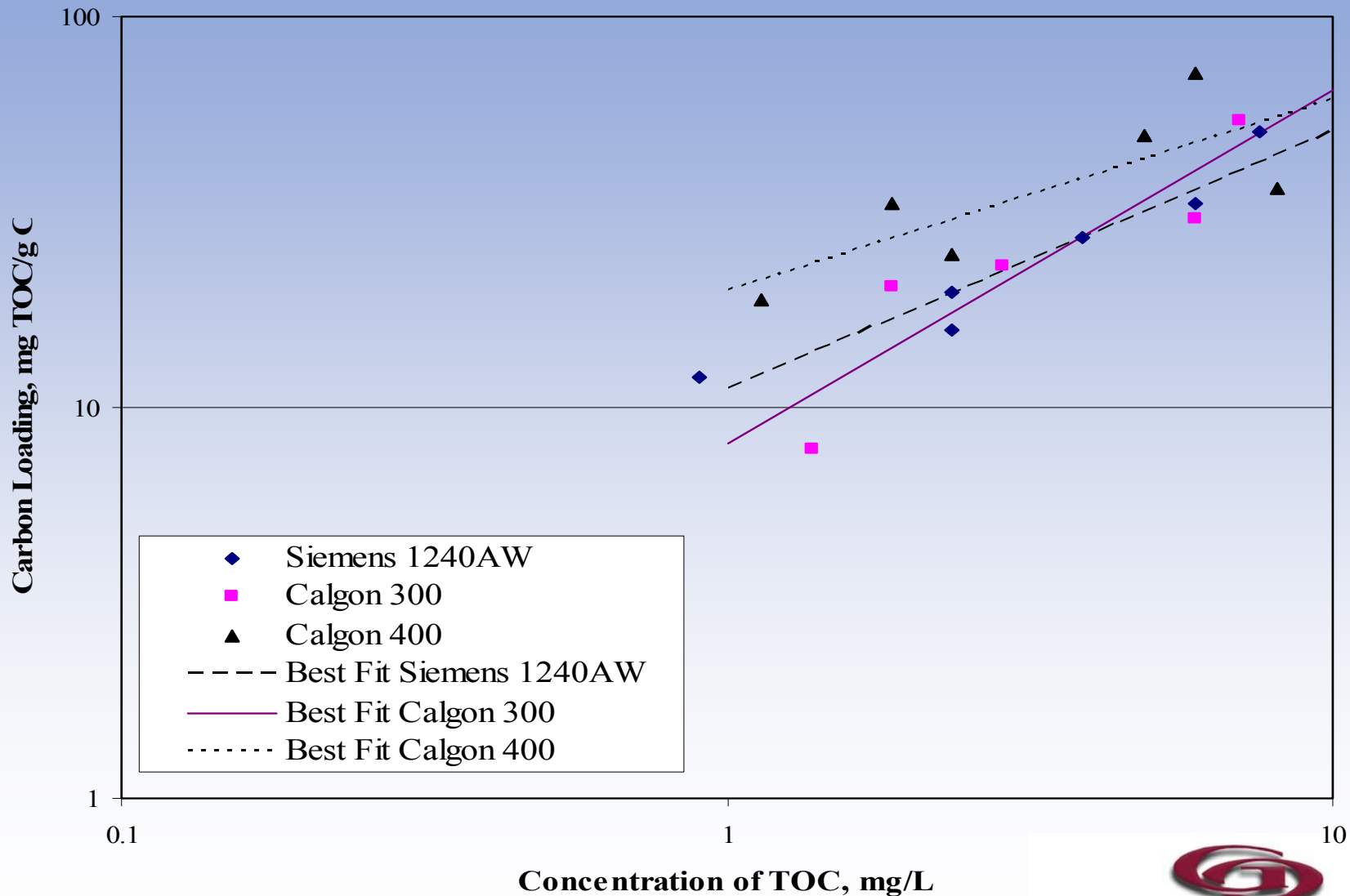
TOC measured at WTP



# Bench Scale Carbon Study



# Bench Scale Carbon Study



# Bench Scale Carbon Study Conclusions

Carbon will remove TOC.

Differences noted in carbon types.

Isotherm data indicate that lots of carbon will be required.

Questions Remain:

Will it be cost effective?

It can remove TOC. – What about DBPs?

=> Column Testing

# Carbon Column Tests

Two Carbons Selected – Calgon 400 and US Filter 1240 AW

Parameter	Value
Columns per Carbon	2 in Series
Carbon Media Depth	48 inches
Media Support	3 inches Pea Gravel
Hydraulic Loading	5.7 gpm/ft <sup>2</sup>
Flow Rate	0.5 gpm
EBCT – 1 vessel	5.2 minutes
EBCT – 2 Vessels	10.4 minutes



# Carbon Column Tests

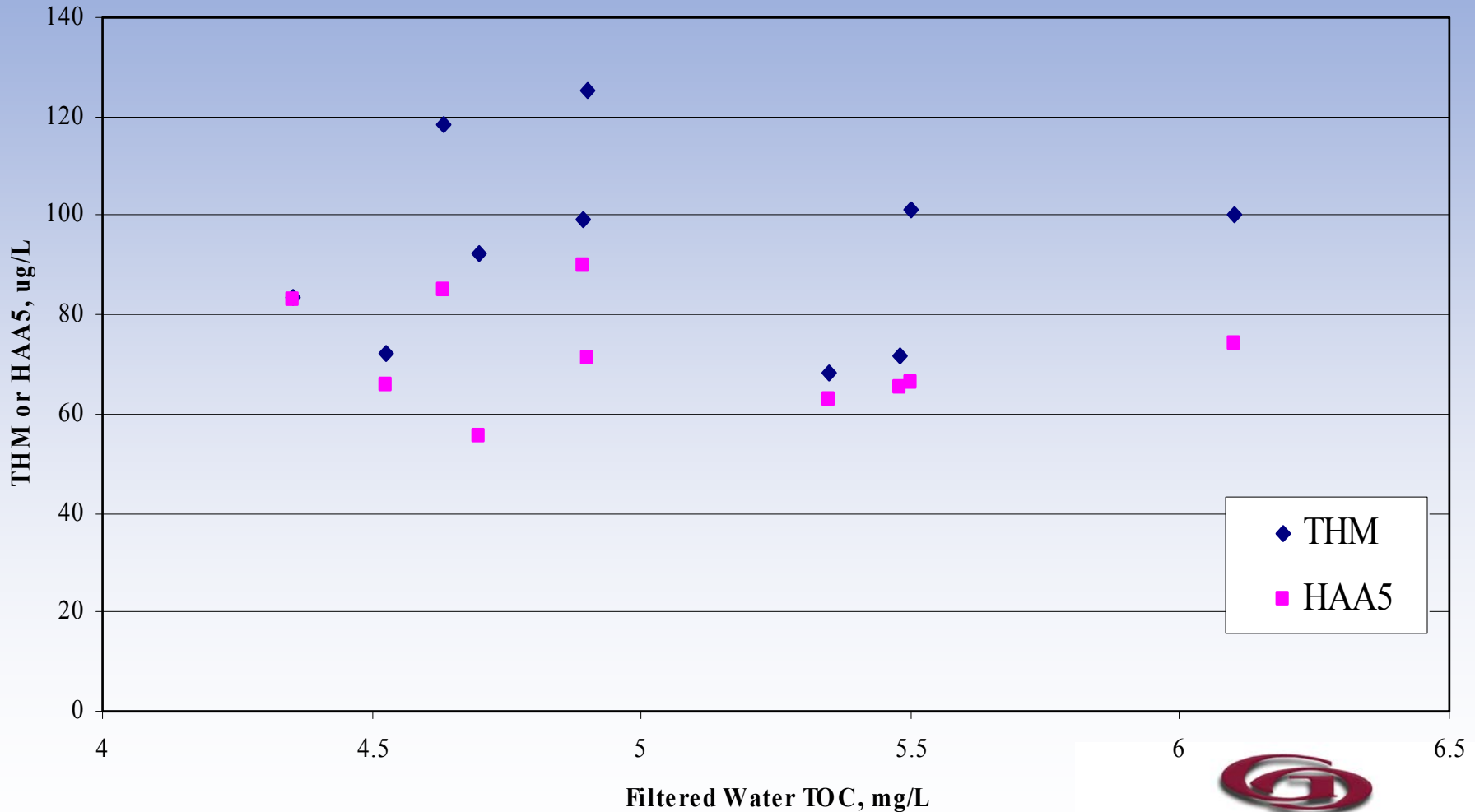
Two columns in series  
Downflow  
8 sample points





# Monitoring Issues

TOC Testing Available at Treatment Plant But Poor Correlation with Historical Compliance DBP Data



# UV 254 nm Measurement

UV 254 nm - simple measurement

No reagents

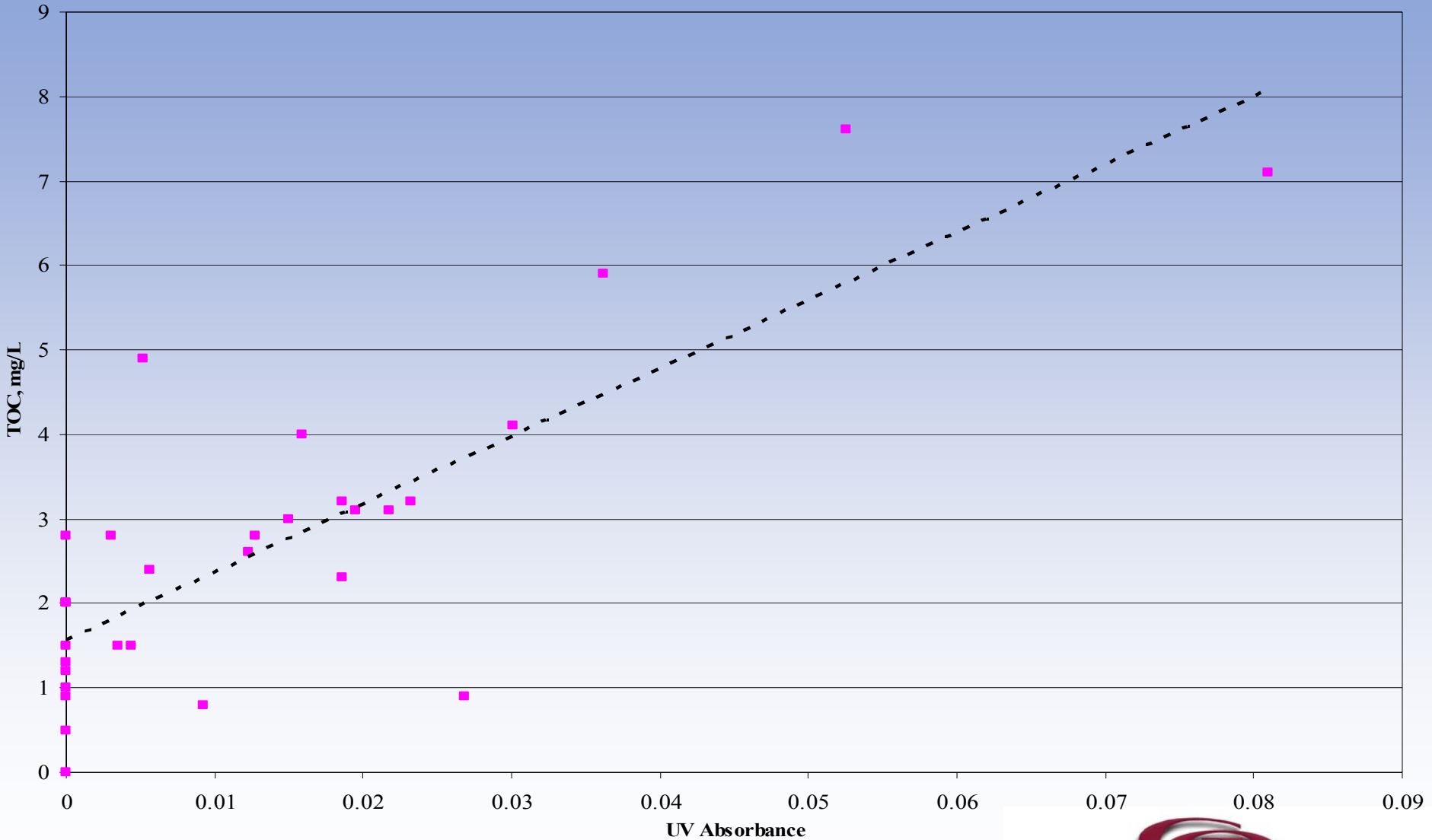
Instant Results

UV 254 nm use established

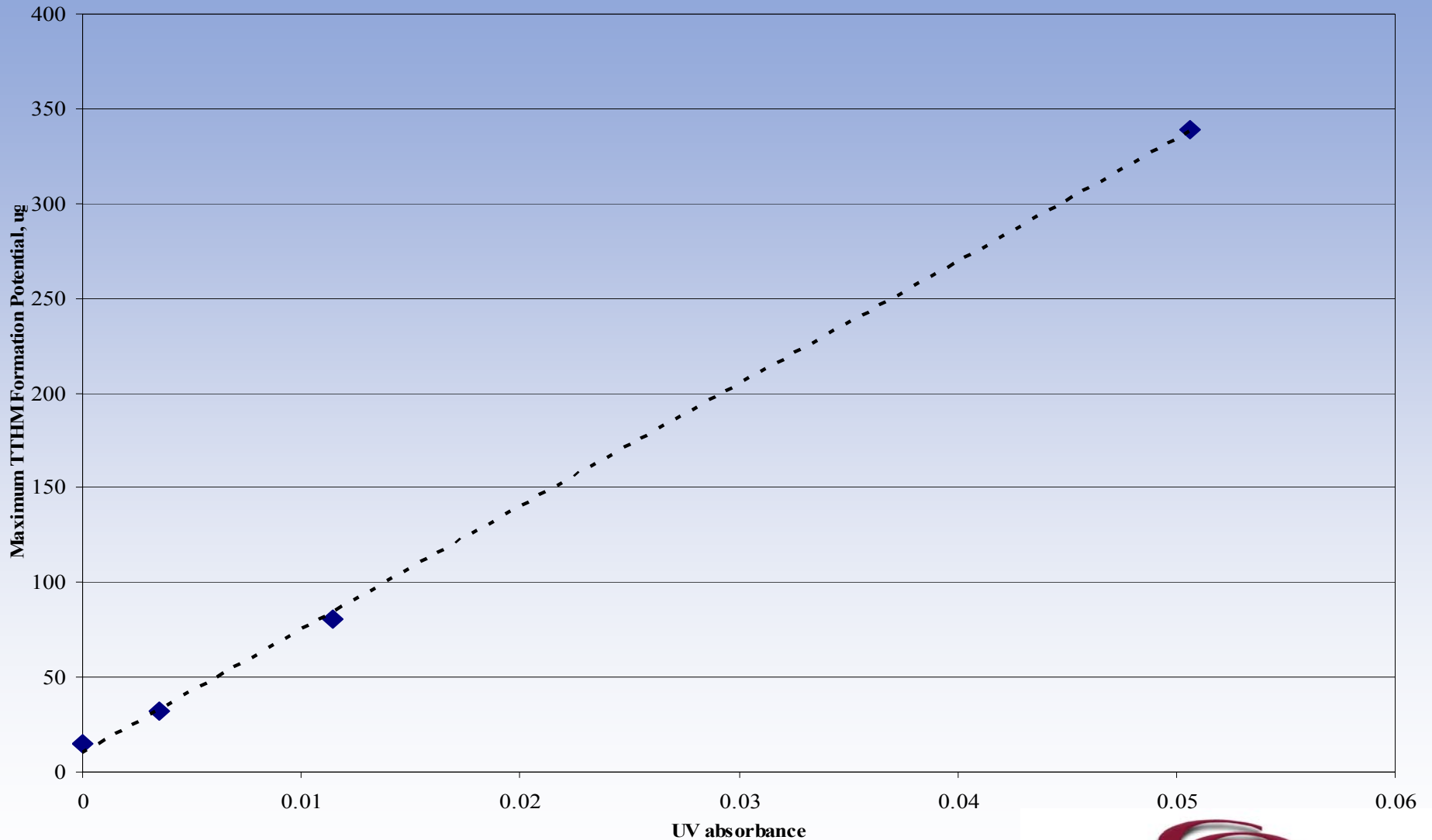
Can it correlate with other parameters – TOC, DBPs?



# UV 254 Correlation with TOC



# UV 254 Correlation with MTTMFP



# Pilot Test Monitoring Protocol

UV 254 nm

TOC

Simulated Distribution System Testing

1 gallon Plastic Jug

Distilled Water & Test Water

Chlorine Added

Refrigerate for 3-4 Days & Monitor Chlorine

Target Residual – 1 mg/L

# Pilot Test Results

## Carbon Column Performance

UV

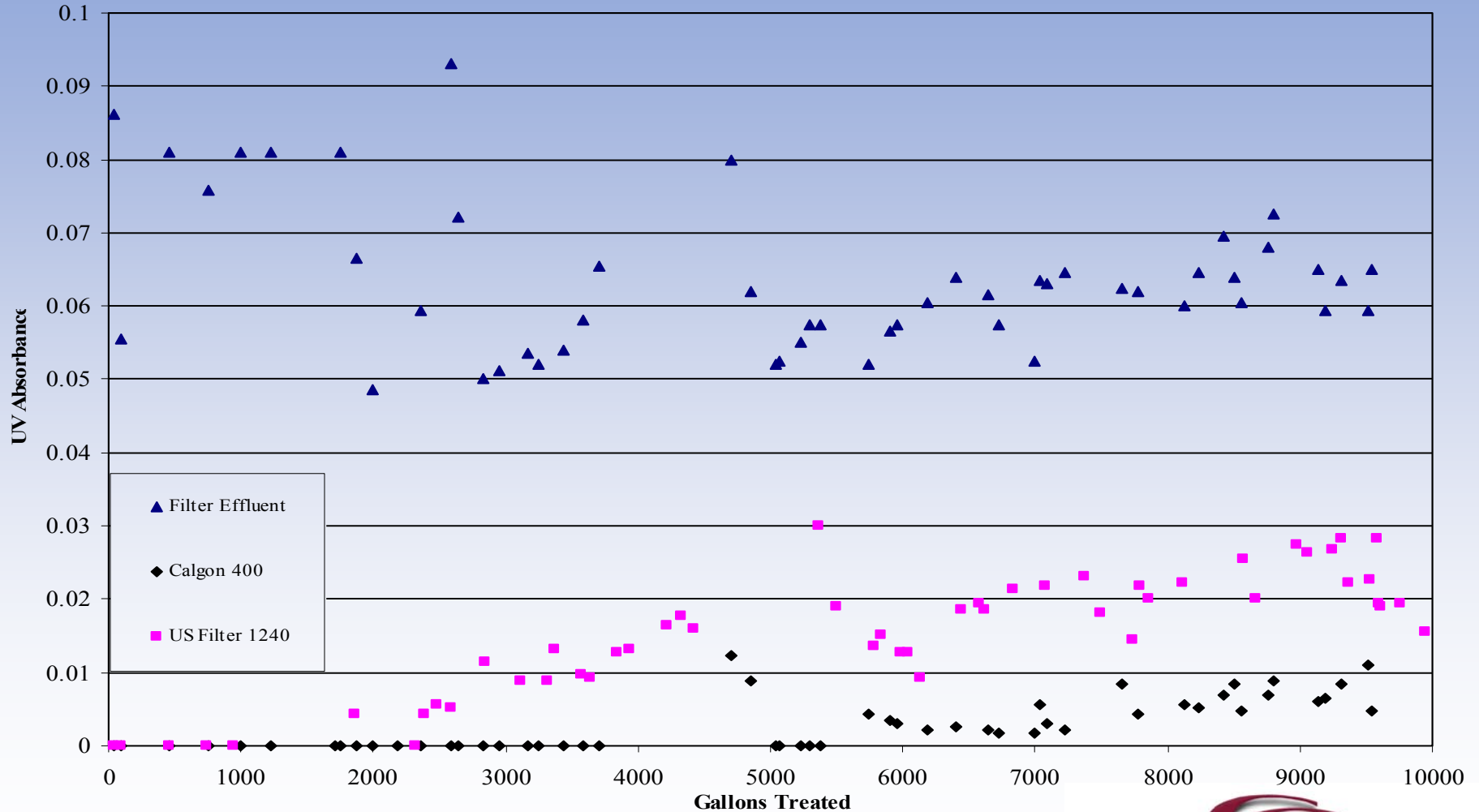
DBP

TOC

## Pilot versus Full-Scale

## Chlorine Demand

# Initial Carbon Column Results



# Carbon Column Results

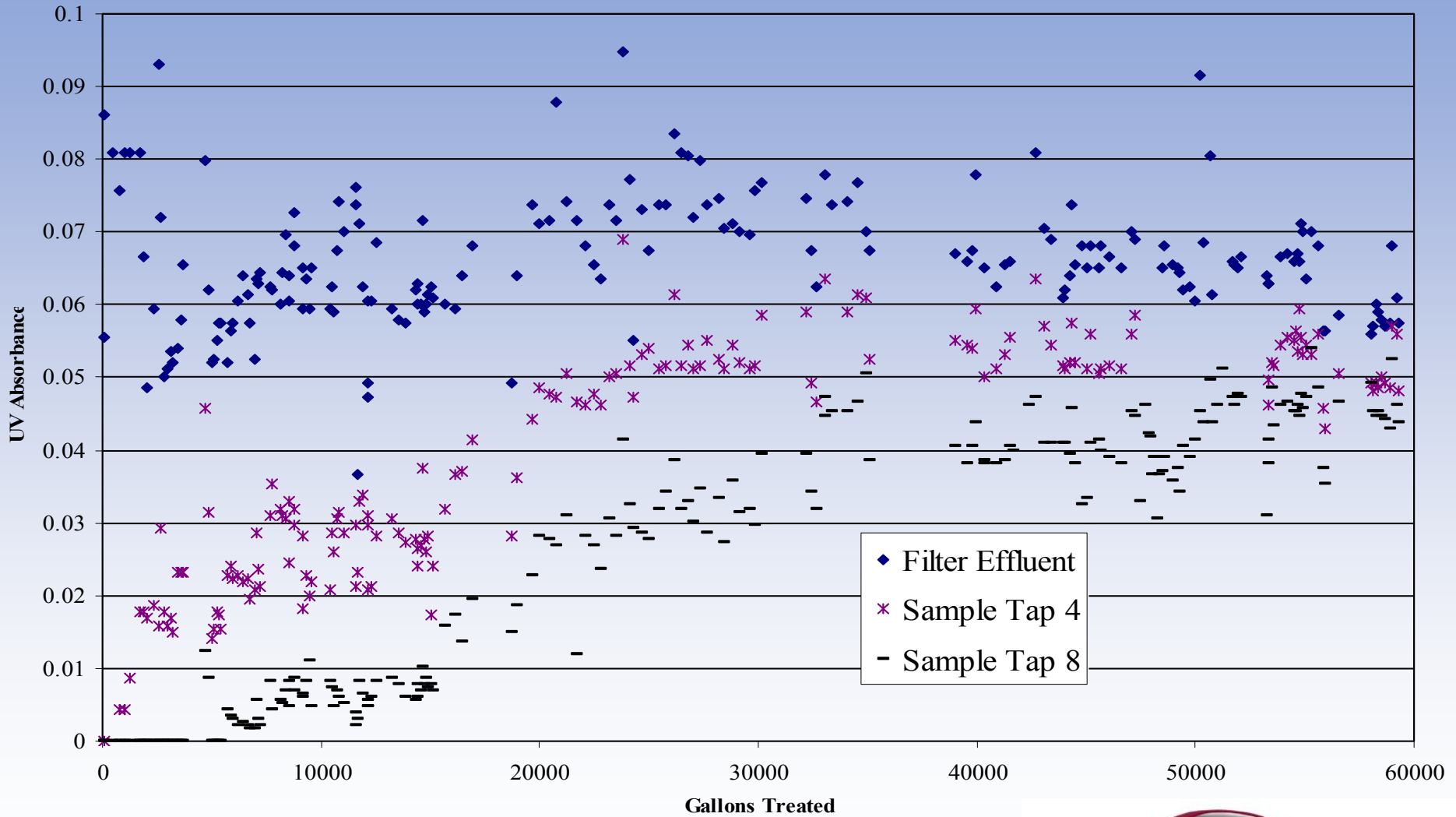
Initial exposure revealed better removal by Calgon carbon.

Subsequent work focused on Calgon unit only.

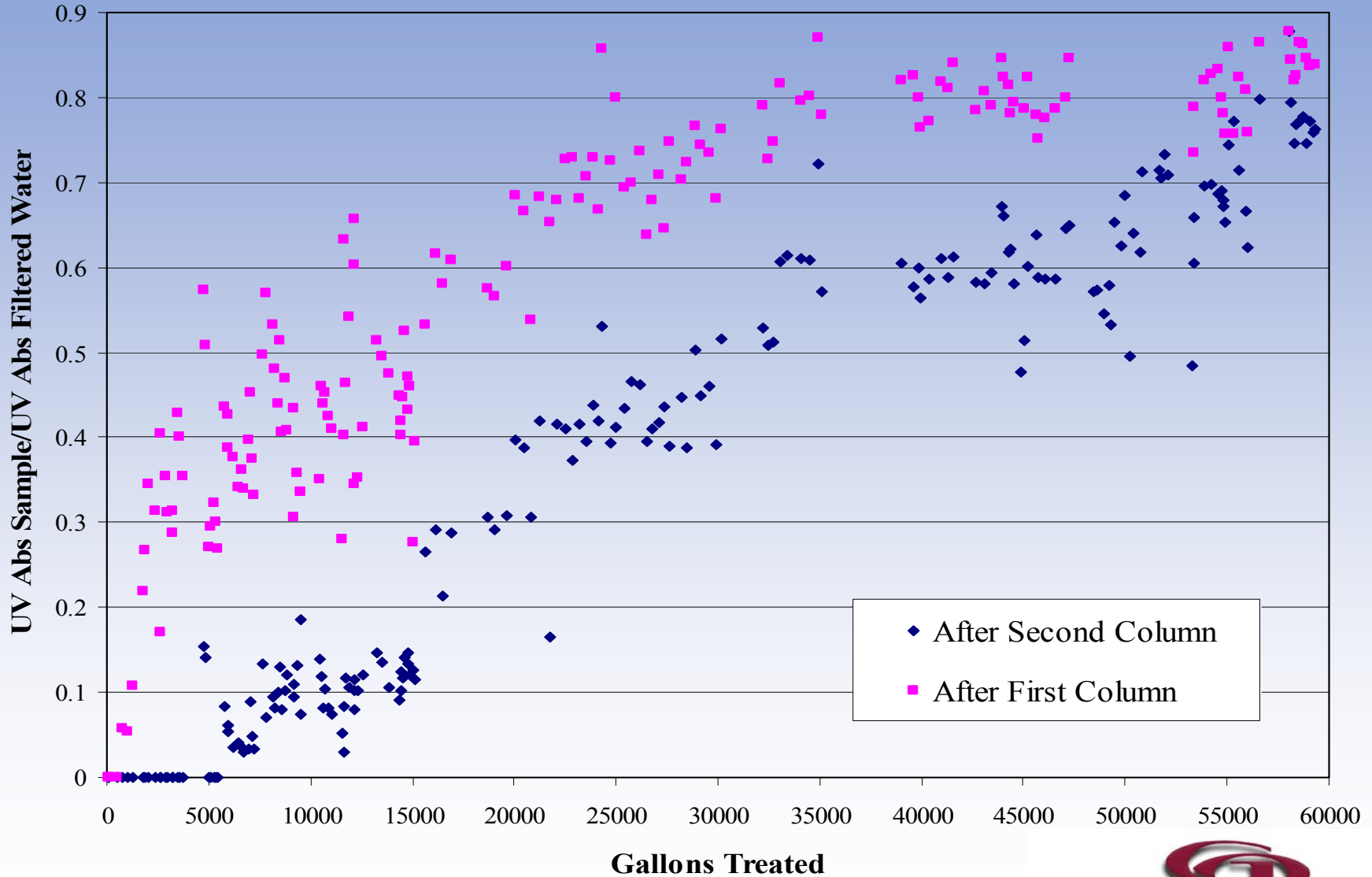
13 month exposure



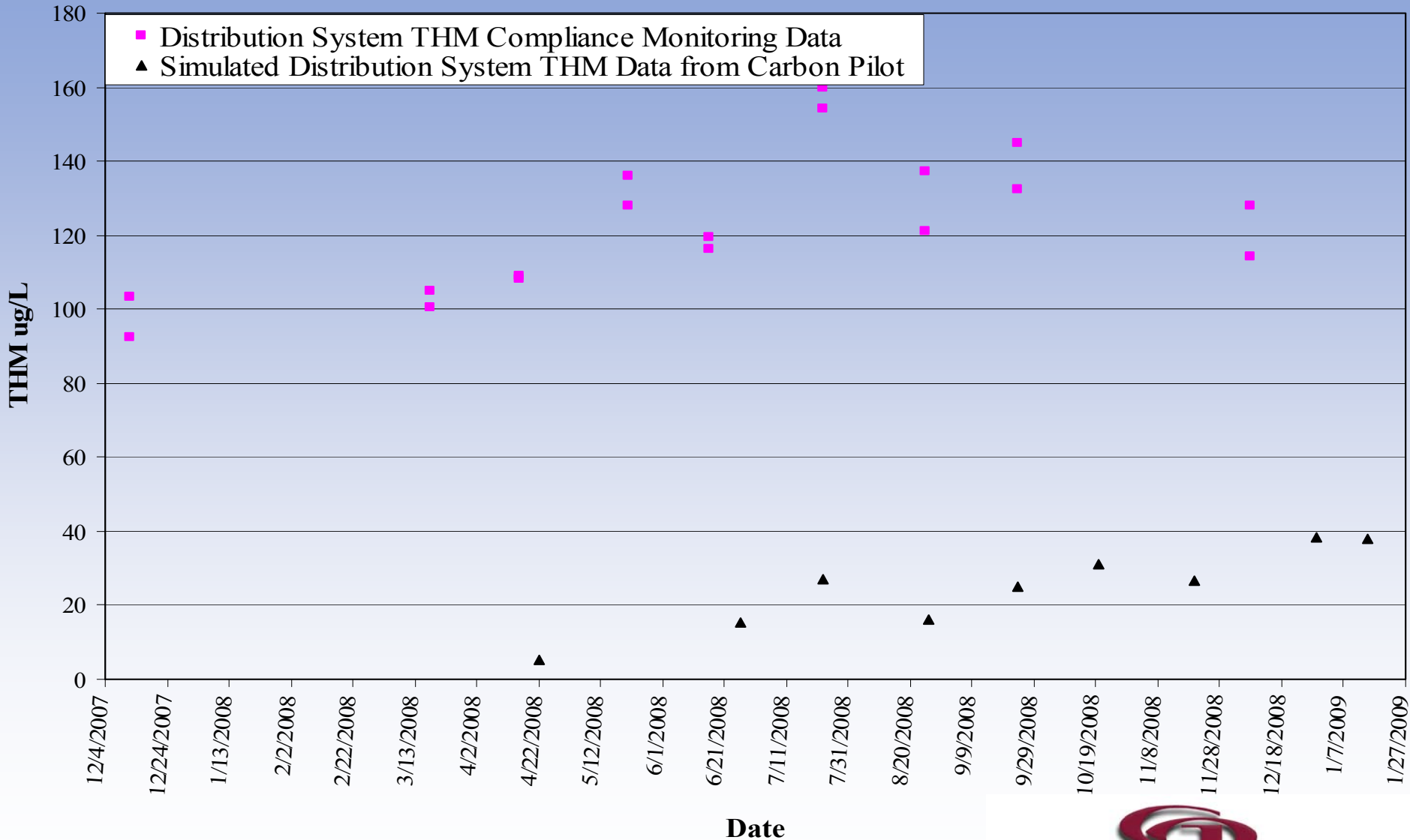
# Carbon Column Results



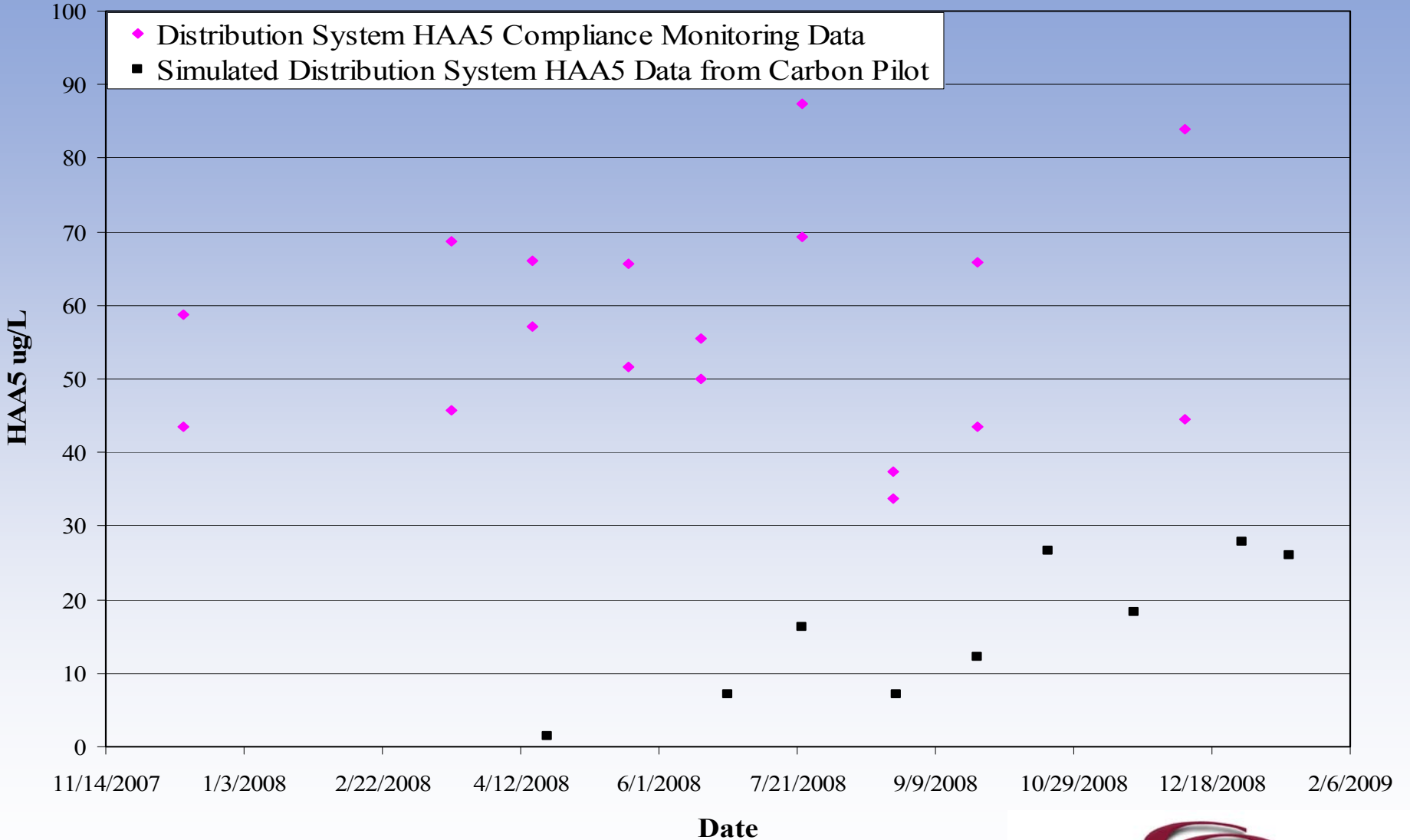
# Carbon Column Results - Normalized



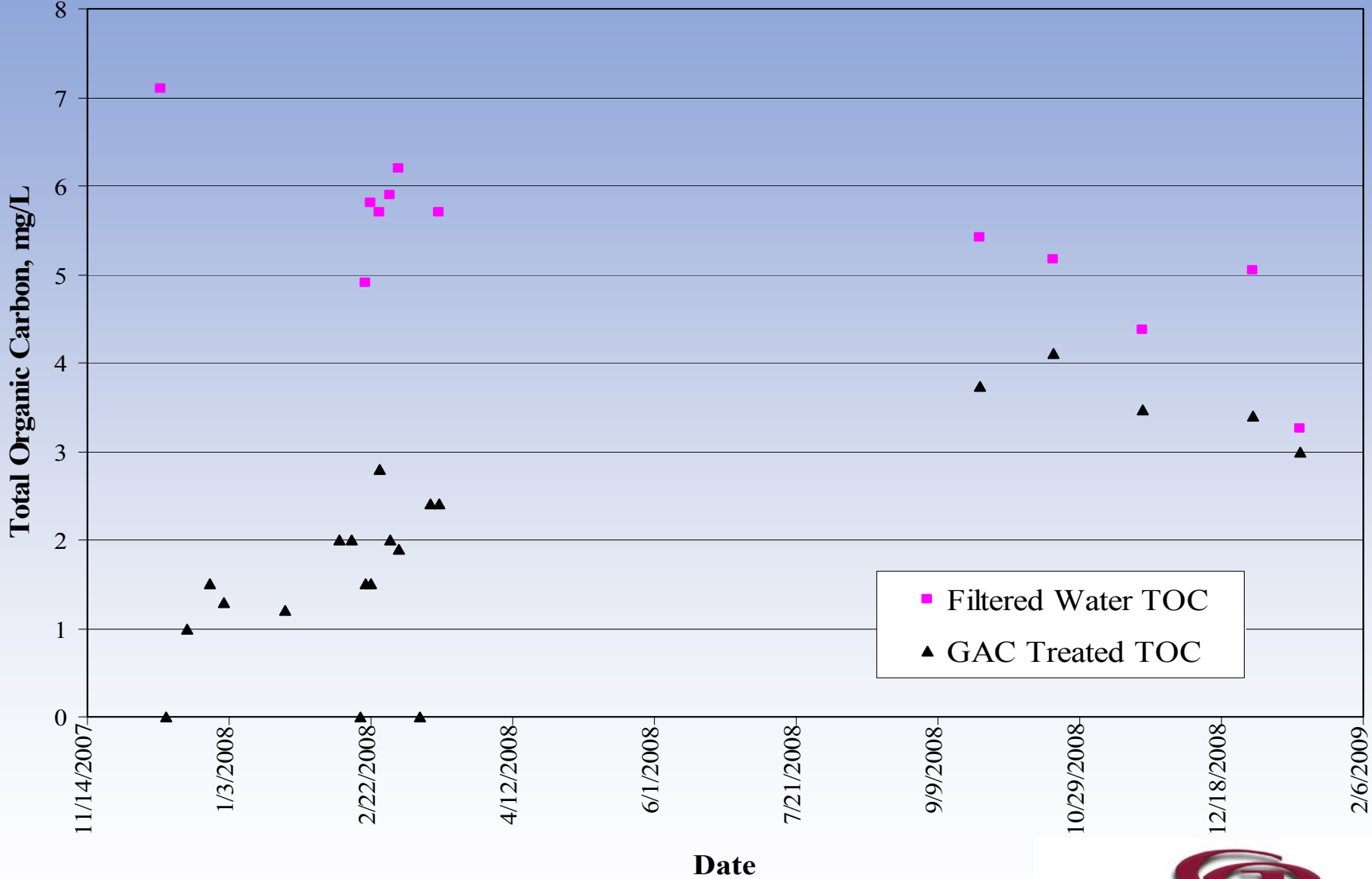
# THM Results



# HAA5 Results



# TOC Data



# Carbon Results

UV 254 Absorbance Data Indicates 20-30% Removal of UV Absorbing Material After 13 Months.

Good THM and HAA5 Results with Carbon.

Initial TOC Removal Good – After Exposure ~25% Removal.

# Review of UV 254 Measurement

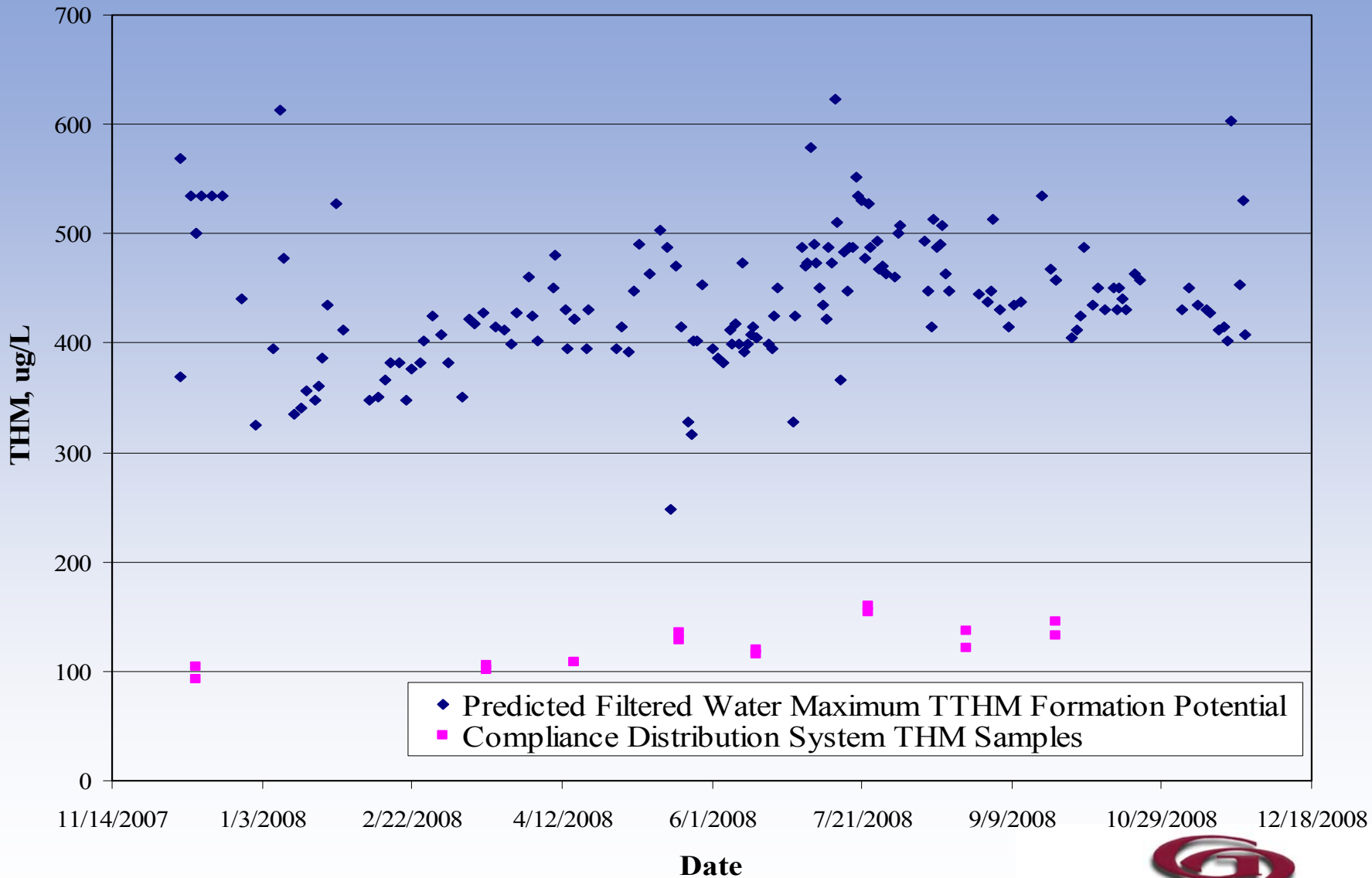
UV 254 used to calculate MTTMFP.

MTTHMP compared to pilot THM data.

Distribution Compliance Data

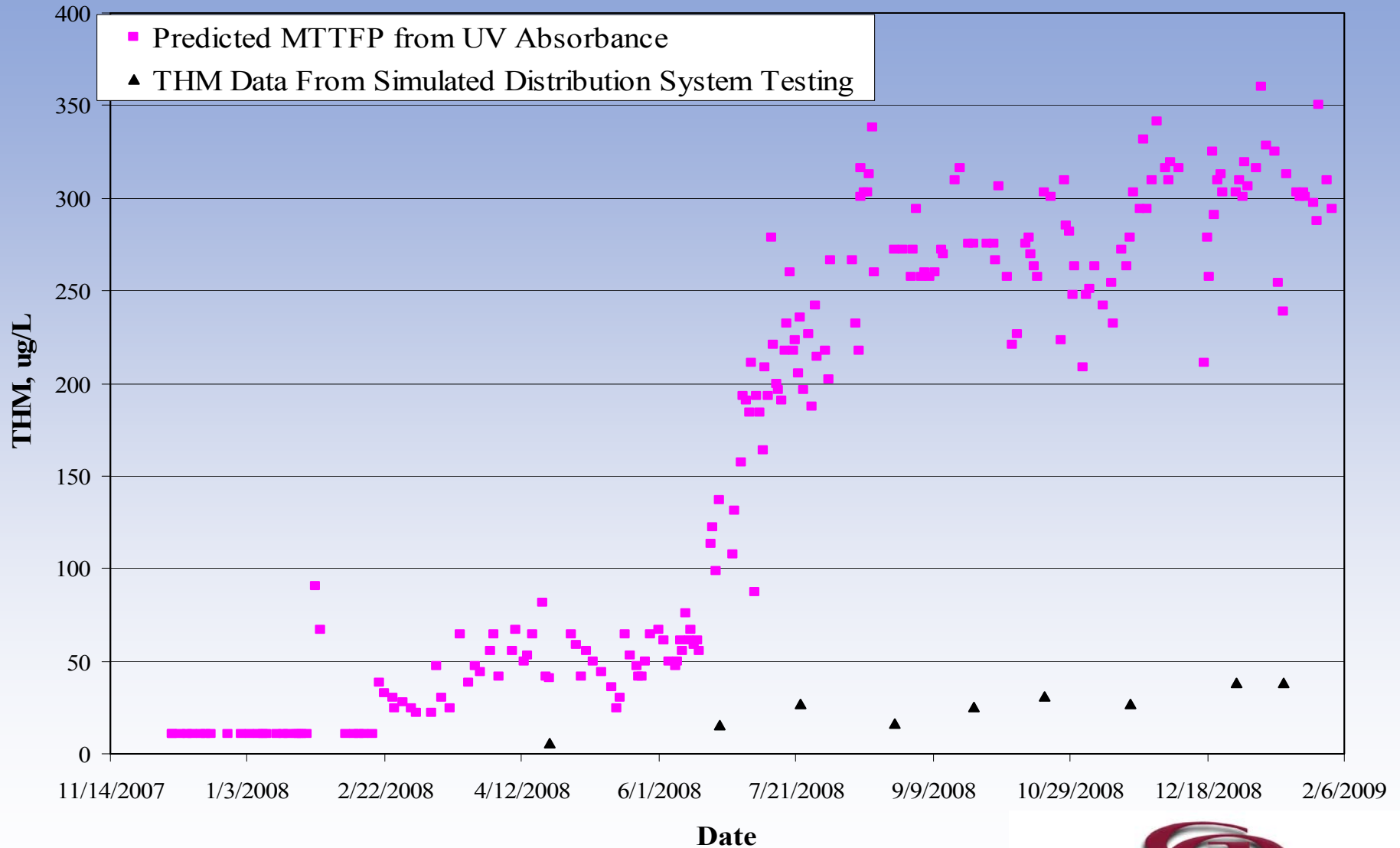
Simulated Distribution System Test Data

# Comparison of Filtered Water UV and Distribution System THMs





# Comparison of UV Data and Simulated Distribution System Data



# Review of UV 254 Measurement

Actual THM ~25% of MTTMFP for Existing Full Scale Plant

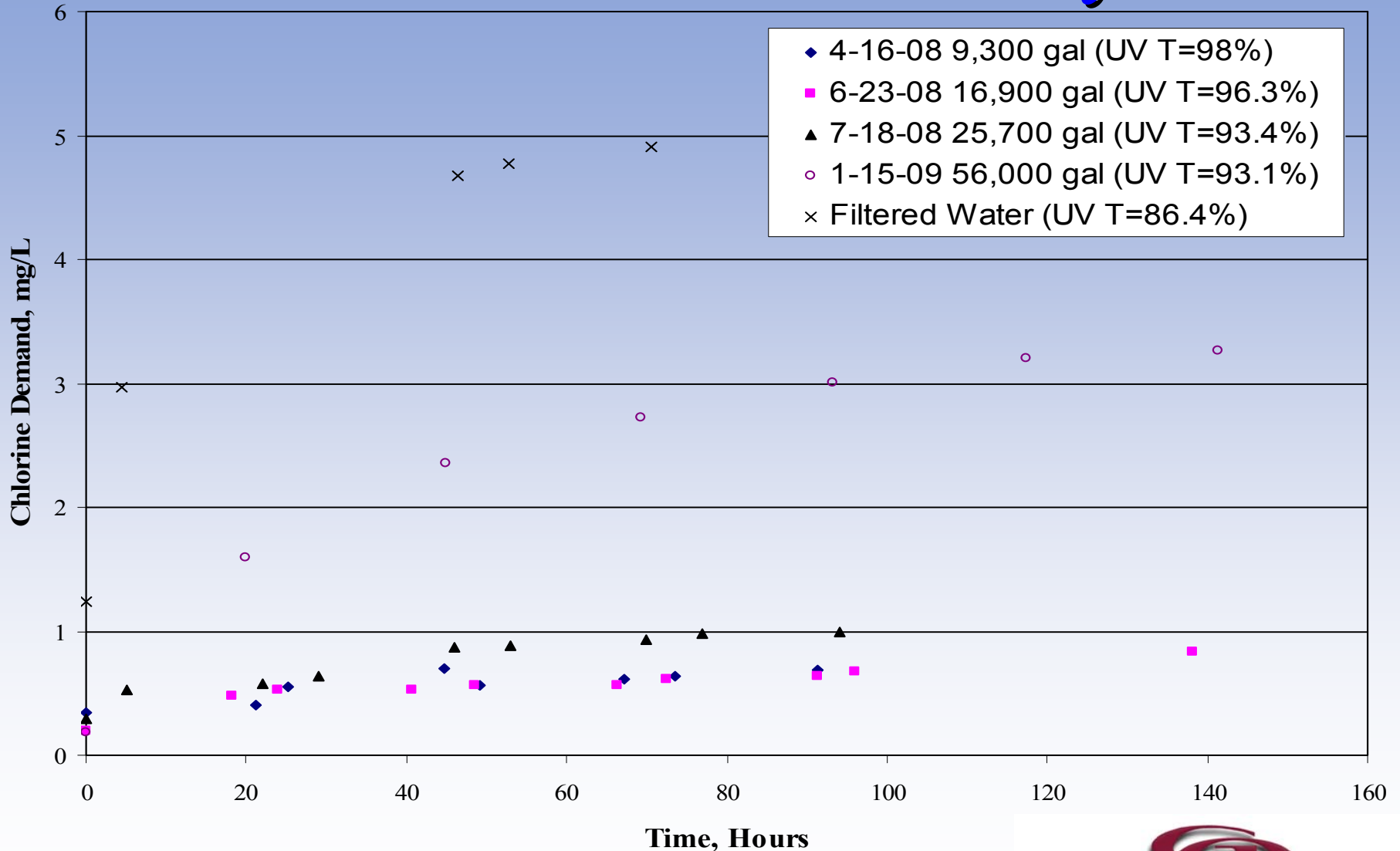
SDS THM ~ 10% of MTTMFP for Carbon Pilot Units

Difference?

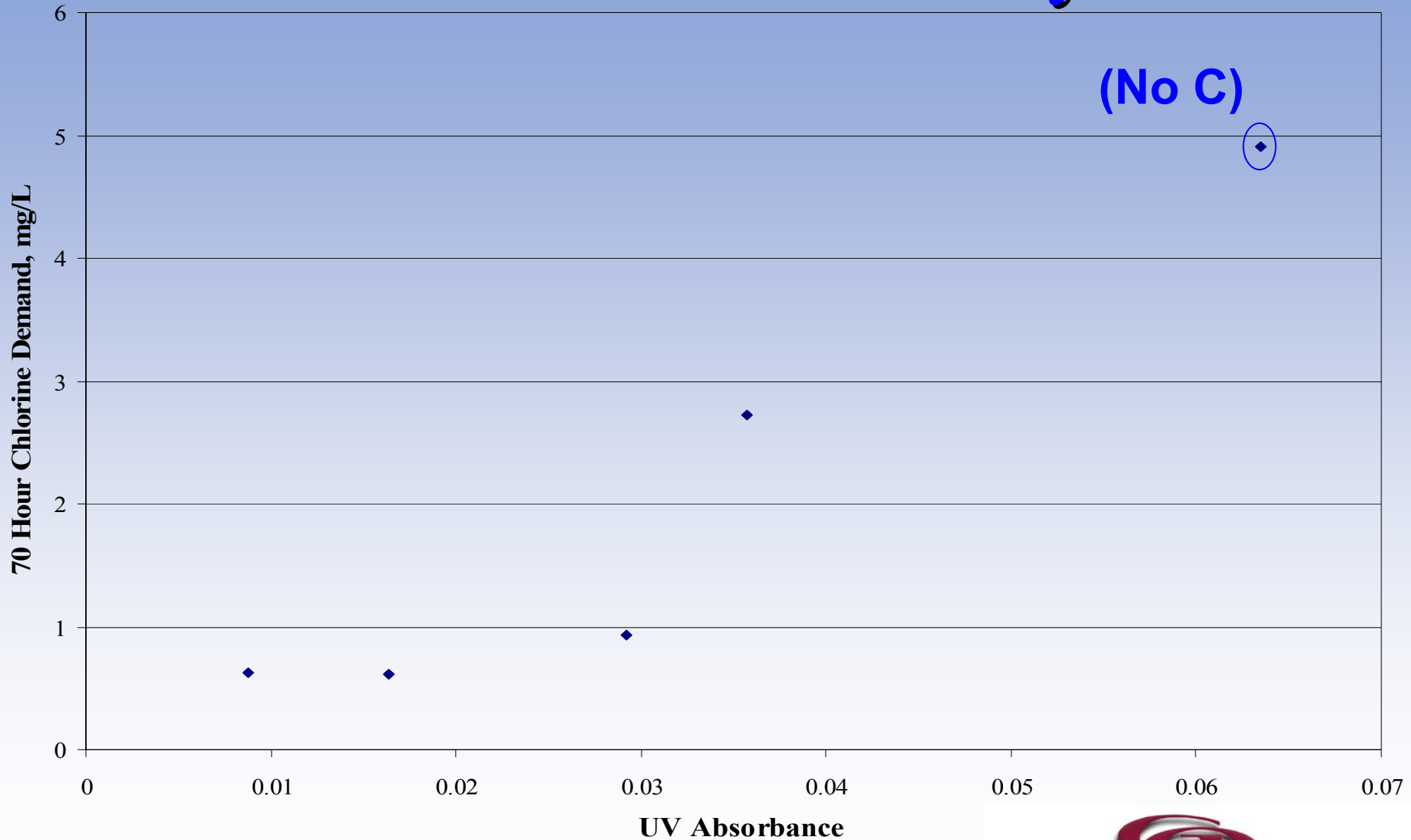
Pipe Wall Interactions

Selective Removal of Pre-cursors

# Chlorine Demand Analysis



# Chlorine Demand Analysis





# Ozone Investigation

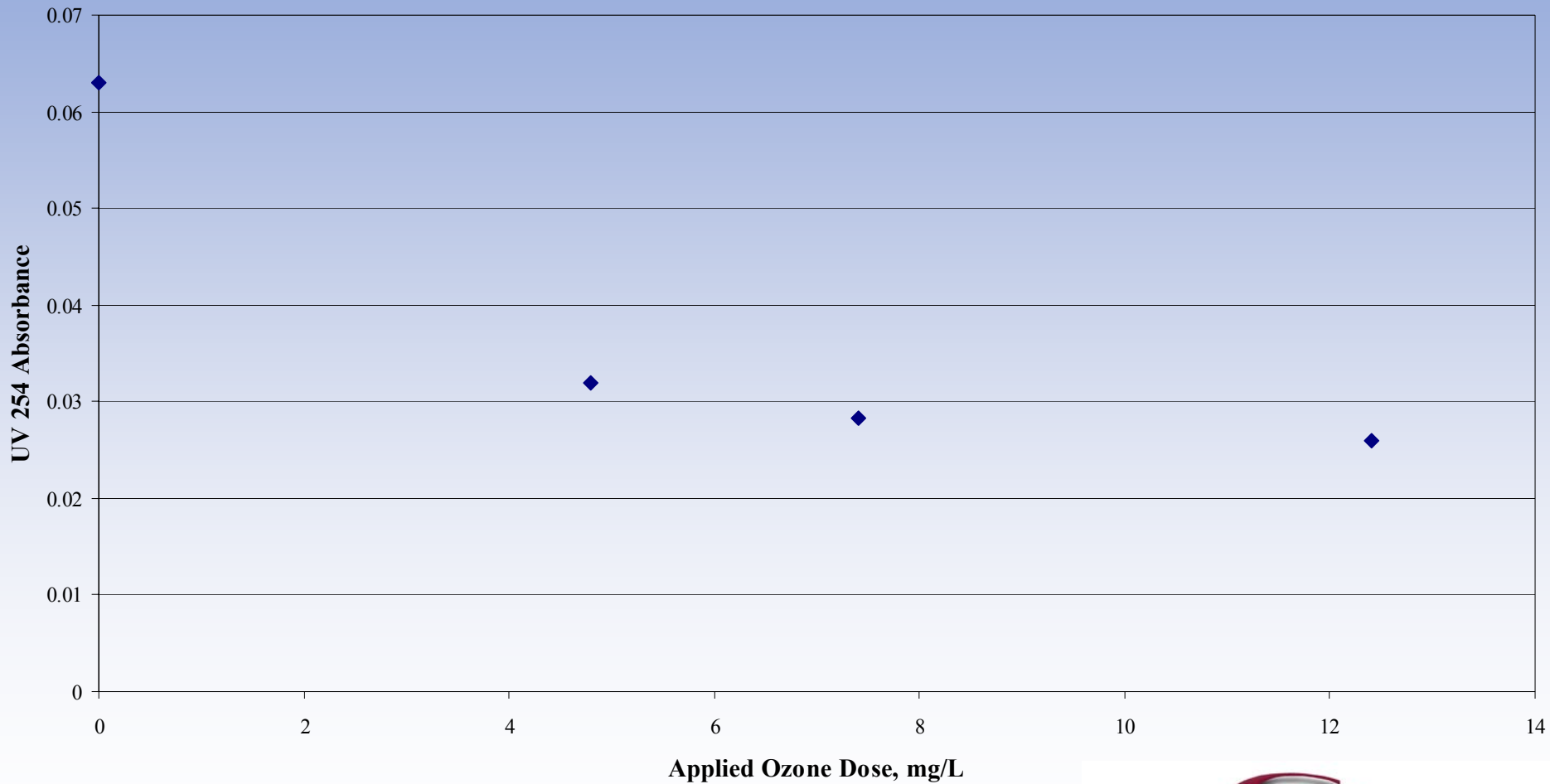
Goal: To develop a dose versus UV 254 nm curve.

Ozone dosing using ozone contactor

Countercurrent air and water flow

Known dose/efficiency relationship from previous work

# Ozone Investigation



# Ozone Investigation

Data indicate that a minimum dose of 7-8 mg/L of ozone required for a calculated MTHMFP of 160 mg/L and possible <80 mg/L THM in distribution system.

1999 slow sand pilot indicated that 15 mg/L ozone was required as pre-treatment for slow sand.

Filtration removes a significant amount of ozone demand but a significant amount remains

# Conclusions

Carbon is effective at removing DBP pre-cursors.

Carbon life is predicted to be cost effective (~\$1 per 1,000 gallons).

UV 254 nm measurement is an effective (DBPs and Cl demand) and easy tool – full scale correlation will be required.

Ozone appears to also be effective but a high dose is required – cost prohibitive.



# Questions?

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