

New Treatment Amendment to Remove Hg from Groundwater/Leachate

Treatability/Design Studies

Doug Gray

Mercury in Chemistry



Mercury in Physics



we are not same bro..

Agenda

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- 02 Technology Overview
- 03 Project Summary
- 04 Results / Evaluation
- 05 Conclusions / Lessons Learned

Acknowledgements

- Rich Hazenstab - York County Solid Waste & Refuse Authority
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- Jon Miller/Kim Pingree - Albemarle

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Introduction / Background

Introduction / Background

- Groundwater/leachate collected via two (2) recovery systems
- Recovery systems consist of ten (10) recovery wells per system
- Recovered water impacted with organics and mercury (Hg)
- Treated through air stripper to remove organics, not effective for Hg removal leading to potential discharge issues
- Initiated studies to determine an Hg removal approach that:
 - Efficient Hg removal as pre-treatment step
 - Cost effective
 - Low operations and maintenance
- New Hg treatment amendment (MercLok™) was identified for as potential candidate over the use of activated carbon

Site Layout



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Technology Overview

MercLok™ - Hg Remediation Technology

- Hg remediation amendment, commercialize in early 2023
- Significant testing was completed prior to commercialization
- Designed for:
 - Rapid stabilization of multiple forms of Hg
 - Effective on soils, groundwater, sediments and industrial wastes
 - High efficacy and low loading requirements
- Compelling and unique solution

MercLok™ Technology Overview

MercLok™ particles chemically react with and bind dissolved Hg under a range of atmospheric and geologic conditions including acidic and alkaline environments, resulting in the Hg becoming non-leachable and preventing the Hg from volatilizing

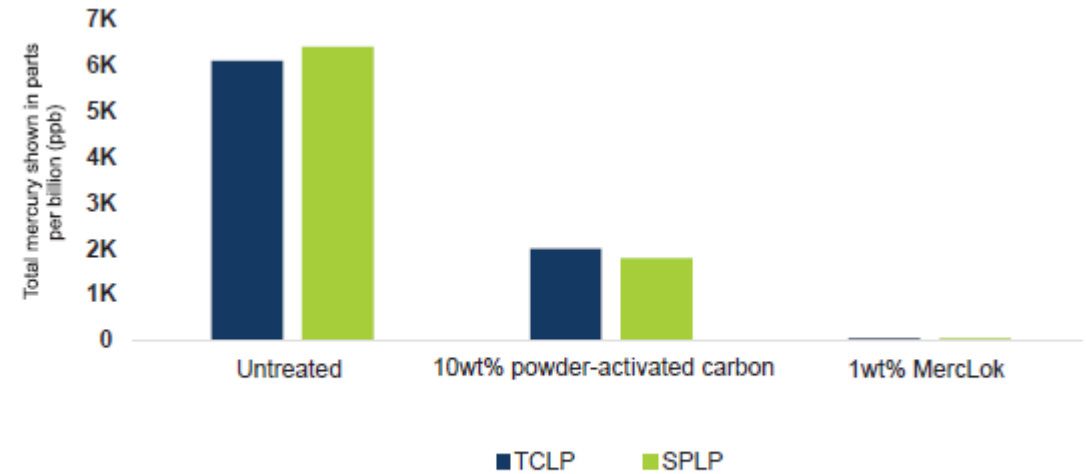


Figure 1: TCLP and SPLP results of mercury contaminated soil taken from a field site

Soil Name	Natural Organic Matter	Water Saturation	Water Type	Soil Types
A	Low	Unsaturated	Fresh	Clay loam
B	Low	Saturated	Fresh	Clay loam
C	High	Saturated	Brackish	Sandy loam
D	High	Saturated	Fresh	Sandy loam
E	Low	Saturated	Fresh	Sandy

Table 1: Reference guide of soil characteristics for Figure 2.

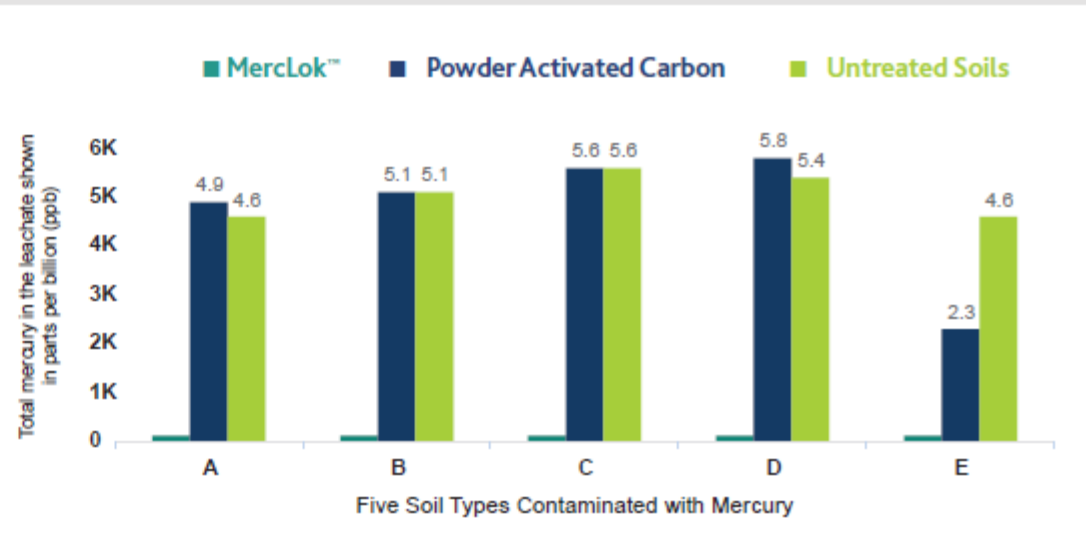


Figure 2: A comparison of SPLP results in a wide range of soils treated with powder activated carbon and MercLok using the untreated soil as the control.

MercLok™ Technology Overview

MercLok™	
Material Phase	Solid
Color & Size Classification	Black Powder
Relative Density (soil)	0.5
Particle Strength	High hardness and high abrasion resistance
Particle Solubility	Non-soluble in water
Function Statement	Stabilization of mercury species onto solid substrate
Reactivity with Mercury	Chemical reaction followed by adsorption of reactant
Toxicity Classification	Mixture is classified as nonhazardous
Personal Protections (PPE)	US SDS Complete, Standard PPE for Powders



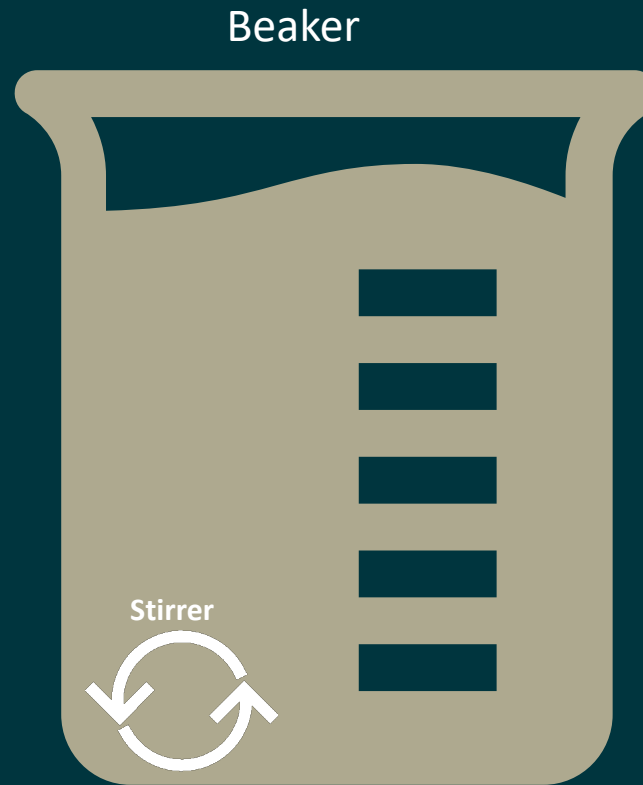
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Project Summary

Project Summary

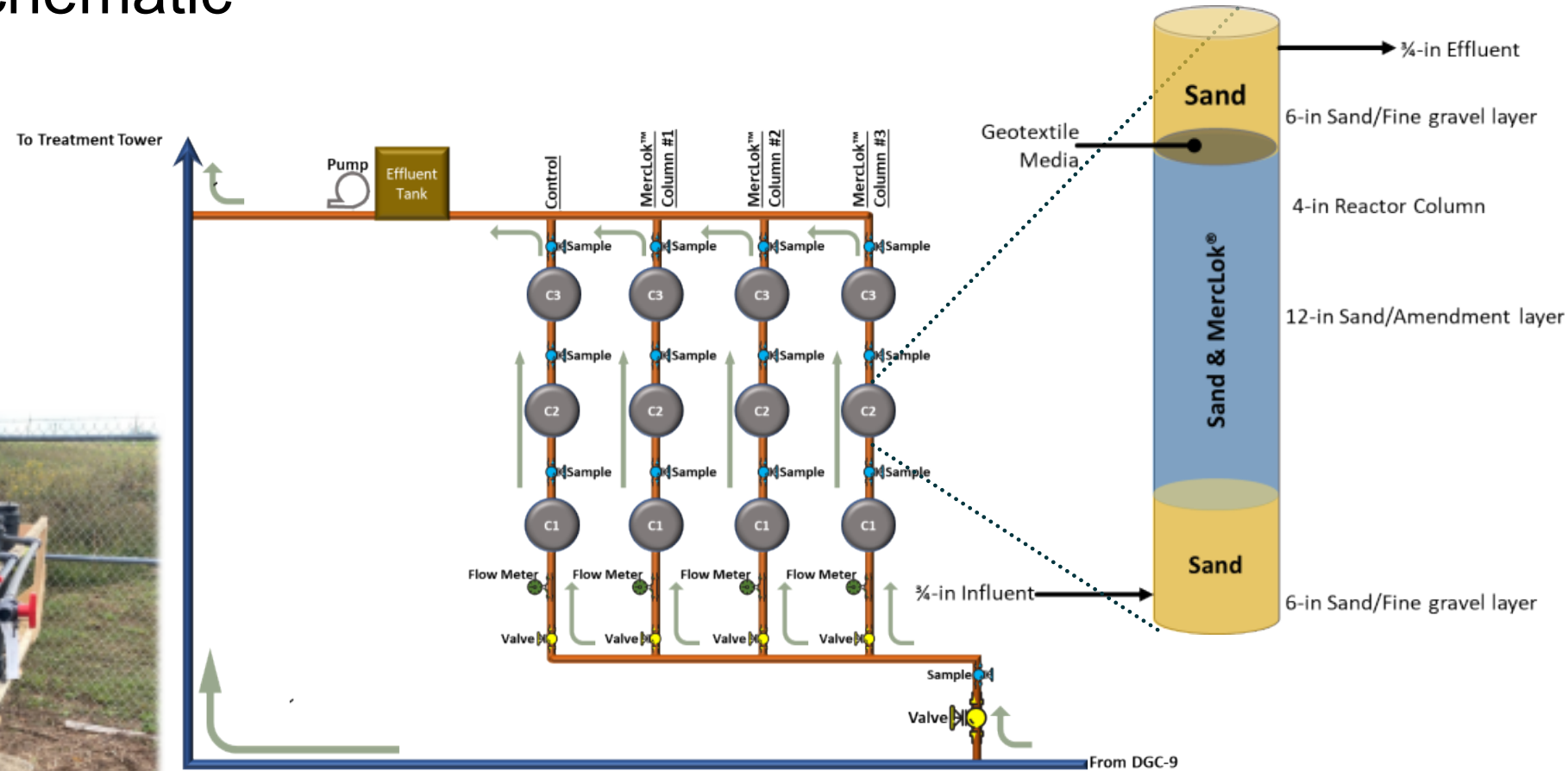
- Because MercLok™ was relatively new, a testing program was initiated to gather data to evaluate the efficacy and treatment system design
- Testing phases:
 - Initial Proof-of-Concept Bench Study
 - Large Diameter Column Study
 - Single Drum Study
 - Loading/Dosing Study
 - Modified Bag Filter Study
- Each of the studies focused on evaluating:
 - Specific design considerations
 - Collect data to demonstrate efficacy to regulators

Initial Proof-of Concept Bench Study Schematic

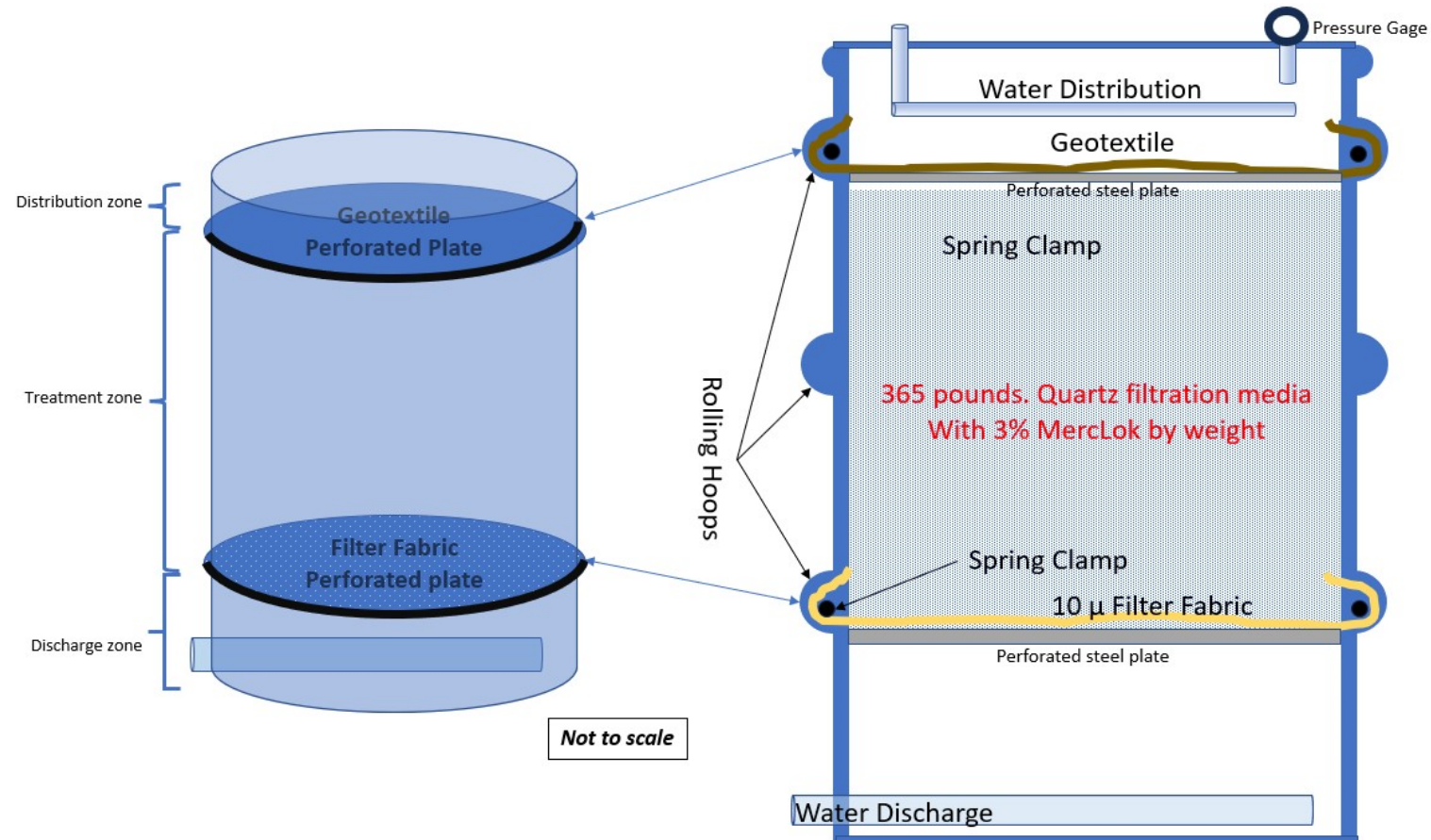


Various Loading of MercLok™
Amendment

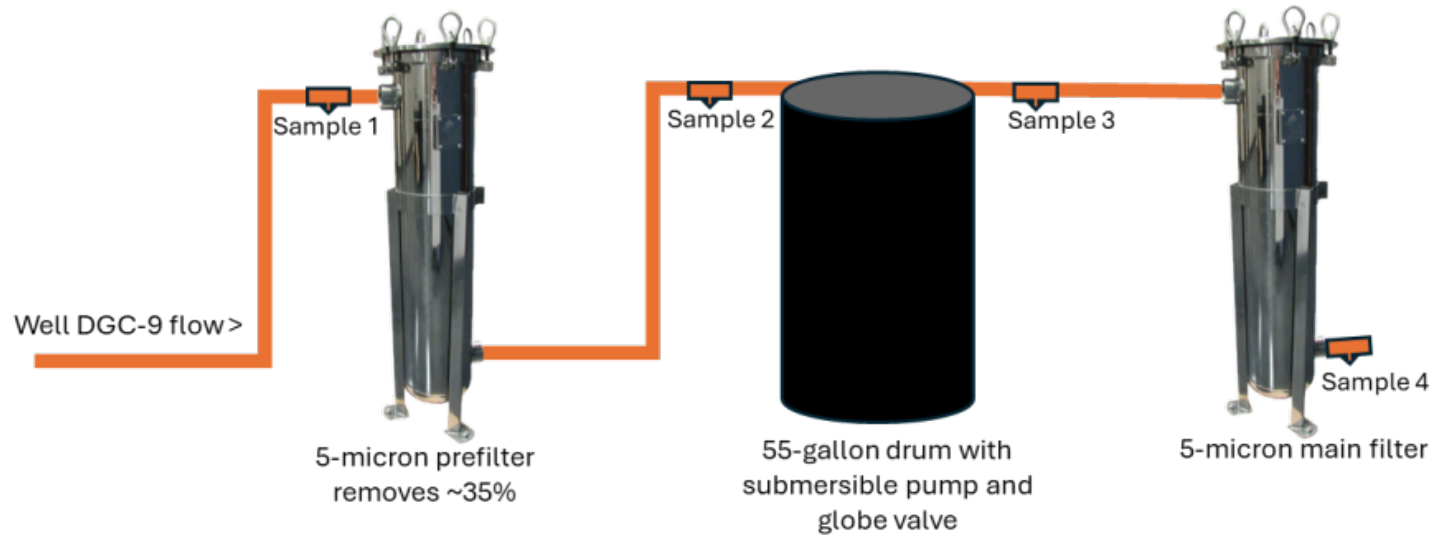
Initial Pilot Study Schematic



Single Drum Study Schematic



Modified Bag Filter Study Schematic



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Results / Evaluation

Initial Bench-scale Study - Results

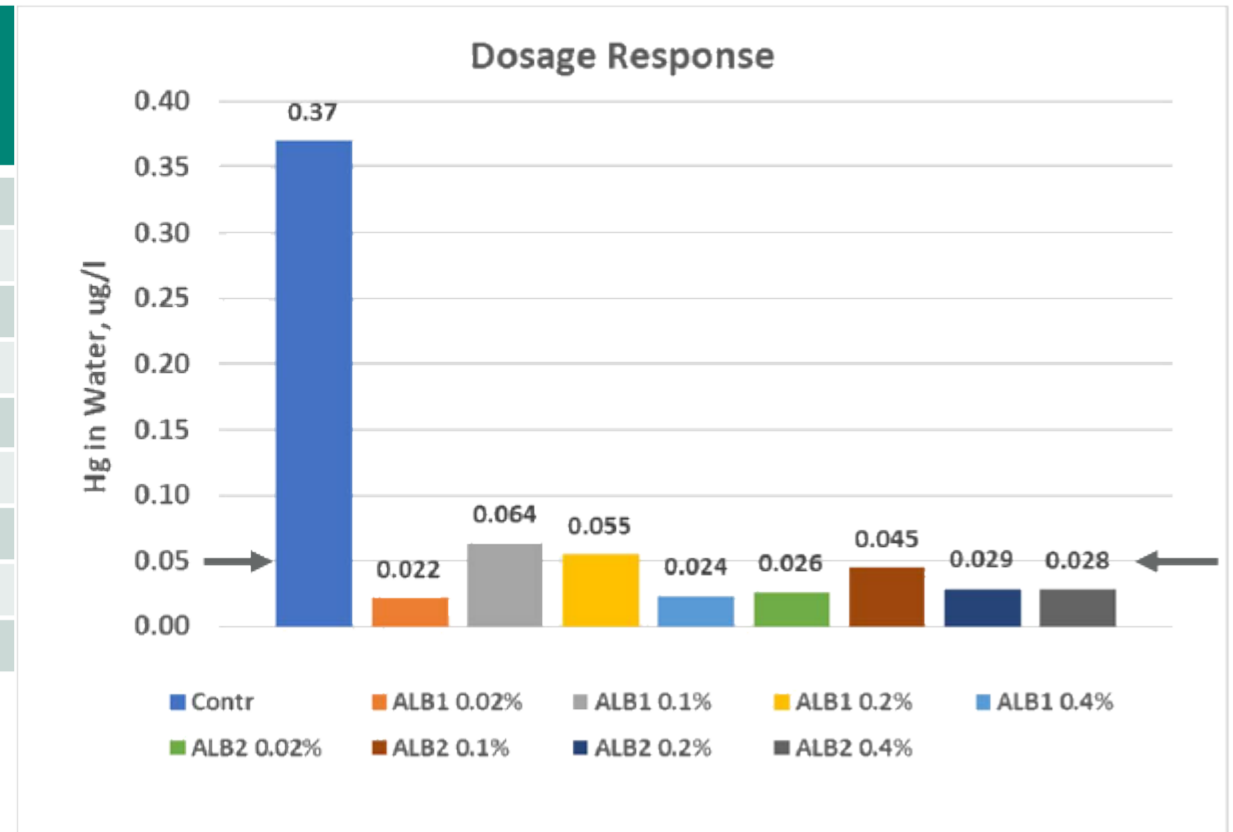
Dosage Response Study – <0.05 µg/l Target

Amendment	Dosage (wt%) *	Hg concentration (ug/L) after treatment **
Control	0	0.371
MercLok™ ALB 1	0.02	0.0215
	0.10	0.0635
	0.20	0.0545
	0.40	0.0235
MercLok™ ALB 2	0.02	0.026
	0.10	0.045
	0.20	0.029
	0.40	0.028

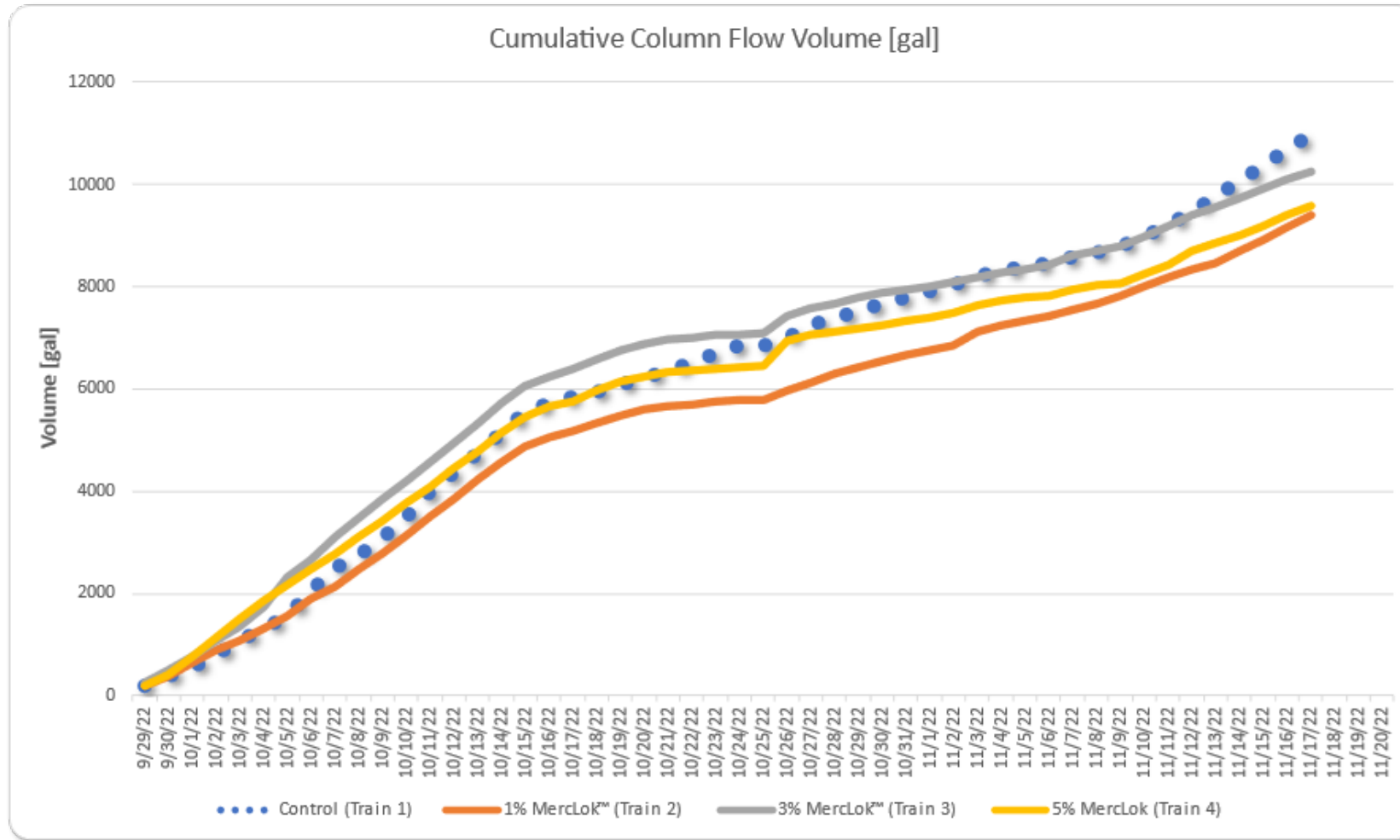
* Batch reactor test, agitated for 24 hours

** Average of two runs

Reference: Data provided by Albemarle R&D Testing Lab



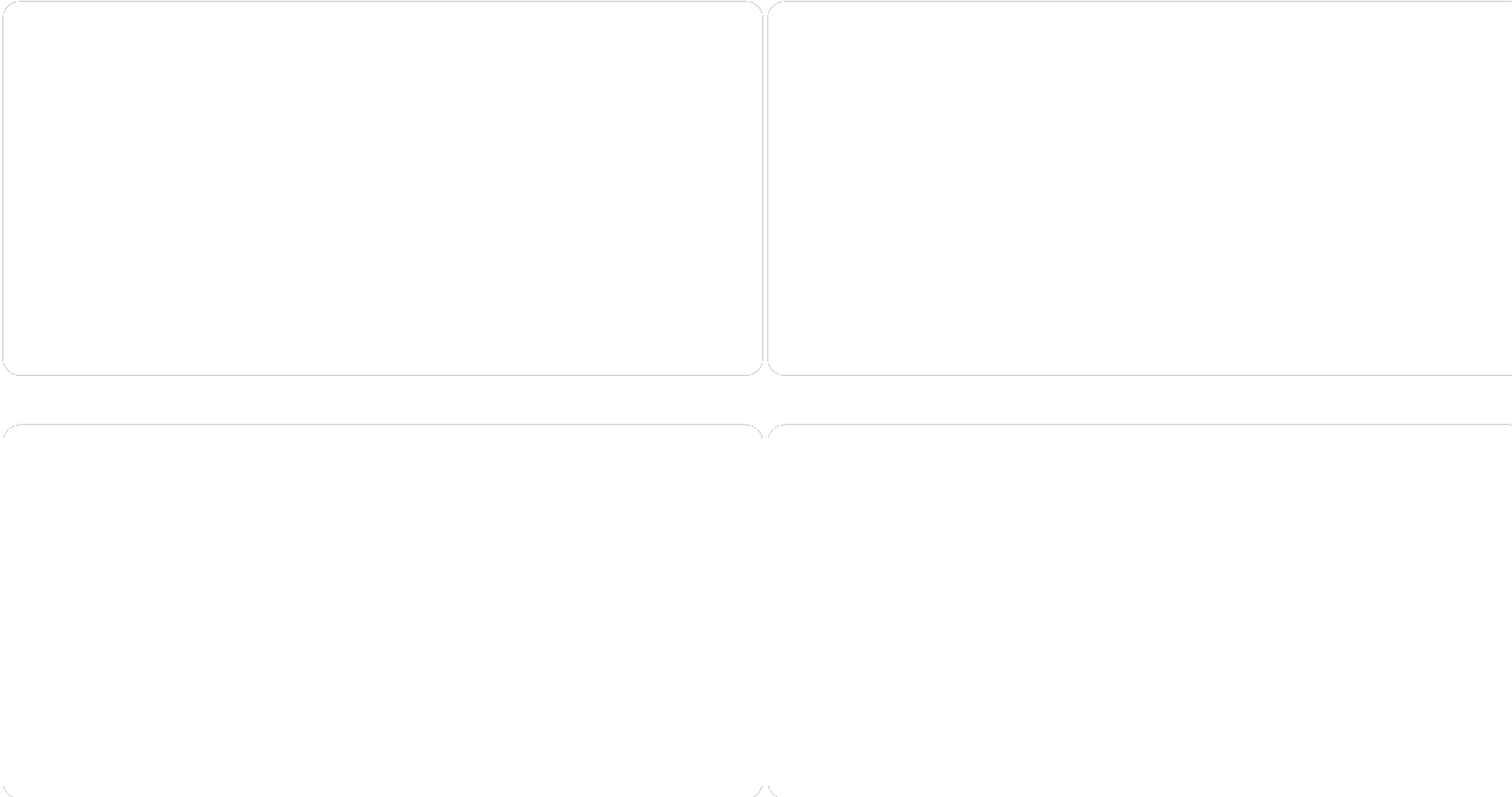
Large Diameter Column Study - Results



Large Diameter Column Study

- ~10,000 gal. through each column
- ~60,000 pore volumes based on packed columns volume

Large Diameter Column Study - Results

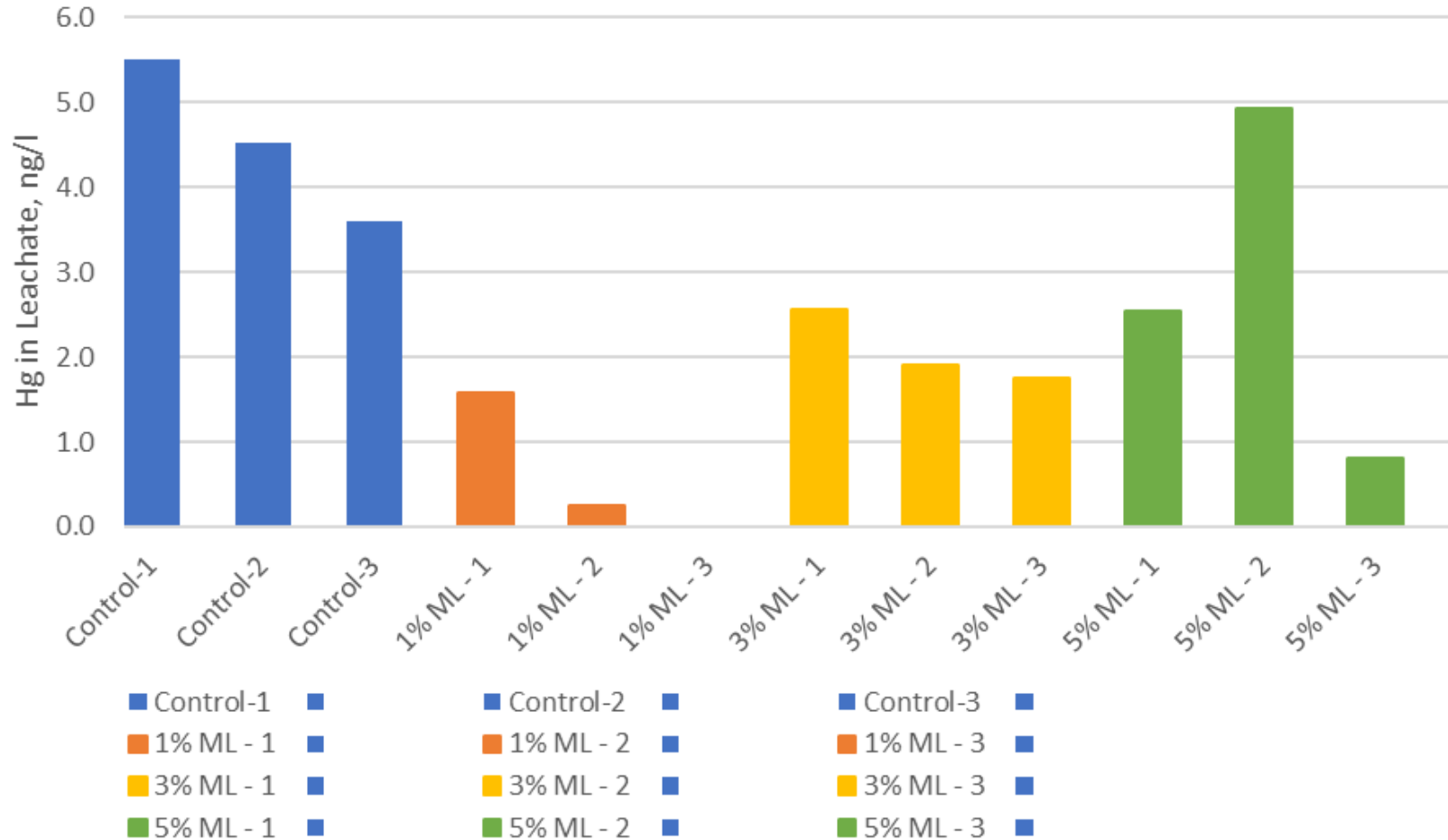


Large Diameter Column Study

- Pilot duration – ~50 days
- Column flow rates maintained from between 0.1 – 0.2 gpm
- Hg removal improved from Col#1 through Col#3
- Hg influent concentration changed dramatically to >500 ng/L 3-4 weeks into study
- % Removal
 - Control - ~55%
 - 1% ML – 90%
 - 3% ML – 92%
 - 5% ML – 94%

Large Diameter Column Study - Results

Average Results of TCLP at pH 2.88

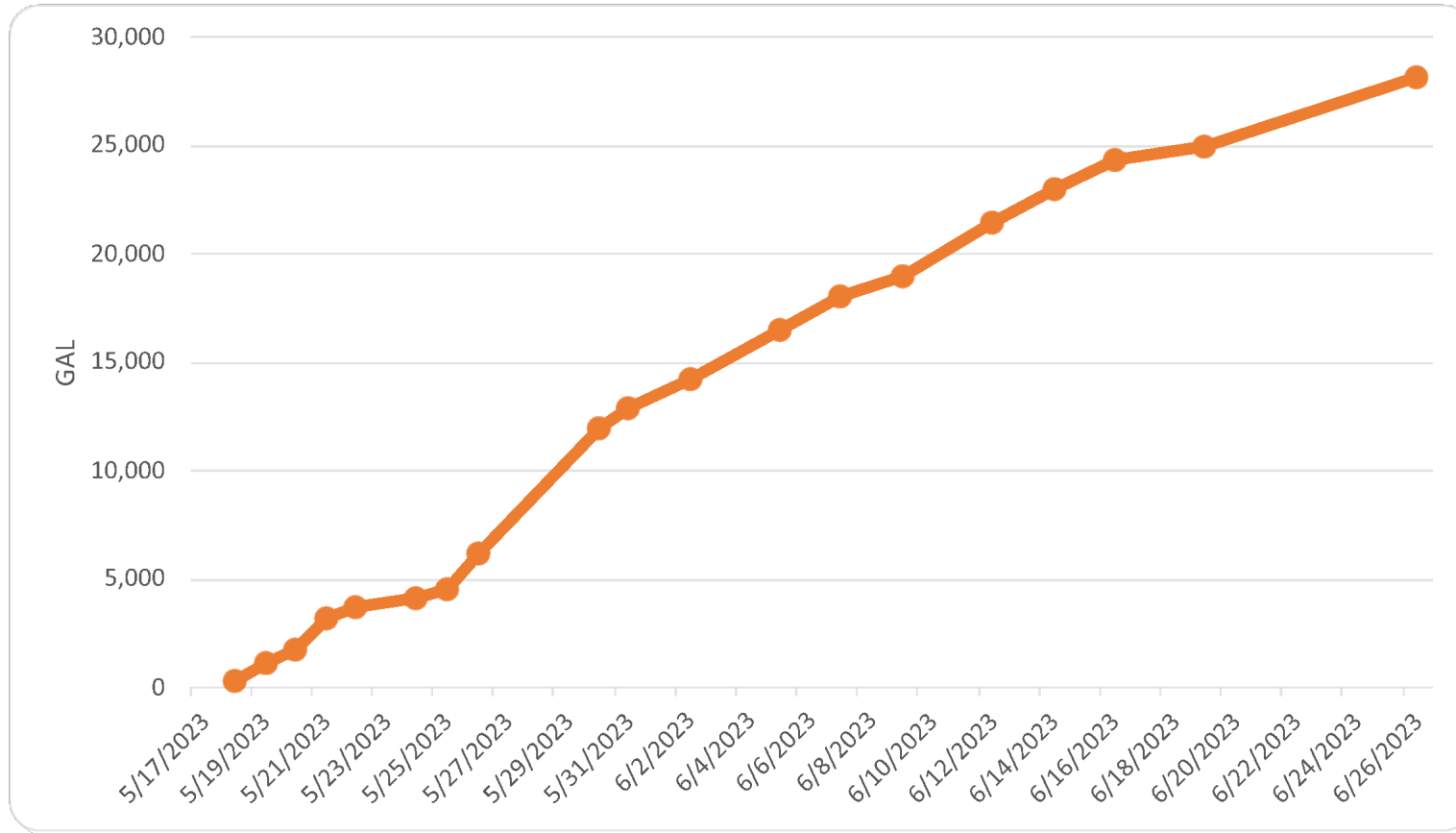


Large Diameter Column Study

- Columns from study sacrificed for TCLP testing
- TCLP tested @ 4.88 and 2.88 pH
- Results similar
- Leachable Hg in MercLok™ was less than in Control

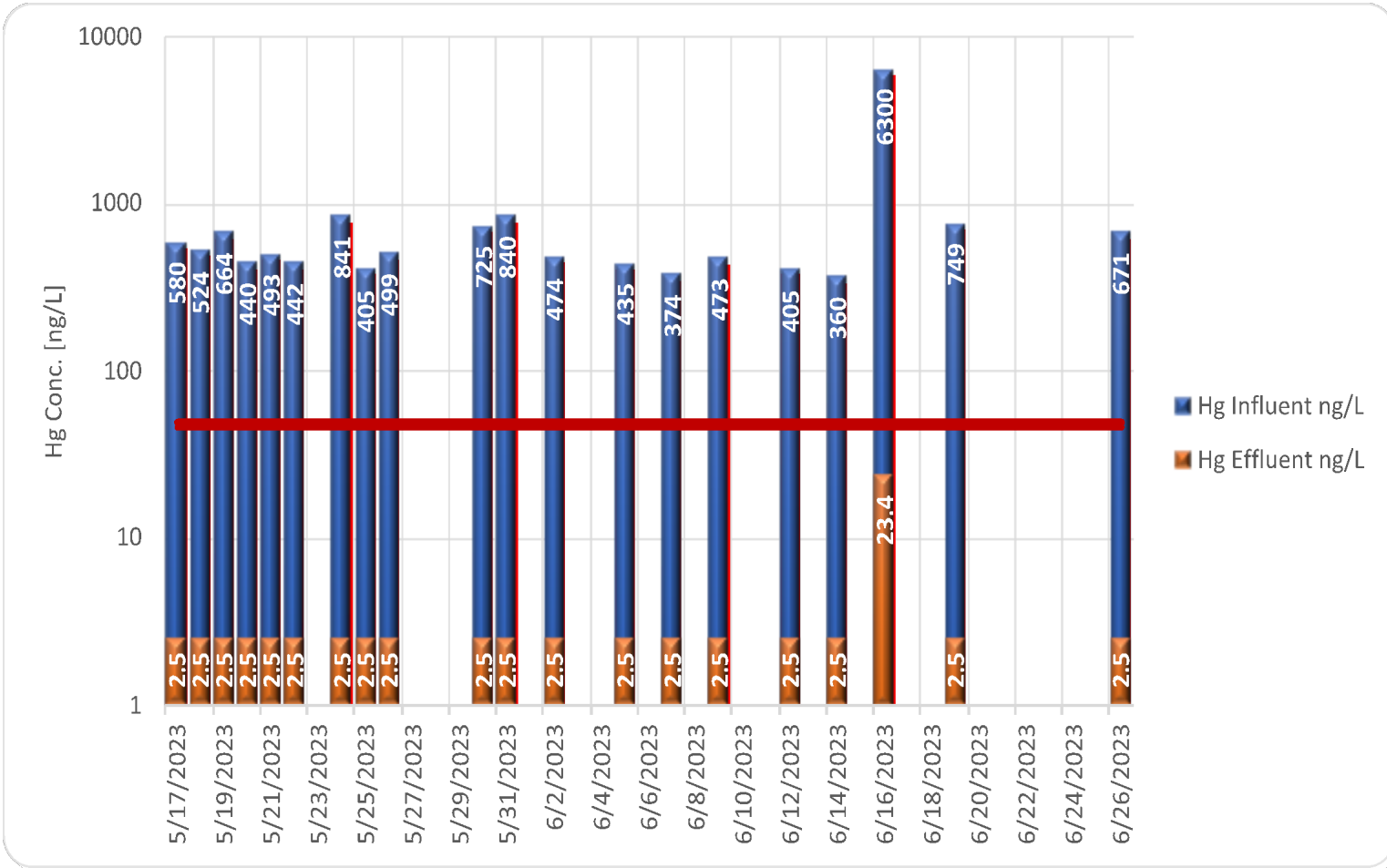


Single Drum Study - Results



- **Single Drum Study**
- Several individual single drum test were completed
- Flow rates varied from 0.5 up to 3 gpm
- Higher flow rates resulted in
 - Higher pressures
 - Associated leaks
 - MercLok™ fines carryover
- Final test utilized flow rates between 0.5 to 1 gpm

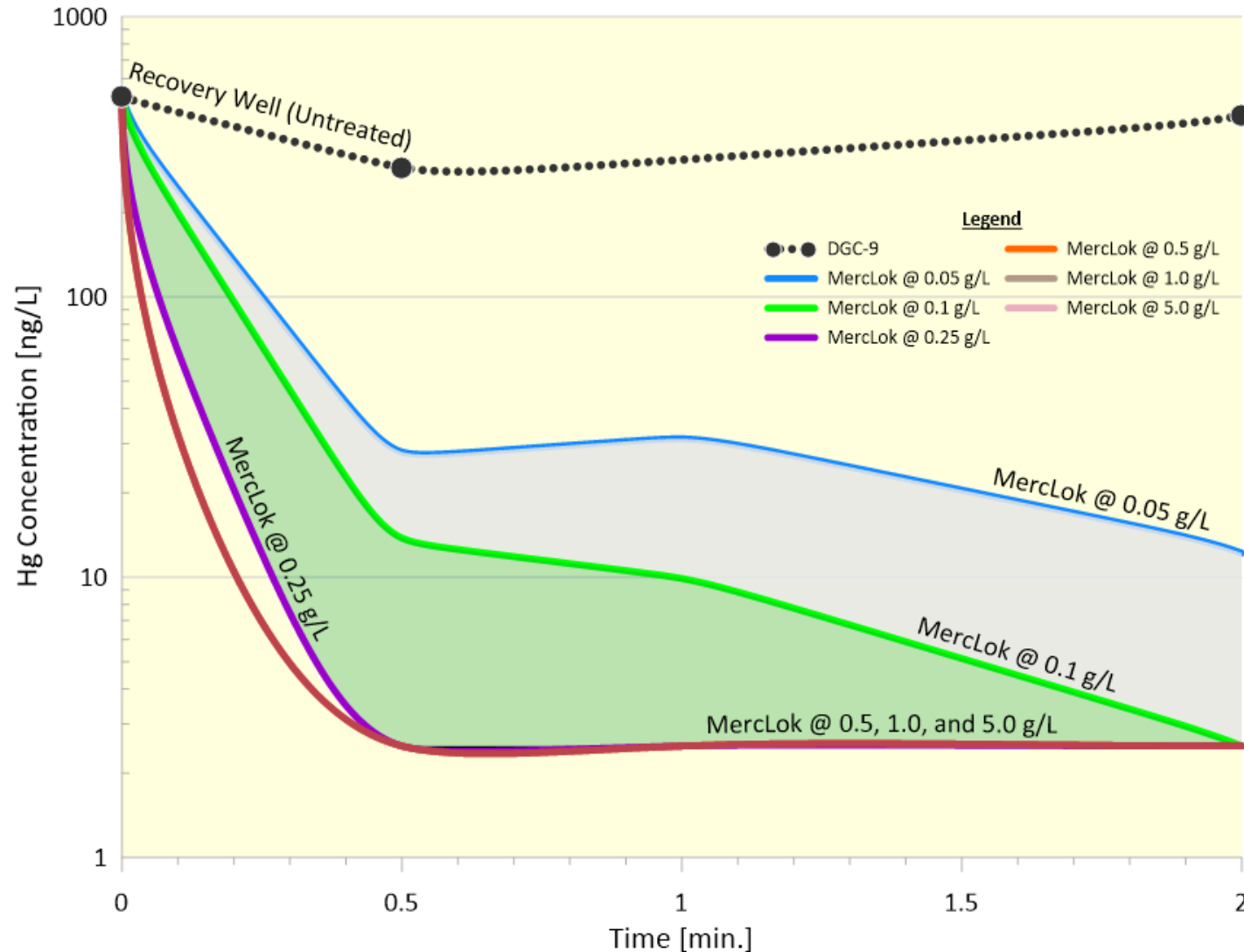
Single Drum Study - Results



- **Single Drum Study**
- Single drum test utilized 3% wt. MercLok™
- Influent concentrations were relatively stable except several notable excursions
- Variable flow rates results in variable contact times within the drum
- Efficient removal of Hg despite influent concentrations and/or contact time
- % Removal
 - Ranged from 97 to >99%
 - Even with variable influent Hg concentrations

Date	5/17/2023	5/18/2023	5/19/2023	5/20/2023	5/21/2023	5/22/2023	5/24/2023	5/25/2023	5/26/2023	5/30/2023	5/31/2023	6/2/2023	6/5/2023	6/7/2023	6/9/2023	6/12/2023	6/14/2023	6/16/2023	6/19/2023	6/26/2023
% Reduction Effluent	99.6%	99.5%	99.6%	99.4%	99.5%	99.4%	99.7%	99.4%	99.5%	99.7%	99.7%	99.5%	99.4%	99.3%	99.5%	99.4%	99.3%	99.6%	99.7%	99.6%

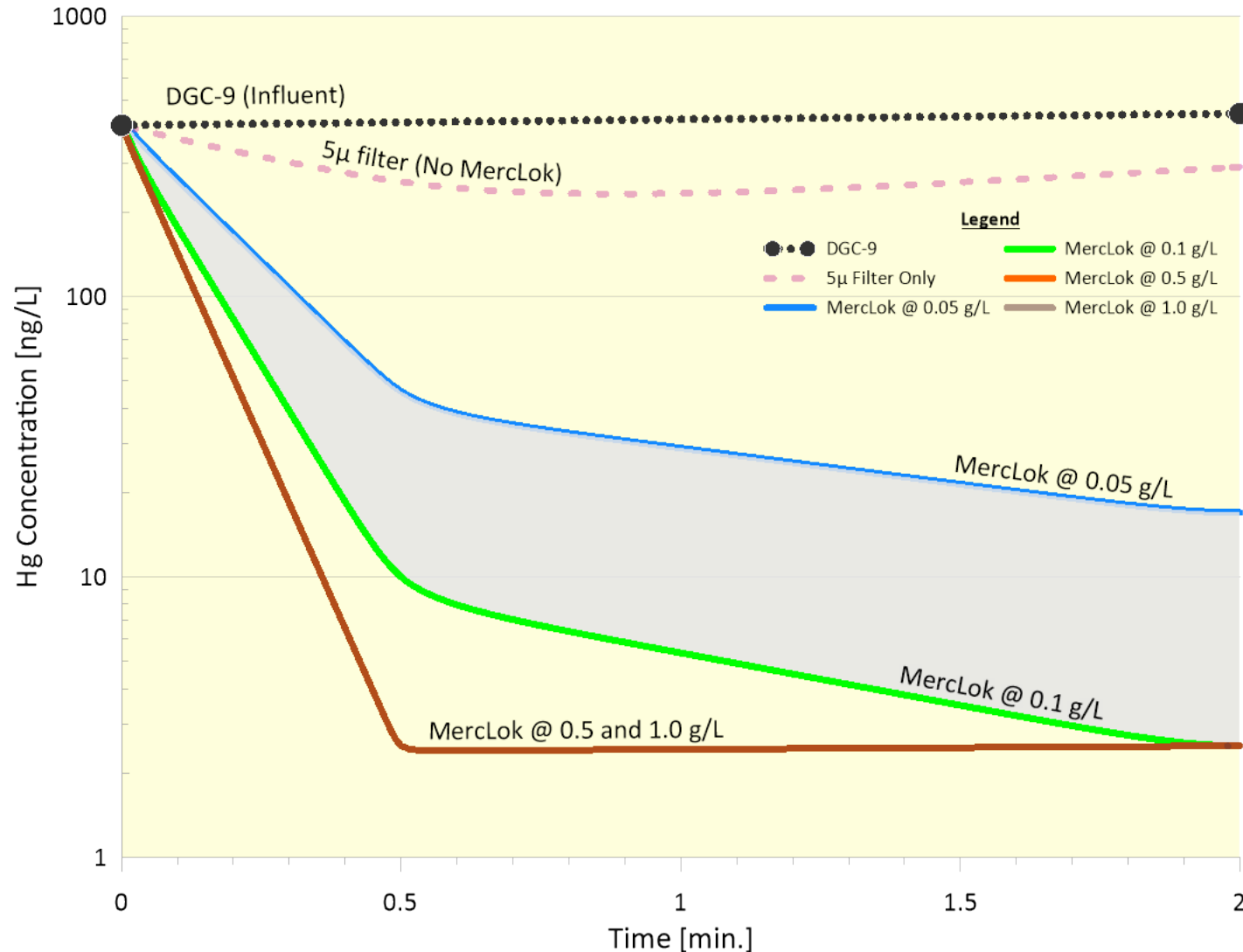
MercLok™ Loading/Dosing Study - Results



MercLok™ Loading Study (0.45 μ filter)

- To minimize the carryover of fines a series of test were completed to evaluate Hg concentration reduction with varying dosing rates of MercLok™
- Six MercLok™ ratios evaluated
- All MercLok™ attained Hg concentration reduction below target 50 ng/L concentration
- Rapid reaction times (i.e., < 2 min.)
- MercLok™ concentrations >0.25 g/L yielded similar results

MercLok™ Loading/Dosing Study - Results



MercLok™ Loading Study (5 µ filter)

- Filter mesh increased to 5µ
- Sample also evaluated with filtering only; no MercLok™ added
 - Average ~35% decreases in Hg
- Four MercLok™ ratios evaluated
- All MercLok™ attained Hg concentration reduction below target 50 ng/L concentration
- Rapid reaction times (i.e., < 2 min.)
- MercLok™ concentrations >0.1 g/L yielded similar results

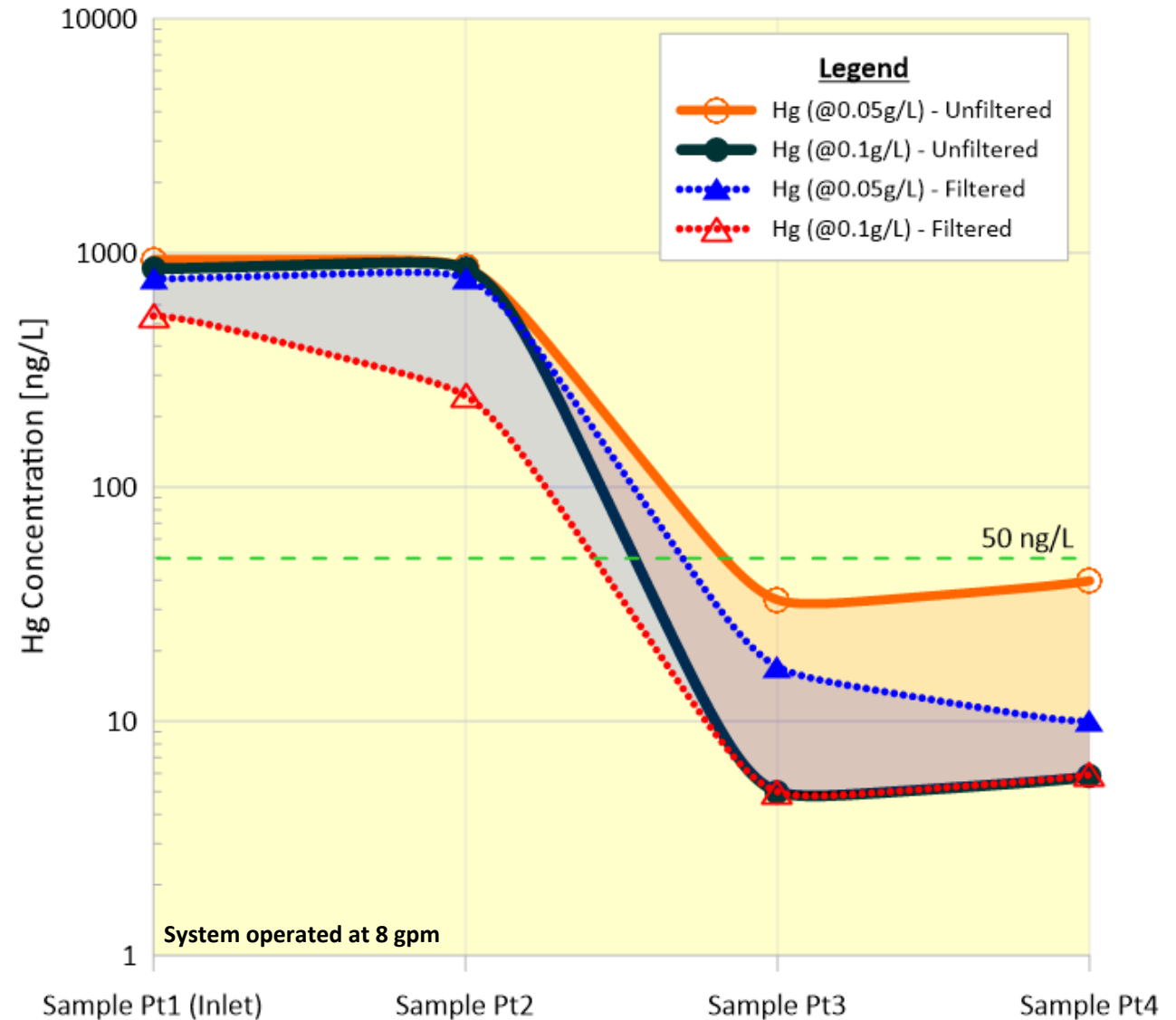
MercLok™ Bag Filter Study – Preliminary Results

Sample ID	Date	Time	Results ng/L
1DGC-9	5/15/2024	15:15	936
2ML0.05_pre	5/15/2024	15:20	868
3ML0.05_mix	5/15/2024	16:05	33
4ML0.05_mainF	5/15/2024	16:10	39.8
1DGC-9	5/16/2024	14:35	856
2ML0.1_pre	5/16/2024	14:40	859
3ML0.1_mix	5/16/2024	15:00	ND (<5)
4ML0.1_mainF	5/16/2024	15:05	5.8

Analyzed by LL Hg Method

Sample ID	Date	Time	Field Filtered µg/L	Results µg/L
1DGC-9_f	5/15/2024	15:15	0.45µ	775
2ML0.05_pre_f	5/15/2024	15:20	0.45µ	780
3ML0.05_mix_f	5/15/2024	16:05	0.45µ	17.1
4ML0.05_mainF_f	5/15/2024	16:10	0.45µ	10
1DGC-9_f	5/16/2024	14:35	0.45µ	538
2ML0.1_pre_f	5/16/2024	14:40	0.45µ	245
3ML0.1_mix_f	5/16/2024	15:00	0.45µ	ND (<5)
4ML0.1_mainF_f	5/16/2024	15:05	0.45µ	5.9

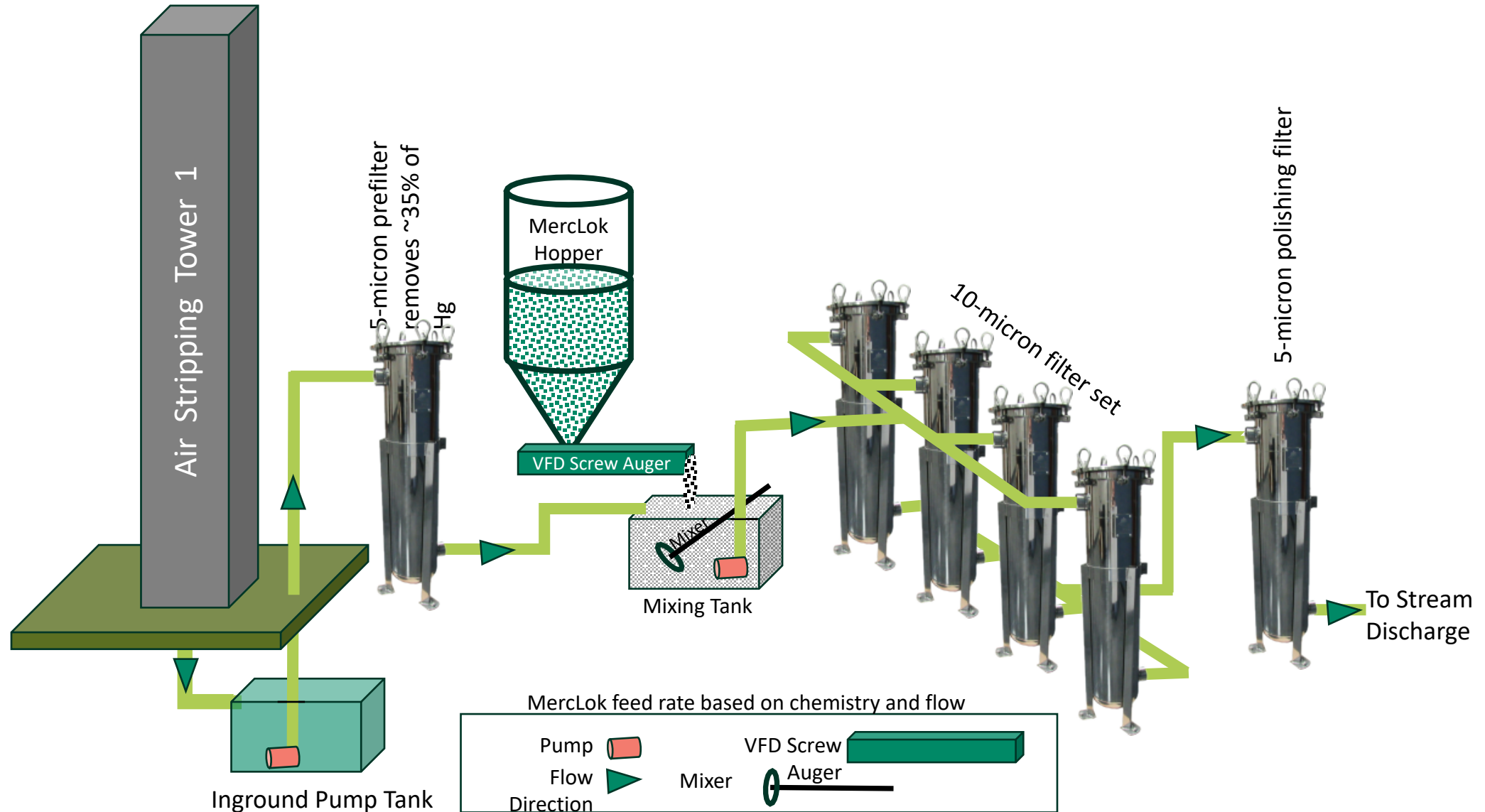
Analyzed by LL Hg Method



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Conclusions Lessons Learned

Conceptual Full-scale System



Conclusions / Lessons Learned

- MercLok™ amendment found to be very effective at Hg removal from recovered water
- Effectiveness demonstrated at relatively low amendment loading rates and fast reaction times
- Mixing MercLok™ with sand was effective but limited flow rates
- TCLP results indicate that Hg is effectively bound to MercLok™ and could be disposed of as non-hazardous

Conclusions / Lessons Learned

- Dosing study results indicated
 - MercLok™ effectiveness at low loading rates
 - Reaction time for Hg removal was very short (i.e., 2 min. or less)
- Initial results from the bag filter testing program are positive and further testing is ongoing

THANK YOU!



Doug Gray
Innovative Remediation Technologies
Group Leader



AECOM