Neutralization Optimization Minneapolis Water Works

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University of Minnesota

Driven to Discover℠

MnTAP

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Facility Background

- **Minneapolis Water provides tap water to Minneapolis and surrounding communities**
- **Produces ~57 million gallons of water per day**
- **Columbia Heights Membrane Plant**
  - Ultrafiltration to remove impurities
  - Uses hollow fiber membranes

Minneapolis
City of Lakes

mpls

Project Background: Backwashes

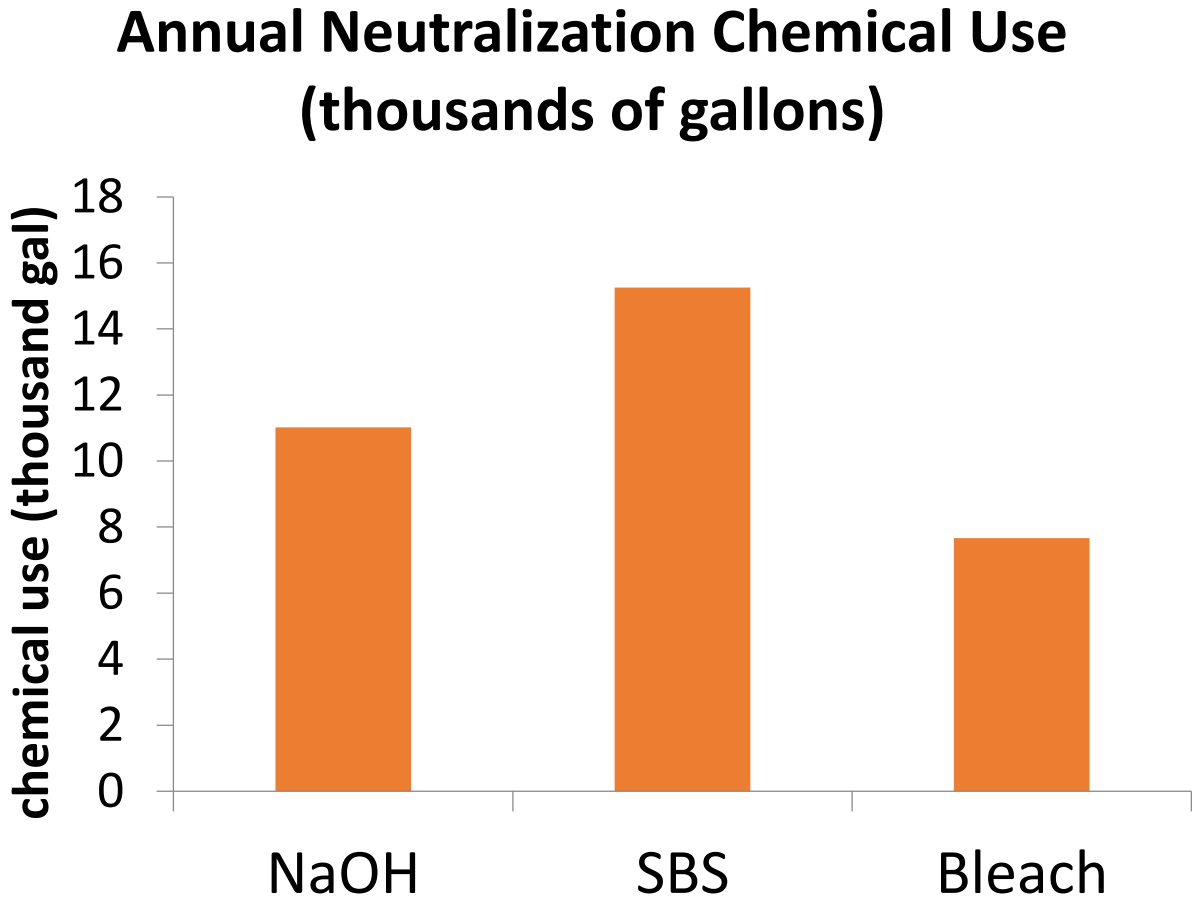
- **Backwashes clean filters**
- **2 types of chemically enhanced backwashes (CEB)**
  - CEB1: Sodium hypochlorite (bleach)
    - Sterilizes filter membranes
  - CEB2: Sodium bisulfite (SBS) and hydrochloric acid (HCl)
    - Removes fouling, particularly ferric chloride coagulant

Project Background: Neutralization

- **Chemical backwashes produce waste**
- **Neutralization process:**
  - Completely automated
  - Waste is sent to neutralization tank after backwash
  - Raw chemicals added to neutralize harmful reactions
  - Neutralized waste eventually added back in Mississippi River
  - Limits:
    - pH = 5.4-8.8
    - ORP = 200-500 mV

Motivations for Change

- $30,000 a year on neutralization chemicals
- More neutralization chemicals means more salts in the water
- Salts a concern, though discharge is within permit
- 40,000 lbs Na+ per year added to water from neut chems



Project Overview

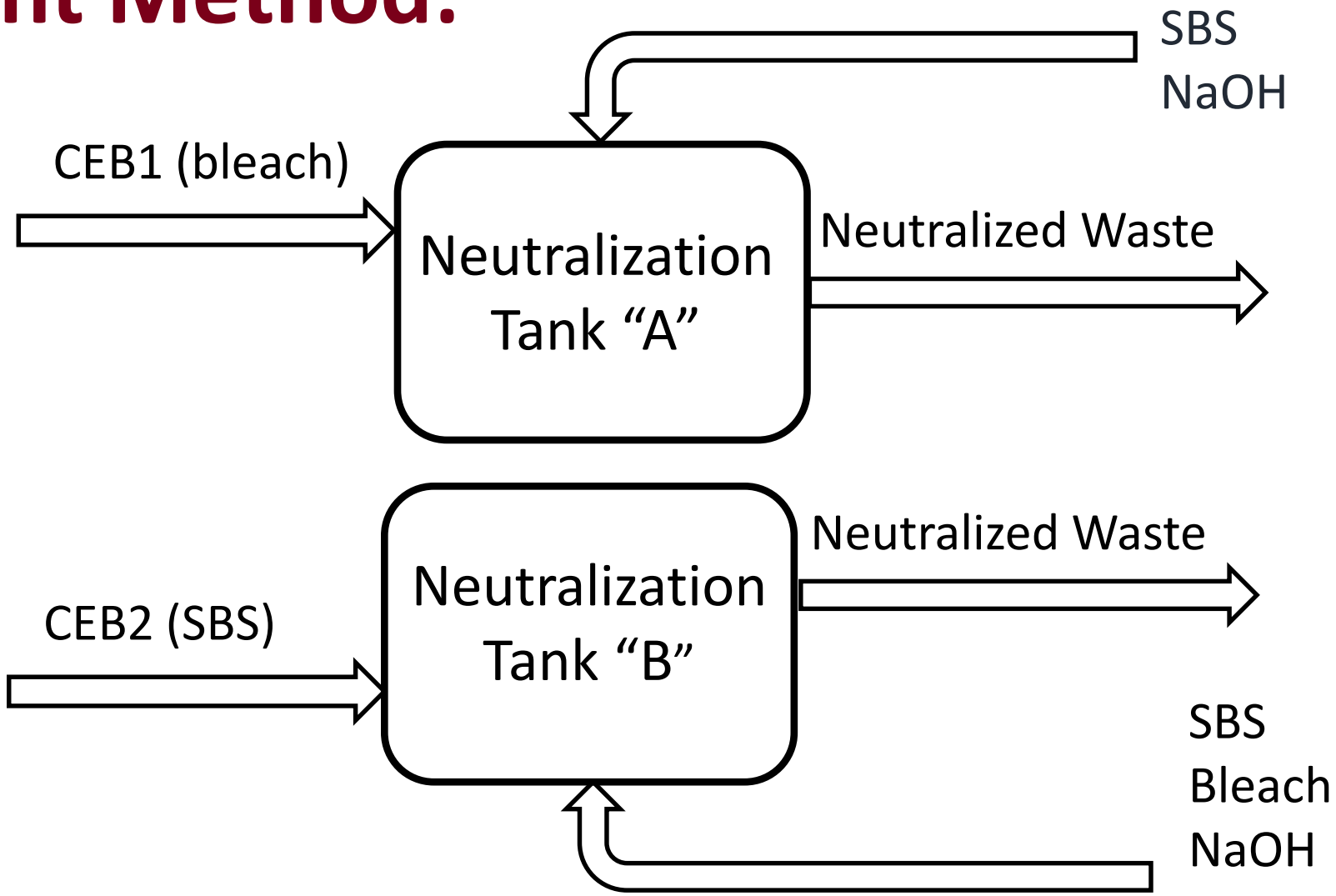
- **Goal: to Reduce Raw Chemicals Used in Neutralization**
- **Areas of interest:**
  - Major:
    - Self-neutralization – complete
  - Minor:
    - Tank mixing – complete
    - Sources of variability in neutralization – complete
    - Re-examine ORP limits – progress, incomplete

https://www.brandonhall.com/totaltech/images/tt-overview-icon-1.png

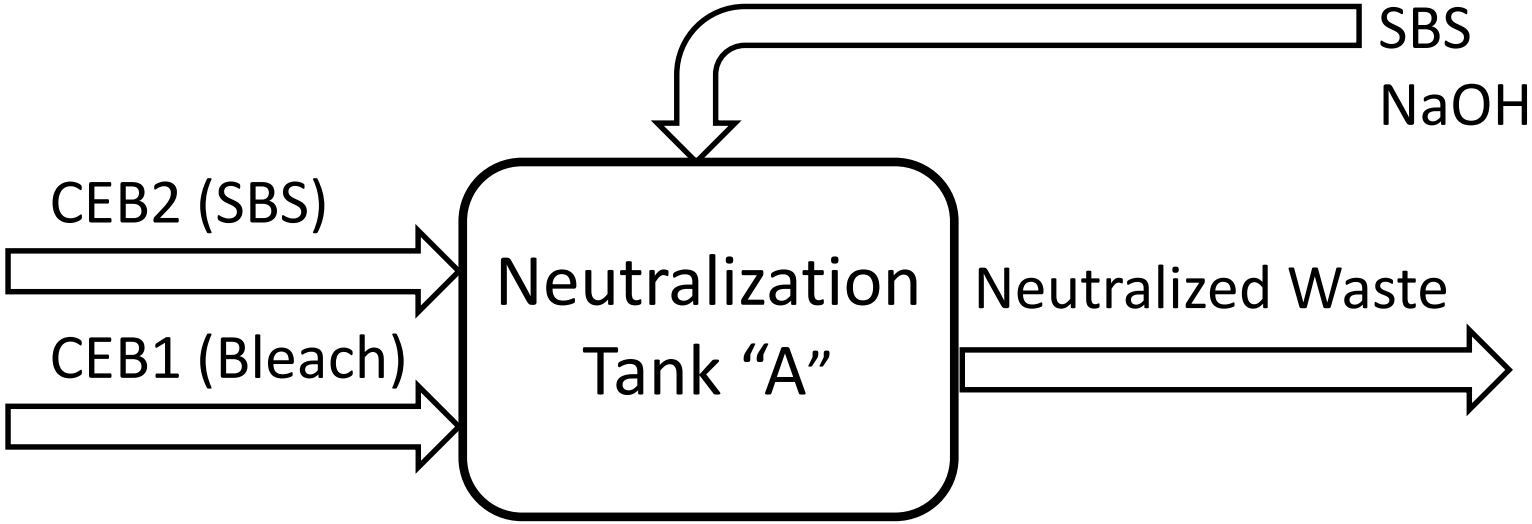
Self-Neutralization

- **CEB2 (sodium bisulfite and HCl) always followed by CEB1 (bleach)**
- **Currently, each wash is neutralized separately**
- **Self-Neutralization**
  - Add CEB2 and CEB1 together to partially neutralize before adding raw chemicals

Current Method:

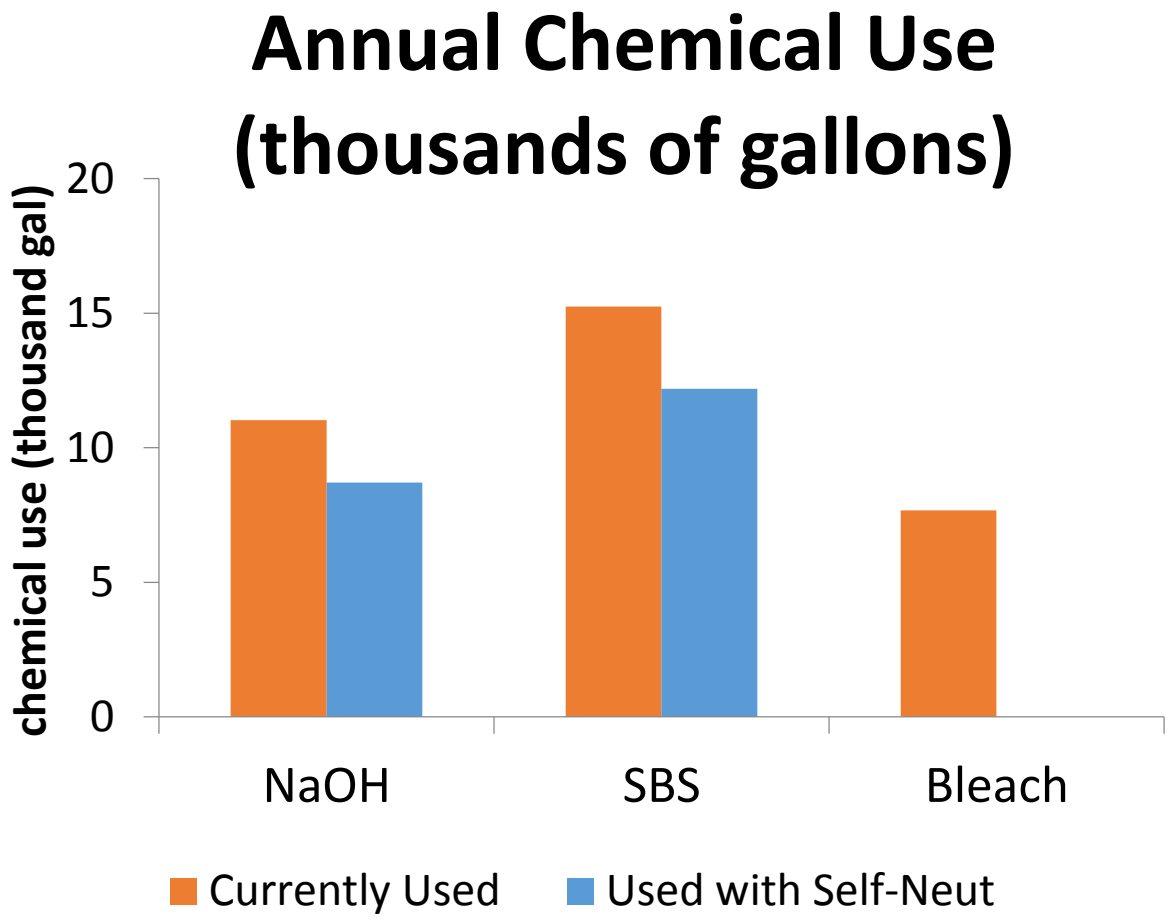


Self-Neutralization:



Findings

- **Full scale tests succeeded**
  - Reduces raw chemical demand
  - Requires no new equipment
  - Requires a self-neutralization routine to be programmed
- **Around 1,500 self-neutralizations per year possible**
- **Savings: $12,000 a year**

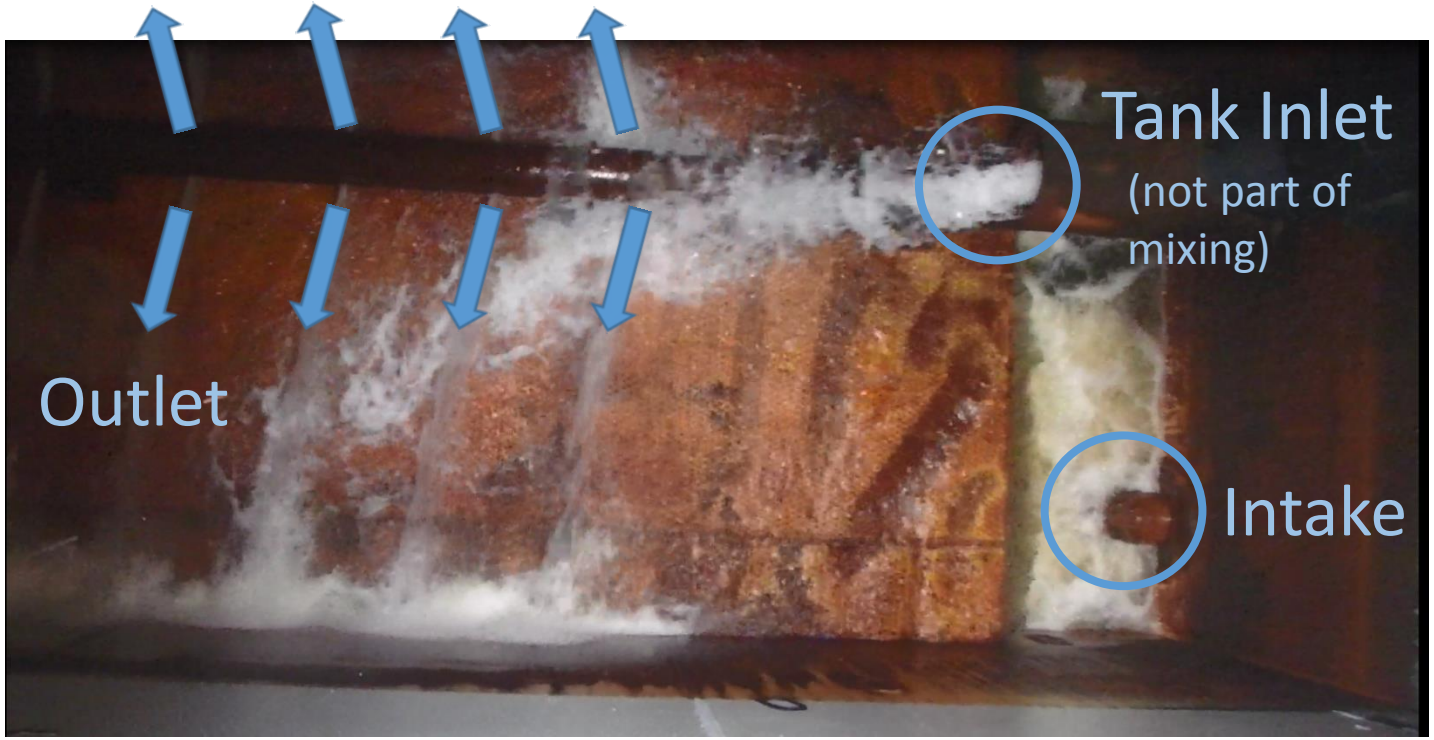


Findings: Summary

Waste reduction option	Change Type	Waste reduced (per year)	Implementation cost	Cost savings (per year)	Payback period	Status
Self-Neutralization	Procedure change	34,000 lbs SBS 80,000 lbs Bleach 26,000 lbs NaOH	$2,200	$12,000	2.2 months	Planned 2018

Tank Mixing

- **Mixing a concern with self-neutralization**
  - Two batches at once = larger volume to mix



Findings

- **Mixing appears adequate**
  - Surface visibly disturbed by mixing
  - Measurements relatively constant as tank empties
- **Self-neutralization requires more mixing time**
  - ~6 min for pH to stabilize, much longer for ORP
  - 10 minutes recommended to mix self-neut batch
- **Recommendation: Perform maintenance on system to ensure no blockages**

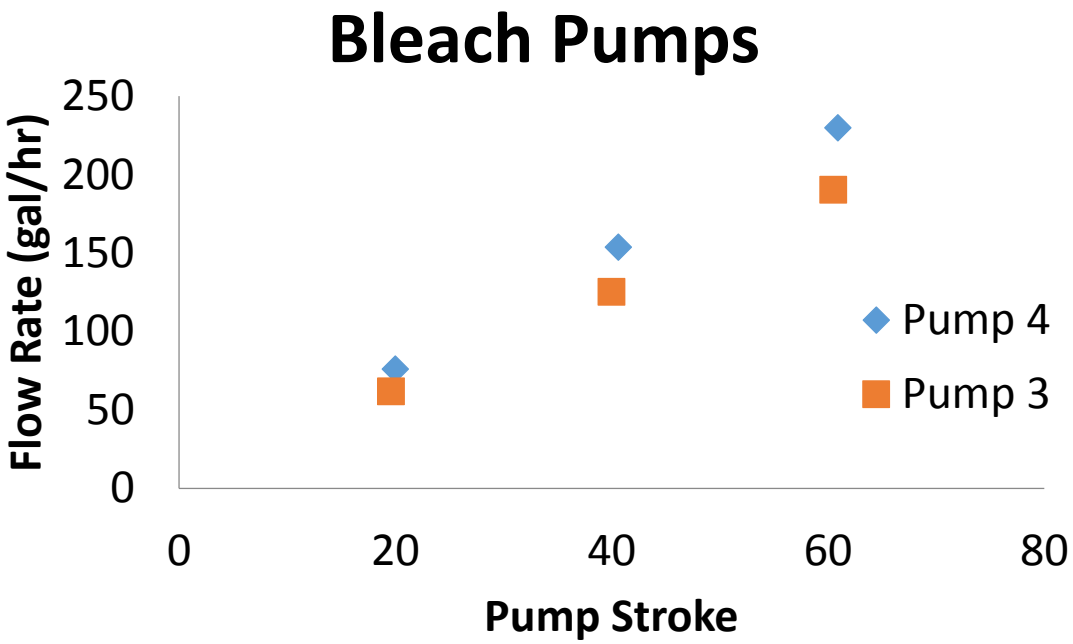
Findings: Summary

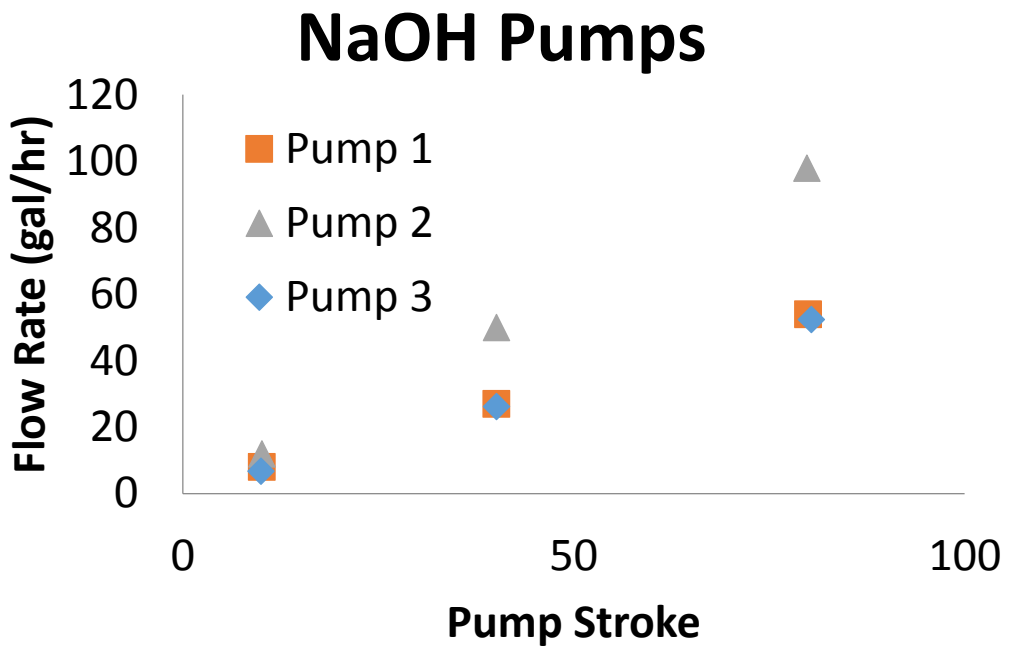
Waste reduction option	Change Type	Waste reduced (per year)	Implementation cost	Cost savings (per year)	Payback period	Status
Maintenance on Tank Mixing	Procedure change	430 lbs SBS 300 lbs Bleach 290 lbs NaOH	$800	$90	8.9 years	Planned Sept 2017

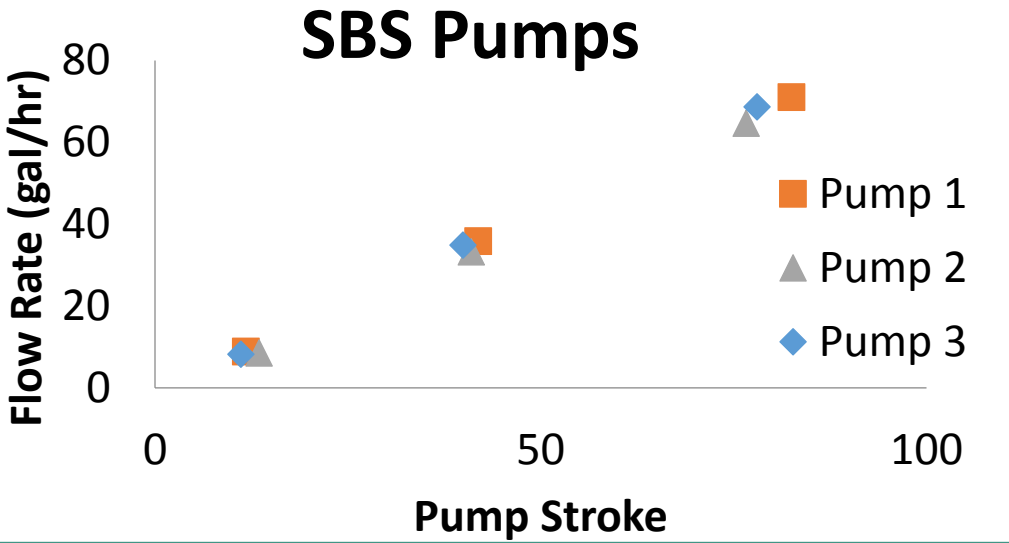
Sources of Variability

- **With more consistency, more efficiency is possible**
- **No correlations between initial and final conditions found**
  - Tank Level
  - Unit distance from neut tank
  - Starting ORP and pH in tank
- **Potential source:**
  - Pumps for same chemical calibrated differently
- **Recommendation: Recalibrate pumps, particularly bleach and NaOH**

Neutralization Pumps







Pump Recalibration Summary

Waste reduction option	Change Type	Waste reduced (per year)	Implementation cost	Cost savings (per year)	Payback period	Status
Recalibrate Pumps	Procedure change	4,000 lbs NaOH	$400	$300	1 year, 4 months	Planned late 2017

Summary Table

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Future Work

- **Continue investigating ORP**
  - Determine new limits?
  - Changes in ORP from exposure to air?
- **Follow-up on pump recalibration**

Personal Benefits

- Balancing independent work vs asking for help
- Planning steps toward a complex goal
- Designing experiments
- Learning to get the information I need from the data I have

Questions?