

# Fill Type & Hold Time Impacts to Limestone-Only Automatic Vertical Flow Pond Performance

## Field Study

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# Overview



What Is The Problem?



Why Do We Care?



What Did We Test?



How Can We Use It?

# What's the Problem?

- Dissolving Rocks
  - Specifically, Limestone
  - Efficiently
- Neutralize Acidity
  - Treatment of AMD
- Minimize Bed Fouling
- Are There Better Ways To Help Dissolve Rocks?



# Why Do We Care?

- How Much Limestone Do We *Actually* Need
  - Size of Ponds
  - Associated Costs
- Various approaches to utilizing limestone
  - Limestone Beds - Flow Through
  - Limestone Beds – Drainable
    - Flushing Frequency Varies Greatly
    - Siphons
    - Agri Drain Smart Drainage System
      - Auto Flushing Vertical Flow Ponds (AFVFPs)
    - Batch Operated Limestone Treatment System (BOLTS)



# Why Do We Care?

- AFVFP
  - Gradual Fill / Rapid Drain Type
    - Daily “Flush”
    - 24-hr of stone (based on Design Flow)
    - 12-hr Avg Retention Time
    - Flows beyond design flow go into flow thru operation
- BOLTS
  - Rapid Fill / Rapid Drain
    - With variable / custom hold time capability
    - Original system operated via float switches (level control)
      - Timers – not as optimal -> Radar sensors possible

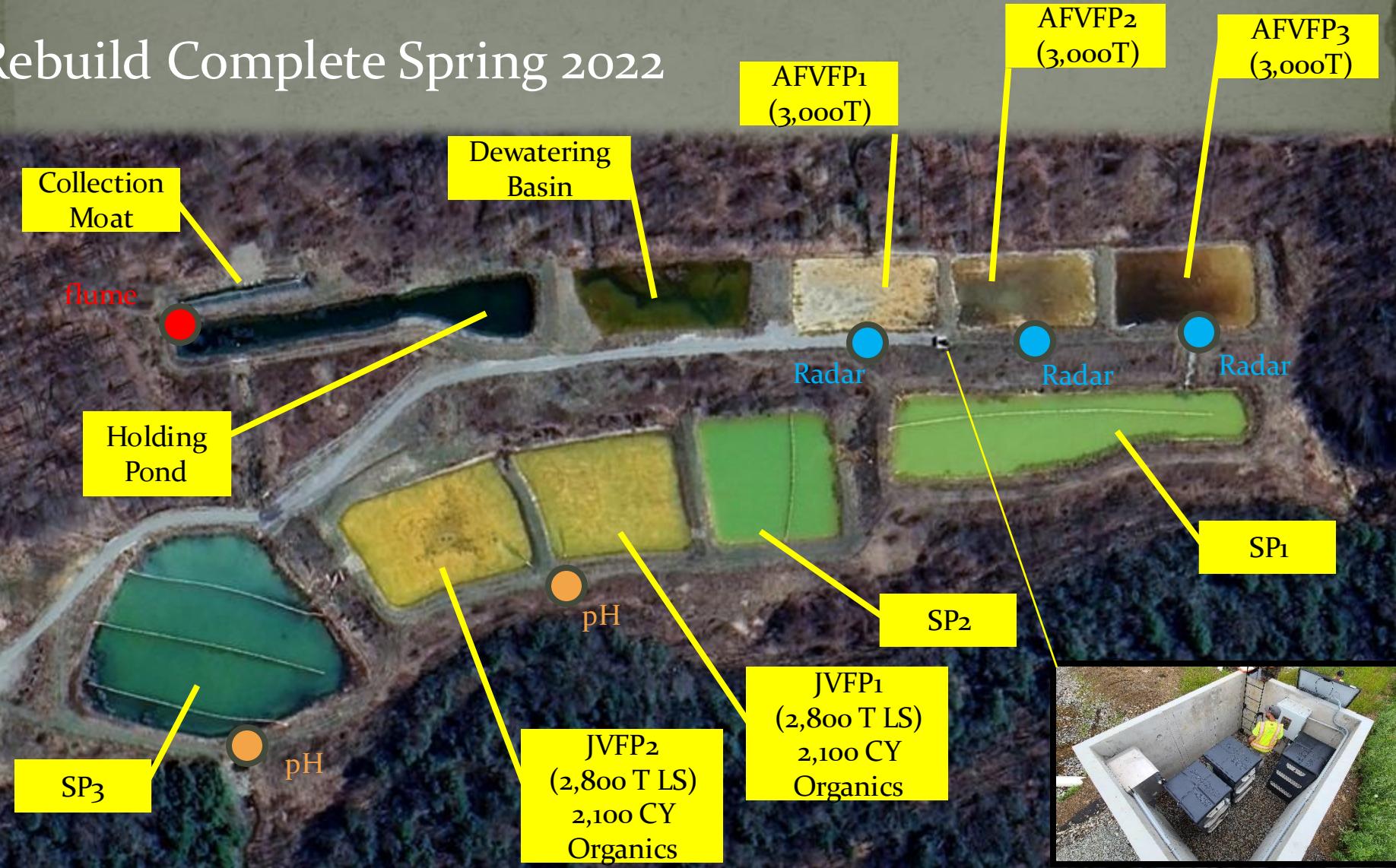


# What Did We Test?

- Oven Run B – Passive Treatment System
  - Allows for Full Scale Testing
- Experimental setups
  - #1: 24-hr gradual fill / 12-hour average hold
  - #2: Rapid fill / 12-hr hold
  - #3: Rapid fill / 9-hr hold
  - #4: Rapid fill / 6-hr hold
- Each testing condition was allowed to run for 2 weeks prior to sampling (Nov 2023 – Jan 2024)
  - No instances of overflow were observed (telemetry)
  - Compare acid load reductions in SP1 effluent

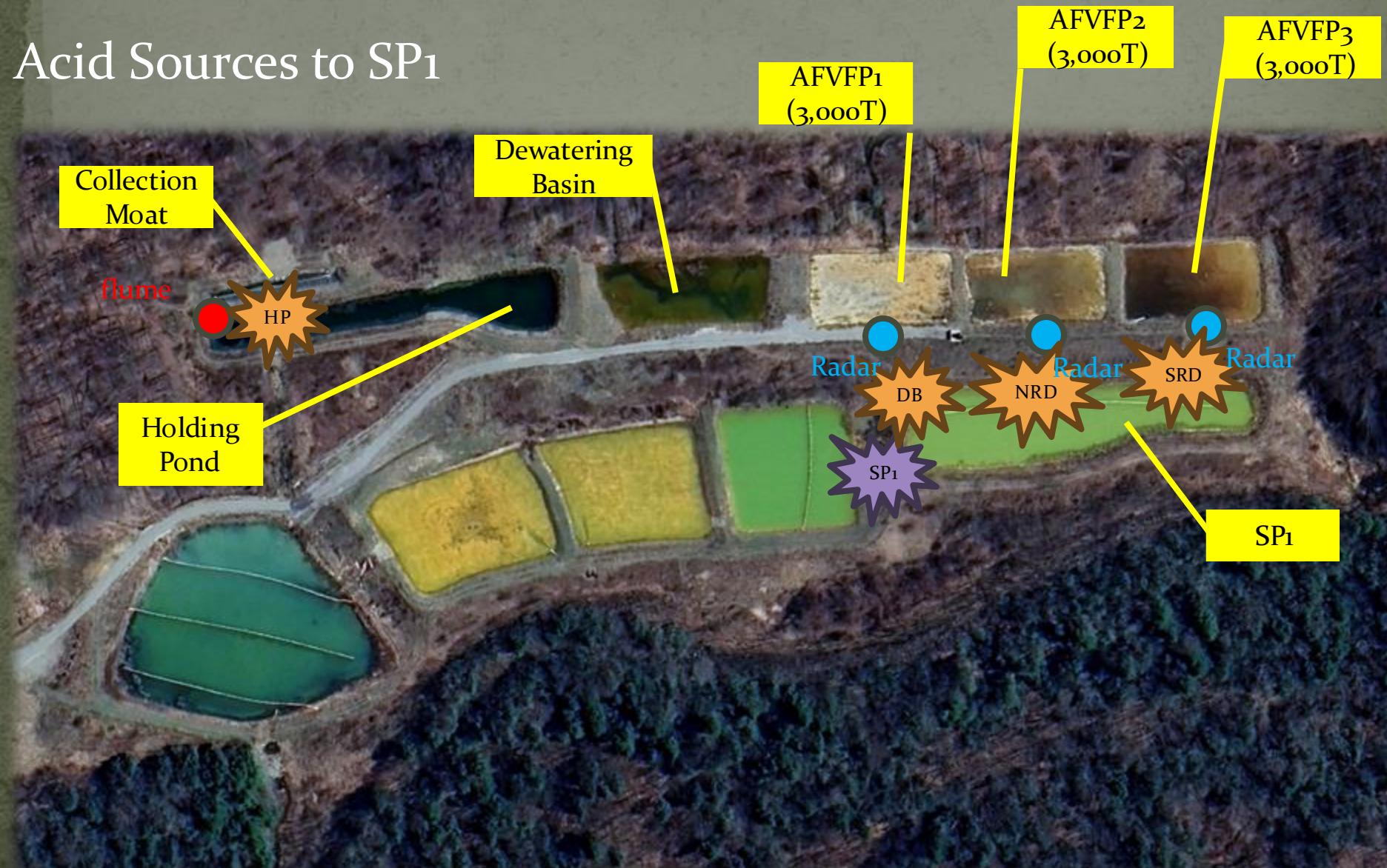
# Oven Run B – Passive Treatment System

Rebuild Complete Spring 2022



# Oven Run B – Passive Treatment System

## Acid Sources to SP1



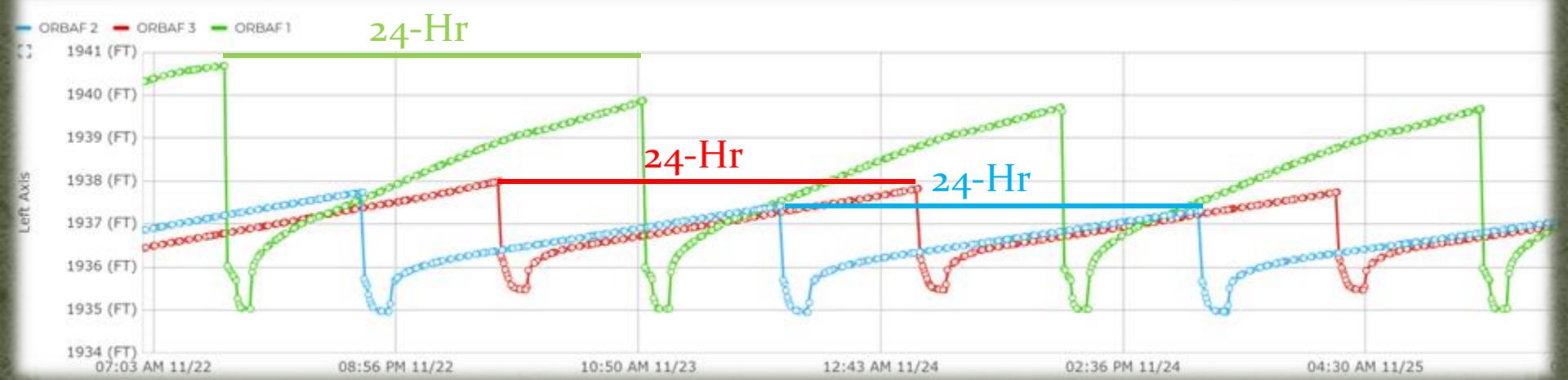
# AVG Influent Water Quality

Source	pH	Flow (gpm)	Cond (μmhos/cm)	D. Al (mg/L)	D. Fe (mg/L)	D. Mn (mg/L)	ACID (mg/L)	ACID LOAD (lb/d)
HP	2.85	90	1682	23.3	19.4	8.1	275	297
DB	2.98	2.8	1468	36.1	28.2	6.5	335	11
NRD	2.97	2.2	1170	14.6	35.2	8.0	213	6
SRD	2.94	4.8	1220	25.3	32.8	6.6	263	15

329 lb/d Acid

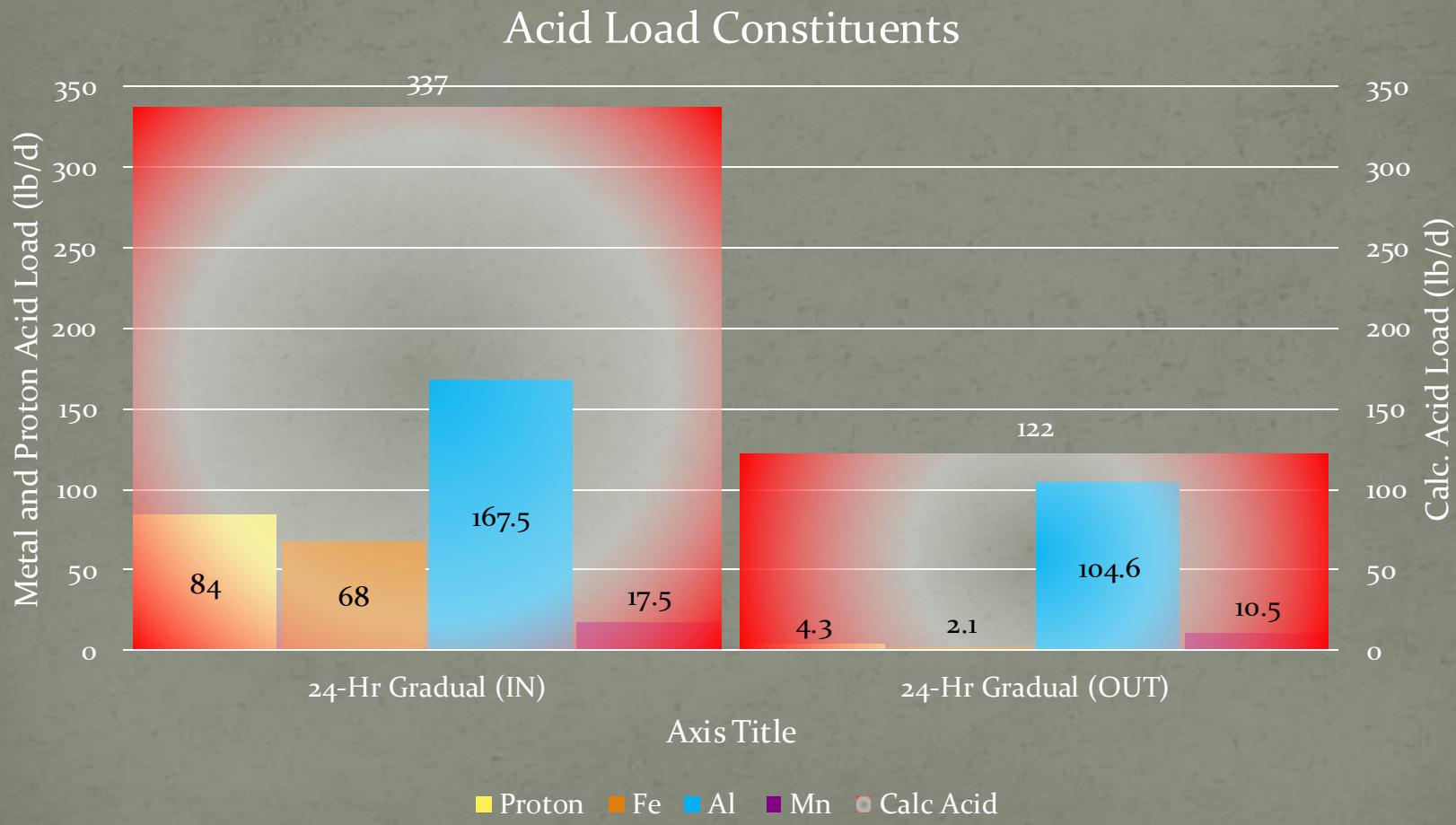
# (#1 ) 24- HR Gradual Fill (12-Hr Avg Hold)

- Rapid Drain initiates 24-hr apart
  - ~1-hr to drain (11.5-hr avg retention)
  - 24-hr cycle
  - 23-hr fill & 1-hr drain



ID	pH	Flow (gpm)	Cond ( $\mu\text{mhos}/\text{cm}$ )	D. Al (mg/L)	D. Fe (mg/L)	D. Mn (mg/L)	ACID (mg/L)	ACID LOAD (lb/d)
SP1 out	4.14	99.7	1260	15.7	0.7	4.9	100	120

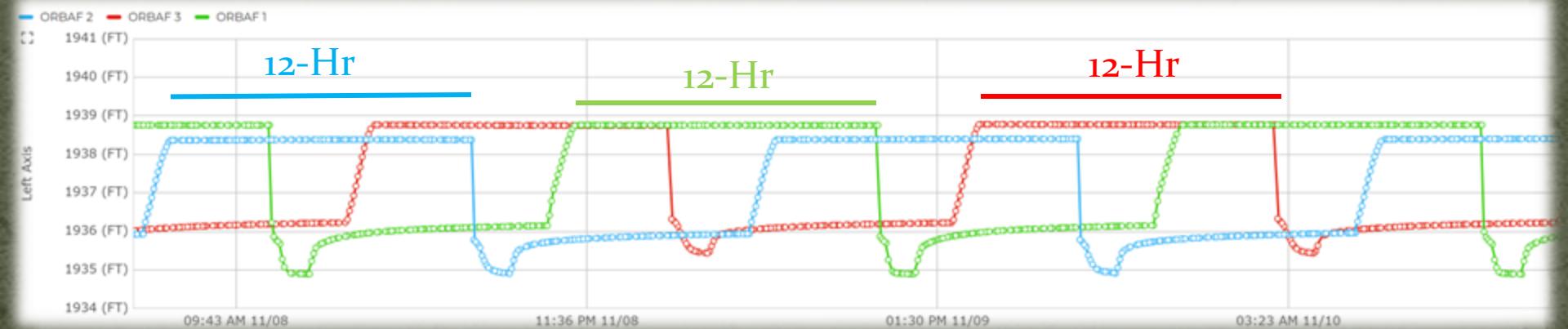
# (#1 ) 24- HR Gradual Fill (12-Hr Avg Hold)



~64% Acid Load Reduction

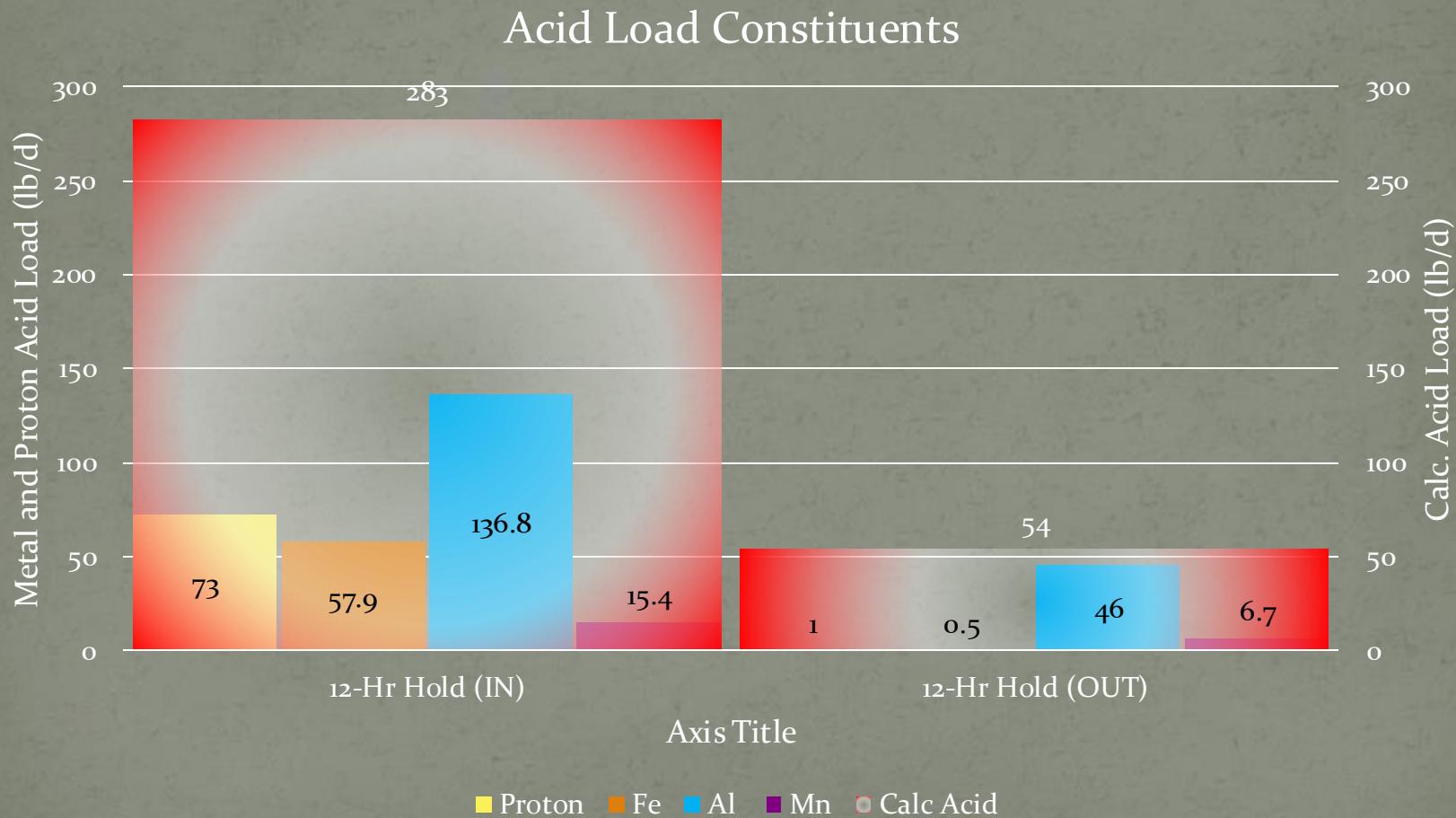
# (#2) Rapid Fill (12-Hr Hold)

- True Hold Times
  - 14-hr cycle
  - 1-hr fill & 1-hr drain



ID	pH	Flow (gpm)	Cond ( $\mu\text{mhos}/\text{cm}$ )	D. Al (mg/L)	D. Fe (mg/L)	D. Mn (mg/L)	ACID (mg/L)	ACID LOAD (lb/d)
SP1 out	4.63	87.2	1220	7.9	0.2	3.5	61	64

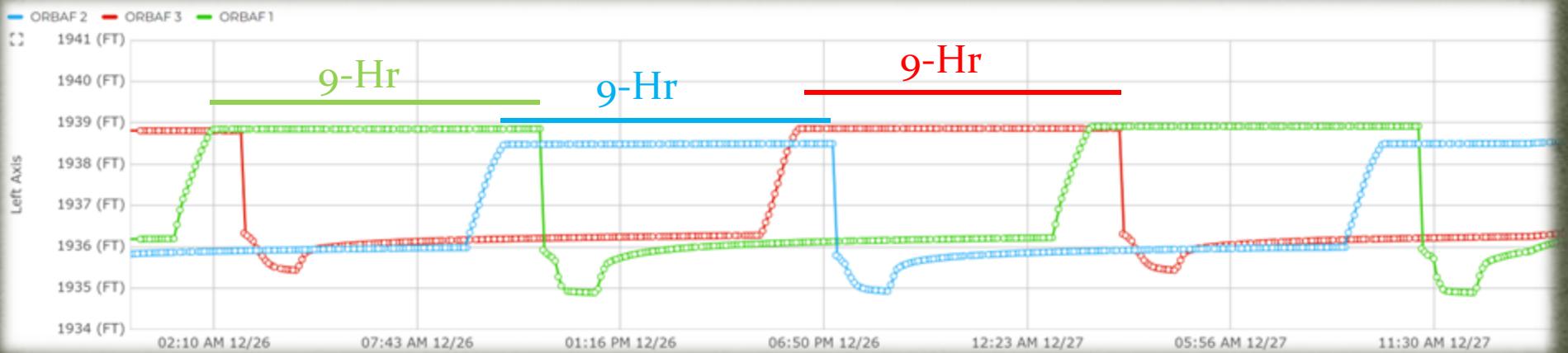
# (#2) Rapid Fill (12-Hr Hold)



~80% Acid Load Reduction

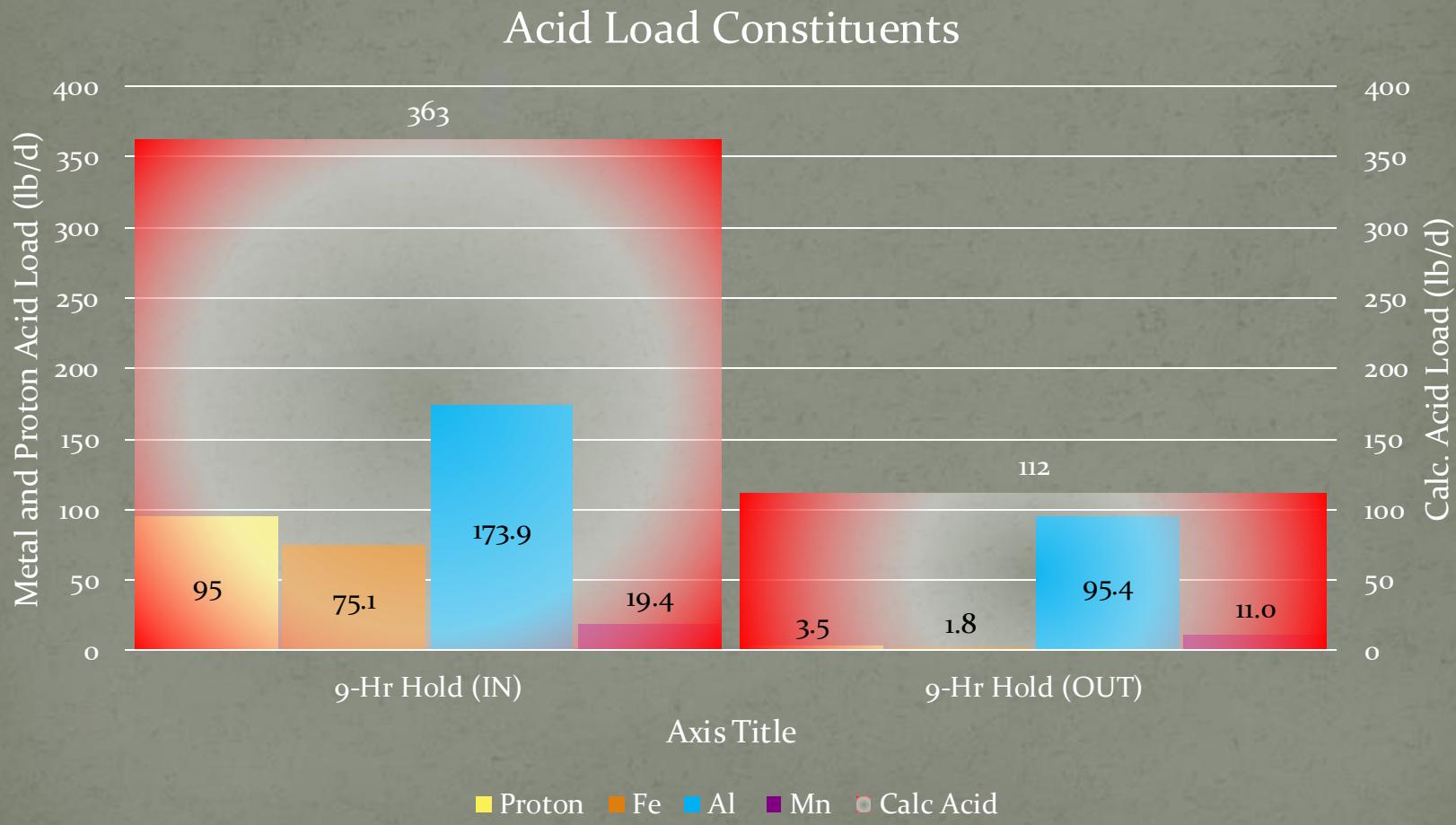
# (#3) Rapid Fill (9-Hr Hold)

- True Hold Times
  - 11-hr cycle
  - 1-hr fill & 1-hr drain



ID	pH	Flow (gpm)	Cond ( $\mu\text{mhos}/\text{cm}$ )	D. Al (mg/L)	D. Fe (mg/L)	D. Mn (mg/L)	ACID (mg/L)	ACID LOAD (lb/d)
SP1 out	4.29	112.4	1240	12.7	0.5	4.5	84	114

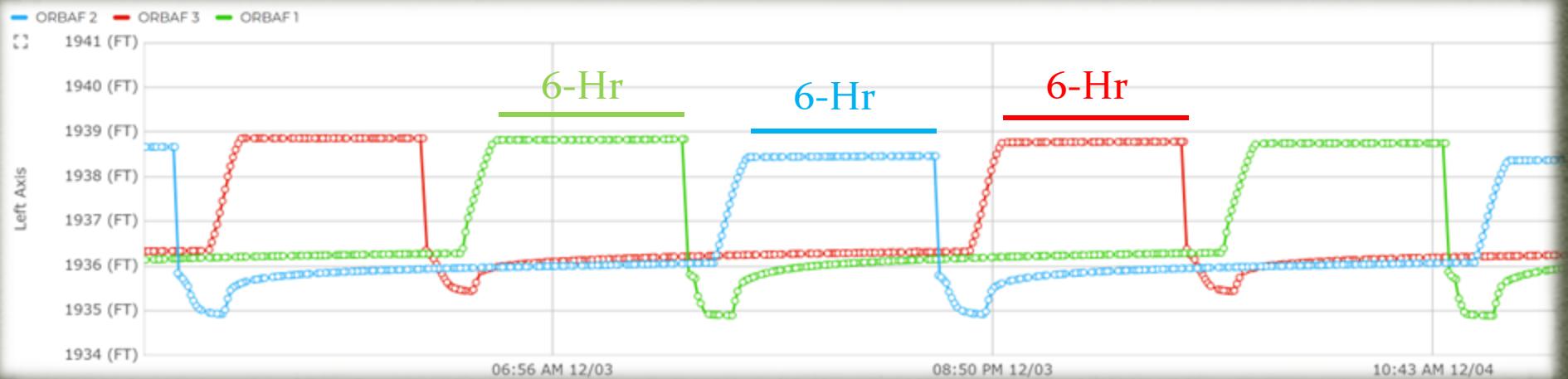
# (#3) Rapid Fill (9-Hr Hold)



~69% Acid Load Reduction

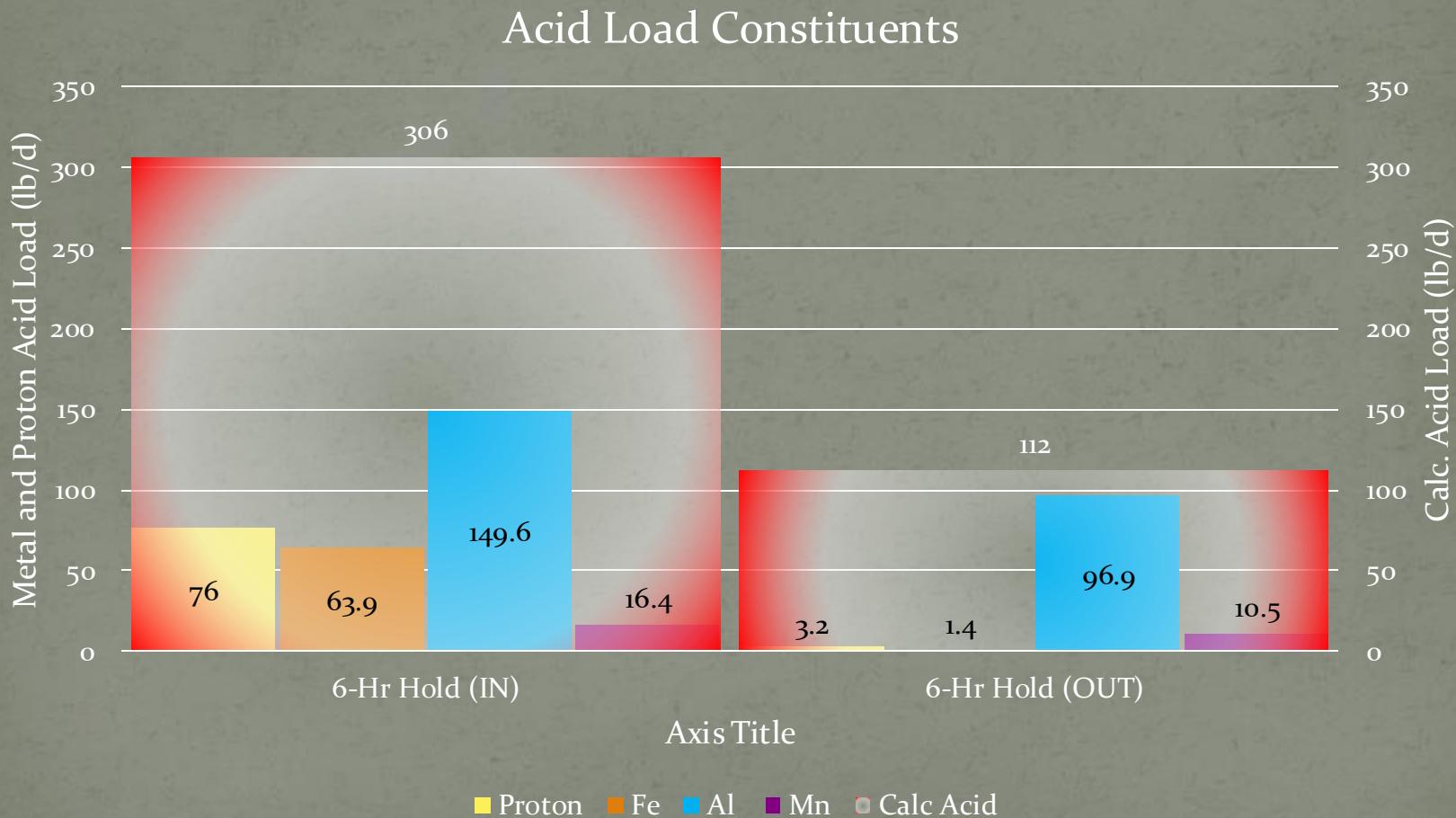
# (#4) Rapid Fill (6-Hr Hold)

- True Hold Times
  - 8-hr cycle
  - 1-hr fill and 1-hr drain



ID	pH	Flow (gpm)	Cond ( $\mu\text{mhos}/\text{cm}$ )	D. Al (mg/L)	D. Fe (mg/L)	D. Mn (mg/L)	ACID (mg/L)	ACID LOAD (lb/d)
SP1 out	4.26	97.9	1280	14.8	0.5	4.9	91	107

# (#4) Rapid Fill (6-Hr Hold)



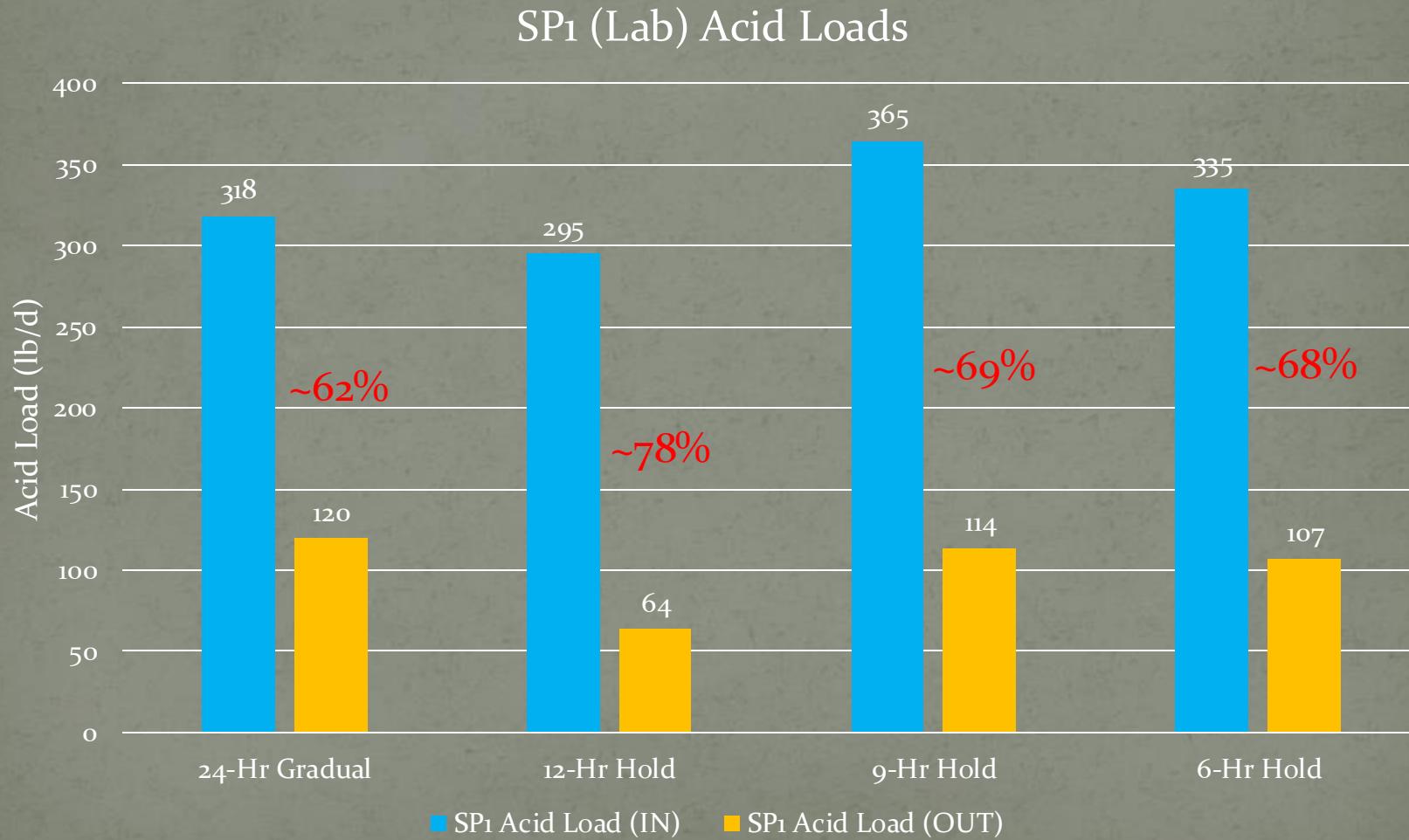
~63% Acid Load Reduction

# Sequential Removal

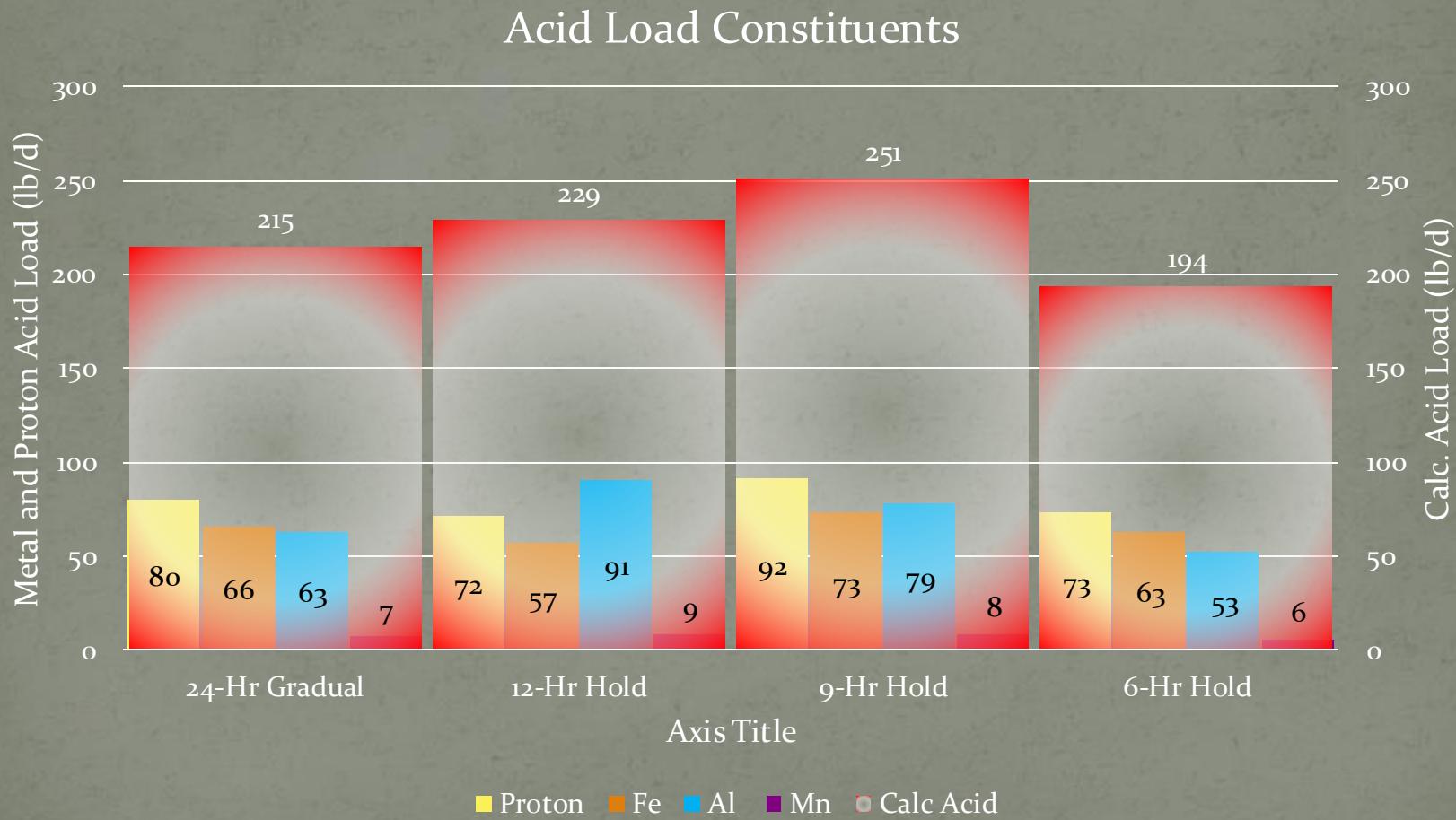


- Ferric Iron
- Aluminum

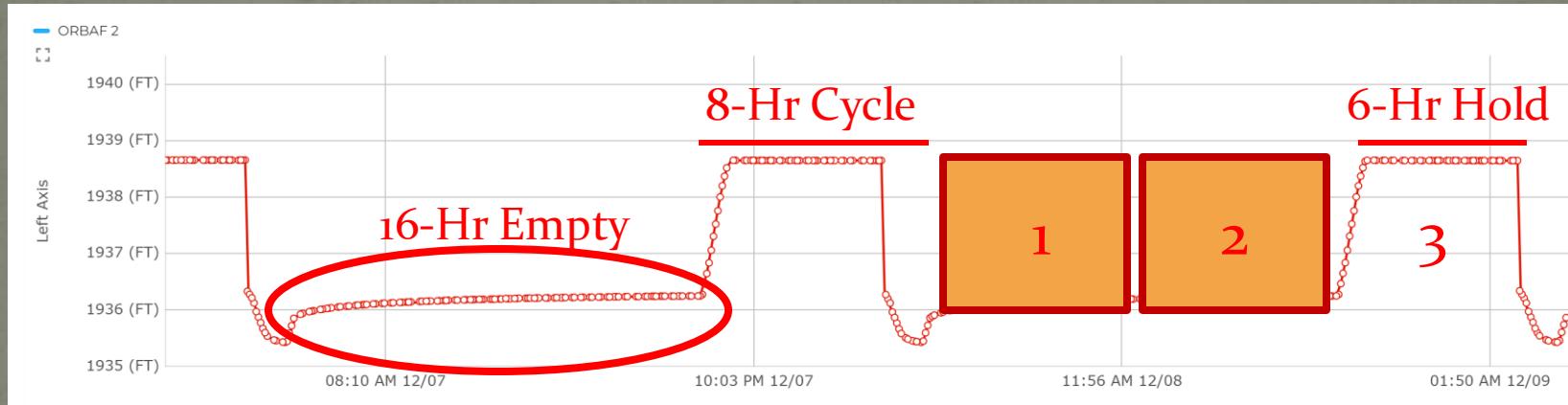
# Acid Load Summary



# ACID LOAD REMOVED



# How Can We Use It?



- Triple Acid Load Neutralization Potential
- Design
  - More efficiently use smaller quantities of limestone
    - \$ or space limited projects
  - How small can you make these ponds?
    - A lot depends on flow

# How Can We Use It?

## Old School

- Agri Drain
  - 1x daily flush capability
- 1 control unit per valve
- Stand Alone (timers)
- OG BOLTS (float switches and radio controls)



## New School

- Agri Drain - advancements
  - 4x / day flush capability per valve
- 1 control unit can control 2 valves & potentially other hardwired inputs
  - Radar Level Sensors etc

# Questions

## Thank You & Acknowledgements

PA DEP BAMR

BioMost, Inc.

Earth Shapers, LLC (Contractor)

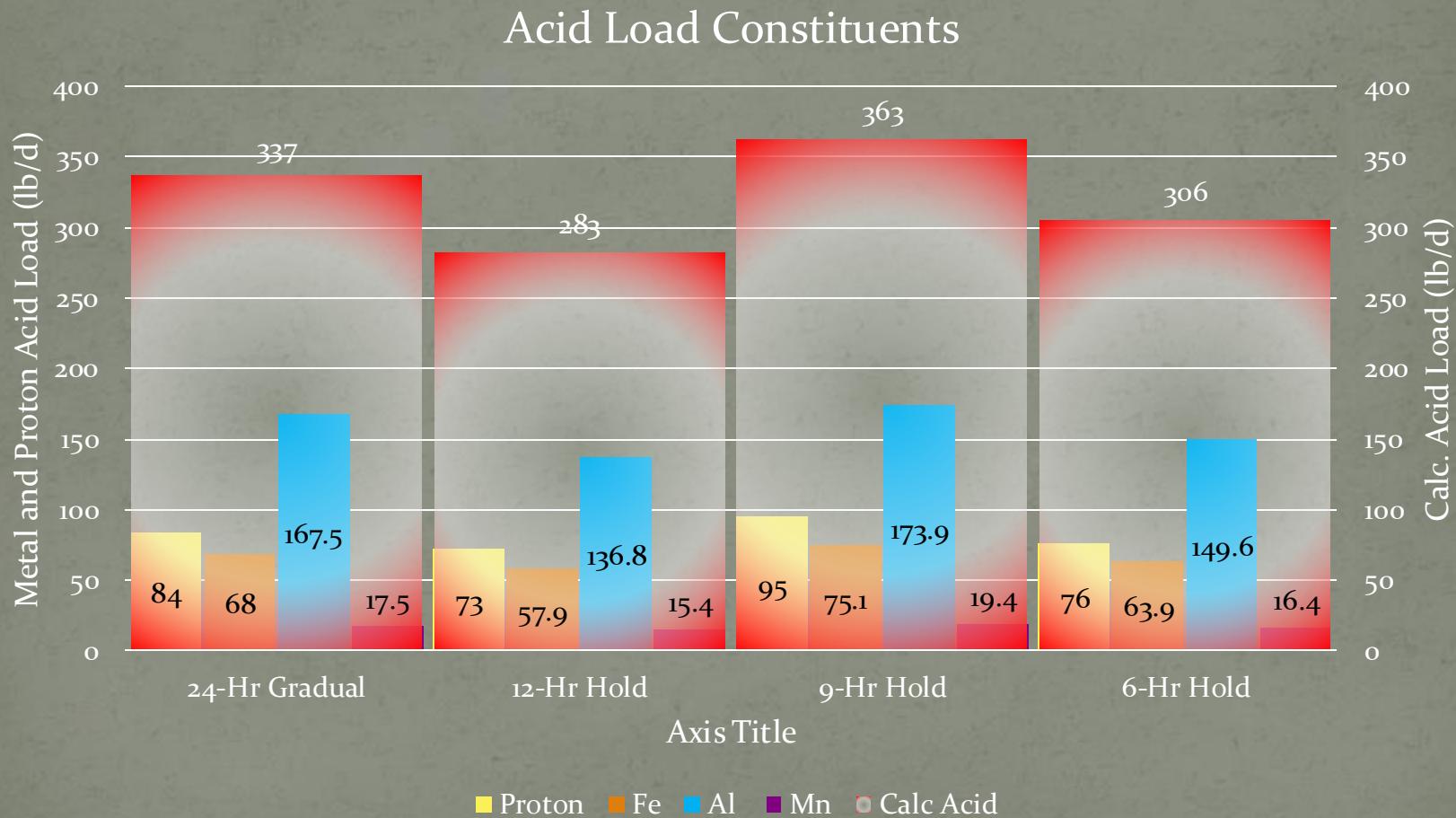
Stonycreek-Conemaugh River Improvement Project (SCRIP)

Landowner

No Really I'm Done

# Extra Slides

# SP1 Influent



# SP1 Effluent

## Acid Load Constituents

