Civil & Environmental Consultants, Inc.

AMD REFURBISHMENT

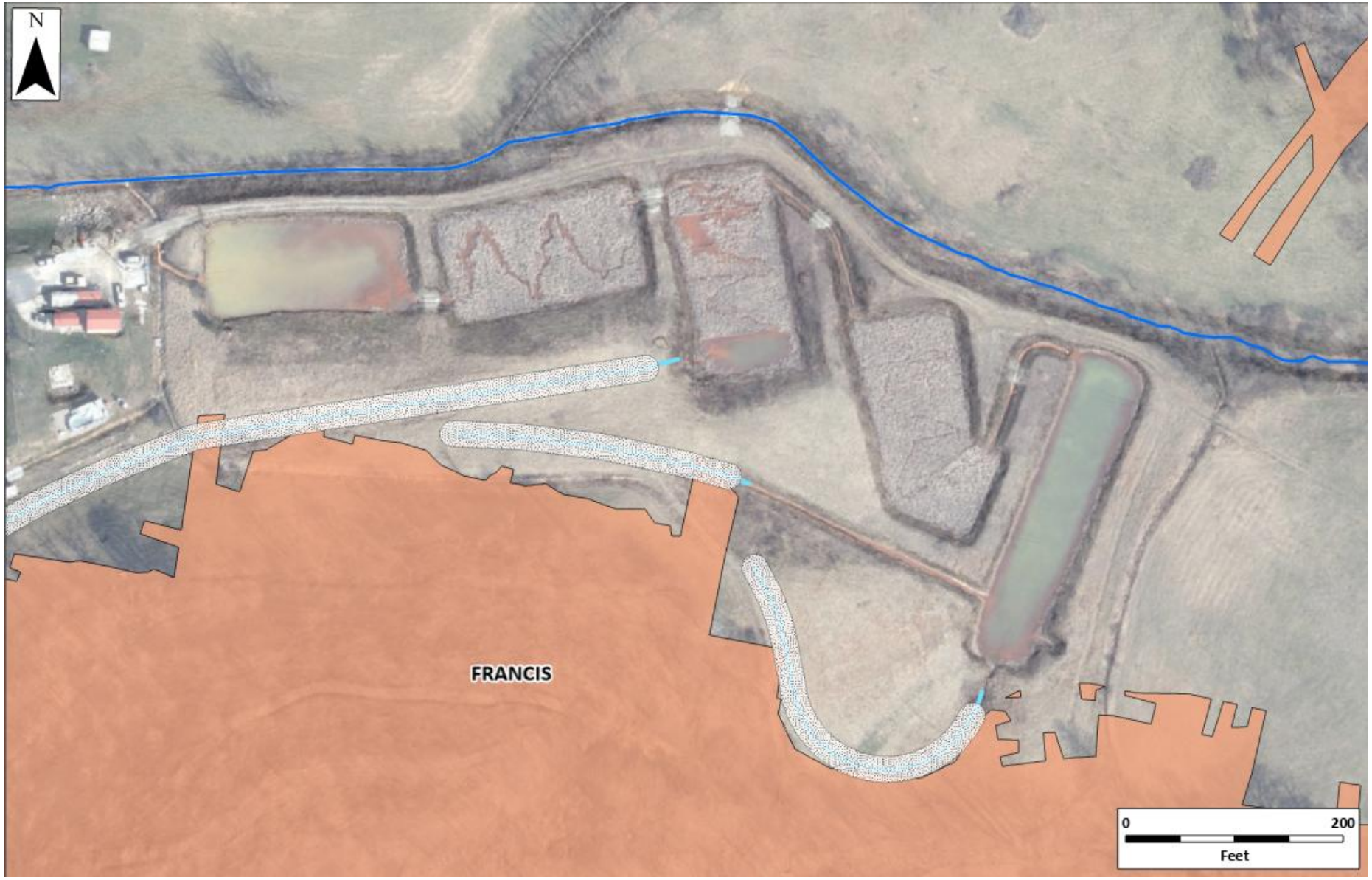
Francis Drainage Maintenance, Harrison County, West Virginia

West Virginia Department of Environmental Protection (WVDEP)

Office of Abandoned Mine Lands and Reclamation (OAMLR)

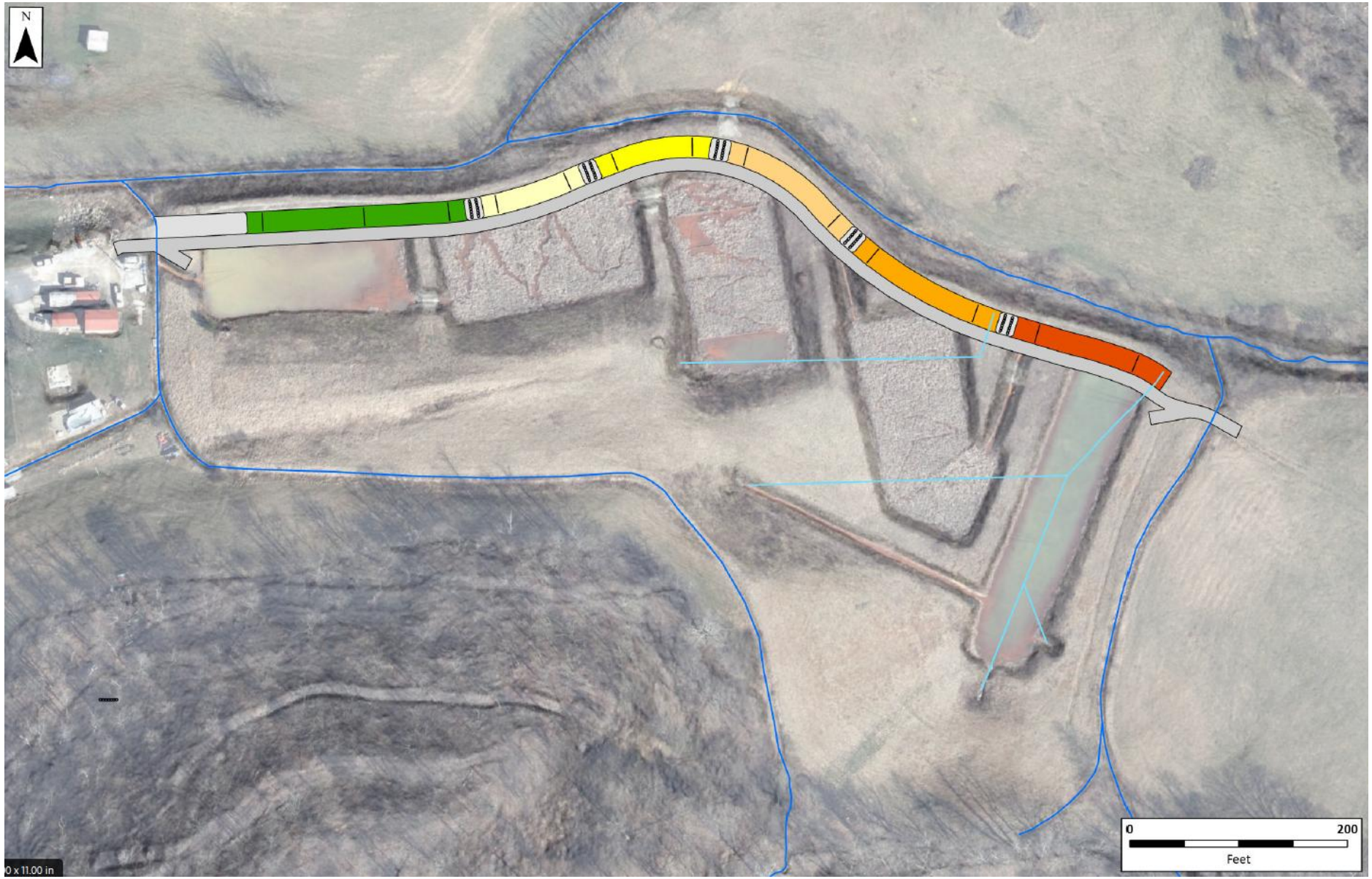
May 6, 2026

Original AMD Treatment System



- Initial AML reclamation / AMD remediation constructed in 1997
  - Refuse reclamation
  - Highwall grading
  - Portal closures
  - Anoxic limestone drains
  - Settling ponds
  - Compost-limestone beds
- Approximately 3-acres of pond surface
- Approximately 5-acre footprint

Proposed AMD Refurbishment



- 20+ years later……
  Time for Refurbishment

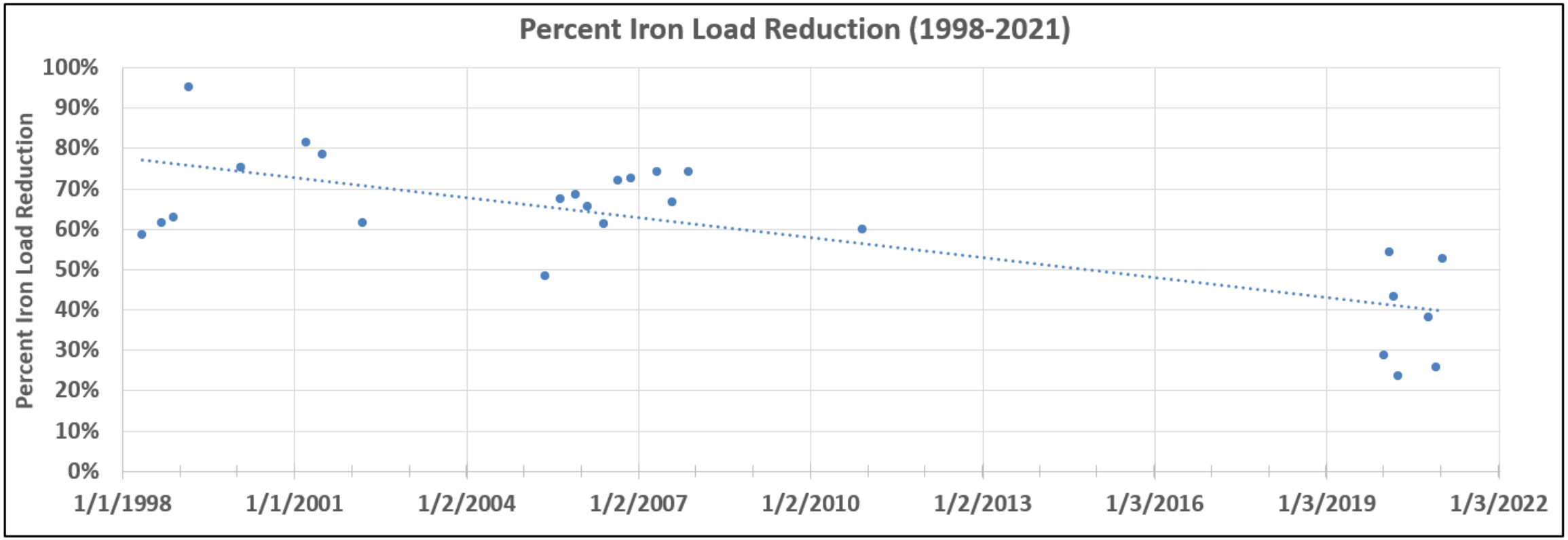
- Landowner objectives
  - Reduced footprint
  - Agriculture grazing
  - Road access
  - Fencing

- Client objectives:
  - Achieve equal treatment as existing condition
  - Adjust technologies
  - Leave ALDs intact

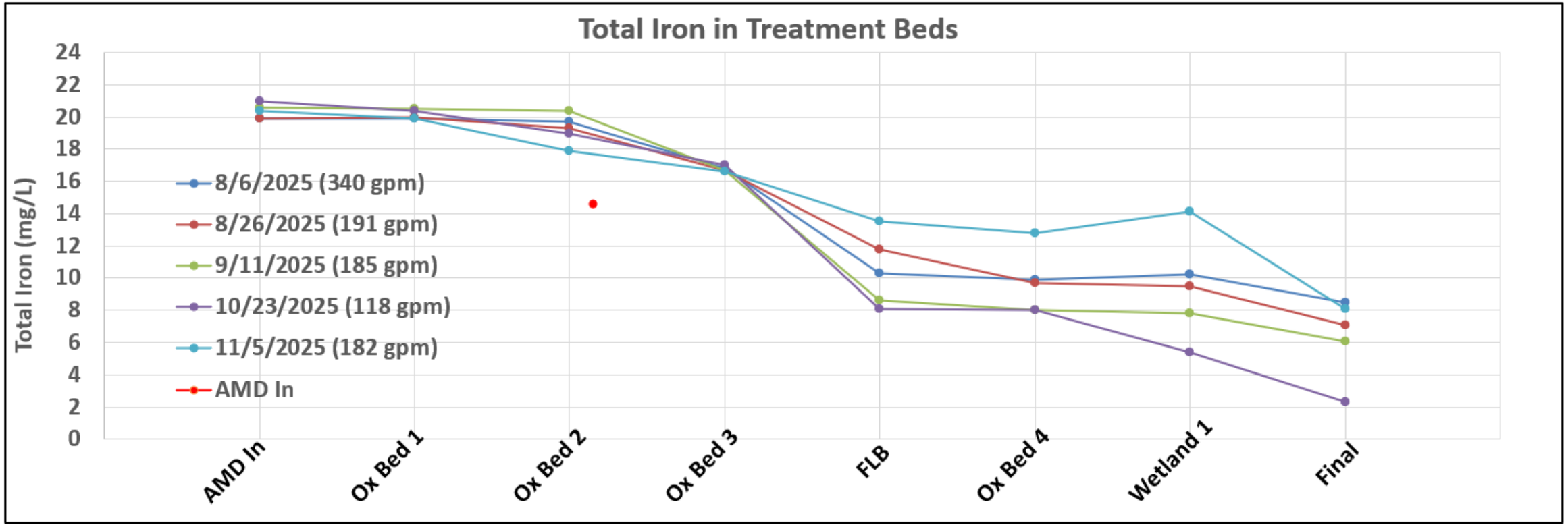
Refurbished Project

- Approximately 0.43-acres of pond surface
  - Three shallow oxidation beds
  - Flushing limestone bed (FLB)
  - Fourth shallow settling/oxidation bed
  - Two polishing wetlands
- Oxidation beds for ferrous to ferric conversion
- FLB due to periodically observed pH=5.7 and metals acidity=alkalinity
- Settling pond for solids collection
- Wetlands for final polishing

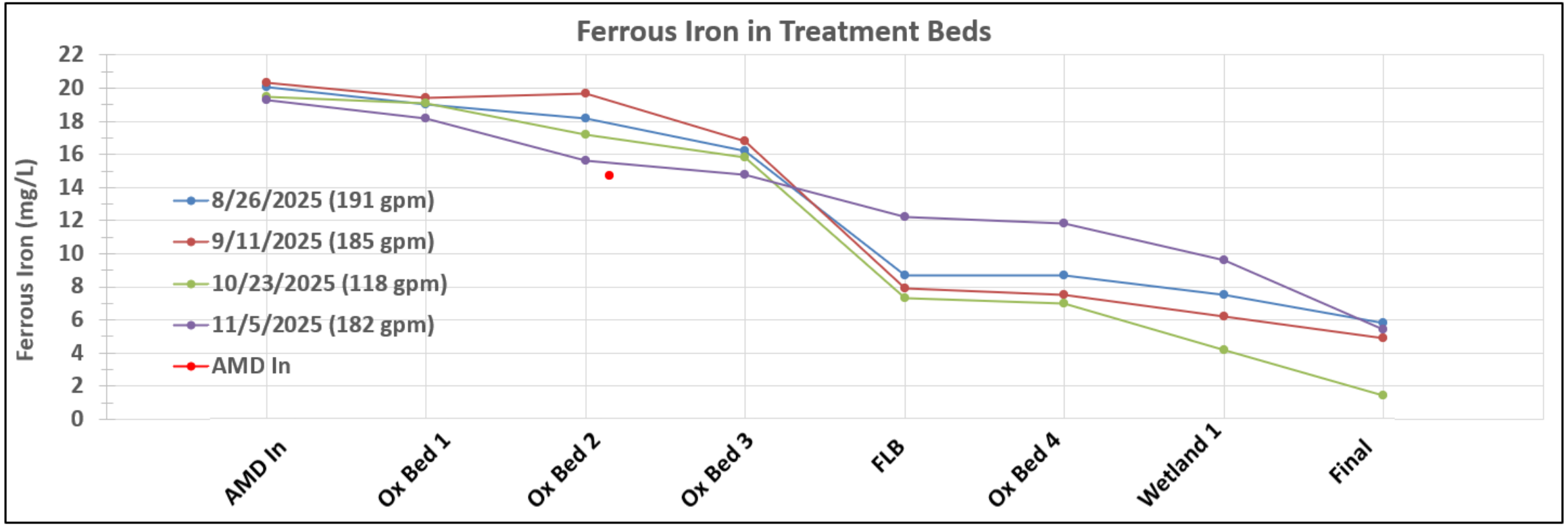
Original AMD Treatment Data



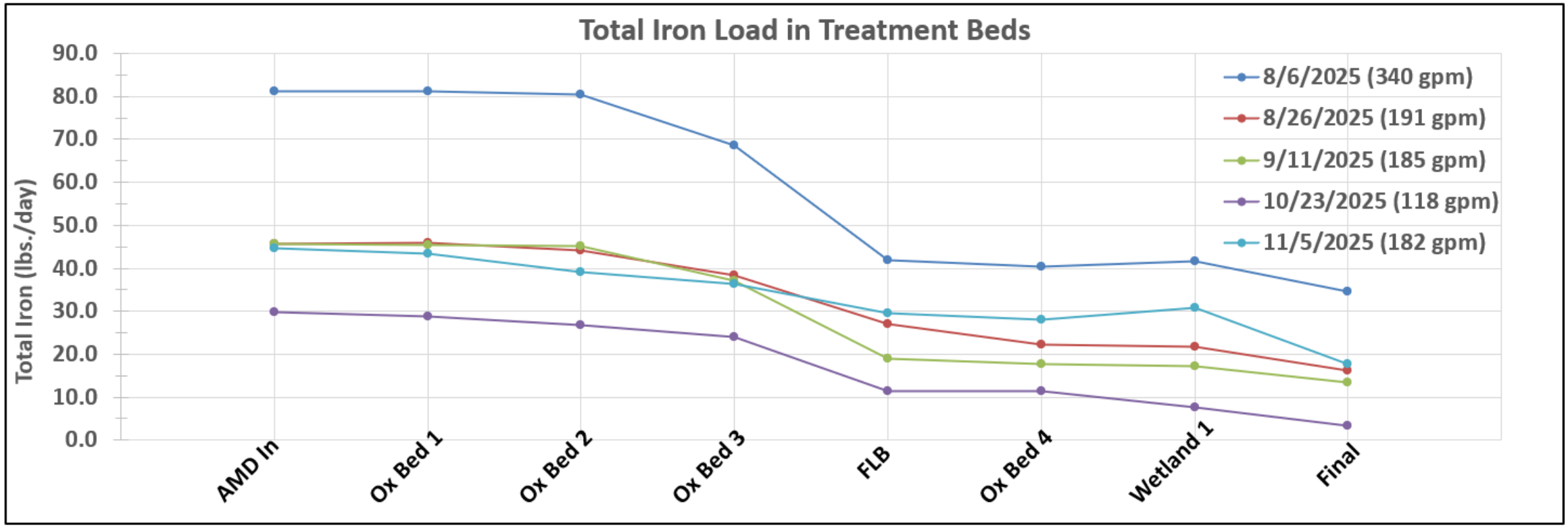
Refurbished Data – Total Iron Concentration



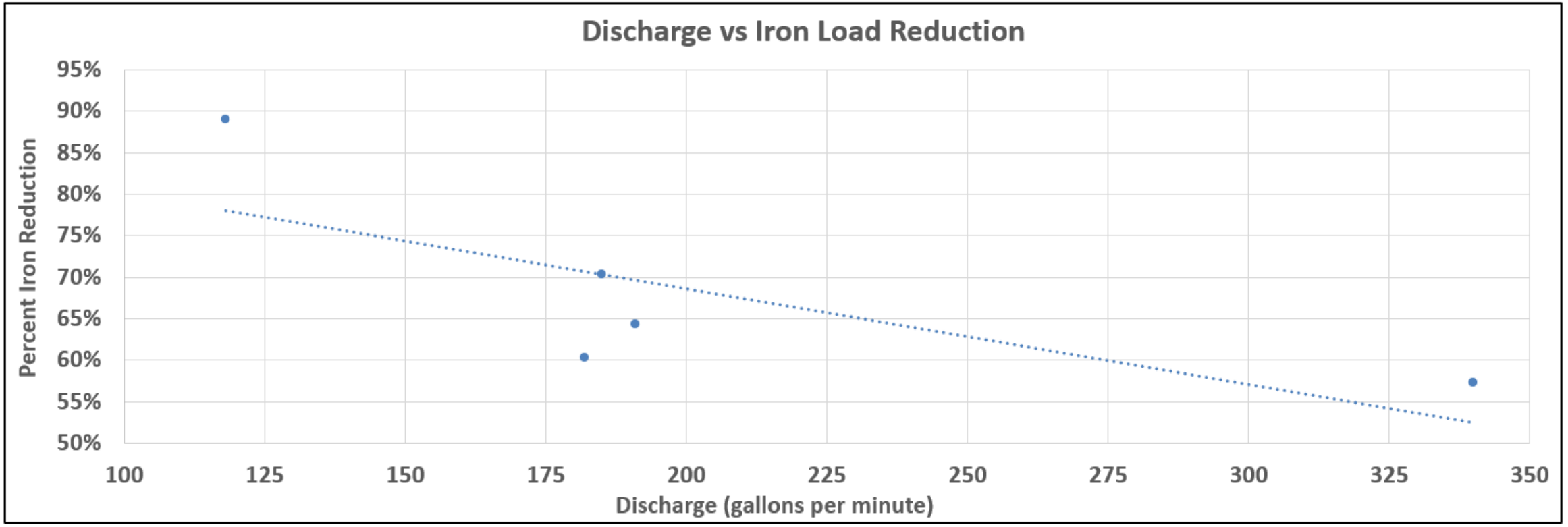
Refurbished Data – Ferrous Iron Concentration



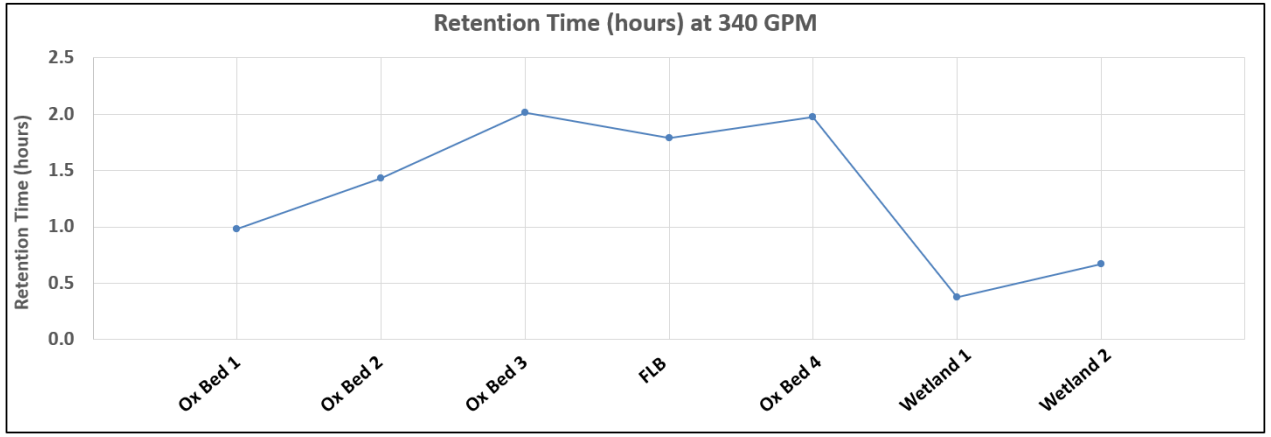
Refurbished Data – Total Iron Load

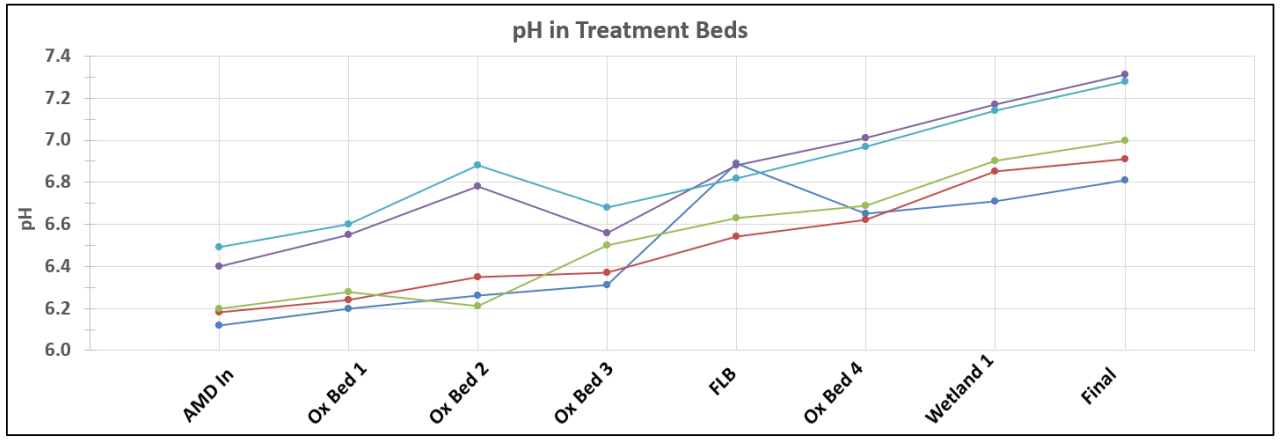


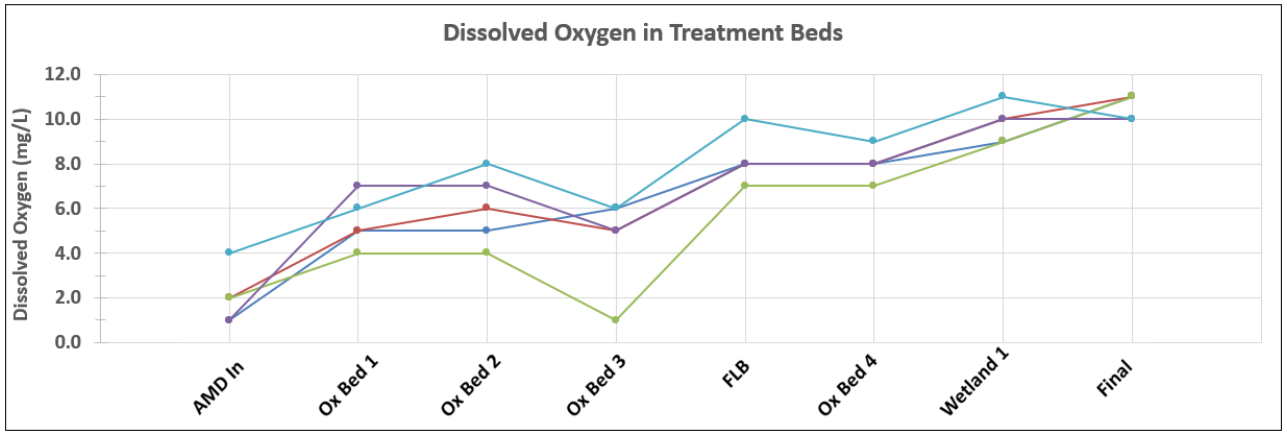
Refurbished Data - Iron Load Reduction



Influences on Treatment Effectiveness







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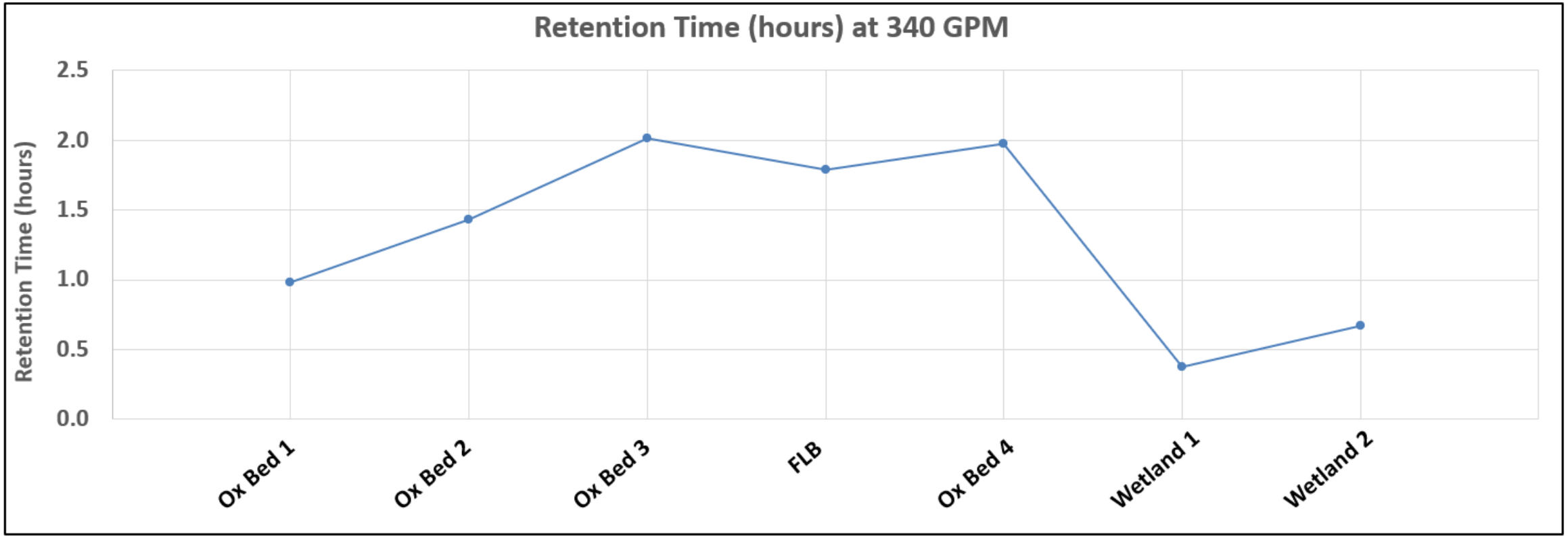
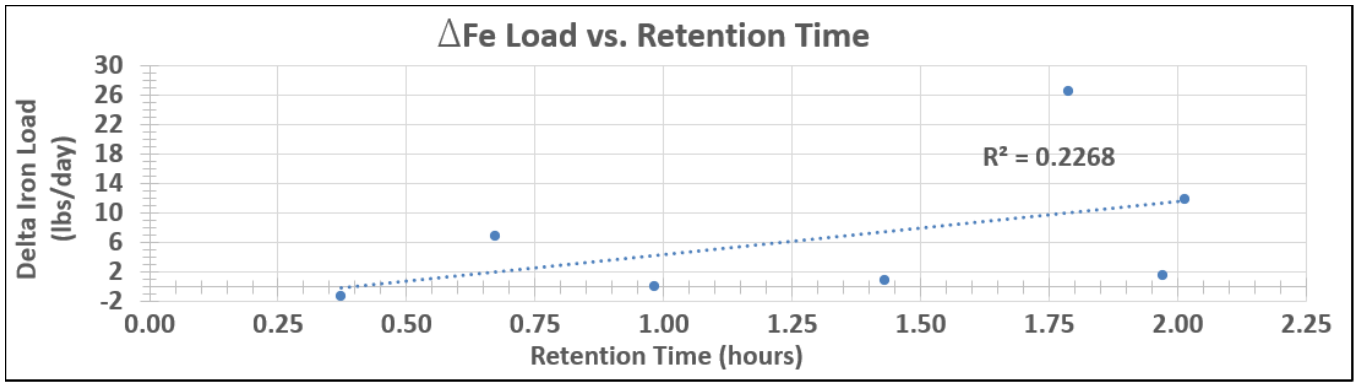
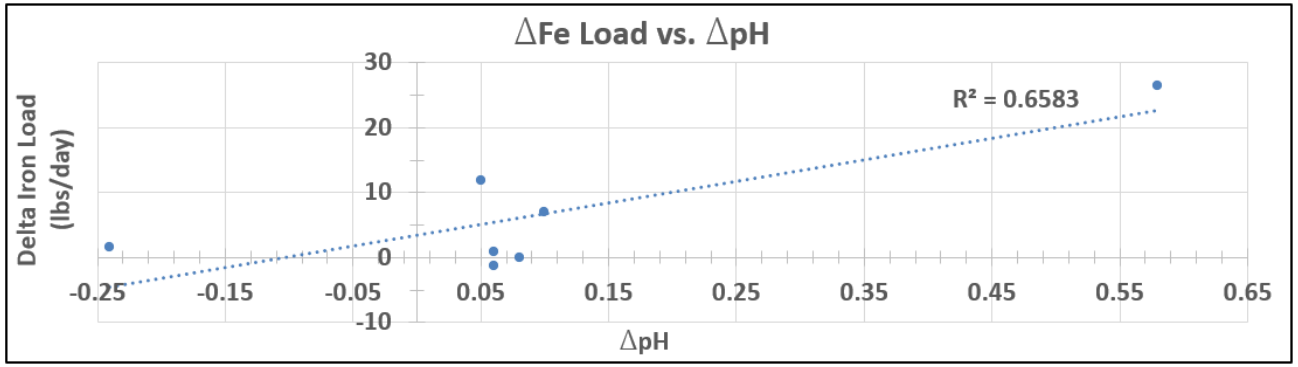
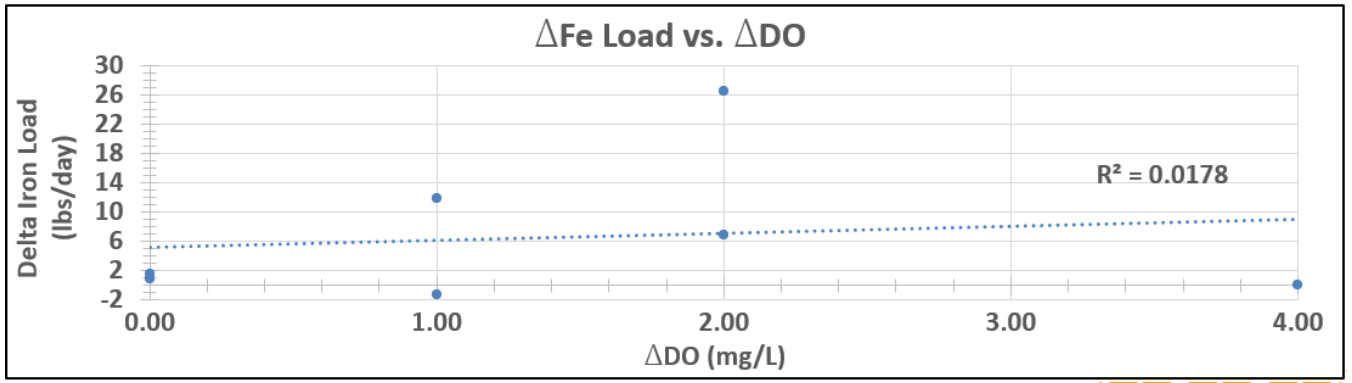


Correlation of Parameters







Conclusions

- Efficacy fluctuates with climatic conditions
- Meeting pre-refurbishment effectiveness in 86% reduced footprint
- Increased iron oxidation and removal at Flushing Limestone Bed
- pH most strongly correlated to increased performance

$$\frac{d[Fe^{2+}]}{dt} = -k_{het}\frac{[Fe^{2+}][O_2][Fe(III)_{solid}]}{[H^+]}$$

- More frequent solids handling with smaller treatment system
  - 4 months, 22,500 gallons vacuumed from FLB

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Thank You

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