# Removing Dissolved Phosphorus with Edge-of-Field Phosphorus Filters

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## Introduction

- The Illinois Nutrient Loss Reduction Strategy calls for a 45% reduction of total P load into the Mississippi River
- Non-point source additions account for 50% of the total P load
- Current mitigation practices include cover cropping, conservation tillage/no-till, and the 4 R's

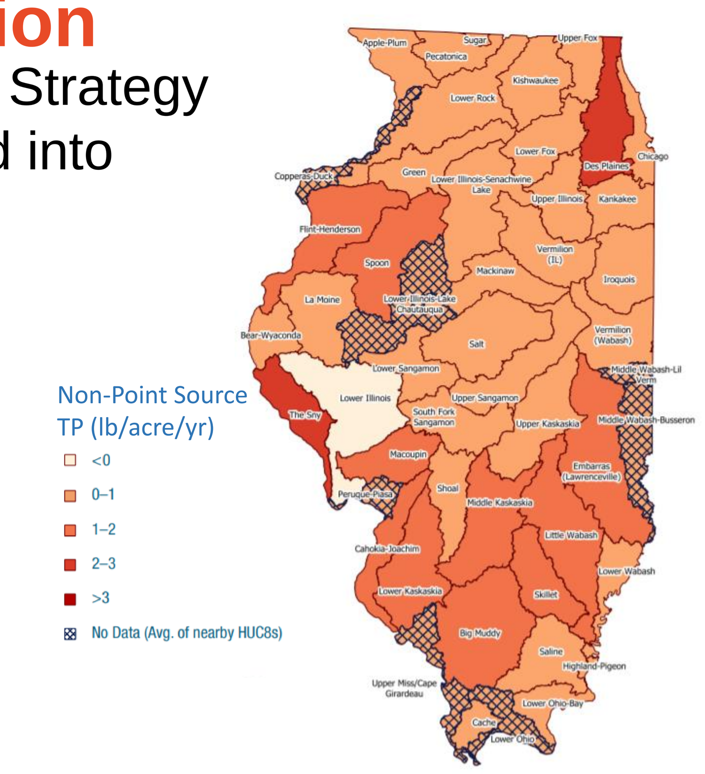
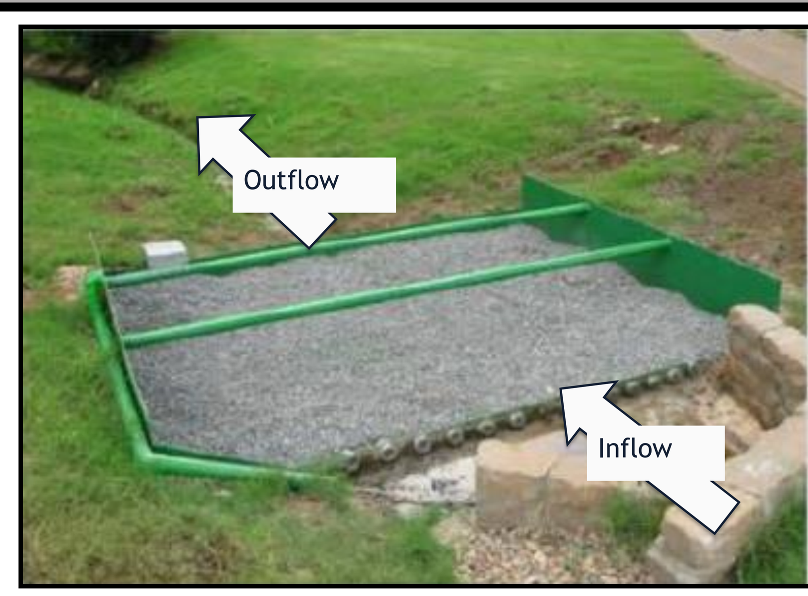



*Figure 3.7. Estimated annual average 2012–17 non-point source TP loads for HUC8s using point source locations relative to monitoring locations.*

Illinois Nutrient Loss Reduction Strategy Biennial Report 2019

## Edge-of-field P filters

- Placed in an area of diverted surface runoff and/or tile drainage
- Filled with industrial waste by-product
- Small footprint, no change in management needed




Penn et al. Trapping Phosphorus in Runoff with a Phosphorus Removal Structure. Journal of Environmental Quality. 2012.

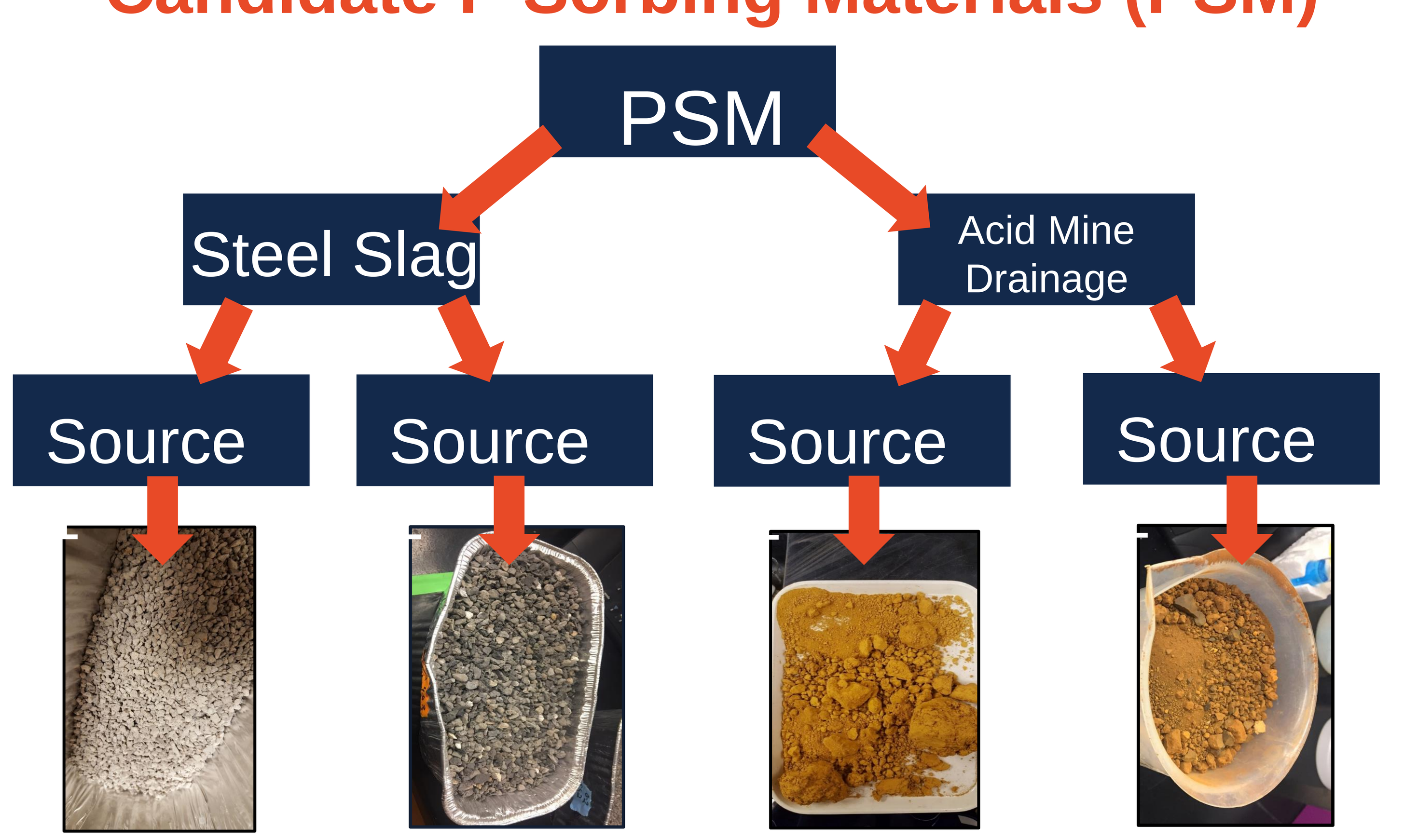
## Research Objectives

**Research Goal**: Determine best-suited P-sorbing material (PSM) to be used in an edge-of-field P filter

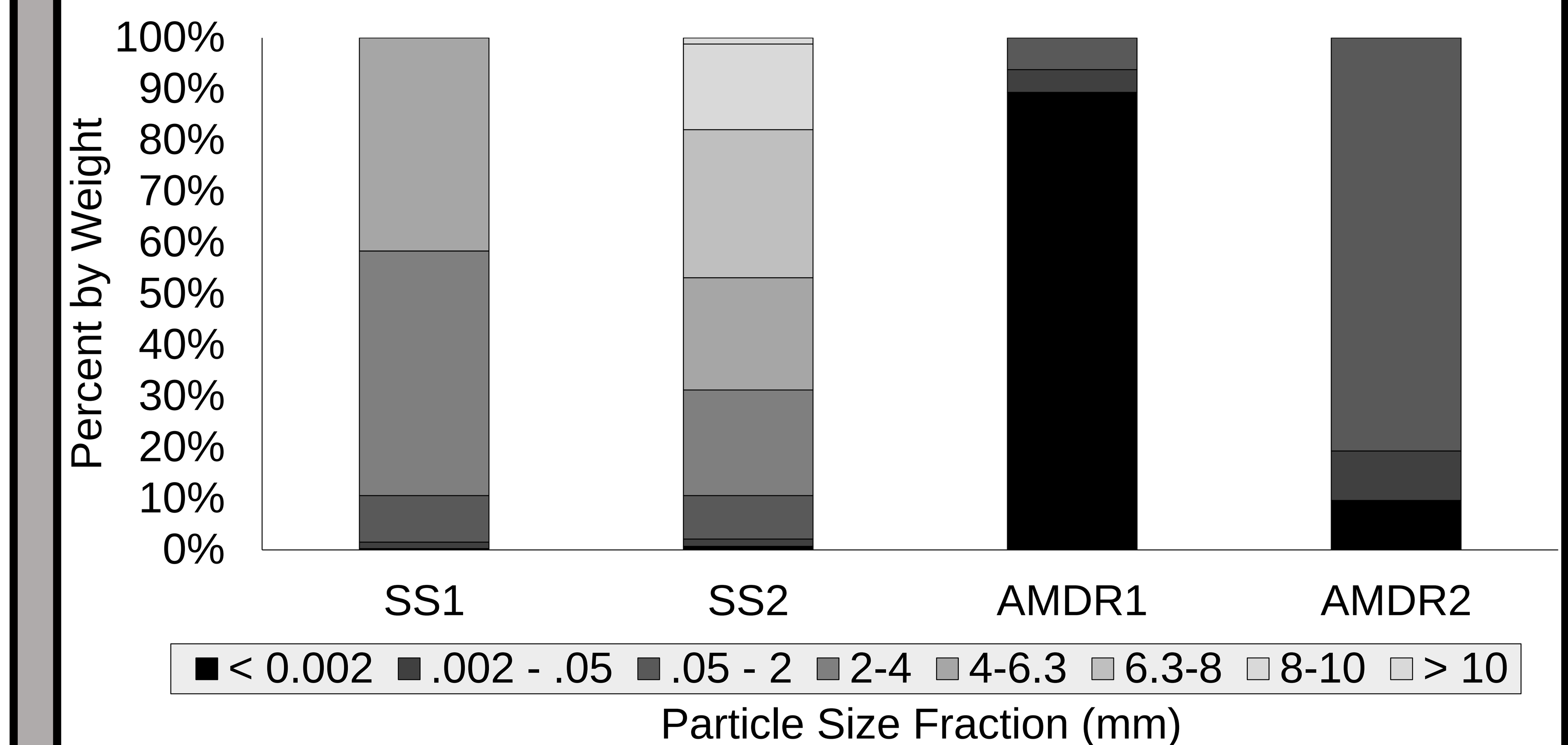
**Questions:**

1. What is the tradeoff between P sorption capacity and hydraulic conductivity?
2. What is the optimum particle size for PSM?
3. How is P bound to each PSM?

## Candidate P Sorbing Materials (PSM)

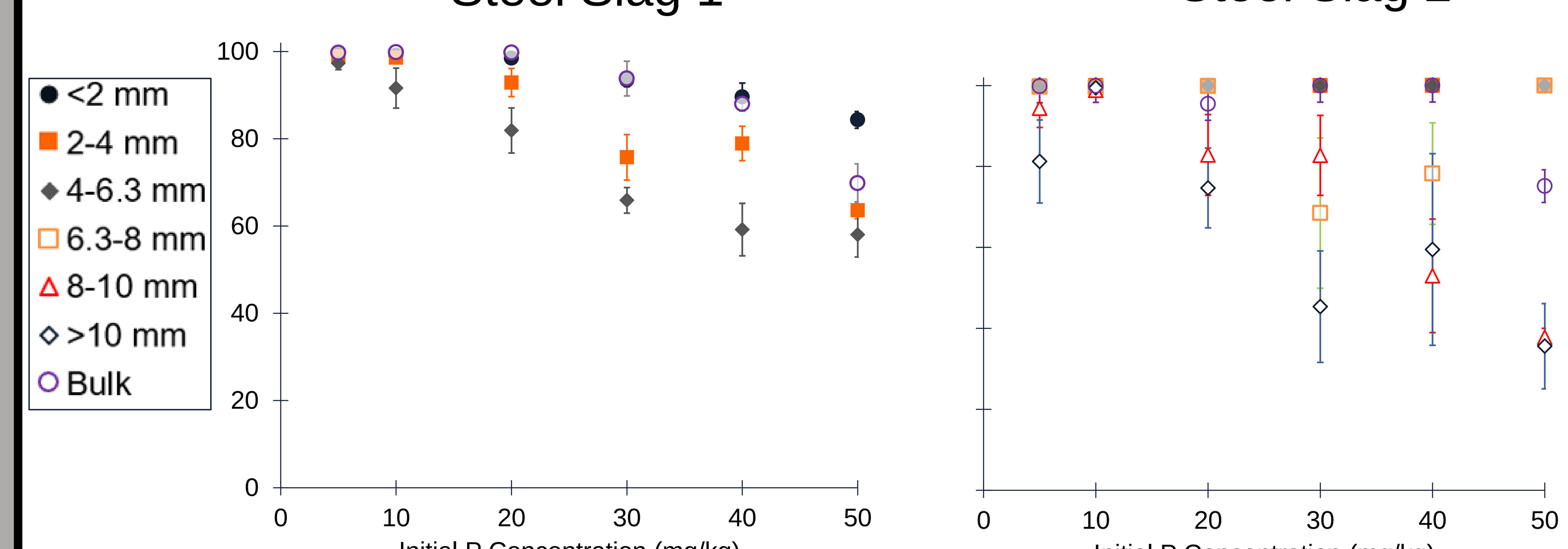



## Particle Size Distribution



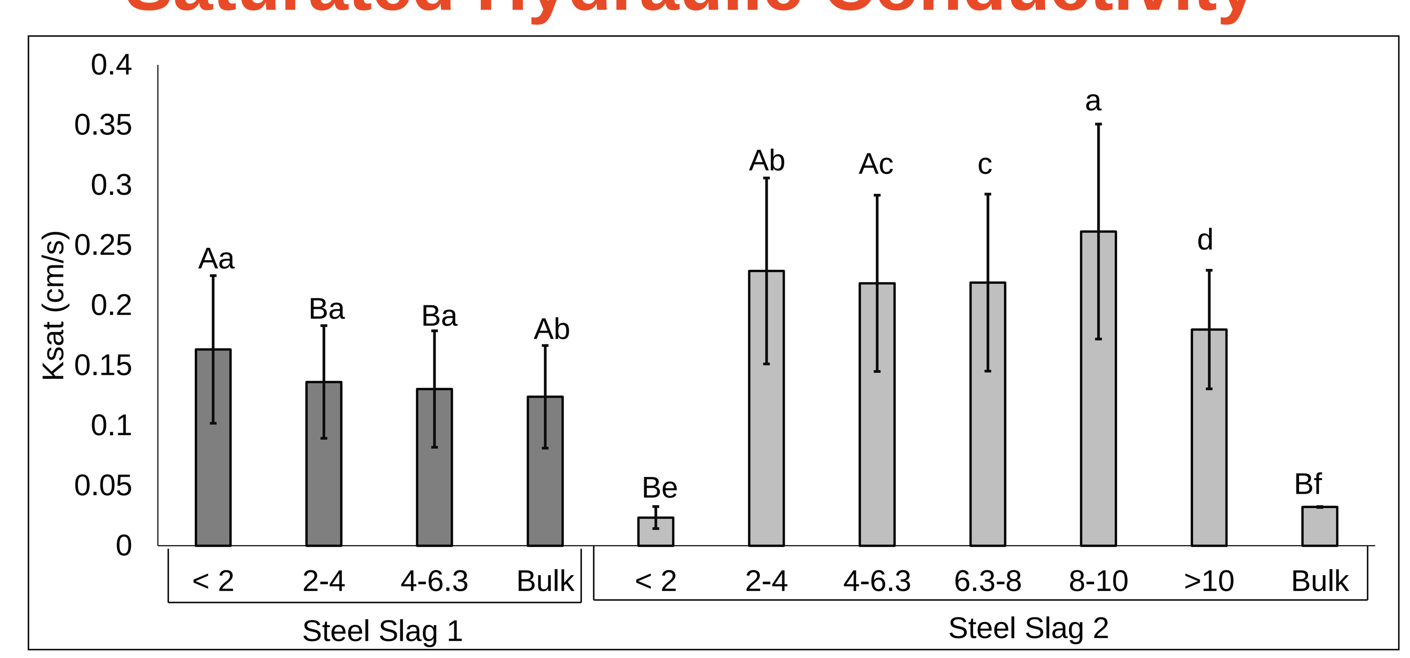

The particle size distribution of each PSM determined by weight.

## Percent P Removal

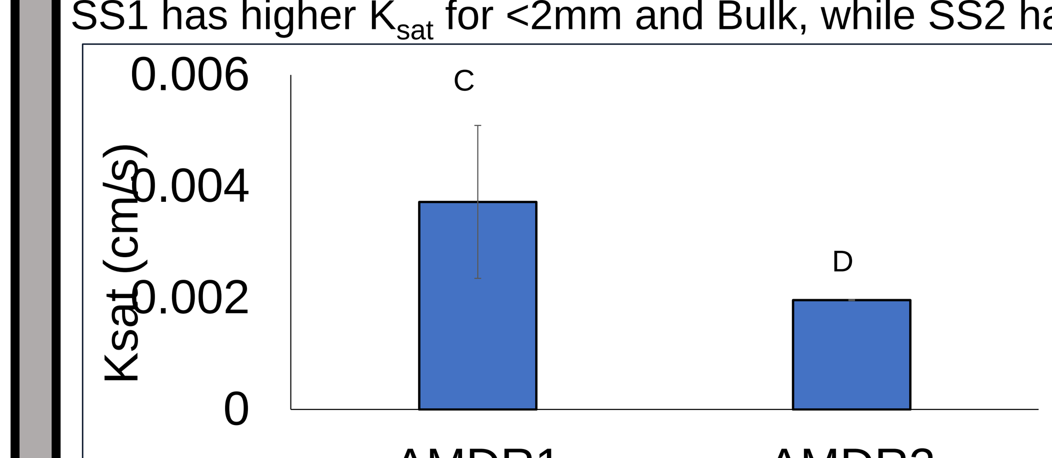



The initial P concentration plotted against the percent P removed by the PSM. **AMDR 1 and AMDR2 had 100% P removed at all initial P concentrations.**

## Saturated Hydraulic Conductivity

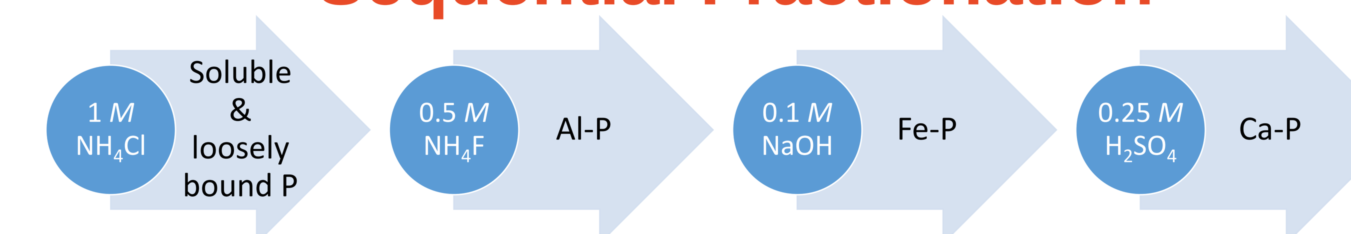


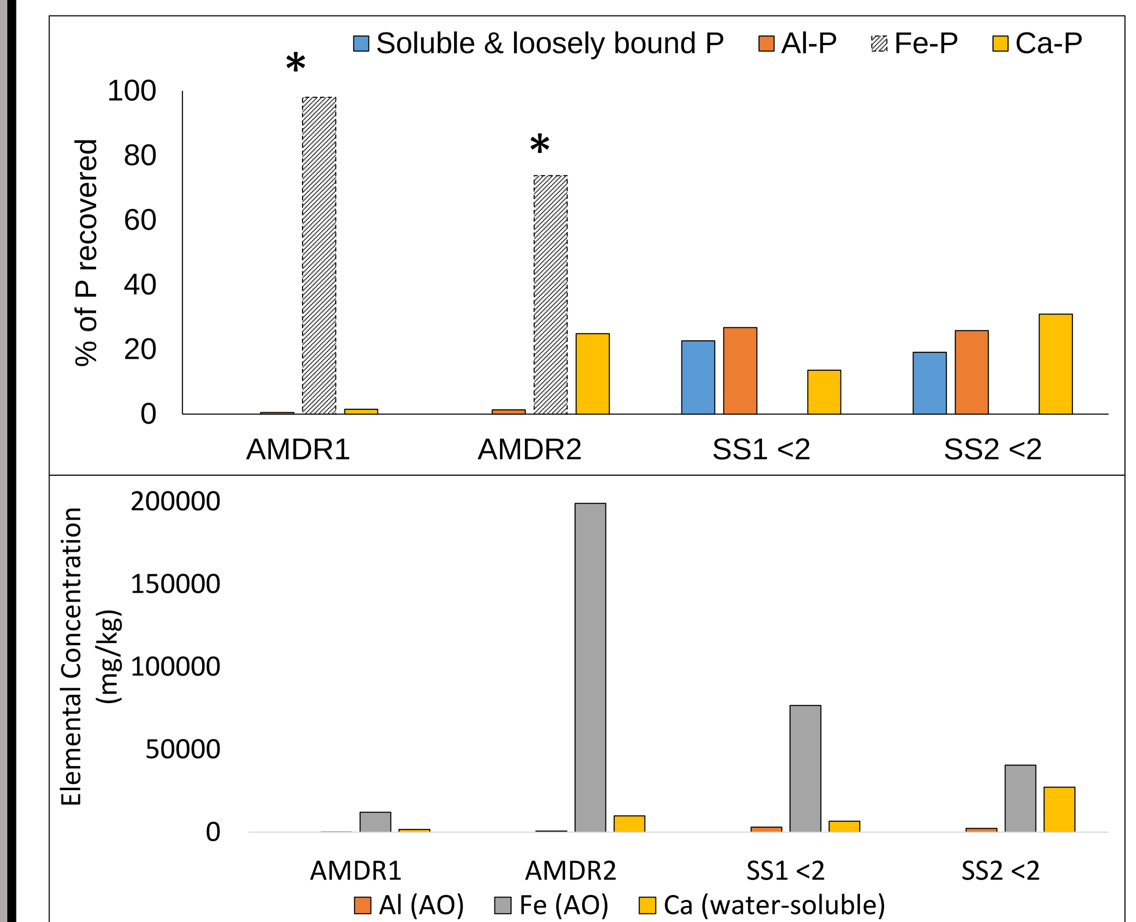

High variability within SS2 particle sizes and little difference within SS1. SS1 has higher $K_{sat}$ for <2mm and Bulk, while SS2 has higher for the other particle sizes.




$K_{sat}$ values of AMDR are one magnitude lower than SS

## Sequential Fractionation

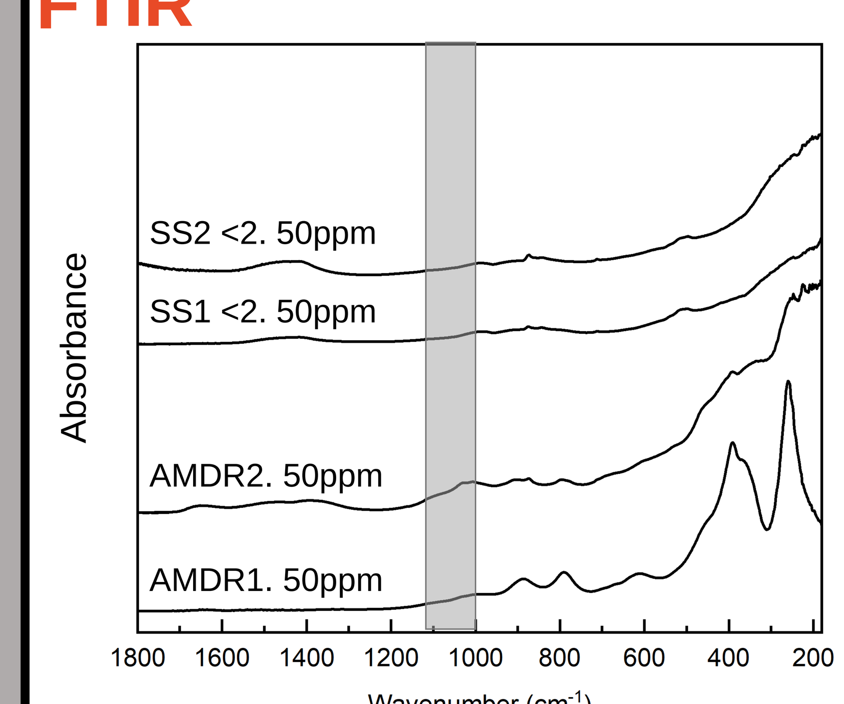


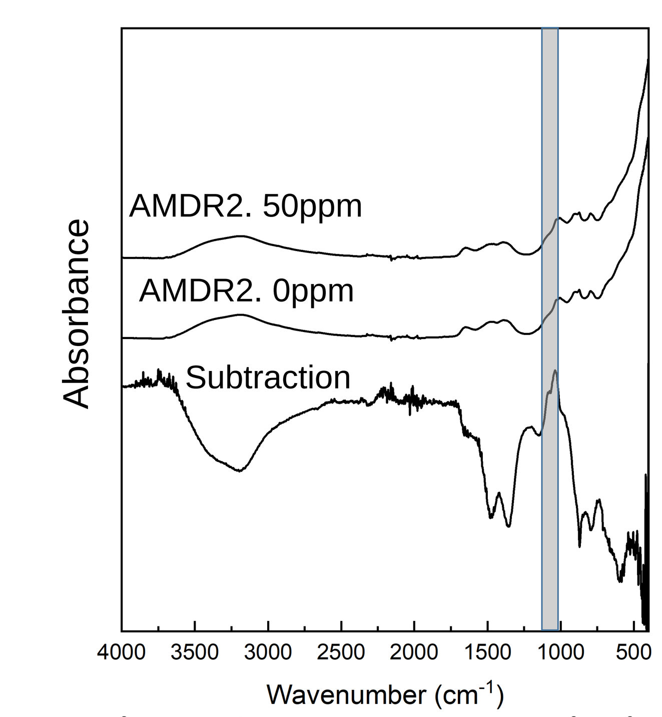

* Not determined due to iron interference but mathematically assumed.

Generally, the elemental composition of the PSM can indicate which fraction will have the highest percent of P recovered, although there are some anomalies.

## FTIR




Raw spectrum of PSM loaded with 50 PSM




Subtraction spectra reveals the orthophosphate bonds

## Key Points

- **P removal decreases as particle size increases**
- **Source matters more than particle size for P removal**
- **Type of material matters for choice of PSM – driven by $K_{sat}$**
- **Optimum particle size: 4-6.3 mm**
- **Fe is the main binding agent of P for AMDR**
- **Calcium is *not* the main binding agent of P for SS**

## Acknowledgments

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