

Phytoremediation of Tritium at the Savannah River Site

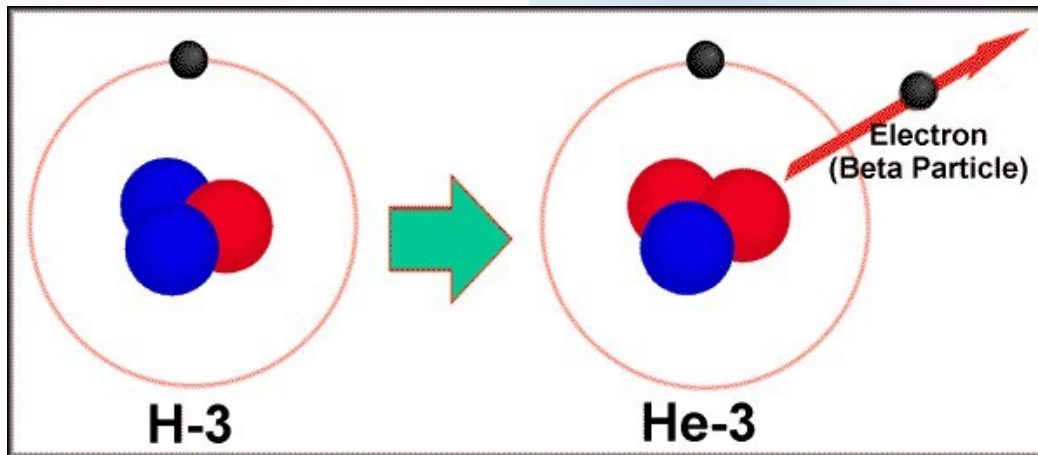
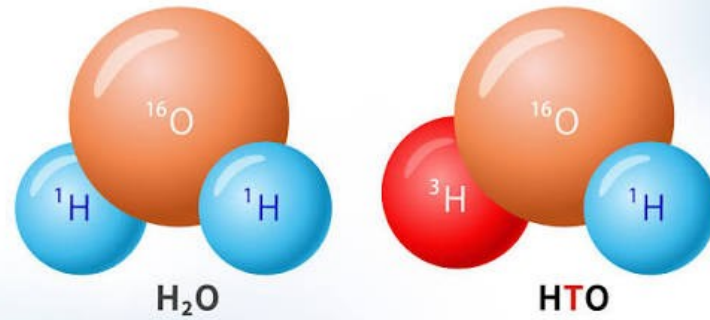
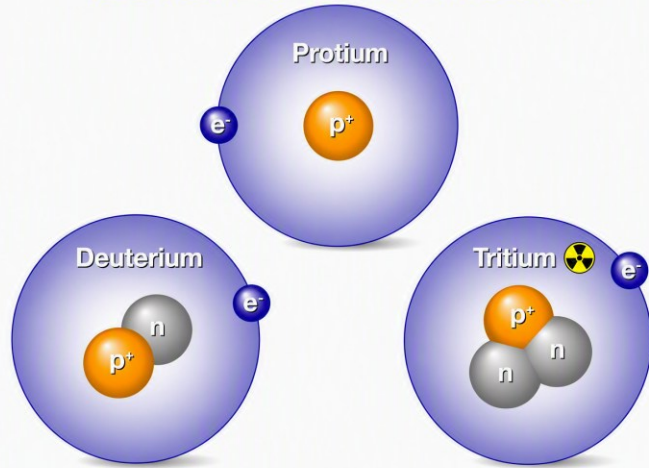
Doug P. Aubrey



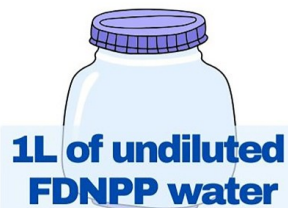
Forest Ecophysiology Lab
Savannah River Ecology Laboratory
Warnell School of Forestry & Natural Resources
UNIVERSITY OF GEORGIA



ISOTOPES OF HYDROGEN



Drinking 1 liter of undiluted FDNPP water



0.11 μSv



Effective dose



Eating 11 bananas



Flying 1,7 hours (at cruise altitude)



Staying 16 hours in the USA

Tritium $\rightarrow$ H Isotope

- Protium (99.985%), ^1H
- Deuterium (0.015%); ^2H
- Tritium (trace); ^3H
- Cosmic rays & nuclear reactors
 - $\text{H}_2\text{O} \rightarrow \text{HTO}$
- β -emitter
 - Half-life = 12.3 yr
 - Decays to ^3He & emits β
 - Low energy $\rightarrow$ do not pass through human skin
- EPA $\rightarrow$ 20,000 pCi L^{-1}
- Banana-equivalent dose
 - ^{40}K
 - HTO @ Fukushima $\rightarrow$ 16,756,740 pCi L^{-1}

Mixed Waste
Management Facility
(MWMF)

Old Radioactive
Waste Burial
Ground

HTO
SW
Plume



Fourmile Branch is Tributary to Savannah River

NO ACTION



EVAPOTRANSPIRATION



RECHARGE

IMPOUNDMENT WITH IRRIGATION



RAINFALL

EVAPOTRANSPIRATION
UNDER IRRIGATION



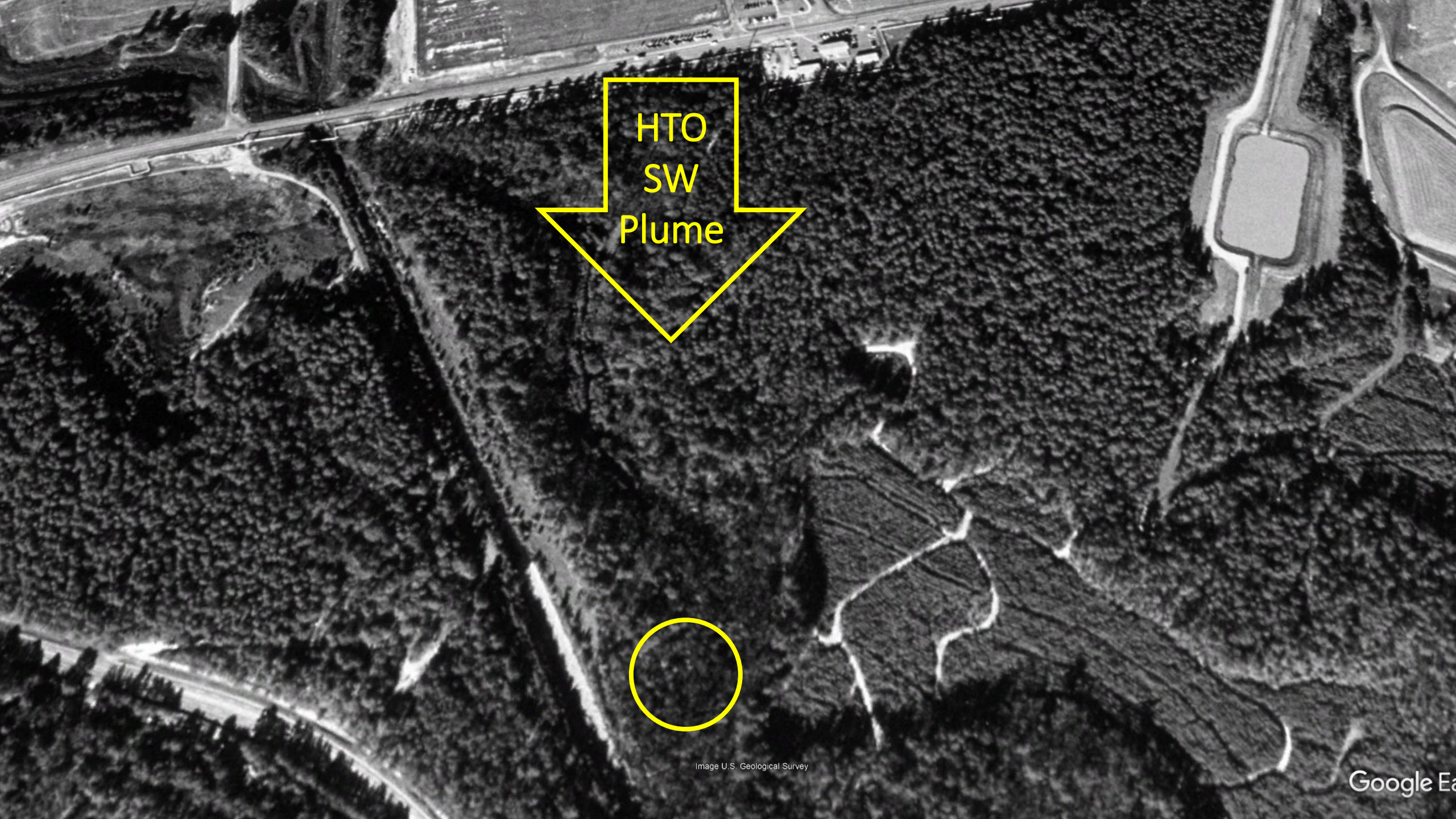
IRRIGATION



RECHARGE

POND EVAPORATION

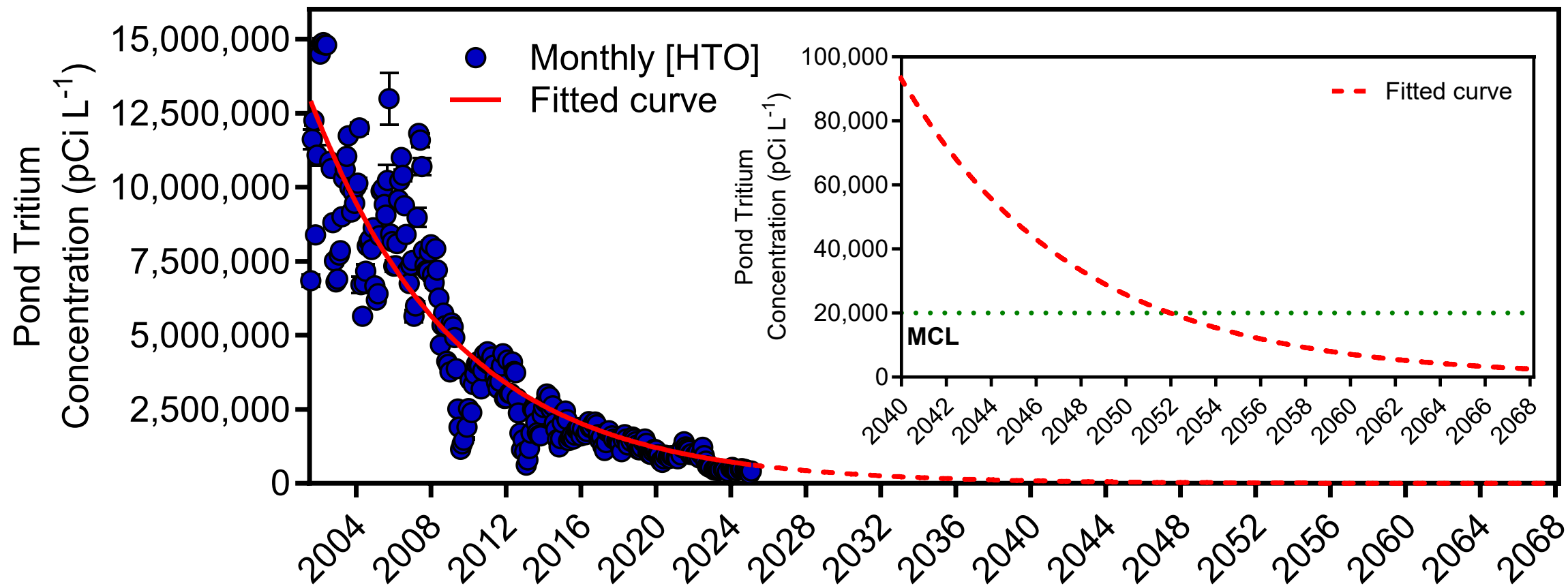




HTO
SW
Plume

An aerial photograph showing a large, dense forest. A yellow, hand-drawn-style outline highlights a specific area in the upper-middle part of the image. The text is written in yellow, matching the outline. The forest is surrounded by roads, parking lots, and some buildings. There are also some small ponds or wetlands visible within the forested area.

Original
(i.e., pre-existing)
Mixed Species
~20 acres



Western
Expansion
2012
Loblolly pine
~11 acres

Original
(i.e., pre-existing)
Mixed Species
~20 acres

Eastern
Expansion
2008
Loblolly pine
~24 acres





Regulatory Monitoring of Phytoremediation System Efficiency

- Tritium mass balance
 - HTO applied + soil [HTO] & moisture
 - Soil samples → Spring & Fall
 - Cryo-Vac extraction
 - [HTO]
 - Calculate Efficiency
 - *Corrective Action Report*



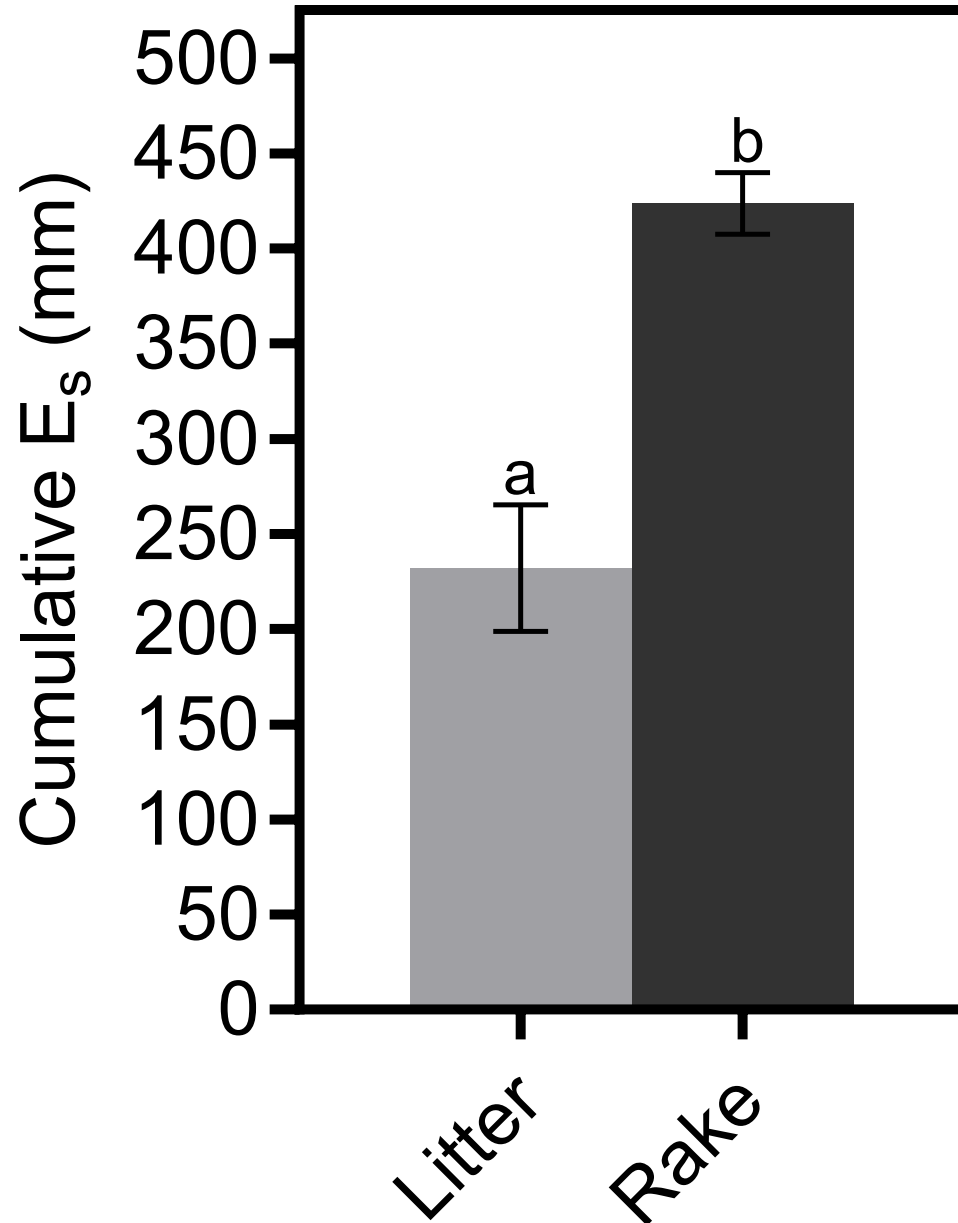
Annual Corrective Action Report for the
F-Area Hazardous Waste Management Facility,
the H-Area Hazardous Waste Management
Facility, and the Mixed Waste Management
Facility (L)

SRNS-RP-2025-00773

Volume I

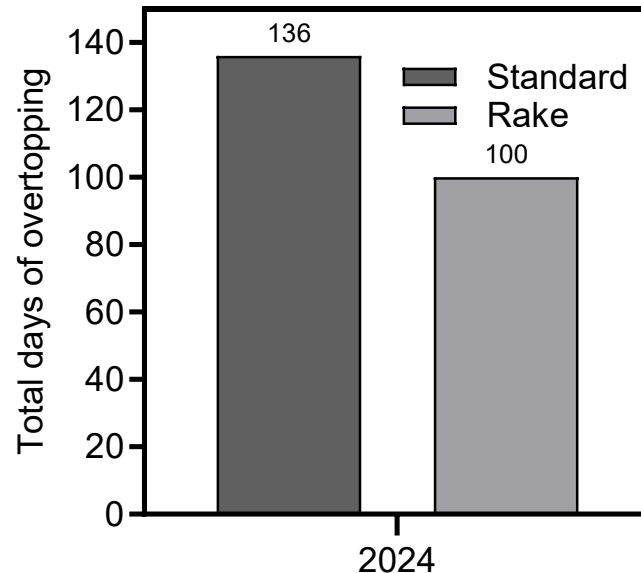
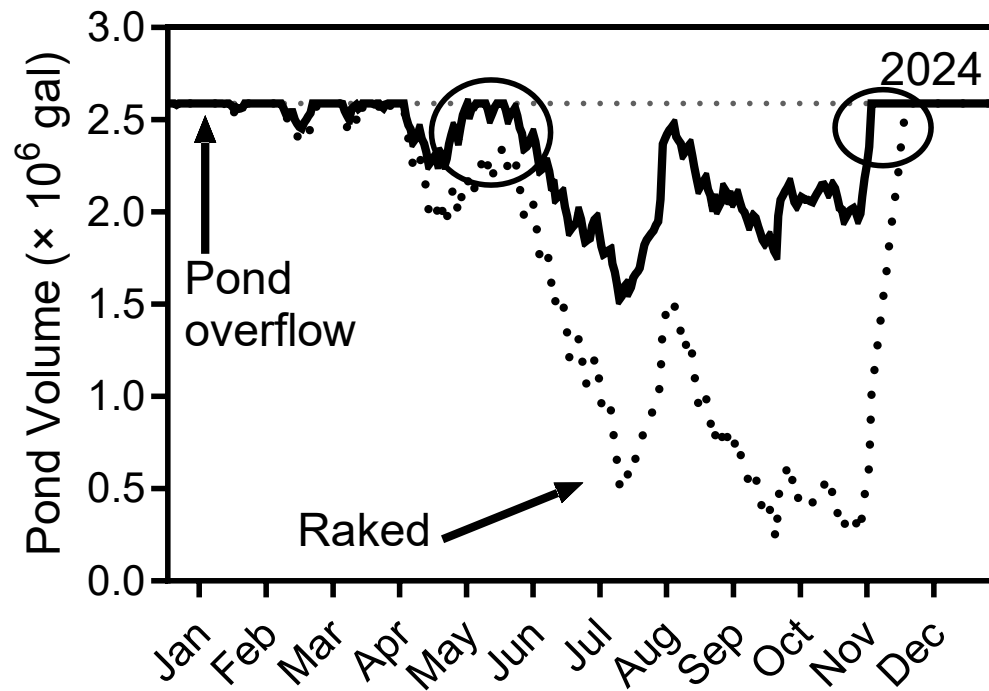
August 2025





Can Raking Increase Capacity?

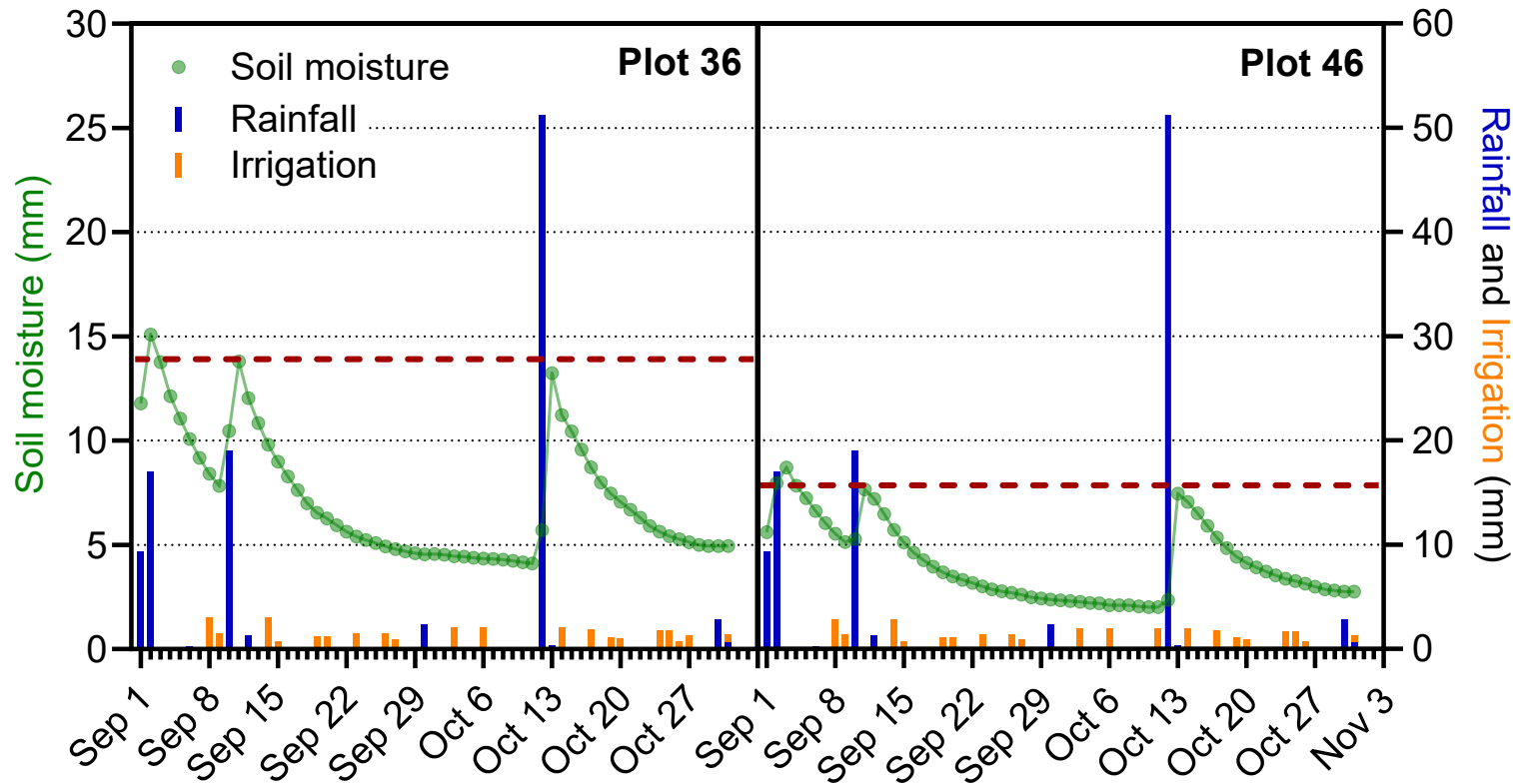
- Intact: 230 mm
- Raked: 425 mm (1.85x)
- Rainfall: 1030 mm
 - 22% vs 41%
- PET: 1395 mm
 - 17% vs 31%
- Transpiration ~ 600 mm



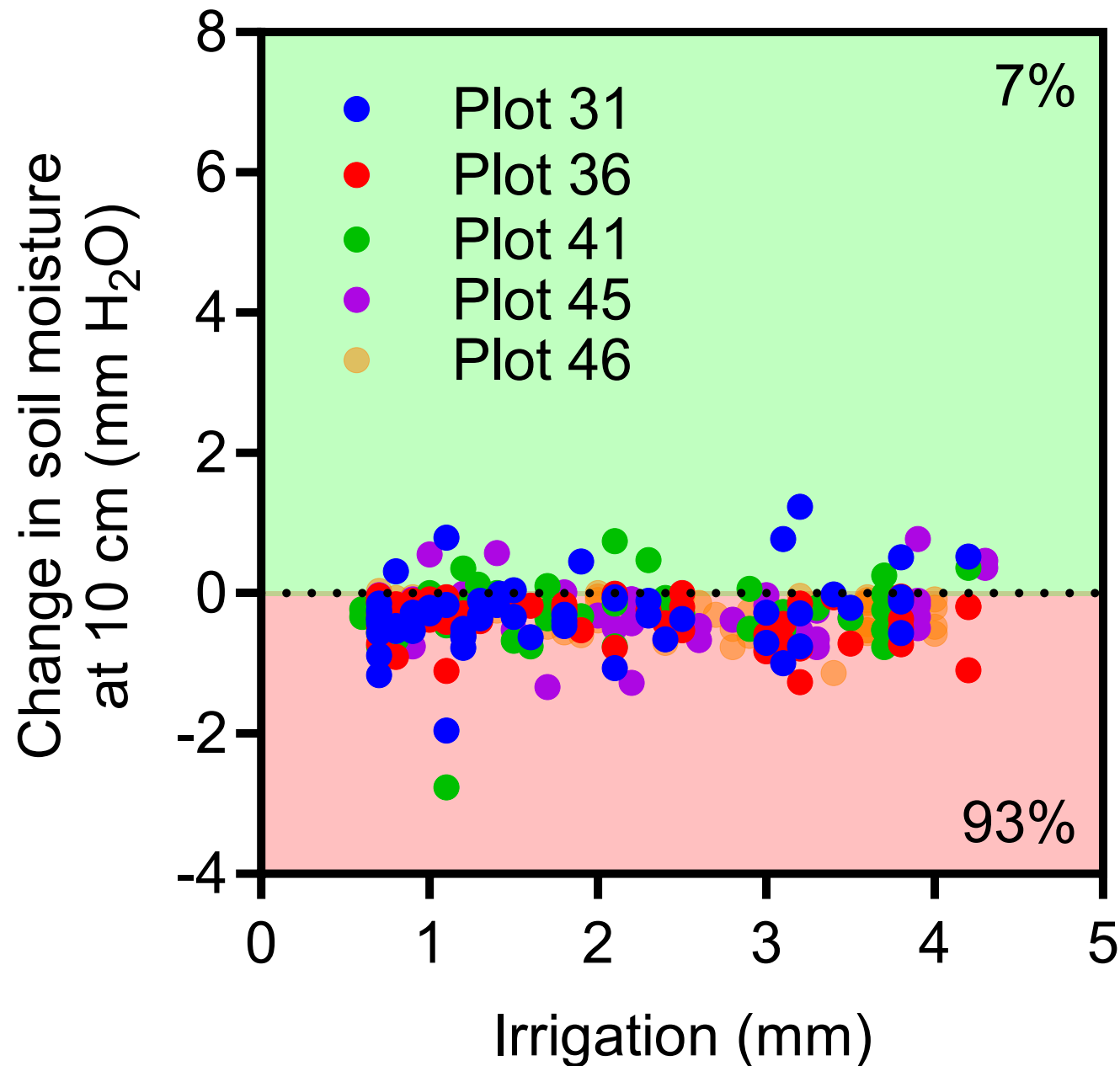
Can raking reduce overtopping & by how much?

- Reduce overtopping by 36 days
 - Additional operational concern/complication
- Retaining litter may be better...

Soil Moisture (10 cm), Rainfall, & Irrigation (2022)

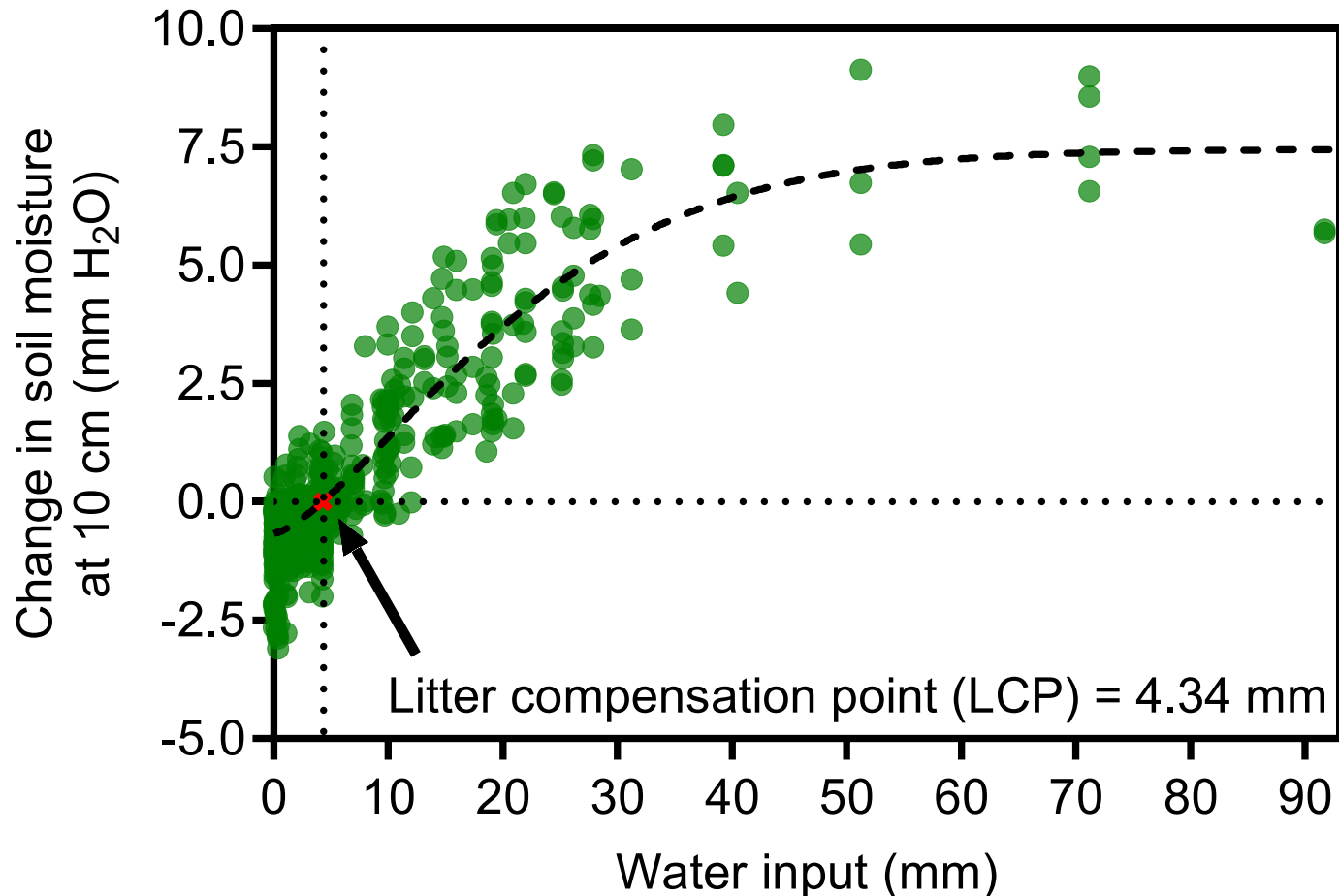


- Horizontal line → Max Water-holding capacity
 - Different soils, same response
 - *Precipitation* → response
 - *Irrigation* → no response
- Is our irrigation water not entering soil & available for uptake?



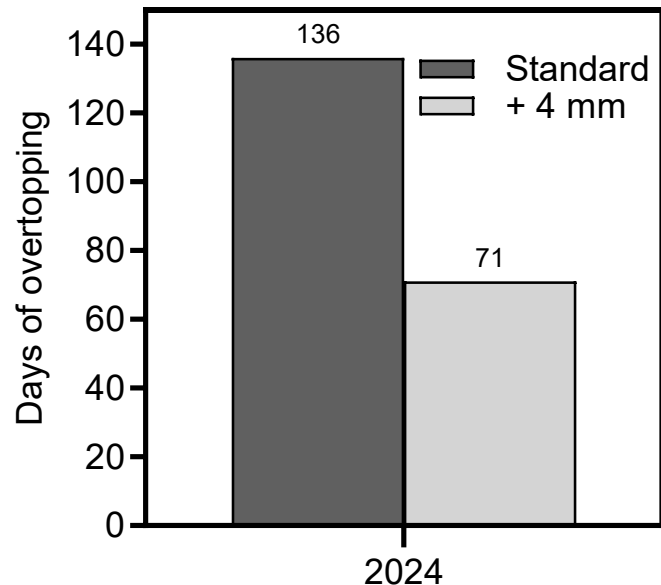
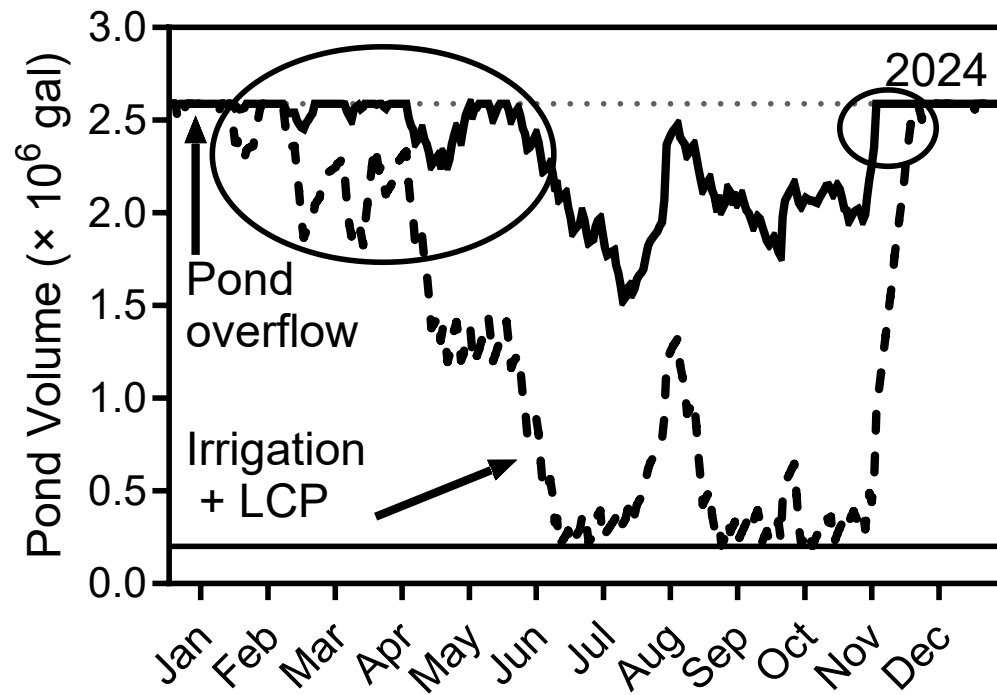
Change in Soil Moisture from Irrigation

- 313 irrigation events where we could isolate irrigation effect
 - 93% no change or decreased
 - Only 7% increased & moisture was already high
- Irrigation water not entering soil & not available for uptake!



Litter intercepts precipitation
& irrigation → acts as a
sponge or hydrologic bucket

- All precipitation (2022)
 - 4.34 mm of P required to overcome litter (LCP)
 - Variation around LCP due to litter moisture status prior to P
- Maximum irrigation ~4-5 mm --? How can this impact MWMF operations?



Can raking reduce overtopping & by how much?

- Reduce overtopping by 65 days
 - Raking reduced by 36 days
 - No additional operational concern/complication
- New model for operations

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