On-farm implementation of on-farm Managed Aquifer Recharge

Groundwater Protection Council
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Delta Water Management Research Unit

Contributions from:

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Delta Water Management Research Unit

- Worksite 2011
- Established 2014
- Scientists
  - Dr. Arlene Adviento-Borbe
  - Dr. Joseph H Massey
- Collaboration
- Water resources
  - Quantity
  - Quality
  - Greenhouse gas emissions

Preserving water quantity and quality for agriculture in the Lowe

Delta Water Management Focus Areas

Water Quality

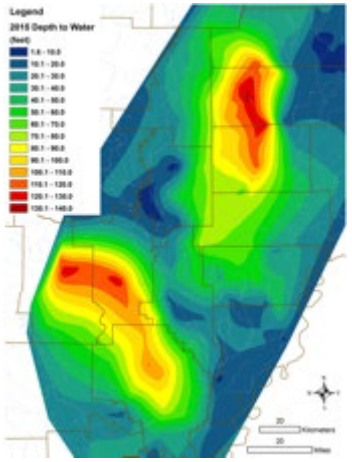
Why?
- Agronomic cost
- Contribute to hypoxic zone

What?
- 9 Edge-of-field
- 10 in-stream
- Excess nutrients & sediment
- National networks

Water Quantity

Why?
- Decline in MRVA
- Cost of pumping from deeper

What?
- Irrigation (Massey)
- Automation (Massey)
- Managed Aquifer Recharge
- Surface Water

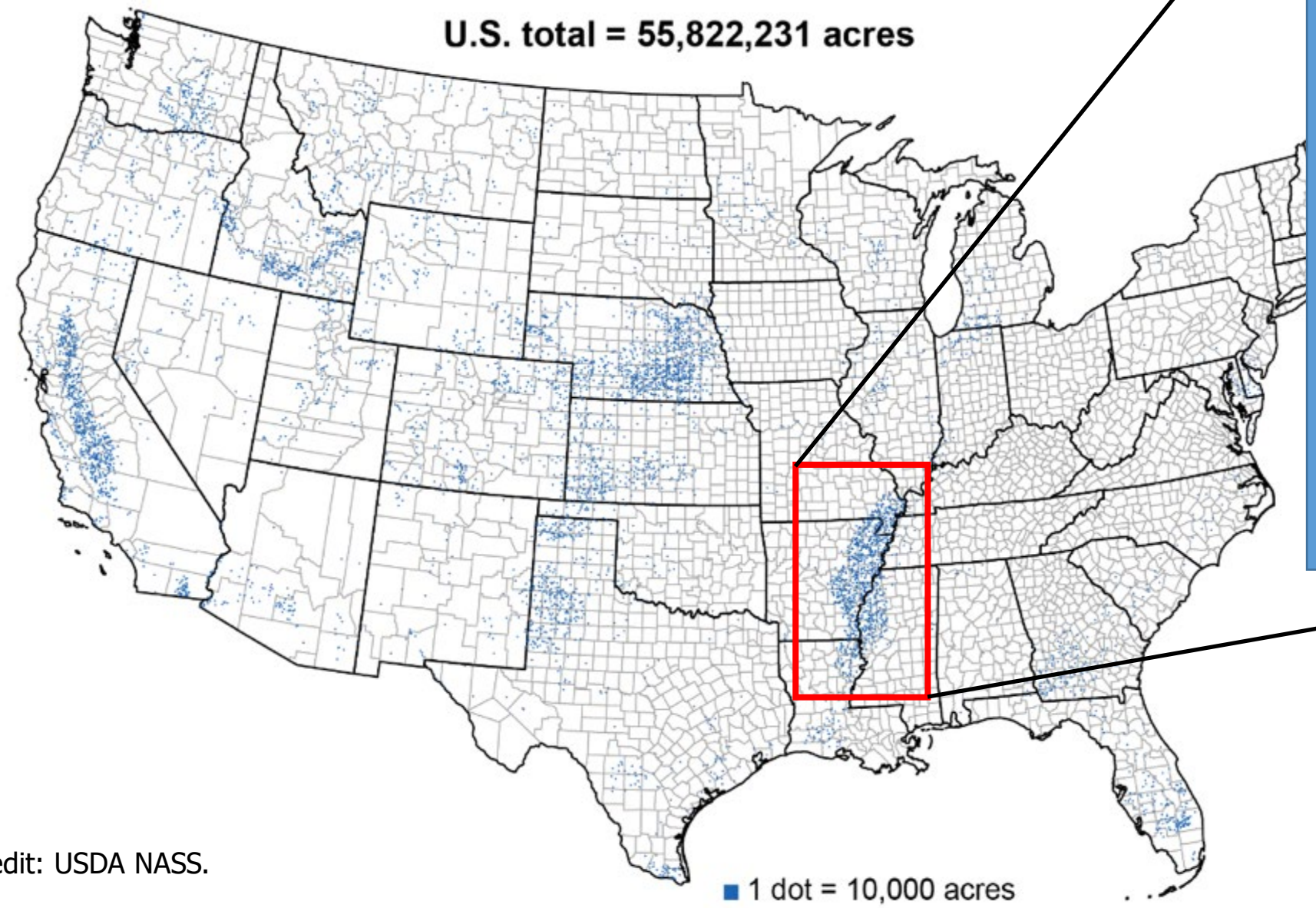


GHG Emissions

Why?
- Mitigation potential
- Environmental markets

What?
- CO_2, CH_4, N_2O
- 8 Eddy covariance towers
- Static vented chamber (AAB)
  - Gold standard

Acres of Irrigated Land in 2012



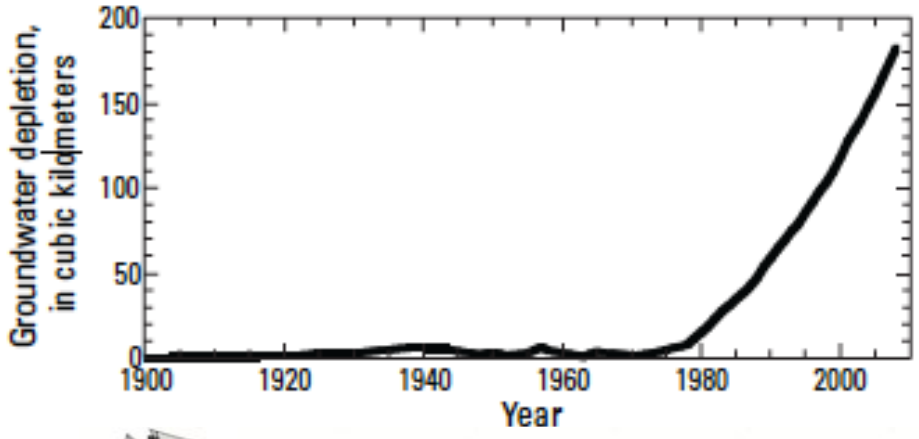
Map credit: USDA NASS.

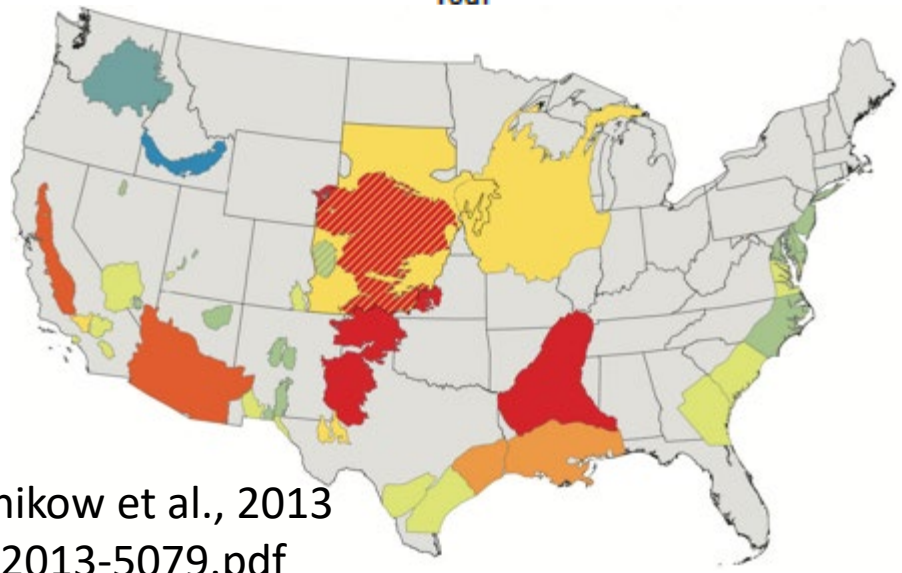
Mississippi River Valley Alluvial Aquifer

Lower Mississippi River Basin (LMRB)

- Over 8 million acres irrigated cropland
- ~60% AR

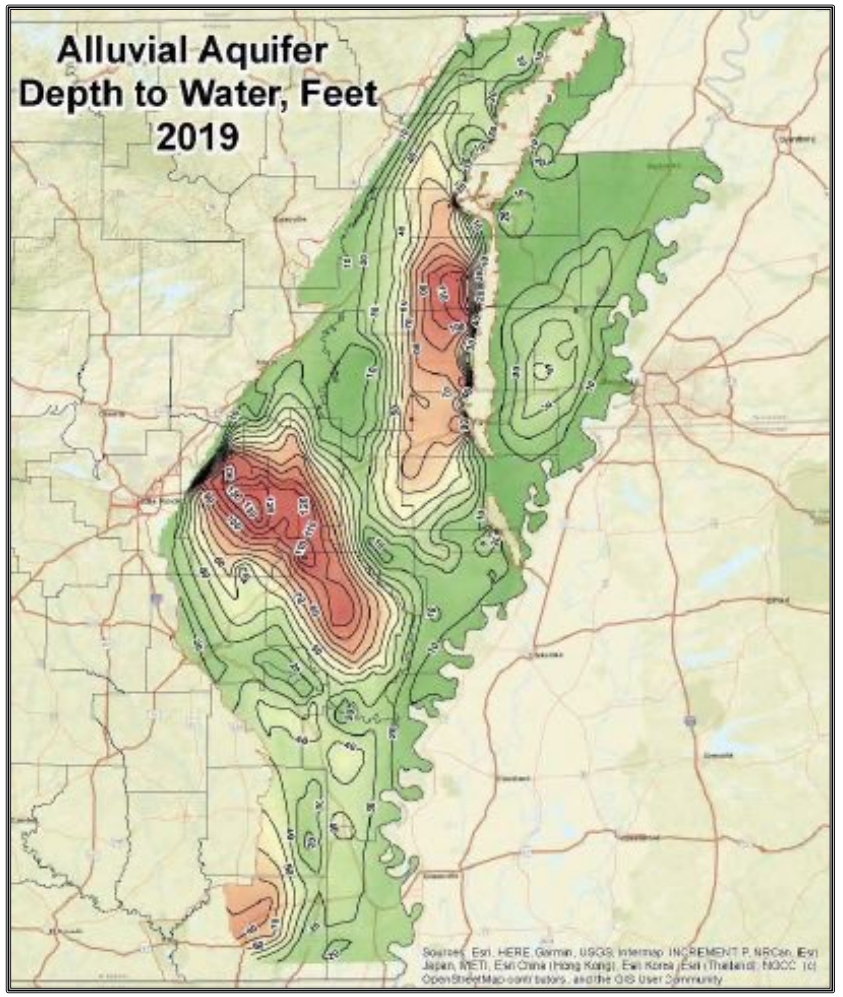
Groundwater decline





Konikow et al., 2013
SIR2013-5079.pdf

- 1930s
- 1980s
- Arkansas
  - Grand Prairie
  - Cache River



(AR Dept of Ag – Natural Resources Division, 2019)

Managed Aquifer Recharge

Managed Aquifer Recharge (MAR) is the efficient storage and recovery of water in aquifers

- Increase the amount of water returning to an aquifer
- Water scarcity driven
- Water quality constrained
- Ongoing USDA-ARS MAR research

Maricopa, AZ

Image source: Clinton Williams

Davis, CA

Image source: Scott Bradford

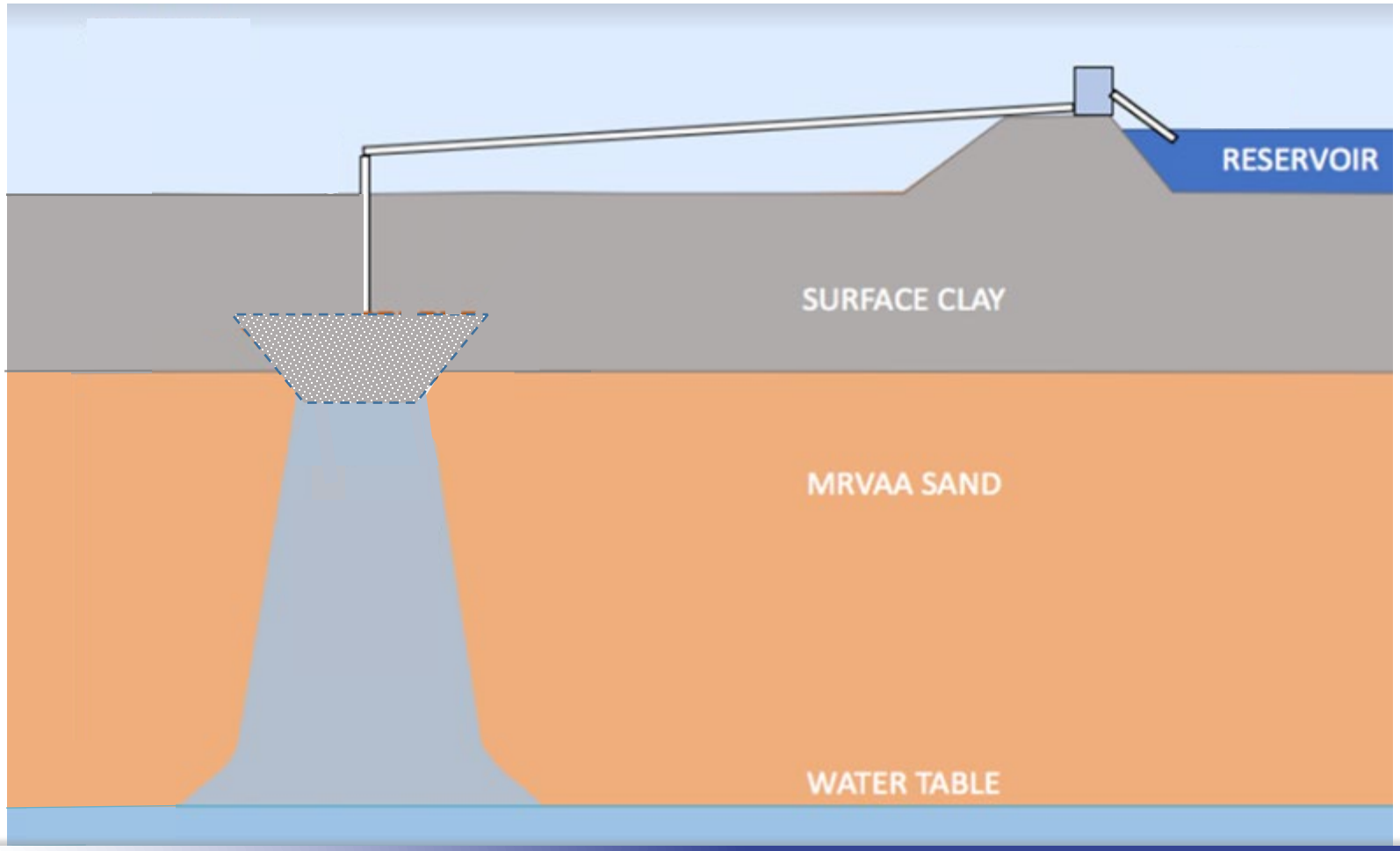
Methods of MAR in Arkansas

- Direct injection
  - USGS 1960s: air entrainment, clogging, chemistry
  - Drinking water standard
- Infiltration basins
  - Space
  - Leslie et al., 2022*
- Direct Injection
  - Water quality
- **Infiltration galleries**

*Leslie, D.L., **M.L. Reba**, and J.B. Czarnecki. Managed aquifer recharge using a borrow pit in connection with the Mississippi River Valley alluvial aquifer in northeastern Arkansas. *Journal of Soil and Water Conservation*. Accepted June 2022.

MAR Technique: Infiltration Galleries

- **Infiltration Galleries -** Trenches excavated to a permeable material, filled with gravel that recharge groundwater through internal plumbing connected to a water source



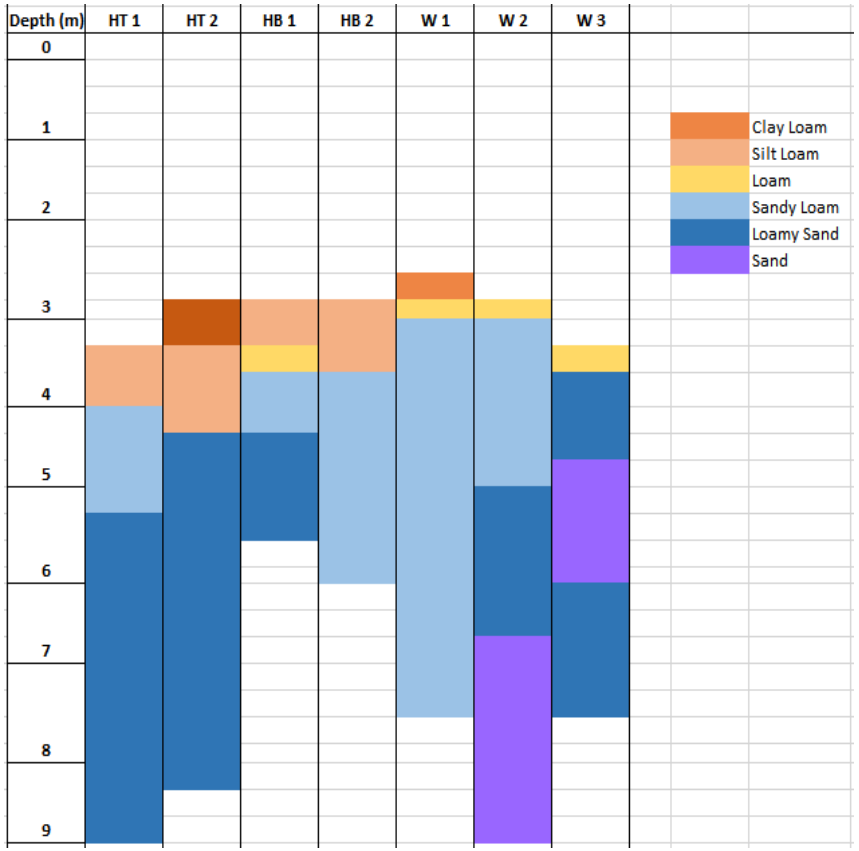
Soil Aquifer Treatment (SAT)

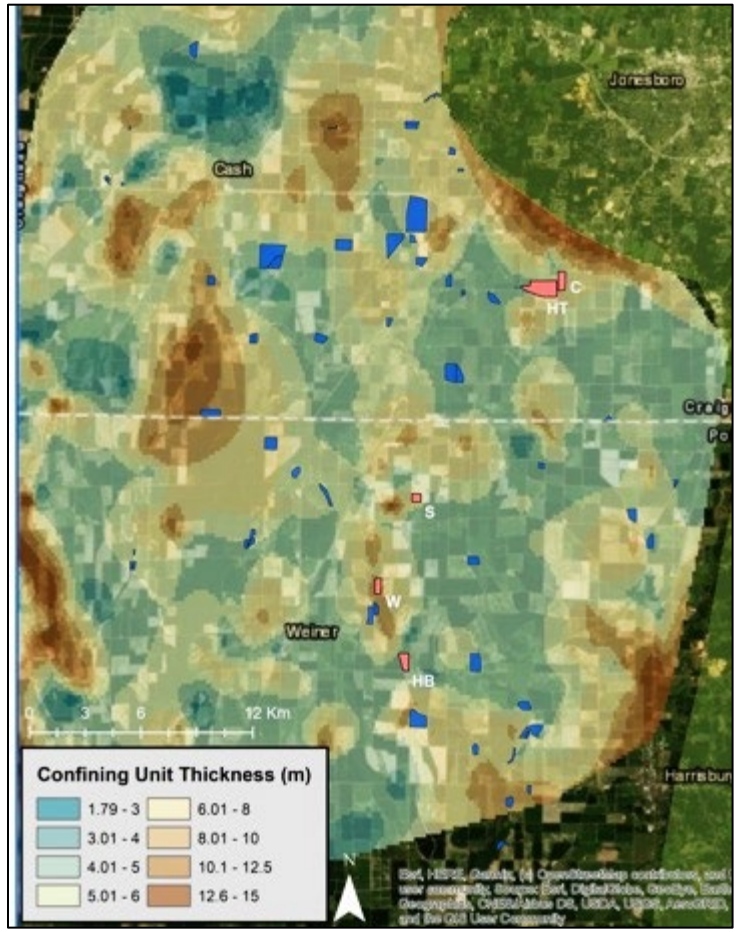
- Vadose zone physically filters recharge water

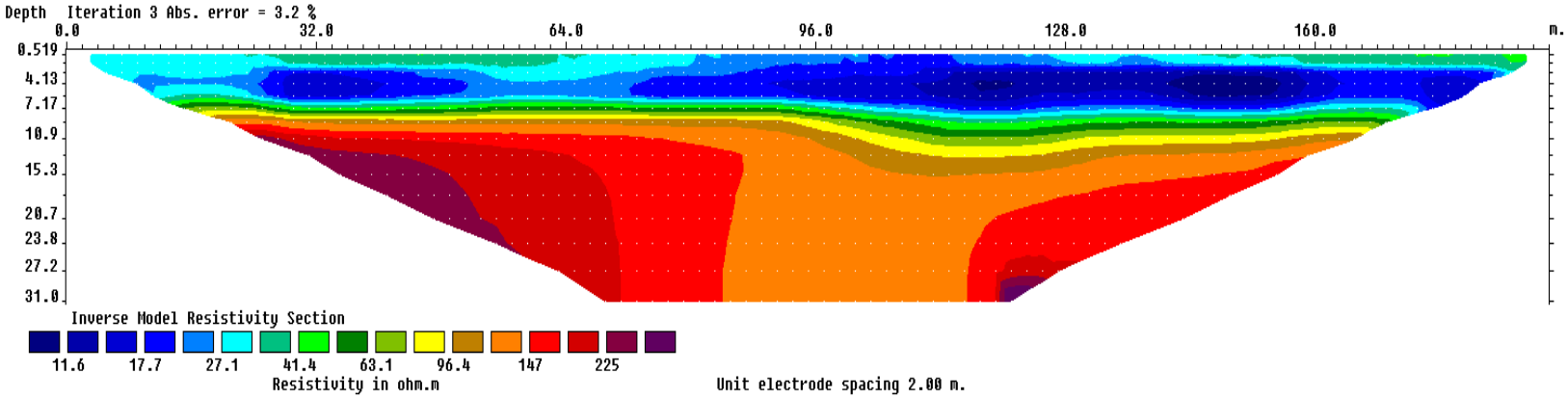
Site evaluation

- Confining unit thickness mapping
- Geophysical surveying
- Sampling surveying

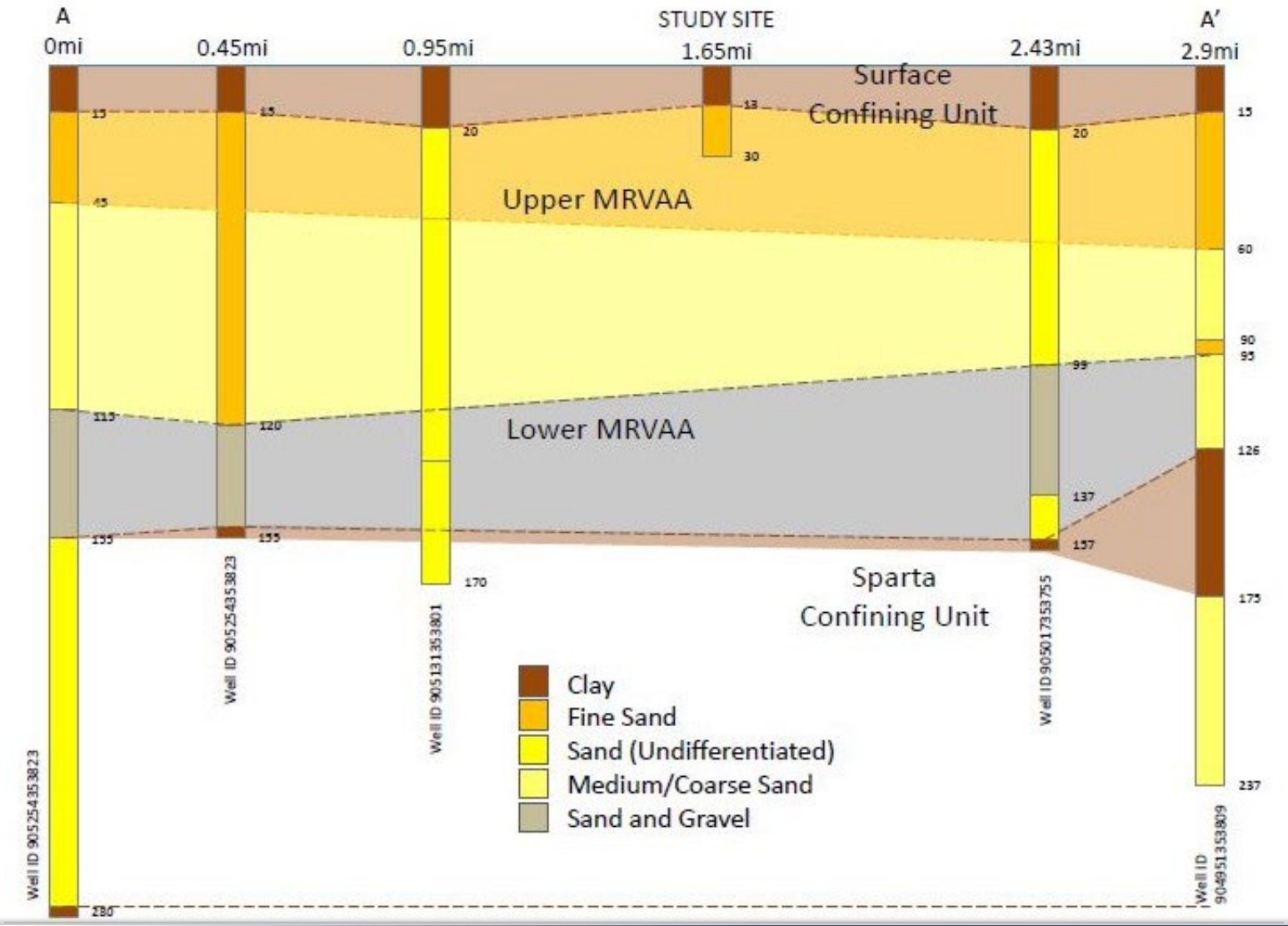
Godwin, I., M.L. Reba, D. Leslie, R. Adams, and J. Rigby. Feasibility of Infiltration Galleries for Managed Aquifer Recharge in the Mississippi River Valley Alluvial Aquifer of Northeast Arkansas. *Agricultural Water Management.* Vol. 264, 107531. https://doi.org/10.1016/j.agwat.2022.107531. 2022.







Hydrogeology



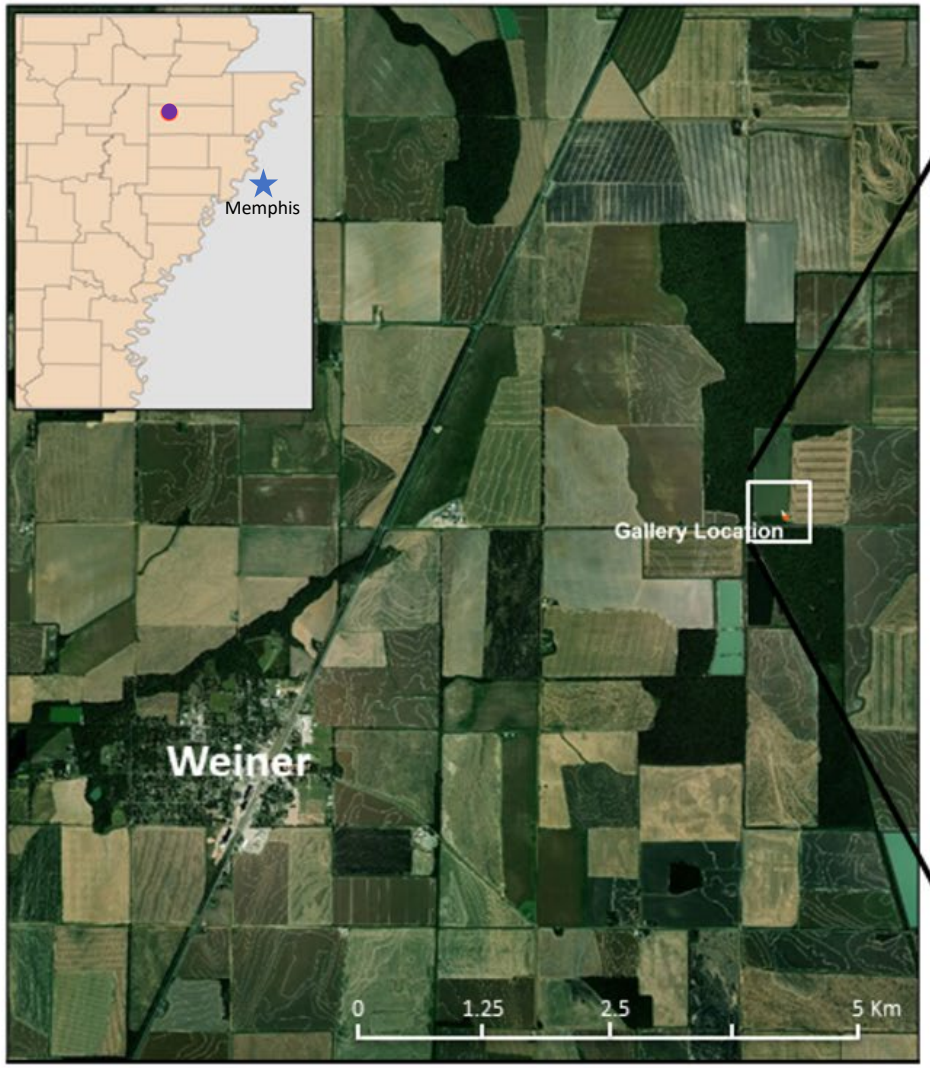
- Surface confining clay unit
  - Rice growing
  - Limits natural recharge
- Upper unit: fine clay, silt, and sand
- Lower unit: coarse sands and gravels

Permission-ADEQ

- Producer interest
- Landowner permission
  - Lease agreement
- Documentation
  - ADEQ UIC Inventory Requirement for “Authorized by Rule” Class V Wells
- Reporting

- Permit included
  - Project Description
  - Monitoring planned
  - Maps of site
  - Adjacent land owners
    - Letter of support
  - Water quality data
  - Nearby wells
  - Geologic cross sections
  - Groundwater elevations

Study Area



(Sharp, 2022)

Located northeast of Weiner, AR

Construction:
- October 2020
- April 2021

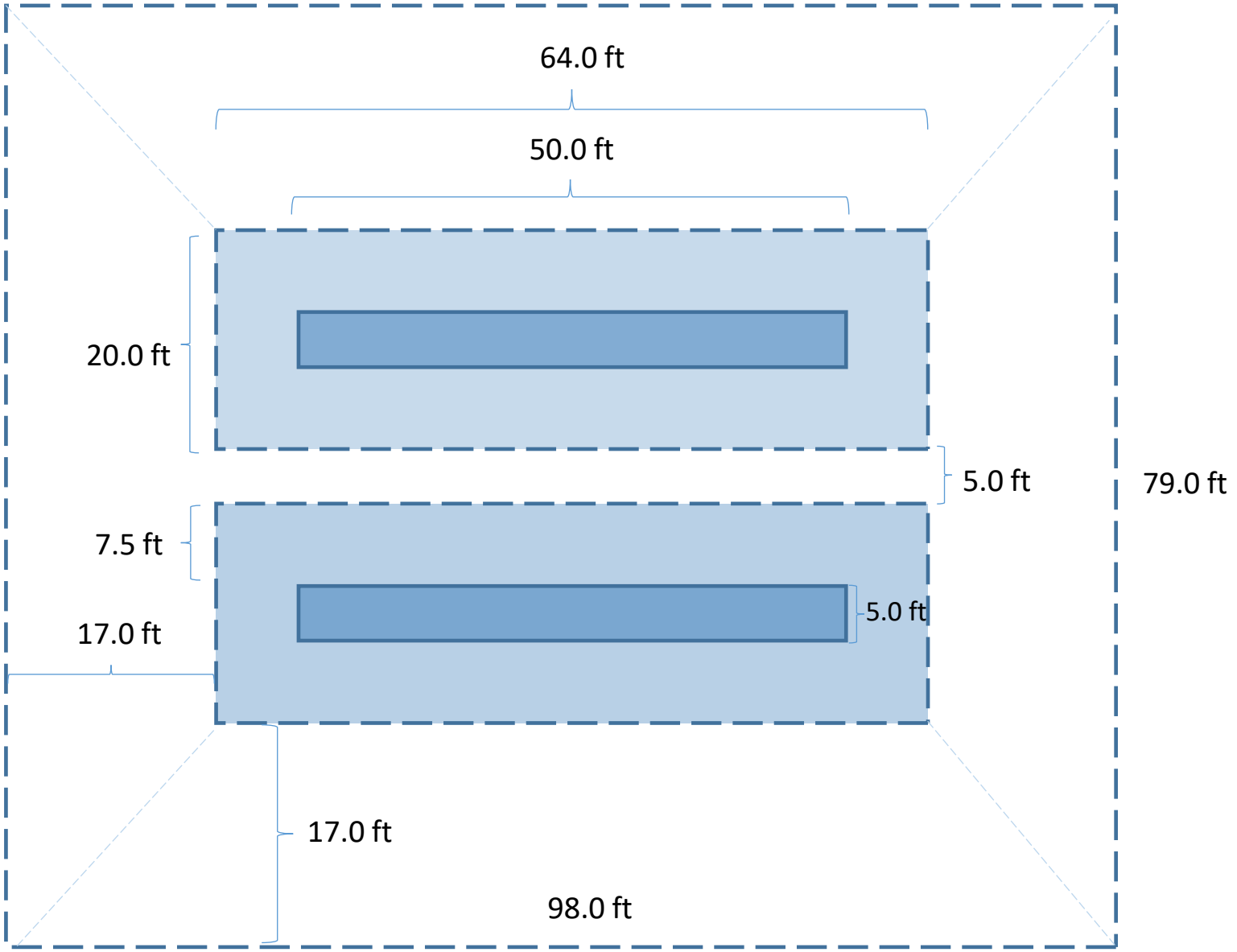
Distribution System:
- October 2021
- February 2022

Infiltration:
- February 10, 2022

Estimated excavation volume from gallery-end slopes: 21200 ft3

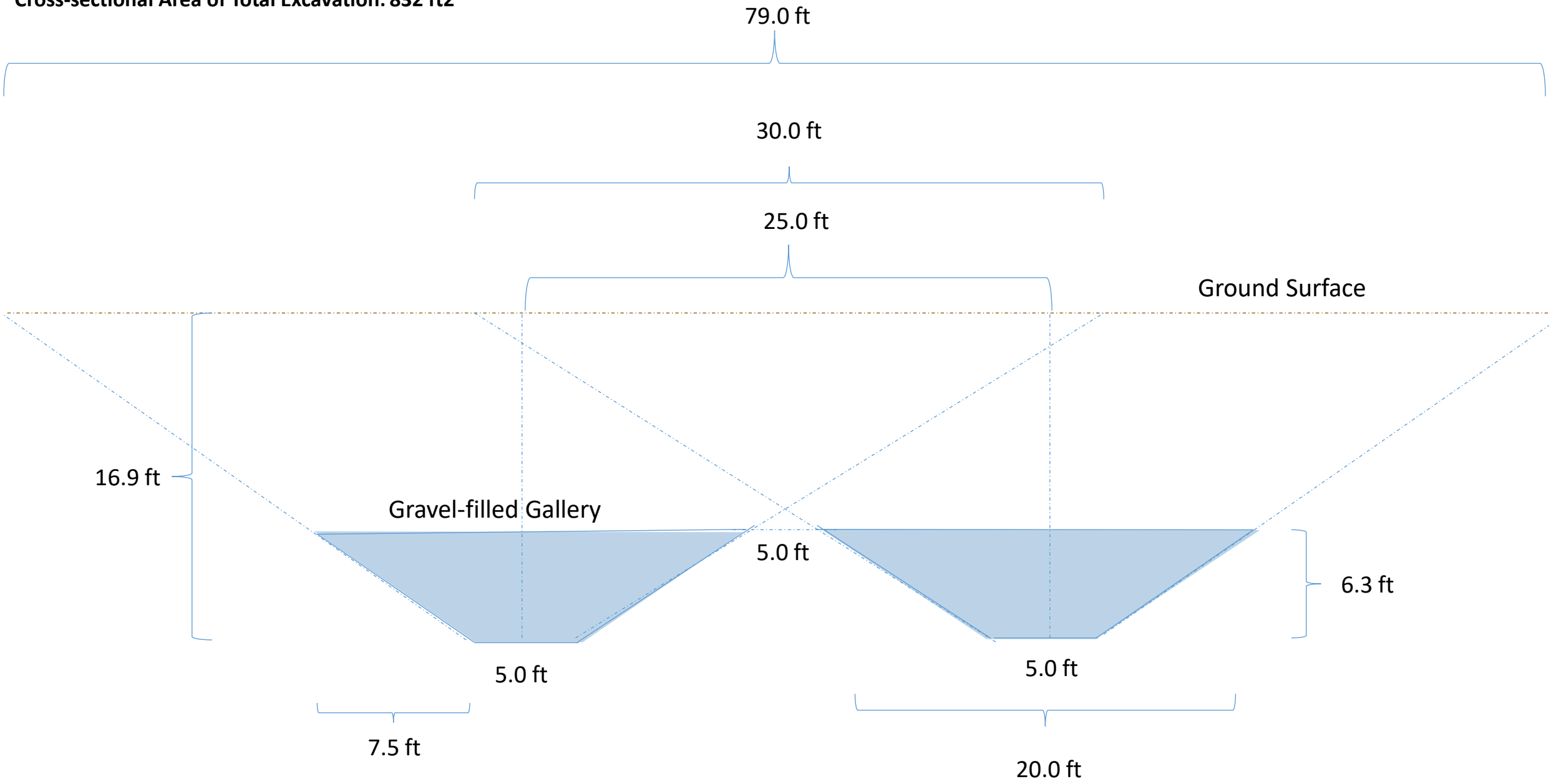
Estimated Total Volume Excavated: 63570 ft3 (2350 cy)

PLAN VIEW



Cross-sectional Area of Each Gallery Excavation: 479 ft2
Cross-sectional Area of Both Galleries w/no Overlap: 958 ft2
Cross-sectional Area of Overlap Region: 126ft2
Cross-sectional Area of Total Excavation: 832 ft2

SIDE VIEW

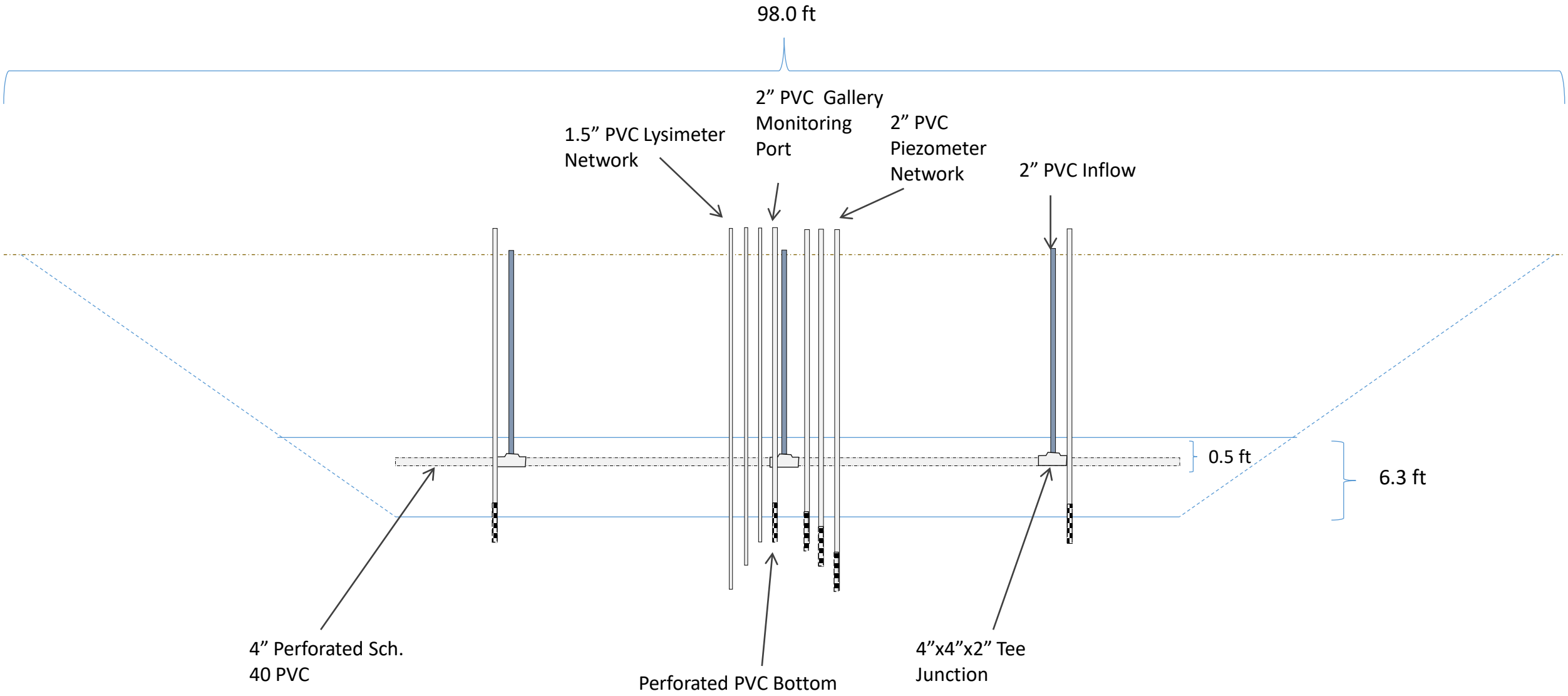







Estimated excavation volume by dirt-pan: 975m3 (1275 cy)
Estimated Volume by Excavator: 825m3 (1080 cy)

SIDE VIEW



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80 m
Google Earth


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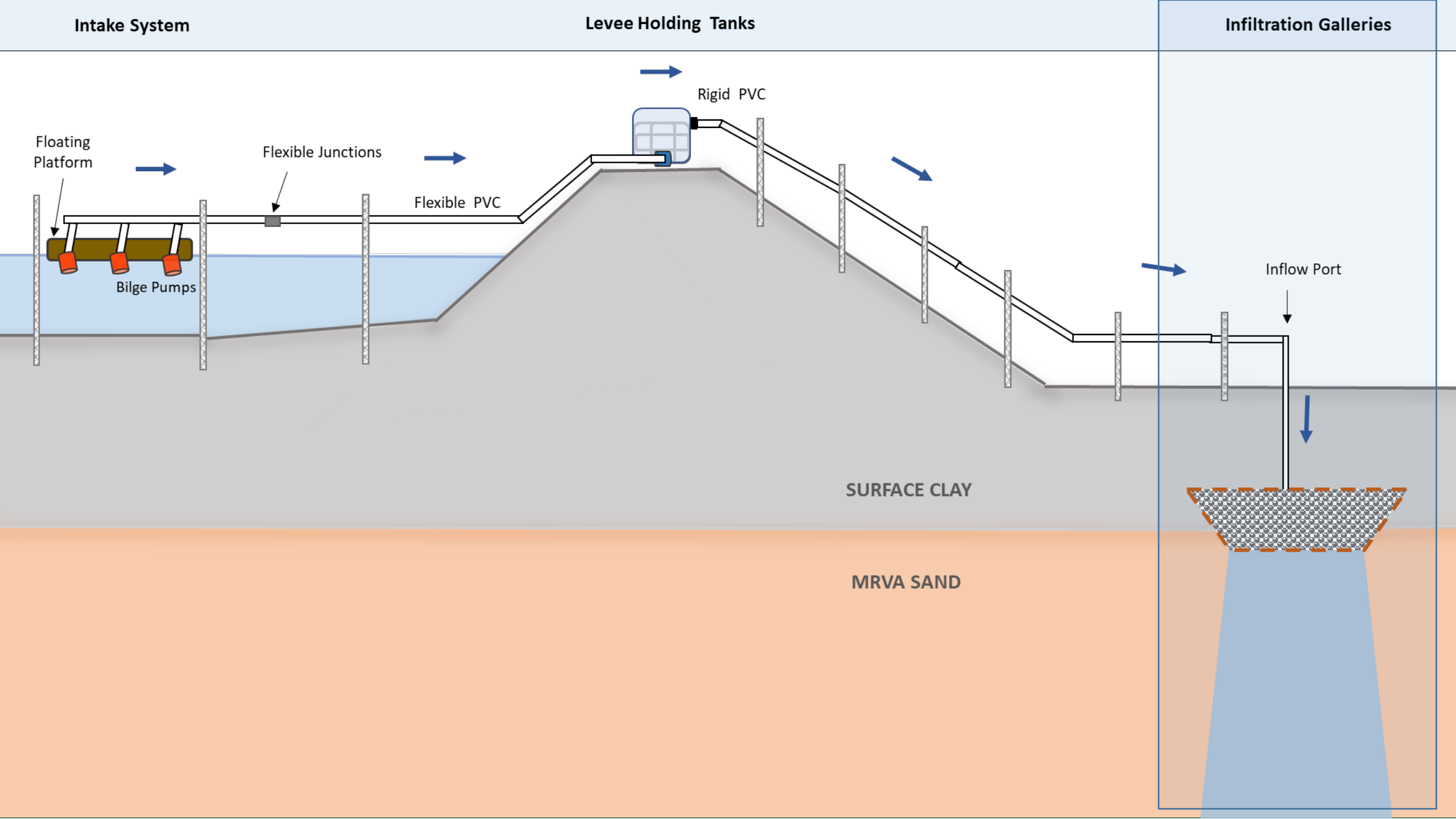
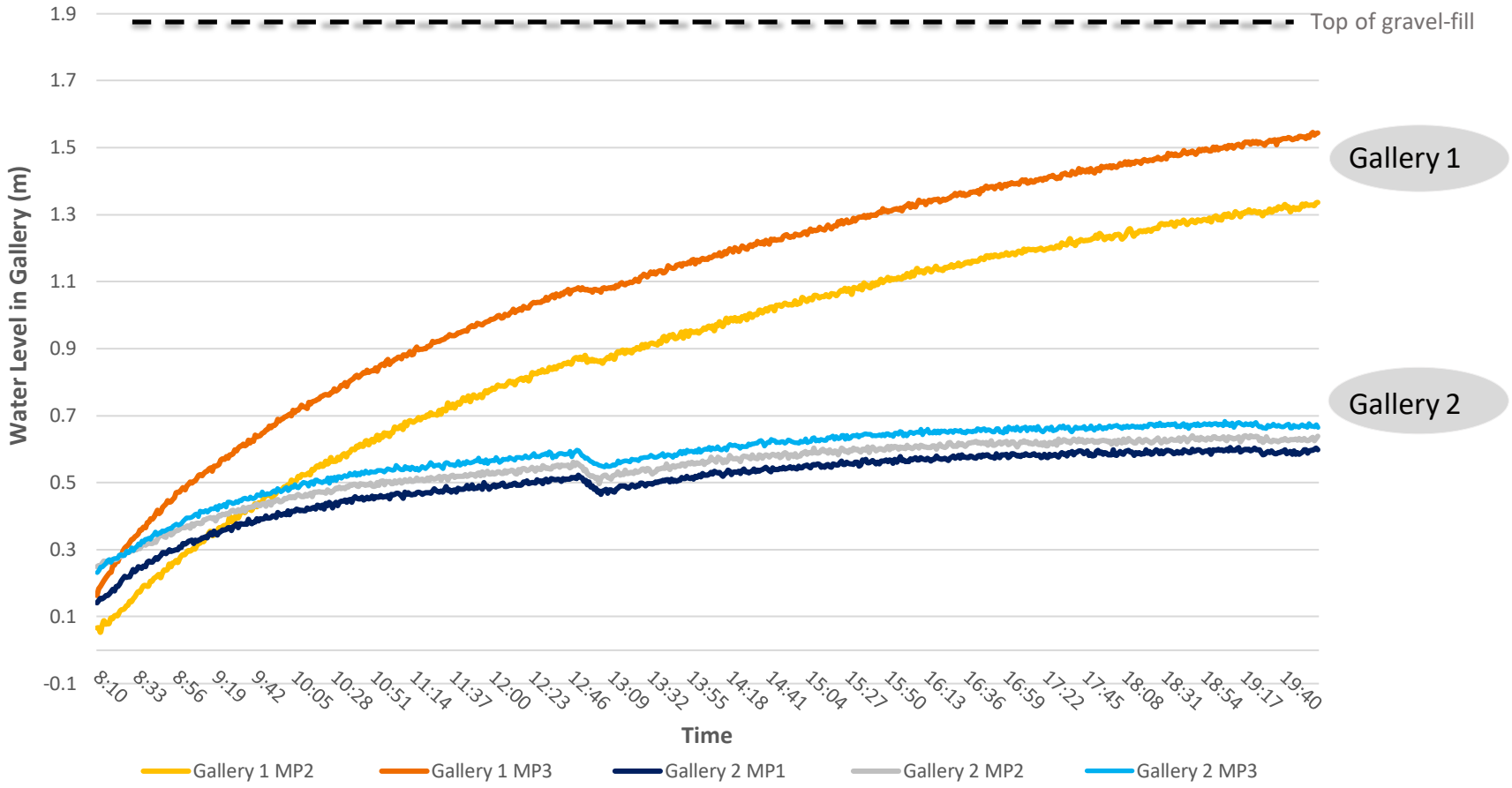
Google Earth
60 m

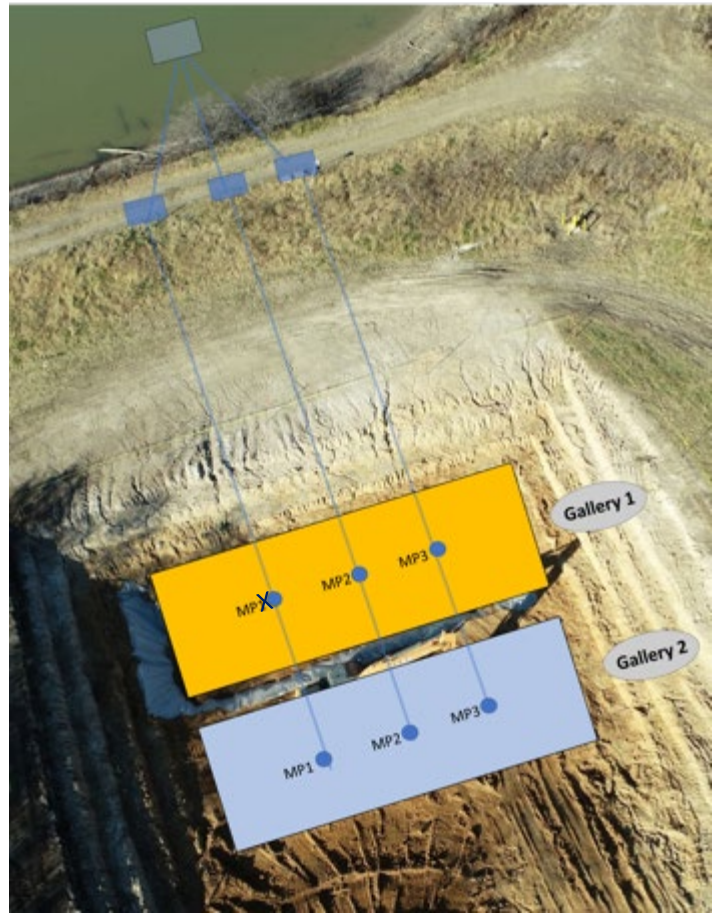

Intake System
Levee Holding Tanks
Infiltration Galleries
Rigid PVC
Floating Platform
Flexible Junctions
Flexible PVC
Bilge Pumps
Inflow Port
SURFACE CLAY
MRVA SAND

Monitoring

- Gallery infiltration rates
  - Flow rates
  - Gallery monitoring port water levels
- Electrical resistivity tomography (ERT) surveys
  - An electrical current is introduced into the ground through two electrodes, and electrical resistivity at the surface is measured
- Water levels of on-site groundwater monitoring wells
- Water quality of reservoir water, lysimeters and on-site groundwater monitoring wells

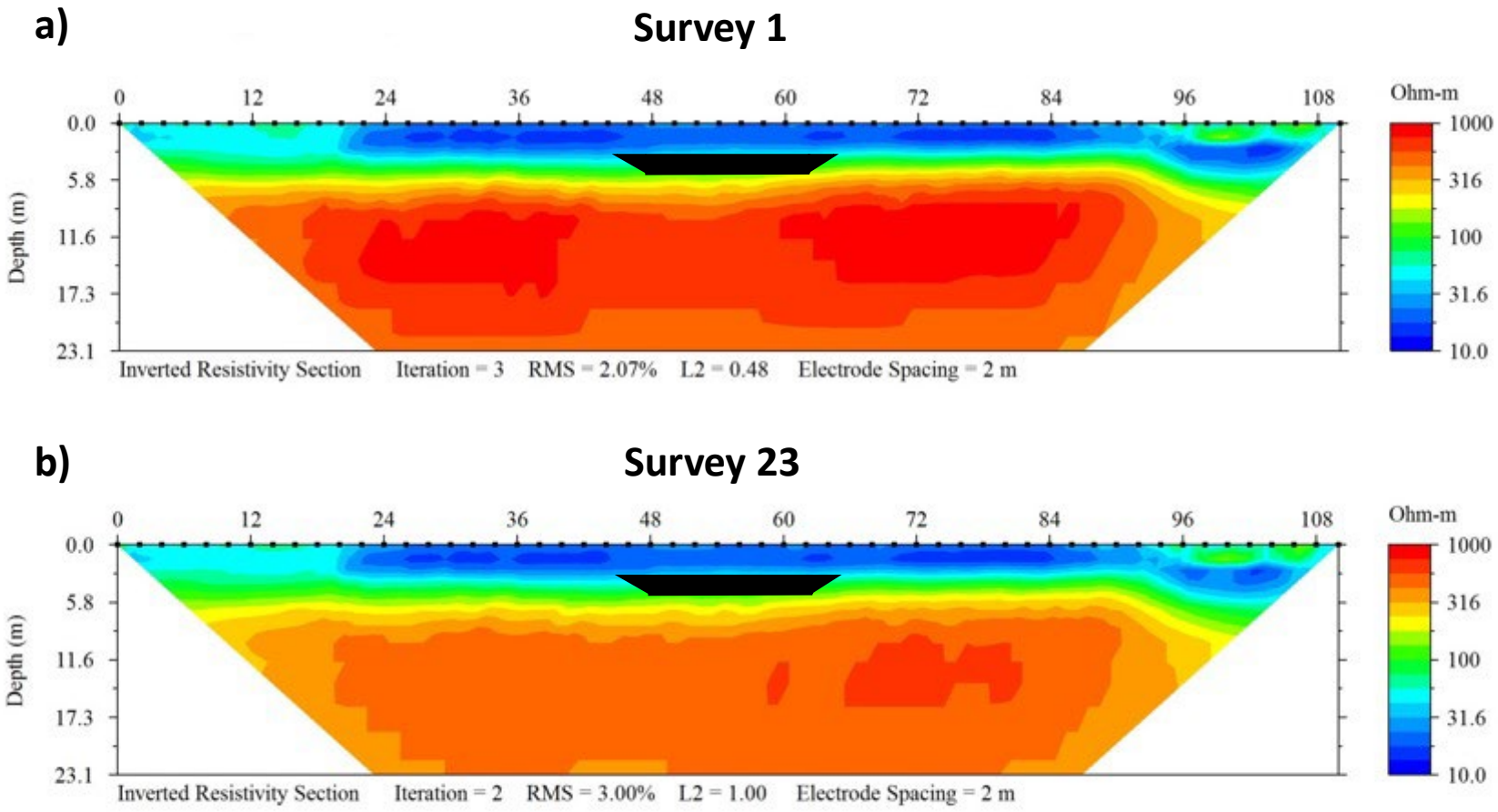
Infiltration rates





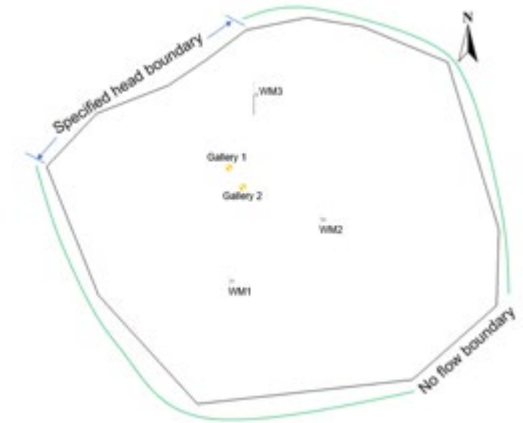
Electrical resistivity surveys

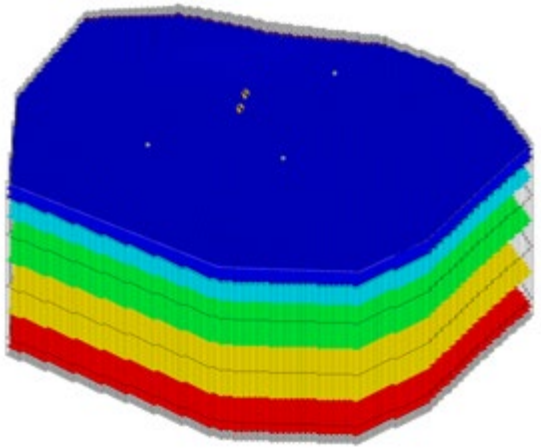
- Black trapezoids represent the gravel fill of the infiltration galleries(drawn to scale)
- Survey 1-Pre-injection
- Survey 23-after injecting approximately 59,347 L (15,768 gal) of reservoir water during hour 17 of the first injection event
- Resistivity in the unsaturated zone was reduced by an order of magnitude as lower resistivity reservoir water was injected



Conclusions & Future Plans

- Managed aquifer recharge may be part of the solution to aquifer decline in the MRVAA
- Made strides to determine the utility of these systems but continue to test
- Simplify design
  - Dry wells
- Winter 2022-2023
  - 6 months of injection
  - Pulses of maximum flow
  - Water quality monitoring
- Modeling





Special Thanks To:

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- **Arkansas State University:** Dr. John Nowlin
- **P&P Consulting:** Richard Pickett
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Thank you

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