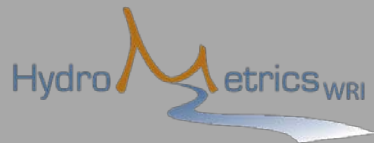


Recharge Capacity Assessment

Tulare Irrigation District

HydroMetrics Water Resources Inc.
Montgomery & Associates



Tulare Irrigation District

- Established in 1889
- Renewable water supplies

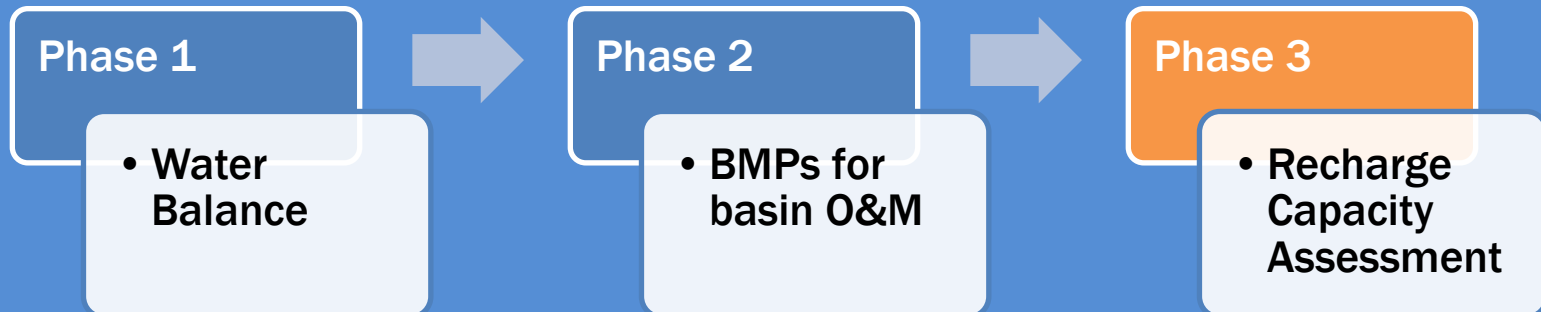
SOURCE	AVG AMOUNT (ACRE-FT/Y)
Central Valley Project Water (Friant)	~70,000
Kaweah River / Local Water	~90,000
Treated Wastewater (pending)	~11,000



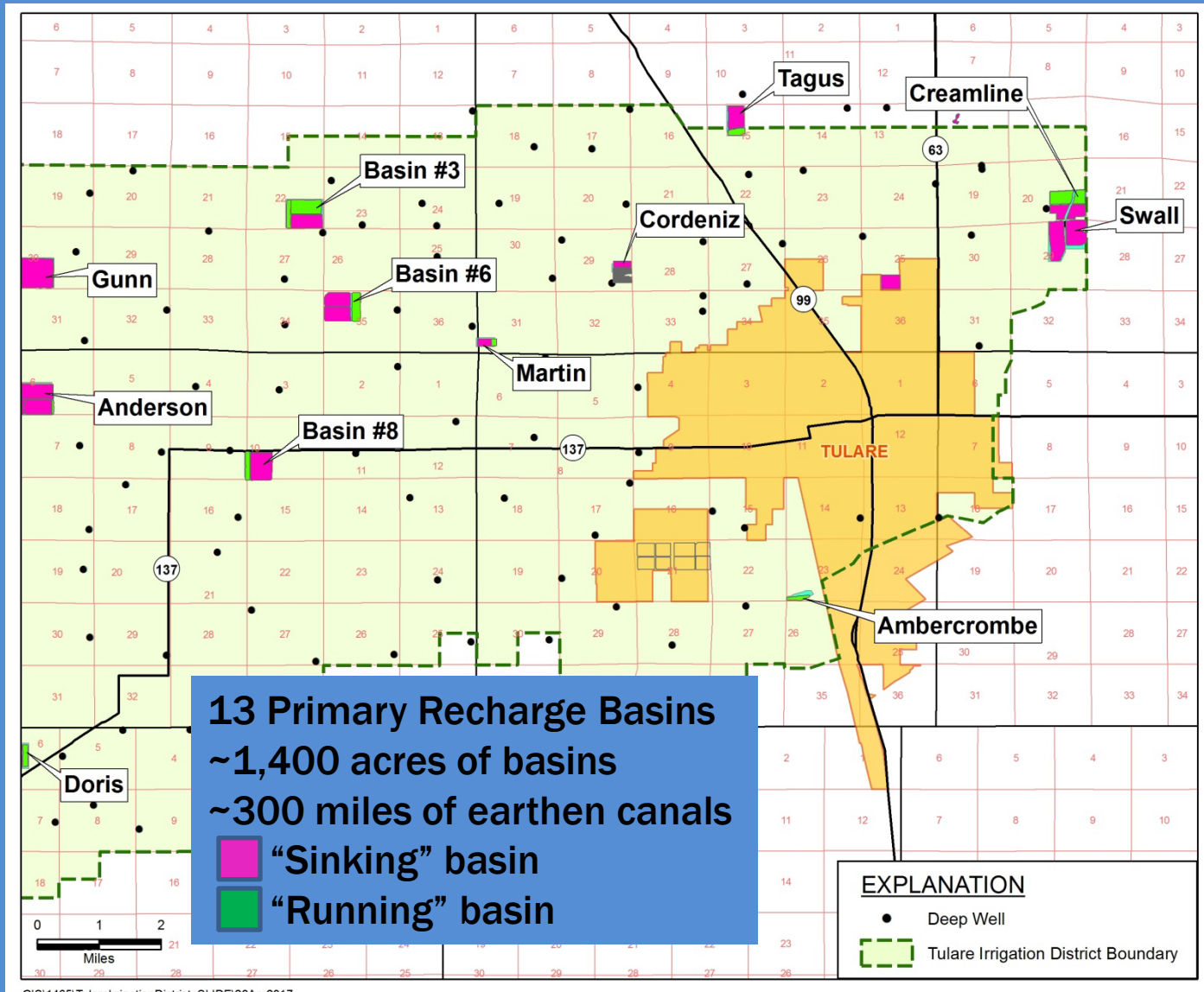
- Conjunctive use district
- Proactive recharge program
- ~230 irrigation customers

Planning for Sustainability

- High-priority groundwater basin
- Mid-Kaweah GSA with City of Visalia and City of Tulare
- TID has been recharging for many decades
- Recharge study (USBR Grant)



Map of Recharge Basins



Critical Questions

What is current District recharge capacity?

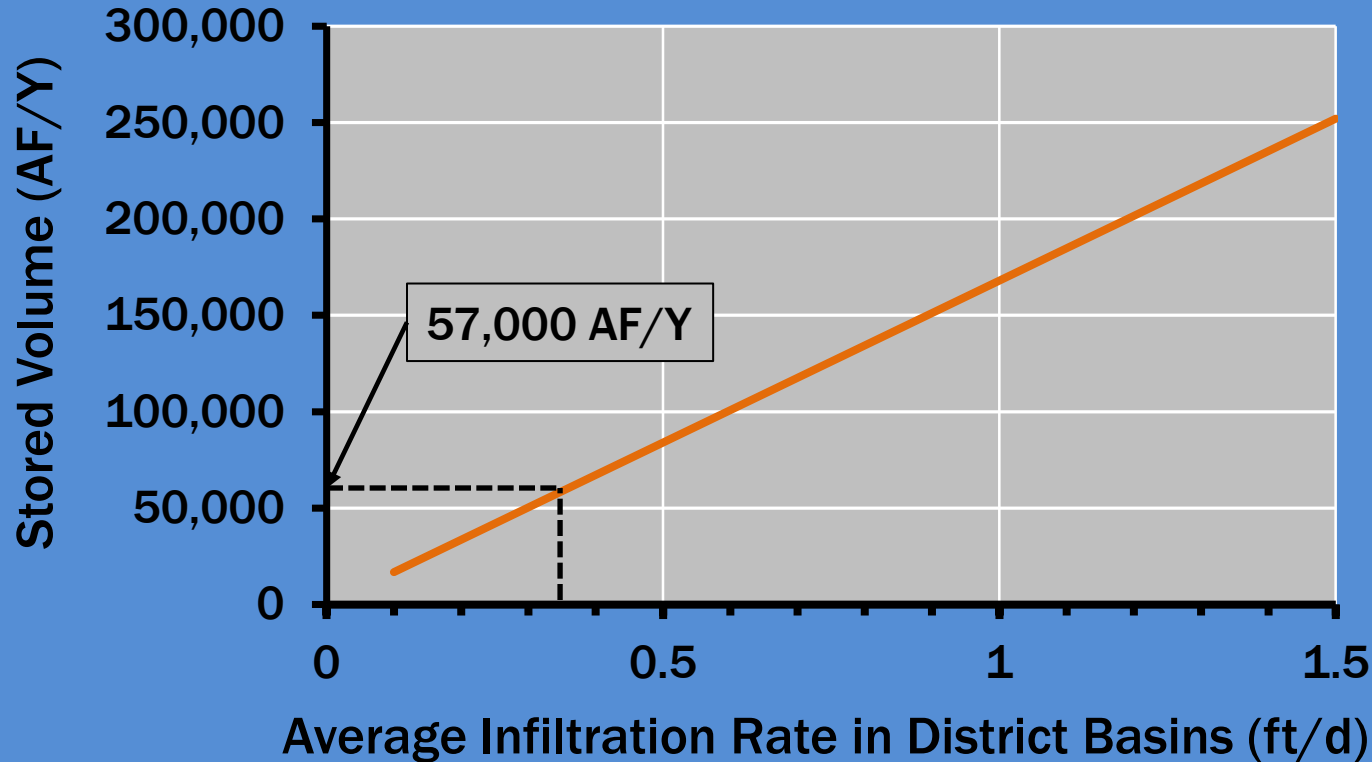
How much additional capacity is needed to meet replenishment goals?

Can existing recharge capacity be feasibly increased to meet replenishment goals?

Water Budget

- Net annual average groundwater storage deficit
 - Regional: ~36,000 AF/Y
 - Pumping > recharge: ~20,000 AF/Y
 - Increase recharge to offset deficit
- Options to increase recharge
 - Add recharge basins
 - Improve existing basins
 - On-farm recharge
 - Other methods: injection wells?

Estimated District Recharge Capacity

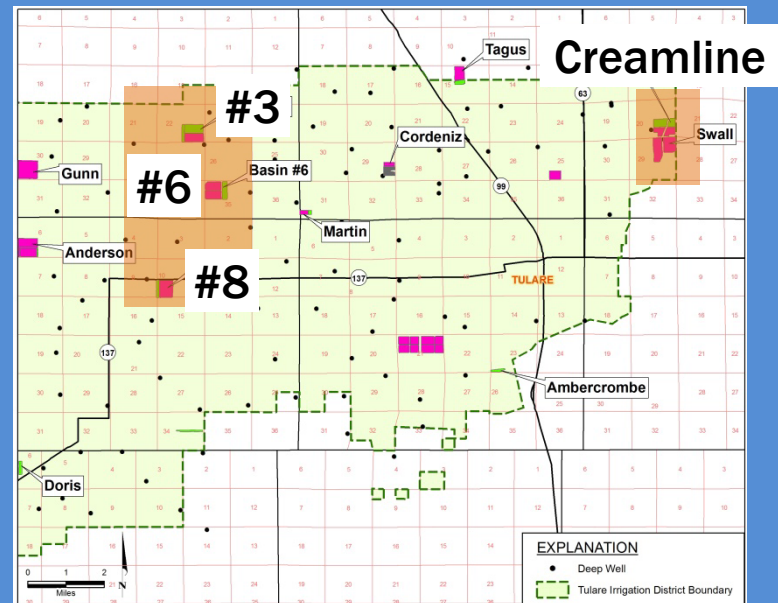


Assumptions:

- Basin Area – about 1,100 acres
- Recharge period - 120 days
- Infiltration rates: 0.25 ft/d (running cell), 0.5 ft/d (sinking cell)

Study Approach

- **Flexible and Adaptable**
 - Limited funds (~\$100K for field investigations)
 - Decision-based investigation approach
 - Maximize amount of useful data
- **Basins investigated**
 - Creamline / Swall
 - Basins #3, #6, #8



Investigation Methods



TRENCHING

- Backhoe
- Up to 12 foot deep
- Lithologic descriptions
- Sample collection



BOREHOLE DRILLING

- Auger method
- Up to 50 feet deep
- Lithologic descriptions
- Sample collection



INFILTRATION TESTING

- Basin-wide
- Falling head tests
- Staff gage
- Transducer / data logger

Lithologic / Infiltration Categories

LITHOLOGIC/INFILTRATION CATEGORIES



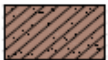
SAND; SILTY SAND (may have minor gravel content). Generally less than or equal to 20% silt; non-cohesive and non-lithified. VERY LARGE estimated infiltration rate (>4 feet/day)



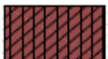
SILTY (FINE) SAND, (may have minor clay content). Generally 25% to 35% silt and clay; generally non to slightly cohesive and non-lithified. LARGE estimated infiltration rate (2 to 4 feet/day)



SILTY (FINE) SAND, SANDY SILT, (CLAYEY) SANDY SILT. Generally 40% to 55% silt and clay; generally non to slightly cohesive and non-lithified, but includes some moderately cohesive sediments. MODERATE estimated infiltration rate (1 to 2 feet/day)

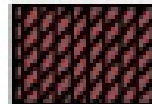


SANDY SILT; (CLAYEY) SANDY SILT. Generally 55% to 70% silt and clay; generally very slightly to moderately cohesive and non-lithified. SMALL estimated infiltration rate (0.5 to 1 feet/day)



(SANDY) CLAYEY SILT, (SANDY) SILT AND CLAY. Generally greater than or equal to 75% silt and clay; generally slightly to very cohesive. VERY SMALL estimated infiltration rate (<0.5 feet/day)

Decreasing Infiltration Rate
Increasing Fines



Estimated Infiltration
Rate

(feet per day)

> 4

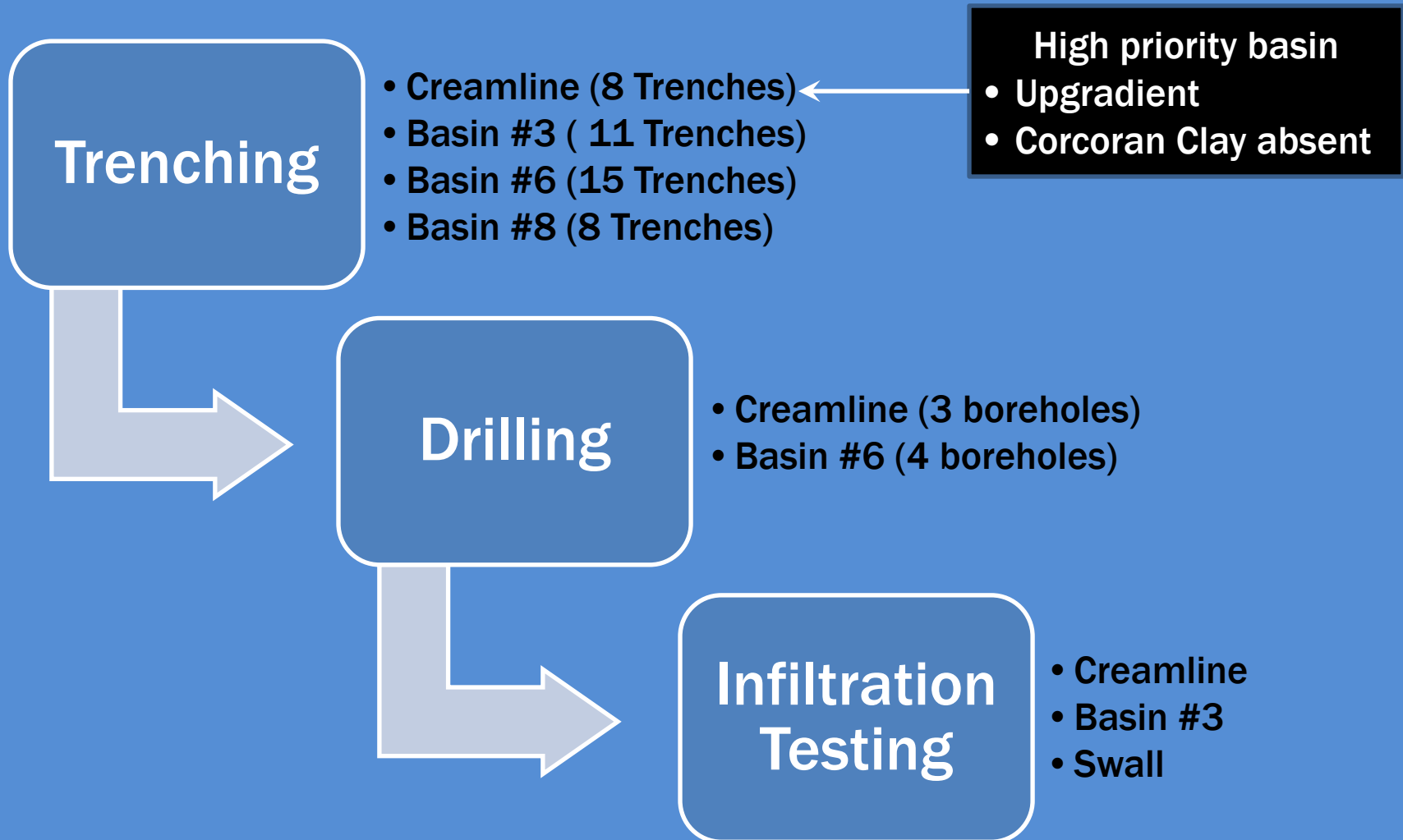
2 to 4

1 to 2

0.5 to 1

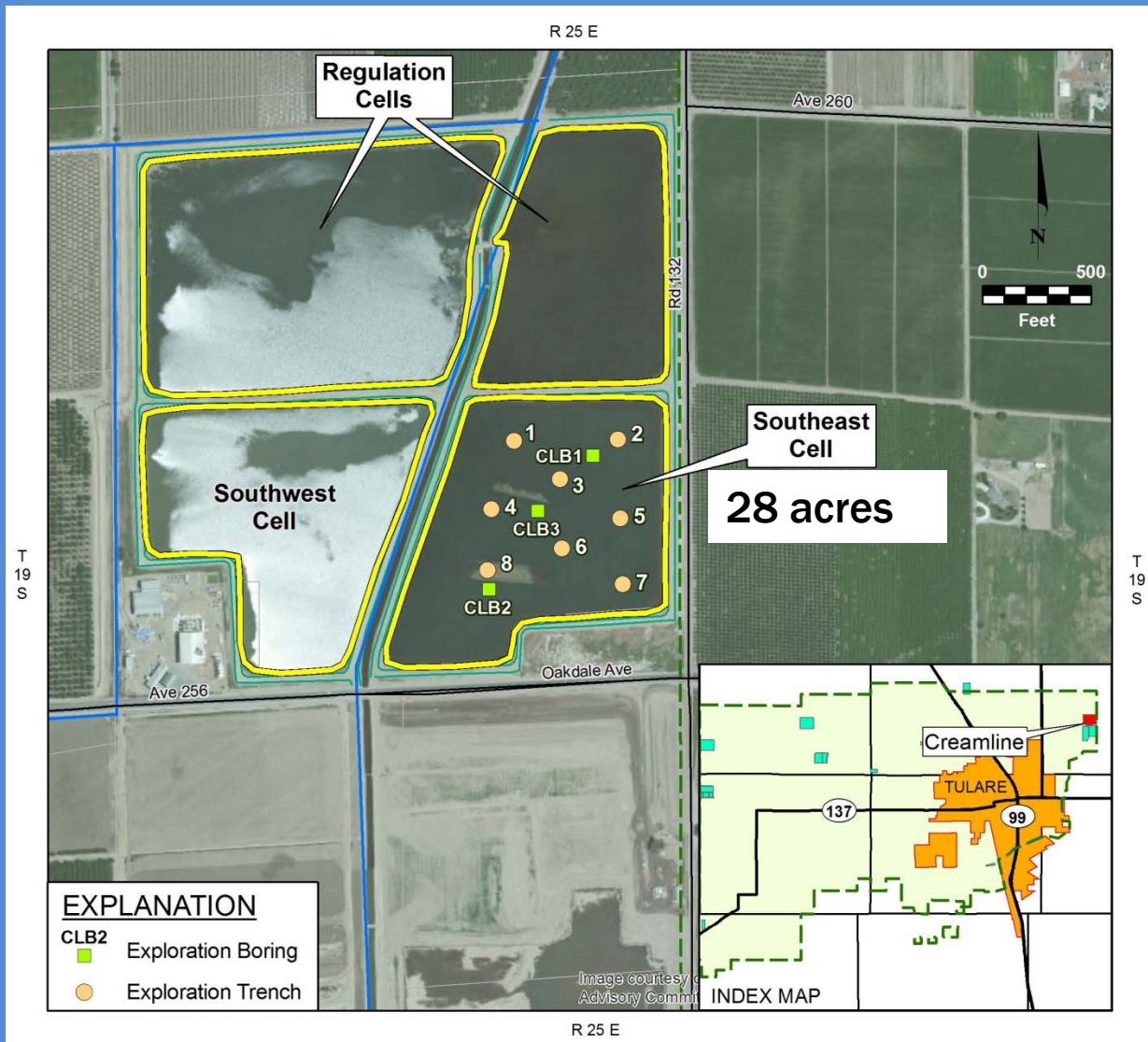
< 0.5

Adaptive Investigation



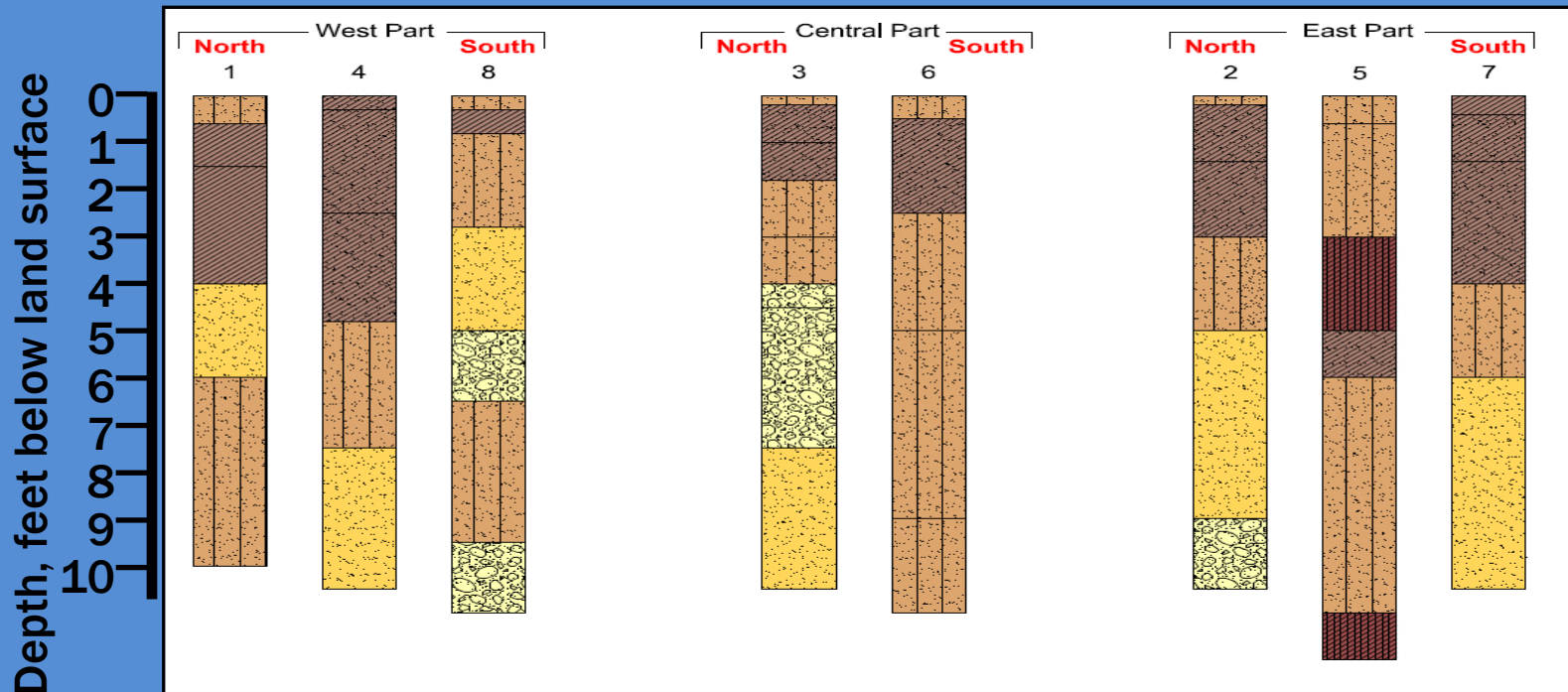
Trenching & Drilling

Creamline SE Basin



Trench Logs

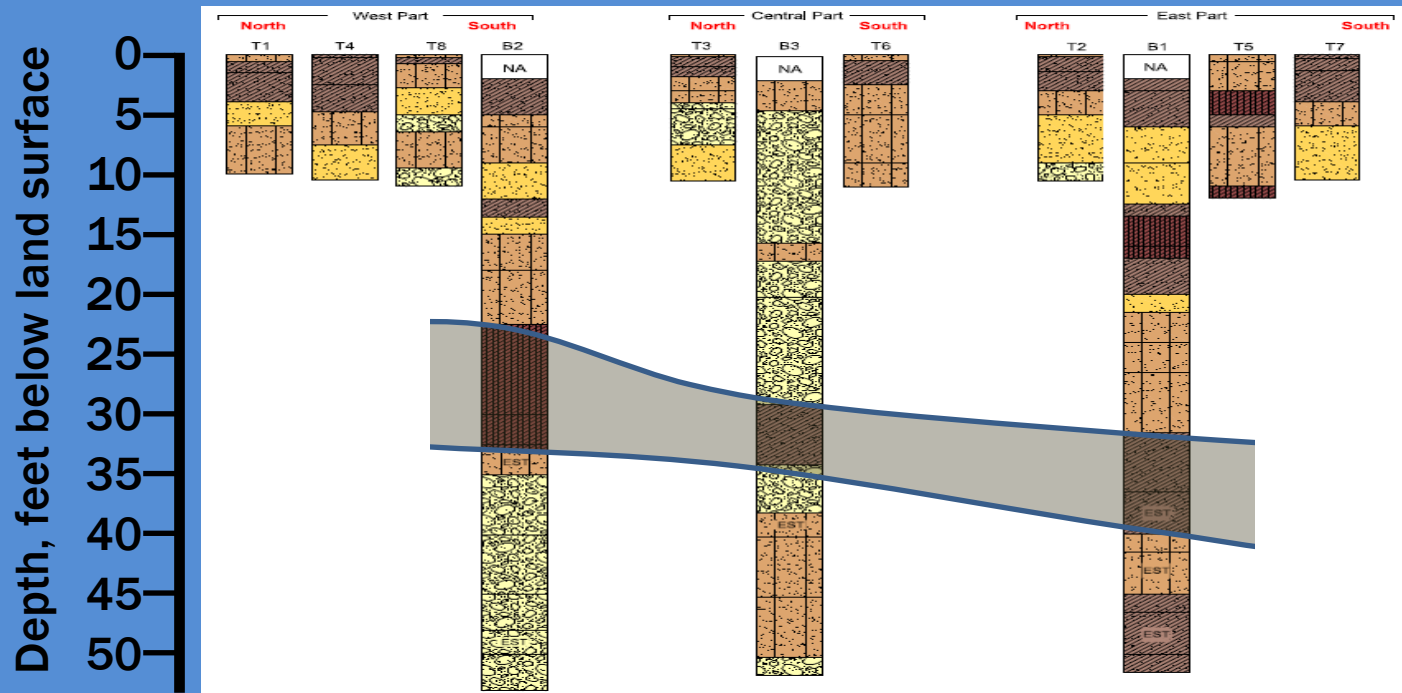
Creamline SE Basin



- Shallow fine-grained sediments may limit infiltration
- Infiltration rate would be increased by excavating upper 5 feet

Trench & Borehole Logs

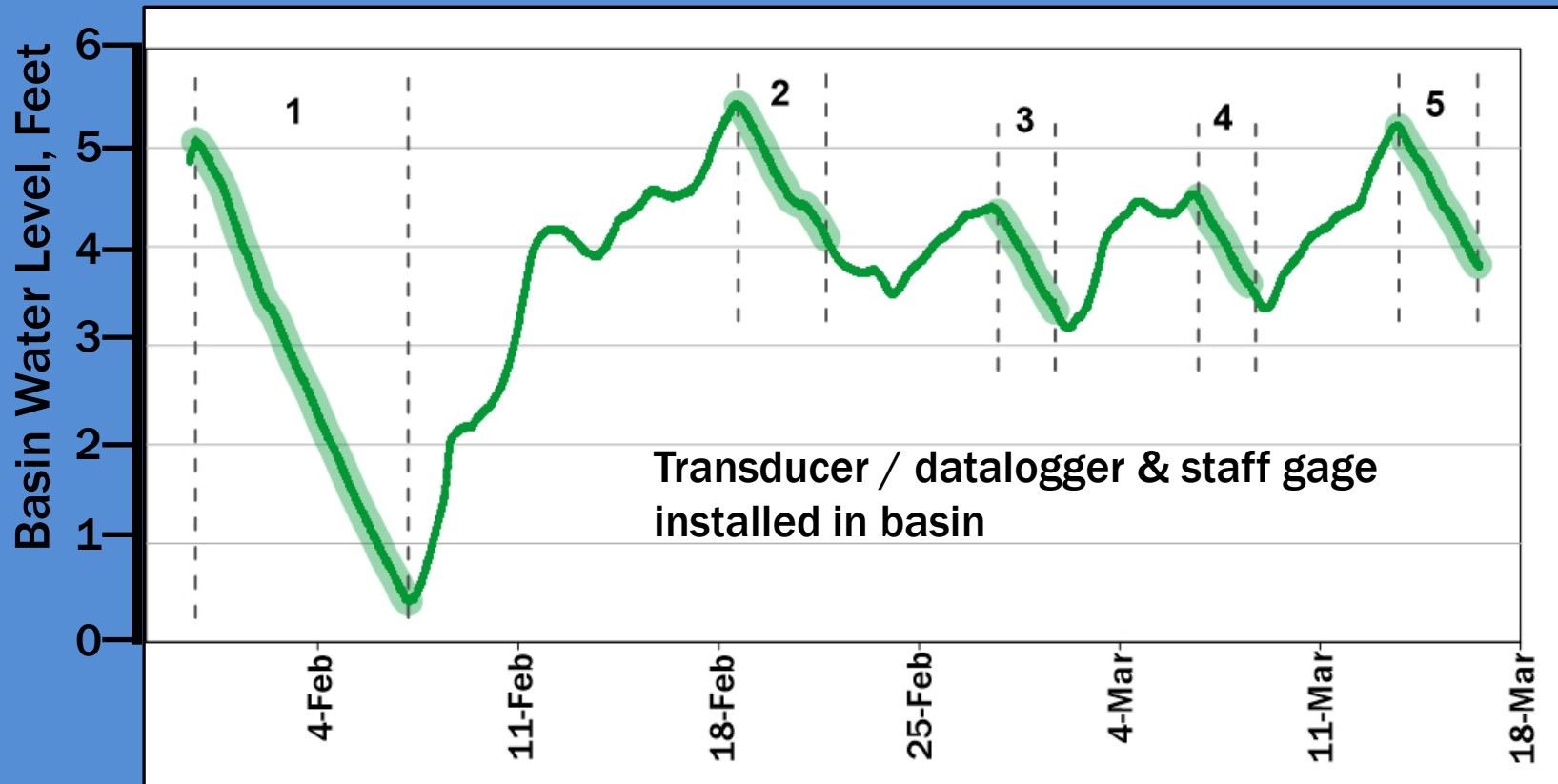
Creamline SE Basin



Fine-grained sediments between 20 and 40 ft bls
Mounding of perched water may limit infiltration

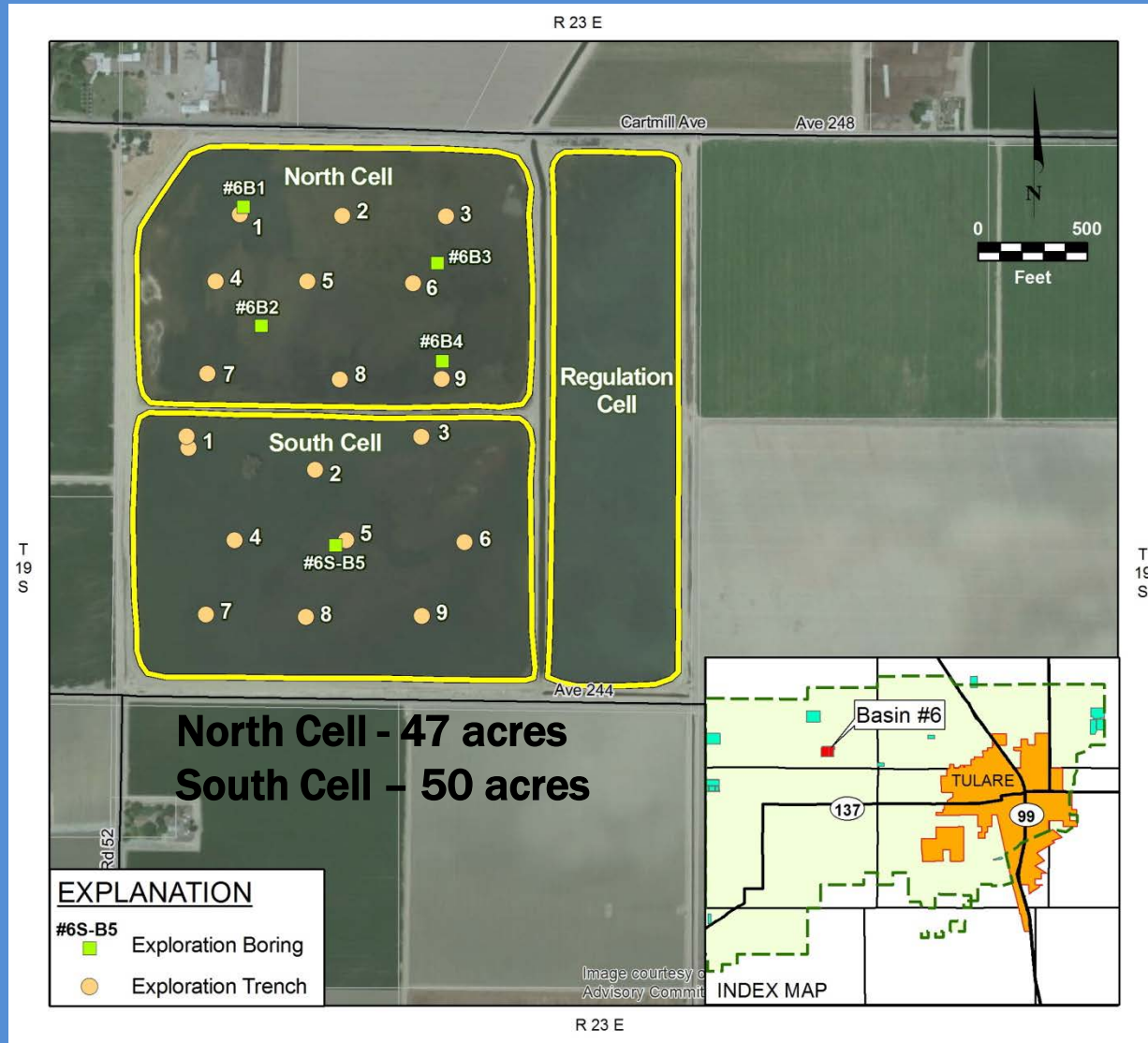
Preliminary Infiltration Testing Results

Creamline SE Basin



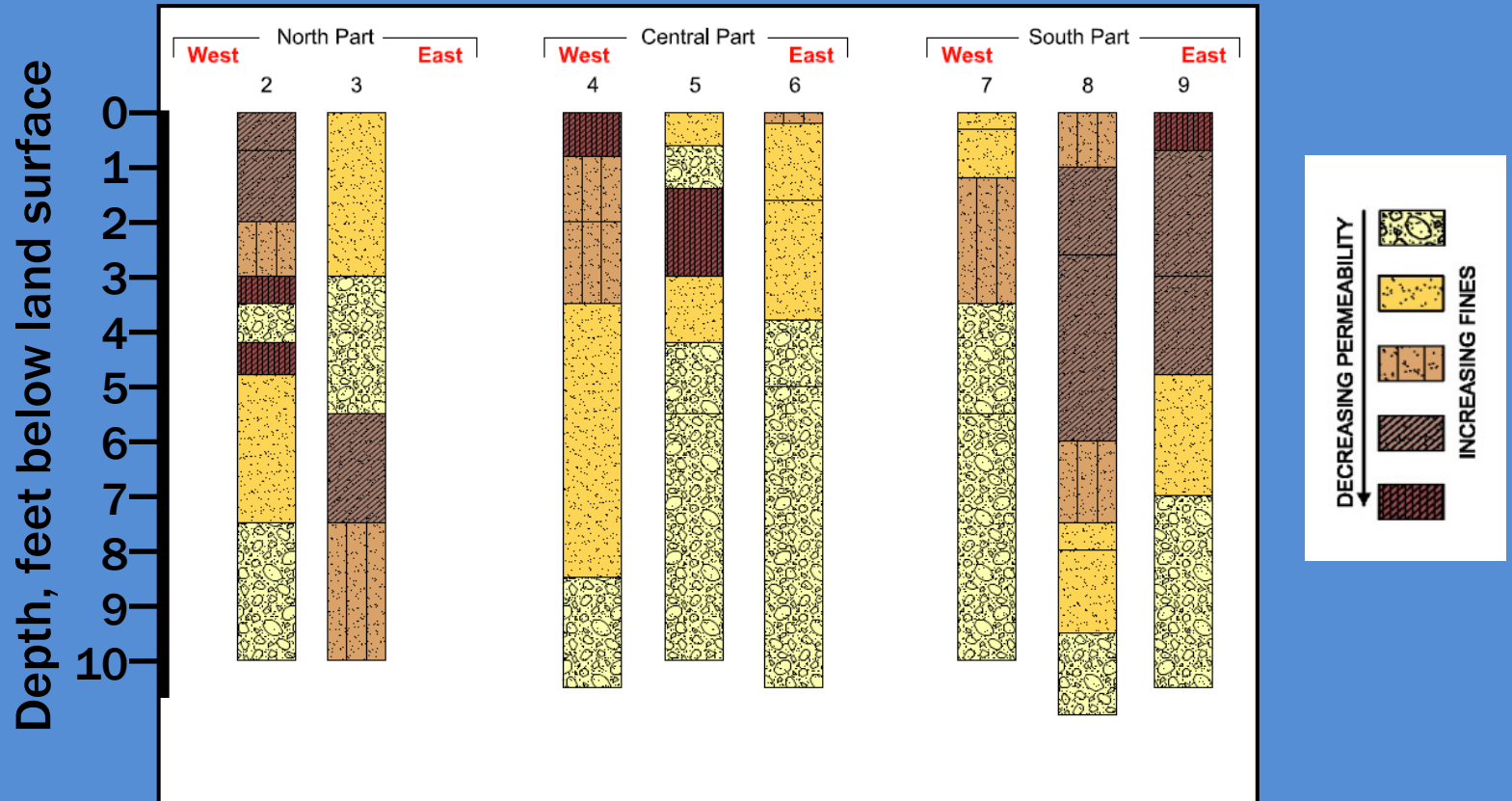
FALLING-HEAD CYCLE	1	2	3	4	5
INFILTRATION RATE (feet/day)	~0.6	~0.5	~0.5	~0.5	~0.5

Trenching & Drilling Basin #6



Trench Logs

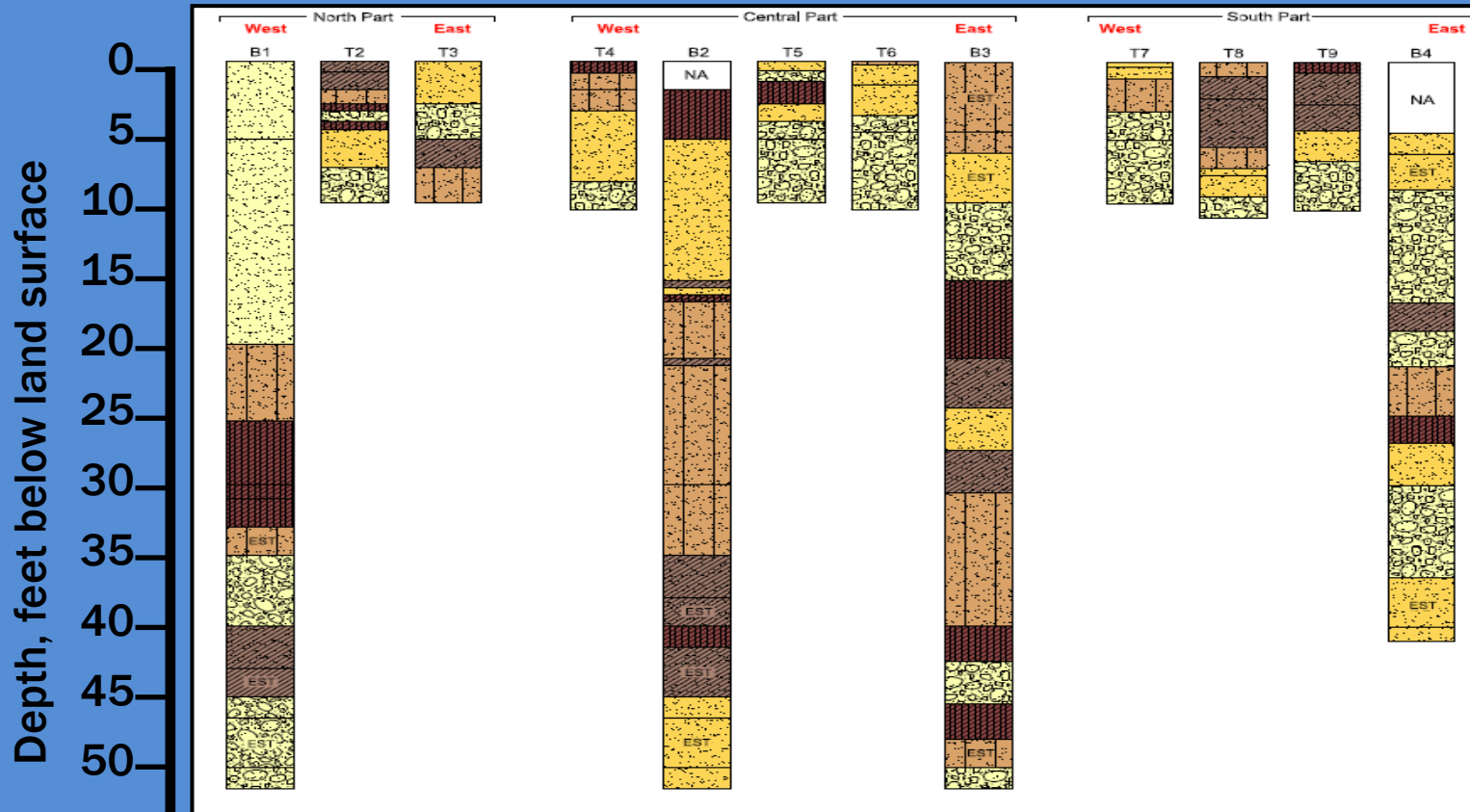
Basin #6 North Cell



Shallow sediments appear conducive for infiltration

Trench & Borehole Logs

Basin #6 North Cell



Limited fine-grained sediments in deeper vadose zone

Preliminary Infiltration Testing Results

BASIN	FALLING-HEAD INFILTRATION TEST CYCLE				
	1	2	3	4	5
CREAMLINE (SE CELL)	~ 0.6	~ 0.5	~ 0.5	~ 0.5	~ 0.5
CREAMLINE (SW CELL)	~ 0.5	~ 0.5	~ 0.5	~ 0.4	~ 0.5
SWALL (E CELL)	~ 0.5	0.45	~ 0.4	~ 0.4	–
SWALL (NW CELL)	~ 0.5	–	–	–	–
BASIN #3 (S CELL)	~ 0.5	~ 0.2	~ 0.3	~ 0.2	~ 0.1

Summary

- TID has a proactive & effective recharge program
- Maximizing recharge capacity is important for conjunctive water management
- Study has provided meaningful new information
- Preliminary study results to date:
 - Shallow & deeper lithology
 - Infiltration rates of tested basins
 - Shallow excavation may improve performance

Next Steps

- **New USBR Grant application submitted**
 - **Excavate shallow material from Creamline SE basin**
- **Continue operational infiltration testing**
- **EGRP feasibility study pending**
- **Evaluate feasibility / cost-benefit of recharge program improvements**