Soil Amendment Studies at BLCA

CRTR

January 29, 2013

Lindsey Hovland

Project Background/Need

- MSCP Habitat Conservation Plan:
  - Habitat creation goals → soil moisture required to support vegetation.
  - Species conservation measures → surface water or moist soils.
- Water Needs
  - Irrigation efficiency → amount of irrigation required.

- How can we create these conditions for soils that lack adequate moisture retention?
- How can we optimize irrigation for sandy soils?
- How can we minimize water required?

GSA GeoSystems Analysis, Inc. Innovations in Hydrology

Lower Colorado River Multi-Species Conservation Program

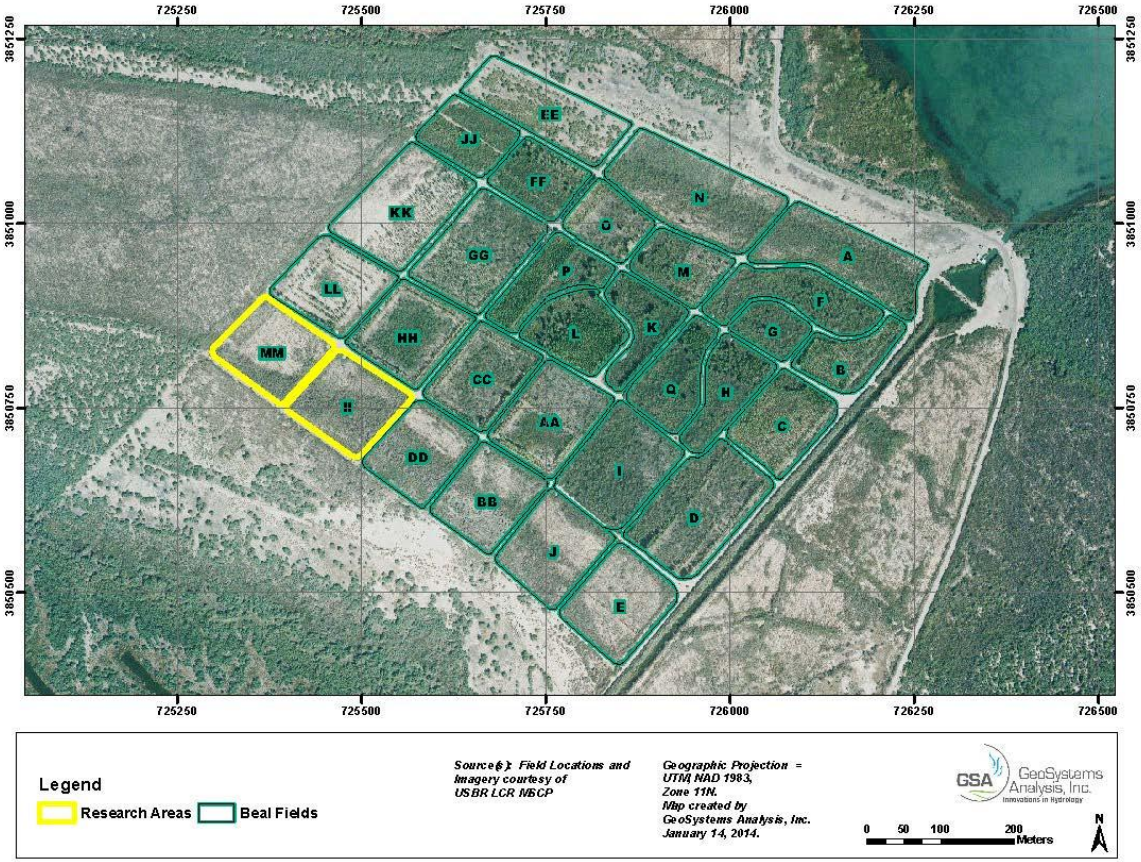
Soils of the LCR and BLCA

- Dominated by alluvial deposited sandy soils
  - BLCA fields include dredged material from Beal Lake
    - 92% sand at BLCA vs 85% sand at PVER2
- Sites often lie 5-15 feet above groundwater and are very well drained
  - Floodplain connectivity
- Soils are limiting to successful revegetation because they retain water poorly
  - Plant establishment and success
  - SWFL habitat requirements

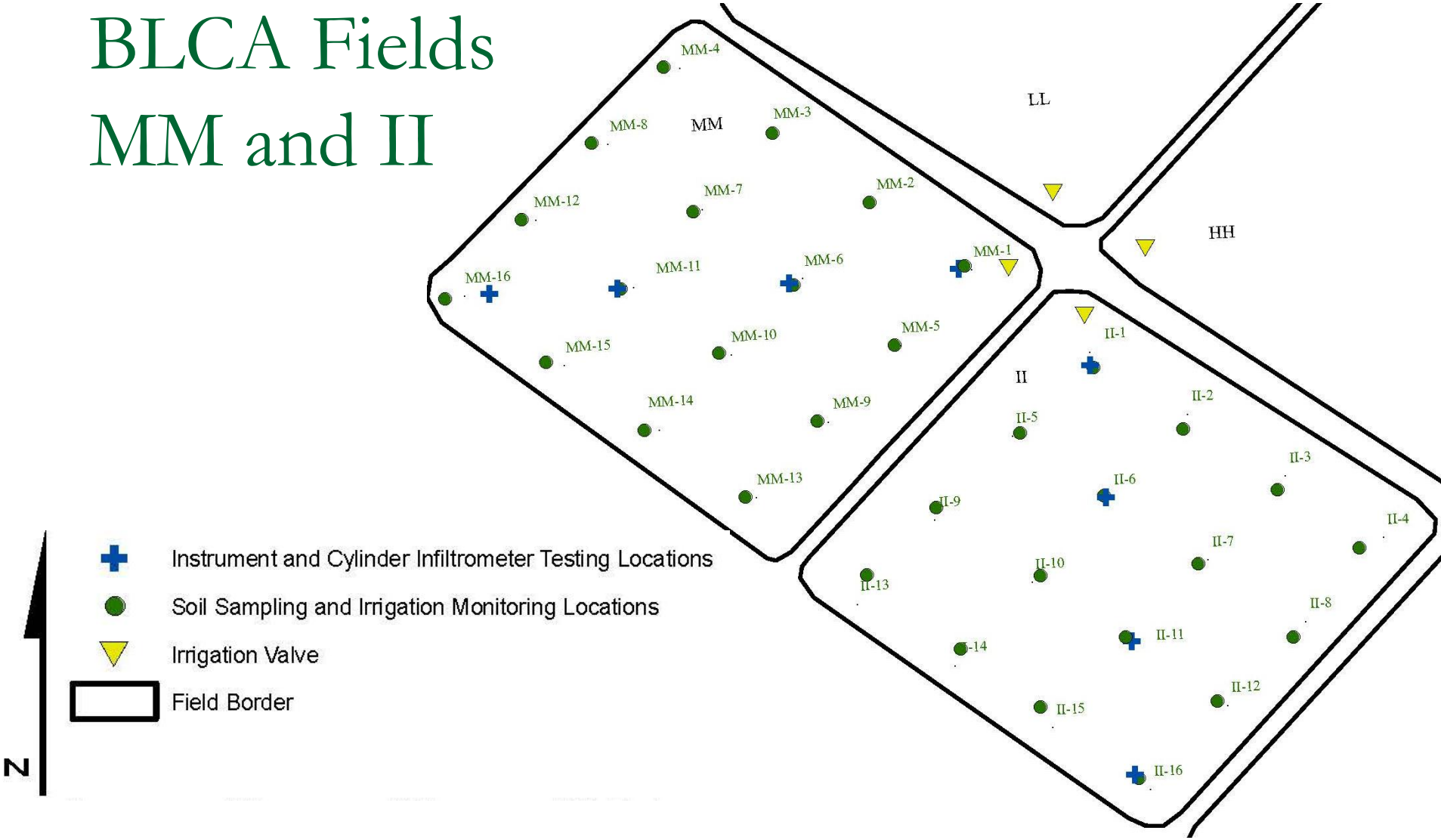
Soil Amendment: Lassenite Pozzolan

- Found to be most suitable amendment from a BOR lab study
- Potential to increase moisture retention in sandy soils
- Composed of volcanic ash and silicious diatom micro-skeletons
- Porous and absorbent
- High salinity (~ 7dS/m)

BLCA 2011-2012



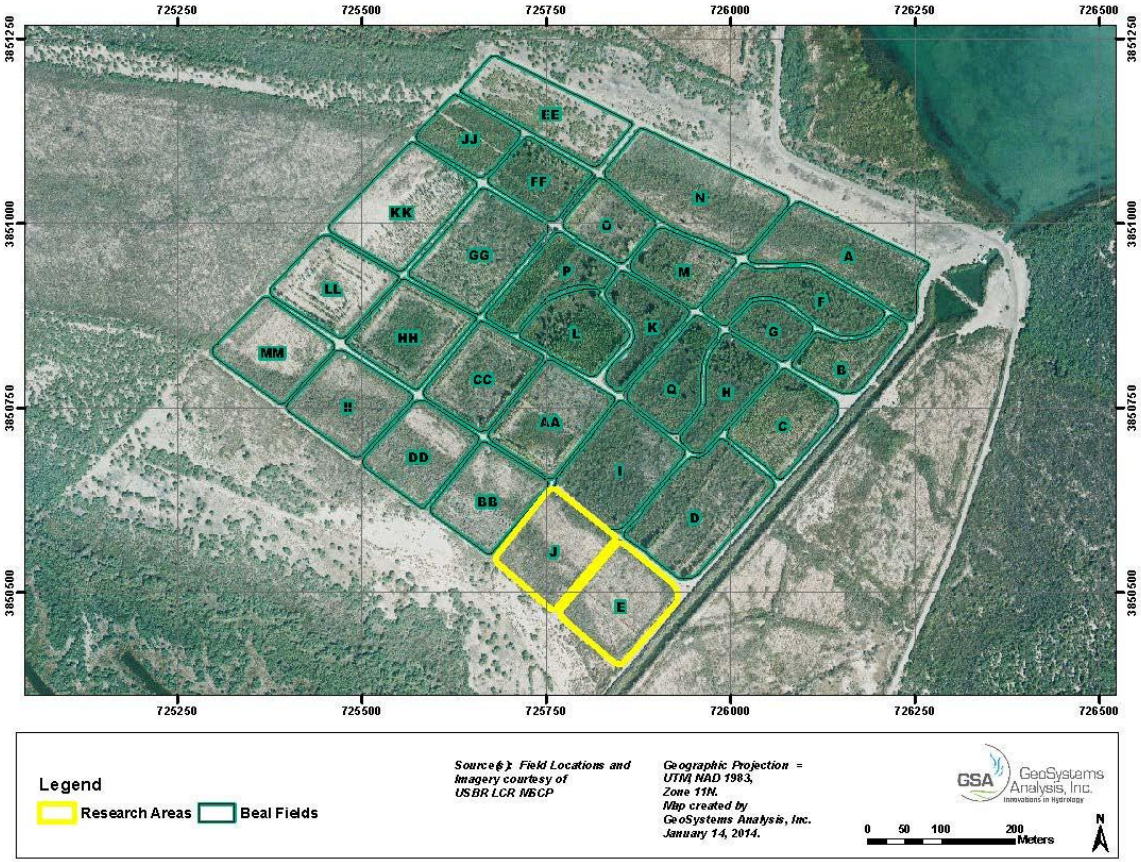
BLCA Fields MM and II



Results: MM and II Amendment Study

- Soil Moisture Retention
  - No effect of 5% pozzolan on increasing soil moisture retention
    - Much of pozzolan volume is aggregated not crushed
    - Highly sandy soils still drain readily
- Salinity
  - Transient increase in EC due to pozzolan application
    - Rectified after one season of irrigation and salt leaching
- No change in irrigation efficiency

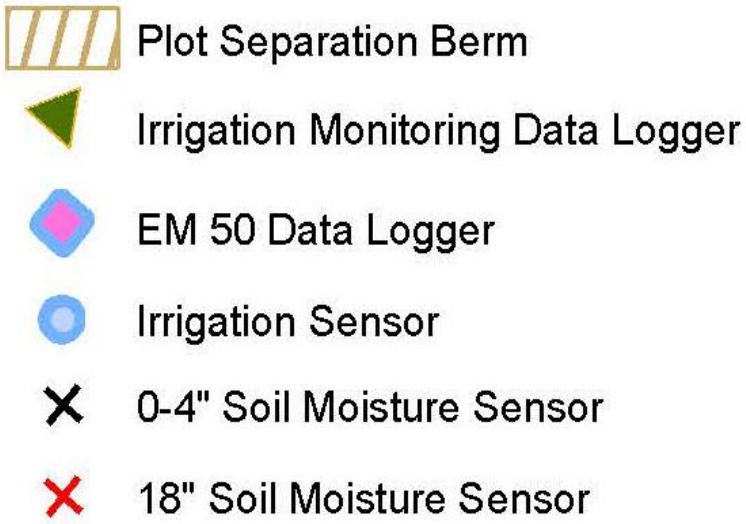
BLCA 2013-2014

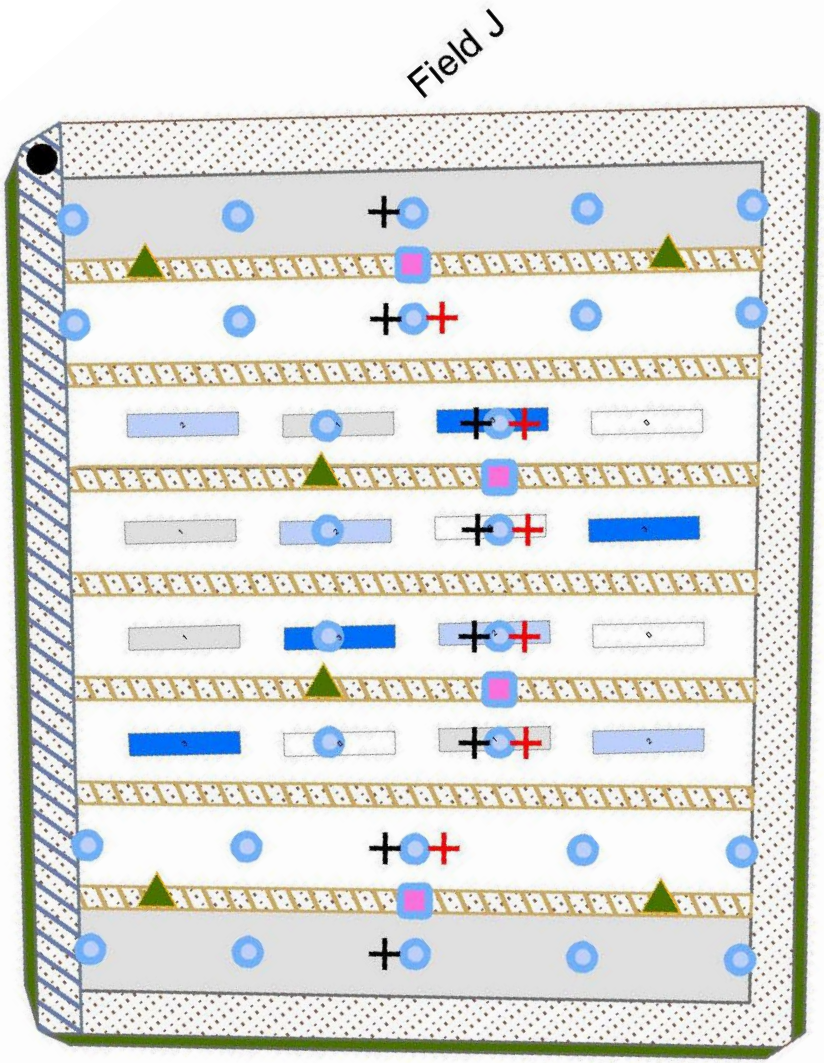


Soil Amendment Study: BLCA J and E

- Do higher rates of pozzolan:
  1. Alter soil moisture retention enough to improve habitat quality for SWFL?
  2. Allow establishment of seedlings where seedling establishment has been unsuccessful?
  3. Alter infiltration enough to improve irrigation efficiency?

BLCA Fields J and E





Project Implementation

Project Implementation

Project Implementation

Project Implementation

Project Implementation

Project Implementation

Project Implementation

Project Implementation

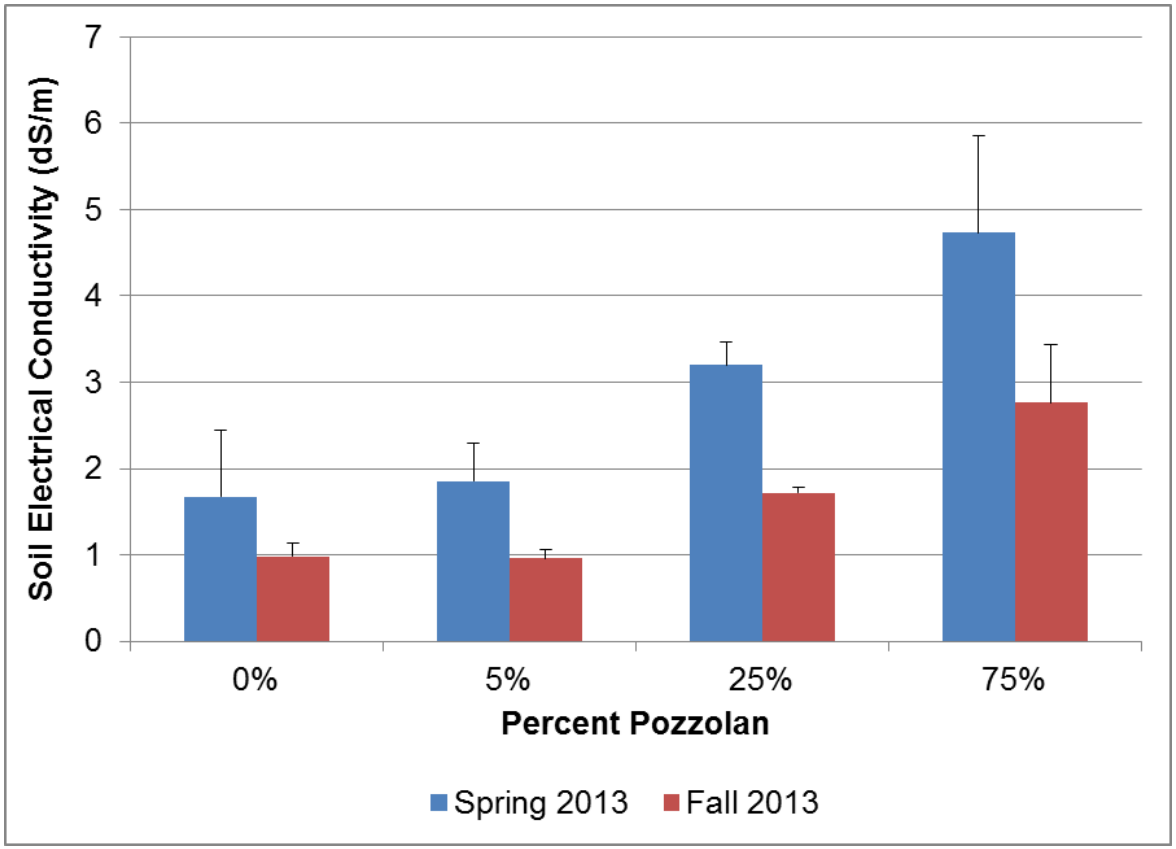
Project Implementation

Project Implementation

Project Implementation

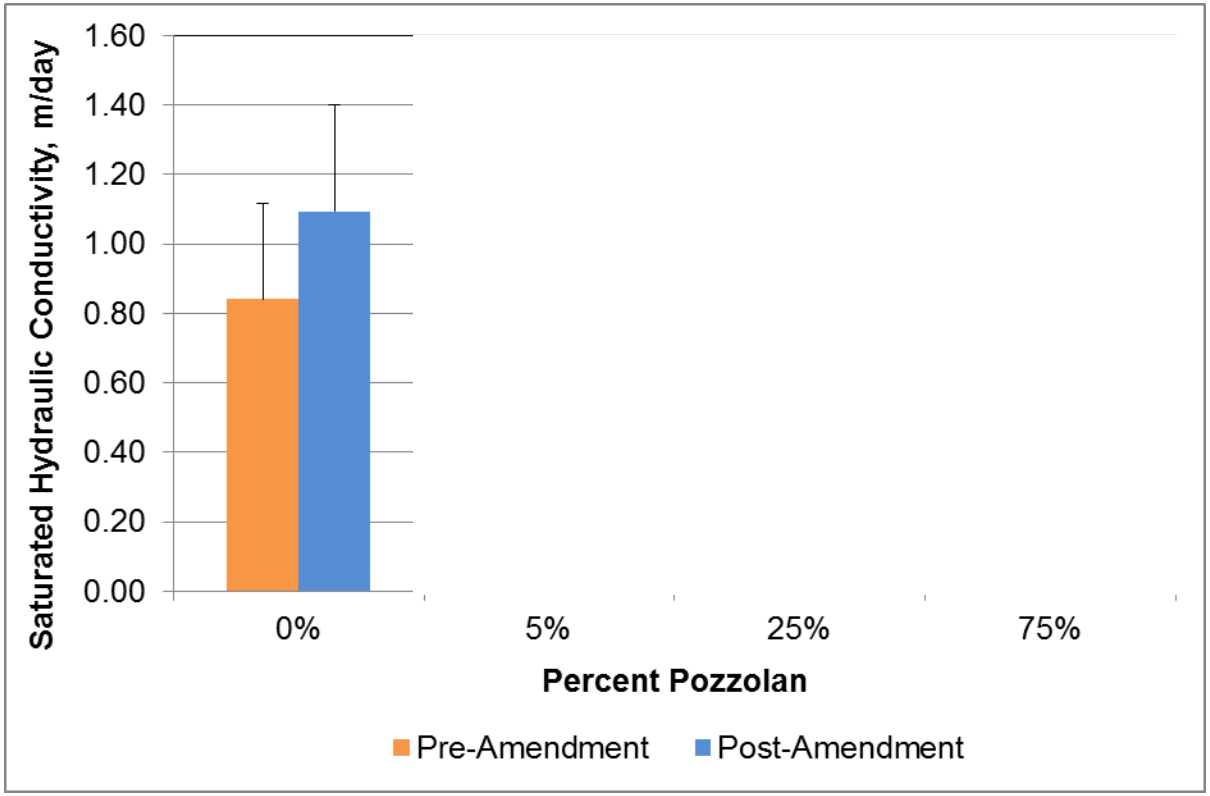
Results: Pozzolan and Soil Properties

Soil Salinity



- Overall reduction in salinity of ~40% for all pozzolan application rates after one irrigation season
- Drop in EC of control area indicates elevated initial field salinity

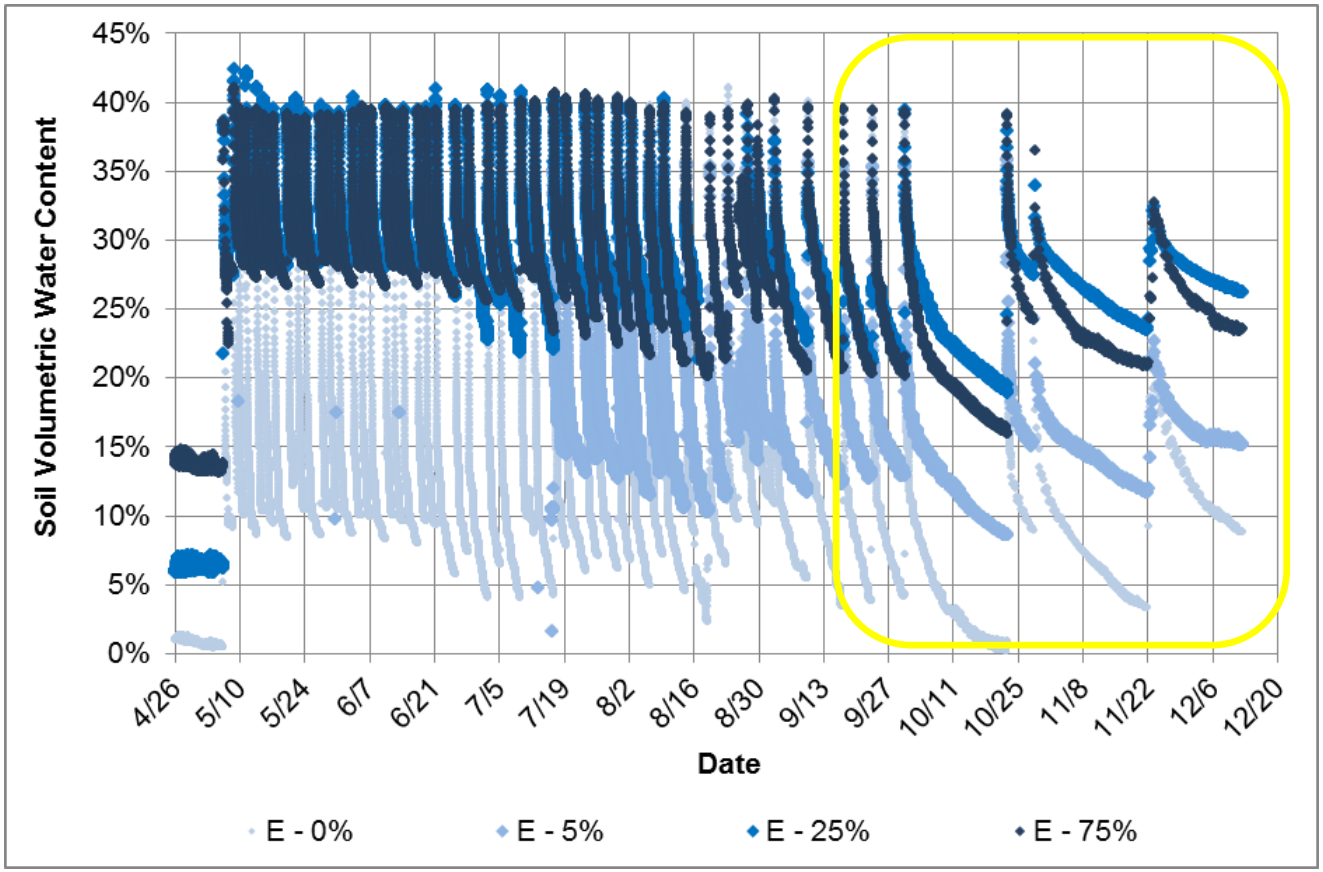
Field Infiltration Rates



- Application of 25% and 75% pozzolan results in significant reduction in infiltration rate

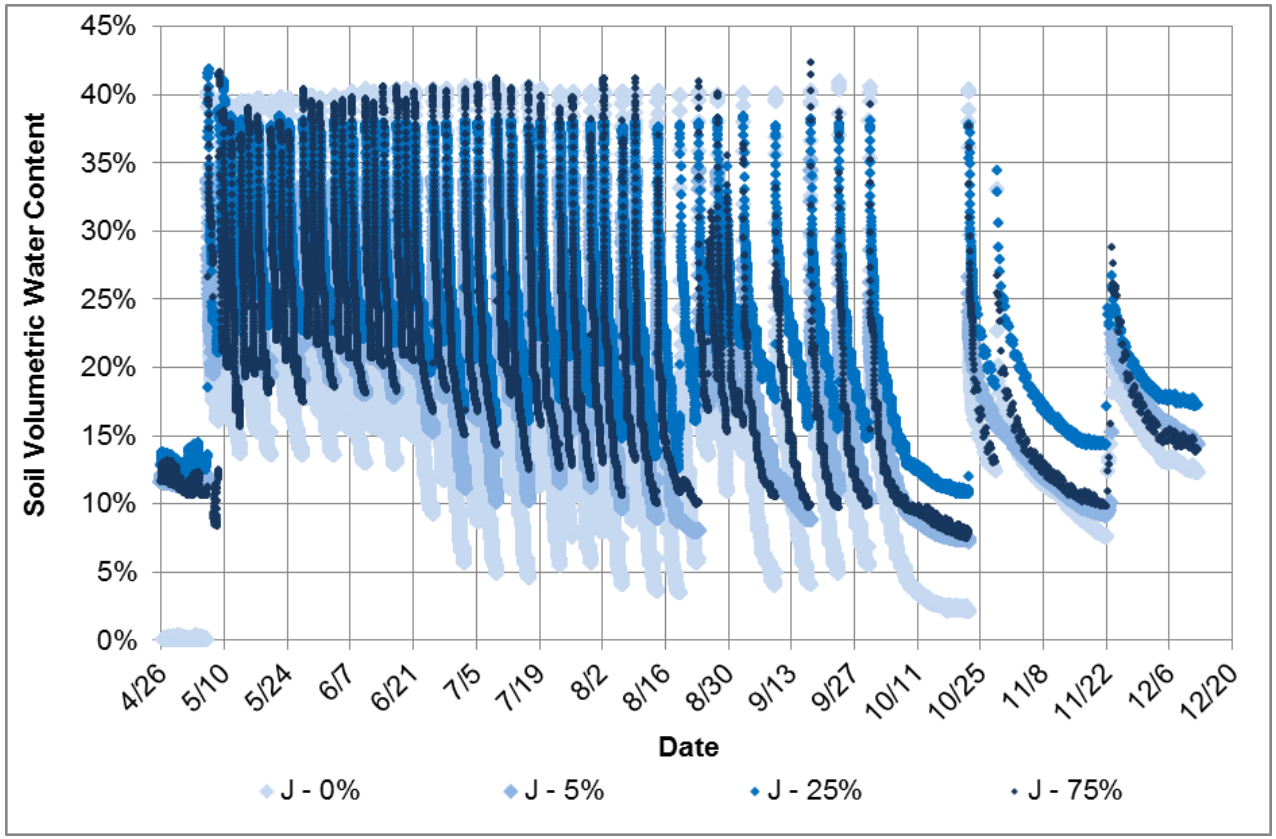
Results: Soil Moisture

Results: Pozzolan Effects on Soil Moisture Retention, Field E



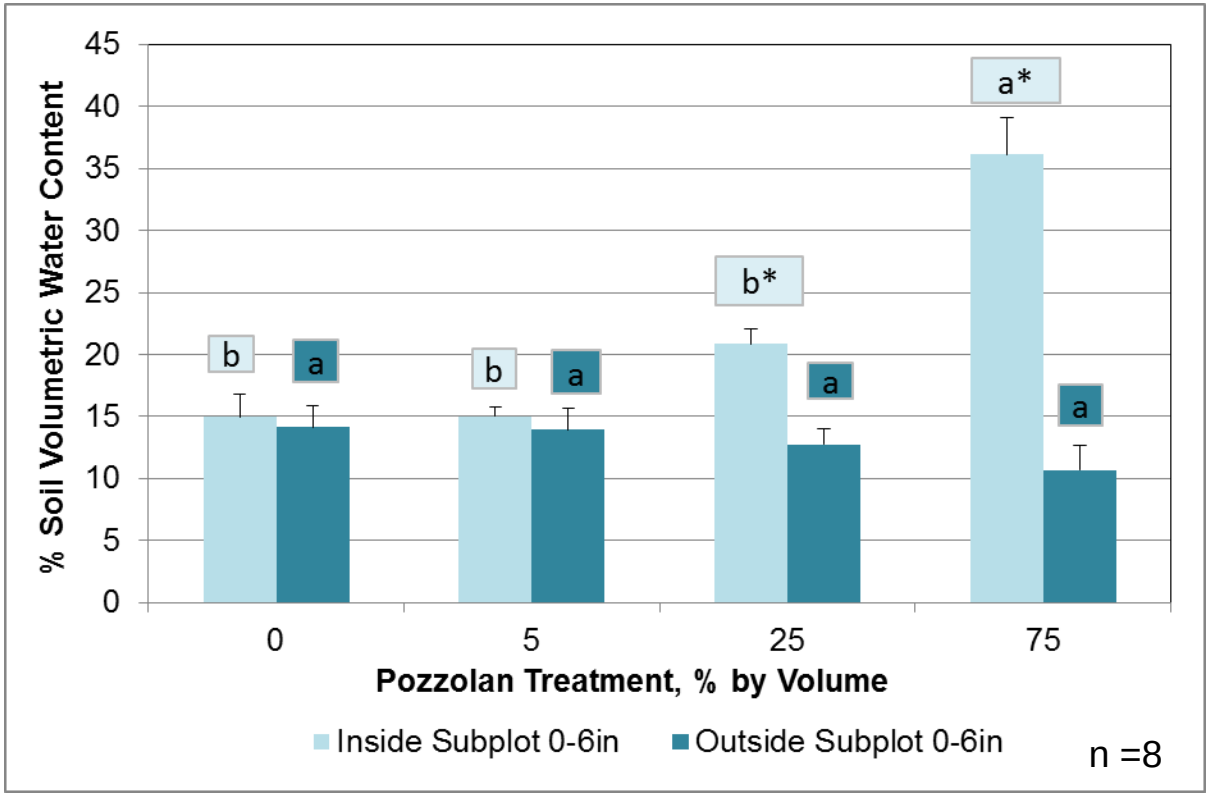
- Pozzolan increases moisture retention between irrigation events
- 75% and 25% pozzolan retain more moisture than 5% and 0%

Results: Pozzolan Effects on Soil Moisture Retention, Field J



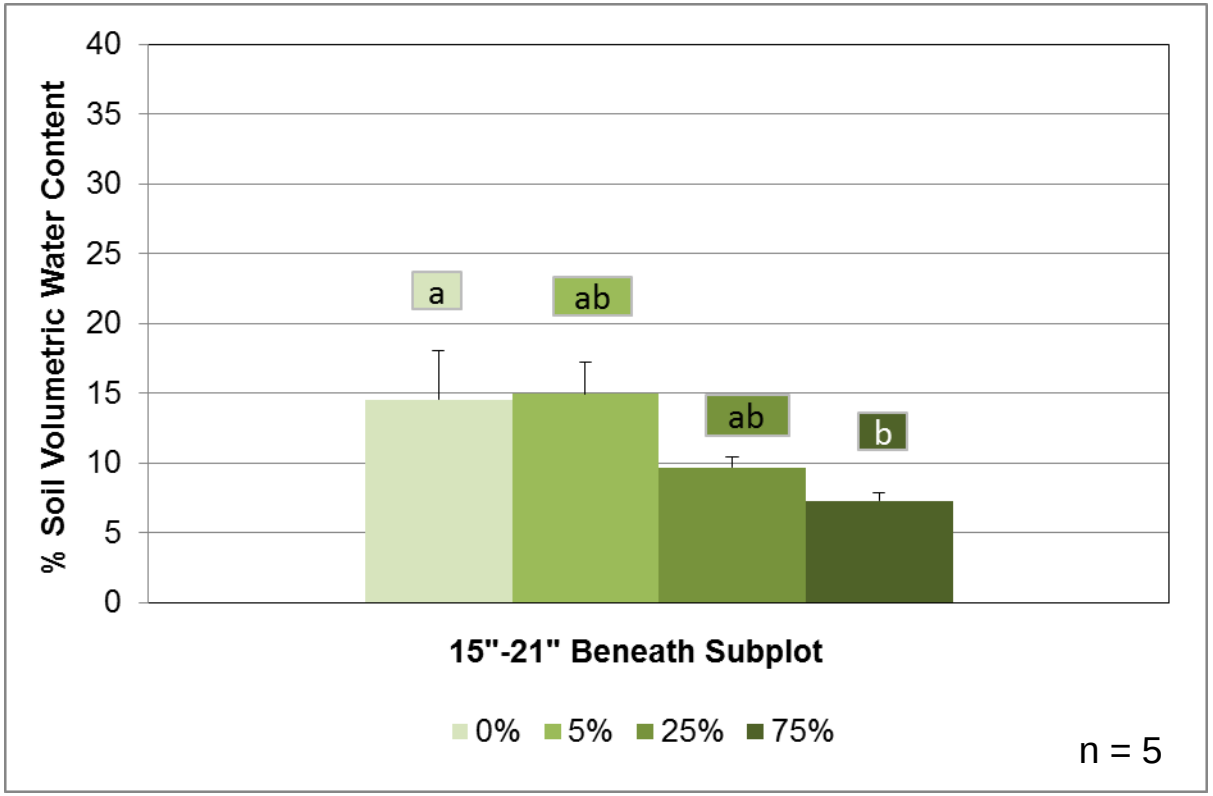
- Pozzolan does not result in significant moisture retention as it does for field E
- 5%, 25%, and 75% all increase moisture retention slightly above the control

Results: post-irrigation water content



- Soil moisture is higher in 75% compared to all other %s
- Soil moisture is higher inside 25% and 75% subplots than outside

Results: post-irrigation water content



- Soil moisture is lower beneath 75% subplots than 0% subplots
  - Slower infiltration = less percolation
  - Capillary draw of moisture from subsurface into surface pozzolan

Results: Vegetation Establishment

Results: Vegetation Characteristics

0% Pozzolan

75% Pozzolan

Results: Vegetation Characteristics

Results		% Pozzolan Treatment			
		0%	5%	25%	75%
Arrowweed	Height (cm)	72 A	80 A	74 A	55 B
	Density (#/acre)	54970 A	44853 A	37602 A	11803 B
Screwbean Mesquite	Height (cm)	35 C	47 BC	56 AB	69 A
	Density (#/acre)	1511 A	1552 A	953 A	1007 A
Avg Shrub Density (per acre)		54997 A	44853 A	37602 A	11871 B
Avg Tree Density (per acre)		1552 A	1932 A	980 A	1252 A
Avg Litter Depth (cm)		0.51 A	0.51 A	0.42 AB	0.24 B

- High pozzolan patches tend to have:
  - Smaller, less dense arroweed
  - Taller screwbean mesquite
  - Lower total shrub density
  - Less litter

Results: Vegetation Characteristics

- Fields are dominated by arrowweed
  - Small components of screwbean mesquite, cottonwood and coyote willow re-sprouts
- Goodding's willow establishment
  - No amount of pozzolan promoted germination and establishment
    - Insufficient soil moisture and/or saturation
    - Amendment salinity may have inhibited germination
  - Seeding successful in portion of field with naturally finer textured soils
    - Estimated establishment of 436 trees/acre
    - Subject to extensive herbivory in fall 2013

Goodding's willow establishment

October 23, 2013

Goodding's willow establishment

December 13, 2013

Conclusions

- Use of Lassenite Pozzolan as a soil amendment:
  - Is likely to be useful for increasing soil moisture retention
  - May increase irrigation efficiency by lowering infiltration rates
  - Did not promote establishment of Goodding's willow from seed

Recommendations

- Continued and improved monitoring
  - Soil moisture
    - Additional paired moisture monitoring, additional dataloggers, MRC
  - Soil properties
    - Salinity, infiltration testing
- Vegetation Analysis
  - Determine if pozzolan affects mass (trans)planting success
  - Revisit pozzolan effects on seedling establishment
- Consider site limitations
  - Plant according to moisture and salinity tolerances
  - Crush pozzolan prior to application
  - Pozzolan placed in depressions
  - Apply pozzolan one season before seeding
- Consider other amendment options as needed

Acknowledgements:

MSCP:

Barbara Raulston

Dianne Bangle

Ashlee Rudolph

Jed Blake

Havasu NWR

lindsey@gsanalysis.com

GSA GeoSystems Analysis, Inc. Innovations in Hydrology

Lower Colorado River Multi-Species Conservation Program

Ongoing questions

- How plant available is the soil moisture held in pozzolan amended soils?
- How does the PSD change over a couple growing seasons as pozzolan aggregates break down?
- Will riparian trees flourish in pozzolan or do other factors inhibit growth?
- Different amendment options?
  - Bentonite, vermiculite, zeolite, peat, organic material

Acknowledgements:

MSCP:

Barbara Raulston

Dianne Bangle

Ashlee Rudolph

Jed Blake

Havasu NWR

lindsey@gsanalysis.com

GSA GeoSystems Analysis, Inc.
Innovations in Hydrology

Lower Colorado River Multi-Species Conservation Program

Acknowledgements:

MSCP:

Barbara Raulston

Dianne Bangle

Ashlee Rudolph

Jed Blake

Havasu NWR

lindsey@gsanalysis.com

GSA GeoSystems Analysis, Inc.
Innovations in Hydrology

Lower Colorado River Multi-Species Conservation Program

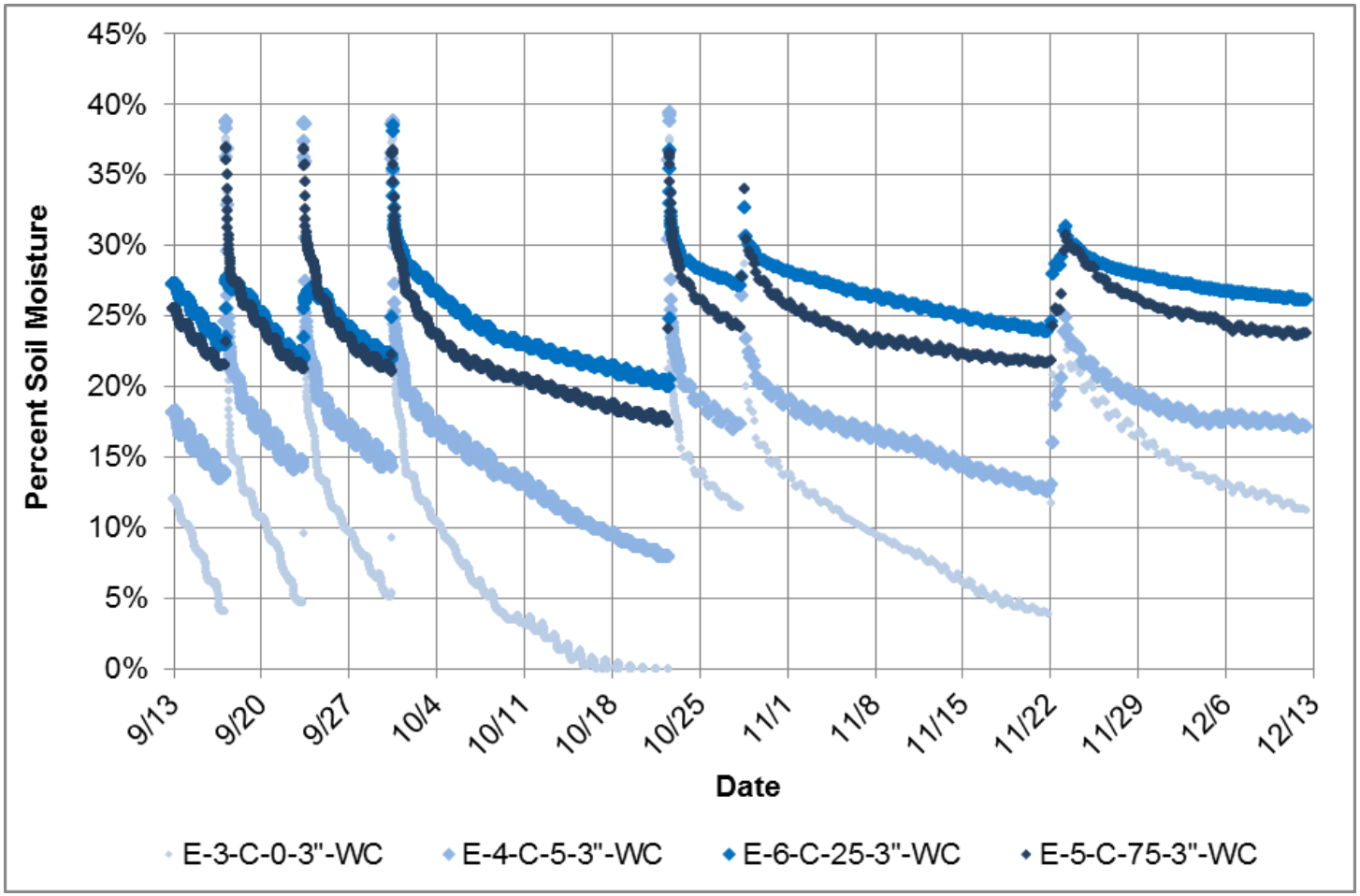
Irrigation Distribution Example

- Utilizing K at Beal to estimate irrigation efficiency at ??

Extra slides – Field J soil moisture

- Pozzolan doesn't retain moisture here as much as for field E – initial soil textures are nearly identical between both fields.

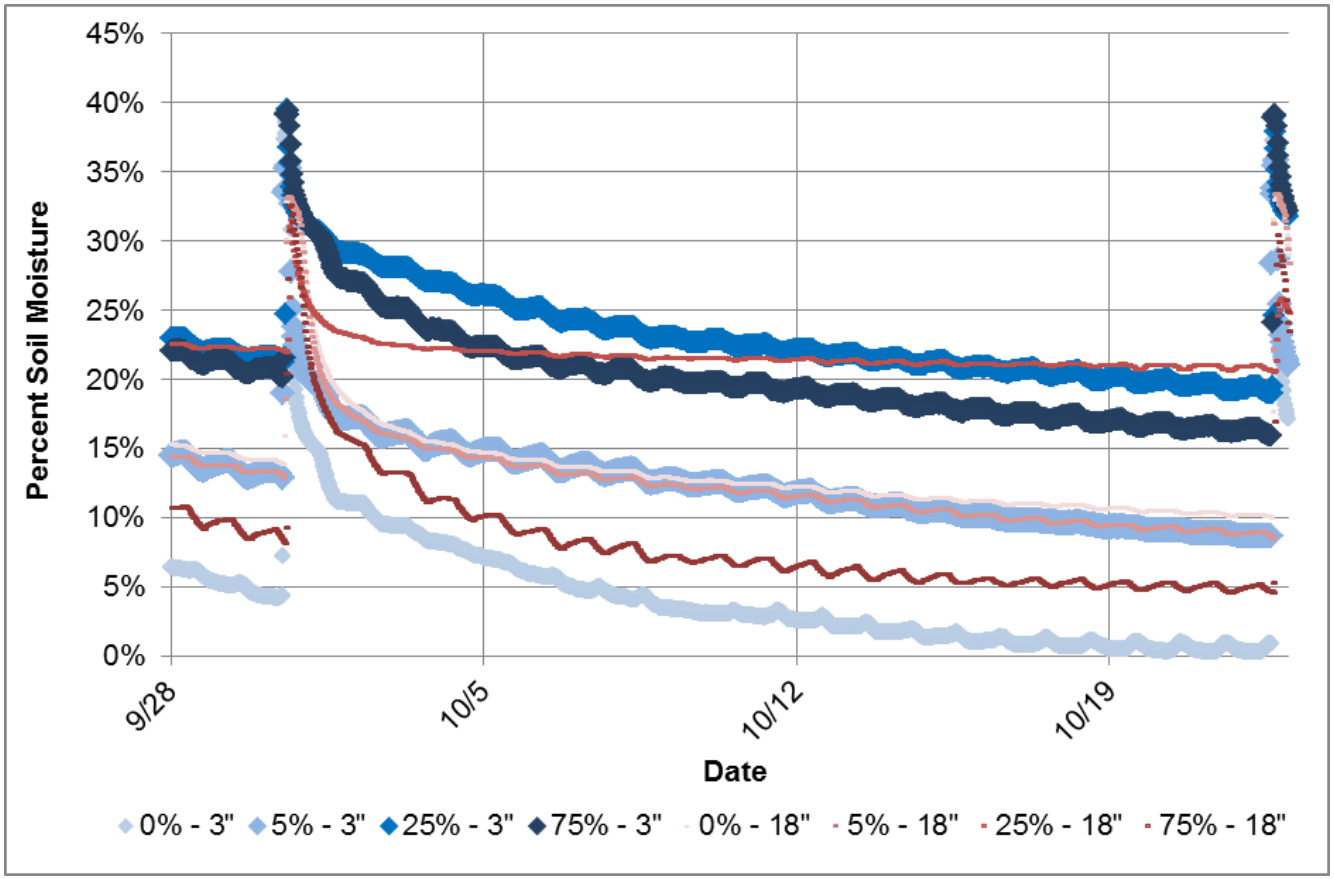
Results: Pozzolan Effects on Soil Moisture Retention, Field E



BLCA Fields J and E

- Determine the effects of a range of pozzolan application rates for reaching target moisture retention 0% (control), 5%, 25%, and 75%
  - Soil moisture retention
  - Gooddings willow seedling establishment
  - Irrigation efficiency

Pozzolan Effects: Subsurface moisture, Field E



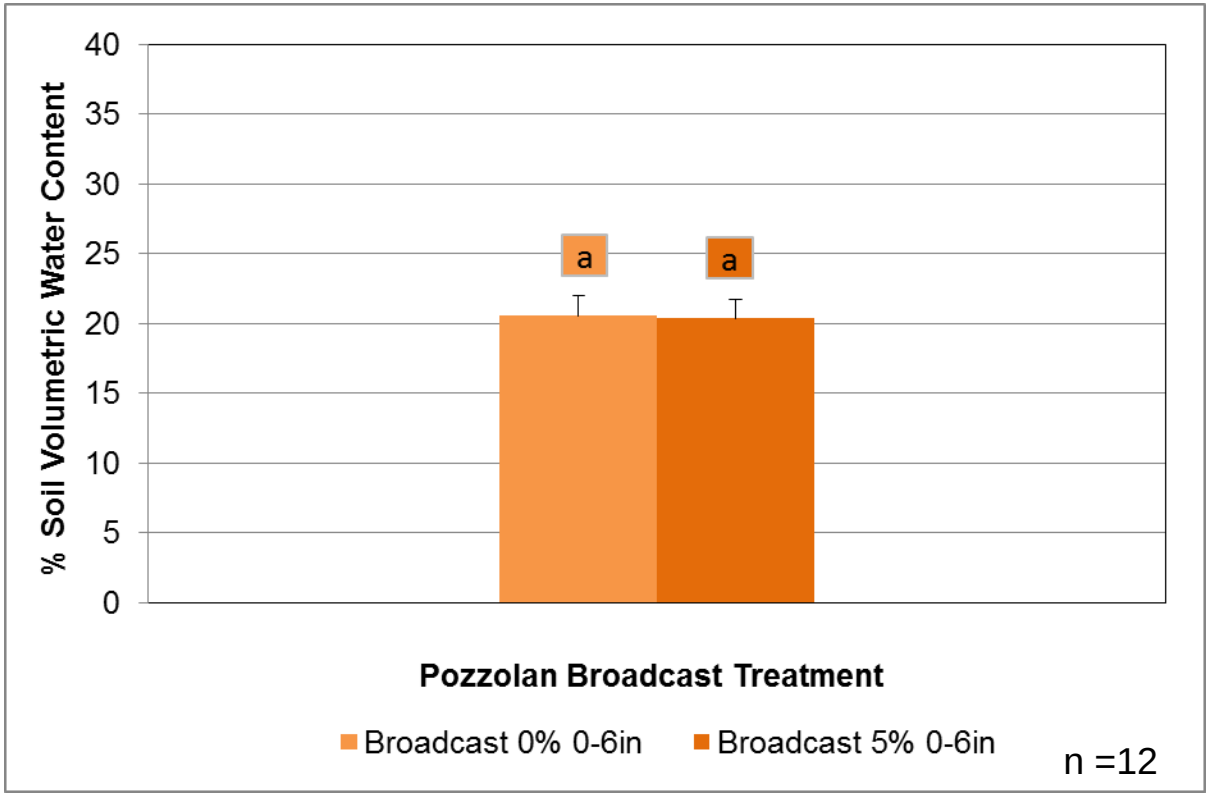
- Decreased soil moisture under 75% plot may be indicative of lower percolation or more well drained soil
- Soil moisture under 25% plots is elevated

Results: Pozzolan Effects on Soil Moisture

% Volumetric Water Content		% Pozzolan			
		0%	5%	25%	75%
Days Since Irrigation	5	8.0 C	13.7 B	22.0 A	12.3 B
	10	6.5 B	11.9 B	19.7 A	9.9 B
	15	5.1 B	10.5 B	18.3 A	8.8 B
	20	4.0 B	9.6 B	17.3 A	8.3 B

- 25% retains more moisture up to 20 days after irrigation
- 75% is only significantly wetter than 0% up to five days after irrigation
- No effect of 5% pozzolan on moisture retention after five days
- 75% retains less water than 25%
  - Aggregates, sub-plots elevated above field level, subsurface drainage effects

Results: post-irrigation water content



- No significant effect of 5% pozzolan on soil moisture retention