Field Hydrologic Performance of Earthen Covers for Uranium Mill Tailings Disposal Sites on the Colorado Plateau

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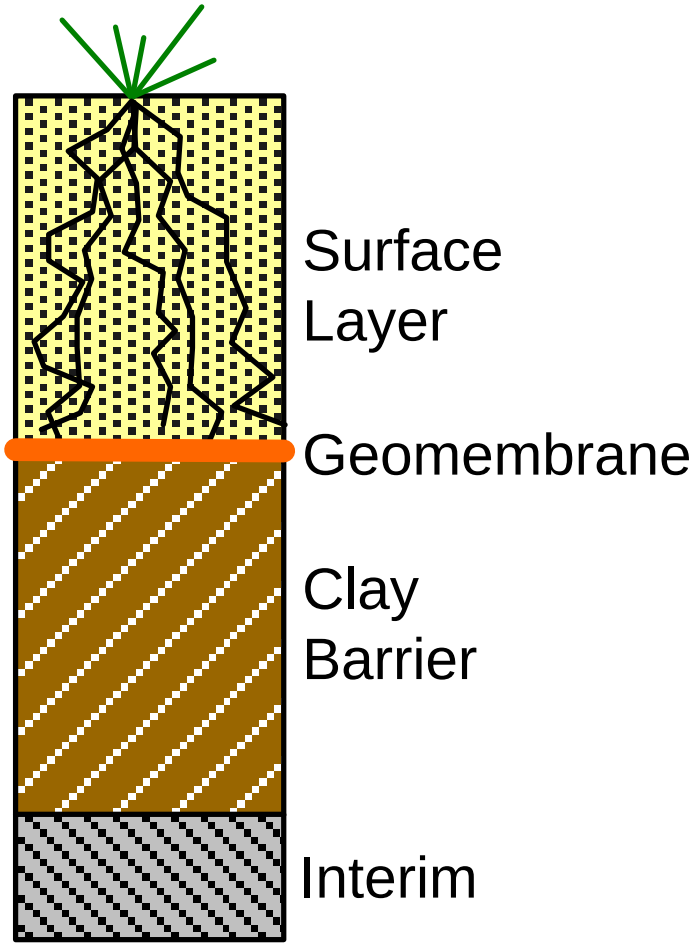
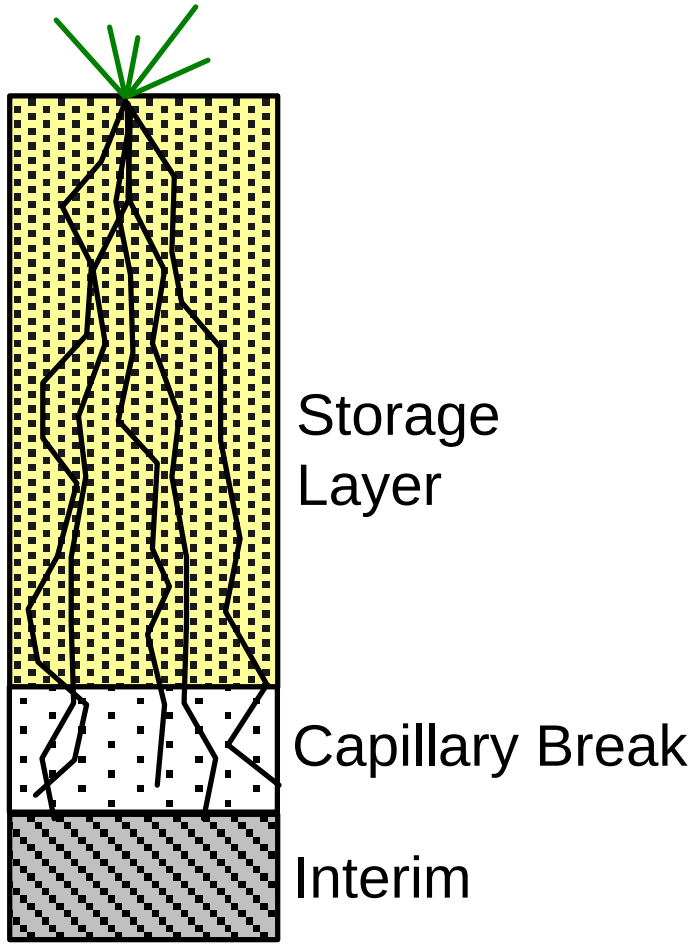
CRESP

Cover Strategy:
Resistive Barrier vs. Water Balance Covers

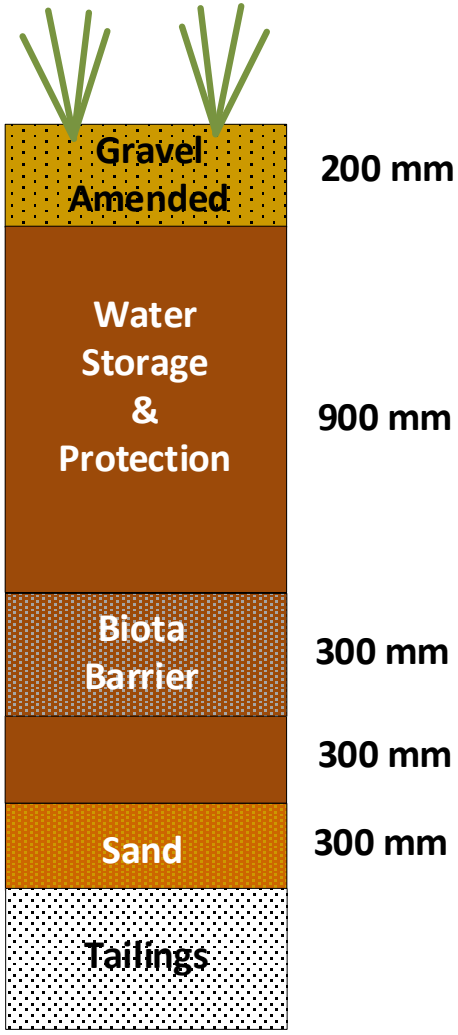




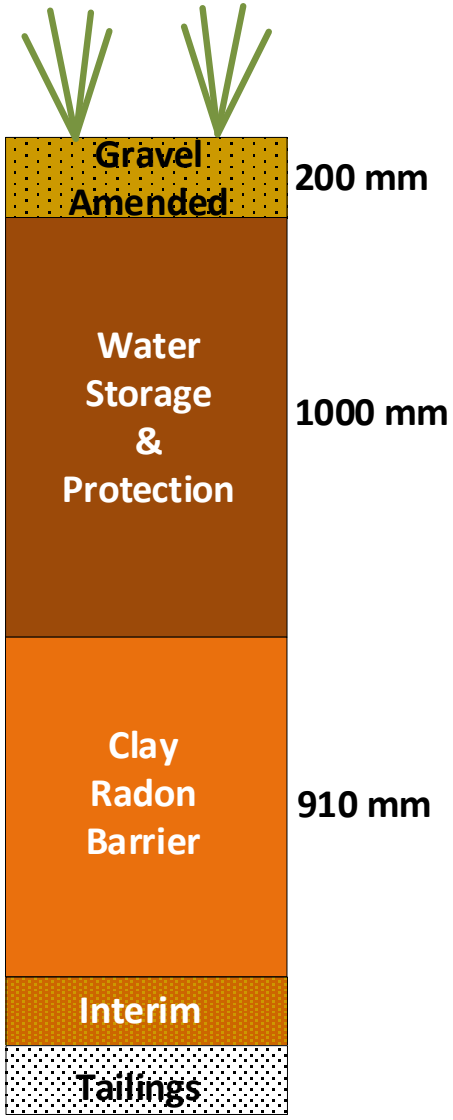
Conventional Cover

Water Balance Cover

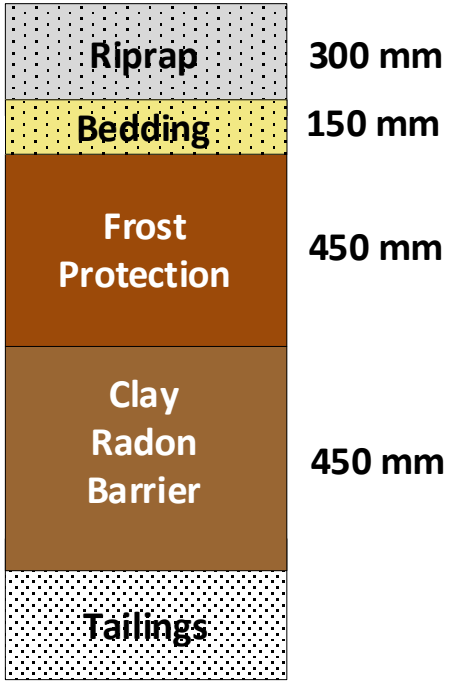
Monticello Disposal Facility



White Mesa Mill Tailings Facility



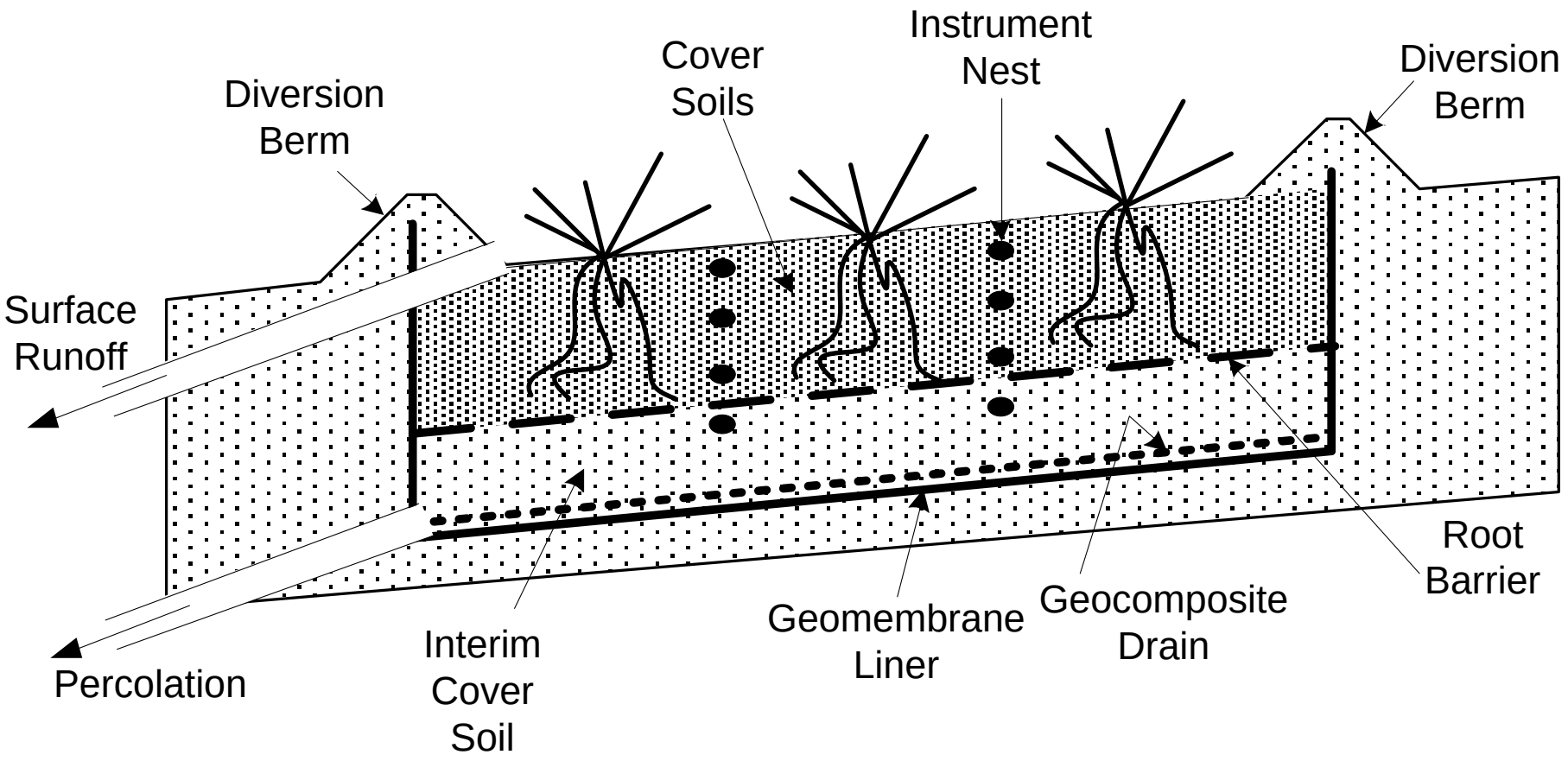
Cheney Disposal Facility




Utah
Colorado
Salt Lake City
Sandy
Provo
Vernal
Price
Moab
Grand Junction
Aspen
Montrose
Cortez
Bluff
Springdale
Kanab
Page
Oljato-Monument Valley
Uinta-Wasatch-Cache National Forest
UINTAH AND OURAY RESERVATION
Medicine Bow-Routt National Forests
White River National Forest
UTAH
Fishlake National Forest
Uncompahgre National Forest
Grand Staircase-Escalante National Monument
San Juan National Forest
UTE MOUNTAIN RESERVATION
Cheney Disposal Facility
Monticello Disposal Facility
White Mesa Mill
80
15
70
15
70

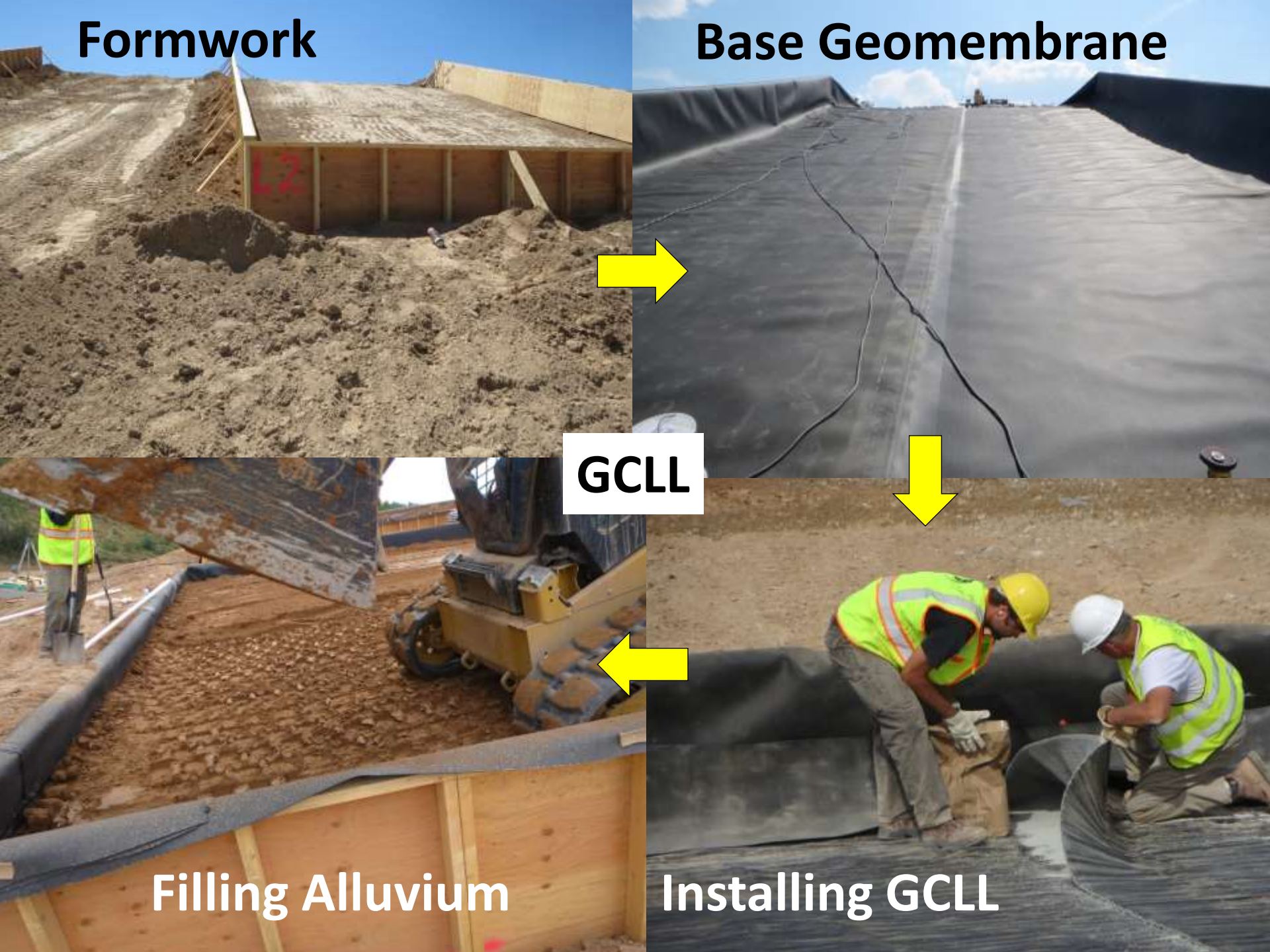
Validate Performance with ACAP Lysimeter

ACAP lysimeters used to confirm a design meets performance goal by directly monitoring percolation and to understand, when necessary, the hydrologic processes controlling percolation.



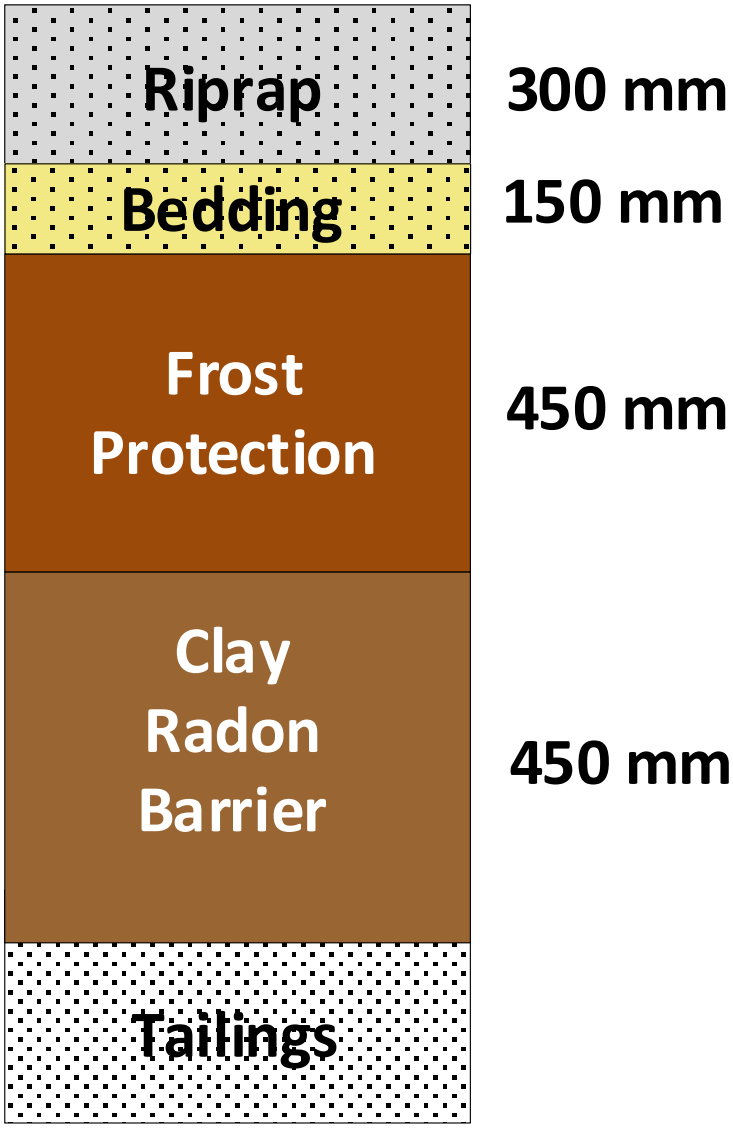
Benson, C., Albright, W., Fratta, D., Tinjum, J., Kucukkirca, E., Lee, S., Scalia, J., Schlicht, P., Wang, X. (2011), Engineered Covers for Waste Containment: Changes in Engineering Properties & Implications for Long-Term Performance Assessment, NUREG/CR-7028, Office of Research, U.S. Nuclear Regulatory Commission, Washington.


Water Balance
Resistive
Blackfoot Bridge, August 2013

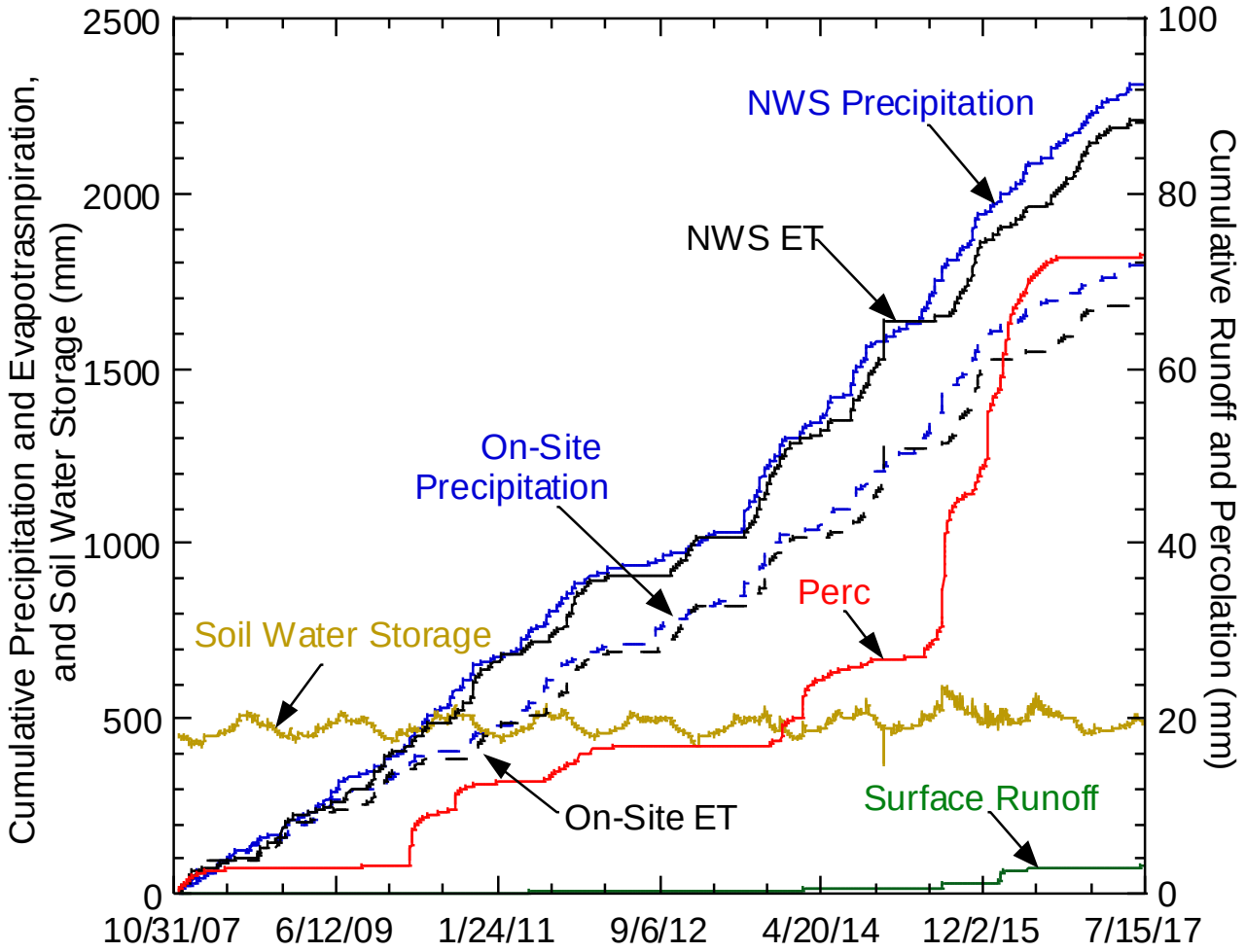

Formwork
Base Geomembrane
GCLL
Filling Alluvium
Installing GCLL


July 2015

Armored Cover at Cheney Disposal Facility

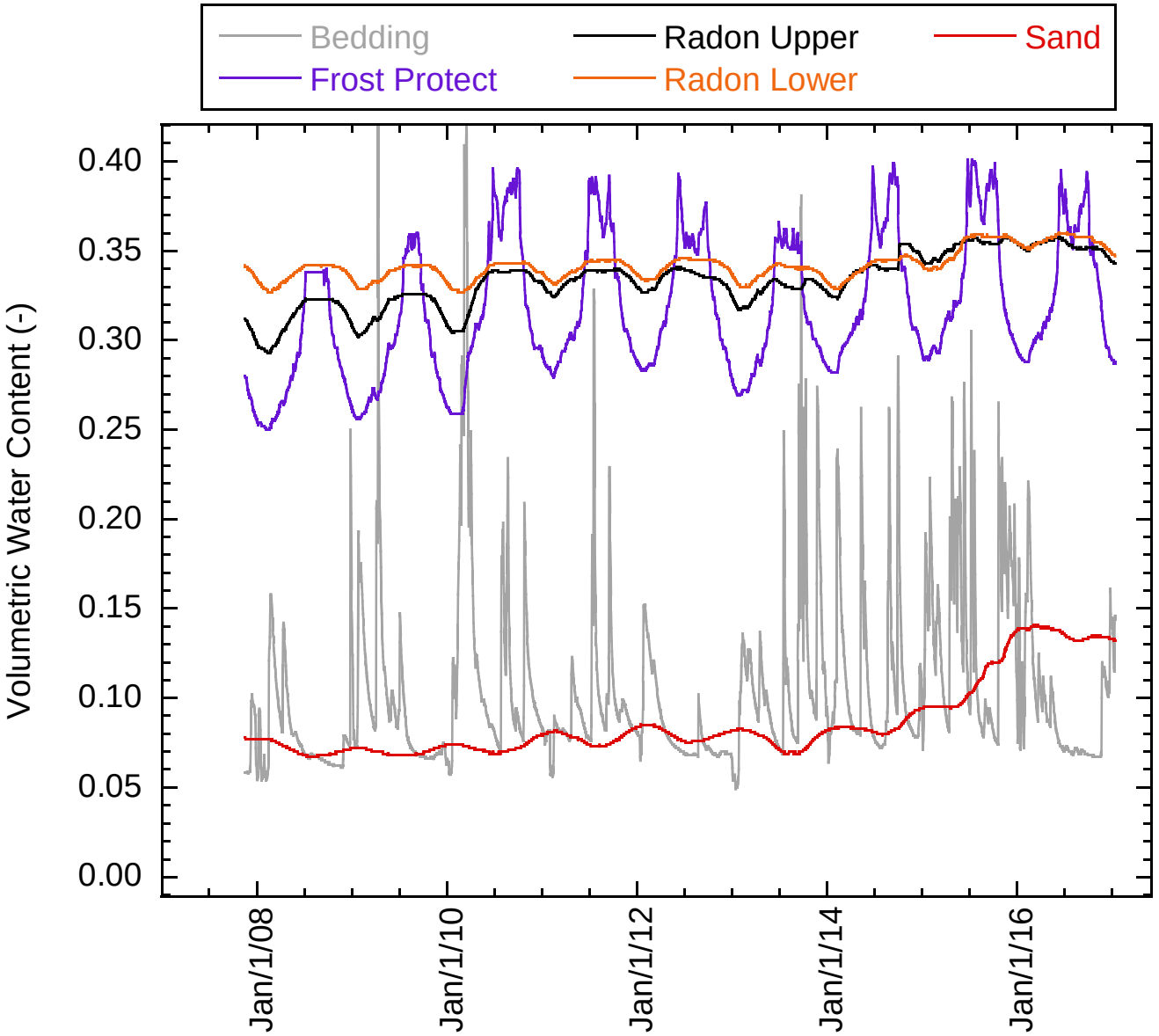


Cheney Water Balance Record



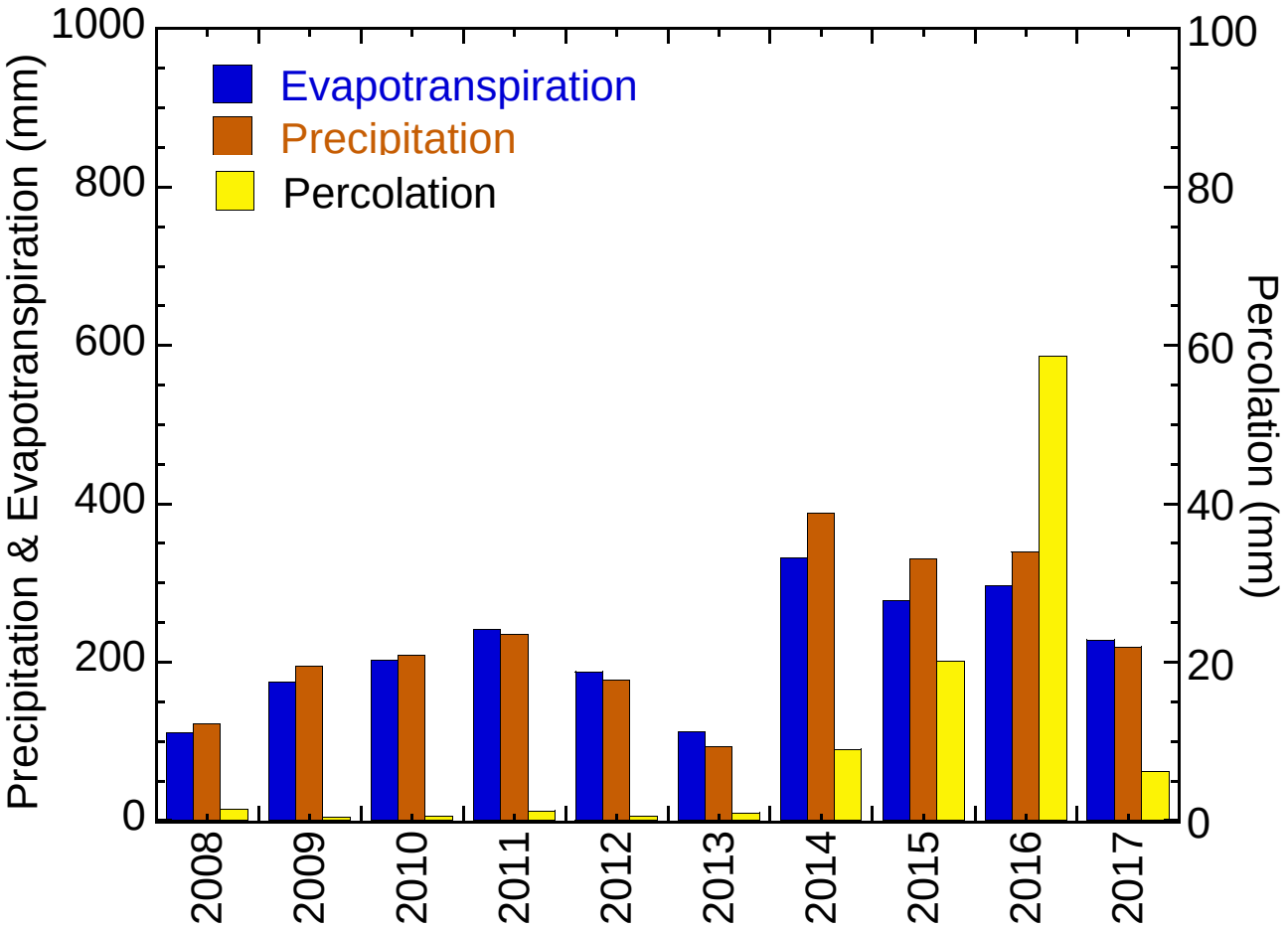
- Most precipitation becomes ET
- Perc much higher later in record.
- Subtle variation in soil water storage.
- Very little runoff.

Cheney Water Content Record



- Bedding and frost protection layer vary seasonally
- Radon barrier saturated at end of record
- Increase in water content of sand consistent with percolation

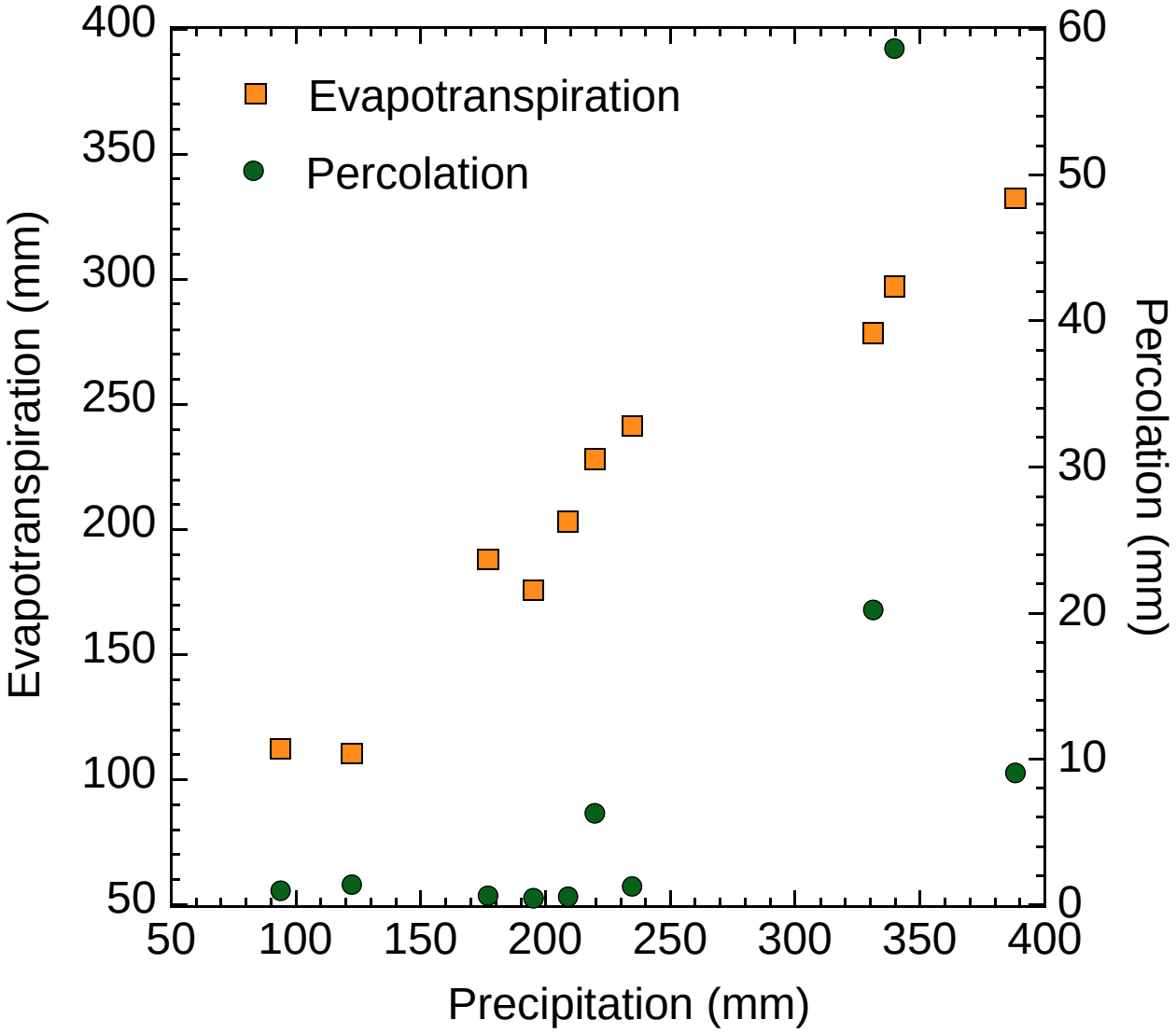
Cheney Annual Water Balance



Note: Y2 scale 10x < than Y1

- ET largest fraction, but usually < precip
- Perc relatively low, **except** during wetter years.
- **Perc tied directly to integrity of clay radon barrier.**

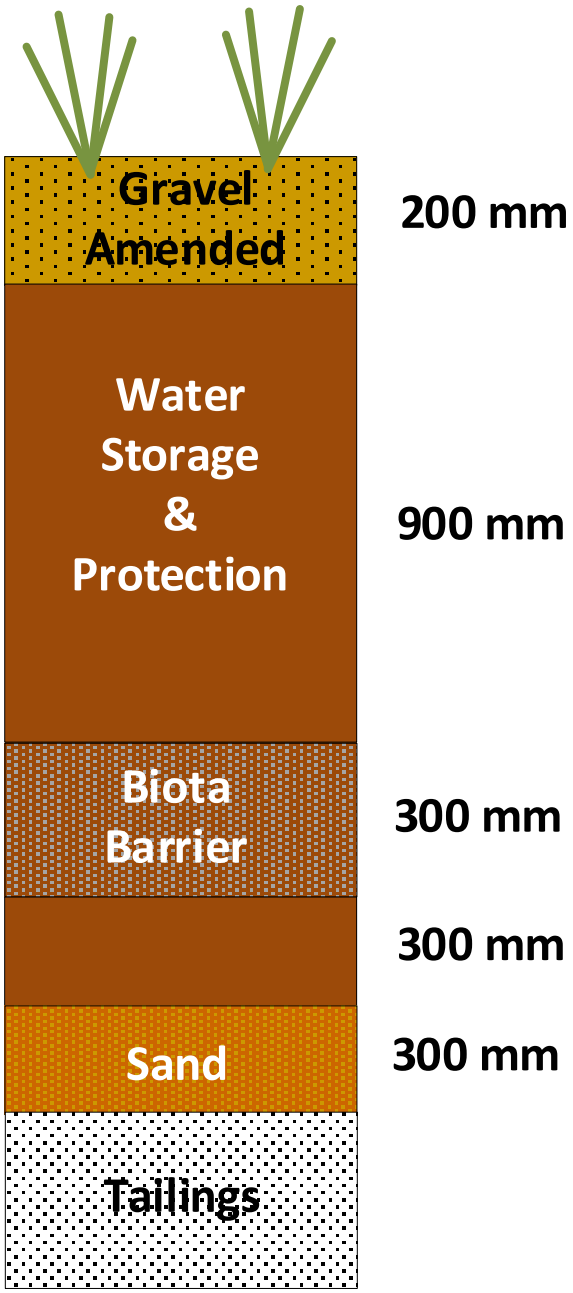
Cheney: Percolation & Precipitation



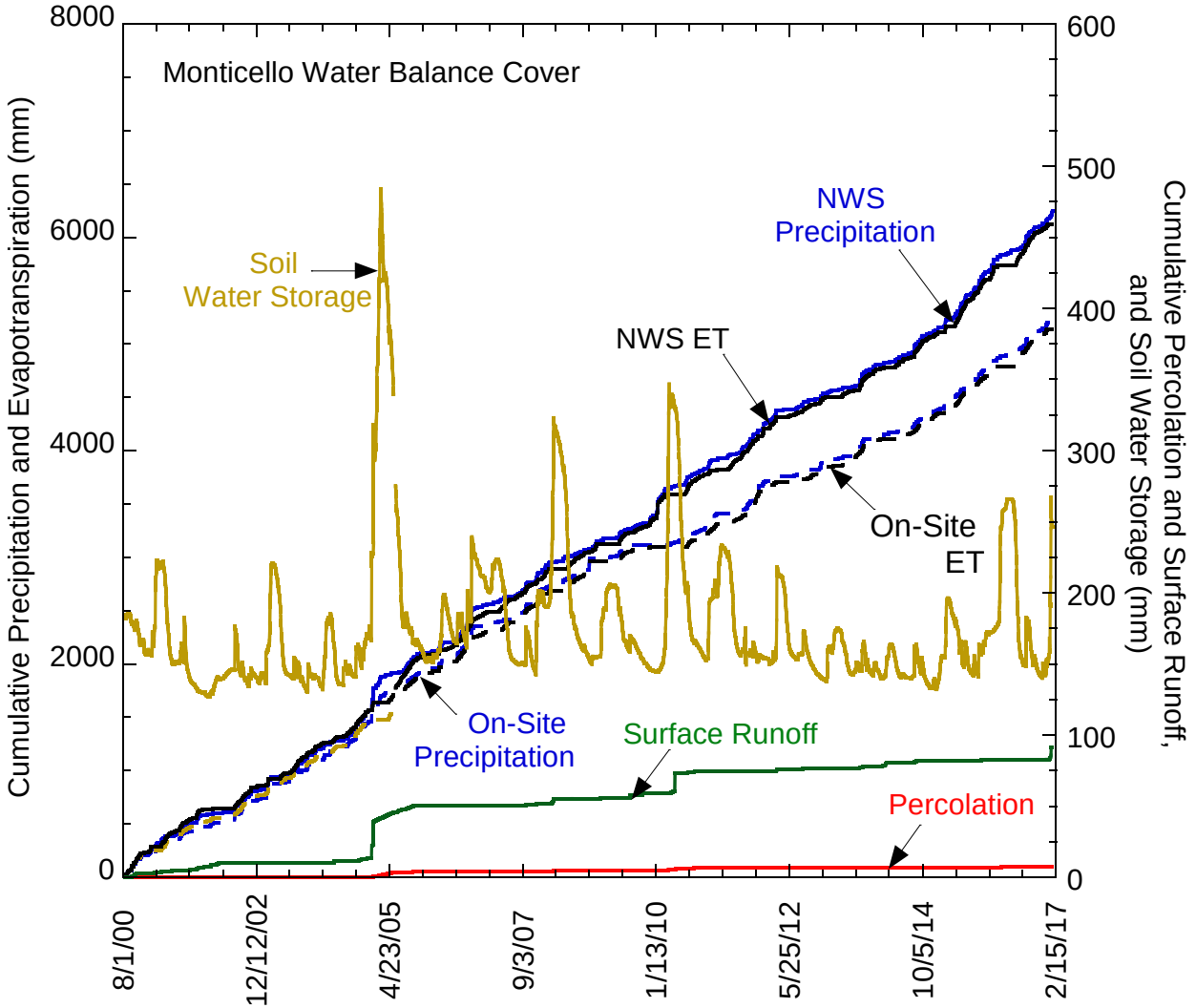
- Most of precipitation becomes ET
- Perc much higher during wetter years
- **Barrier integrity critical for managing wet conditions.**

Water Balance Cover at Monticello Disposal Facility

Elevation: 2150 mm
Precipitation: 370 mm
Climate: Seasonal semi-arid
Cover Thickness: 2.0 m

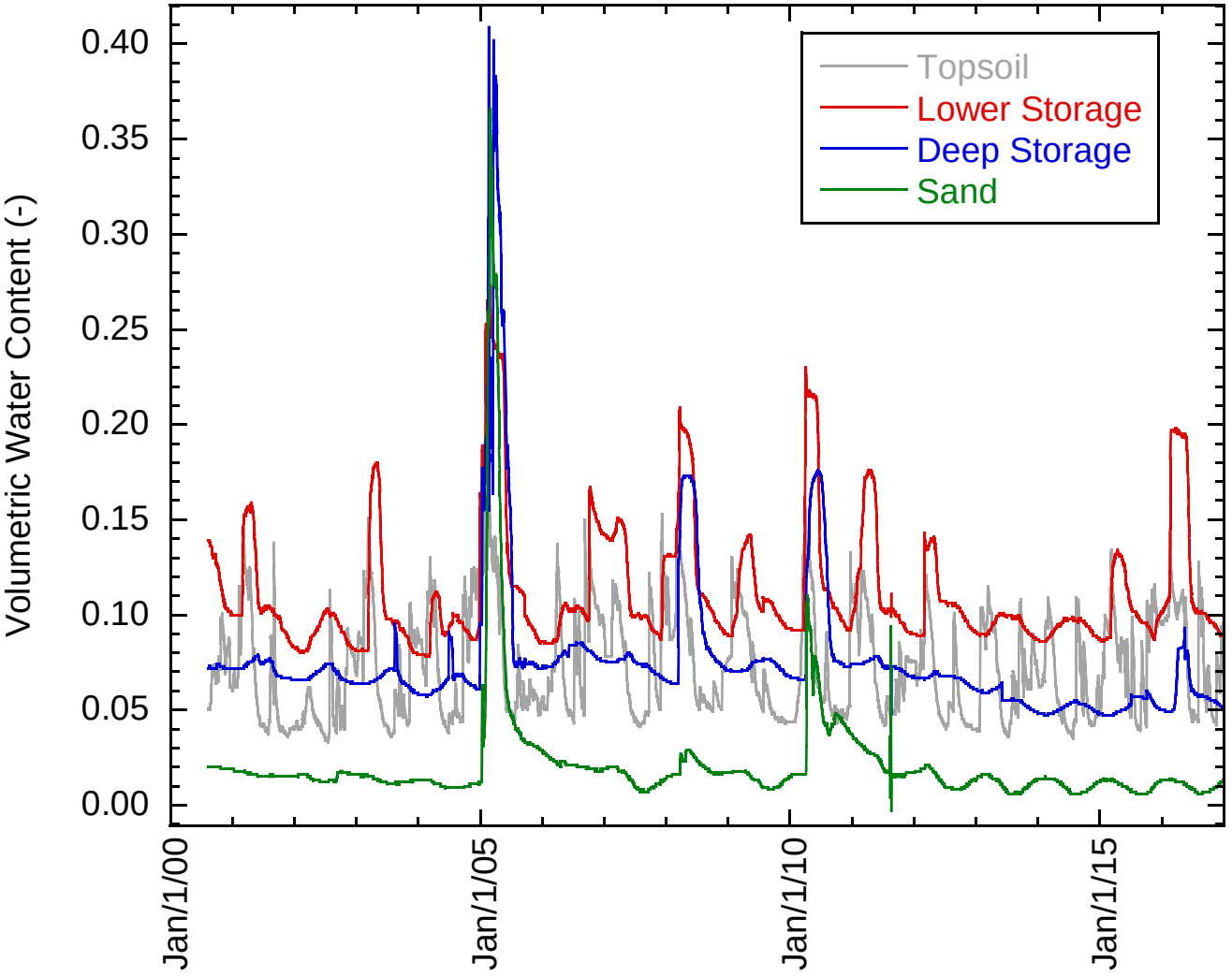


Monticello Water Balance Record



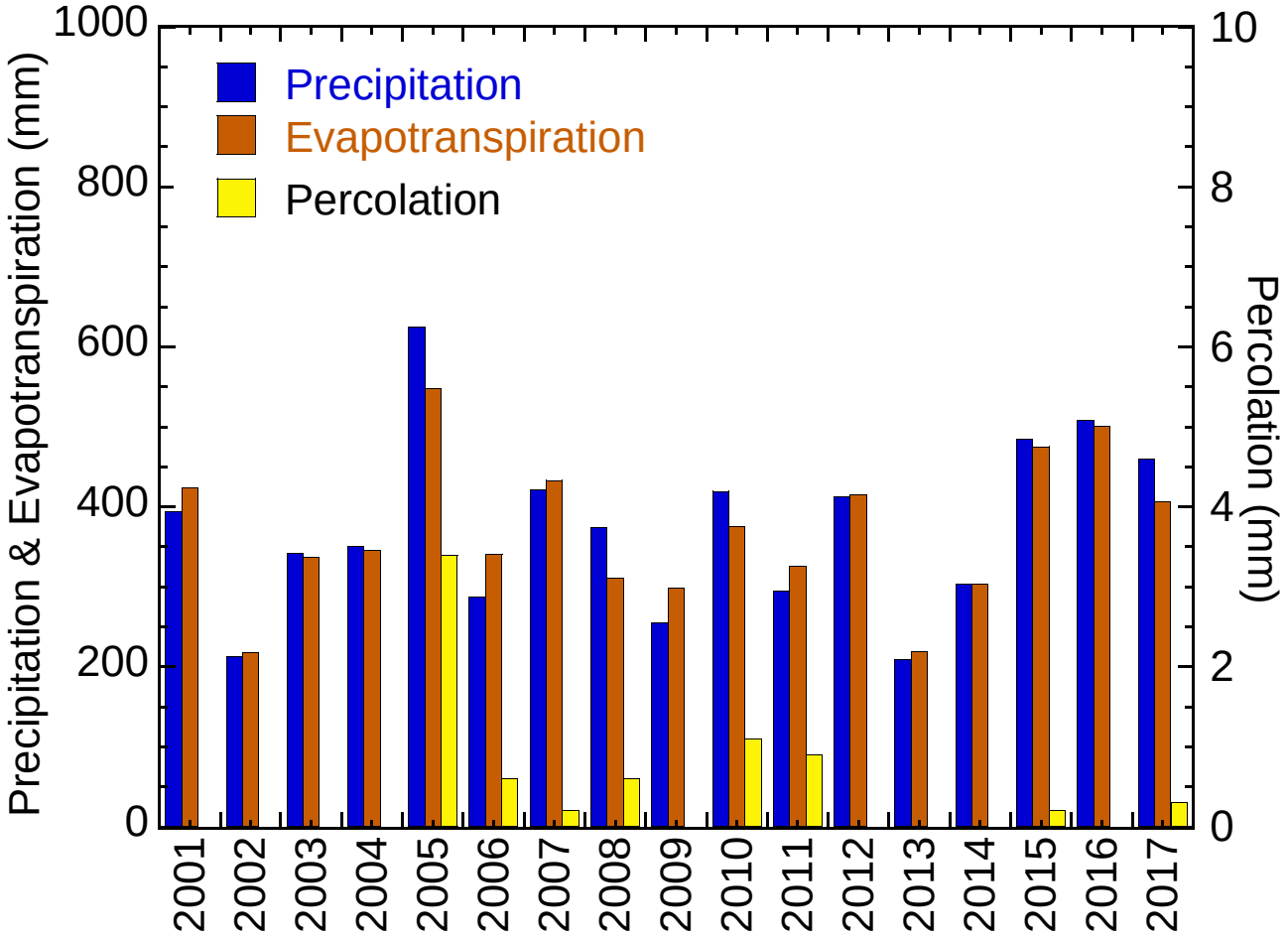
- Nearly all precip becomes ET
- Storing & releasing water each year
- Runoff very small fraction (minimal erosion)
- Avg percolation rate < 0.5 mm/yr

Monticello Water Content Record



- High frequency variation near surface.
- Dampens with depth
- Runoff very small fraction (minimal erosion)
- Avg percolation rate < 0.5 mm/yr

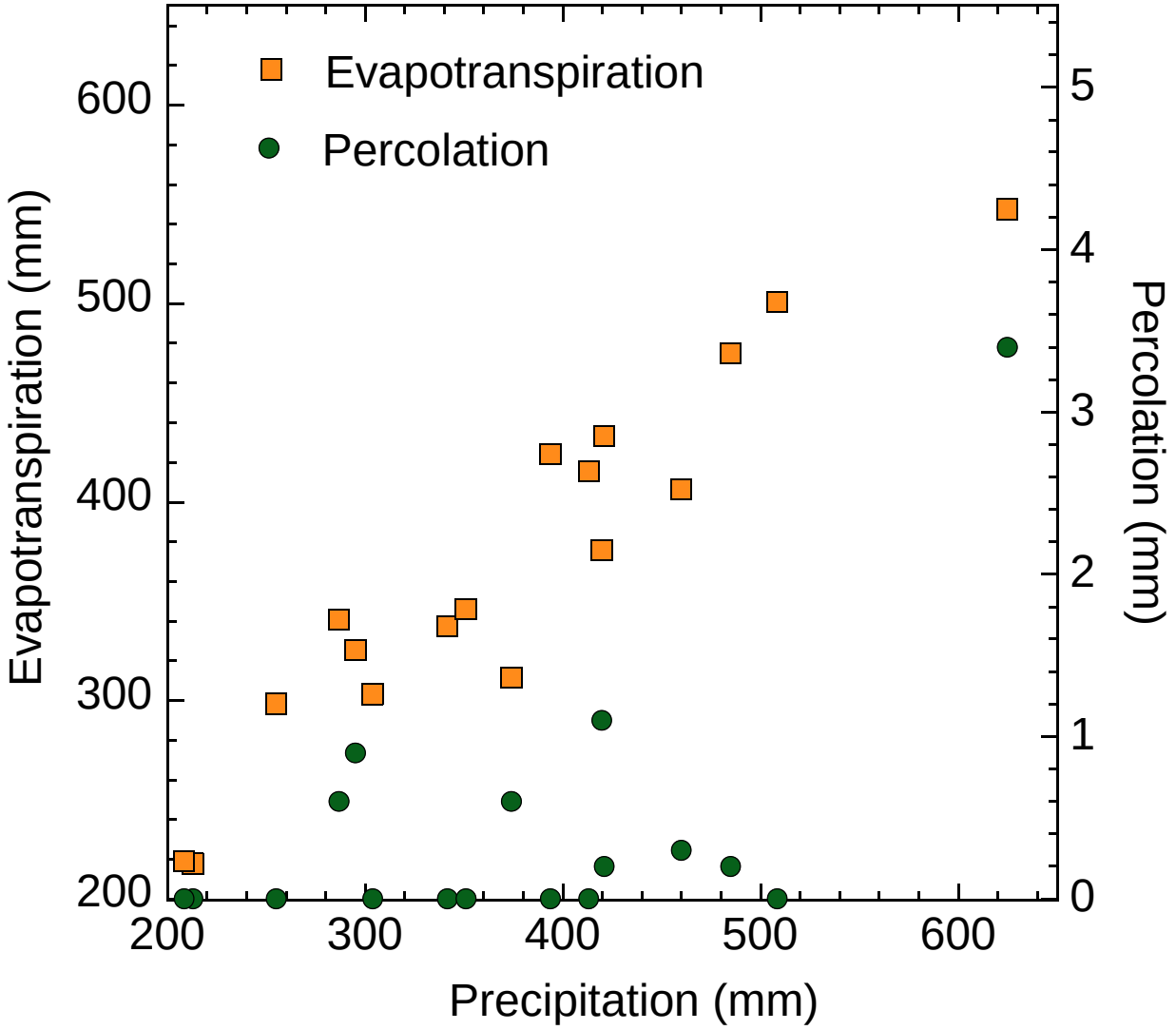
Monticello Annual Water Balance



- ET largest fraction, ≈ precip
- Perc very low, elevated **only** during wettest year

Note: Y2 scale **100x** < than Y1

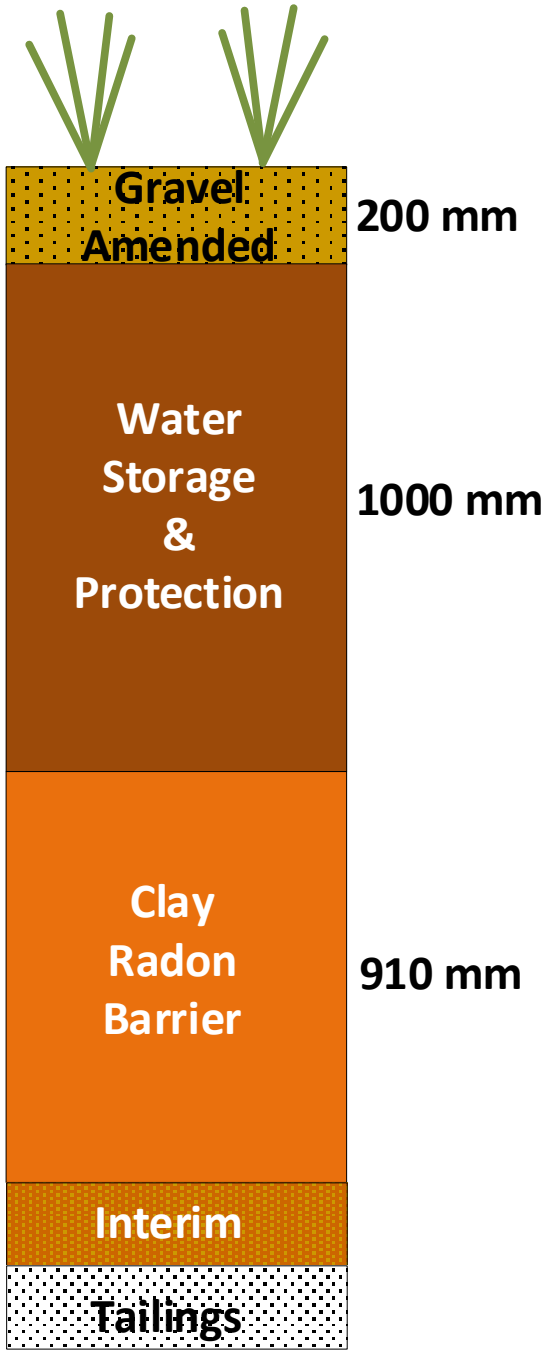
Monticello: Percolation & Precipitation



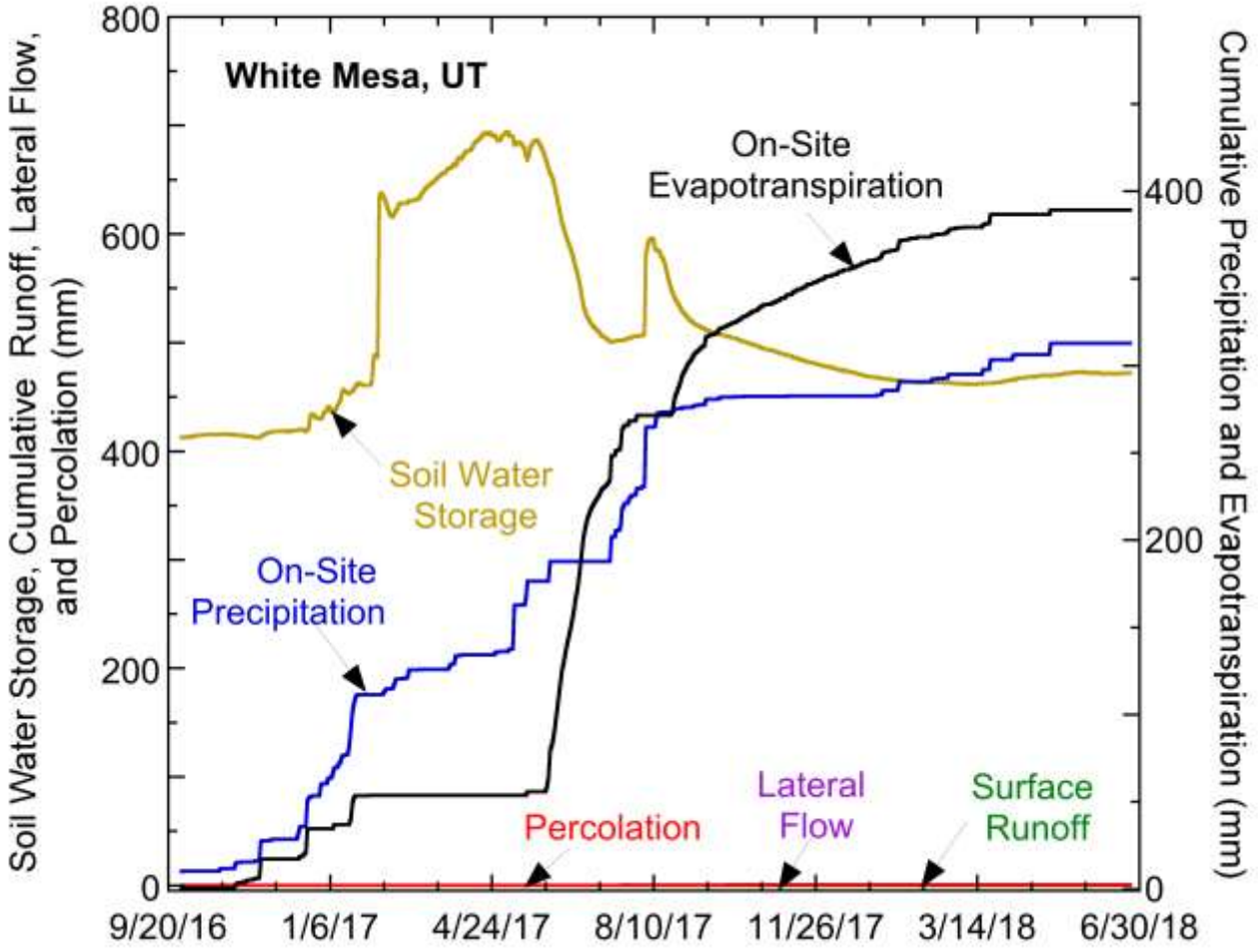
- Nearly **ALL** of precipitation becomes ET
- Perc elevated in very wet year **only**. Not dependent on magnitude of precipitation.

White Mesa Mill Tailings Facility

Elevation: 1900 m
Precipitation: 360 mm
Climate: Seasonal semi-arid
Cover Thickness: 2.0 m



White Mesa Water Balance Record



- Large seasonal change in soil water storage
- Vegetation being established, allowing longer residence of water in profile
- Perc, lateral flow, and runoff very low. Little erosion potential

Lessons Learned

- Water balance covers very effective in managing water balance at semi-arid sites for broad range of conditions. Percolation typically < than 0.5 mm/y on average.
- Water balance covers consistent with natural ecological setting, promoting long-term sustainable performance with minimal maintenance.
- Armored resistive barrier functions well with modest precipitation, but **long-term integrity of the barrier layer critical to proper functioning**.
- **At higher precipitation**, **percolation** from cover with resistive earthen barriers **increases substantially**.