

# THEHANFORDSITE

#### Modeling Evapotranspiration and Soil-Moisture Flow of a Modified RCRA Subtitle C Surface Barrier

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# Background: Tank Farms



- In December 2013, DOE issued the Tank Closure and Waste Management Environmental Impact Statement record of decision (ROD)
- The ROD stated the single-shell tanks will be landfill-closed, meaning an engineered modified Resource Conservation and Recovery Act Subtitle C (RCRA C) barrier put in place followed by post-closure care.









# Background: Surface Barrier over Tank Farms











#### THE **HANFORD** SITE

Natural land, MRV

# Objectives

- -Simulate
  - ET by vegetation
  - Flow process
    - Within the surface barrier
    - Beneath the surface barrier
    - In the soil without a surface barrier



ET Cover, DRV (in the barrier only)



### **HEHRNFORDSITE** Determination of ET

 $\mathbf{ET} = \boldsymbol{\beta}_{et} \cdot \boldsymbol{\beta}_{w} \cdot \mathbf{ETo}$ 

ETo: Reference ET

- Penmann-Monteith method for alfafa
- Daily ETo values were calculated based on weather data at Hanford

 $\beta_{et}$  : coefficient of evapotranspiration ( 0 to 1)

- Seasonal variation of ET
- dependent on the plant phenology and weather

 $\beta_{w}$ : soil water stress factor (0 to 1)







#### **ET Simulation with eSTOMP-W**

- STOMP: Subsurface Transport Over Multiple Phases
- The model solves sets of nonlinear conservation equations for water mass
- Water due to ET is removed from the soil where roots reside

https://www.pnnl.gov/projects/stomp





Cumulative Root Fraction (Zeng, 2001):

 $Y = 1-0.5[\exp(-az) + \exp(-bz)]$ 







#### Mesh and Simulation Execution



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#### Water Content: 0-2 years (Video)



#### Water Content: 41-44 years (Video)







2023-09-05\_zfz\_barrier\_1\_contour\_pos3\_qw\_200\_0-2.png



2023-09-11\_zfz\_barrier\_1\_contour\_pos3\_mc\_200\_0-5.png

#### Soil Moisture Flux of Profile #3: 0-5 yr

Below the Surface Barrier

Top 4 m



Aqueous Flux Rate (mm/yr)









**Below the Surface Barrier** 

Top 4 m

<sup>2023-09-11</sup>\_zfz\_barrier\_1\_contour\_pos3\_qw\_200.png



<sup>2023-08-24</sup>\_zfz\_barrier\_1\_contour\_pos1\_qw\_192.png



<sup>2023-08-24</sup>\_zfz\_barrier\_1\_contour\_pos2\_qw\_192.png



<sup>2023-08-24</sup>\_zfz\_barrier\_1\_contour\_pos3\_qw\_full.png



<sup>2023-08-24</sup>\_zfz\_barrier\_1\_contour\_pos1\_qw\_full.png



<sup>2023-08-24</sup>\_zfz\_barrier\_1\_contour\_pos2\_qw\_full.png

#### **Evapotranspiration:** Surface Cover











#### **Evapotranspiration:** Natural Land



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![](_page_20_Picture_3.jpeg)

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- The ET-type modified RCRA Subtitle C surface barrier design has been proposed for Single Shell Tank Waste Management Area.
- Simulation capability of ET is needed for understanding the longterm performance of such a surface barrier.
- The eSTOMP-W simulator with the ET-simulation capability appears reasonably predicted the flow processes of and ET from the surface barrier, the side slopes, and the natural land.

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