

EVAPORATION – EVALUATION & CONTROL

4-YEAR STUDY – RESULTS AND LESSONS LEARNED

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EVAPORATION – EVALUATION & CONTROL

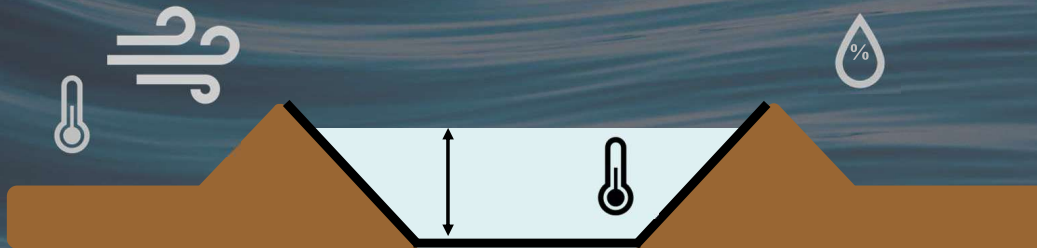
Understanding evaporation is important for managing oilfield water:

Produced Water – Reduce volumes

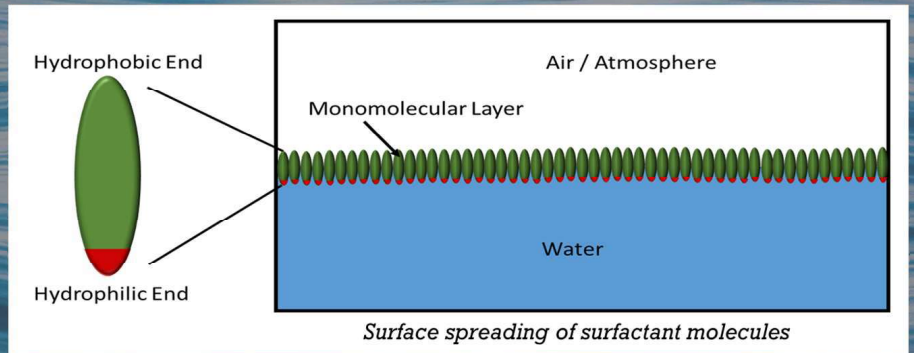
Fresh / Brackish Water – Conservation

Factors influencing evaporation from oilfield frac pits:

- **Air temperature**
- **Water temperature**
- **Wind speed & direction**
- **Pit Design**
 - Liner properties
 - Depth
- **Relative humidity of surroundings**
- **Water Salinity**
- **Atmospheric Pressure**



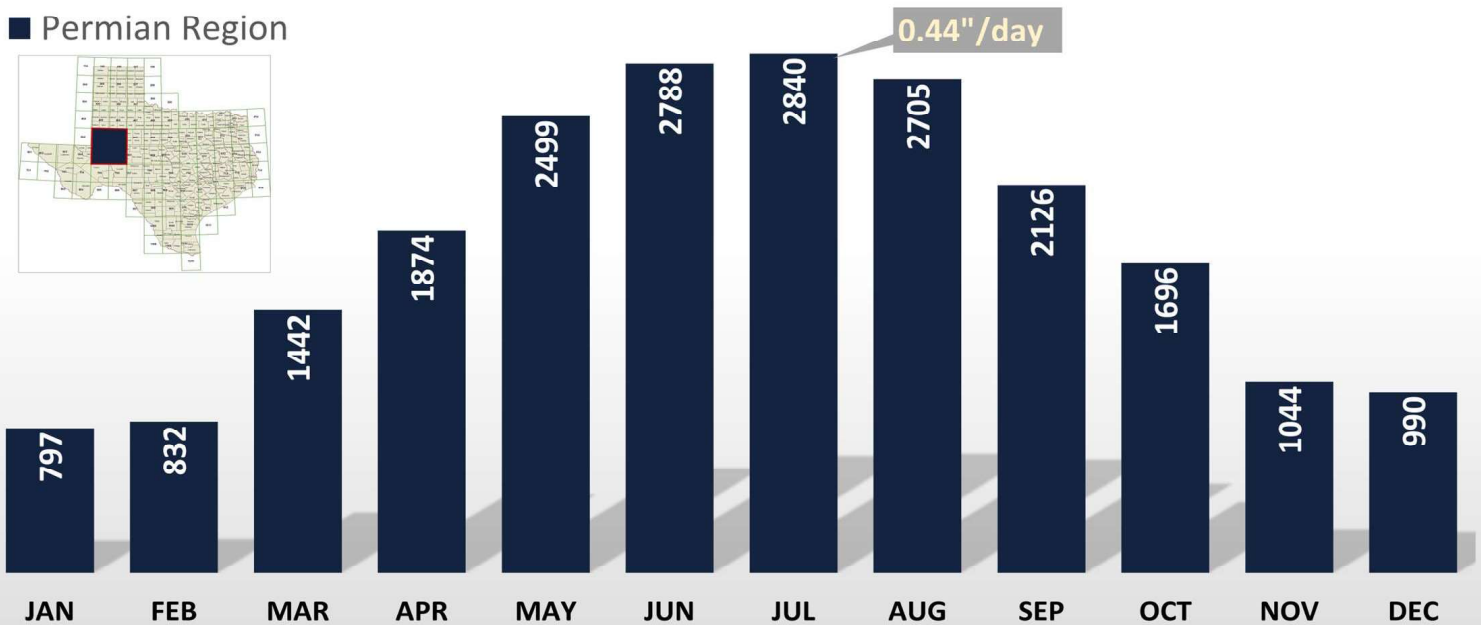
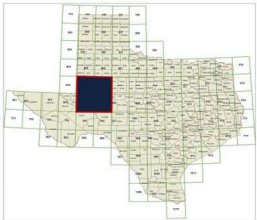
EVAPORATION CONTROL



EVAPORATION IN THE PERMIAN

1,000,000-bbl Pit: Barrels Lost per Day

■ Permian Region



†Data obtained from Texas Water Development Board; estimates based on 3-year monthly evaporation averages 2020-2022; evaporation pan coefficients adjusted to account for shallow, lined water pits

EVAPORATION EVALUATION

Conventional Method



New Method: Apply Product & Measure



EVAPORATION MODEL & VALIDATION

MODIFIED PENMAN-ROHWER EVAPORATION MODEL:

$$E = C_p [0.40 (e_w - e_a) (1 + 0.168 u_{2m})]$$

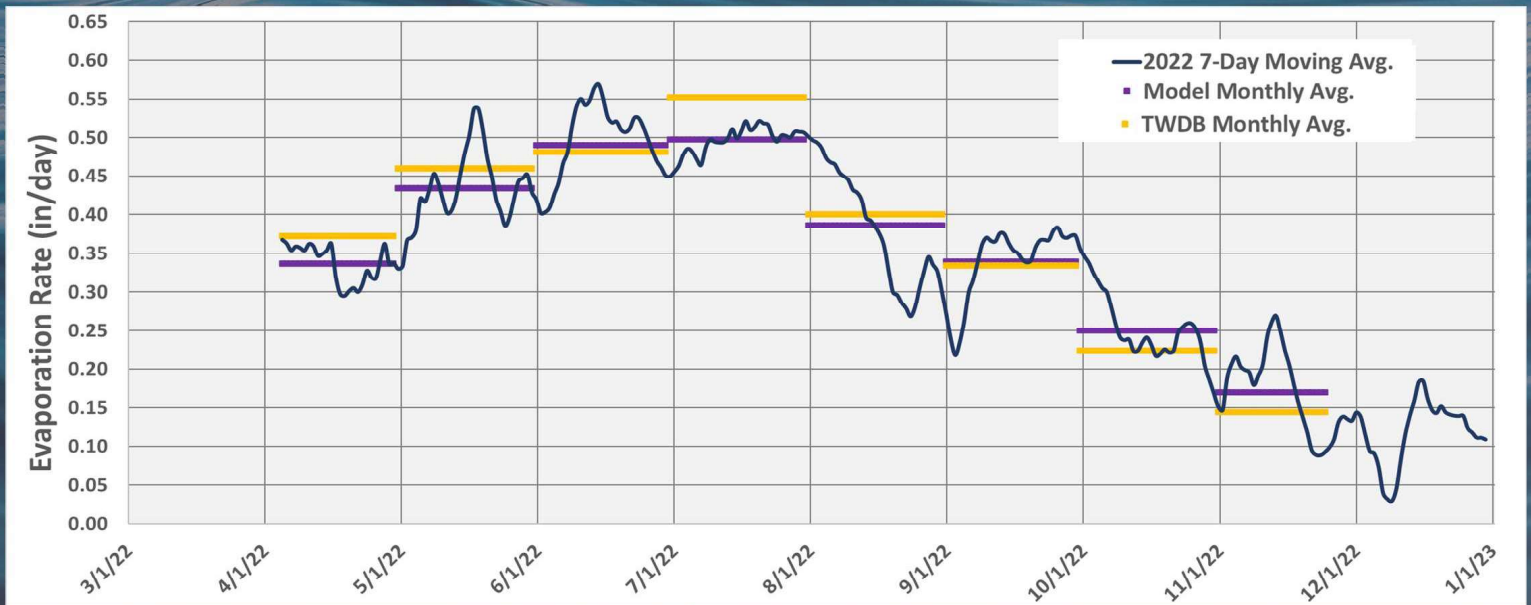
E = Evap. Rate [mm/day]

C_p = Pan Evap. Coefficient

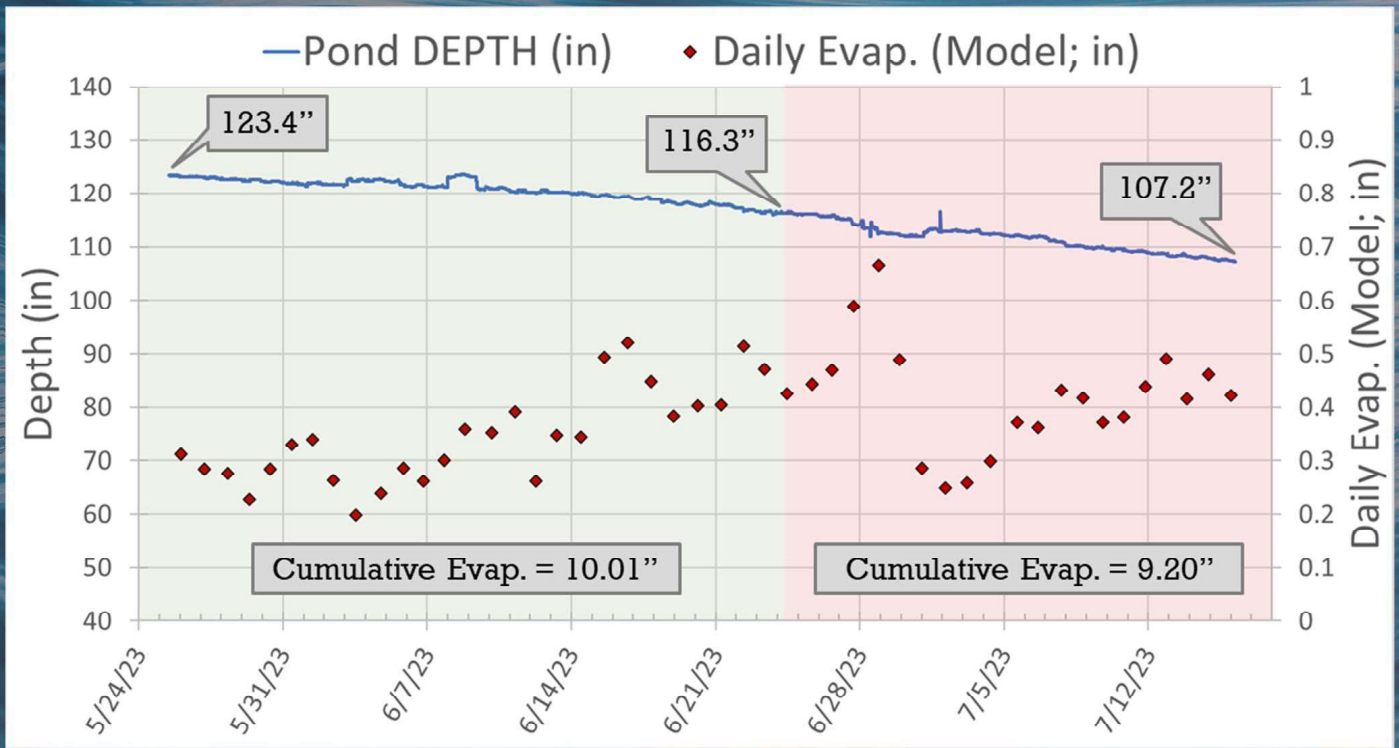
u_{2m} = Wind Speed at 2m Above Ground [mph]

e_w = Sat. Vapor Press. @ Water Surface Temp. [mmHg]

e_a = Vapor Press. in Air = (Rel. Humidity) x (Sat. Vapor Press. @ Air Temp.) [mmHg]



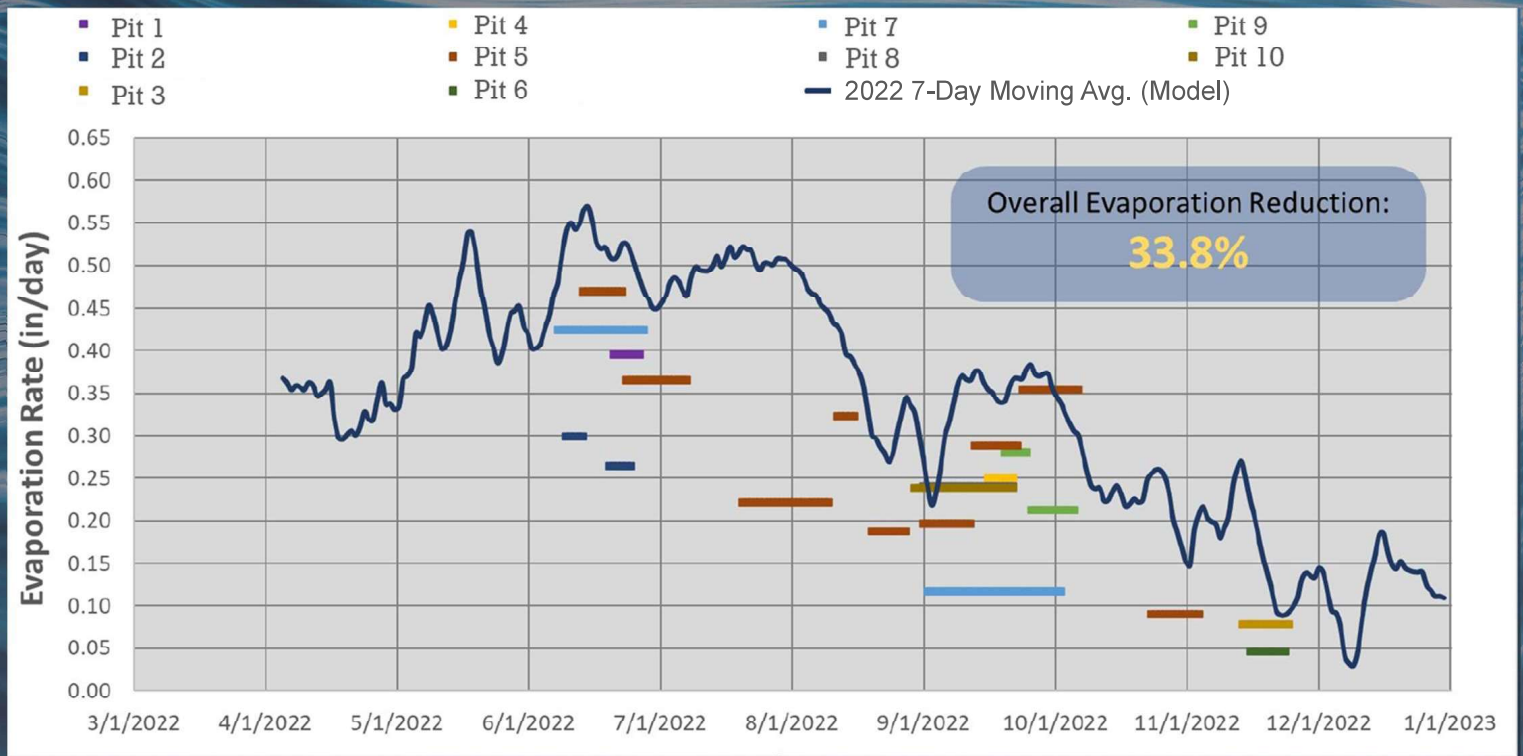
EVALUATION OF EVAPORATION INHIBITOR



Protected with Surfactant Layer:
 Water Loss = 7.08"
 Total Evap. (model) = 10.01"
29.2% EVAP. REDUCTION

Without Surfactant Layer:
 Water Loss = 9.12"
 Total Evap. (model) = 9.20"
EVAP. MODEL VALIDATION

EVAPORATION REDUCTION 2022



FINAL THOUGHTS

- Developed an excellent evaporation model for oilfield pits
- Evaporation inhibitor proven effective in the **Permian** and **Eagle Ford**
- 48 Automatic Dispensers presently deployed (24 with Data Acquisition)
- Observed evaporation reduction between **25 – 34%**
- Inhibitor currently being applied to **~ 100 pits**
- Excellent ROI up to **8:1**

