

Thermal Remediation in Fractured Rock

USGS / USEPA Region 10 Fractured Rock Workshop
Fractured Rock 102: Focus on Remediation
September 12, 2019

Lauren D. Soós
TRS Group, Inc.
978-514-3133
Isoos@thermalrs.com



TRS
TRS Group, Inc.
Accelerating Value

Safe. Fast. Certain. Guaranteed.

An Employee Owned Company
www.thermalrs.com

Outline

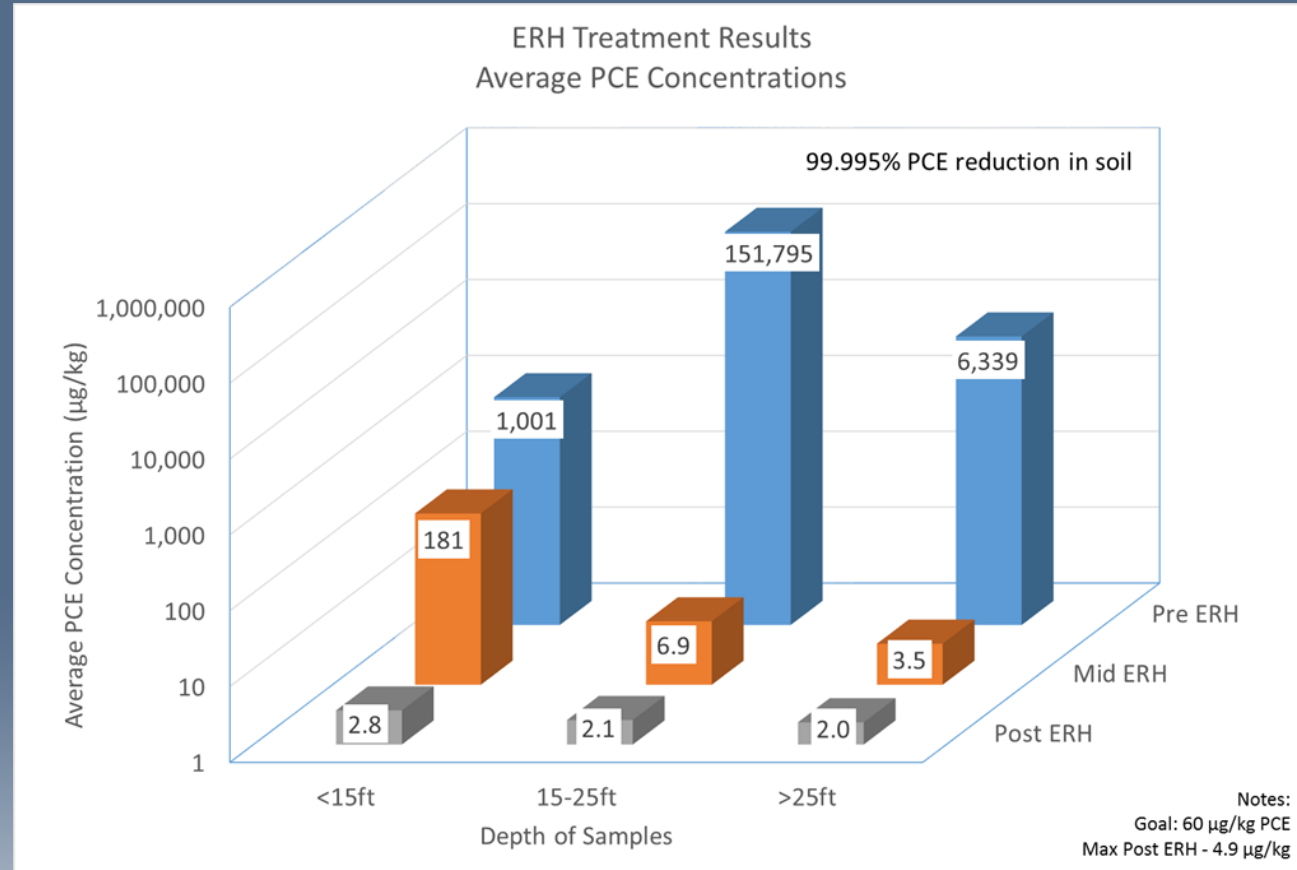
- ISTR introduction
- Thermal methods
- Technology fundamentals
- Case studies

Why ISTR: The Results

Guaranteed 99.9%
Removed 99.995%

Water to steam
1,600x expansion

Vadose zone
Saturated zone
Silty clay



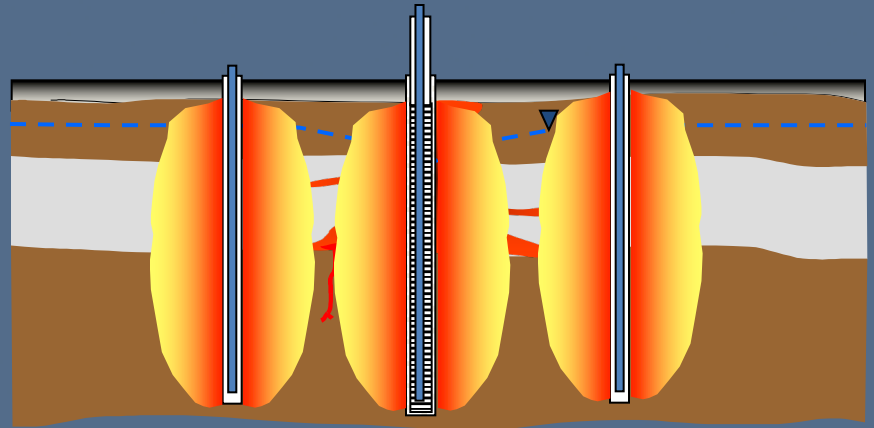
Strip Mall in Alexandria, Virginia

ISTR Value

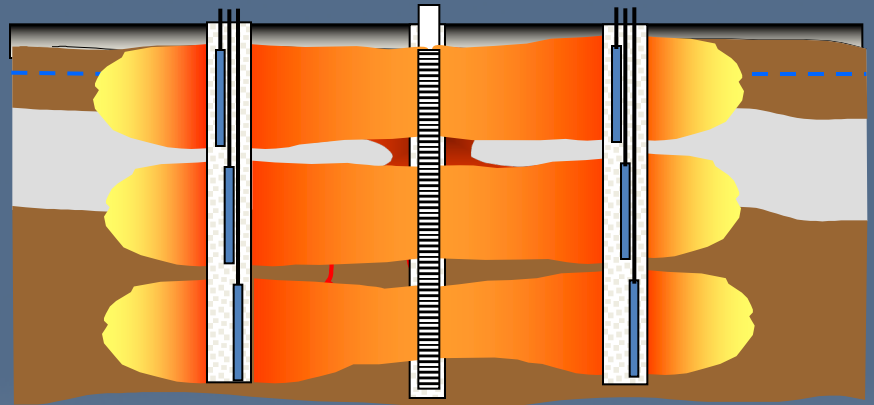
- Certainty in difficult matrices
- Fast: 3 to 6 months
- Reduce concentrations by >99%
- Remediation outside of treatment volume
- Low temperature strategies

ISTR Technologies

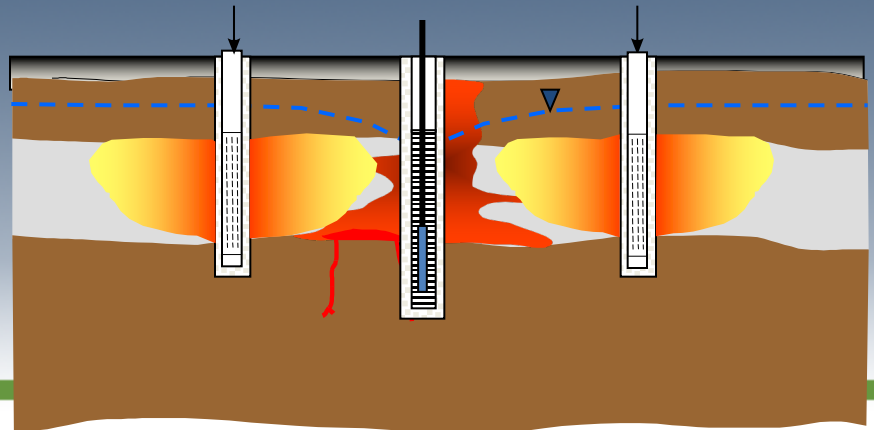
TCH – thermal conductivity



ERH – electrical conductivity



SEE – hydraulic conductivity



ISTR Technologies

Thermal Conduction Heating

Electrical Resistance Heating

Steam Enhanced Extraction

TCE

PCE

Xylenes
Naphthalene
Chlorobenzenes

PCB

Dioxin
PAH

PFAS

Boiling Points: 100°C

200°C

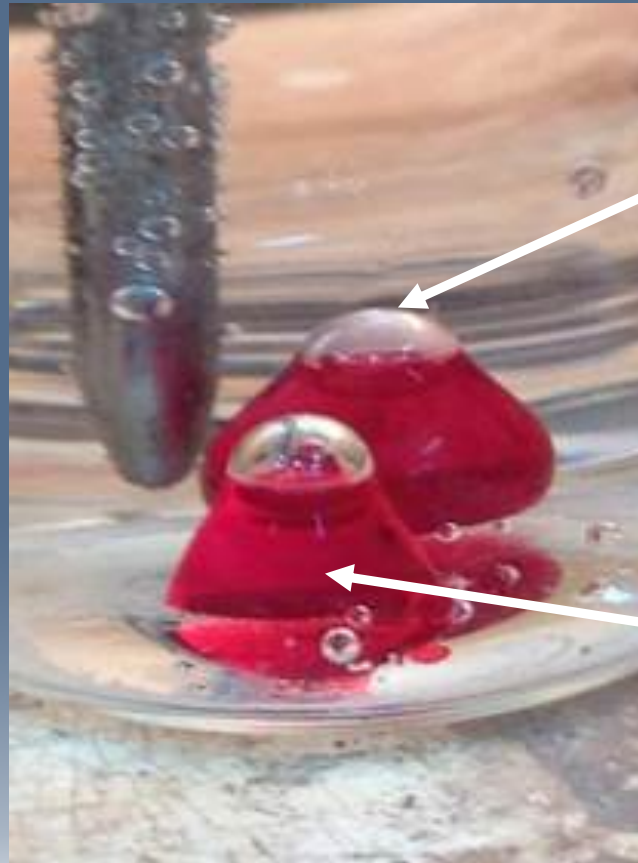
300°C

Heteroazeotrope of 1,2-Dichlorobenzene

1,2-DCB boils at 179°C

Azeotrope boils at 98°C

60% steam
40% 1,2-DCB

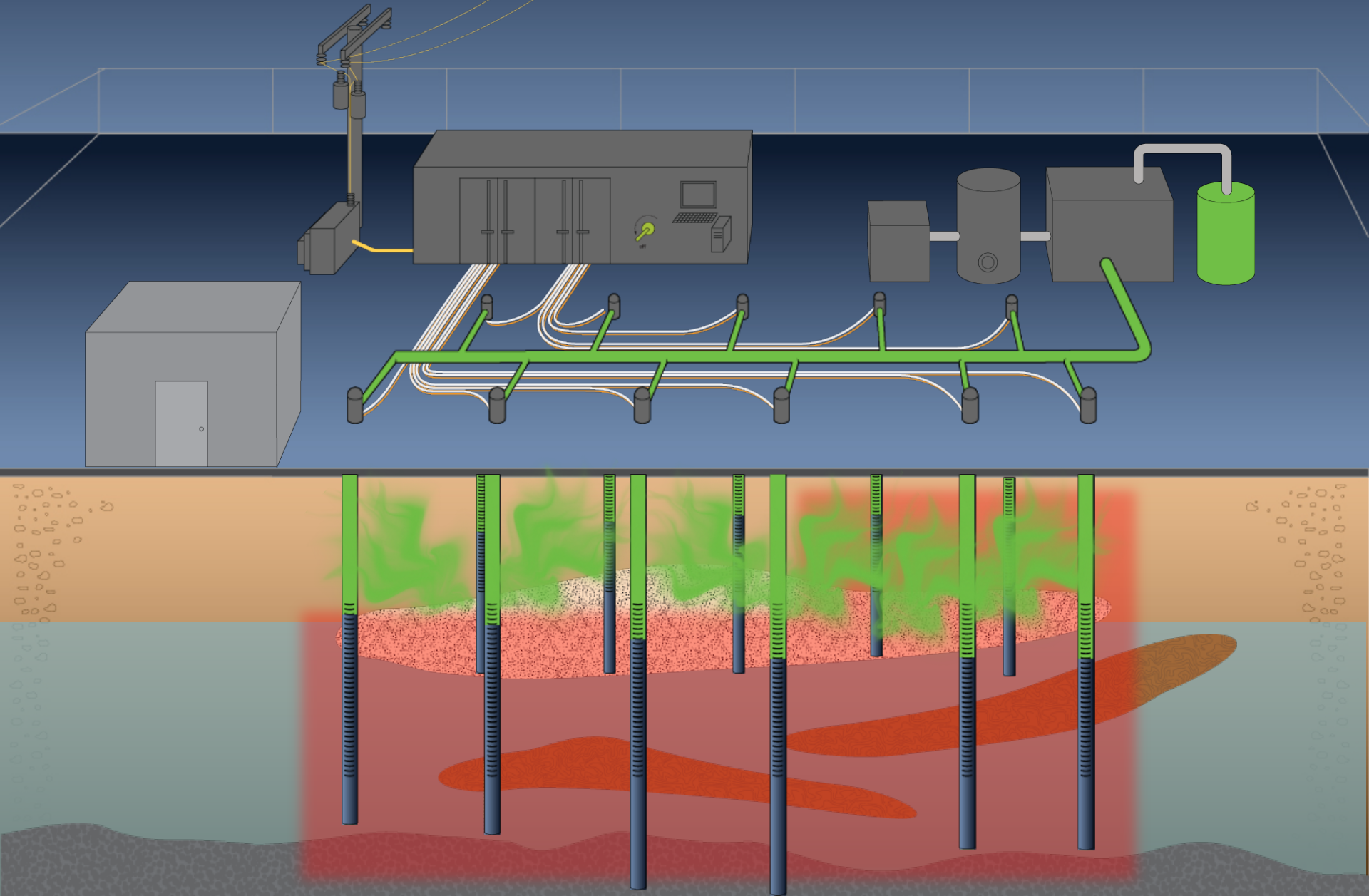


1,2-DCB DNAPL

Sweet Spot

- Electrical resistance heating: VOCs
- Thermal conduction heating: VOCs, SVOCs & PFAS
- Steam enhanced extraction: transmissive aquifers
- Combining technologies
- Heat enhanced processes

Electrical Resistance Heating





Installation Beneath Buildings

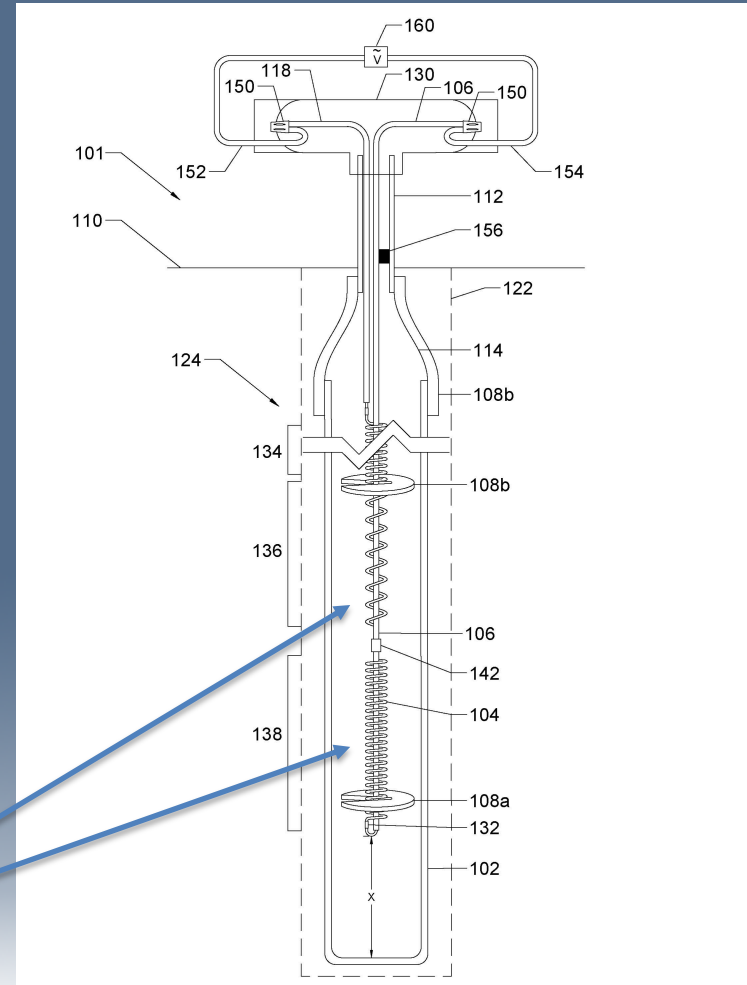


16° angle off horizontal (pictured)

FlexHeater® Remediation Services

- Patented design
- Infra-red radiation heats pipe
- Coil density affects soil temperature
- Fits in small diameter casing

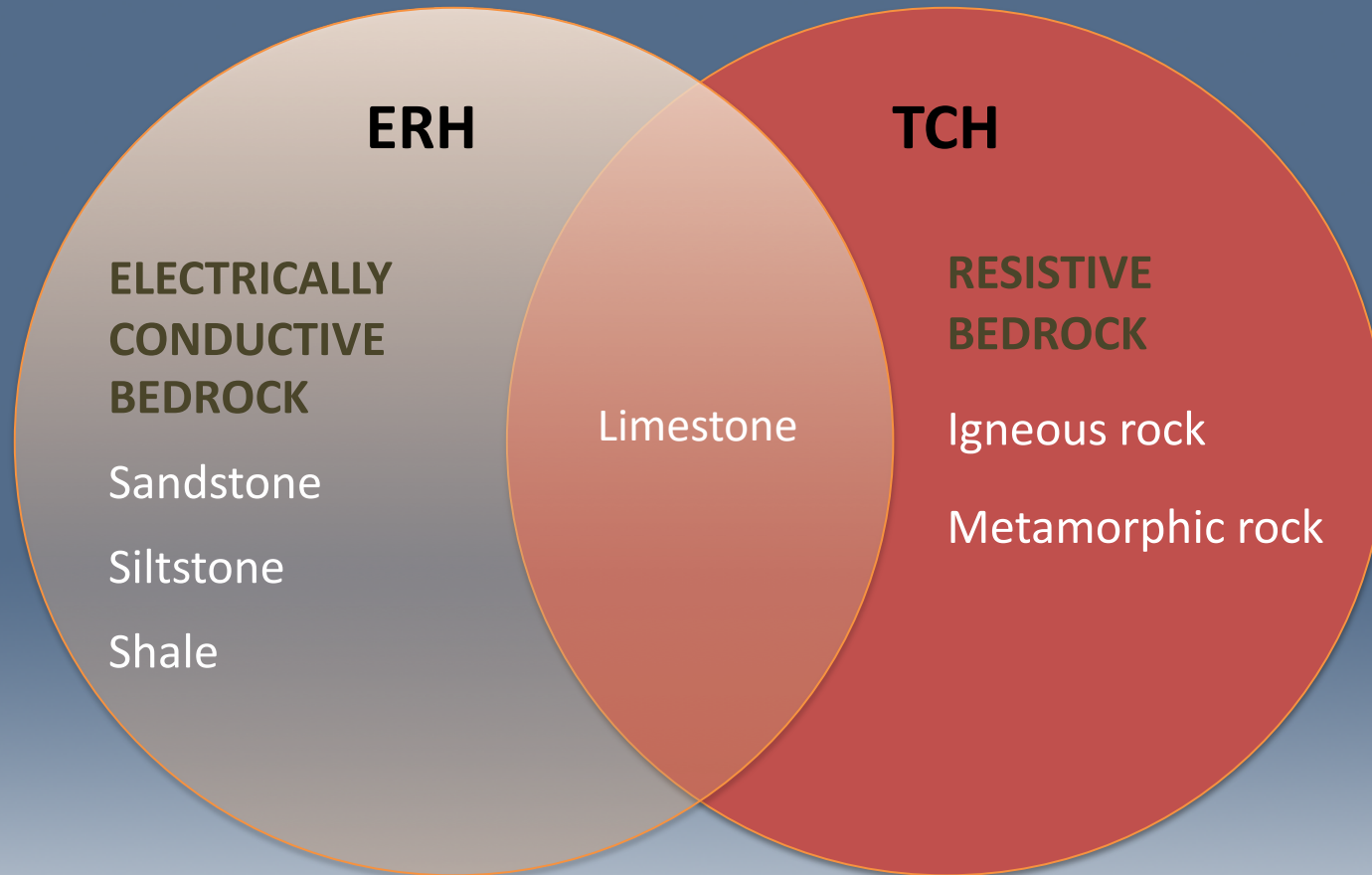
Variable Heating at Different Depths



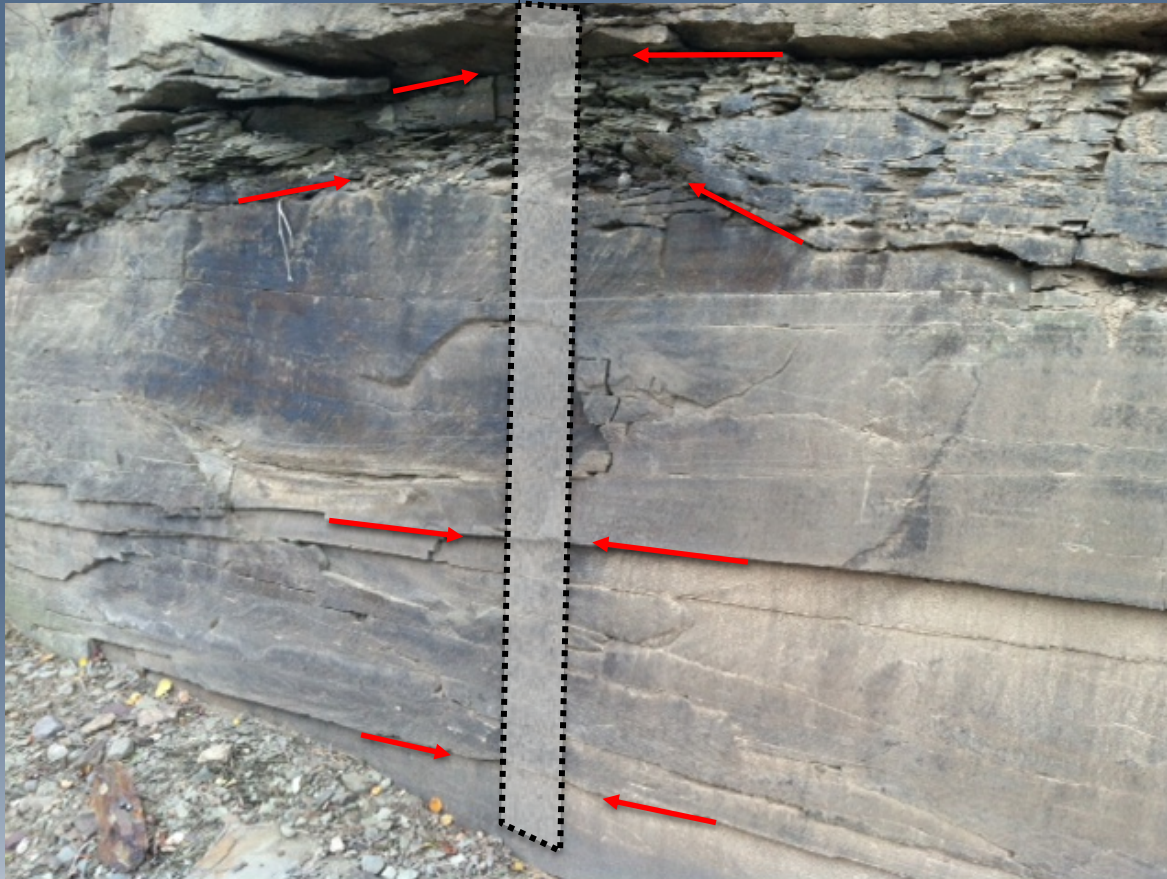
Thermal Conduction Heating



ISTR Technology Selection



Sedimentary Rock in Eastern PA



90' sandstone w/coal seams

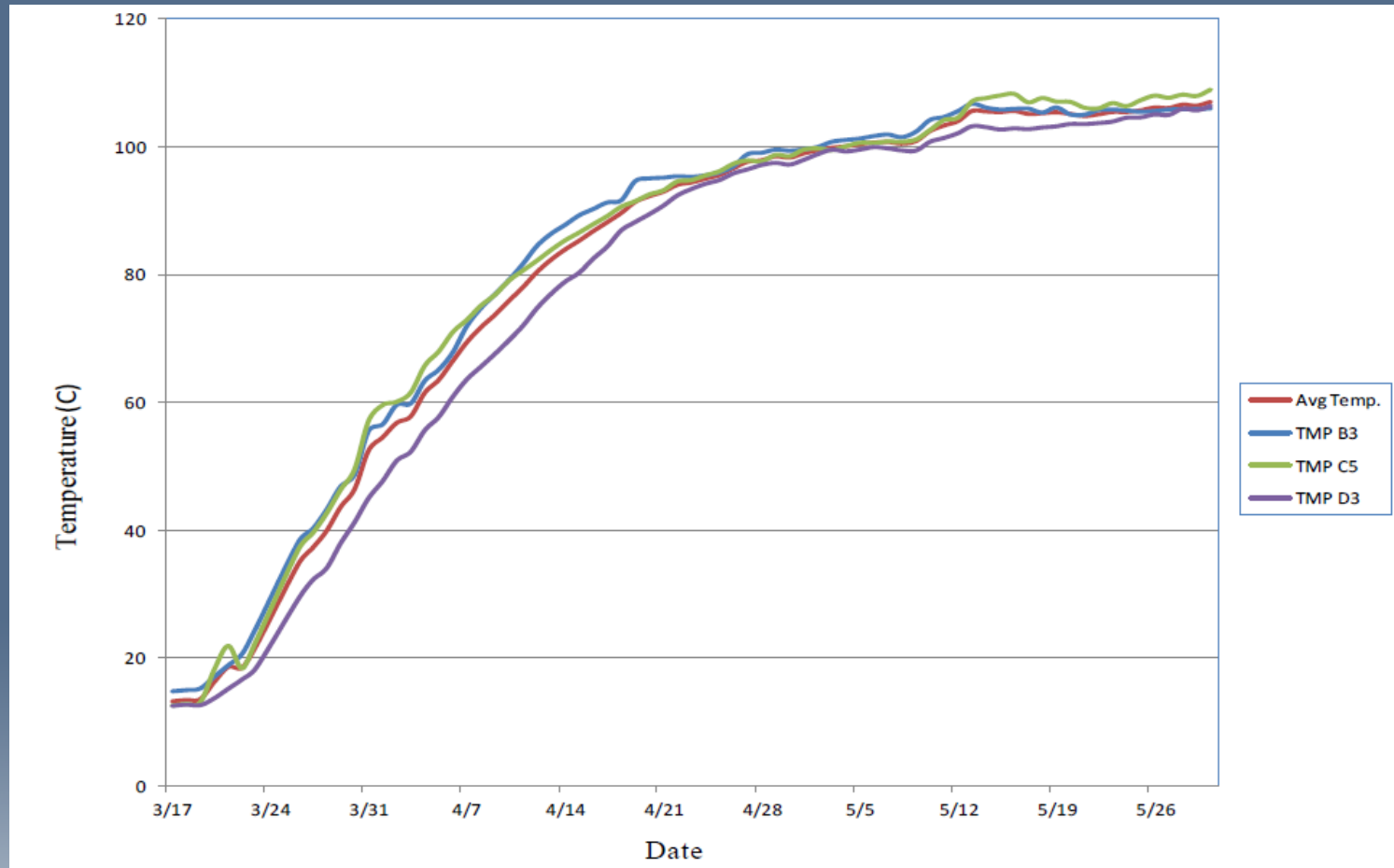
8% primary porosity

82 days of heating

400 lbs. TCE removed

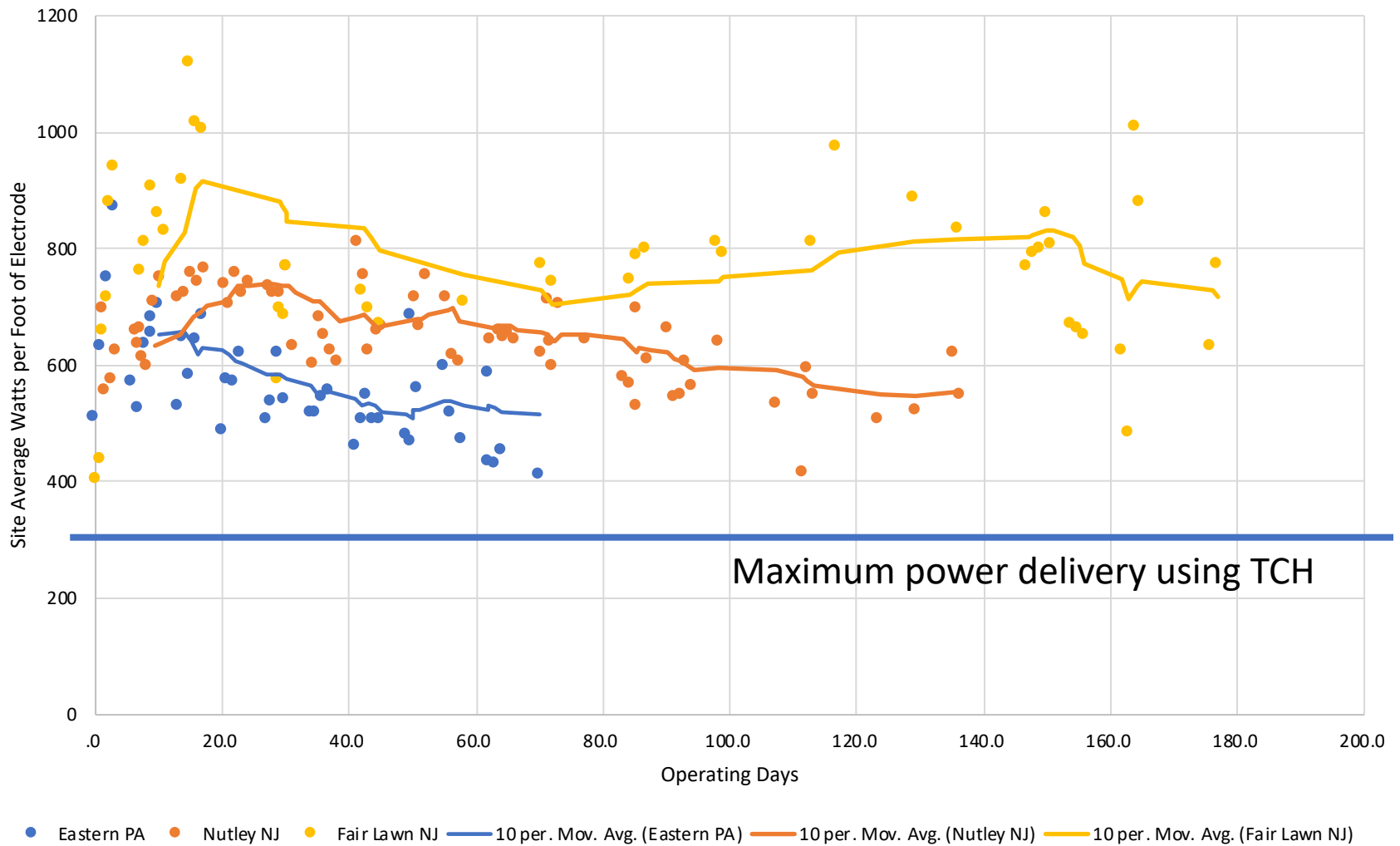
99.9% mass reduction

Sedimentary Rock in Eastern PA



← 2 months →

ERH in Fractured Rock

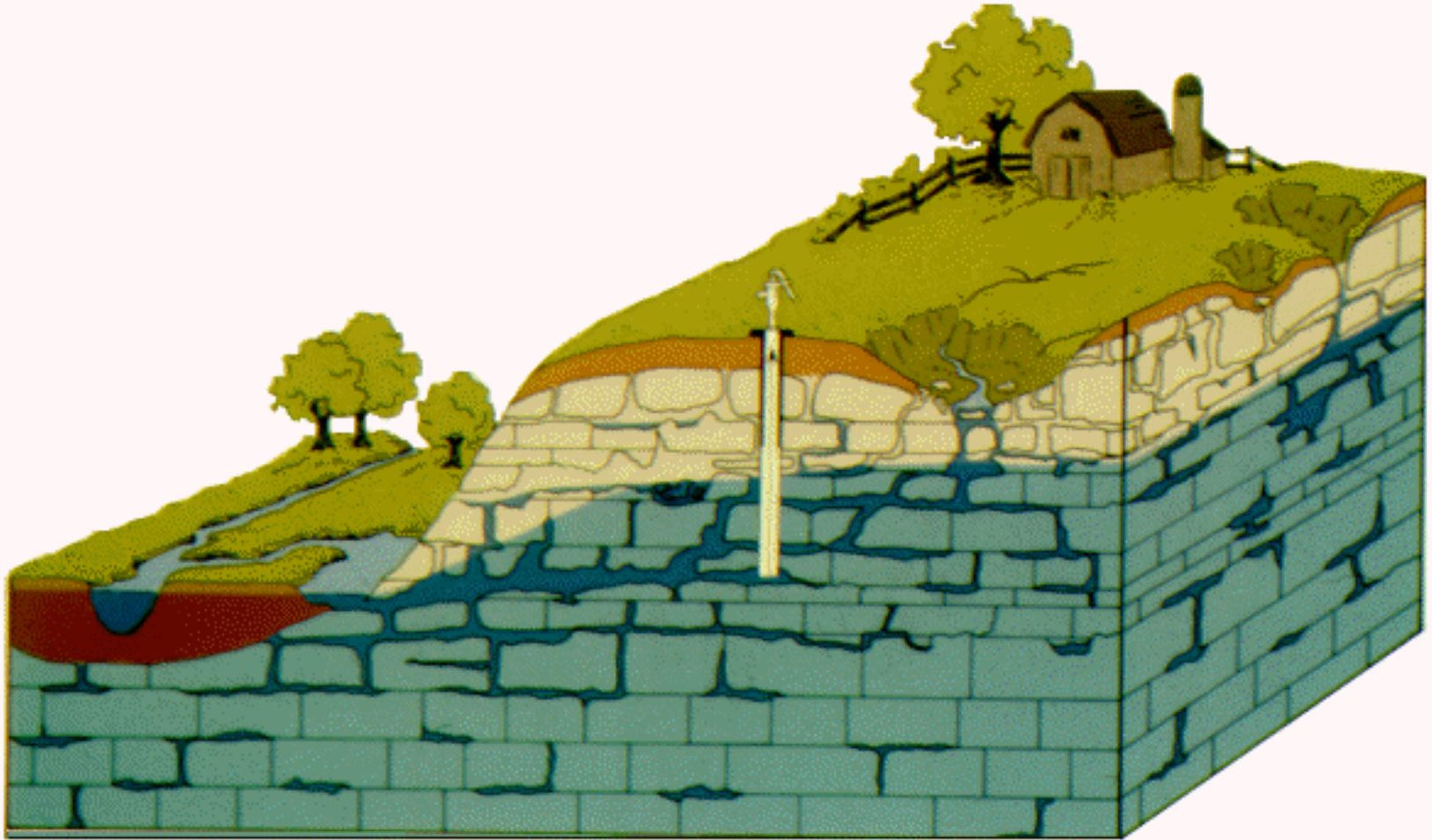


Redstone Arsenal, Alabama



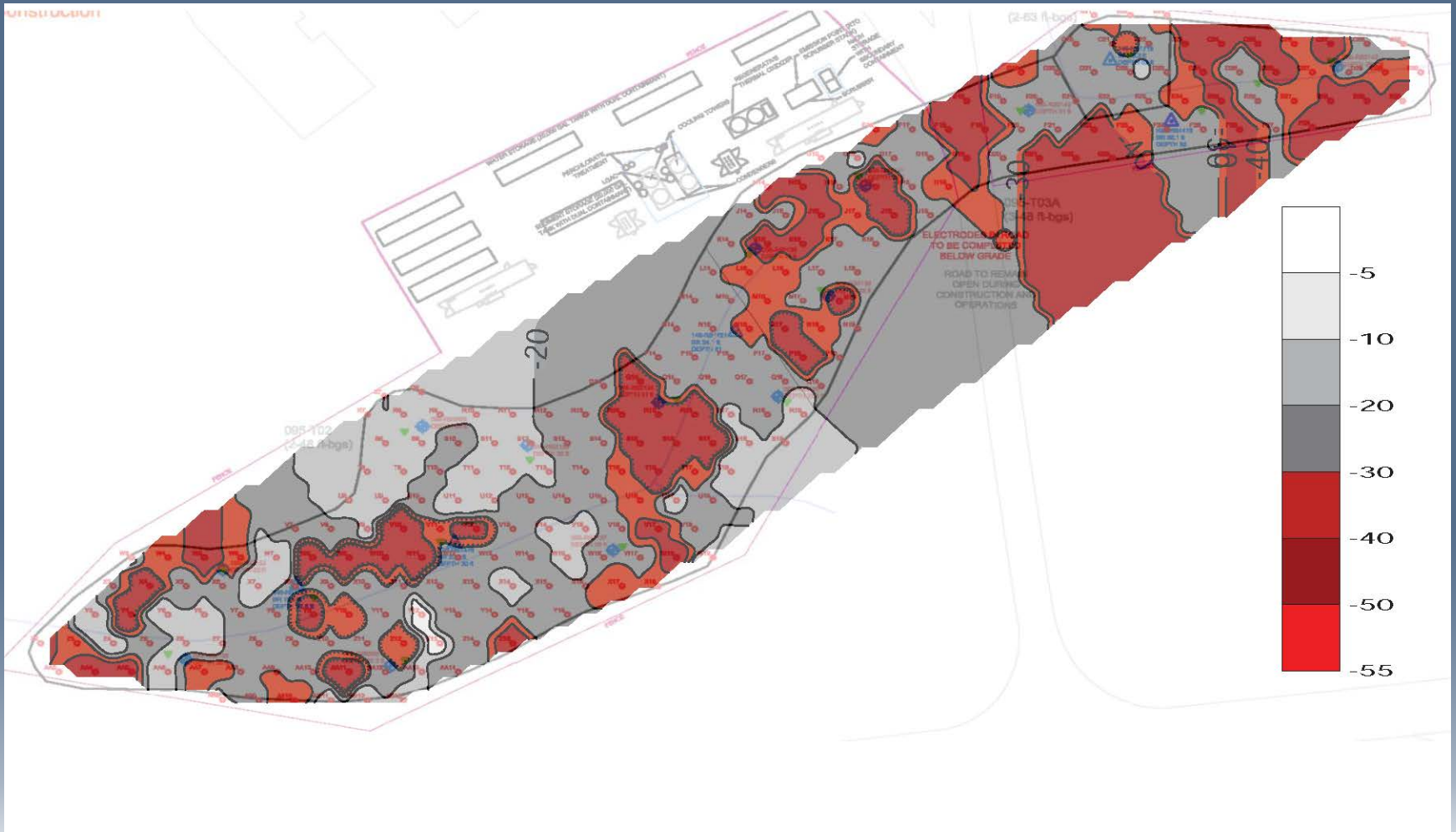
Courtesy of U.S. Army - Redstone Arsenal Historical Information

Karstic System



Courtesy of the Univ. of Iowa

Bedrock Surface



6 ERH Projects at Redstone Arsenal

1. RSA-053 – Chlorobenzene

2. RSA-096

3. RSA-142

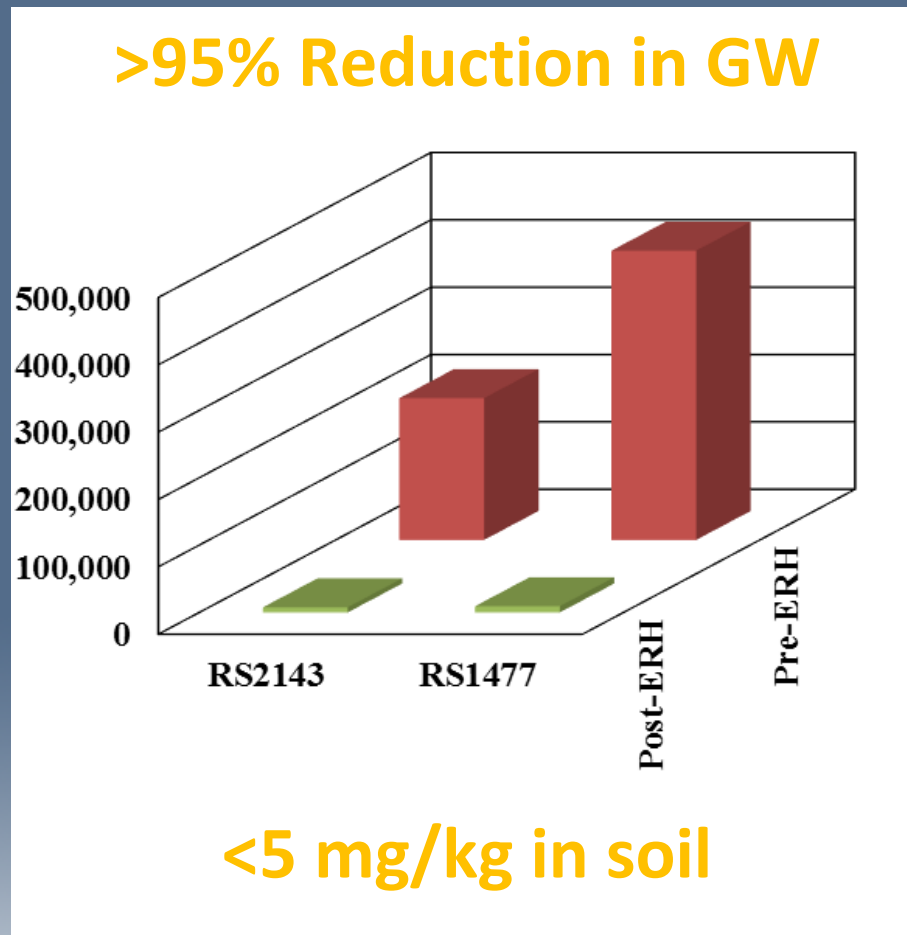
4. **RSA-095 East**

5. **RSA-095 West**

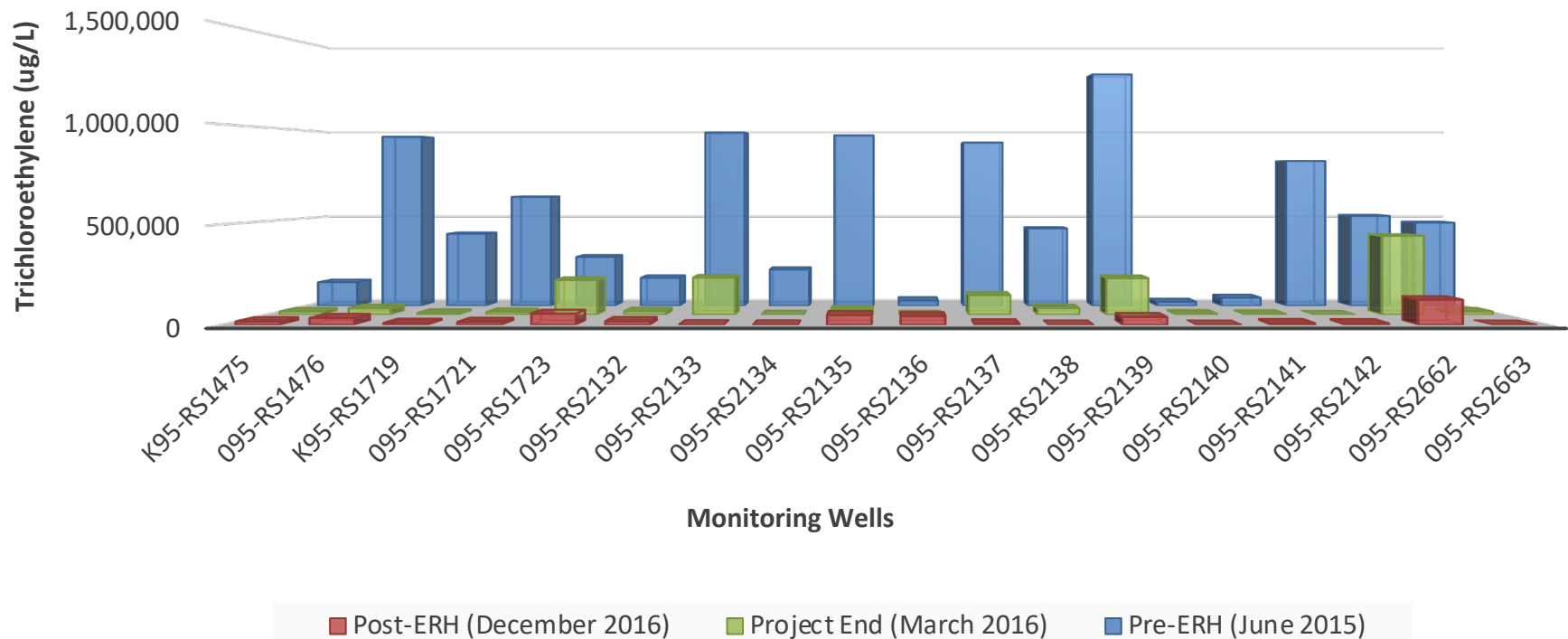
6. **RSA-7363**

Trichloroethylene

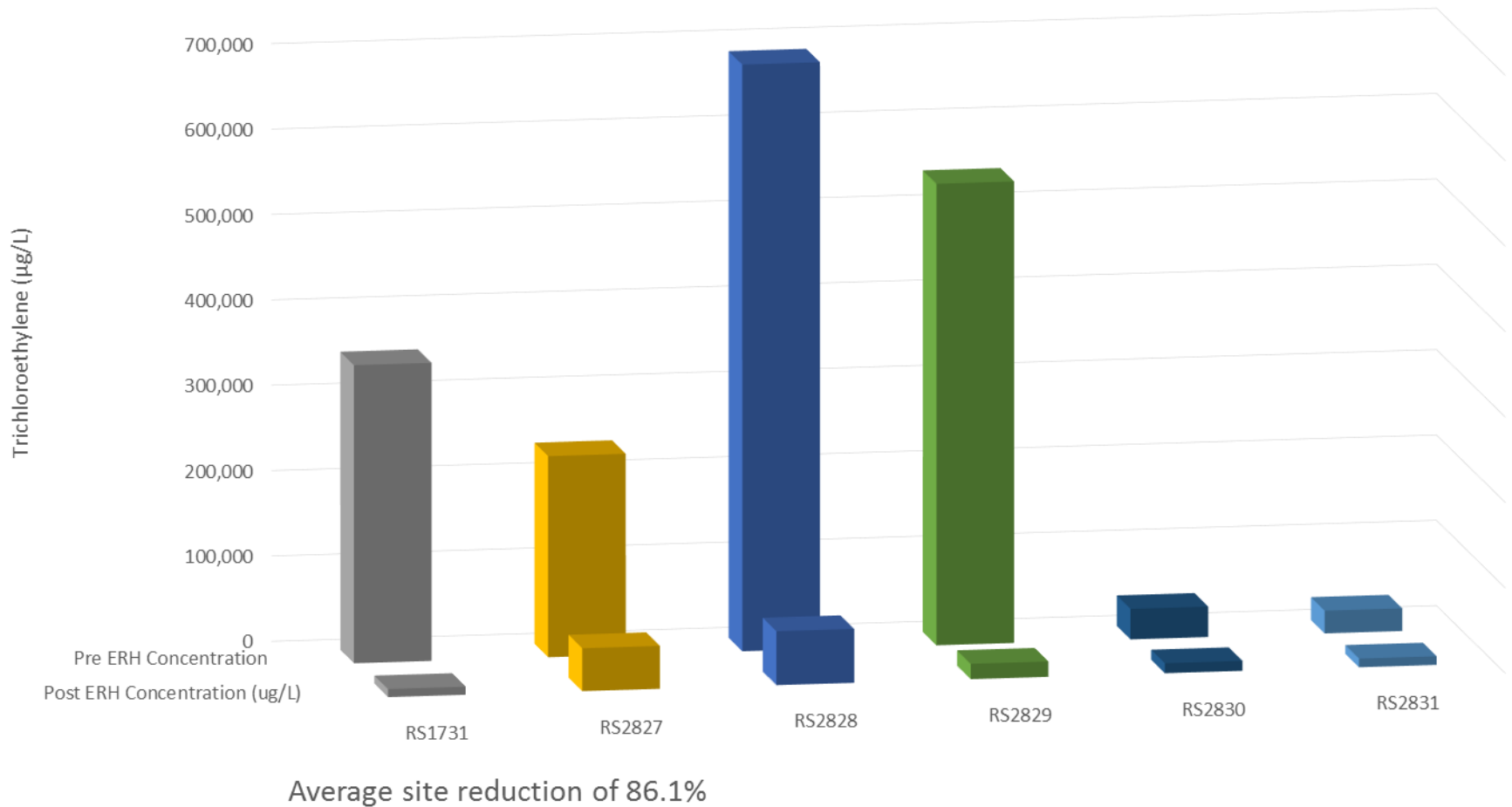
RSA-095 East Results



RSA-095 West Results



RSA-7363 Results



Conclusions

- Heat solves the matrix diffusion problem
- Bedrock resistivity testing
- Efficiency of ERH and TCH drives selection
- Power & energy density: key design elements
- Flexibility during implementation

Contact Information

Lauren D. Soós

lsoos@thermalrs.com

www.thermalrs.com

978-514-3133



TRS

TRS Group, Inc.
Accelerating Value

Safe. Fast. Certain. Guaranteed.

An Employee Owned Company

www.thermalrs.com