Welcome to Our Webinar:

"Using Hydraulic Profiling Tool (HPT) Logs for Site Characterization"

This presentation will start soon…

Using HPT Logs in Site Characterization Studies

Running HPT logs in the Platte River alluvial aquifer, Clarks, NE.

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(mccallw@Geoprobe.com)

HPT >>> High Resolution Site Characterization

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Webinar Outline

- HPT Principles of Operation
- Equipment Needed and Logging Technique
- Interpreting an HPT log
- HPT Log Cross Section and Hydrostratigraphy
- Dissipation Tests … How and Why?
- Estimating Hydraulic Conductivity (K) with Q & P_c
- Using HPT Logs for Subsurface Interpretation
  (conceptual site model … CSM)

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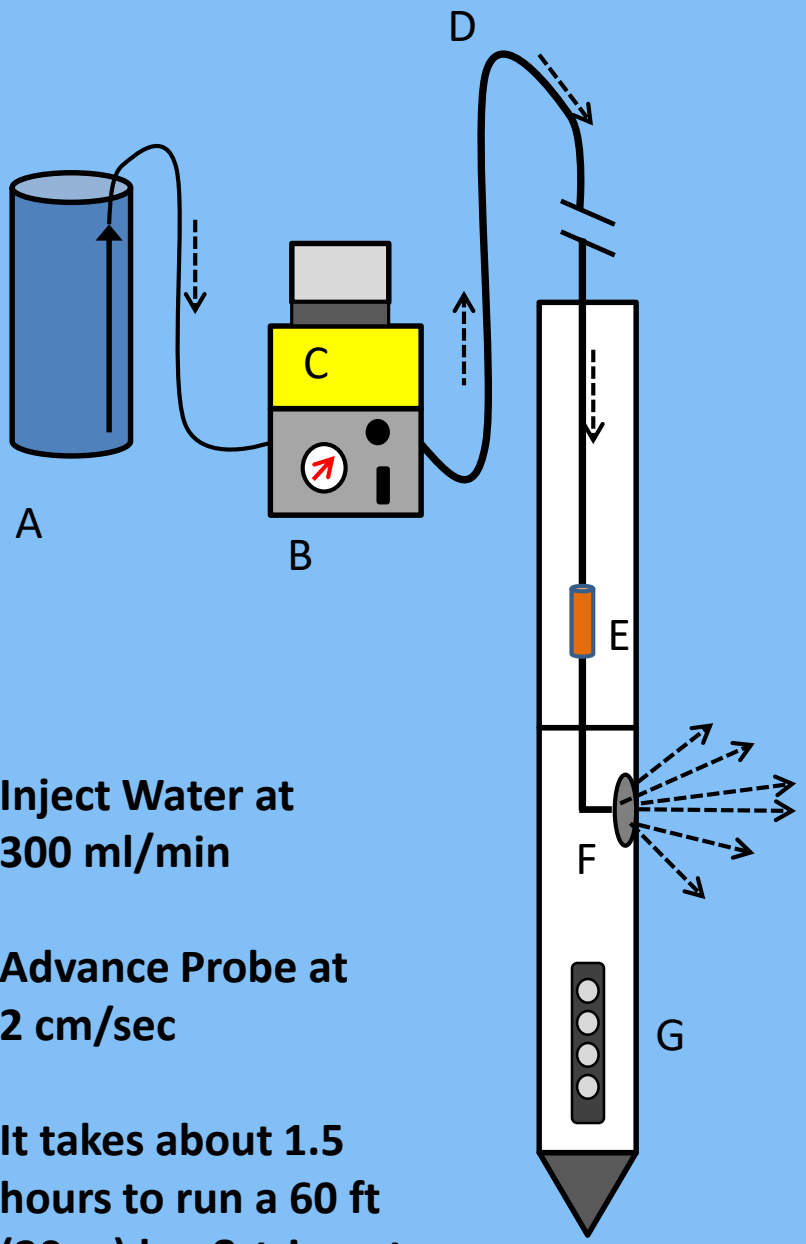
HPT Principles of Operation



Inject Water at 300 ml/min

Advance Probe at 2 cm/sec

It takes about 1.5 hours to run a 60 ft (20 m) log & trip out

A) Water Tank

B) Pump & Flow Meter

C) Electronics/computer

D) Trunkline

E) Pressure Sensor

F) Screened Injection Port

G) Elec. Conductivity Array

Water Flow Lines

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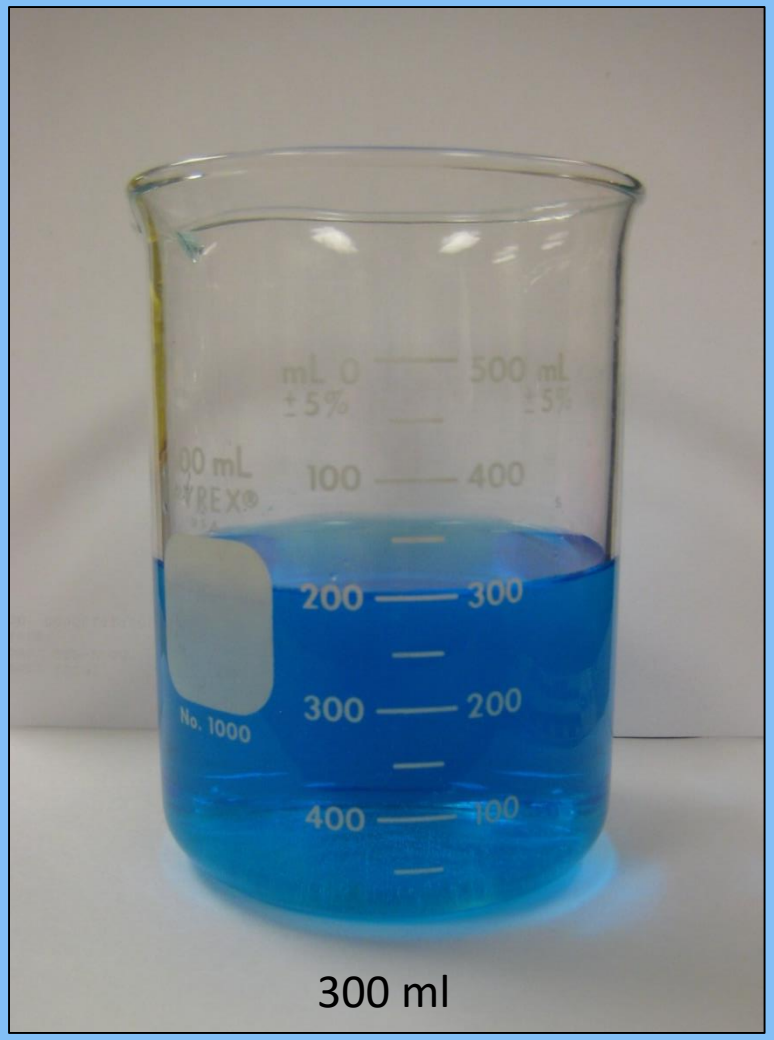
How Much Injection Flow ?



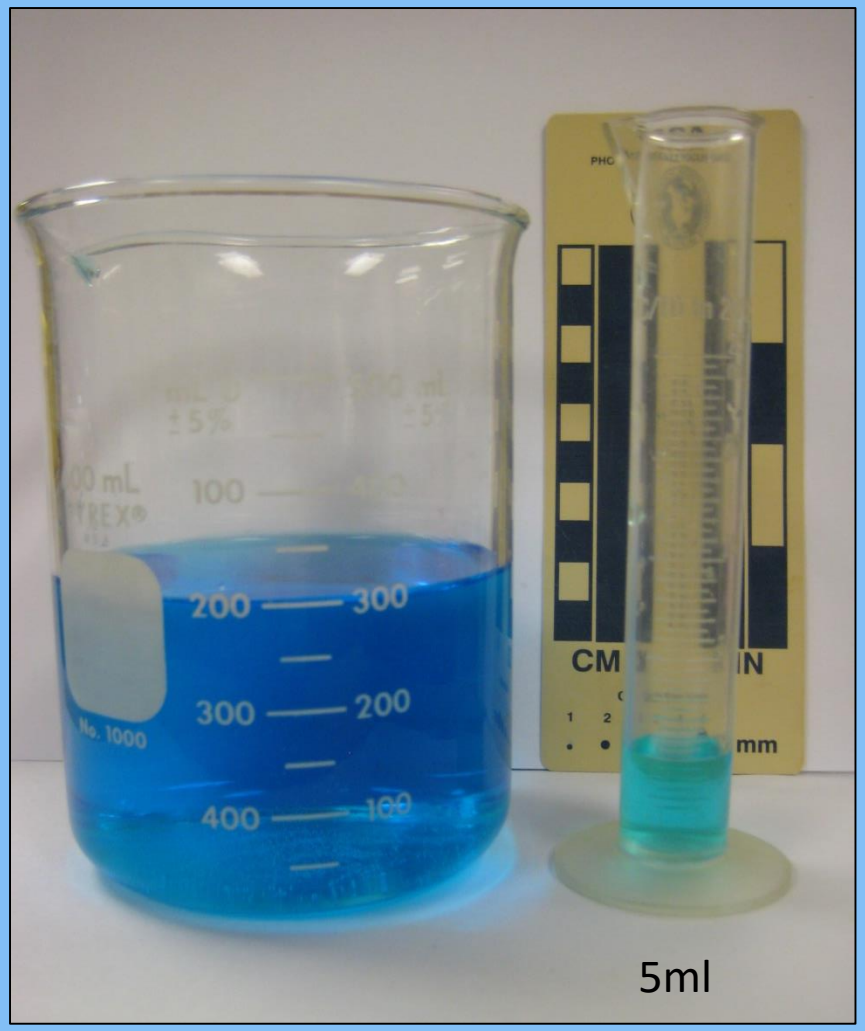
300 ml

300 ml/min

= ? ml/sec

How much per log?

How Much Injection Flow ?



5ml

300 ml/min X 1min/60sec

= 5 ml/sec

Advance probe at 2 cm/sec

So Inject 5 ml over 2 cm

~ 75 ml/ft of log

Reality ~ 5 gal (20 l) for 60ft log

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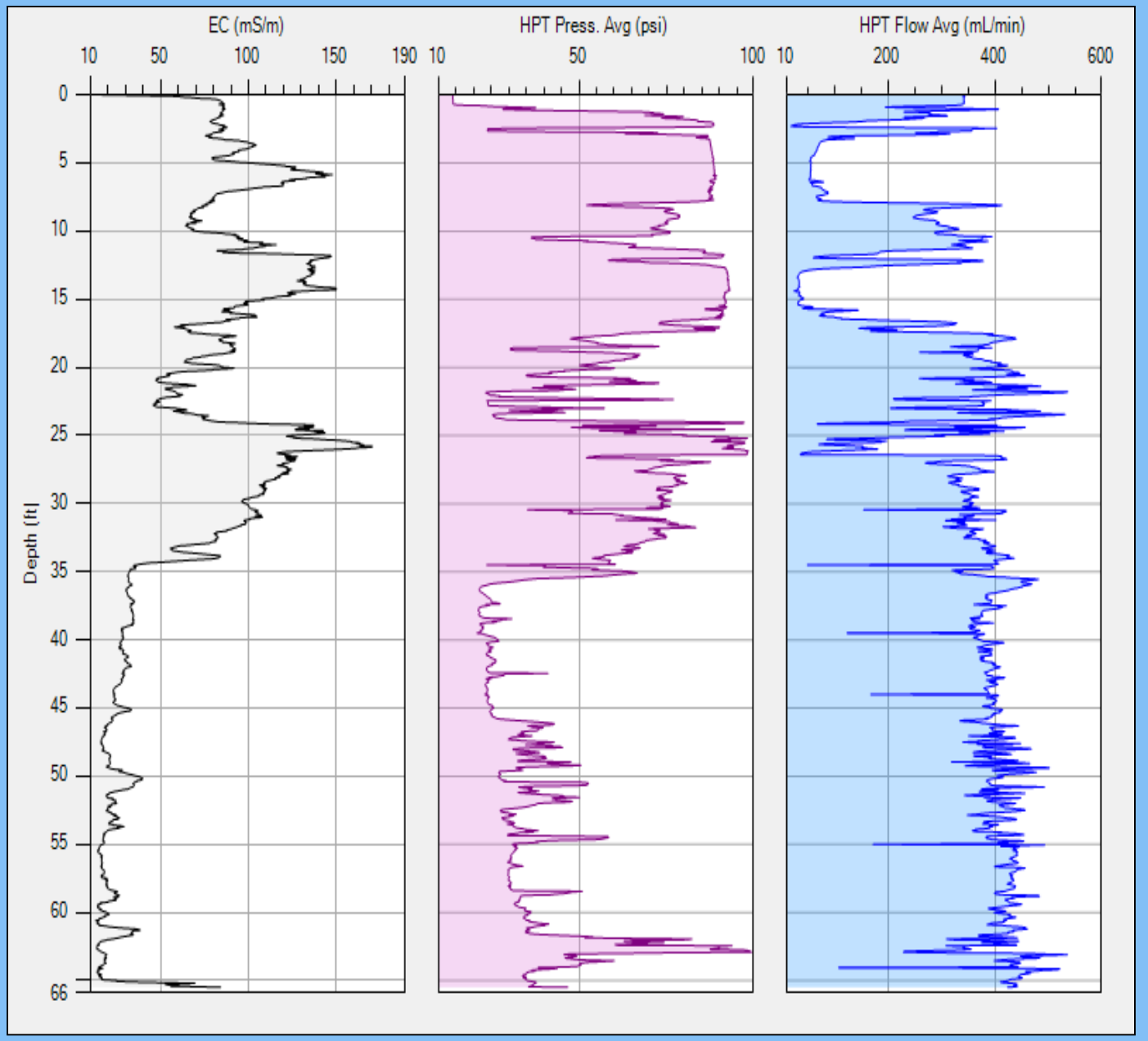
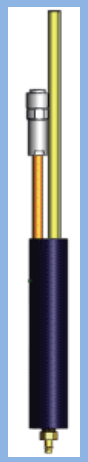
Example HPT Log

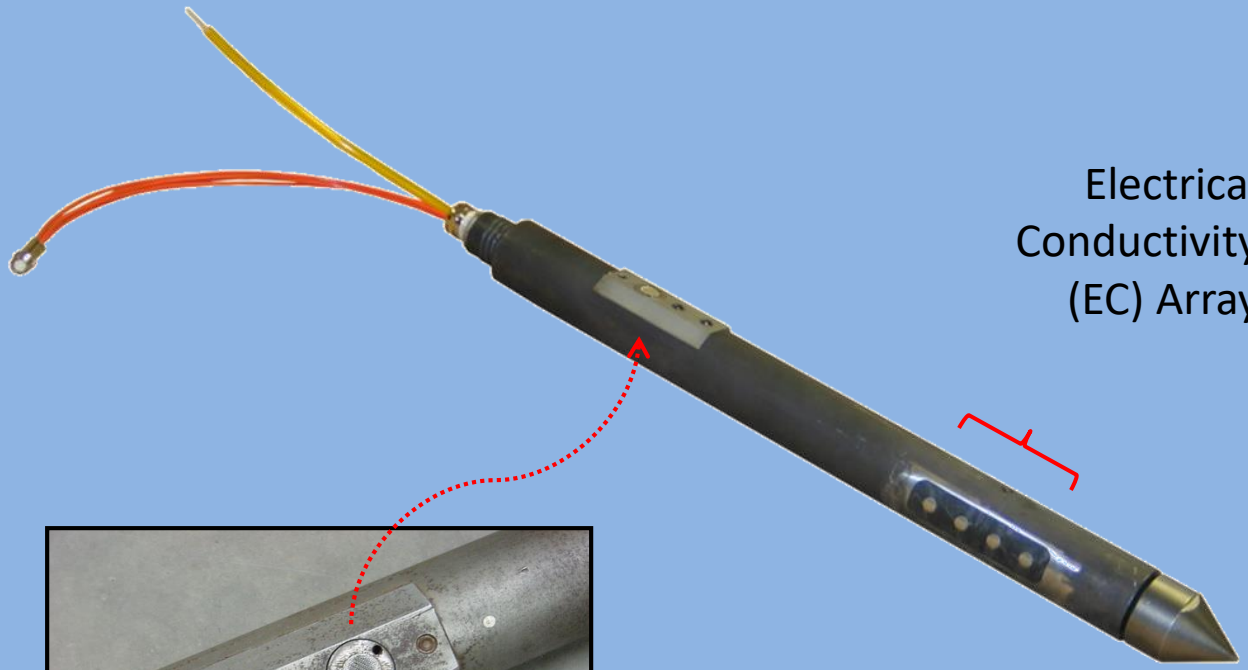
- EC
- Pressure
- Flow



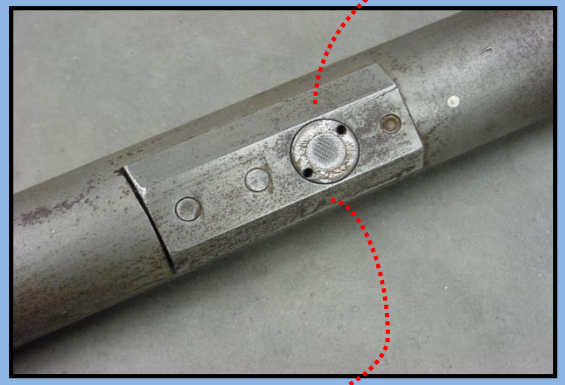
Components of the HPT System : HPT Probe

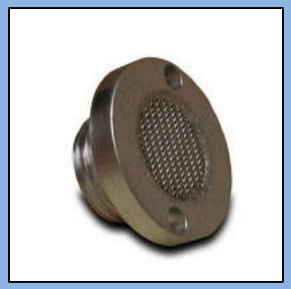


Pressure Sensor Module 100 psi/ 690kPa



Electrical Conductivity (EC) Array





Replaceable Screens

HPT Trunkline

HPT System Components: Electronics

- Lap Top Computer
  (with Acquisition software)
- Field Instrument
  (FI 6000)
- HPT Flow Module
  (K 6300)

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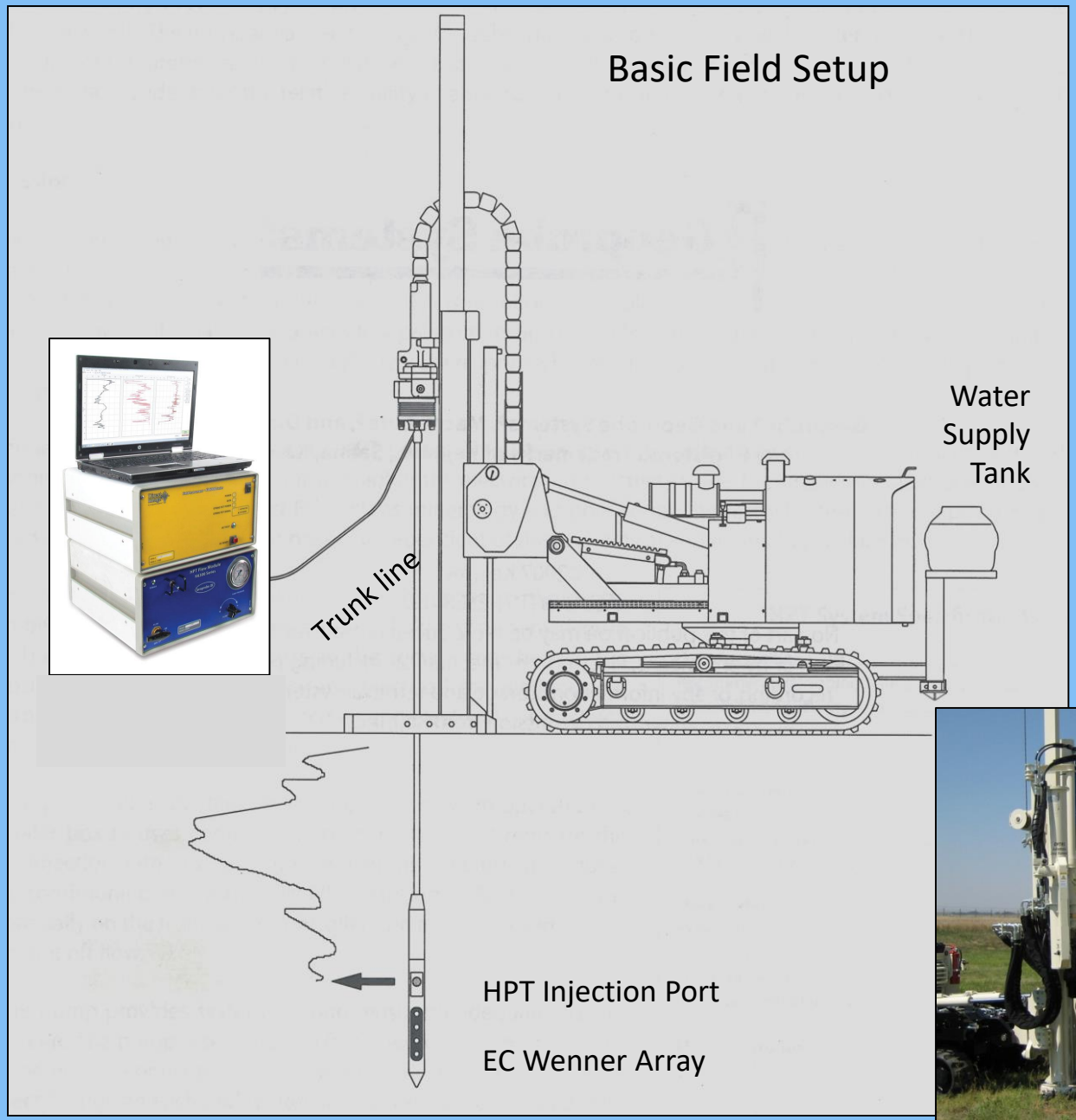
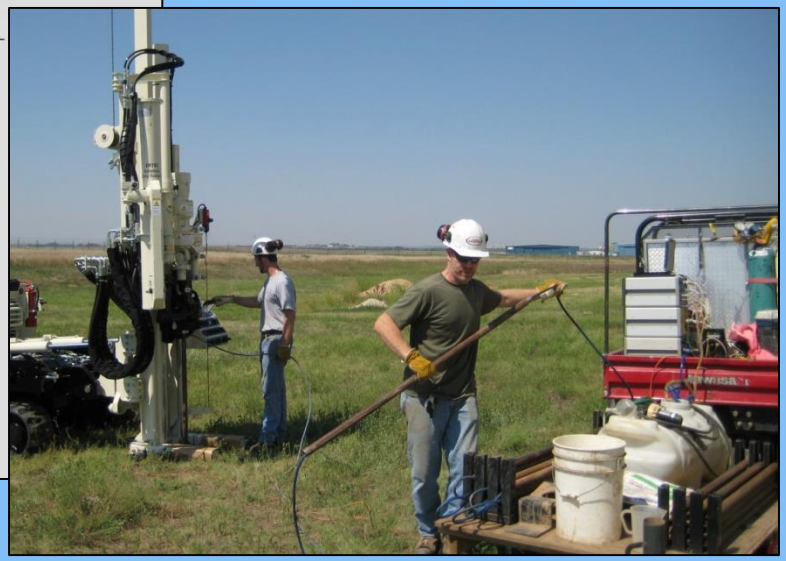
Running an HPT Log and Field QA/QC



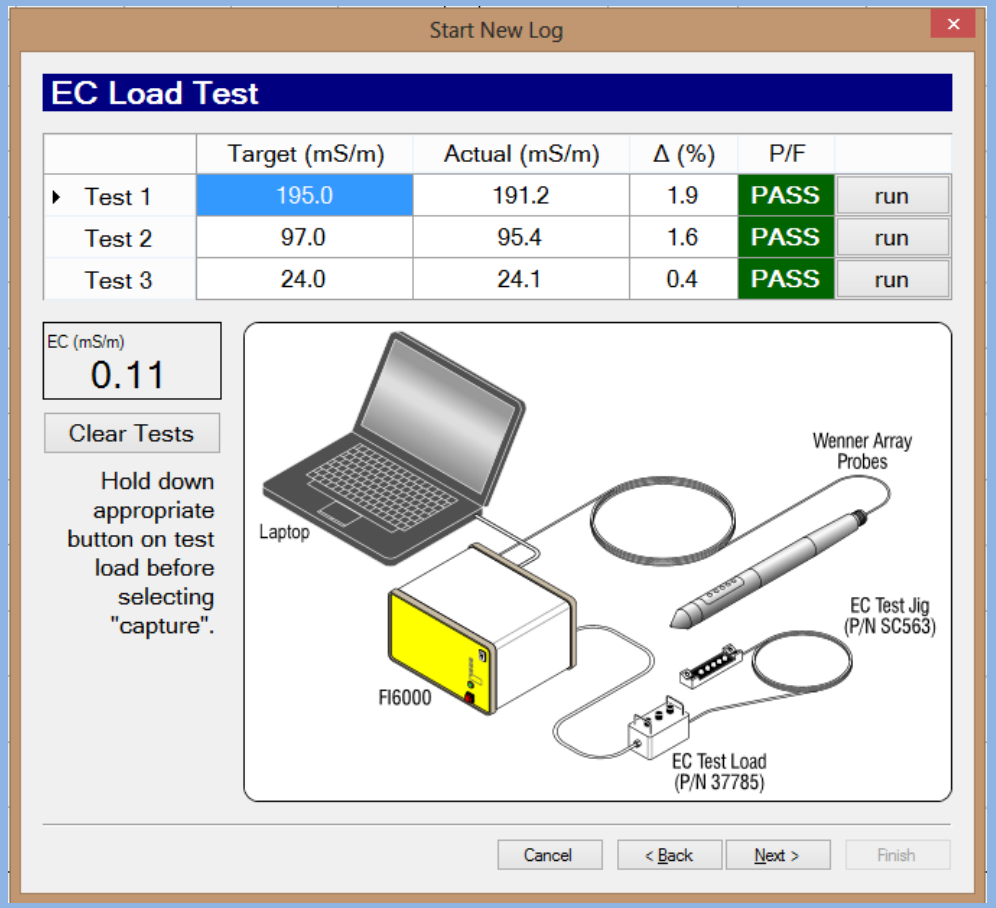


Before Every Log Run QA Tests

EC Test Jig on Probe

EC Test Load Used to Verify EC System is Working

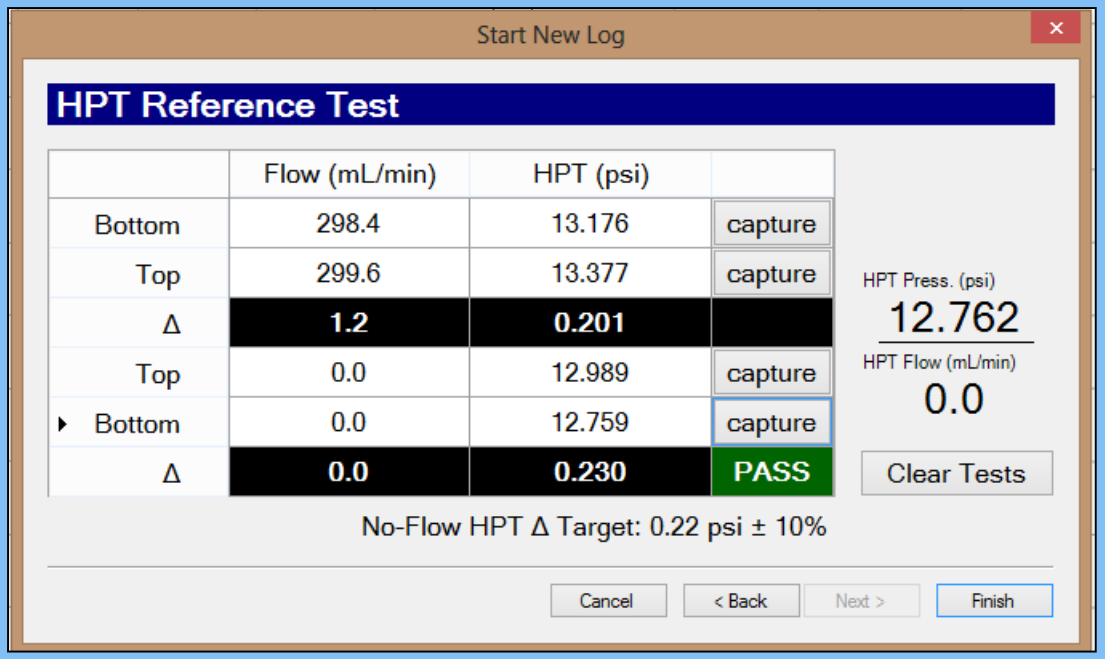
Pre-Log QA: EC Test Load



Electrical Conductivity Onscreen QA Report
(data saved to log file)

Pre-Log QA: HPT Reference Test

HPT Probe in Reference Tube to Verify Measurement of Δ6” (15cm) of Water Pressure = 0.22 psi (1.52kPa)



HPT Pressure Transducer Onscreen QA Report
(data saved to log file)

IF YOU DON’T DO THE QA TEST DON’T RUN THE LOG !

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Running an HPT Log : Advancing the Probe

Live time
data review

Trunkline
Managment

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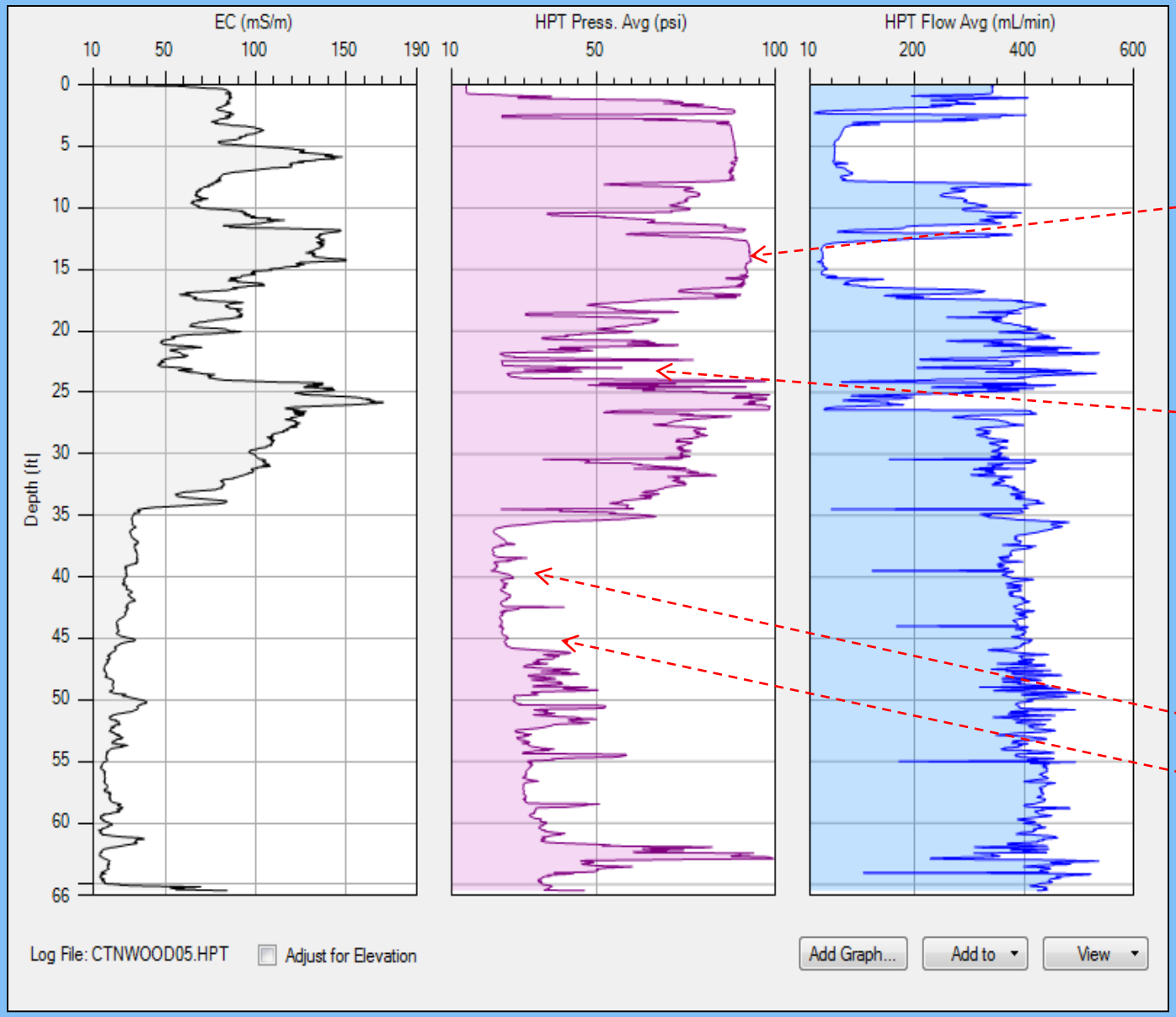
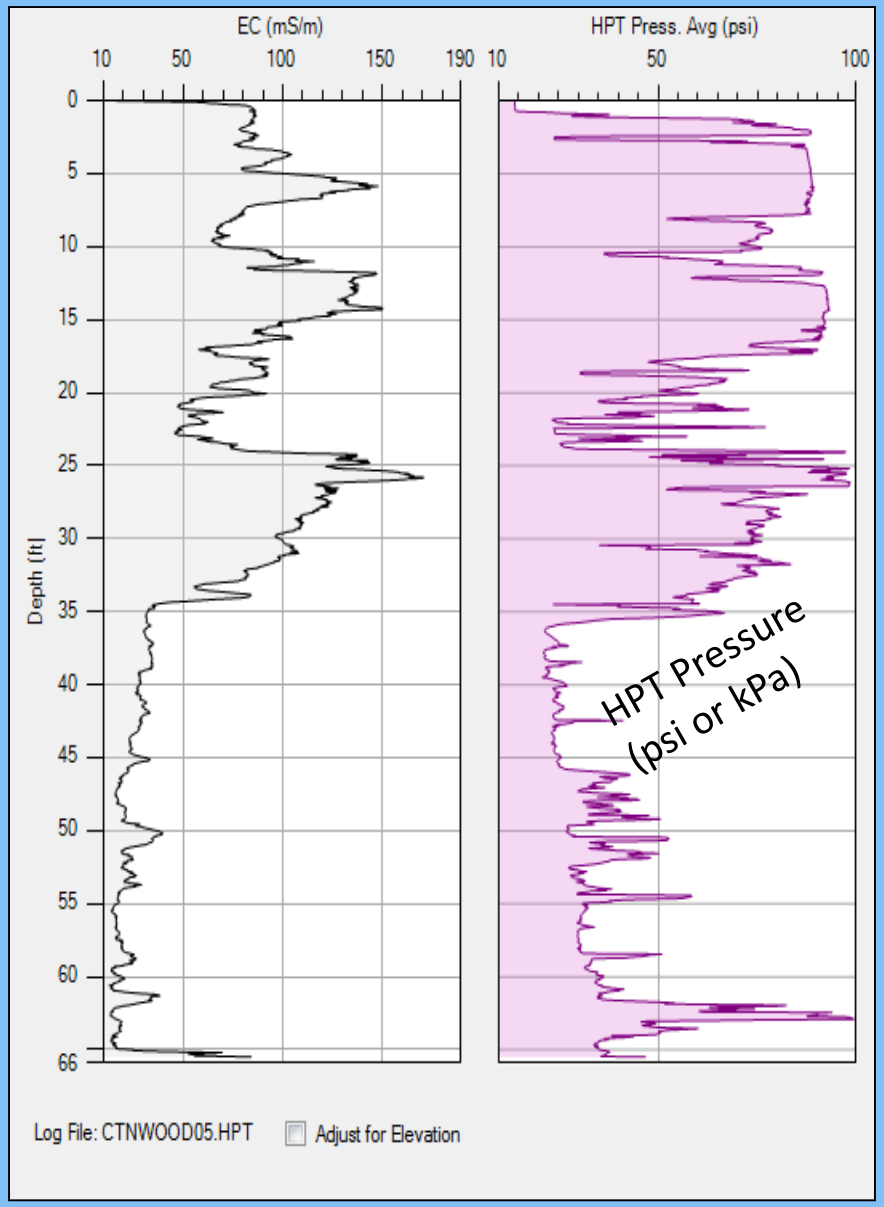
A Basic HPT Log & Interpretation



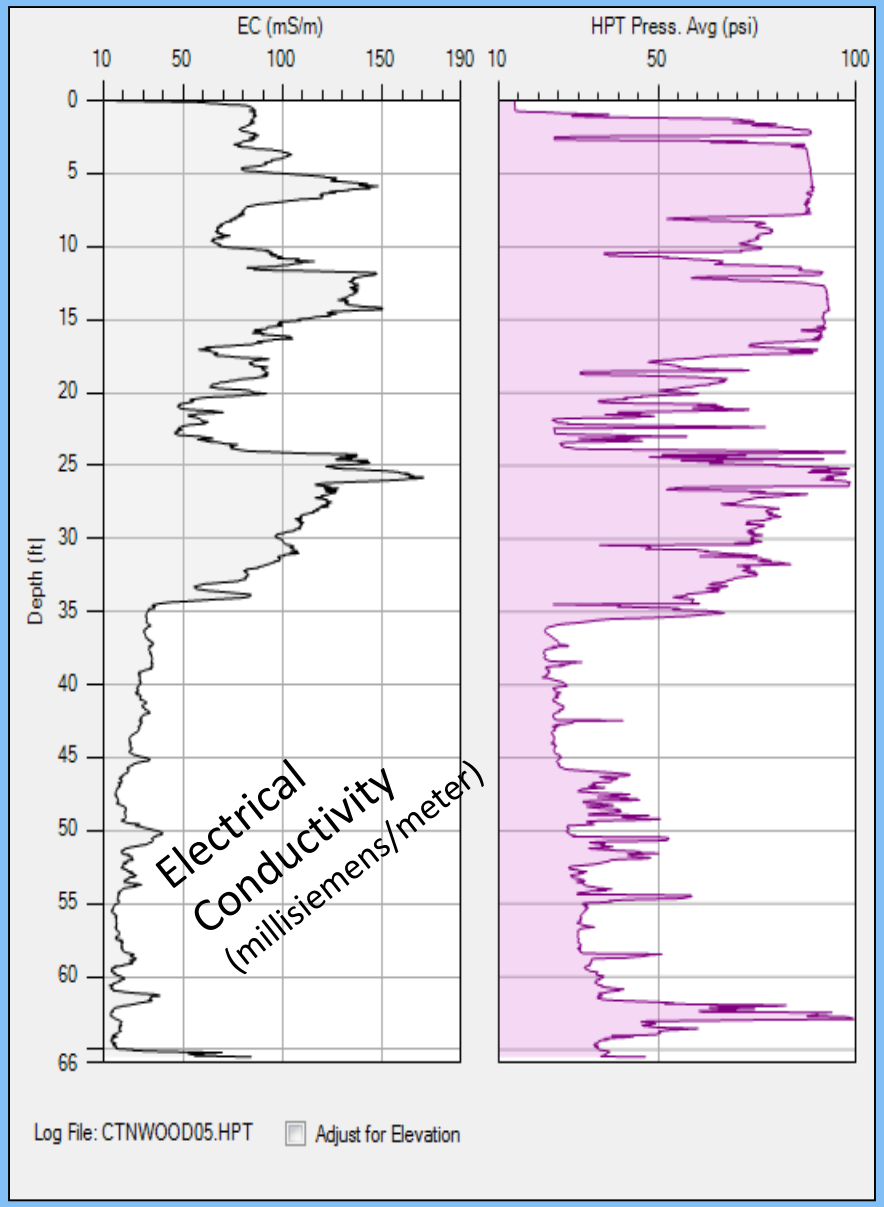
Basic Interpretation Rules



HPT Pressure
(all formations)

- Increasing P = decreasing permeability
- Decreasing P = increasing permeability

Basic Interpretation Rules

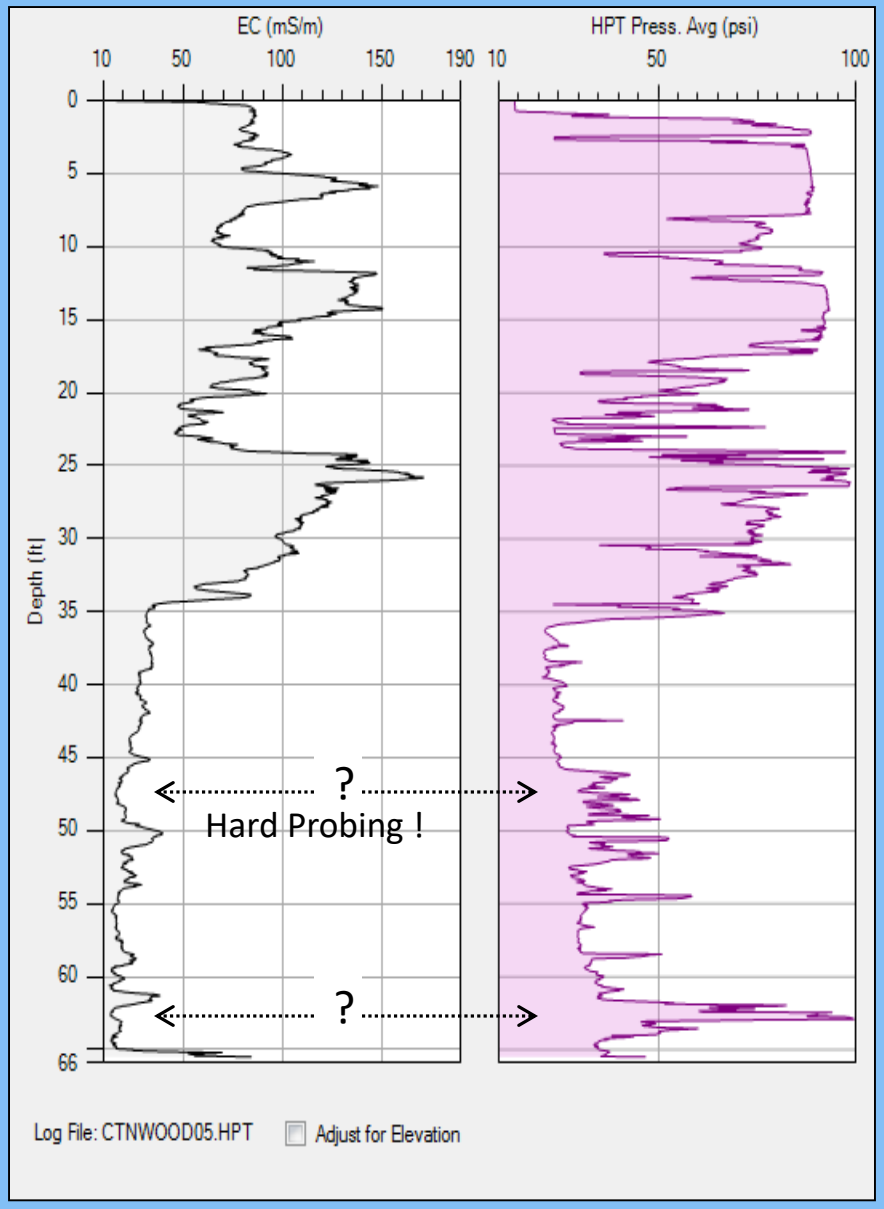


Electrical Conductivity (EC)
(*in fresh water formations)*

- Increasing EC = increasing clay content
  = lower permeability
- lower EC = coarser grained
  = higher permeability

EC Exceptions ?

Basic Interpretation Rules



Electrical Conductivity (EC)

- *Exceptions !*

- *Low EC but High Pressure*
  - Silts & cementing
  - Not all clays = high EC

- High EC can exhibit low HPT pressure
  - Seawater
  - Oilfield brine
  - Ionic remediation fluids *(ionic compounds)*

  = high EC

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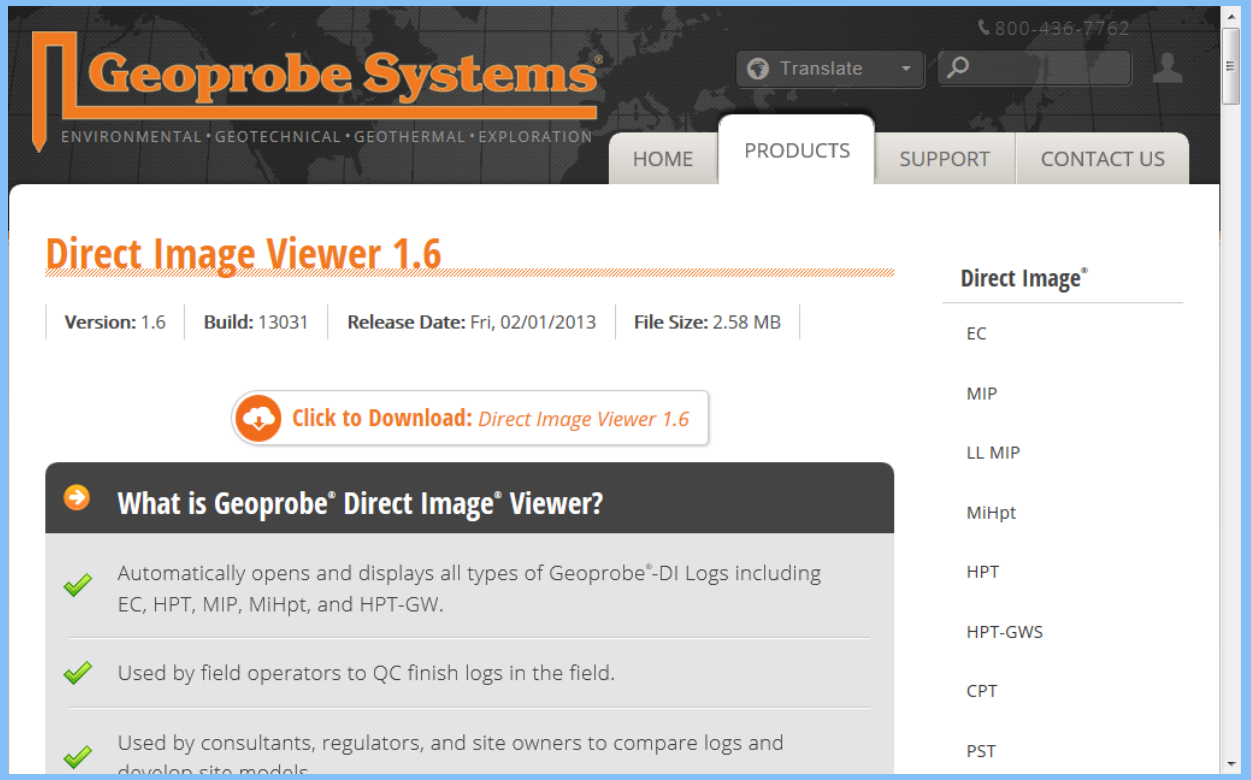
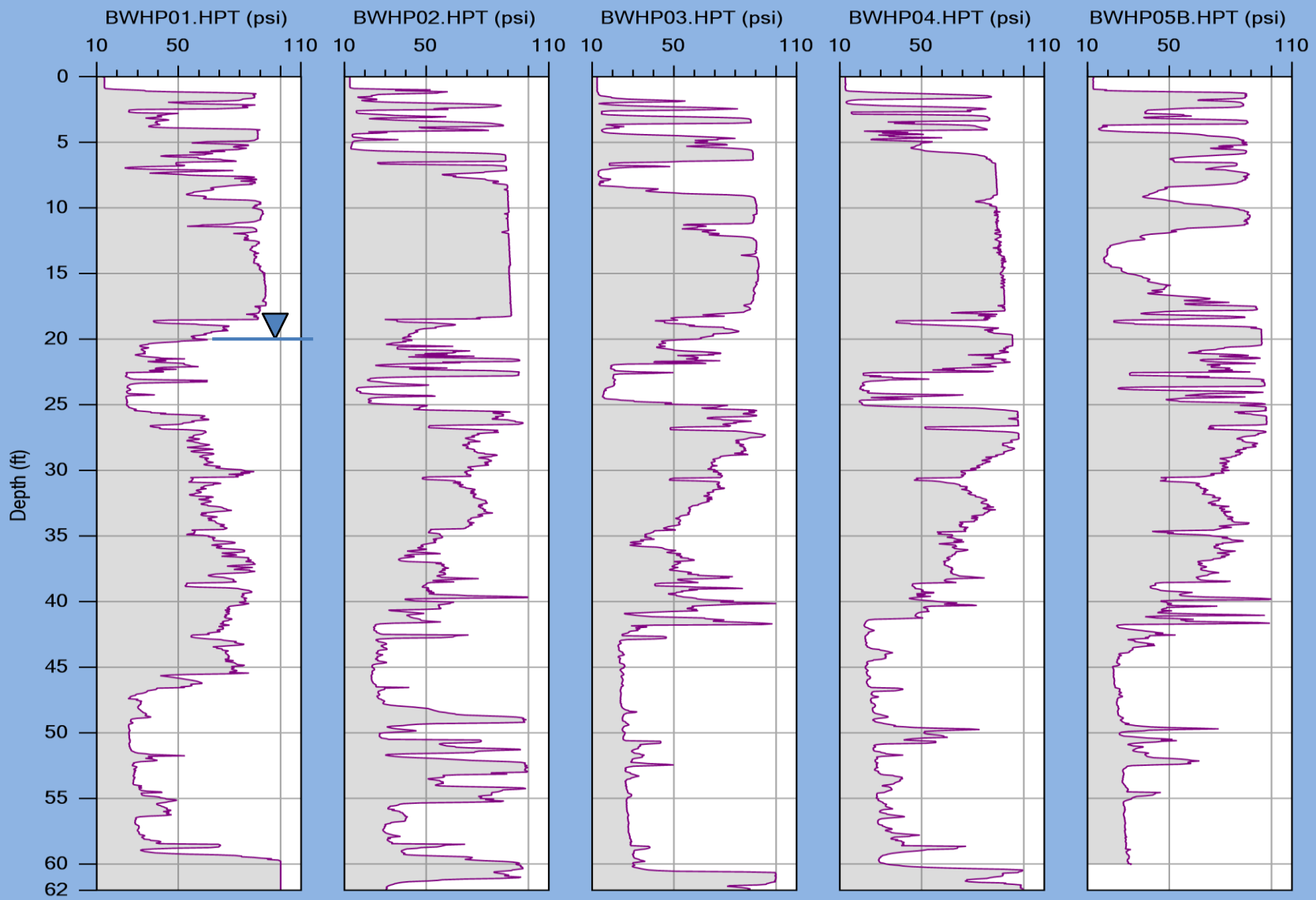
Let's use the DI Viewer Software to open a single HPT log and then create a cross section from several HPT pressure logs …



The DI Viewer software is available as a free down load at:
http://geoprobe.com/downloads/direct-image-viewer-16

Hydrostratigraphy with HPT Pressure Cross Section

West East

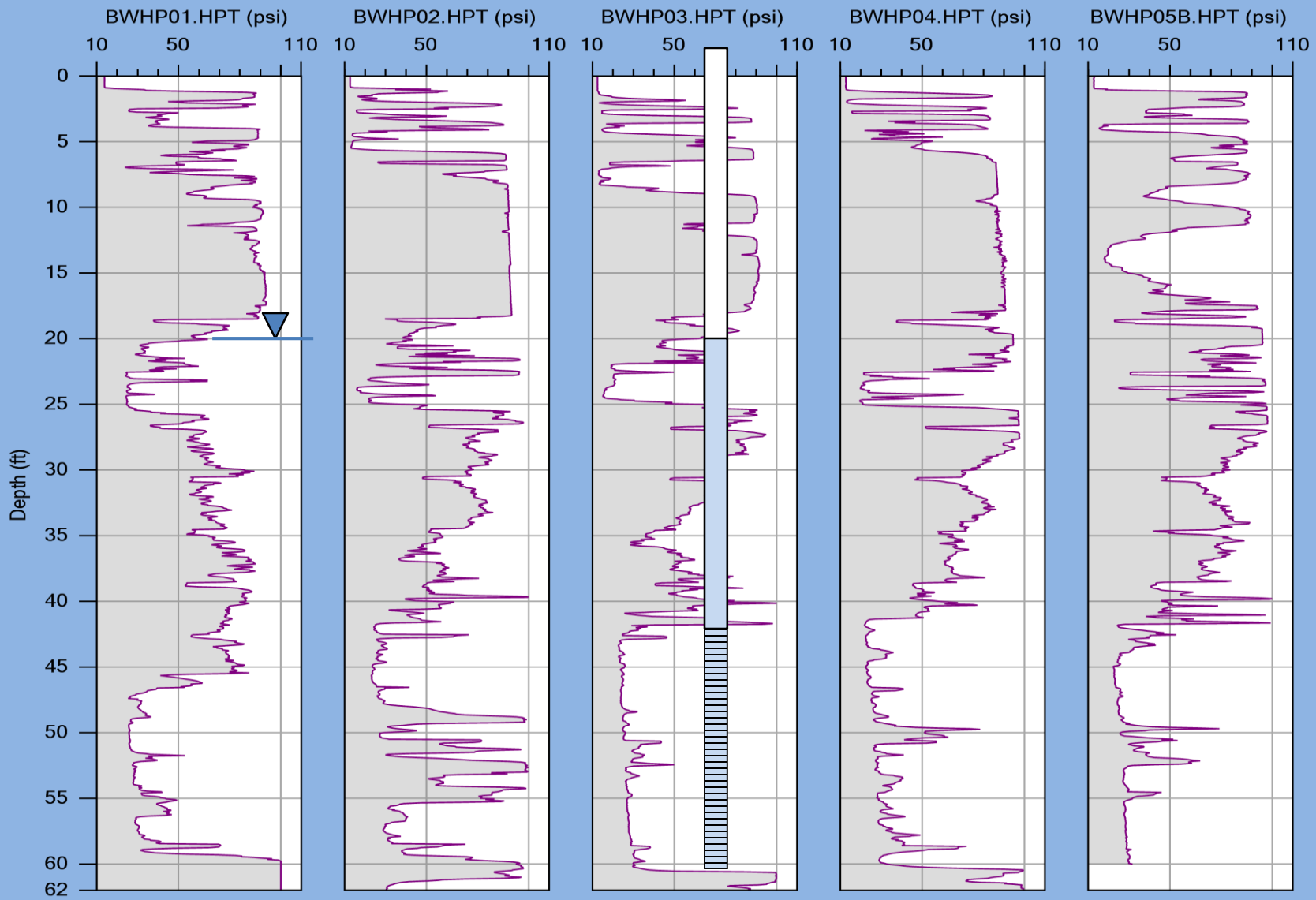


Facing North: 50 ft spacing between log locations: alluvial deposits

HPT Press. Avg

Hydrostratigraphy … Water Supply Well Placement

West East



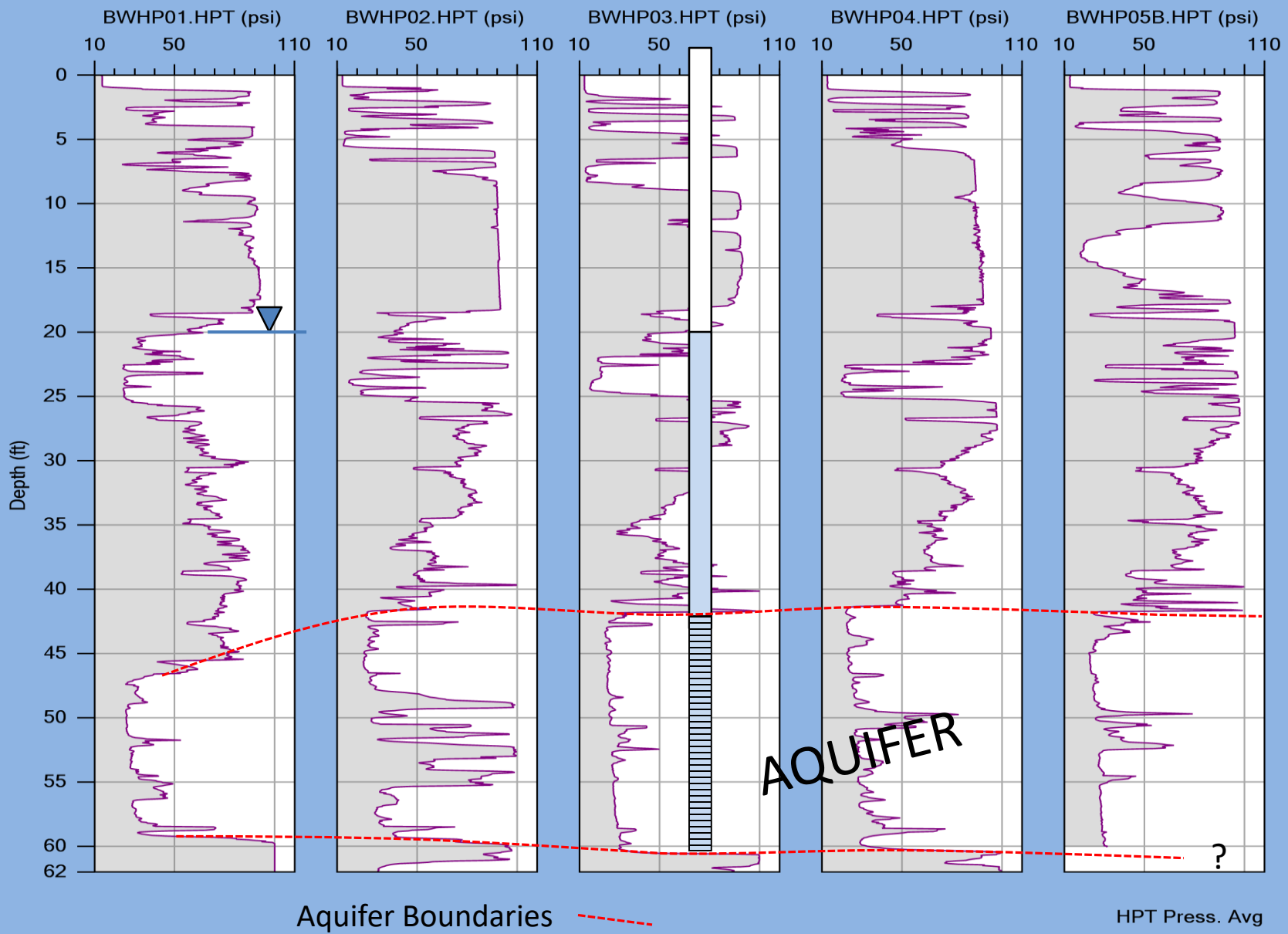
Facing North: 50 ft spacing between log locations: alluvial deposits

HPT Press. Avg

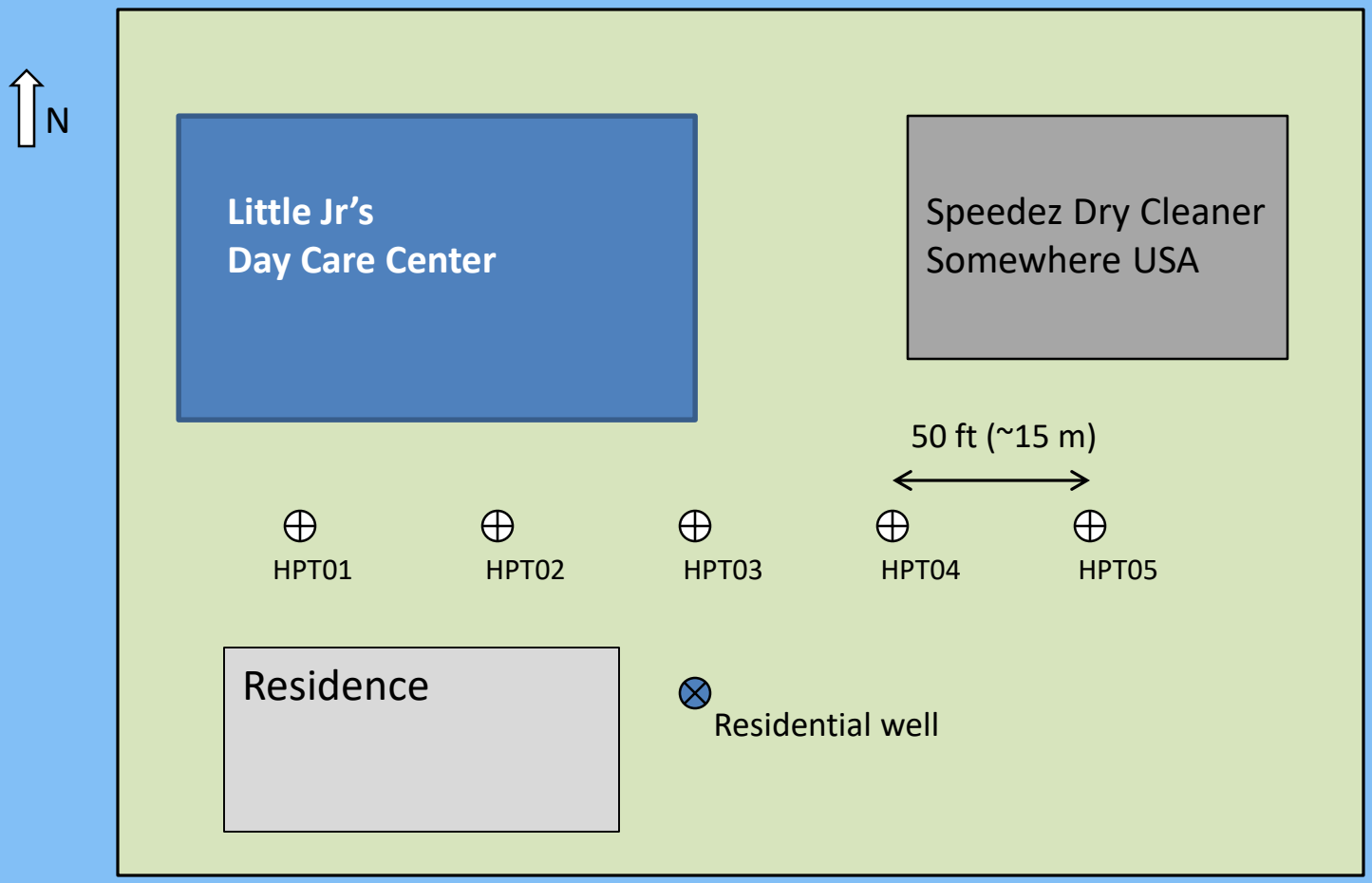
Hydrostratigraphy … Aquifer Boundaries

West

East



Our Hypothetical Dry Cleaner Site …



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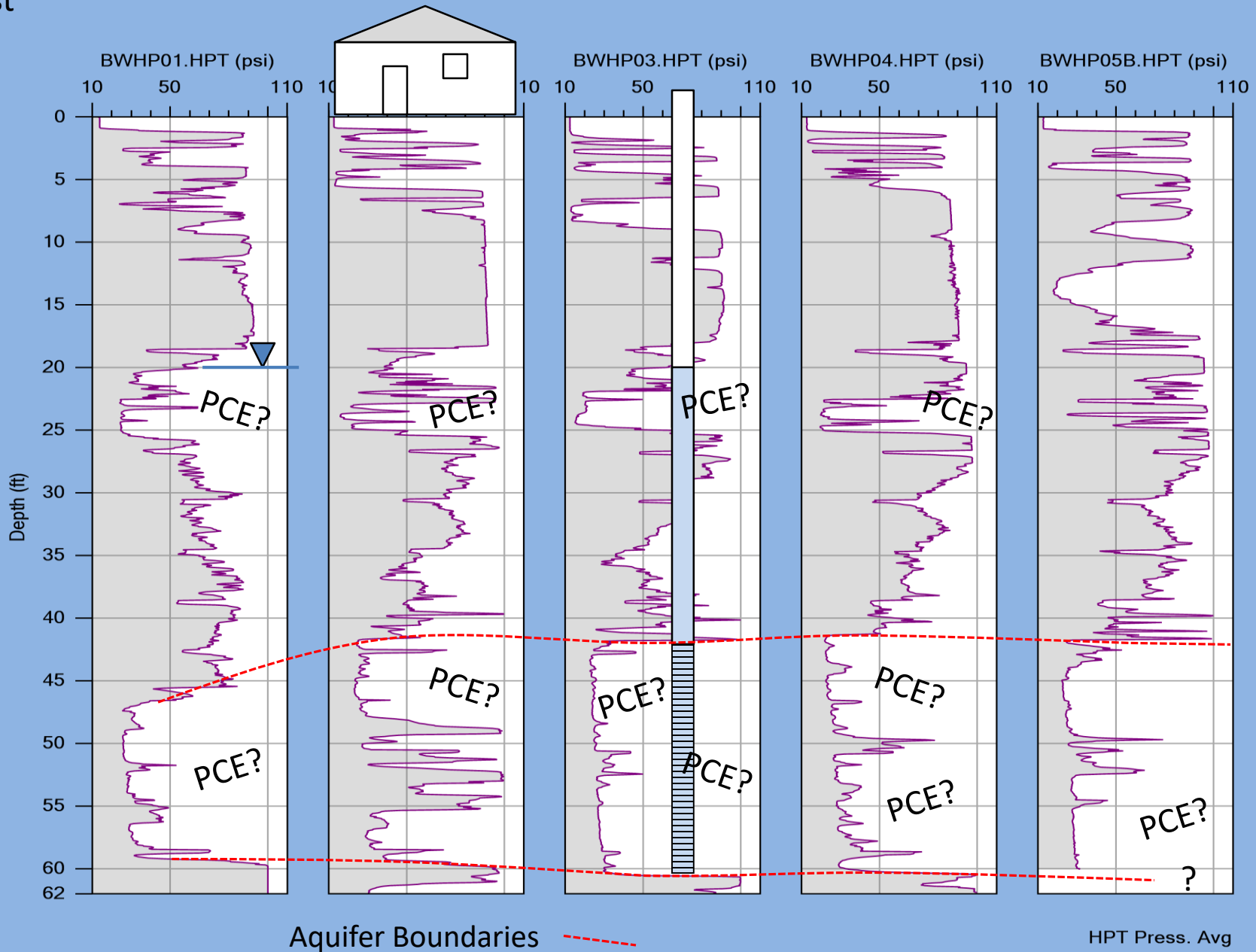
Hydrostratigraphy … Groundwater PCE Plume

West

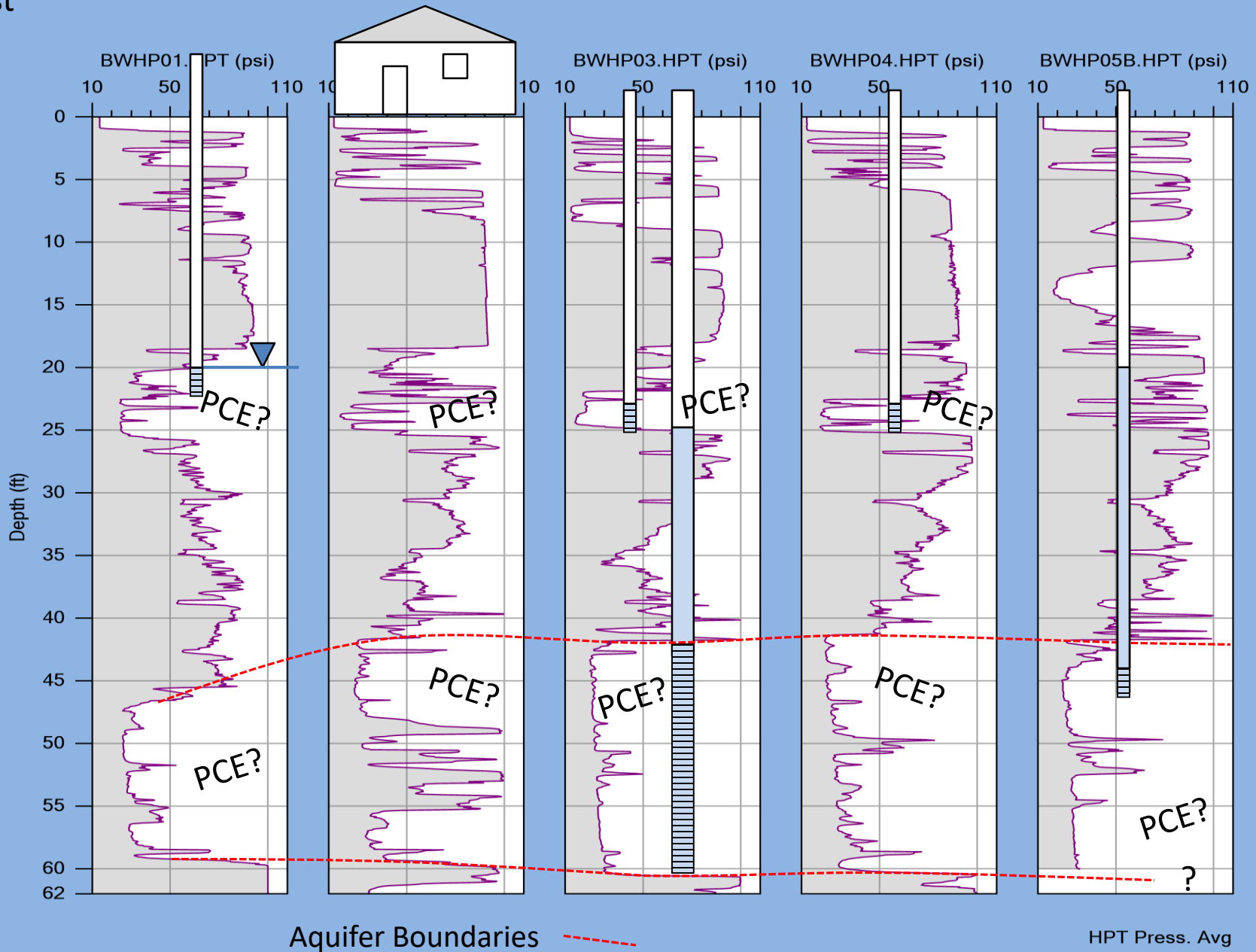
East



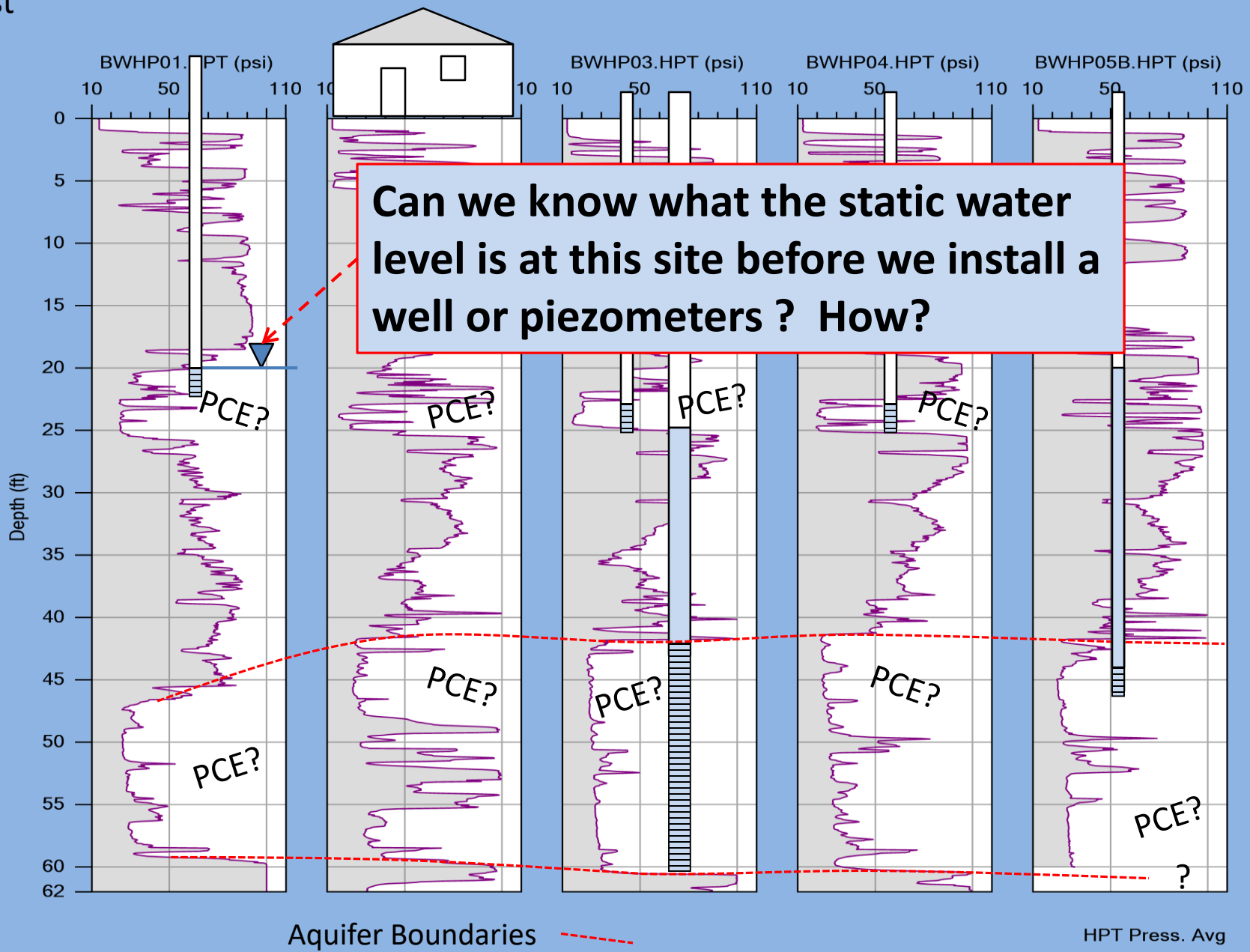
Hydrostratigraphy … Groundwater PCE Plume

West

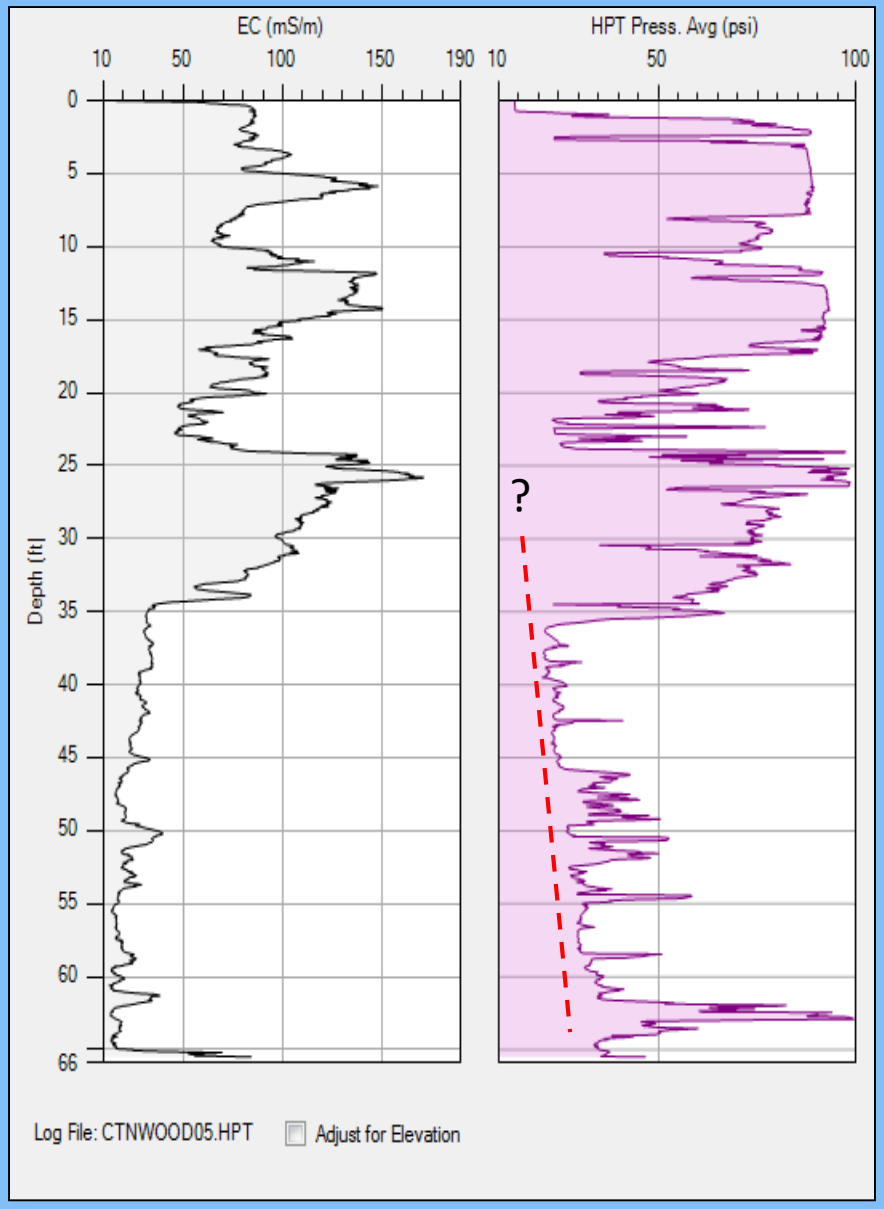
East



Hydrostratigraphy … Groundwater PCE Plume



Hydrostatic Pressure, Dissipation Tests, Water Levels & More



Hydrostatic Pressure =

- 2.31 ft of water = 1 psi
- 0.433 psi/ft water
- 1 meter of water = 9.81 kPa

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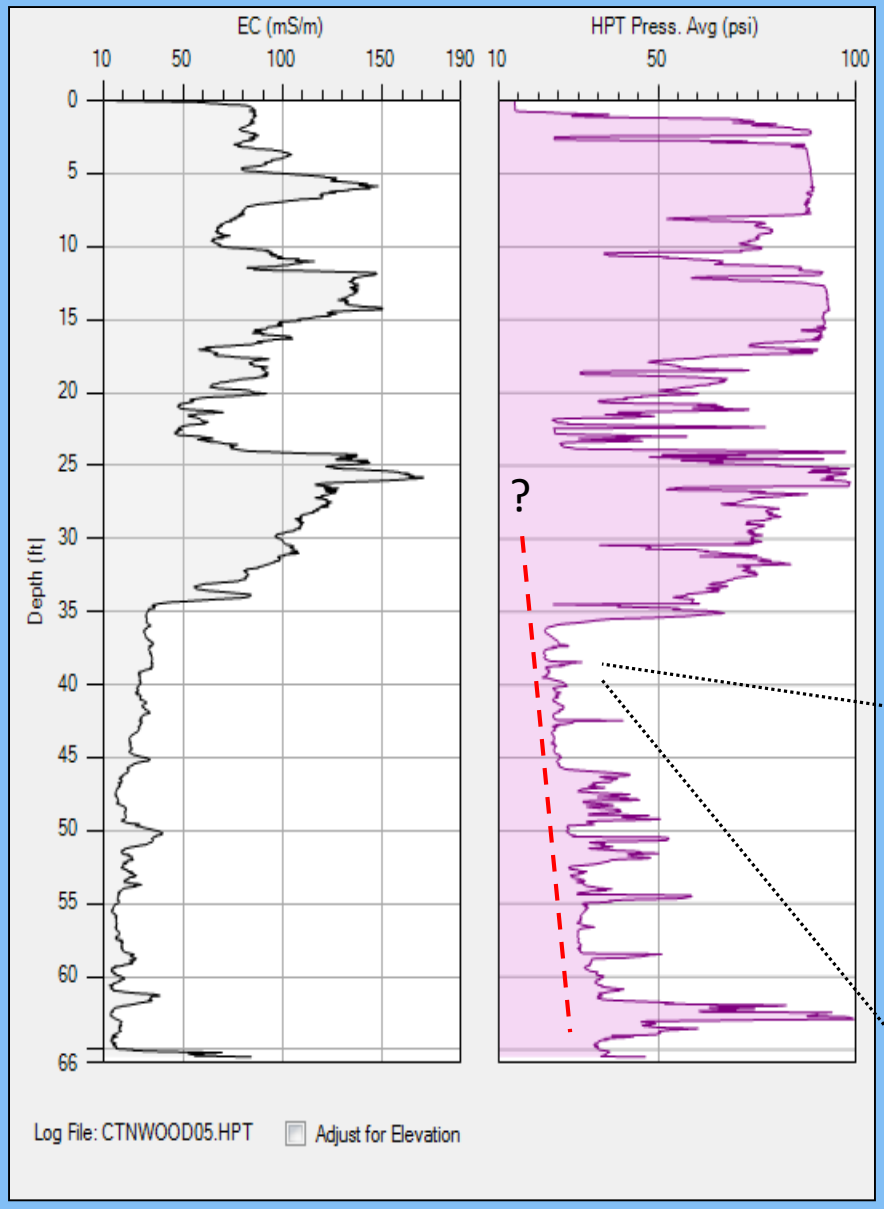
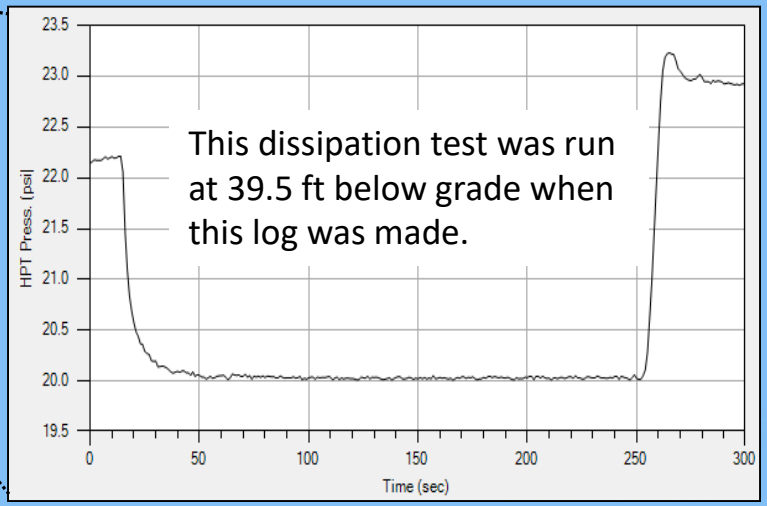
Hydrostatic Pressure, Dissipation Tests, Water Levels & More



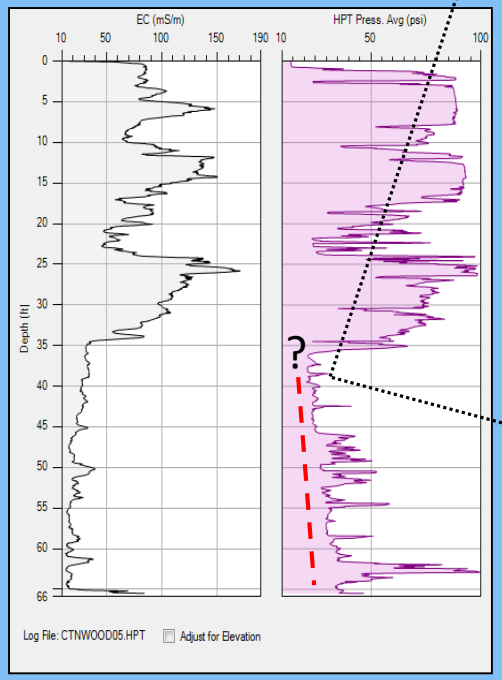
Pressure **Dissipation Tests** yield absolute hydrostatic pressure below the water table.

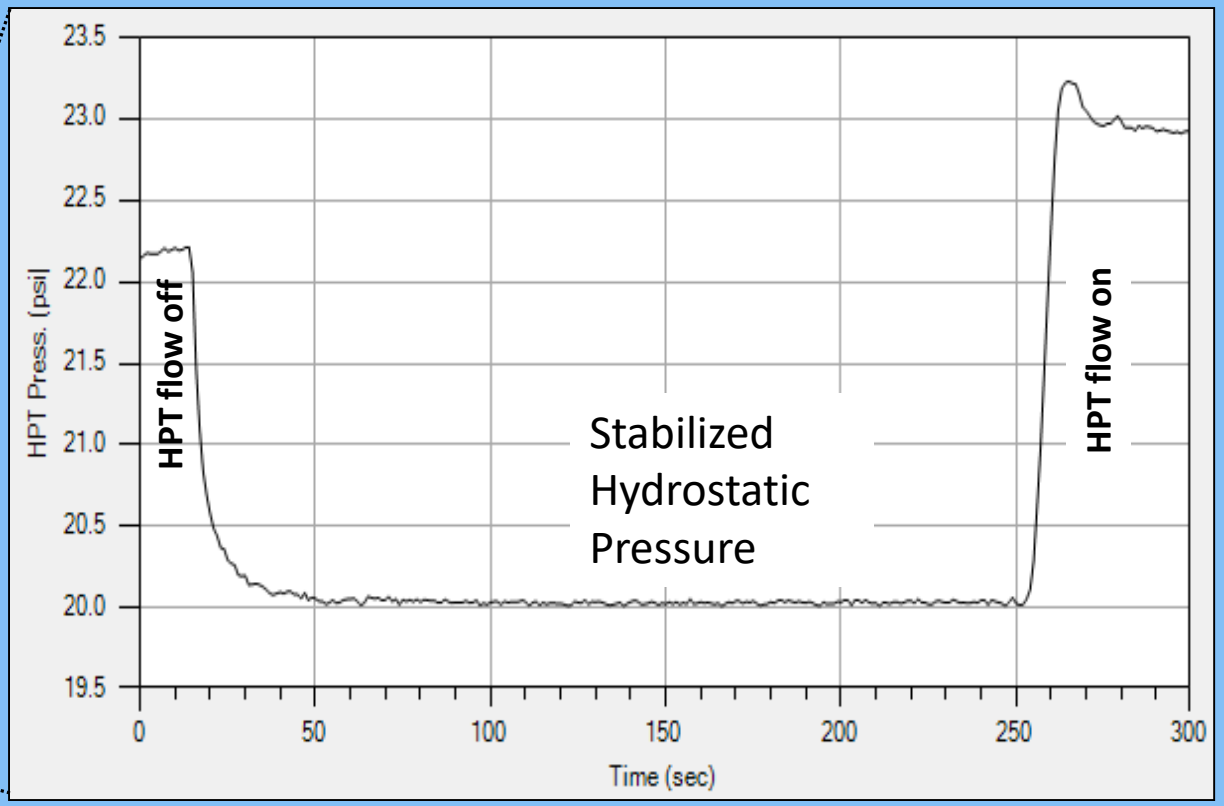
Prefer to run dissipation tests in sandy zones.



To Run a Dissipation Test …

- Stop Probe Advancement
- Turn off HPT flow
- Record pressure changes in a time file





This dissipation test was run at 39.5 ft below grade when this log was made.

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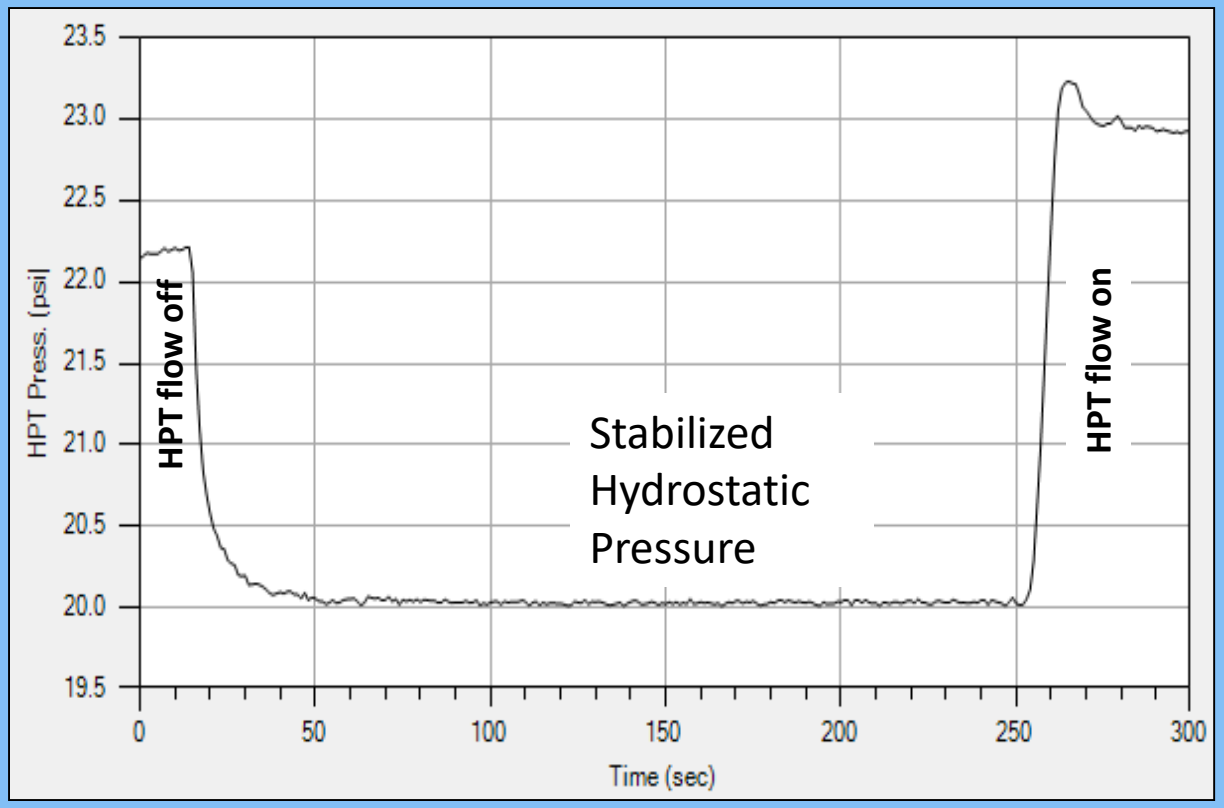
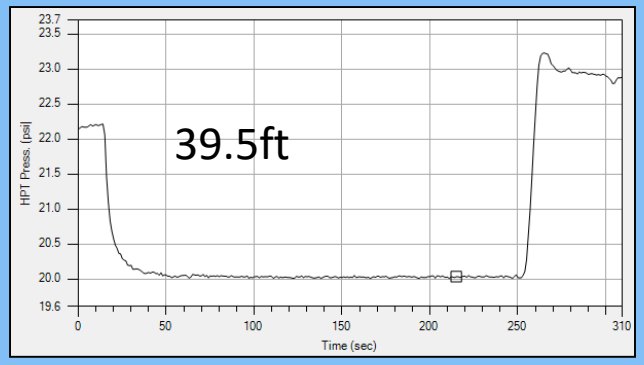
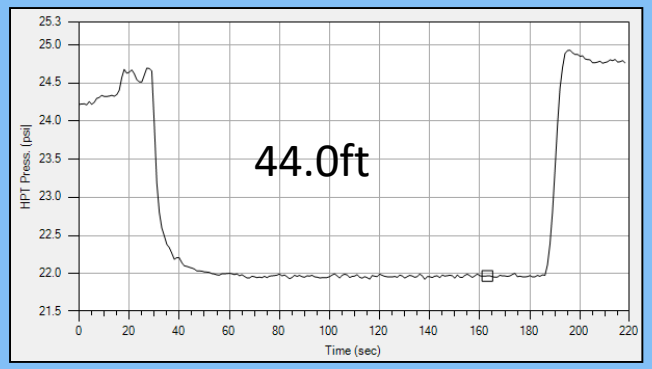
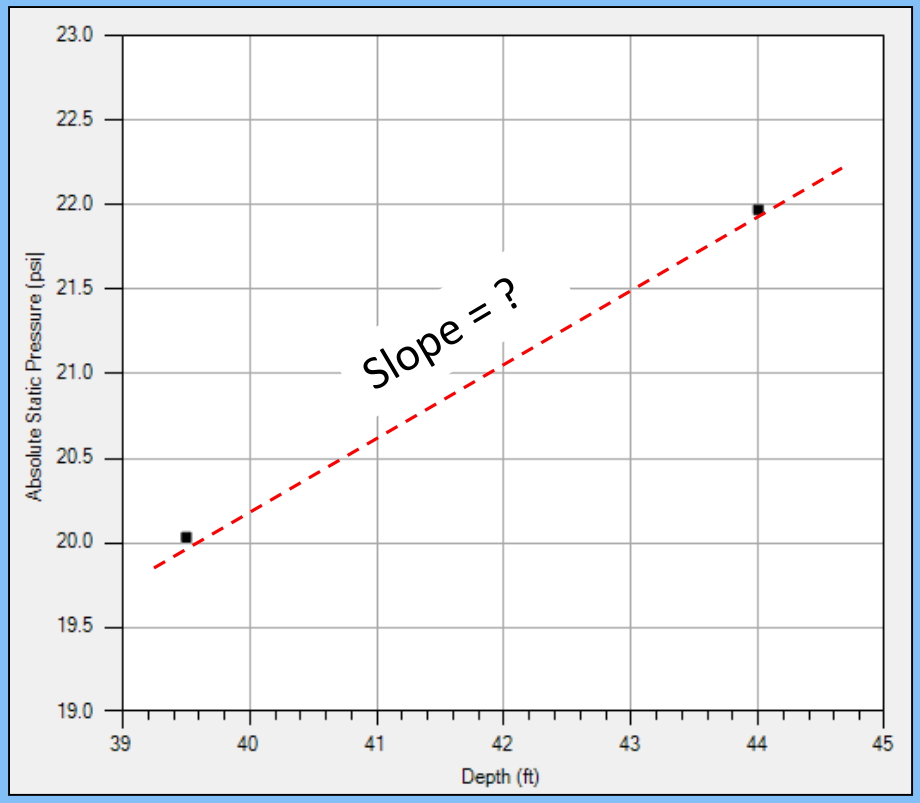
Let's use the DI Viewer Software to review some dissipation tests …



Is Slope of the Hydrostatic Pressure Line Correct?







$$\frac{21.971 - 20.036 \text{ psi}}{44.0 - 39.5 \text{ ft}} = \frac{1.935 \text{ psi}}{4.5 \text{ ft}} = 0.430 \text{ psi/ft} = \text{hydrostatic pressure slope}$$

(for a water table aquifer)

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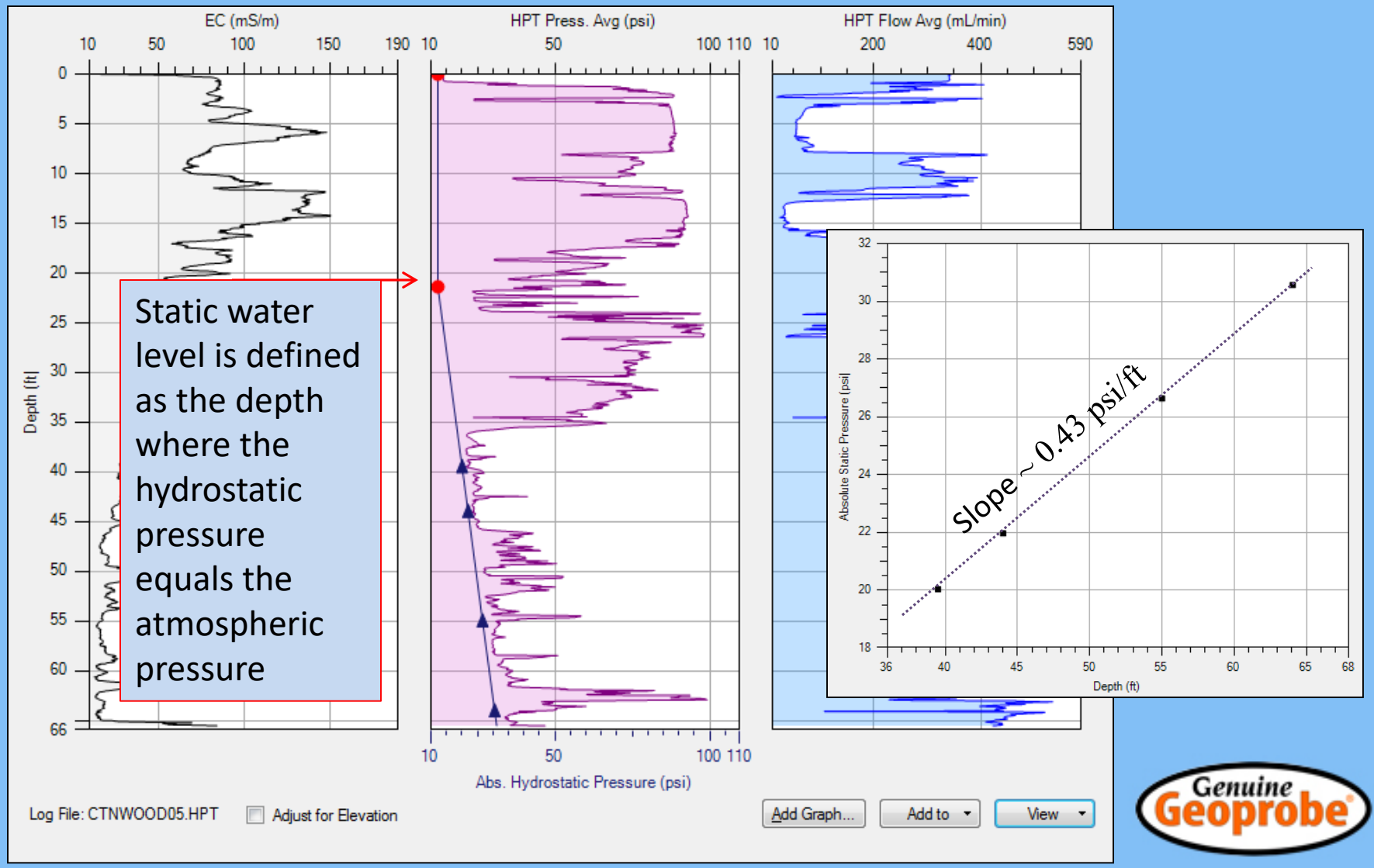
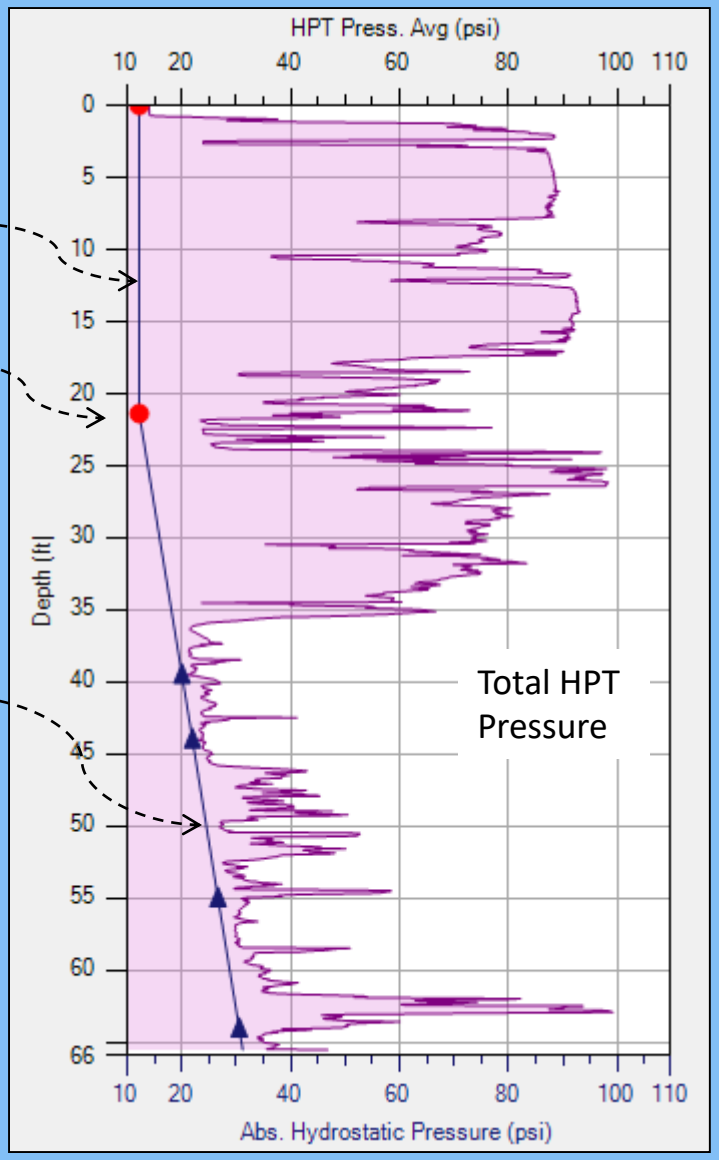
Fully Dissipated Tests = Good Hydrostatic Pressure Line and Water level



Corrected HPT Pressure



Atmospheric Pressure

Static Water Level

Hydrostatic + Atmospheric Pressure

At each depth increment:

Corrected HPT Pressure (Pc) =

Total HPT Pressure – (Atm. Press. + Hydro. Press)

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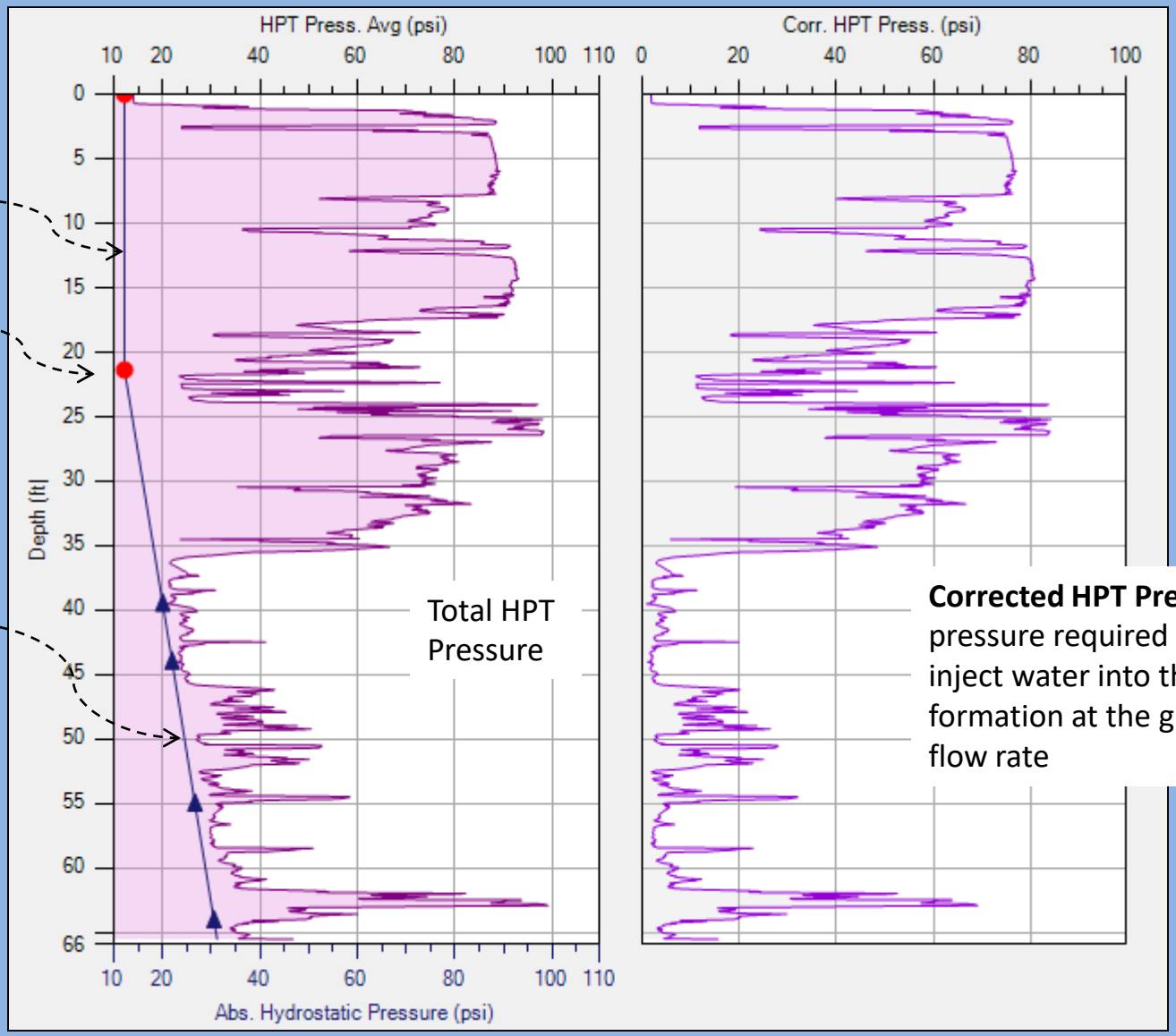
Corrected HPT Pressure



Atmospheric Pressure

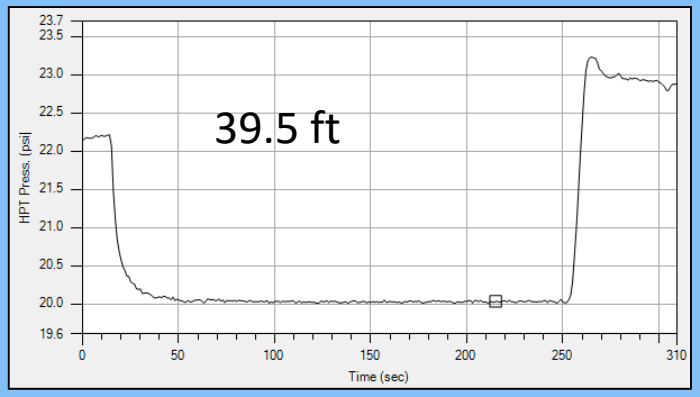
Static Water Level

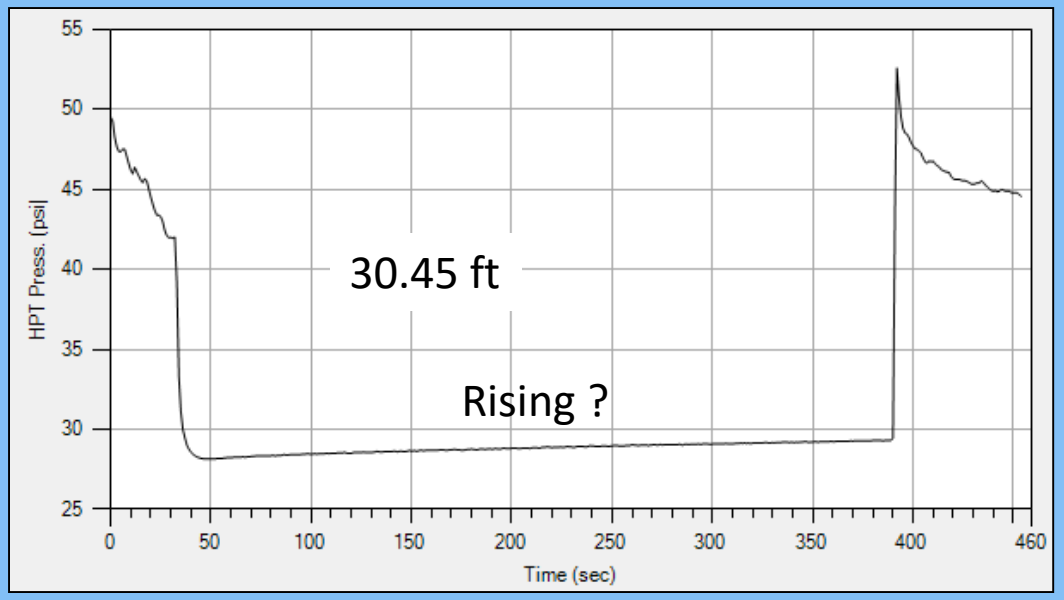
Hydrostatic + Atmospheric Pressure

Corrected HPT Pressure = pressure required to inject water into the formation at the given flow rate

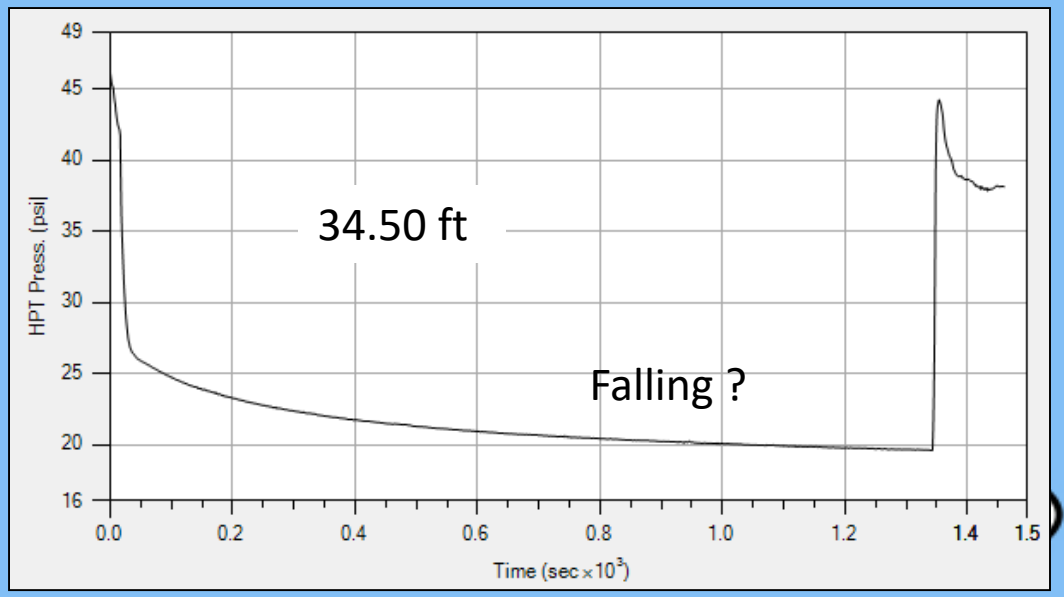
At each depth increment: Corrected HPT Pressure = Total HPT Pressure – (Atm. Pressure + Hydrostatic Pressure)

Is Your Dissipation Test Fully Dissipated ?

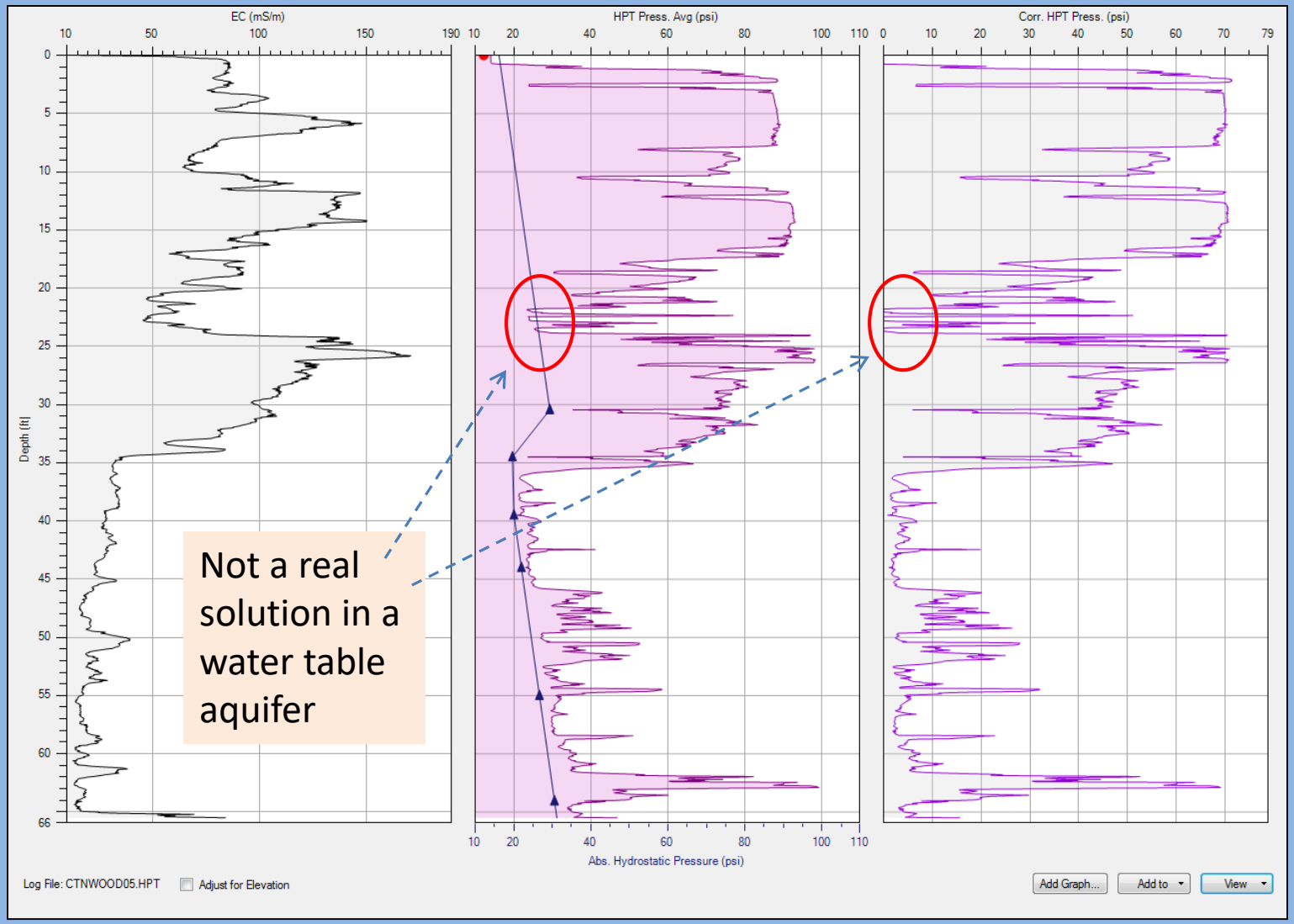




Why do I care ?

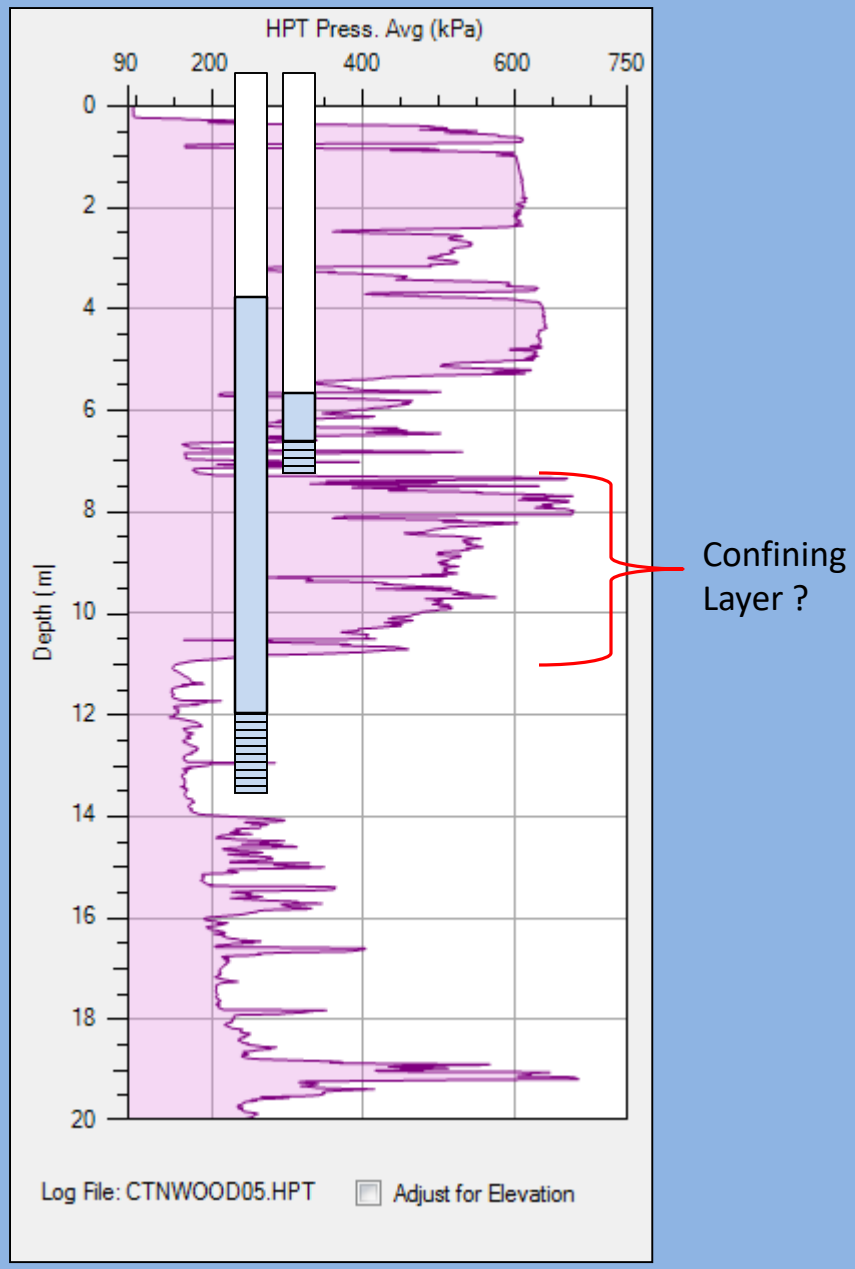


Incomplete Dissipation Tests …

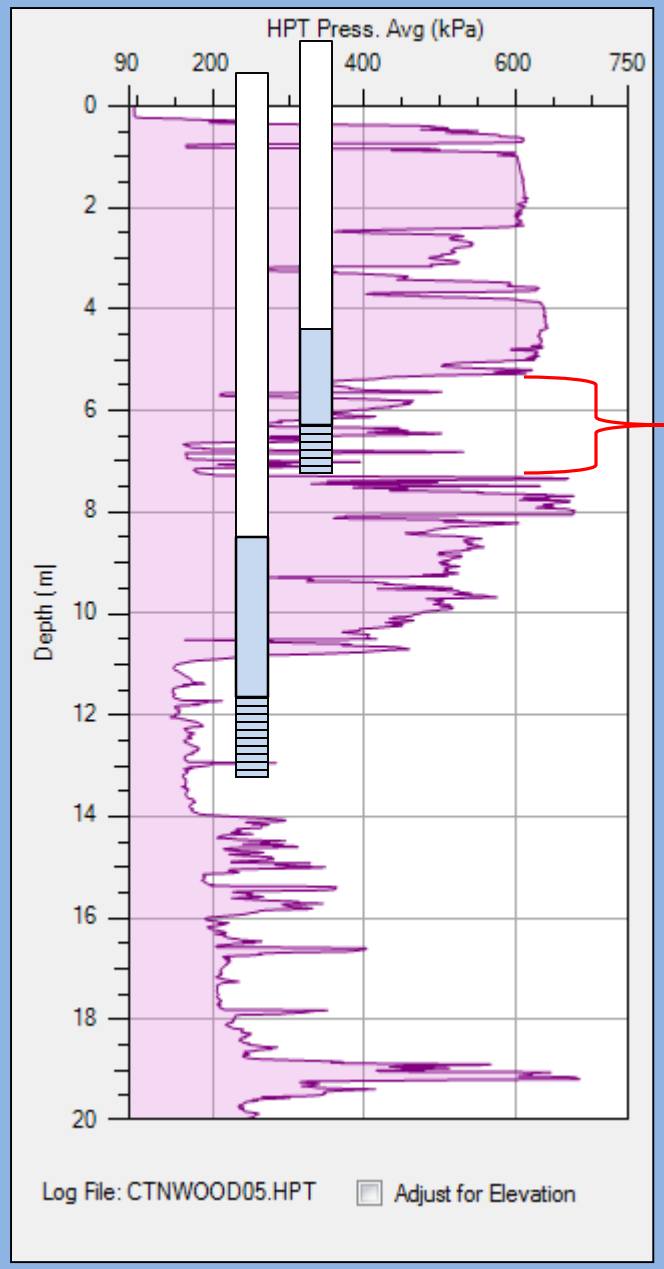


… result in incorrect hydrostatic pressure lines (slope), incorrect static water levels and incorrect corrected pressure graphs …

However, in the real world …



Confining Layer ?



Perched Water ?

Estimating Hydraulic Conductivity (K) with HPT Log Data

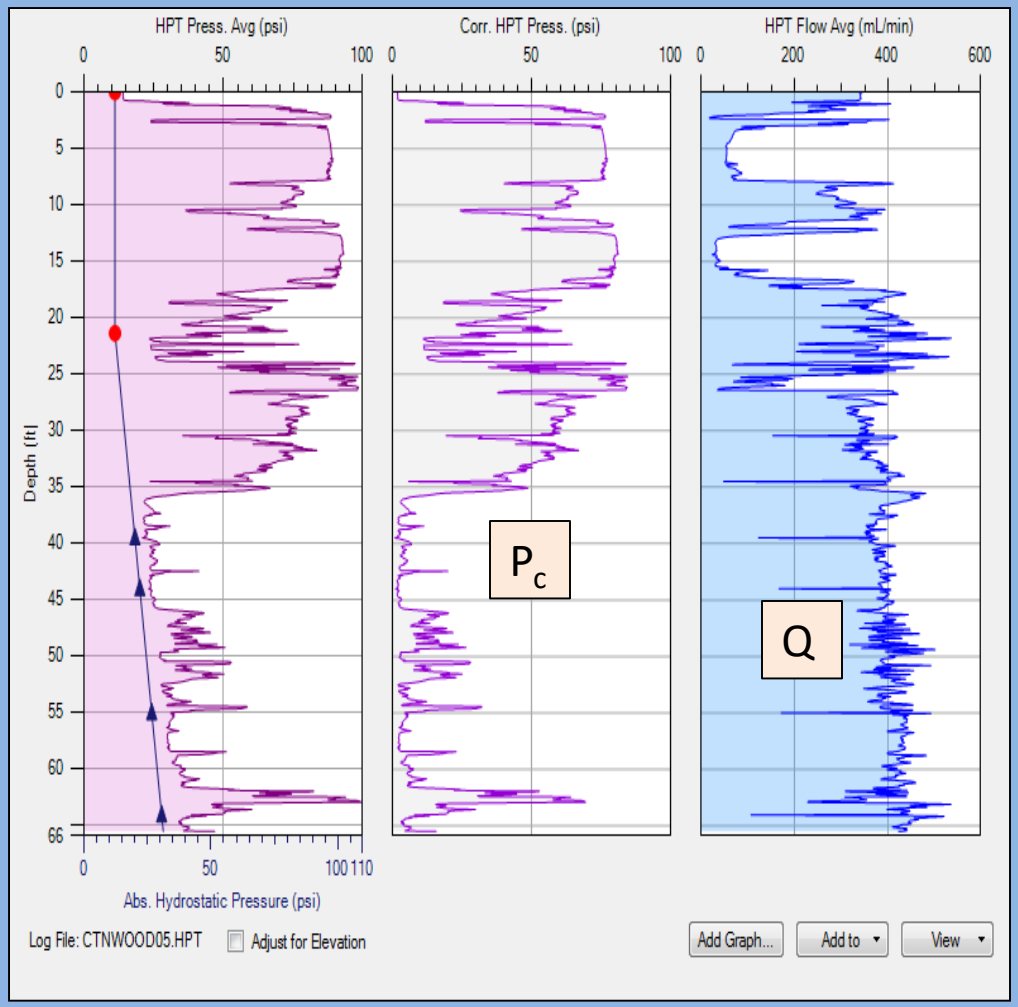
From Darcy's Law:

Hydraulic Conductivity (K) = f(Q/P)

HPT logs provide both:

Corrected Pressure (P_c)

And Flow Rate (Q)



Estimating K with HPT Q and P_c Data

Empirical Model developed from co-located slug tests and HPT logs to calculate K from Q/P_c ratio.

Performing a Pneumatic Slug Test

Study area next to cottonwood tree

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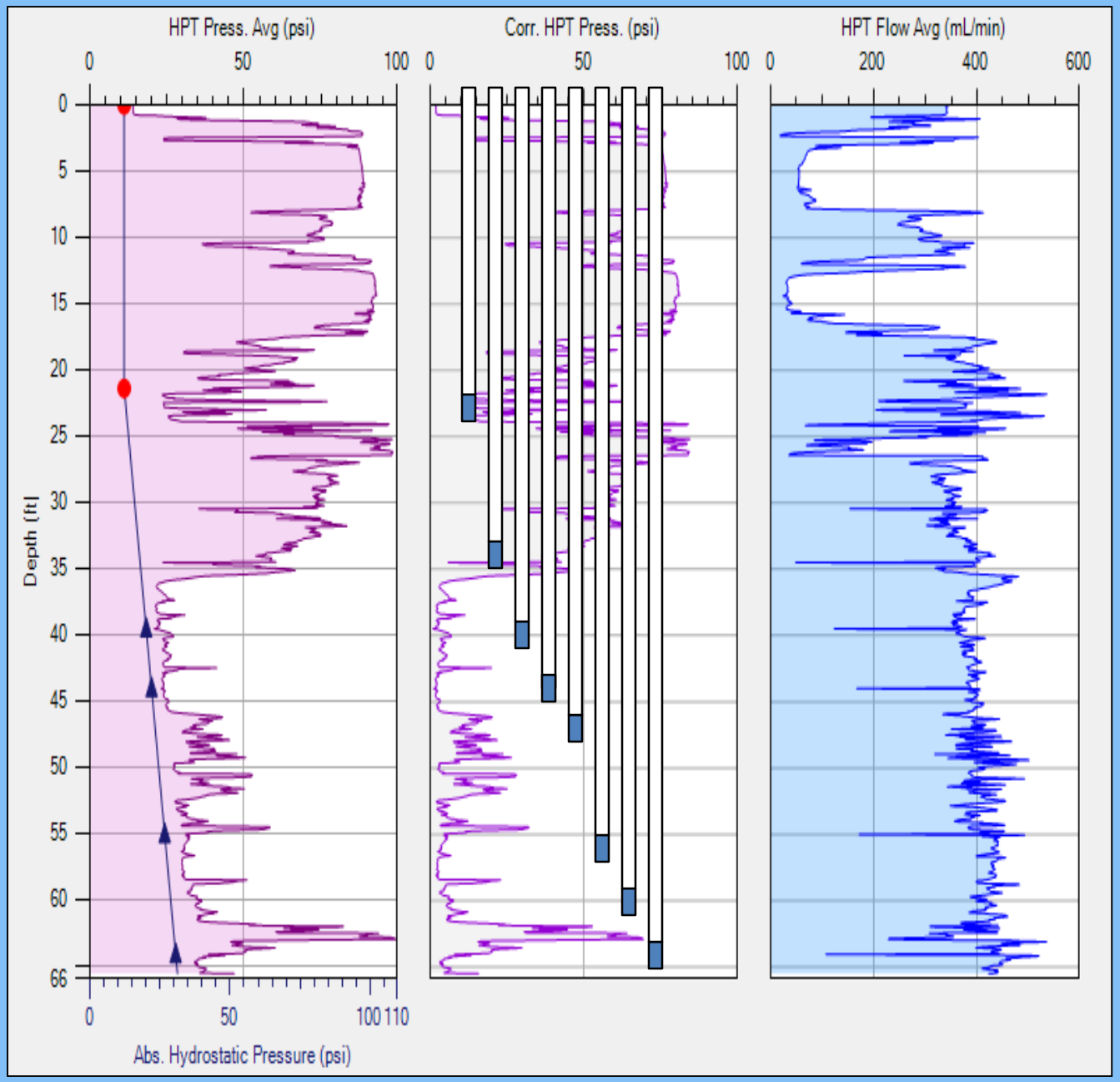
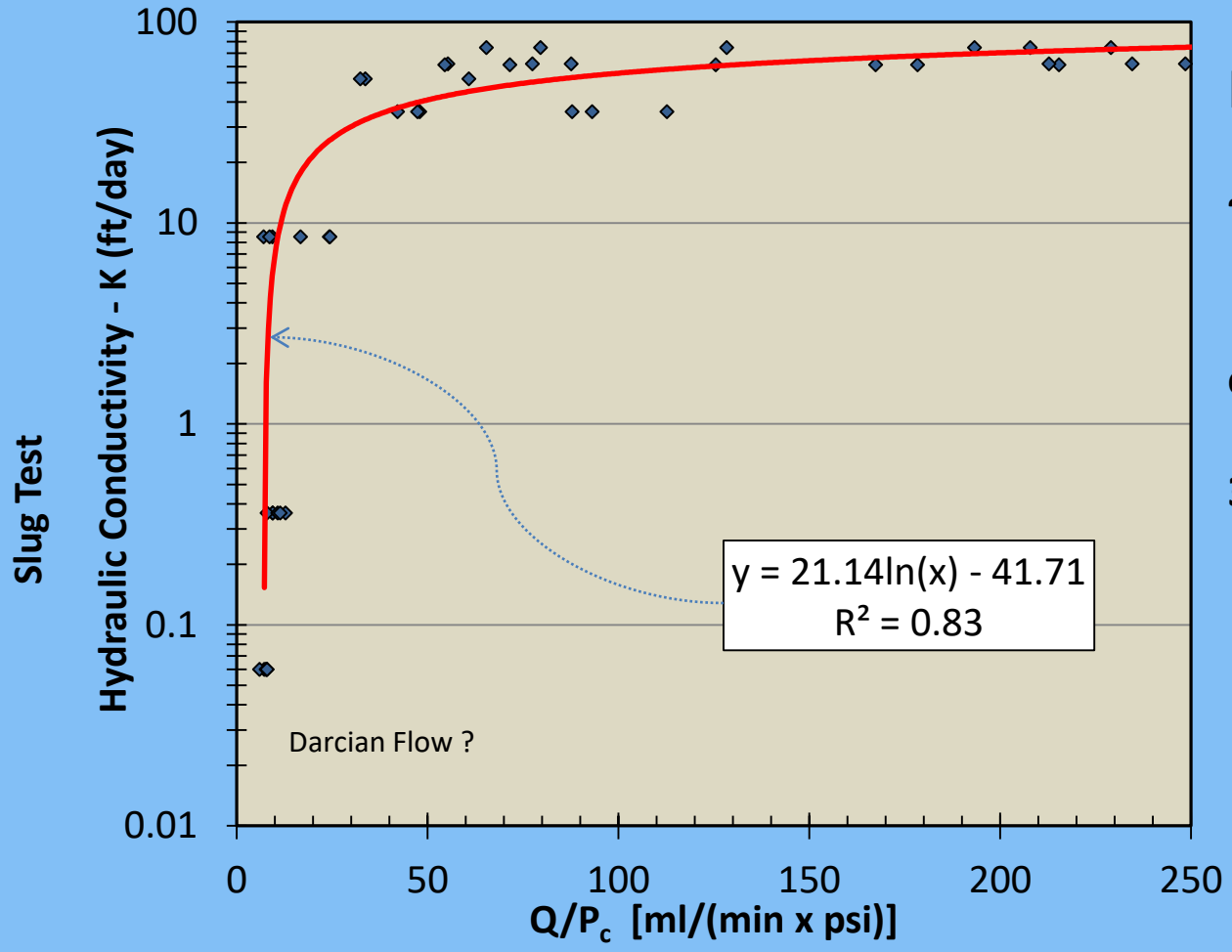
Multi-Level Discrete Interval Slug Tests

$K = f(Q/Pc)$



Empirical Model for Estimating K with HPT Q & P_c



Model Limits

~ 0.1 ft/day to 75 ft/day

or

3.5E-5 cm/sec to 2.6E-2cm/sec

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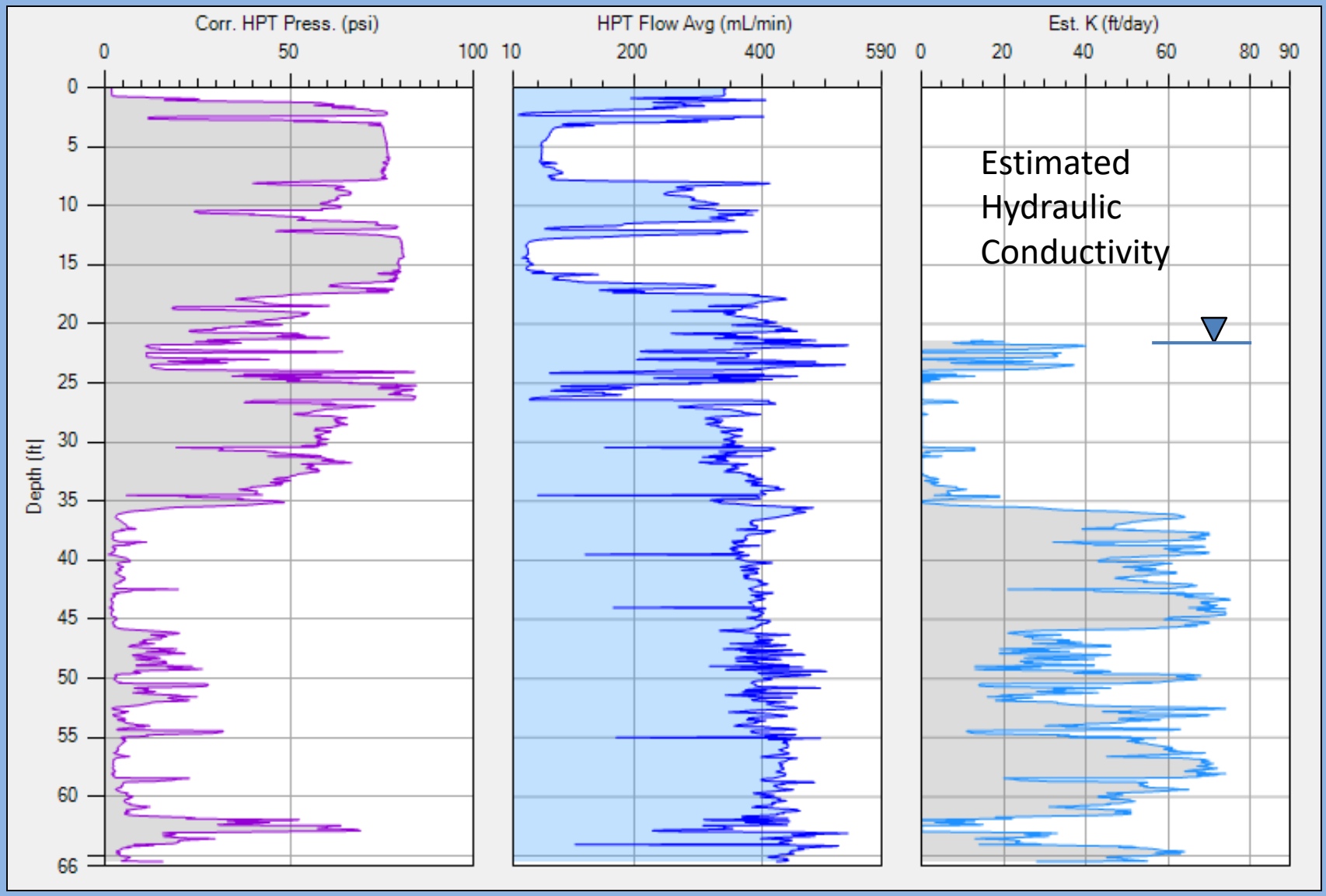
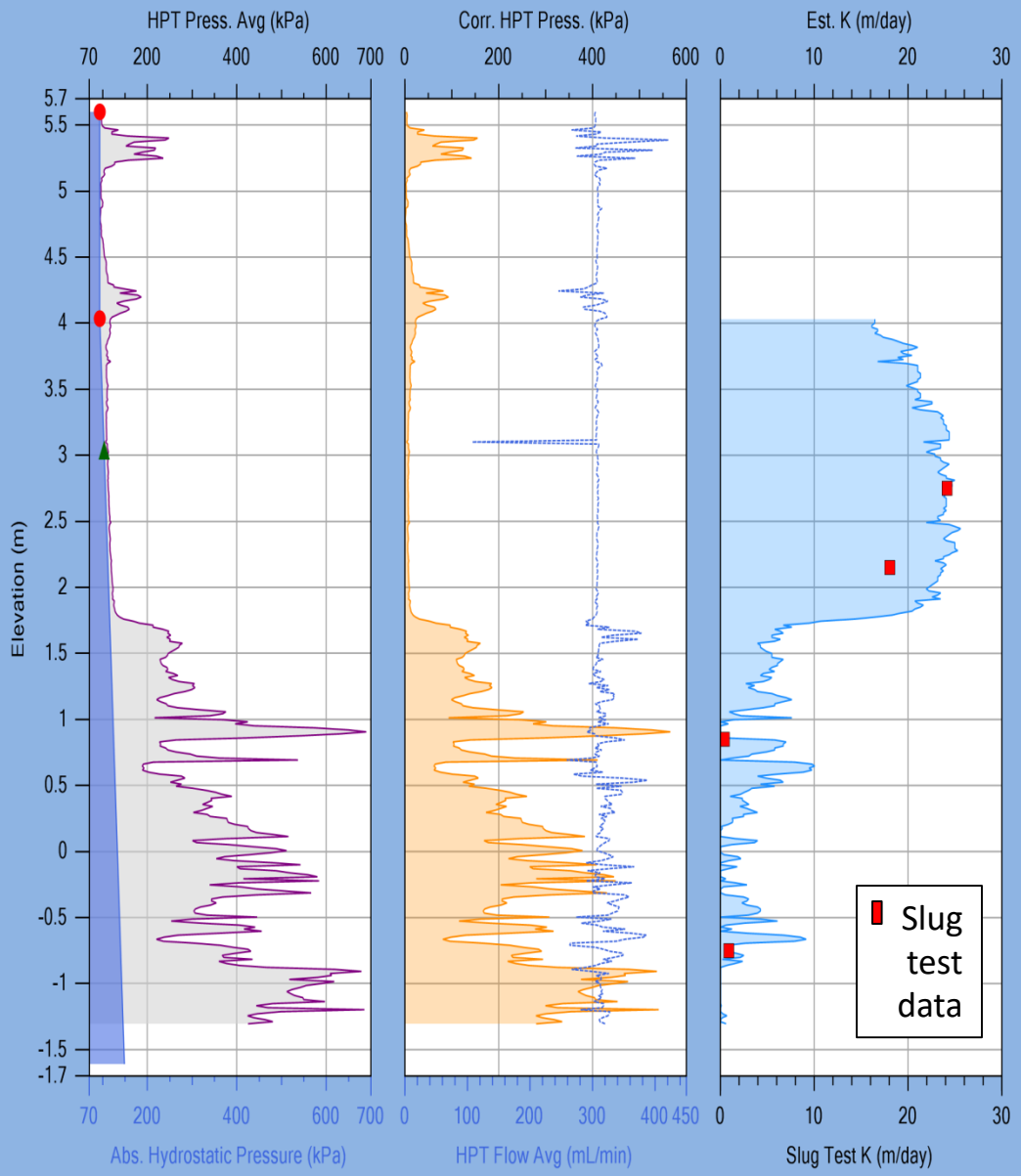
Estimated K with the DI Viewer Software



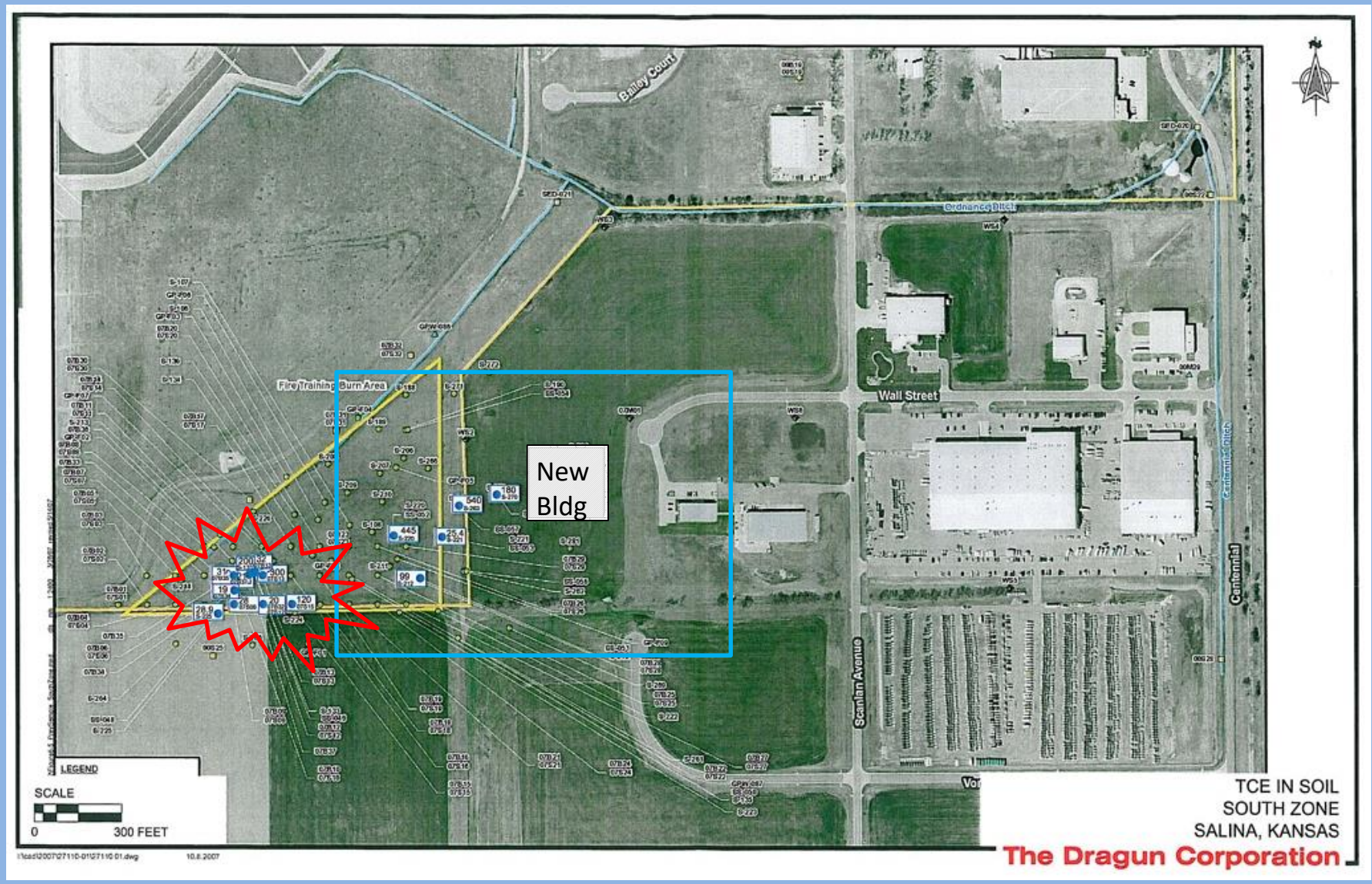
How Well Does the Est. K Model Work ?

MiHpt Logging, Skuldelev, DK

Co-Located Slug Testing in Skuldelev

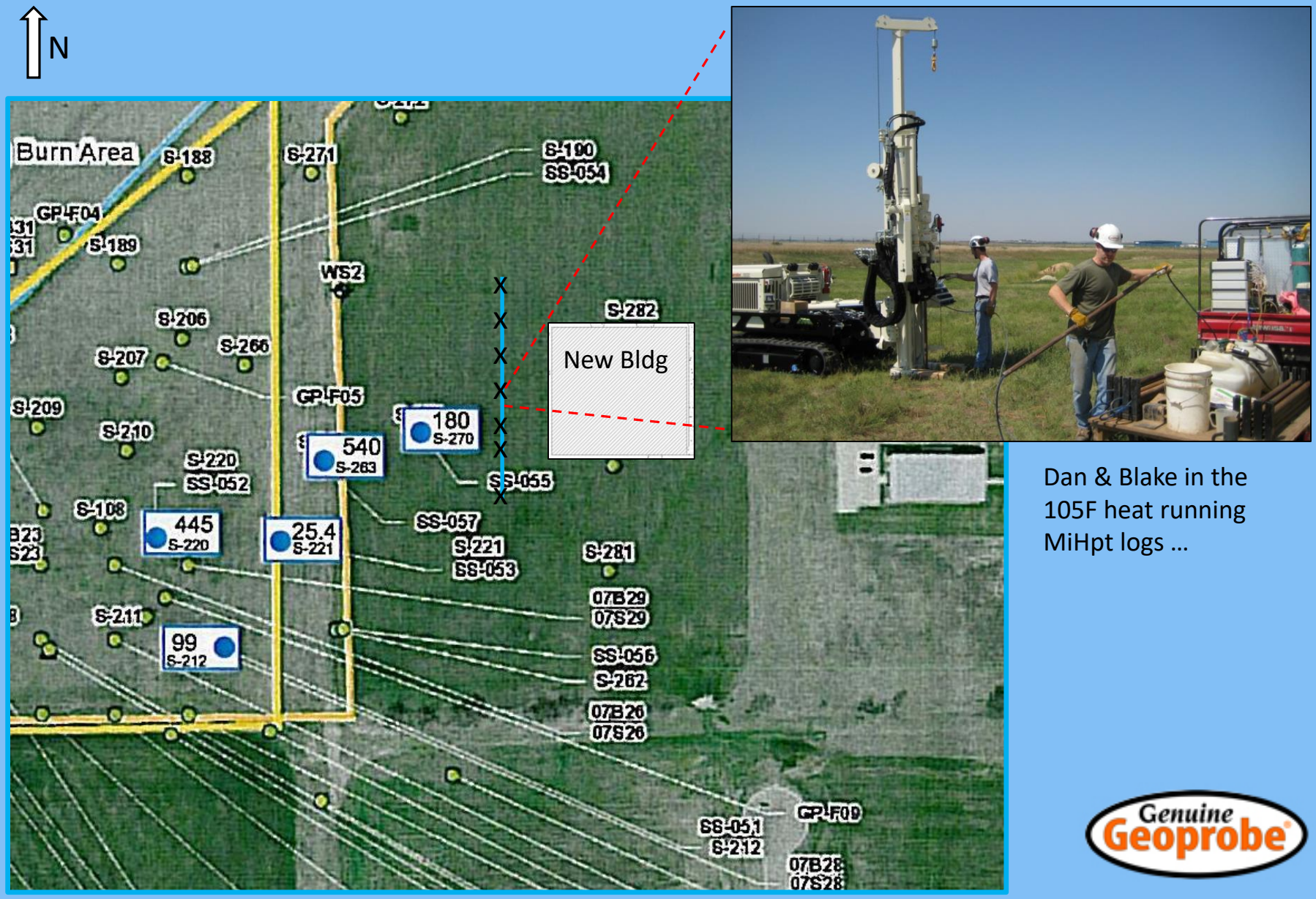


Former Schilling AFB: Old Fire Training Area Site



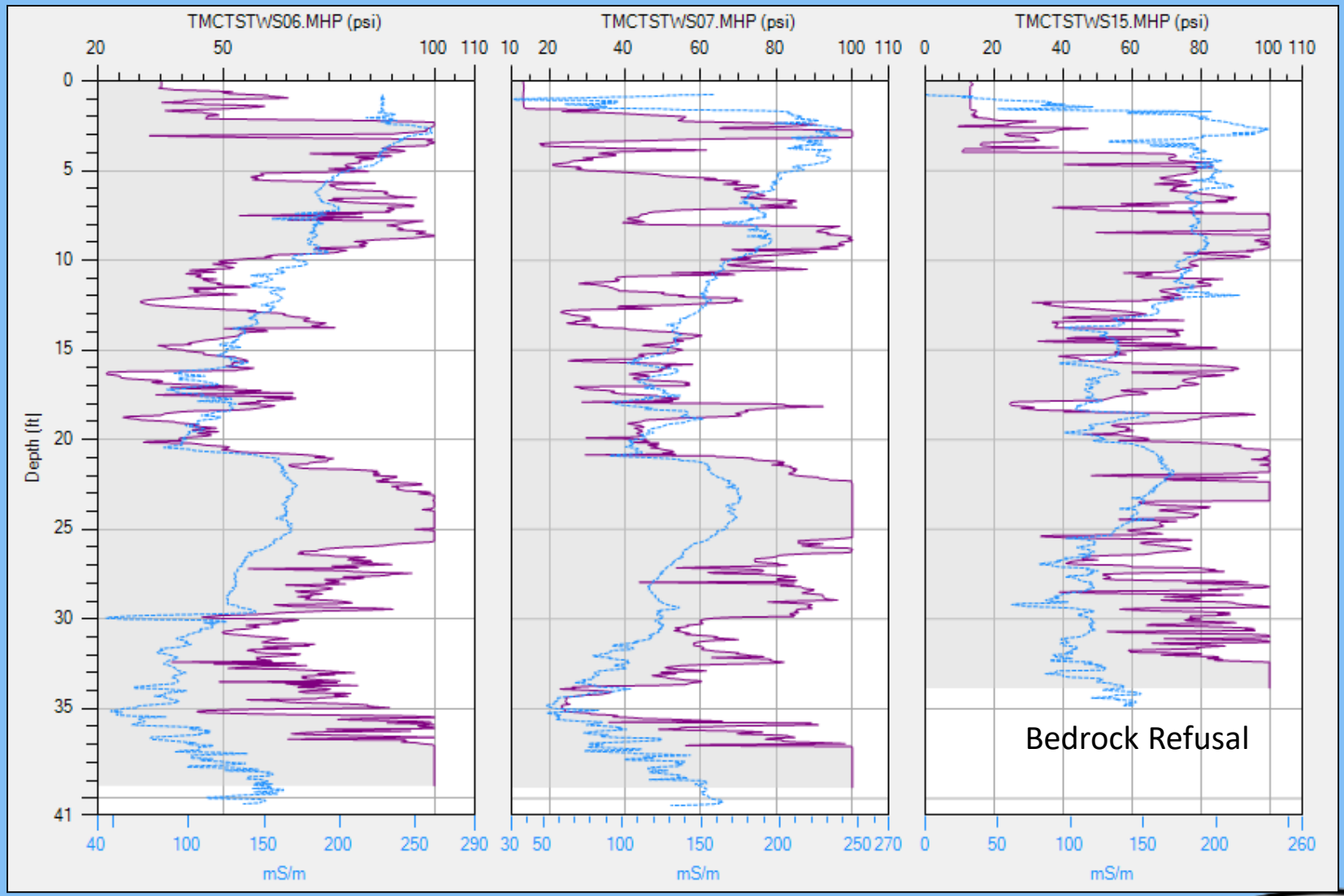
TCE in Groundwater at the Former SAFB

HPT Logging Transect

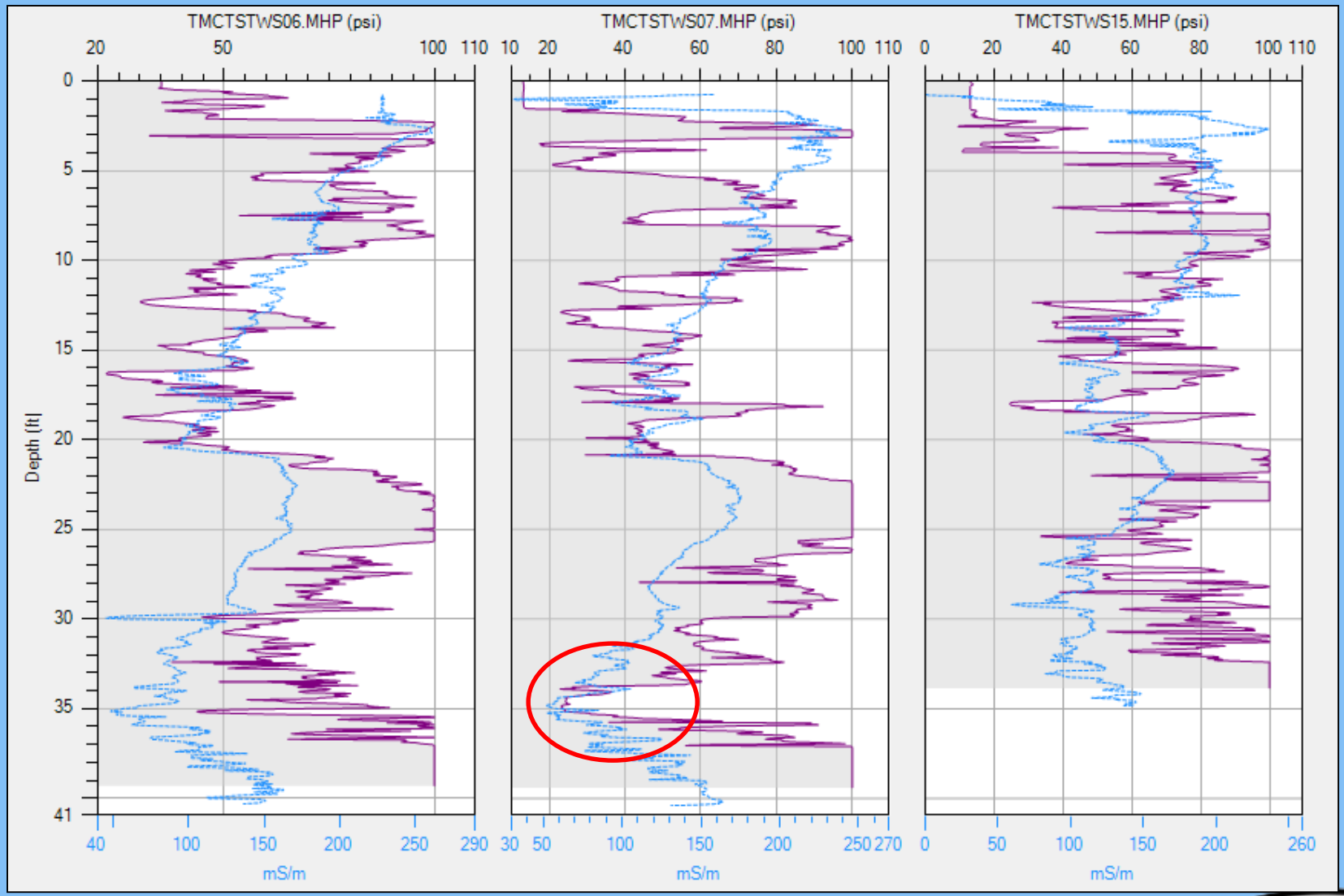


Dan & Blake in the 105F heat running MiHpt logs …

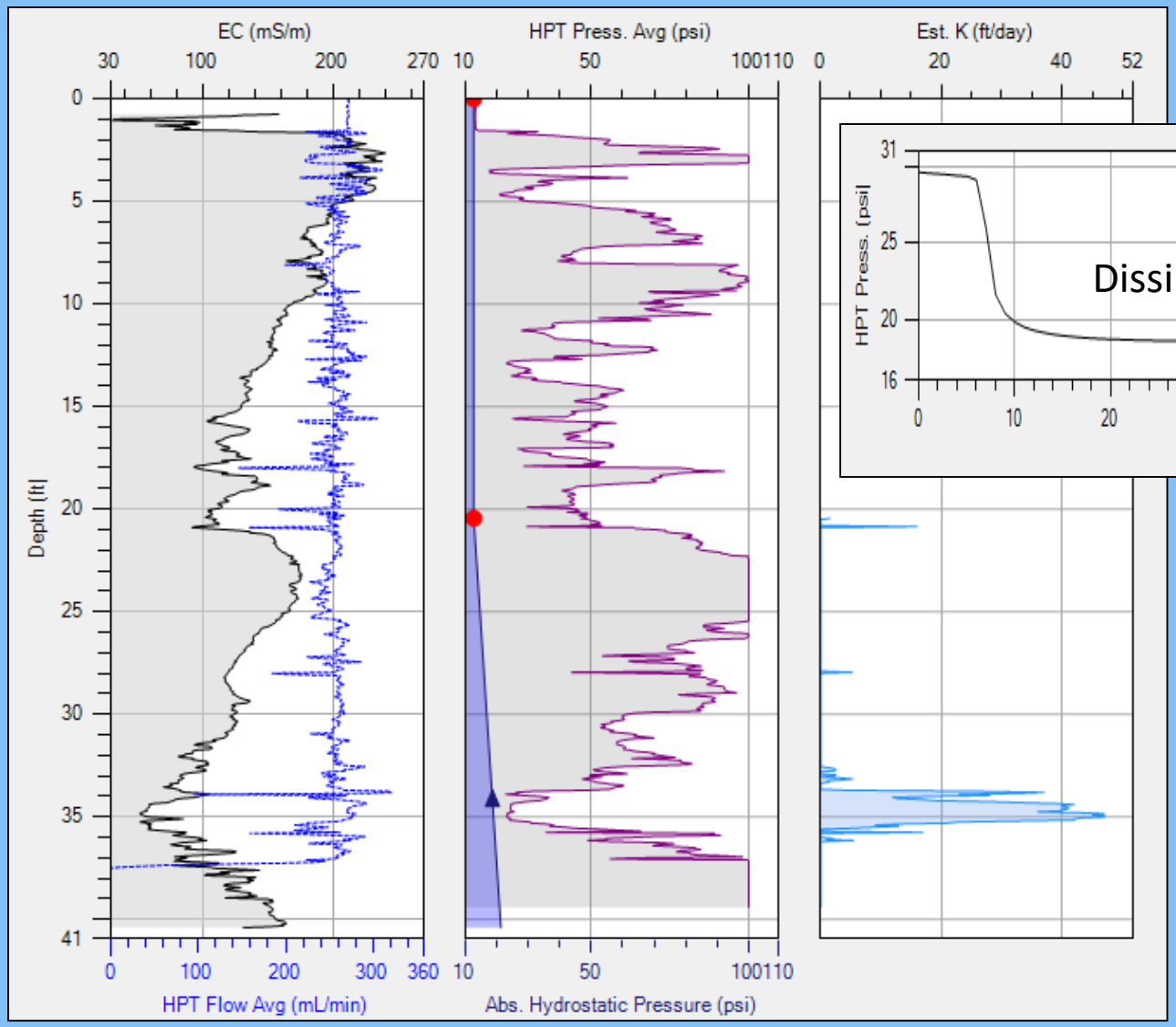
Logs WS06, 07 and 15

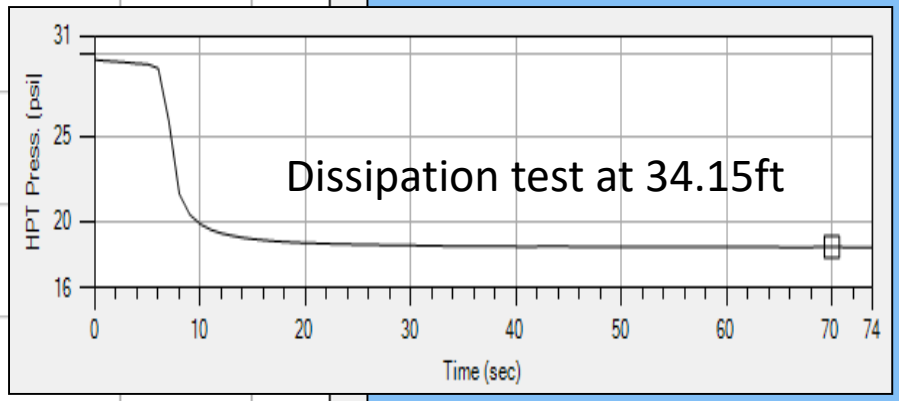


Logs WS06, 07 and 15



SK07 HPT Log Detail





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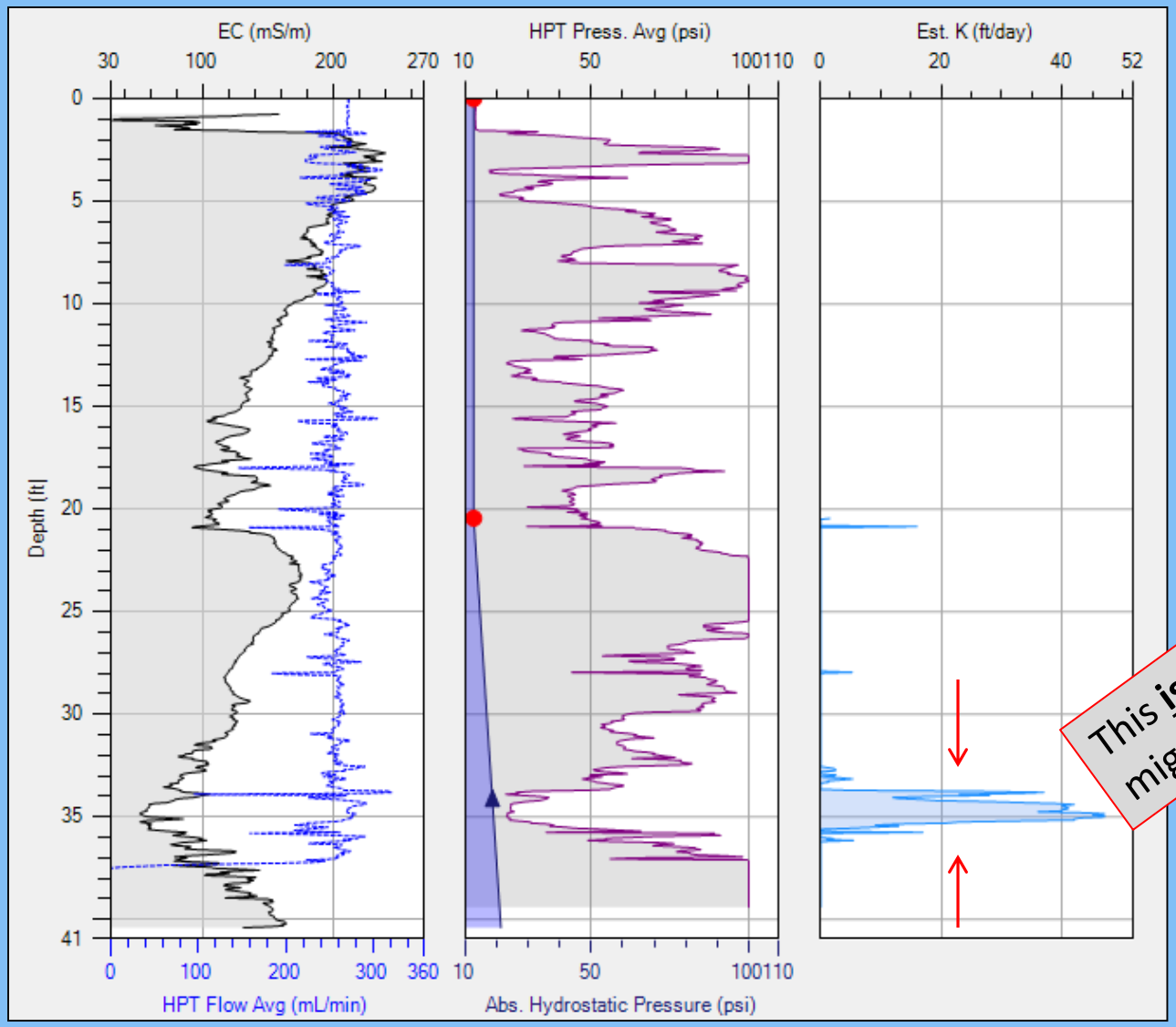
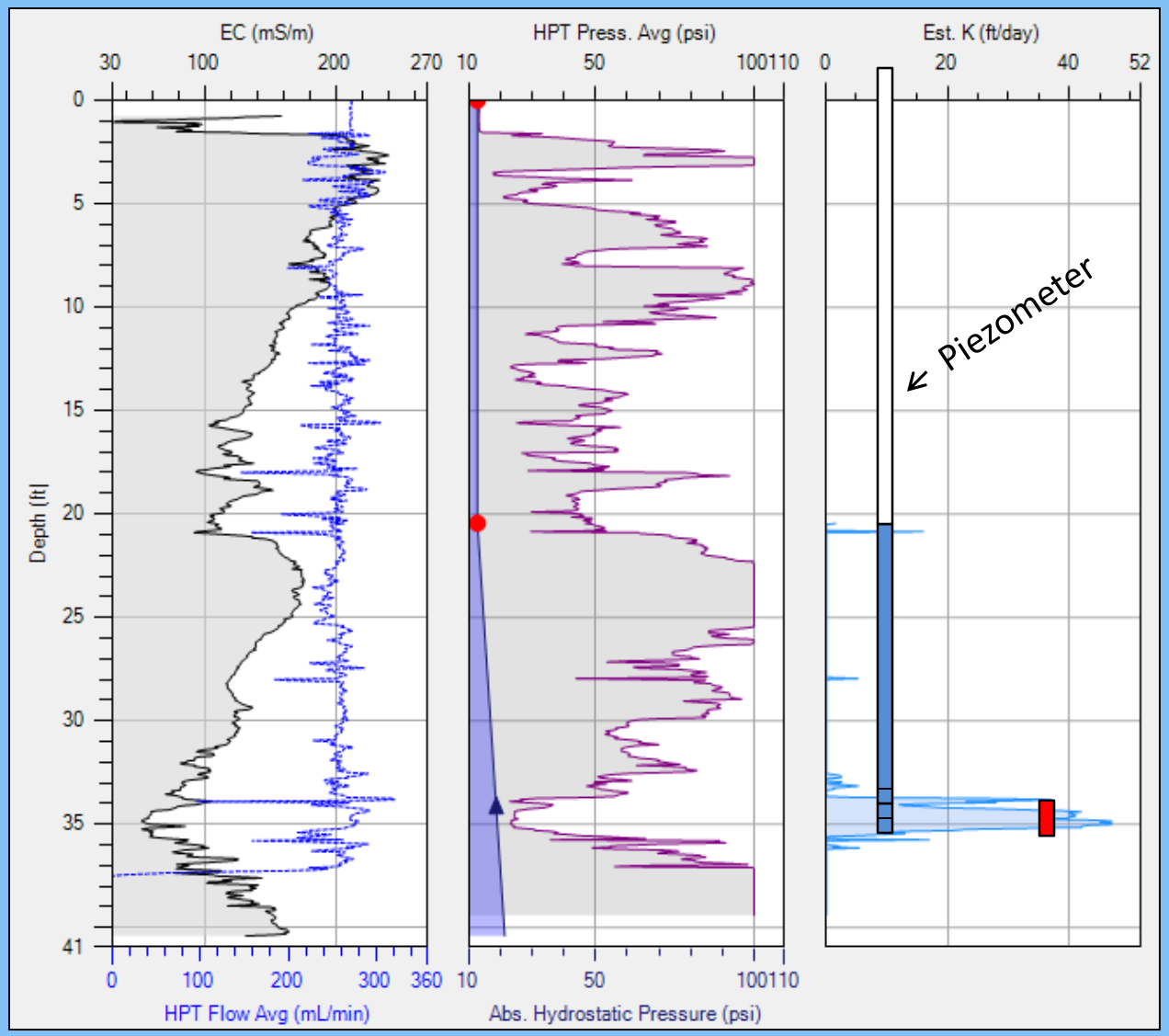
SK07 HPT Log Detail



This **is** your contaminant migration pathway !

Genuine Geoprobe®

SK07 Location Slug Test and Groundwater Sample Results



Slug Test K over this interval is :

35.4 ft/day or
10.8 m/day

X-VOC contaminants detected were:

Carbon tet = 13,000 µg/l
Chloroform = 370
TCE = 5480

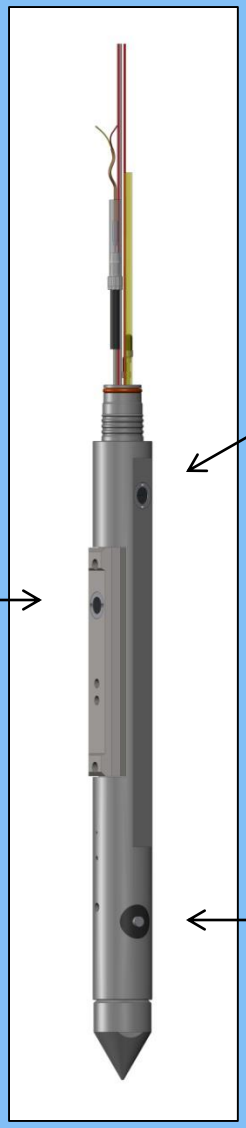
Total X-VOC = 18,850 µg/l

Genuine Geoprobe

Using HPT Logs for Subsurface Interpretation (Developing a Conceptual Site Model … CSM)

MiHpt Logs from Skuldelev, DK

MiHpt is a combined membrane interface probe and HPT probe



Genuine Geoprobe

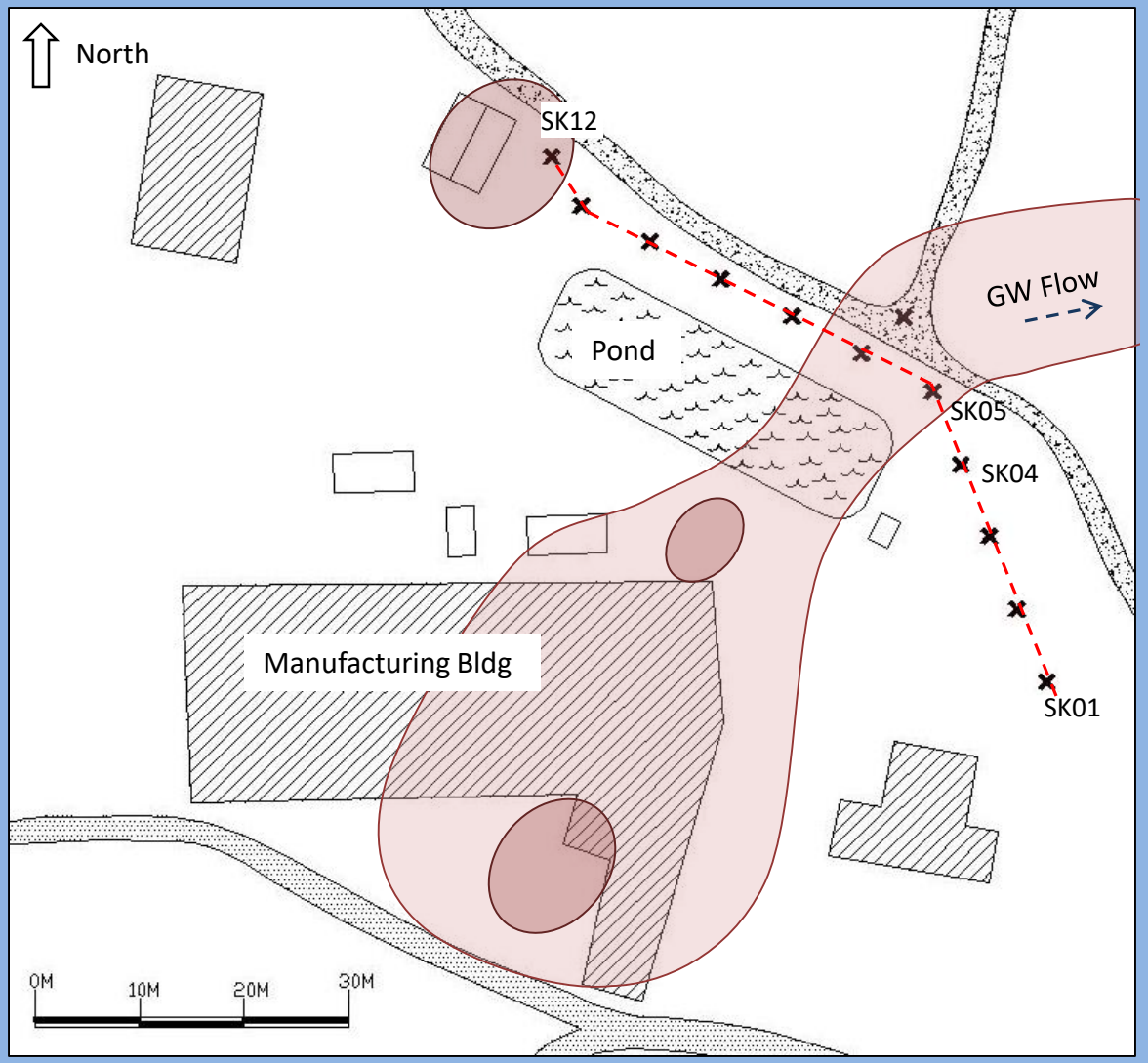
Skuldelev Location & Site Map

MiHpt Log **X**

Cross section Line - - - - -

GW Plume & Hot Spot

PCE, TCE, DCE & VC

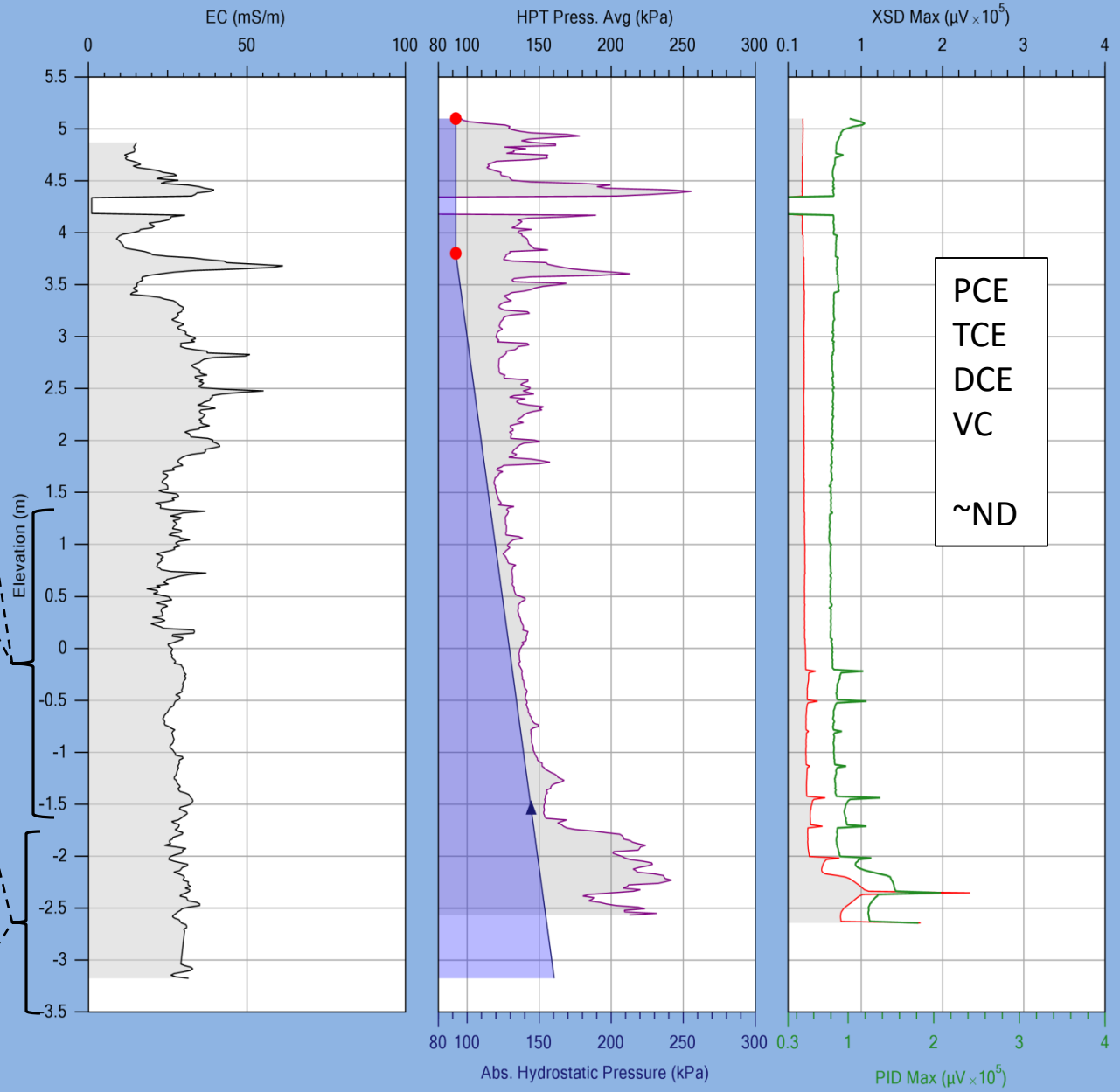


Logs are spaced 8 m (~25ft) apart.

Skuldelev SK04 Location Log

Sand & Gravel

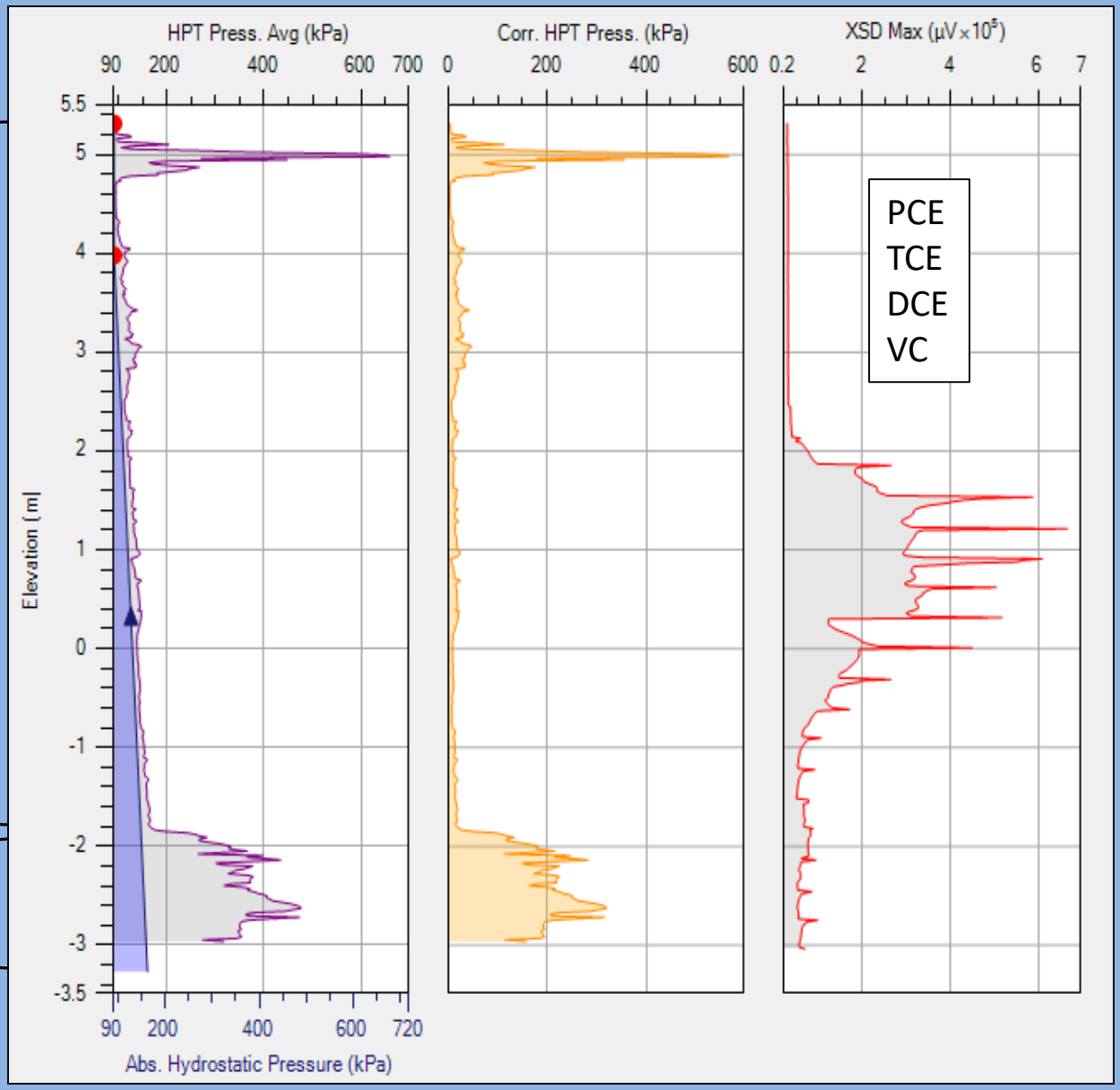
Clay-Till



Skuldelev SK05 Location Log

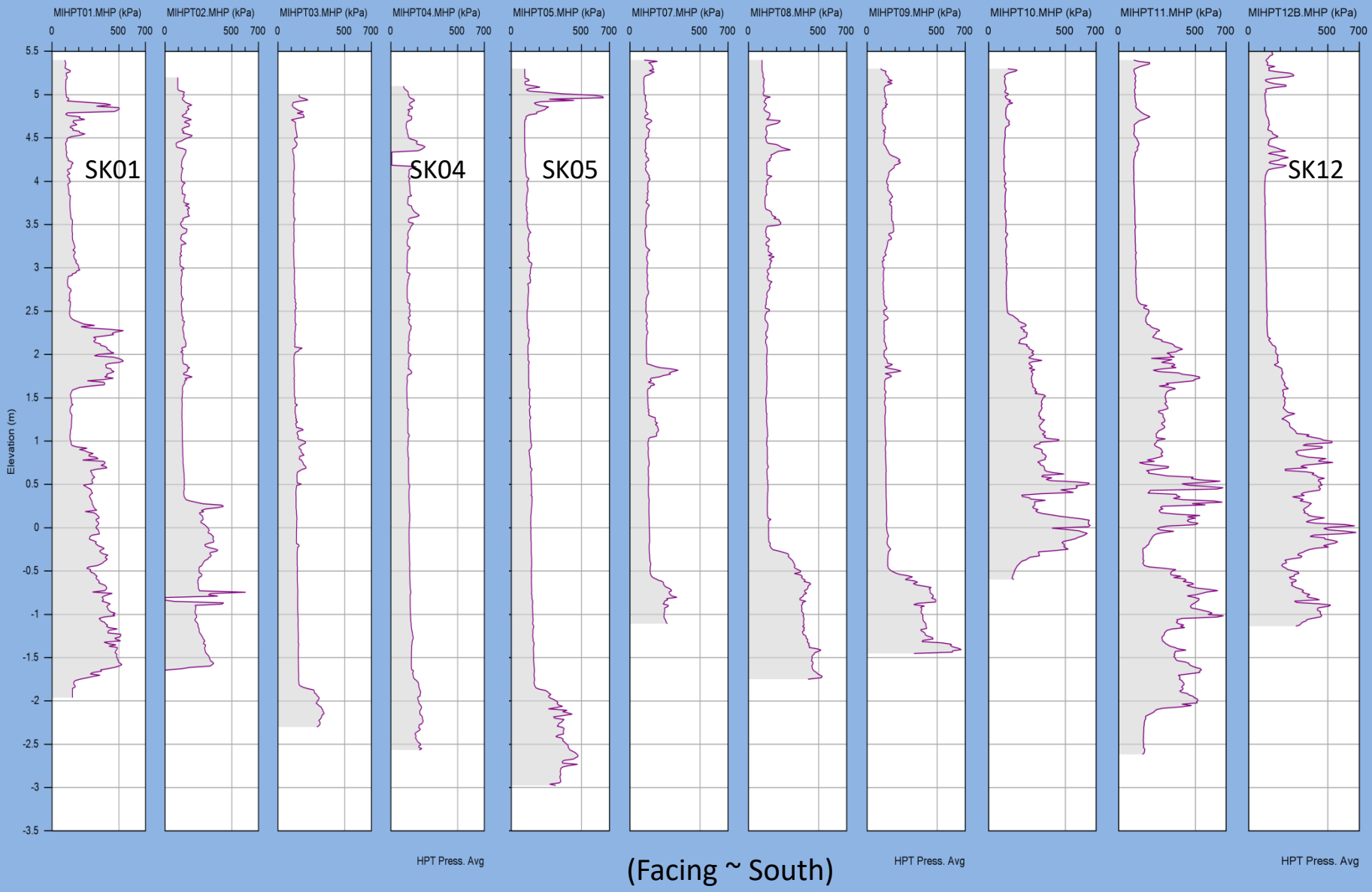
Sand & Gravel ± Fines

Clay-Till



Skuldelev HPT Pressure X-Section

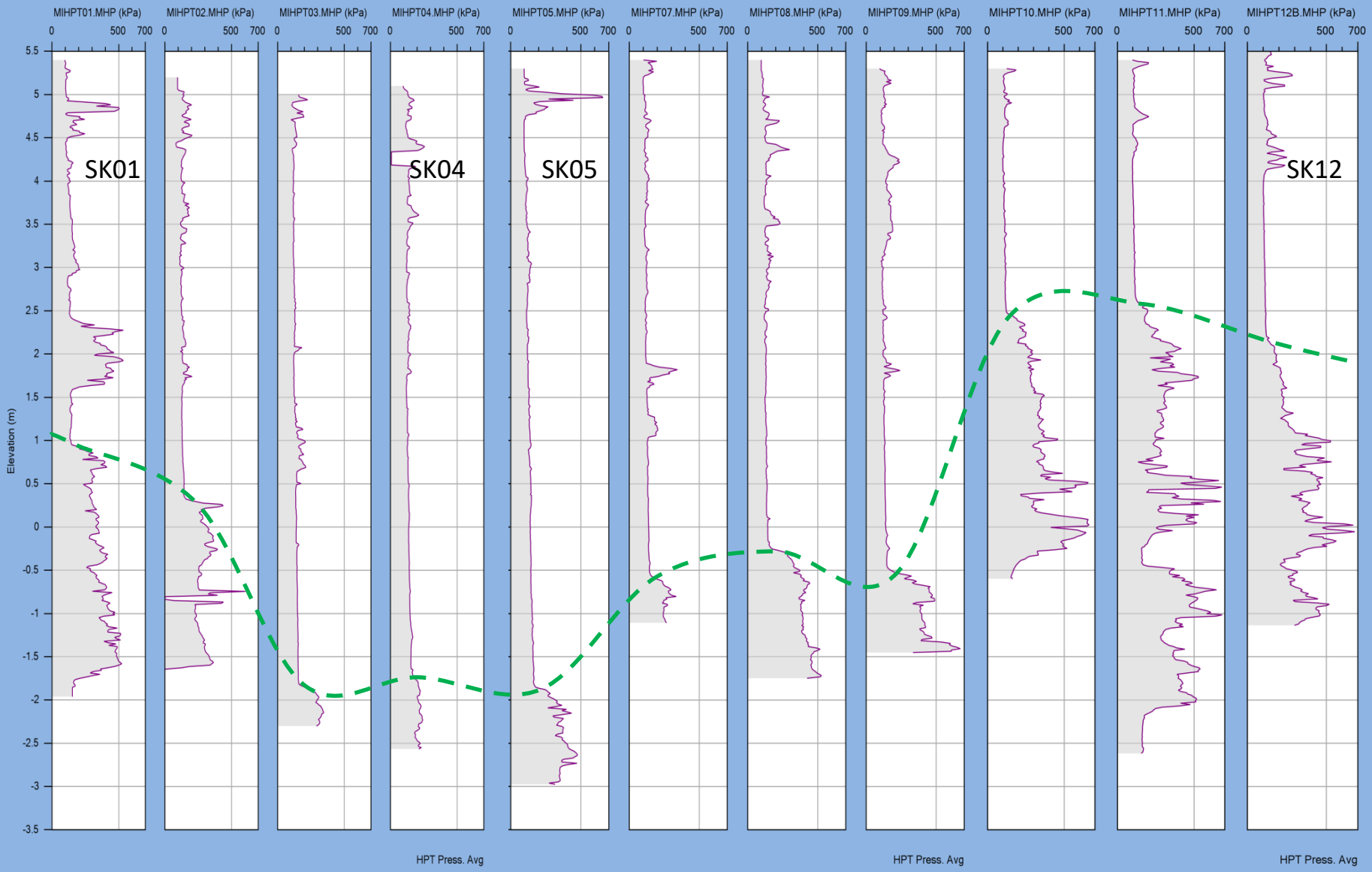
East (Elevation Corrected) West



(Facing ~ South)

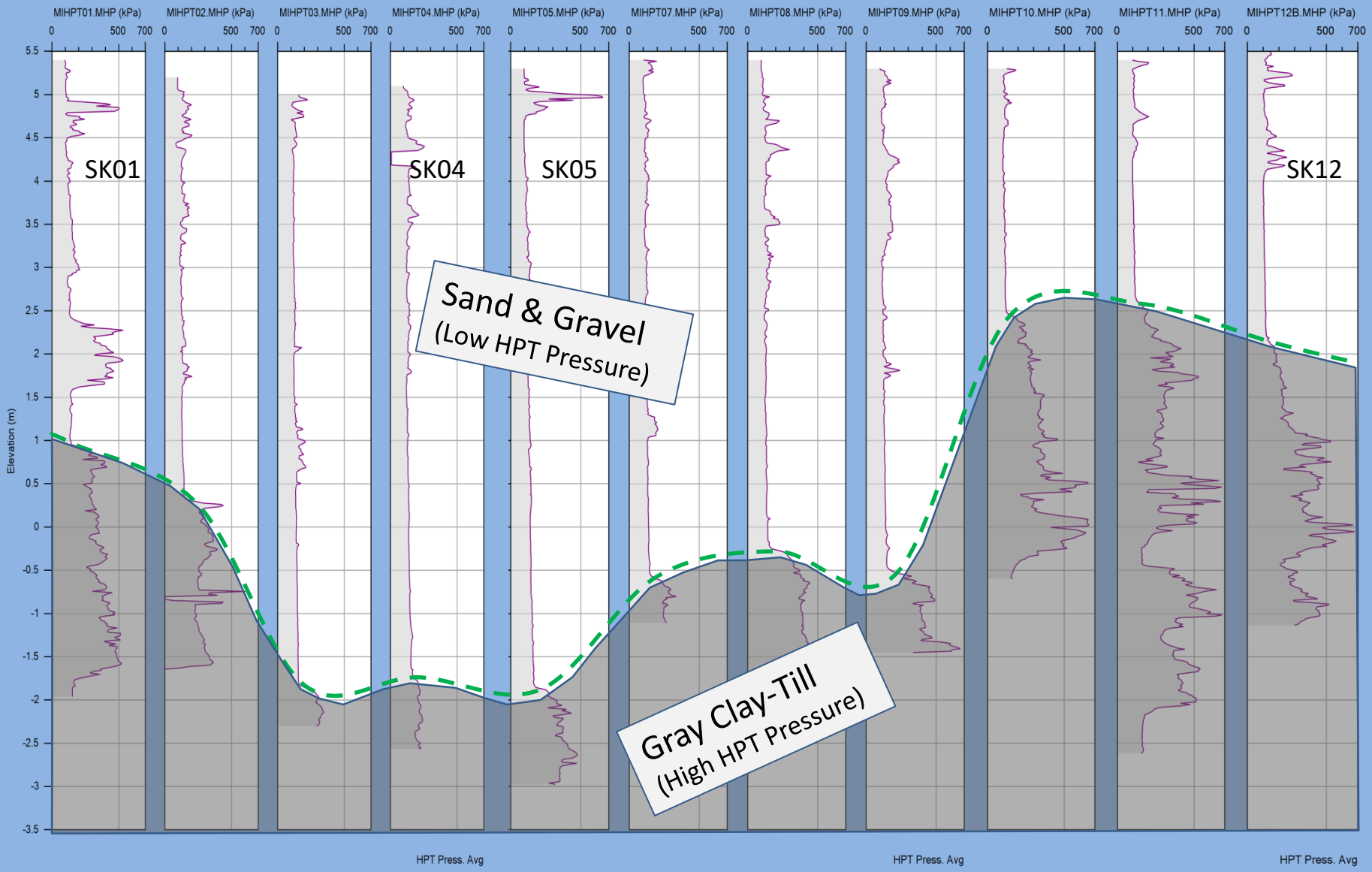
Skuldelev HPT Pressure X-Section

East (Elevation Corrected) West



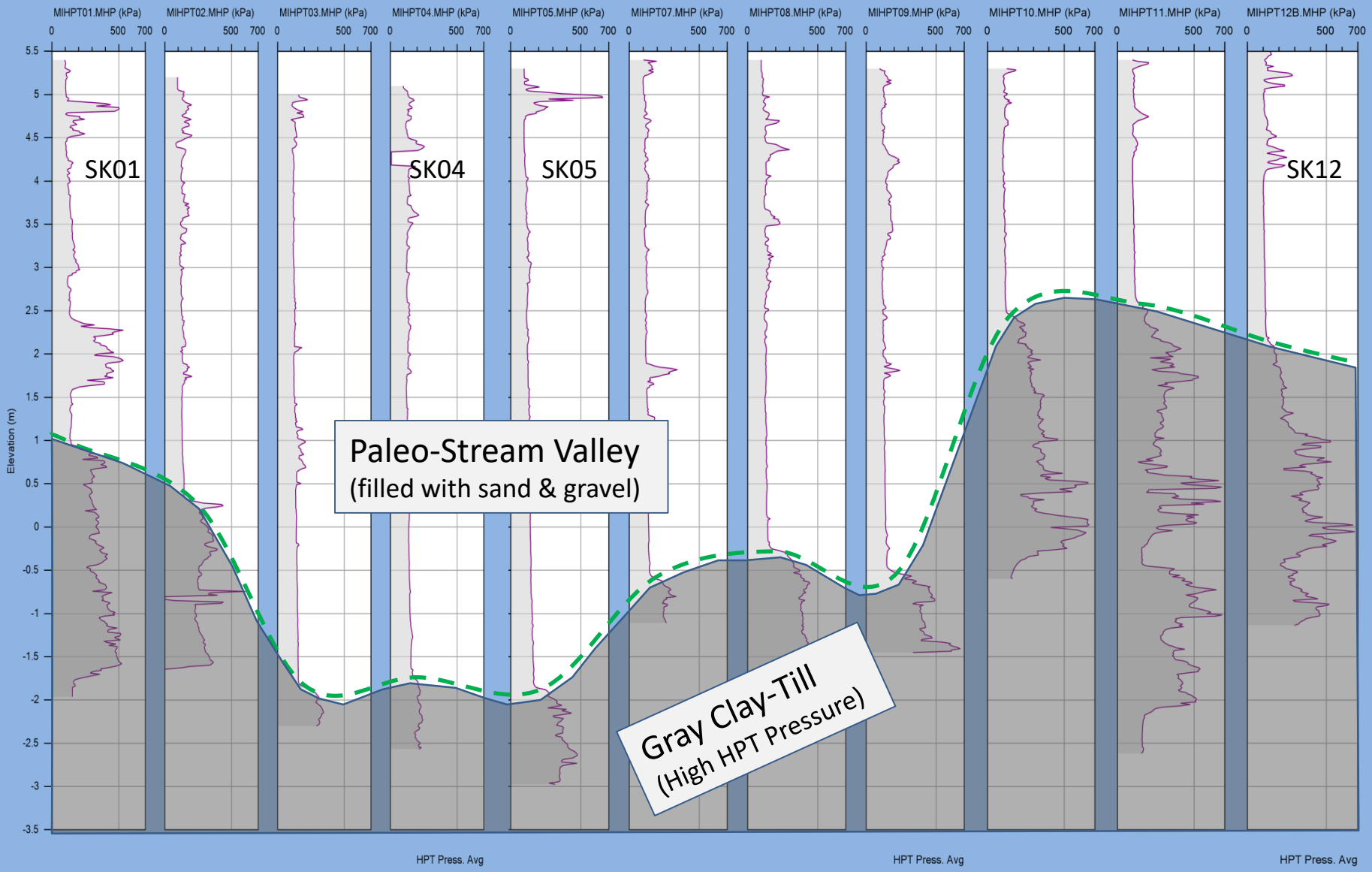
Skuldelev HPT Pressure X-Section

East West



Skuldelev HPT Pressure X-Section = hydrogeologic model = CSM

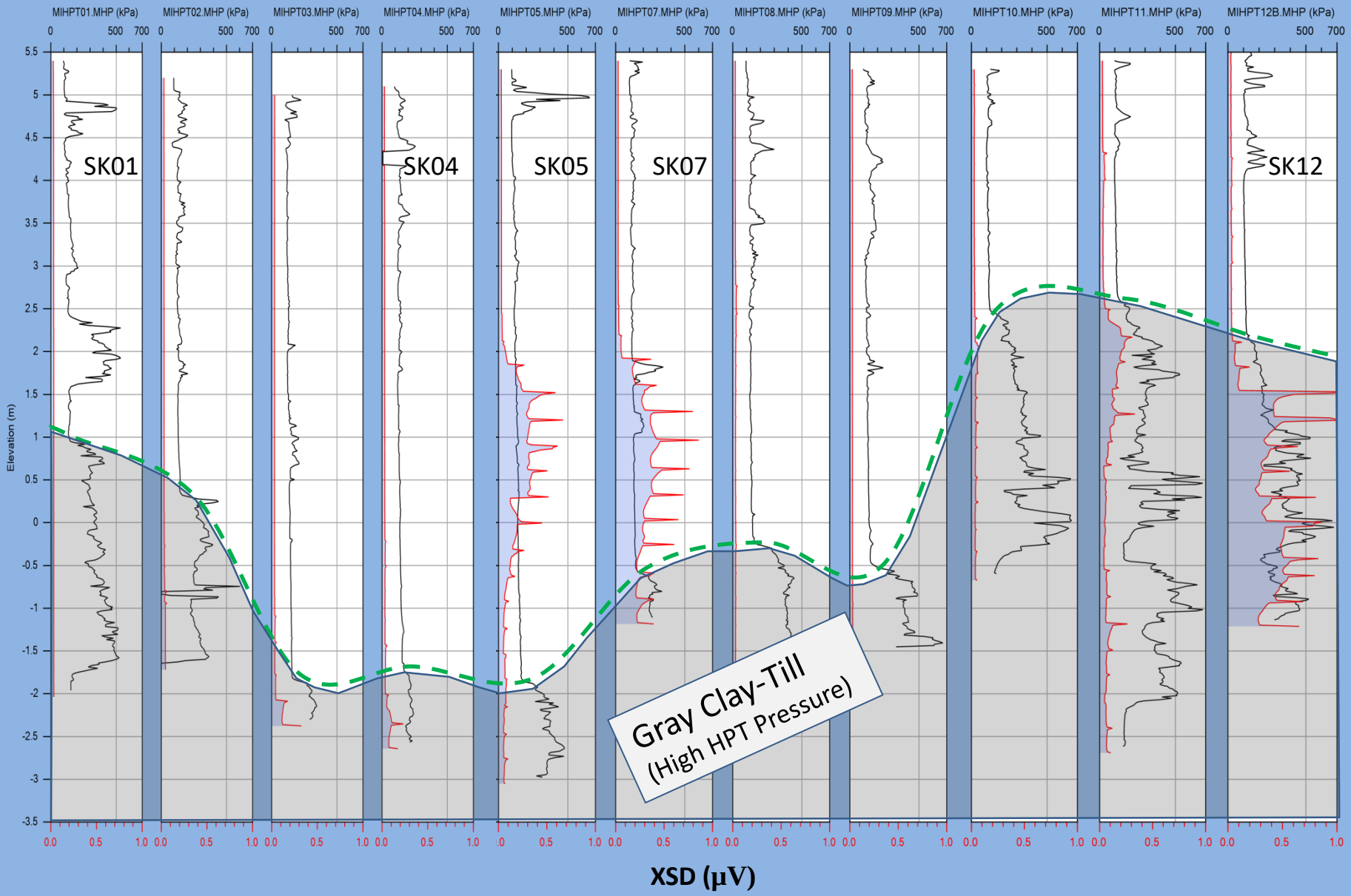
East West



Skuldelev HPT Pressure and XSD Cross Section

East

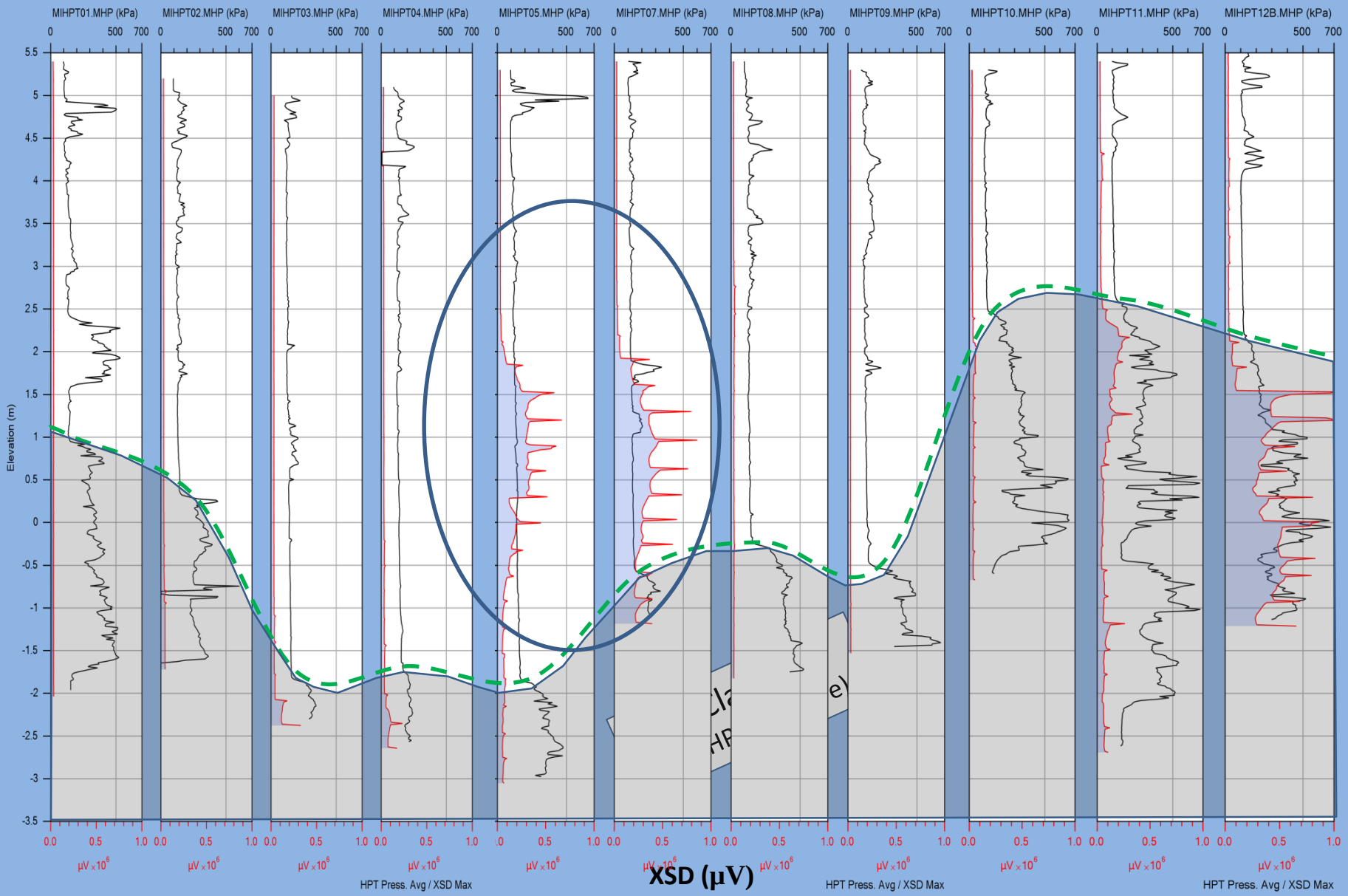
West



Skuldelev HPT Pressure and XSD Cross Section

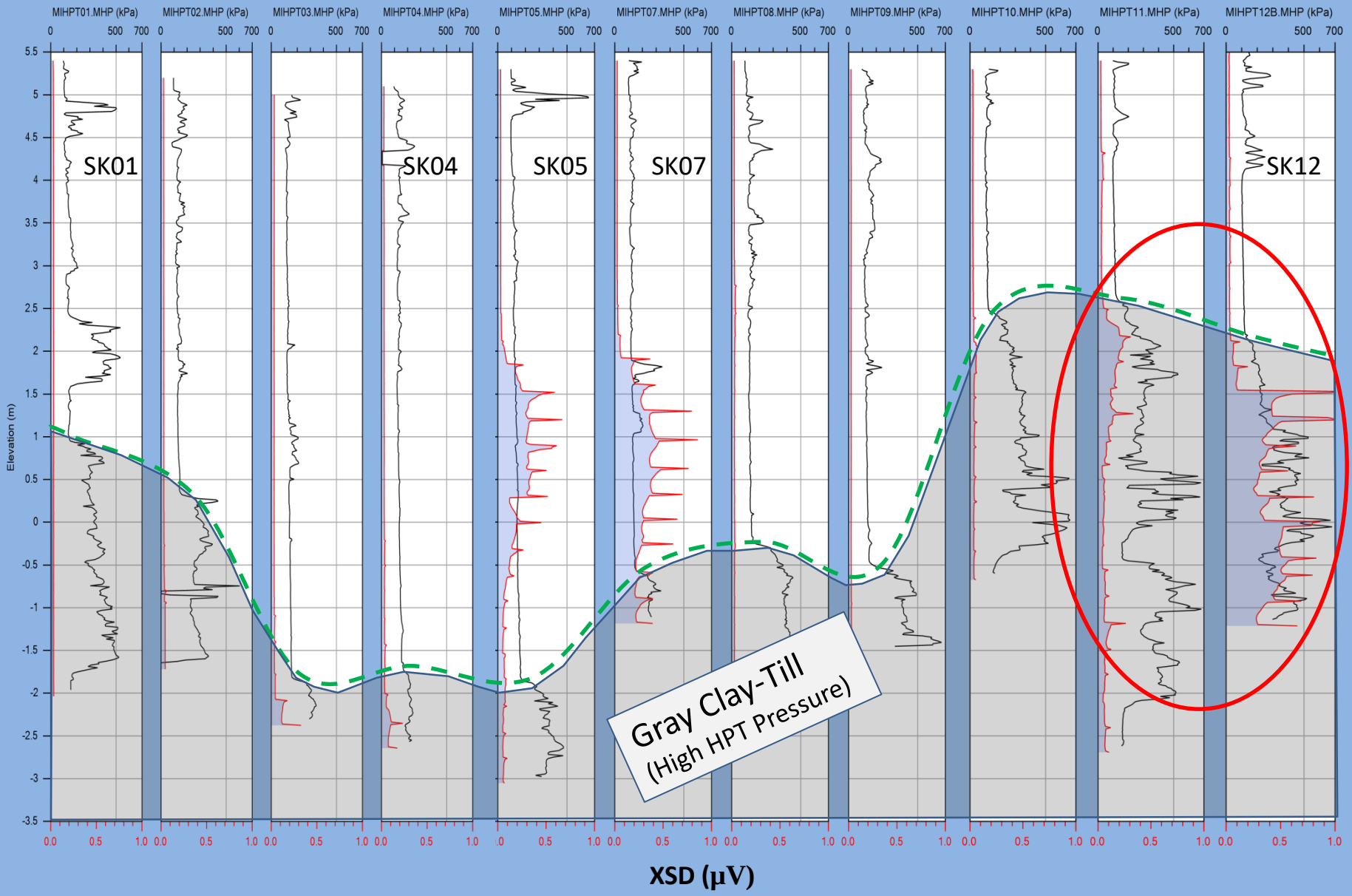
East

West



Skuldelev HPT Pressure and XSD Cross Section

East West



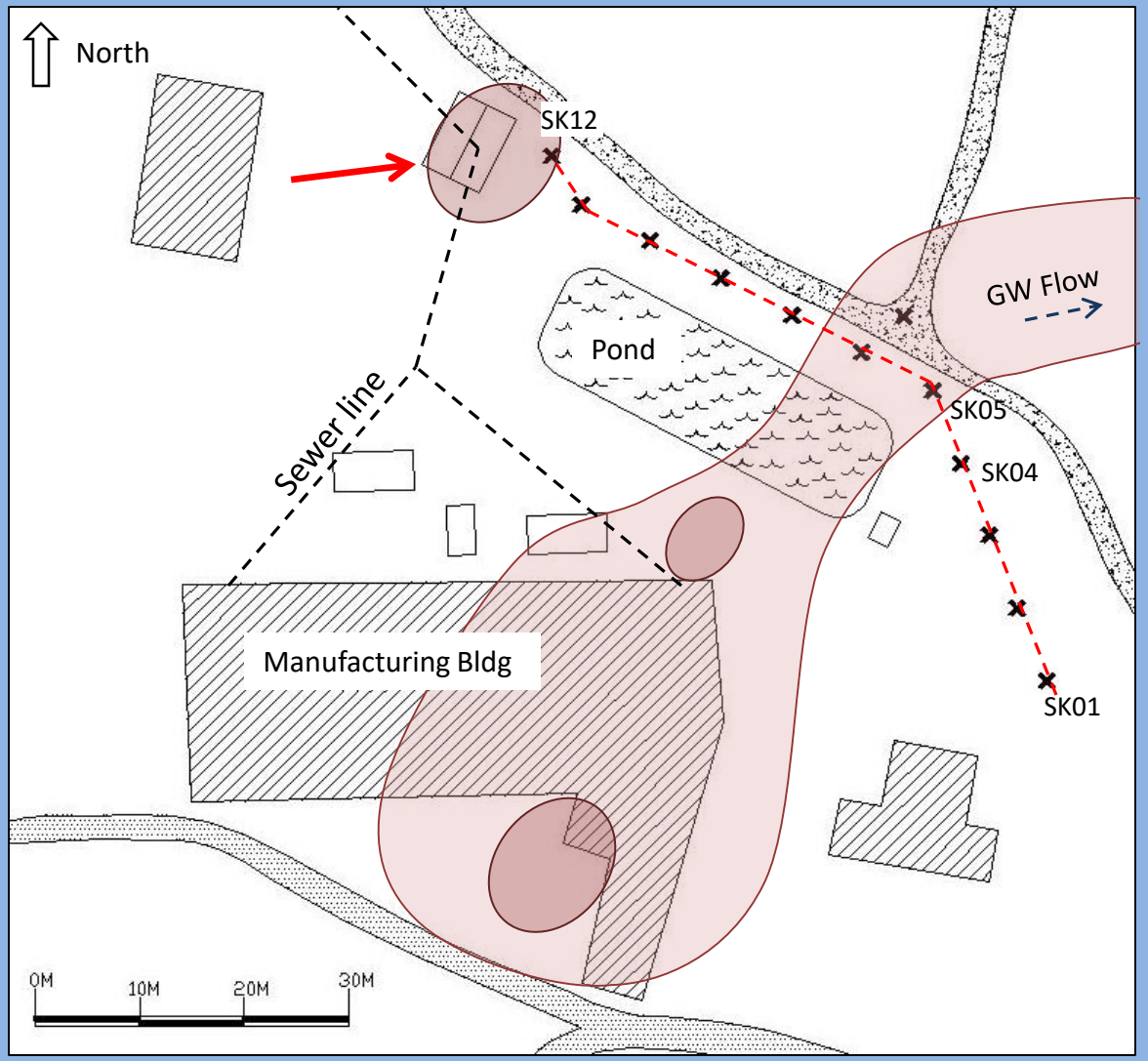
Skuldelev Location & Site Map

MiHpt Log **X**

Cross section Line - - - - -

GW Plume & Hot Spot

PCE, TCE, DCE & VC

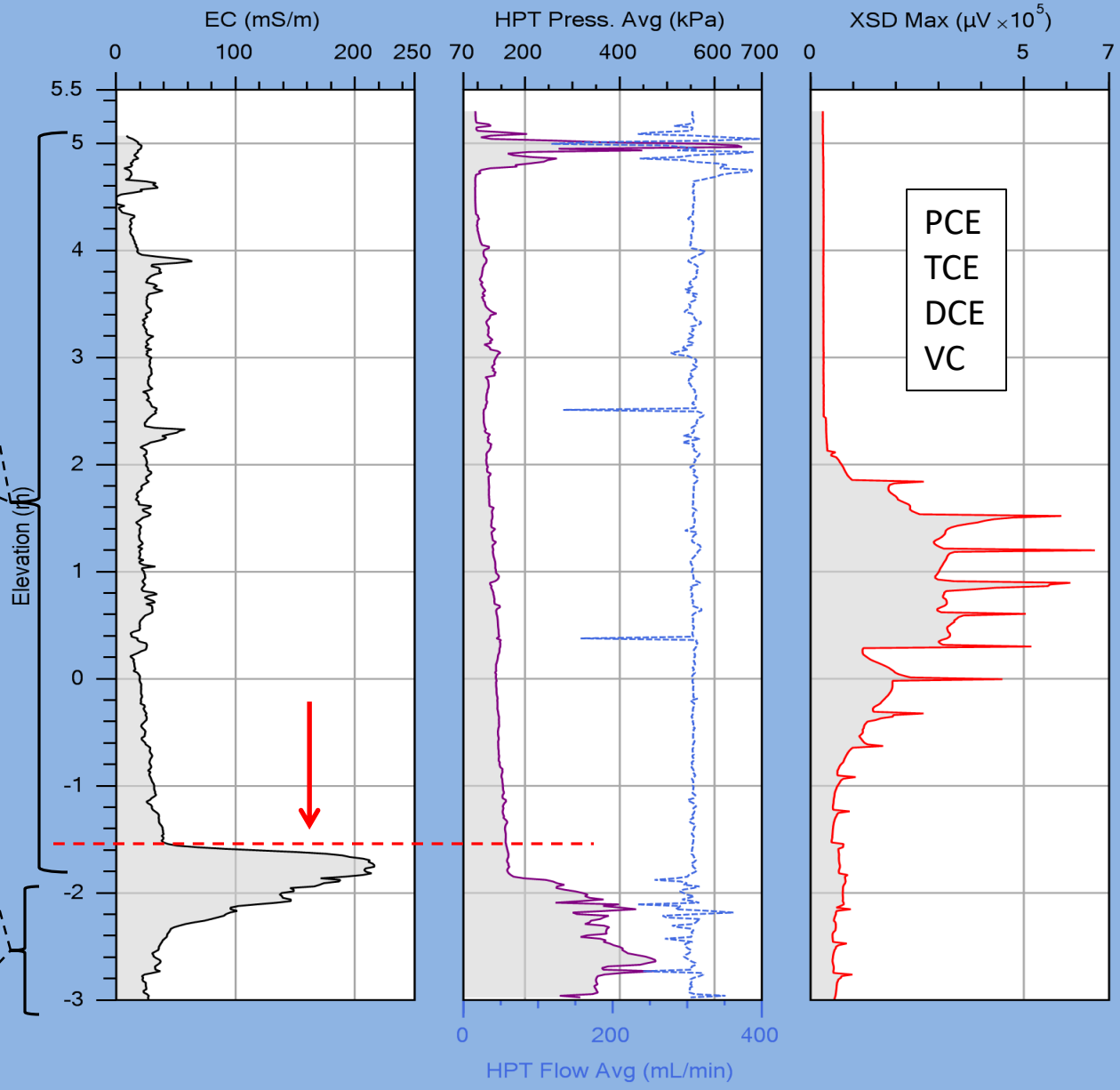


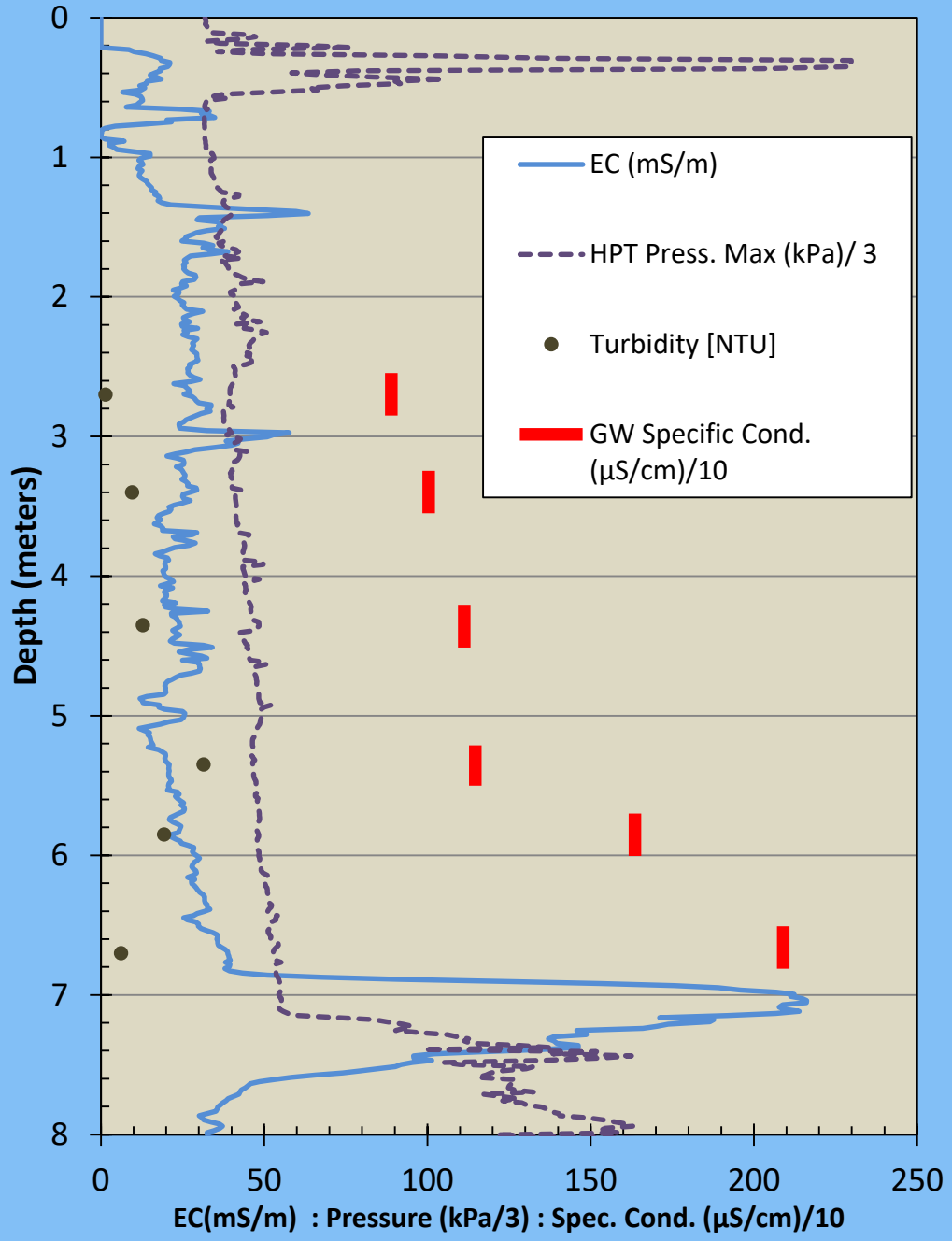
Logs are spaced 8 m (~25ft) apart.

Skuldelev SK05 Location Log

Sand & Gravel ± Fines

Clay-Till





SK05 Location

EC & HPT Pressure

Groundwater specific conductance

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Skuldelev Location & Site Map

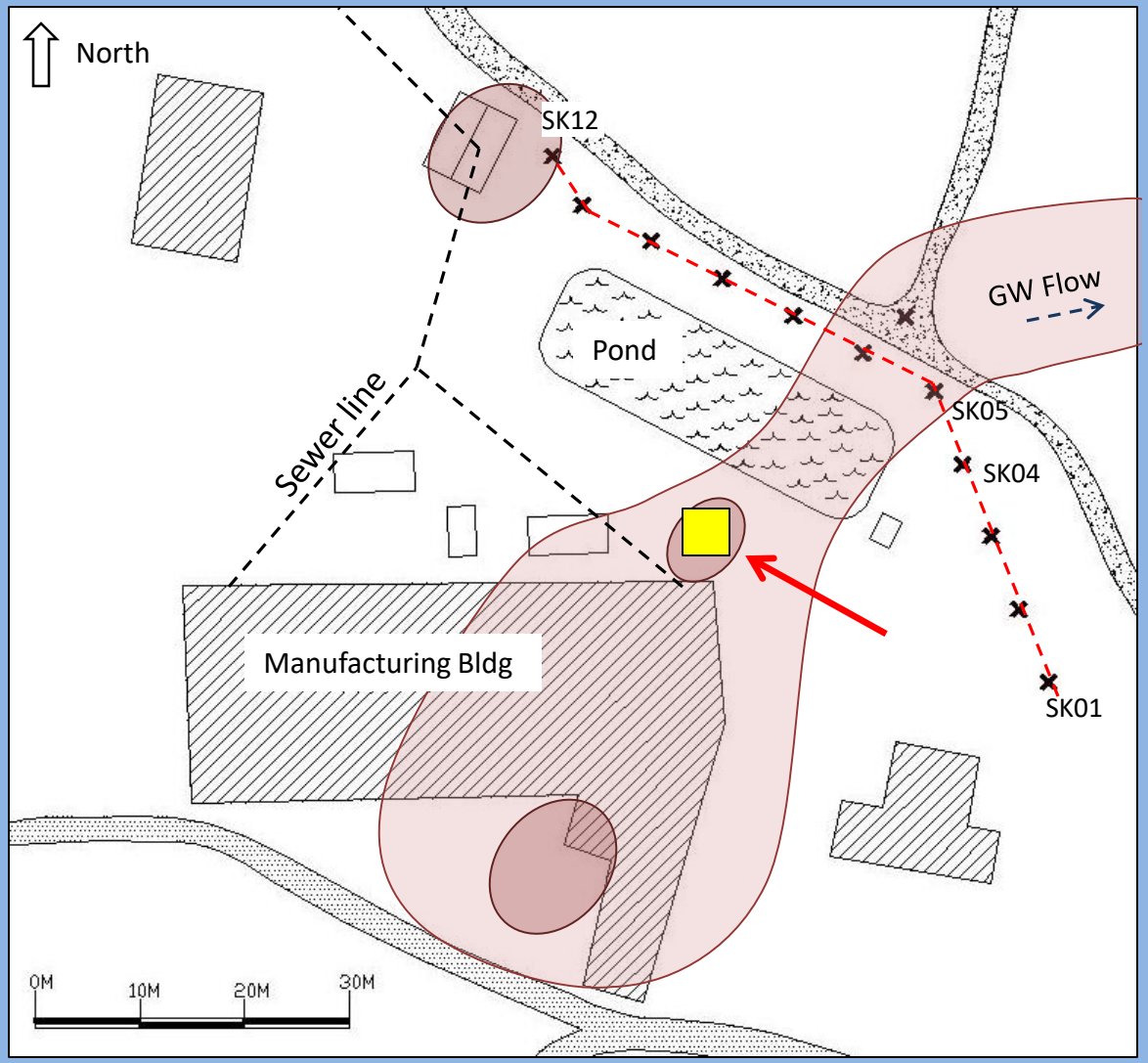
MiHpt Log **X**

Cross section Line - - - - -

GW Plume & Hot Spot

PCE, TCE, DCE & VC

Persulfate Injection



Logs are spaced 8 m (~25ft) apart.

Skuldelev Location & Site Map

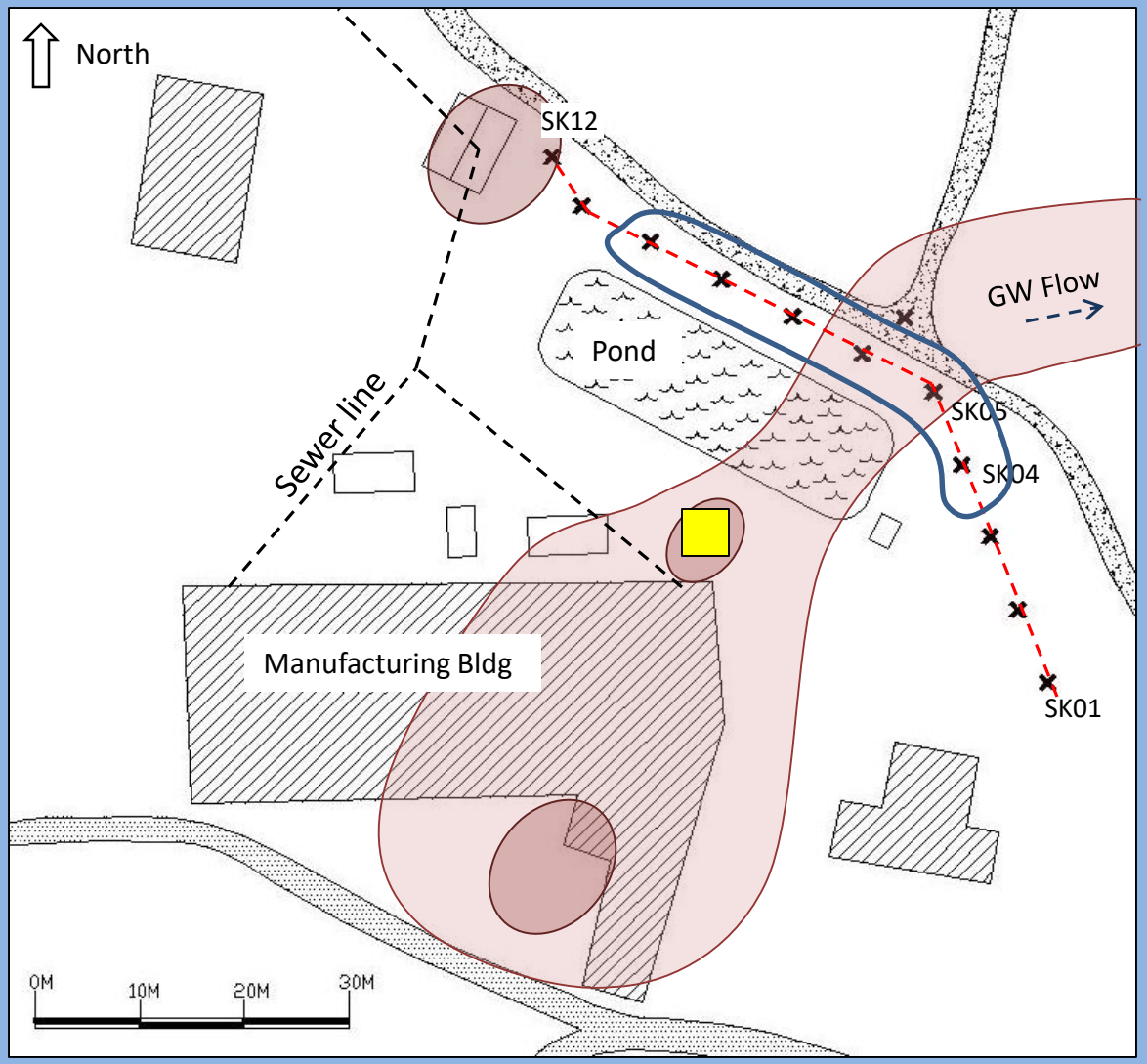
MiHpt Log **X**

Cross section Line - - - - -

GW Plume & Hot Spot

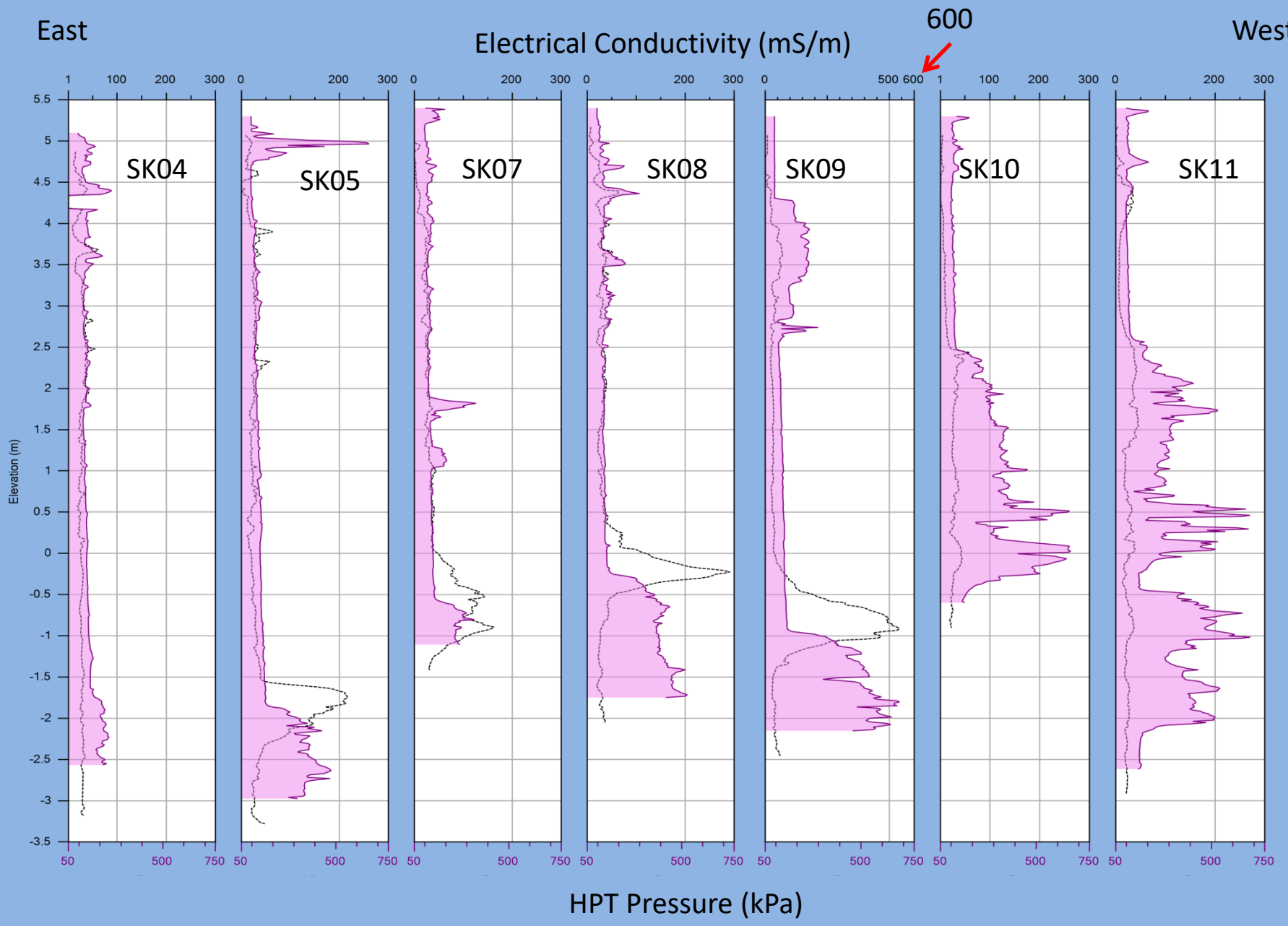
PCE, TCE, DCE & VC

Persulfate Injection

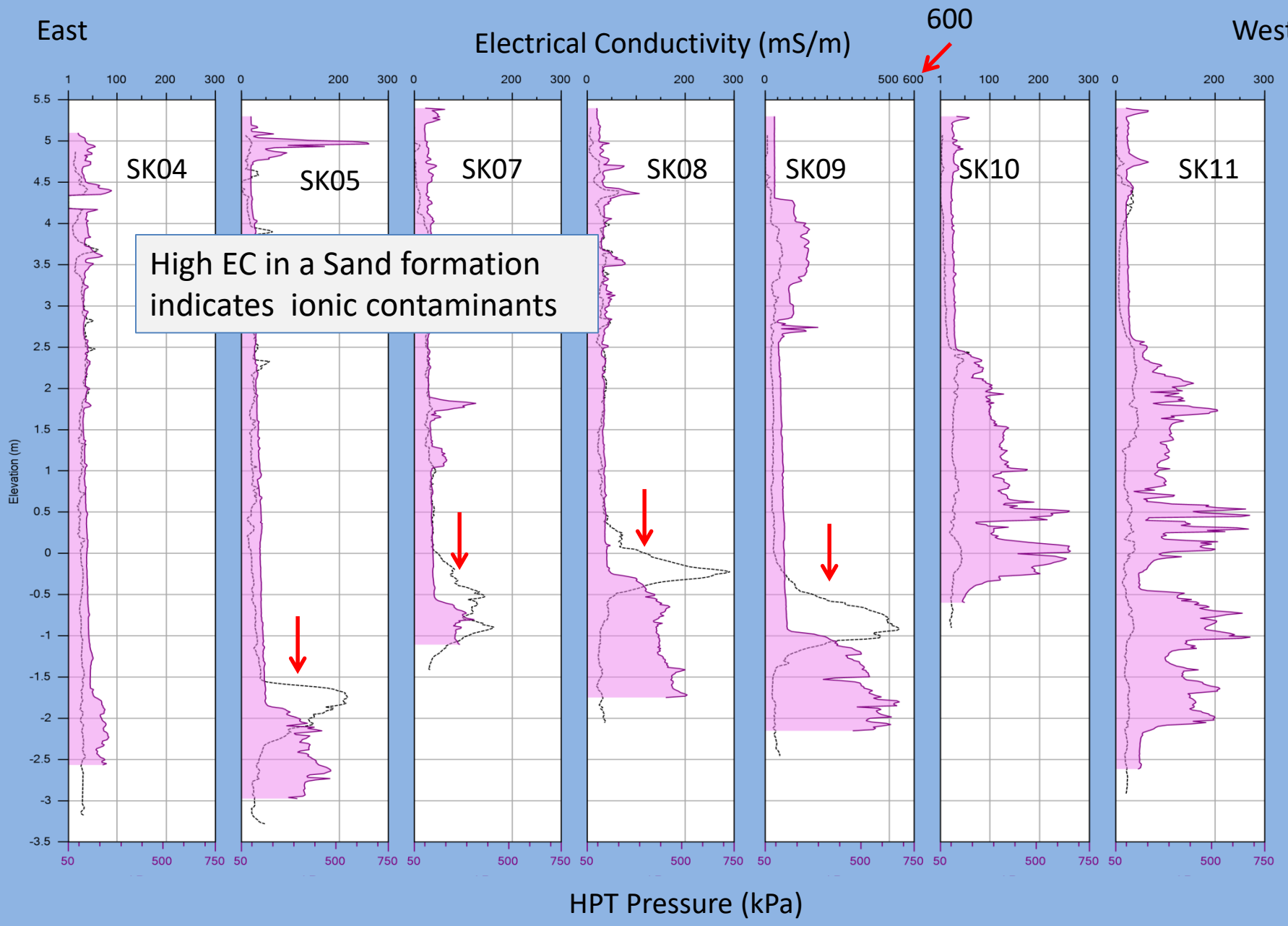


Logs are spaced 8 m (~25ft) apart.

Cross Section with HPT Pressure & EC

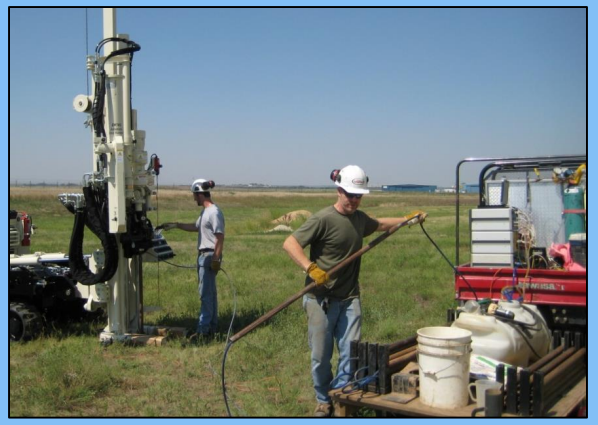


Cross Section with HPT Pressure & EC



Summary

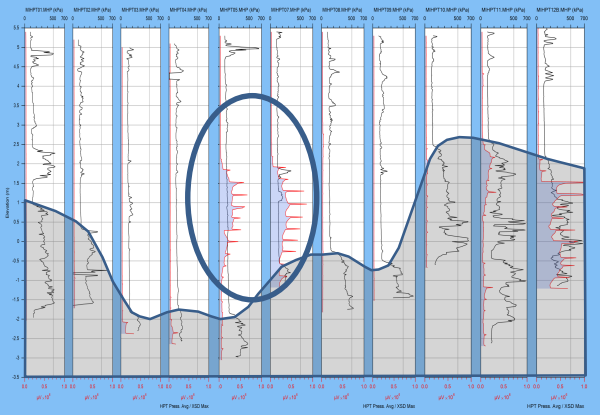
- HPT Principles of Operation
- Equipment Required for Logging
- Basics of HPT Log Interpretation
- Making a Cross Section with HPT Logs
- Interpreting Hydrostratigraphy with HPT



HPT >>> High Resolution Site Characterization

Genuine Geoprobe®

Summary



- Dissipation Tests, Hydrostatic Pressure & Water Levels
- Correcting HPT Pressure (Pc)
- Estimating Hydraulic Conductivity from Pc and Q
- Developing a CSM with HPT Cross Sections
- Tracking an ionic contaminant or remediation fluid by combining HPT and EC logs

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Simply reply to that email and fill in the webinar code:

“KS28”

You will then receive a .PDF of your certificate.

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Please submit your questions from the “chat” window on the WebEx screen.

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To learn more about Geoprobe’s HPT logging system or the NEW HPT-GWS (groundwater sampler) and other Direct Image systems like MIP, MiHpt, Low Level MIP, EC, CPT and PST check out this link:

http://geoprobe.com/geoprobe-systems-direct-image-products