Wisconsin
Department of Natural Resources

Remediation and Redevelopment Program

Issues & Trends 2015

November 18, 2015

12:00 p.m. – 1:00 p.m.

Dial: 1-855-947-8255

Passcode: 6612 745#

Questions will be taken during the presentation or can be submitted to DNRRRComments@wisconsin.gov

WISCONSIN DNR Department of Natural Resources

NAPL Evaluation

Integrating NAPL Distribution & Geologic Data

(Using LIF Surveys to Define NAPL Micro-Traps)

David Swimm, PG

David.Swimm@wisconsin.gov

608.264-8766

WISCONSIN DEPT. OF NATURAL RESOURCES

NAPL Data

- Monitor well thickness measurements (and GW contaminant analytical results)
- Soil boring analytical results
- Laboratory fluid analyses
- Transmissivity testing (well and remedial production results)
- NAPL saturation concepts/Core evaluation
- Computer modeling (e.g., LDRM)
- **Laser Induced Fluorescence (LIF) Surveys**

Geophysical Interpretation:

What are we attempting to show?

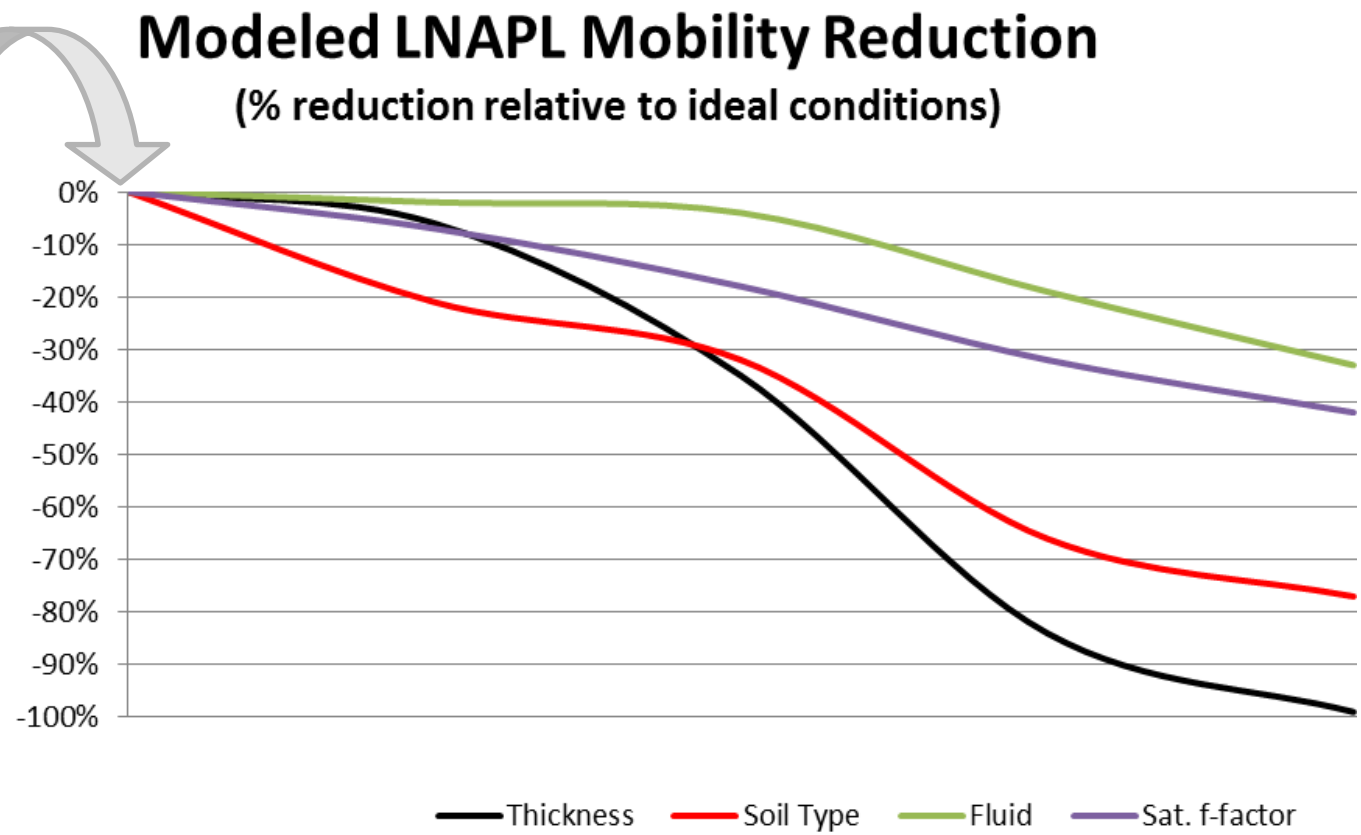
Ideal (origin):

3' LNAPL

Clean Sand (<10% fines)

Un-weathered Fluid (0.62 Cp)

Low sat. f-factor (18%)



LDRM model results - see Appendix E, Assessment Guidance For Sites With Residual Weathered Product (RR-787)

LIF Interpretation Goals:

Determine NAPL thickness in formation
- Lateral extent also determined
- Volumes below the water table also determined

Nature of soils containing/trapping NAPL
- Smear zone soil types
- Geometry of permeable carrier and confining layers

Why?

- NAPL formation thickness “drives” hydraulic recovery,
- Soil geometries define micro traps which “drives” remedial options,
- Soil heterogeneity “drives” residual NAPL saturation

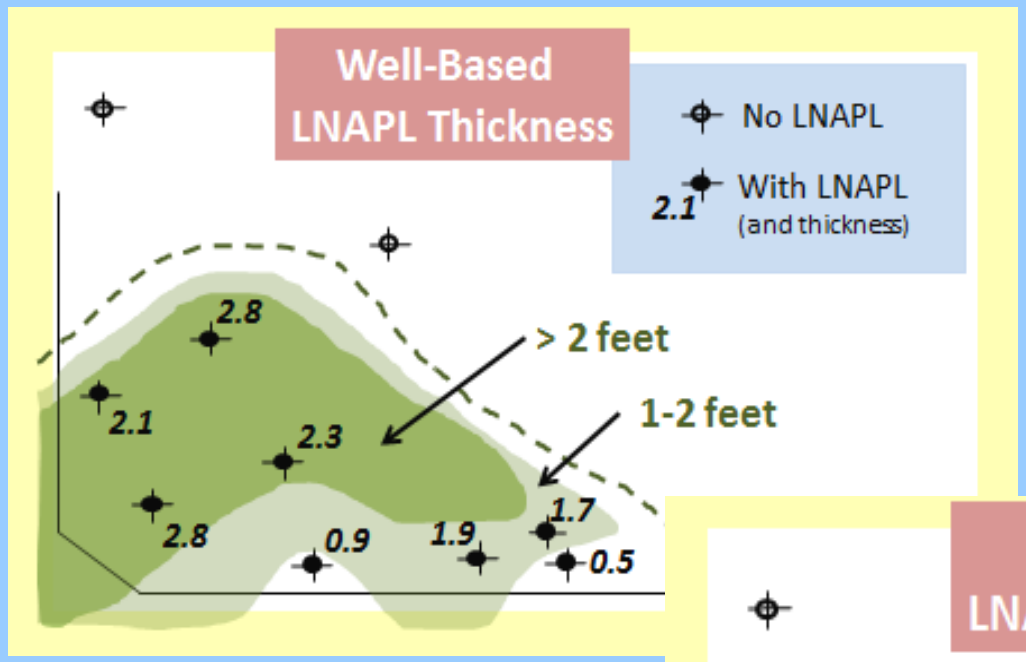
(i.e., NAPL saturations ultimately drive recovery efficiency)

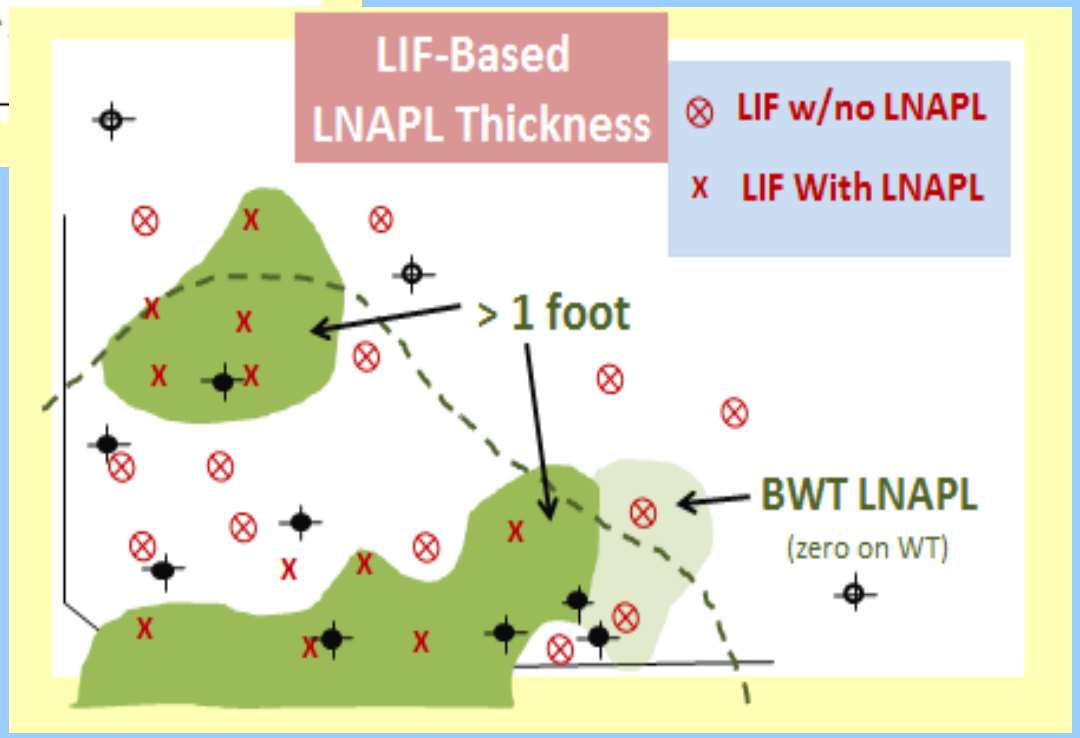
? ? ?

So why the focus on LIF-based, NAPL thickness when we already have monitoring wells that show us that?

? ? ? ?

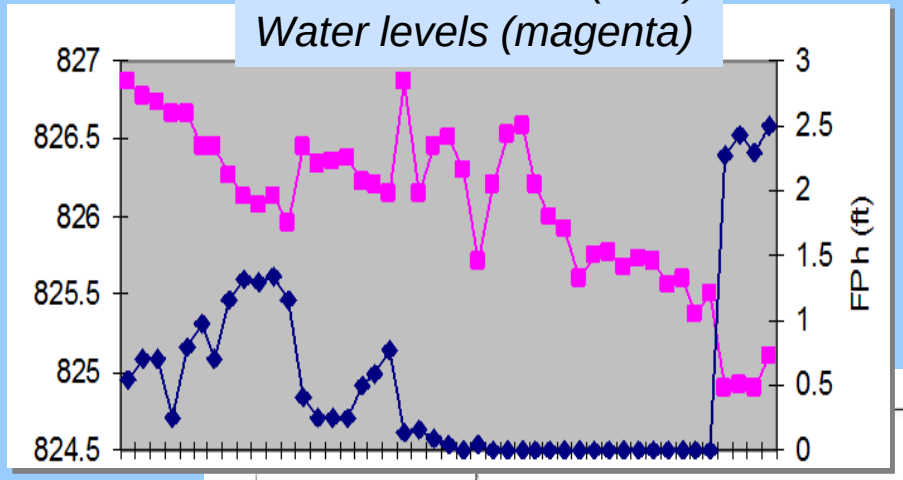
Lateral Distribution



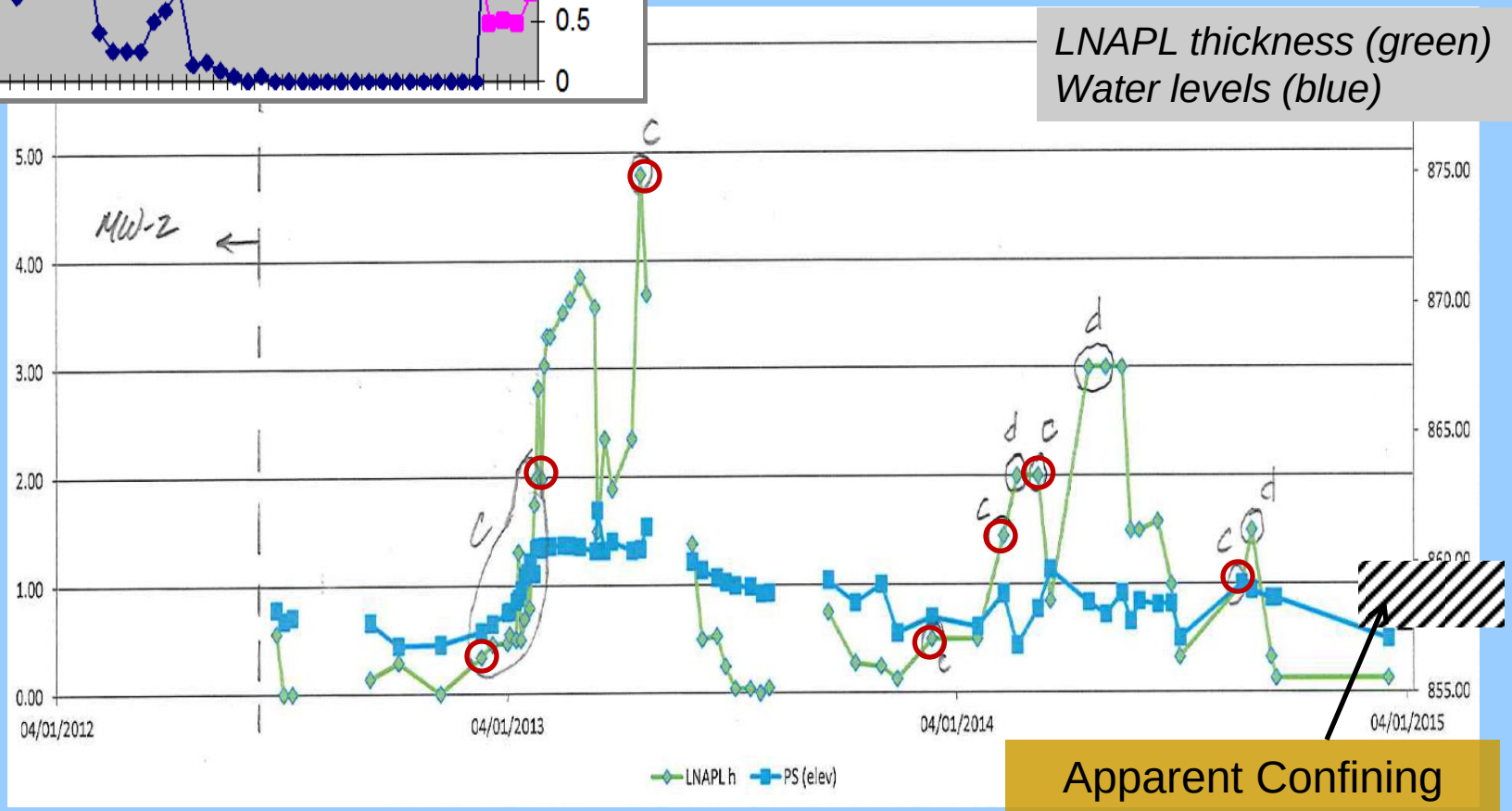


Vertical Expression

LNAPL thickness (blue)
Water levels (magenta)



LNAPL thickness (green)
Water levels (blue)

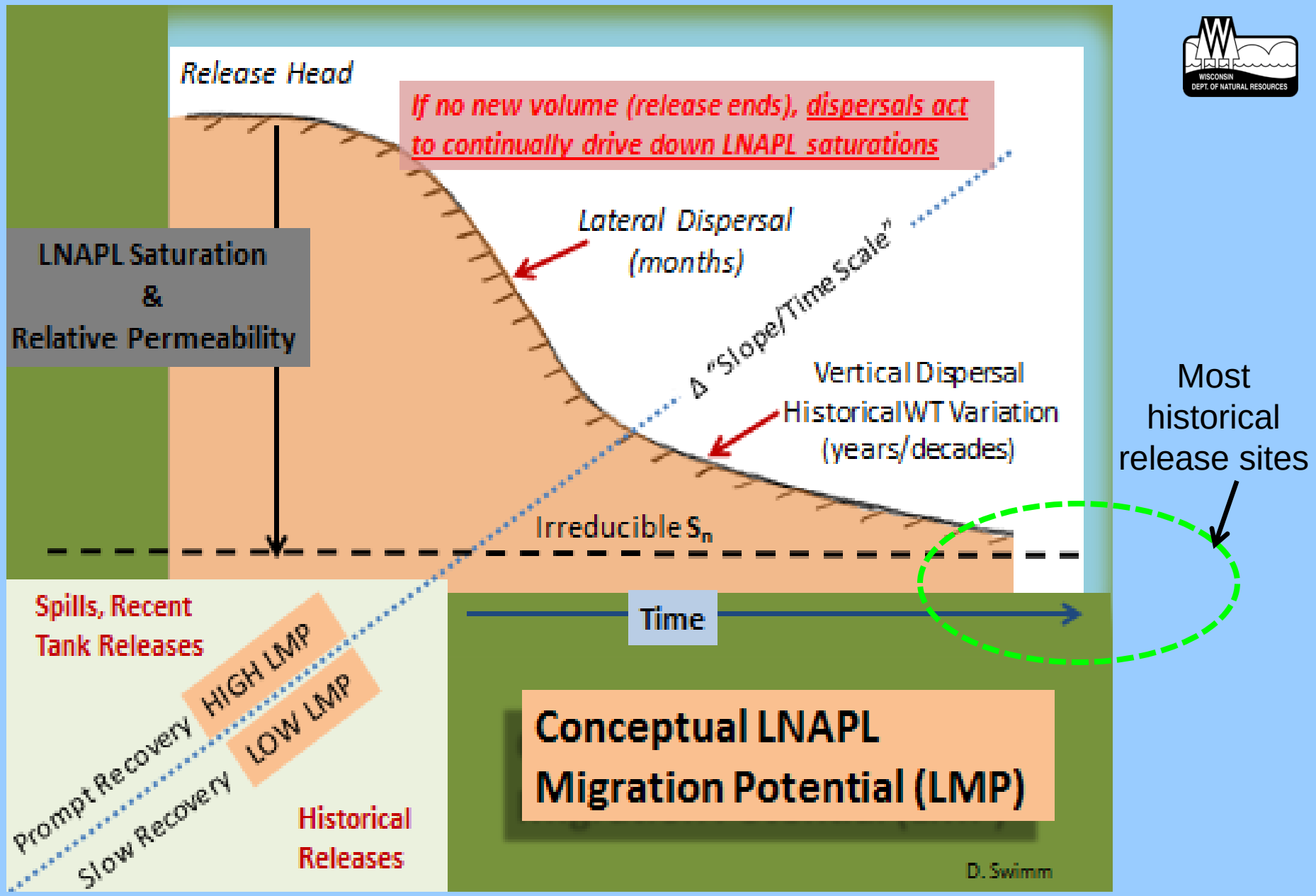


Apparent Confining Interval

Note: plots are unrelated (i.e., different wells from different LNAPL sites)

Well-based NAPL Thickness

- Poor indicator of NAPL formation thickness.
- Tend to show near well-bore artifacts that result from vertical water level variation (i.e., non-equilibrium conditions).
- May show *qualitative* NAPL confinement and drainage effects; more consequential if consistently observed at the same elevations (and in several wells).


Release Head
If no new volume (release ends), dispersals act to continually drive down LNAPL saturations
LNAPL Saturation & Relative Permeability
Lateral Dispersal (months)
Δ "Slope/Time Scale"
Vertical Dispersal
Historical WT Variation (years/decades)
Irreducible S_n
Time
Spills, Recent Tank Releases
HIGH LMP
LOW LMP
Prompt Recovery
Slow Recovery
Historical Releases
Conceptual LNAPL Migration Potential (LMP)
D. Swimm
Most historical release sites

Questions ?

Next: LNAPL Site Example

General LIF Interpretation Steps:

Reconnaissance/review fluorescence logs:

- Look for most obvious examples that illustrate accumulation
- Annotate contemporaneous water levels
- Assess correlation (or lack thereof) with wells
- Look for LNAPL top confinement
- Look for DNAP bottom confinement
- Determine fluorescence bias (discriminator) – for mapping purposes

Reconnaissance/review conductivity logs or other soil-related discriminators:

- Compare to significant geologic transitions from boring logs
- Eliminate logs showing problematic responses (possible calibration problems)
- Calibrate response to smear zone sieve results
- Determine soil biases – for mapping purposes

General LIF Interpretation Steps (cont.):

Correlate geologic contacts – away from obvious NAPL accumulations:

- Progressively build detailed three dimensional understanding of NAPL container
- Incorporate well-based NAPL artifacts (e.g. confining interval, oil saturated aquifer matrix samples, etc.), if applicable

Products:

- NAPL formation thickness maps
- Detailed smear zone geologic cross sections
- Define micro-traps or confining layers

LIF Response (%RE)

Signal Amplitude Map

Complex LUST site:

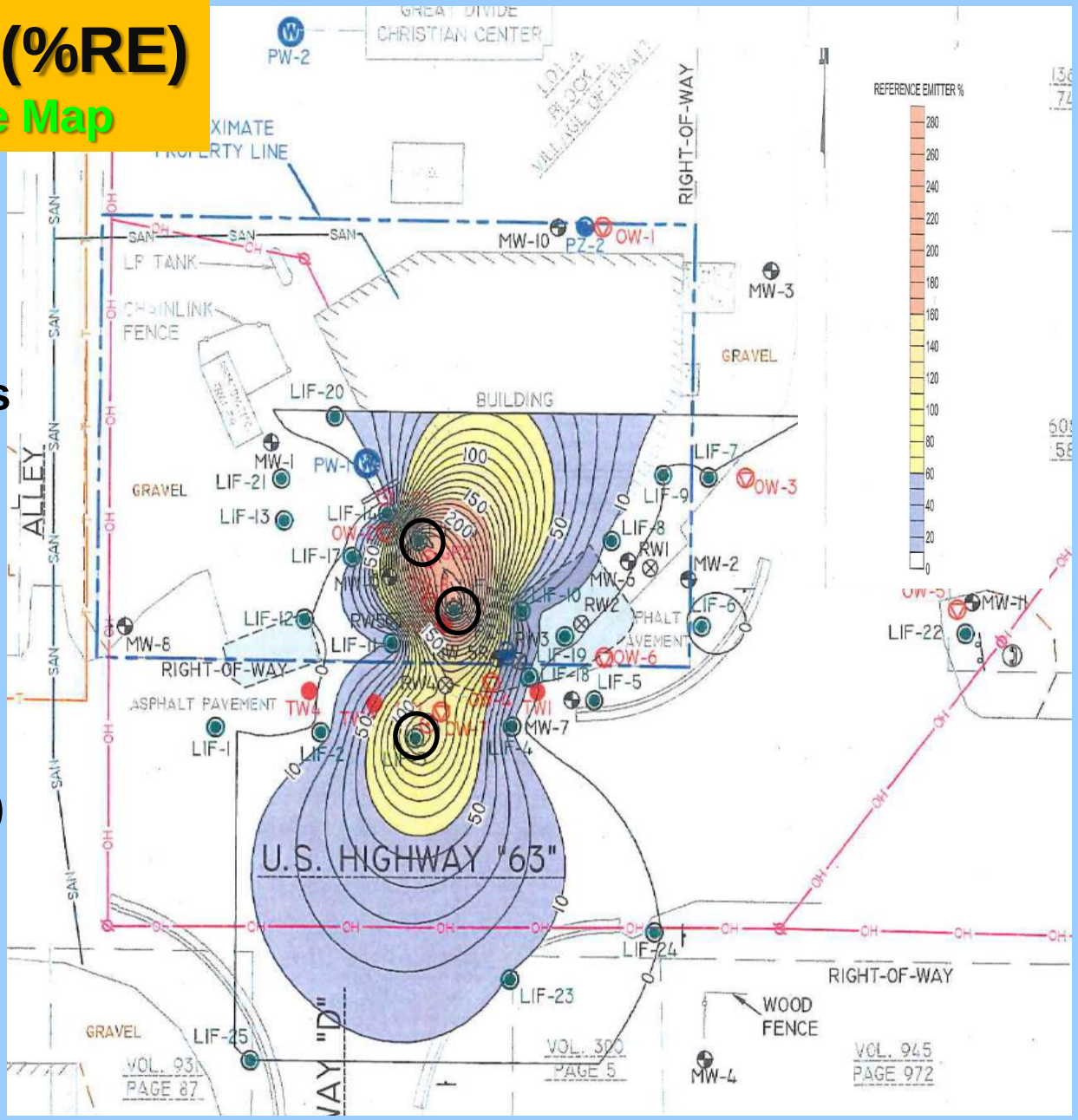
LNAPL at various depths

Potable well risk

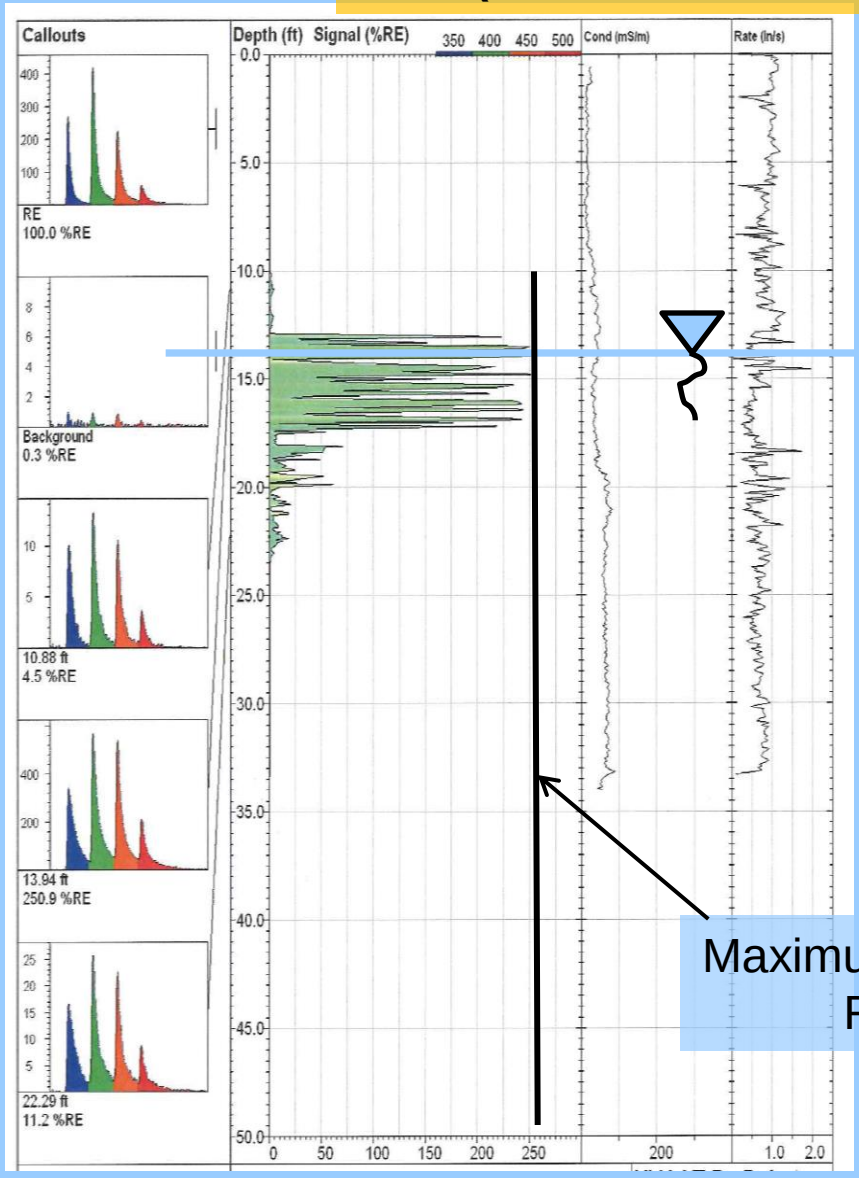
PVI risk

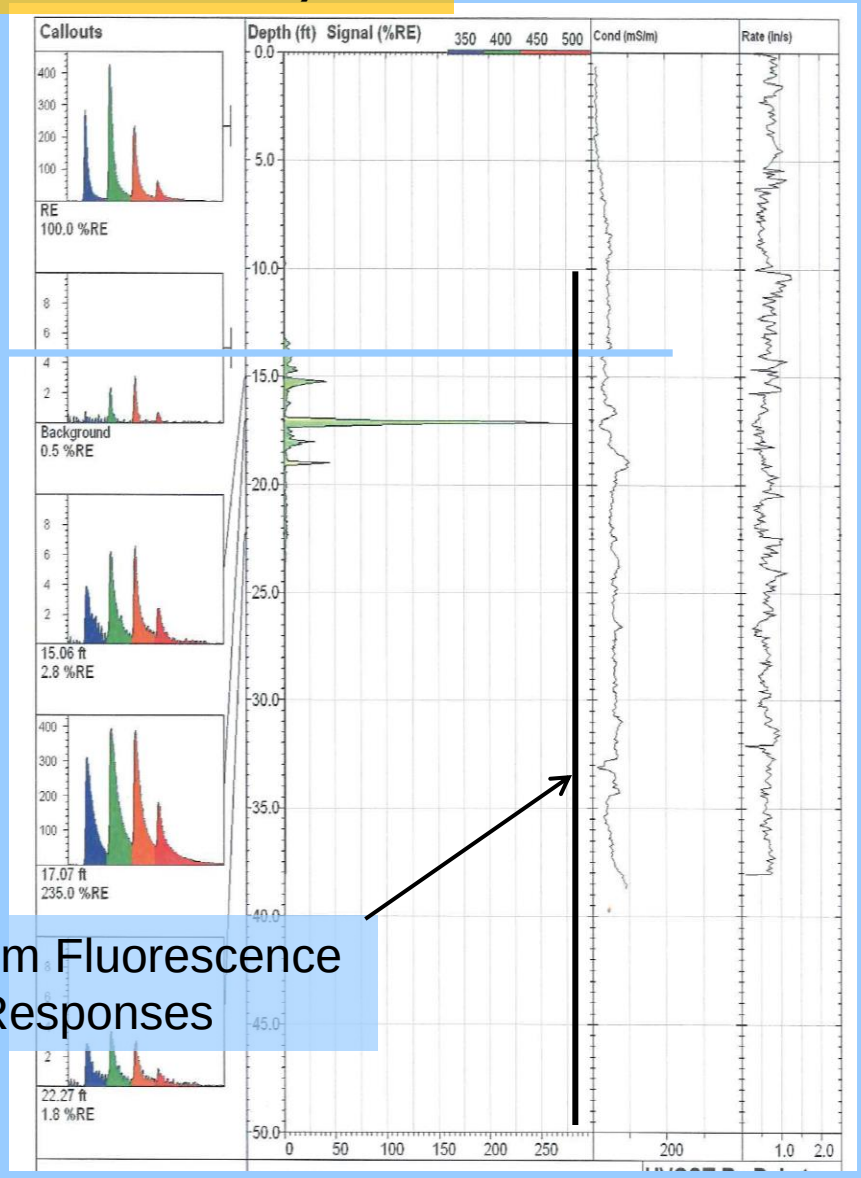
Conducted remedies:

- Partial Excavation
- DPE Extraction
- PECFA: $600K (overall)



Amplitude "Bulls Eye"
(Water Table LNAPL Accumulation)





Maximum Fluorescence Responses

LIF-15 **LIF-16**

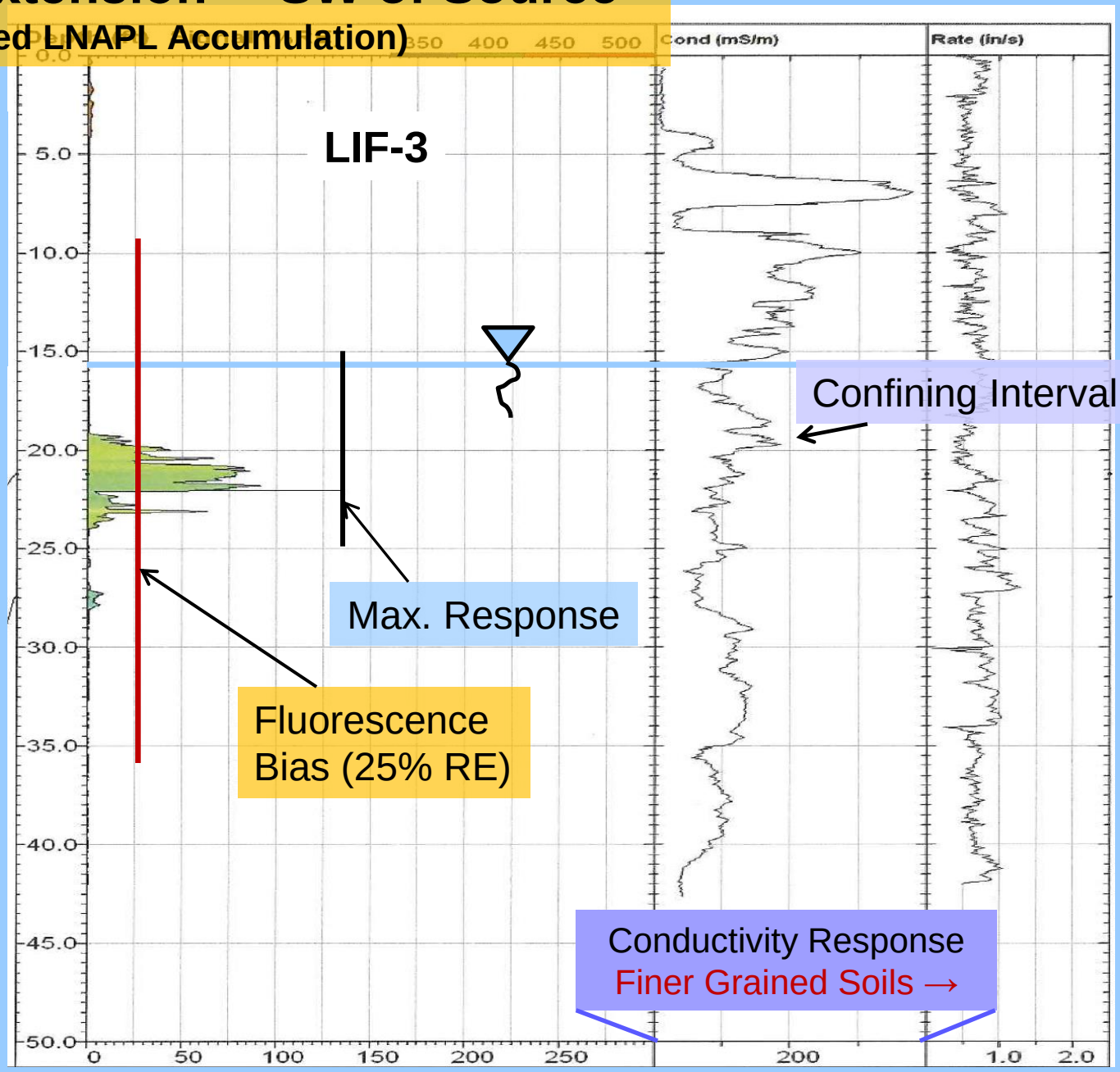
Amplitude "Extension"– SW of Source

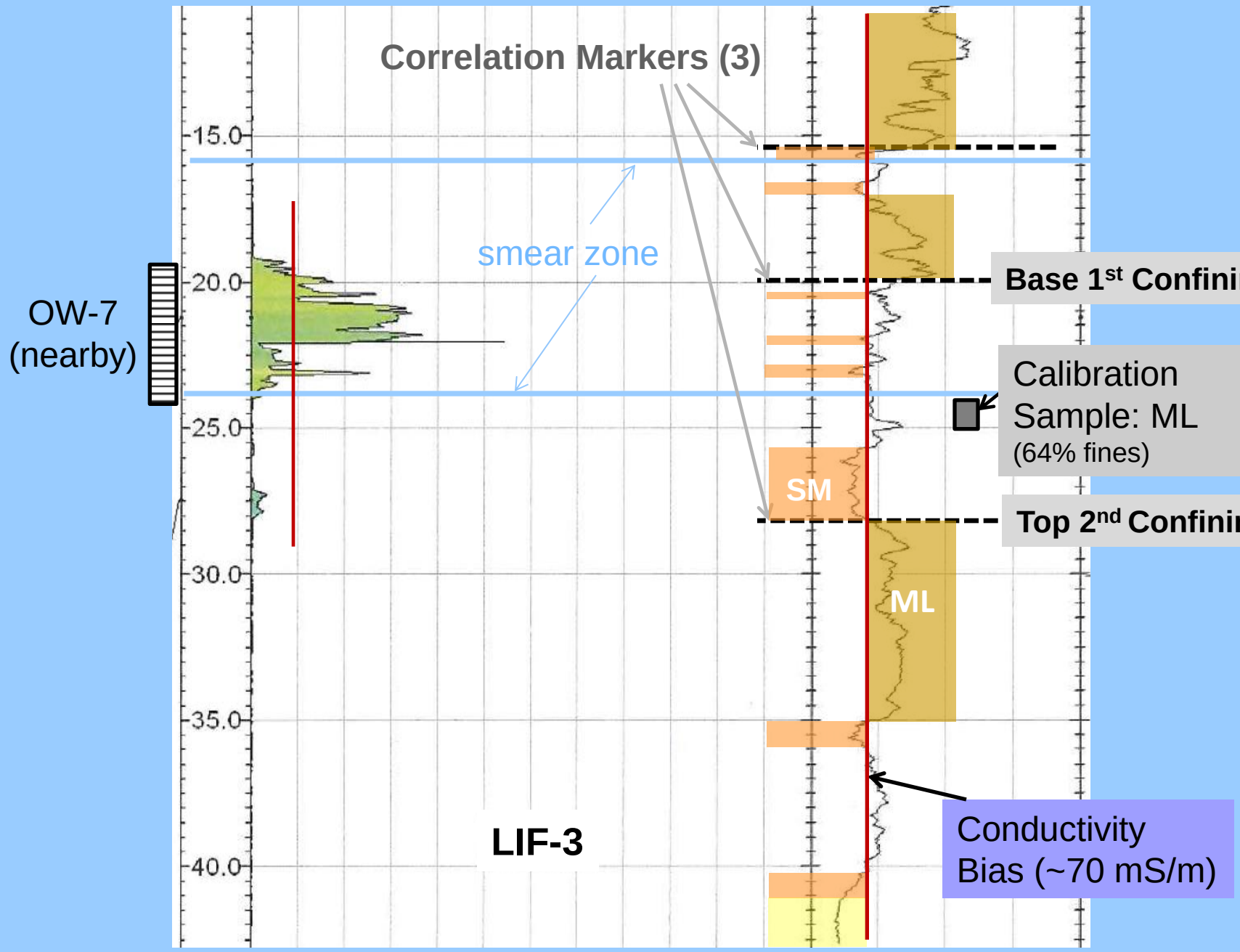
(Confined LNAPL Accumulation)

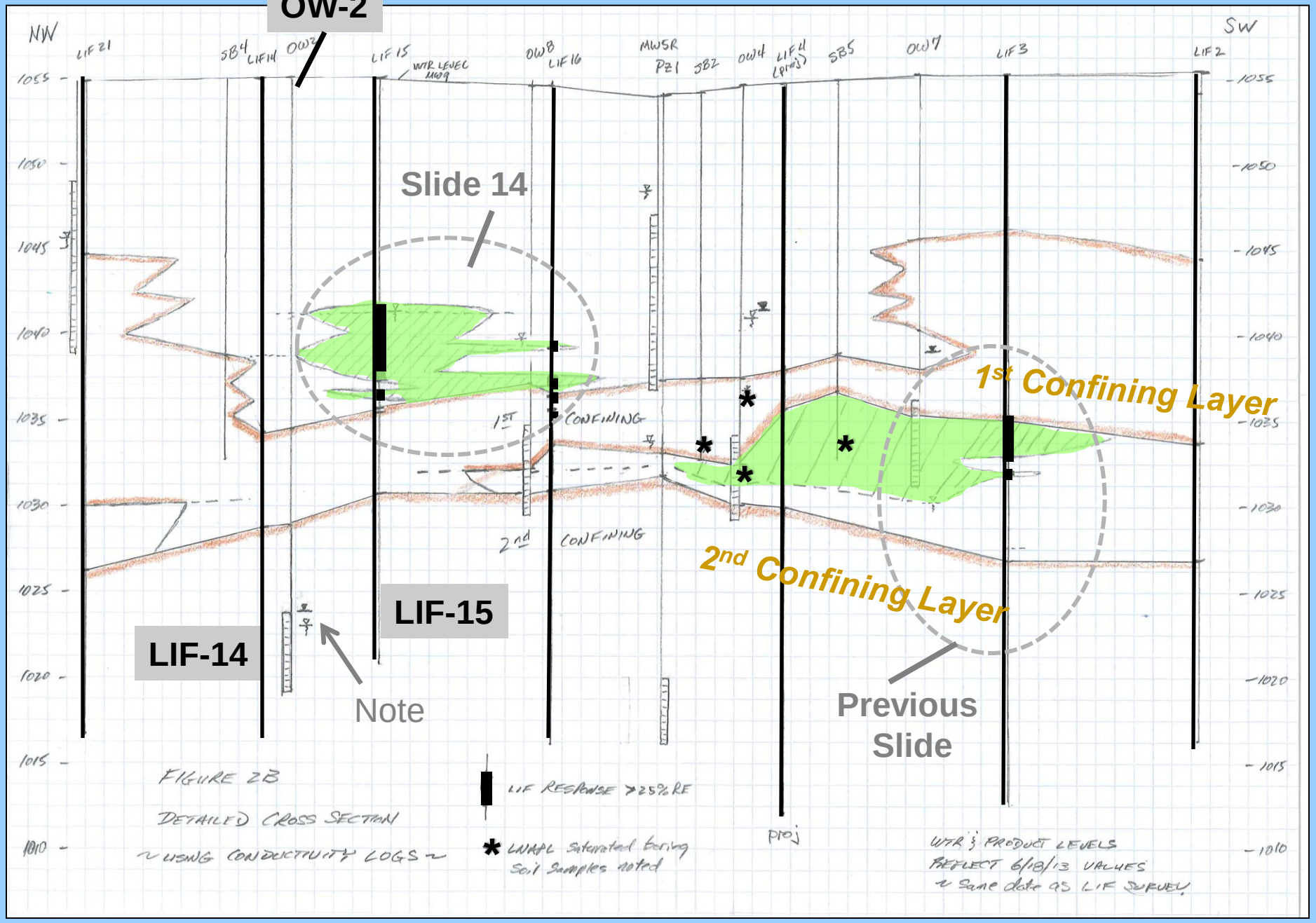
Amplitude map does not discriminate depth-related, separate LNAPL volumes.

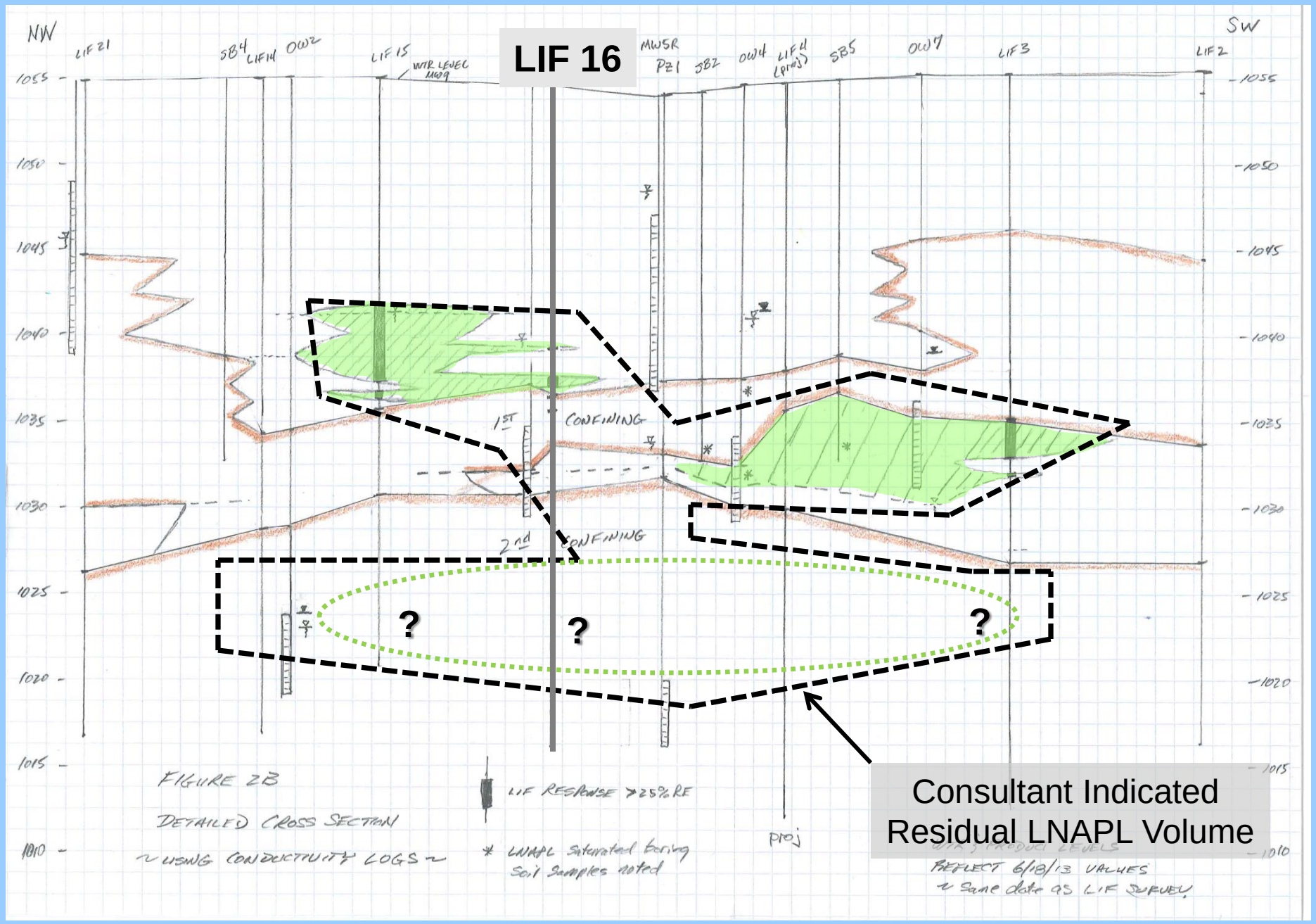
Max.RE response, again, tells us nothing about LNAPL thickness.

Conductivity curve discriminates soil grain size

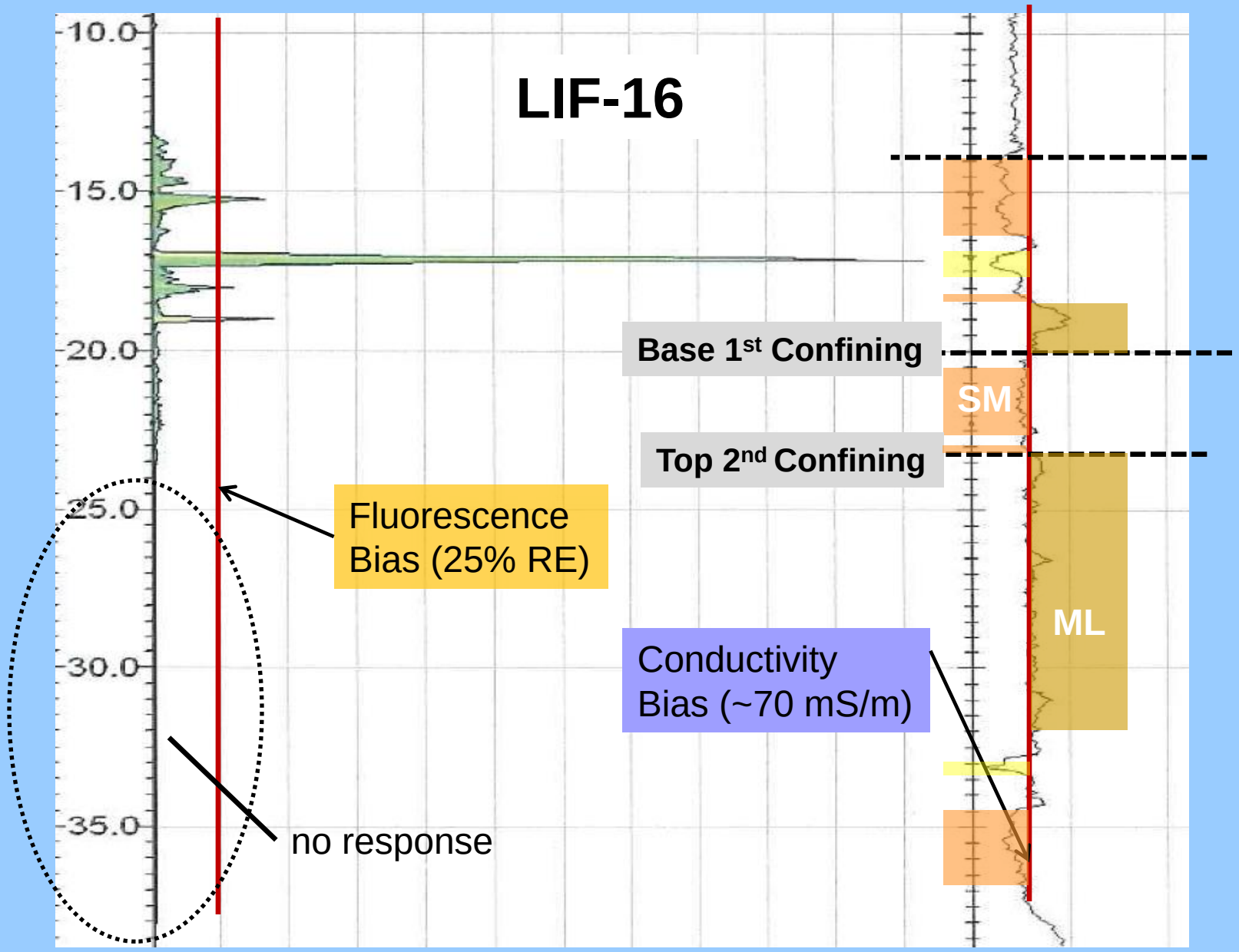



Correlation Markers (3)
15.0
20.0
25.0
30.0
35.0
40.0
smear zone
OW-7
(nearby)
Base 1st Confining
Calibration
Sample: ML
(64% fines)
SM
Top 2nd Confining
ML
LIF-3
Conductivity
Bias (~70 mS/m)


OW-2
NW
SW
LIF21
SB4
LIF14
OW2
LIF15
WTR LEVEL MW9
OW8
LIF16
MW5R
PZ1
SB2
OW4
LIF4 (PROJ)
SB5
OW7
LIF3
LIF2
1055
1050
1045
1040
1035
1030
1025
1020
1015
1010
Slide 14
1st CONFINING
2nd CONFINING
1st Confining Layer
2nd Confining Layer
LIF-15
LIF-14
Note
Previous Slide
FIGURE 2B
DETAILED CROSS SECTION
~ USING CONDUCTIVITY LOGS ~
LIF RESPONSE >25% RE
* LNAPL Saturated boring Soil Samples noted
PROJ
WTR & PRODUCT LEVELS REFLECT 6/18/13 VALUES ~ Same date as LIF SURVEY

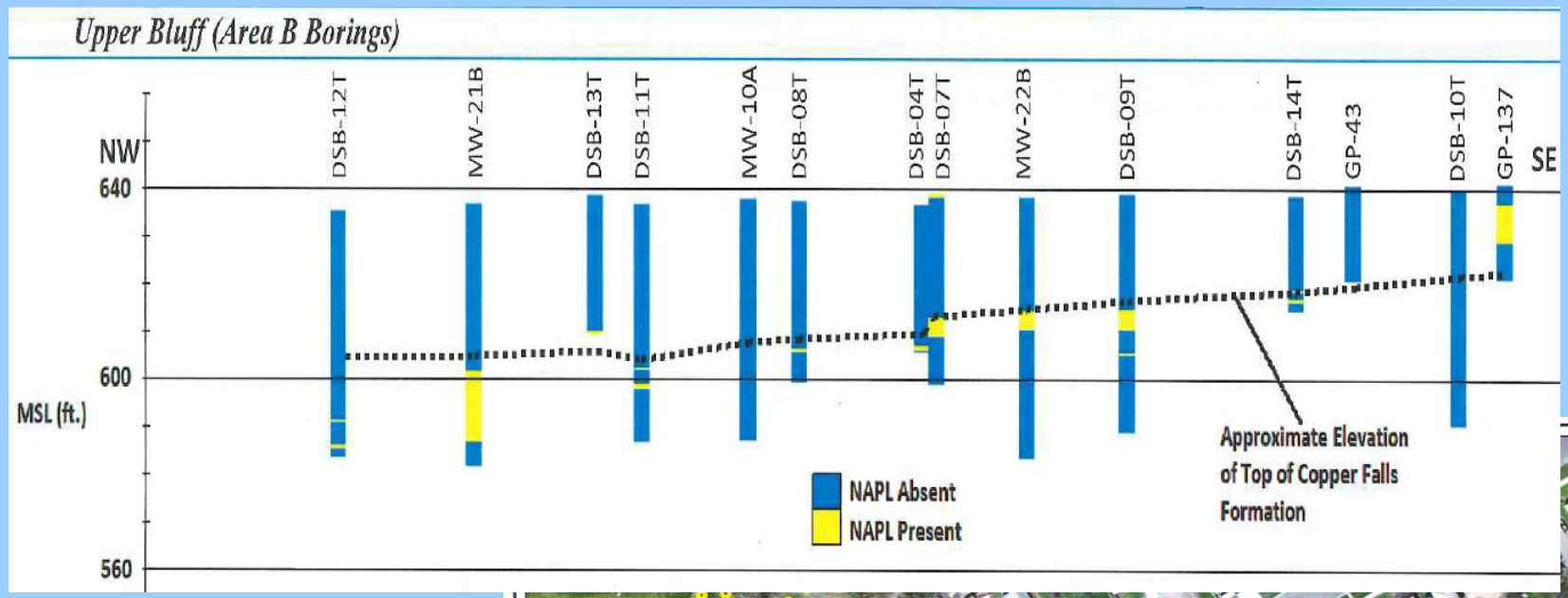


Consultant Indicated Residual LNAPL Volume


LIF-16
10.0
15.0
20.0
25.0
30.0
35.0
Base 1st Confining
SM
Top 2nd Confining
ML
Fluorescence
Bias (25% RE)
Conductivity
Bias (~70 mS/m)
no response

Questions?

Next: DNAPL Site Example

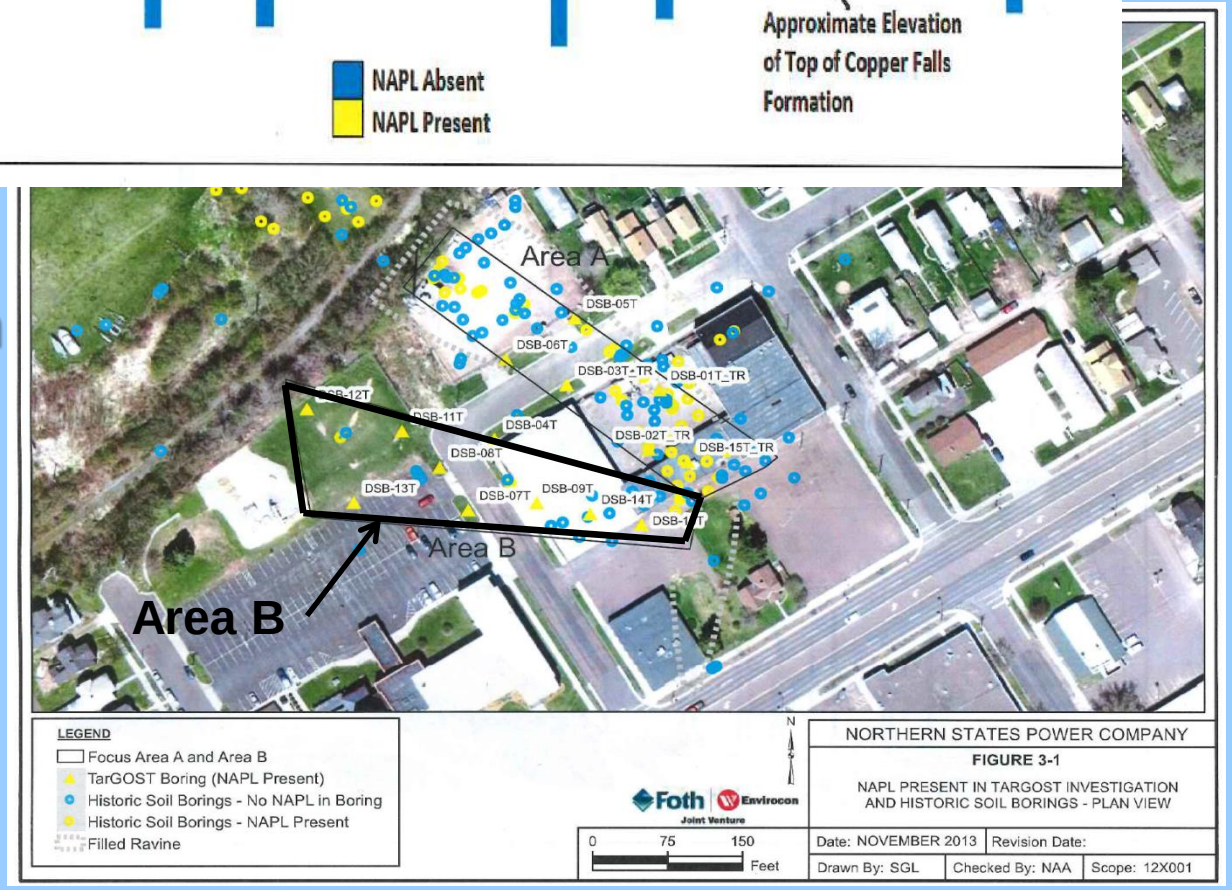


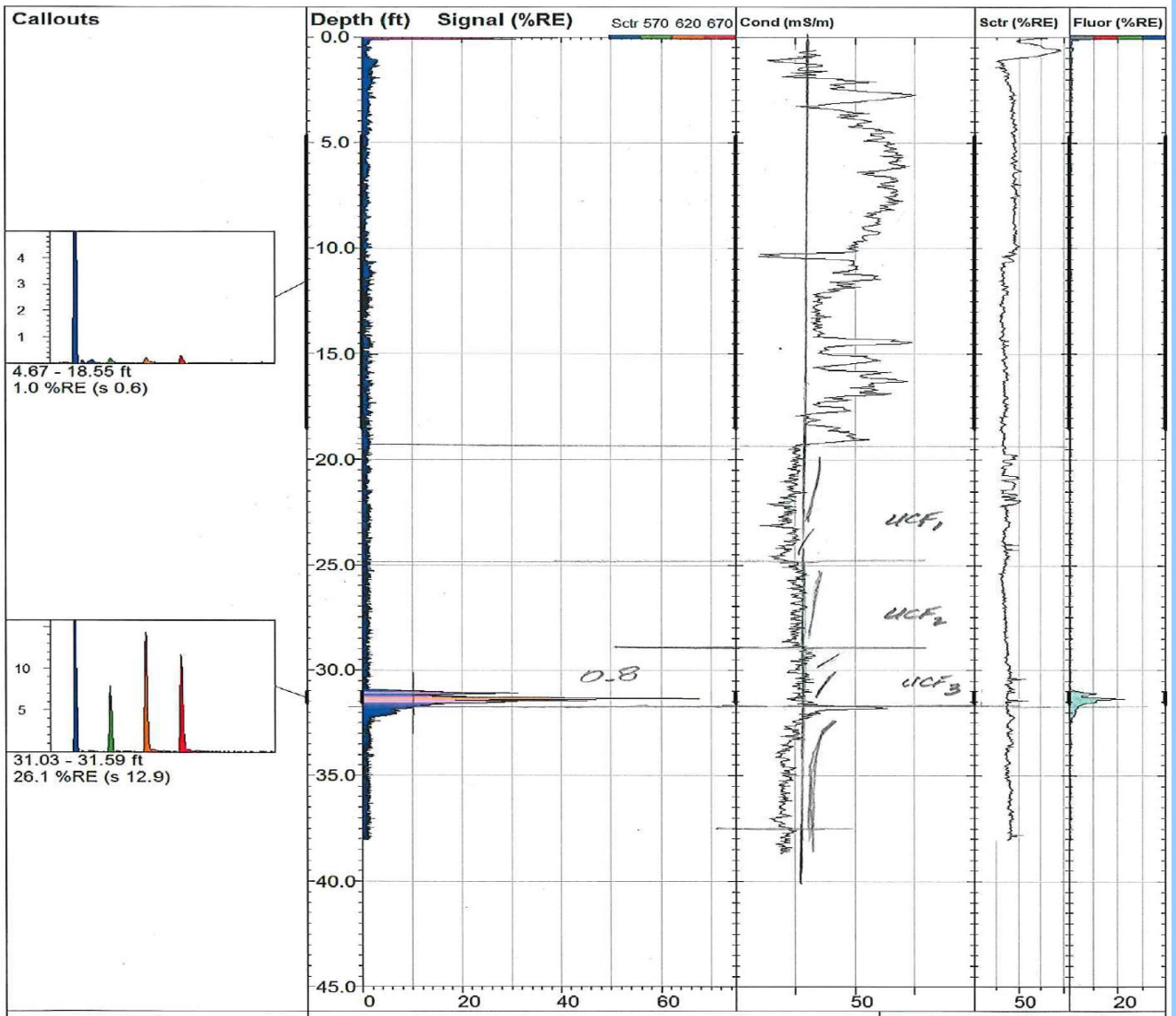
DNAPL Distribution

Area B: "Upper Bluff"
Copper Fall Fm.

Ashland Lakefront Site
(Historic MGP)

TarGOST LIF Survey

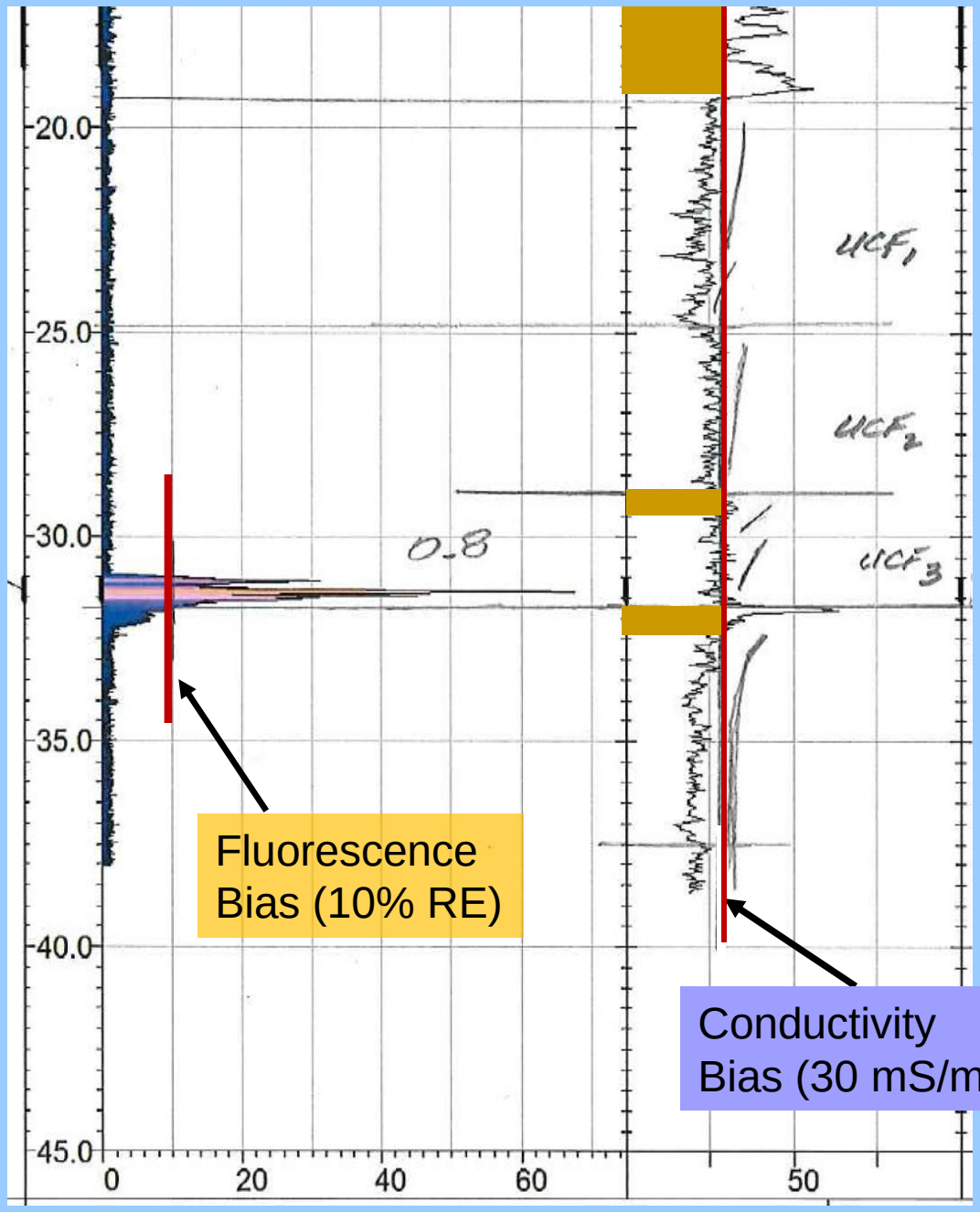


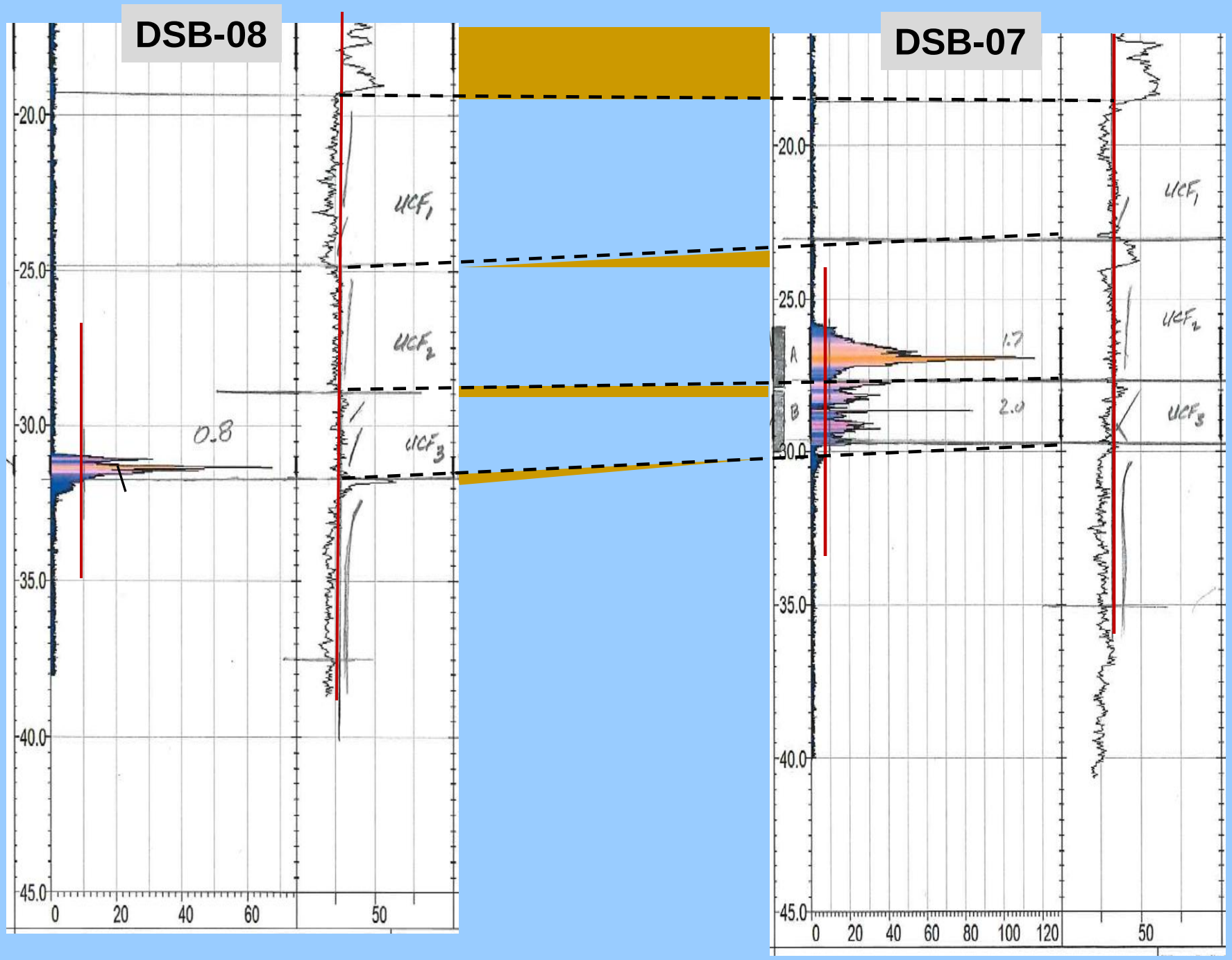


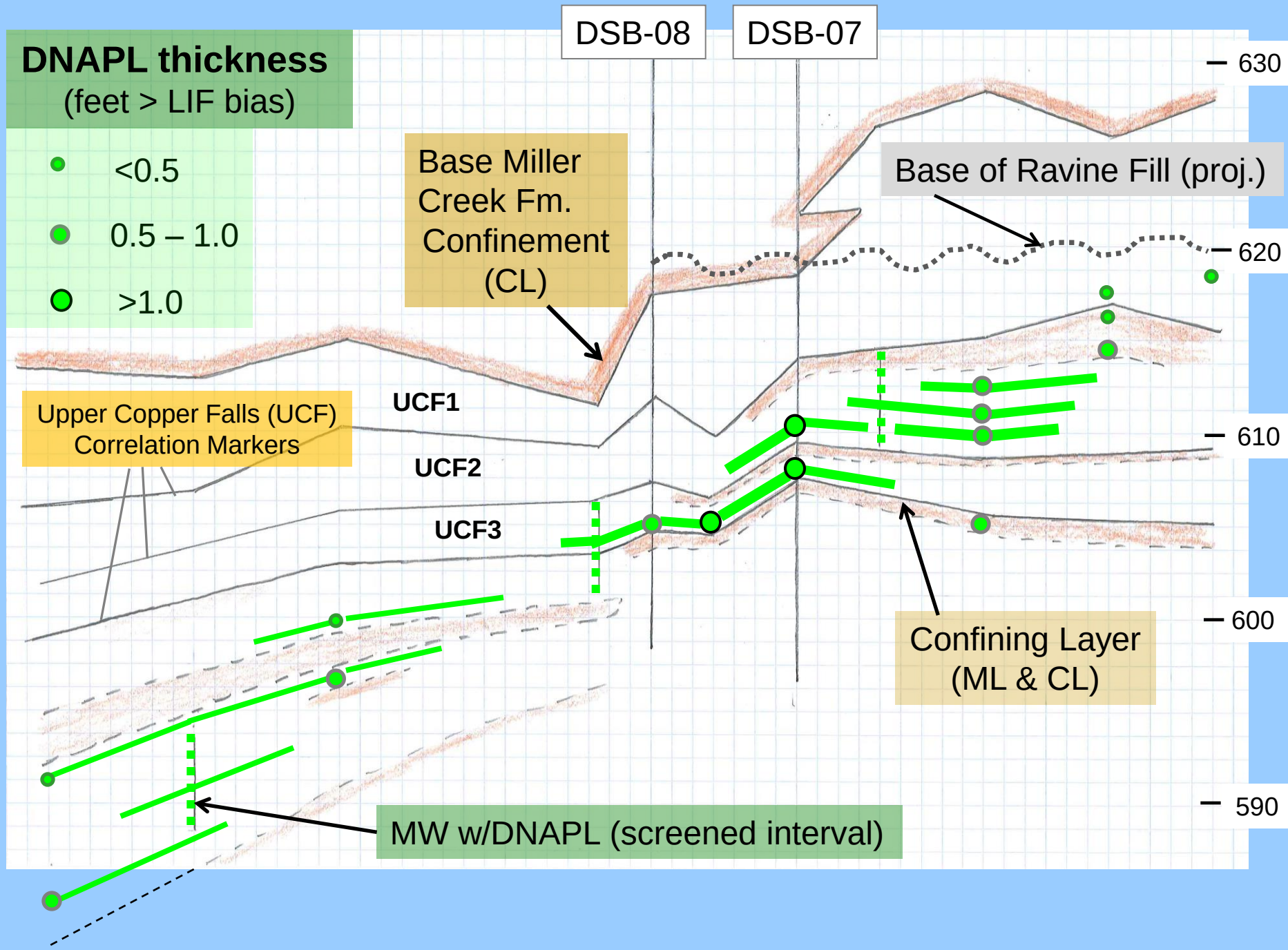
DAKOTA TECHNOLOGIES
FARGO, ND 701.237.4908
WWW.DAKOTATECHNOLOGIES.COM

DSB-08T		TarGOST By Dakota www.DakotaTechnologies.com
Site: **NSP Lake Front**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **38.04 ft**
Client / Job: **Foth /**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **68.6 %RE @ 31.35 ft**
Operator / Unit: **J.Lutz / TG1005**	*Elevation:* **Unavailable**	*Date & Time:* **2013-07-11 20:29 EDT**

DSB-08 w/interpretation biases




DSB-08
DSB-07
20.0
25.0
30.0
35.0
40.0
45.0
0
20
40
60
80
100
120
50
0.8
1.7
2.0
A
B
UCF1
UCF2
UCF3


DNAPL thickness
(feet > LIF bias)
<0.5
0.5 – 1.0
>1.0
DSB-08
DSB-07
630
620
610
600
590
Base Miller Creek Fm. Confinement (CL)
Base of Ravine Fill (proj.)
Upper Copper Falls (UCF) Correlation Markers
UCF1
UCF2
UCF3
Confining Layer (ML & CL)
MW w/DNAPL (screened interval)

Question to attendees/environmental industry:

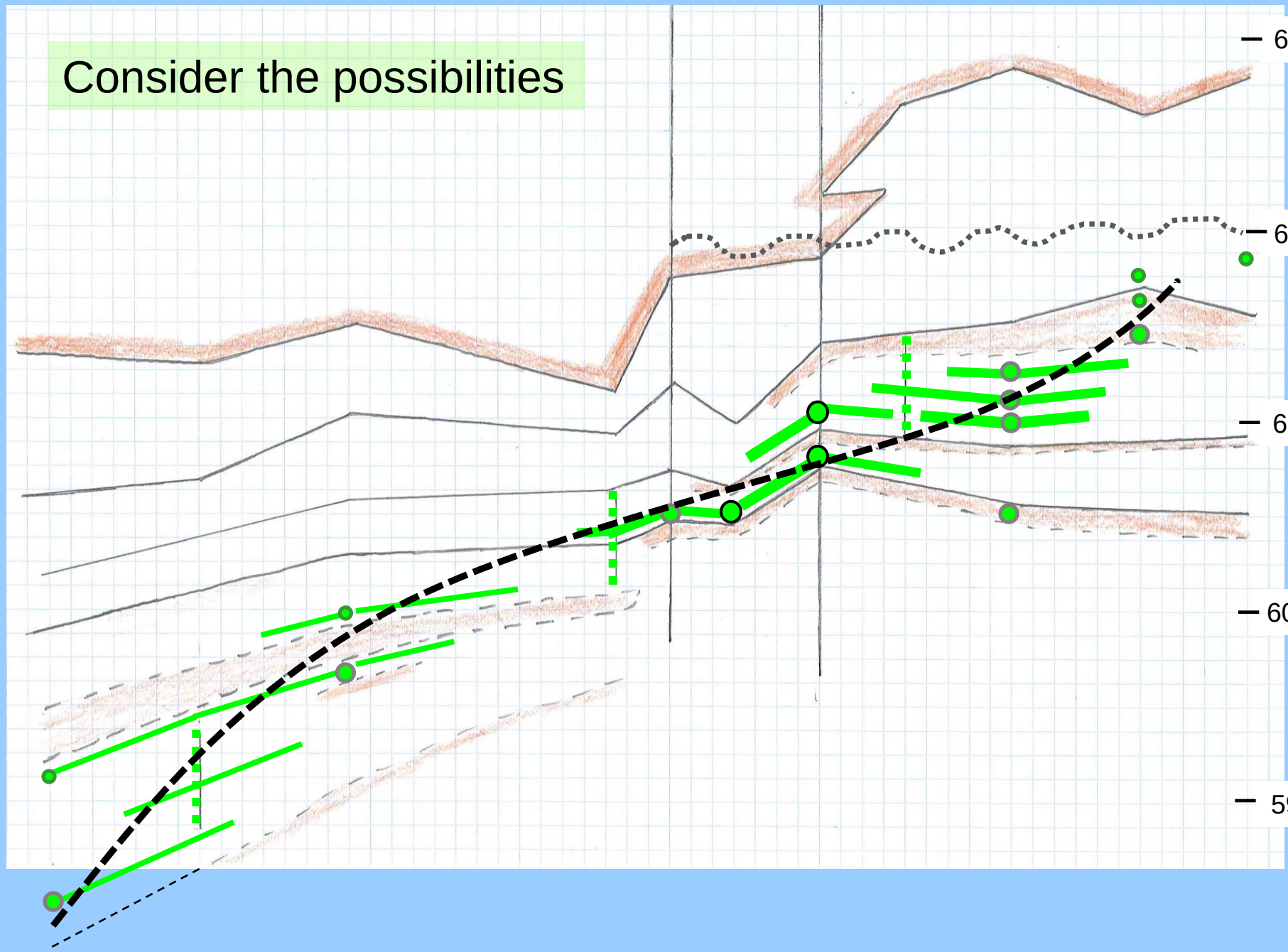
If NAPL typically accumulates in horizontal, tabular-shaped volumes, and most soils have strong horizontal anisotropy,

Why not consider using more horizontal remedial wells at NAPL sites

- NAPL “drains” for slow hydraulic pumping
- SVE wells
- Injection wells

In other words:
Install remedial wells oriented similar to how the NAPL originally migrated into the aquifer – to access the most advantageous NAPL saturations (and highest relative NAPL permeability) instead of working against them.

Consider the possibilities



Questions

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Issues & Trends 2015/16

January 6, 2016
12:00 – 1:00 p.m.

RR Sites Map Mobile

Sonya Rowe
Wisconsin DNR Brownfields Specialist

Audio from today's presentation and information about this and future *Issues & Trends Series* can be found on the RR Program Training Webpage at:
dnr.wi.gov/topic/Brownfields/Training.html

Questions / Comments / Suggestions regarding the Issues & Trends Series can be submitted to:

DNRRRComments@wisconsin.gov

Thank you