

Fuel Fluorescence Logging using the Optical Image Profiler (OIP)



October, 2016

Note: A Patent is Pending for this System.

Daniel Pipp, Chemist, Geoprobe Systems; Tom Christy, V.P., Geoprobe Systems

Jonathan Wiley, Direct Imaging Manager, Stock Drilling

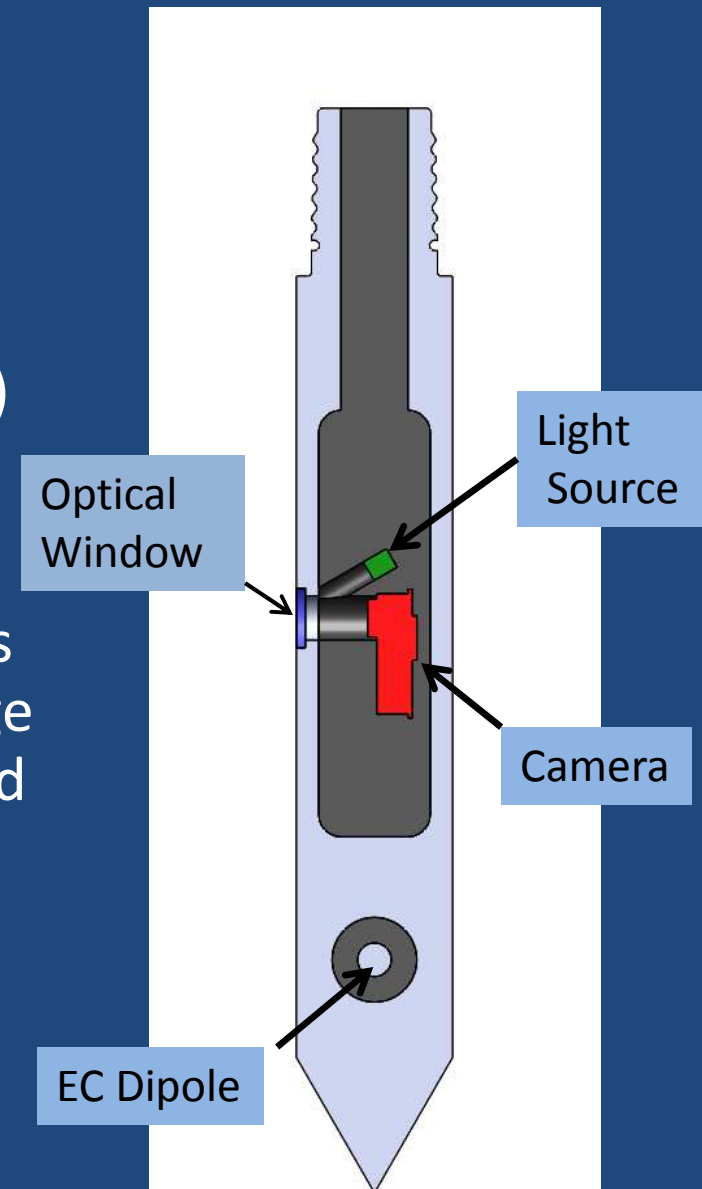
Sheryl Doxtader, Environmental Quality Analyst, MI DEQ

John Fontana, PG, President, Vista GeoScience

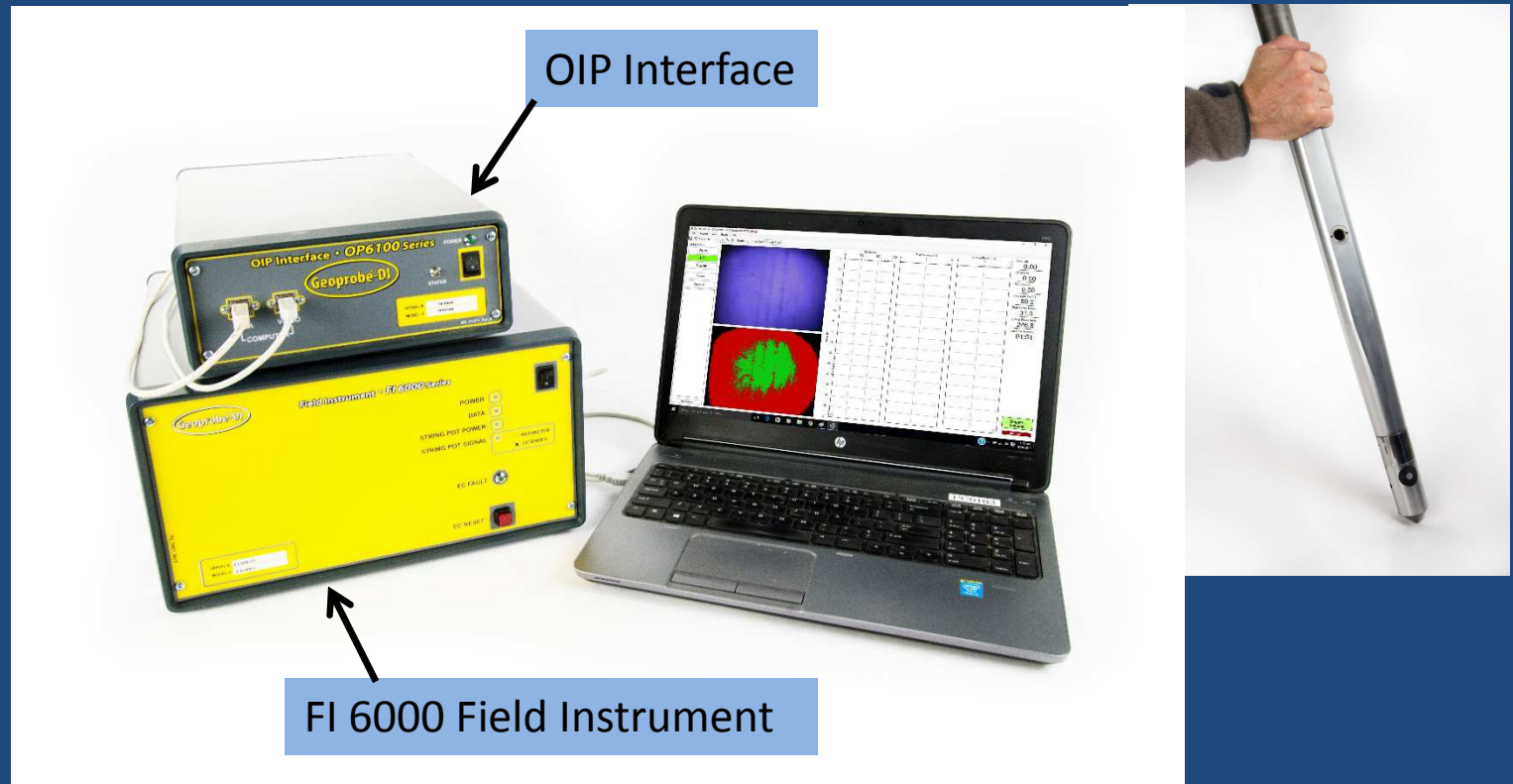


OIP Description

- **Purpose:** Detecting UV induced fluorescence of fuel hydrocarbons or light non aqueous phase liquids (LNAPL) in soil.
- **Method:** High intensity UV light directed at the soil causes hydrocarbons present in the soil to fluoresce. An Image of the soil is captured by the camera and analyzed for fluorescence.
- Visible light images of the soil may also be obtained.



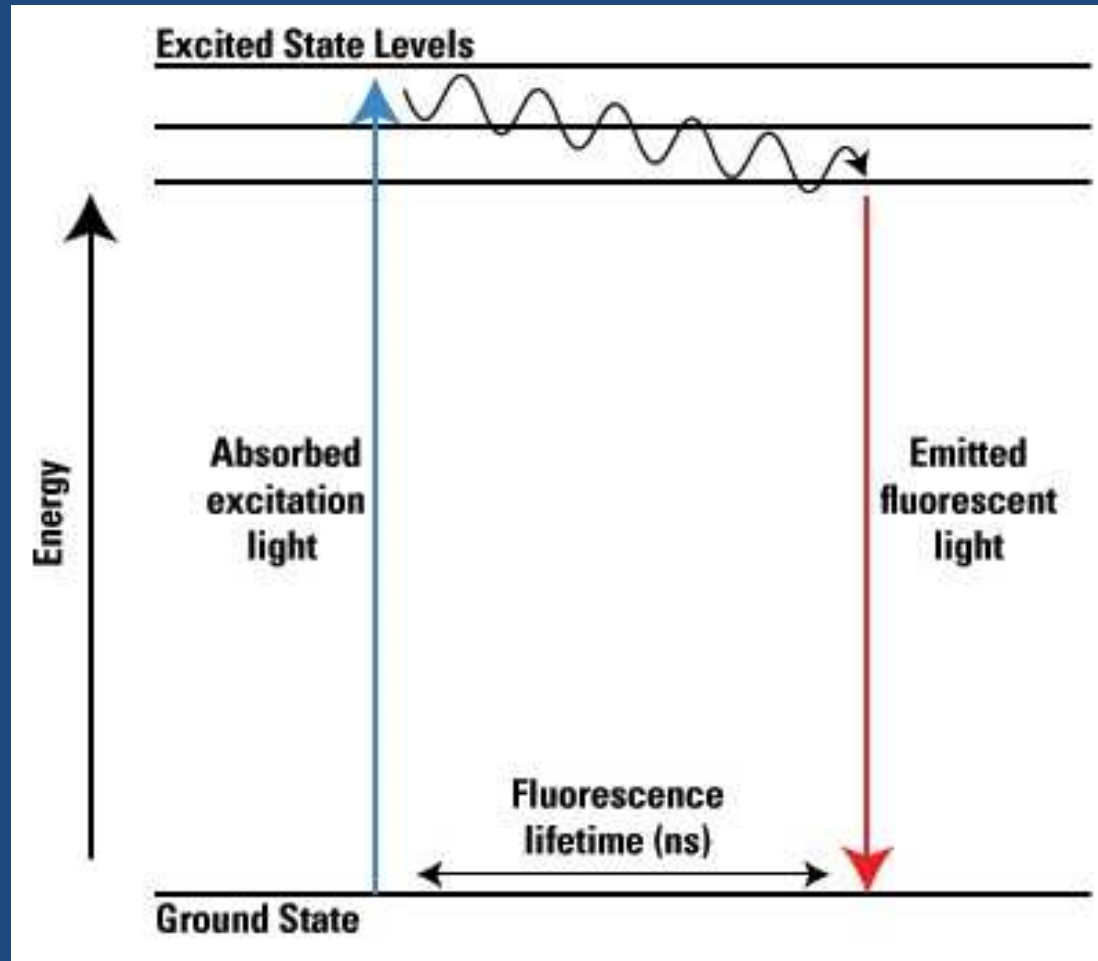
OIP Instrumentation



Instrumentation to run optical logs includes the FI6000 and the OIP Interface. A laptop computer is also required.



Fluorescence



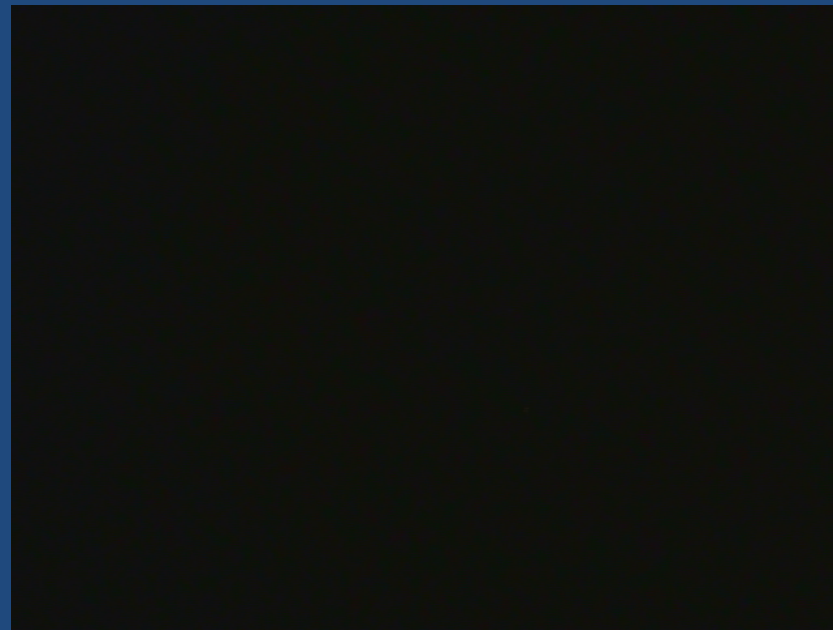
Jablonski Energy Diagram of Fluorescence

<https://www.thermofisher.com/>



OIP UV Image

9.5 mm



7 mm



Typical OIP background image with no fluorescence using the UV light source.



OIP UV Image

9.5 mm



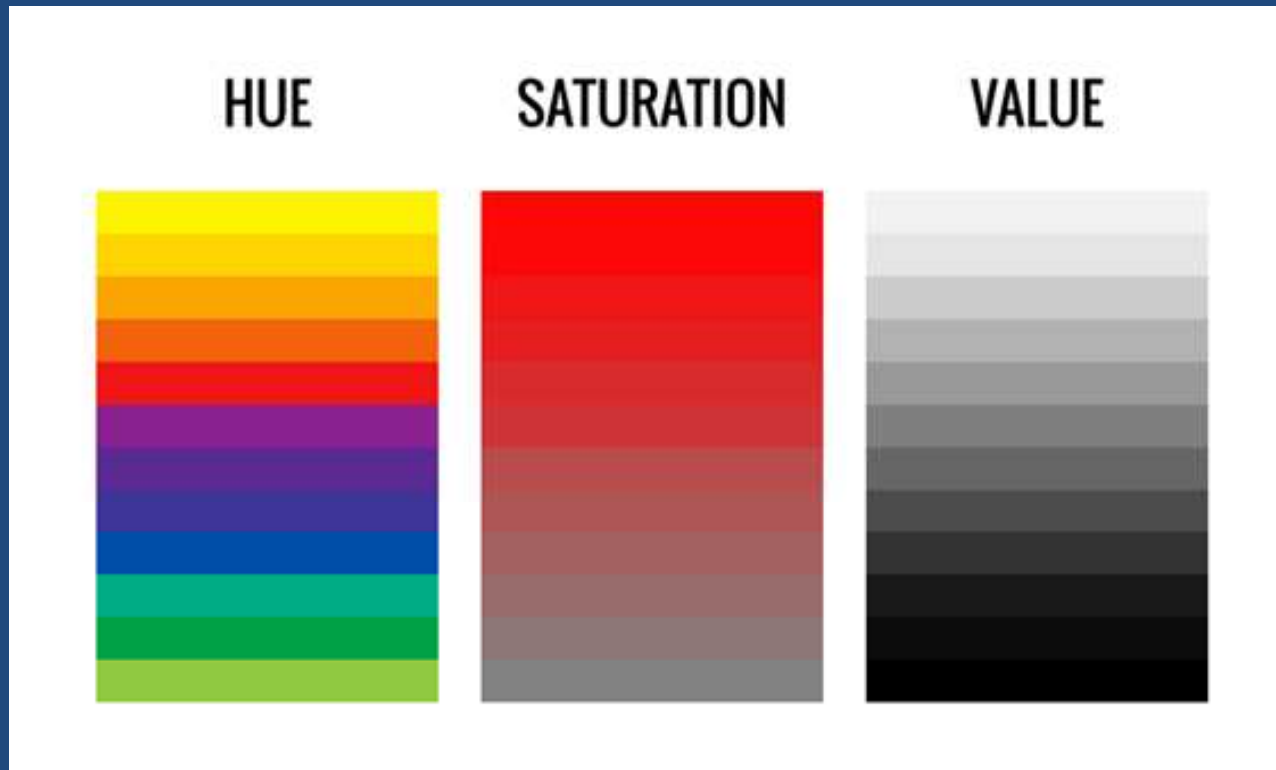
7 mm



Typical OIP image of hydrocarbon fluorescence using the UV light source.



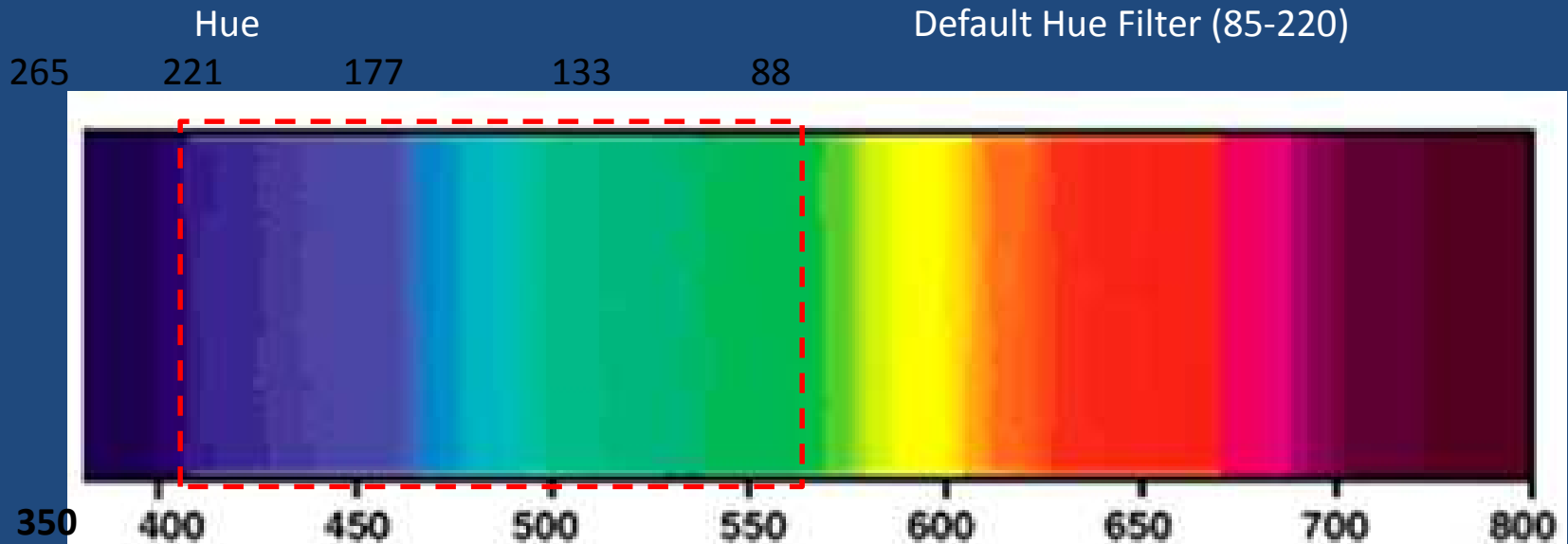
Software Color Analysis



Color defined by Hue, Saturation and Value
HSV

Color Analysis

Approximate Conversion, Hue to Wavelength



Visible Spectrum 380-740nm

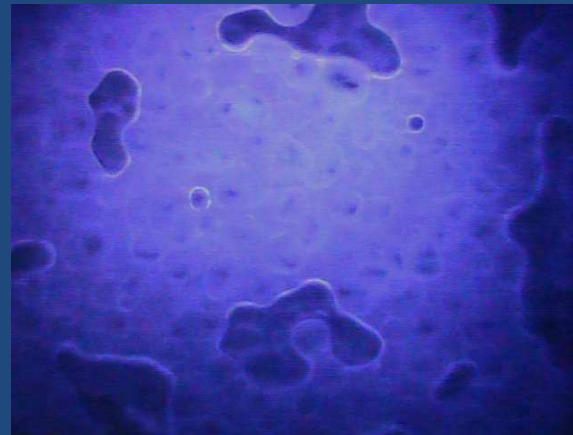
Wavelength in nanometers



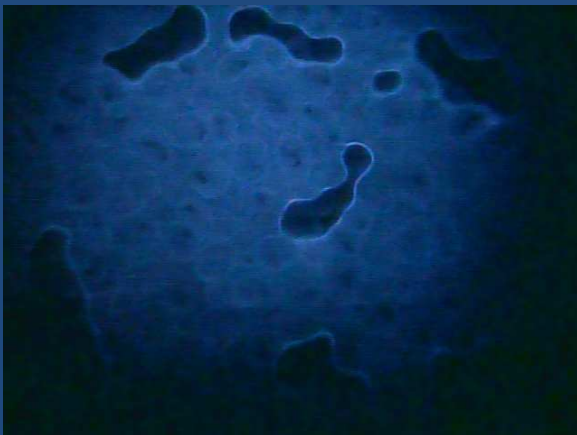
Color Analysis



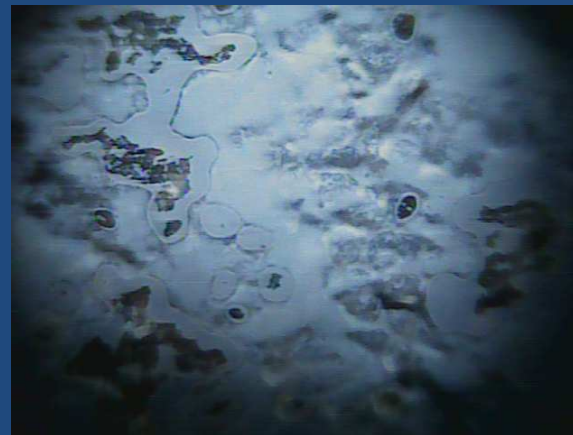
Motor Oil SAE 30



Diesel



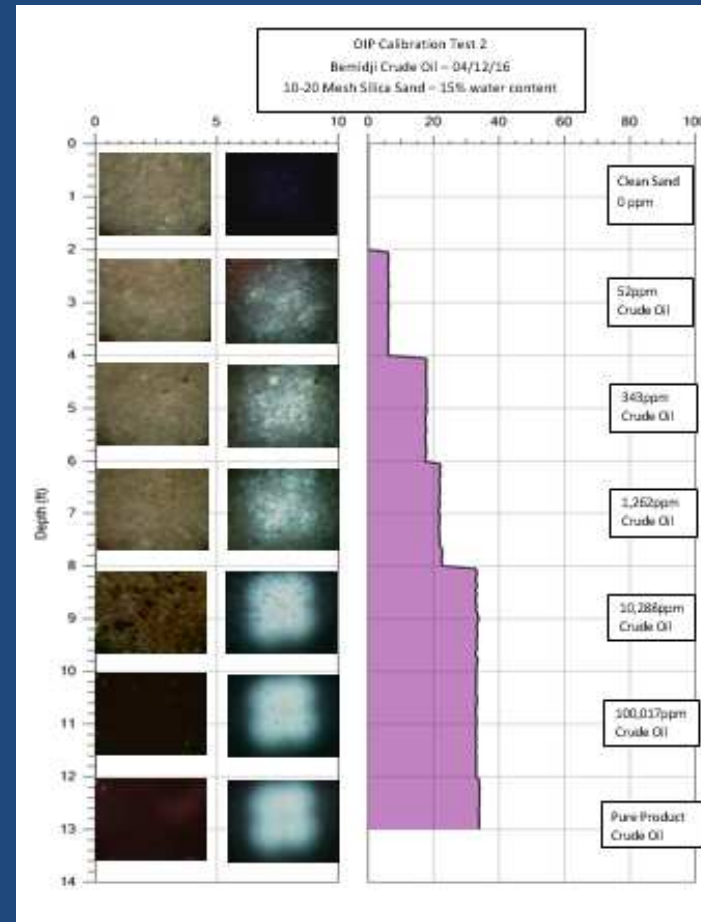
Unleaded Gas



Crude Oil



OIP Fuel Fluorescence

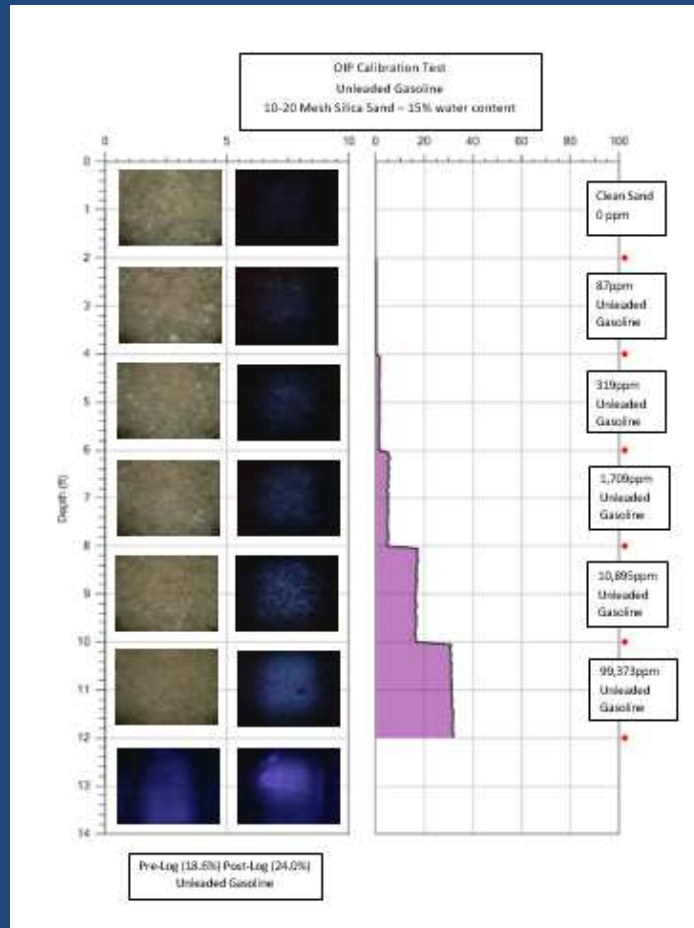


Crude Oil

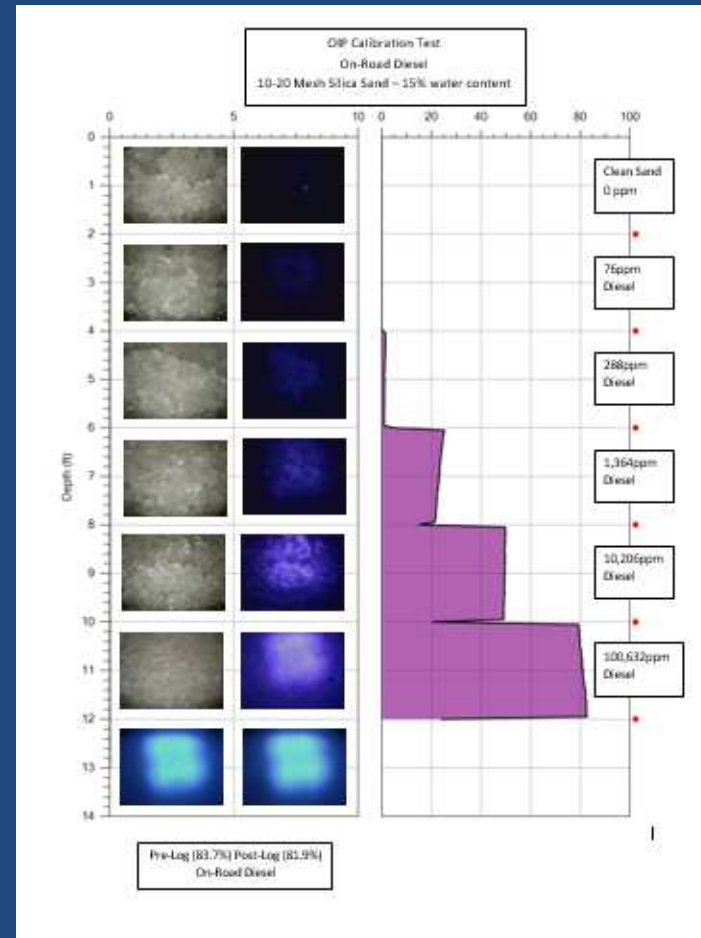
OIP % fluorescence with increasing concentrations



OIP Fuel Fluorescence



Unleaded Gas



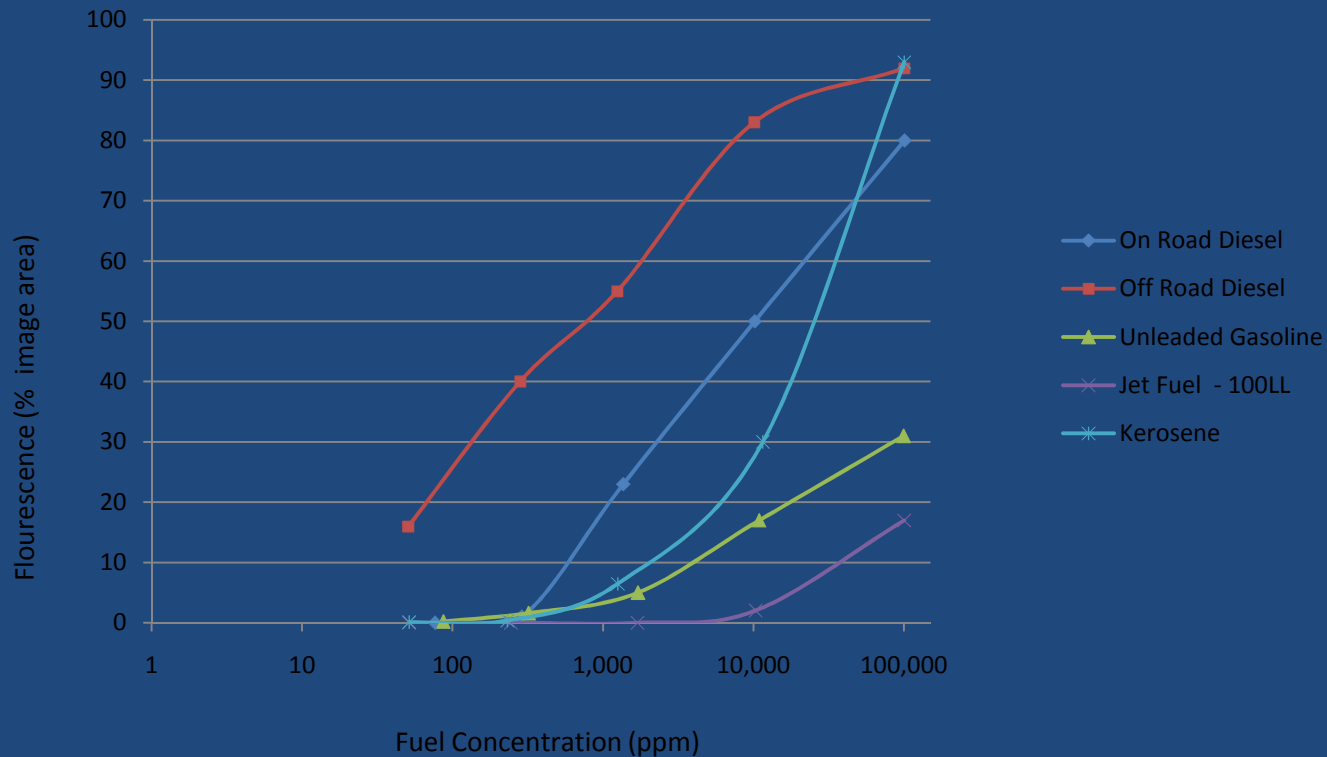
Diesel

OIP % fluorescence with increasing concentrations



OIP Fuel Fluorescence

OIP Fuel Fluorescence Response
on Silica Sand - 15% water content



OIP % fluorescence for Fuels with
increasing concentrations



OIP System QA

- To assure proper operation, the OIP probe is exposed to cuvette samples of target fuels before and after each log as well as a blank and visible targets – for color and focus

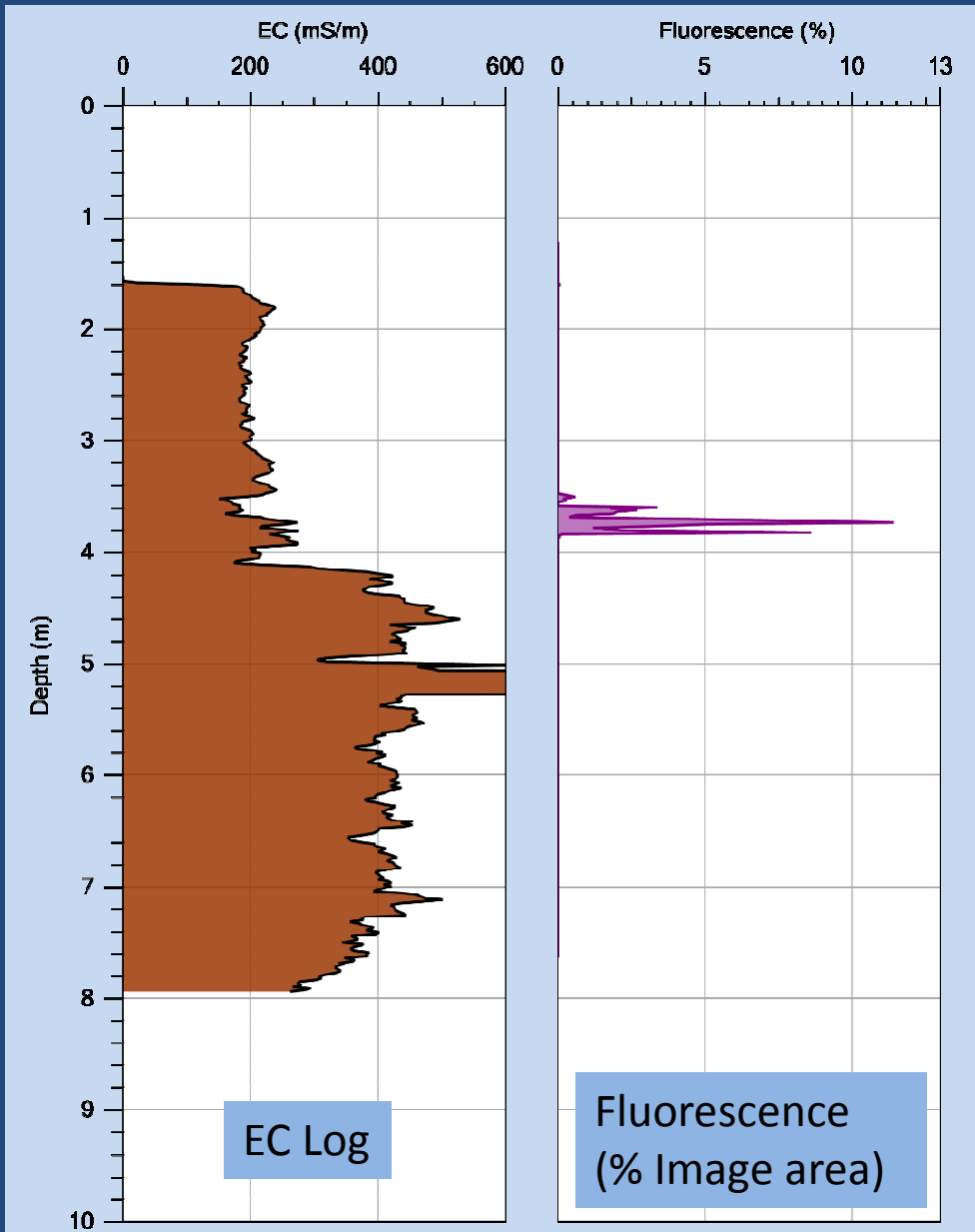


Log QA, Diesel Fuel



QA, Visible Target

OIP 1



The OIP Log

- Images captured every 15mm (.05 ft.).
- Images are analyzed for fluorescence in real time.
- The average percent of the image area representing fuel fluorescence for every 0.05ft is recorded on the log.



3.0m
0% detected



3.73m
12% detected

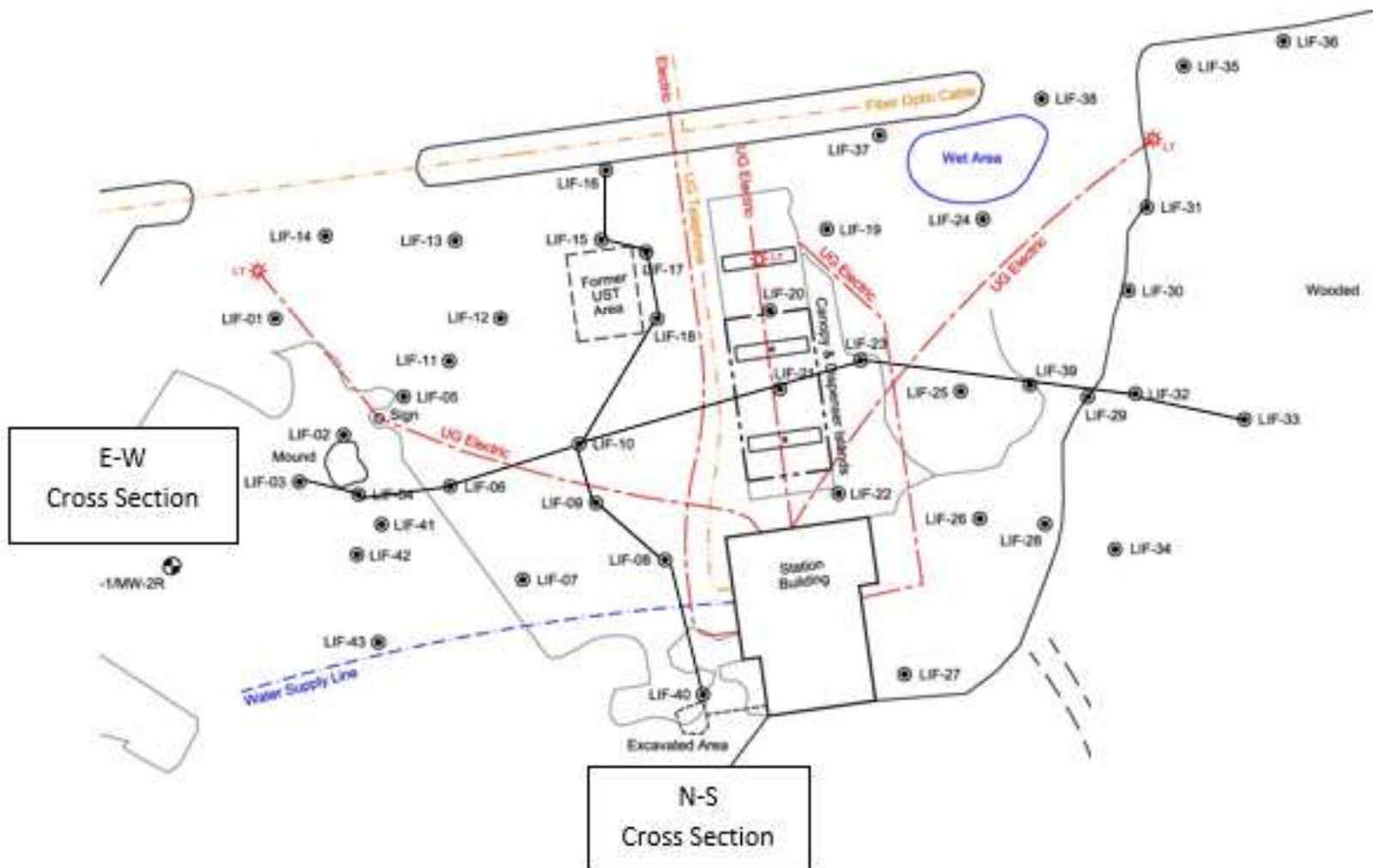
Field Site Data

Former Truck Stop in Michigan



Field Site Data

Former Truck Stop in Michigan



Field Site Data

Gasoline Fluorescence

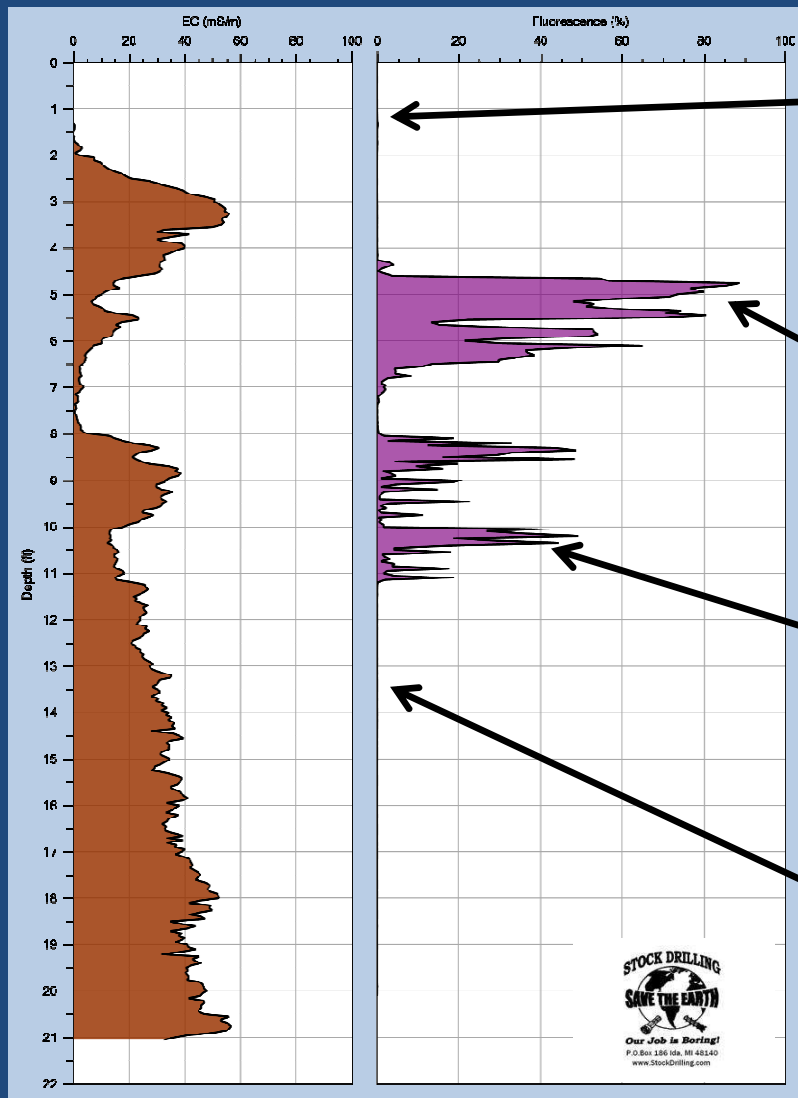


Image at
2.4ft



Image at
5.0ft

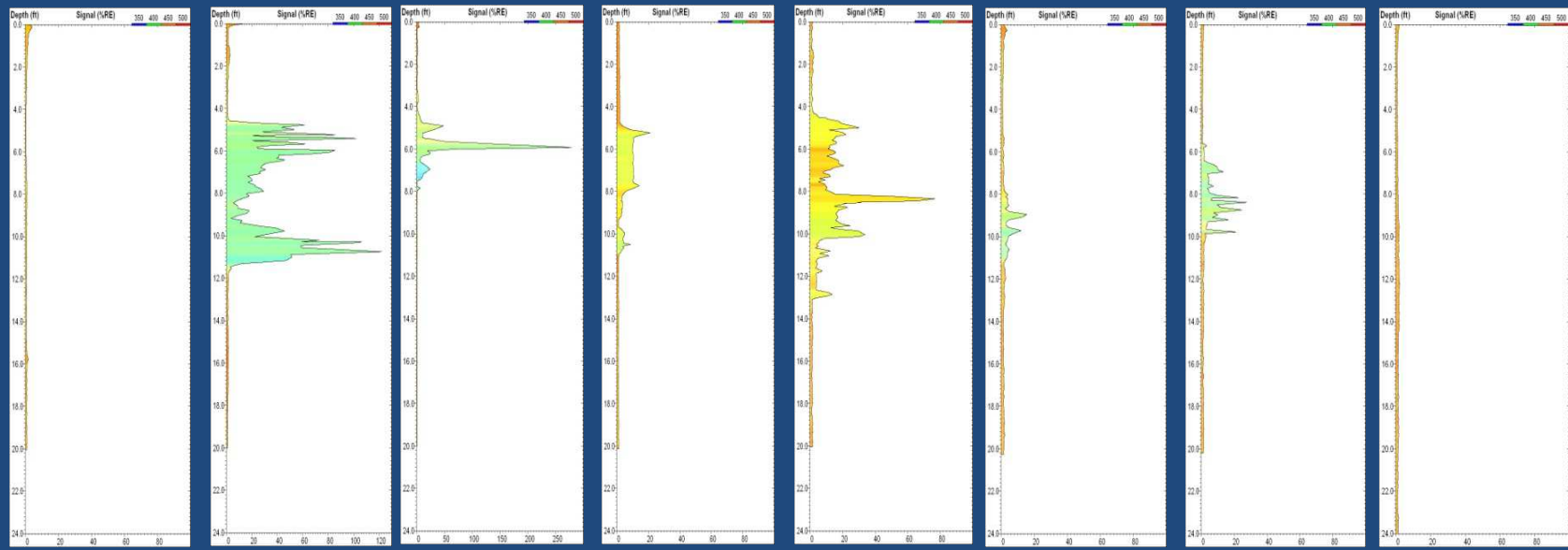
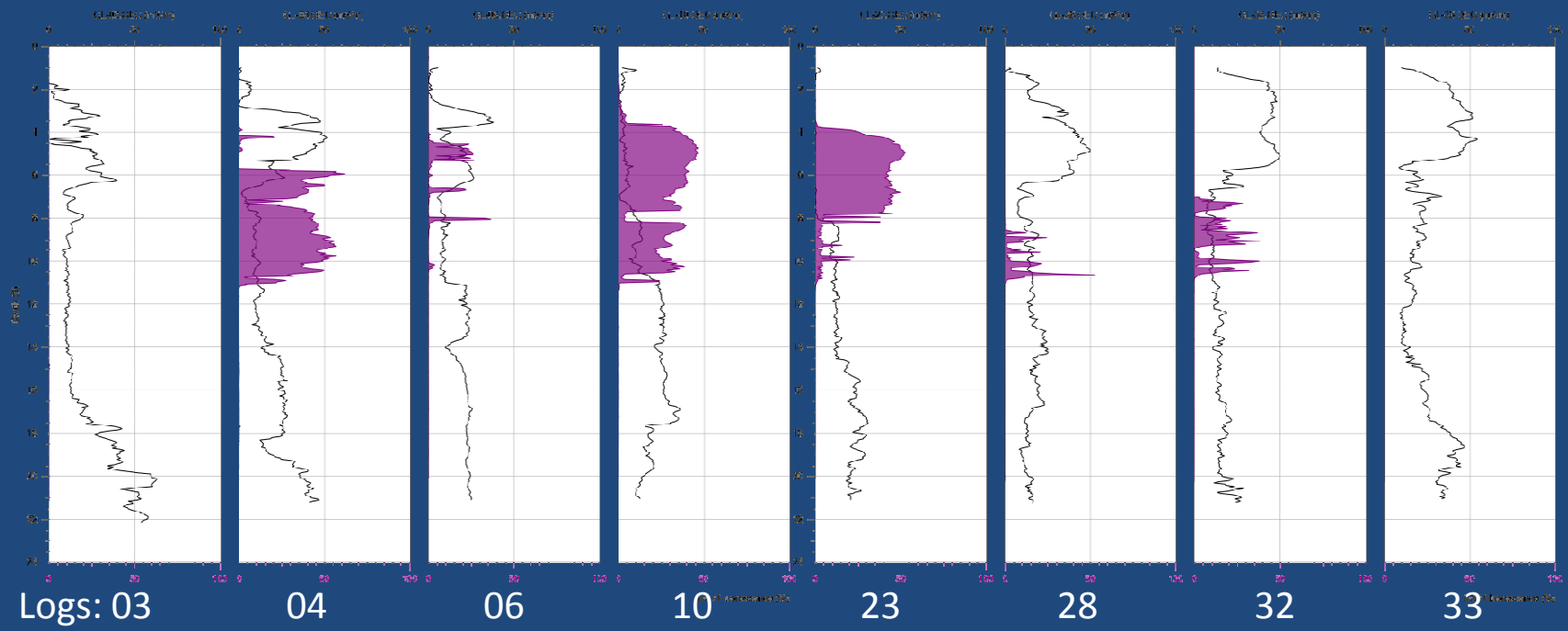


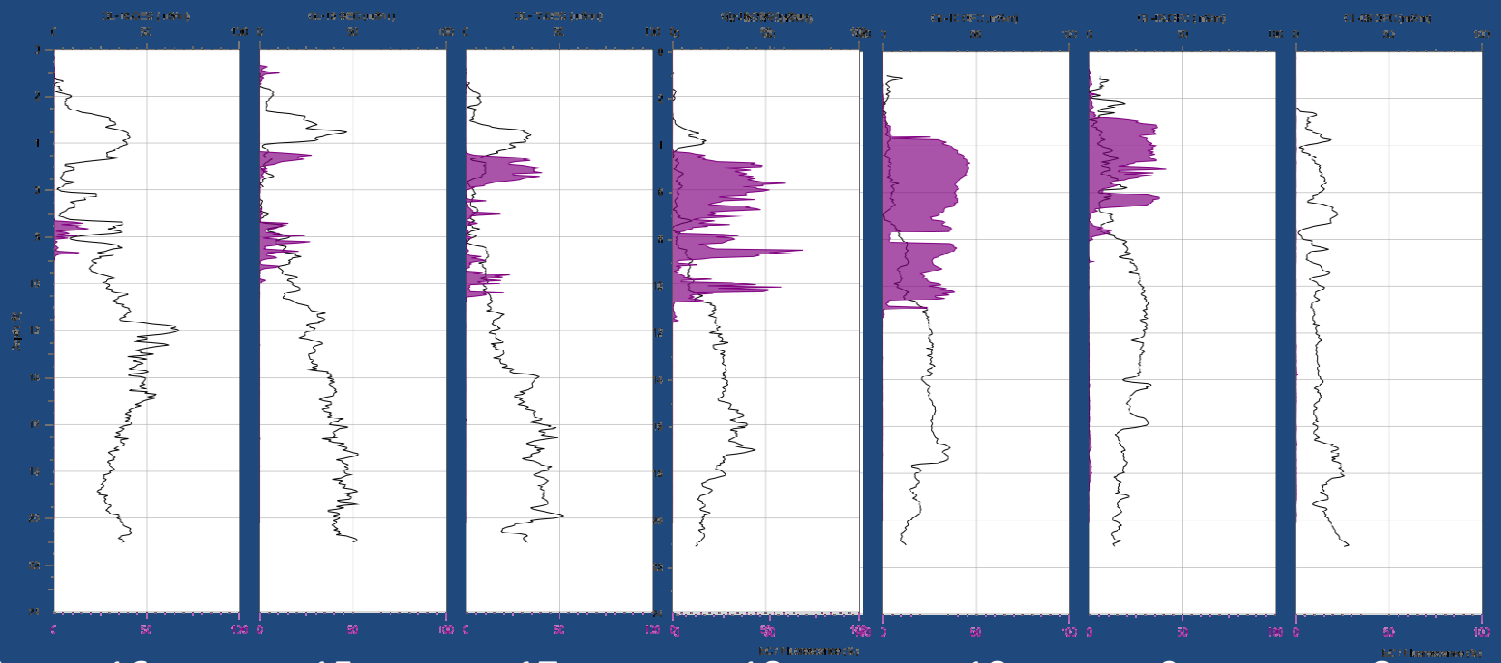
Image at
10.20ft



Image at
12.2ft







Logs: 16

15

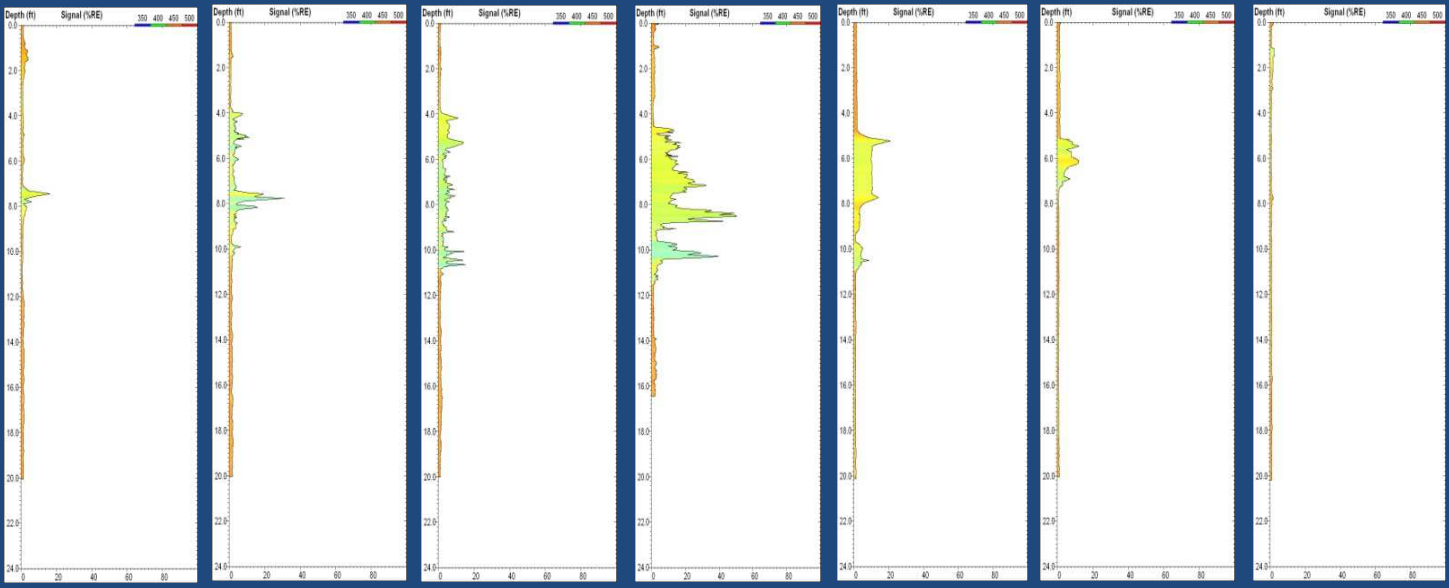
17

18

10

9

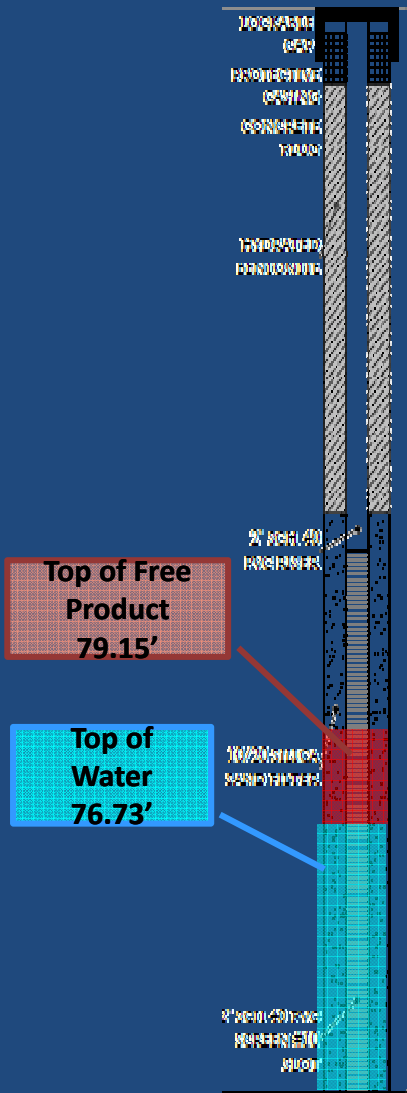
8



Former Dave's Downtown Conoco Grand Junction, CO



Former Dave's Downtown Conoco Grand Junction, CO

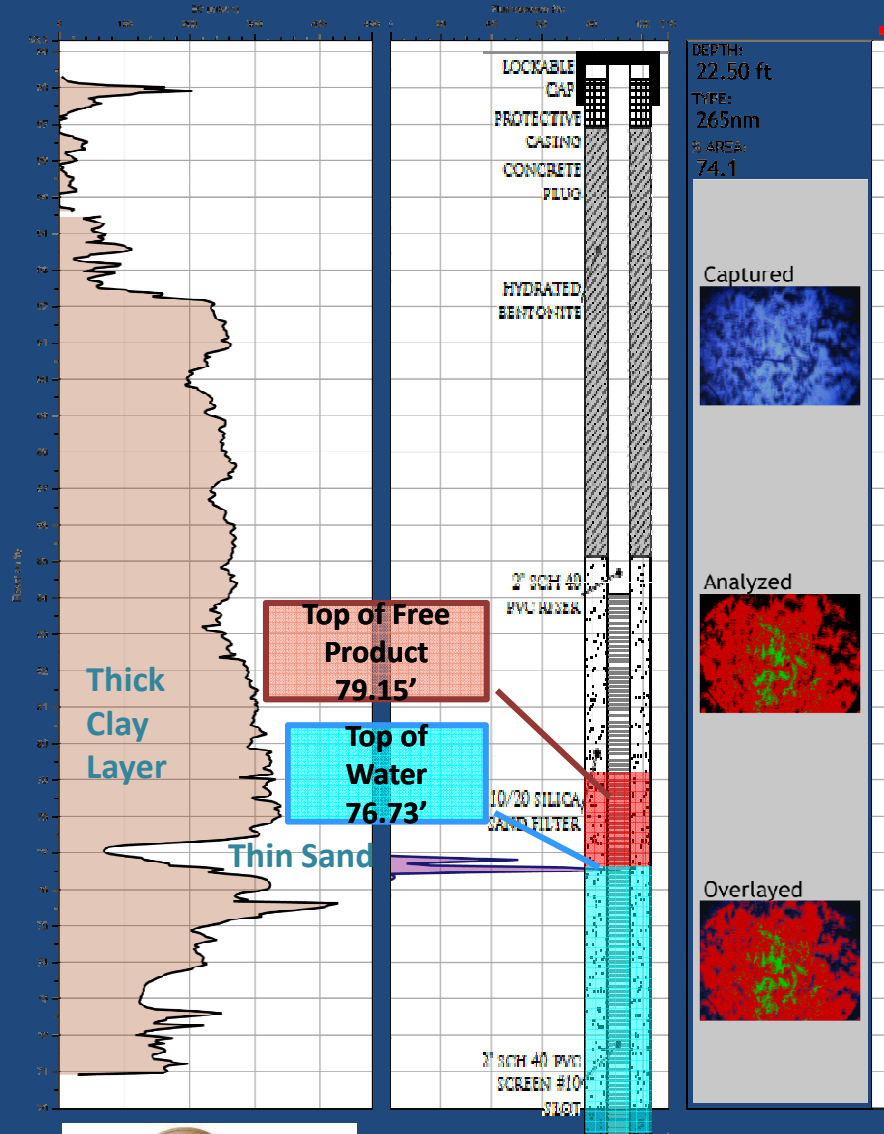


Former Dave's Downtown Conoco Grand Junction, CO



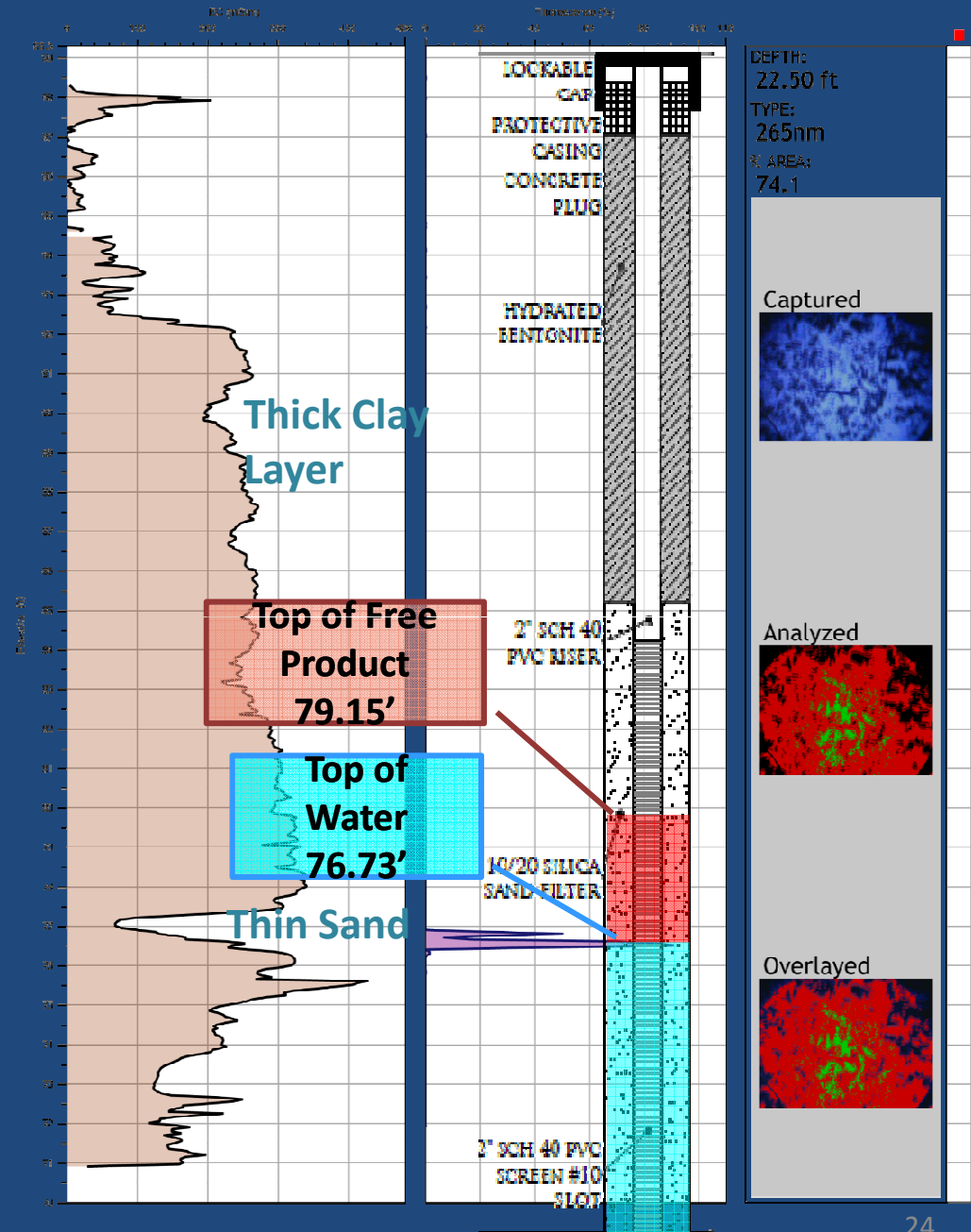
Dave's Former Conoco
OIP Log: OIP-A07; Elev. = 99.31'

DG-45
TOC = 99.01'

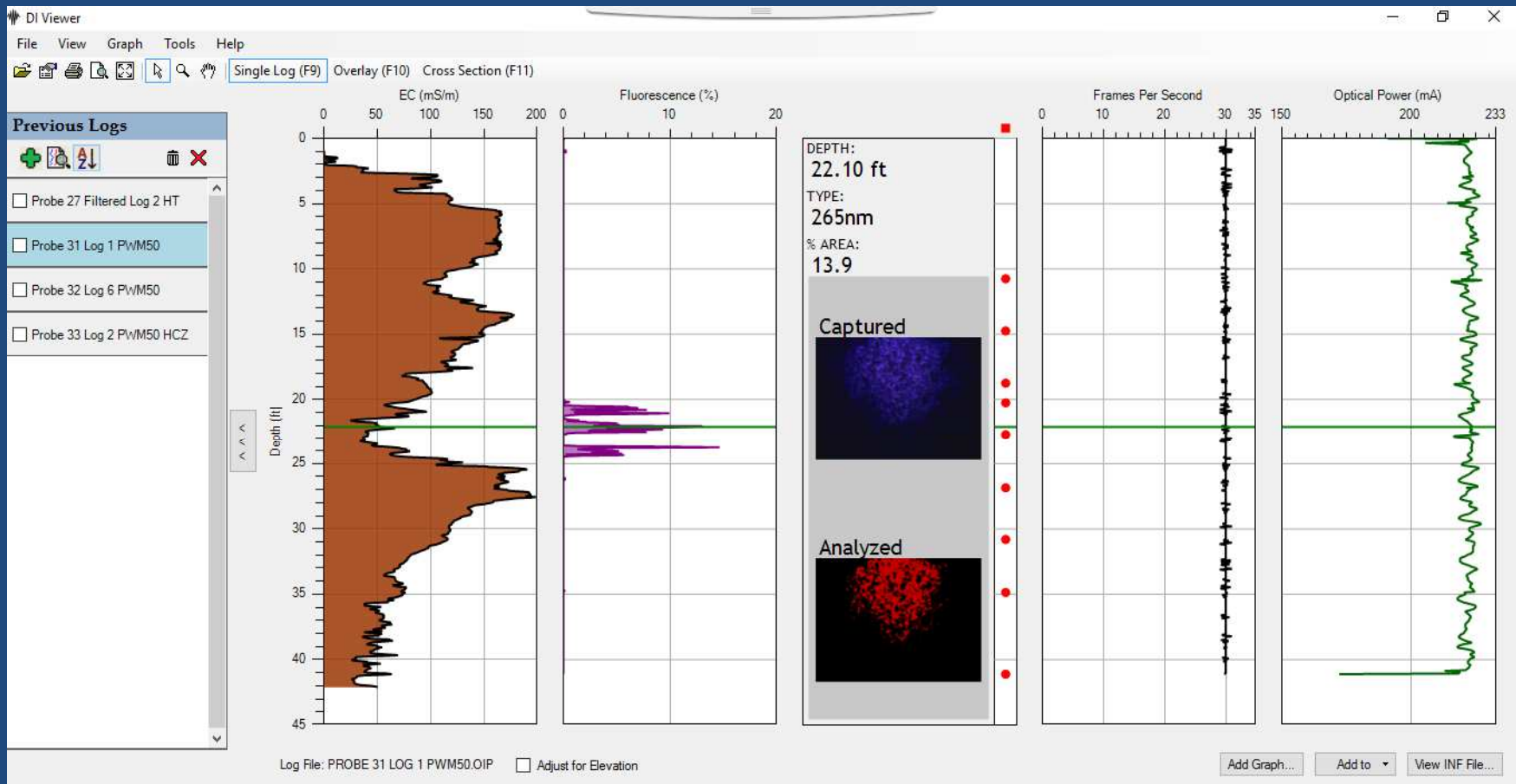


OIP Shows LNAPL Not as Bad as it Looks!

- Well ~20' from OIP Boring
- Thick Low Perm Clay
- LNAPL in Thin Sand Stringer, below water table.
- LNAPL displays false thickness in well.

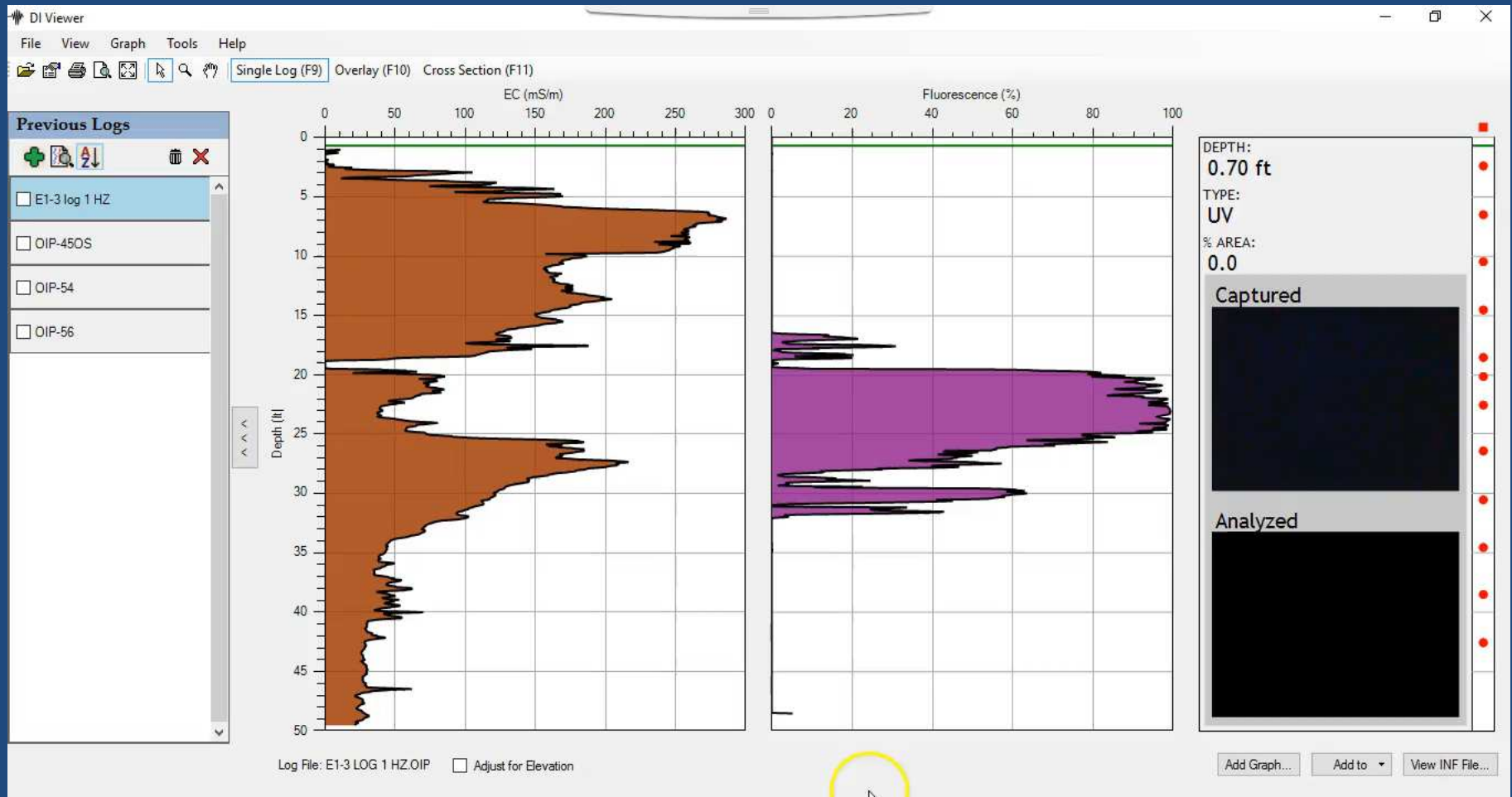


Viewing OIP Logs

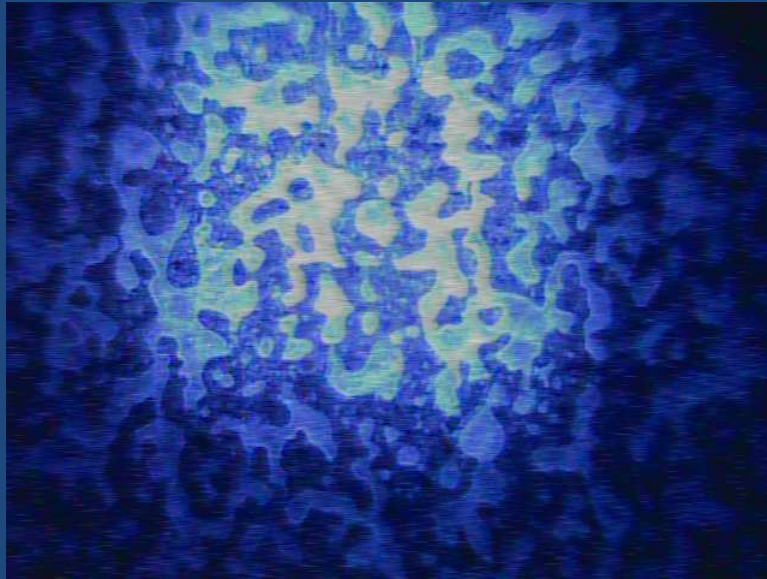


OIP Logs can be opened using Geoprobe's DI Viewer software. The user can view OIP optical images at any selected interval in the log. The DI Viewer also may be used to develop log cross sections and overlays.

Viewing OIP Logs



OIP Visible Images



Fluorescence images of fuel globules in soil.



Visible image of Sand matrix.

Visible images of soil may be obtained by stopping the probe and switching to the visible light source. The above images are of the same soil made with the two different light sources. Visible light images are useful for assessing the type of soil where hydrocarbons are found.

OIP LNAPL

DI Acquisition - C:\Users\pipdd\Documents\DI Field Projects\Albany, NY - S2C2 4-16\OIP-062.zip

File Sensors View Graph Help

Range: 10 ft Depth (F9) Time (F10) Optical (F11)

Lighting Options

None

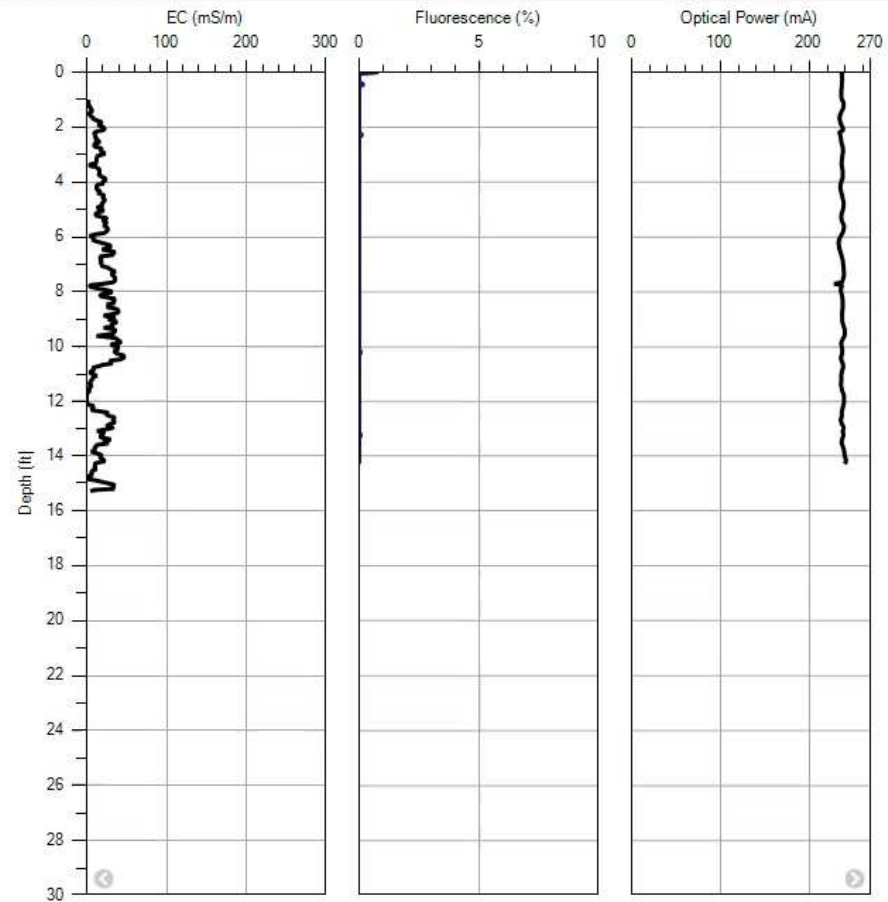
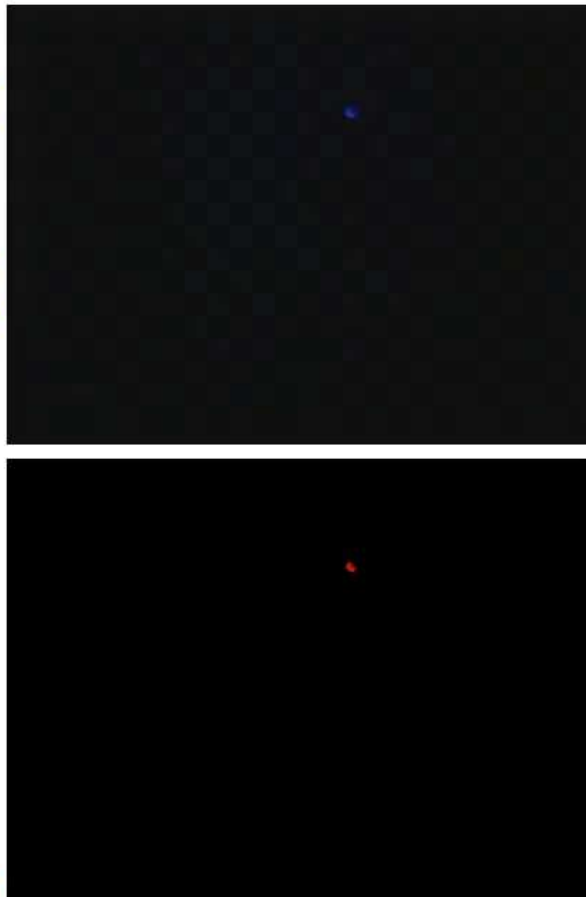
265nm

Visible

Capture

Capture All

Start Camera



Depth (ft)
14.35

EC (mS/m)
6.07

ROP (ft/min)
1.71

Fluorescence (%)
0.0

Frames Per Second
30.0

Optical Power (mA)
237.8

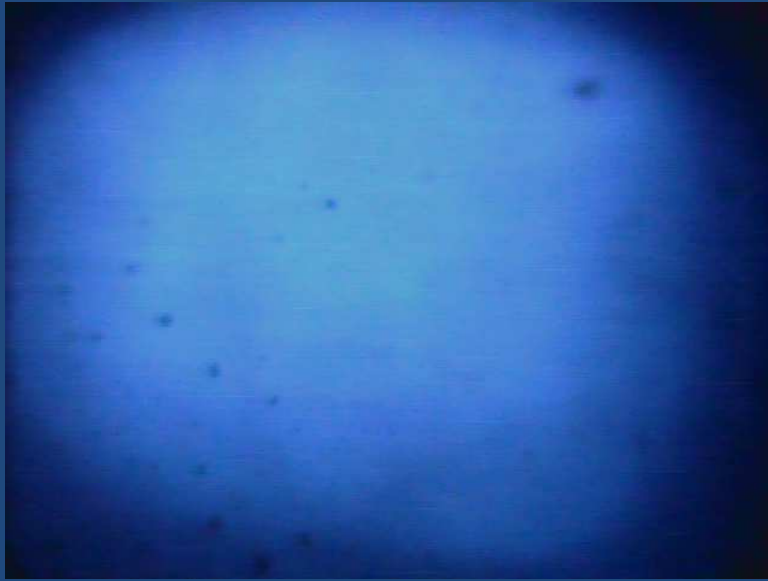
Log Time (min:sec)
34:46

T

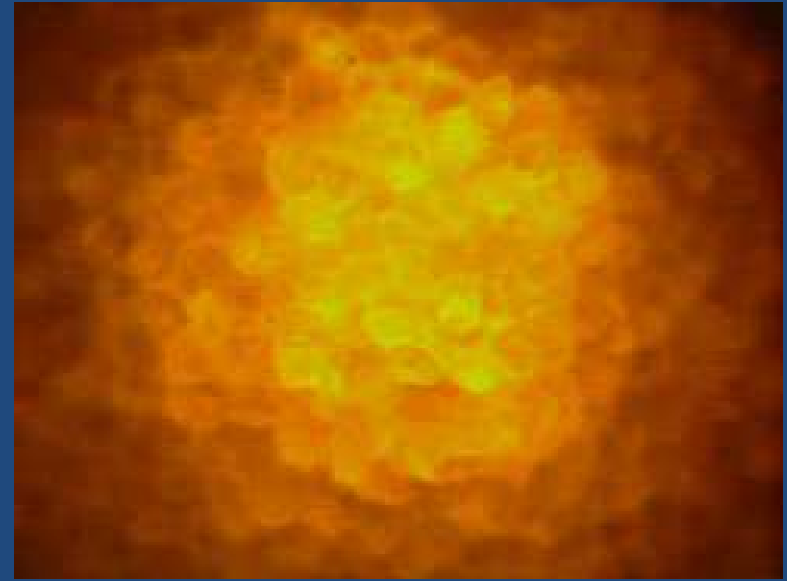
Stop Log...



Other Uses



Diesel Fuel



Rhodamine Dye

OIP Summary

- Primary use is to map fluorescence of LNAPL with depth.
- The OIP System is capable of capturing both UV and Visible light images of soil.
- Saved fluorescence images can show spatial distribution of hydrocarbons in the soil matrix and serve as a QC check of the log.
- Visible images of the soil may be examined to identify changes in texture and color.
- Visible light logs could be created.

