NON-AQUEOUS PHASE LIQUID (NAPL) DELINEATION REPORT
FORMER UNION 76
329 EAST FIRST AVENUE SOUTH
CAMBRIDGE, MINNESOTA
MPCA SITE ID: LEAK8001

Prepared for:

MILLE LACS OIL COMPANY
102 MAIN STREET
CAMBRIDGE, MN 55008

November 2011

Prepared by:

Liesch Companies

Minneapolis • Chicago • Los Angeles • Madison • Milwaukee • Phoenix

NON-AQUEOUS PHASE LIQUID (NAPL) DELINEATION REPORT FORMER UNION 76 329 EAST FIRST AVENUE SOUTH CAMBRIDGE, MINNESOTA MPCA SITE ID: LEAK8001

Prepared for:

MILLE LACS OIL COMPANY
102 MAIN STREET
CAMBRIDGE, MN 55008

Prepared by:

LIESCH ASSOCIATES, INC.
13400 15TH AVENUE NORTH
PLYMOUTH, MINNESOTA 55441
(763) 489-3100

NOVEMBER 16, 2011
PROJECT NUMBER: 65677.00

This report was prepared by me
or under my direct supervision.

Aaron Benker
Project Manager

Dan Larson, PG
Hydrogeologist

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

Liesch Associates, Inc. (Liesch) was retained by Mille Lacs Oil Company to conduct a non-aqueous phase liquid (NAPL) delineation for the former Union 76 site located at 102 Main Street, Kanabec County, Cambridge, Minnesota (the Property). **Figure 1** located in **Appendix A** illustrates the location of the Property. **Figure 2 (Appendix A)** is the site plan of the property with laser-induced fluorescence (LIF) locations. The Property consists of a former service station building, a former tank basin and pump island, and a former bulk site. This investigation was performed to attempt to identify horizontal and vertical extent of petroleum non-aqueous phase liquid (NAPL). Note that this NAPL Delineation report is being submitted concurrently with the 2011 Annual Report form.

2.0 SCOPE OF INVESTIGATION

The extent of petroleum NAPL was determined by advancing a probe equipped to measure laser-induced fluorescence (LIF) and electrical conductivity (EC).

2.1 LASER-INDUCED FLUORESCENCE (LIF)

The delineation investigation was accomplished using an Ultra-Violet Optical Screening Tool (UVOST), which is a laser-induced fluorescence (LIF) screening tool designed to detect NAPL (free product) in the subsurface.

The UVOST system sends light (via 308 nm laser) through a fiber optic cable strung within probe rods. The light, reflected by a parabolic mirror, then exits through a sapphire window in the side of the probe. As the probe is advanced, the soil is exposed to the UV laser light. If PAHs are present, longer wavelength light is emitted by the contaminants. PAHs are compounds in petroleum-oil lubricants (POLs) that fluoresce, i.e. LNAPL. This "signal" light is transmitted through a return fiber, back up hole to be analyzed. Responses are indicated in real-time on a graph of signal vs. depth. The UVOST log displays "color mixed" signal logs (contributions from 4 channels) and waveforms ("fingerprint" of multi-wavelength) to aid in identification and relative quantity of the contaminant present.

Prior to every log the UVOST system is checked for optical quality by observing the background signal for sources of signal in the fiber, filter, mirror and sapphire window. Also, the reference emitter (a standard proprietary NAPL mixture called the "RE") is placed on the window to determine the qualitative and semi-quantitative properties of the laser system. This is to assure that the RE response has the correct shape and intensity and that the UVOST system is ready to log. Typically the RE will fall between 10,000 and 12,000 picovolt-seconds (PVs, a measure of

waveform area) and the background can vary from 0.1% to 1% (area of about 0-100 pVs). It is important to remember that the relationship between the NAPL in the ground and the RE depends on that particular NAPL. The calibration of the system is not to a concentration, but to a known fluorescence signature. Additional information regarding the UVOST® system and procedures is included in **Appendix C**.

2.2 ELECTRICAL CONDUCTIVITY (EC)

Electrical Conductivity (EC) is a measure of the soils ability to conduct an electrical current between two dipoles on the LIF/EC probe. Conductivity is the reciprocal of the electrical resistivity and has the units (in our application) of millisiemens per meter (mS/m). Since soil is in the pathway of the charge flow, the grain size can be determined by comparing the EC log to a soil boring. Conductivity readings in the 100s indicate smaller grain (size such as clay). Larger grain size (sand and gravels) are typically in the 10s of mS/m range. Prior to every log the EC point of the UVOST probe is checked for the proper operation by performing a voltage test with a voltage meter and a conductivity test with a test block. Additional information regarding the UVOST® system and procedures is included in **Appendix C**.

2.3 LIF PROBE INVESTIGATION

Liesch retained Matrix Technologies, Inc. (Matrix) to assist with the delineation investigation using a UVOST LIF screening tool pushed by a truck-mounted 6610DT Geoprobe® rig. Forty-one (41) probes designated as L-1 through L-41 were completed on the Property on March 21 through March 25, 2011. The probe locations are shown on **Figure 2** in **Appendix A**.

Prior to the probe investigation, a sample of free product was collected from MW-7 and analyzed with the UVOST system. This analysis produced a waveform typical of gasoline NAPL. Probe L-1 was completed near the worst case or known area of free product, monitoring well MW-3. The waveform at 18.3 feet was very similar to the waveform from the free product sample in M-7, further confirming the efficacy of the UVOST analysis.

LIF probes were generally completed on the Property radially from probe L-1. Probes were then completed in two lines, north-south in South Buchanan Street. Utilities played a role in the location of probes in South Buchanan Street. Finally, probes were completed downgradient on the American Legion property. The UVOST logs for each probe, at two different scales (40% and 160%), are included in **Appendix B**.

3.0 DISCUSSION OF FINDINGS

The results of this investigation indicate that gasoline NAPL was identified with maximum fluorescence signal above 2.0% at all of the locations examined with the exception of probes L-11, L-18, L-36, and L-39, which ranged from 1.1% to 1.9%. Liesch considers the background signal to be at approximately 2%, i.e. signals detected below 2% are considered non-detect. The highest signals were found in L-1 (156.4%) and L-2 (146.9%). All other signals were below 100%. Based on the probe coverage and analysis, the plume is adequately delineated. The source area has been defined and downgradient NAPL is minimal with response signals ranging from 1.1% (L-36) to 23.8% (L-35). Completing a probe downgradient from L-35 was not possible due to utilities in the alley. A boring would have to be placed on the west side of the American Legion building to be downgradient from L-35. The highest perimeter signals exist at the upgradient side of the plume with signal readings of 30.4% (L-8) and 43.7 (L-19). Liesch does not anticipate a significant presence of NAPL beyond the boundaries of the probe locations in any direction.

Vertical delineation was also achieved during the investigation. All of the probes were advanced to depth intervals with no NAPL. All of the probes were completed to approximately 32 to 33 feet below grade. Three deeper probes were completed: L-1 (57.03'), L-29 (36.24') and L-32 (38'). The deepest NAPL encountered was in the source area (L-1) at a depth of approximately 36 to 37.5 feet. All of the other probes identified the deepest NAPL at or just below the water table (20-25').

One of the LIF investigation findings of note is that the NAPL occurs at the water table (18-20') across the site and west of the site; however NAPL shallower than 18 feet only occurs in and around the source area. There is no shallow NAPL west of the east curb line separating South Buchanan Street and the Union 76 Property. The exceptions to this are low signals at or very near the surface in L-11, L-24, L-27, and L-37; these shallow signals are not considered to be indicative of the gasoline NAPL signals found near the source area or at the water table across the site. This observation is important since utilities are not buried deeper than 12 feet beneath Buchanan Street; this significantly reduces the risk these utilities pose as a receptor. Further, the EC plots do not indicate heterogeneous soil conditions in the presence of shallow NAPL which could lead to preferential migration of NAPL. As noted during previous soil boring and monitoring well installations, the site consists of coarser-grained sand and gravel. The following probes exhibited potential finer-grained sediment (silt/clay) based on the EC plot: L-1 (40' and 43-45'), L-11 (9-11' and 17-18'), L-12 (11.5' and 29'), L-22 (17-18.5'), L-31 (19'), L-34 (19'), L-39 (19.5'), L-41 (3').

Figure 3 in **Appendix A** identifies the maximum signal at each probe location and the depth of that signal. **Figure 4** in **Appendix A.** is a Isocontour map of the maximum signals. The

maximum signal results for probes L-10, L-11, L-18, L-24, L-27, and L-37 were modified from the maximum signal, which occurred in the upper two feet, to the maximum signal at the water table. As previously mentioned, these shallow signals are not considered to be indicative of the gasoline NAPL signals found near the source area or at the water table across the site. The map view locations of two cross-sectional views (North-South and West-East) are depicted on **Figure 5** in **Appendix A.** The Cross-sectional views for North-South and West-East are included in the Matrix Direct Sensing Report included as **Appendix B.**

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS AND SUMMARY OF RESULTS

The results of the LIF investigation has predominantly defined the horizontal and vertical extent of petroleum NAPL at the site. The most significant concentrations of NAPL were found in shallow soil near the suspected source area around MW-3.

NAPL was found continuously in probes L-1 through L-4 from near surface to just below the water table (approximately 23 feet). Outside of the source area, NAPL has spread along the water table (18-20') and is following the hydraulic gradient, west-northwest.

There is no shallow gasoline NAPL west of the east curb line separating South Buchanan Street and the Union 76 Property. This observation is important since utilities are not buried deeper than 12 feet beneath Buchanan Street; this significantly reduces the risk these utilities pose as a receptor. Further, the EC plots do not indicate heterogeneous soil conditions in the presence of shallow NAPL which could lead to preferential migration of NAPL.

NAPL present at the site exists in the vadose zone in and around the source area, mobilized during precipitation events (the source area is primarily grass covered with some bituminous). NAPL is also present near the water table over a larger area beneath the site and downgradient from the site. Based on the minimal presence of NAPL as free phase liquid in monitoring wells MW-3 and MW-7, it does not appear that this NAPL is available for collection through product recovery methods such as total fluid recovery or free phase NAPL recovery via the existing monitoring wells or any additionally installed wells.

The upper NAPL zone largely exists at depths between 4 to 15 feet. While the majority of this NAPL may influence the underlying water table NAPL, it does not appear to be contributing at a significant rate based on groundwater monitoring results and product levels in the monitoring wells.

4.2 RECOMMENDATIONS

Liesch recommends Site Closure. Supporting documentation for closure, in addition to material presented in this report, can be found in the 2011 Annual Report, being submitted concurrently with this NAPL Delineation Report.

5.0 REFERENCES

"UVOST Log Reference Guide", Matrix Environmental, LLC

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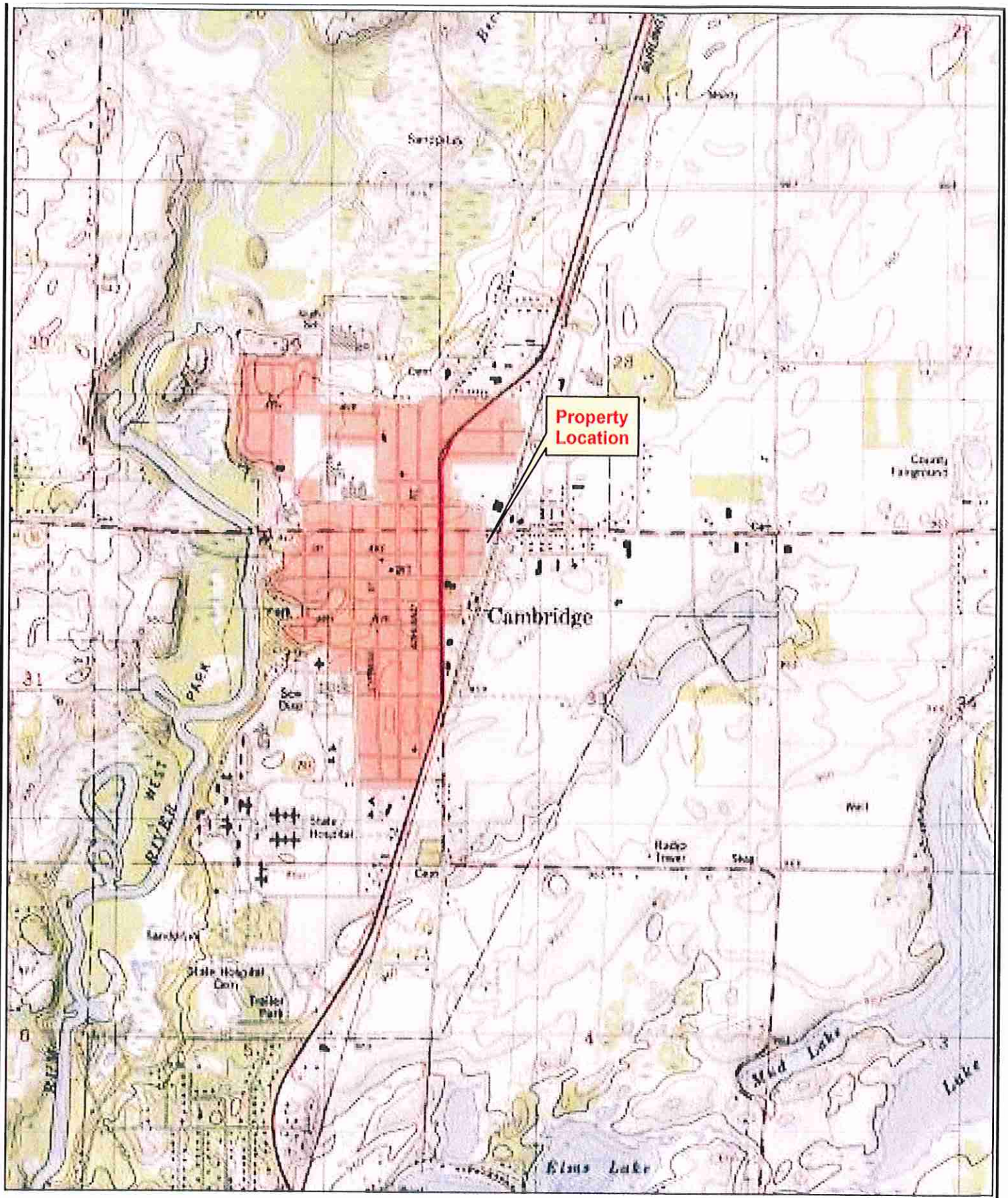
APPENDIX A



Source: MS Virtual Eath Topographic Quad
Projection: NAD83 UTM Zone 15N

0 2,000 4,000 Feet
1:24,000
1 Inch = 2,000 Feet

N

W:\ts\65677\GIS\Fig1 7-19-10.mxd W:\ts\65677\Figures\Fig1 7-19-10.pdf

LIESCH
www.liesch.com
Hydrogeologists ▪ Engineers ▪ Environmental Scientists
Minneapolis ▪ Chicago ▪ Los Angeles ▪ Madison ▪ Milwaukee ▪ Phoenix

Former Union 76 Fuel Station 329 East First Avenue, Cambridge, Minnesota	Jul 10
Property Location	Figure 1

ALLEY

SOUTH BUCHANAN STREET

UNION 76

CASEY'S

NORDBERG ELECTRIC

SHED

AMERICAN LEGION

RR ROW / PROPERTY BOUNDARY

RAILROAD TRACKS

2nd AVENUE

TH-12
TH-17
TH-22
TH-23
TH-24
TH-7
TH-9
TH-10
TH-11
TH-13
TH-14
TH-15
TH-16
MW-2/TH-6
MW-3/TH-8
MW-7

L-1
L-2
L-3
L-4
L-5
L-6
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L-38
L-39
L-40
L-41

A B C D E F G H I J K L M N

1 2 3 4 5 6 7 8 9

0 10 20 40

LEGEND

TH-7 SOIL BORING

MW-7 MONITORING WELL

L-8 LIF/EC PROBE

LIESCH HYDROLOGISTS • ENGINEERS • ENVIRONMENTAL SCIENTISTS

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FORMER UNION 76 FUEL STATION
CAMBIRDGE, MN

NOV 11

BORING LOCATIONS MAP

FIGURE 2

MK 11-17-2011 1=1 w:\ba\65677\cadd\figure probe results nov11

ALLEY

CASEY'S

NORDBERG ELECTRIC

SHED

AMERICAN LEGION

SOUTH BUCHANAN STREET

UNION 76

RR ROW / PROPERTY BOUNDARY

RAILROAD TRACKS

2nd AVENUE

TH-12
TH-17
TH-15
TH-13
TH-16
TH-14
TH-22
TH-7
TH-23
TH-24
TH-10
TH-11
MW-2/TH-6
MW-3/TH-8
MW-7
TH-9

L-11 2%(0.1')
L-24 6%(0.1')
L-12 6%(19.3')
L-8 30%(8')
L-7 21%(8.6')
L-19 44%(7.9')
L-23 7%(19.5')
L-13 18%(19.8')
L-6 63%(6.4')
L-39 2%(18.6')
L-40 12%(20.4')
L-22 16%(19.5')
L-14 31%(19.7')
L-36 1%(20.4')
L-37 2%(0.1')
L-38 12%(22.1')
L-1 156%(5.4')
L-2 147%(6.2')
L-3 71%(6.4')
L-4 9%(5.6')
L-5 2%(25.4')
L-21 24%(18')
L-20 16%(19.4')
L-15 16%(18.6')
L-28 7%(19.9')
L-35 24%(22')
L-9 54%(5.5')
L-18 2%(2')
L-25 14%(19')
L-16 25%(20')
L-34 6%(20.8')
L-30 43%(21')
L-29 15%(20.4')
L-10 6%(1.0')
L-26 4%(20.3')
L-17 2%(21')
L-32 18%(19.8')
L-31 20%(19.7')
L-33 14%(20.4')
L-41 11%(18.8')
L-27 5%(0.1')

A B C D E F G H I J K L M N

1 2 3 4 5 6 7 8 9

0 10 20 40

LEGEND

TH-7 SOIL BORING

MW-7 MONITORING WELL

L-8 LIF/EC PROBE

14%(20.4') NAPL Fluorescence%(*Depth of Reading*)

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FORMER UNION 76 FUEL STATION
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NOV 11

MAXIMUM FLUORESCENCE AT EACH PROBE LOCATION

FIGURE 3

SOUTH ADAMS STREET

ALLEY

SOUTH BUCHANAN STREET

UNION 76

RR ROW / PROPERTY BOUNDARY

RAILROAD TRACKS

CASEY'S

NORDBERG ELECTRIC

SHED

AMERICAN LEGION

2nd AVENUE

TH-12
TH-17
TH-29
TH-22
TH-15
TH-13
TH-16
TH-14
MW-7
MW-2/TH-6
TH-7
TH-24
TH-23
MW-8/TH-8
TH-9
TH-10
TH-11

L-11 1%(18.6')
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L-12 6%(19.3')
L-8 30%(8')
L-7 21%(8.6')
L-23 7%(19.5')
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L-2 147%(6.2')
L-3 71%(6.4')
L-4 9%(5.6')
L-5 2%(25.4')
L-21 24%(18')
L-20 16%(19.4')
L-15 16%(18.6')
L-28 7%(19.9')
L-9 54%(5.5')
L-18 1%(19')
L-25 14%(19')
L-16 25%(20')
L-10 3%(18.50')
L-26 4%(20.3')
L-17 2%(21')
L-27 3.7%(20.3')
L-41 11%(18.8')
L-39 2%(18.6')
L-40 12%(20.4')
L-36 1%(20.4')
L-37 1%(20')
L-38 12%(22.1')
L-35 24%(22')
L-34 6%(20.8')
L-30 13%(21')
L-29 15%(20.4')
L-32 18%(19.8')
L-31 20%(19.7')
L-33 14%(20.4')

1% 10% 20% 30% 40% 60% 80% 100% 130%

A B C D E F G H I J K L M N

N

0 10 20 40

LEGEND

- TH-7 SOIL BORING
- MW-7 MONITORING WELL
- L-8 LIF/EC PROBE
- 14%(20.4') NAPL Fluorescence%(*Depth of Reading*)

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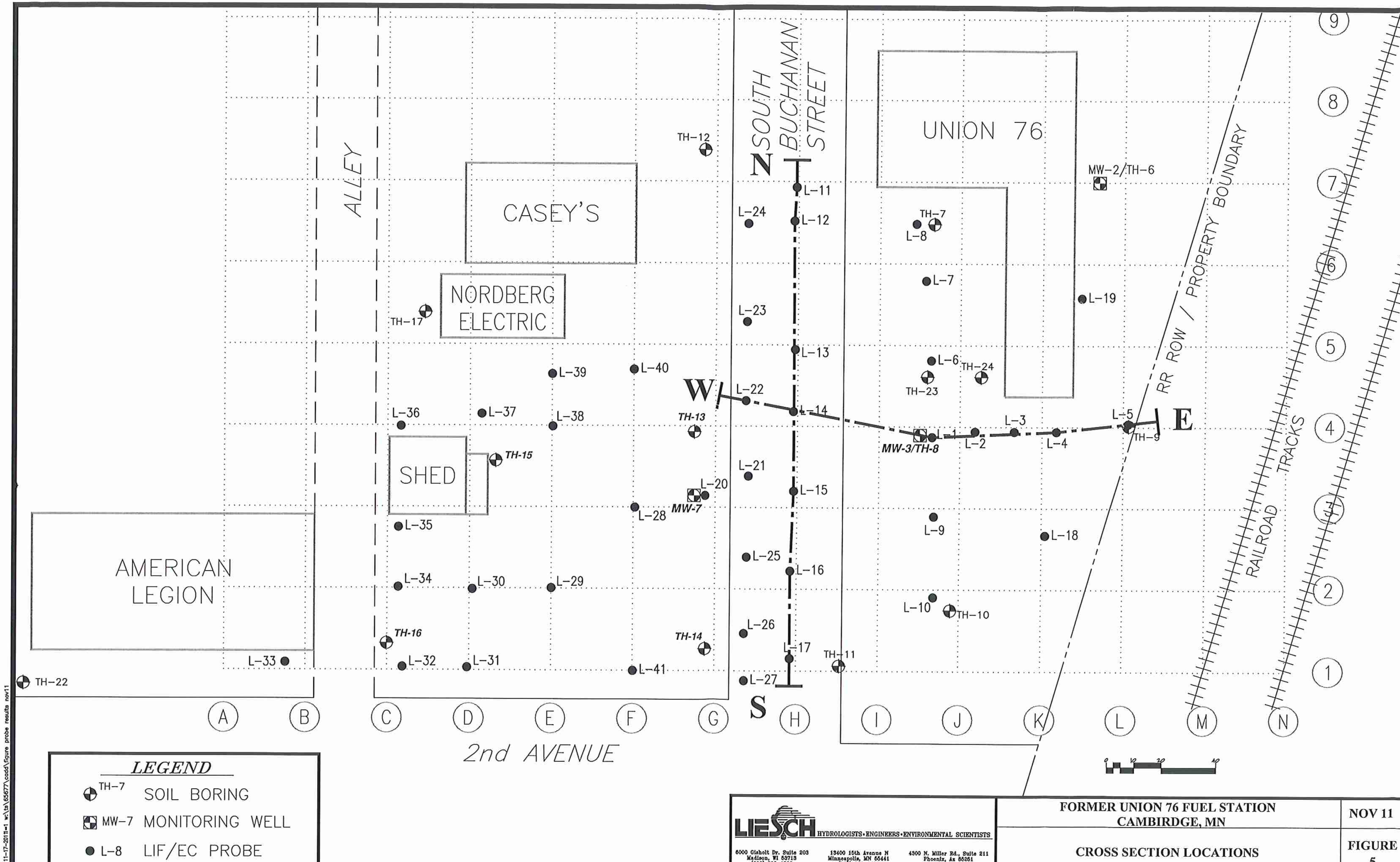
FORMER UNION 76 FUEL STATION
CAMBIRDGE, MN

NOV 11

MAXIMUM FLUORESCENCE ISOCONTOUR MAP

FIGURE 4


SOUTH BUCHANAN STREET
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AMERICAN LEGION
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FORMER UNION 76 FUEL STATION
CAMBIRDGE, MN

CROSS SECTION LOCATIONS

NOV 11

FIGURE 5

APPENDIX B

MATRIX ENVIRONMENTAL LLC

Thursday, March 31, 2011

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Maple Grove, MN 55369
763-424-4803
FAX: 763-424-9452

-Direct Sensing Report-

Client:	**Liesch**
Project Name:	**Former Union 76**
Location:	**Cambridge, MN**
Project Number:	**024-MNDS-10UV**

The analysis and opinions expressed in this report are based upon data obtained from UVOST logs generated (and samples collected for emulations if applicable) at the location specified, and from other information discussed in this report. Exceptions, if any, are discussed in the accompanying discussion if applicable. This report is prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted practices. Reported results shall not be reproduced, except in full, without written approval of the lab. The sample results relate only to the analytes of interest tested. No warranties, expressed or implied are intended or made.

I certify that the data contained in this final report has been generated and reviewed in accordance with approved methods and our Standard Operating Procedure. Release of this final report is authorized by Laboratory management, which is verified by the following signature.

Approval Signature Date 3/31/11

LIF SYSTEM DESCRIPTION & ANALYSIS

UVOST

Fluorescence is a property of some compounds where absorbed UV light stimulates the emission of photons (light) of a longer wavelength relative to the source emission. The release of the photons can be used to detect small amounts of substance (i.e. polycyclic aromatic hydrocarbons or PAHs) in a larger matrix (soil). This method of detection has been used in laboratories for decades. Now, with the availability of lasers and optical fibers, this technology can be applied down hole in the field.

The UVOST system sends light (via 308 nm laser) through a fiber optic cable strung within probe rods. The light, reflected by a parabolic mirror, then exits through a sapphire window in the side of the probe. As the probe is advanced, the soil is exposed to the UV laser light. If PAHs are present (compounds in POLs that fluoresce, i.e. LNAPL) longer wavelength light is emitted by the contaminants. This "signal" light is transmitted through a return fiber, back up hole to be analyzed. Responses are indicated in real-time on a graph of signal vs. depth. The UVOST log displays "color mixed" signal logs (contributions from 4 channels) and waveforms ("fingerprint" of multi-wavelength) to aid in identification and relative quantity of the contaminant present.

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MATRIX ENVIRONMENTAL LLC

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fax (763) 424-9452

Client: Liesch
Contact: Dan Larson
Services: UVOST Logging

Date: 03/21/11-03/25/11
Project: Former Union 76
Project #: 024-MNDS-11UV
Address: Cambridge, MN

UVOST Log Summary

Probe ID	Date/Time	Final Depth	Max Signal	Max. Signal Depth	Initial RE Area	Background Area	<---------(zone1, zone2 etc.)---------> Depth to Top of NAPL	Depth to bottom of NAPL	NAPL Zone Thickness	Comments: fluourecence @ indicated depths
MW-7	3/21/2011 9:58	3.2	90	1.2	11370	55	NA	NA	NA	Emulation log
L-1	3/21/2011 10:11	57.0	156	5.4	11956	47	0, 35.5	21, 37.75	21, 2.25	24-35.5 ~14% spikes
L-2	3/21/2011 11:21	38.0	147	6.2	11874	24	2	22.5	20.5	
L-3	3/21/2011 13:13	33.0	71	6.4	11201	37	2	23	21	
L-4	3/21/2011 13:48	32.0	9	5.6	11076	35	4.0, 15.0	6.5, 22.0	2.5, 7.0	
L-5	3/21/2011 14:23	31.1	2	25.4	11639	42	NA	NA	NA	25.0-26.0 2%, orange
L-6	3/21/2011 15:02	32.0	63	6.4	11102	32	1	21	21	
L-7	3/21/2011 15:31	32.0	21	8.6	11168	53	7.5, 17.5	15, 22	7.5, 4.5	
L-8	3/21/2011 16:04	32.0	30	7.9	11382	32	6	21	15	13-17.5 ~1%
L-9	3/21/2011 16:34	31.0	54	5.5	11085	35	1	20.5	19.5	
L-10	3/21/2011 17:01	30.0	6	1.0	11440	34	18.5	20	1.5	~3%, 6% spike
L-11	3/22/2011 9:26	30.0	2	0.0	11615	32	NA	NA	NA	
L-12	3/22/2011 11:12	31.0	6	19.3	11114	85	18.5	20	1.5	~3%, 6% spike
L-13	3/22/2011 11:41	31.0	18	19.8	11794	79	16	21	5	
L-14	3/22/2011 13:39	31.0	31	19.7	11243	81	17	21	4	
L-15	3/22/2011 14:13	31.0	16	18.6	11599	70	17.5	21	3.5	15-17.5 ~2%
L-16	3/22/2011 14:47	31.0	25	20.0	11800	64	16.5	20.5	4	
L-17	3/22/2011 15:16	31.0	2	20.5	11451	65	NA	NA	NA	
L-18	3/22/2011 15:44	31.0	2	2.0	11077	62	NA	NA	NA	
L-19	3/22/2011 16:11	33.1	44	7.8	11145	62	6.25, 21	15, 22.75	8.75, 2.75	
L-20	3/24/2011 8:48	33.1	16	19.4	11057	56	18.5	22	3.5	15.5-18.5 ~2%

MATRIX ENVIRONMENTAL LLC

11253 91st Ave. N.
Maple Grove, Minnesota 55369
(763) 424-4803
fax (763) 424-9452

Client: Liesch
Contact: Dan Larson
Services: UVOST Logging

Date: 03/21/11-03/25/11
Project: Former Union 76
Project #: 024-MNDS-11UV
Address: Cambridge, MN

UVOST Log Summary

Probe ID	Date/Time	Final Depth	Max Signal	Max. Signal Depth	Initial RE Area	Background Area	Depth to Top of NAPL	<---------(zone1, zone2 etc.)---------> Depth to bottom of NAPL	NAPL Zone Thickness	Comments: fluourecence @ indicated depths
L-21	3/24/2011 9:30	32.0	24	17.9	11400	66	17.25	20.5	3.25	
L-22	3/24/2011 10:08	32.1	16	19.5	10833	50	17.5	20.5	3	
L-23	3/24/2011 10:51	32.0	7	19.5	11618	58	19	20	1	16.5-19 ~2%
L-24	3/24/2011 11:30	32.0	6	0.0	11598	71	NA	NA	NA	
L-25	3/24/2011 13:04	32.0	14	19.1	11301	66	16.5	22	5.5	
L-26	3/24/2011 13:40	32.0	4	20.3	11292	68	NA	NA	NA	4% spike @ 20.34
L-27	3/24/2011 14:16	32.0	5	0.1	11984	62	18.5	21	2.5	
L-28	3/24/2011 14:56	32.0	7	19.9	11764	64	18	21.5	3.5	
L-29	3/24/2011 15:38	36.2	15	20.4	11386	64	19.5	21.5	2	
L-30	3/24/2011 16:12	32.0	43	20.9	11226	66	19.5	21.75	2.25	
L-31	3/24/2011 16:45	32.0	20	19.7	11621	66	16.5	21.5	5	
L-32	3/25/2011 8:50	38.0	18	19.8	11518	56	19.25	20.75	1.5	
L-33	3/25/2011 9:28	32.0	14	20.4	11292	56	19.75	22	2.25	
L-34	3/25/2011 10:02	32.0	6	20.7	11234	54	20	21.25	1.25	
L-35	3/25/2011 10:34	33.0	24	22.0	11440	73	20.5	23	2.5	
L-36	3/25/2011 11:13	32.0	1	20.4	11964	66	NA	NA	NA	1.1% @ 20.38
L-37	3/25/2011 12:41	32.0	2	0.0	11144	53	NA	NA	NA	
L-38	3/25/2011 14:15	33.0	12	22.2	11359	57	19	23	4	
L-39	3/25/2011 14:46	32.0	2	18.6	11775	67	NA	NA	NA	1.9% @ 18.61
L-40	3/25/2011 15:21	32.0	12	20.4	11397	48	16.5	21.5	5	
L-41	3/25/2011 15:52	32.0	11	18.8	11648	55	18.25	20.25	2	

UVOST Log Reference Guide

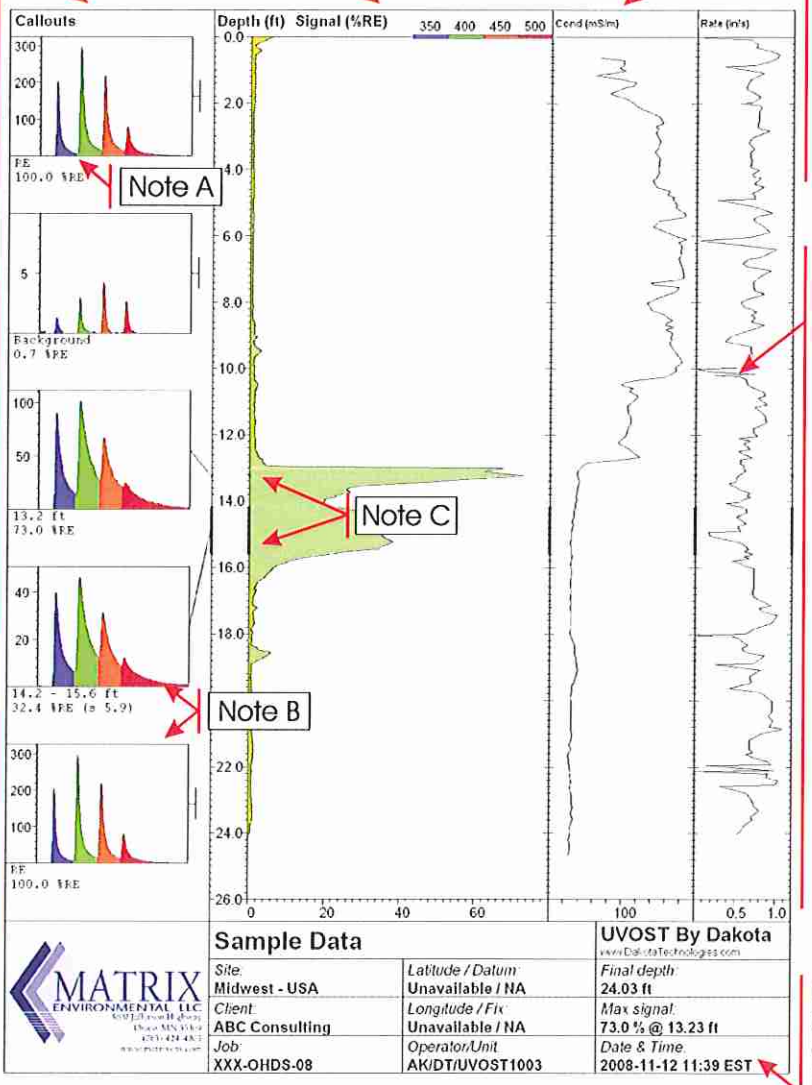
Main Plot :
Signal (total fluorescence) versus depth where signal is relative to the Reference Emitter (RE).The total area of the waveform is divided by the total area of the Reference Emitter yielding the %RE.This %RE scales with the NAPL fluorescence. The fill color is based on relative contribution of each channel's area to the total waveform area (see callout waveform).The channel-to-color relationship and corresponding wavelengths are given in the upper right corner of the main plot.

Callouts :
Waveforms from selected depths or depth ranges showing the multi-wavelength waveform for that depth.

The four peaks are due to fluorescence at four wavelengths and referred to as "channels". Each channel is assigned a color.

Various NAPLs will have a unique waveform "fingerprint" due to the relative amplitude of the four channels and/or broadening of one or more channels.

Basic waveform statistics and any operator notes are given below the callout.



Conductivity Plot :
The Electrical Conductivity (EC) of the soil can be logged simultaneously with the UVOSTdata. EC often provides insight into the stratigraphy.
Note the drop in EC from 10 - 13 ft, indicating a shift from consolidated to unconsolidated stratigraphy.This correlates with the observed NAPL distribution.

Rate Plot :
The rate of probe advancement. ~ 0.8 in (2cm) per second is preferred.

A noticeable decrease in the rate of advancement may be indicative of difficult probing conditions (gravel, angular sands, etc.).

Notice that this log was terminated arbitrarily, not due to "refusal", which would have been indicated by a sudden rate drop at final depth.

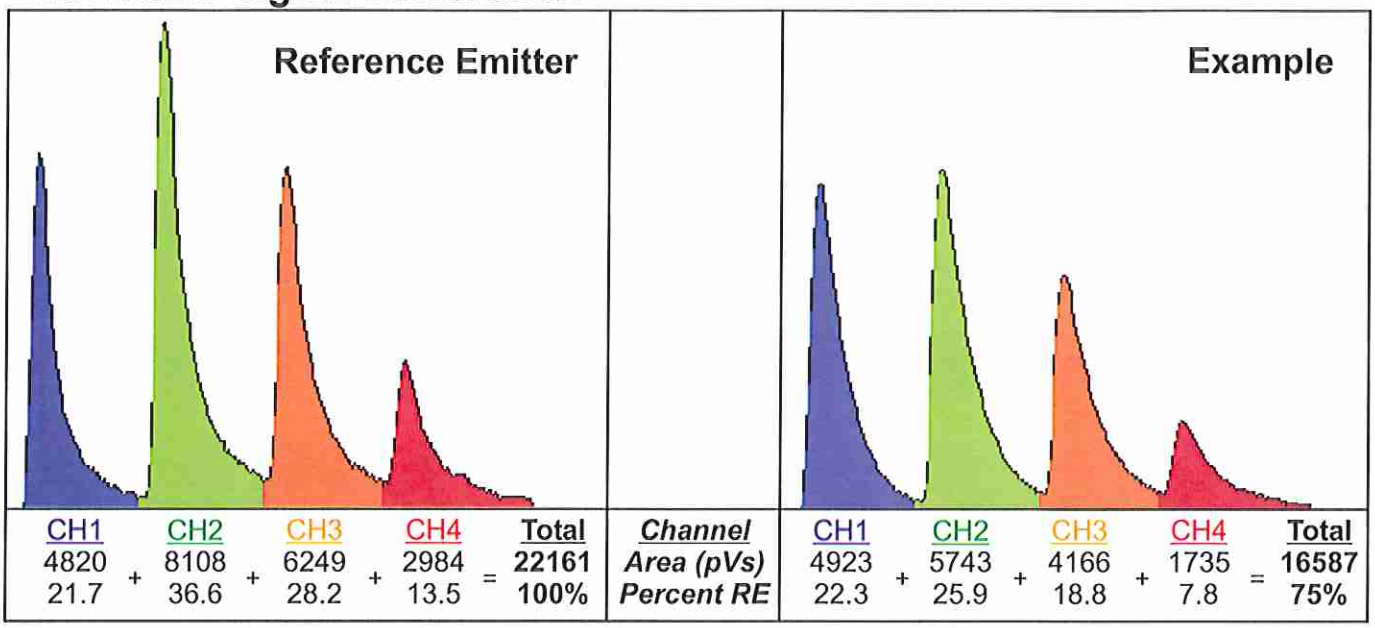
Info Box :
Contains pertinent log info including name and location.

NoteA:
Time is along the x axis. No scale is given, but it is a consistent 320ns wide.
The y axis is in mV and directly corresponds to the amount of light striking the photodetector.

Note B :
These two waveforms are clearly different.The first is weathered diesel from the log itself while the second is the Reference Emitter (a blend of NAPLs) always taken before each log for calibration.

Note C :
Callouts can be a single depth (see 3rd callout) or a range (see 4th callout).The range is noted on the depth axis by a bold line. When the callout is a range, the average and standard deviation in %RE is given below the callout.

Waveform Signal Calculation

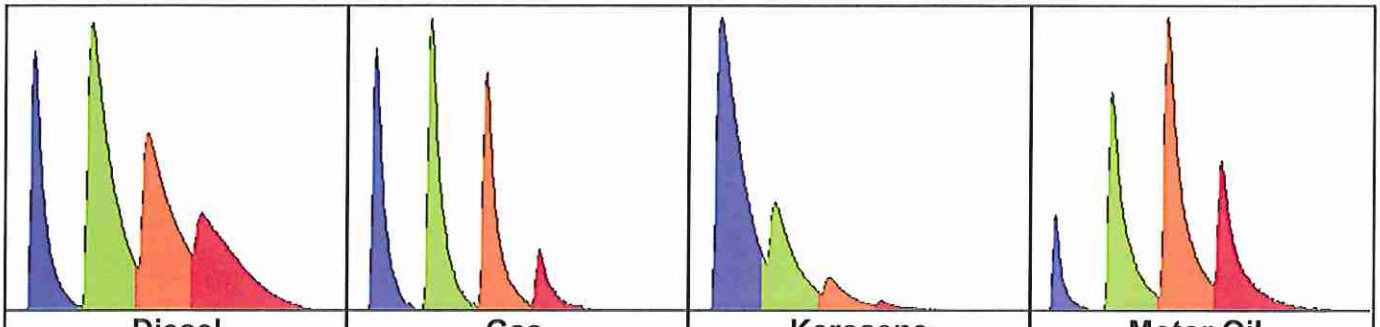


CH1		CH2		CH3		CH4		Total		CH1		CH2		CH3		CH4		Total
4820	+	8108	+	6249	+	2984	=	**22161**	***Channel***	4923	+	5743	+	4166	+	1735	=	**16587**
21.7		36.6		28.2		13.5		**100%**	***Area (pVs)***	22.3		25.9		18.8		7.8		**75%**
									Percent RE									

Data Files

***.lif.raw.bin**	Raw data file. Header is ASCII format and contains information stored when the file was initially written (e.g. date, total depth, max signal, gps, etc., and any information entered by the operator). All raw waveforms are appended to the bottom of the file in a binary format.
***.lif.plt**	Stores the plot scheme history (e.g. callout depths) for associated Raw file. Transfer along with the Raw file in order to recall previous plots.
***.lif.jpg**	A jpg image of the OST log including the main signal vs. depth plot, callouts, information, etc.
***.lif.dat.txt**	Data export of a single Raw file. ASCII tab delimited format. No string header is provided for the columns (to make importing into other programs easier). Each row is a unique depth reading. The columns are: Depth, Total Signal (%RE), Ch1%, Ch2%, Ch3%, Ch4%, Rate, Conductivity Depth, Conductivity Signal. Summing channels 1 to 4 yields the Total Signal.
***.lif.sum.txt**	A summary file for a number of Raw files. ASCII tab delimited format. The file contains a string header. The summary includes one row for each Raw file and contains information for each file including: the file name, gps coordinates, max depth, max signal, and depth at which the max signal occured.
***.lif.log.txt**	An activity log generated automatically located in the OST application directory in the 'log' subfolder. Each OST unit the computer operates will generate a separate log file per month. A log file contains much of the header information contained within each separate Raw file, including: date, total depth, max signal, etc.

Common Waveforms (highly dependent on soil, weathering, etc.)



UVOST
CROSS SECTIONS

South Buchanan Cross Section.xls

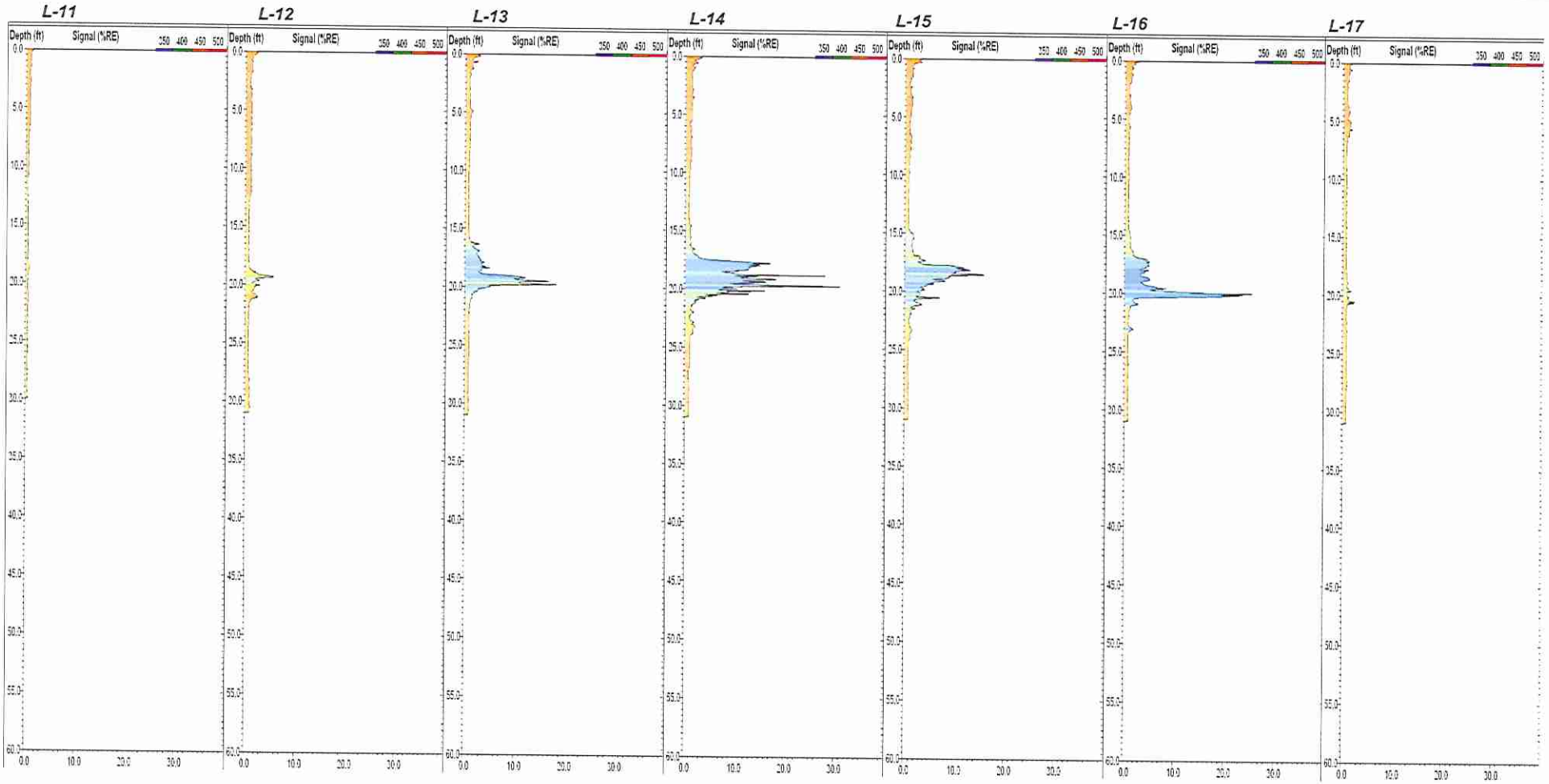
MATRIX ENVIRONMENTAL LLC

11253 91st Ave. N.
Maple Grove, MN 55369
(763) 424-4803
fax (763) 424-9452

Client:	Liesch
Contact:	Dan Larson
Services:	UVOST Logging
Date:	03/21/11-03/25/11
Project:	Former Union 76
Project #:	024-MNDS-11UV
Address:	Cambridge, MN

North

South



East to West Cross Section.xls

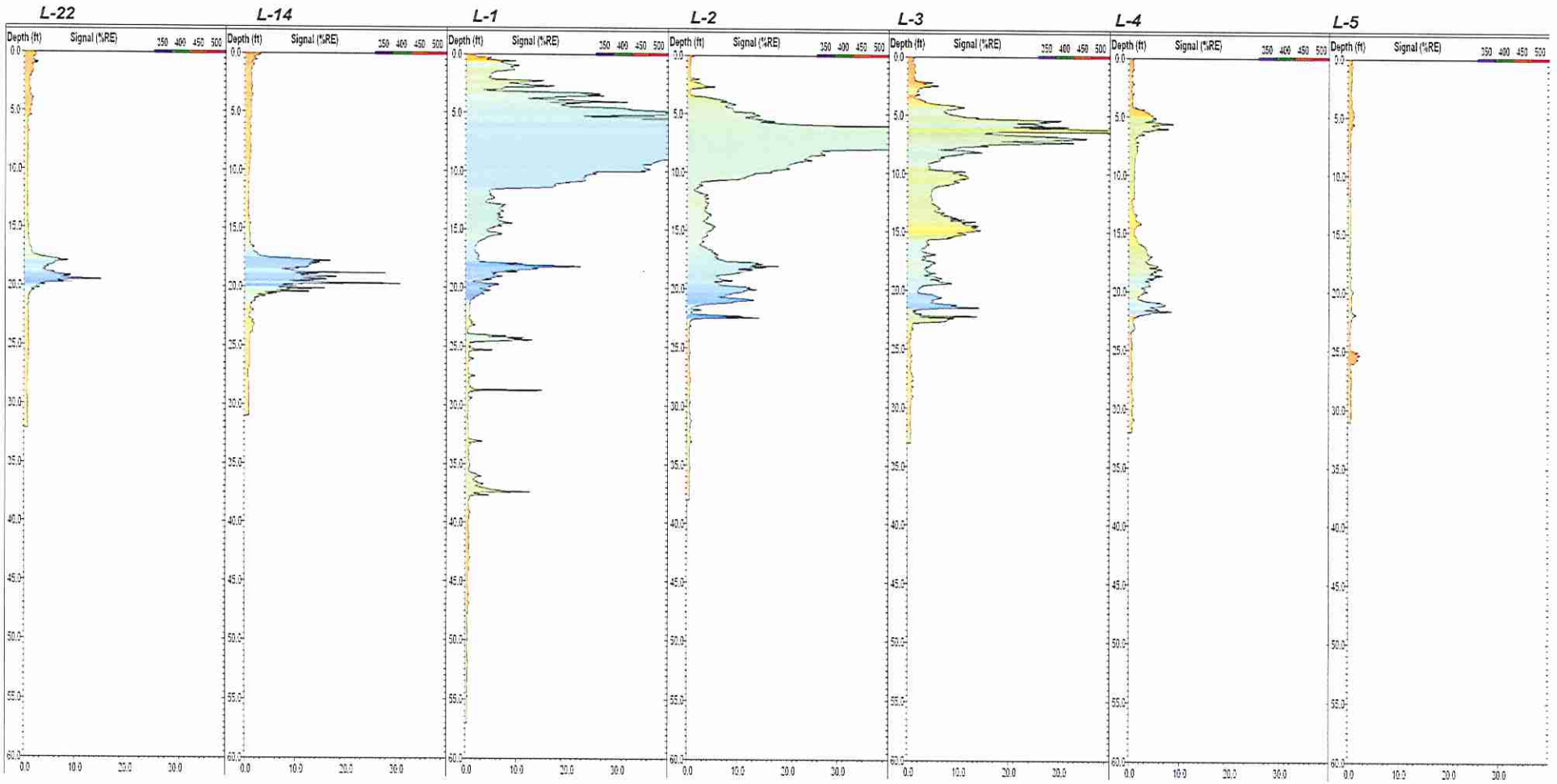
MATRIX ENVIRONMENTAL LLC

11253 91st Ave. N.
Maple Grove, MN 55369
(763) 424-4803
fax (763) 424-9452

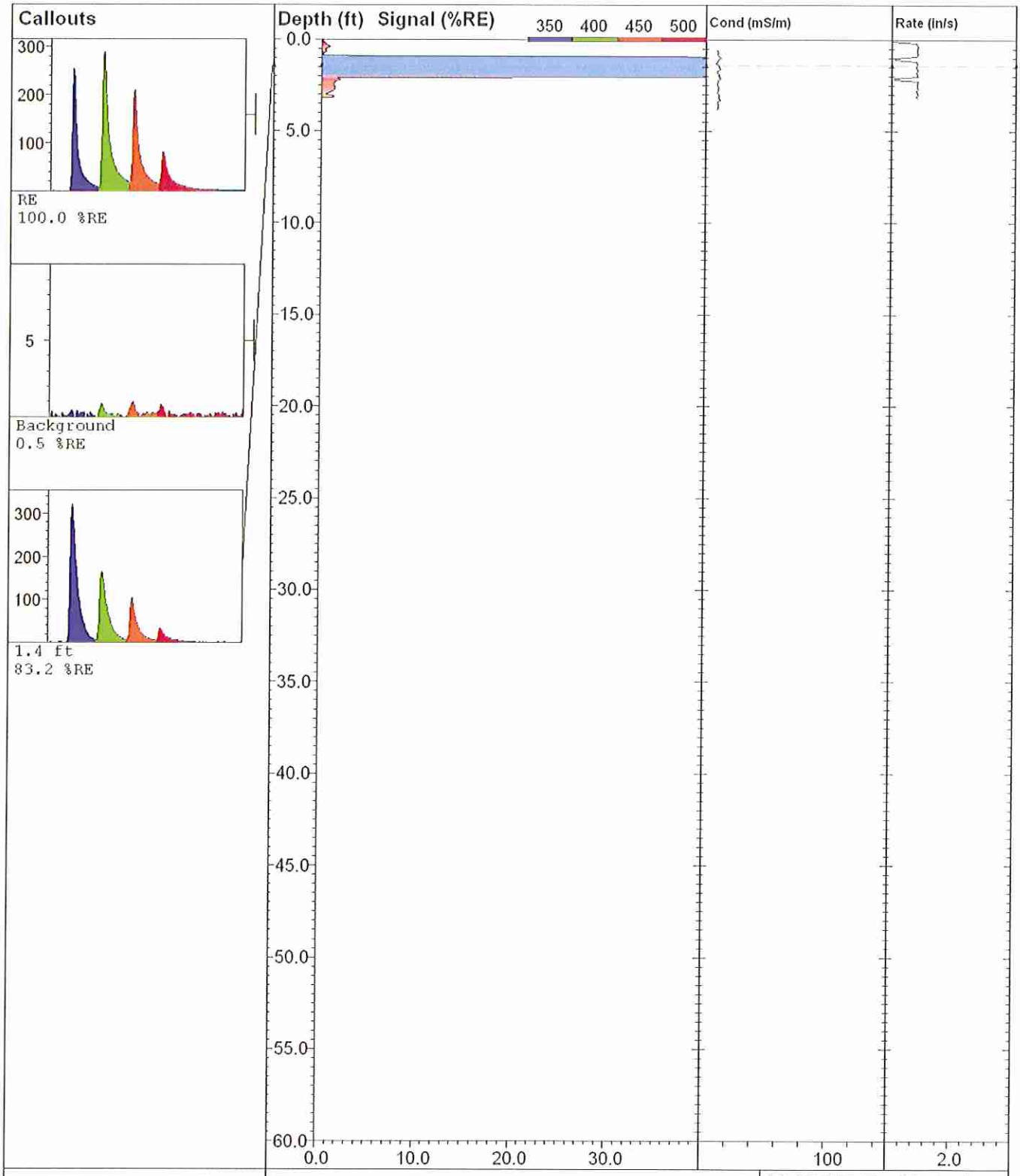
Client:	Liesch
Contact:	Dan Larson
Services:	UVOST Logging
Date:	03/21/11-03/25/11
Project:	Former Union 76
Project #:	024-MNDS-11UV
Address:	Cambridge, MN

West

East



UVOST LOGS
@ 40% RE



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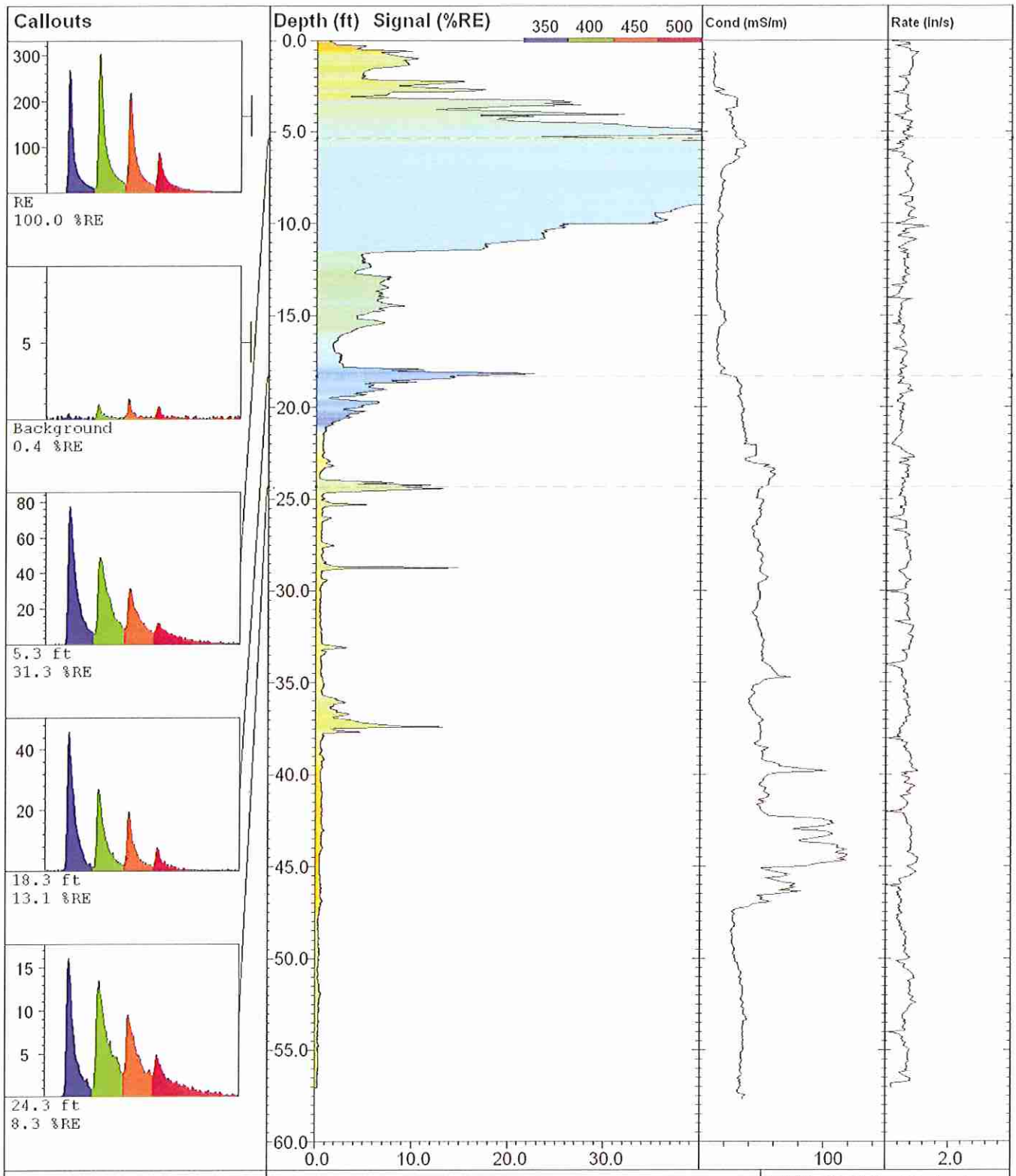
MW-7

UVOST By Dakota
www.DakotaTechnologies.com

Site: **Former Union 76**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **3.20 ft**
Client: **Liesch**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **89.8 % @ 1.20 ft**
Job: **024-MNDS-11UV**	*Operator/Unit:* **MJ/DT/UVOST1003**	*Date & Time:* **2011-03-21 09:58 CDT**



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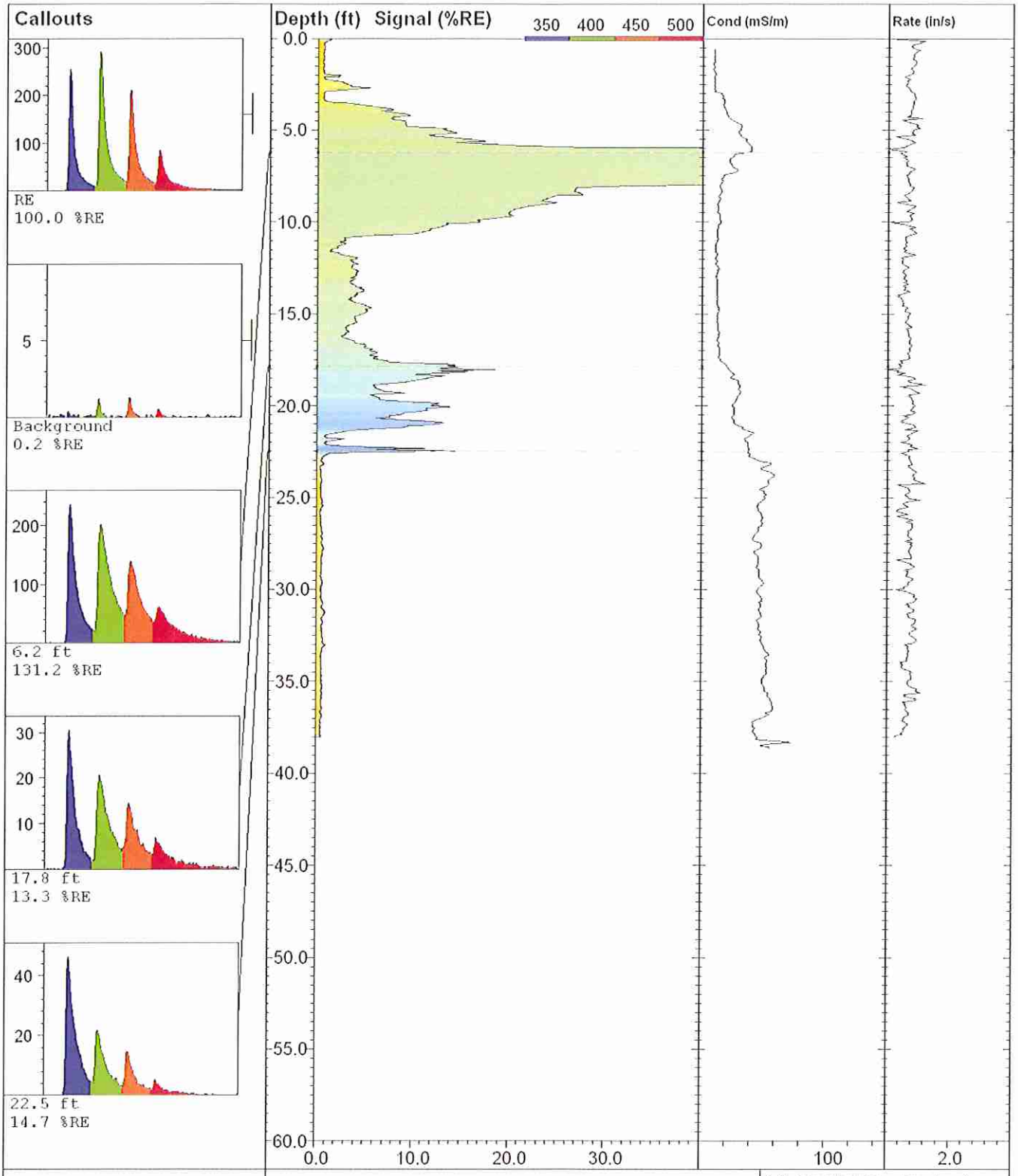
L-1

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 57.03 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 156.4 % @ 5.43 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 10:11 CDT



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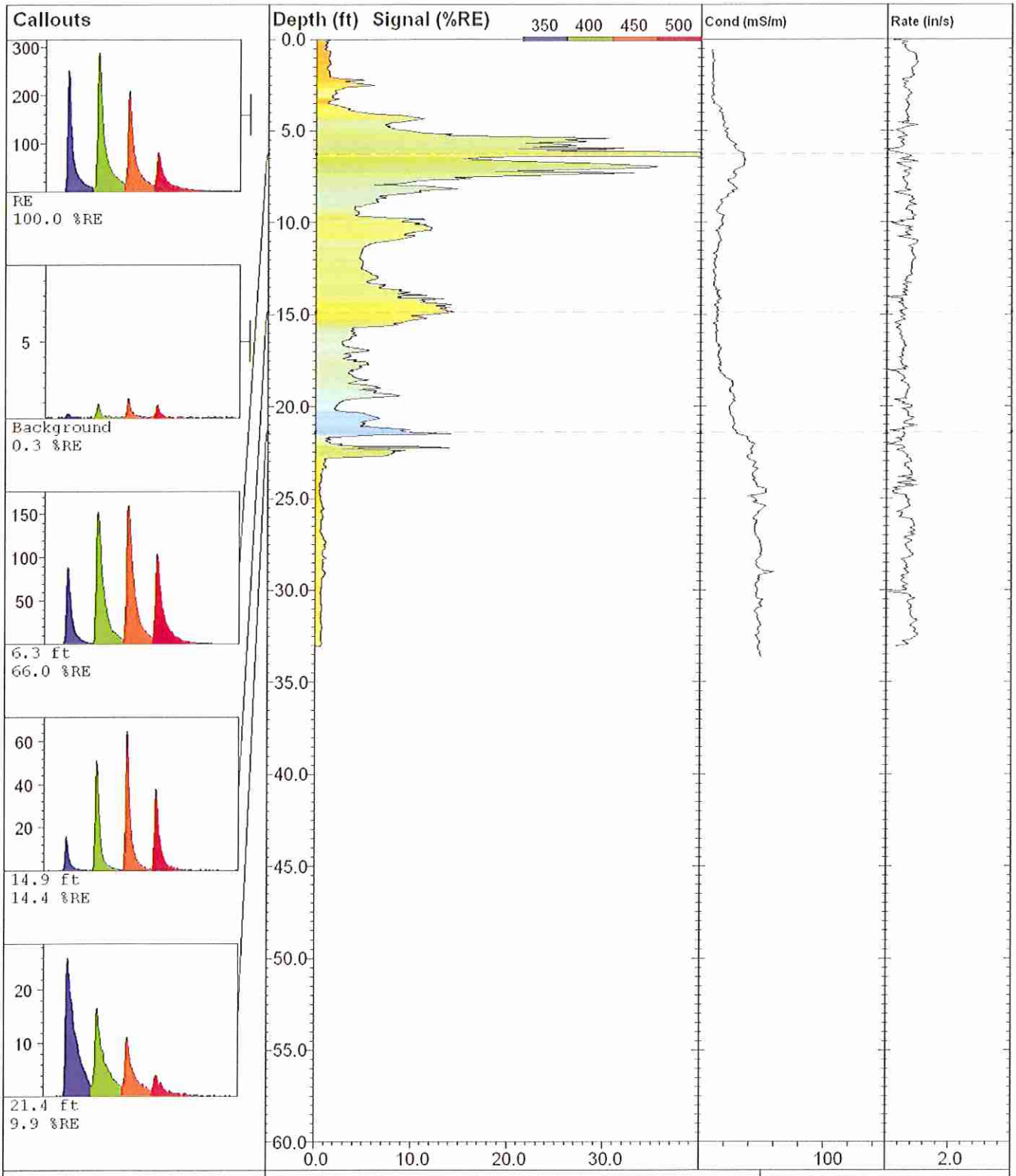
L-2

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 38.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 146.9 % @ 6.16 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 11:21 CDT



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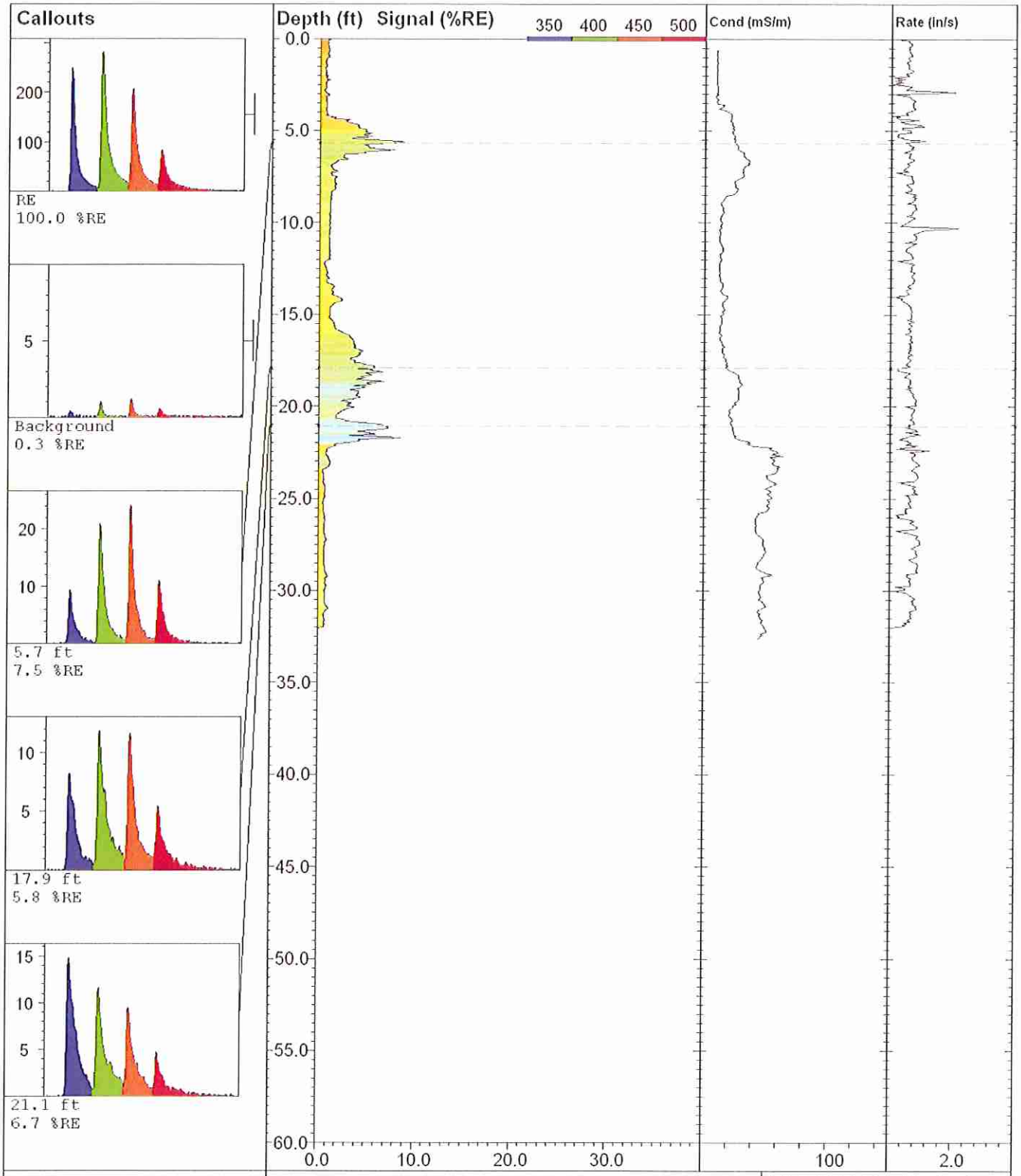
L-3

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 33.02 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 70.8 % @ 6.39 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 13:13 CDT



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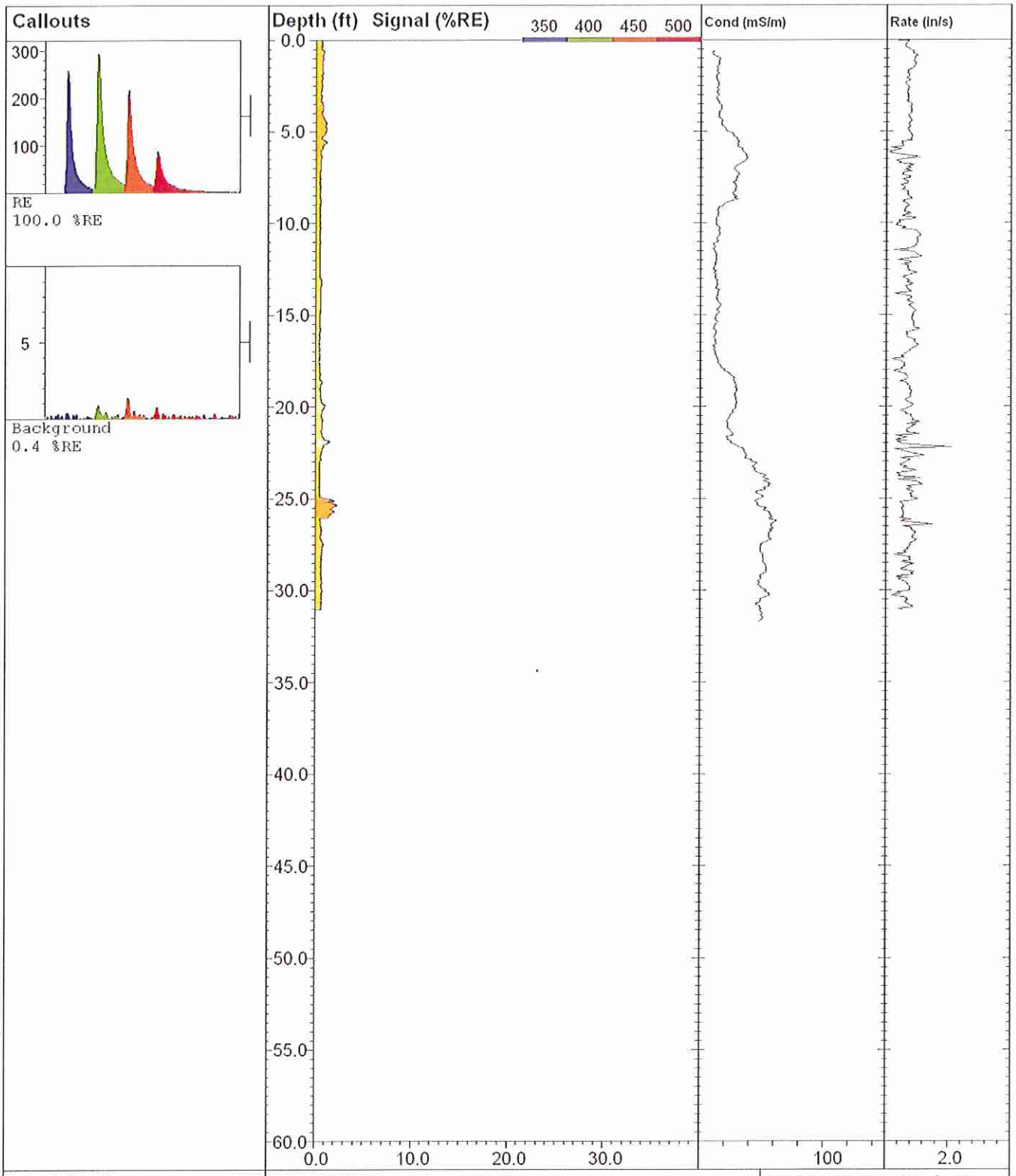
L-4

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.01 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 8.7 % @ 5.62 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 13:48 CDT



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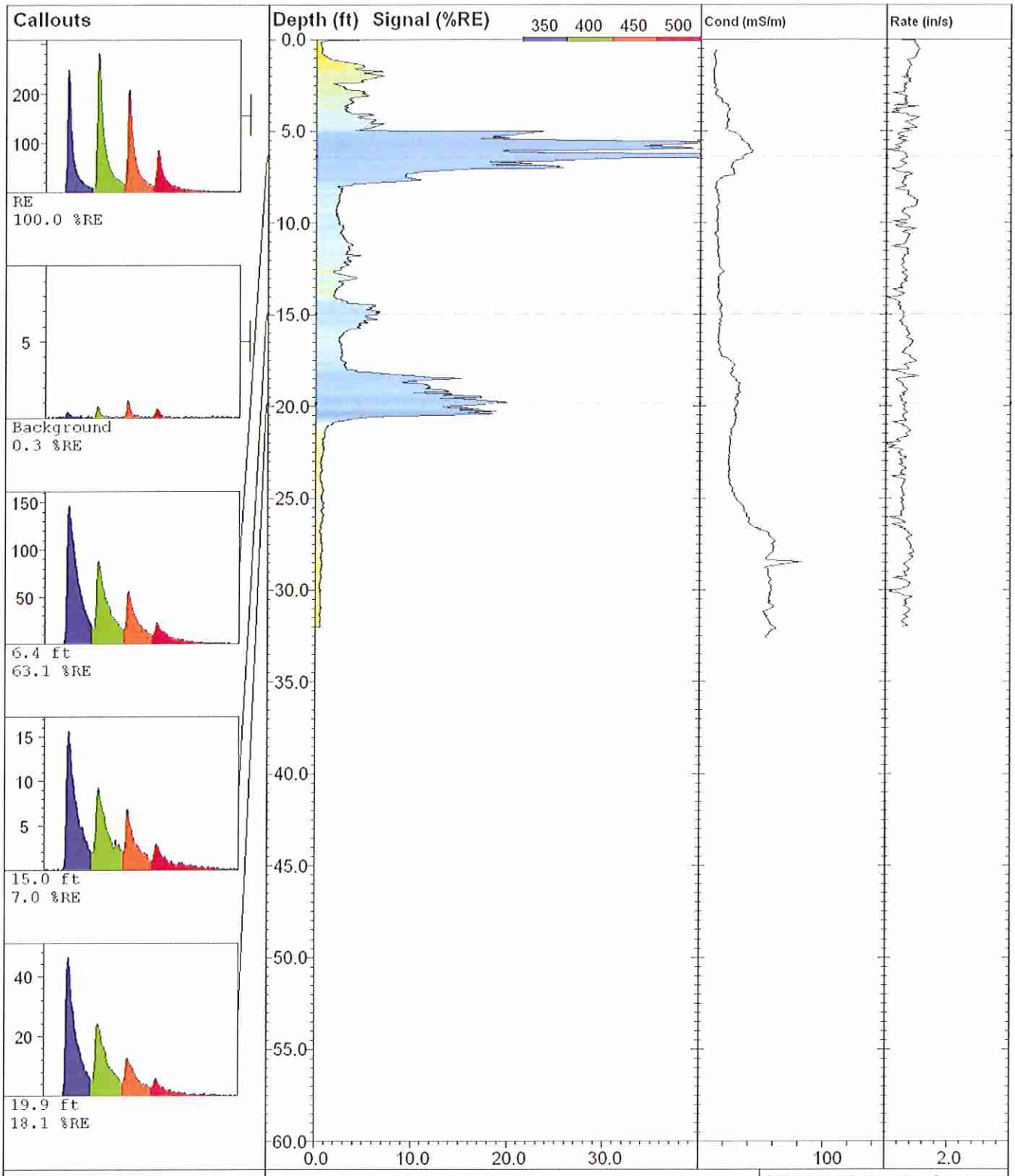
L-5

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 31.05 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 2.3 % @ 25.37 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 14:23 CDT



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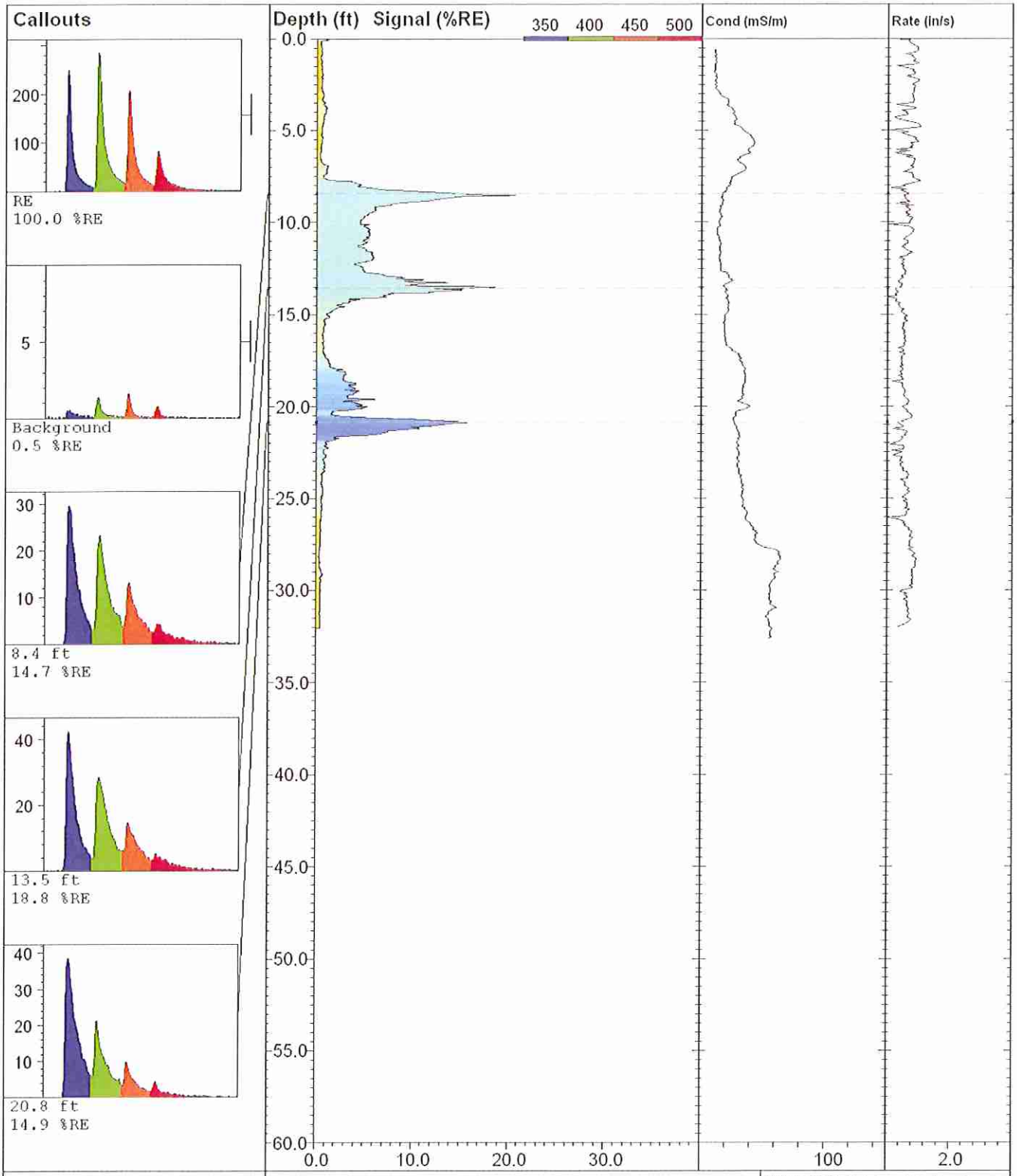
L-6

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 63.1 % @ 6.36 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 15:02 CDT



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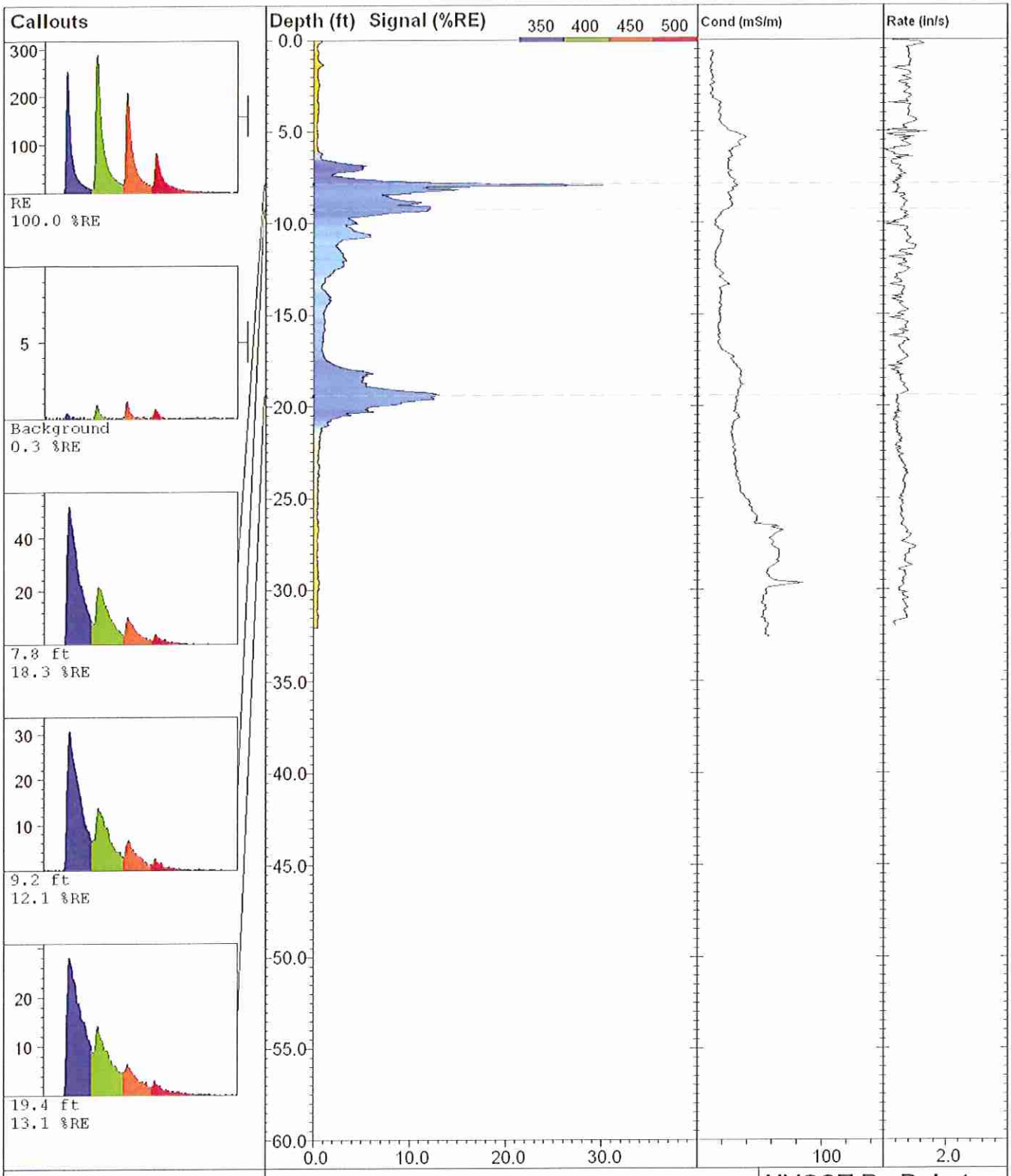
L-7

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.03 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 20.7 % @ 8.55 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 15:31 CDT



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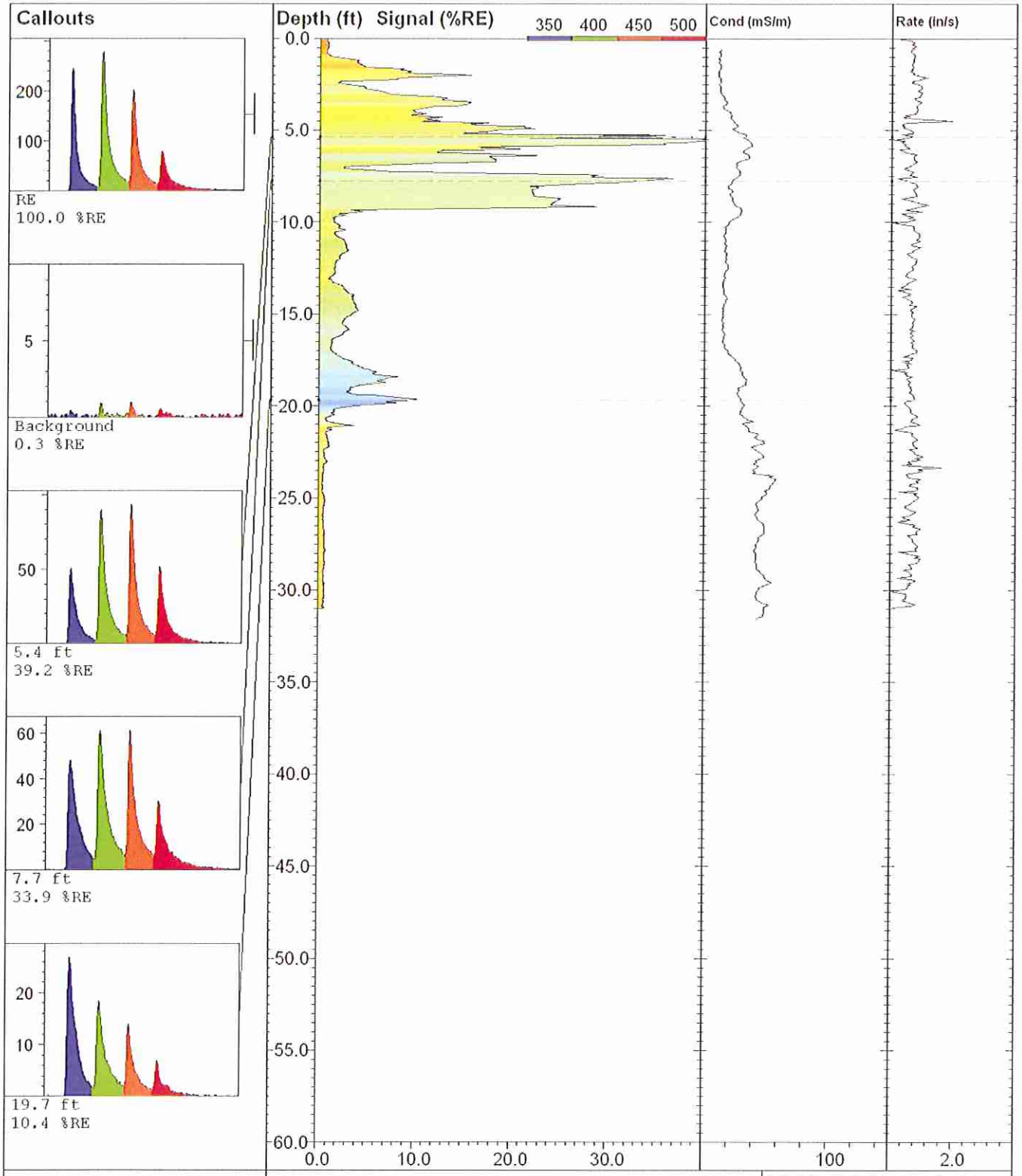
L-8

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.02 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 30.4 % @ 7.95 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 16:04 CDT



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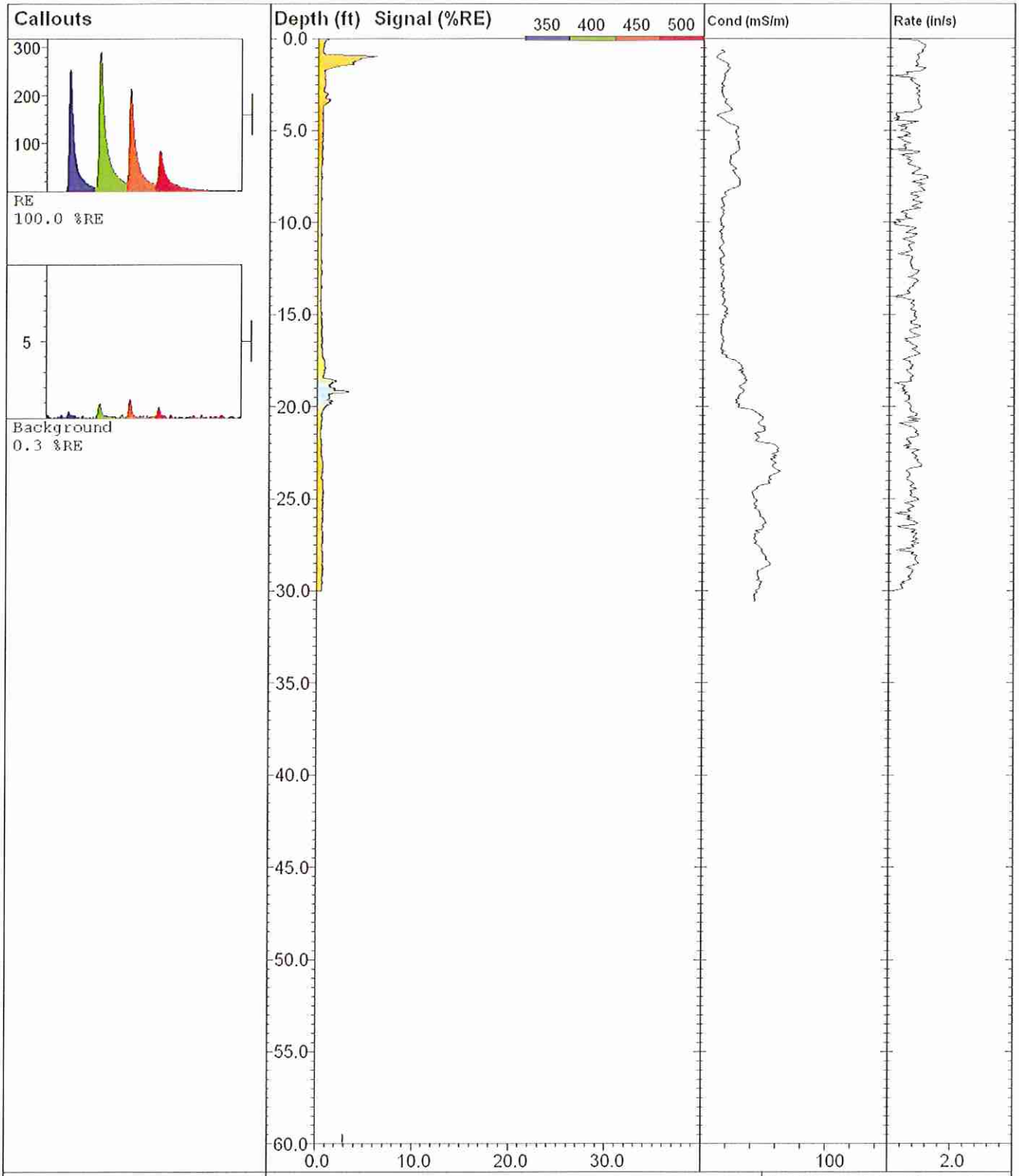
L-9

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 30.98 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 54.3 % @ 5.53 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 16:34 CDT



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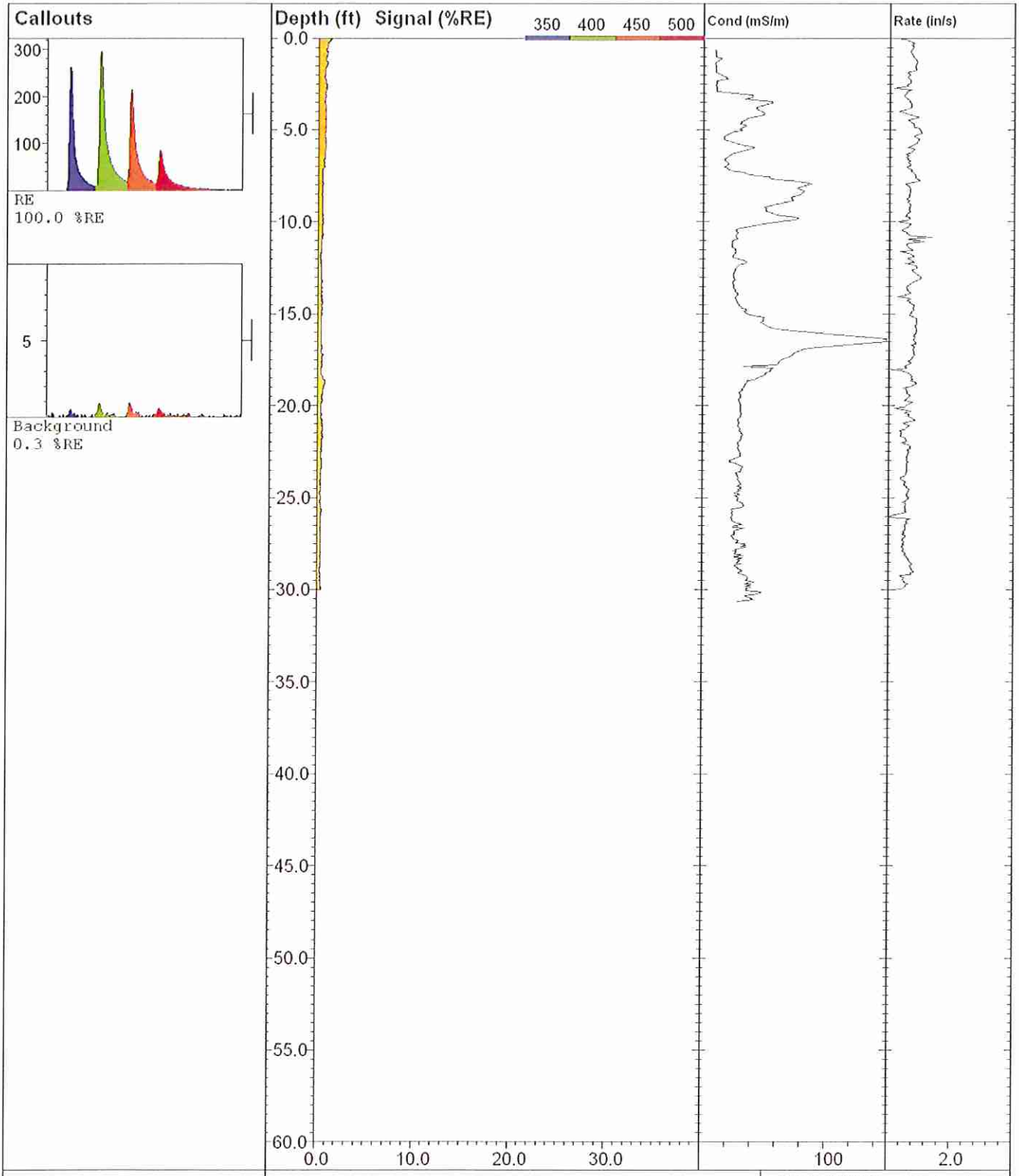
L-10

UVOST By Dakota

www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 30.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 6.2 % @ 0.97 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 17:01 CDT



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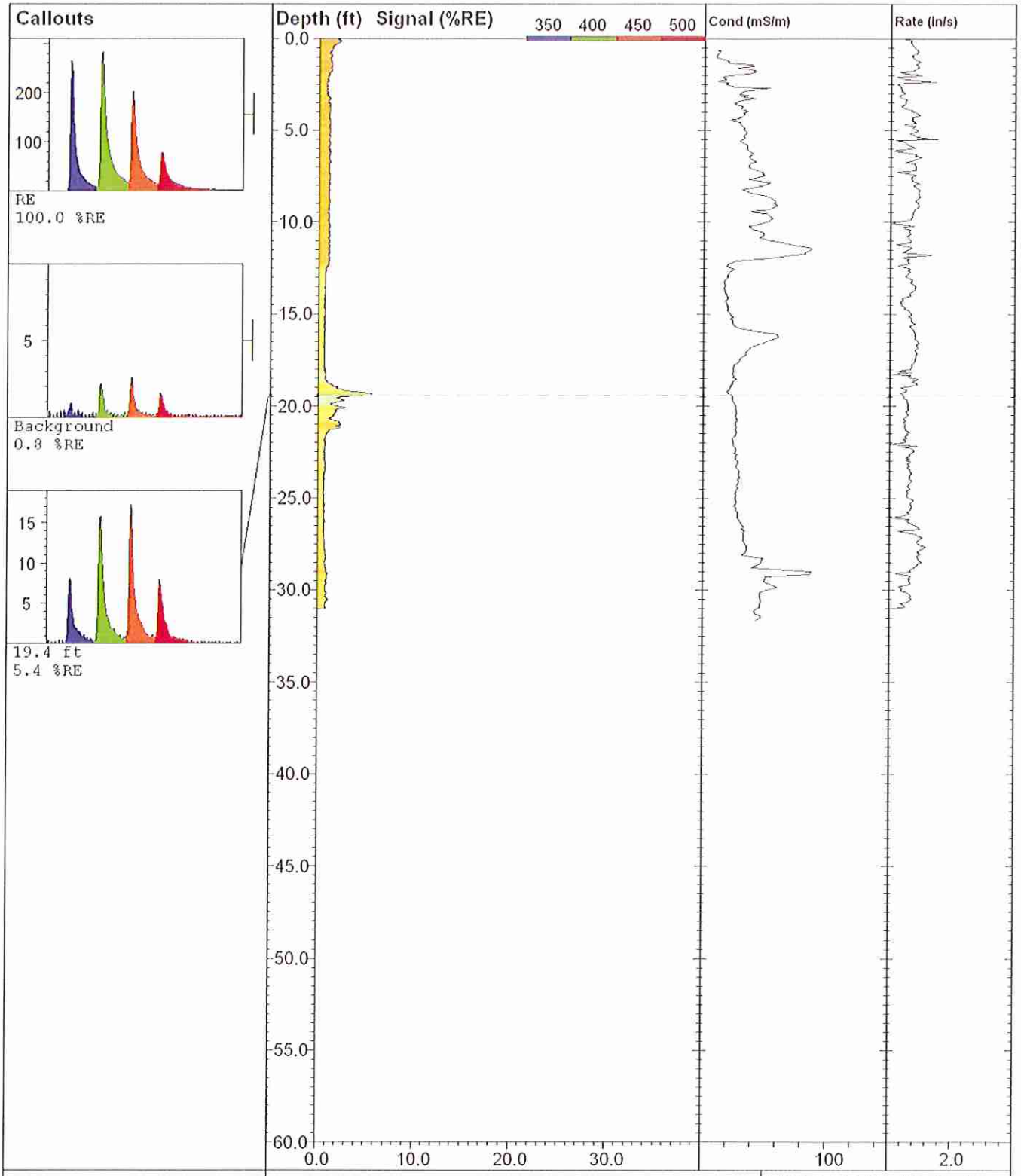
L-11

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 30.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 1.5 % @ 0.01 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 09:26 CDT



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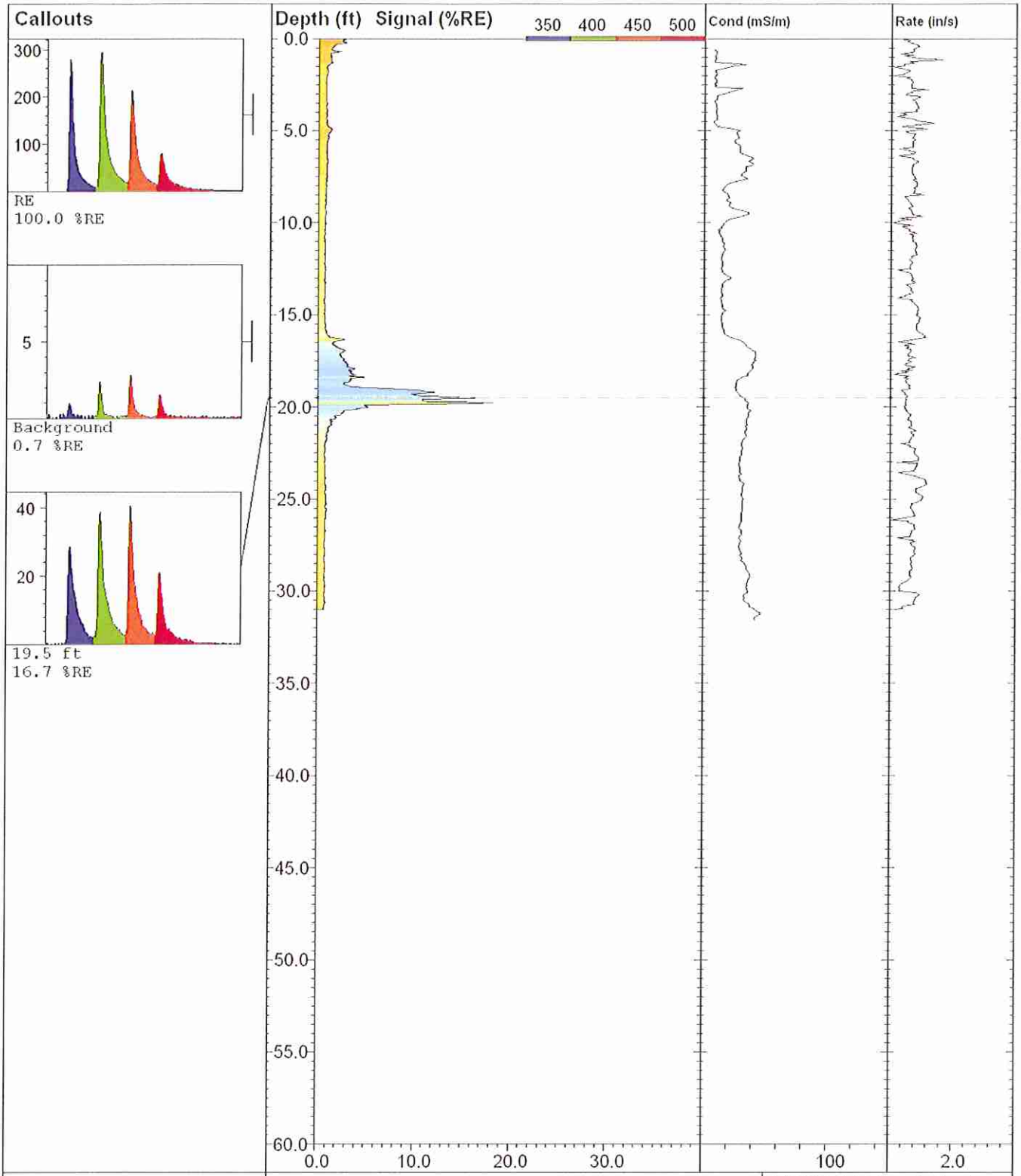
L-12

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 31.01 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 5.5 % @ 19.33 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 11:12 CDT



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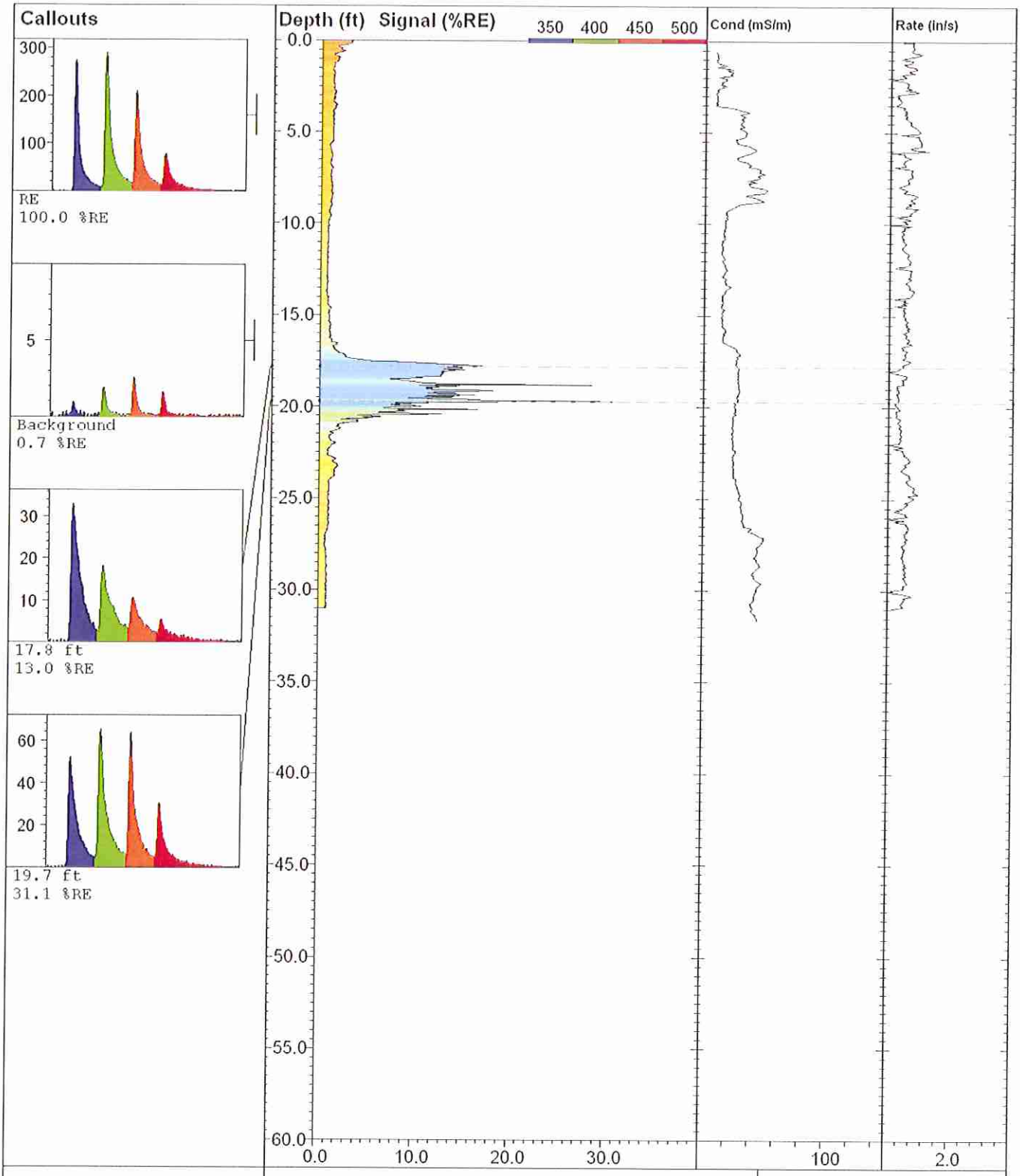
L-13

UVOST By Dakota

www.DakotaTechnologies.com

Site: **Former Union 76**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **31.01 ft**
Client: **Liesch**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **18.4 % @ 19.77 ft**
Job: **024-MNDS-11UV**	*Operator/Unit:* **MJ/DT/UVOST1003**	*Date & Time:* **2011-03-22 11:41 CDT**



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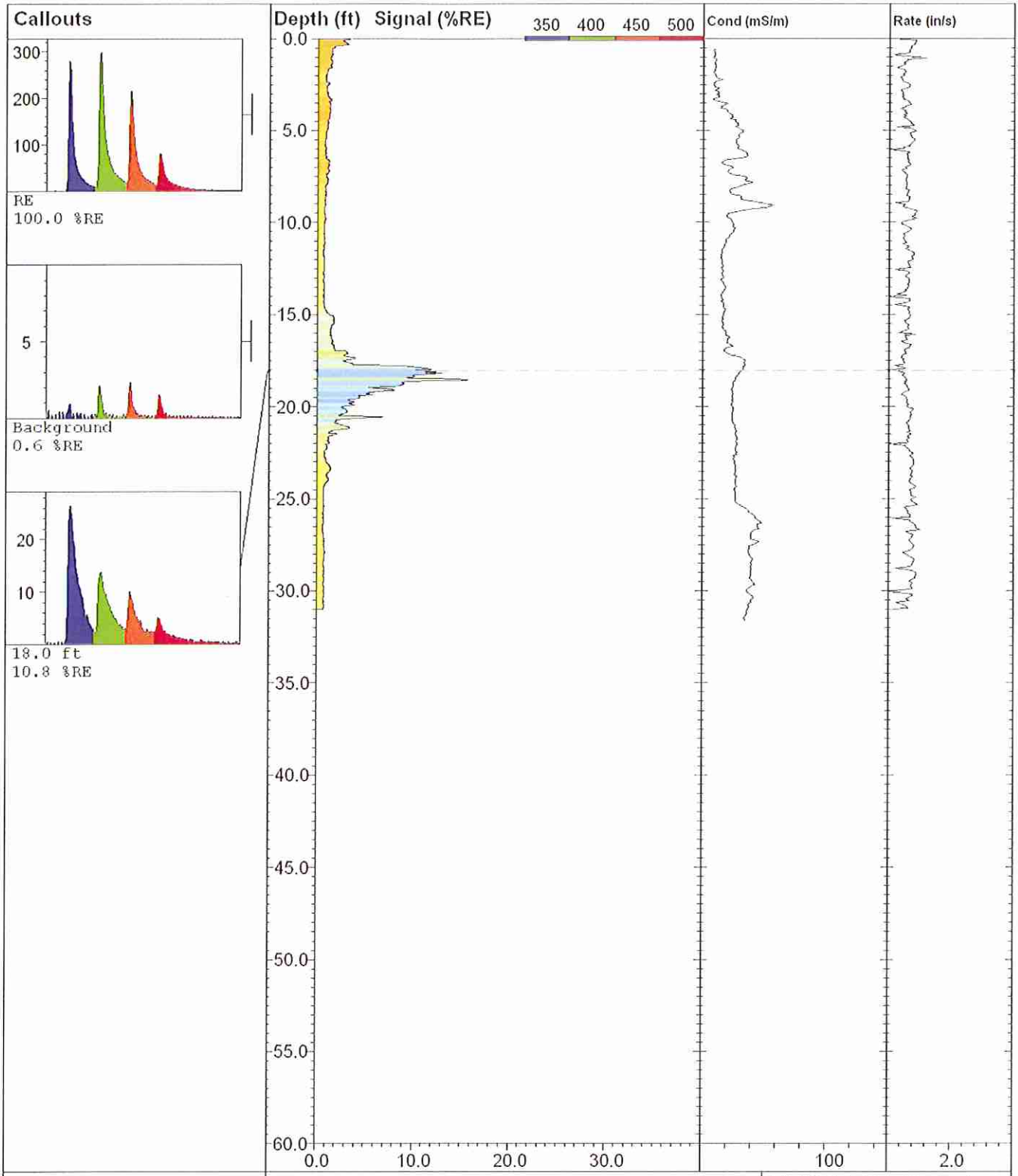
L-14

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 31.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 31.1 % @ 19.70 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 13:39 CDT



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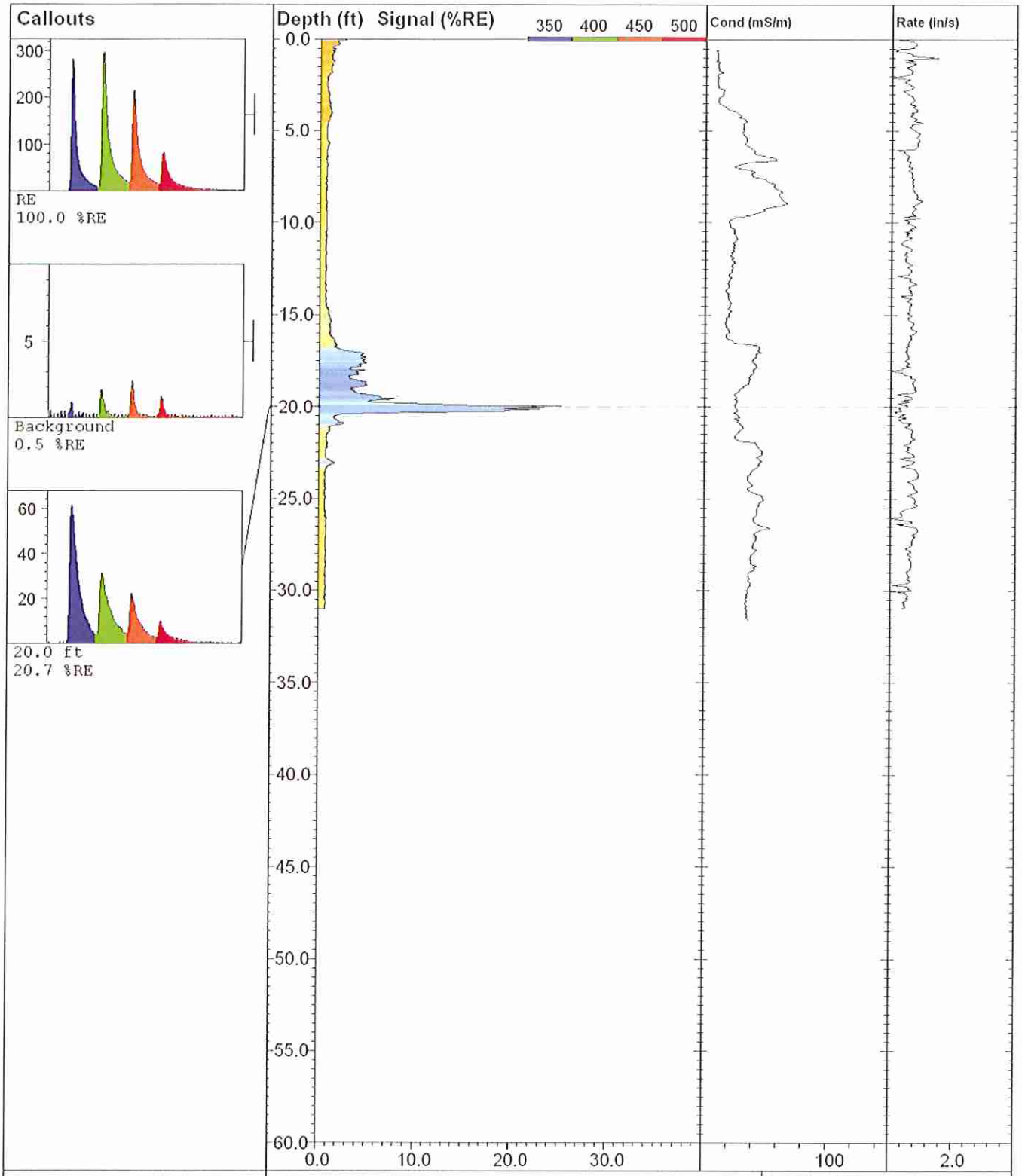
L-15

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 31.01 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 15.8 % @ 18.56 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 14:13 CDT



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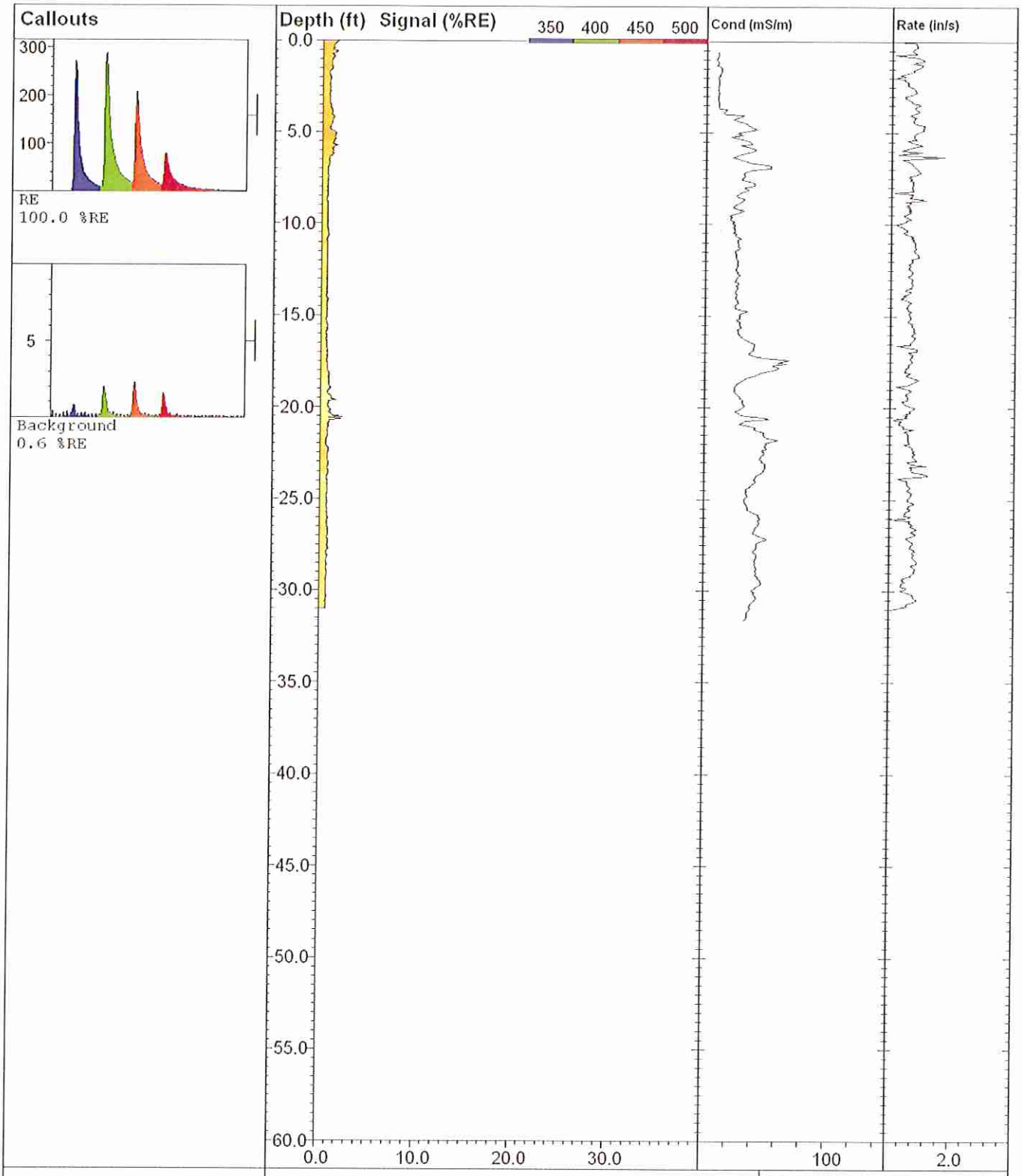
L-16

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 31.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 25.4 % @ 19.96 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 14:47 CDT



MATRIX ENVIRONMENTAL LLC

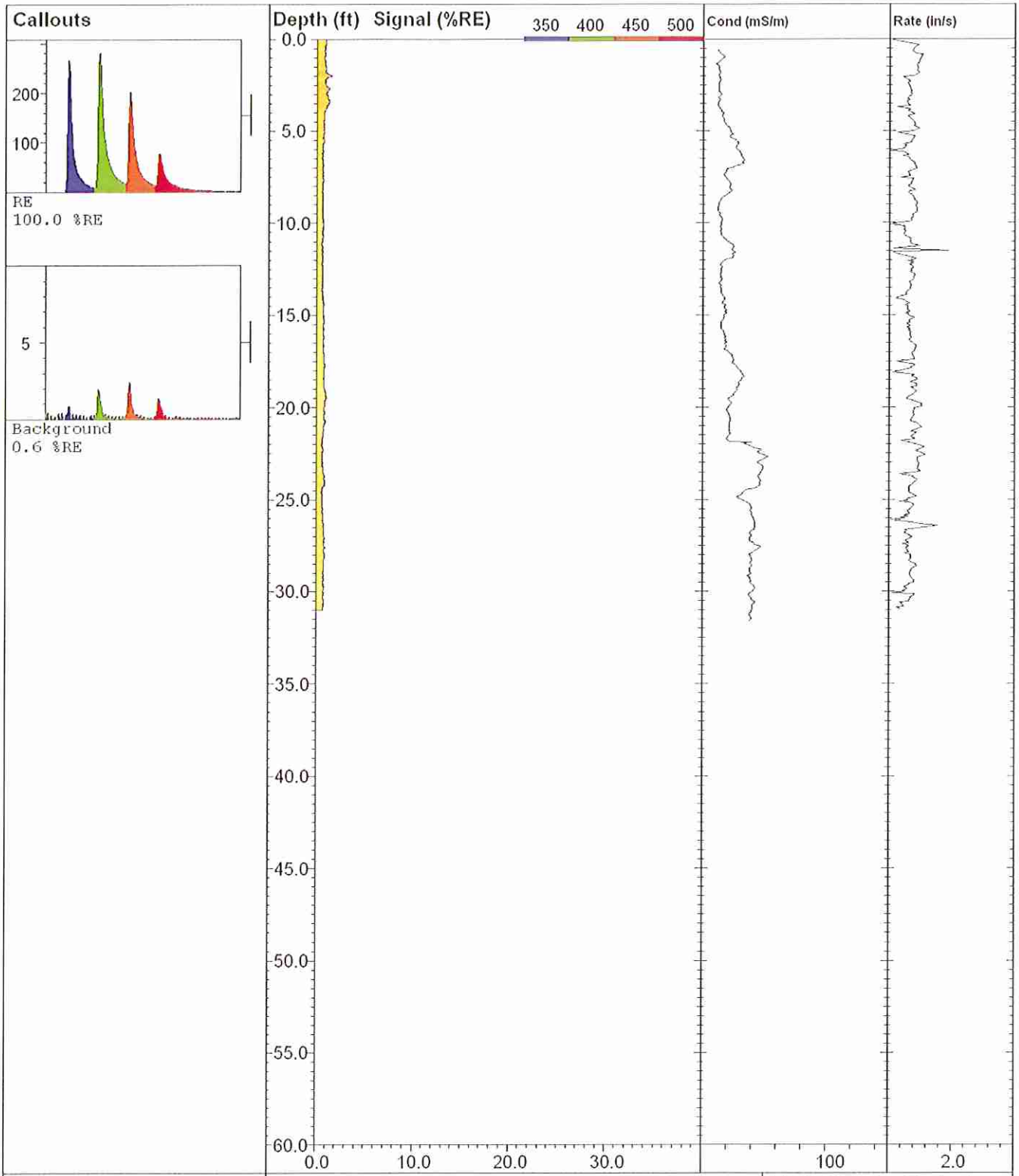
www.matrixenv.com

L-17

UVOST By Dakota

www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 31.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 2.3 % @ 20.54 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 15:16 CDT



MATRIX ENVIRONMENTAL LLC

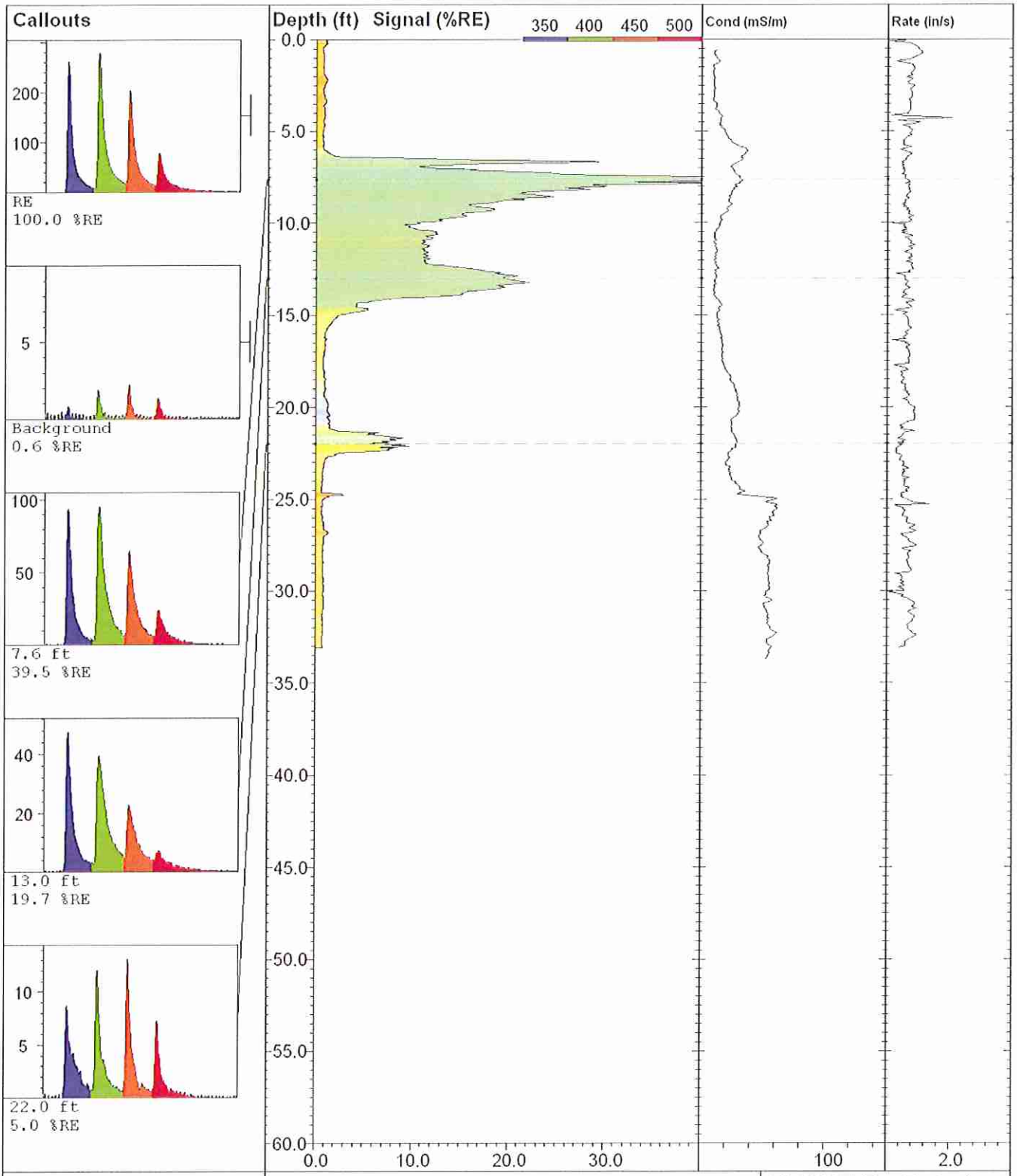
www.matrixenv.com

L-18

UVOST By Dakota

www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 31.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 1.6 % @ 2.02 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 15:44 CDT

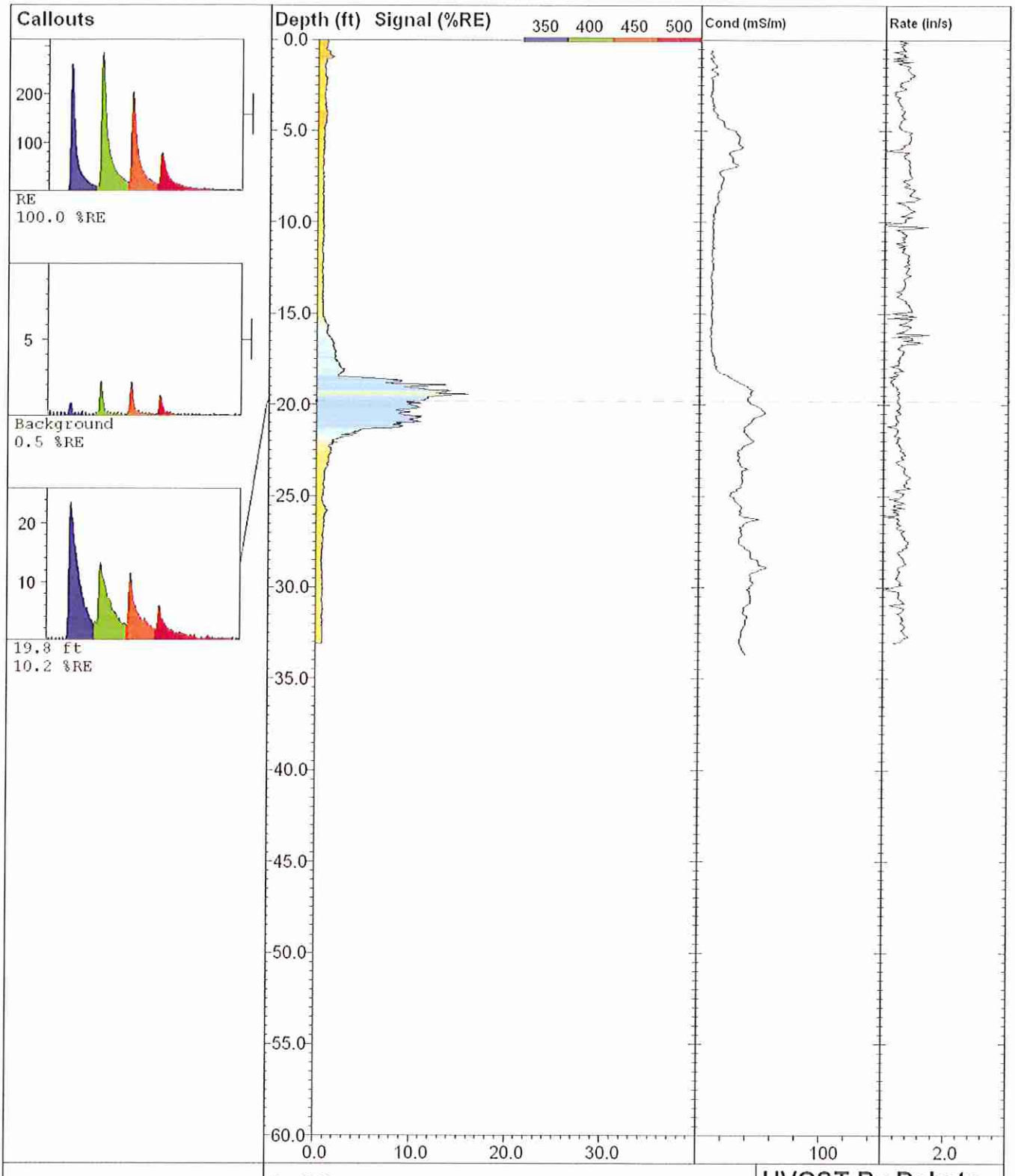


MATRIX ENVIRONMENTAL LLC

L-19

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 33.07 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 43.7 % @ 7.85 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 16:11 CDT

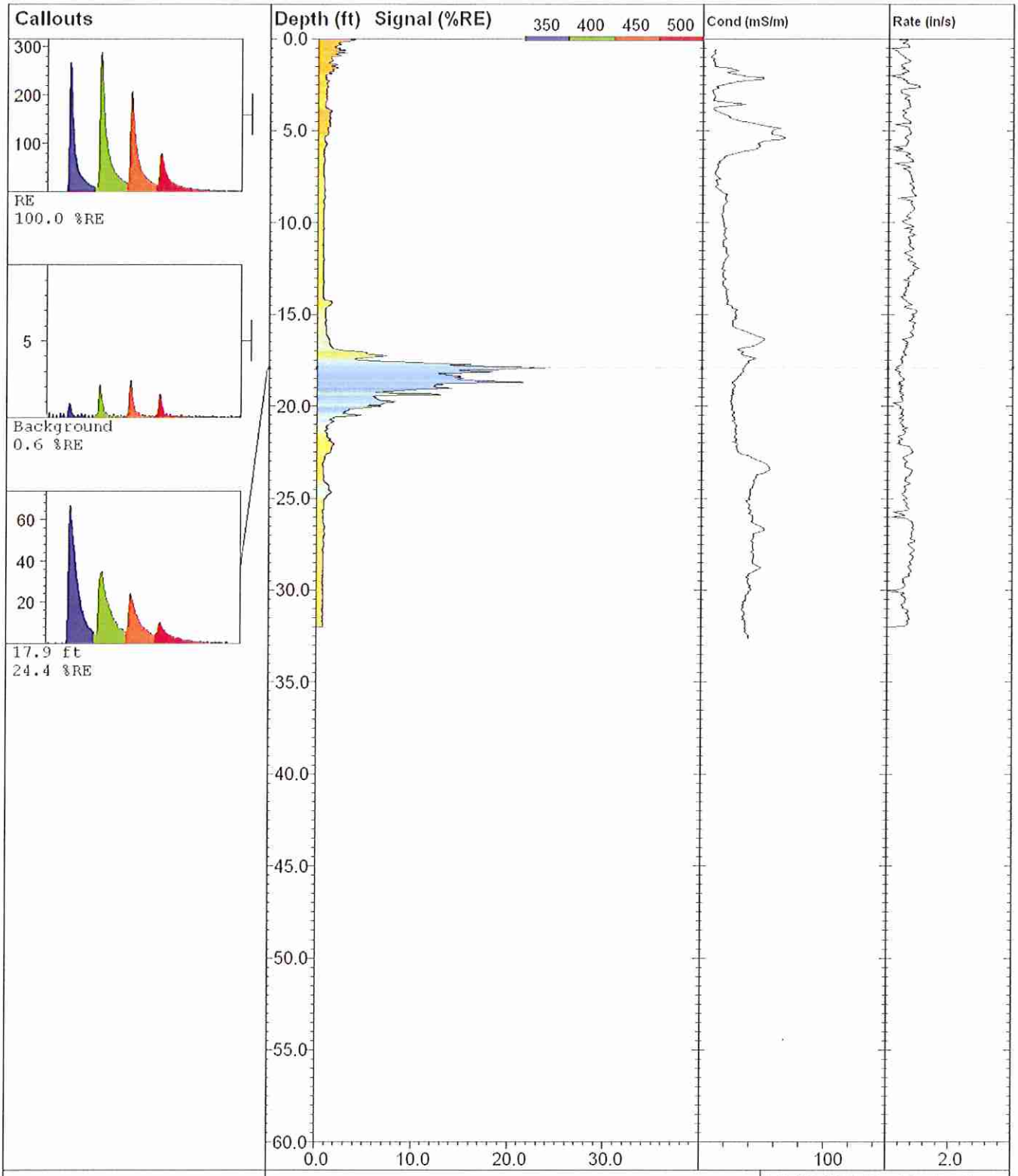


MATRIX ENVIRONMENTAL LLC
www.matrixenv.com

L-20

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 33.06 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 15.8 % @ 19.43 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 08:48 CDT



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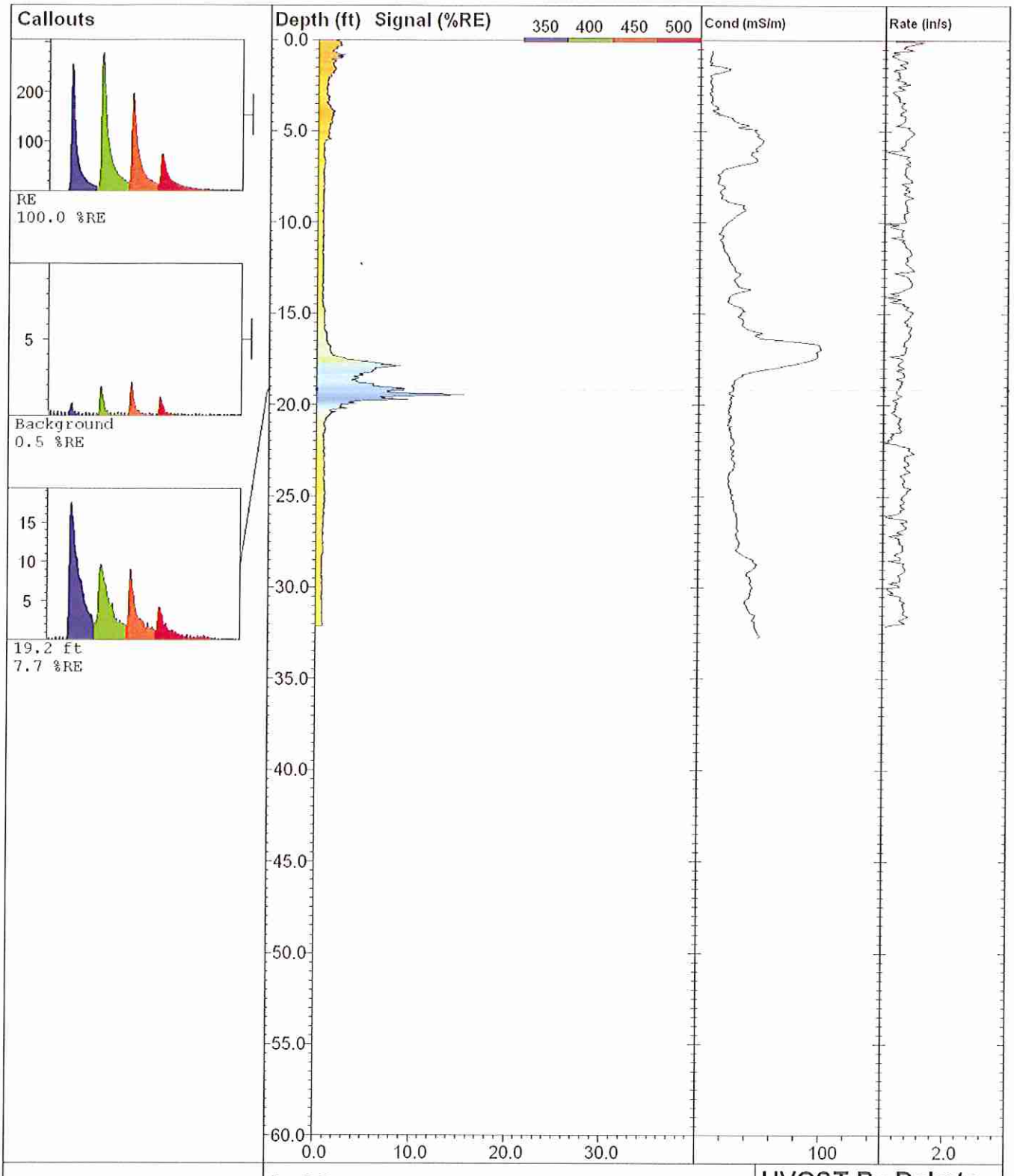
L-21

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 24.4 % @ 17.92 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 09:30 CDT



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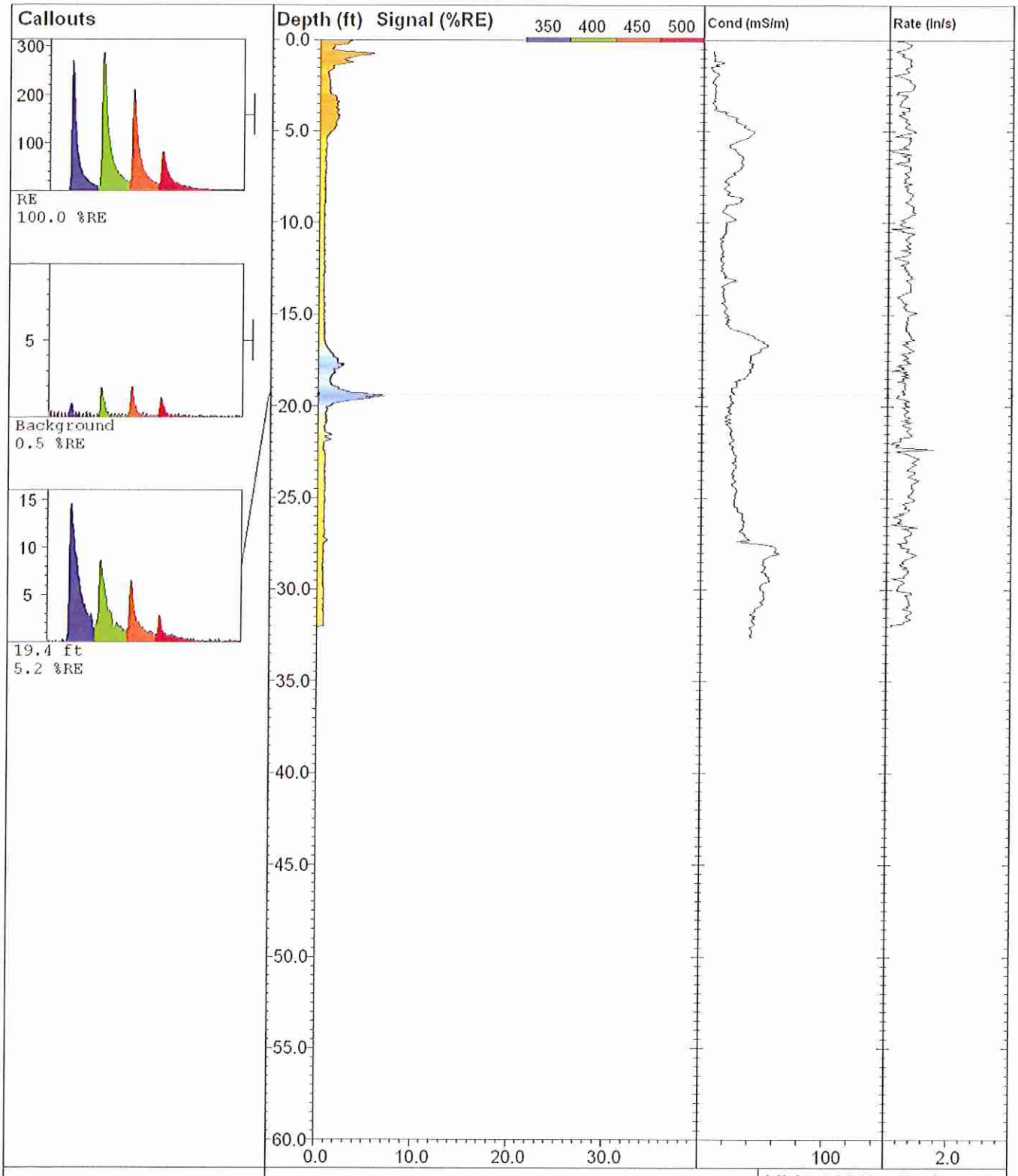
L-22

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.13 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 15.5 % @ 19.45 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 10:08 CDT



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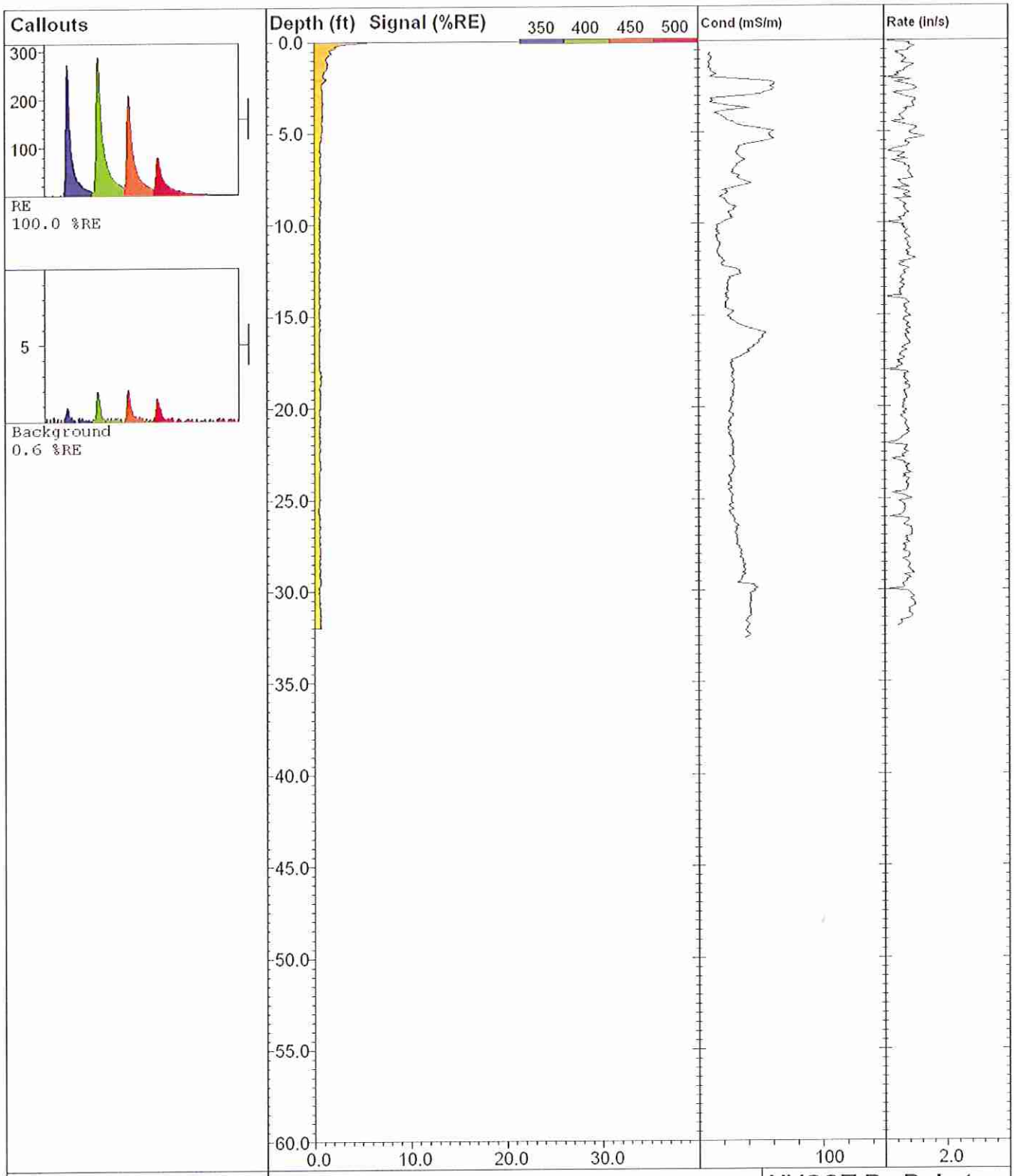
L-23

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.01 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 7.0 % @ 19.46 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 10:51 CDT



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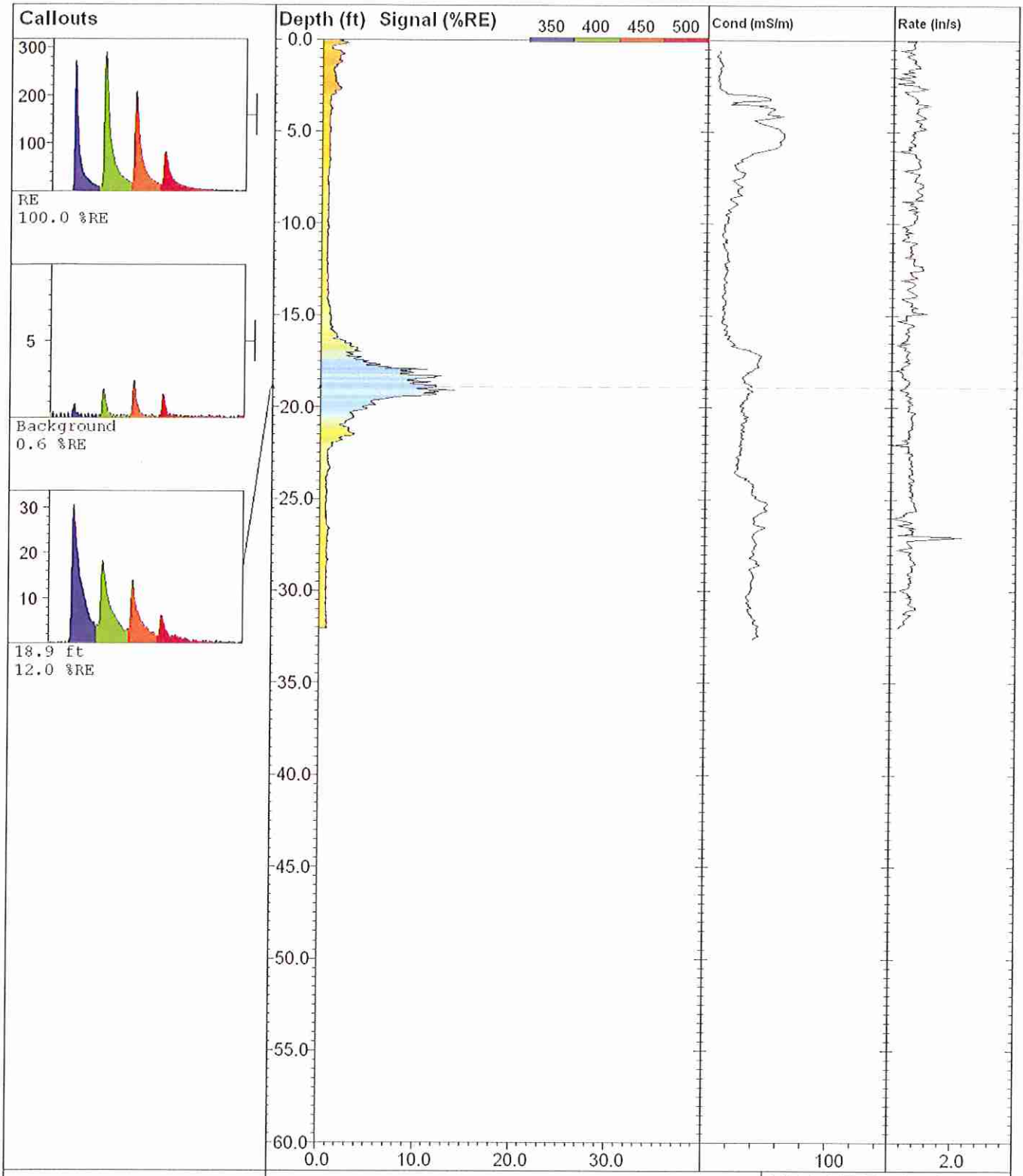
L-24

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 6.2 % @ 0.01 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 11:30 CDT



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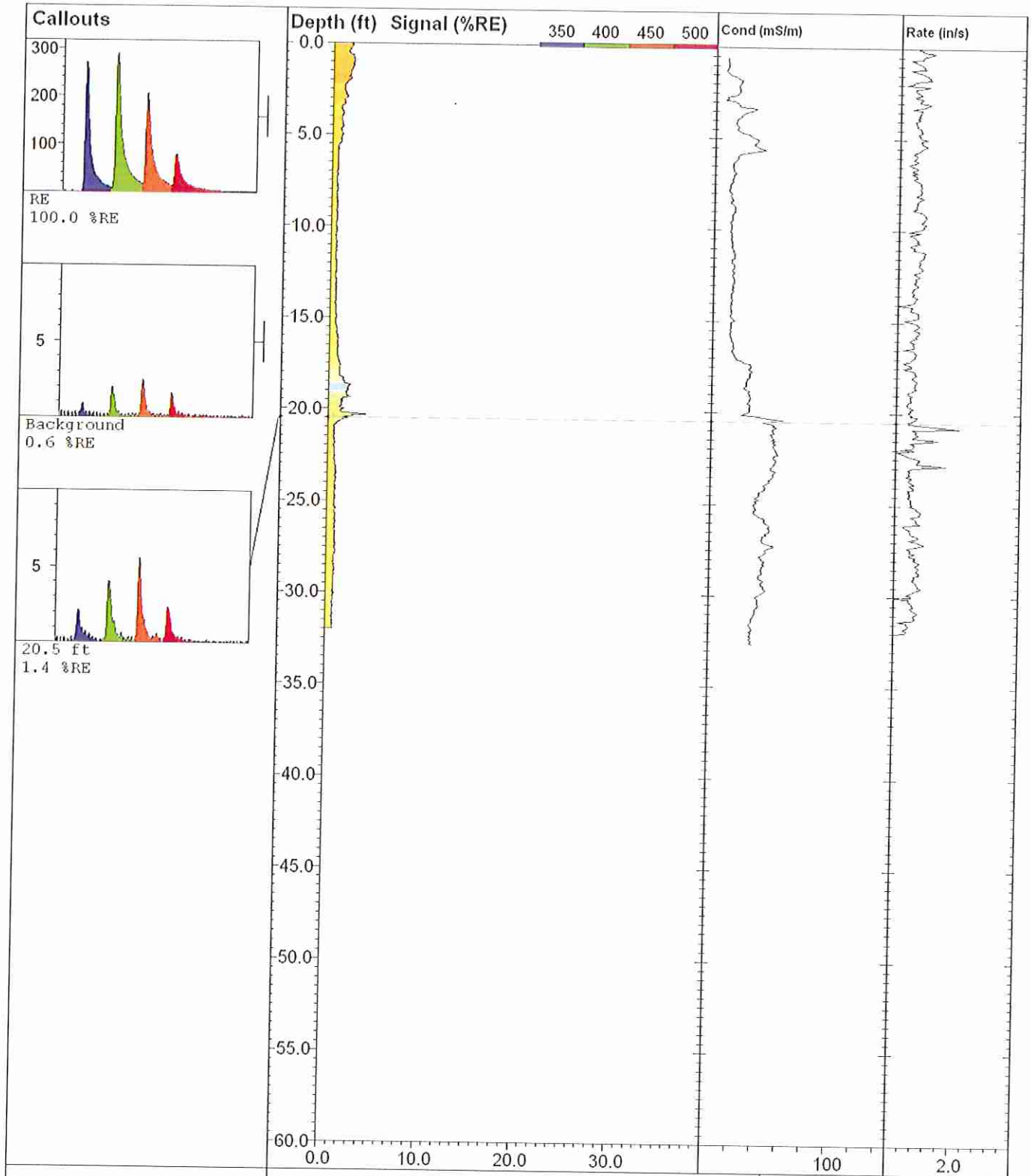
L-25

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.02 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 13.9 % @ 19.07 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 13:04 CDT



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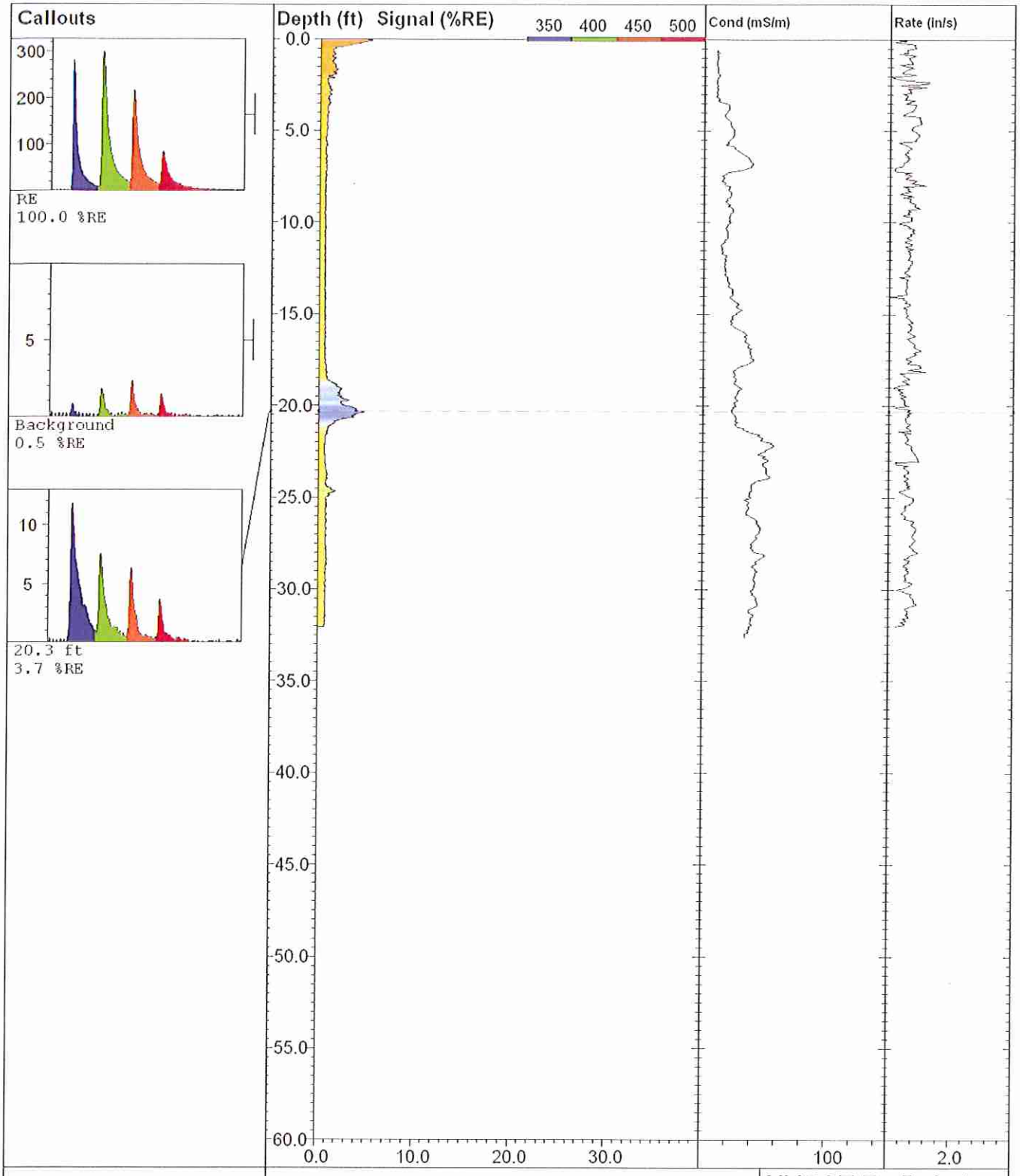
www.matrixenv.com

L-26

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 4.0 % @ 20.34 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 13:40 CDT



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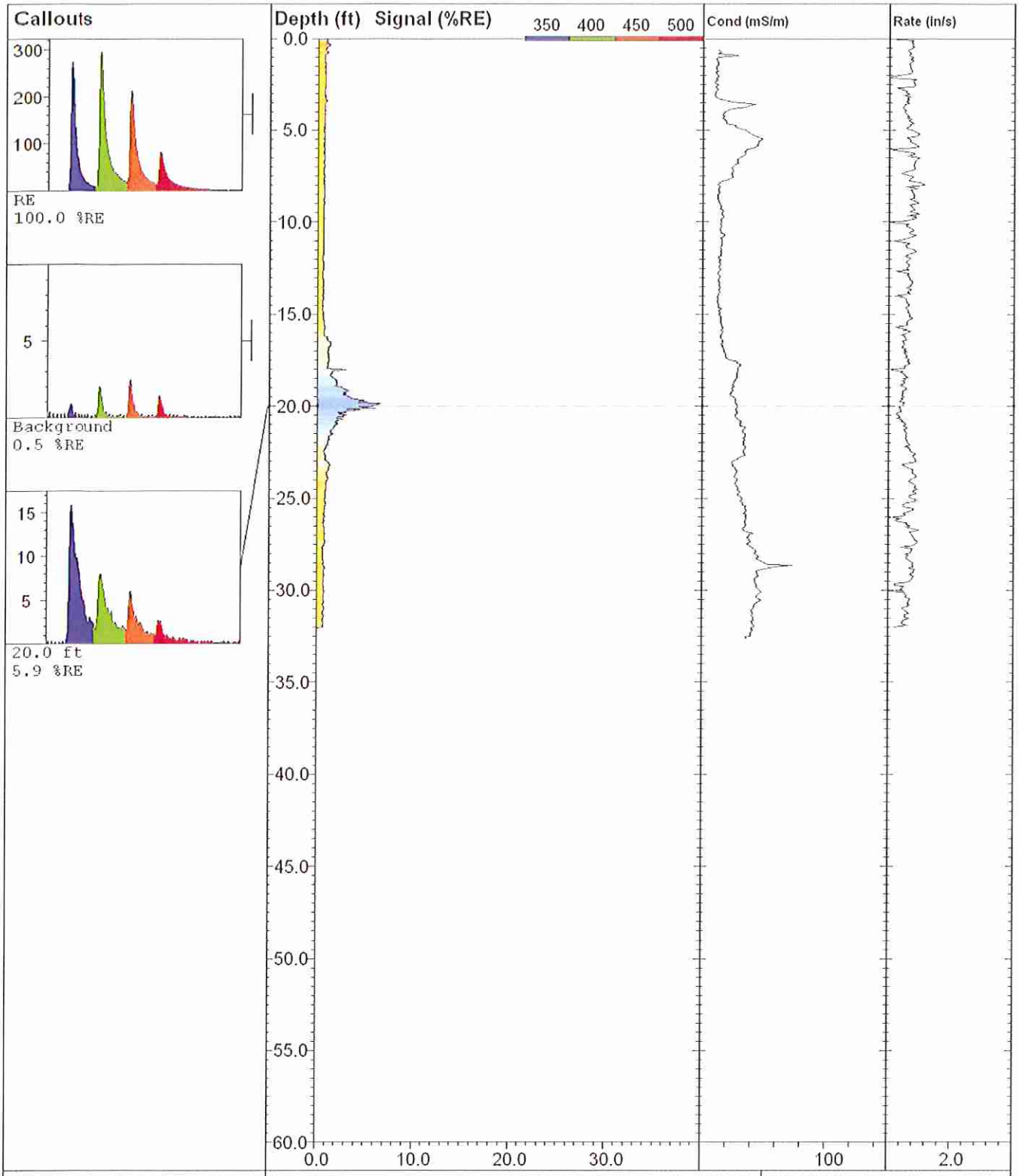
L-27

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.02 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 5.3 % @ 0.11 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 14:16 CDT



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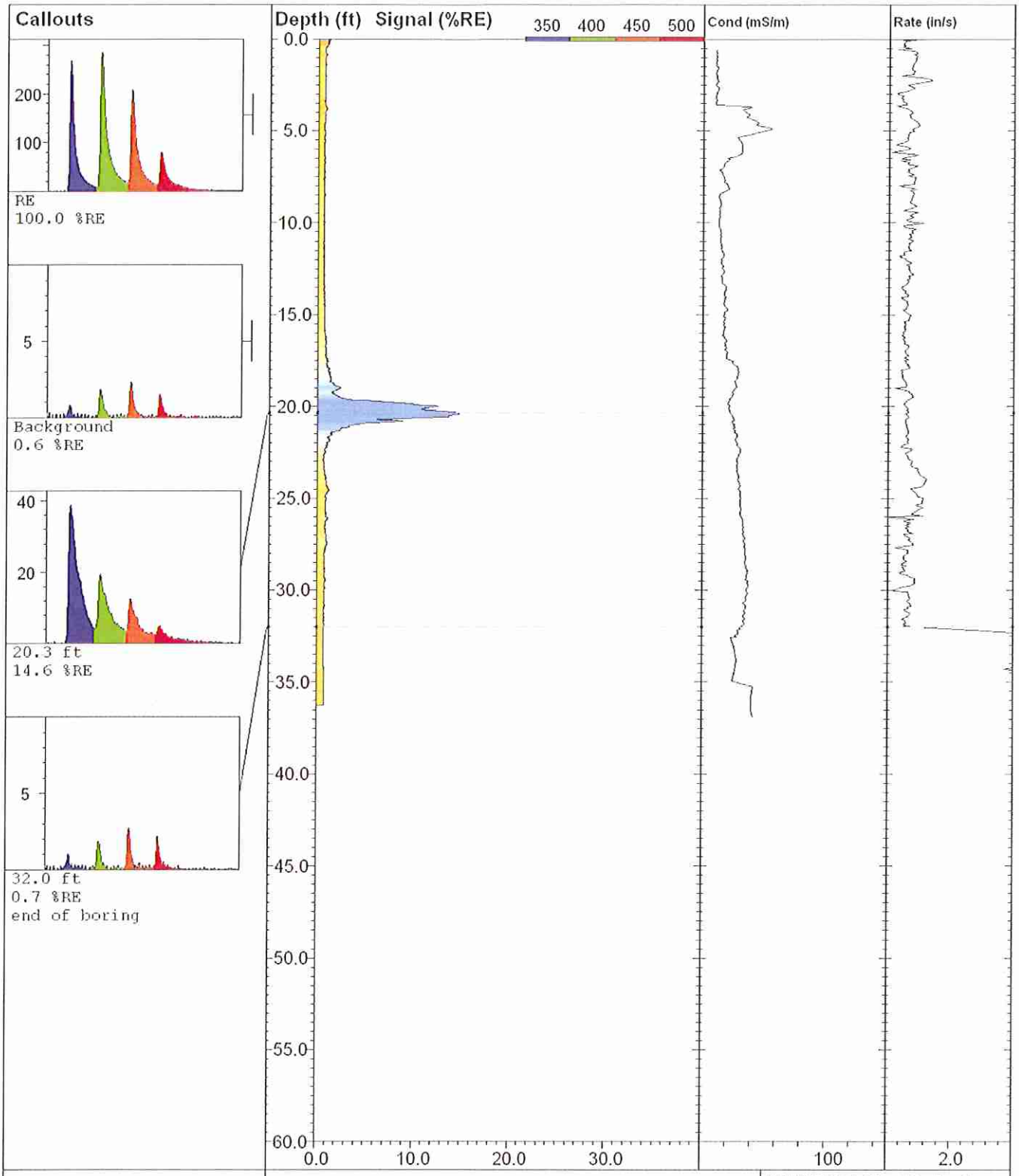
L-28

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.01 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 6.6 % @ 19.85 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 14:56 CDT



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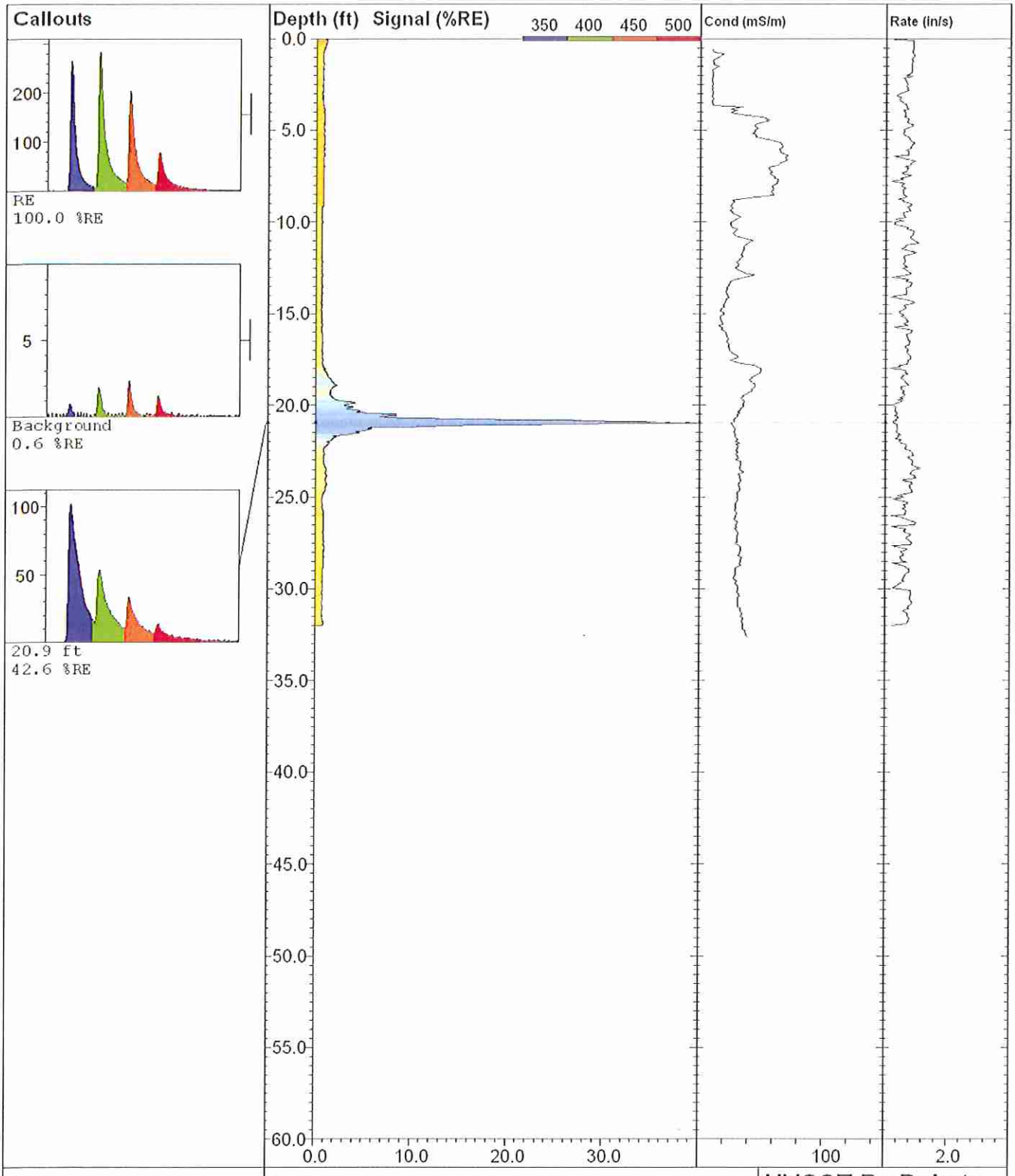
L-29

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 36.24 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 14.7 % @ 20.41 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 15:38 CDT



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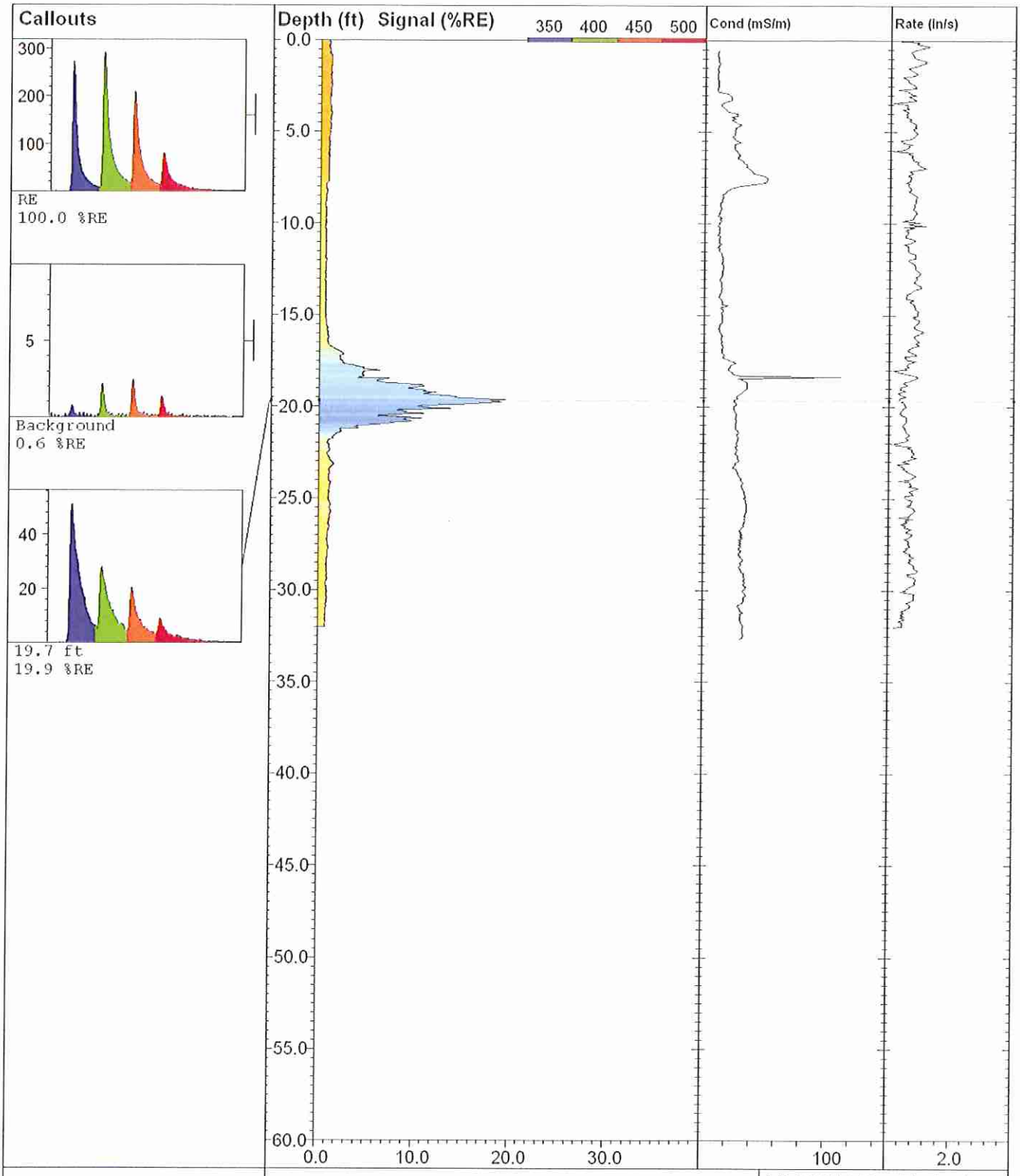
L-30

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 42.6 % @ 20.95 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 16:12 CDT



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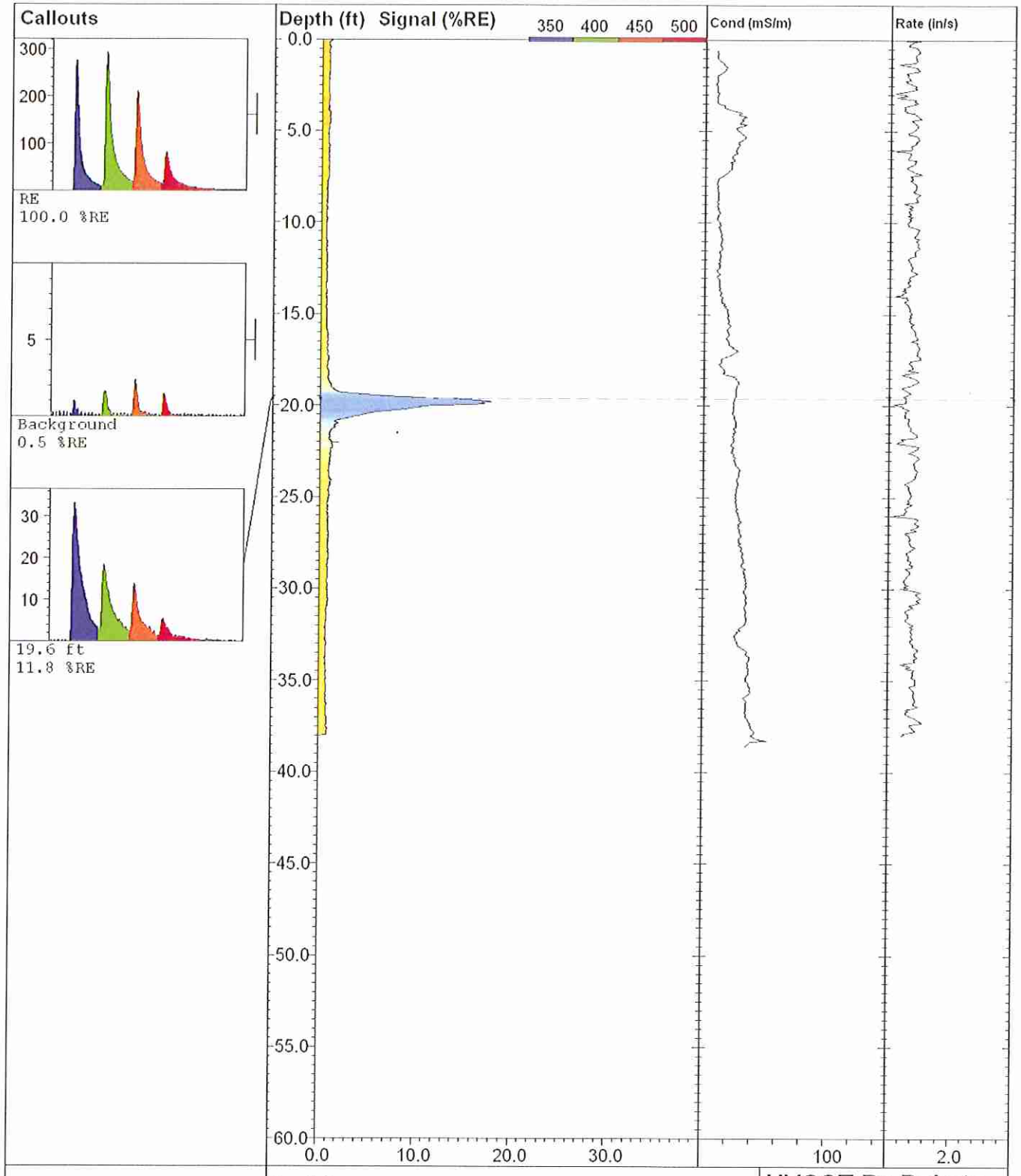
L-31

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 19.9 % @ 19.66 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 16:45 CDT



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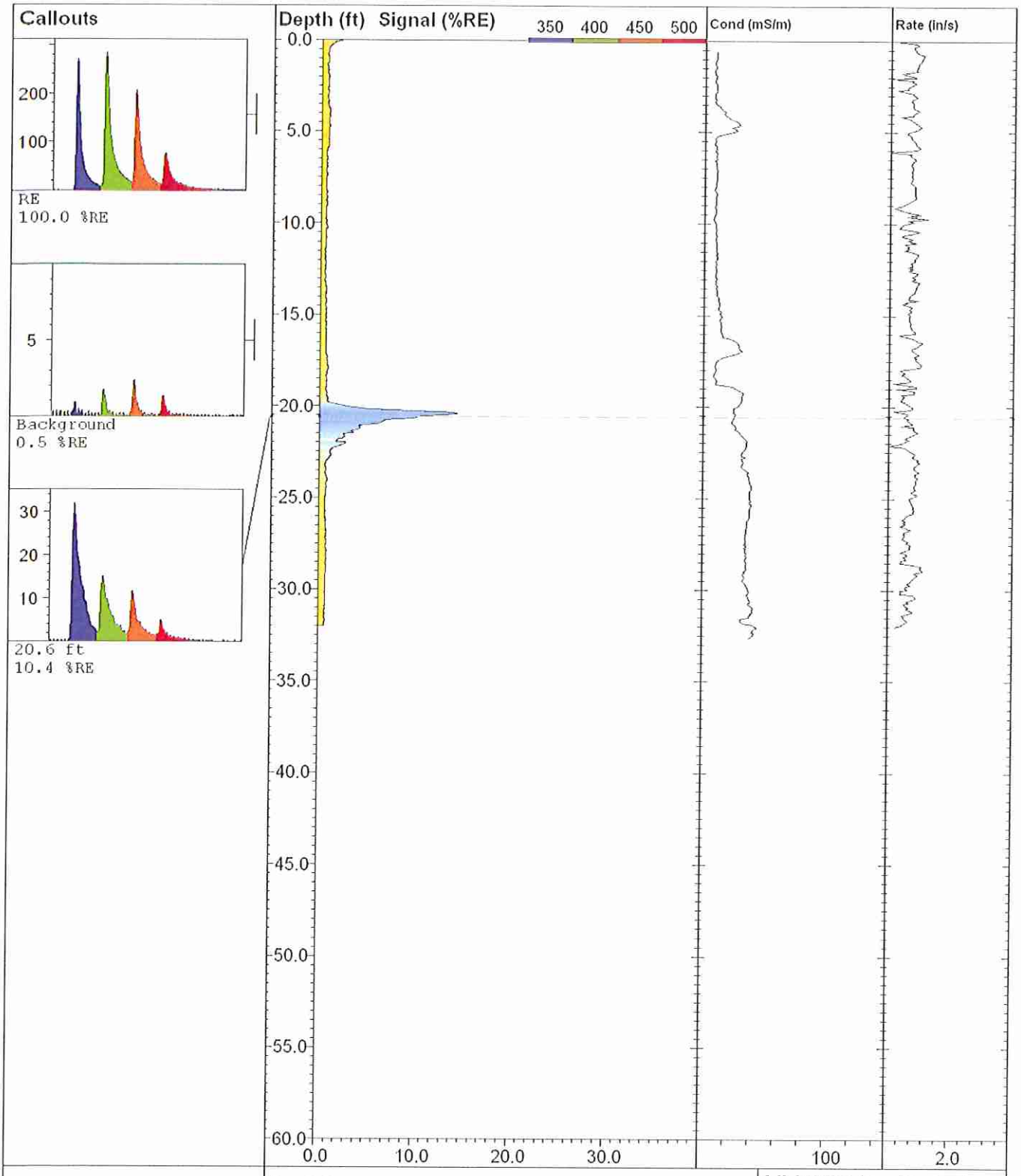
L-32

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 38.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 17.9 % @ 19.80 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 08:50 CDT



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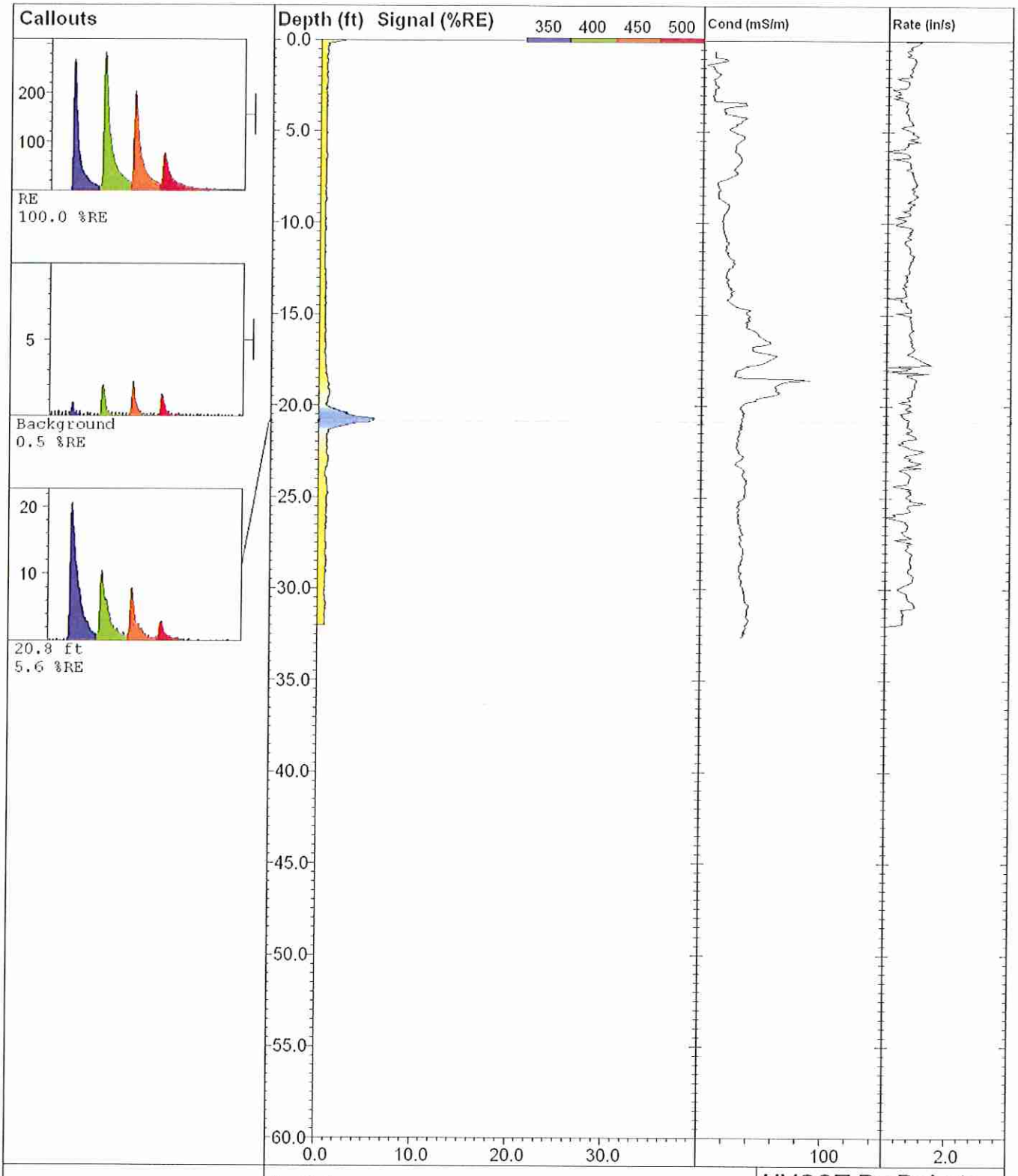
L-33

UVOST By Dakota

www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 14.4 % @ 20.44 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 09:28 CDT



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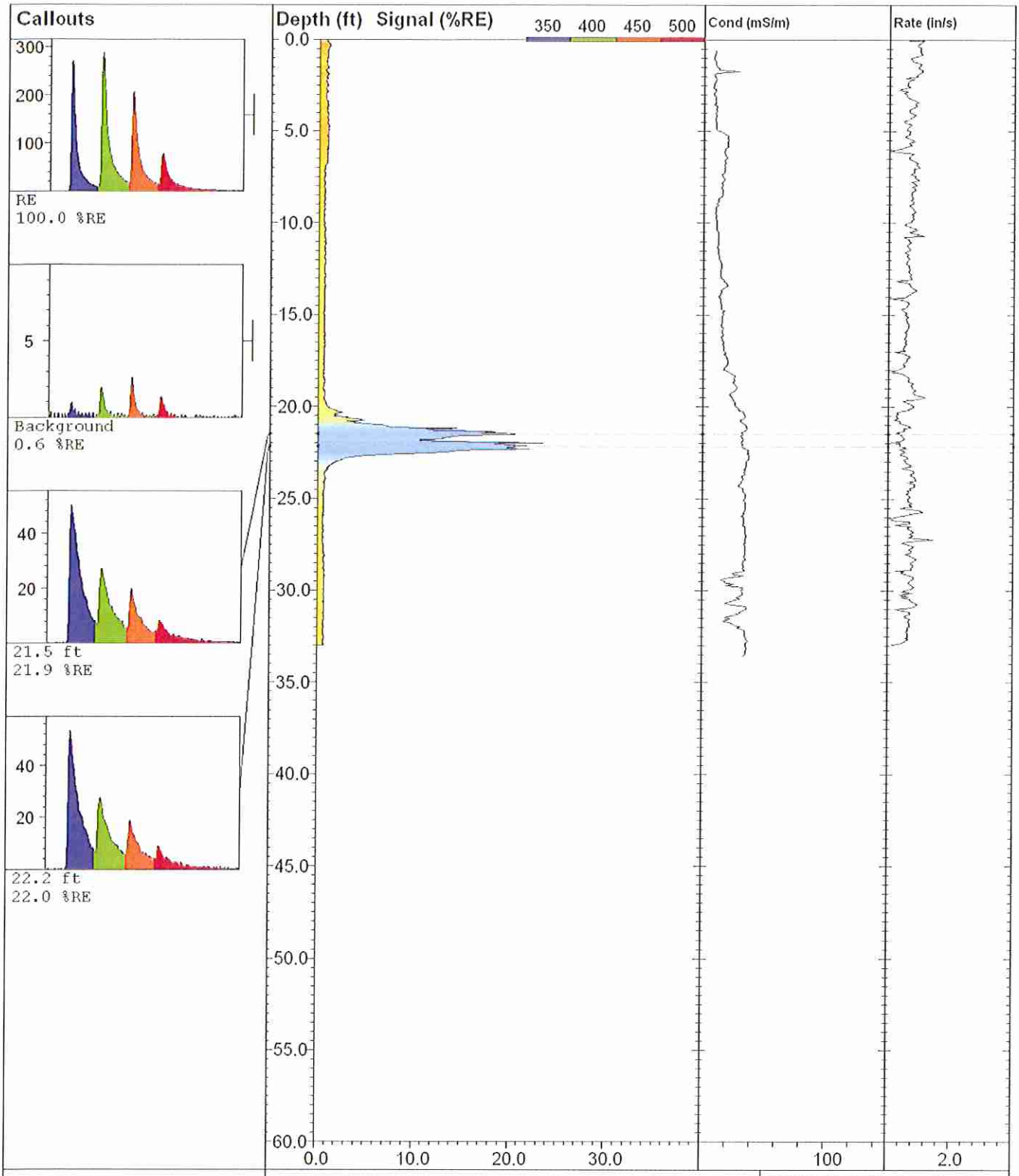
L-34

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 5.9 % @ 20.75 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 10:02 CDT



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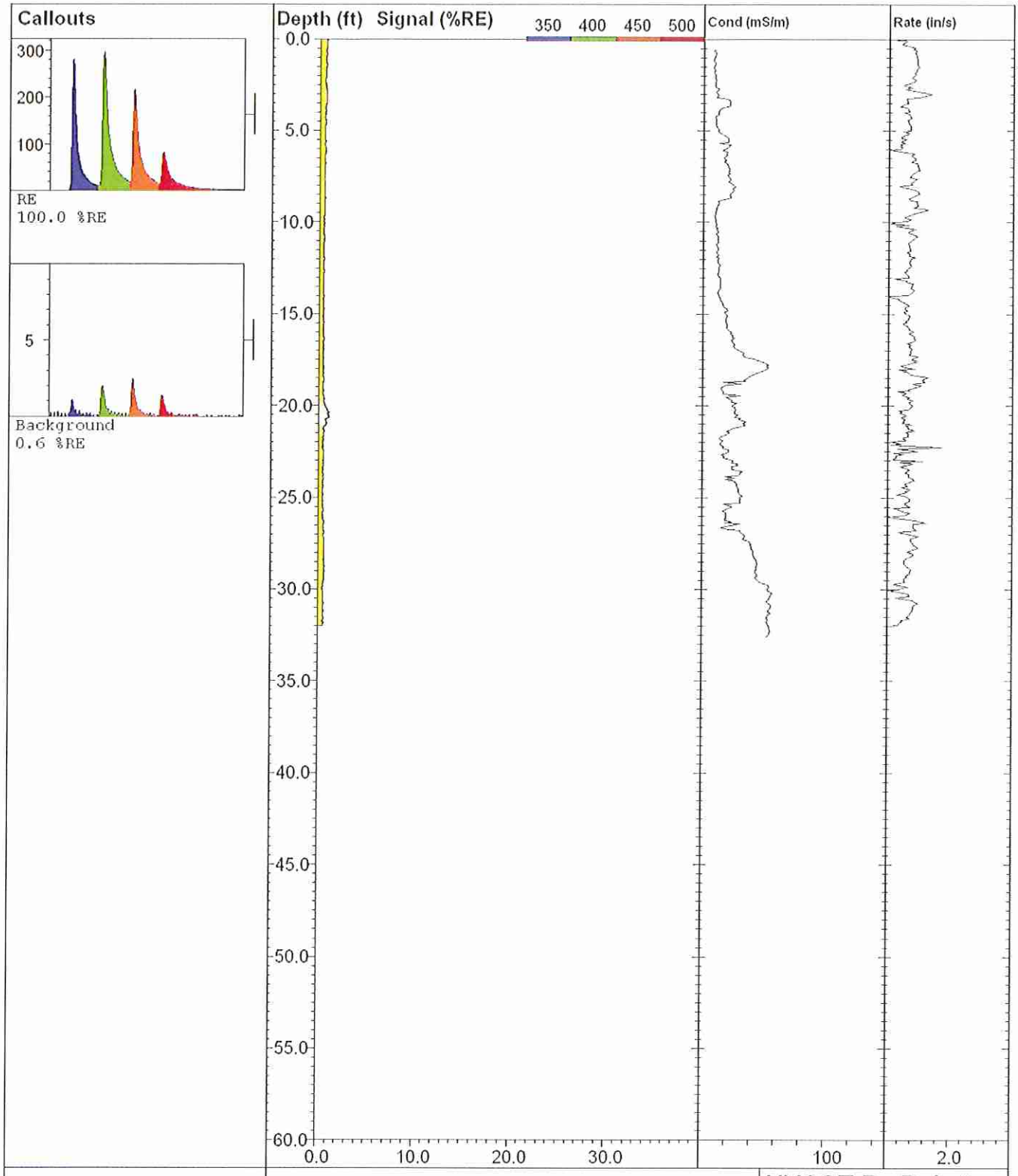
L-35

UVOST By Dakota

www.DakotaTechnologies.com

Site: **Former Union 76**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **33.00 ft**
Client: **Liesch**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **23.8 % @ 21.98 ft**
Job: **024-MNDS-11UV**	*Operator/Unit:* **DT/UVOST1003**	*Date & Time:* **2011-03-25 10:34 CDT**



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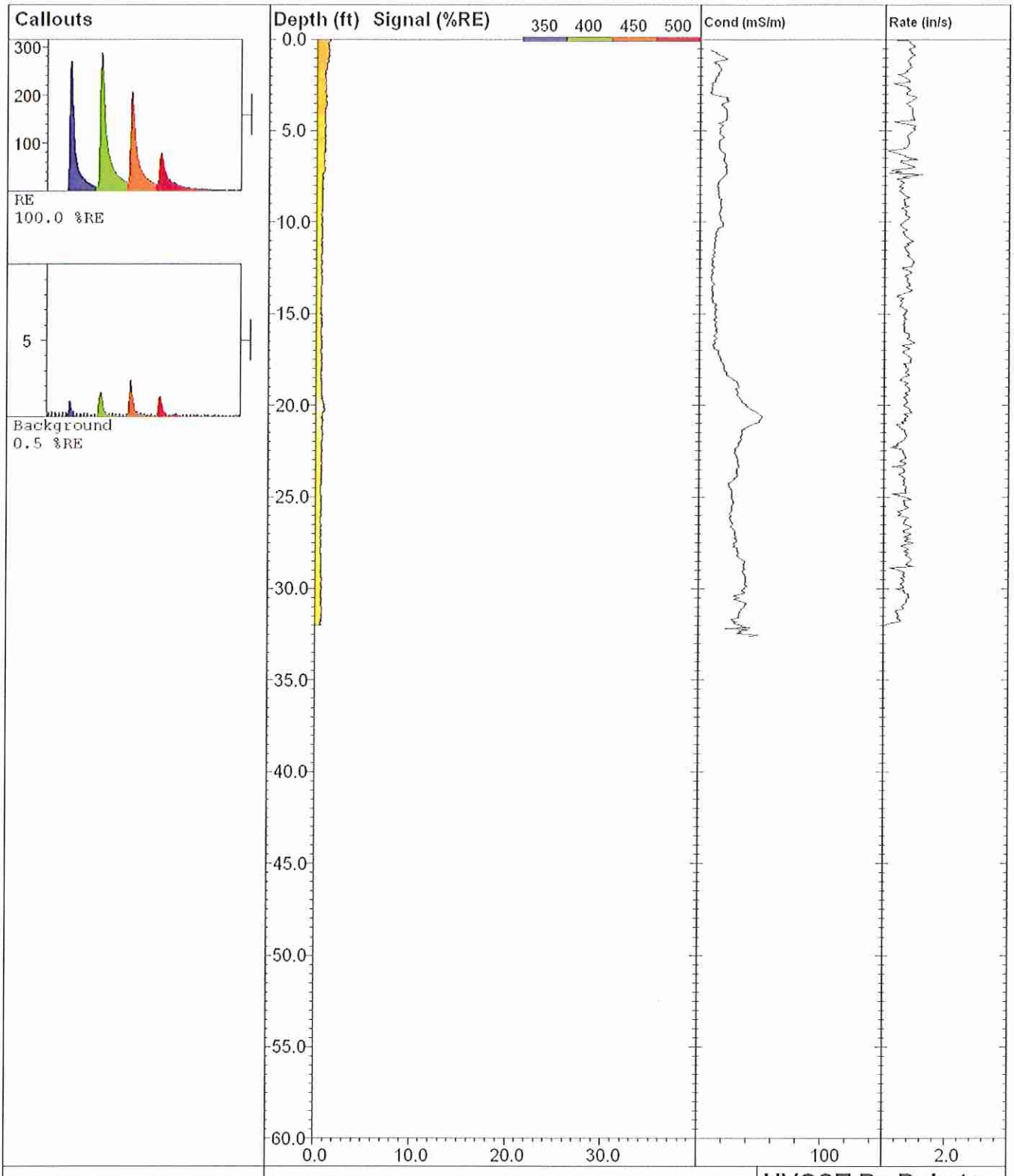
L-36

UVOST By Dakota

www.DakotaTechnologies.com

Site: **Former Union 76**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **32.00 ft**
Client: **Liesch**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **1.1 % @ 20.38 ft**
Job: **024-MNDS-11UV**	*Operator/Unit:* **DT/UVOST1003**	*Date & Time:* **2011-03-25 11:13 CDT**



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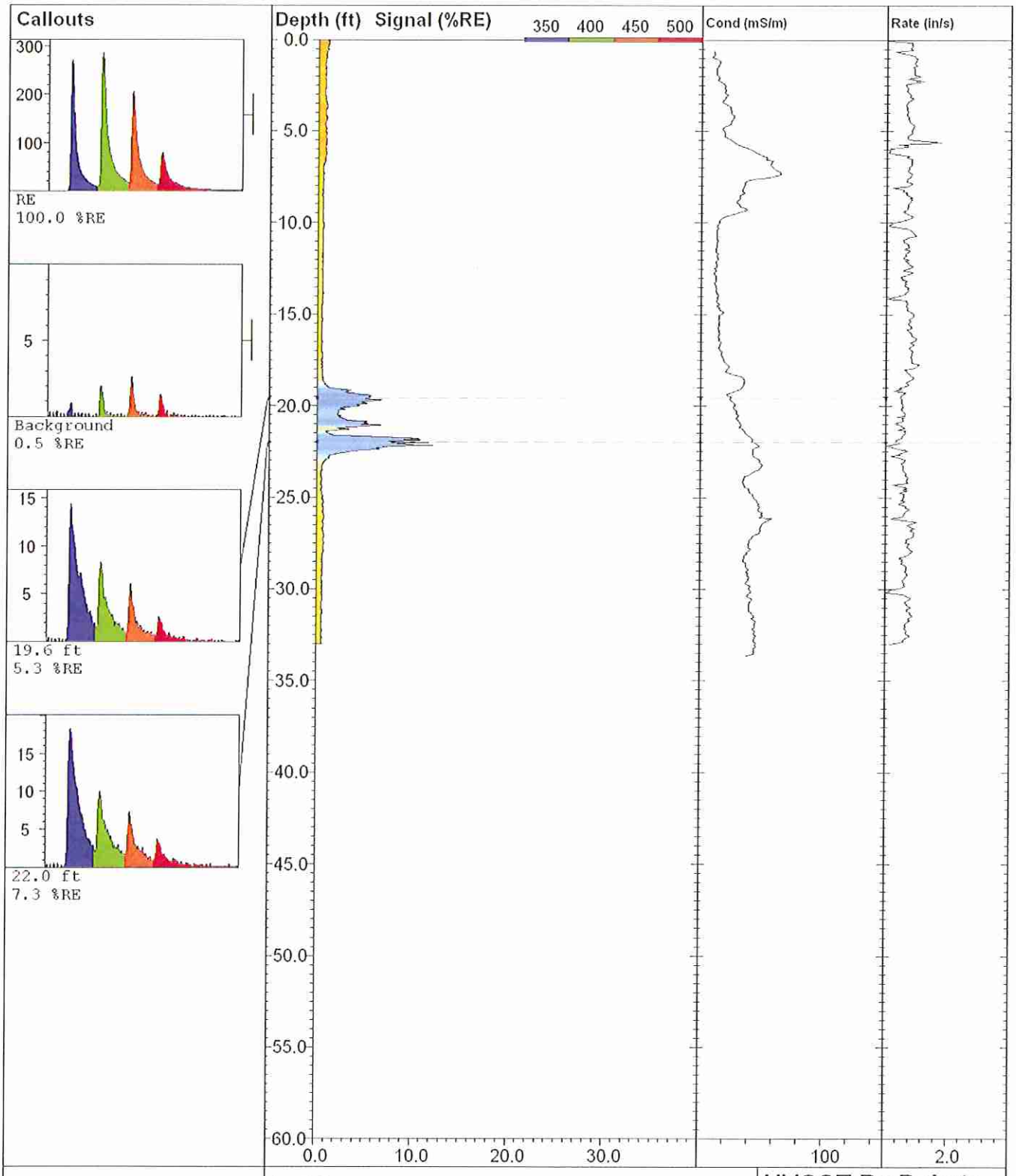
www.matrixenv.com

L-37

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 1.6 % @ 0.00 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 12:41 CDT



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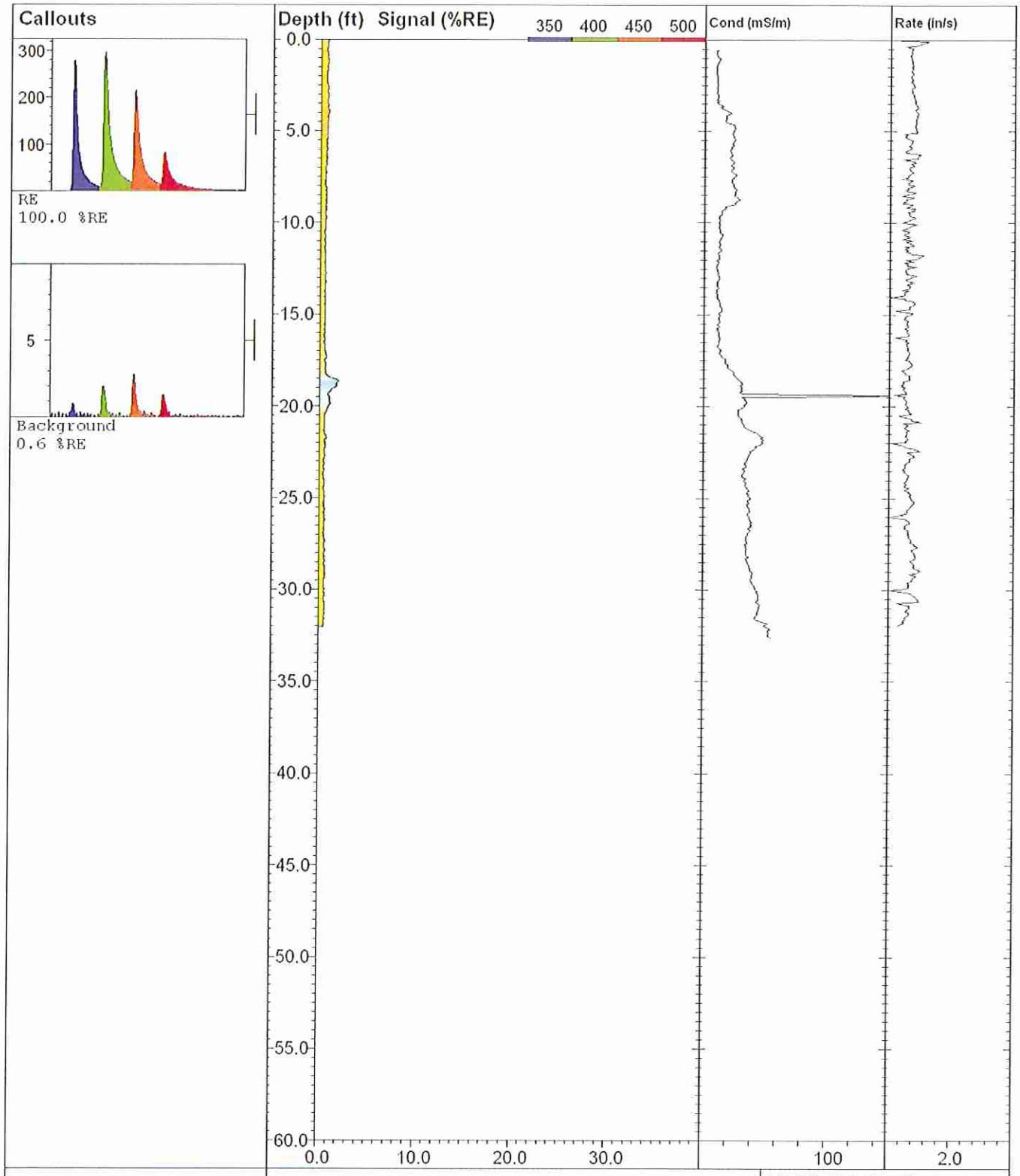
www.matrixenv.com

L-38

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 33.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 12.0 % @ 22.17 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 14:15 CDT



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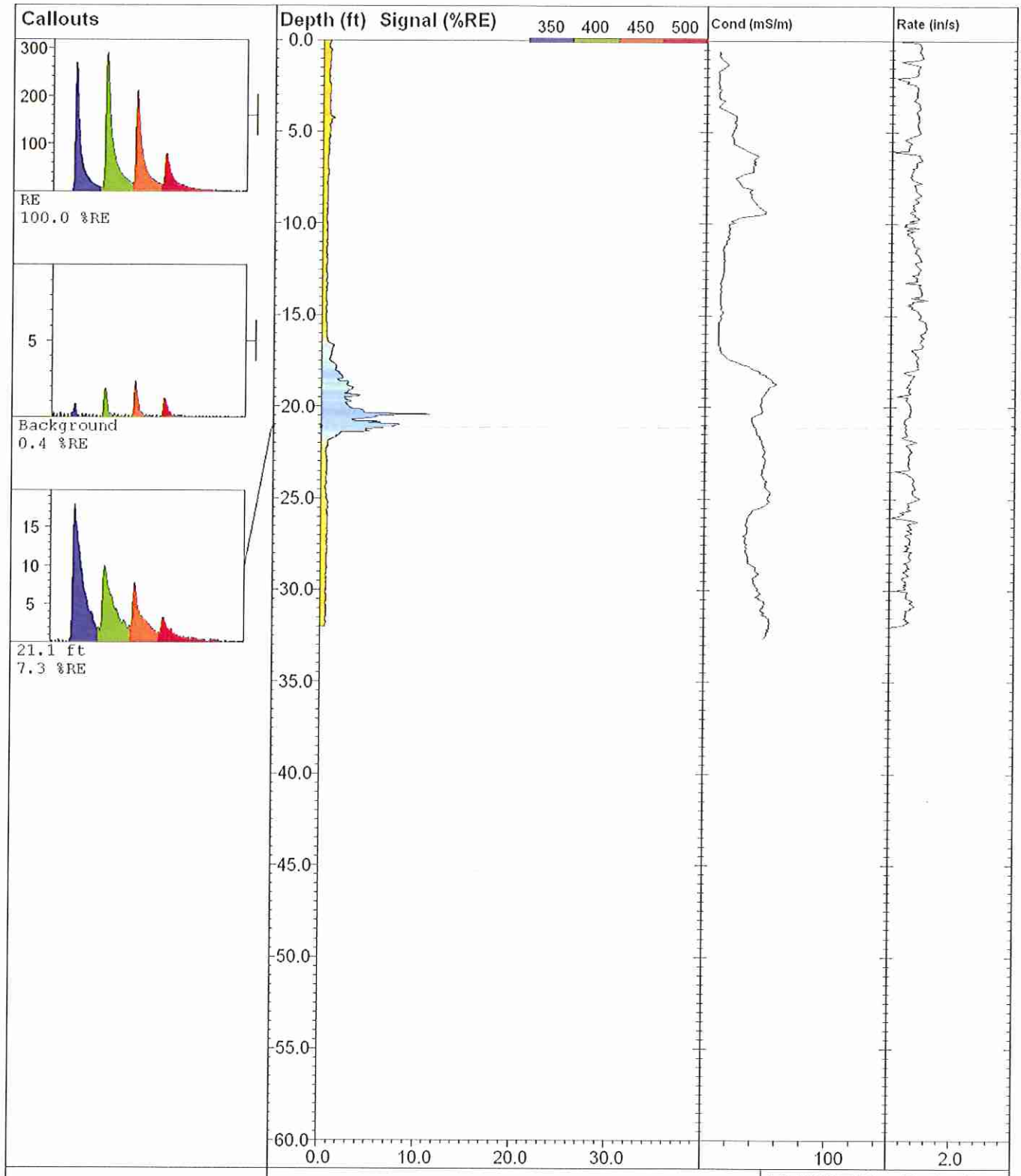
L-39

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.02 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 1.9 % @ 18.61 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 14:46 CDT



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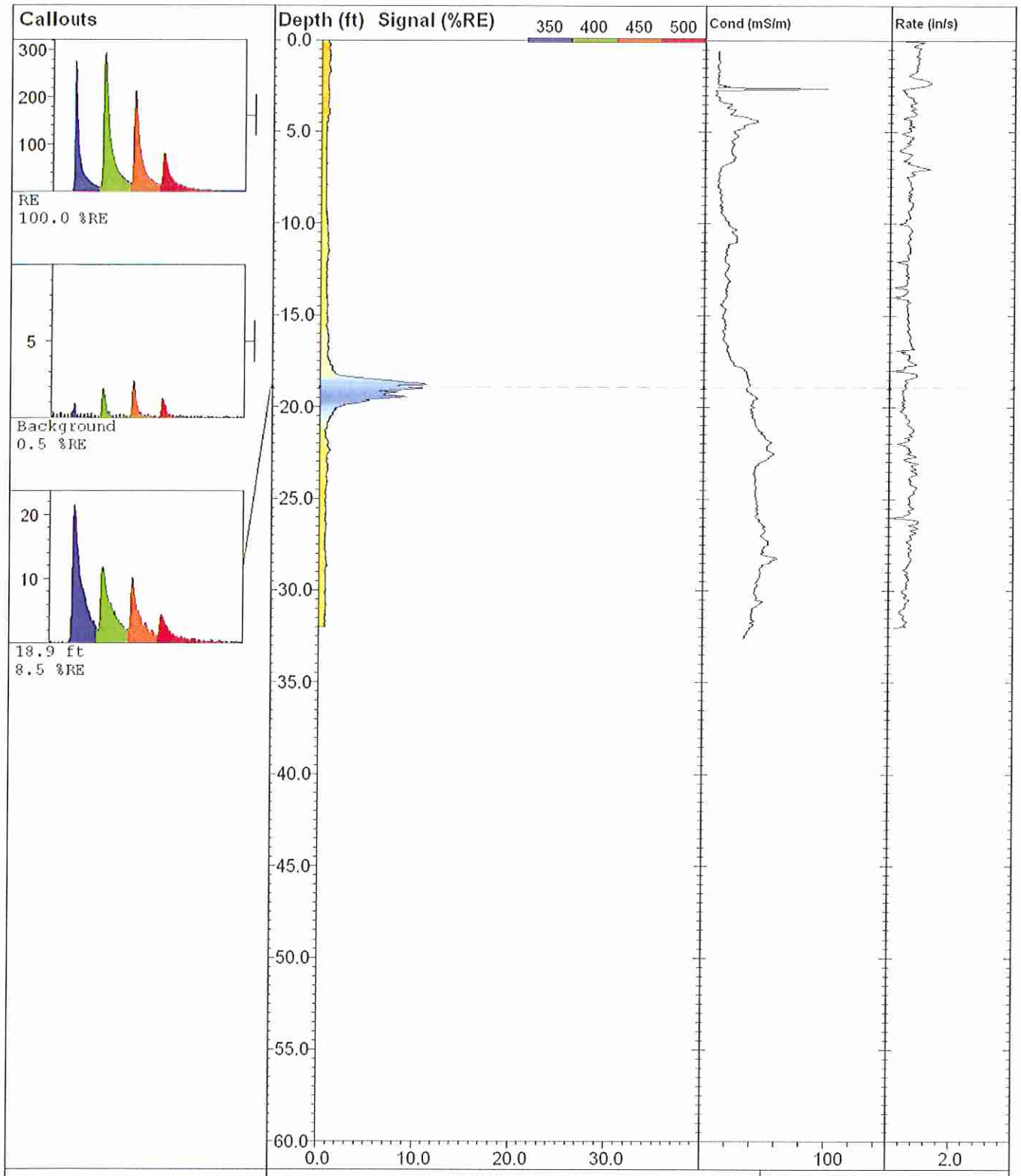
www.matrixenv.com

L-40

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 11.6 % @ 20.43 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 15:21 CDT



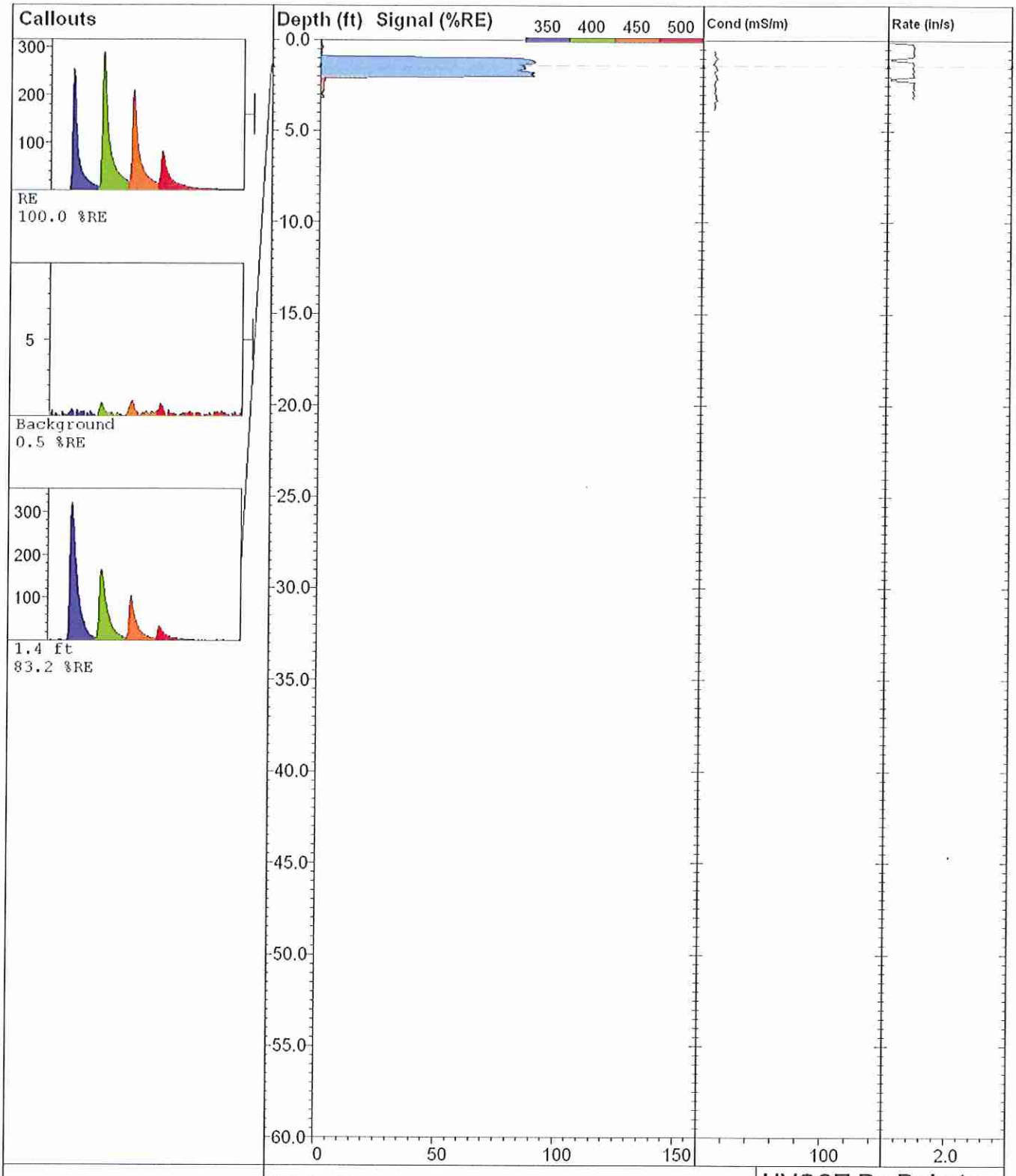
MATRIX ENVIRONMENTAL LLC

L-41

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 11.2 % @ 18.78 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 15:52 CDT

UVOST LOGS
@ 160% RE



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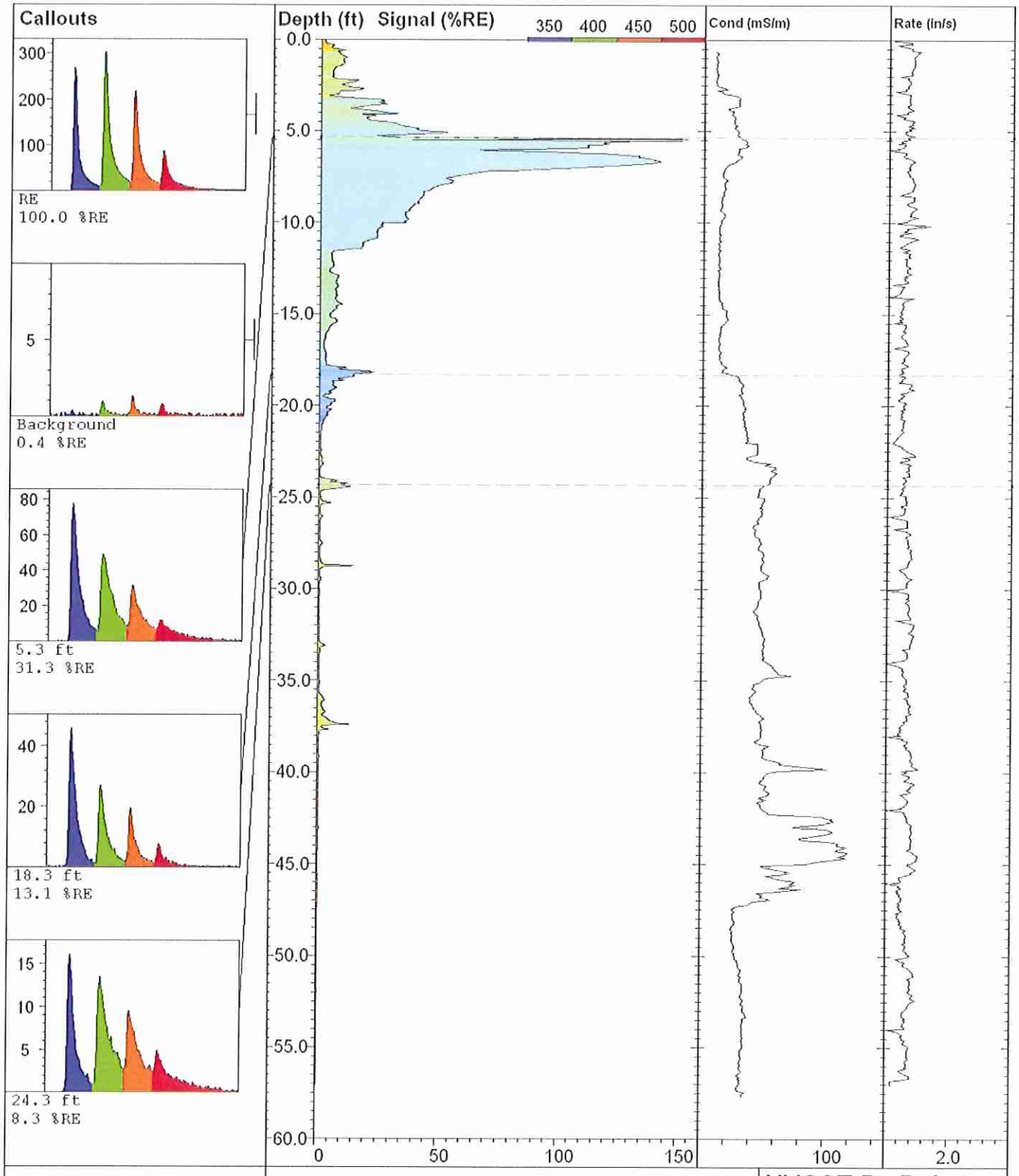
MW-7

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 3.20 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 89.8 % @ 1.20 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 09:58 CDT



MATRIX ENVIRONMENTAL LLC

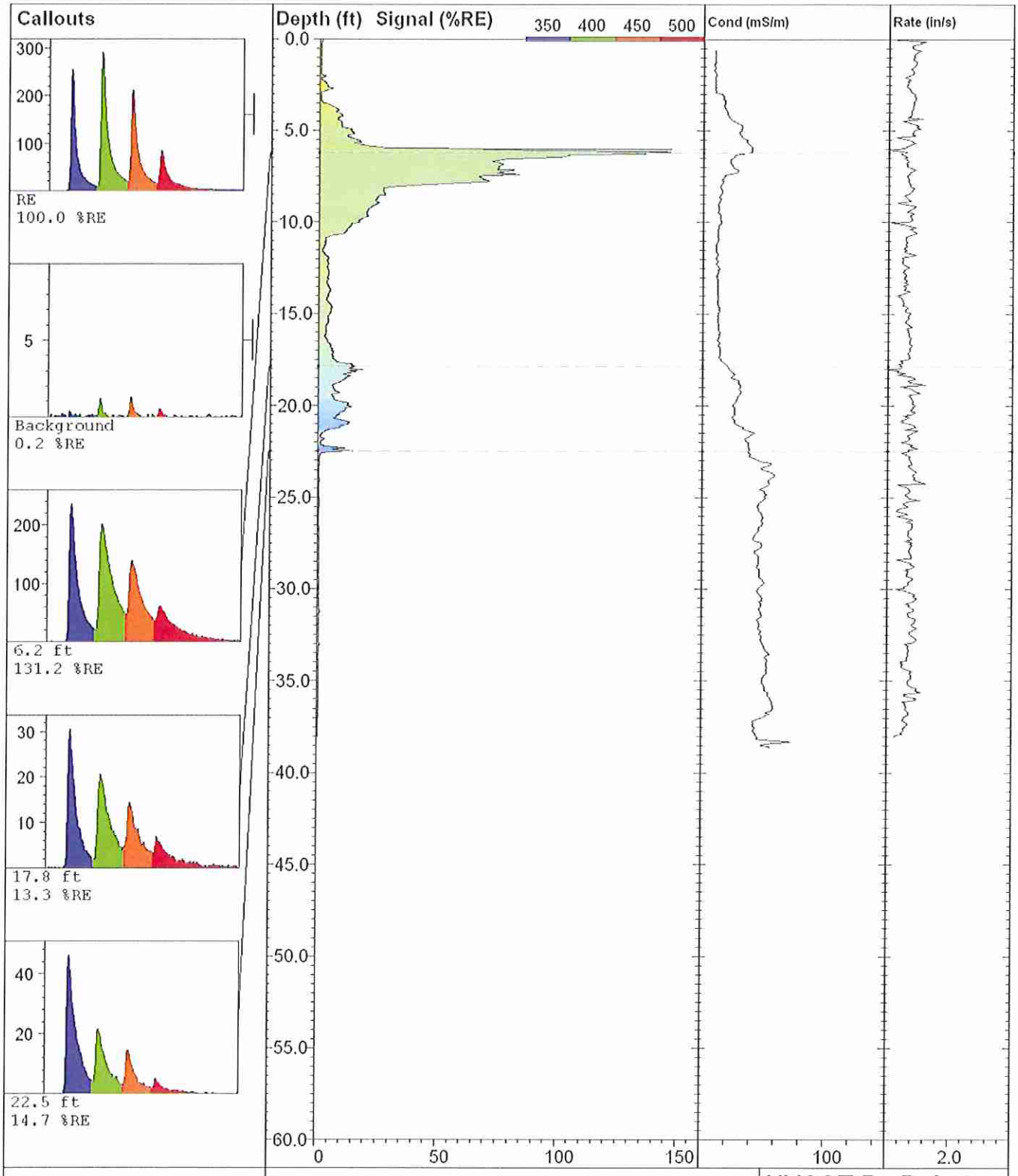
www.matrixenv.com

L-1

UVOST By Dakota

www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 57.03 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 156.4 % @ 5.43 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 10:11 CDT



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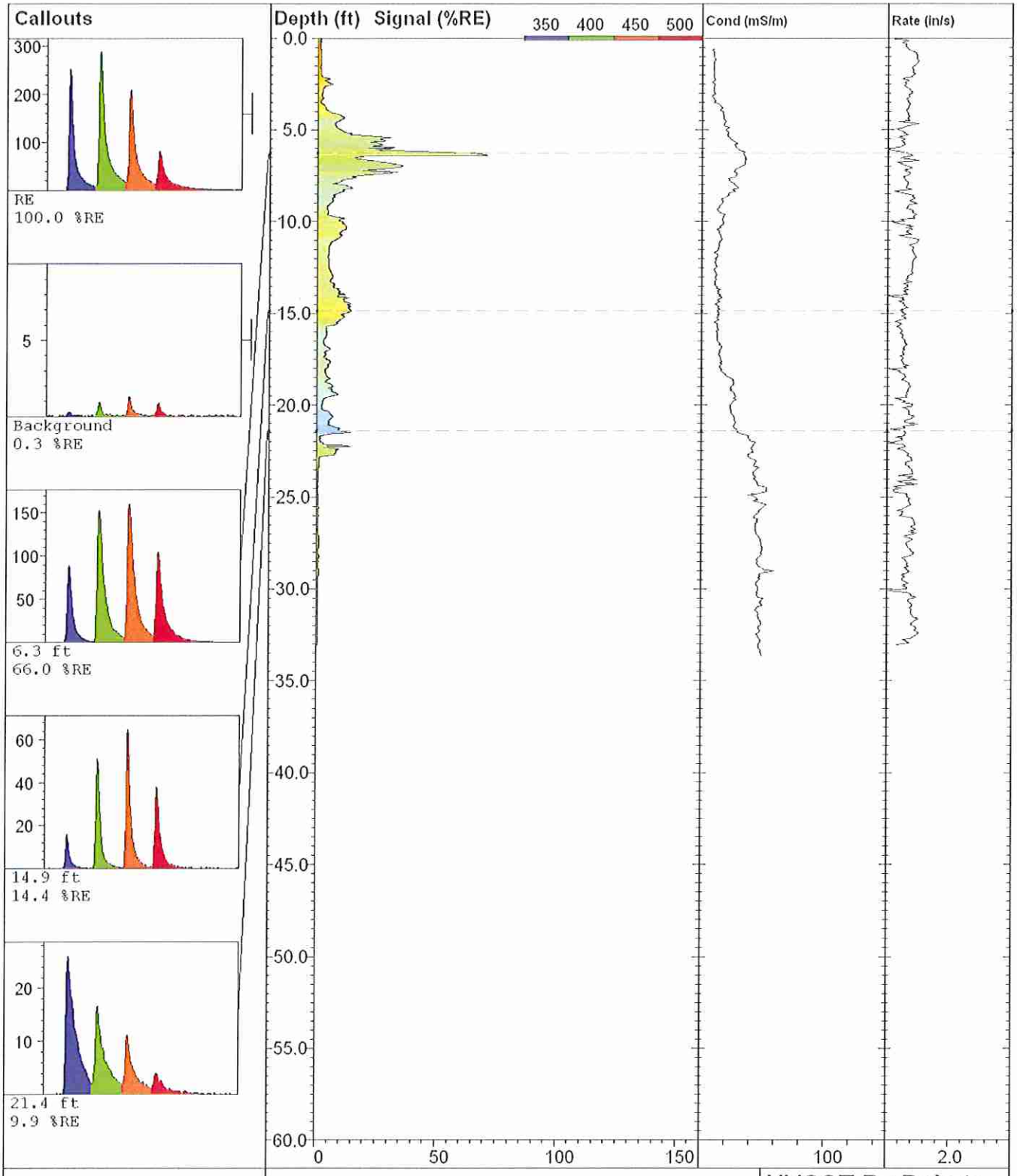
www.matrixenv.com

L-2

UVOST By Dakota

www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 38.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 146.9 % @ 6.16 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 11:21 CDT



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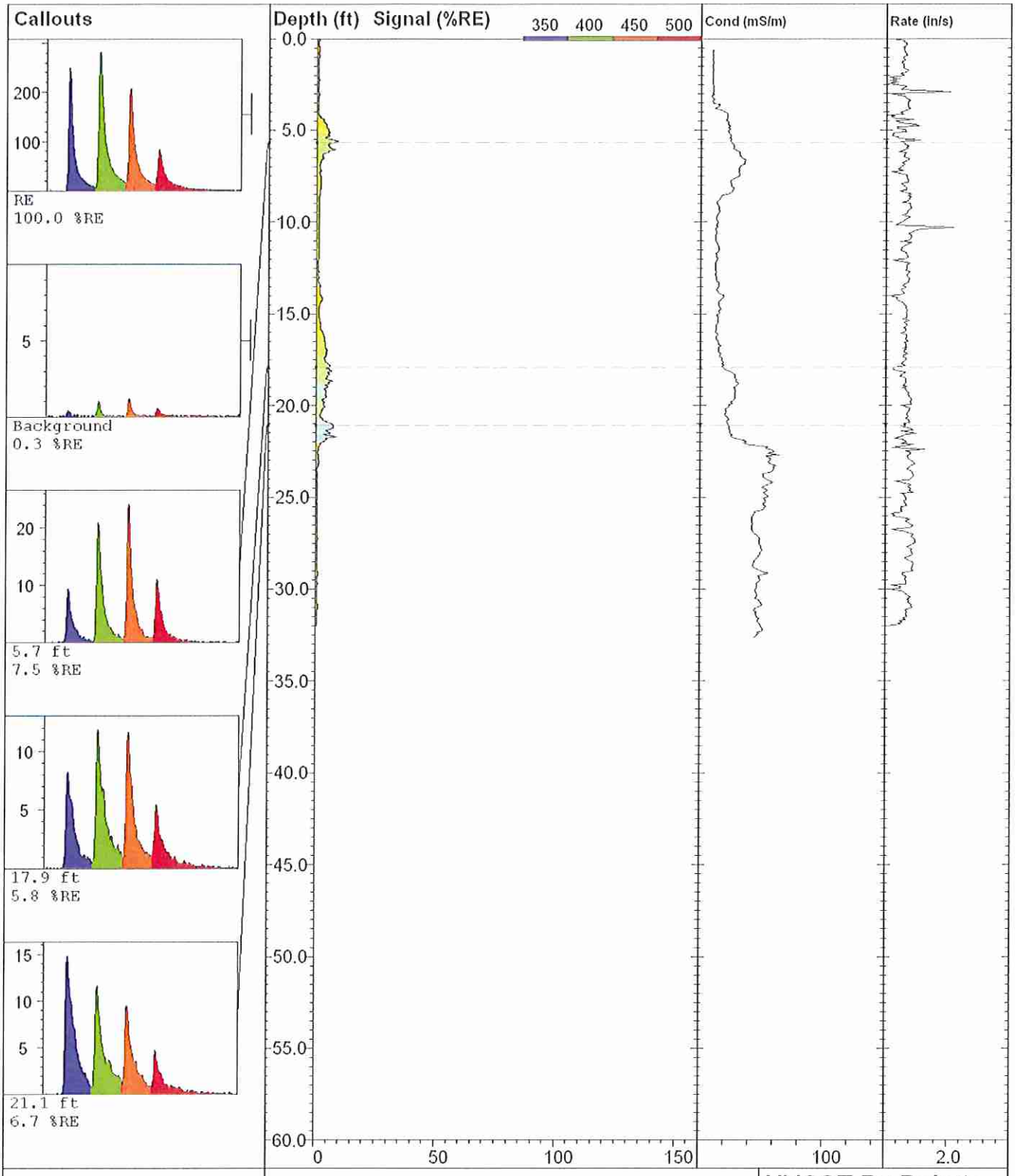
www.matrixenv.com

L-3

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 33.02 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 70.8 % @ 6.39 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 13:13 CDT



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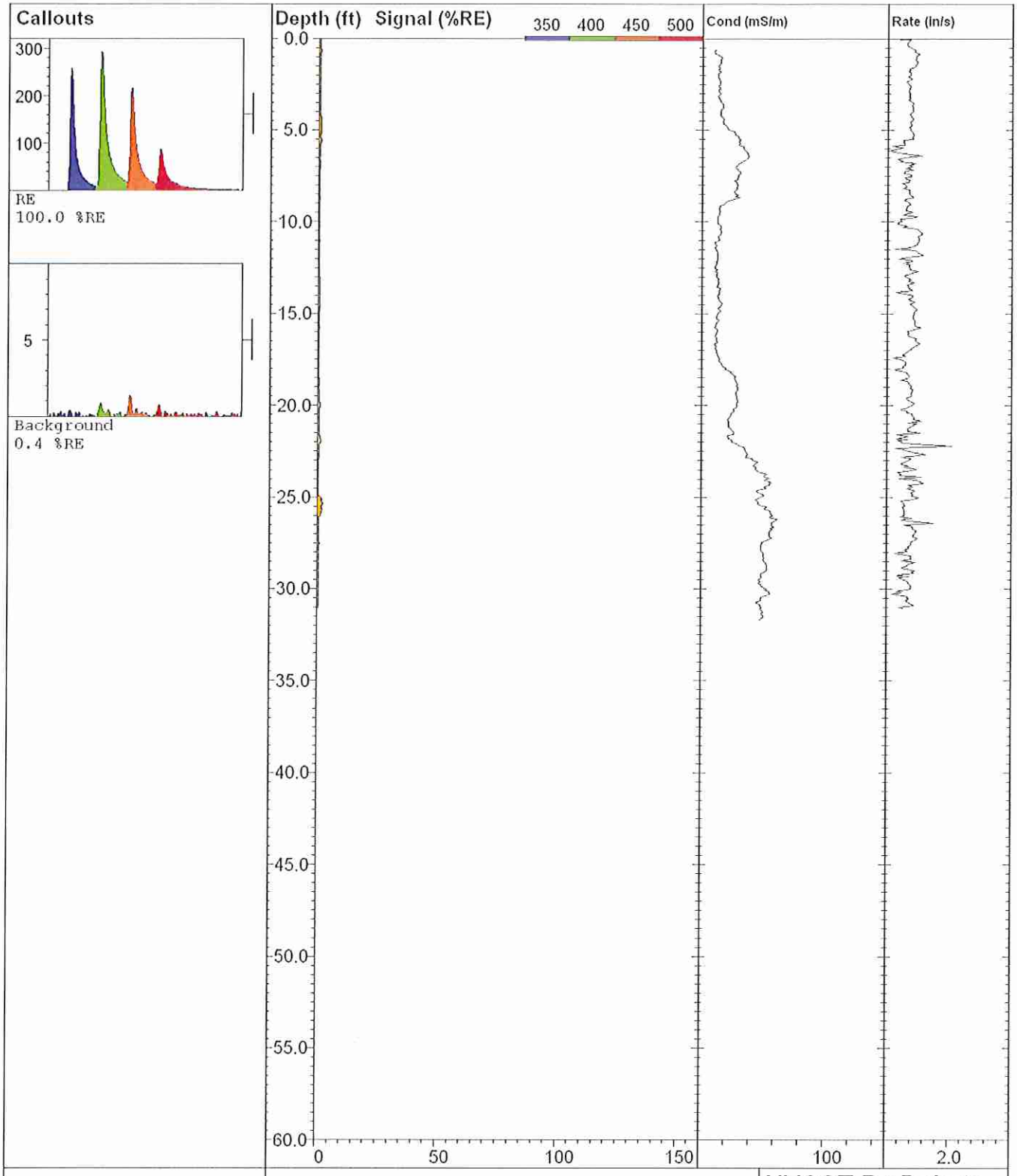
L-4

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.01 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 8.7 % @ 5.62 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 13:48 CDT

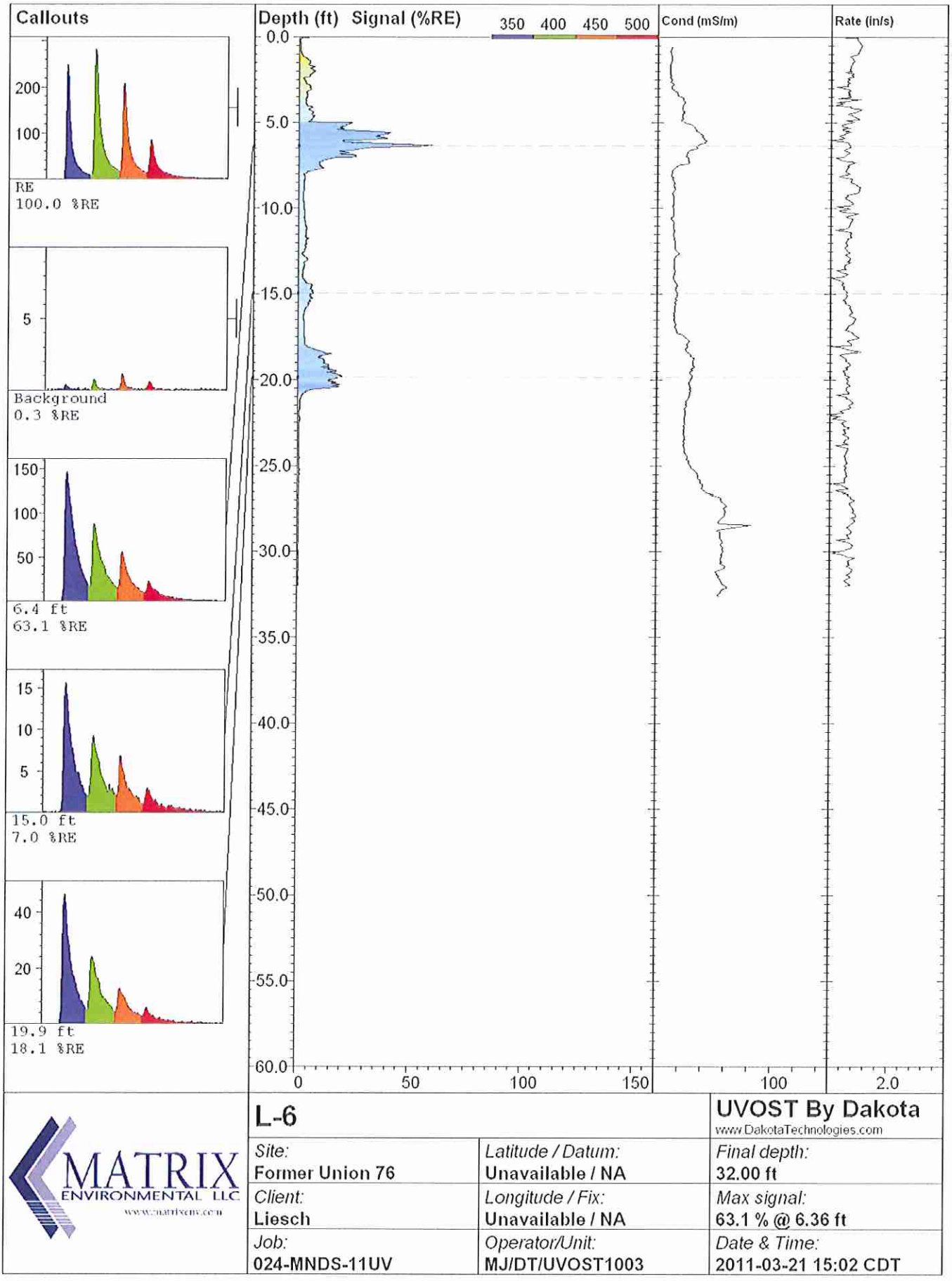


MATRIX ENVIRONMENTAL LLC
www.matrixenv.com

L-5

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 31.05 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 2.3 % @ 25.37 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 14:23 CDT



MATRIX ENVIRONMENTAL LLC

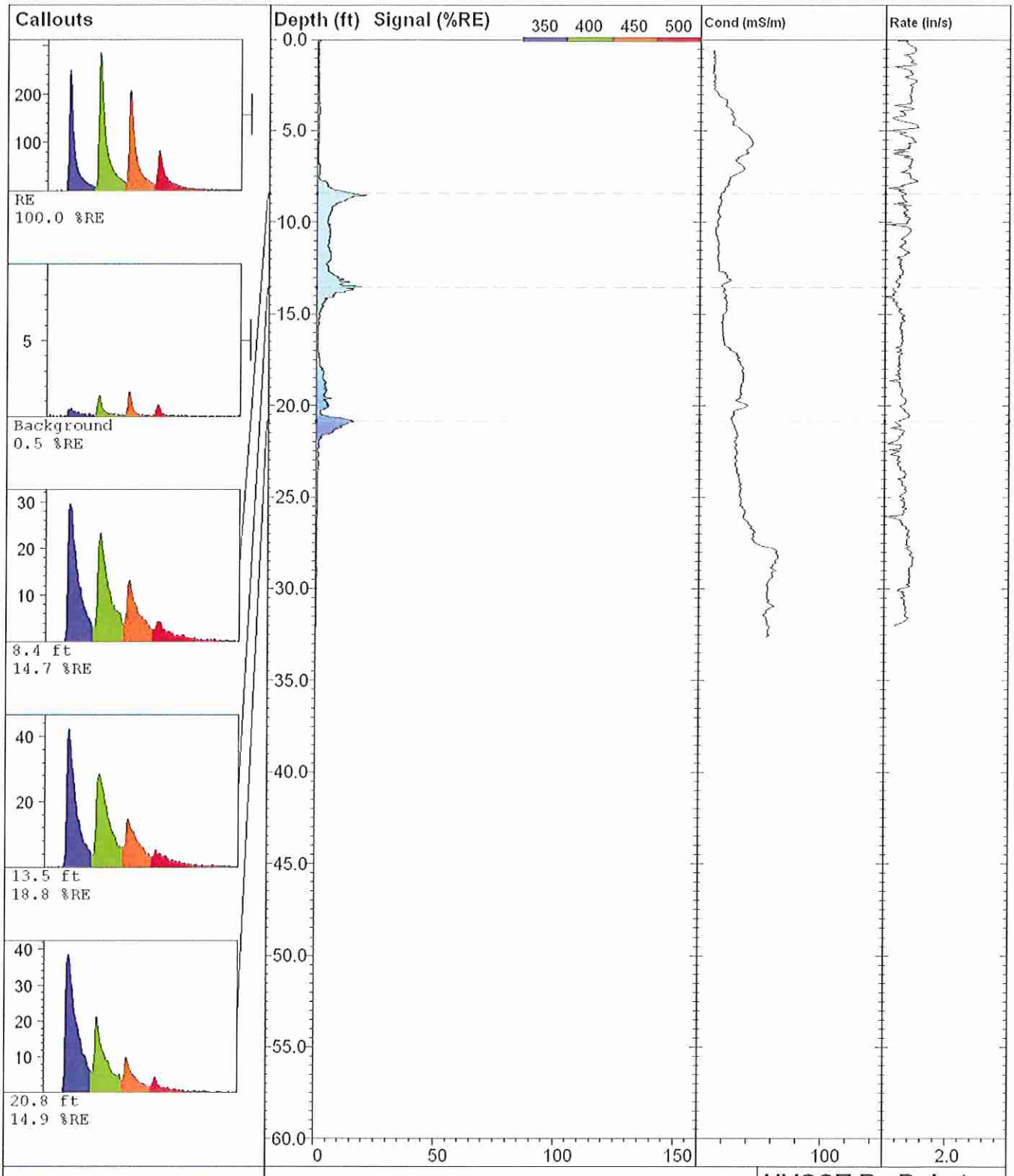
www.matrixenv.com

L-6

UVOST By Dakota

www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 63.1 % @ 6.36 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 15:02 CDT

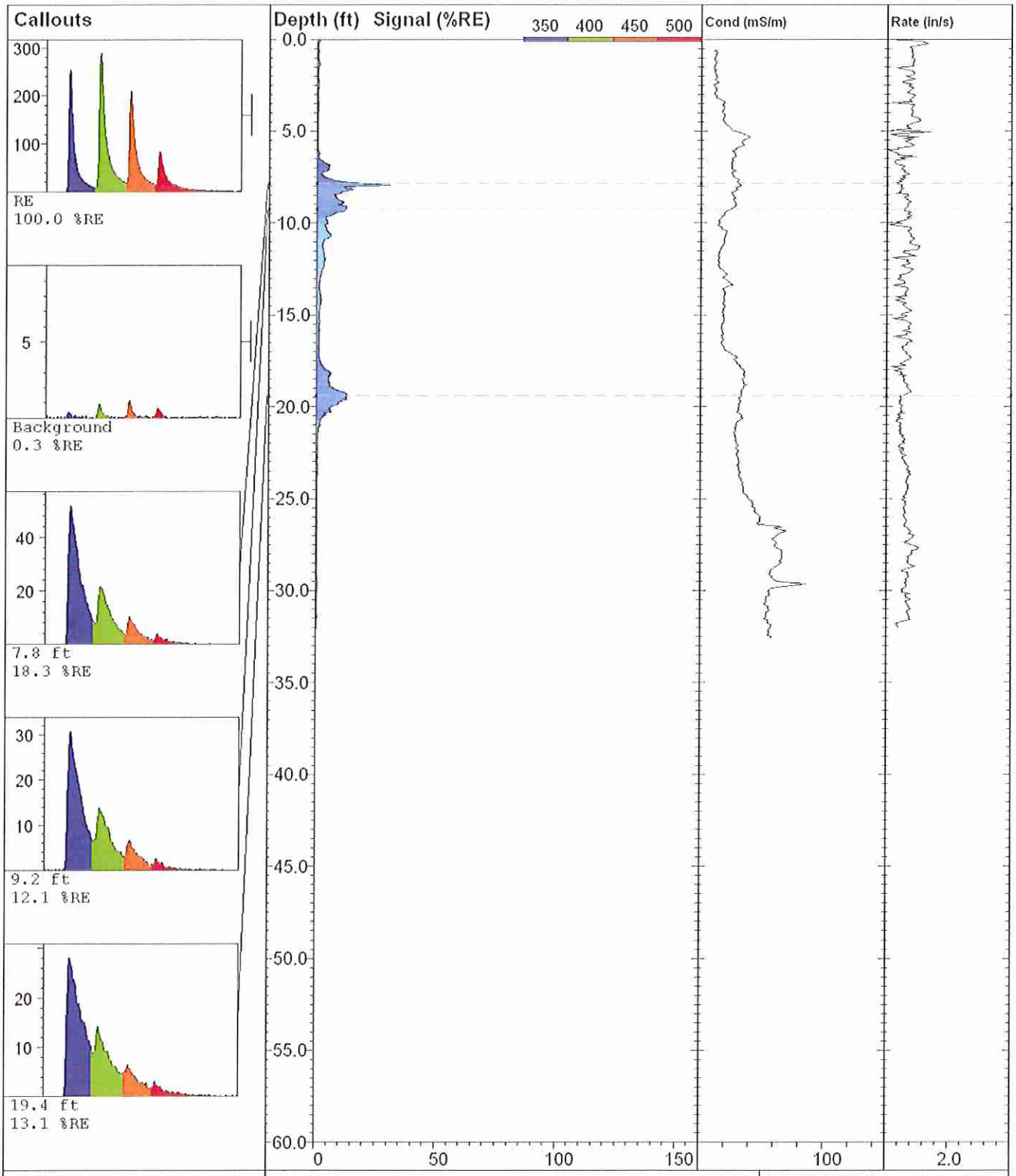


MATRIX ENVIRONMENTAL LLC
www.matrixenv.com

L-7

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.03 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 20.7 % @ 8.55 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 15:31 CDT



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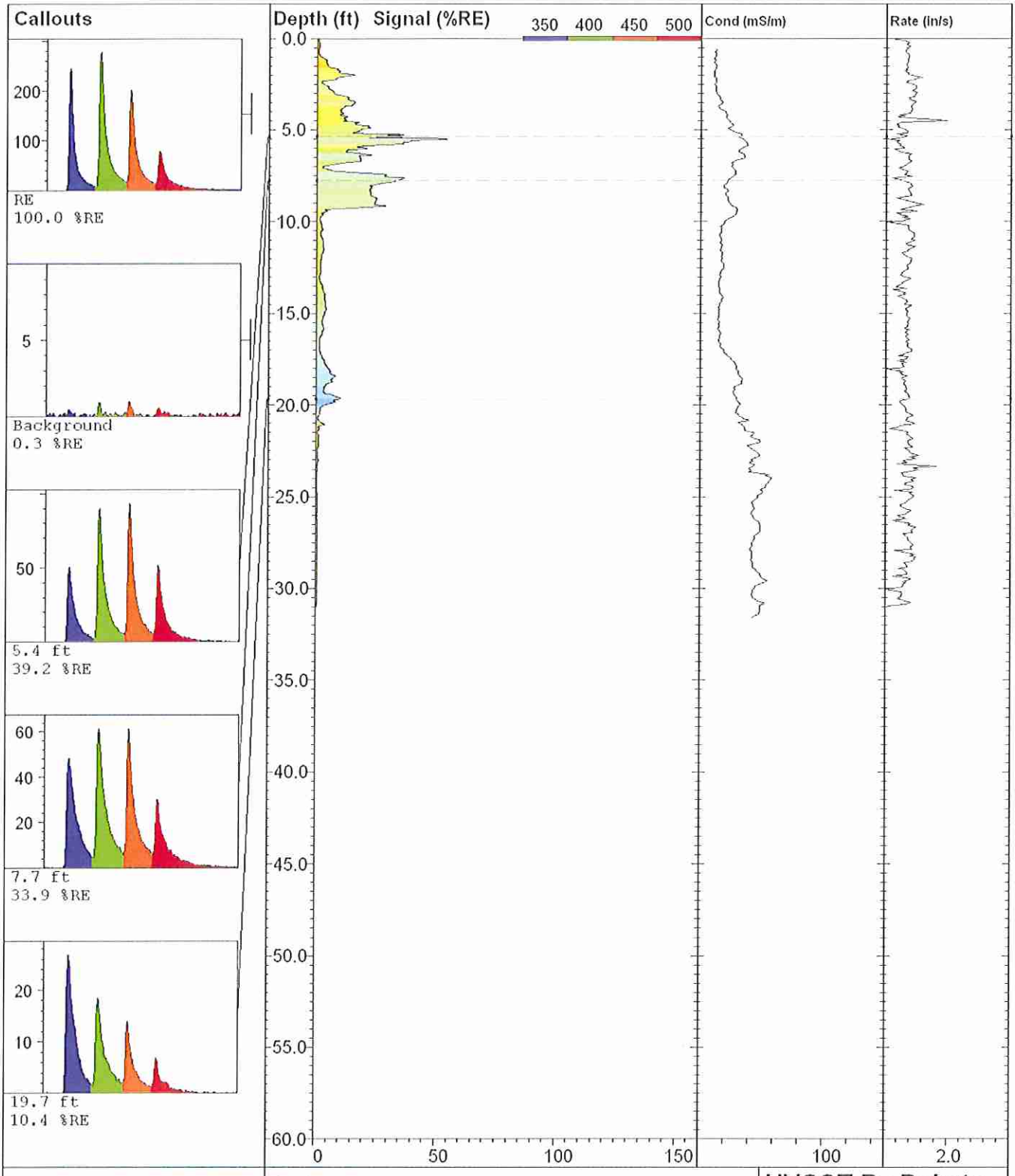
L-8

UVOST By Dakota

www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.02 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 30.4 % @ 7.95 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 16:04 CDT



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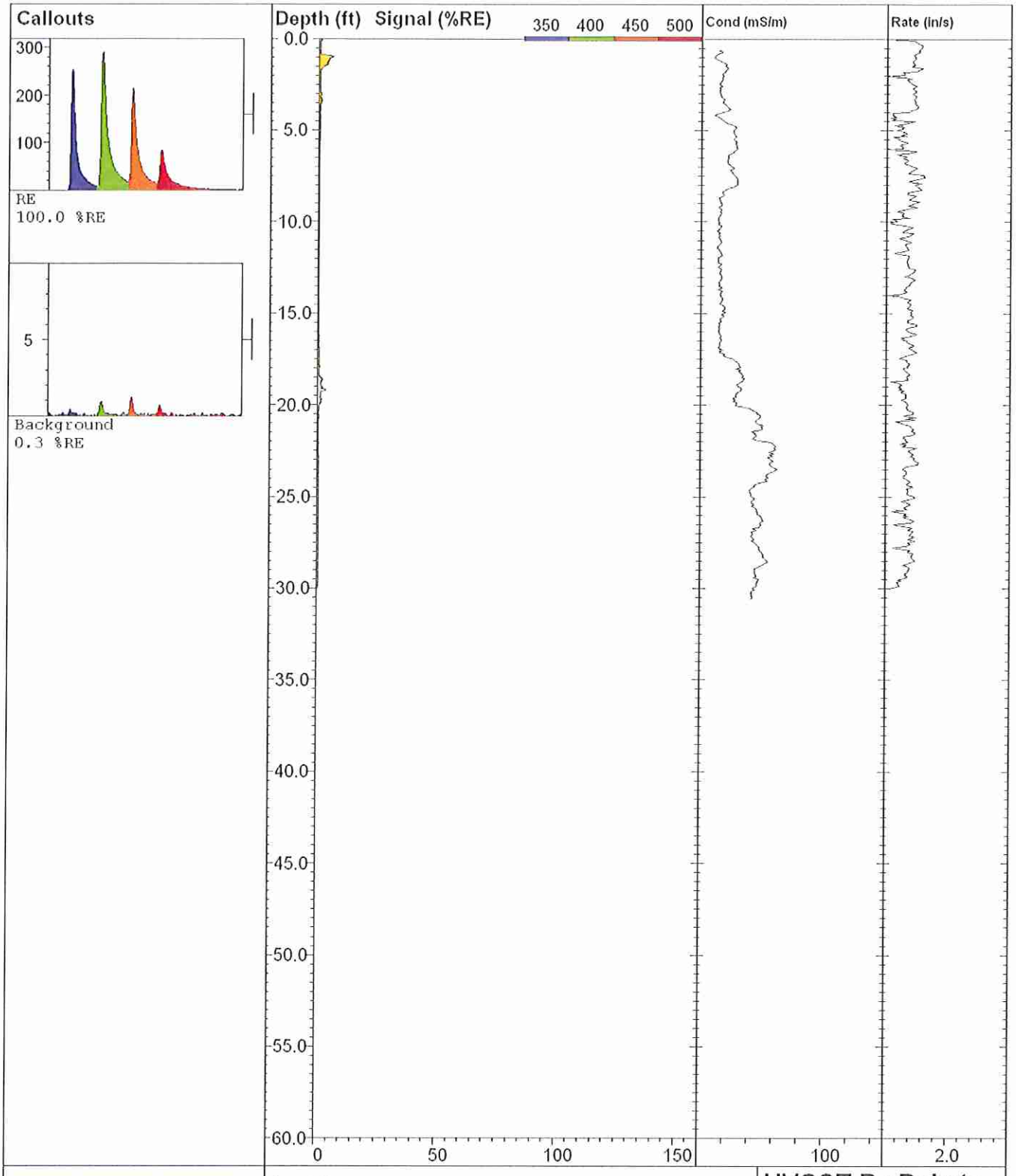
L-9

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 30.98 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 54.3 % @ 5.53 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 16:34 CDT



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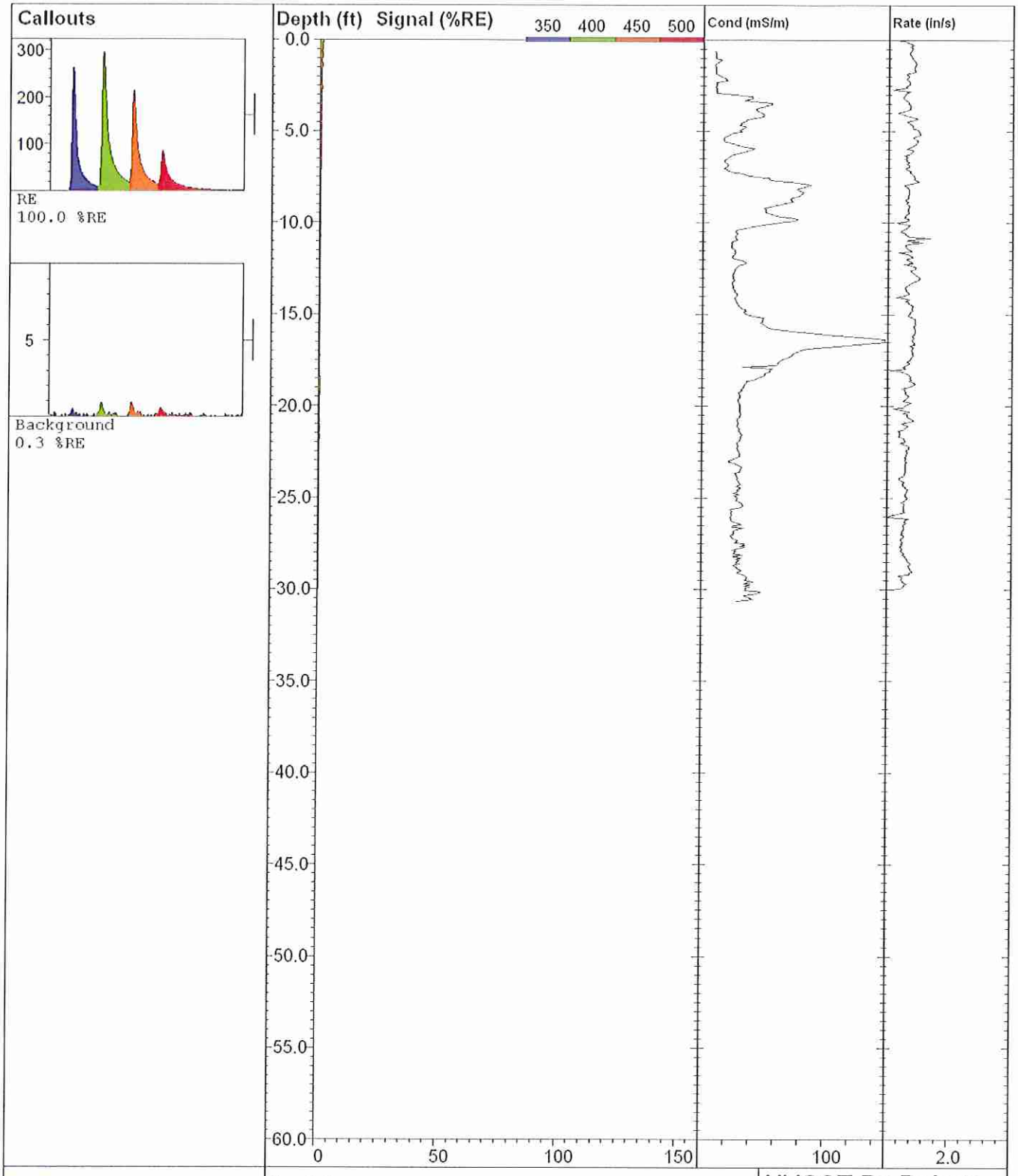
L-10

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 30.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 6.2 % @ 0.97 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-21 17:01 CDT



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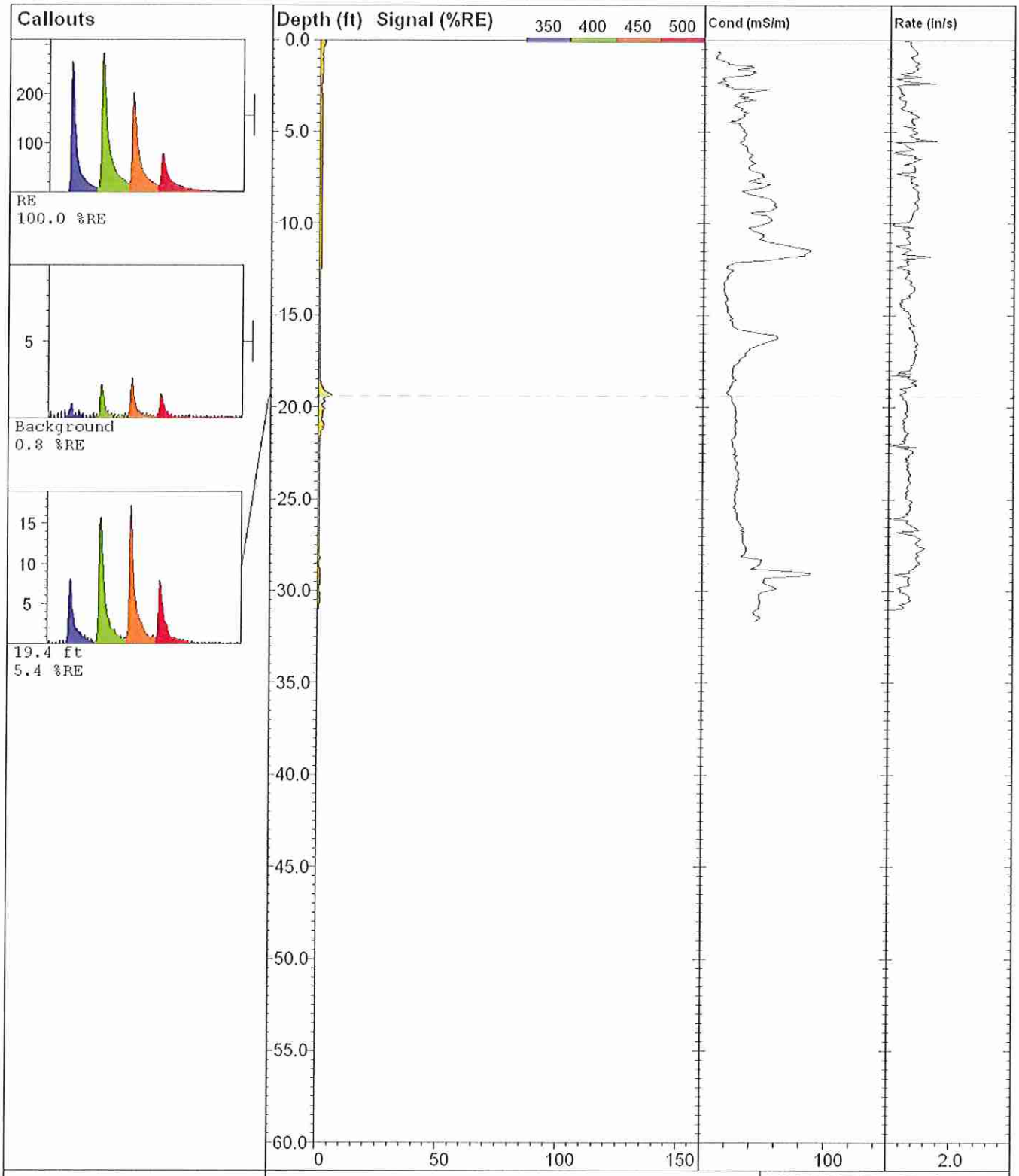
L-11

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 30.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 1.5 % @ 0.01 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 09:26 CDT



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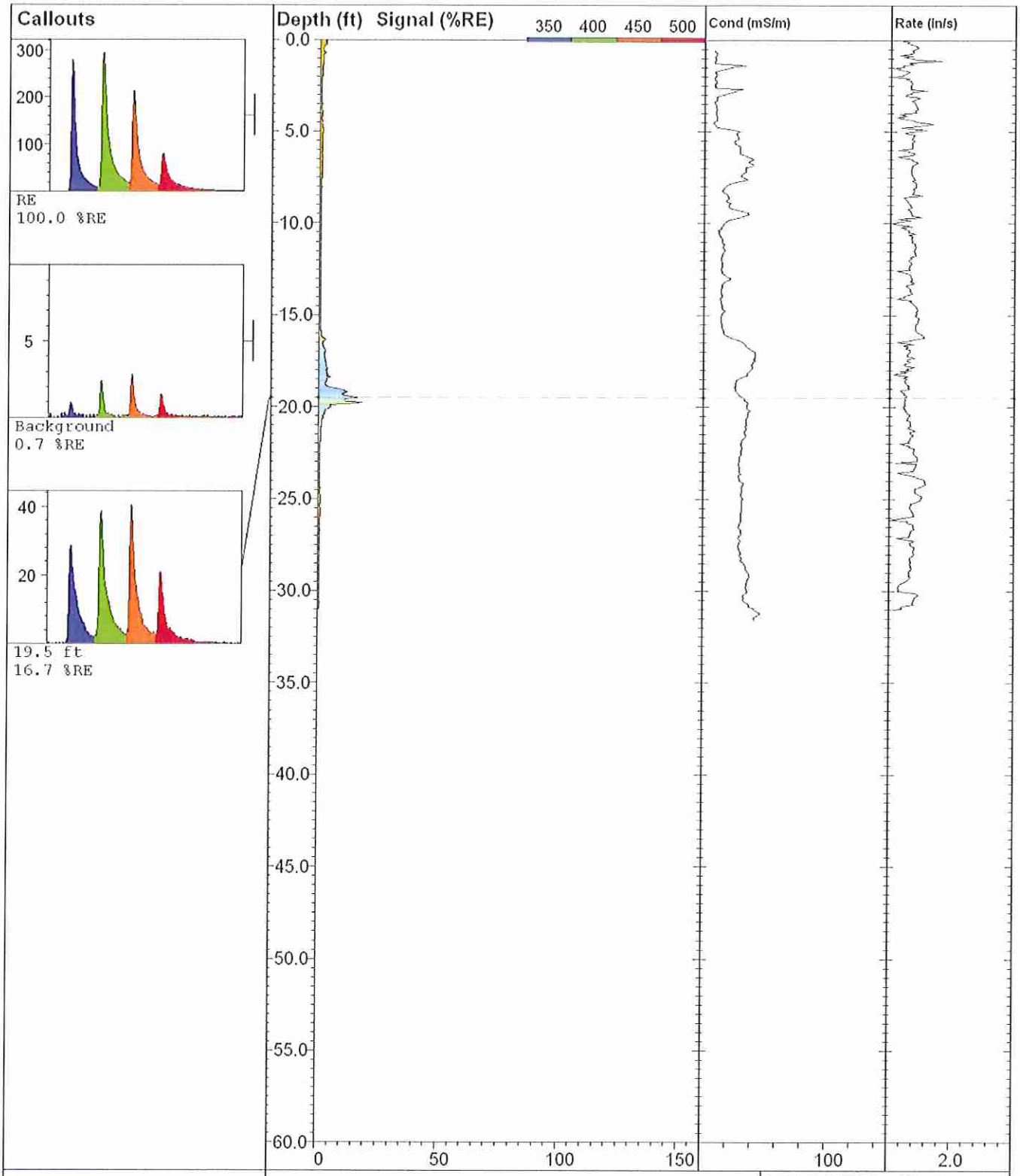
L-12

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 31.01 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 5.5 % @ 19.33 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 11:12 CDT



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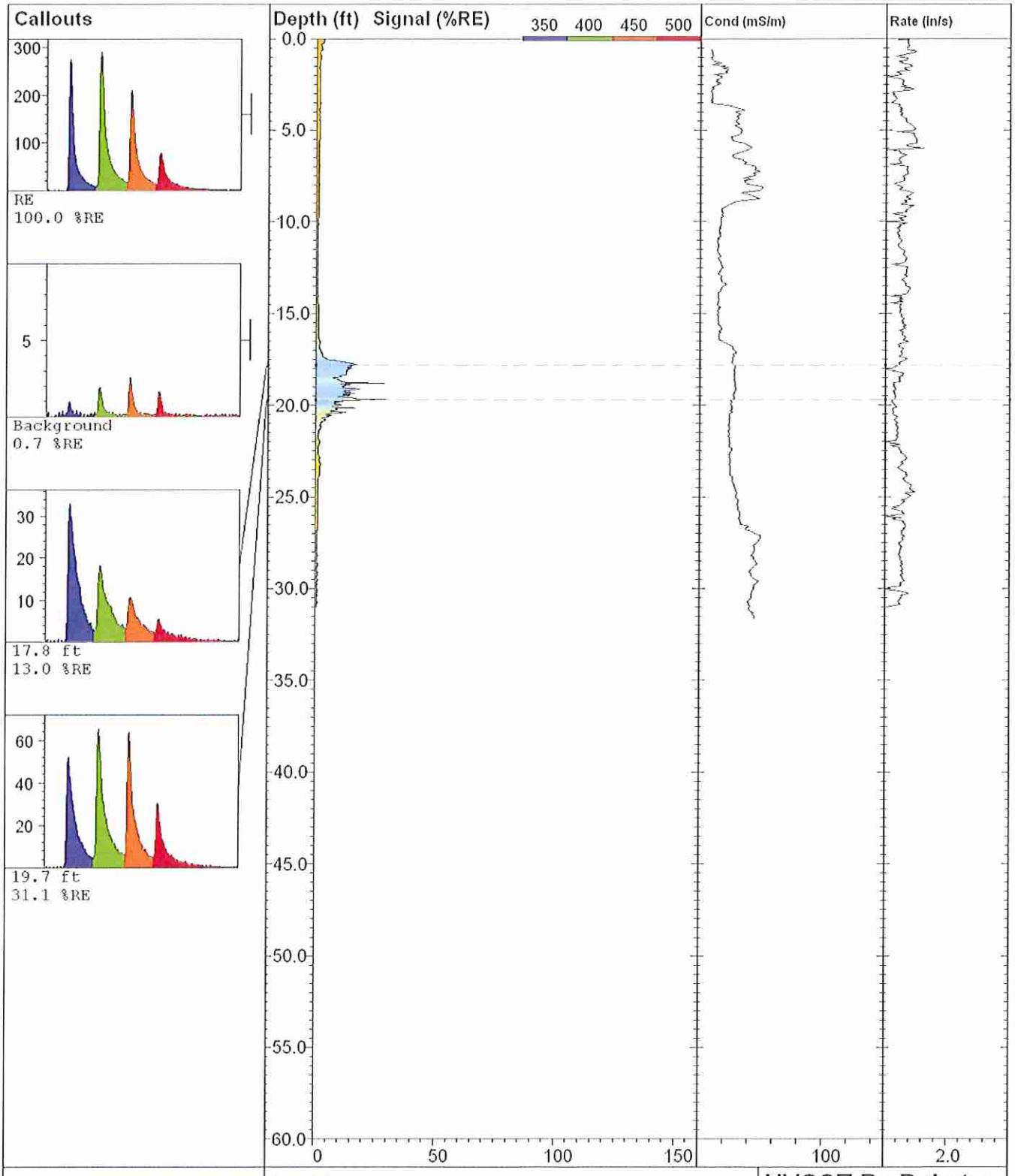
L-13

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 31.01 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 18.4 % @ 19.77 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 11:41 CDT



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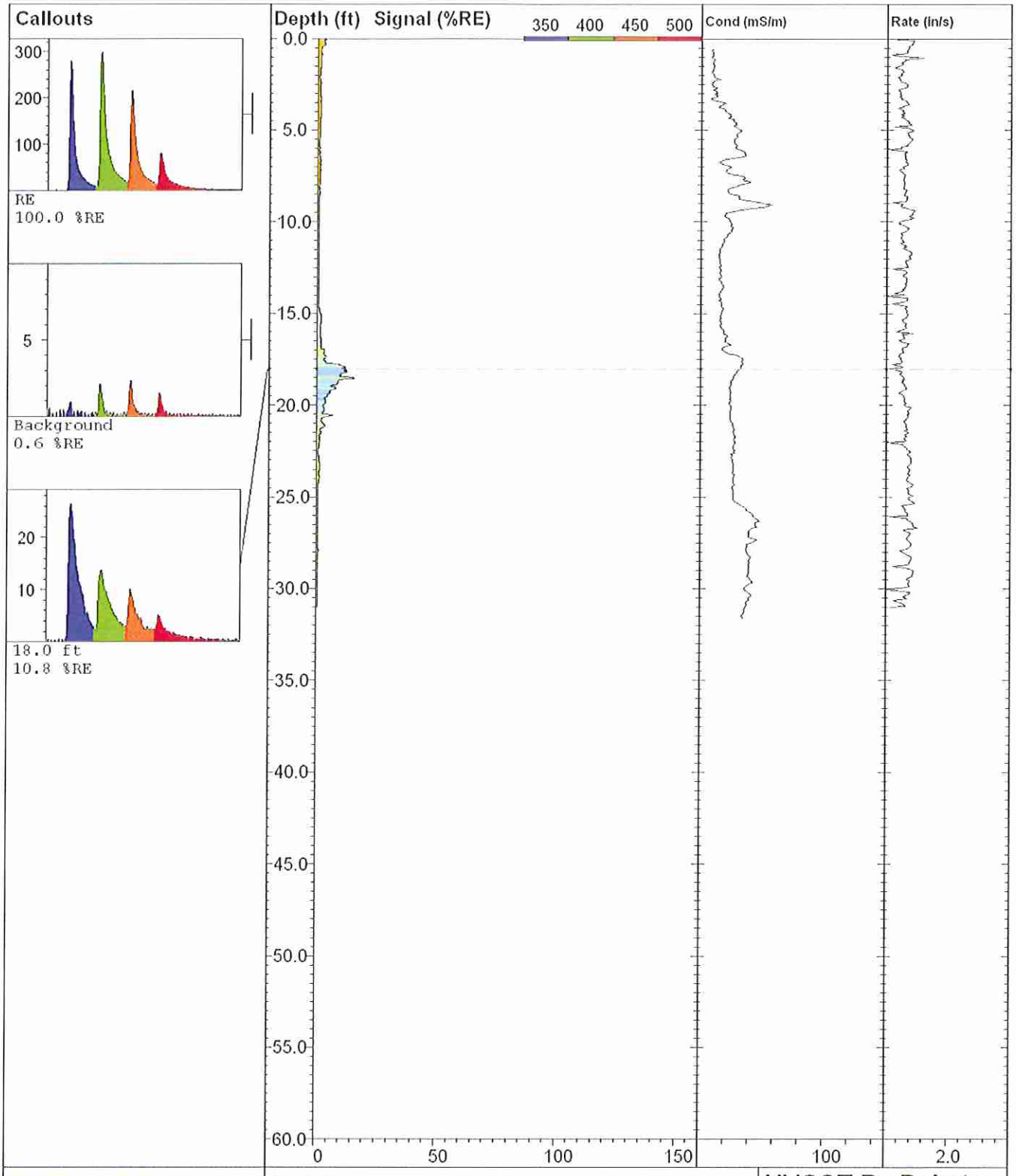
L-14

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 31.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 31.1 % @ 19.70 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 13:39 CDT



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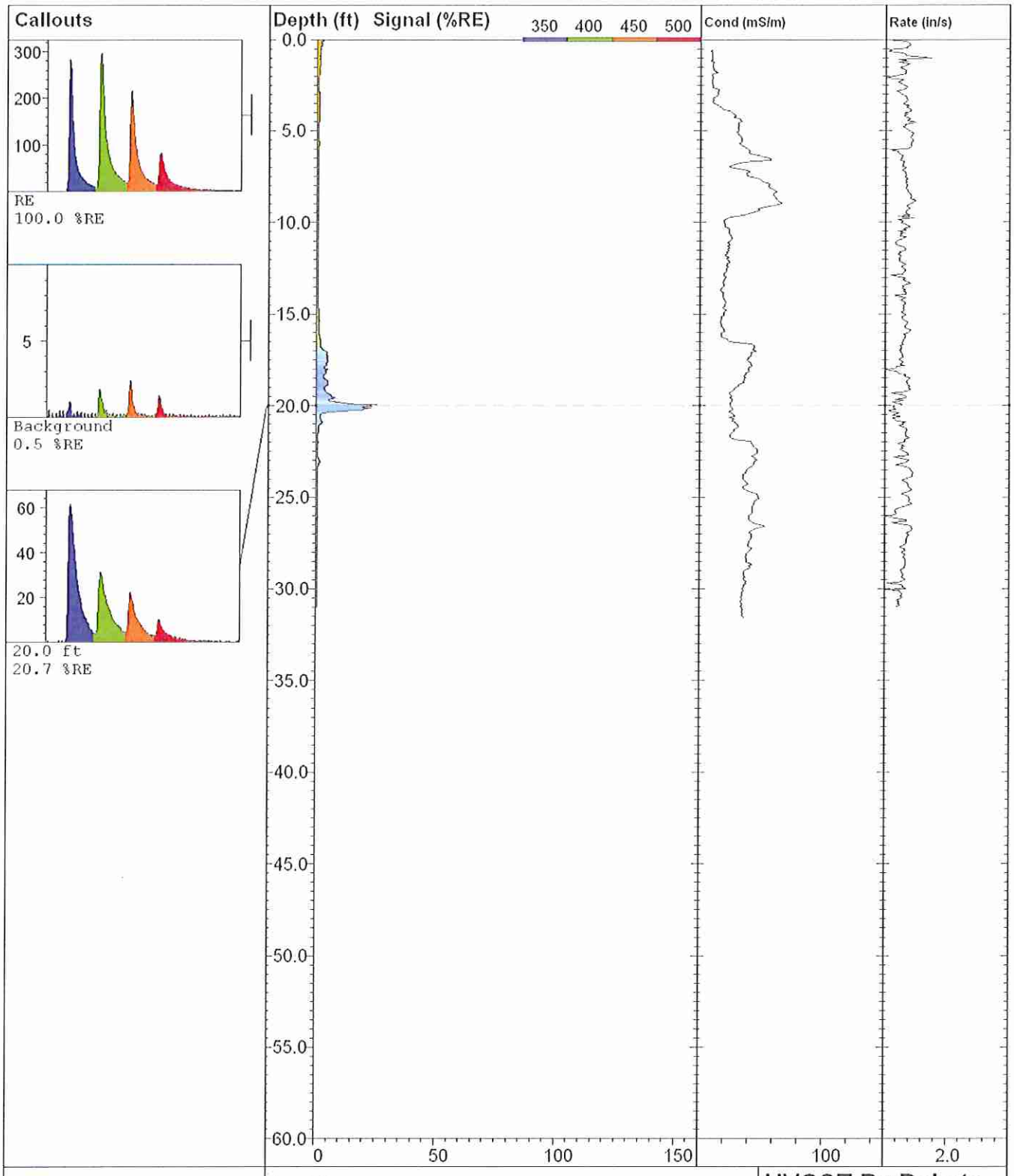
L-15

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 31.01 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 15.8 % @ 18.56 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 14:13 CDT

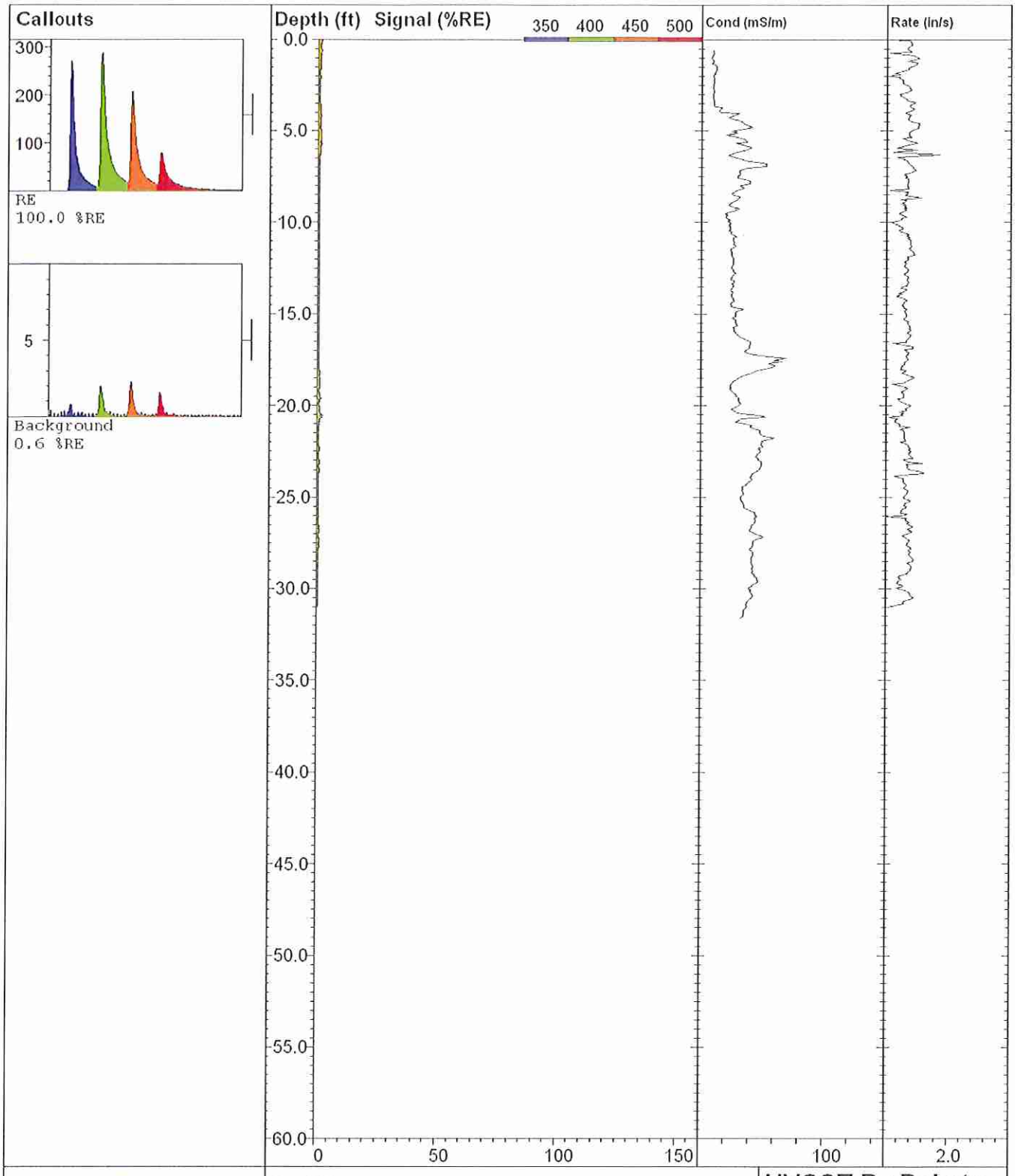


MATRIX ENVIRONMENTAL LLC

L-16

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 31.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 25.4 % @ 19.96 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 14:47 CDT



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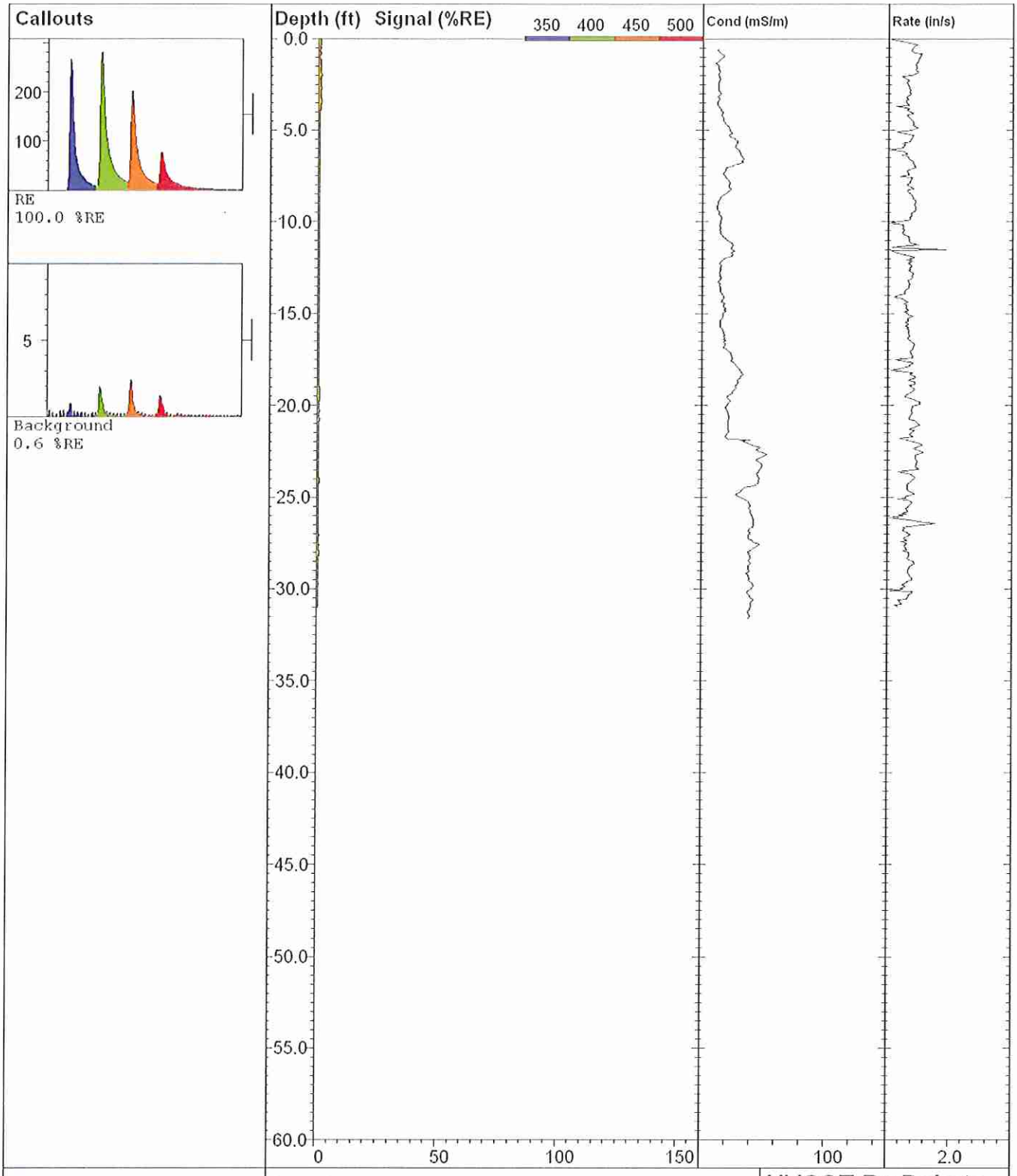
L-17

UVOST By Dakota
www.DakotaTechnologies.com

Site: **Former Union 76**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **31.00 ft**
Client: **Liesch**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **2.3 % @ 20.54 ft**
Job: **024-MNDS-11UV**	*Operator/Unit:* **MJ/DT/UVOST1003**	*Date & Time:* **2011-03-22 15:16 CDT**



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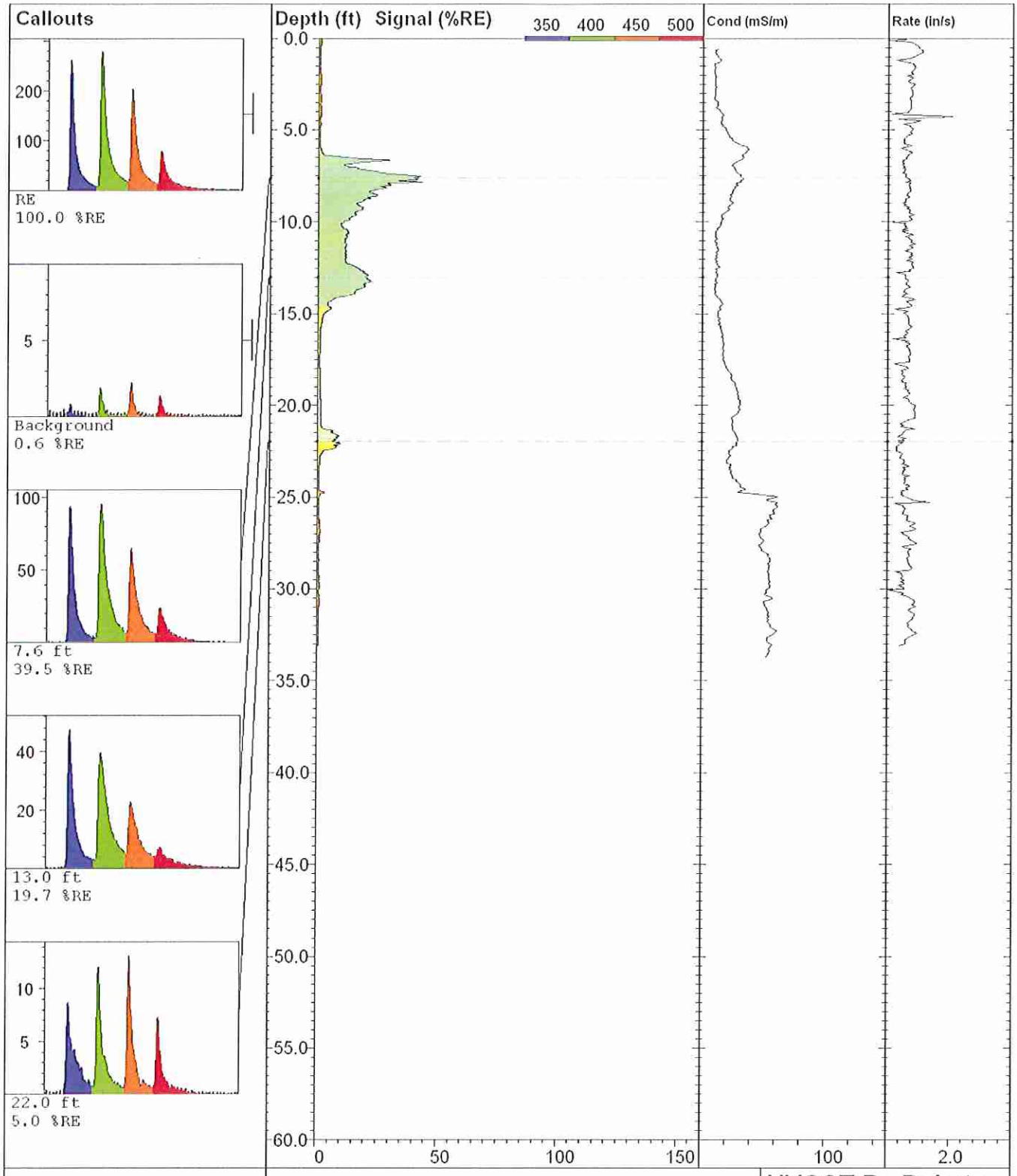
L-18

UVOST By Dakota

www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 31.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 1.6 % @ 2.02 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 15:44 CDT



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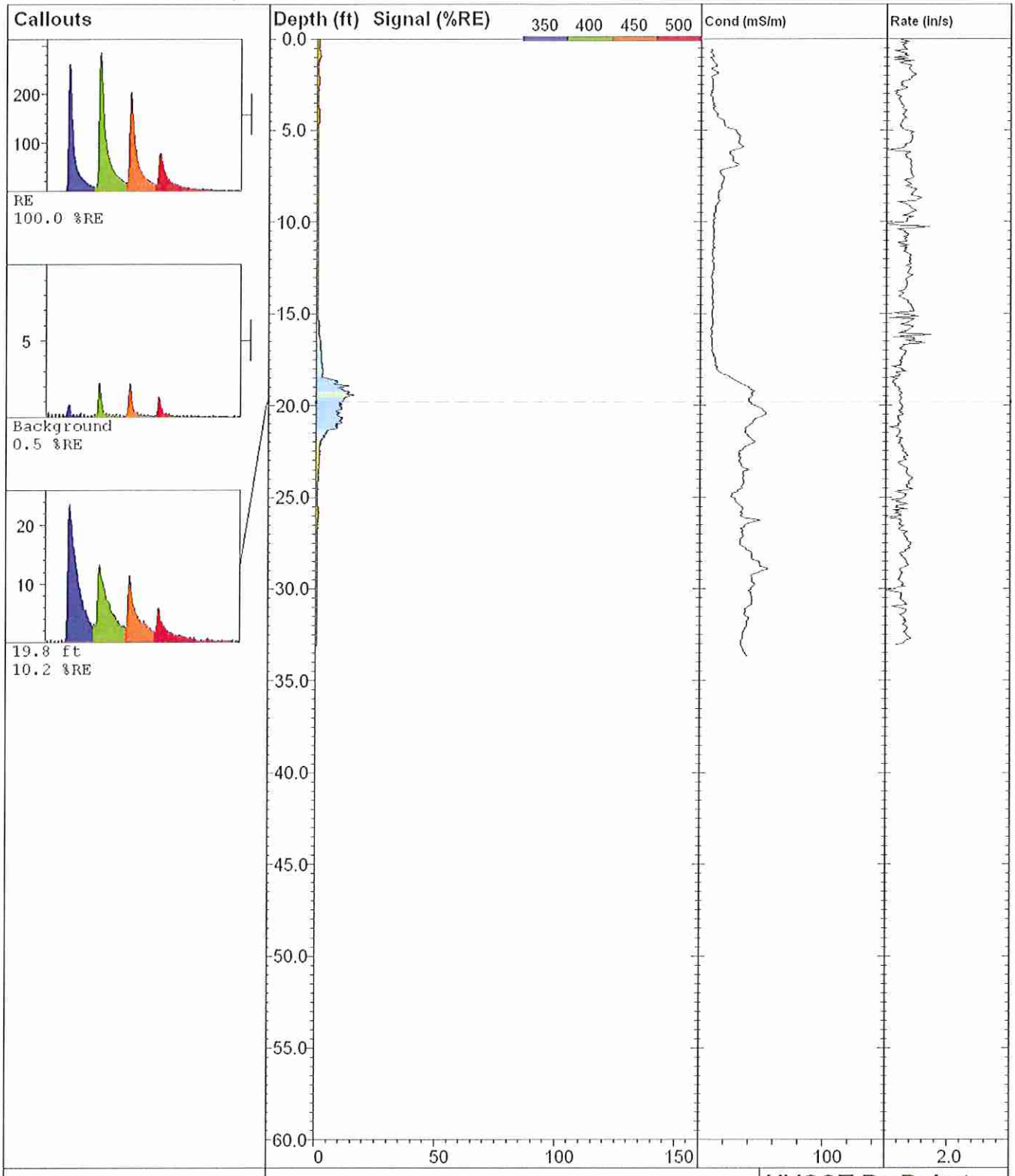
L-19

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 33.07 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 43.7 % @ 7.85 ft
Job: 024-MNDS-11UV	*Operator/Unit:* MJ/DT/UVOST1003	*Date & Time:* 2011-03-22 16:11 CDT



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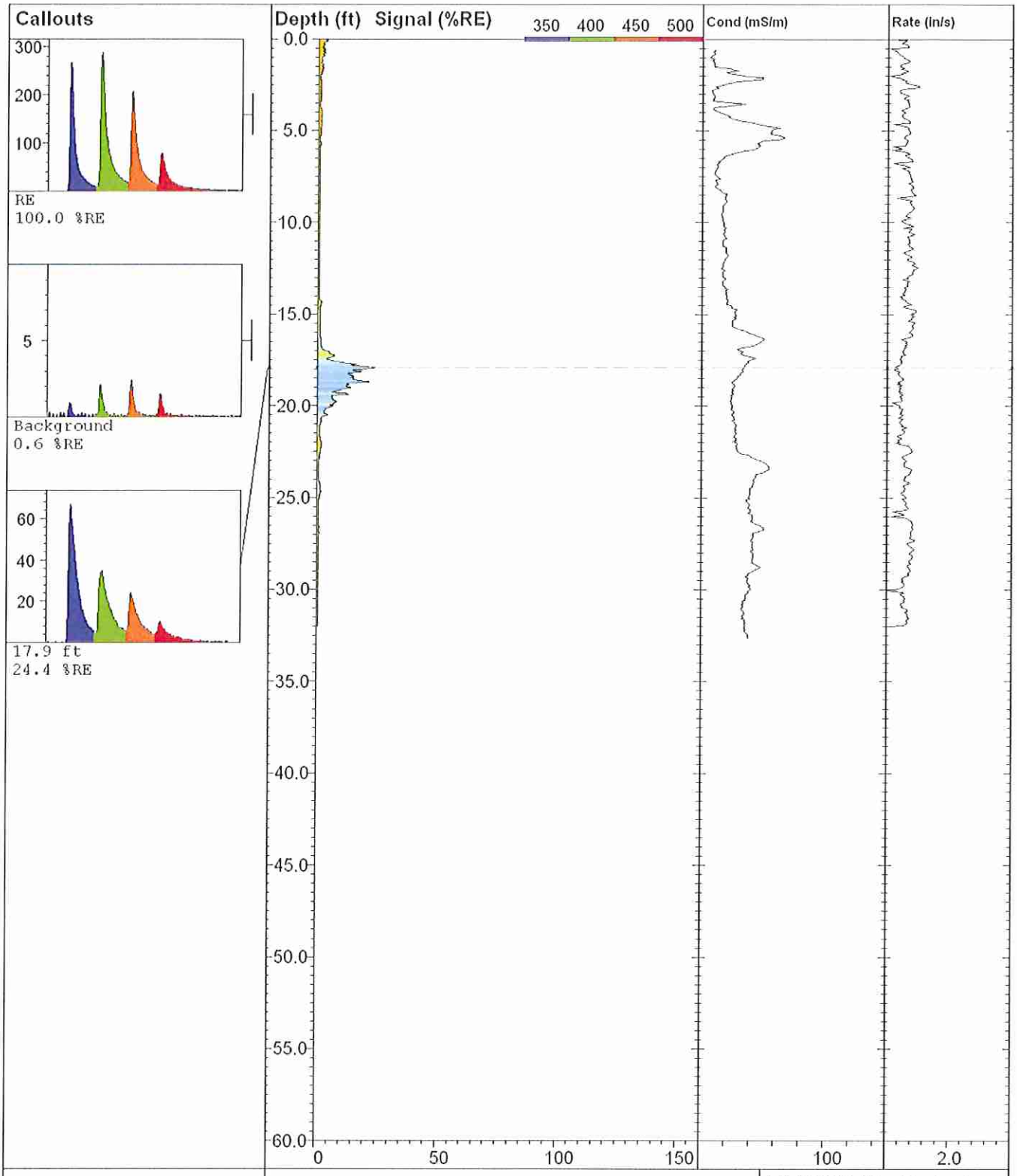
L-20

UVOST By Dakota

www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 33.06 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 15.8 % @ 19.43 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 08:48 CDT



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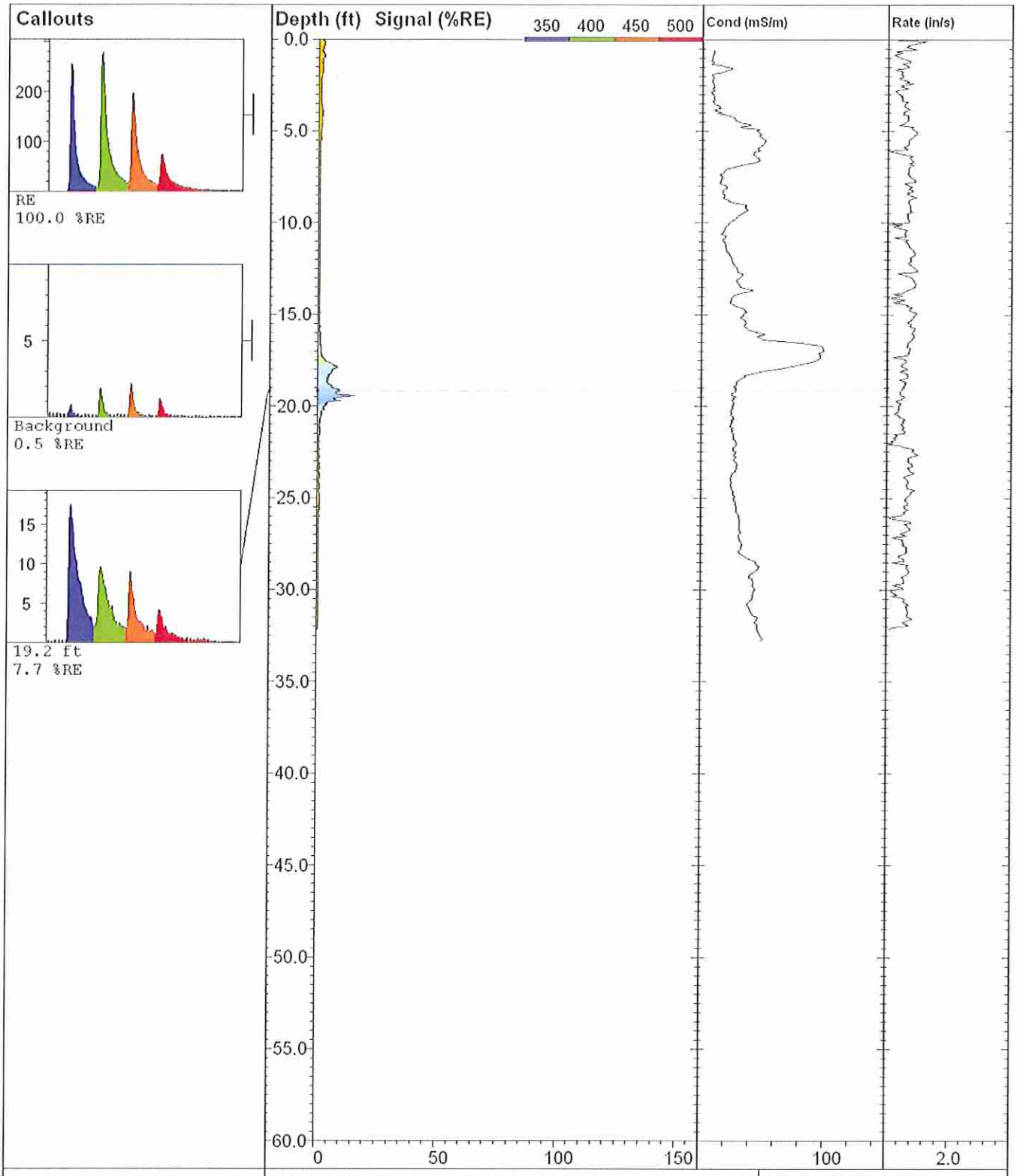
L-21

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 24.4 % @ 17.92 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 09:30 CDT



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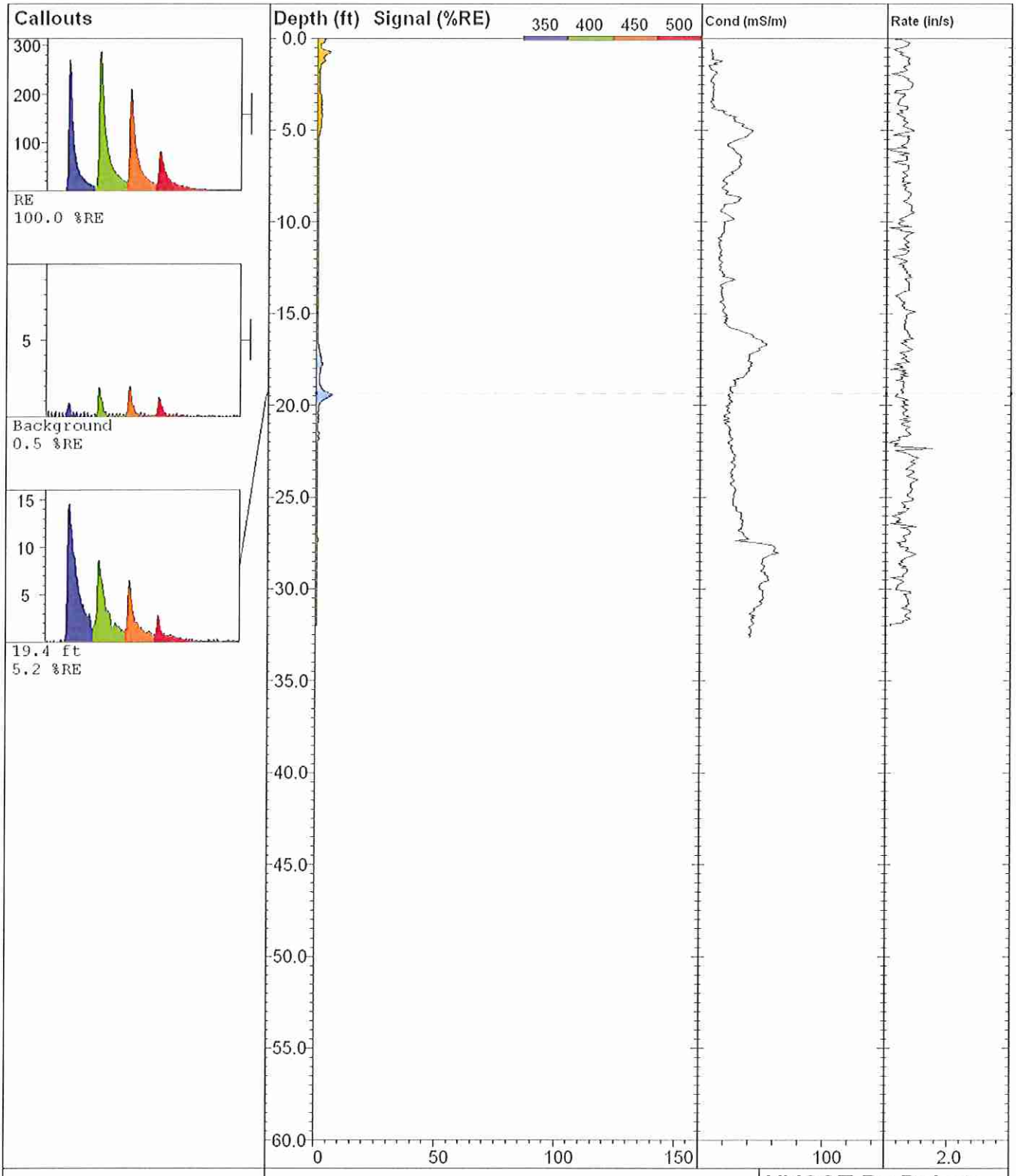
L-22

UVOST By Dakota

www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.13 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 15.5 % @ 19.45 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 10:08 CDT



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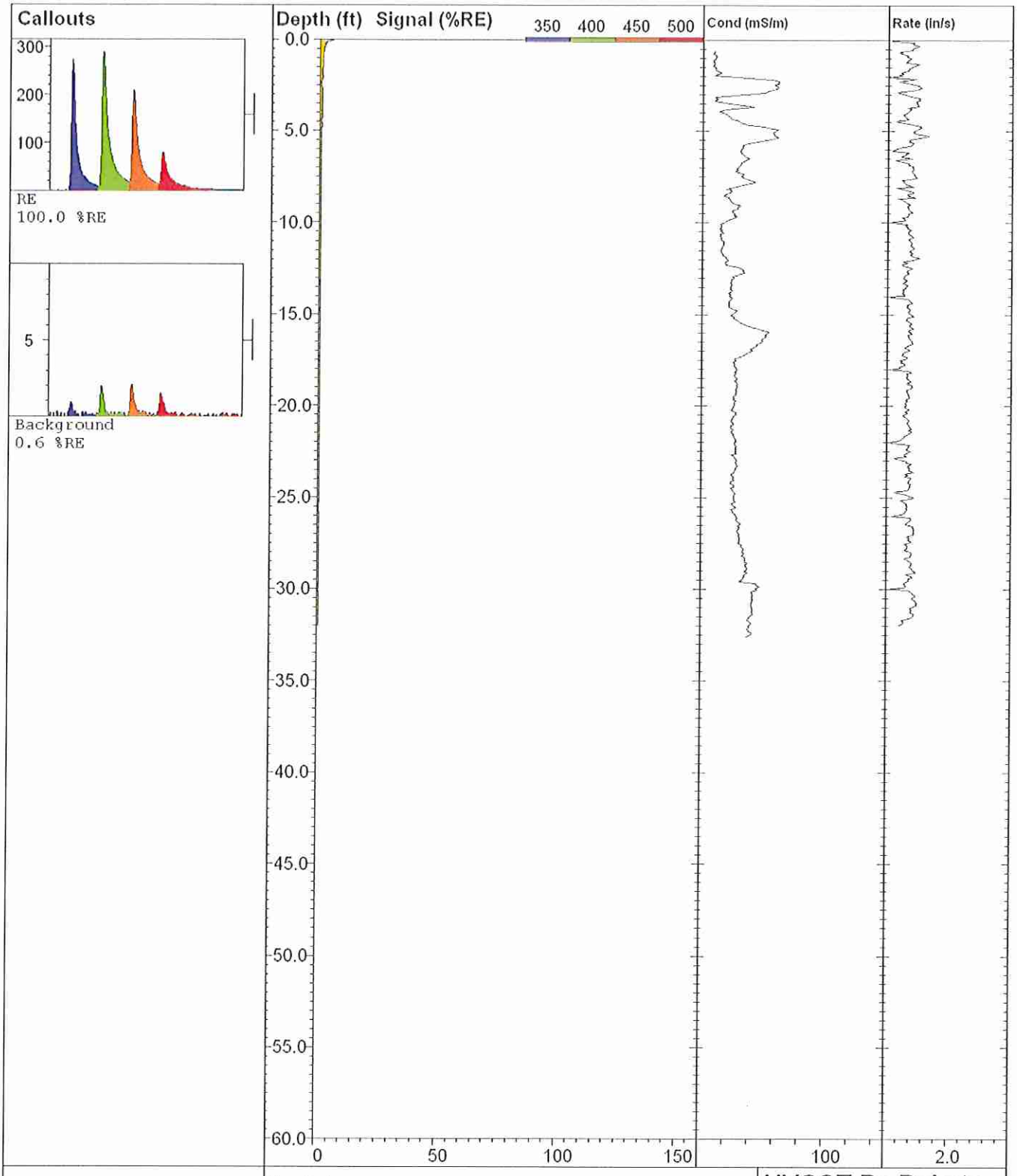
L-23

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.01 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 7.0 % @ 19.46 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 10:51 CDT



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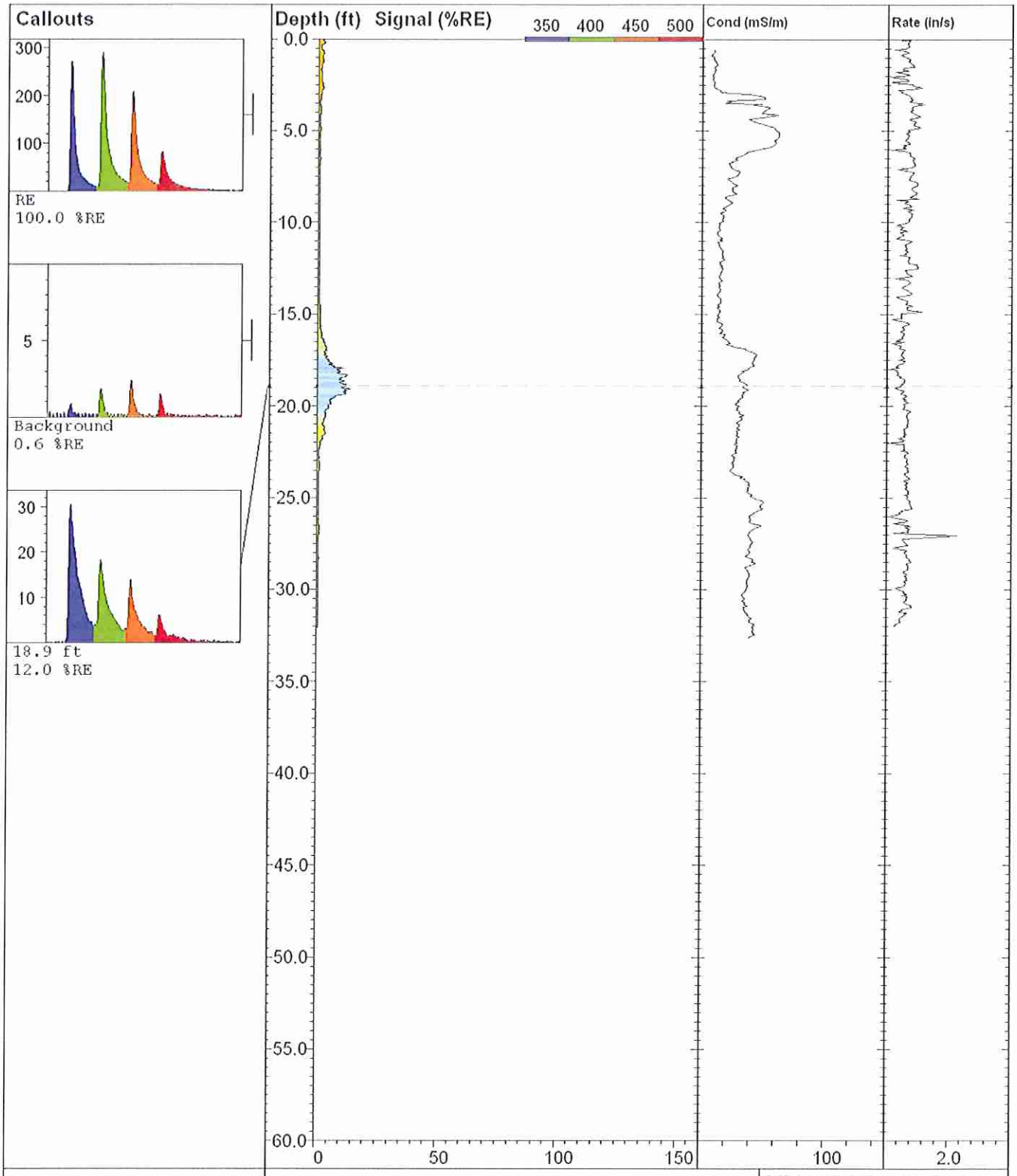
L-24

UVOST By Dakota

www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 6.2 % @ 0.01 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 11:30 CDT



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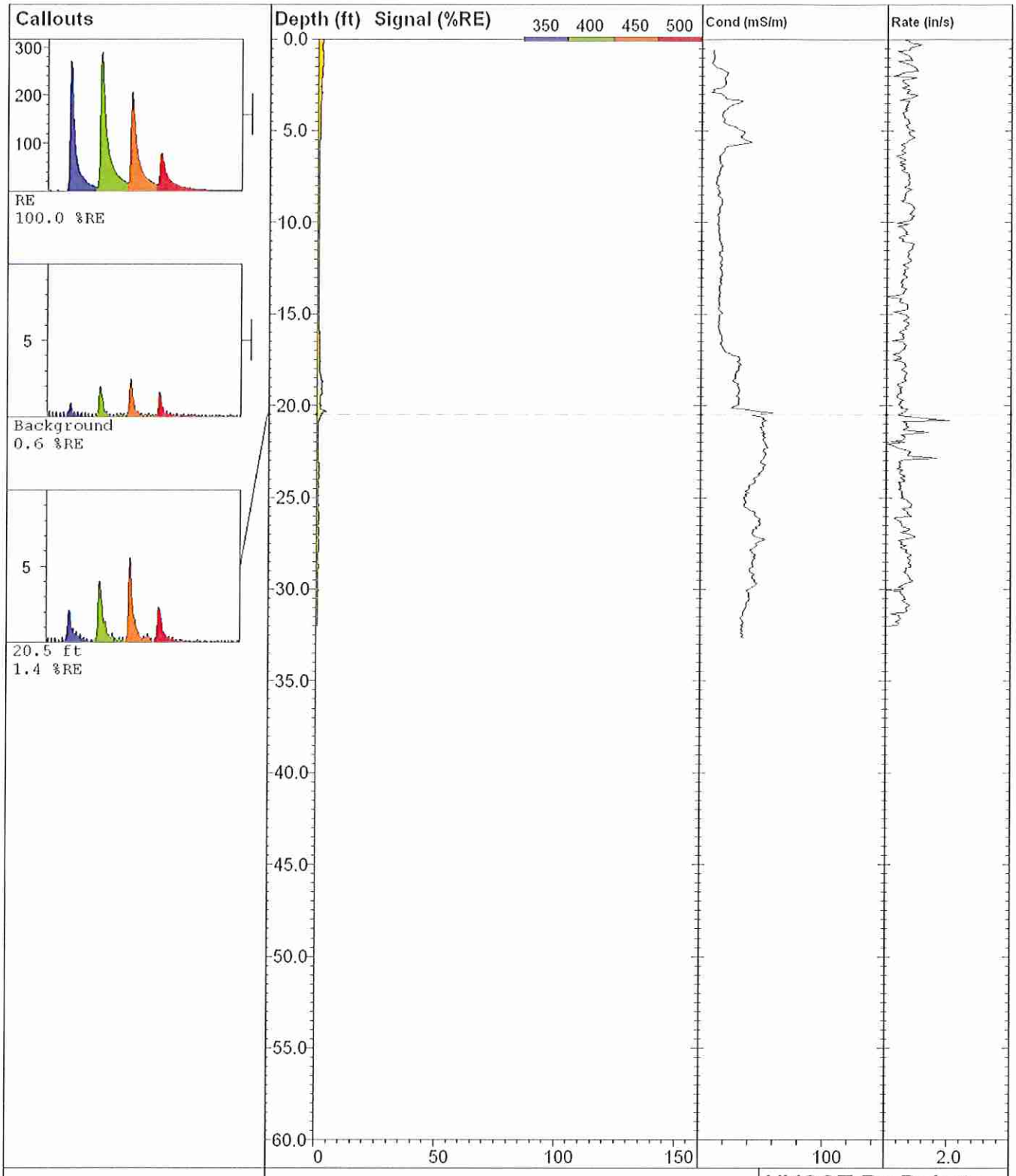
L-25

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.02 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 13.9 % @ 19.07 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 13:04 CDT



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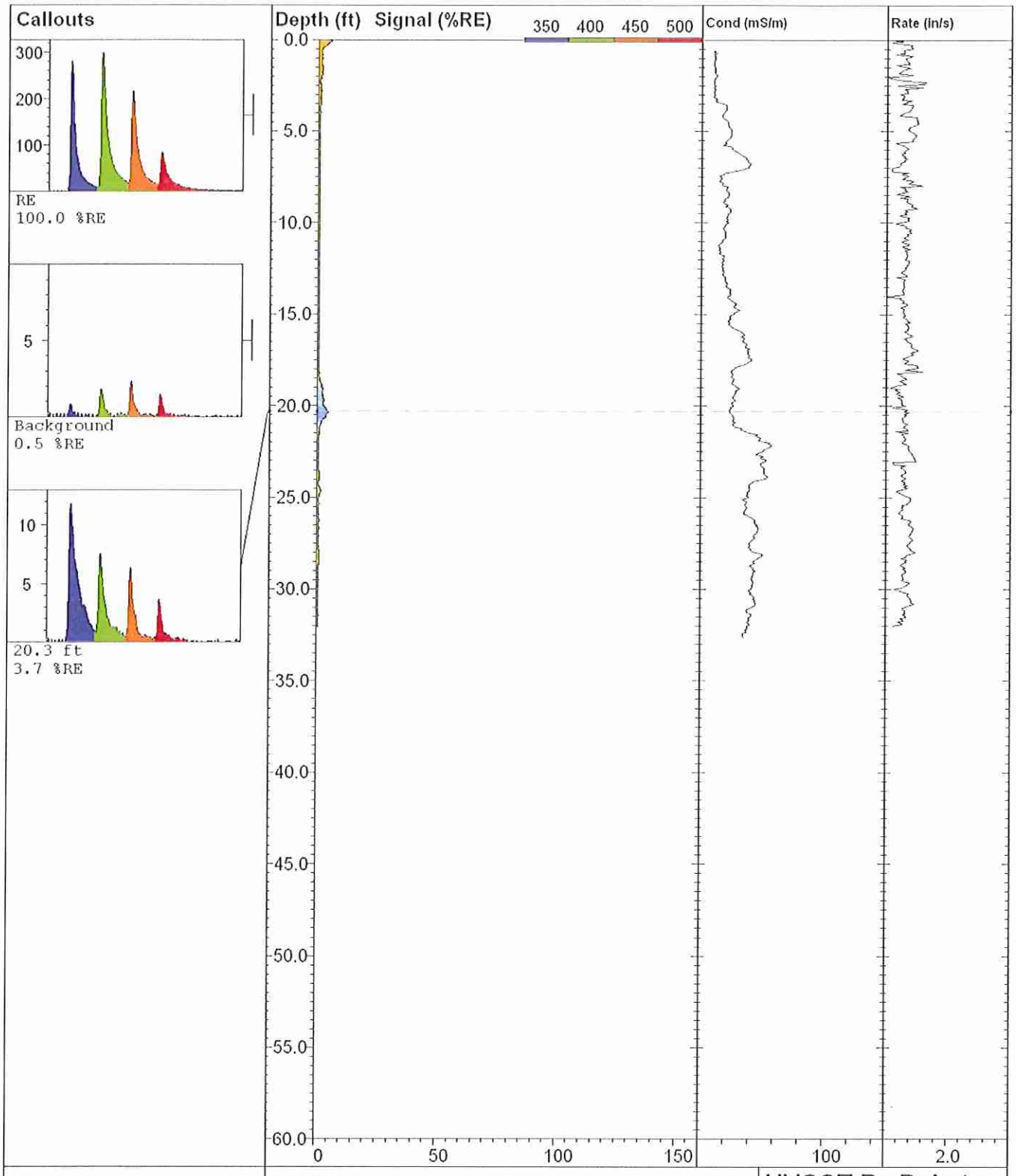
L-26

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 4.0 % @ 20.34 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 13:40 CDT



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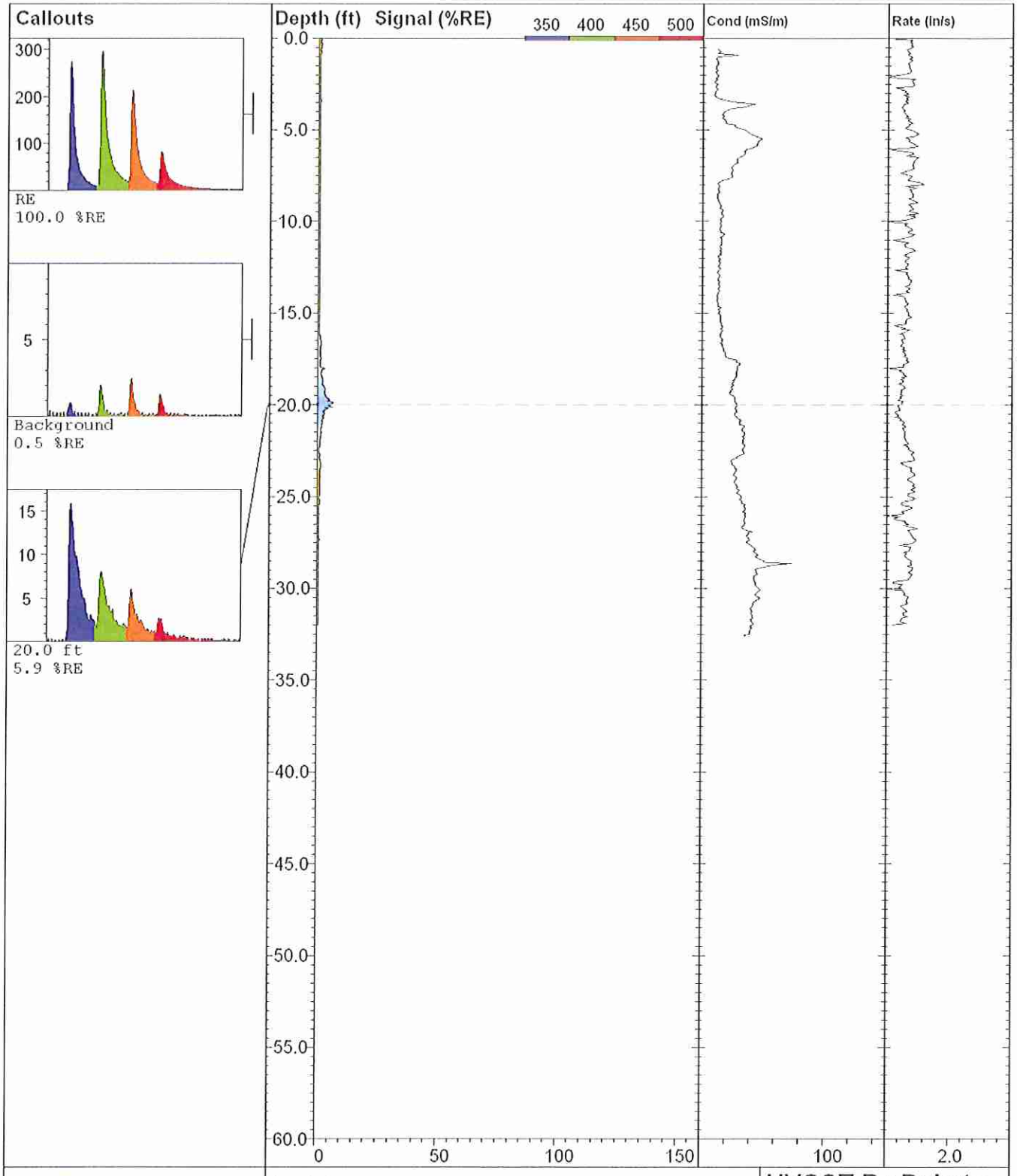
L-27

UVOST By Dakota

www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.02 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 5.3 % @ 0.11 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 14:16 CDT



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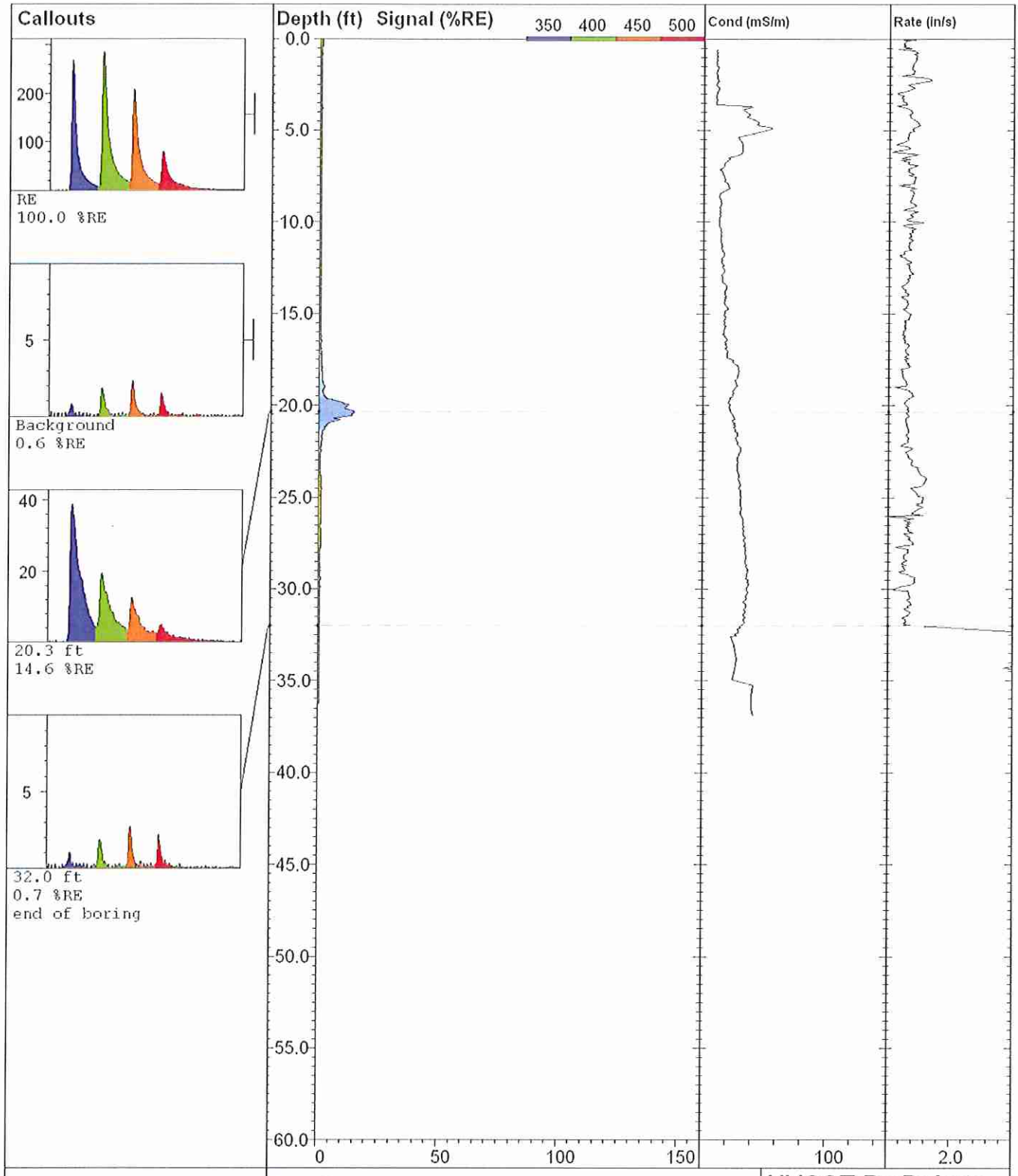
L-28

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.01 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 6.6 % @ 19.85 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 14:56 CDT



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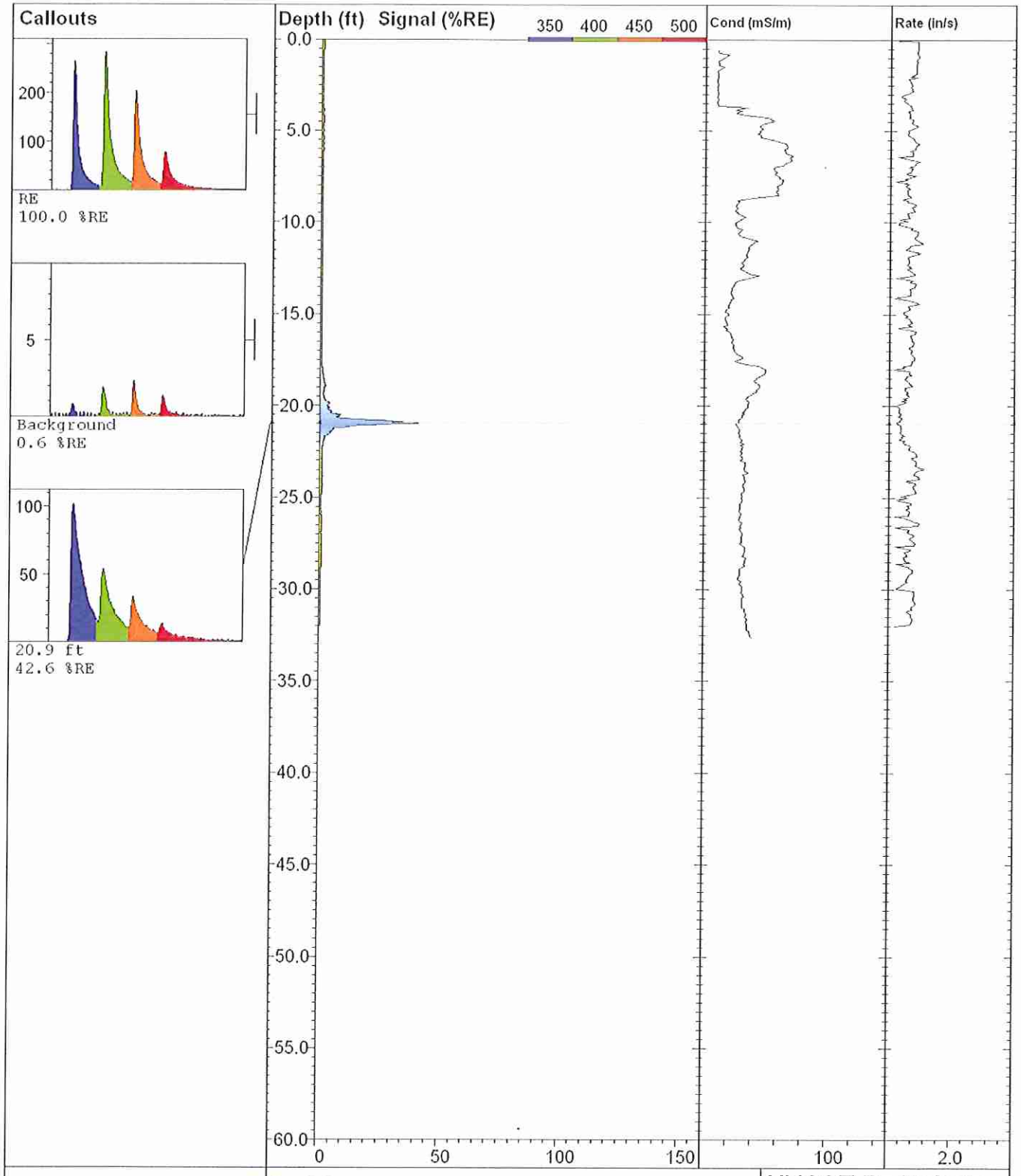
L-29

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 36.24 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 14.7 % @ 20.41 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 15:38 CDT



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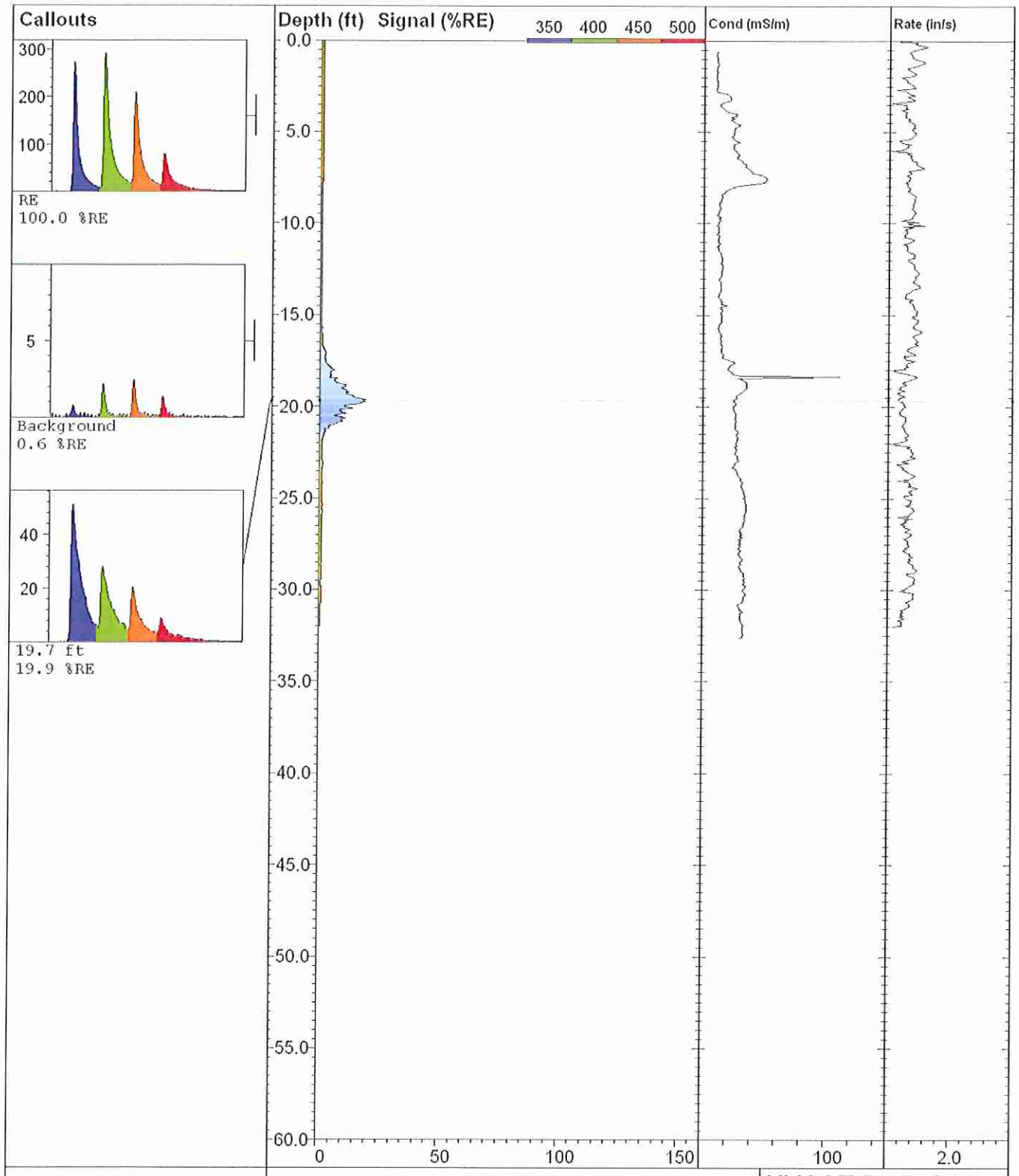
L-30

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 42.6 % @ 20.95 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 16:12 CDT



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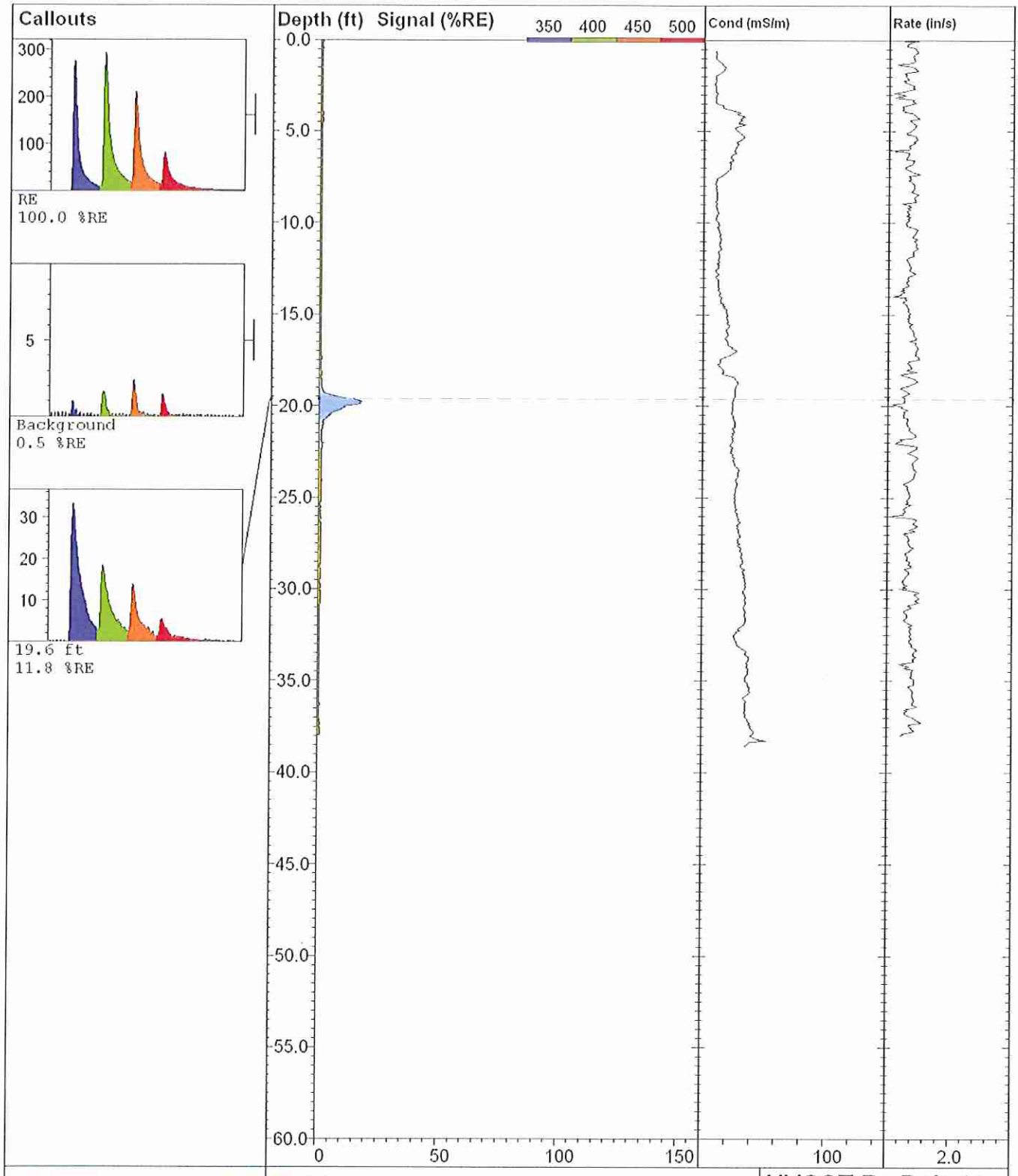
L-31

UVOST By Dakota

www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 19.9 % @ 19.66 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-24 16:45 CDT



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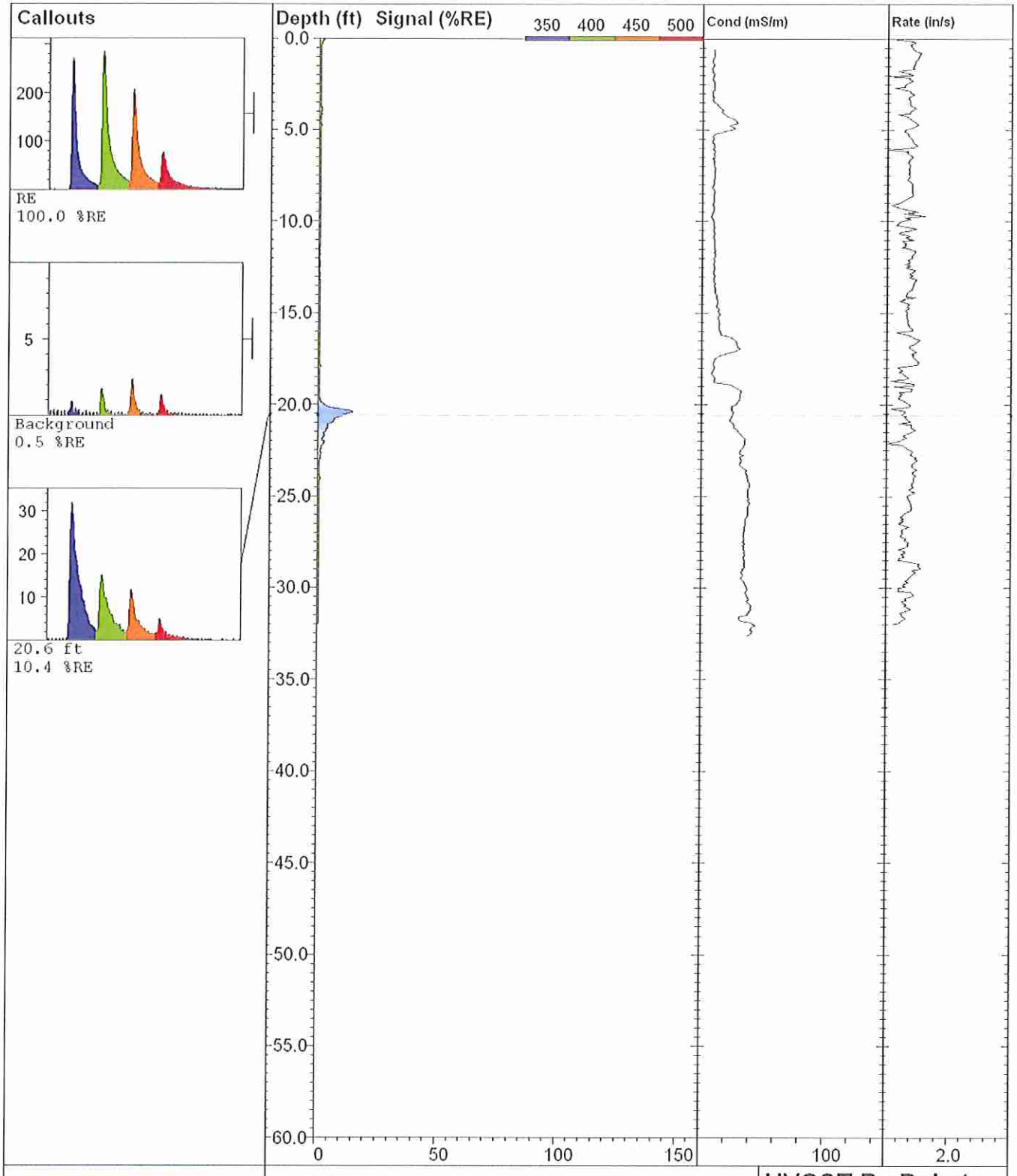
L-32

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 38.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 17.9 % @ 19.80 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 08:50 CDT



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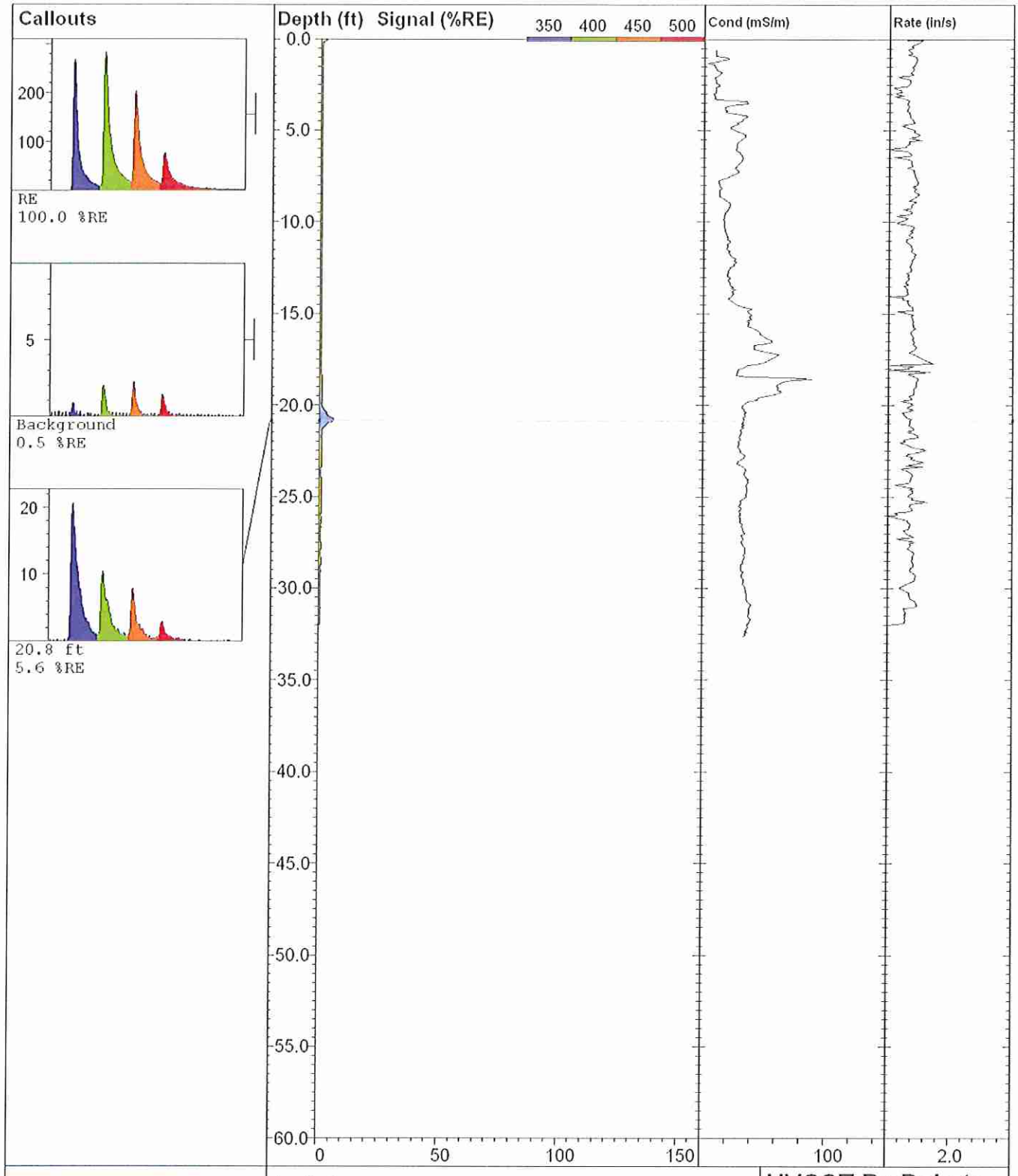
L-33

UVOST By Dakota
www.DakotaTechnologies.com

Site: **Former Union 76**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **32.00 ft**
Client: **Liesch**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **14.4 % @ 20.44 ft**
Job: **024-MNDS-11UV**	*Operator/Unit:* **DT/UVOST1003**	*Date & Time:* **2011-03-25 09:28 CDT**



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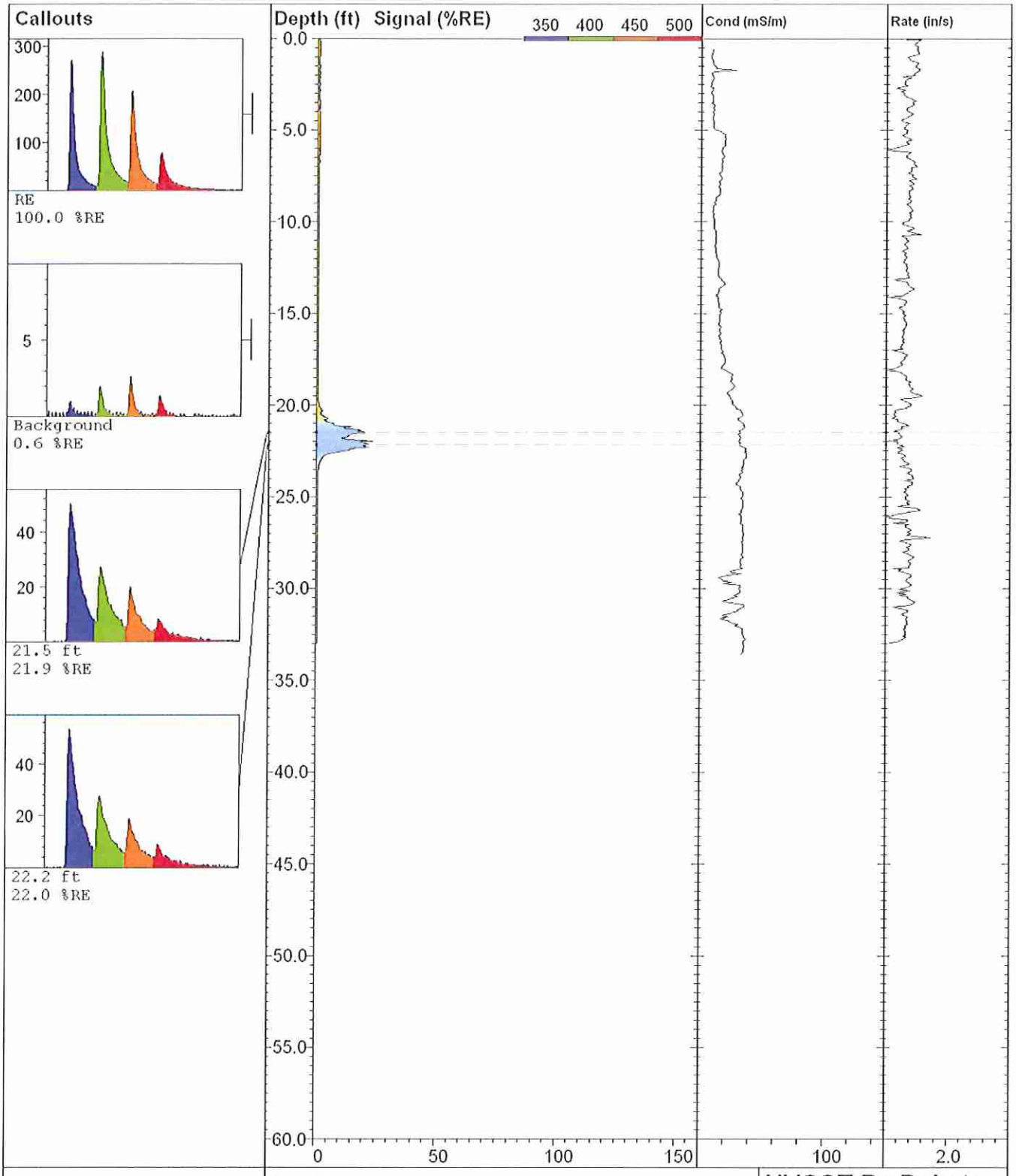
L-34

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 5.9 % @ 20.75 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 10:02 CDT



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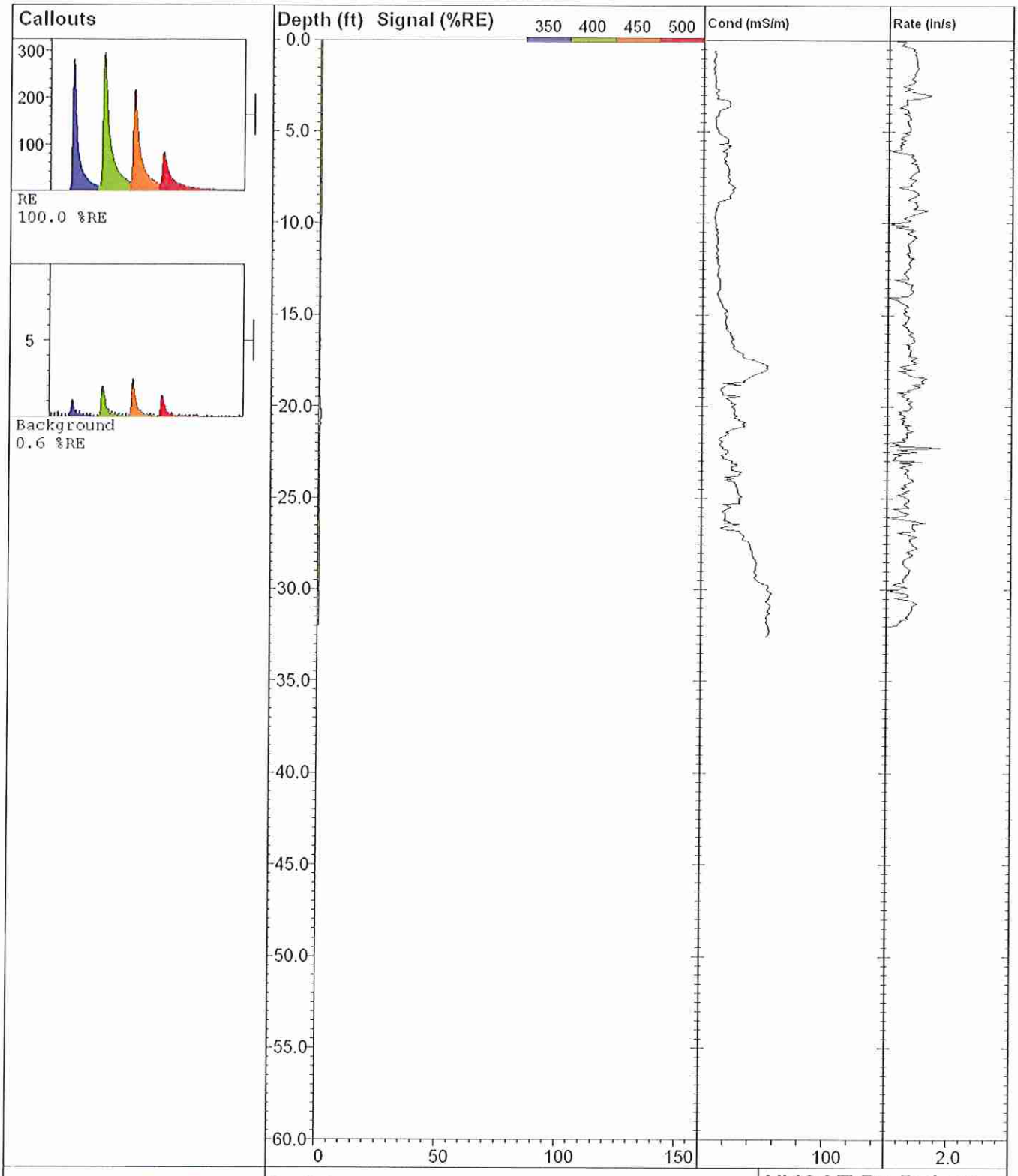
L-35

UVOST By Dakota
www.DakotaTechnologies.com

Site: **Former Union 76**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **33.00 ft**
Client: **Liesch**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **23.8 % @ 21.98 ft**
Job: **024-MNDS-11UV**	*Operator/Unit:* **DT/UVOST1003**	*Date & Time:* **2011-03-25 10:34 CDT**



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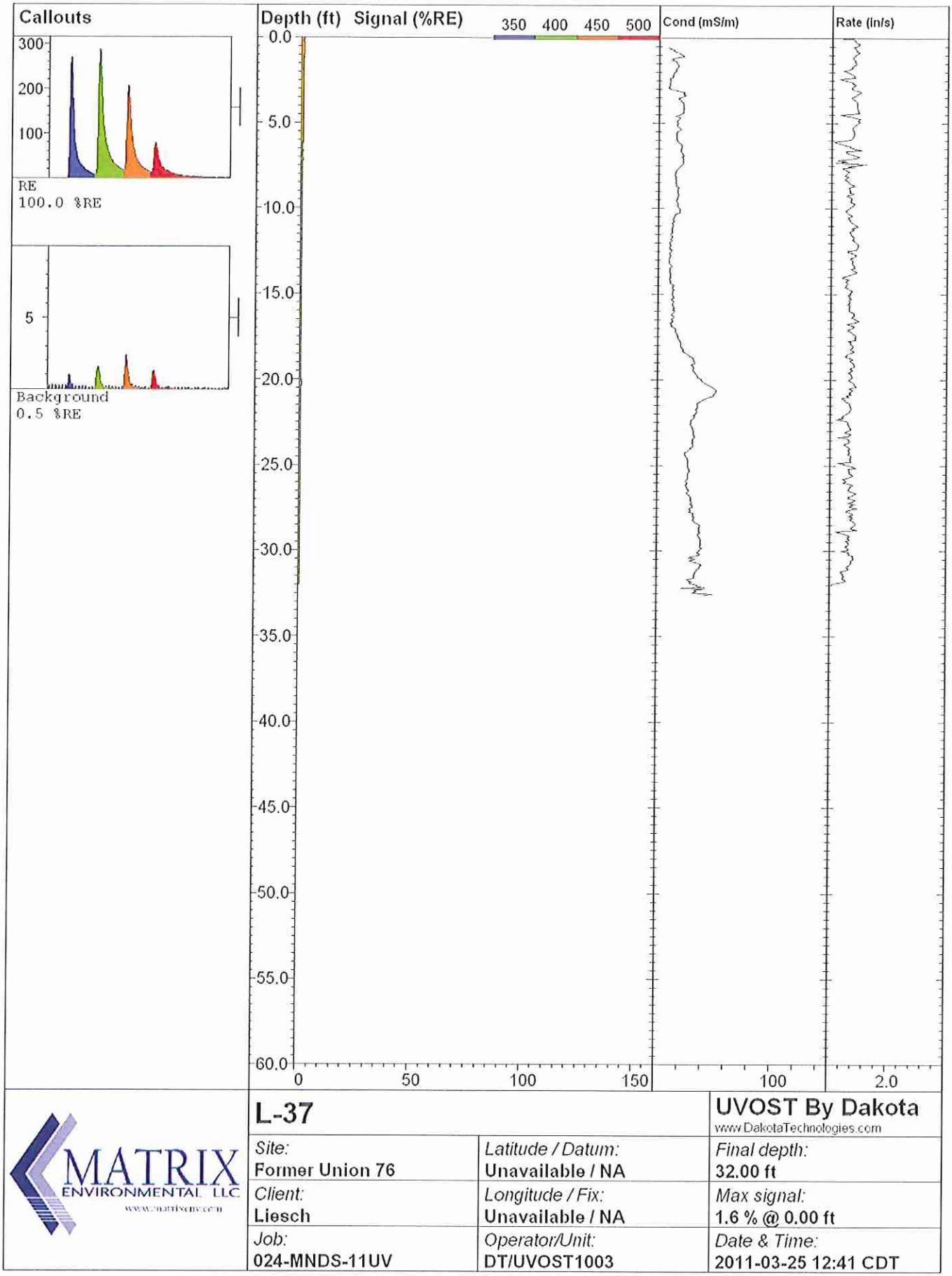
L-36

UVOST By Dakota
www.DakotaTechnologies.com

Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 1.1 % @ 20.38 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 11:13 CDT



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L-37

UVOST By Dakota
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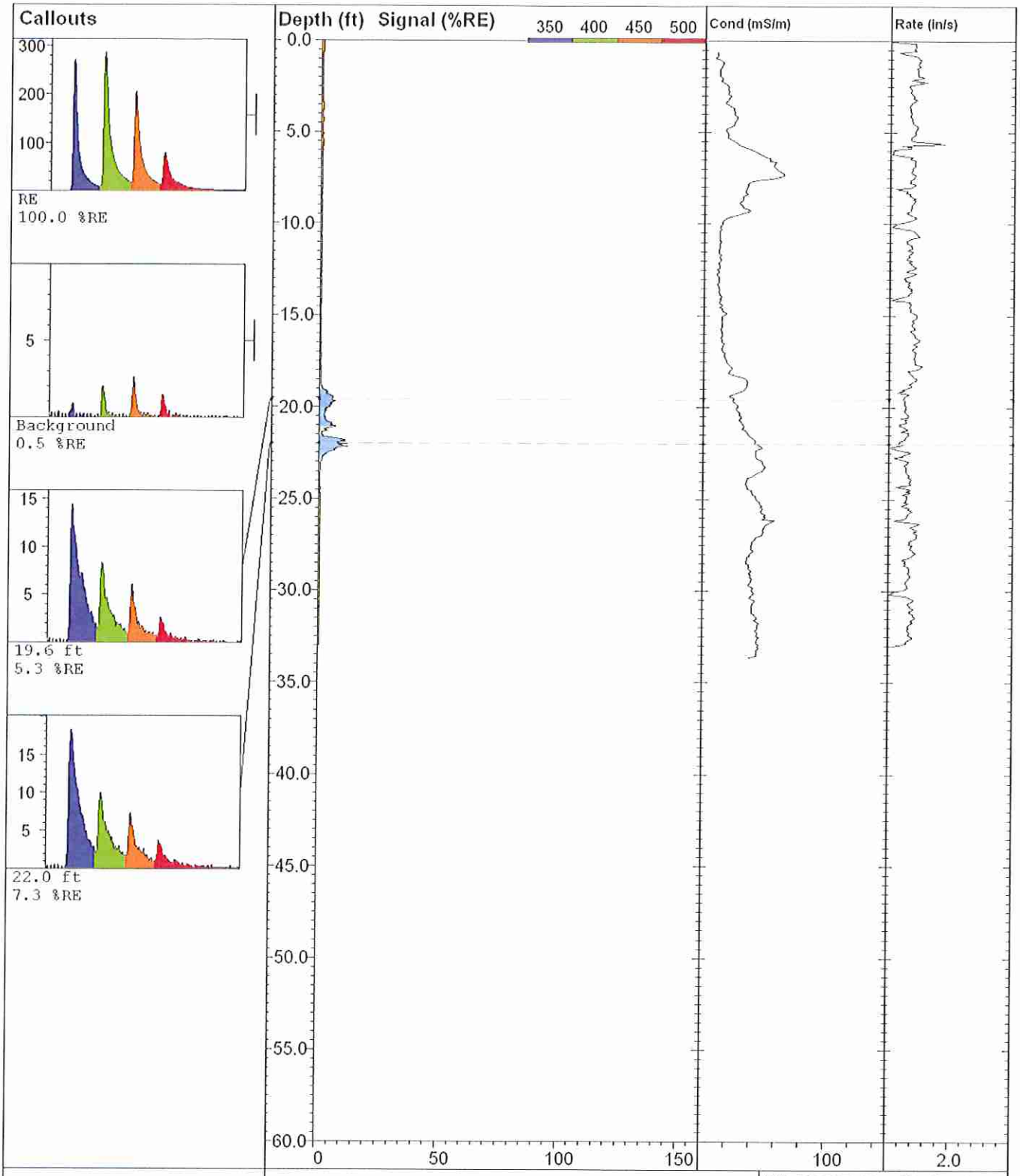
Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 1.6 % @ 0.00 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 12:41 CDT



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L-38

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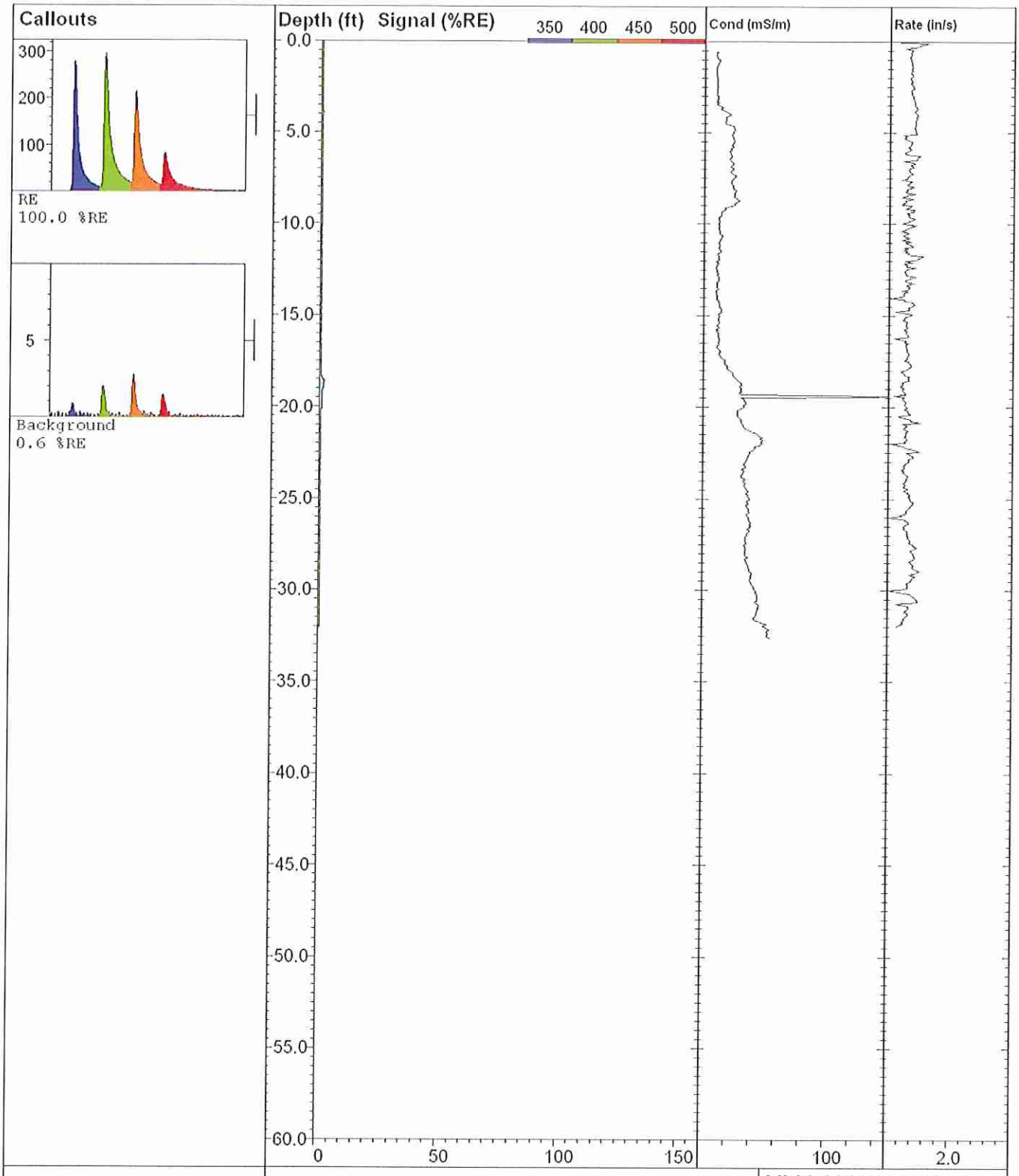
Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 33.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 12.0 % @ 22.17 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 14:15 CDT



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L-39

UVOST By Dakota
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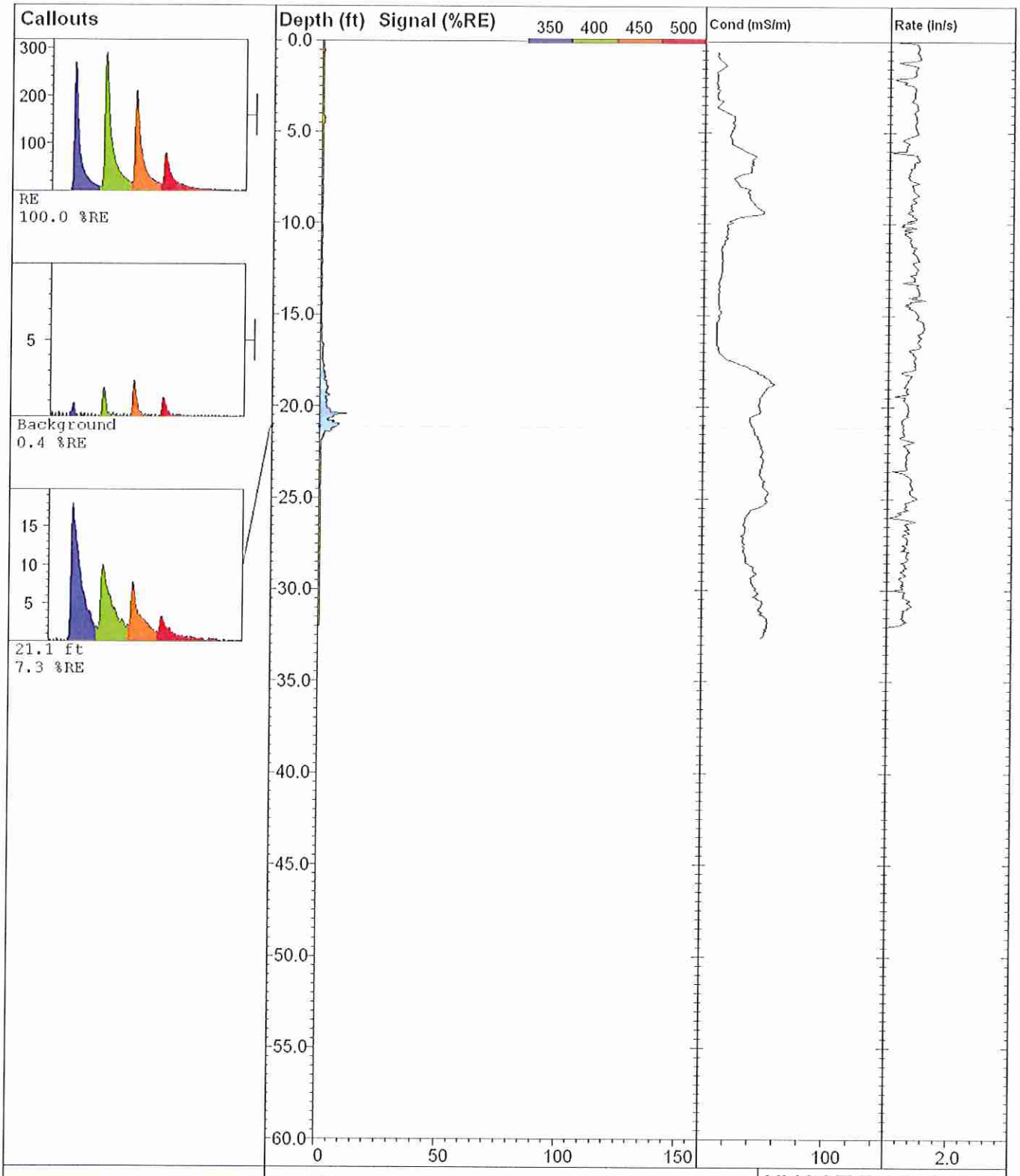
Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.02 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 1.9 % @ 18.61 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 14:46 CDT



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L-40

UVOST By Dakota

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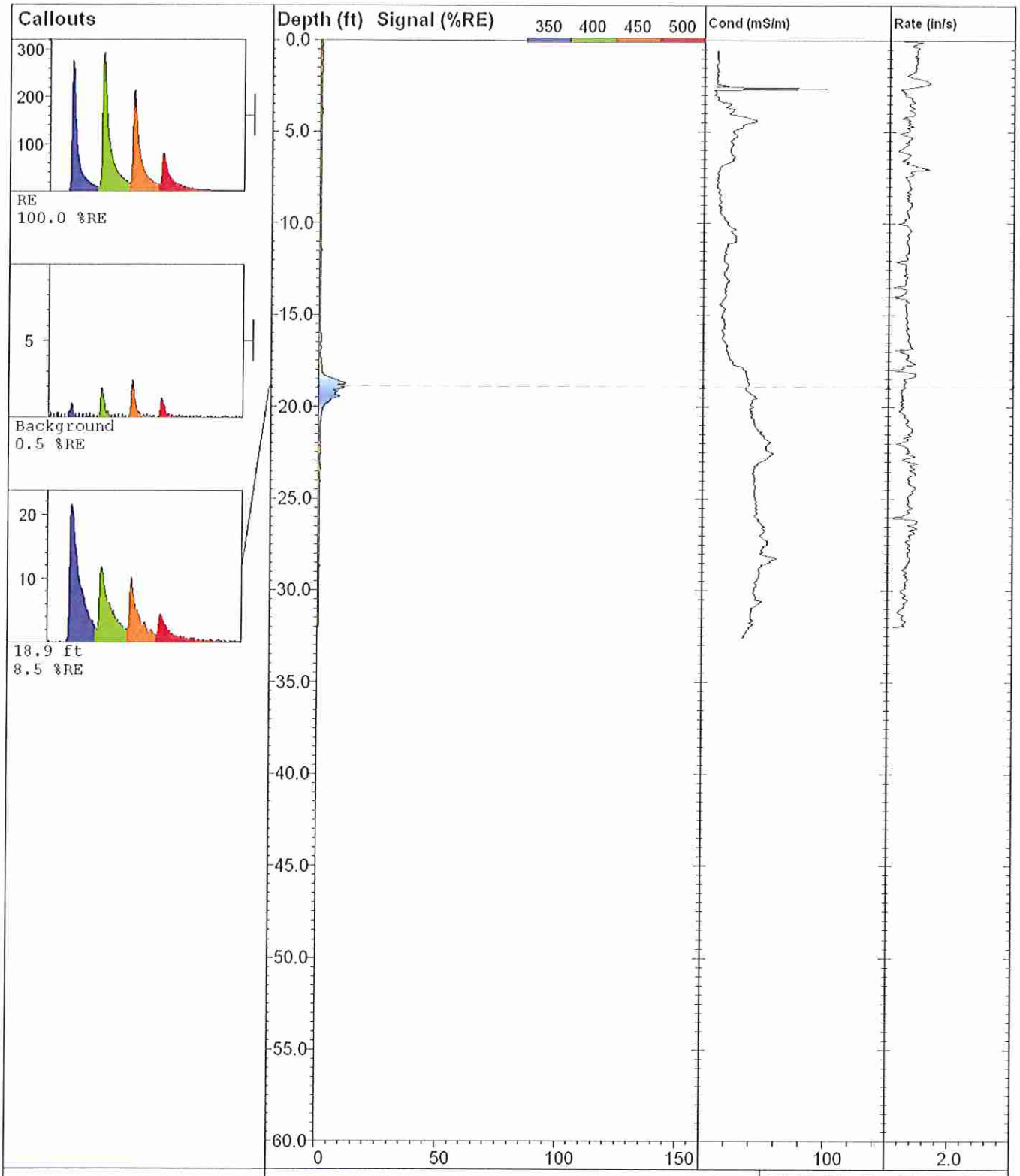
Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 11.6 % @ 20.43 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 15:21 CDT



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L-41

UVOST By Dakota
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Site: Former Union 76	*Latitude / Datum:* Unavailable / NA	*Final depth:* 32.00 ft
Client: Liesch	*Longitude / Fix:* Unavailable / NA	*Max signal:* 11.2 % @ 18.78 ft
Job: 024-MNDS-11UV	*Operator/Unit:* DT/UVOST1003	*Date & Time:* 2011-03-25 15:52 CDT