New Jersey Geological Survey

Bulletin 77

Contributions to the Geology and Hydrogeology of the Newark Basin

State of New Jersey
Department of Environmental Protection
Water Resource Management
New Jersey Geological Survey
2010

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Front cover. Geophysical logging of the Springdale Golf Course, Princeton University, Mercer County, NJ by the NJ Geological Survey in December 2003. The Princeton University Carillon (Class of 1892 Bells) looms in the distance.

Contributions to the Geology and Hydrogeology of the Newark Basin

Edited by Gregory C. Herman and Michael E. Serfes, N.J. Geological Survey

Prepared in cooperation with
the U.S. Geological Survey,
Oberlin College, Lafayette College and
Michalski and Associates.

This volume is published as chapters A through F and Appendixes 1 to 4.

N.J. Geological Survey Bulletin 77

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Conversion Factors and Datums

Multiply	By	To obtain
	Length	
micrometer (μm)	0.00003937	Inch (in.)
millimeter (mm)	0.03937	Inch (in.)
centimeter (cm)	0.3937	Inch (in.)
meter(m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Area	
square kilometer (km^2)	0.3861	square miles (mi^2)
	Fluid volume	
1 gallon	231	cubic inches (in^3)
1 gallon	0.134	cubic feet (ft^3)
1 liter	0.264	gallon (gal)
	Flow rate (volumetric)	
1 liter per second (L/s)	15.85	gallons per minute (gpm)
1 cubic meter per day (m^3/d)	0.183	gallons per minute (gpm)
1 cubic meter per day (m^3/d)	35.3107	cubic foot per day (cfd)
1 cubic foot per second (cfs)	449	gallons per minute (gpm)
	Hydraulic conductivity	
1 centimeter/second (cm/sec)	1.97	feet per minute (ft/min)
1 centimeter/second (cm/sec)	2837	feet per day (ft/day)
1 centimeter/second (cm/sec)	21200	gallons per day per foot squared (gpd/ft^2)
1 meter/day (m/day)	24.5	gallons per day per foot squared (gpd/ft^2)
1 meter/day (m/day)	3.281	feet per day (ft/day)
	Transmissivity*	
meters squared per day (m^2/day)	**10.765**	feet squared per day (ft^2/d)
	Volume of water in wells	
h = height of water column (ft)	2” well	V = 0.16 h
	4” well	V = 0.65 h
	6” well	V = 1.47h
	8” well	V = 2.61 h
	10” well	V = 4.08 h

Temperature in Fahrenheit (^oF) = (1.8 x ^oC) + 32

*Standard units for transmissivity (T) are cubic foot per day per square foot times foot of aquifer thickness "[(ft^3/d)/ft^2]ft" or cubic meters per day per square meter times meter of aquifer thickness "[(m^3/d)/m^2]m." These mathematical expressions reduce to foot squared per day "ft^2/d" or meter squared per day "m^2/d."

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD83) unless otherwise stated. Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88) unless otherwise stated.

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[1]US Geological Survey, [2]Oberlin College, [3]West Virginia Dept. of Environmental Protection, [4]Lafayette College, [5]Michalski & Associates, Inc., [6]NJ Geological Survey, [7]Rutgers University

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Photos of organizers and panelists at the hydrogeology workshop at the New Brunswick campus of Rutgers University, November 11-12, 2004.
Workshop organizers (from left to right): Glen Carleton (USGS), Pierre Lacombe (USGS), Ying Fan Reinfelder (Rutgers University), Michael Serfes (NJGS), Zoltan Szabo (USGS), Lisa Senior (USGS), Gregory Herman (NJGS). Not shown are Laura Toran (Temple University), and Andrew Michalski (Michalski Associates).

Panel Discussion, Day 1. From left to right: Pierre LaCombe (USGS), Joseph Smoot (USGS), Paul Olsen (Lamont Doherty Earth Observatory), Roy Schlische (Rutgers University), Robert Bond (Langan Engineering), Andrew Michalski (Michalski & Associates), MaryAnn Malinconico (Lafayette College), and Gregory Herman (NJGS).

Panel Discussion, Day 2. From left to right: Daniel Goode (USGS), Joseph Smoot (USGS), Glen Carleton (USGS), Zoltan Szabo (USGS), Michael Serfes (NJGS), Donna Fennell (Rutgers University), and Danielle Rhine (Rutgers Uinversity). Photographs by Yuri Mun (Rutgers University).

Introduction

New Jersey Geological Survey Bulletin 77 is an outgrowth of a group discussion that took place in early 2004 following a Henry Darcy distinguished lecture given by Dr. Alan Shapiro of the U.S. Geological Survey at the New Brunswick campus of Rutgers University. This discussion focused on hydrogeological work being conducted in the Newark basin, an Early Mesozoic basin filled with fractured sedimentary and igneous bedrock located in eastern Pennsylvania, central New Jersey, and southwest New York State. The basin underlies some of the most densely populated areas in the country, and therefore, is increasingly subject to environmental stresses including increasing groundwater demand and pollution. Discussion revealed that there is a large amount of information being collected by investigators, but there is a lack of awareness and availability of this information, including the diversity of processes studied, the competing views concerning major controls on groundwater flow, flux, and quality, the various advanced tools and techniques currently used to understand these controls. A regional workshop subsequently was convened to address some of these needs on November 11-12, 2004 at the New Brunswick campus of Rutgers University. Participation of various government agencies, universities, and the private sector provided an initial forum for exchanging and integrating ideas and findings (see photos on the opposite page). At this workshop, a NJ Geological Survey publication was proposed to provide a synthesis of the cumulative body of work.

The result, Bulletin 77 contains six articles and four appendixes detailing geological research conducted in the Newark basin during the past 30 years. The purpose of this bulletin is to provide geologists and environmentalists with a more thorough understanding of how the basin formed and evolved, and how these developments affected present day groundwater storage, transmission, and chemistry. The first two articles (chapters A and B) focus on traditional geological aspects including the stratigraphic framework and bedrock composition, and detailed analyses and descriptions of the secondary minerals filling aquifer pores. These are critical aspects of how the basin aquifers formed and evolved into their present state, and provide a sense of dimension, geometry and composition for aquifers throughout the basin. The remaining four articles (chapters C through F) focus on hydrogeological topics. Chapter C addresses basin-scale groundwater movement in early stages of the basin's history using vitrinite-reflectance thermal-alteration indexes for the three primary formations in the basin, together with reported fission-track geothermometry, geochronology, and radiometric-age controls. With respect to modern groundwater issues, chapter D summarizes practical methods of characterizing groundwater flow in the shallow subsurface at contamination sites and discusses conceptual flow models for the fractured-bedrock aquifers. Chapter E focuses on arsenic in groundwater, a recognized public health issue, and summarizes the state of knowledge of its geologic sources, and its mobilization and transport in organic-rich black and gray beds and other red mudstone and siltstone beds. Chapter F summarizes the results of research conducted by NJGS on the types and distribution of subsurface water-bearing features (WBFs) penetrated by water wells throughout the basin. The WBFs are identified, photographed, measured, classified, and related to other aquifer properties using geophysical logs for each well. Detailed results of each project are summarized in the appendixes.

Appendixes 1 to 4 include study results from more than 30 hydrogeology studies of hundreds of water wells in the New Jersey part of the Newark basin from 2001 to 2008. The appendixes provide location maps, borehole-televiewer photographic records of borehole walls and features, and hydrogeological sections detailing the different types and occurrences of WBFs in the subsurface water-bearing zones of each aquifer. The appendixes are based on aquifer groups, including: 1) diabase and basalt igneous rocks, 2) Brunswick aquifer coarse-grained rocks, including conglomerate and sandstone, 3) Brunswick aquifer fine-gained rocks, including mudstone and siltstone and 4) Lockatong argillite and Stockton sandstone. Each appendix includes multiple entries, with each entry detailing the results for a single project.

We are thankful to have had the opportunity to work with the contributors and editors to see this bulletin to completion. This work provides a modern understanding of how the basin aquifers formed, how groundwater is stored and flows in these fractured-bedrock aquifers, and the sources, mobilization, and transport of naturally-occurring arsenic in the basin's groundwater.

Borehole Geophysics and Hydrogeology Studies in the Newark Basin, New Jersey

By Gregory C. Herman and John F. Curran, N.J. Geological Survey

Appendixes 1 to 4 of

Contributions to the Geology and Hydrogeology of the Newark Basin

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Appendixes 1 to 4

Borehole Geophysics and Hydrogeology Studies in the Newark Basin, New Jersey

Gregory C. Herman and John F. Curran[1]

Description of Contents

Appendixes 1 to 4 include study results from 36 hydrogeology projects involving 127 water wells in the New Jersey part of the Newark basin from 2001 to 2008. The studies are based on geophysical logs collected in open-hole parts of the wells for aquifer-characterization research and ground-water supply and pollution projects supported and/or regulated by the NJ Dept. of Environmental Protection.

The purpose of these appendixes is to provide location maps, visual records and hydrogeologic sections detailing the different types of hydraulically-conductive bedrock features in the subsurface water-bearing zones (WBZs) of each aquifer. Appendixes 1 through 4 are organized using aquifer groups including: 1) diabase and basalt igneous rocks, 2) Brunswick aquifer coarse-grained rocks including conglomerate and sandstone, 3) Brunswick aquifer fine-gained rocks including mudstone and siltstone and 4) Lockatong argillite and Stockton sandstone. Each appendix includes entries detailing the results for a single project. The location and nature of the projects are listed in table AP1 and shown on figures AP1 and AP2 below. Table AP1 includes construction and location details for each well.

An appendix entry includes a map showing well locations and illustrations of the hydrogeologic aspects of the local aquifer, based on the geophysical logs acquired for each study. The suite of geophysical logs collected at each site varies, but commonly includes a caliper (borehole-diameter) log, water temperature and electrical conductivity or resistivity logs, bedrock natural gamma radiation and single-point electrical-resistance logs, and borehole televiewer (BTV) logs. BTV logs are collected using optical televiewer (OPTV) and acoustical televiewer (ATV) probes. The OPTV captures oriented camera images of the borehole walls and therefore, visual records of the bedrock strata and structures penetrated by a well. ATV probes capture oriented images of the borehole walls using reflected sound-waves. BTV logs therefore provide direct measurements of bedrock features that store and convey ground water, and serve as the primary basis for conducting a detailed hydrogeologic assessment of the aquifer. Beds, layers and fractures are traced in BTV imagery, then measured and statistically analyzed using circular histograms and stereonet diagrams to determine orientations of the most common structural features in a well. The location maps include oriented bedding, layering and fracture symbols stemming from these structural analyses that are plotted on a topographic base to demonstrate the link between bedrock strata, structures and topographic landforms.

The hydrogeologic sections relate the various geophysical-log responses in a well to bedrock features of the aquifer. They include geologic interpretation of the geophysical logs, summarize aspects of well construction, depict the types and spatial distribution of subsurface water-bearing features in a well and therefore relate stratigraphic and structural heterogeneity of the aquifer to observed anomalies in the geophysical logs. Some hydrogeologic sections incorporate the results of borehole flow studies detailing flow rates and directions determined using a heat-pulse flowmeter and/or straddle-packers.

Projects having many wells in close proximity may provide enough information to construct a hydrogeologic framework interpretation for an area. These entries are noted as framework studies in the list of appendix contents and include hydrogeologic cross-section interpretations showing the location and extent of WBZs in relative stratigraphic context. They commonly rely on the use of stratigraphic marker beds seen in OPTV records to constrain the stratigraphic framework and depict the continuity of WBZs in the subsurface. These diagrams therefore illustrate how permeable features are arranged in the subsurface between wells and provide a basic framework to relate borehole cross flows to local topographic variations, ground-water recharge and discharge areas, weathered- and deep-bedrock intervals. Other appendix entries detail the results for only one or two wells, or lack the necessary logs to conduct a framework analysis.

Appendix entry 2F is unique because it includes results of an unpublished geotechnical investigation conducted in the 1990s for the proposed Passaic flood tunnel project. It lacks BTV records and relies upon

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third-party geotechnical documentation.

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Weems, R. E., and Olsen, P. E., 1997, Synthesis and revision of groups within the Newark Supergroup, eastern North America: Geological Society of America Bulletin, v. 109, no. 2, p. 195-20.

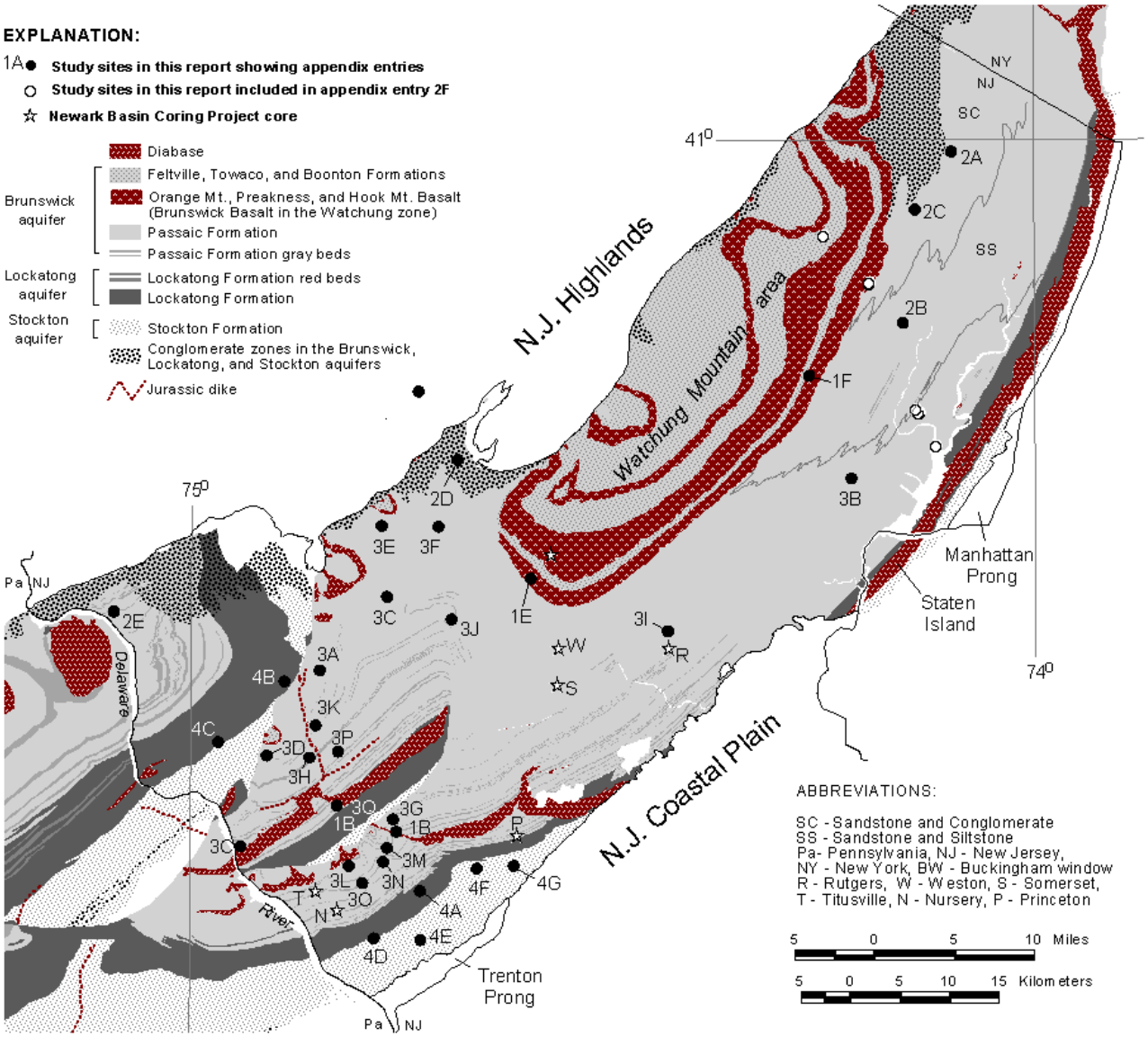

Figure AP1. Map of study locations in the appendixes with core locations for the Newark Basin Coring Project (Olsen and others, 1996). Geology compiled from Geographic Information Systems coverage of the basin from Pennsylvania (Pennsylvania Geological Survey written communication, February 2000; New Jersey (NJ Geological Survey, 2000) and New York (http://www.nysm.nysed.gov/data/lhud_bedr1a.zip).

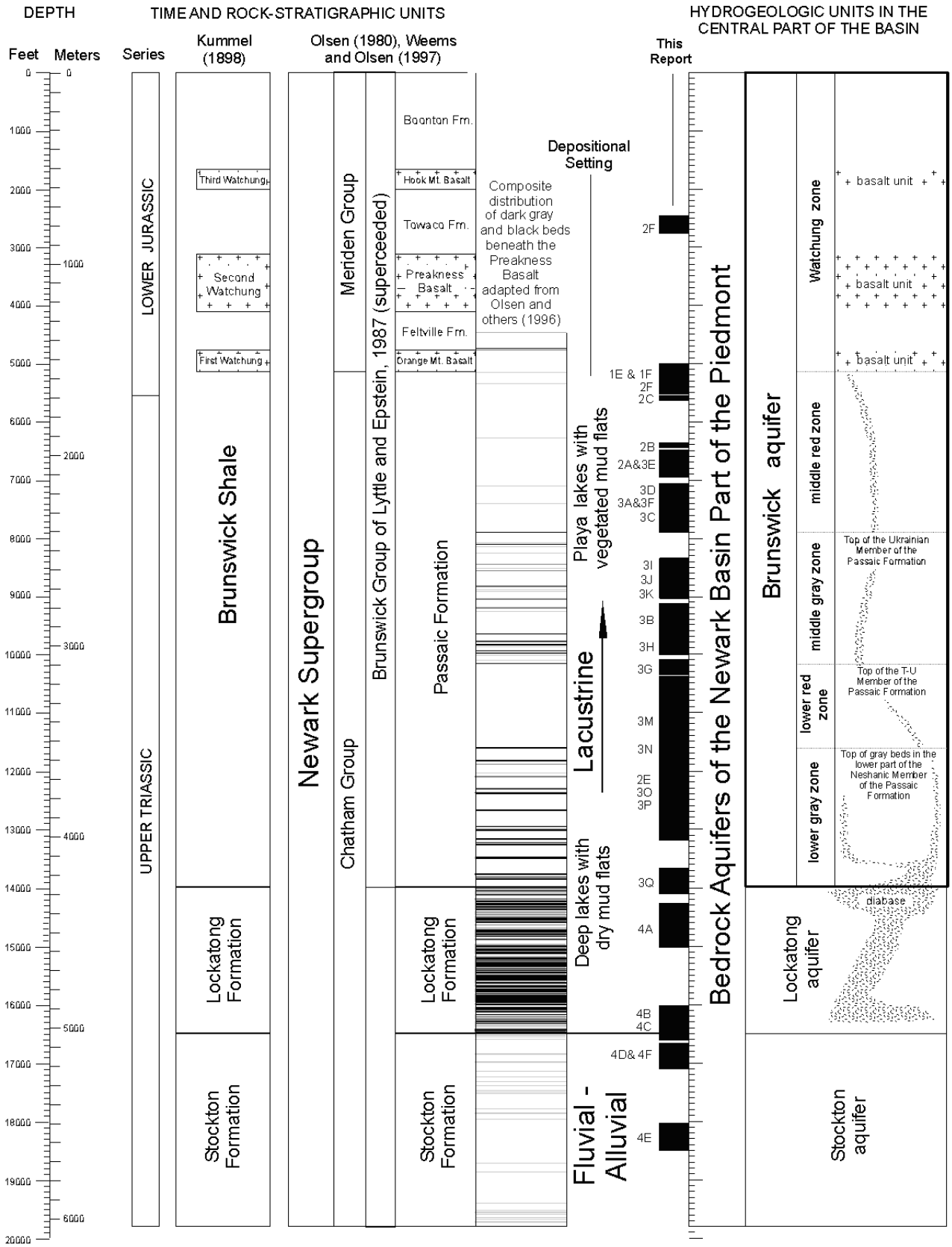

Figure AP2. Summary of time, rock and hydrogeologic units in the central part of the Newark basin showing approximate stratigraphic intervals covered by each study.

TABLE AP1. RECORDS OF WELLS AND CORES IN THE NEWARK BASIN, NEW JERSEY INCLUDED IN APPENDIXES 1 TO 4

Well	Appendix Entry	NJGS Project	Project Identification or Location	Diameter (inches)	Well Type	Log Source	Aquifer or Aquifer Zone
1	1A	258 S. Franklin St.AGW	258 S. Franklin St.	6	Domestic	NJGS	Diabase
2	1B	Snydertown Rd. AGW	SR65	6	Domestic	NJGS	Diabase
3	1B	Snydertown Rd. AGW	SR66	6	Domestic	NJGS	Diabase overlying Brunswick lower gray
4	1B	Snydertown Rd. AGW	SR69	6	Domestic	NJGS	Diabase
5	1B	Snydertown Rd. AGW	SR98	6	Domestic	NJGS	Diabase
6	1C	Crusher Rd. WS	Crusher Rd.	6	Domestic	NJGS	Diabase
7	1D	East Amwell WS	Block 38, Lot 16	6	Domestic	NJGS	Diabase
8	1E	Essex County Country Club WS	Well 1	8	Irrigation	NJGS	Brunswick Watchung basalt and middle red
9	1E	Essex County Country Club WS	Well 2	8	Irrigation	NJGS	Brunswick Watchung basalt and middle red
10	1E	Essex County Country Club WS	Well 3	8	Irrigation	NJGS	Brunswick Watchung basalt and middle red
11	1F	1163 Delaware AGW	1163 Delaware Ave	6	Domestic	NJGS	Brunswick Watchung basalt and middle red
12	2A	Ridgewood Shell GWI	MW-9D	6	Monitoring	DEP/SRP	Brunswick sandstone conglomerate
13	2A	Ridgewood Shell GWI	MW-27	6	Monitoring	DEP/SRP	Brunswick sandstone conglomerate
14	2A	Ridgewood Shell GWI	MW-29	6	Monitoring	DEP/SRP	Brunswick sandstone conglomerate
15	2A	Ridgewood Shell GWI	MW-30	6	Monitoring	DEP/SRP	Brunswick sandstone conglomerate
16	2A	Ridgewood Shell GWI	MW-32	6	Monitoring	DEP/SRP	Brunswick sandstone conglomerate
17	2A	Ridgewood Shell GWI	MW-33	6	Monitoring	DEP/SRP	Brunswick sandstone conglomerate
18	2A	Ridgewood Shell GWI	MW-37	6	Monitoring	DEP/SRP	Brunswick sandstone conglomerate
19	2A	Ridgewood Shell GWI	MW-38	6	Monitoring	DEP/SRP	Brunswick sandstone conglomerate
20	2A	Ridgewood Shell GWI	MW-43	6	Monitoring	DEP/SRP	Brunswick sandstone conglomerate
21	2B	Sandos_Clariant GWI	MW-29R	8	Monitoring	DEP/SRP	Brunswick sandstone conglomerate
22	2B	Sandos_Clariant GWI	MW-30R	8	Monitoring	DEP/SRP	Brunswick sandstone conglomerate
23	2C	Hoffman-LaRoche GWI	CH-1	8	Monitoring	DEP/SRP	Brunswick sandstone
24	2C	Hoffman-LaRoche GWI	CH-2	8	Monitoring	DEP/SRP	Brunswick sandstone
25	2C	Hoffman-LaRoche GWI	60 Princeton Place	5	Domestic	DEP/SRP	Brunswick sandstone
26	2D	Hamilton Farms Golf Course WS	HF2	8	Irrigation	NJGS	Brunswick conglomerate
27	2D	Hamilton Farms Golf Course WS	HF3	8	Irrigation	NJGS	Brunswick conglomerate
28	2D	Hamilton Farms Golf Course WS	HF5	6	Observation	NJGS	Brunswick conglomerate
29	2E	Private Housing Development WS	7032	6	Test	NJGS	Brunswick lower gray (coarse)
30	2E	Private Housing Development WS	7034	6	Test	NJGS	Brunswick lower gray (coarse)
31	2E	Milford Boro WS	Milford Boro OBS-A	6	Observation	NJGS	Brunswick lower gray (coarse)
32	2E	Milford Boro WS	Milford Boro OBS-B	6	Observation	NJGS	Brunswick lower gray (coarse)
33	2E	Milford Boro WS	Milford Boro OBS-D	6	Observation	NJGS	Brunswick lower gray (coarse)
34	2F	Passaic Flood Tunnel GI	Workshaft 2 IT-2-PB	4	Test	IT Corp.	Brunswick sandstone
35	2F	Passaic Flood Tunnel GI	Workshaft 2 IT-2-PW	8	Test	IT Corp.	Brunswick sandstone
36	2F	Passaic Flood Tunnel GI	Workshaft 2B core C-23	3	Core	ACE	Brunswick lower red
37	2F	Passaic Flood Tunnel GI	Workshaft 2B IT-2-BK-PB01	4	Test	IT Corp.	Brunswick lower red
38	2F	Passaic Flood Tunnel GI	Workshaft 2B IT-2-BF-PW01	8	Test	IT Corp.	Brunswick lower red
39	2F	Passaic Flood Tunnel GI	Workshaft 2C IT-2C-PB	4	Test	IT Corp.	Brunswick lower red
40	2F	Passaic Flood Tunnel GI	Workshaft 2C IT-2C-PW	8	Test	IT Corp.	Brunswick lower red
41	2F	Passaic Flood Tunnel GI	Workshaft 3 IT-3-PB01	4	Test	IT Corp.	Brunswick Watchung siltstone and mudstone
42	2F	Passaic Flood Tunnel GI	Workshaft 3 IT-3-PW01	8	Test	IT Corp.	Brunswick Watchung siltstone and mudstone
43	3A	Flemington Boro WS	OBS-1	6	Observation	NJGS	Brunswick middle red
44	3B	Hillside Car Wash WS	1260 North Broad St.	6	Commercial	NJGS	Brunswick middle red
45	3C	Readington Twp. GWI	15 Roosevelt Rd.	6	Domestic	NJGS	Brunswick middle red
46	3C	Readington Twp. GWI	16 Arrowhead Dr.	6	Domestic	NJGS	Brunswick middle red
47	3C	Readington Twp. GWI	39 42nd Str.	6	Domestic	NJGS	Brunswick middle red
48	3C	Readington Twp. GWI	Readington Middle School	6	Public NC	NJGS	Brunswick middle red
49	3C	Readington Twp. GWI	Rusinksi Farm	6	Test	NJGS	Brunswick middle red
50	3D	Delaware Twp. AGW	74 Lambert Rd.	6	Domestic	NJGS	Brunswick middle red
51	3D	Delaware Twp. AGW	81 Dunkard Church Rd.	6	Domestic	NJGS	Brunswick middle red
52	3D	Delaware Twp. AGW	79 Dunkard Church Rd.	6	Domestic	NJGS	Brunswick middle red
53	3D	Delaware Twp. AGW	77 Dunkard Church Rd.	6	Domestic	NJGS	Brunswick middle red
54	3D	Delaware Twp. AGW	32-34 Haines Rd.	6	Domestic	NJGS	Brunswick middle red
55	3E	Rt 22 Potterstown GWI	24-40973 Hartsell	6	Monitoring	NJGS	Brunswick middle red
56	3E	Rt 22 Potterstown GWI	24-40974 Huska	6	Monitoring	NJGS	Brunswick middle red
57	3E	Rt 22 Potterstown GWI	24-40975	6	Monitoring	NJGS	Brunswick middle red
58	3E	Rt 22 Potterstown GWI	287-4 Rt 22	6	Domestic	NJGS	Brunswick middle red
59	3E	Rt 22 Potterstown GWI	Salem B2	6	Test	NJGS	Brunswick middle red
60	3E	Rt 22 Potterstown GWI	Salem Supply	6	Public NC	NJGS	Brunswick middle red
61	3F	Trump National Golf Course WS	A2	6	Observation	Mid-Atlantic	Brunswick middle red
62	3F	Trump National Golf Course WS	C3	6	Observation	Mid-Atlantic	Brunswick middle red
63	3F	Trump National Golf Course WS	C9	6	Observation	Mid-Atlantic	Brunswick middle red
64	3F	Trump National Golf Course WS	D2	6	Observation	Mid-Atlantic	Brunswick middle red

TABLE AP1. (continued)

County	Municipality	USGS 7-1/2' Quadrangle	XY Source	GEOGRAPHIC (degrees) Latitude	Longitude	NAD83 NJSPF X_coord	Y_coord	NGVD88 Land elev (ft)	Elev. Source	Total Depth (ft)[1]	Casing (ft)[1]
Hunterdon	Lambertville	Lambertville, Pa-NJ	Map	39.8470978	74.2735330	369301.85	555707.65	269.53	DEM	370.0	48.5
Hunterdon	East Amwell	Hopewell, NJ	GPS	40.3973192	74.8244674	401759.26	569809.38	406.25	DEM	172.0	39.3
Hunterdon	East Amwell	Hopewell, NJ	GPS	40.3978303	74.8239106	401915.00	569995.00	409.20	DEM	591.0	46.1
Hunterdon	East Amwell	Hopewell, NJ	GPS	40.3975830	74.8255657	401453.71	569906.60	406.23	DEM	246.0	25.0
Hunterdon	East Amwell	Hopewell, NJ	GPS	40.3993800	74.8299300	400240.69	570565.72	376.00	DEM	283.0	30.0
Mercer	Hopewell	Pennington, NJ	Map	40.3739328	74.7575905	420360.00	561229.00	325.00	MAP	521.0	49.7
Hunterdon	East Amwell	Hopewell, NJ	GPS	40.4366880	74.7749039	415607.55	584103.74	490.00	DEM	493.5	45.1
Essex	West Orange	Orange, NJ	GPS	40.7829916	74.2647840	558141.67	710552.77	544.83	DEM	110.0	19.5
Essex	West Orange	Orange, NJ	GPS	40.7829916	74.2647840	557258.49	710226.32	516.82	DEM	317.4	17.9
Essex	West Orange	Orange, NJ	GPS	40.7842234	74.2618569	558067.82	710677.24	543.91	DEM	500.0	49.4
Somerset	Somerset	Bound Brook, NJ	Map	40.1084272	73.9533597	464880.00	645016.00	422.00	MAP	298.5	26.1
Bergen	Ridgewood	Hackensack, NJ	Map	40.9875499	74.0943230	604115.46	784920.77	108.25	DEM	84.4	26.7
Bergen	Ridgewood	Hackensack, NJ	Map	40.9869448	74.0940572	604189.86	784700.68	109.26	DEM	82.8	53.5
Bergen	Ridgewood	Hackensack, NJ	Map	40.9879161	74.0940012	604203.67	785054.62	108.93	DEM	67.8	47.9
Bergen	Ridgewood	Hackensack, NJ	Map	40.9875221	74.0948540	603968.92	784909.99	109.20	DEM	80.6	42.7
Bergen	Ridgewood	Hackensack, NJ	Map	40.9865378	74.0934963	604345.39	784553.14	109.62	DEM	84.1	47.2
Bergen	Ridgewood	Hackensack, NJ	Map	40.9863766	74.0941528	604164.42	784493.55	109.66	DEM	78.6	45.3
Bergen	Ridgewood	Hackensack, NJ	Map	40.9861891	74.0930351	604473.30	784426.68	107.90	DEM	88.3	44.0
Bergen	Ridgewood	Hackensack, NJ	Map	40.9857001	74.0940964	604181.14	784247.17	105.70	DEM	79.5	53.0
Bergen	Ridgewood	Hackensack, NJ	Map	40.9838796	74.0925265	604617.63	783585.96	94.35	DEM	69.3	44.0
Bergen	Fairlawn	Paterson, NJ	Map	40.9358056	74.1398888	591614.30	766014.60	42.08	DEM	163.8	68.3
Bergen	Fairlawn	Paterson, NJ	Map	40.9344168	74.1392223	591800.50	765509.40	47.49	DEM	165.5	41.4
Essex	Nutley	Orange, NJ	Map	40.8344695	74.1580233	586748.41	729077.07	103.23	DEM	638.1	100.3
Passaic	Clifton	Orange, NJ	Map	40.8383097	74.1592703	586397.95	730474.72	131.28	DEM	638.6	80.5
Passaic	Clifton	Orange, NJ	Map	40.8328891	74.1516463	588515.20	728508.28	137.69	DEM	170.0	34.1
Somerset	Bedminster	Gladstone, NJ	Map	40.0458747	73.8095045	442374.54	685428.27	367.03	DEM	296.0	51.7
Somerset	Bedminster	Gladstone, NJ	Map	40.0452714	73.8129509	442147.34	684465.15	323.07	DEM	297.2	
Somerset	Bedminster	Gladstone, NJ	Map	40.0439260	73.8142072	441654.53	684117.20	322.79	DEM	302.0	57.7
Hunterdon	Milford Boro	Frenchtown, NJ-Pa	GPS	39.7374866	74.0090849	329675.00	630173.00	275.74	DEM	415.0	49.0
Hunterdon	Milford Boro	Frenchtown, NJ-Pa	GPS	39.7369054	74.0079830	329465.00	630484.00	284.29	DEM	418.0	48.6
Hunterdon	Milford Boro	Frenchtown, NJ-Pa	GPS	39.7366802	74.0053816	329387.00	631216.00	266.87	DEM	216.0	48.6
Hunterdon	Milford Boro	Frenchtown, NJ-Pa	GPS	39.7360533	73.9930858	329178.00	634675.00	401.03	DEM	378.0	57.6
Hunterdon	Milford Boro	Frenchtown, NJ-Pa	GPS	39.7347064	73.9908376	328691.00	635310.00	386.88	DEM	434.0	48.6
Passaic	Little Falls	Orange, NJ	Map	40.4117712	73.6026173	576176.68	741998.43	391.08	DEM	517.0	
Passaic	Little Falls	Orange, NJ	*							526.0	10.0
Hudson	Kearny	Orange, NJ	Map	40.4548126	73.7495025	591474.56	700965.10	5.00	DEM	470.0	
Hudson	Kearny	Orange, NJ	Map	40.4578337	73.7554285	592561.12	699306.78	7.65	DEM	505.0	145.0
Hudson	Kearny	Orange, NJ	*							407.0	78.0
Hudson	Kearny	Jersey City, NJ-NY	Map	40.4753376	73.799304	598837.60	687047.43	6.00	DEM	504.0	87.0
Hudson	Kearny	Jersey City, NJ-NY	*							506.0	
Passaic	Wayne	Pompton Plains, NJ	Map	40.3701181	73.5472901	561164.45	757567.85	174.06	DEM	360.0	
Passaic	Wayne	Pompton Plains, NJ	*							357.0	105.0
Hunterdon	Raritan	Flemington, NJ	GPS	40.5203700	74.8461700	395891.00	614657.00	129.00	DEM	339.0	58.3
Union	Hillside	Elizabeth, NJ-NY	Map	40.6932604	74.21659145	570709.00	677577.00	71.00	DEM	385.0	137.0
Hunterdon	Readington	Flemington, NJ	Map	39.9832548	73.9813126	419238.47	637463.34	209.60	Map	89.0	30.4
Hunterdon	Readington	Flemington, NJ	Map	39.9753370	73.9847749	416348.80	636509.83	197.32	Map	117.0	49.0
Hunterdon	Readington	Flemington, NJ	Map	39.9828710	73.9689427	419119.09	640930.28	267.42	Map	104.7	44.6
Hunterdon	Readington	Flemington, NJ	Map	39.9861400	73.9699979	420308.06	640627.53	234.57	Map	98.0	51.2
Hunterdon	Readington	Flemington, NJ	Map	39.9805345	73.9671432	418271.01	641439.59	239.82	Map	149.0	24.5
Hunterdon	Delaware	Stockton, NJ	GPS	39.8663238	74.1568425	376409.13	588442.73	219.81	DEM	198.0	50.7
Hunterdon	Delaware	Stockton, NJ	GPS	39.8755772	74.1632664	379772.74	586626.94	204.09	DEM	172.0	48.0
Hunterdon	Delaware	Stockton, NJ	GPS	39.8763267	74.1631564	380045.88	586656.80	204.51	DEM	195.0	48.2
Hunterdon	Delaware	Stockton, NJ	GPS	39.8770174	74.1630627	380297.54	586682.15	206.13	DEM	196.6	49.0
Hunterdon	East Amwell	Stockton, NJ	GPS	39.8806616	74.1639552	381623.98	586426.69	179.95	DEM	245.0	59.4
Hunterdon	Readington	Califon, NJ	GPS	39.9602140	73.9116848	410966.97	657028.80	217.56	DEM	69.6	45.8
Hunterdon	Readington	Califon, NJ	GPS	39.9566048	73.9084316	409658.34	657949.38	248.09	DEM	69.0	44.6
Hunterdon	Readington	Califon, NJ	GPS	39.9601320	73.9089167	410942.20	657804.89	230.03	DEM	69.0	45.7
Hunterdon	Readington	Califon, NJ	Map	39.9575706	73.9088700	410009.30	657824.18	249.01	DEM	165.0	21.1
Hunterdon	Readington	Califon, NJ	GPS	39.9583499	73.9100671	410290.96	657486.74	232.17	DEM	145.0	19.3
Hunterdon	Readington	Califon, NJ	GPS	39.9593811	73.9105874	410665.61	657338.41	244.92	DEM	248.0	65.5
Somerset	Bedminster	Gladstone, NJ	Map	40.0268383	73.8838555	435287.71	664661.62	186.50	DEM	514.0	50.0
Somerset	Bedminster	Gladstone, NJ	Map	40.0341279	73.8947355	437922.12	661596.89	196.54	DEM	252.0	15.5
Somerset	Bedminster	Gladstone, NJ	Map	40.0335830	73.8946976	437723.69	661608.83	199.72	DEM	498.3	52.1
Somerset	Bedminster	Gladstone, NJ	Map	40.0299752	73.8831712	436431.68	664845.33	148.11	DEM	511.8	52.9

TABLE A1. RECORDS OF WELLS AND CORES IN THE NEWARK BASIN, NEW JERSEY INCLUDED IN APPENDICES 1 - 4

Well	Appendix Entry	NJGS Project	Project Identification or Location	Diameter (inches)	Well Type	Log Source	Aquifer or Aquifer Zone
65	3F	Trump National Golf Course WS	F	6	Observation	Mid-Atlantic	Brunswick middle red
66	3F	Trump National Golf Course WS	H	6	Observation	Mid-Atlantic	Brunswick middle red
67	3F	Trump National Golf Course WS	P	6	Observation	Mid-Atlantic	Brunswick middle red
68	3G	Hopewell Boro Supply Well 6 AGW	CH-1	2	Core	NJGS	Brunswick middle gray and middle red
69	3G	Hopewell Boro Supply Well 6 AGW	OBS-1	6	Observation	NJGS	Brunswick middle gray and middle red
70	3G	Hopewell Boro Supply Well 6 AGW	OBS-2	6	Observation	NJGS	Brunswick middle gray
71	3G	Hopewell Boro Supply AGW	MW-1m	6	Monitoring	NJGS	Brunswick middle gray and middle red
72	3G	Hopewell Boro Supply AGW	MW-2m	6	Monitoring	NJGS	Brunswick middle gray and middle red
73	3G	Hopewell Boro Rockwell	MW-24	6	Monitoring	BBL	Brunswick middle gray and middle red
74	3G	Hopewell Boro Rockwell	VO-7	6	Monitoring	BBL	Brunswick middle gray and middle red
75	3H	Larison's Corner GWI	S-1	6	Domestic	NJGS	Brunswick middle gray
76	3I	Home Depot/Vitaulic GWI	MW-10	6	Monitoring	NJGS	Brunswick middle gray
77	3I	Home Depot/Vitaulic GWI	MW-11	6	Monitoring	NJGS	Brunswick middle gray
78	3I	Home Depot/Vitaulic GWI	MW-12	6	Monitoring	NJGS	Brunswick middle gray
79	3J	Branchburg Rt. 202 GWI	1011 Rt. 202	6	Domestic	NJGS	Brunswick middle gray
80	3J	Branchburg Rt. 202 GWI	75 North Branch Rd.	6	Domestic	NJGS	Brunswick middle gray
81	3J	Branchburg Rt. 202 GWI	941 Route 202	6	Domestic	NJGS	Brunswick middle gray
82	3J	Branchburg Rt. 202 GWI	947 Route 202	6	Domestic	NJGS	Brunswick middle gray
83	3J	Branchburg Rt. 202 GWI	954 Route 202	6	Domestic	NJGS	Brunswick middle gray
84	3J	Branchburg Rt. 202 GWI	971 Route 202	6	Domestic	NJGS	Brunswick middle gray
85	3K	Heron Glen Golf Course WS	Heron Glen N	6	Observation	NJGS	Brunswick middle gray
86	3K	Heron Glen Golf Course WS	Heron Glen B	6	Public NC	NJGS	Brunswick middle gray
87	3K	Heron Glen Golf Course WS	Heron Glen L	6	Observation	NJGS	Brunswick middle gray
88	3K	Private Housing Development WS	QNS	6	Test	NJGS	Brunswick lower red
89	3L	Harbat Farms WS	East well in field	6	Domestic	NJGS	Brunswick lower red
90	3M	Stony Brook-Millstone Reserve AGW	SB1	6	Test	NJGS	Brunswick lower red
91	3M	Stony Brook-Millstone Reserve AGW	SB3	6	Test	NJGS	Brunswick lower red
92	3M	Stony Brook-Millstone Reserve AGW	SB6	6	Test	NJGS	Brunswick lower red
93	3M	Stony Brook-Millstone Reserve AGW	SB8	6	Test	NJGS	Brunswick lower red
94	3M	Stony Brook-Millstone Reserve AGW	SB9	6	Test	NJGS	Brunswick lower red
95	3M	Stony Brook-Millstone Reserve AGW	SB11	6	Test	NJGS	Brunswick lower red
96	3M	Stony Brook-Millstone Reserve AGW	SB14	6	Test	NJGS	Brunswick lower red
97	3M	Stony Brook-Millstone Reserve WS	OFW-2	8	Test	NJGS	Brunswick lower red
98	3M	Honey Brook Organic Farm WS	OFHW	6	Domestic	NJGS	Brunswick lower red
99	3M	Honey Brook Organic Farm WS	OFW-1	8	Test	NJGS	Brunswick lower red and lower gray
100	3N	Bristol-Myers Squibb GWI	POW-1	6	Observation	NJGS	Brunswick lower gray
101	3N	Bristol-Myers Squibb GWI	POW-2	6	Observation	NJGS	Brunswick lower gray
102	3N	Bristol-Myers Squibb GWI	TB-1	6	Observation	NJGS	Brunswick lower gray
103	3N	Bristol-Myers Squibb GWI	TB-4	6	Observation	NJGS	Brunswick lower gray
104	3N	Bristol-Myers Squibb GWI	TB-5	6	Observation	NJGS	Brunswick lower gray
105	3O	Pennington Boro WS	OBS-2	6	Observation	NJGS	Brunswick lower gray
106	3P	The Ridge Golf Club WS	CH	6	Public NC	NJGS	Brunswick lower gray
107	3P	The Ridge Golf Club WS	MWA	6	Observation	NJGS	Brunswick lower gray
108	3Q	Snydertown Rd. WS	SRDD	6	Domestic	NJGS	Brunswick lower gray and Lockatong
109	4A	Terhune Orchards WS	Well 1	6	Test	NJGS	Lockatong
110	4A	Terhune Orchards WS	Well 2	8	Test	NJGS	Lockatong
111	4B	Domestic Supply Well	241 Route 12	6	Domestic	NJGS	Lockatong
112	4B	Hilltop Development WS	HT24-24	6	Test	NJGS	Lockatong
113	4B	Hilltop Development WS	HT24-18	6	Test	NJGS	Lockatong
114	4B	Hilltop Development WS	HT24-17	6	Test	NJGS	Lockatong
115	4B	Hilltop Development WS	HT6	6	Test	NJGS	Lockatong
116	4C	29 Pine Hill Rd. AGW	29 Pine Hill Rd.	6	Domestic	NJGS	Lockatong and Stockton
117	4D	Ewingville Rd & Rt31 GWI	EMmw12d	6	Monitoring	NJGS	Stockton
118	4D	Ewingville Rd & Rt31 GWI	EMmw13d	6	Monitoring	NJGS	Stockton
119	4D	Ewingville Rd & Rt31 GWI	EMmw14dd	6	Monitoring	NJGS	Stockton
120	4E	Greenacres County Club WS	OW-1	8	Observation	NJGS	Stockton
121	4E	Greenacres County Club WS	OW-2	6	Observation	NJGS	Stockton
122	4F	Springdale Golf Course WS	IW1	8	Irrigation	NJGS	Stockton
123	4F	Springdale Golf Course WS	IW2	8	Irrigation	NJGS	Stockton
124	4F	Springdale Golf Course WS	MW1	6	Observation	NJGS	Stockton
125	4G	Princeton Plasma Physics GWI	MW-22	6	Monitoring	Secor Intl.	Stockton
126	4G	Princeton Plasma Physics GWI	MW-24	6	Monitoring	Secor Intl.	Stockton
127	4G	Princeton Plasma Physics GWI	MW-28	6	Monitoring	Secor Intl.	Stockton

Abbreviations: AGW - arsenic in ground water, DEM - Digital Elevation Model, GI - Geotechnical investigation, GPS - Global Positioning System,
* approximate location for a well cluster, [1]Below land surface

TABLE AP1. (continued)

County	Municipality	Quadrangle	XY Source	GEOGRAPHIC (degrees) Latitude	Longitude	NAD83 NJSPF X_coord	Y_coord	NGVD88 Land elev (ft)	Elev. Source	Total Depth(ft)[1]	Casing(ft)[1]
Somerset	Bedminster	Gladstone, NJ	Map	40.0319501	73.8911383	437135.69	662609.52	225.25	DEM	333.0	19.3
Somerset	Bedminster	Gladstone, NJ	Map	40.0346112	73.8952620	438097.15	661448.27	187.16	DEM	97.6	41.5
Somerset	Bedminster	Gladstone, NJ	Map	40.0347871	73.8918457	438167.72	662404.38	185.67	DEM	243.6	50.8
Mercer	Hopewell Boro	Hopewell, NJ	GPS	39.9852041	74.2371006	419634.40	565788.27	180.00	MAP	402.7	27.5
Mercer	Hopewell Boro	Hopewell, NJ	GPS	39.9852311	74.2371015	419644.23	565787.99	170.00	MAP	400.0	44.6
Mercer	Hopewell Boro	Hopewell, NJ	GPS	39.9849321	74.2362354	419536.03	566030.97	180.00	MAP	300.0	51.5
Mercer	Hopewell Boro	Hopewell, NJ	GPS	39.9817463	74.2390144	418373.33	565255.70	215.00	MAP	105.0	34.9
Mercer	Hopewell Boro	Hopewell, NJ	GPS	39.9822532	74.2403494	418556.87	564881.10	193.00	DEM	72.0	14.4
Mercer	Hopewell Boro	Hopewell, NJ	GPS	40.3932450	74.7579150	420290.00	568264.12	177.00	DEM	199.0	20.1
Mercer	Hopewell Boro	Hopewell, NJ	GPS	40.3939790	74.7571750	420496.99	568530.86	181.00	DEM	192.8	25.2
Hunterdon	East Amwell	Hopewell, NJ	MAP	40.4408584	74.8585932	392319.38	585706.44	262.00	Map	314.0	19.7
Middlesex	South Plainfield	Plainfield, NJ	GPS	40.2338653	74.0126721	510476.00	628176.00	103.35	DEM	99.0	25.7
Middlesex	South Plainfield	Plainfield, NJ	GPS	40.2360773	74.0125237	511282.00	628213.00	101.36	DEM	109.0	25.4
Middlesex	South Plainfield	Plainfield, NJ	GPS	40.2366887	74.0103665	511508.00	628814.00	95.16	DEM	114.0	25.6
Somerset	Somerset	Raritan, NJ	Map	40.0376831	74.0051844	439026.11	630664.25	105.05	MAP	161.7	22.6
Somerset	Somerset	Raritan, NJ	Map	40.0403593	74.0061734	439999.40	630381.92	69.44	MAP	99.3	22.0
Somerset	Somerset	Raritan, NJ	Map	40.0442549	74.0013954	441425.85	631711.70	89.00	MAP	86.0	26.6
Somerset	Somerset	Raritan, NJ	Map	40.0438828	74.0018208	441289.65	631593.36	88.00	MAP	92.8	19.8
Somerset	Somerset	Raritan, NJ	Map	40.0422735	74.0011516	440704.50	631783.98	81.96	MAP	198.4	69.2
Somerset	Somerset	Raritan, NJ	Map	40.0412186	74.0031495	440317.12	631226.79	80.30	MAP	122.7	64.2
Hunterdon	Raritan	Hopewell, NJ	GPS	39.9138643	74.1291829	393756.47	596134.37	202.26	DEM	394.0	50.4
Hunterdon	Raritan	Hopewell, NJ	GPS	39.9150252	74.1291437	394179.39	596143.61	211.75	DEM	296.0	56.0
Hunterdon	Raritan	Hopewell, NJ	GPS	39.9171783	74.1245455	394969.04	597430.05	206.22	DEM	178.0	40.2
Hunterdon	Raritan	Hopewell, NJ	Map	39.9312613	74.1204691	400103.54	598551.56	155.00	MAP	195.0	58.5
Mercer	Hopewell	Pennington, NJ	GPS	40.3450575	74.8105410	405571.00	550757.88	223.00	GPS	293.0	48.2
Mercer	Hopewell	Hopewell, NJ	GPS	39.9797880	74.2728721	417634.03	555770.25	166.89	DEM	152.0	21.0
Mercer	Hopewell	Hopewell, NJ	GPS	39.9805987	74.2726821	417929.47	555822.75	168.42	DEM	148.5	20.9
Mercer	Hopewell	Hopewell, NJ	GPS	39.9797685	74.2725267	417627.19	555867.06	155.10	DEM	189.0	18.6
Mercer	Hopewell	Hopewell, NJ	GPS	39.9803370	74.2735653	417833.50	555575.50	157.00	DEM	148.5	17.5
Mercer	Hopewell	Hopewell, NJ	GPS	39.9798856	74.2739618	417668.81	555464.81	163.23	DEM	146.5	25.0
Mercer	Hopewell	Hopewell, NJ	GPS	40.3593940	74.7684970	417305.24	555941.92	171.00	DEM		
Mercer	Hopewell	Hopewell, NJ	GPS	39.9803307	74.2727983	417831.78	555790.44	161.20	DEM	370.0	58.5
Mercer	Hopewell	Hopewell, NJ	GPS	39.9803754	74.2742856	417846.99	555373.64	169.00	DEM	395.0	68.0
Mercer	Hopewell	Hopewell, NJ	GPS	39.9821135	74.2758906	418478.97	554922.29	158.00	DEM	207.0	69.7
Mercer	Hopewell	Hopewell, NJ	GPS	39.9826013	74.2772170	418655.72	554550.19	163.00	DEM	600.0	124.0
Mercer	Hopewell	Pennington, NJ	GPS	39.9722499	74.2931797	414874.46	550086.08	145.64	DEM	335.0	49.9
Mercer	Hopewell	Pennington, NJ	GPS	39.9731079	74.2986592	415183.46	548549.74	159.58	DEM	440.0	50.5
Mercer	Hopewell	Pennington, NJ	GPS	39.9740105	74.2867373	415520.00	551890.00	180.31	DEM	302.0	18.2
Mercer	Hopewell	Pennington, NJ	GPS	39.9824170	74.2898517	418580.00	551010.00	209.74	DEM	297.0	21.5
Mercer	Hopewell	Pennington, NJ	GPS	39.9762539	74.2846718	416338.54	552466.89	196.12	DEM	274.0	17.1
Mercer	Pennington	Pennington, NJ	GPS	39.9582072	74.3098755	409749.00	545418.00	200.00	GPS	298.0	49.4
Hunterdon	East Amwell	Hopewell, NJ	GPS	40.4436100	74.8219400	402524.58	586669.50	242.00	MAP	560.0	56.2
Hunterdon	East Amwell	Hopewell, NJ	GPS	40.4458300	74.8280600	400824.30	587484.47	139.00	MAP	555.0	52.7
Hunterdon	East Amwell	Hopewell, NJ	GPS	40.3948300	74.8269500	401064.48	568905.18	342.42	DEM	478.0	51.7
Mercer	Lawrence	Princeton, NJ	GPS	40.0106200	74.3225724	428833.00	541821.00	180.45	DEM	402.0	48.8
Mercer	Lawrence	Princeton, NJ	GPS	40.0079273	74.3228757	427852.00	541738.00	187.02	DEM	484.0	48.3
Hunterdon	Raritan	Pittstown, NJ	GPS	39.8901642	74.0805706	385184.17	609810.08	389.12	DEM	700.0	48.9
Hunterdon	Raritan	Pittstown, NJ	GPS	39.8898258	74.0787269	385063.32	610327.98	431.30	DEM	516.0	45.0
Hunterdon	Raritan	Pittstown, NJ	GPS	39.8878562	74.0767849	384348.51	610876.26	450.47	DEM	291.0	49.0
Hunterdon	Raritan	Pittstown, NJ	GPS	39.8876016	74.0772645	384255.12	610742.14	450.57	DEM	256.9	46.4
Hunterdon	Raritan	Pittstown, NJ	GPS	39.8843129	74.0777503	383056.60	610611.49	469.42	DEM	494.1	48.2
Hunterdon	Delaware	Stockton, NJ	Map	40.4551039	74.9964407	362330.00	591036.00	411.00	MAP	395.6	49.1
Mercer	Ewing	Pennington, NJ	SURVEY	39.9689957	74.3804627	413644.36	525626.73	132.81	SURVEY	361.0	52.3
Mercer	Ewing	Pennington, NJ	SURVEY	39.9689709	74.3795106	413635.67	525893.57	136.18	SURVEY	354.0	48.6
Mercer	Ewing	Pennington, NJ	SURVEY	39.9694125	74.3796441	413796.47	525855.93	139.80	SURVEY	68.0	20.0
Mercer	Lawrence	Princeton, NJ	GPS	40.2769700	74.7263900	428962.00	525885.00	79.00	MAP	66.5	26.0
Mercer	Lawrence	Princeton, NJ	GPS	40.2761000	74.7264300	428950.00	525568.00	79.00	MAP	87.0	18.5
Mercer	Princeton	Princeton, NJ	GPS	40.0609909	74.2960729	447196.59	549201.28	127.15	DEM	352.0	43.1
Mercer	Princeton	Princeton, NJ	GPS	40.0612208	74.2965596	447280.03	549064.86	130.82	DEM	486.4	49.5
Mercer	Princeton	Princeton, NJ	GPS	40.0622153	74.2980332	447641.32	548651.60	111.95	DEM	492.0	51.1
Middlesex	Plainsboro	Hightstown, NJ	Map	40.0960176	74.2949487	459955.97	549486.52	97.69	DEM	85.0	24.5
Middlesex	Plainsboro	Hightstown, NJ	Map	40.0971045	74.2899032	460355.19	550897.03	108.78	DEM	50.0	28.0
Middlesex	Plainsboro	Hightstown, NJ	Map	40.0961881	74.2923956	460019.73	550200.60	106.00	DEM	91.0	26.2

GWI - Ground-water contaminant investigation, WS- Water Supply , NAD83 NJSPF - 1983 North American Datum New Jersey State Plane Coordinate Feet
NGVD88 -National Geodetic Vertical Datum 1988

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Summary of Borehole Geophysical Studies in the Newark Basin, New Jersey:

Diabase and Brunswick Basalt in the Watching Zone

By Gregory C. Herman and John F. Curran, N.J. Geological Survey

Appendix 1 of

Contributions to the Geology and Hydrogeology of the Newark Basin

N.J. Geological Survey Bulletin 77

State of New Jersey
N.J. Department of Environmental Protection
Water Resource Management
N.J. Geological Survey
2010

Well 1 – Diabase

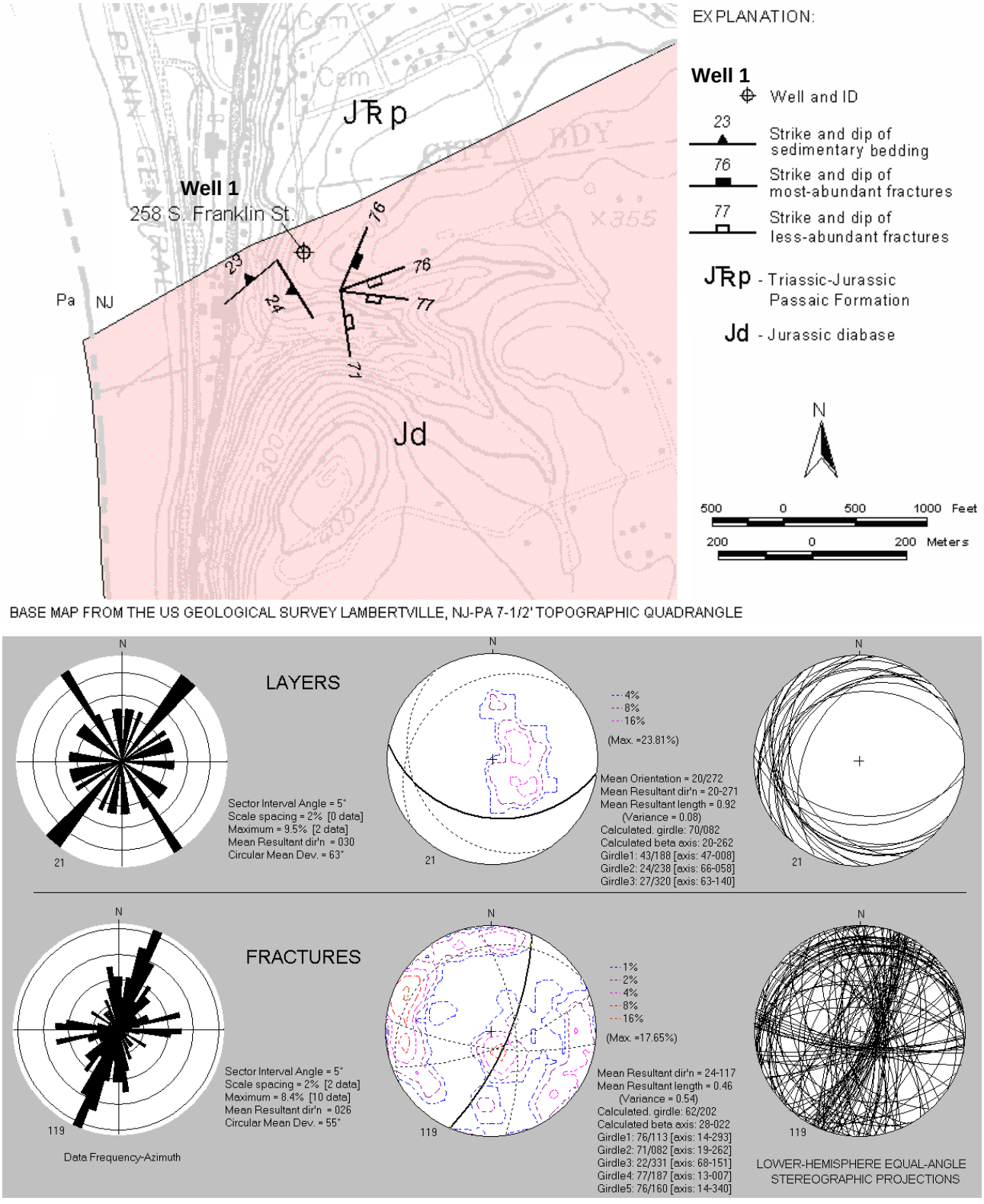


Figure 1A1. Map (above) shows well 1 at 258 South Franklin St., Lambertville, Hunterdon County, NJ. Mapped bedrock structures based on a structural analysis (below) of the OPTV record. Note that topographic ridges and streams parallel structural trends.

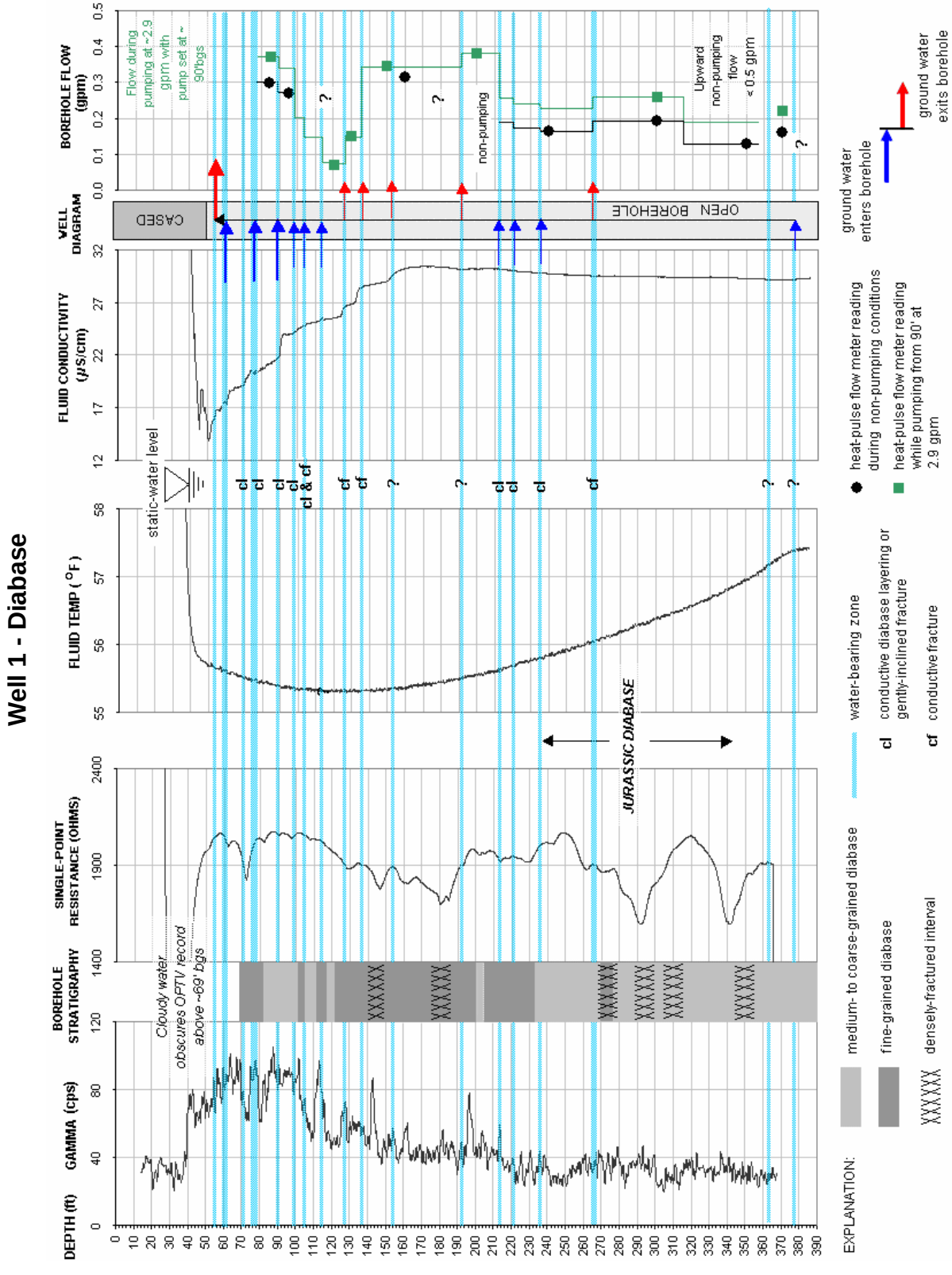


FIGURE 1A2. Hydrogeologic section based on geophysical logs for well 1 showing the vertical distribution and types of hydraulically-conductive features and water-bearing zones. Depth values are in feet below land surface.

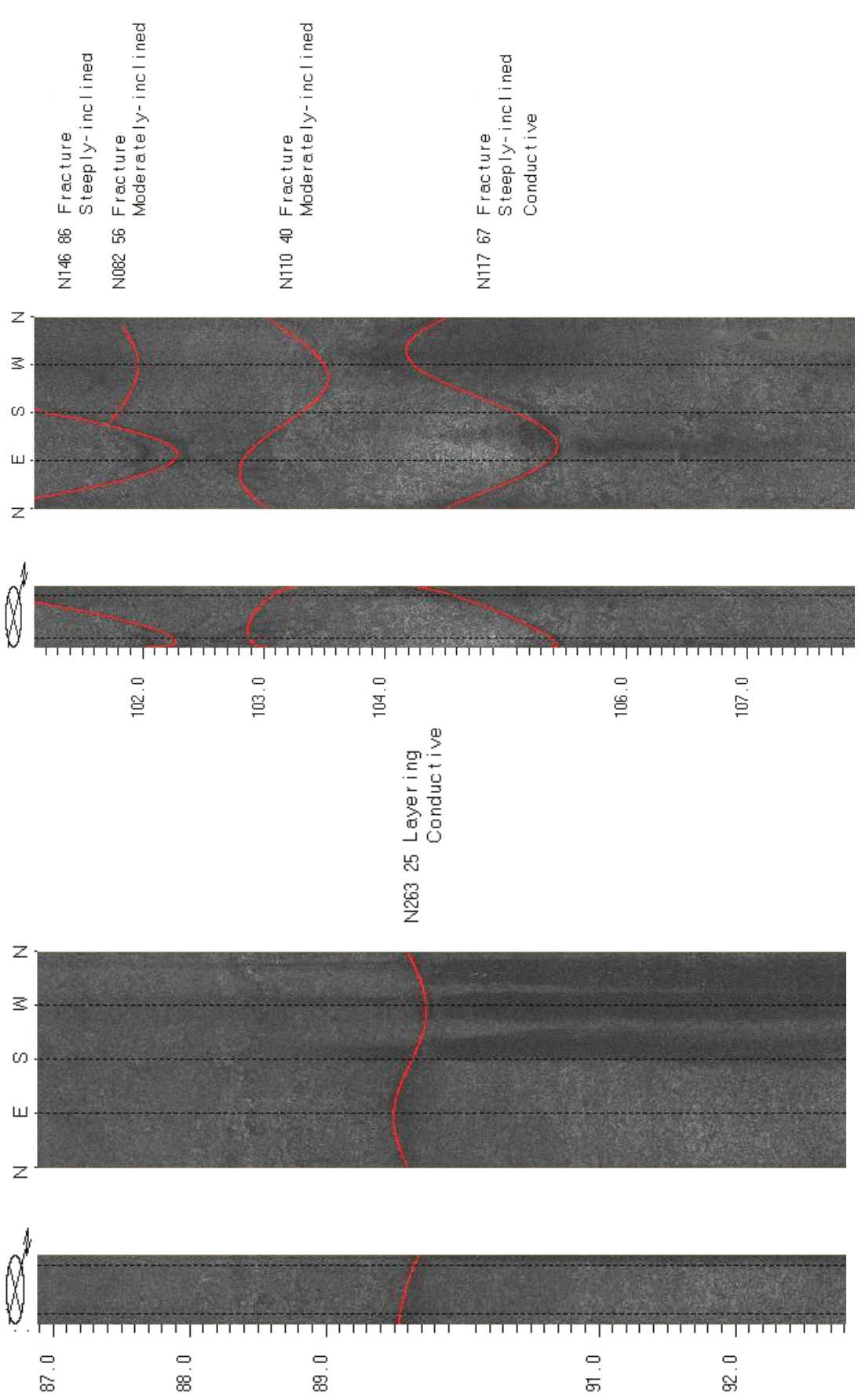


FIGURE 1A3. OPTV records of the 6-inch diameter well 1showing bedrock structures and hydraulically-conductive features in diabase. Mineral deposits seen as dark stains on the borehole wall emanate from conductive features and taper off in the direction of water flow. Upward-tapering stains are less pronounced than downward ones, indicating upward non-pumping cross flows are less than pumping-induced downward flows where the conductive features occur above the pump depth. Depth values are in feet below land surface.

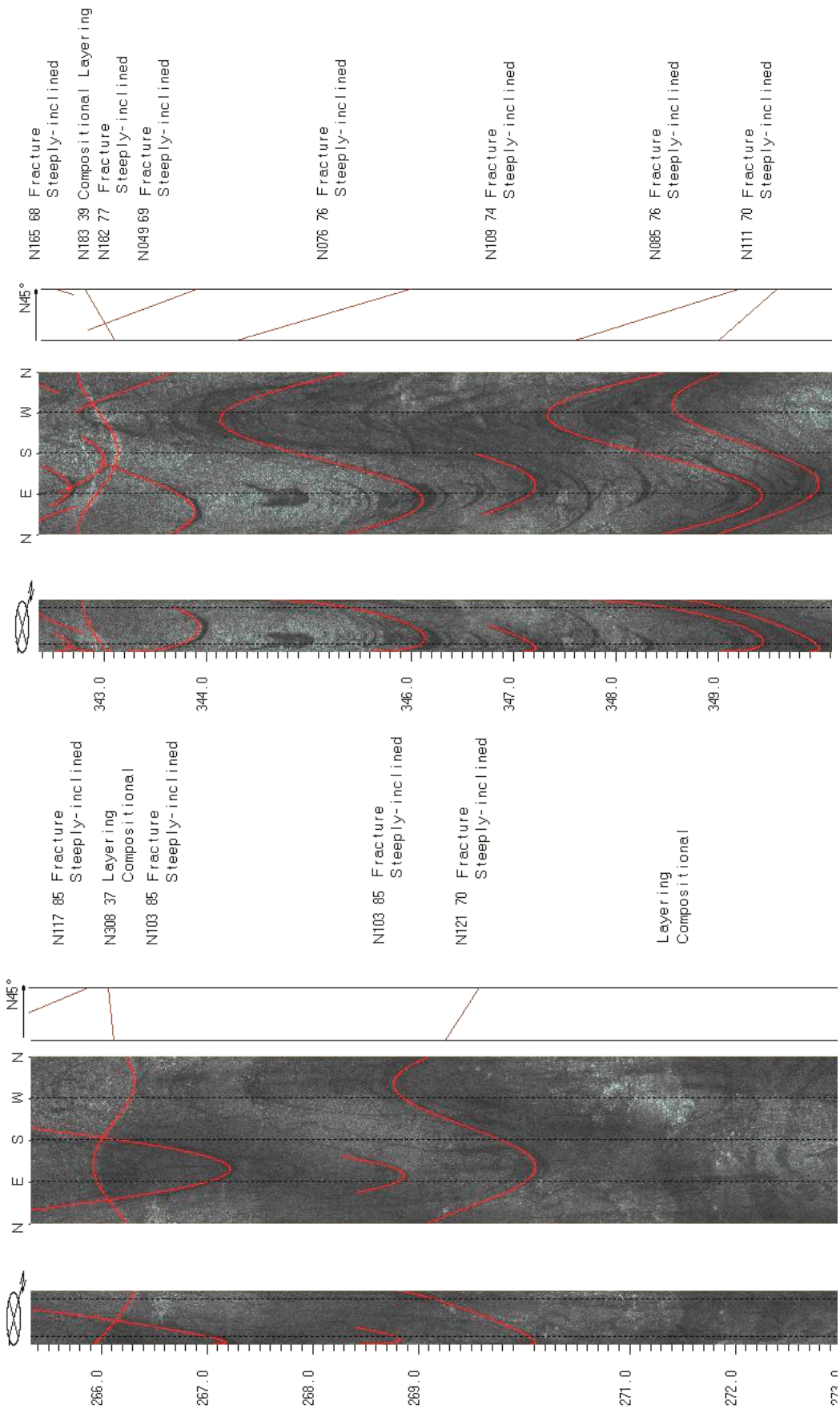


FIGURE 1A4. OPTV records of the 6-inch diameter well 1 showing bedrock structures in diabase. Depth values are in feet below land surface.

Wells 2 to 5 – Diabase overlying the Brunswick lower gray zone and Lockatong aquifers

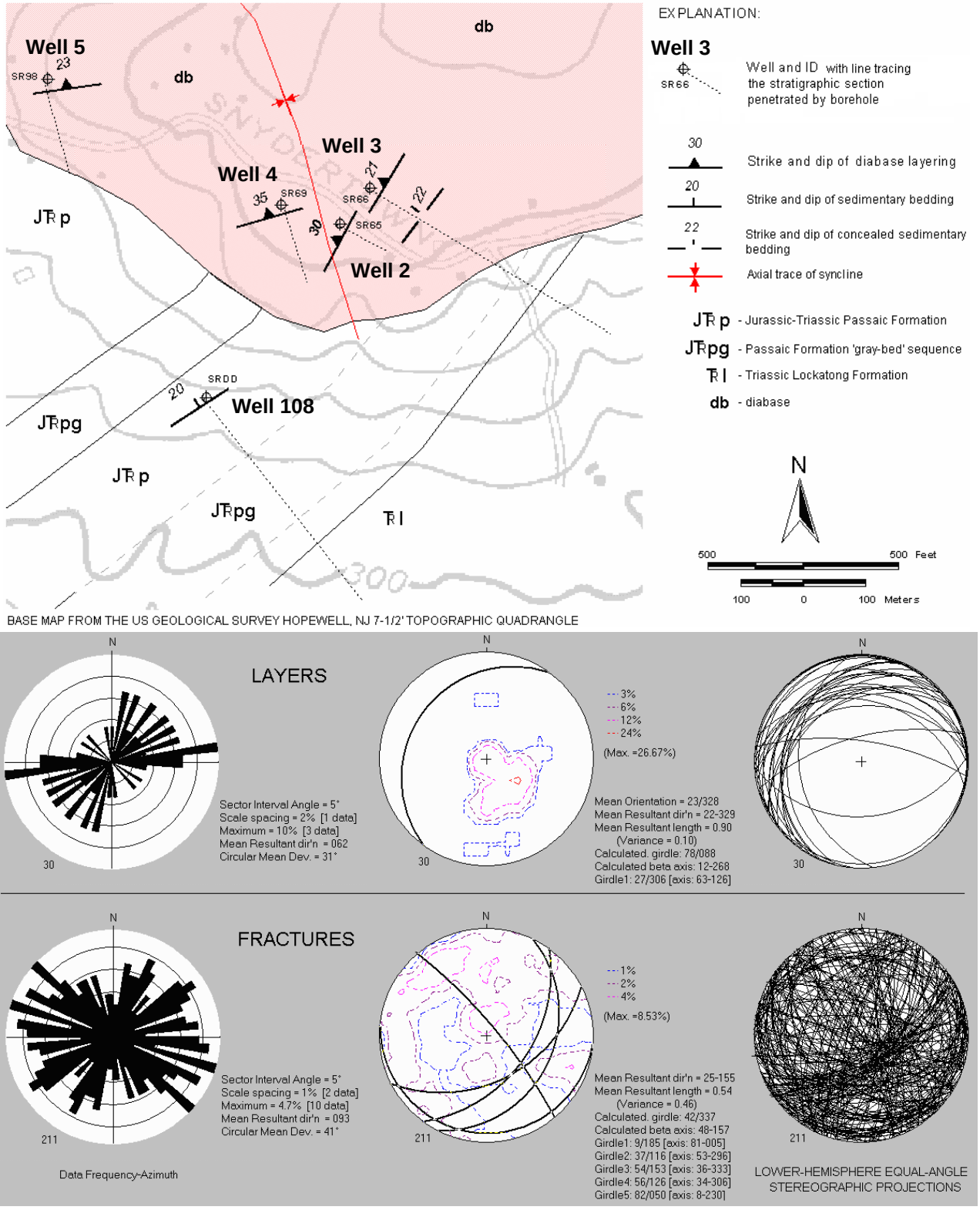


Figure 1B1. Map (above) shows wells 2 through 5 and 112 along Snydertown Rd., East Amwell Twp., Hunterdon Country, NJ. Mapped bedrock structures are based on a structural analysis (bottom) of the OPTV records. Hydrogeologic analysis of well 108 is in appendix entry 3Q.

Wells 2 to 5 – Diabase overlying the Brunswick lower gray zone and Lockatong aquifers

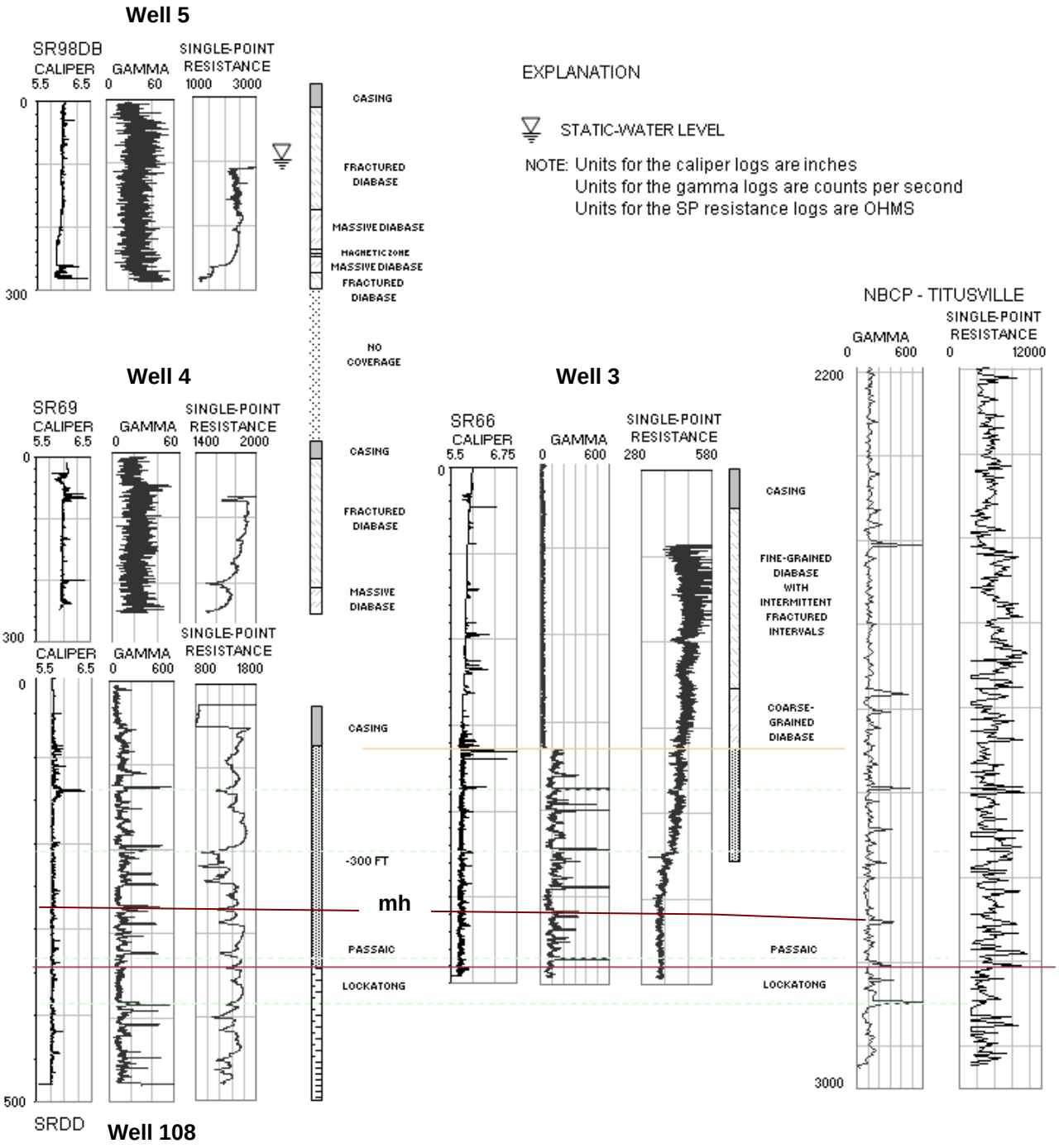


FIGURE 1B2. Stratigraphic section based on geophysical logs for wells 3, 4, 5 and 108 showing diabase overlying the Passaic and Lockatong Formations. Wells 3 and 108 are correlated with the Titusville core hole of Olsen and others (1996) using natural gamma and electrical resistance logs. Depth values are in feet below land surface. Marker horizon (mh) shown using OPTV records in figure 3Q3.

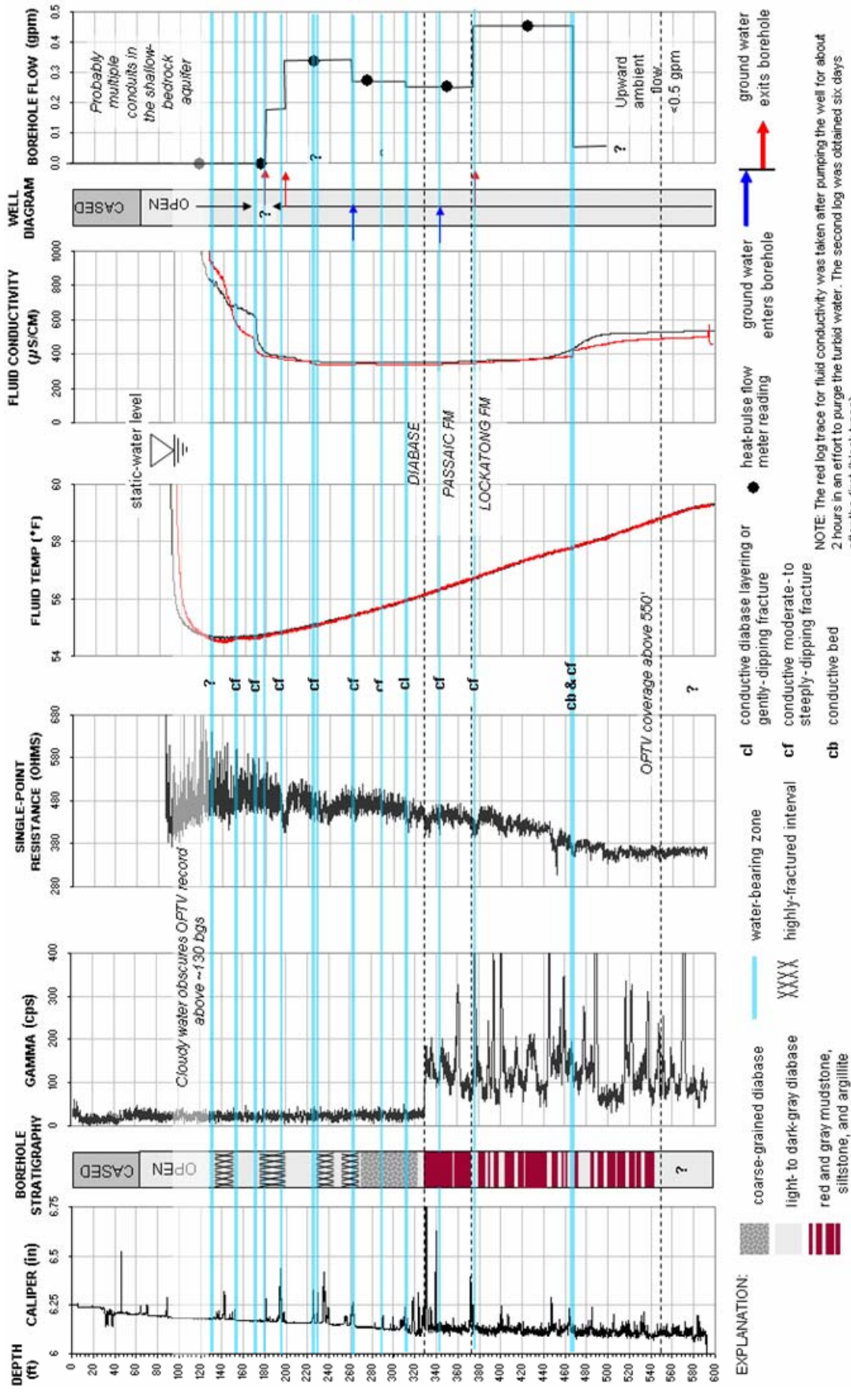


FIGURE 1B3. Hydrogeologic section based on geophysical logs for well 3 showing the vertical distribution and types of hydraulically-conductive features and water-bearing zones in diabase, the lower gray zone of the Brunswick aquifer and the Lockatong aquifer, Depth values are in feet below land surface.

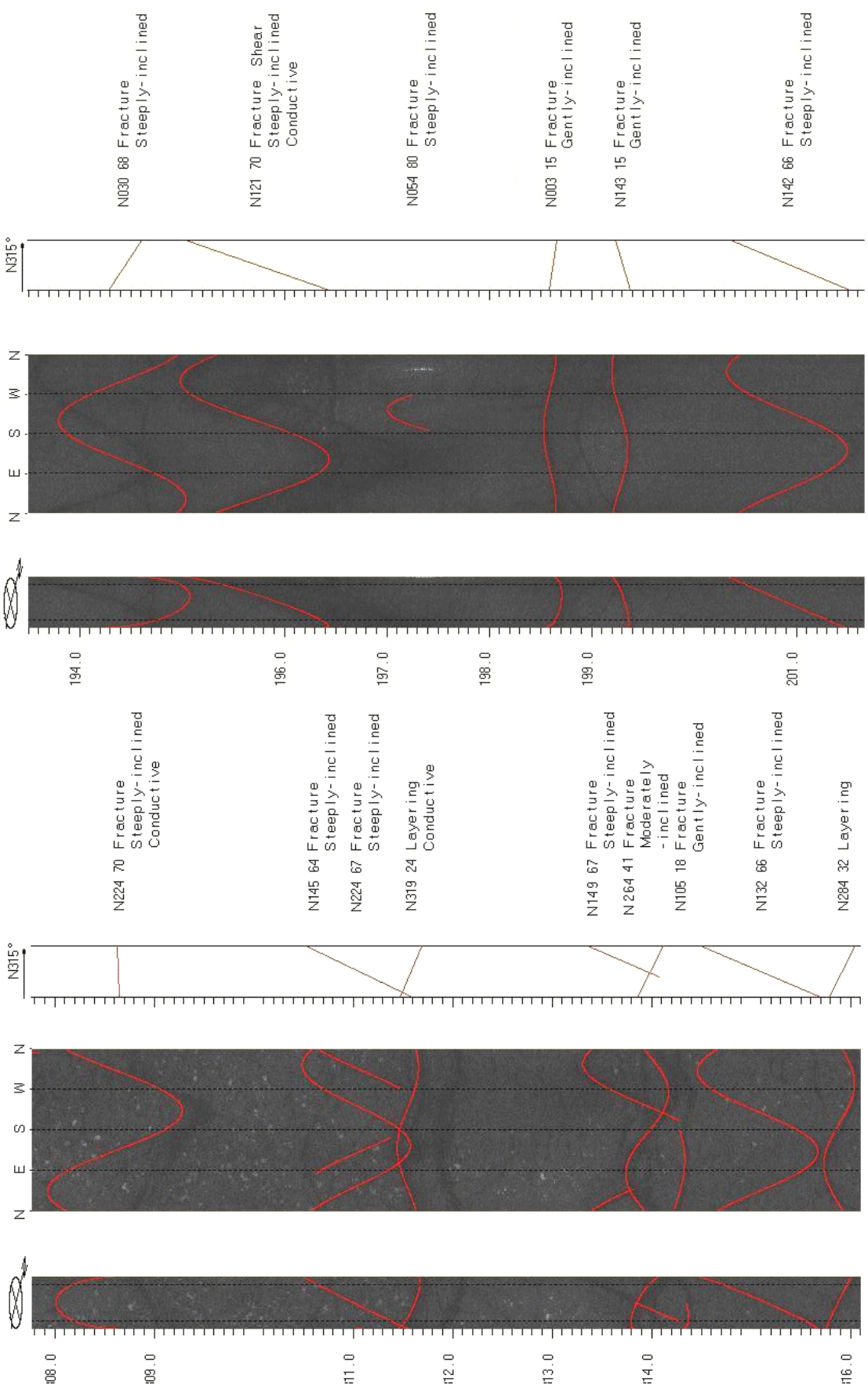


FIGURE 1B4. OPTV records of the 6-inch diameter well 3 showing bedrock structures and hydraulically-conductive features in diabase. Depth values are in feet below land surface.

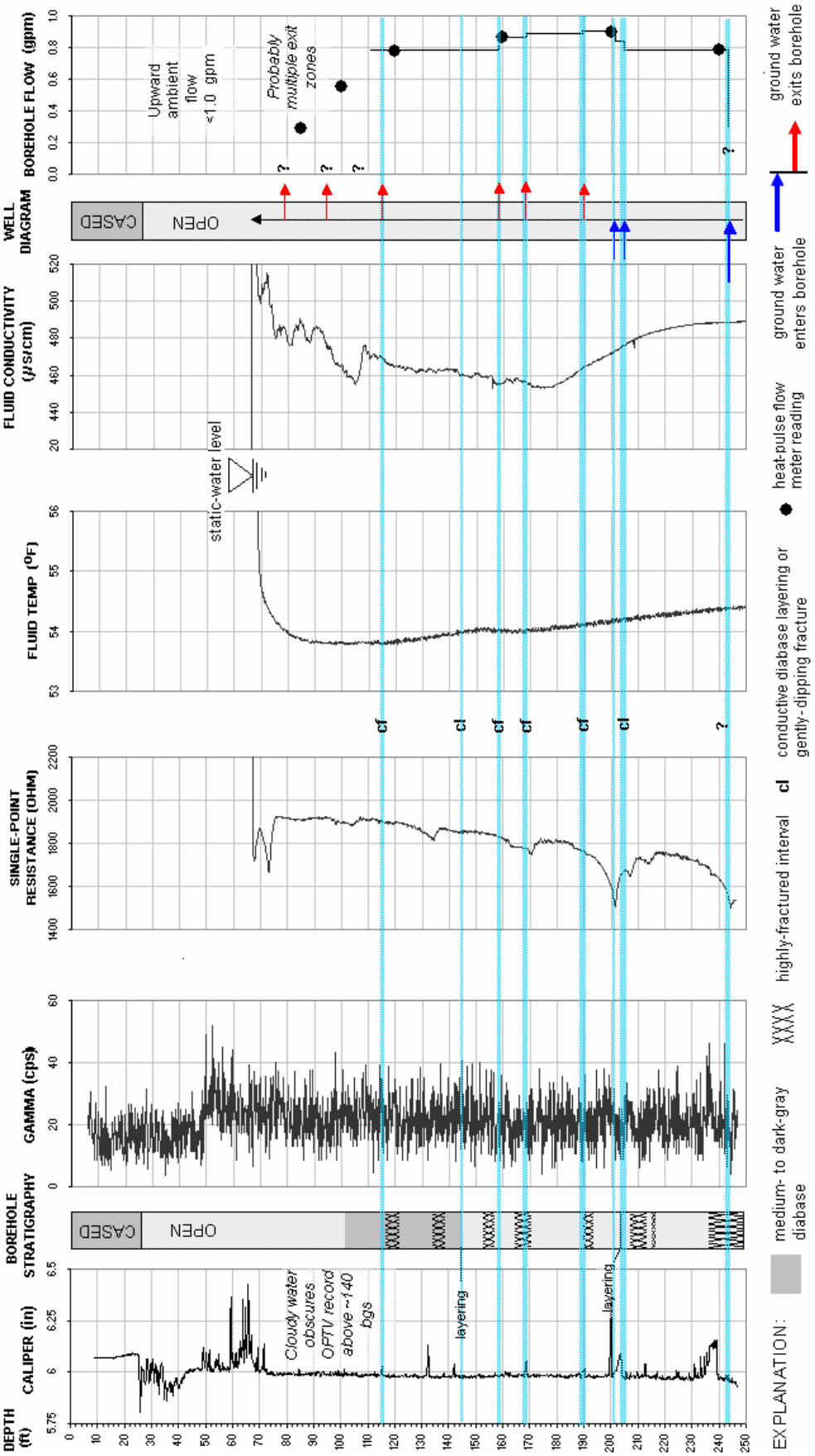


FIGURE 1B5. Hydrogeologic section based on geophysical logs for well 4 showing the vertical distribution and types of hydraulically-conductive features and water-bearing zones in diabase. Depth values are in feet below land surface.

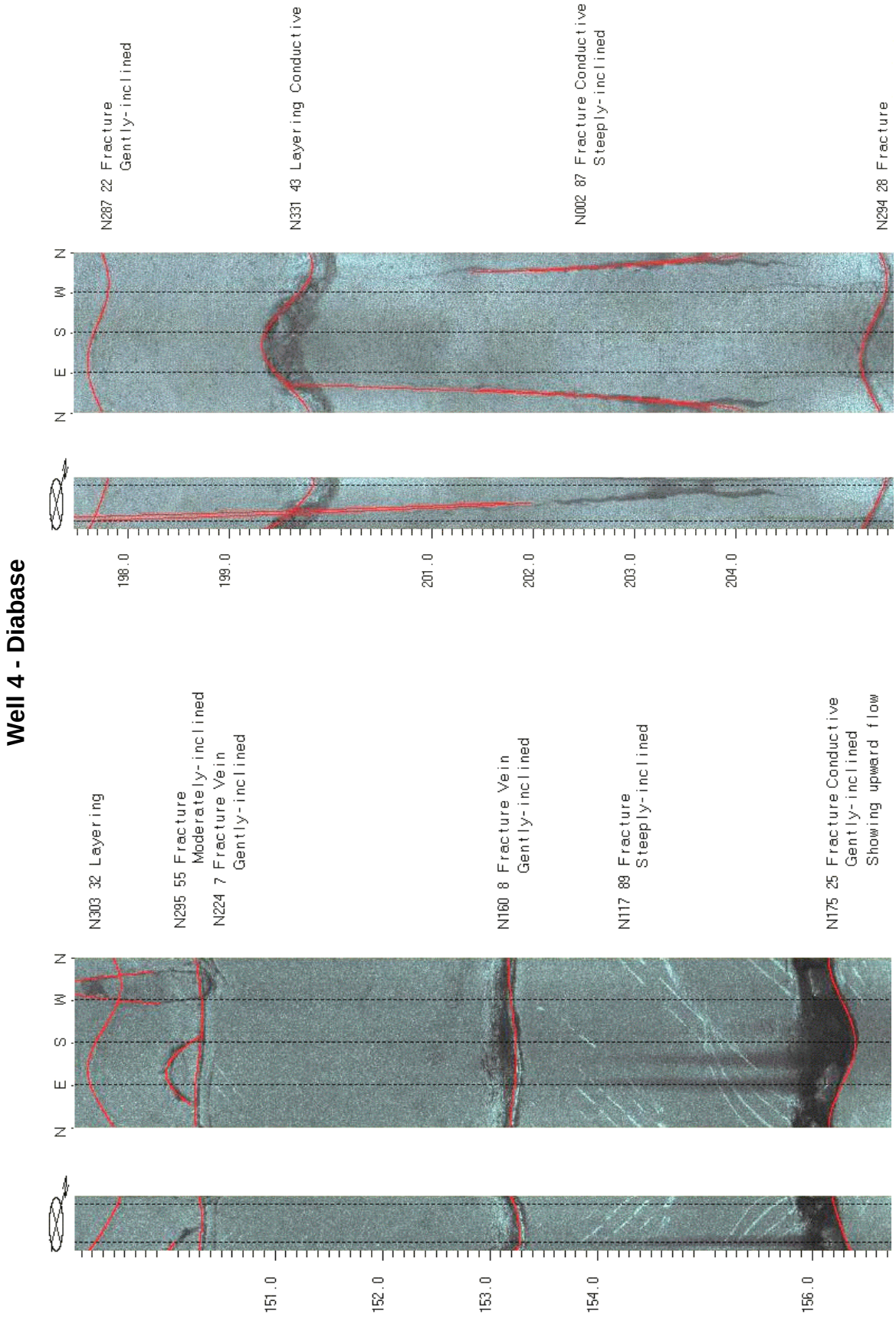


FIGURE 1B6. OPTV records of the 6-inch diameter well 4 showing bedrock structures and hydraulically-conductive features in diabase. Mineral deposits seen as dark stains on the borehole wall (left) emanate from a conductive layer and taper upward in the direction of water flow. These stains indicate upward, non-pumping cross flows that are confirmed by HPFM readings (fig. 1B5). Depth values are in feet below land surface.

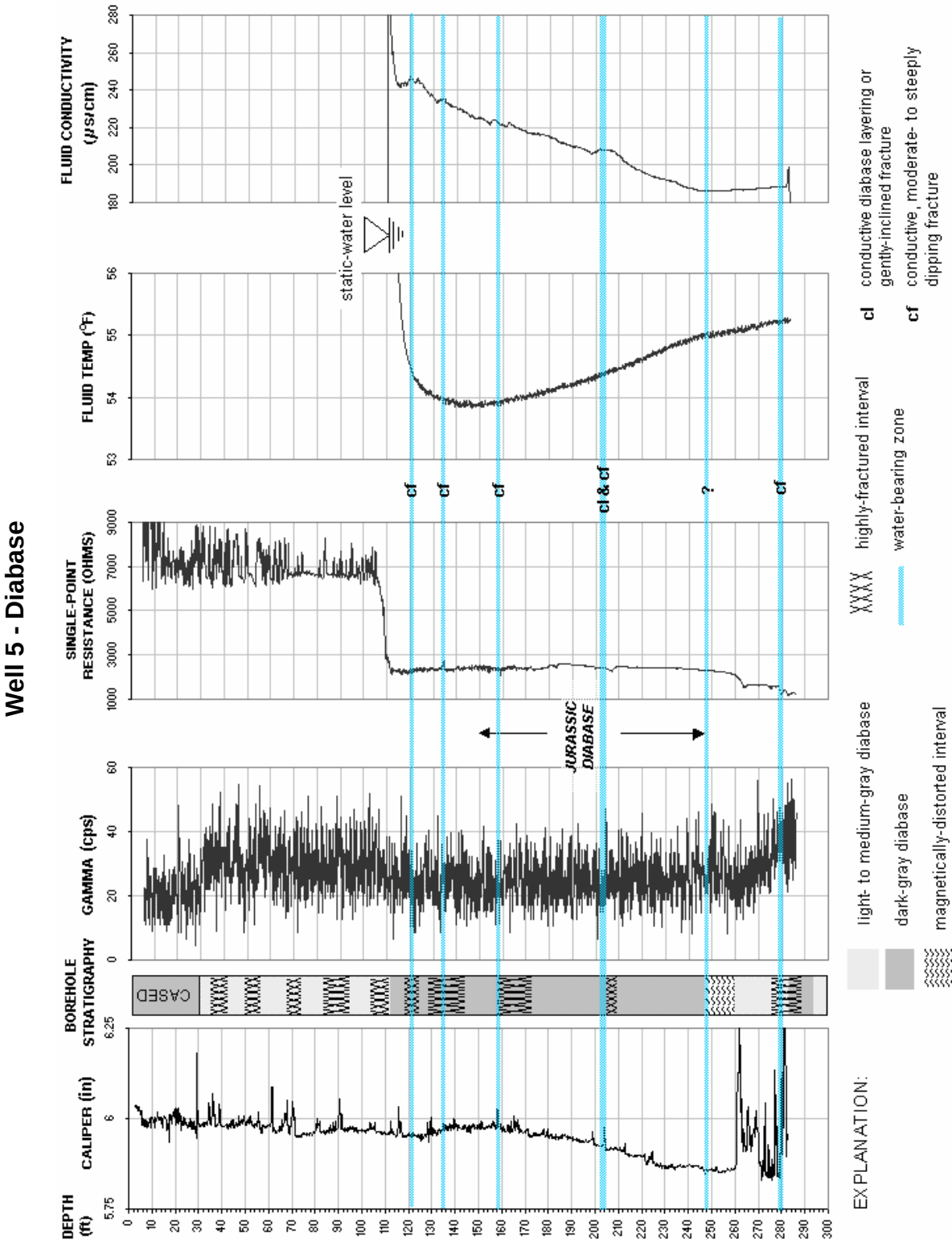


FIGURE 1B7. Hydrogeologic section based on geophysical logs for well 5 showing the vertical distribution and types of hydraulically-conductive features and water-bearing zones in diabase. Depth values are in feet below land surface.

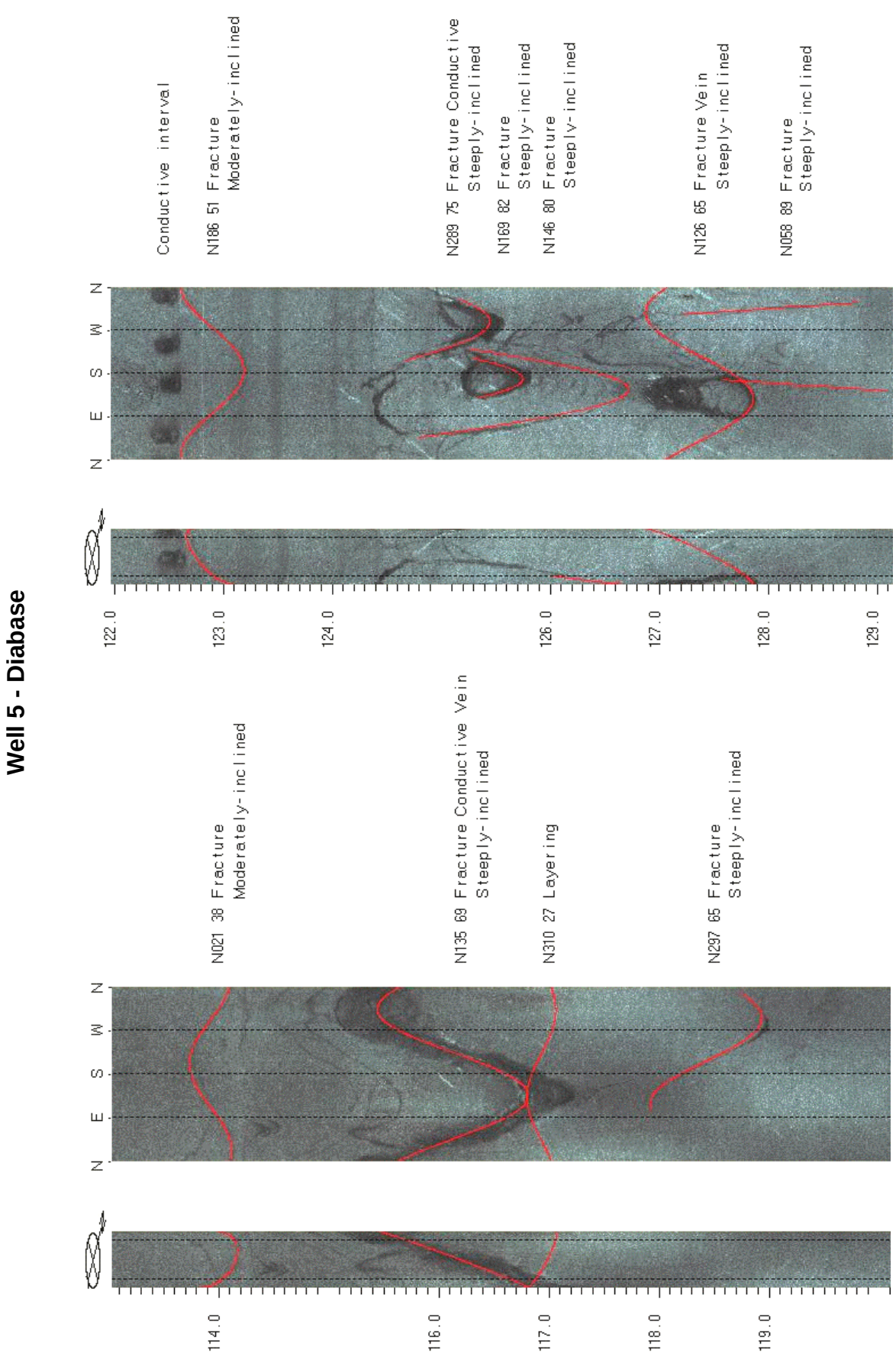


FIGURE 1B8. OPTV records of the 6-inch diameter well 5 showing bedrock structures and hydraulically-conductive features in diabase. Depth values are in feet below land surface.

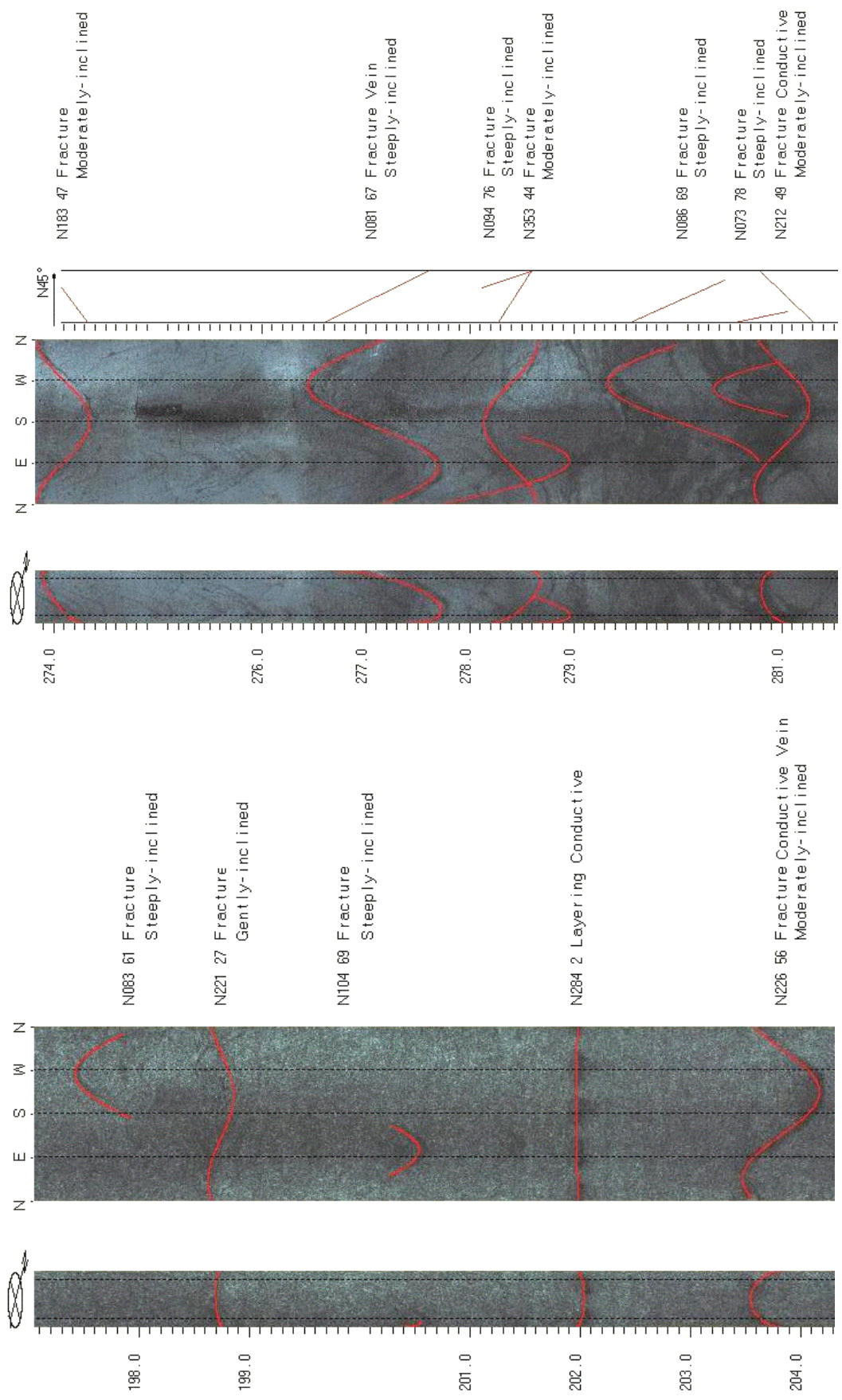
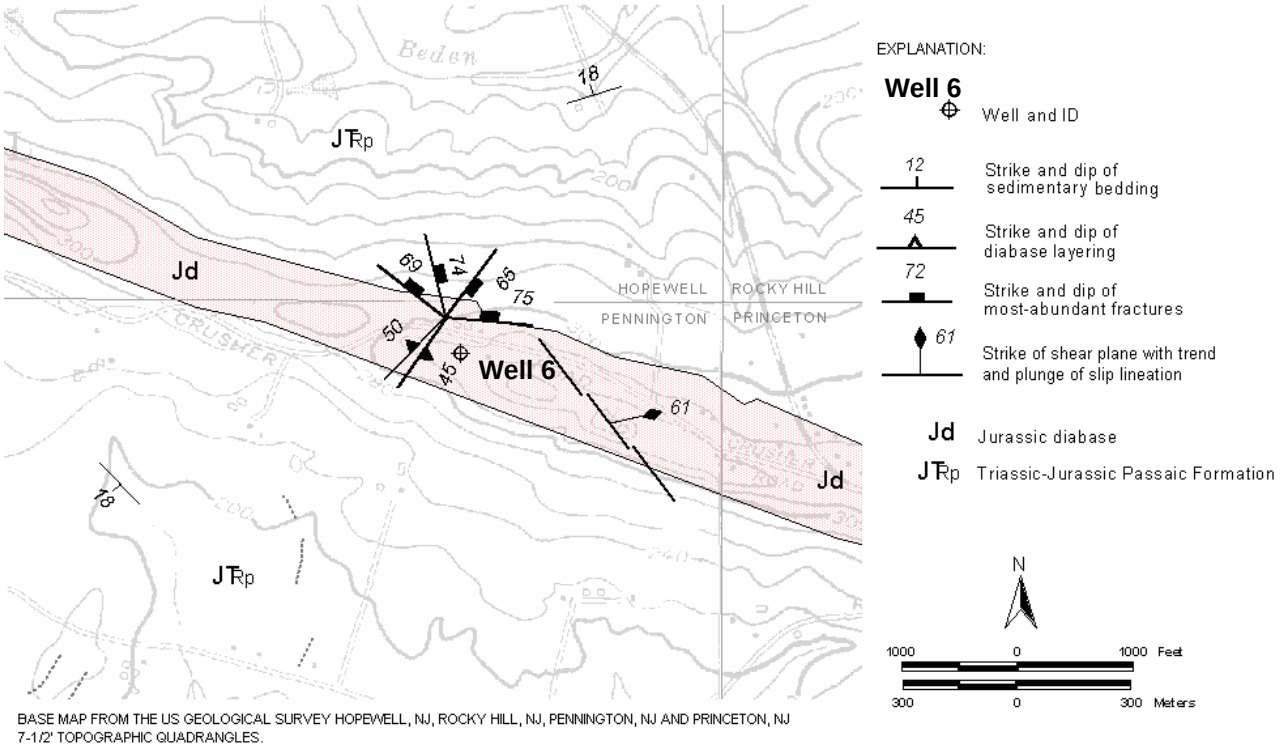


FIGURE 1B9. OPTV records of the 6-inch diameter well 5 showing bedrock structures and hydraulically-conductive features in diabase. Depth values are in feet below land surface.

Well 6 - Diabase



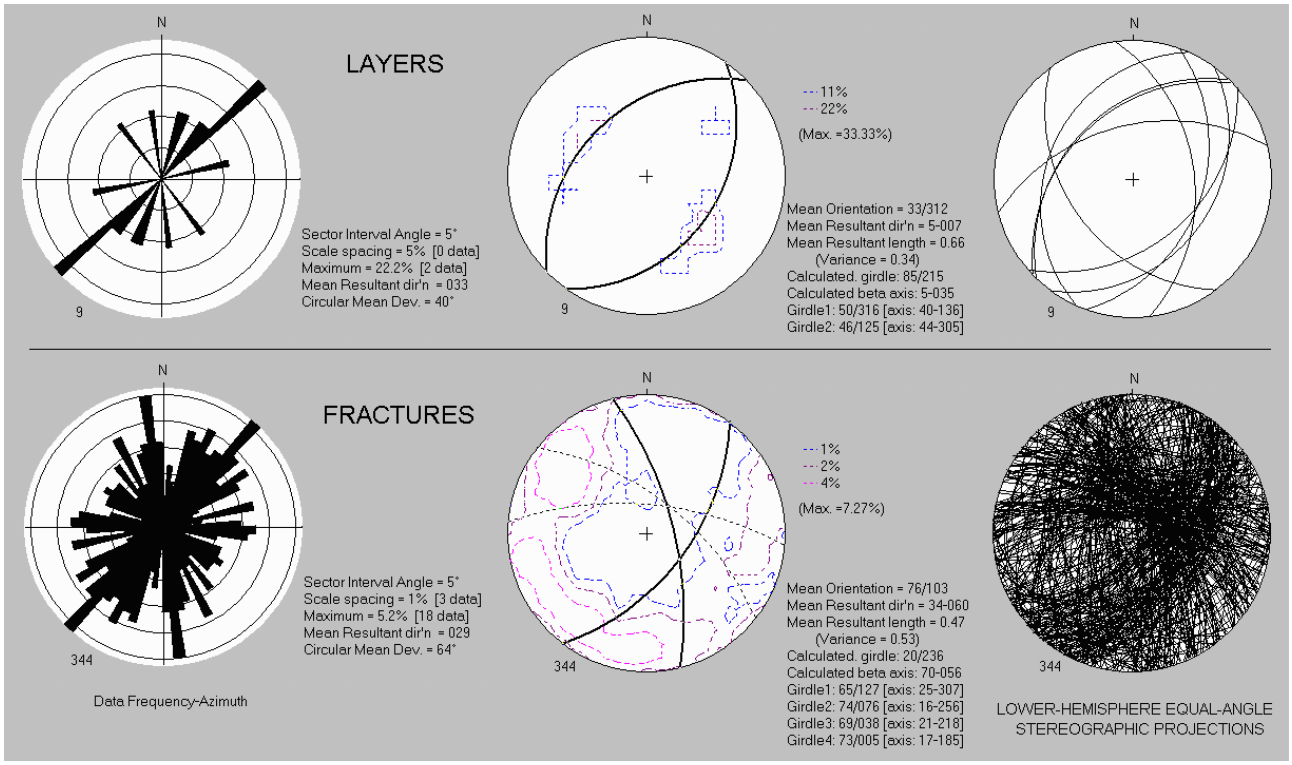


Figure 1C1. Map (above) shows well 6 at 65 Crusher Rd., Hopewell Twp., Mercer County, NJ. Mapped bedrock structures are based on a structural analysis (bottom) of the OPTV record.

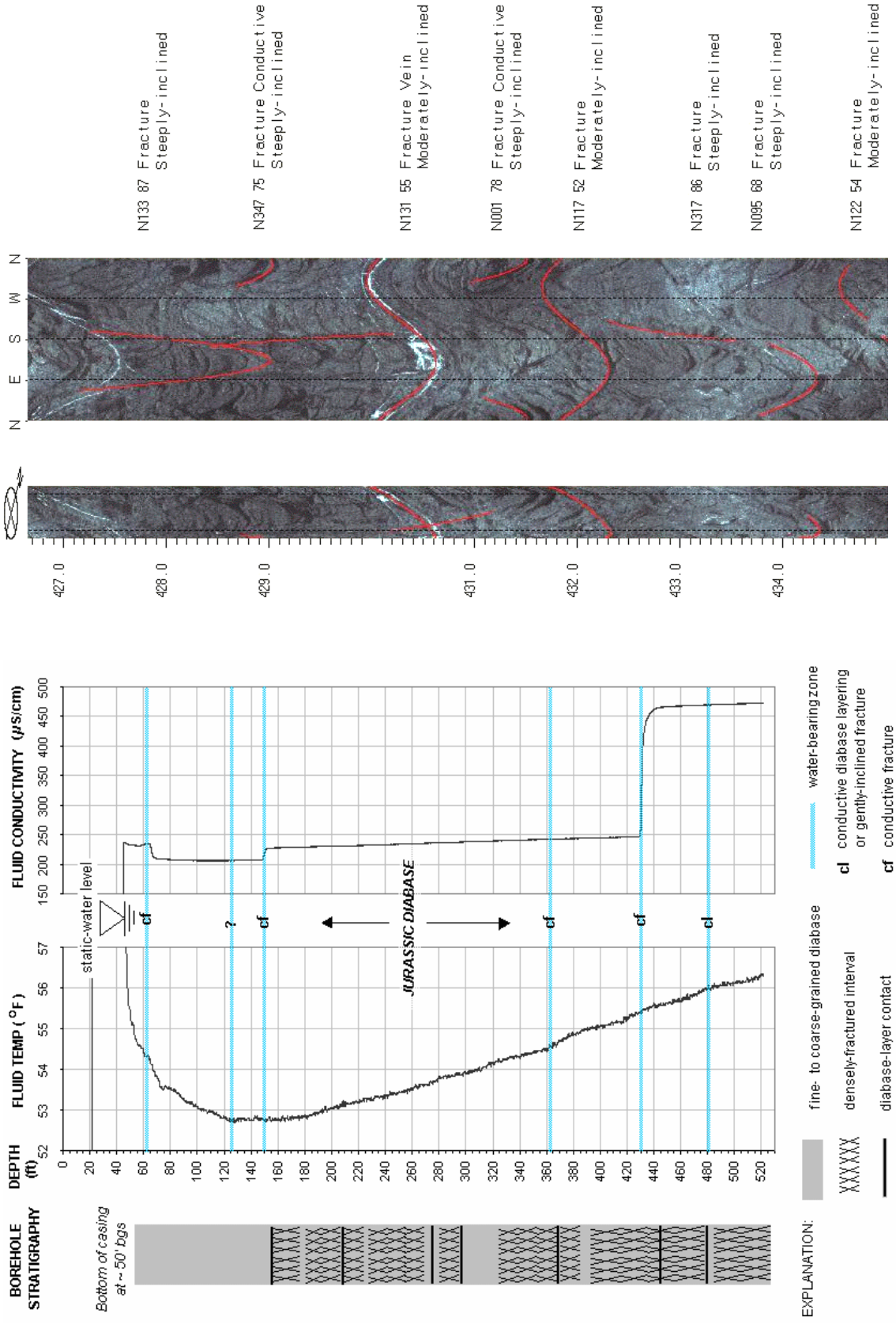


FIGURE 1C2. Hydrogeologic section based on geophysical logs for well 6 (left) shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in diabase. OPTV record (right) of the 6-inch diameter well shows bedrock structures in diabase. Depth values are in feet below land surface.

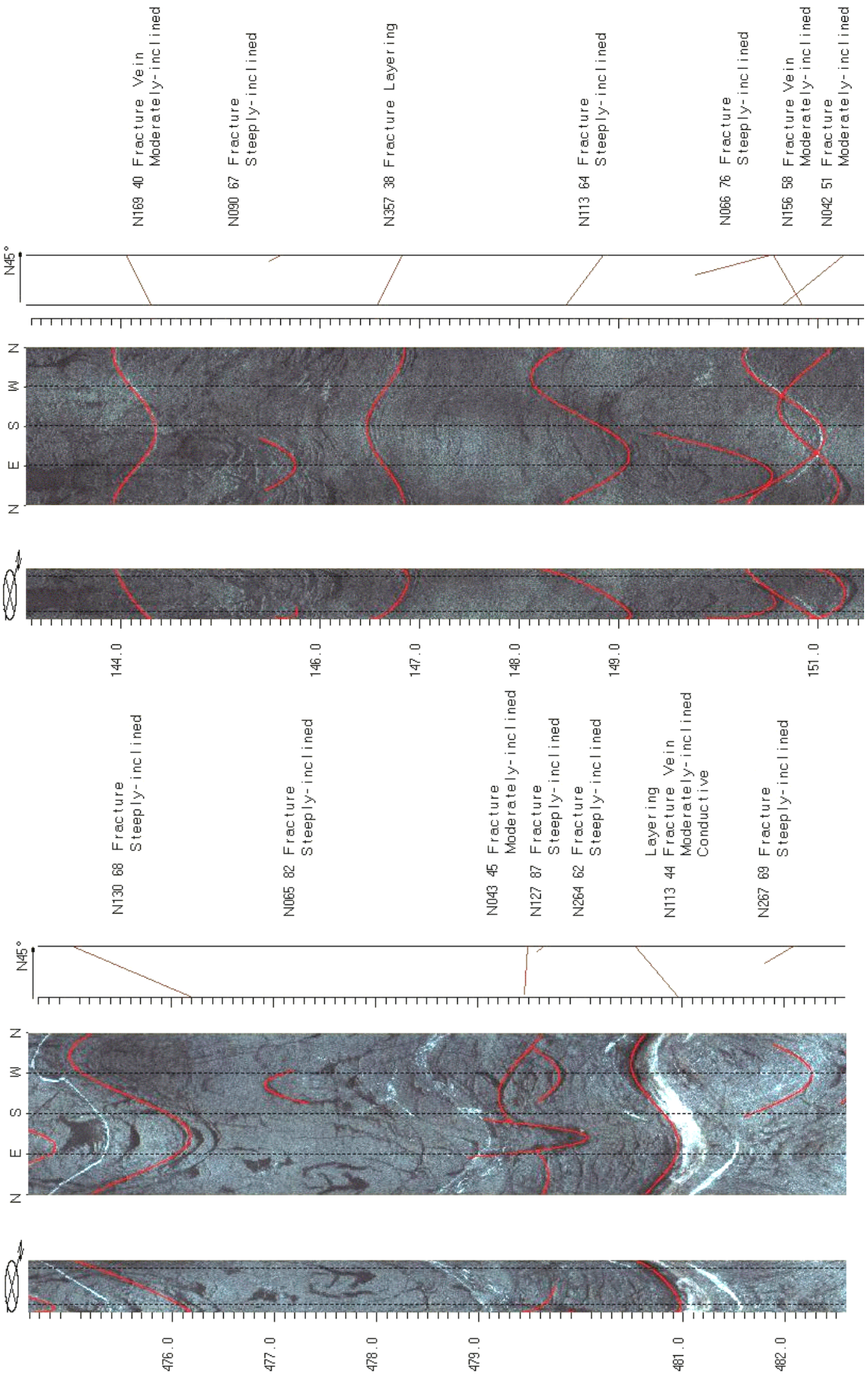


FIGURE 1C3. OPTV records of the 6-inch diameter well 6 showing bedrock structures and hydraulically-conductive features in diabase. Depth values are in feet below land surface.

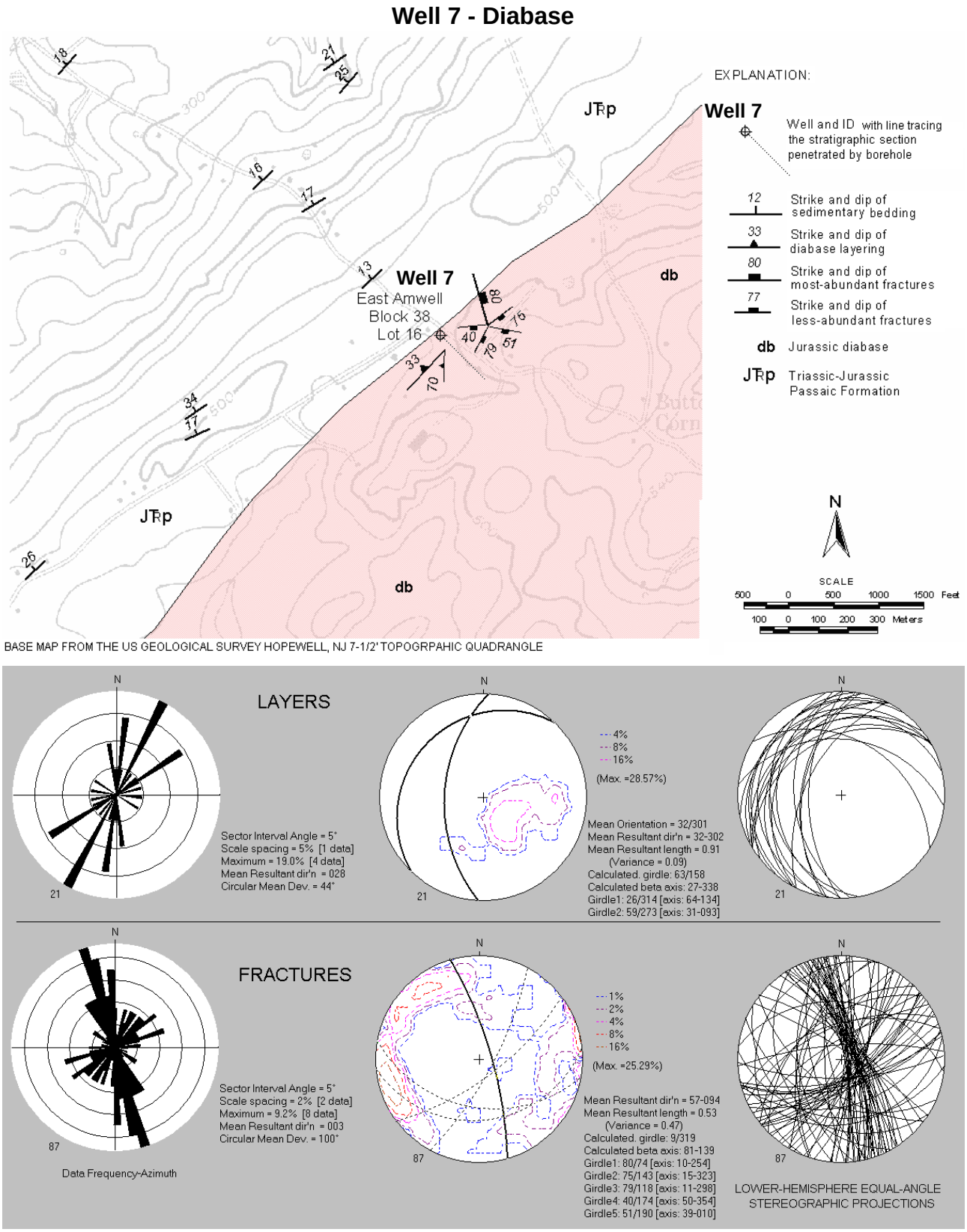


Figure 1D1. Map (above) shows well 7 on Block 38, Lot 16, East Amwell Twp., Hunterdon County, NJ. Bedrock structures mapped near the well are based on a structural analysis (bottom) of the OPTV record. Strike and dip of nearby sedimentary beds from outcrop measurements compiled by the NJ Geological Survey, Trenton, NJ.

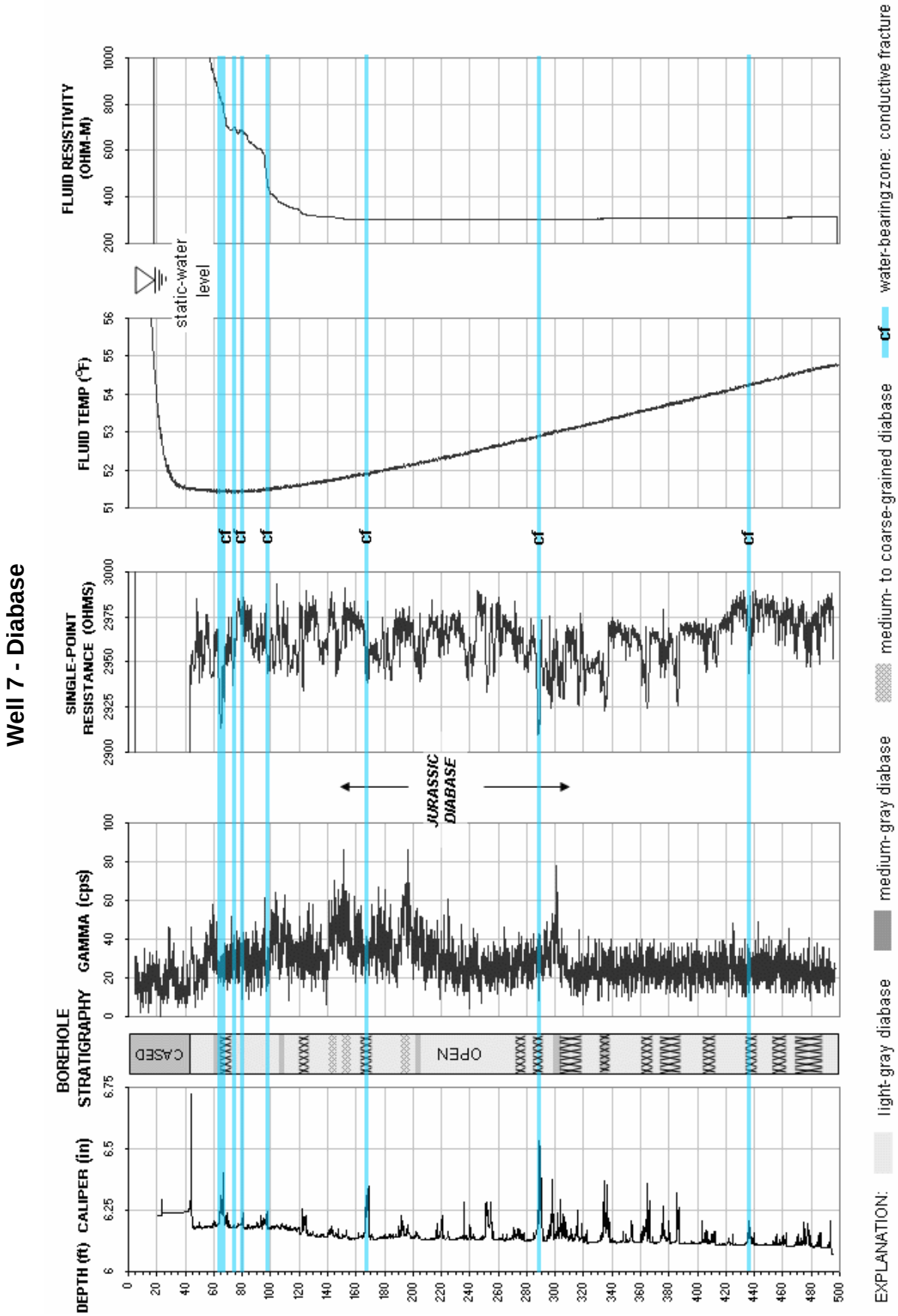


FIGURE 1D2. Hydrogeologic section based on geophysical logs for well 7 showing the vertical distribution of hydraulically-conductive fractures and water-bearing zones in diabase. Depth values are in feet below land surface.

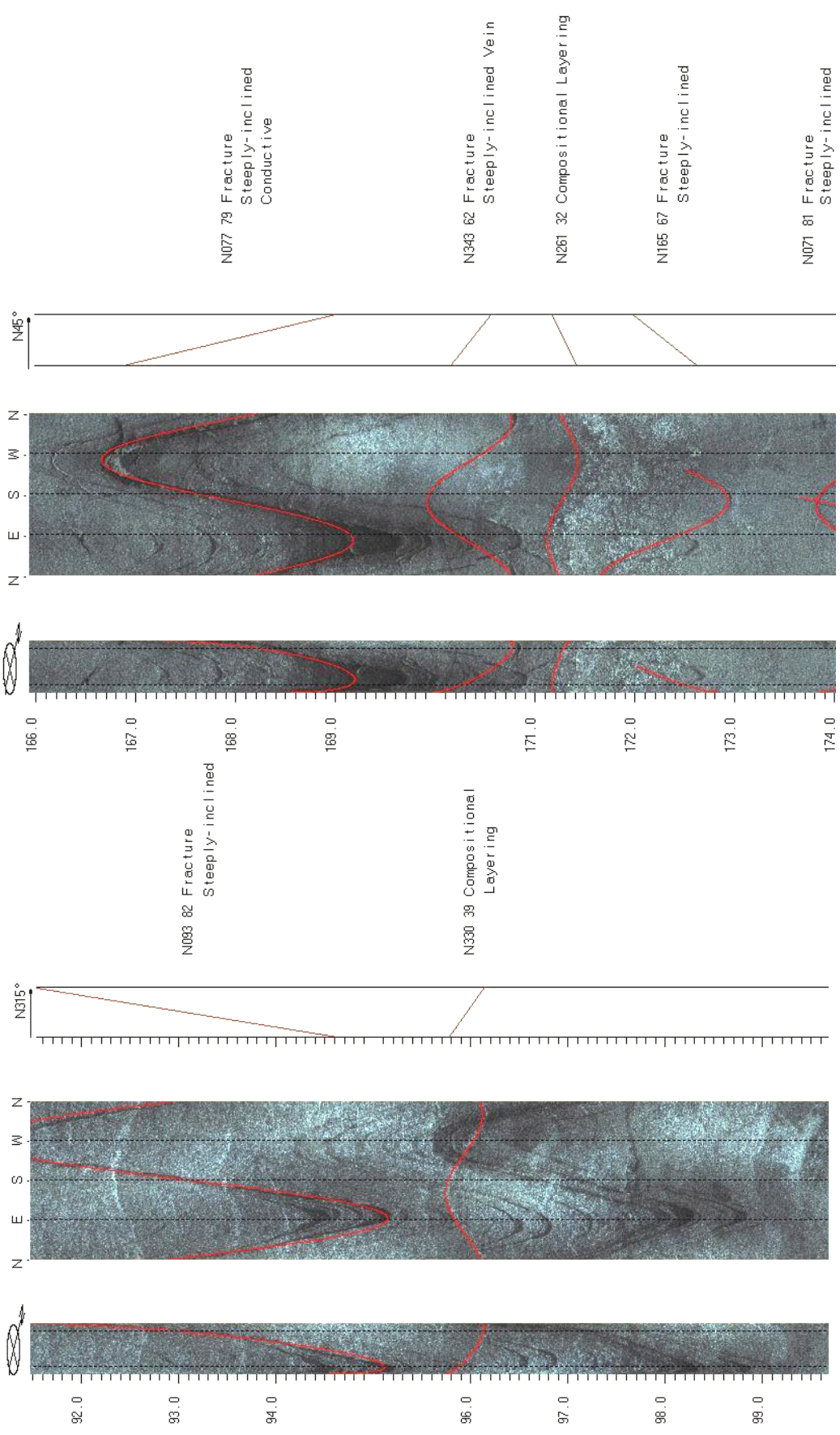


FIGURE 1D3. OPTV records of the 6-inch diameter well 7 showing bedrock structures and hydraulically-conductive features in diabase. Depth values are in feet below land surface.

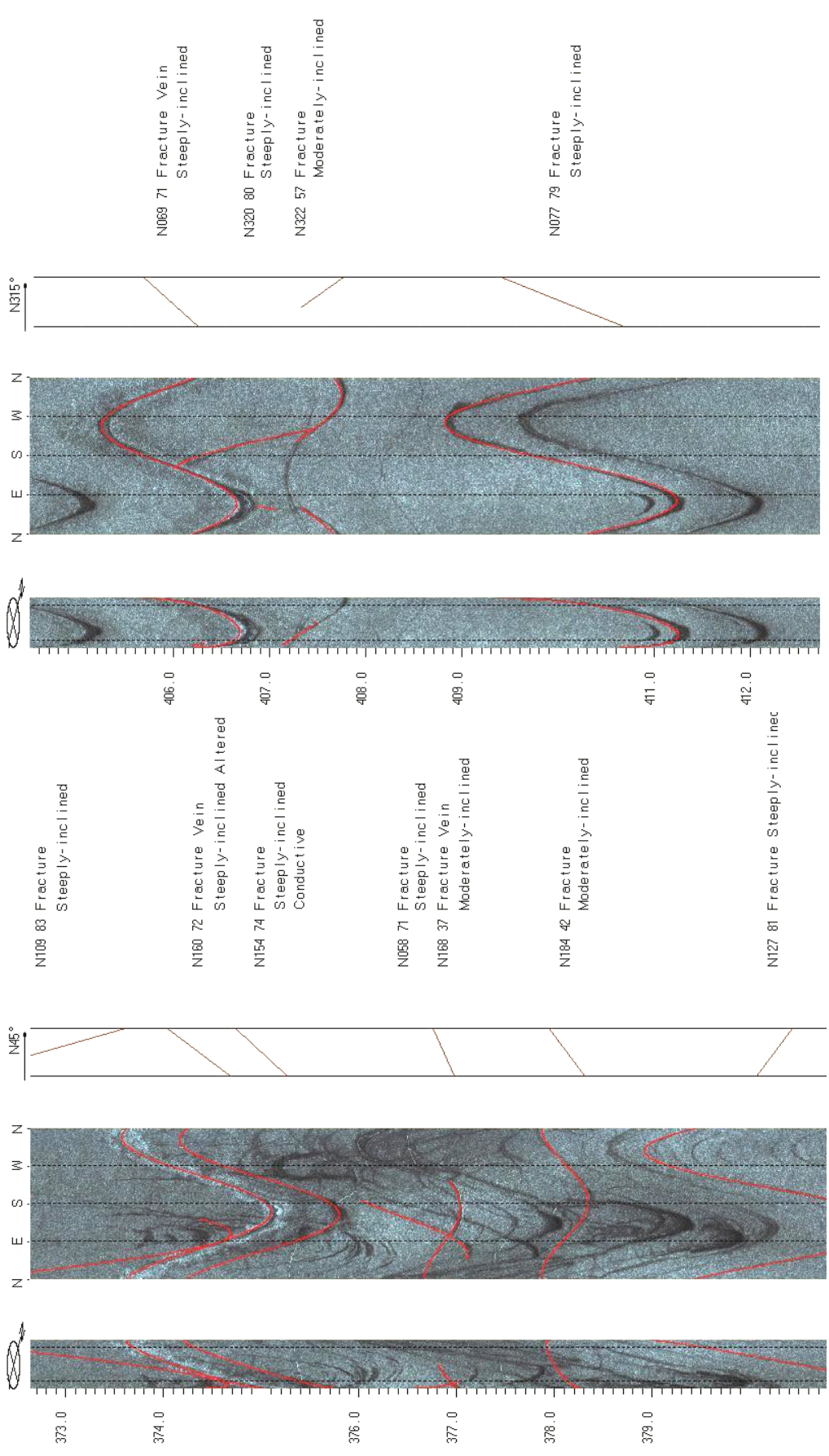


FIGURE 1D4. OPTV records of the 6-inch diameter well 5 showing bedrock structures and hydraulically-conductive features in diabase. Depth values are fin eet below land surface.

Wells 8 to 10 – Brunswick basalt of the Watchung zone overlying the Brunswick upper red zone

FIGURE 1E1. Map above shows wells 8 through 10 on the Essex County Country Club golf course, 350 Mt. Pleasant Ave, West Orange Twp., Essex County, NJ. Map below shows bedrock structures for each well based on a structural analysis of OPTV records.

Wells 8 to 10 – Brunswick basalt of the Watchung zone overlying the Brunswick upper red zone

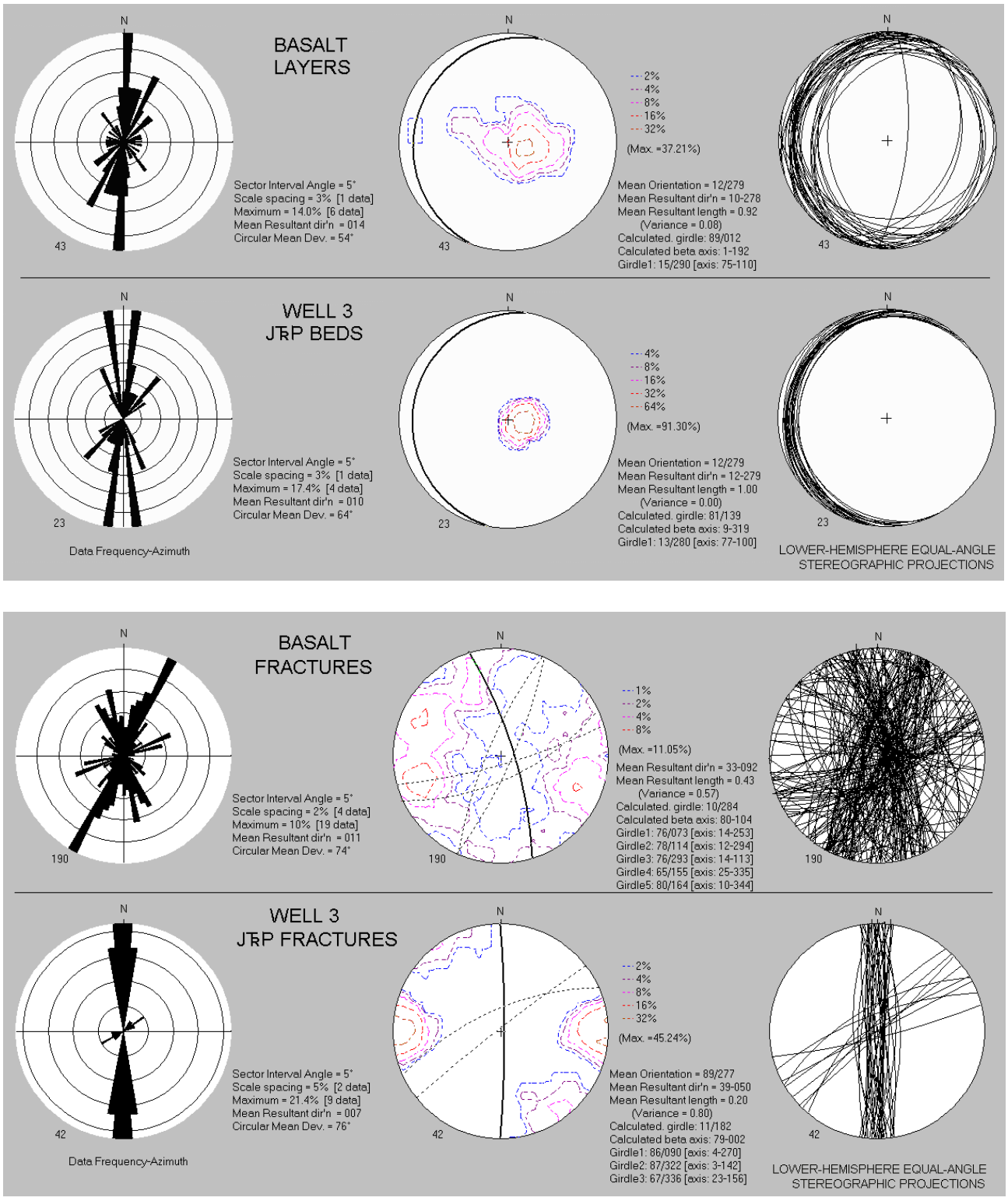


FIGURE 1E2. Structural analyses of OPTV records for wells 8 to10. Analysis above is for basalt layers and underlying sedimentary beds in the upper red zone of the Brunswick aquifer. Analysis below is for fractures in basalt and underlying sedimentary beds.

Well 8 – Brunswick basalt in the Watchung zone

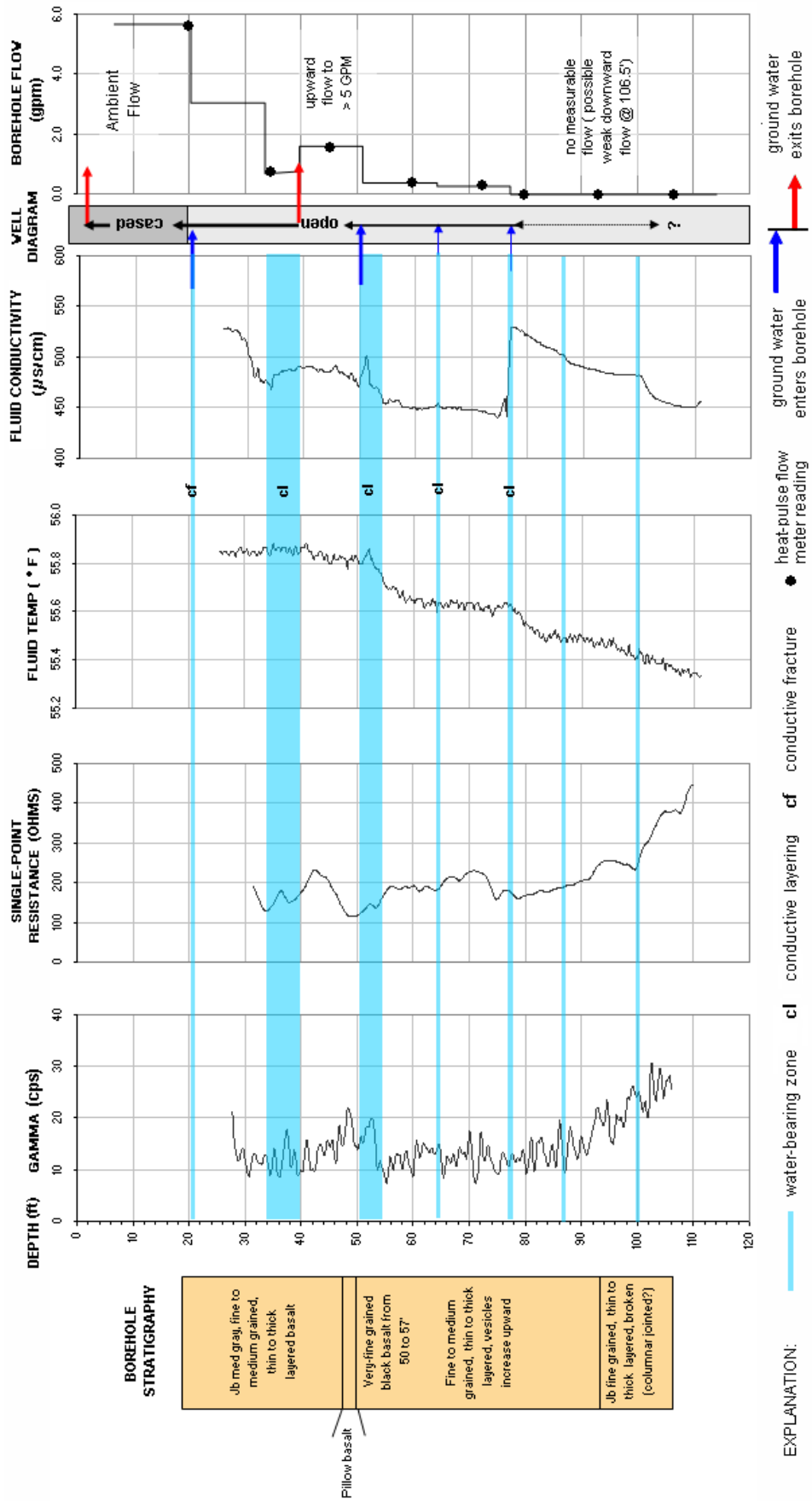


FIGURE 1E3. Stratigraphic and hydrogeologic sections based on geophysical logs for well 8 showing the vertical distribution and types of hydraulically-conductive features and water-bearing zones in basalt. Depth values are in feet below land surface.

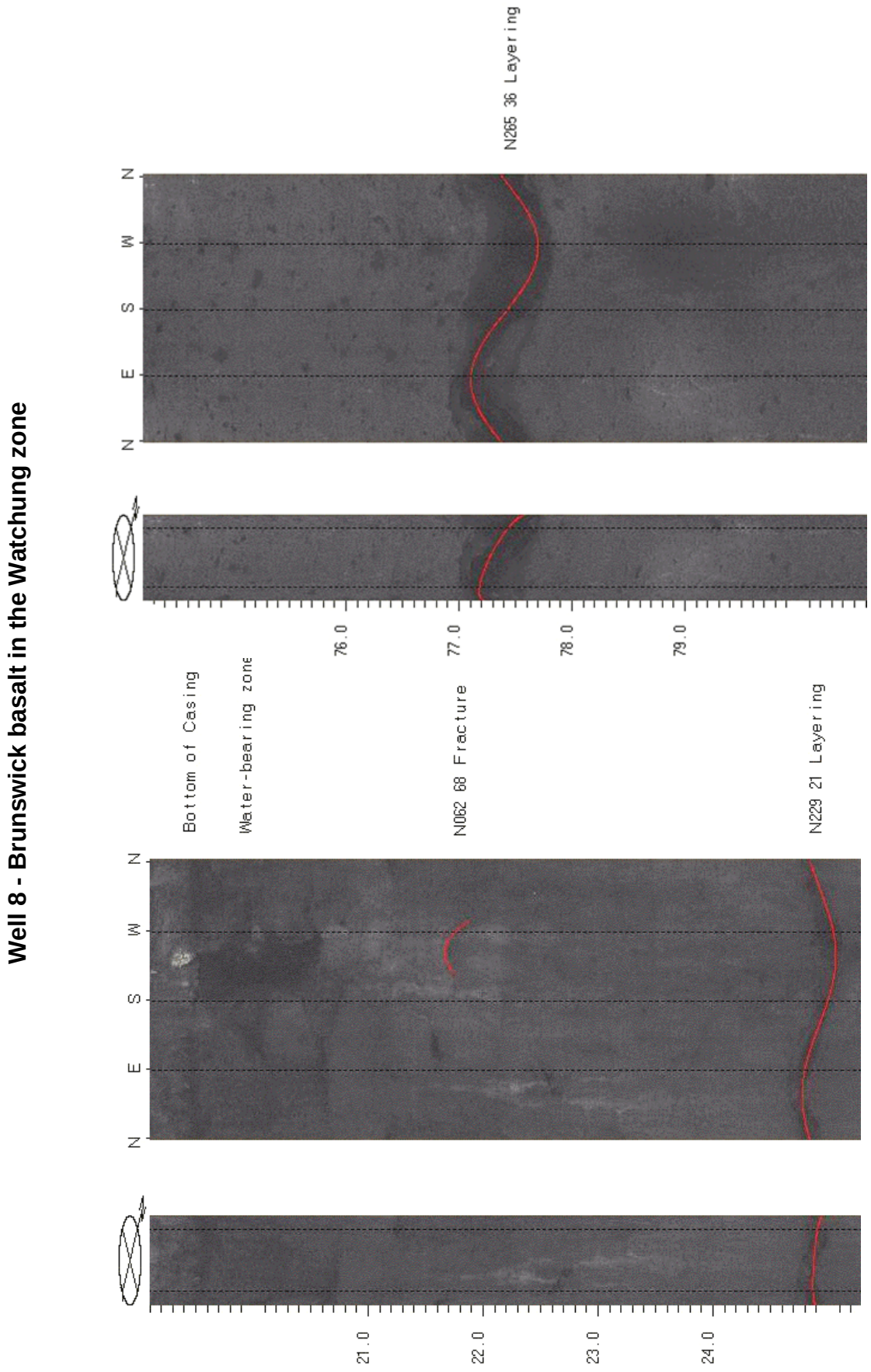


FIGURE 1E4. OPTV records of the 8-inch diameter well 8 showing bedrock structures and hydraulically-conductive features in basalt. Depth values are in feet below land surface..

Well 9 – Brunswick basalt of the Watchung zone

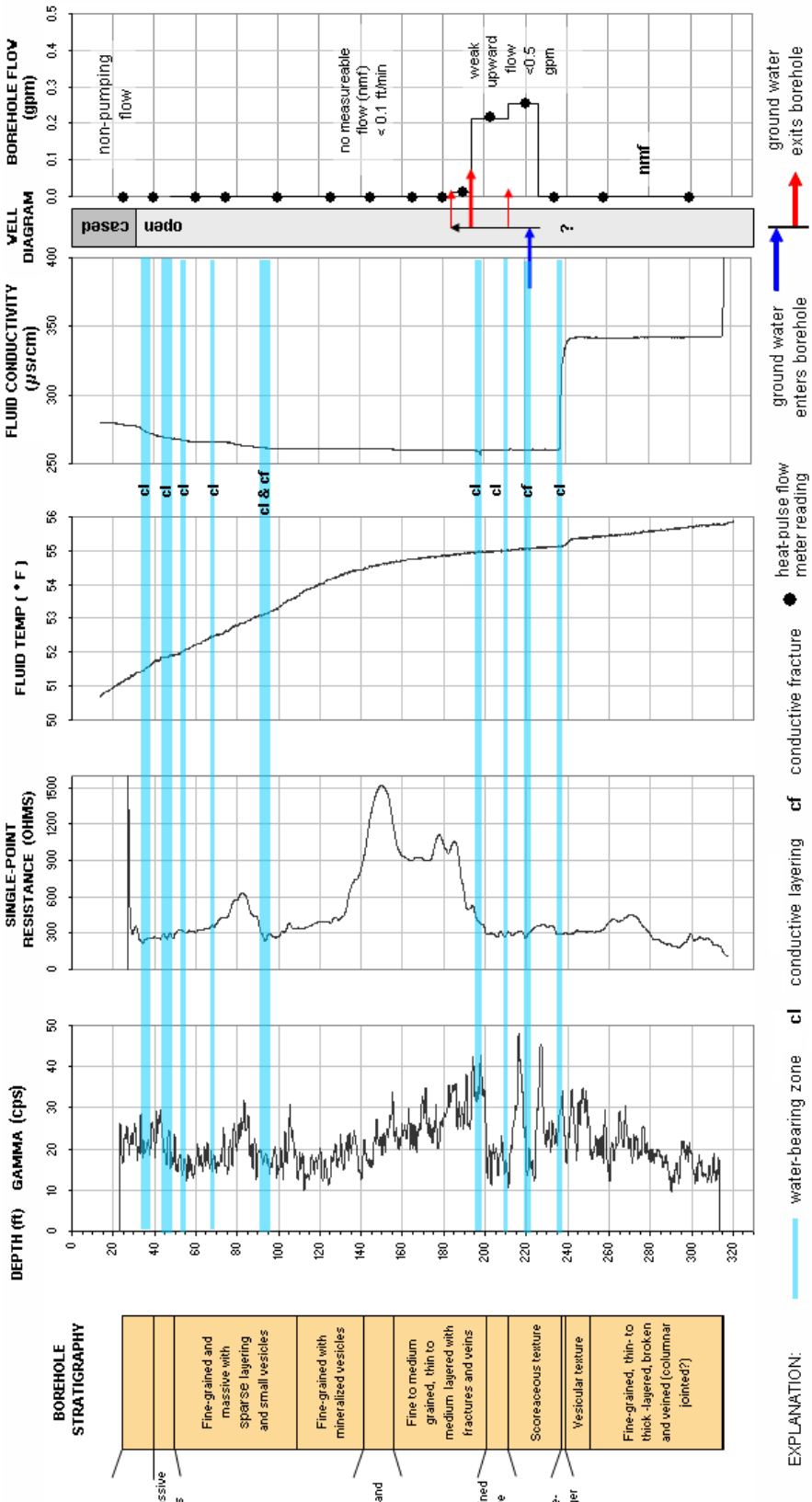


FIGURE 1E5. Stratigraphic and hydrogeologic sections based on geophysical logs for well 9 showing the vertical distribution and types of hydraulically-conductive features and water-bearing zones in basalt. Depth values are in feet below land surface.

Well 9 - Brunswick basalt in the Watchung zone

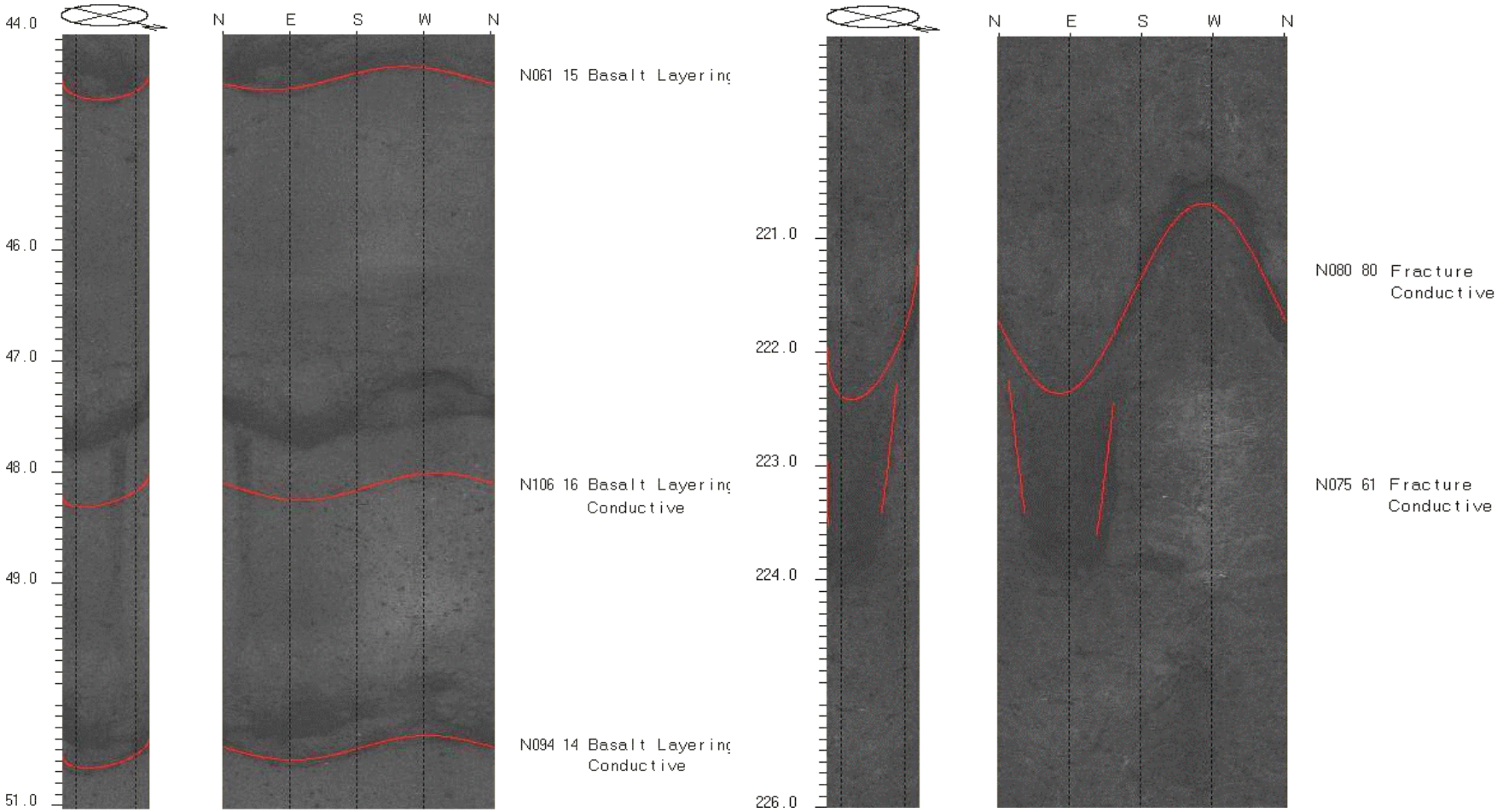


FIGURE 1E6. OPTV records of the 8-inch-diameter well 9 showing bedrock structures and hydraulically-conductive features in basalt. Depth values are feet below land surface.

Well 10 – Brunswick basalt of the Watchung zone overlying Brunswick upper red zone

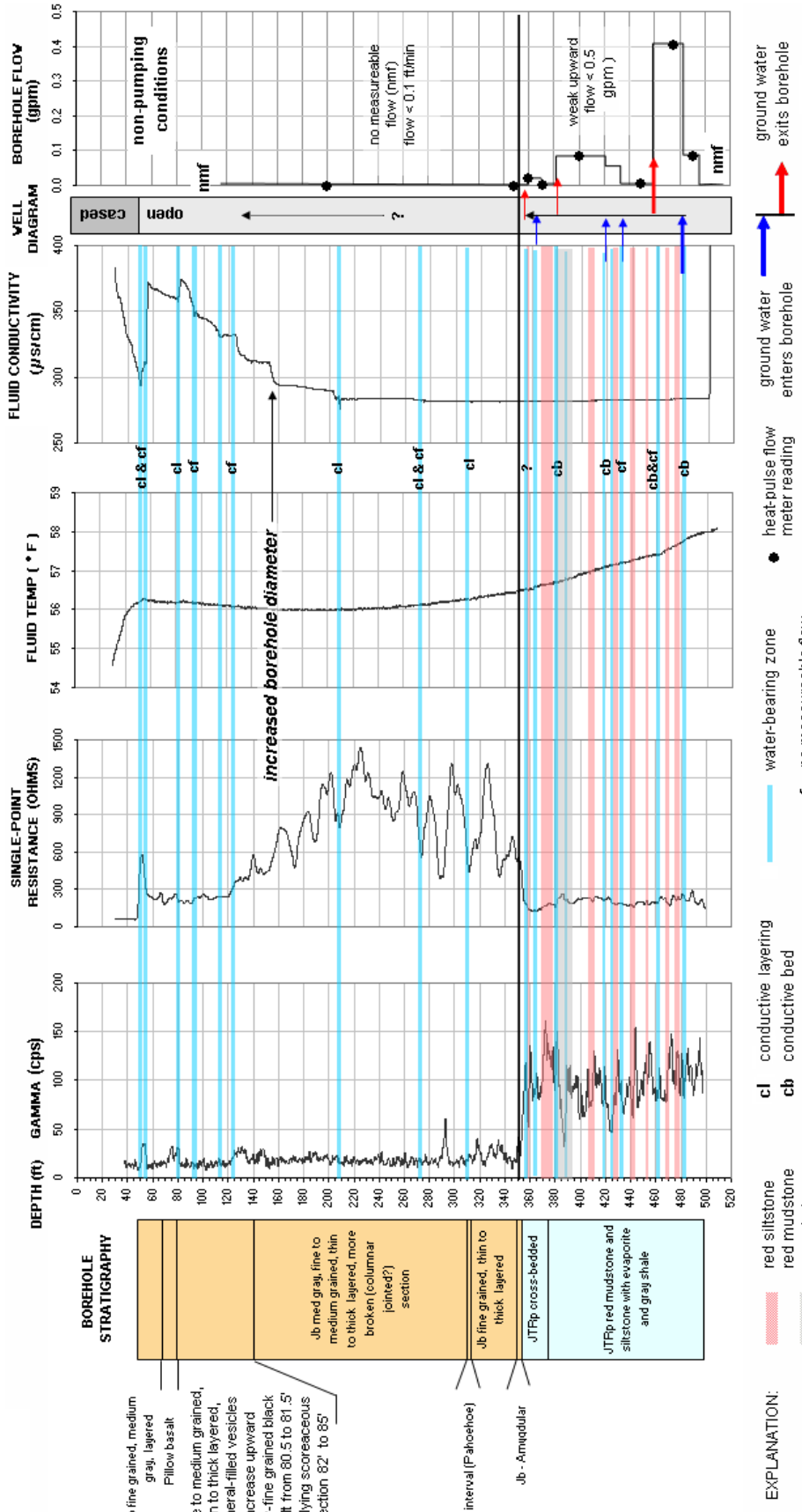


FIGURE 1E7. Stratigraphic and hydrogeologic sections based on interpretation of geophysical logs for well 10 showing the vertical distribution and types of hydraulically-conductive features and water-bearing zones in basalt, red mudstone and siltstone and gray sandstone. Depth values are in feet below land surface.

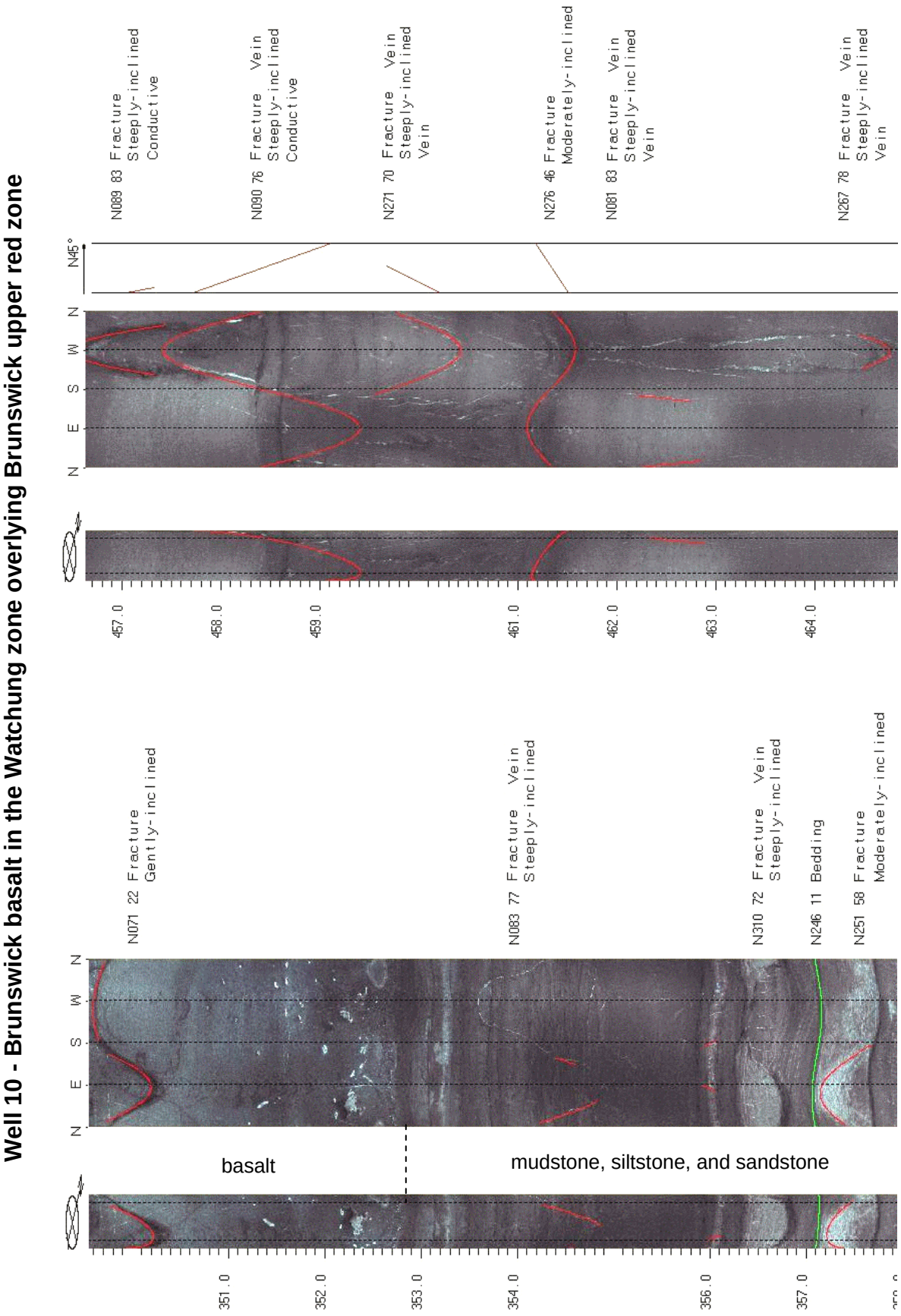


FIGURE 1E8. OPTV records for the 6-inch-diameter well 10 showing bedrock structures and hydraulically-conductive features in basalt and underlying mudstone, siltstone, and sandstone. Depth values are in feet below land surface.

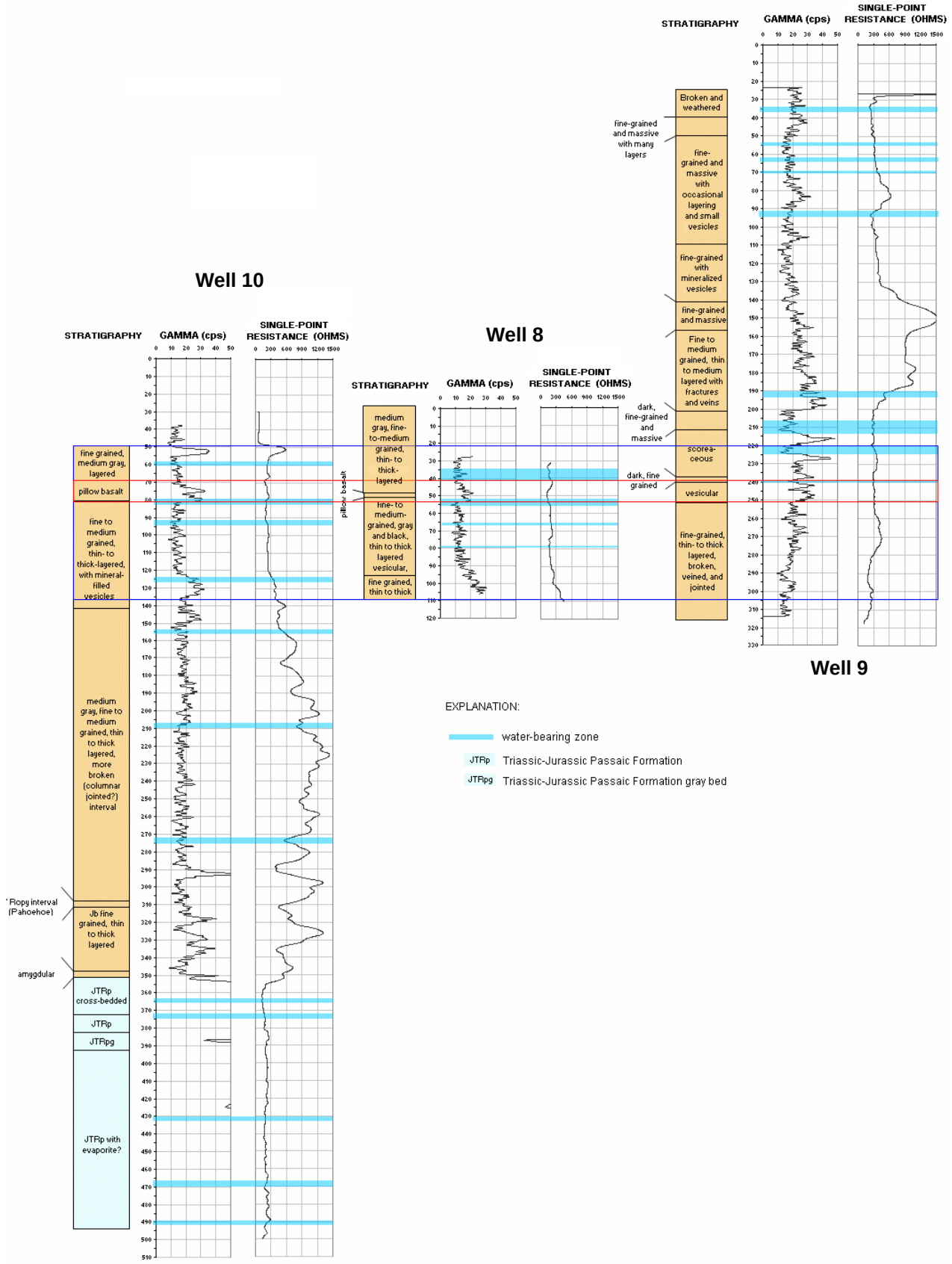
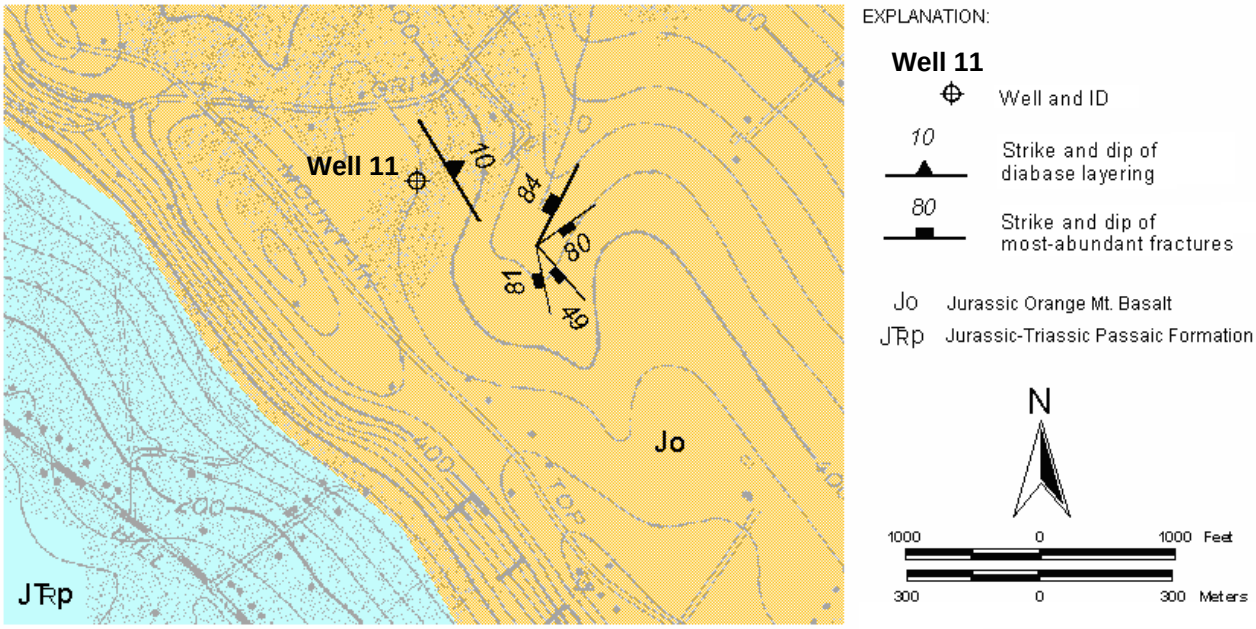


FIGURE 1E9. Correlation of hydro-stratigraphic sections for wells 8 through10 based on geophysical logs. Depth values are in feet below land surface.

Well 11 – Brunswick basalt of the Watchung zone overlying Brunswick upper red zone



BASE MAP FROM THE US GEOLOGICAL SURVEY BOUND BROOK, NJ 7-1/2' TOPOGRAPHIC QUADRANGLE

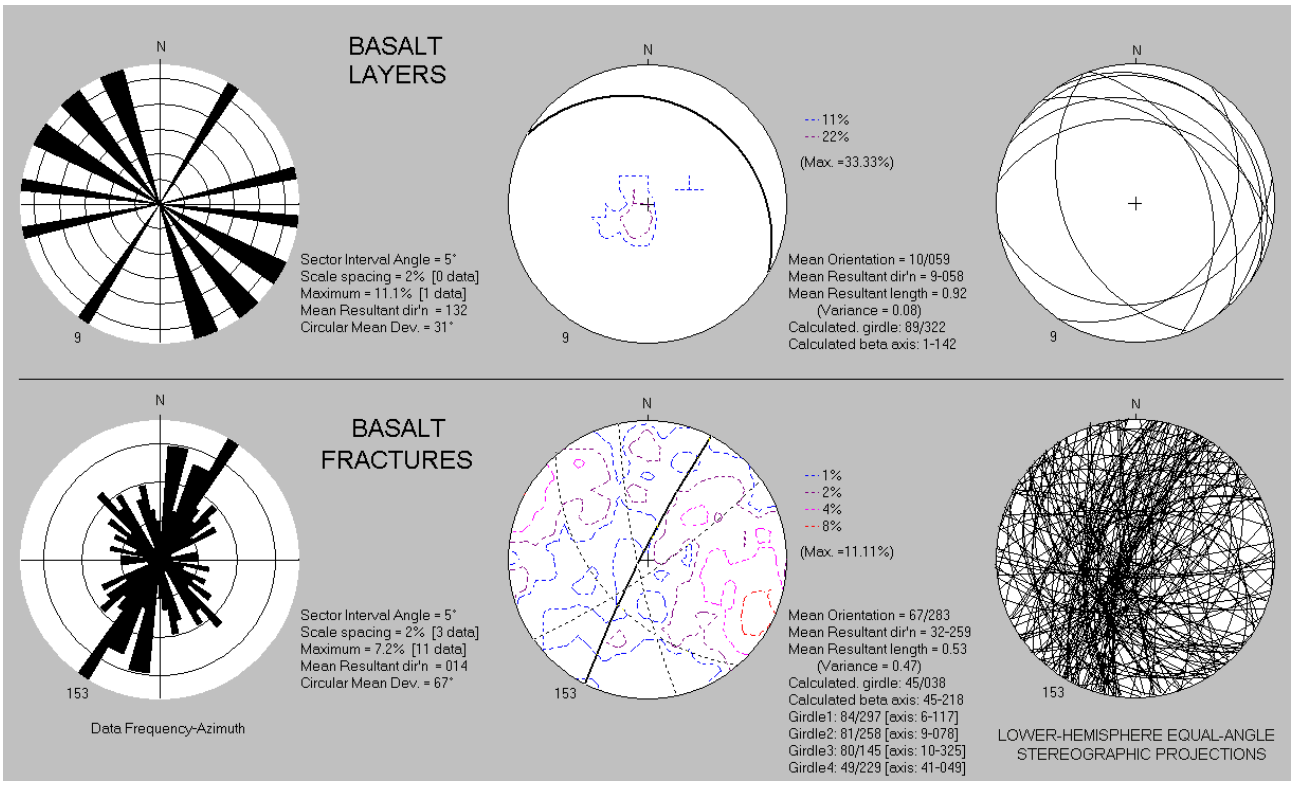


Figure 1F1. Map (above) shows the location of well 11 at 1163 Delaware Ave., Bridgewater Twp., Somerset County, NJ. Mapped bedrock structures are based on a structural analysis (bottom) of the OPTV record. Note that topographic ridges and surface streams parallel structural trends.

Well 11 – Brunswick basalt of the Watchung zone overlying mudstone and siltstone of the Brunswick upper red zone

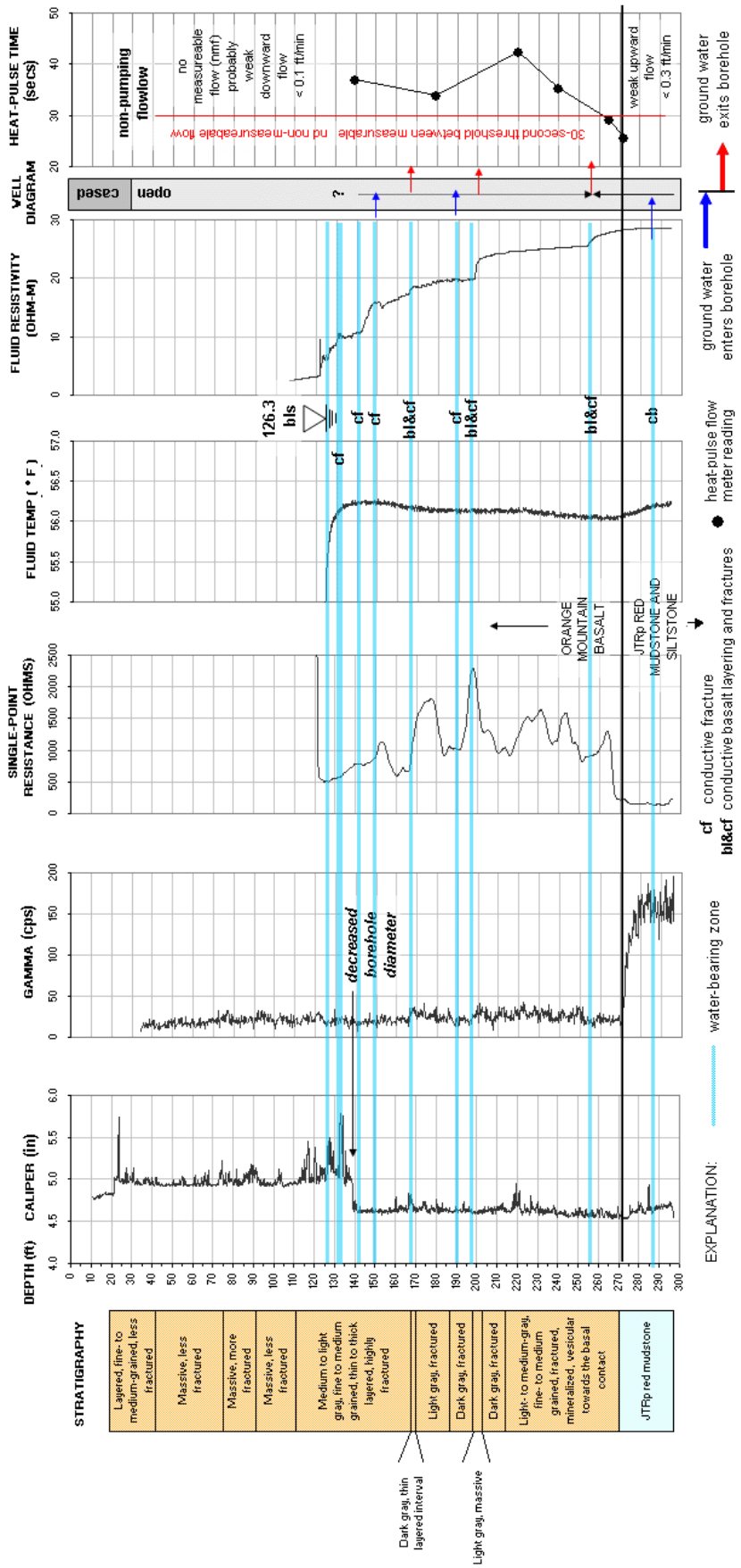


FIGURE 1F2. Stratigraphic and hydrogeologic sections based on geophysical logs for well 11 showing the vertical distribution and types of hydraulically-conductive features and water-bearing zones. Depth values are in feet below land surface.

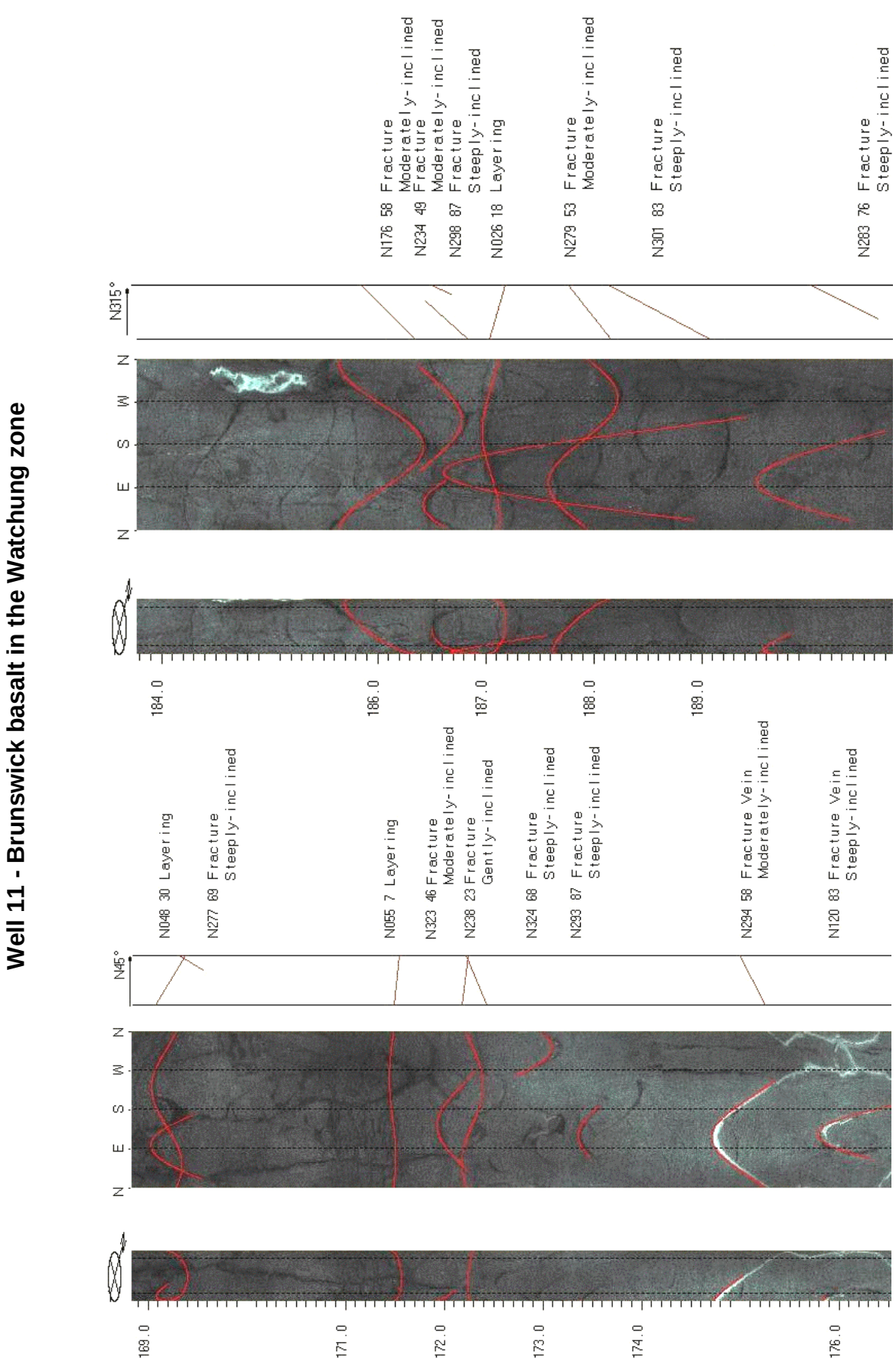


FIGURE 1F3. OPTV records of the 6-inch diameter well 11 showing bedrock structures in basalt. Depth values are in feet below land surface.

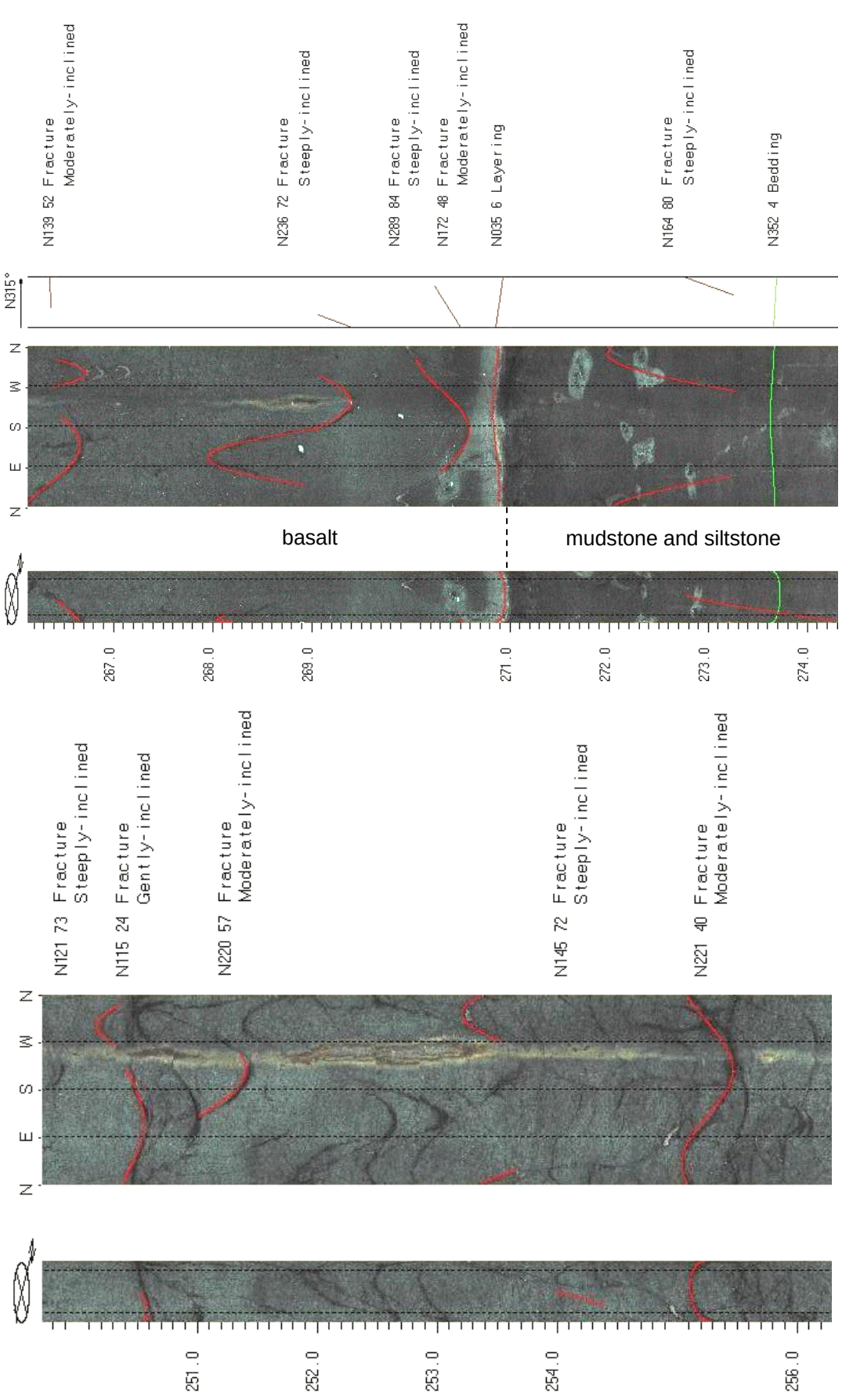


FIGURE 1F4. OPTV records of the 6-inch diameter well 11 showing bedrock structures in basalt (left and upper right) and underlying mudstone and siltstone of the Brunswick upper red zone (lower right). The stain seen on the borehole well in the image on the left is caused by the pump string resting against the borehole wall. Note the light-colored pockets of hydrothermal alteration in the shale and siltstone. Depth values are in feet below land surface.

Summary of Borehole Geophysical Studies in the Newark Basin, New Jersey:

Brunswick conglomerate and sandstone, and the Passaic flood tunnel workshaft geotechnical investigations

By Gregory C. Herman and John F. Curran, N.J. Geological Survey

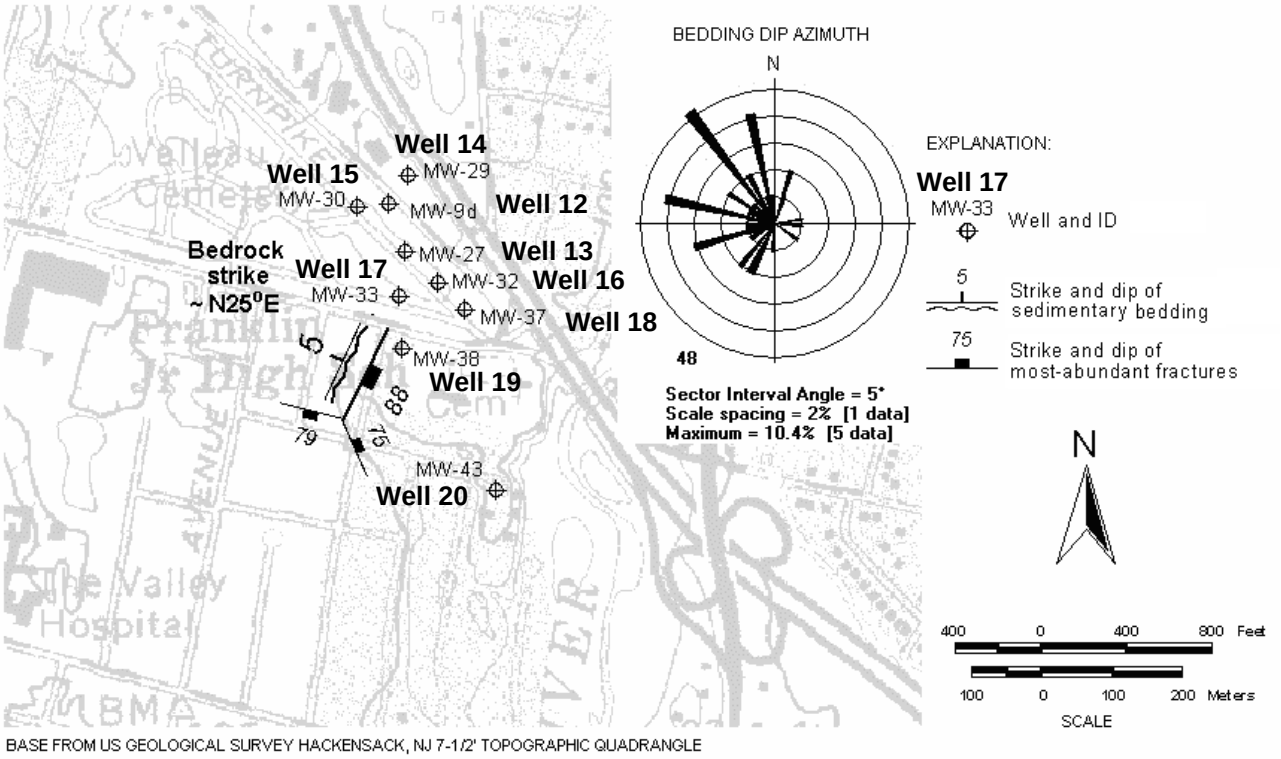
Appendix 2 of

Contributions to the Geology and Hydrogeology of the Newark Basin

N.J. Geological Survey Bulletin 77

State of New Jersey
Department of Environmental Protection
Water Resource Management
New Jersey Geological Survey
2010

Wells 12 to 20 - Brunswick sandstone and conglomerate



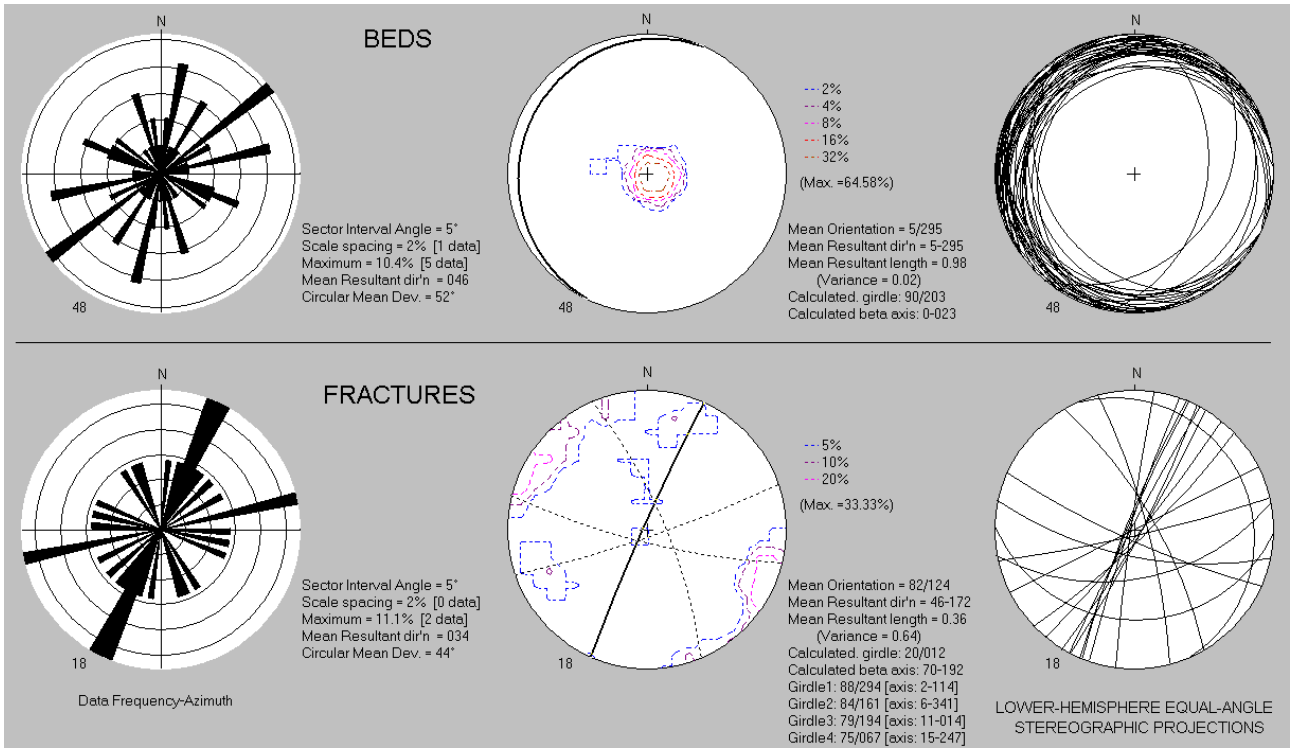


Figure 2A1. Map (above) shows wells 12 through 20 in the vicinity of the Ridgewood Shell Service Station, Ridgewood Twp., Bergen County, NJ. Mapped bedrock structures based on a structural analysis (below) of the OPTV records.

Wells 15 and 18 – Brunswick sandstone and conglomerate

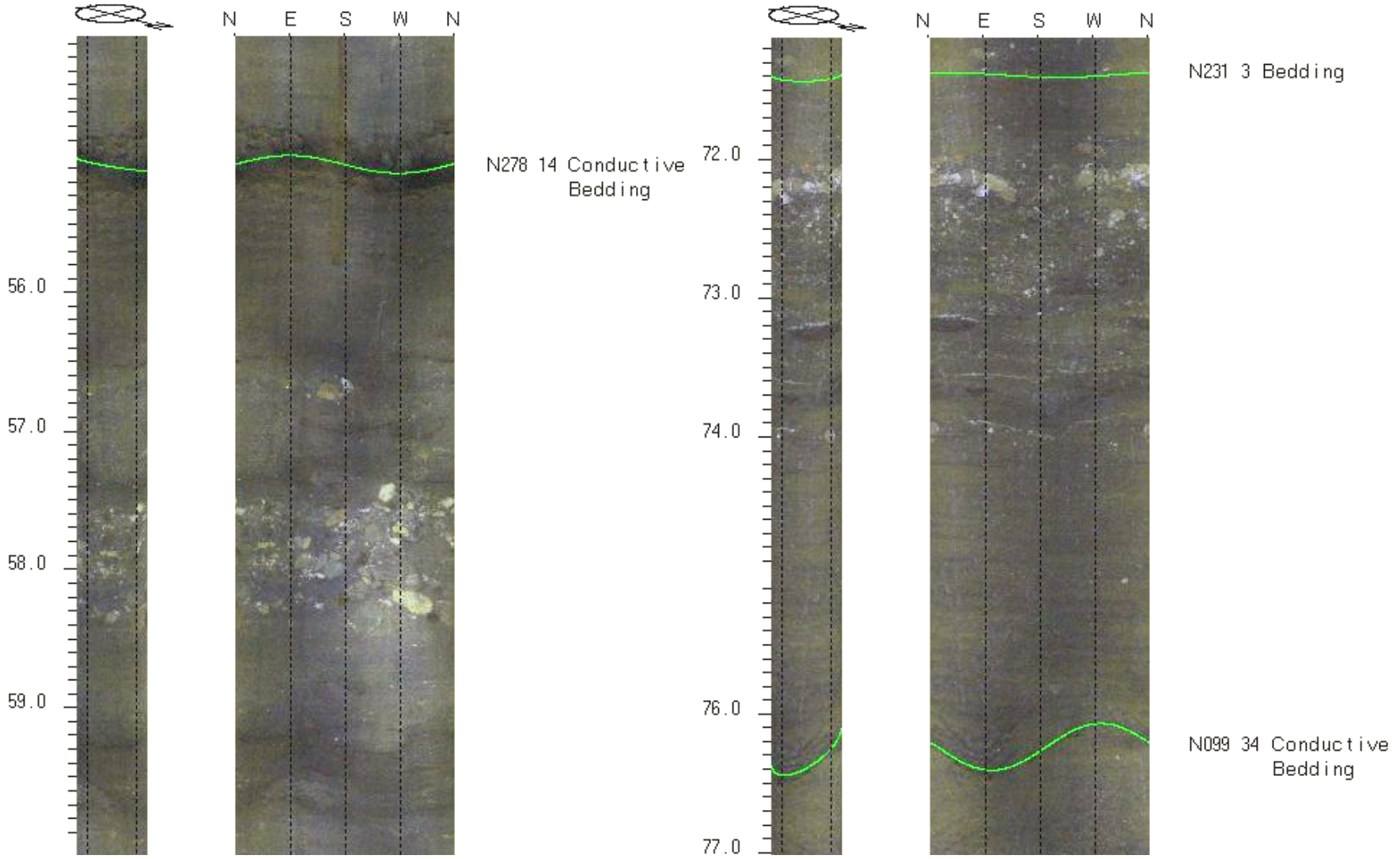


FIGURE 2A2. OPTV records of the 6-inch diameter wells 15 (left) and 18 (right) showing bedrock structures and hydraulically-conductive features in sandstone and conglomerate. Depth values are in feet below land surface.

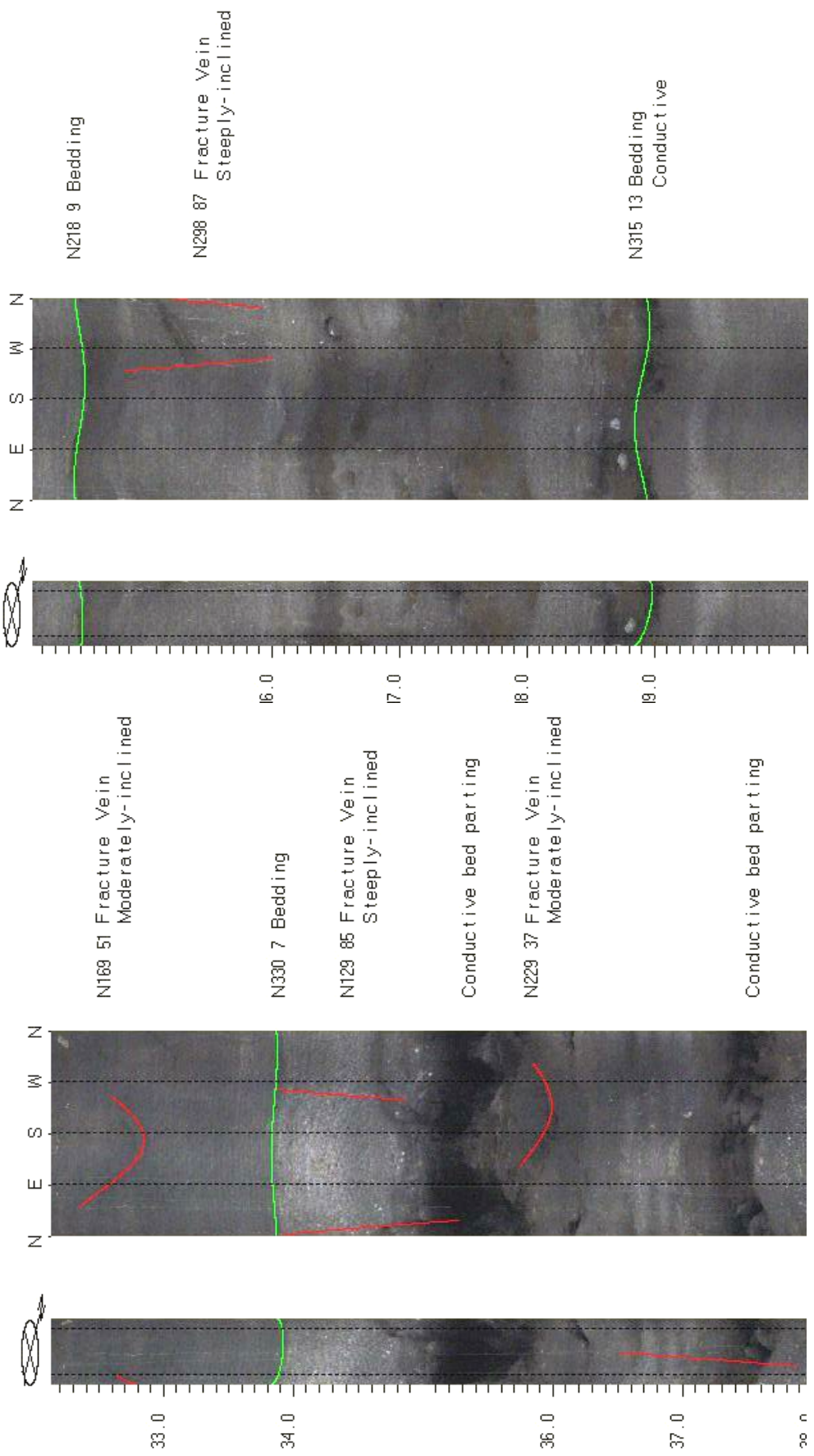
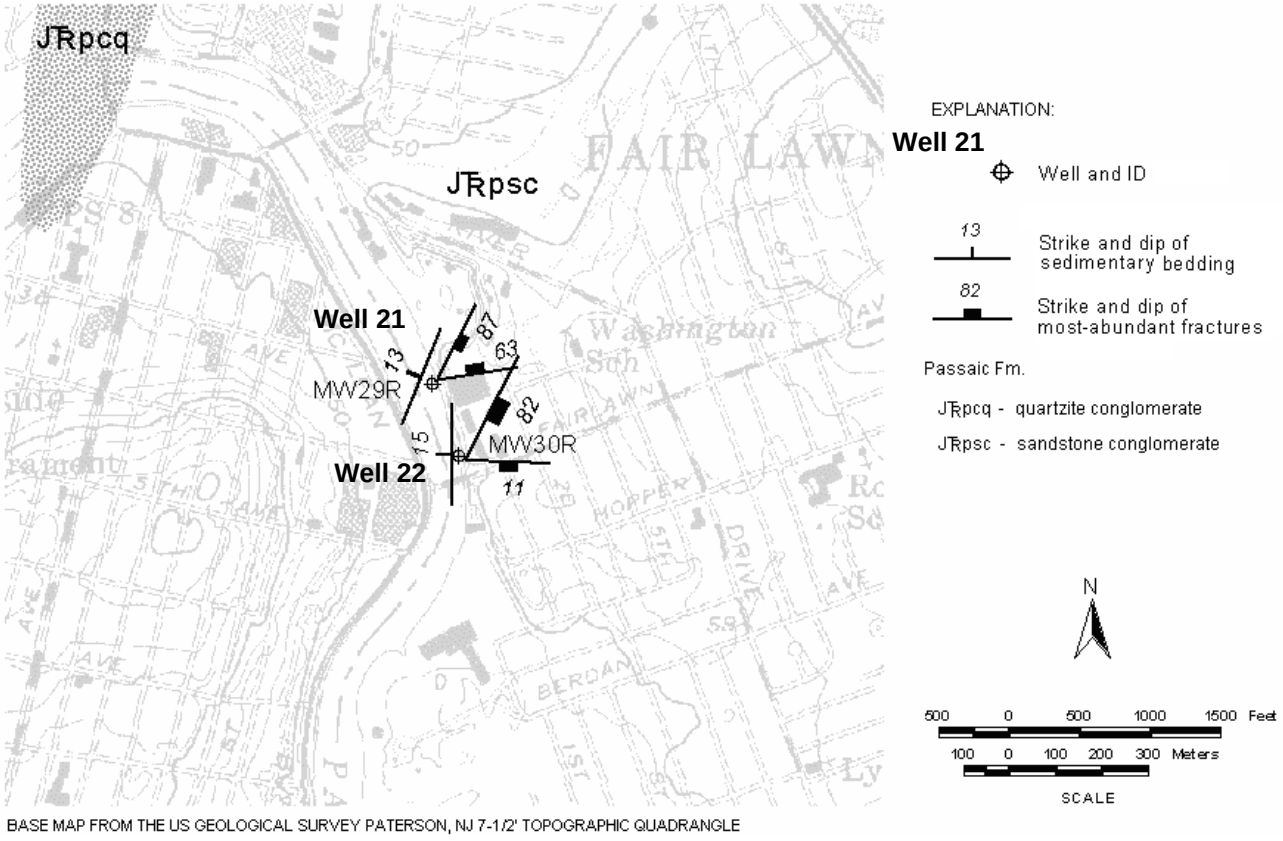


FIGURE 2A3. OPTV records of the 6-inch diameter well 12 showing bedrock structures and hydraulically-conductive features in sandstone and conglomerate. Depth values are in feet below land surface.

Wells 21 and 22 - Brunswick sandstone and conglomerate



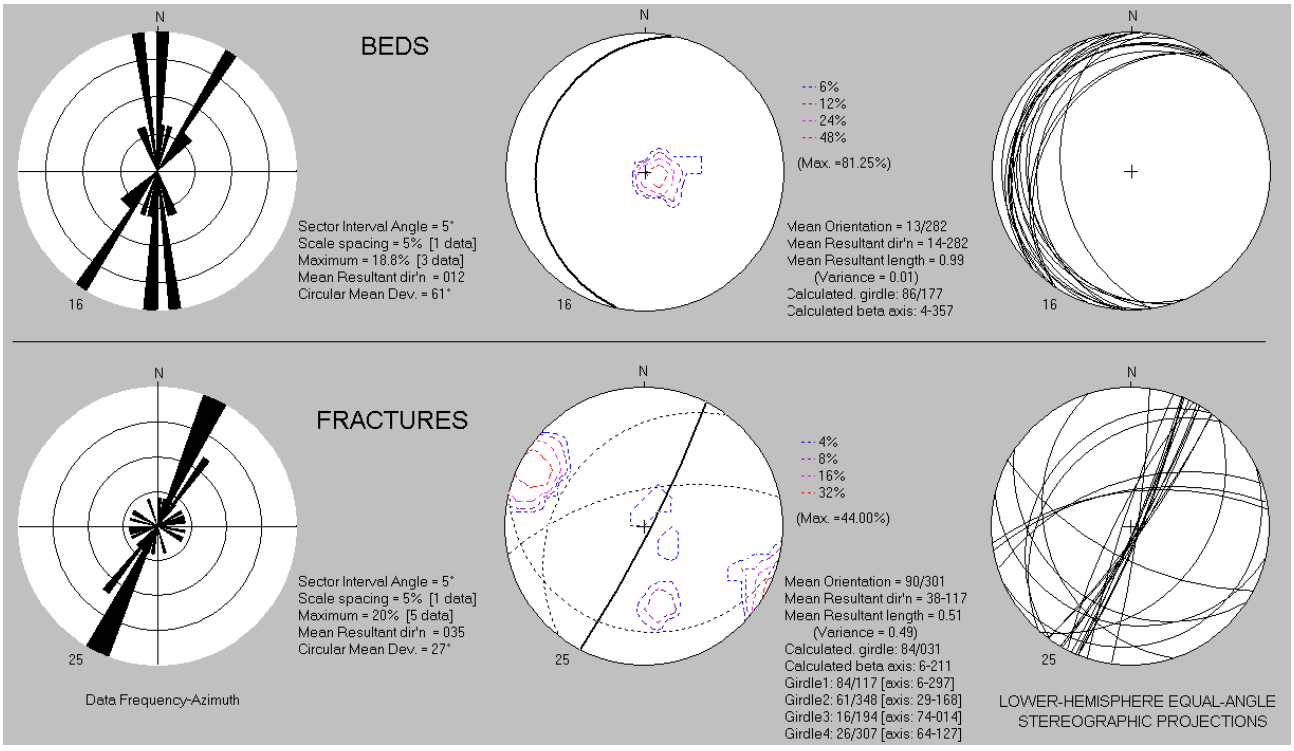


Figure 2B1. Map (above) shows wells 21 and 22 at the Sandoz Chemical Corp., Fairlawn Ave. and 3rd Street, Fairlawn Boro., Bergen County, NJ. Mapped bedrock structures based on a structural analysis (below) of the OPTV records.

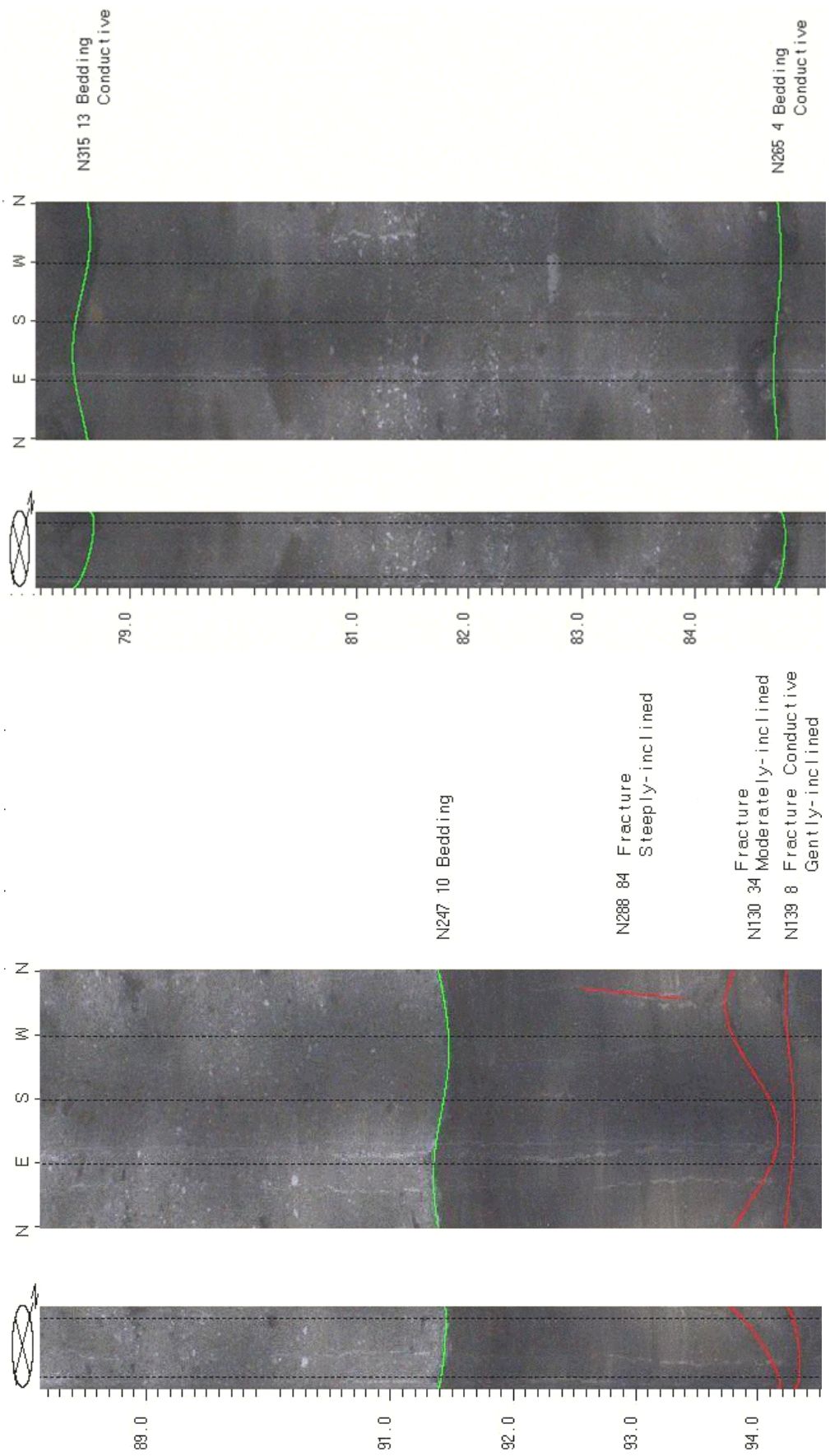


FIGURE 2B2. OPTV records of the 8-inch diameter well 21 showing bedrock structures and hydraulically-conductive features in sandstone and siltstone. Depth values are in feet below land surface.

Well 22 – Brunswick sandstone and conglomerate

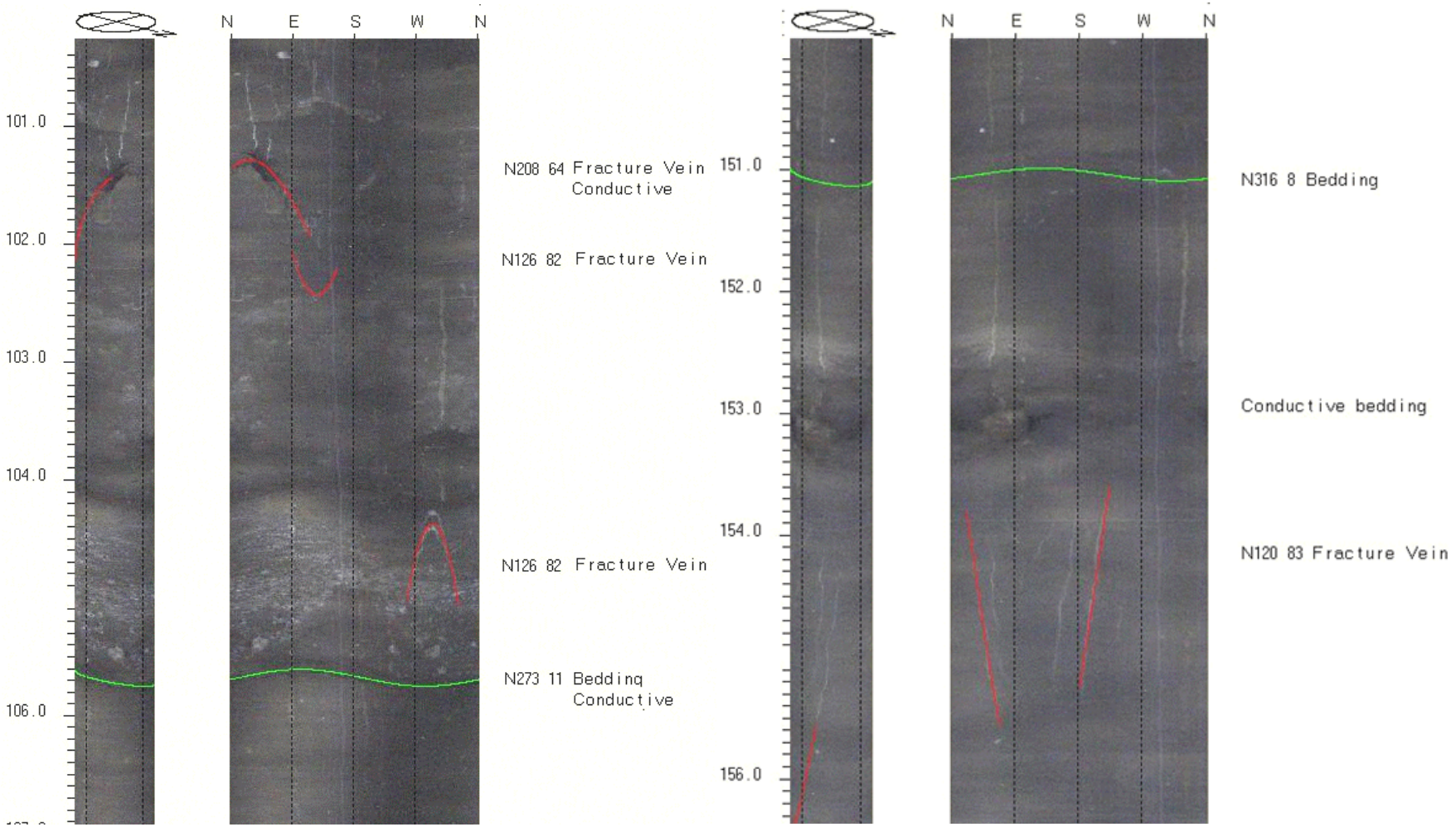
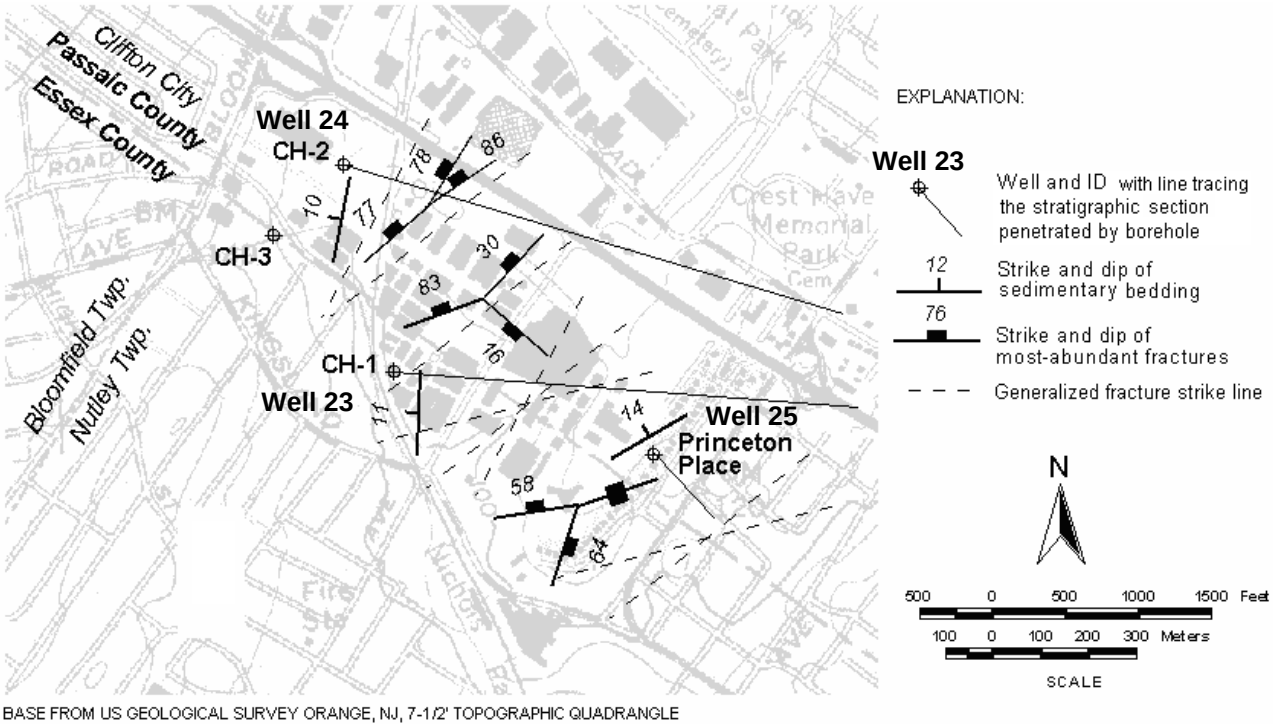


FIGURE 2B3. OPTV records of the 8-inch diameter well 22 showing bedrock structures and hydraulically-conductive features in sandstone and siltstone. Depth values are in feet below land surface.

Wells 23 to 25 - Brunswick sandstone



BASE FROM US GEOLOGICAL SURVEY ORANGE, NJ, 7-1/2' TOPOGRAPHIC QUADRANGLE

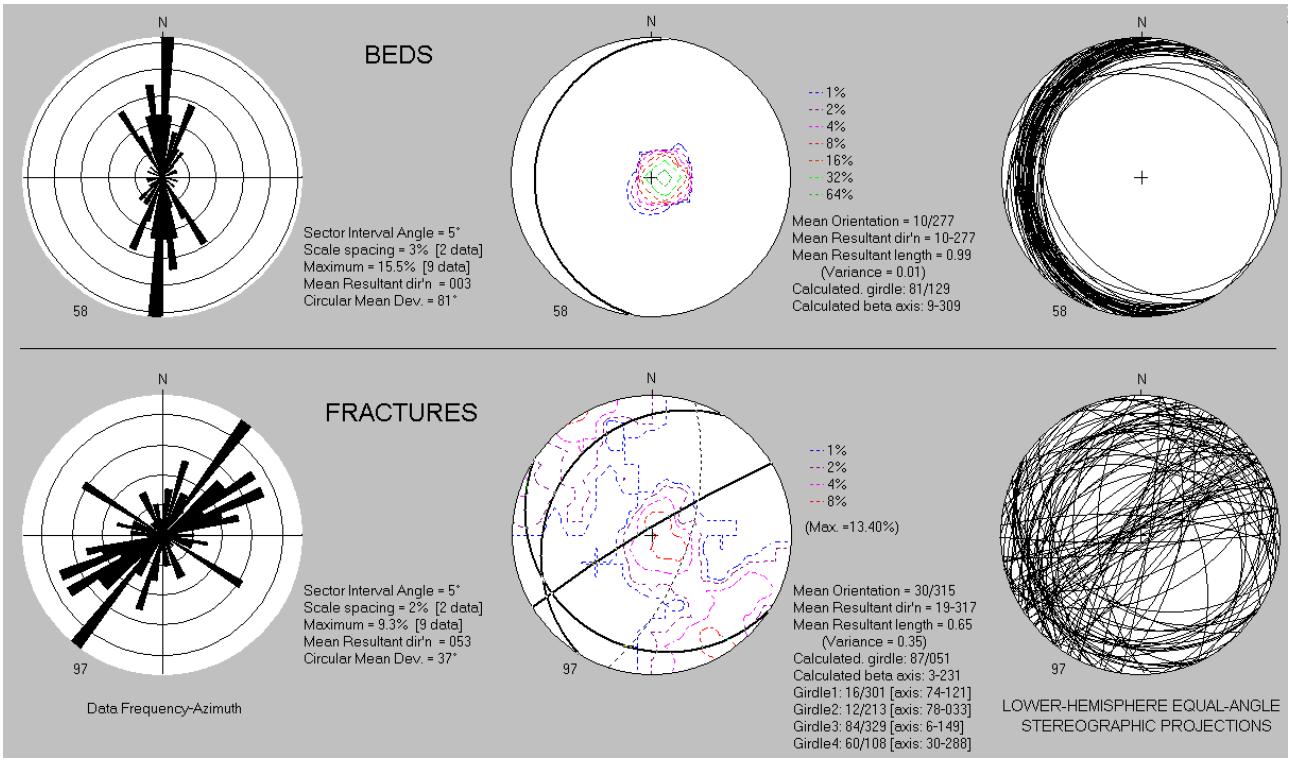


Figure 2C1. Map (above) shows wells 23 through 25 in the vicinity of the Hoffman-LaRoche facility, Clifton City, Passaic County and Nutley Twp., Essex County, NJ. Mapped bedrock structures based on a structural analysis (below) of the OPTV records.

Well 23 – Brunswick sandstone

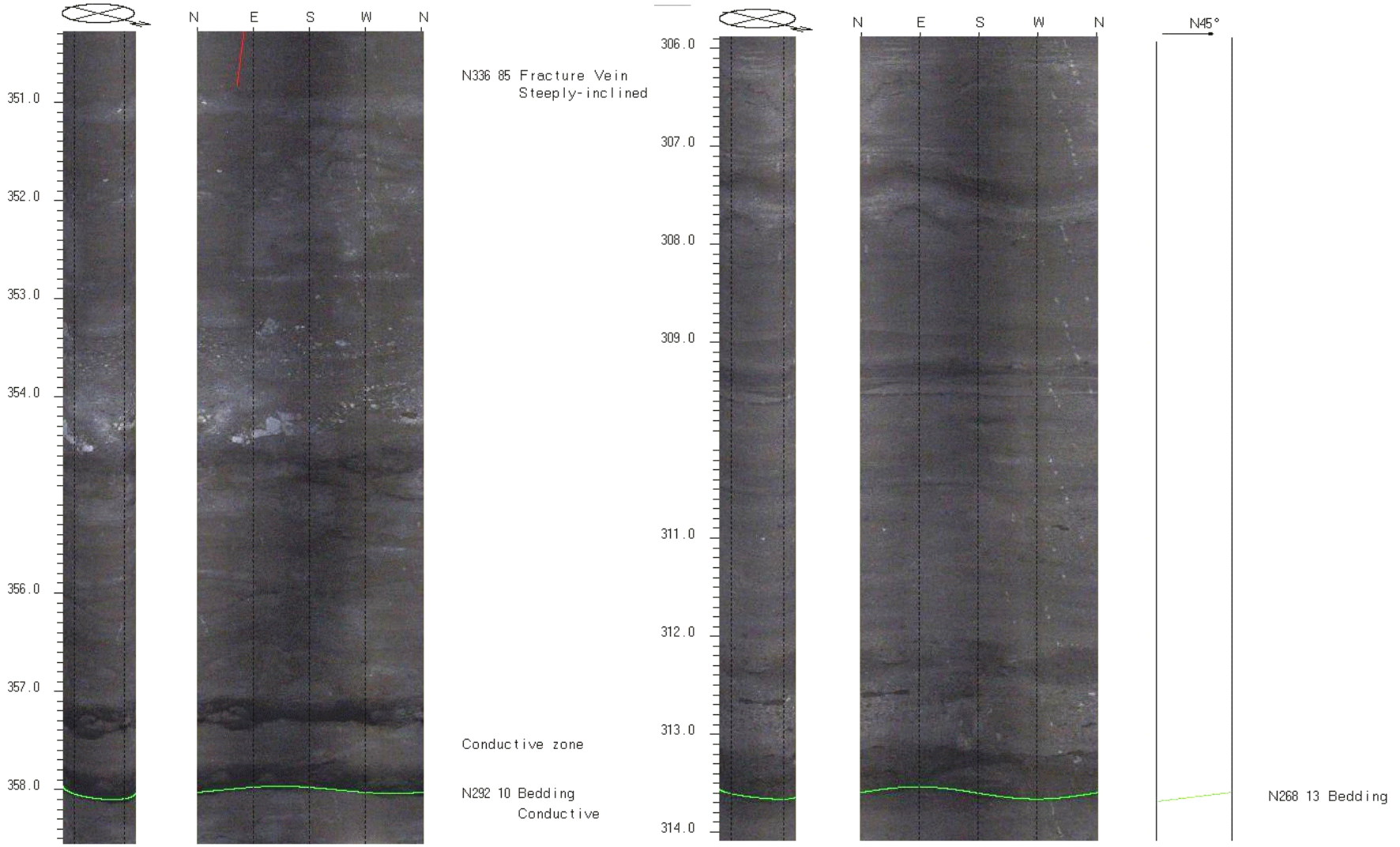


FIGURE 2C2. OPTV records of the 8-inch diameter well 23 showing bedrock structures and hydraulically-conductive features in sandstone. Depth values are in feet below land surface.

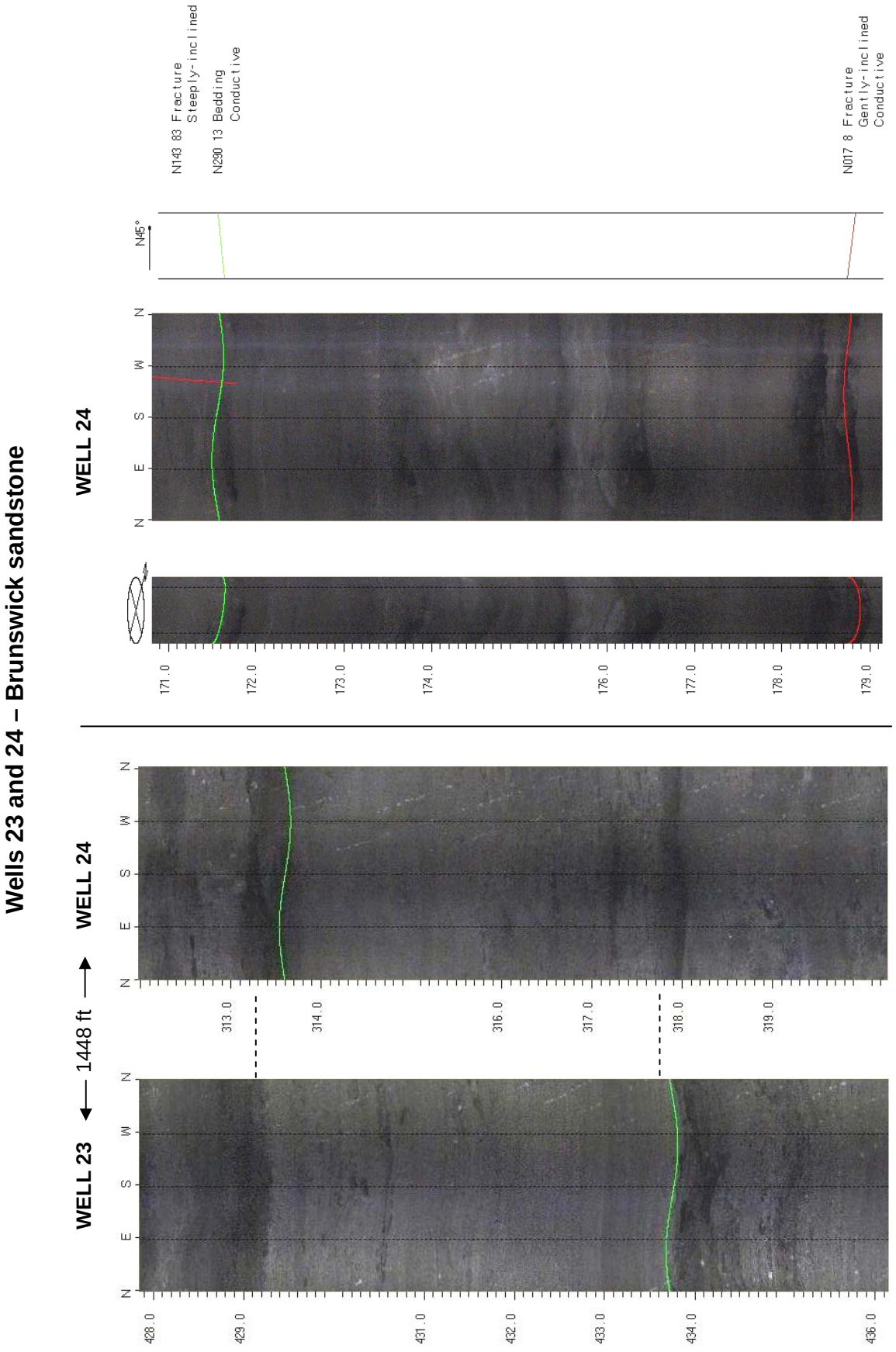


FIGURE 2C3. Stratigraphic correlation (left) for wells 23 and 24 based on OPTV records and an OPTV record for the 8-inch diameter well 24 (right) showing bedrock structures and hydraulically-conductive feature in sandstone and siltstone. Depth values are in feet below land surface.

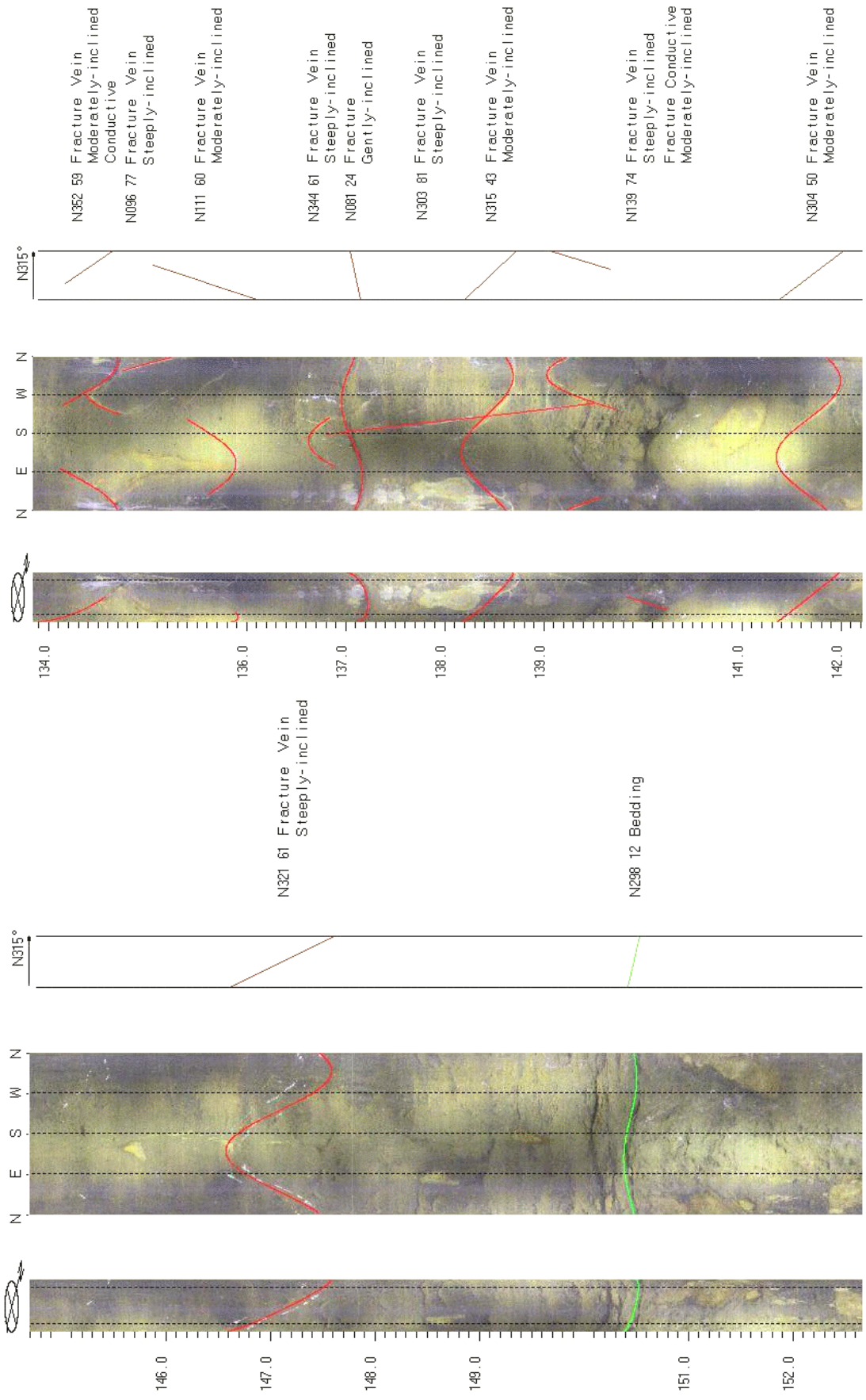
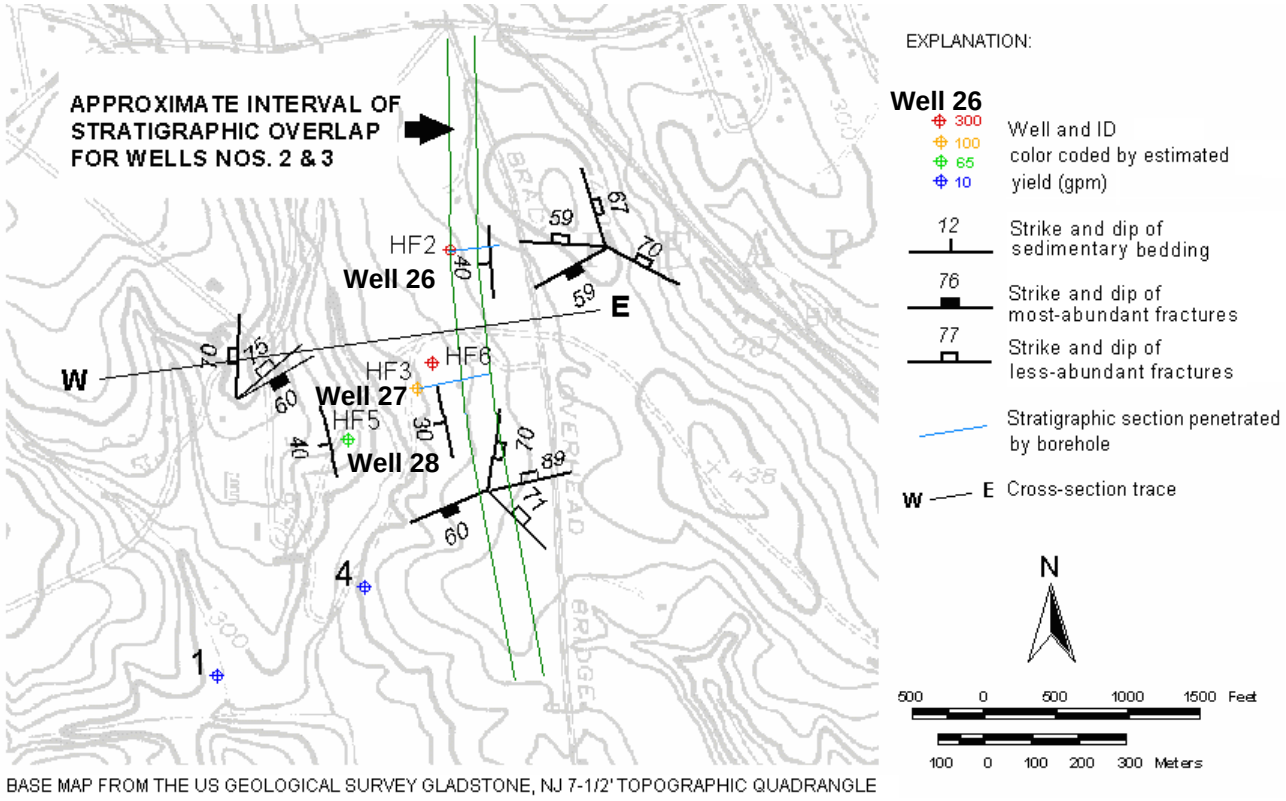


FIGURE 2C4. OPTV records of the 6-inch diameter well 25 showing bedrock structures and hydraulically-conductive features in sandstone. Depth values are in feet below land surface.

Wells 26 to 28 - Brunswick conglomerate



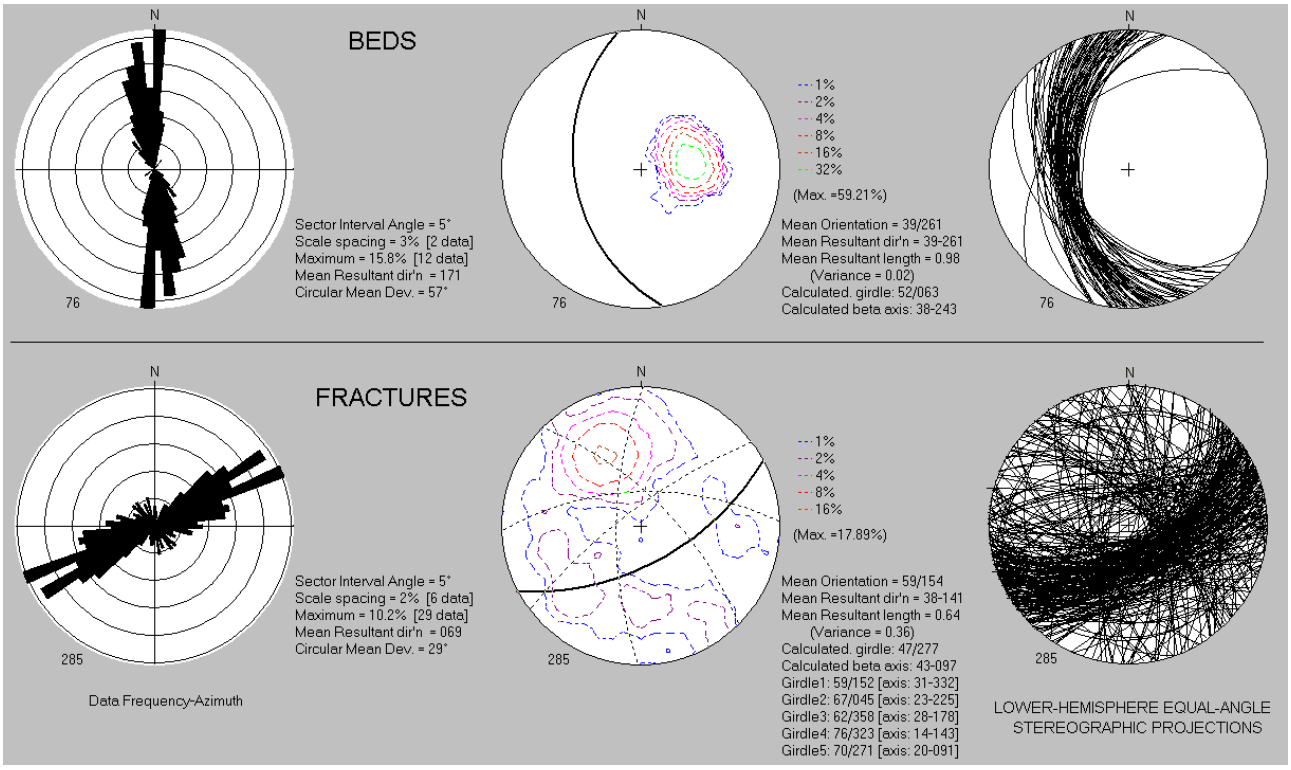
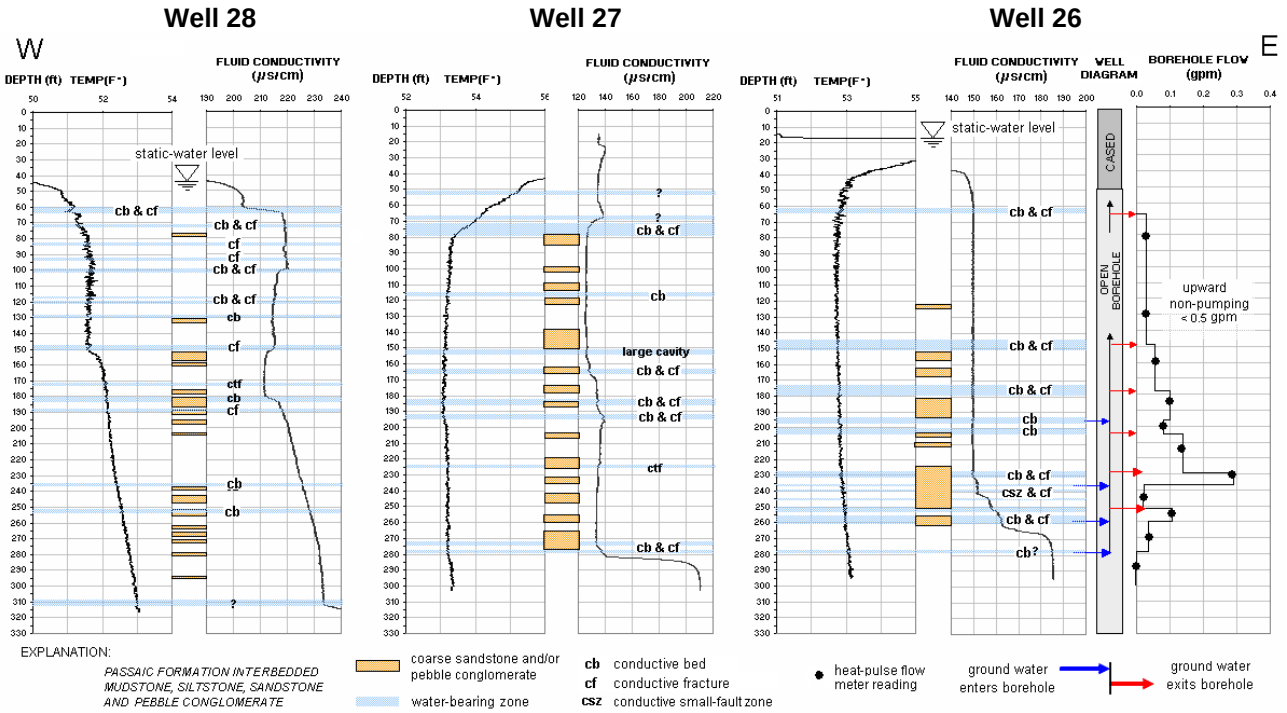


Figure 2D1. Map (above) shows wells 26 through 28 on the Hamilton Farms Golf Club, Bedminster Twp., Somerset County, NJ. Mapped bedrock structures based on structural analysis (below) of the OPTV records.

Wells 26 to 28 - Brunswick conglomerate



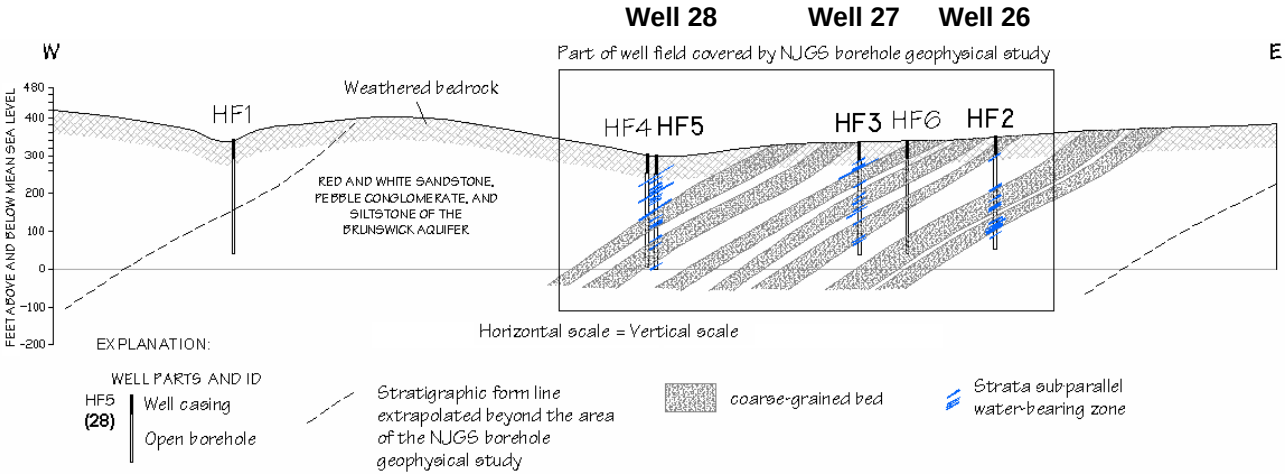


Figure 2D2. Hydrogeologic sections (above) based on geophysical logs for wells 26 through 28 showing the vertical distribution of hydraulically-conductive features and water-bearing zones in red and gray sandstone, conglomerate, siltstone and mudstone. Depth values are feet below land surface. The map trace for the hydrogeologic cross section (below) shown on figure 2D1.

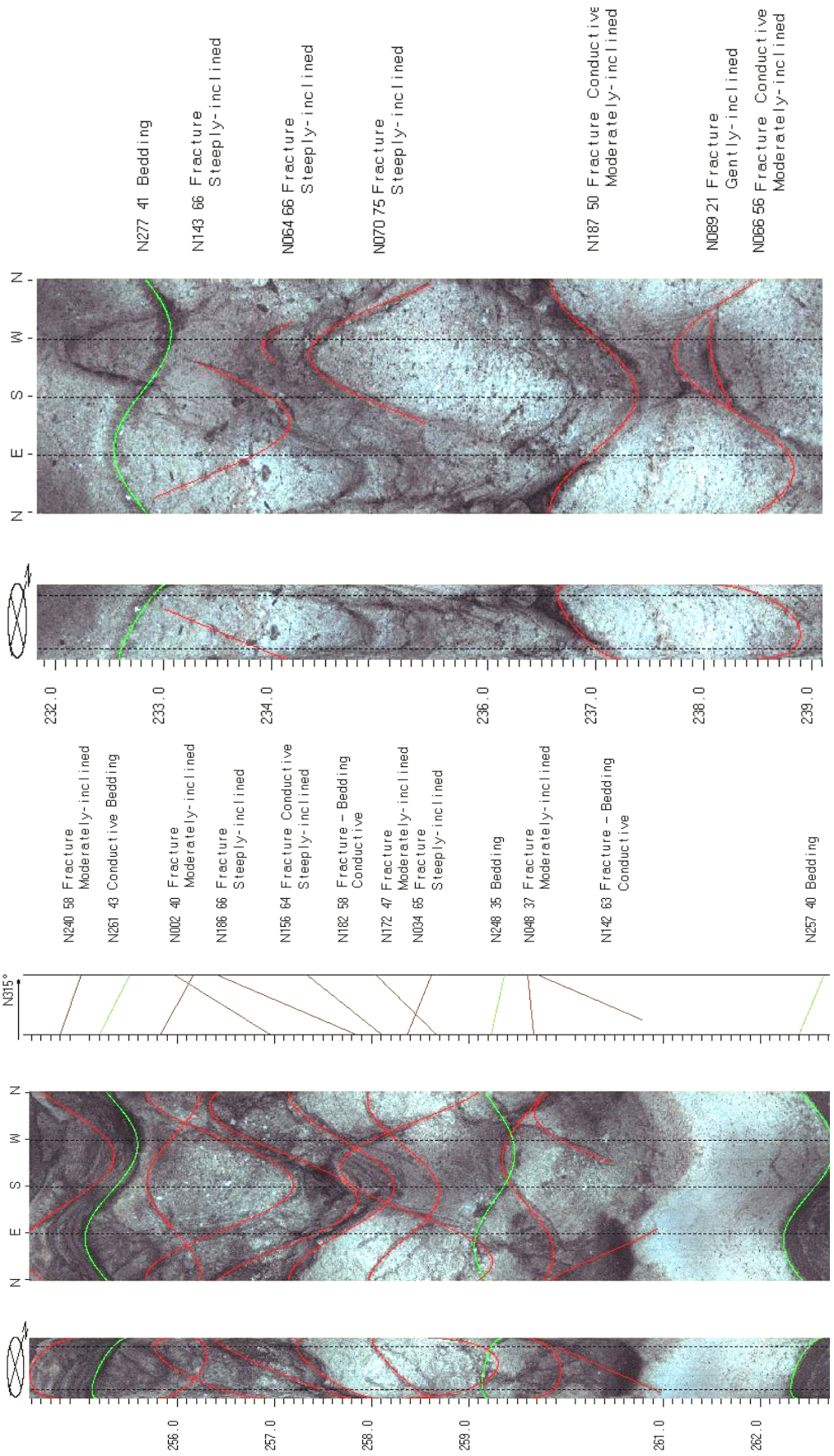


FIGURE 2D3. OPTV records of the 8-inch diameter well 26 showing bedrock structures and hydraulically-conductive features in conglomerate and sandstone. Depth values are in feet below land surface.

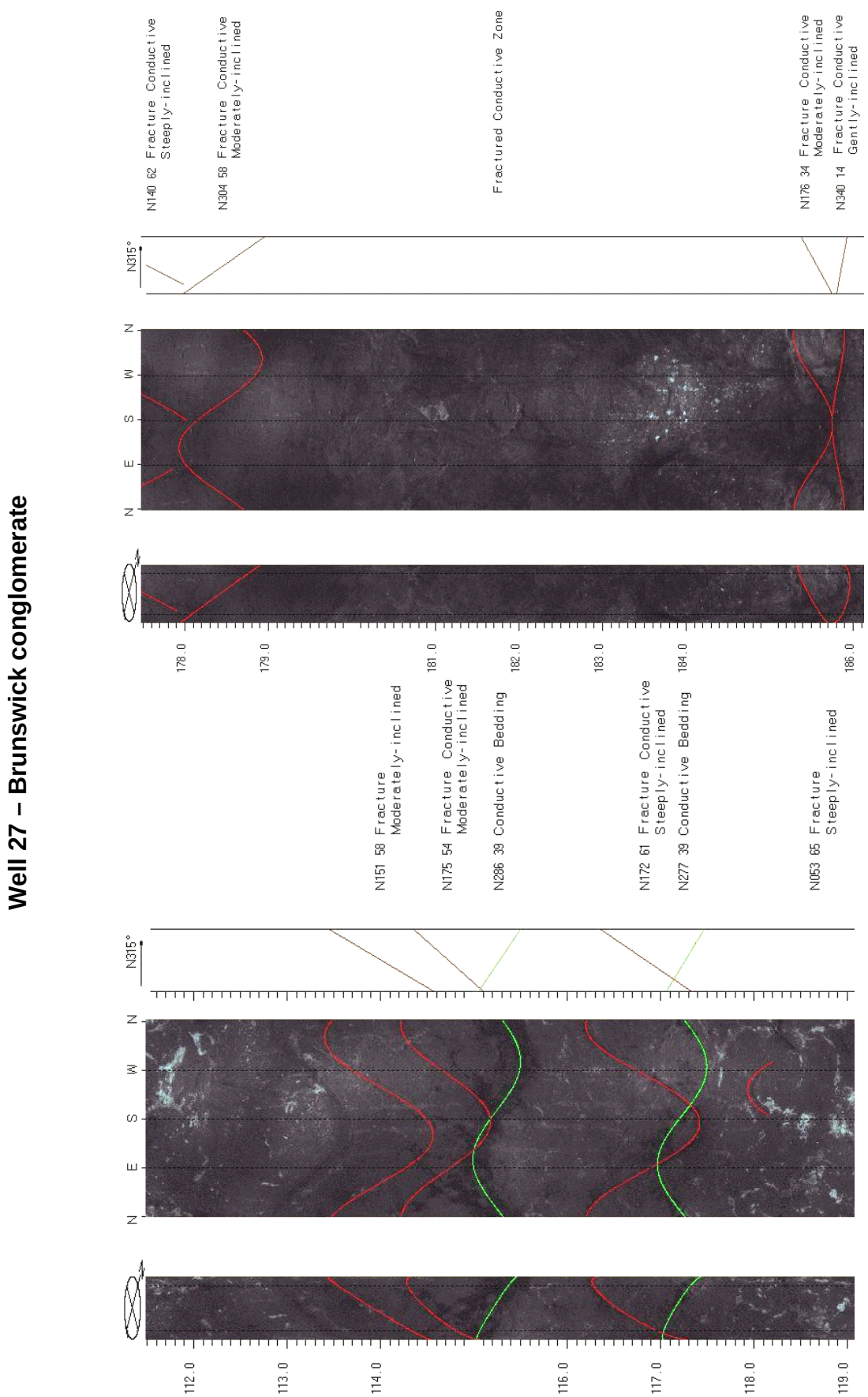


FIGURE 2D4. OPTV records of the 8-inch diameter well 27 showing bedrock structures and hydraulically-conductive features in conglomerate, sandstone and siltstone. Depth values are in feet below land surface.

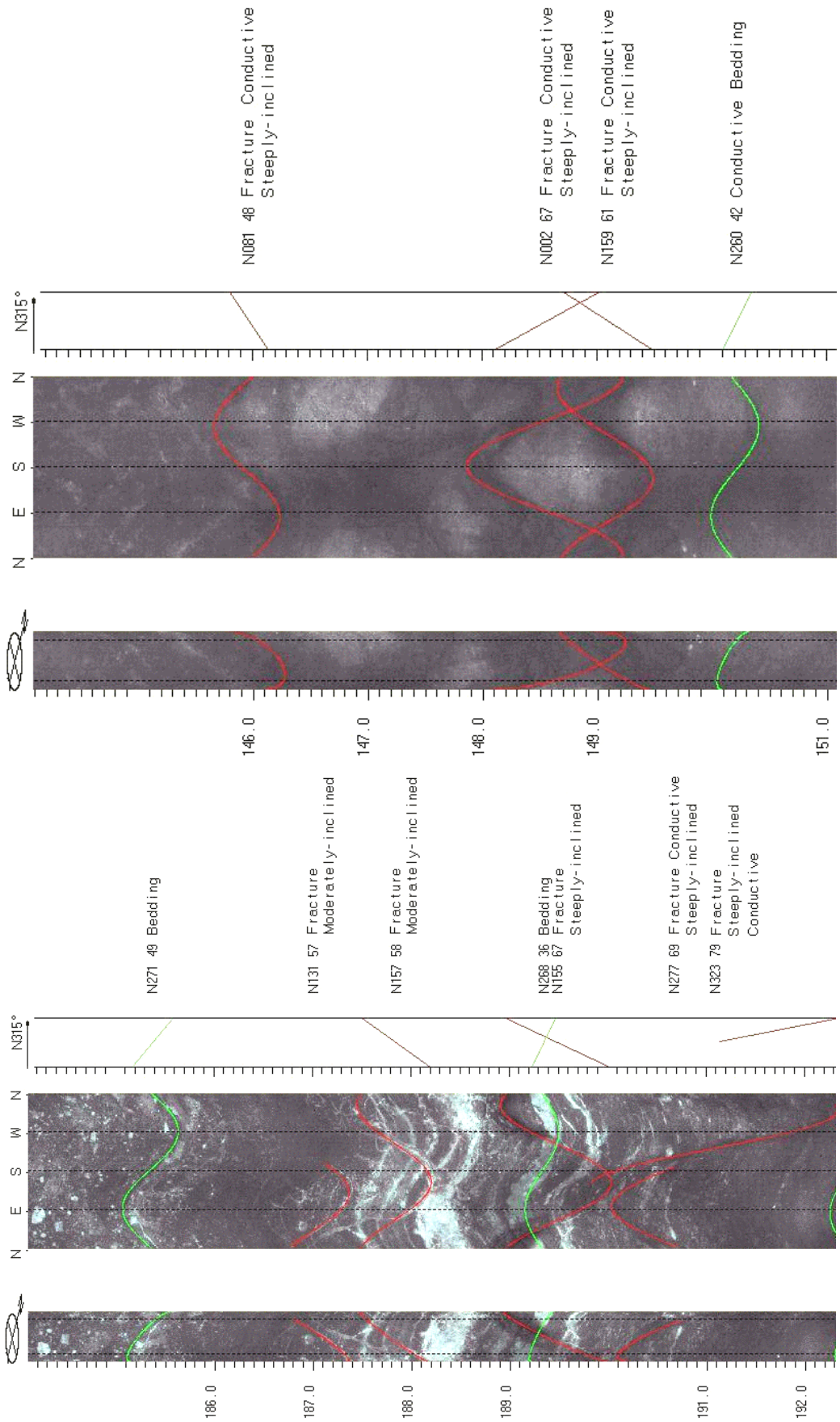


FIGURE 2D5. OPTV records of the 6-inch diameter well 28 showing bedrock structures and hydraulically-conductive features in conglomerate, sandstone, siltstone and mudstone. Depth values are in feet below land surface.

Wells 29 to 33 – Coarse-grained units in the Brunswick lower gray zone

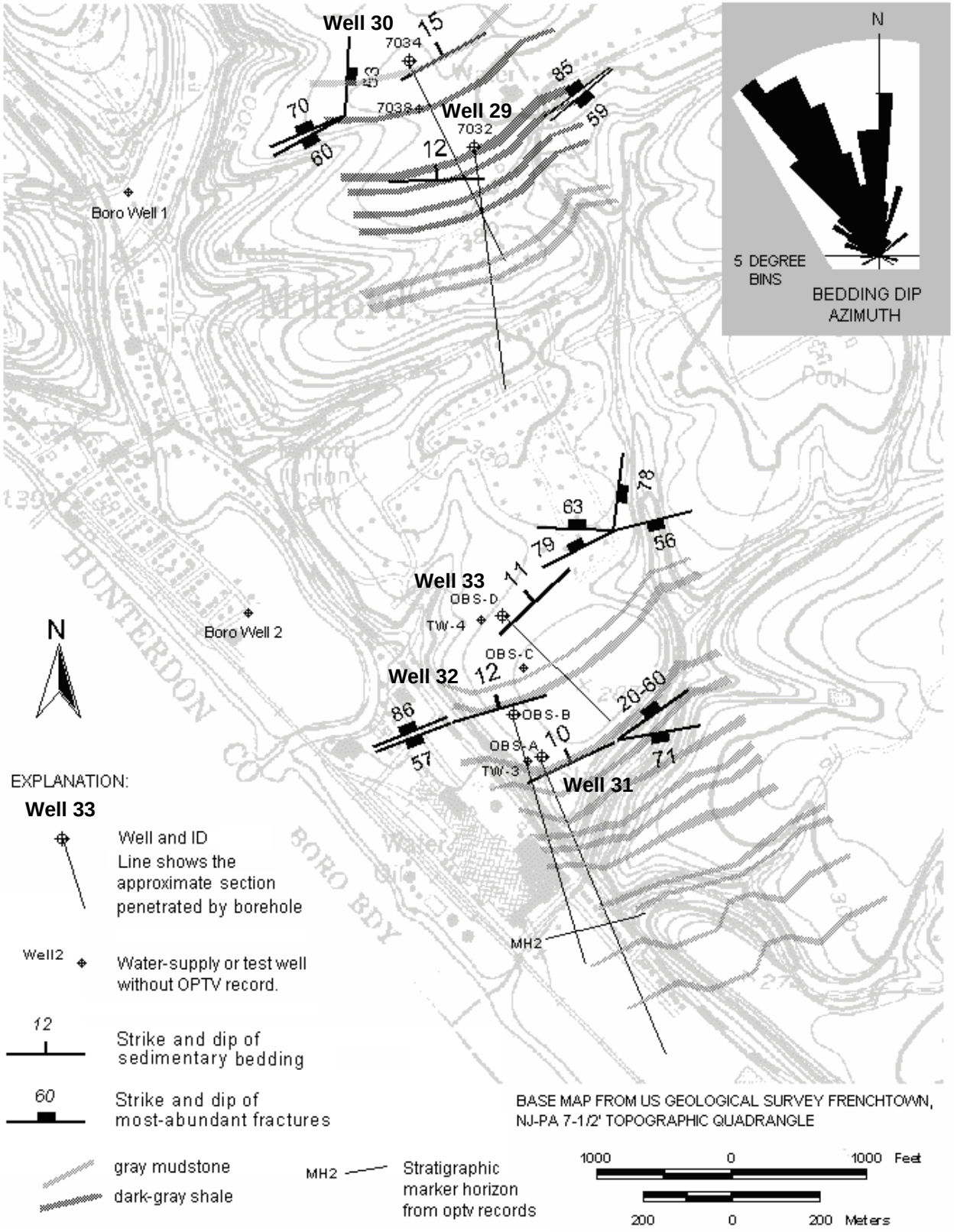
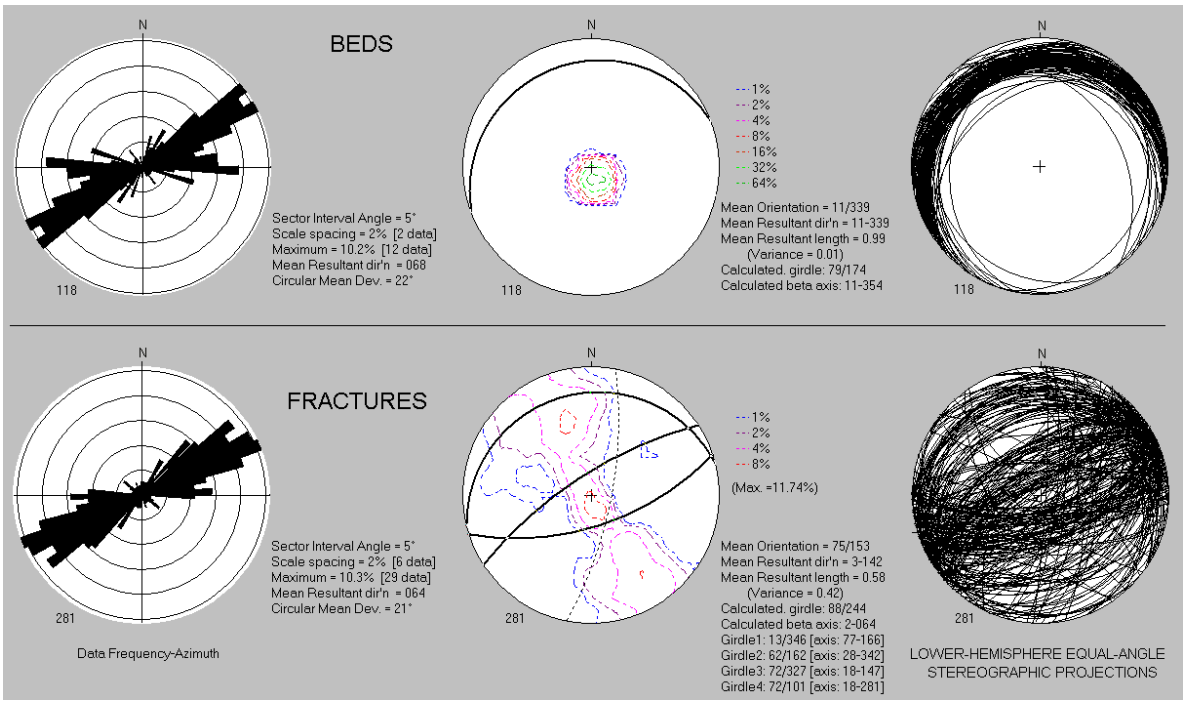


Figure 2E1. Map shows wells 29 through 33 in the vicinity of Milford Boro., Milford Twp., Hunterdon County, NJ. Mapped bedrock structures based on structural analyses of the OPTV records.

Wells 29 to 33 - Coarse-grained units in the Brunswick lower gray zone



Well 29 - Coarse-grained units in the Brunswick lower gray zone

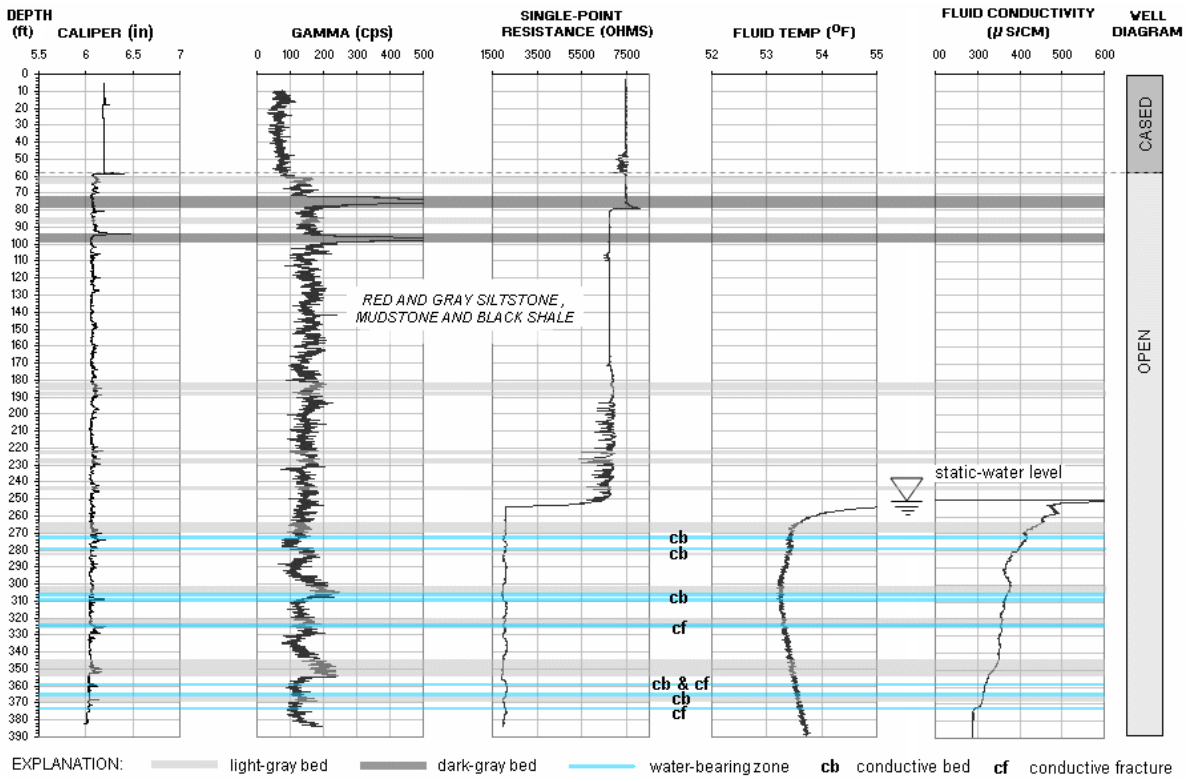
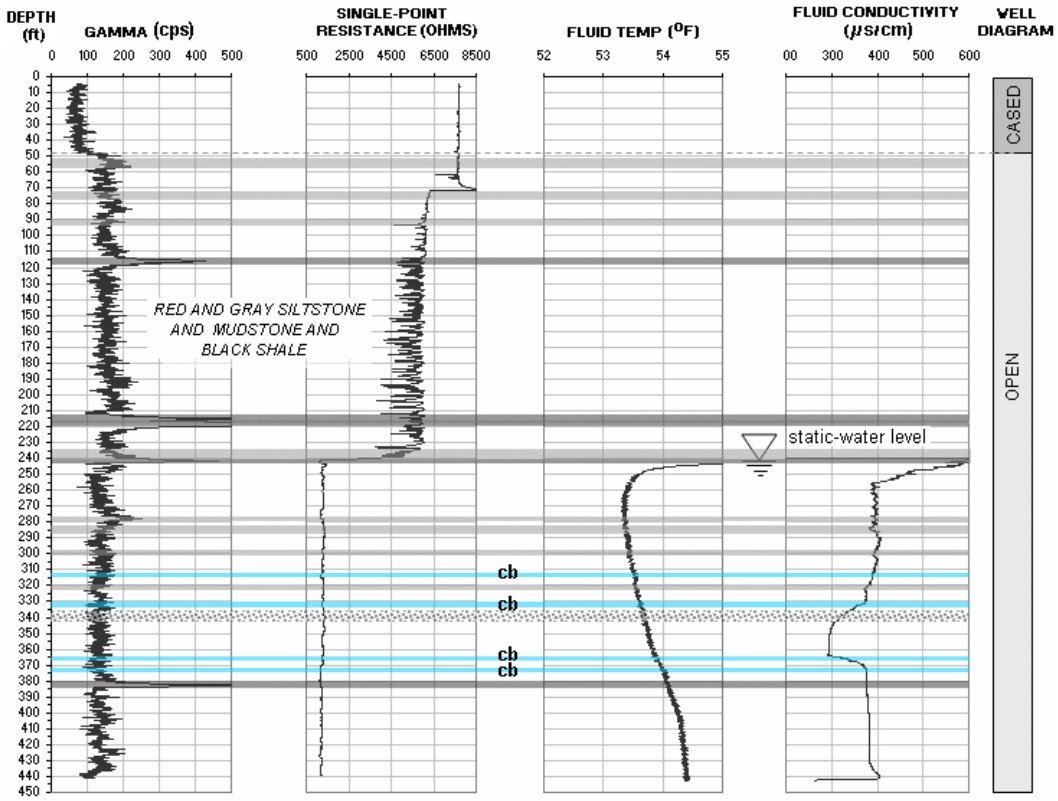


Figure 2E2. Structural analysis of OPTV records for wells 29 through 33 (above) and hydrogeologic section based on geophysical logs for well 29 (below) showing the vertical distribution and types of hydraulically-conductive features and water-bearing zones in siltstone, mudstone and shale. Depth values are in feet below land surface.

Well 30 - Coarse-grained units in the Brunswick lower gray zone



Well 31 - Coarse-grained units in the Brunswick lower gray zone

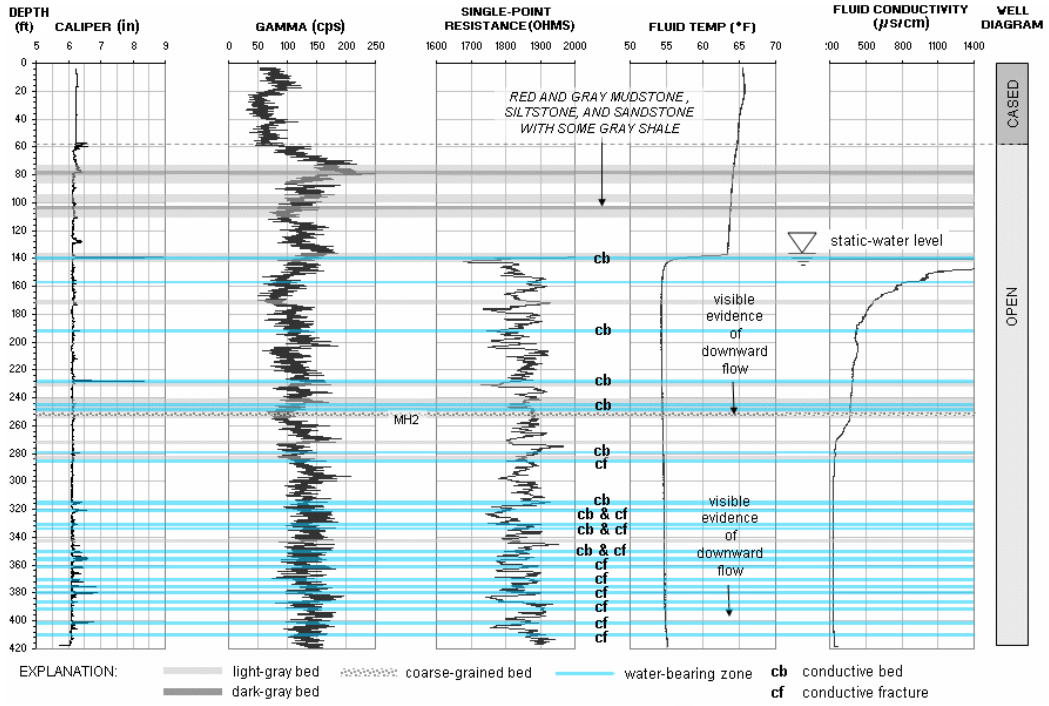
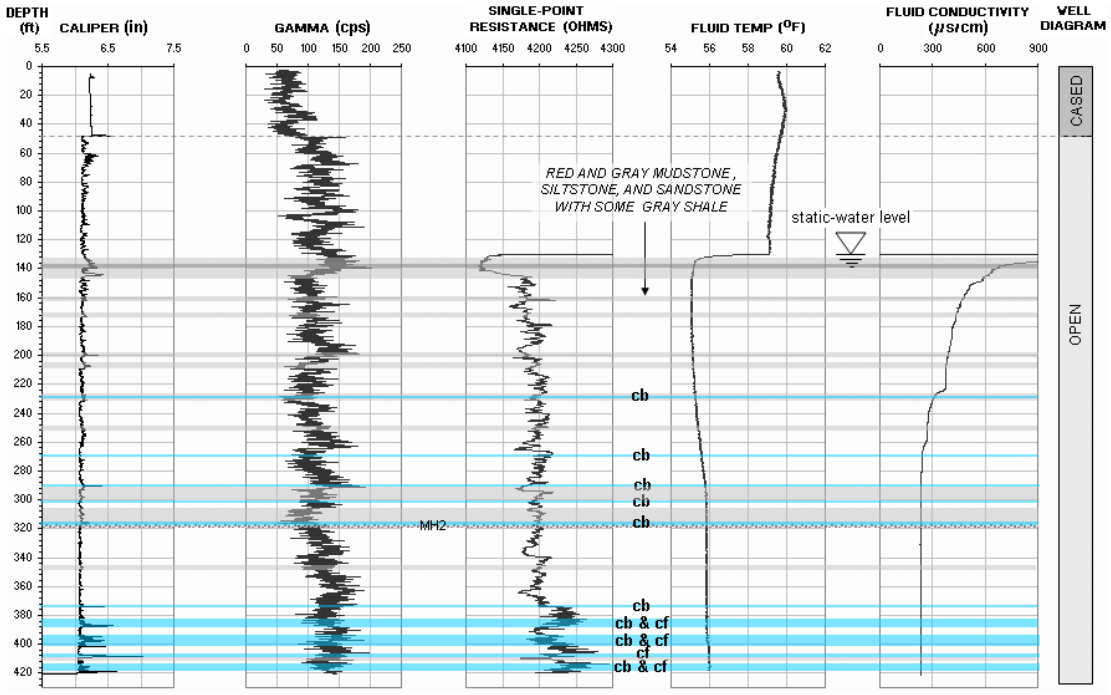


Figure 2E3. Hydrogeologic sections based on geophysical logs for wells 30 (above) and 31 (below) showing the vertical distribution and types of hydraulically-conductive features and water-bearing zones in siltstone, mudstone, shale and sandstone. Depth values are in feet below land surface.

Well 32 - Coarse-grained units in the Brunswick lower gray zone



Well 33 - Coarse-grained units in the Brunswick lower gray zone

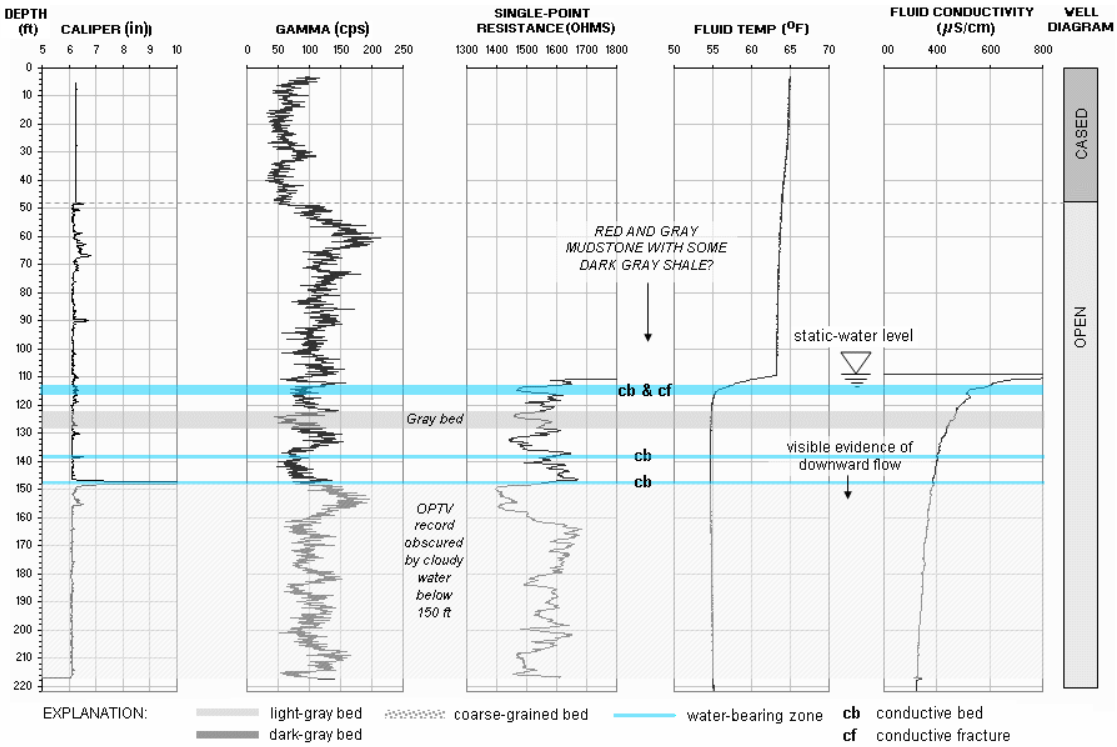


Figure 2E4. Hydrogeologic sections based on geophysical logs for wells 32 (above) and 33 (below) showing the vertical distribution and types of hydraulically-conductive features and water-bearing zones in siltstone, mudstone, shale and sandstone. Depth values are in feet below land surface.

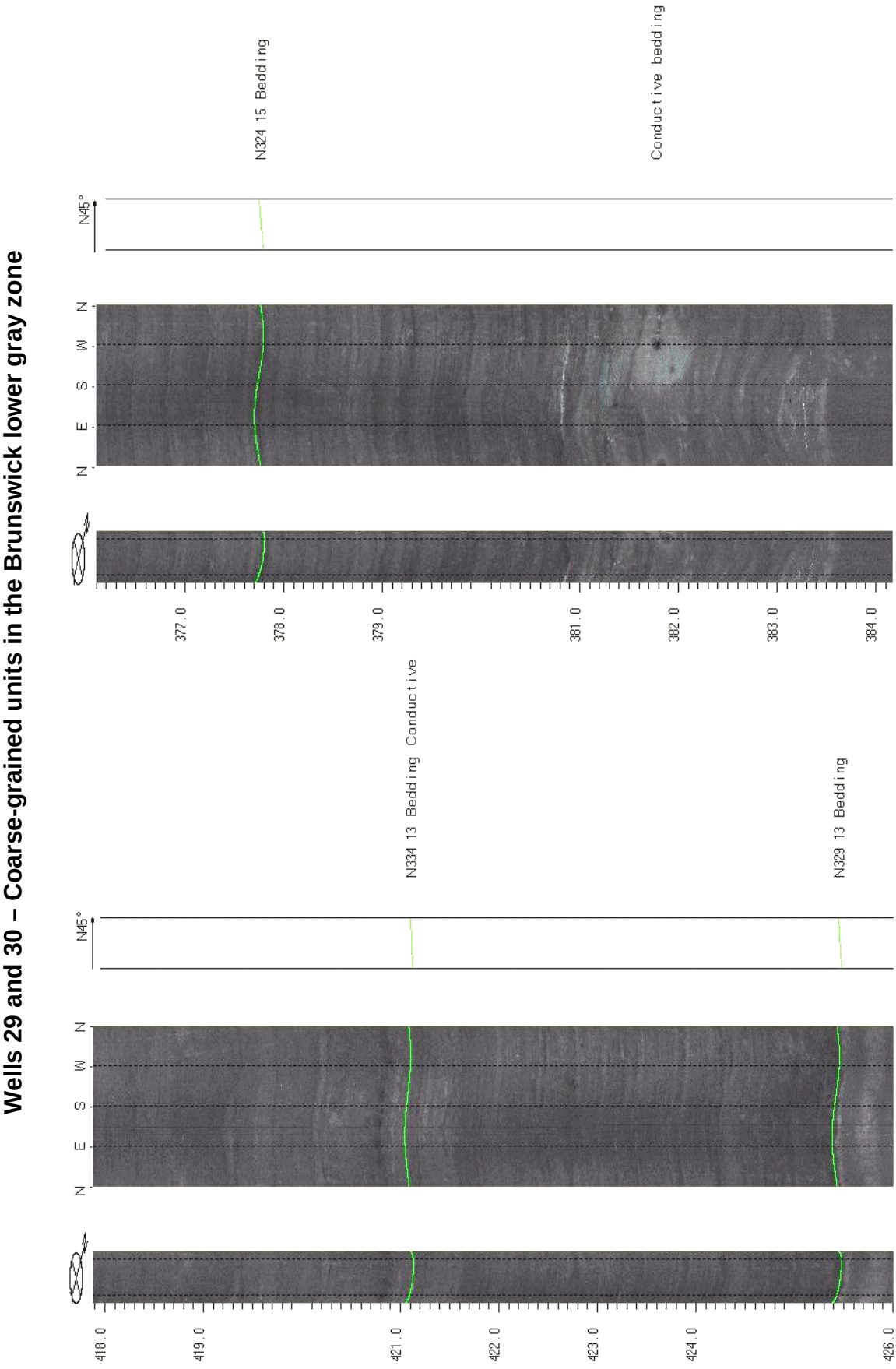


FIGURE 2E5. OPTV records of the 6-inch diameter wells 29 (left) and 30 (right) showing bedrock structures and hydraulically-conductive features in sandstone and siltstone. Depth values are in feet below land surface.

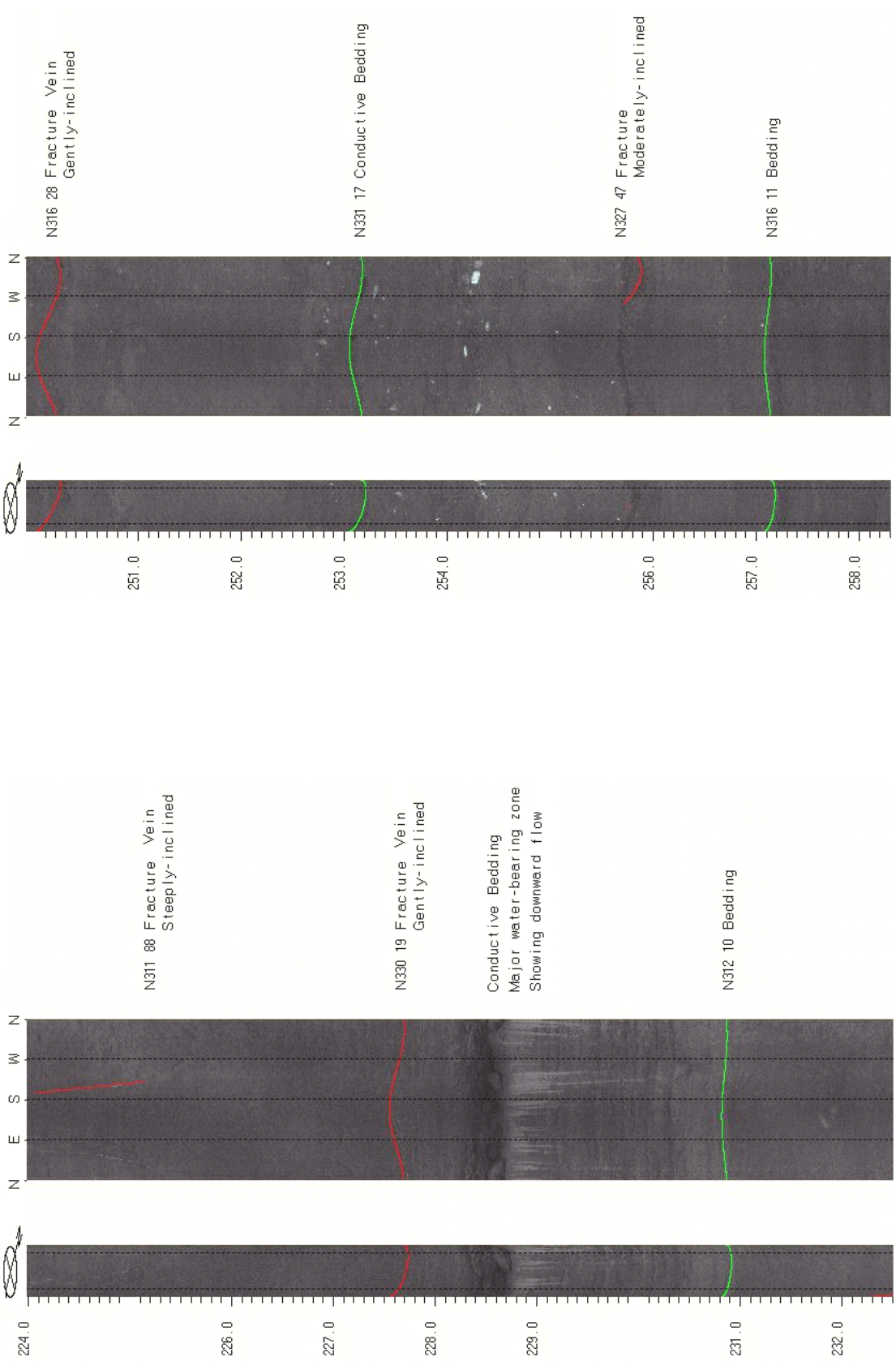


FIGURE 2E6. OPTV records of the 6-inch diameter well 31 showing bedrock structures and hydraulically-conductive features in sandstone and siltstone. Mineral deposits seen as light-colored stains on the borehole wall (left) emanate from conductive feature and taper downward in the direction of water flow. Depth values are in feet below land surface.

Wells 31 and 32 – Coarse-grained units in the Brunswick lower gray zone

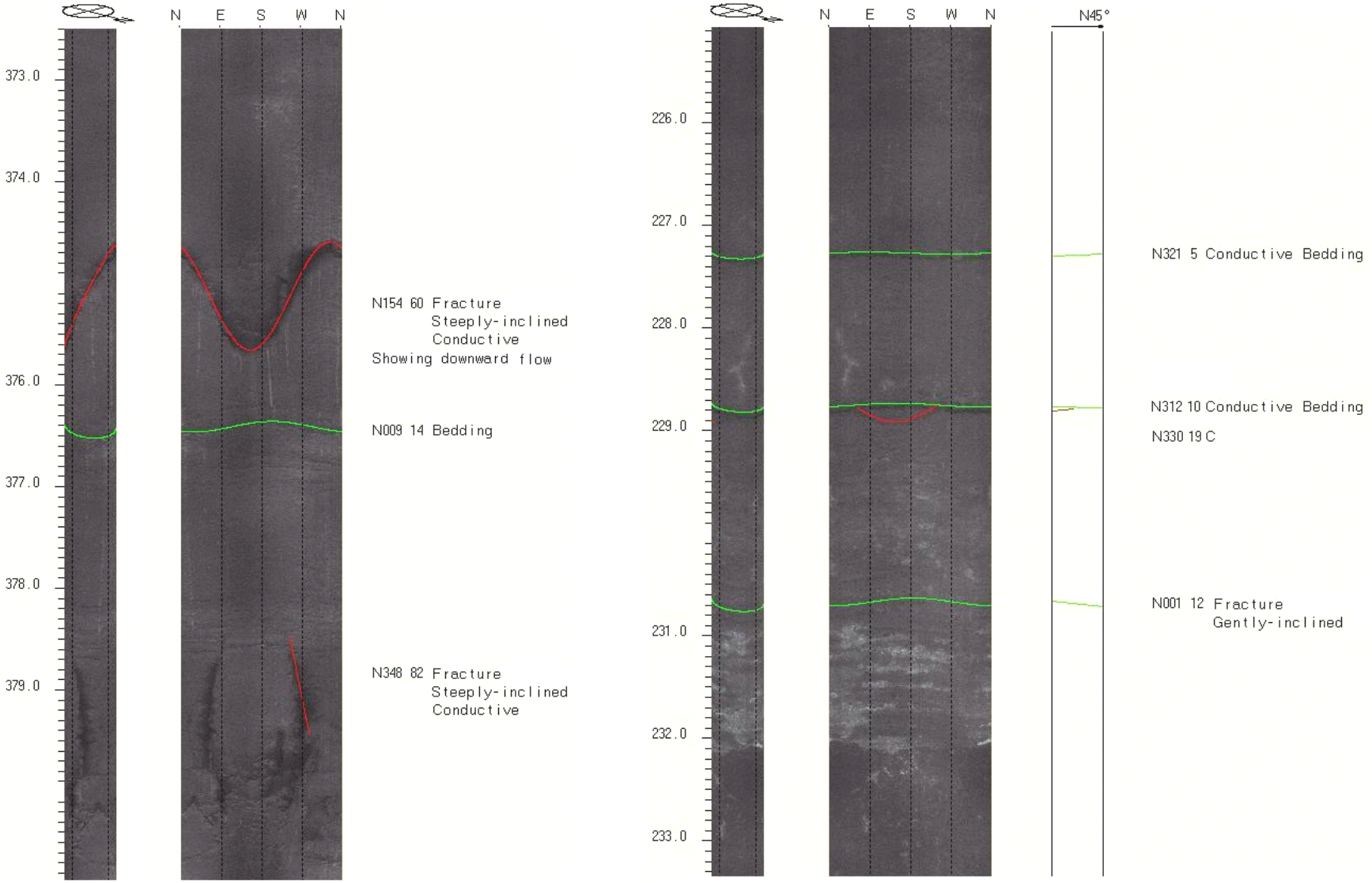


FIGURE 2E7. OPTV records of the 6-inch diameter wells 31 (left) and 32 (right) showing bedrock structures and hydraulically-conductive features in sandstone, siltstone and mudstone. Depth values are in feet below land surface.

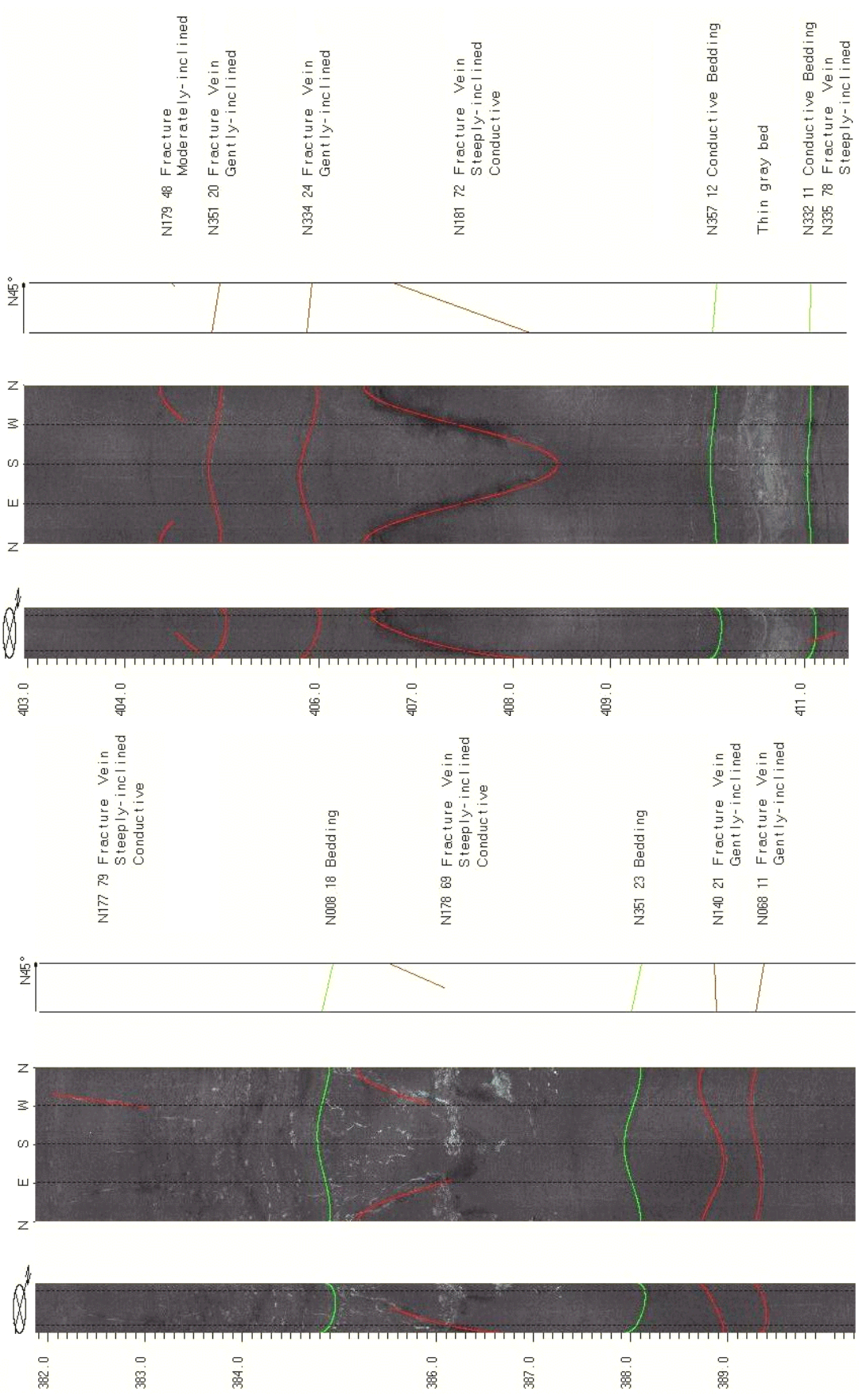


FIGURE 2E8. OPTV records of the 6-inch diameter well 32 showing bedrock structures and hydraulically-conductive features in conglomerate and sandstone. Depth values are in feet below land surface.

Wells 34 to 42 – Passaic flood tunnel workshaft geotechnical investigations

Flooding in New Jersey's Passaic river valley has seriously affected human habitation since the mid-19th century. Since then, the Army Corps of Engineers (ACE) proposed several flood control projects resulting in various subsurface geotechnical investigations conducted in the region from 1959 to 1983. A major flood in 1984 resulted in a new proposal for the Passaic River Flood Protection Plan that was accepted by local, State, and Federal officials. This plan called for construction of a dual-inlet water-diversion tunnel system that would prevent flooding by diverting floodwater through a tunnel connecting the upper watershed to a lower reach of the Passaic River. The U.S. Congress initially appropriated $60 million for the project. Subsurface investigations conducted during 1985-86 included the drilling of 45 rock cores along the proposed tunnel alignment (Phase 1 – fig. 2F1). A revised tunnel alignment (Phase 2 – fig. 2F1) was subsequently proposed based on analyses from Phase1 investigations. The revised tunnel system was about 20 miles long, 40 feet wide and as much as 450 feet below the surface extending to an outlet in the vicinity of Kearny Point in Newark Bay.

In 1990, the U.S. Congress authorized $1.2 billion for the Passaic River Flood Protection Project to be administered by the State of New Jersey and the ACE New York District. Phase 2 work included 154 additional rock cores and a set of detailed hydrogeological analyses conducted near workshafts along the tunnel alignment beginning in 1994. These analyses included detailed geological descriptions of bedrock core, geophysical logs of deep bedrock borings, and straddle packer-test studies for determining ground-water yield and aquifer parameters for specific bedrock intervals. The results of the hydrogeological analyses were summarized in a report by IT Corporation in 1995 and are recompiled here with a series of borehole-data summaries. The Passaic River Flood Protection Plan was abandoned by Federal and State legislators in the mid-1990s because of rising costs and local concerns of negative environmental impacts.

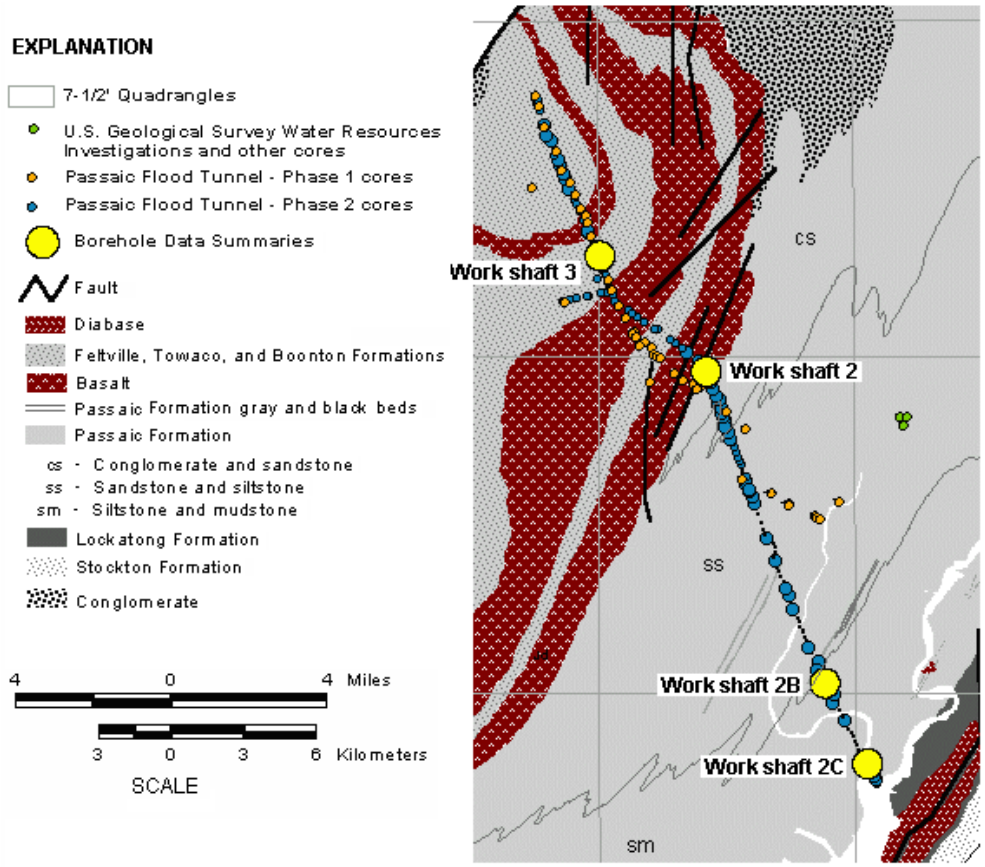


FIGURE 2F1 - Map showing location of rock cores and work shafts from the Army Corp. of Engineers Passaic flood tunnel project.

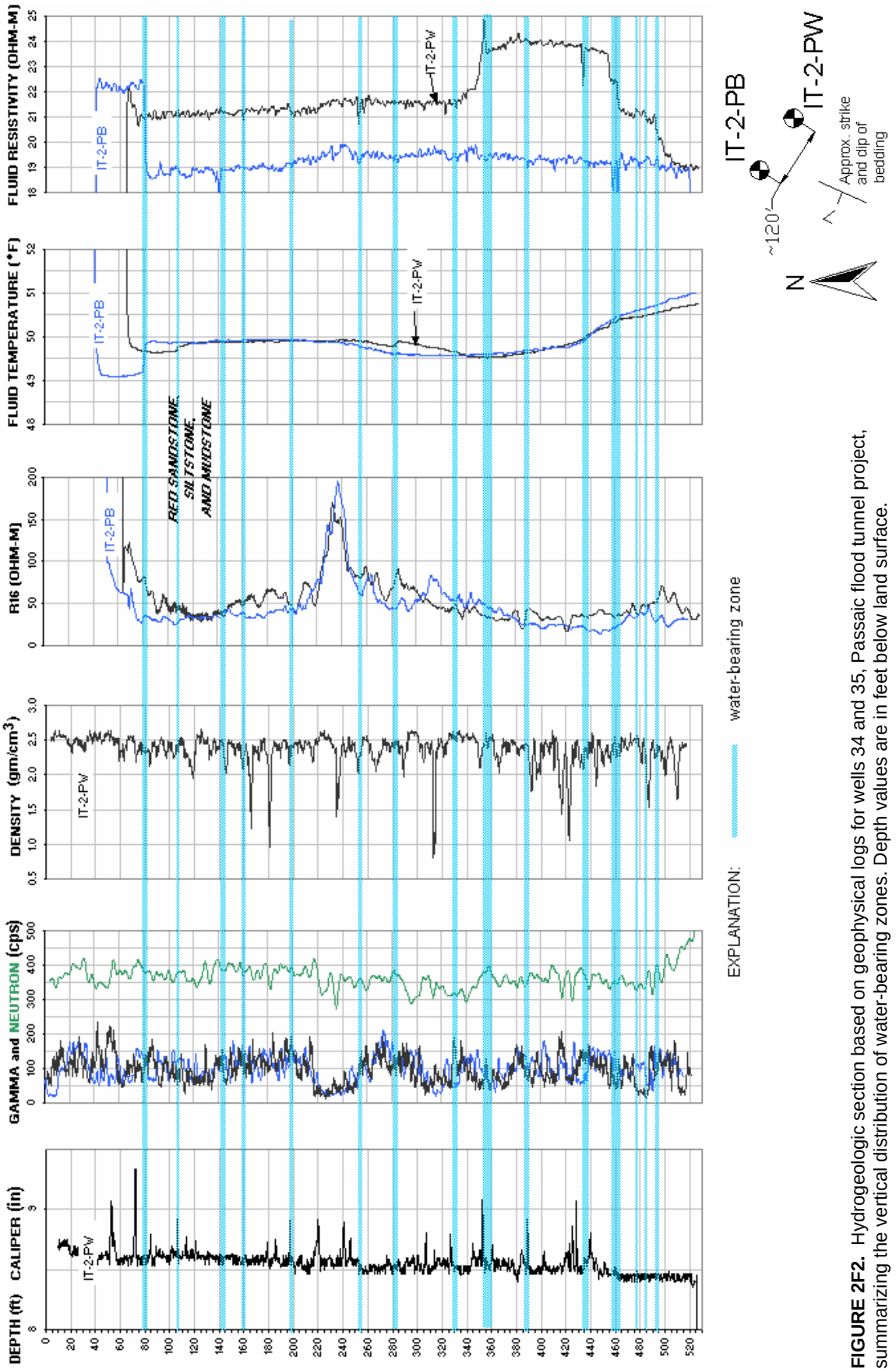


FIGURE 2F2. Hydrogeologic section based on geophysical logs for wells 34 and 35, Passaic flood tunnel project, summarizing the vertical distribution of water-bearing zones. Depth values are in feet below land surface.

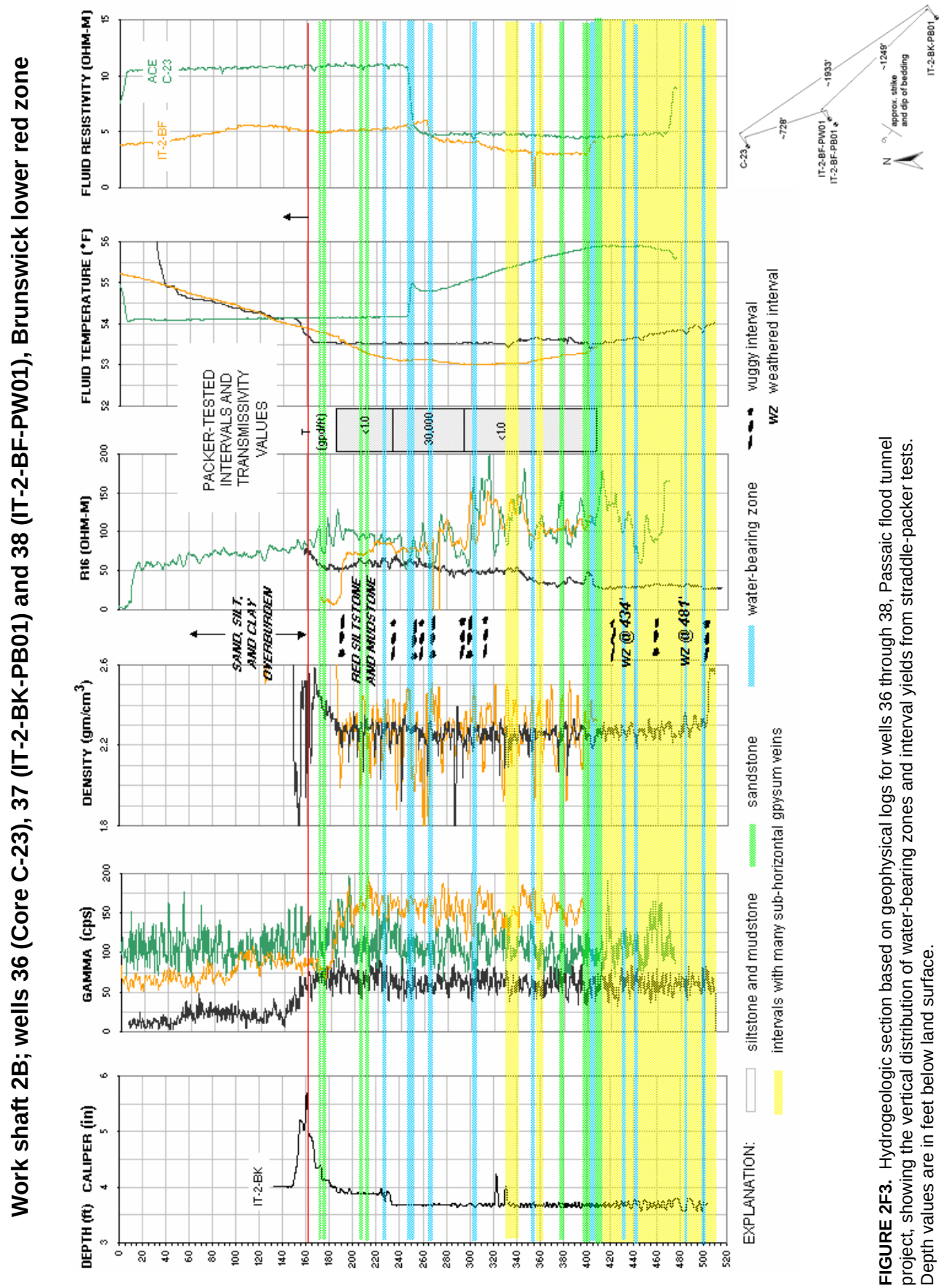


FIGURE 2F3. Hydrogeologic section based on geophysical logs for wells 36 through 38, Passaic flood tunnel project, showing the vertical distribution of water-bearing zones and interval yields from straddle-packer tests. Depth values are in feet below land surface.

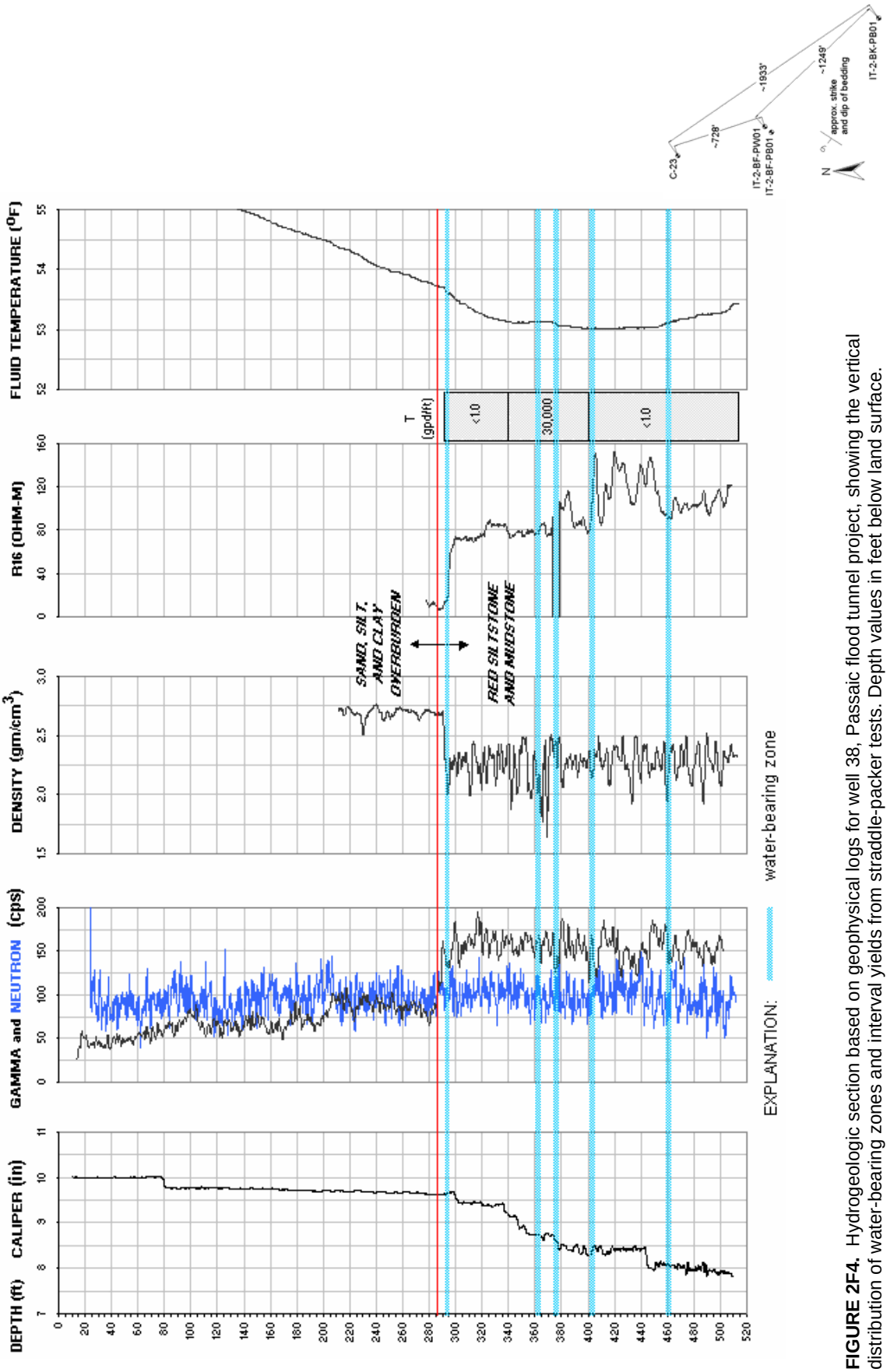


FIGURE 2F4. Hydrogeologic section based on geophysical logs for well 38, Passaic flood tunnel project, showing the vertical distribution of water-bearing zones and interval yields from straddle-packer tests. Depth values in feet below land surface.

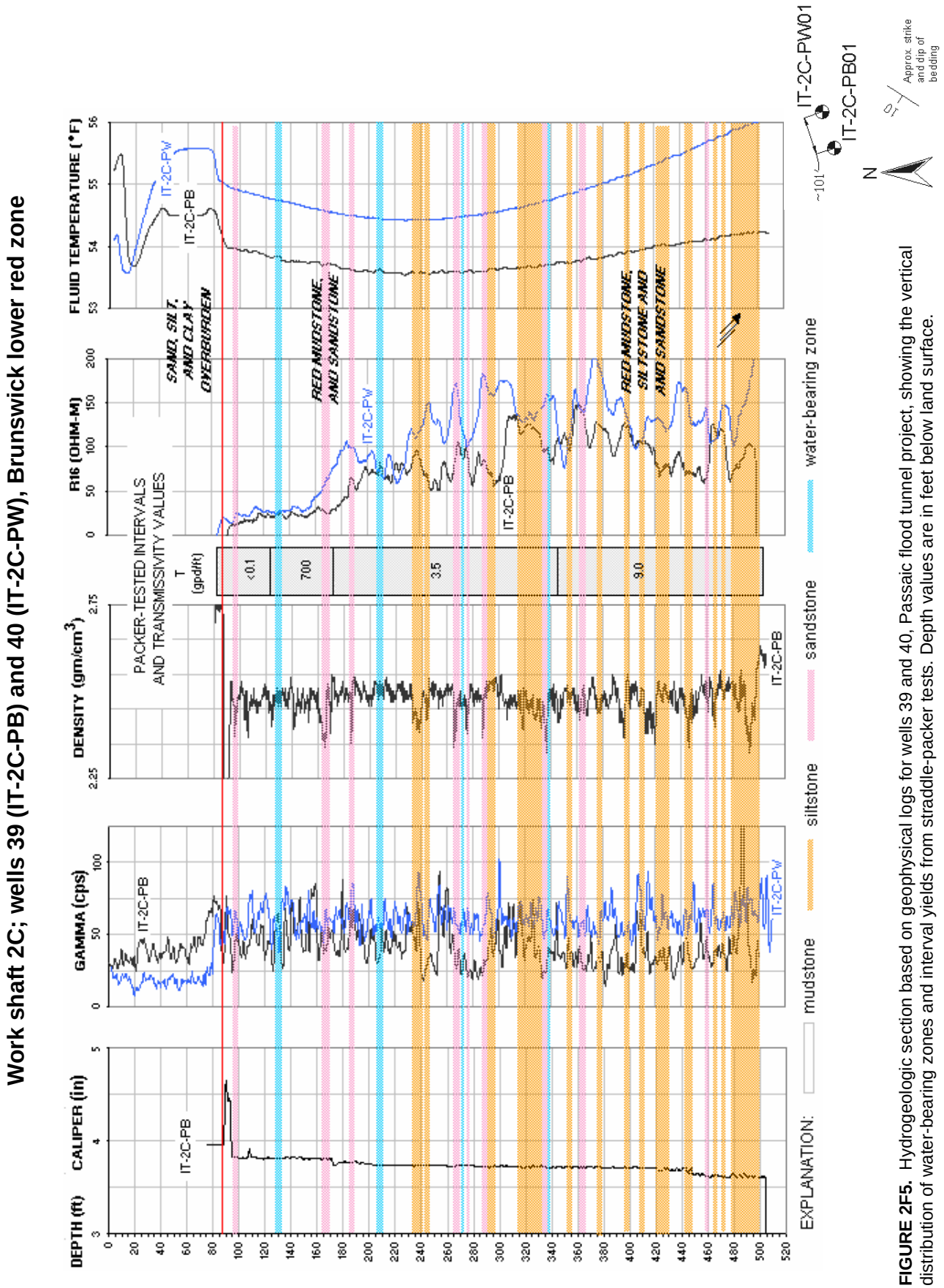


FIGURE 2F5. Hydrogeologic section based on geophysical logs for wells 39 and 40, Passaic flood tunnel project, showing the vertical distribution of water-bearing zones and interval yields from straddle-packer tests. Depth values are in feet below land surface.

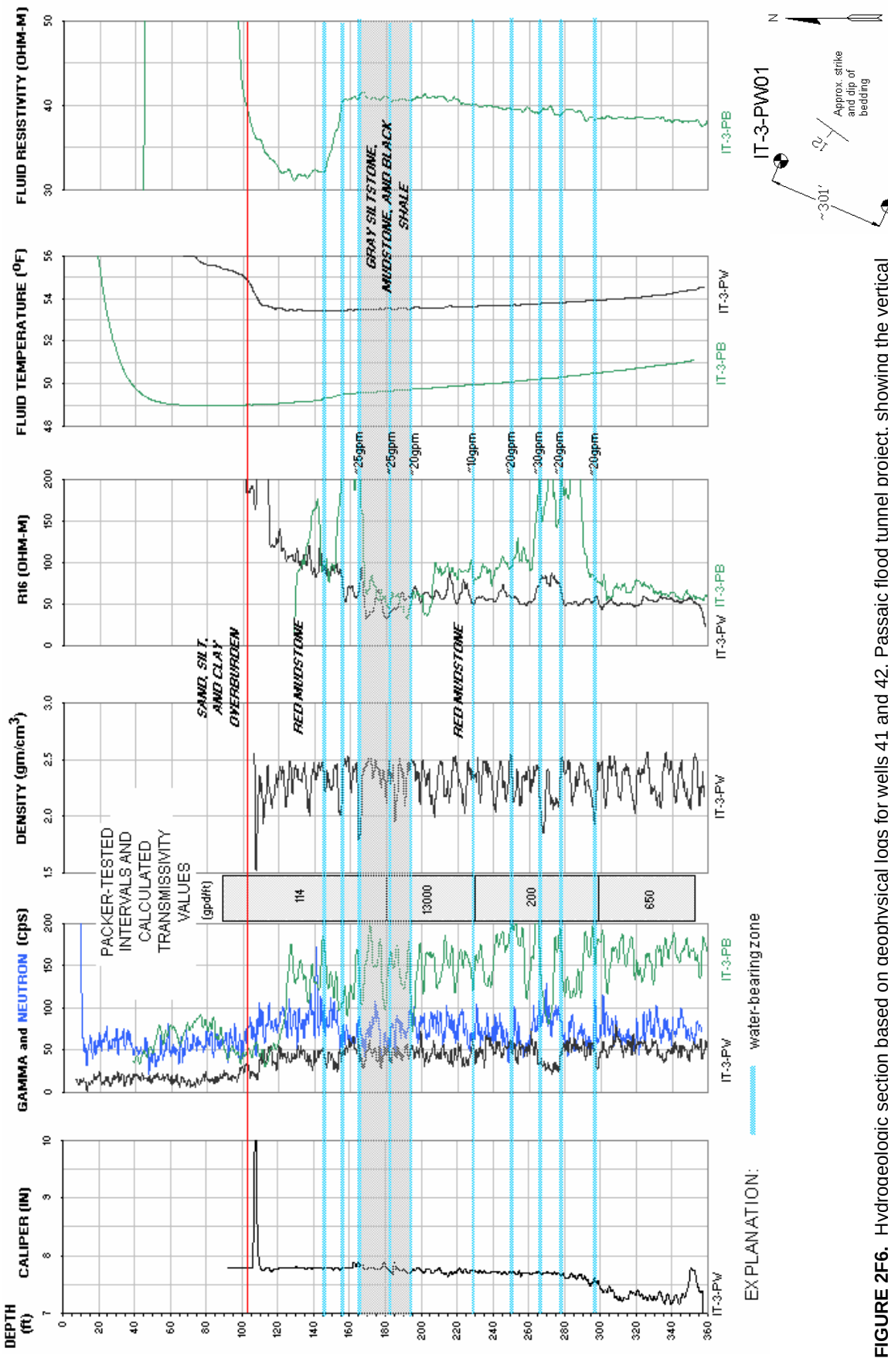


FIGURE 2F6. Hydrogeologic section based on geophysical logs for wells 41 and 42, Passaic flood tunnel project, showing the vertical distribution of water-bearing zones and interval yields from a straddle-packer test. Depth values are in feet below land surface.

Summary of Borehole Geophysical Studies in the Newark Basin, New Jersey:

Brunswick mudstone, siltstone and shale; middle red, middle gray, lower red and lower gray zones

By Gregory C. Herman and John F. Curran, N.J. Geological Survey

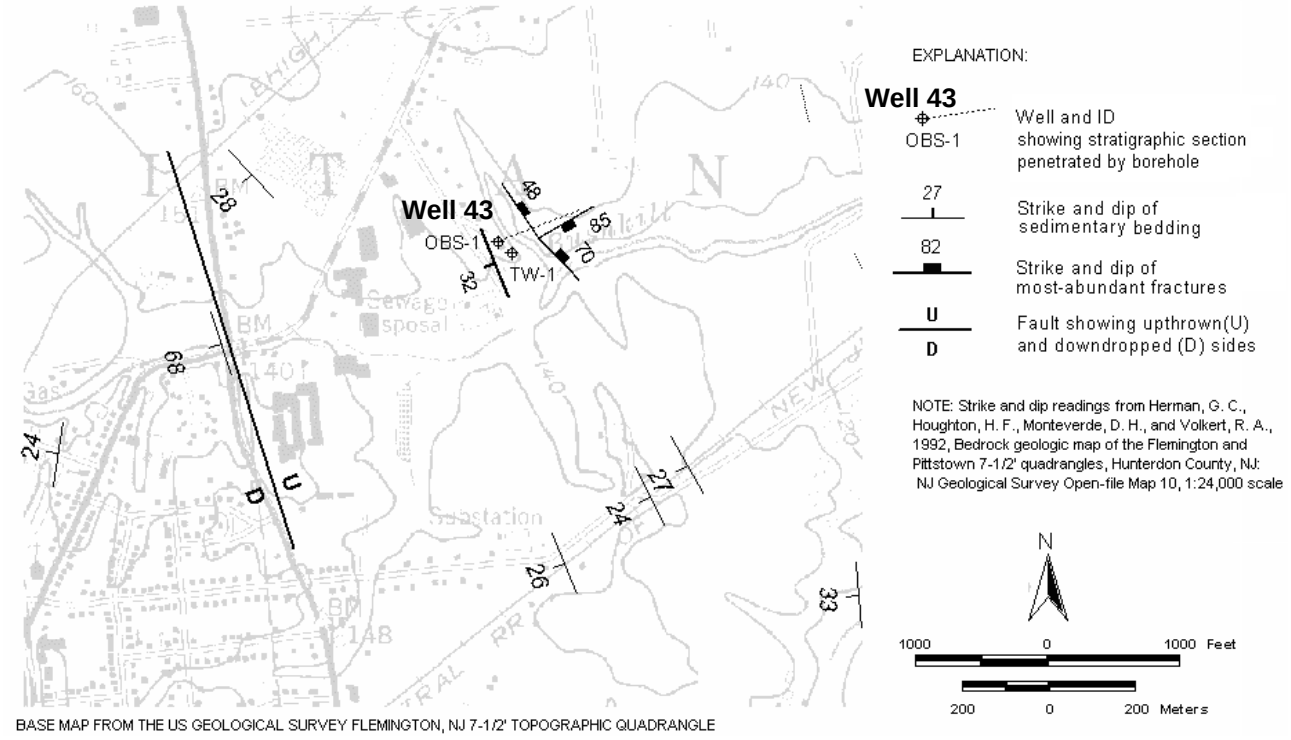
Appendix 3 of

Contributions to the Geology and Hydrogeology of the Newark Basin

N.J. Geological Survey Bulletin 77

State of New Jersey
Department of Environmental Protection
Water Resource Management
New Jersey Geological Survey
2010

Well 43 - Brunswick middle red zone



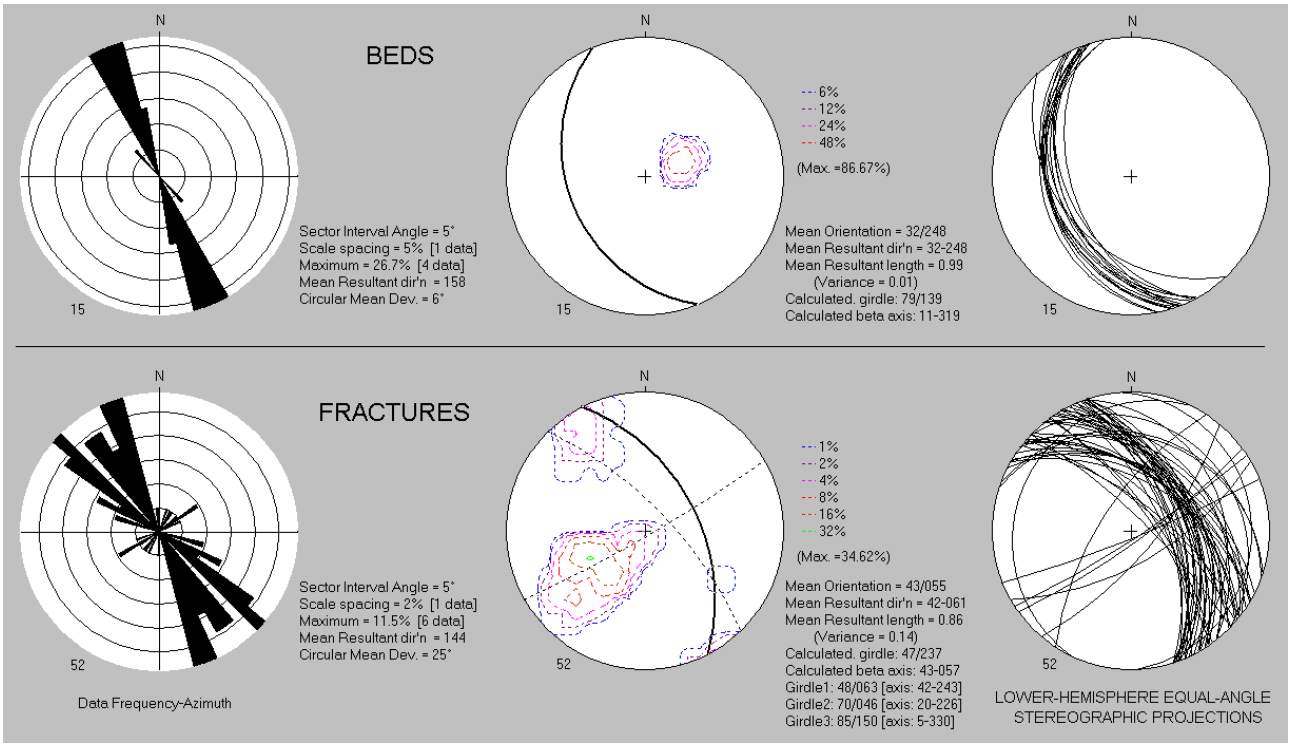


Figure 3A1. Map (above) shows well 43, Junction Rd., Raritan Twp., Hunterdon County, NJ. Bedrock structures mapped near the well are based on a structural analysis (below) of the OPTV record. Note how nearby topographic ridges and streams parallel the strike of structures.

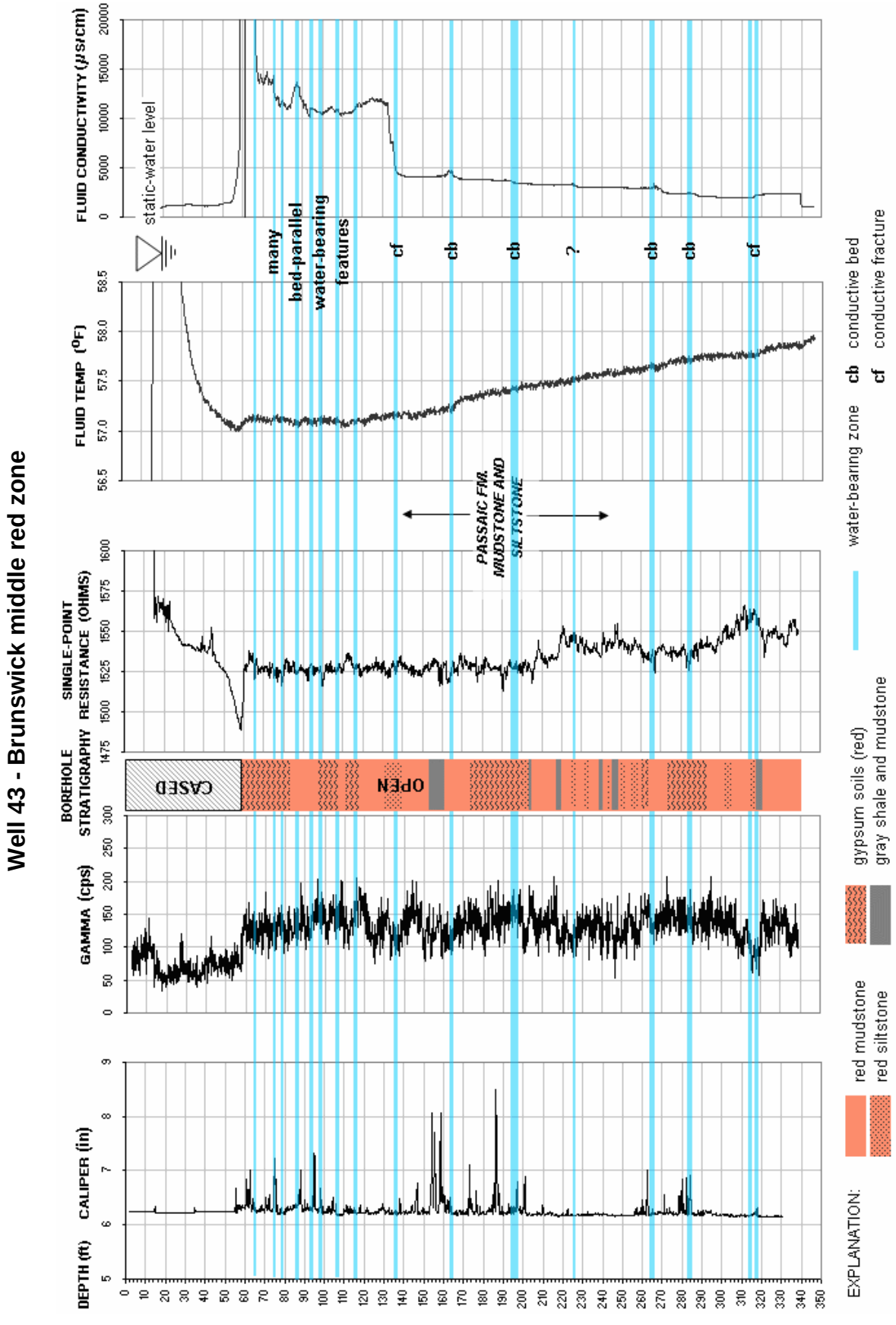


FIGURE 3A2. Hydrogeologic section based on geophysical logs for well 43 showing the vertical distribution and types of hydraulically-conductive features and water-bearing zones. Depth values are in feet below land surface.

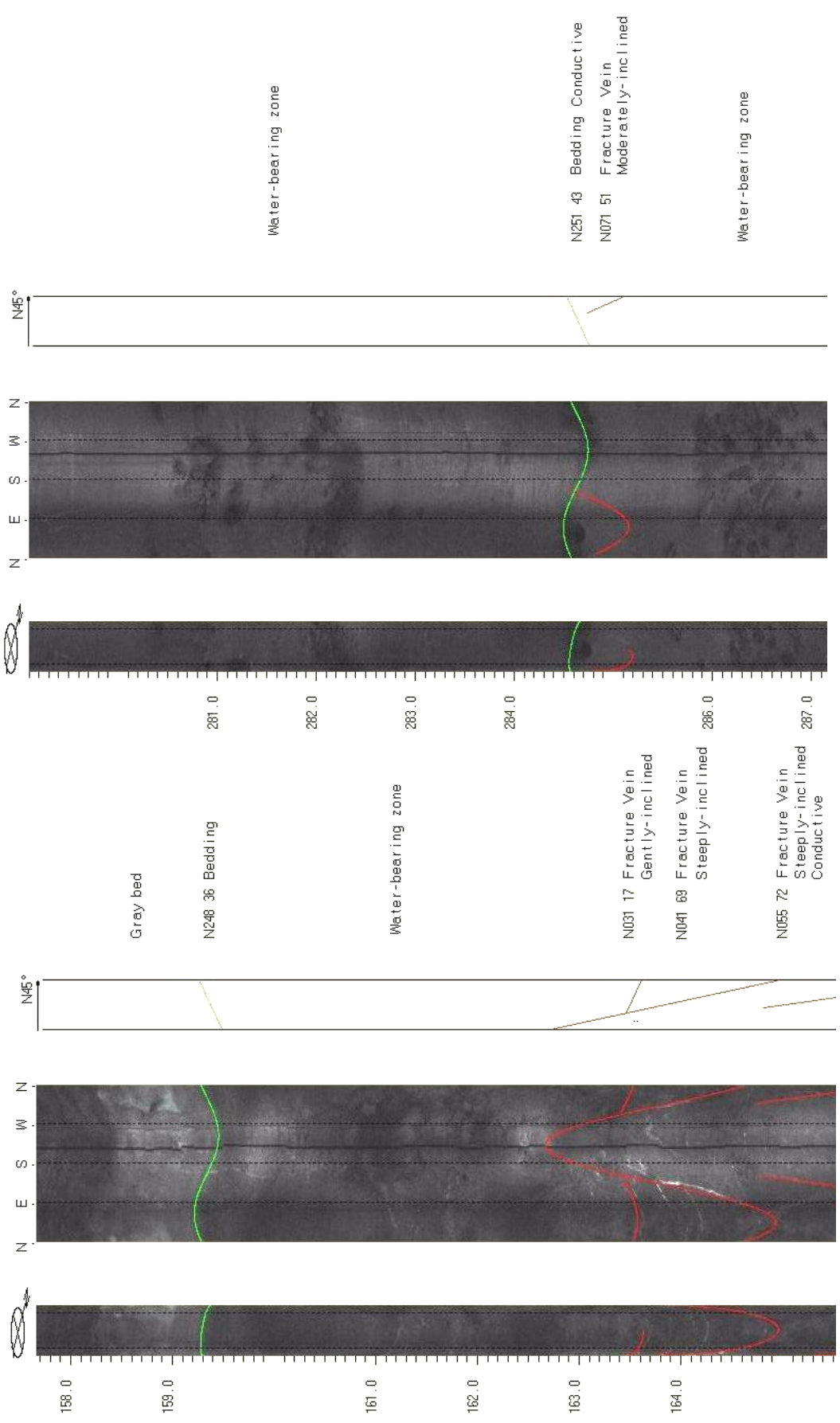
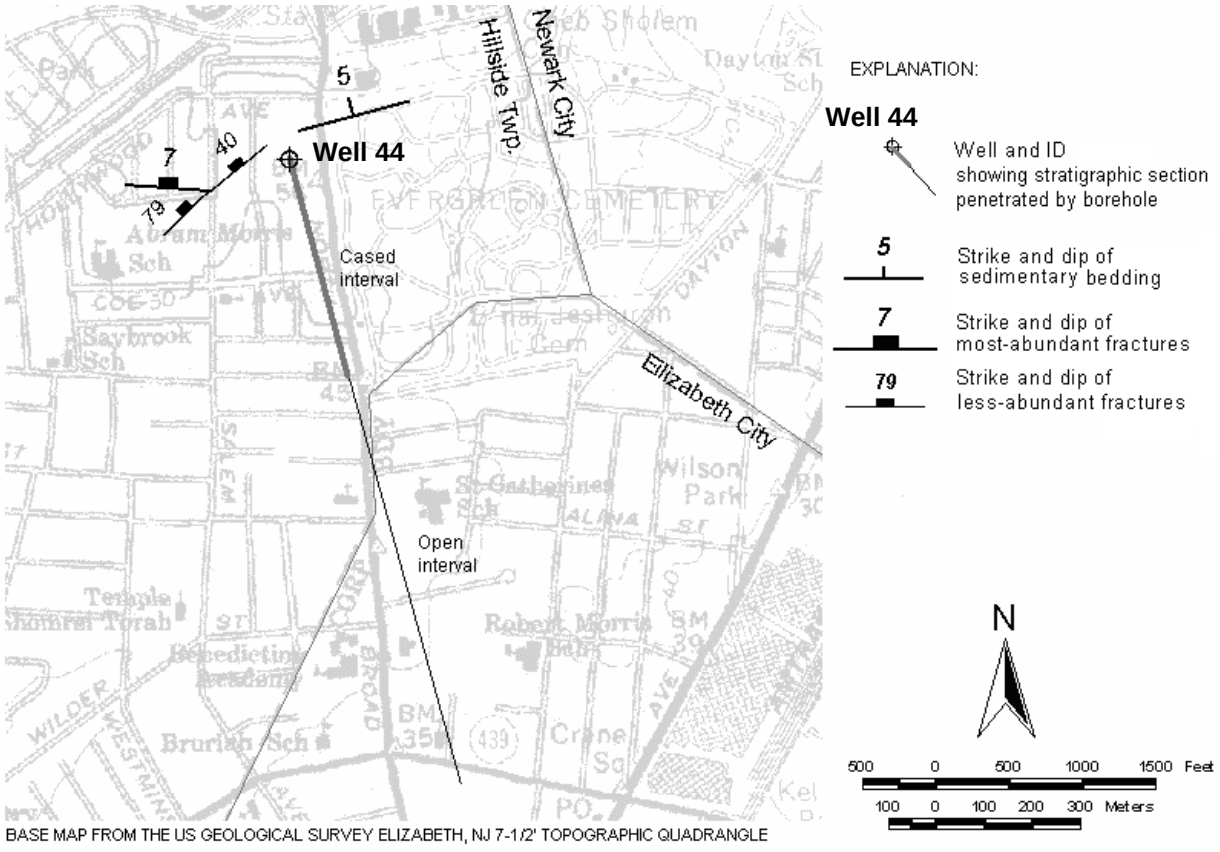


FIGURE 3A3. OPTV records of the 6-inch diameter well 43 showing bedrock structures and hydraulically-conductive features in red and gray mudstone. Depth values are in feet below land surface.

Well 44 - Brunswick middle red zone



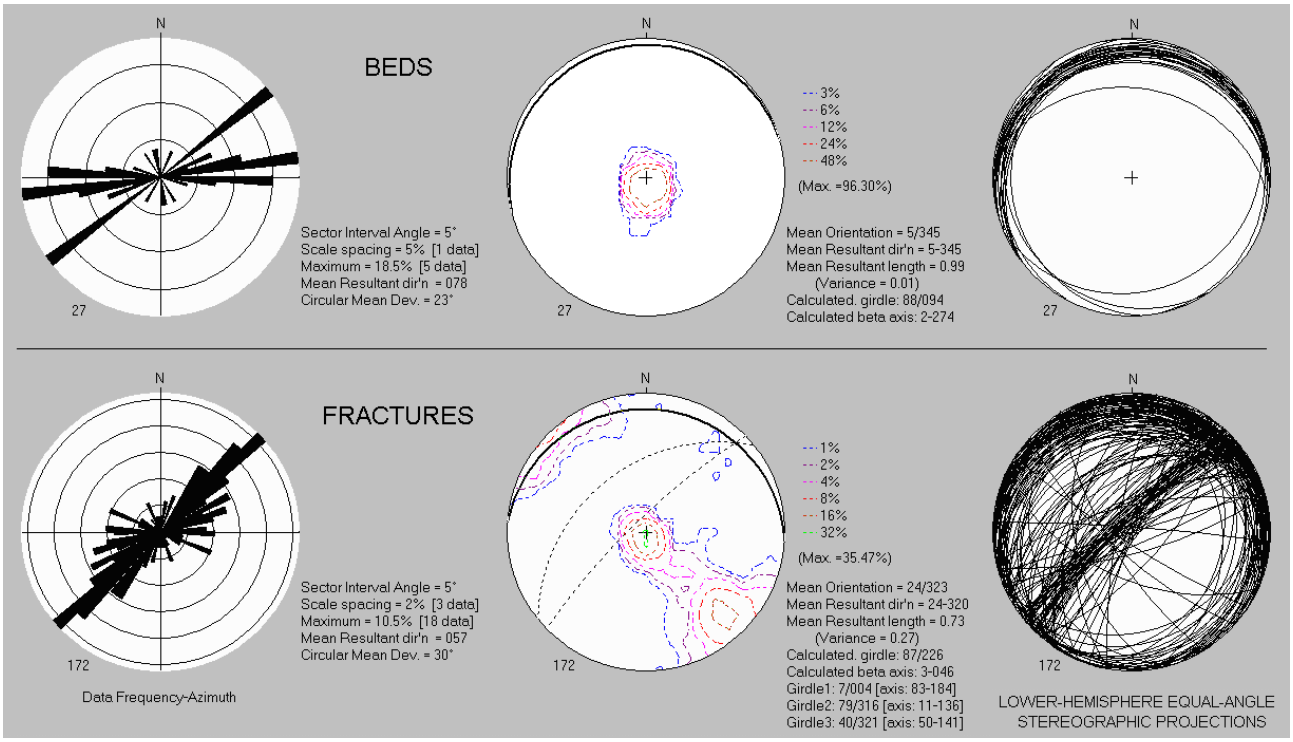
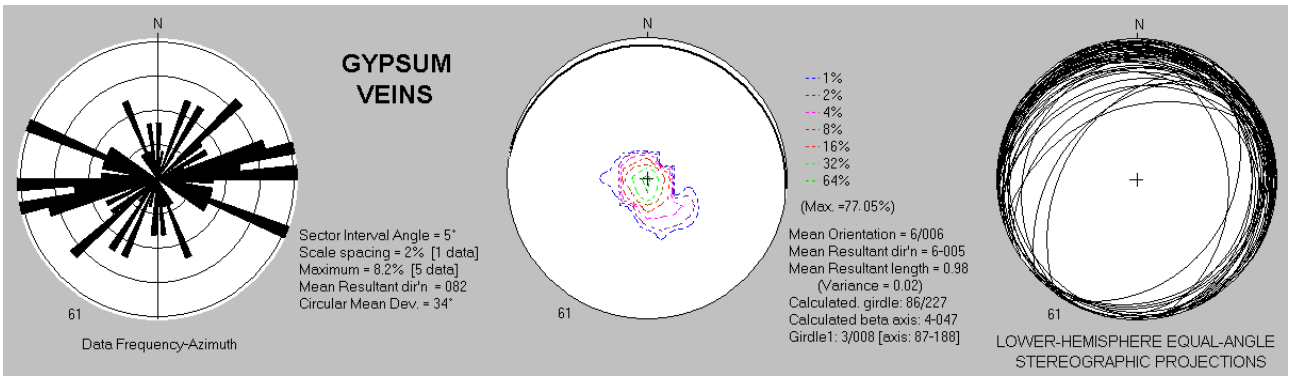


Figure 3B1. Map (above) shows well 44 at the Hillside Car Wash, 1260 North Broad St., Hillside Twp., Union County, NJ. Bedrock structures are based on a structural analysis (below) of the OPTV record.

Well 44 - Brunswick middle red zone



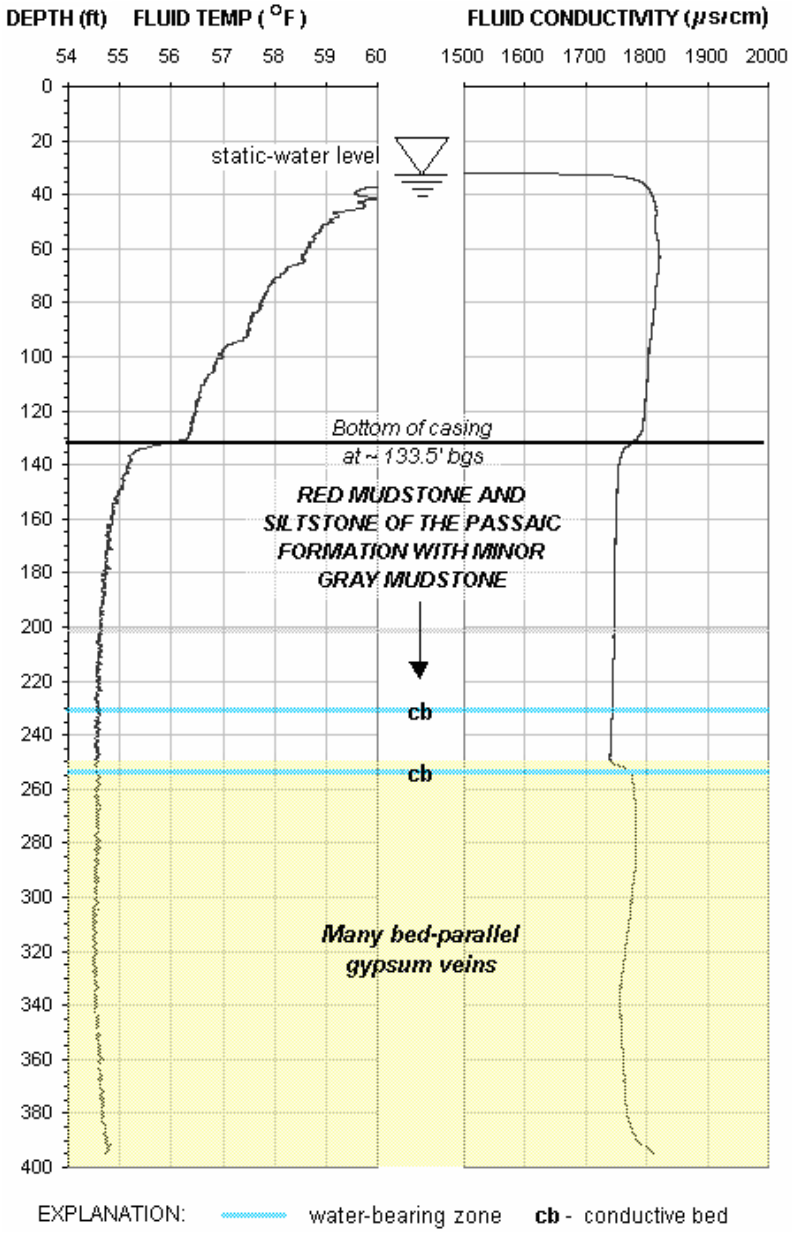


Figure 3B2. Structural analysis of gently-dipping gypsum veins from the OPTV record (above), and hydrogeologic section based on geophysical logs (below) showing the vertical distribution of hydraulically-conductive features, water-bearing zones, and the stratigraphic interval containing many gypsum veins. Depth values are in feet below land surface.

Well 43 - Brunswick middle red zone

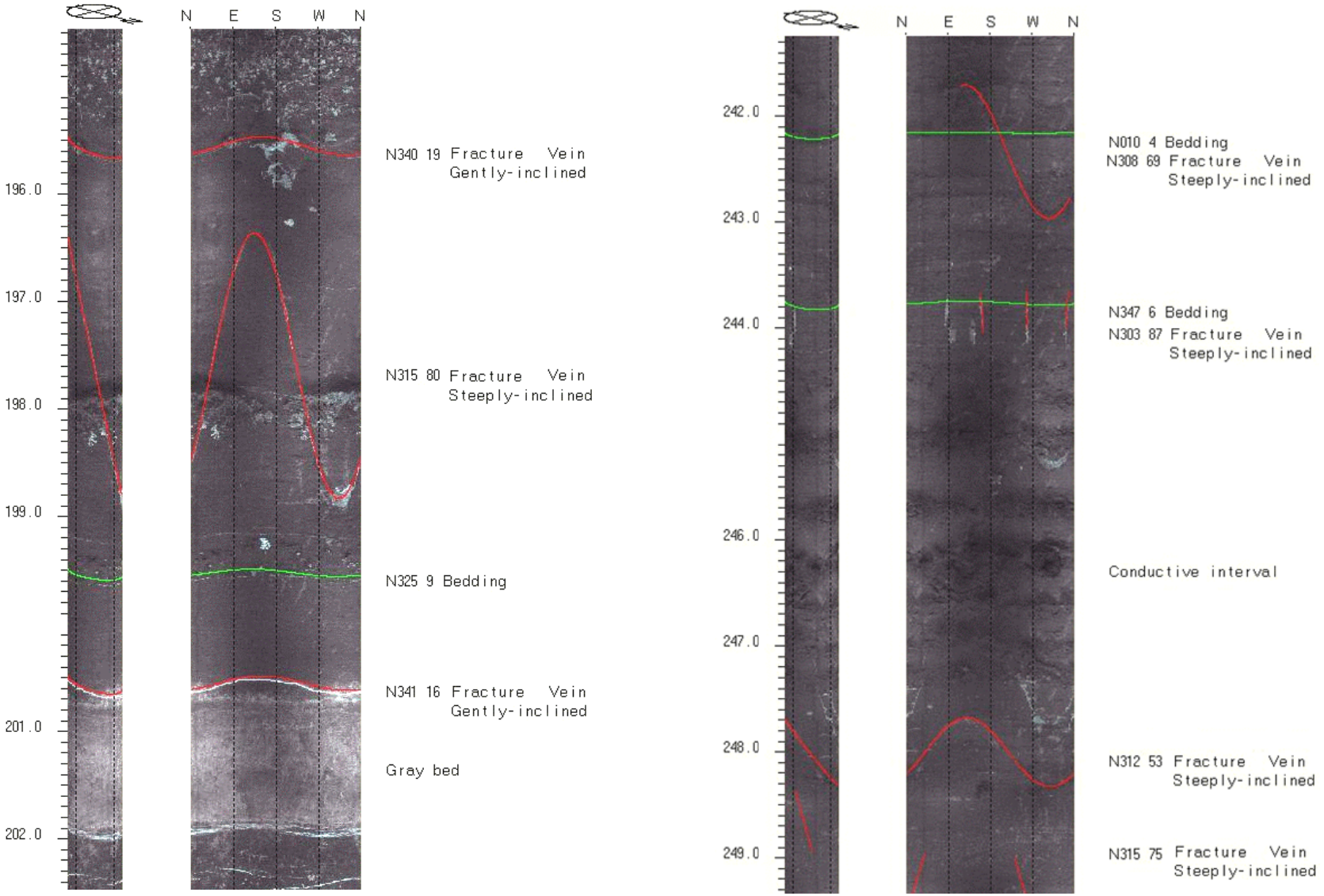


FIGURE 3B3. OPTV records of the 6-inch diameter well 44 showing bedrock structures and hydraulically-conductive features in red and gray mudstone. Depth values are in feet below land surface.

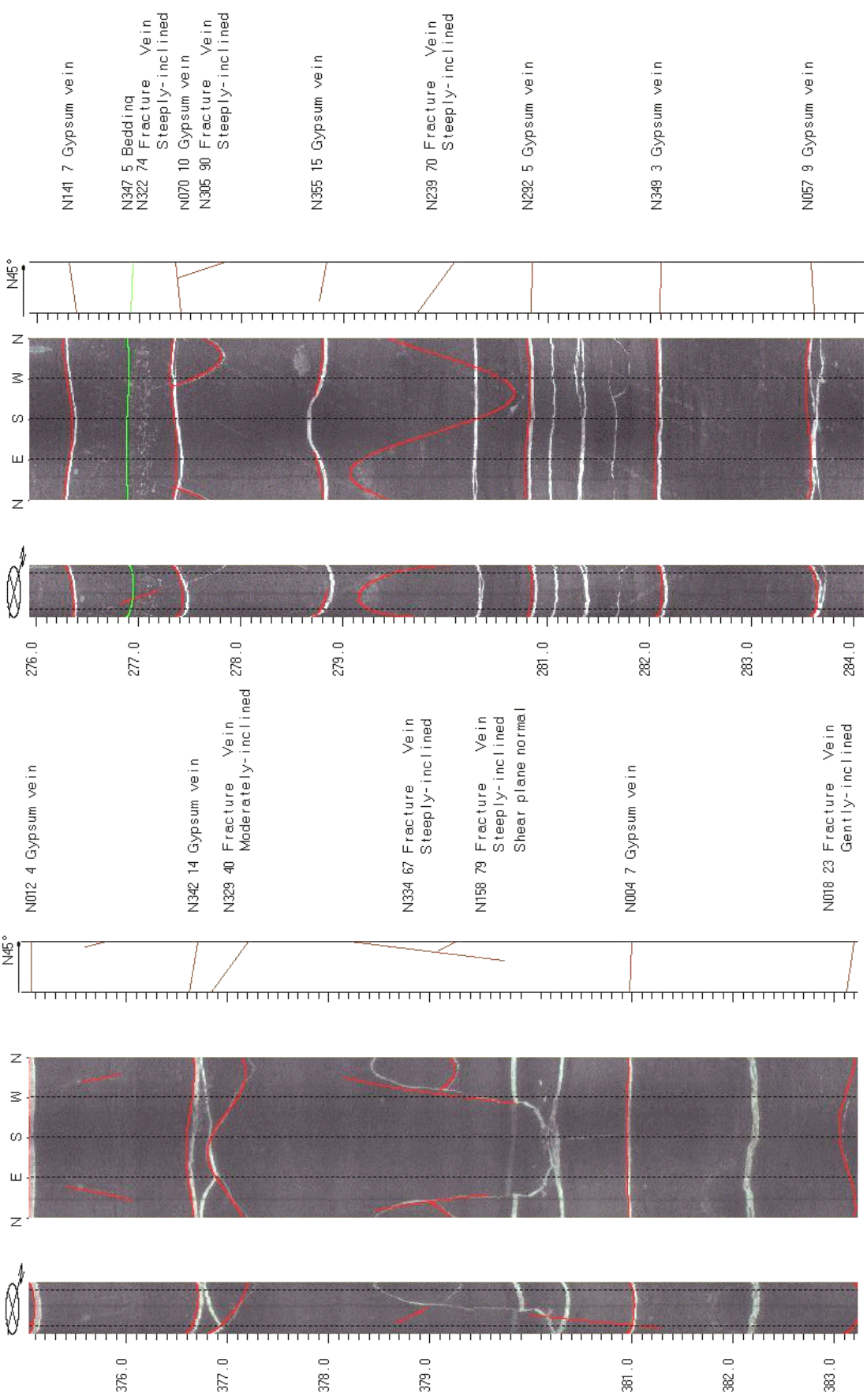
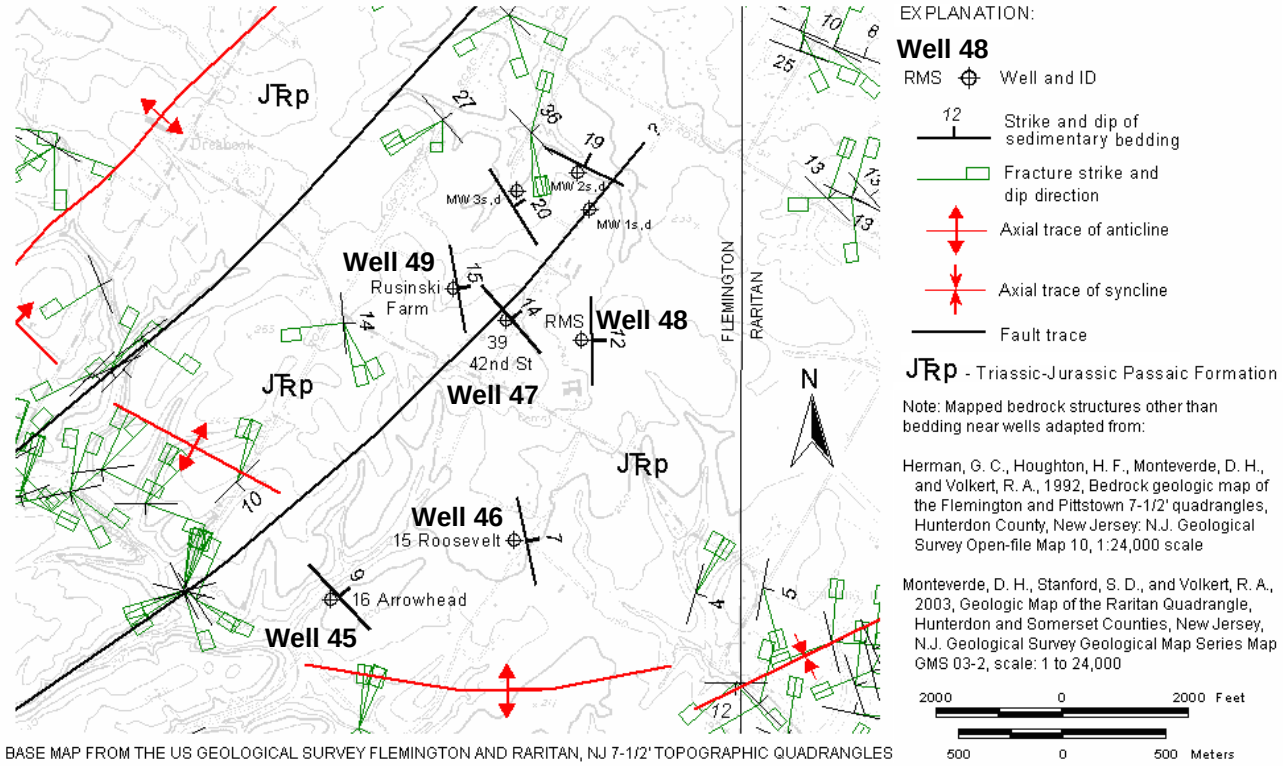


FIGURE 3B4. OPTV records of the 6-inch diameter well 43 showing bedrock structures in red mudstone. Depth values are in feet below land surface.

Wells 45 to 49 - Brunswick middle red zone



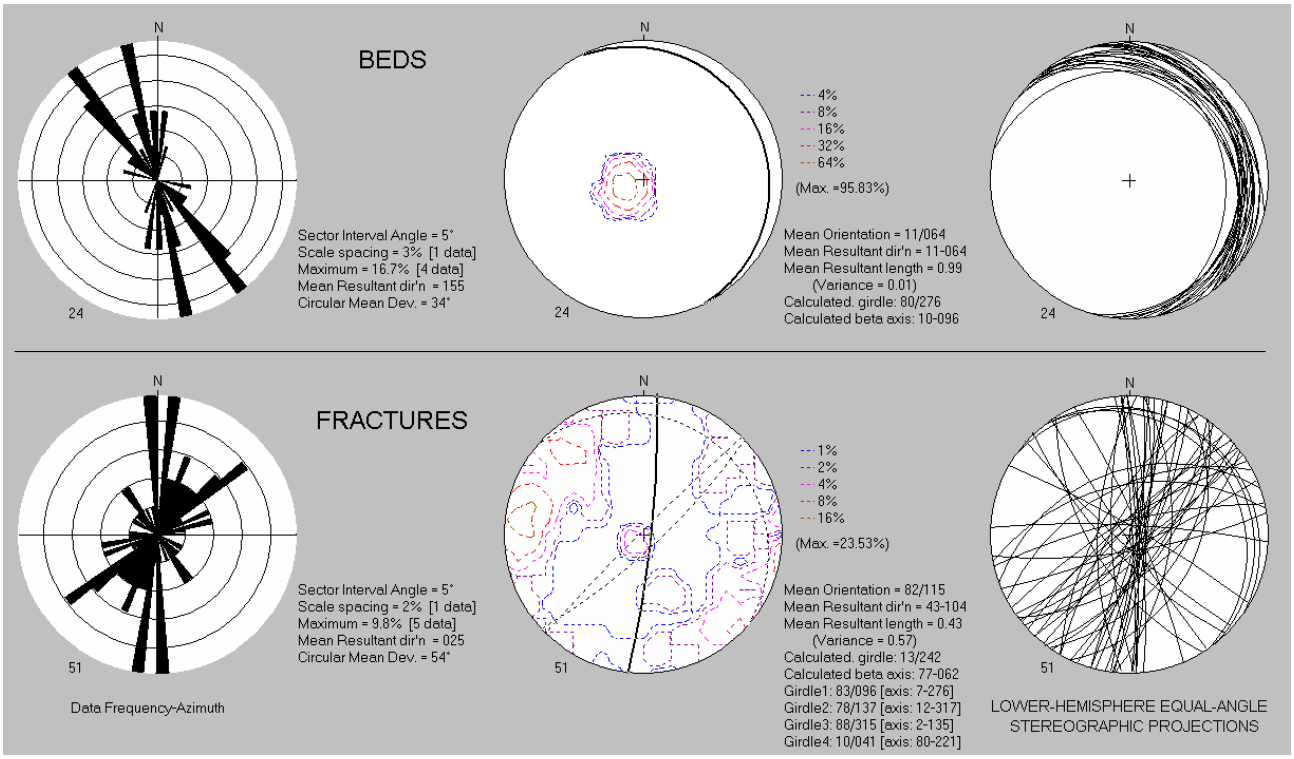


Figure 3C1. Map (above) shows wells 45 through 49 that were logged as part of a regional ground-water investigation in Readington Twp, Hunterdon County, NJ. The structural analysis (below) of the OPTV records summarizes bed and fracture orientations for the wells.

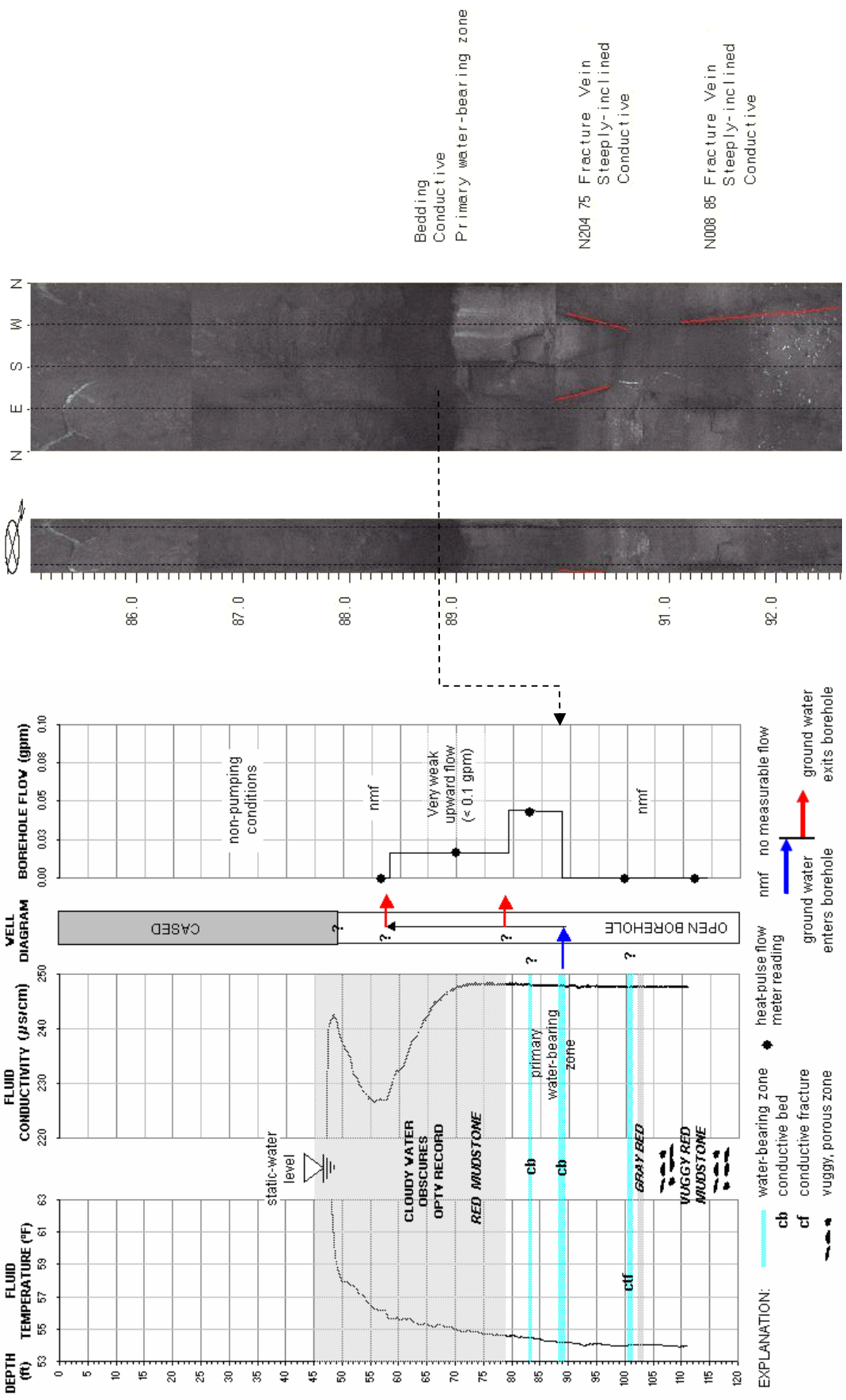


FIGURE 3C2. Hydrogeologic section based on geophysical logs (left) for well 45 at 16 Arrowhead Rd, Readington Twp, Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red mudstone. An OPTV record of the 6-inch diameter well (right) shows the primary inflow zone. Light-colored mineral stains emanating from the conductive bed extend downward in response to periodic downward flows induced by pumping. Depth values are in feet below land surface.

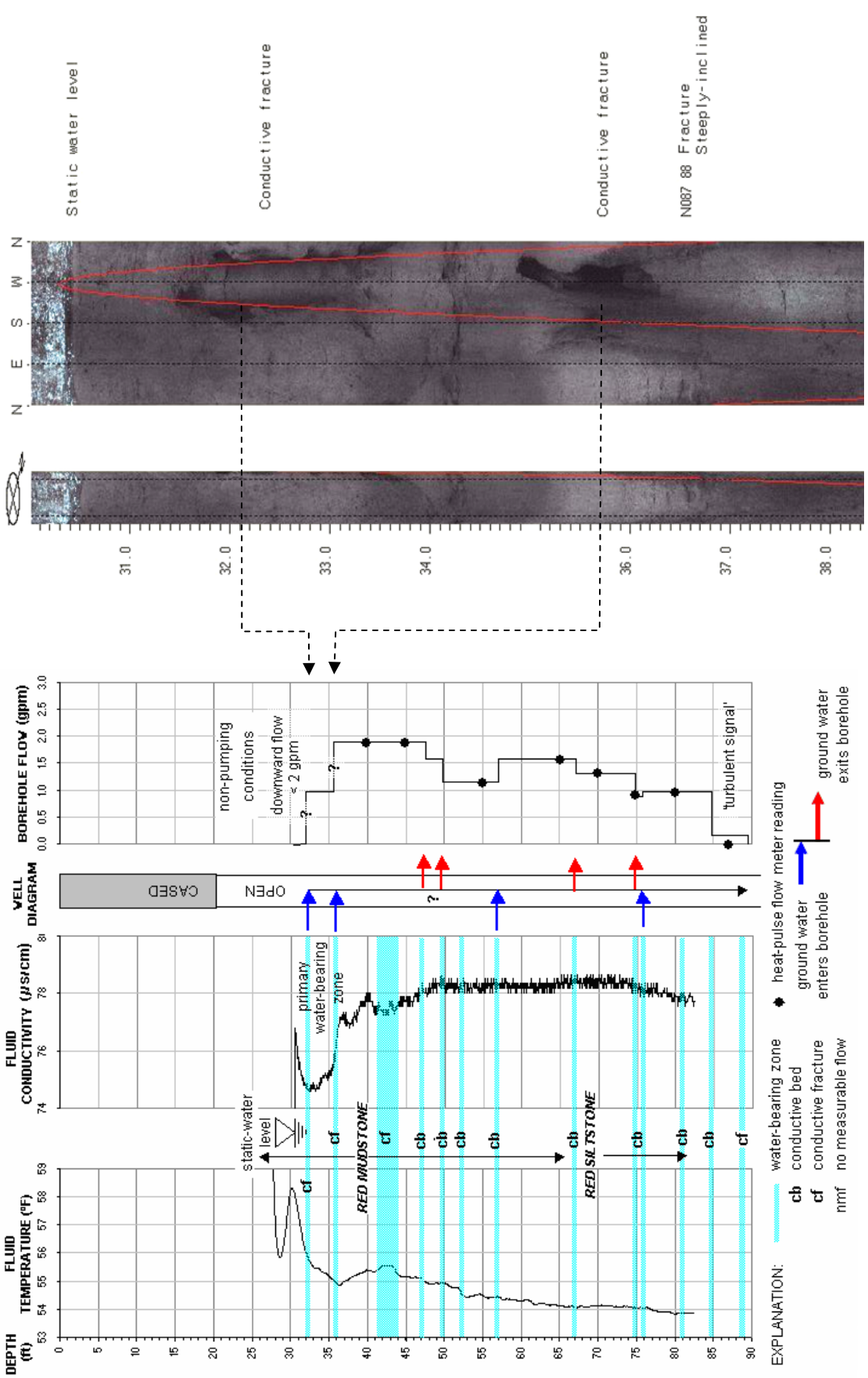


FIGURE 3C3. Hydrogeologic section based on geophysical logs (left) for well 46 at 15 Roosevelt Rd, Readington Twp, Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red mudstone. An OPTV record of the 6-inch diameter well (right) shows primary inflow zones. Depth values are in feet below land surface.

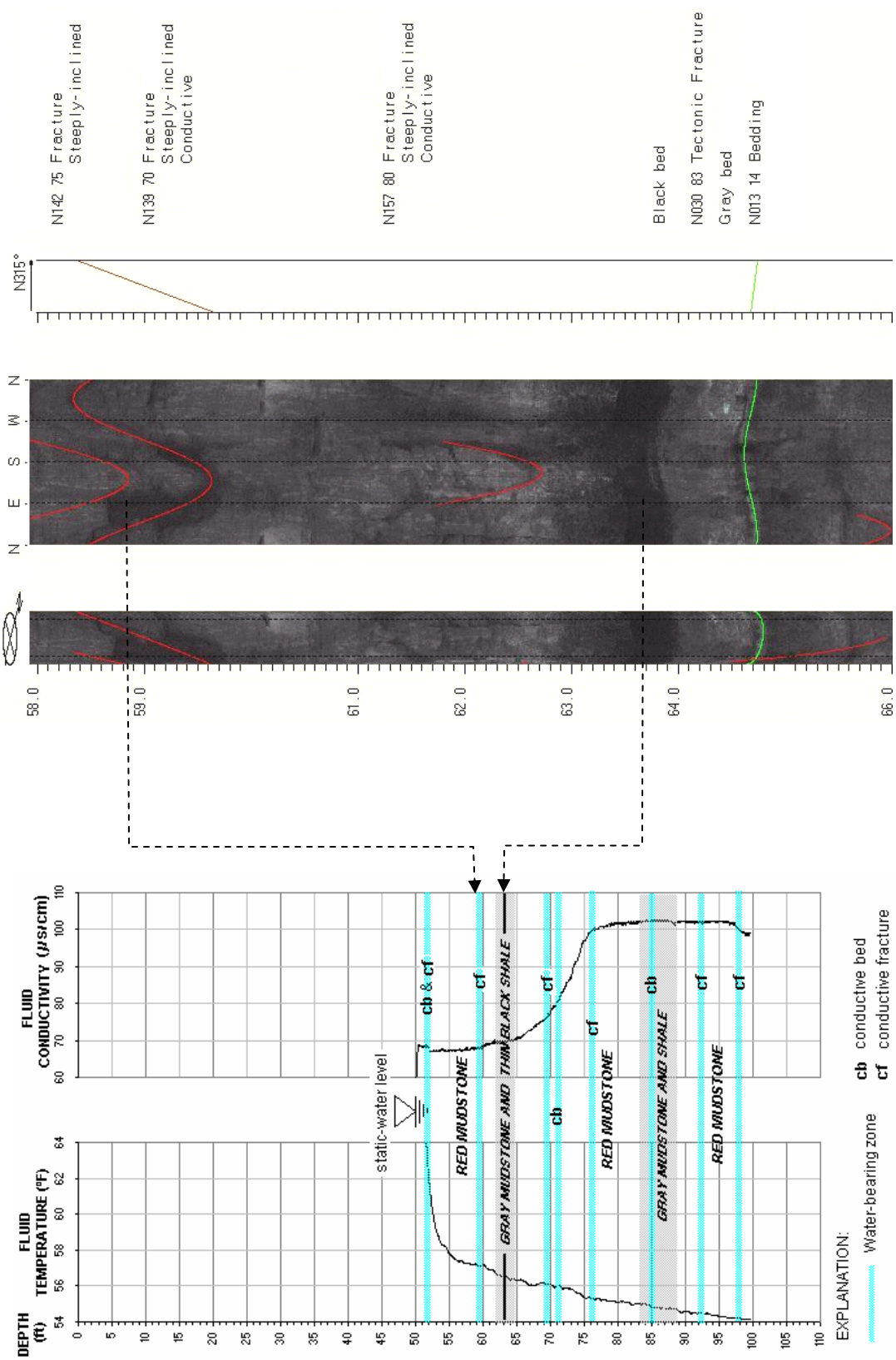


FIGURE 3C4. Hydrogeologic section based on geophysical logs (left) for well 47 at 139 42nd Street, Readington Twp, Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and black shale. An OPTV record (right) of the 6-inch diameter well shows geologic structures and hydraulically-conductive features in red and gray mudstone. Depth values are in feet below land surface.

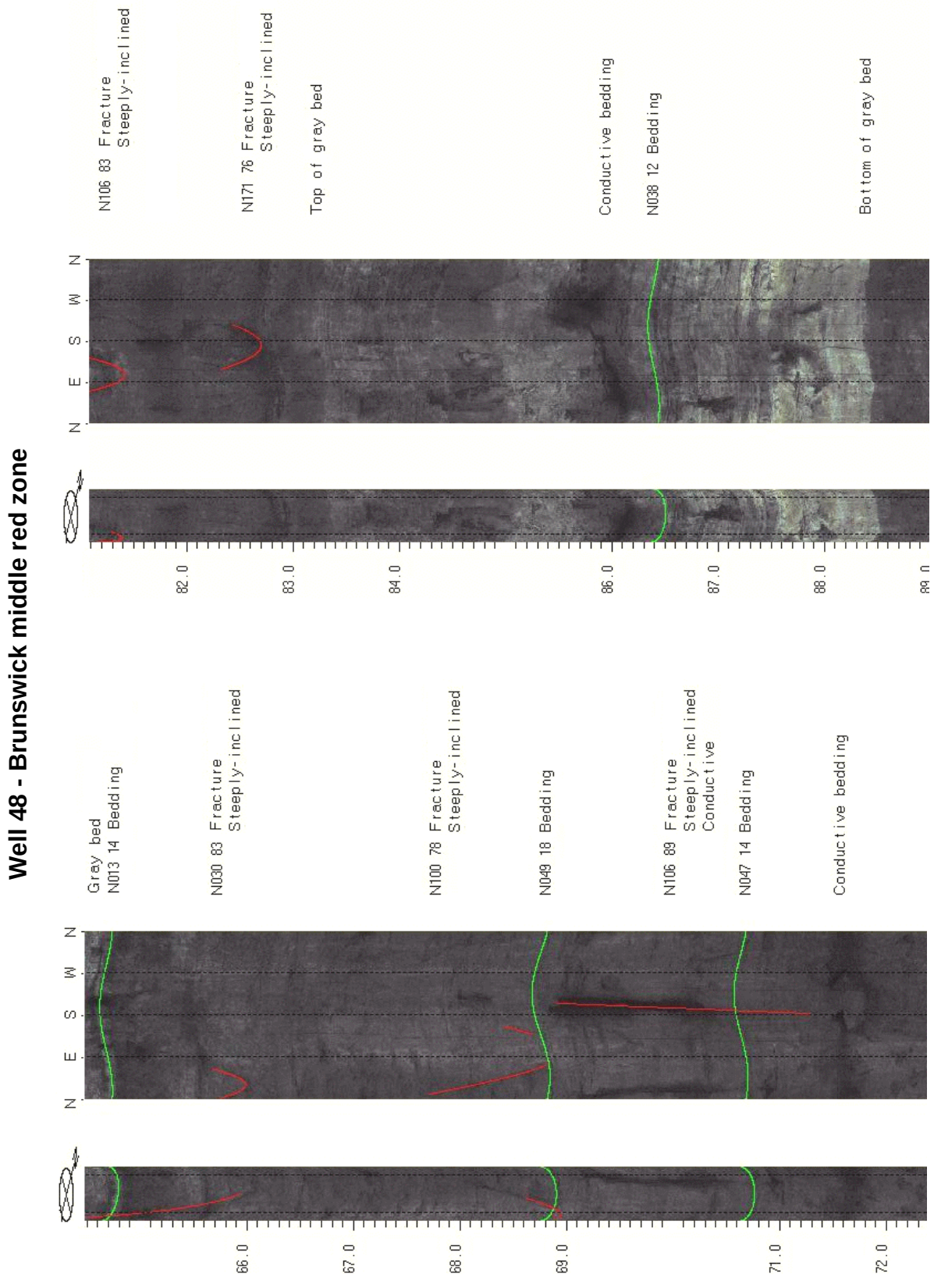


FIGURE 3C5. OPTV records of the 6-inch diameter well 48 at the Readington Middle School, Readington, Township, Hunterdon County, NJ showing geologic structures and conductive features in red and gray mudstone and gray shale. Depth values are in feet below land surface.

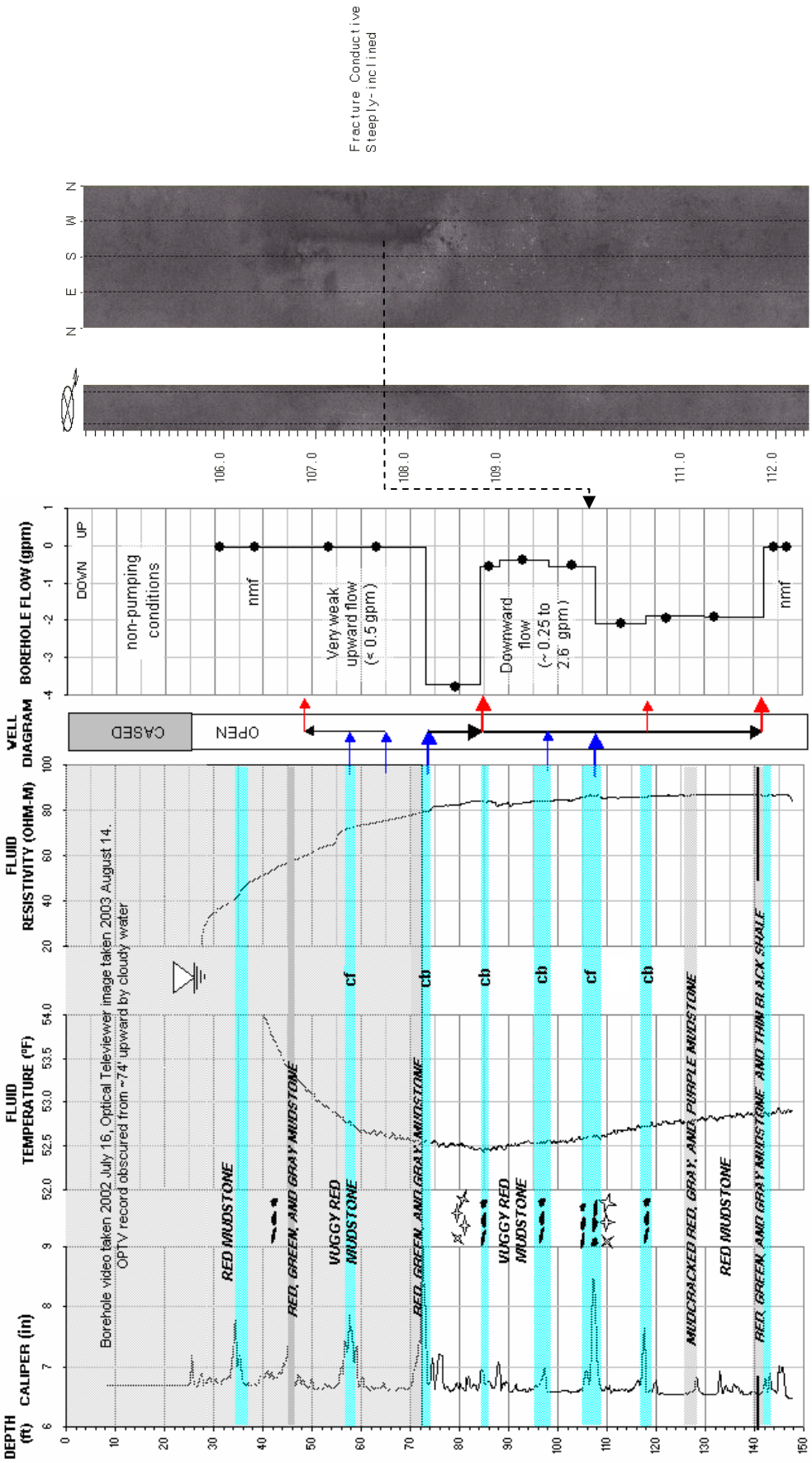


FIGURE 3C6. Hydrogeologic section based on geophysical logs (left) for well 49 at the Rusinski Farm, Readington Twp, Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and black shale. An OPTV record (right) of the 6-inch diameter well shows a conductive fracture in red mudstone. Depth values are in feet below land surface.

Wells 50 to 54 - Brunswick middle red zone

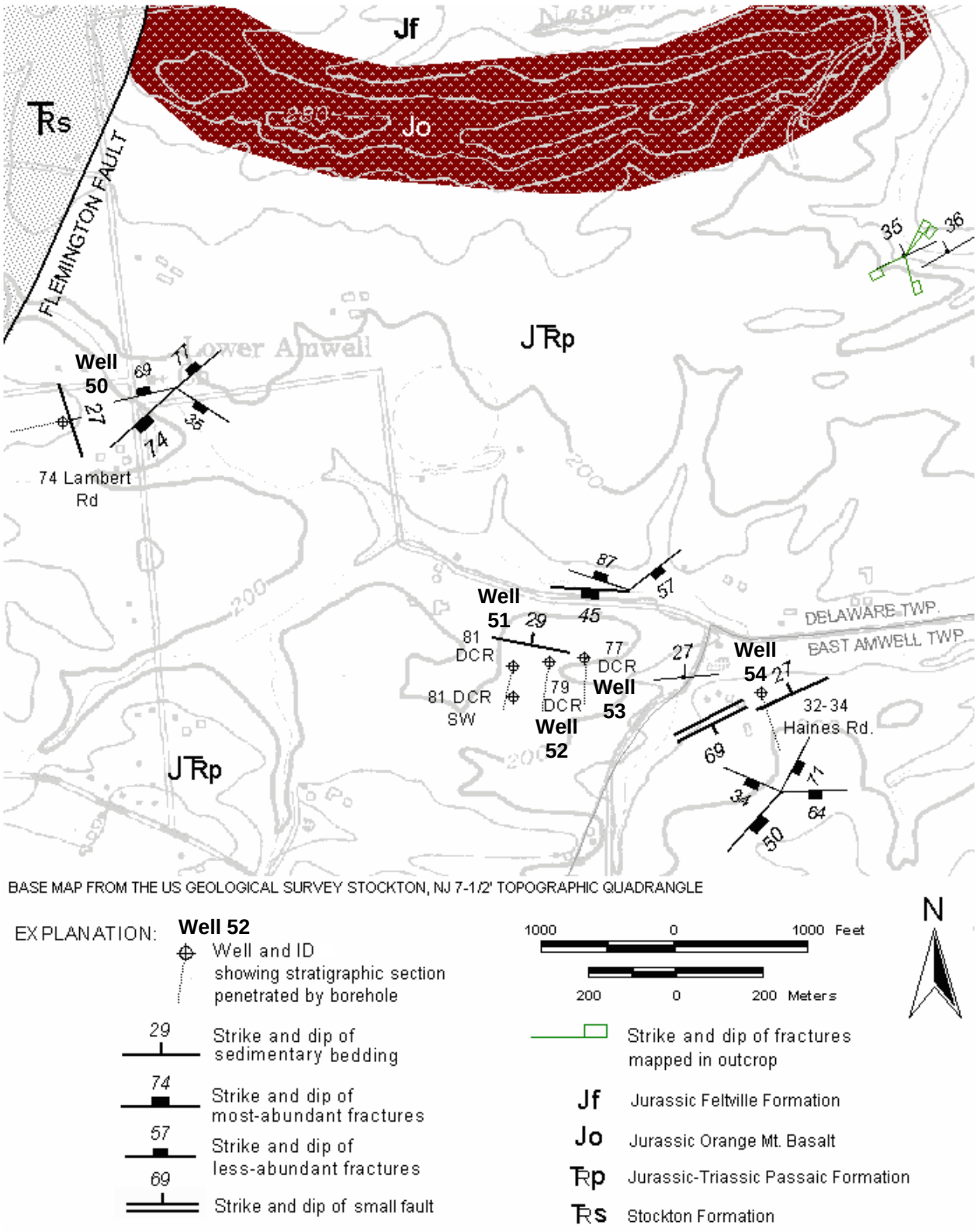
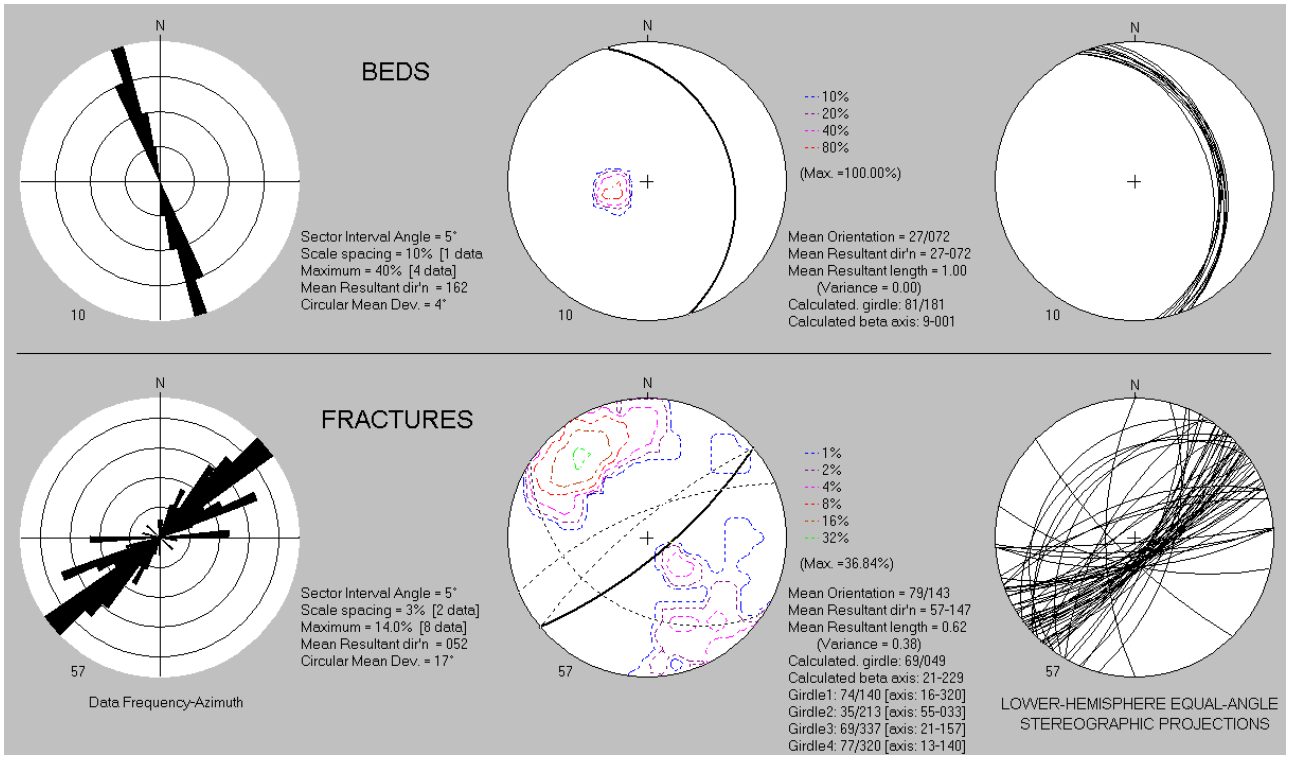


Figure 3D1. Map showing wells 50 through 54 as part of a regional arsenic-in-groundwater investigation in Delaware and East Amwell Twps., Hunterdon County, NJ.

Well 50 - Brunswick middle red zone



Wells 51 to 53 - Brunswick middle red zone

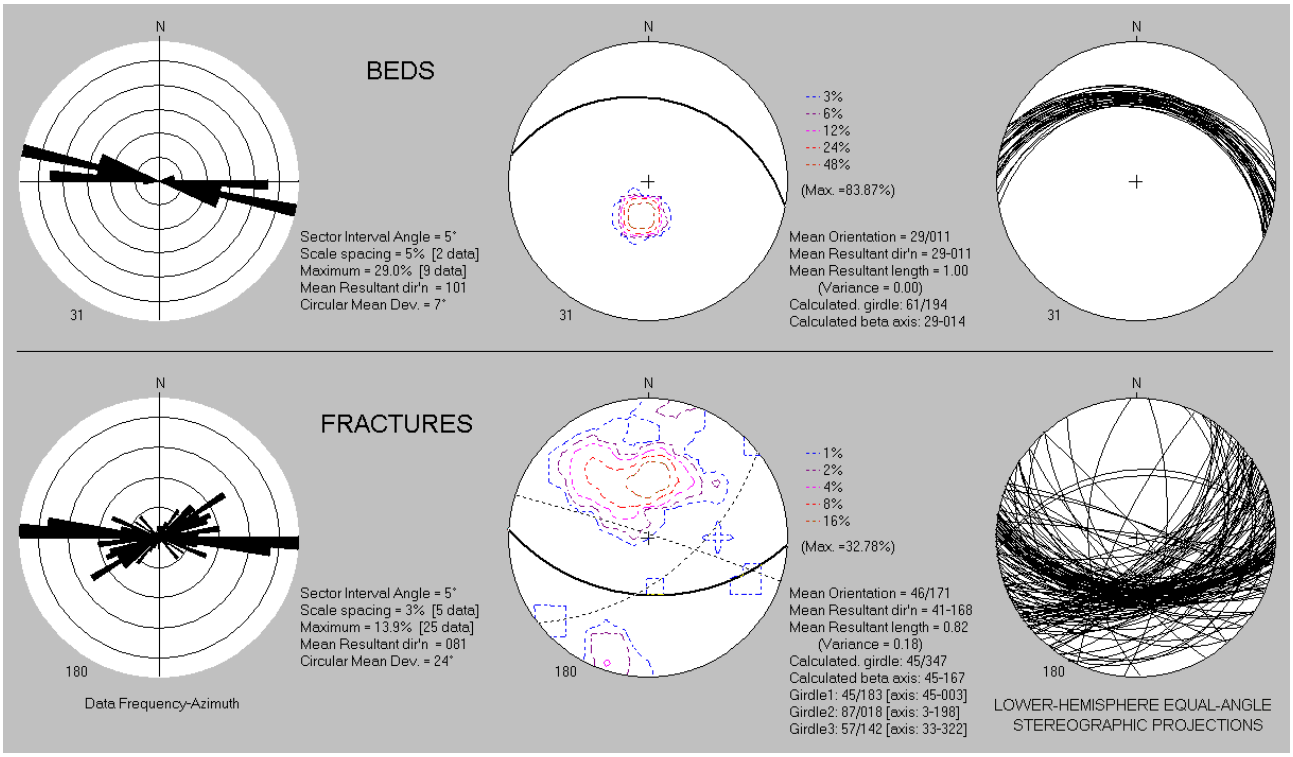
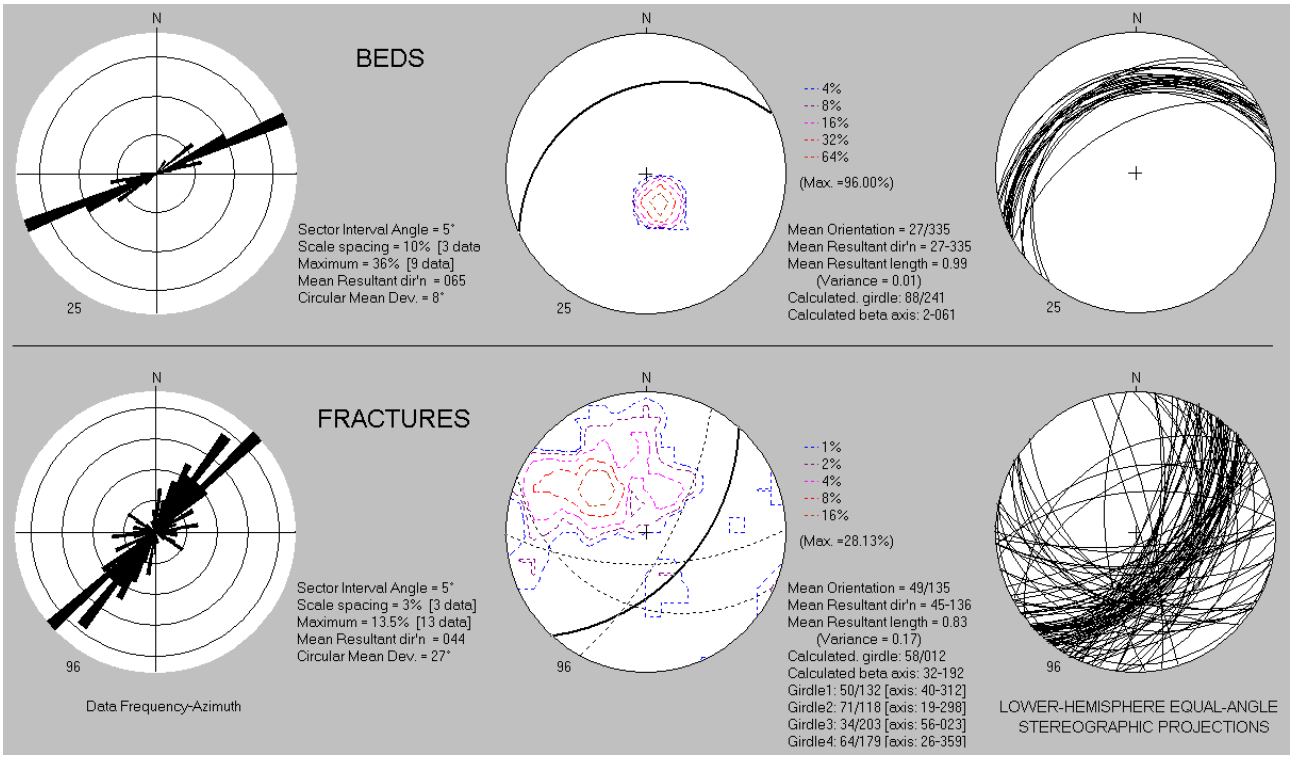


Figure 3D2. Structural analyses of OPTV records for wells 50 (above) and 51 to 53 (below) in Delaware and East Amwell Townships, Hunterdon County, NJ.

Well 54 - Brunswick middle red zone



Well 50 - Brunswick middle red zone

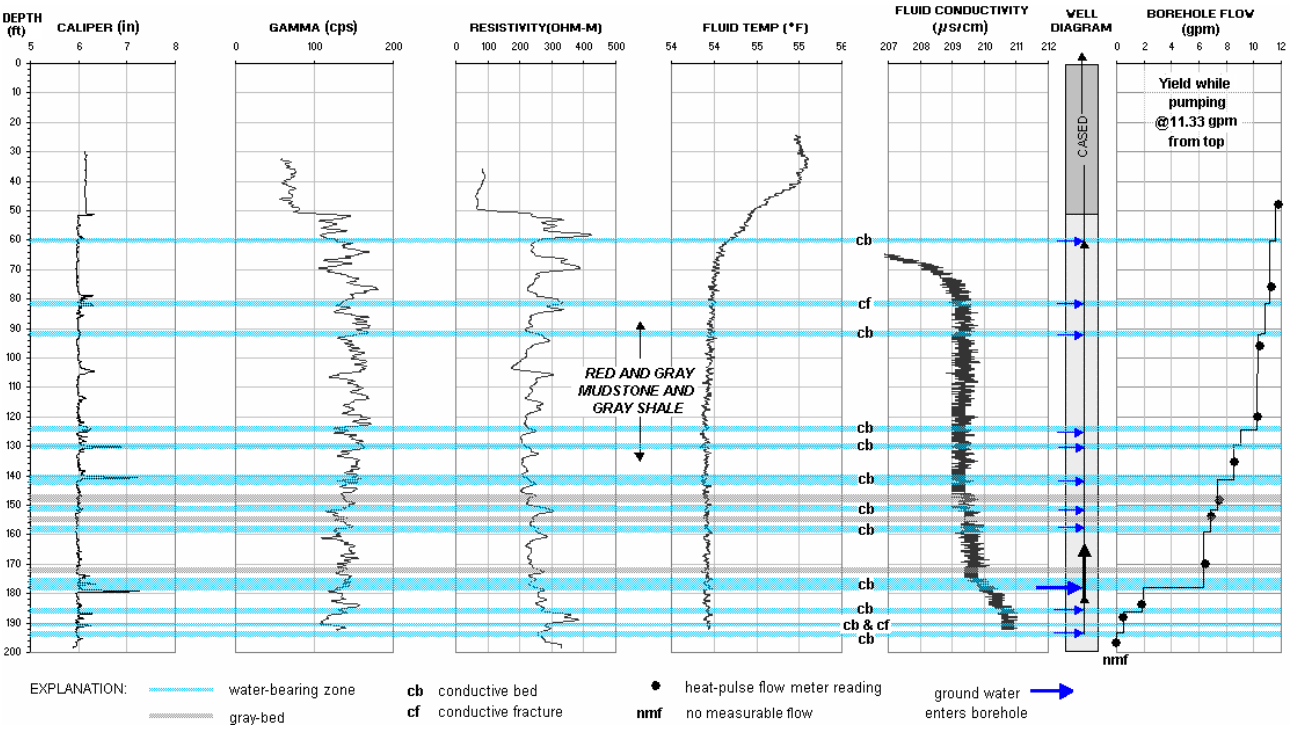


Figure 3D3. Structural analysis of the OPTV record for well 54 (above) and a hydrogeologic section for well 50 (below) based on geophysical logs. The section summarizes the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and shale. Depth values are in feet below land surface.

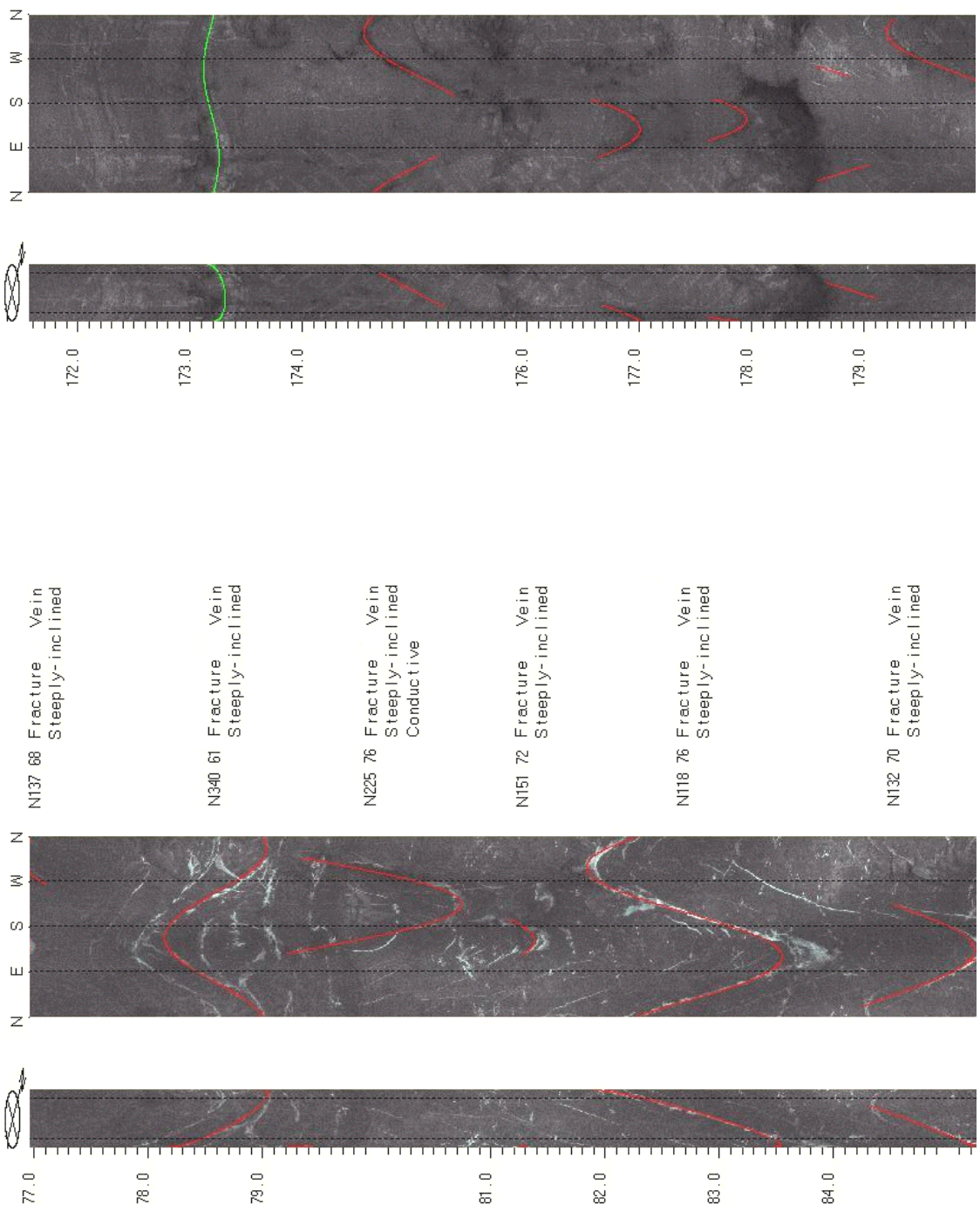


FIGURE 3D4. OPTV records of the 6-inch diameter well 50 at 74 Lambert Rd., Delaware Twp., Hunterdon County, NJ showing geologic structures and conductive features in red mudstone and gray shale. Depth values are in feet below land surface.

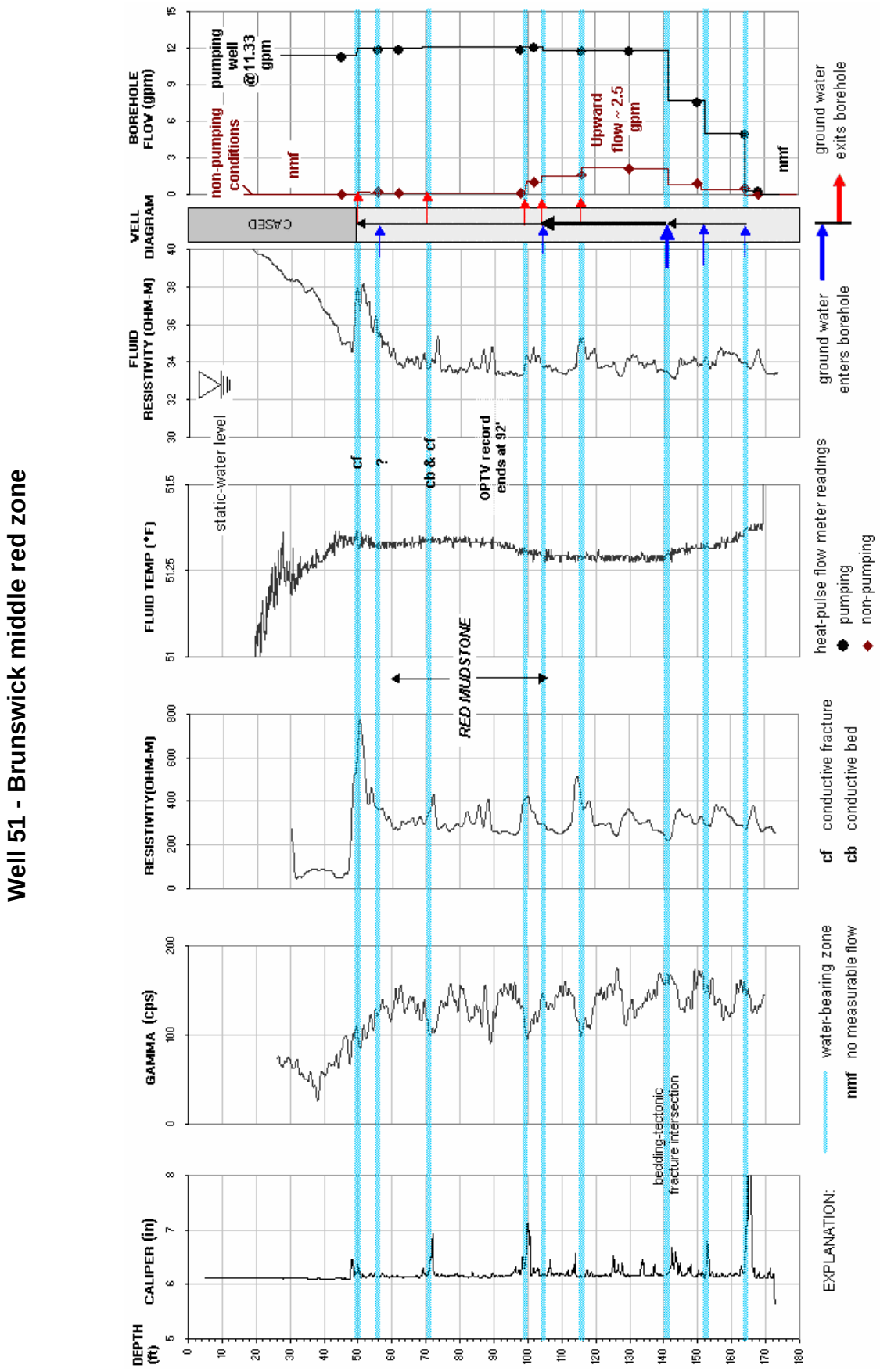


FIGURE 3D5. Hydrogeologic section based on geophysical logs for well 51 at 81 Dunkard Church Rd., Delaware Twp., Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red mudstone. Depth values are in feet below land surface.

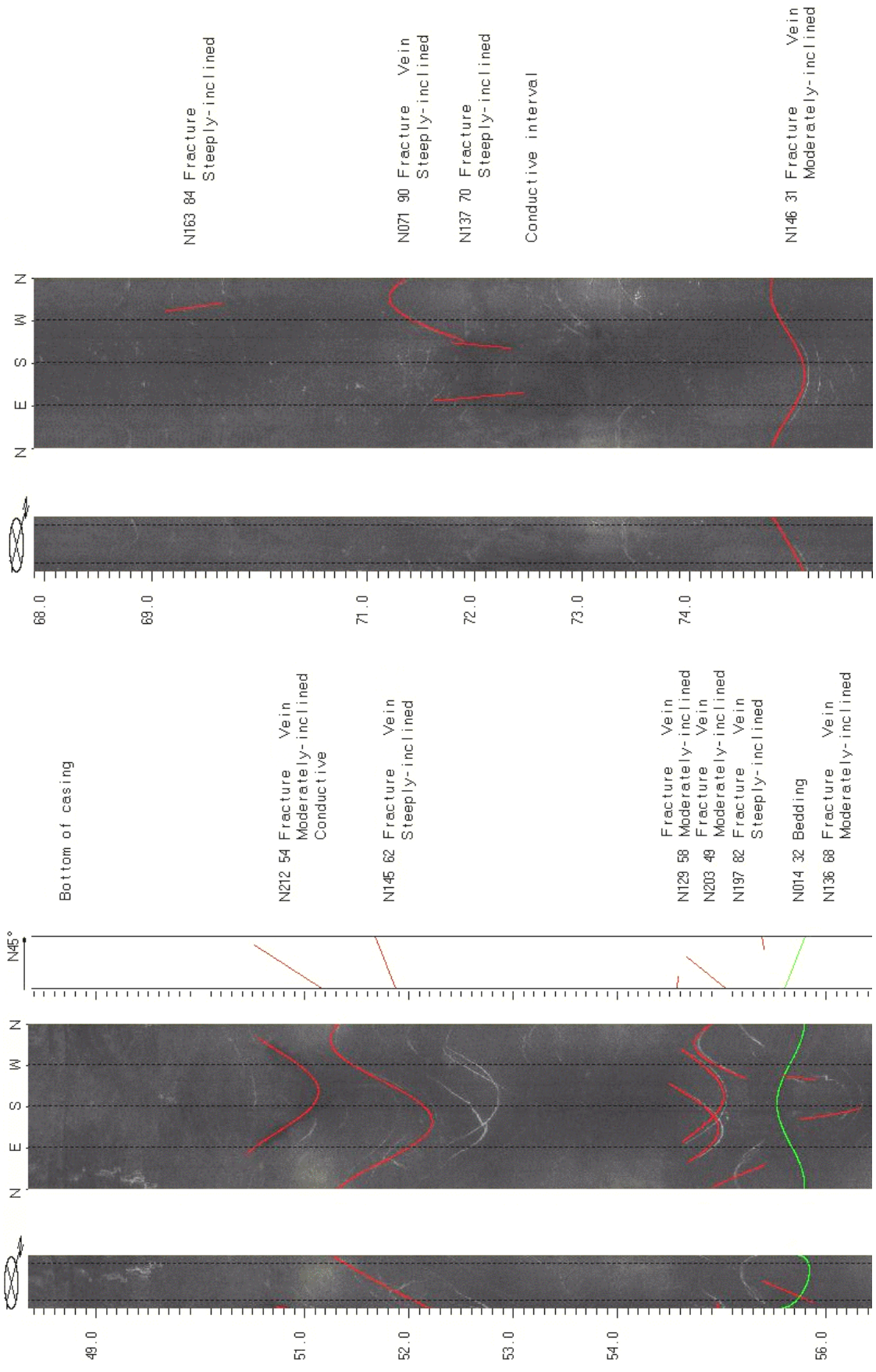


FIGURE 3D6. OPTV records of the 6-inch diameter well 51at 81 Dunkard Church Rd., Delaware Twp., Hunterdon County, NJ showing geologic structures and conductive features in red mudstone. Depth values are in feet below land surface.

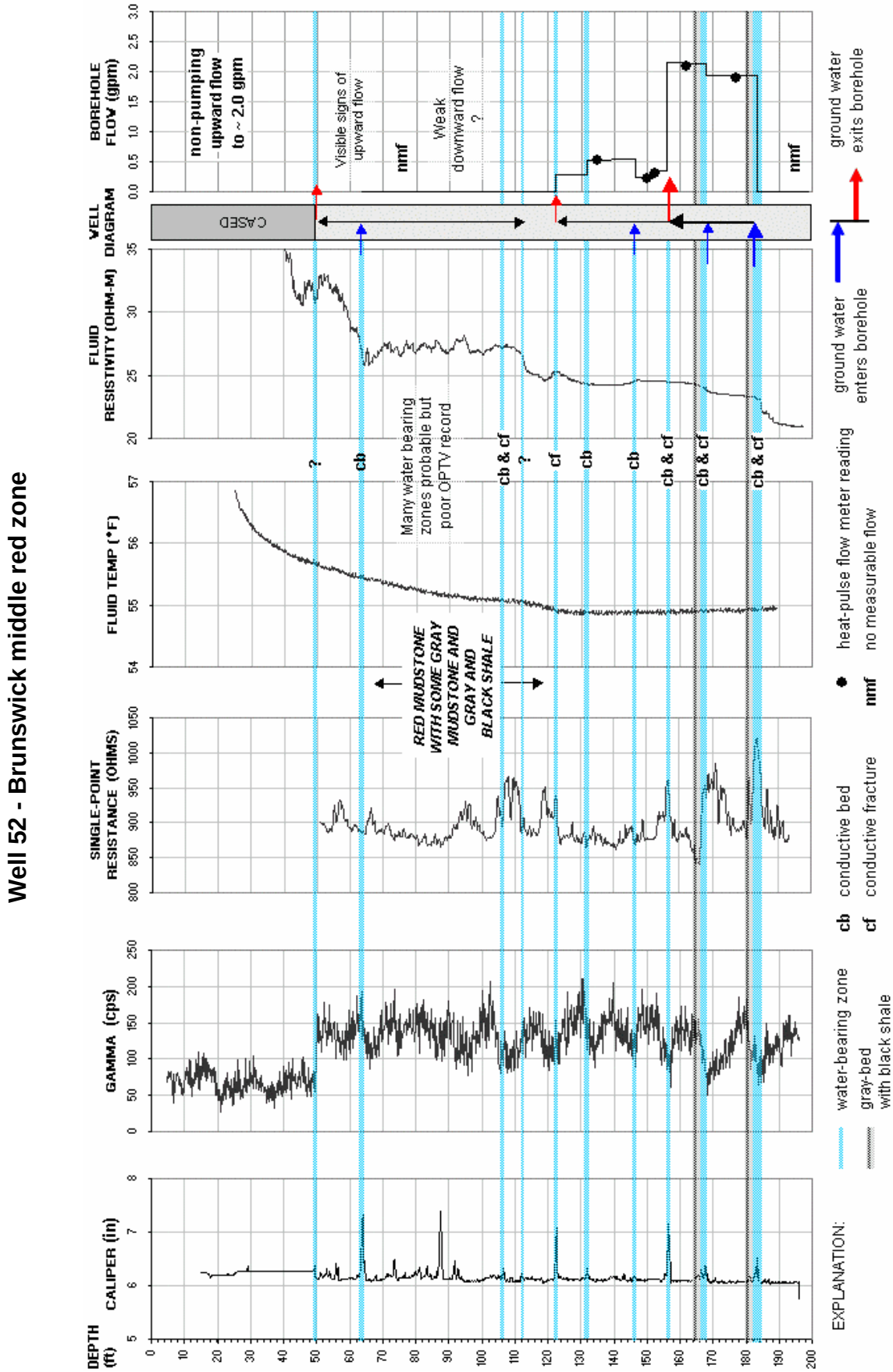


FIGURE 3D7. Hydrogeologic section based on geophysical logs for well 52 at 79 Dunkard Church Rd., Delaware Twp., Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and black shale. Depth values are in feet below land surface.

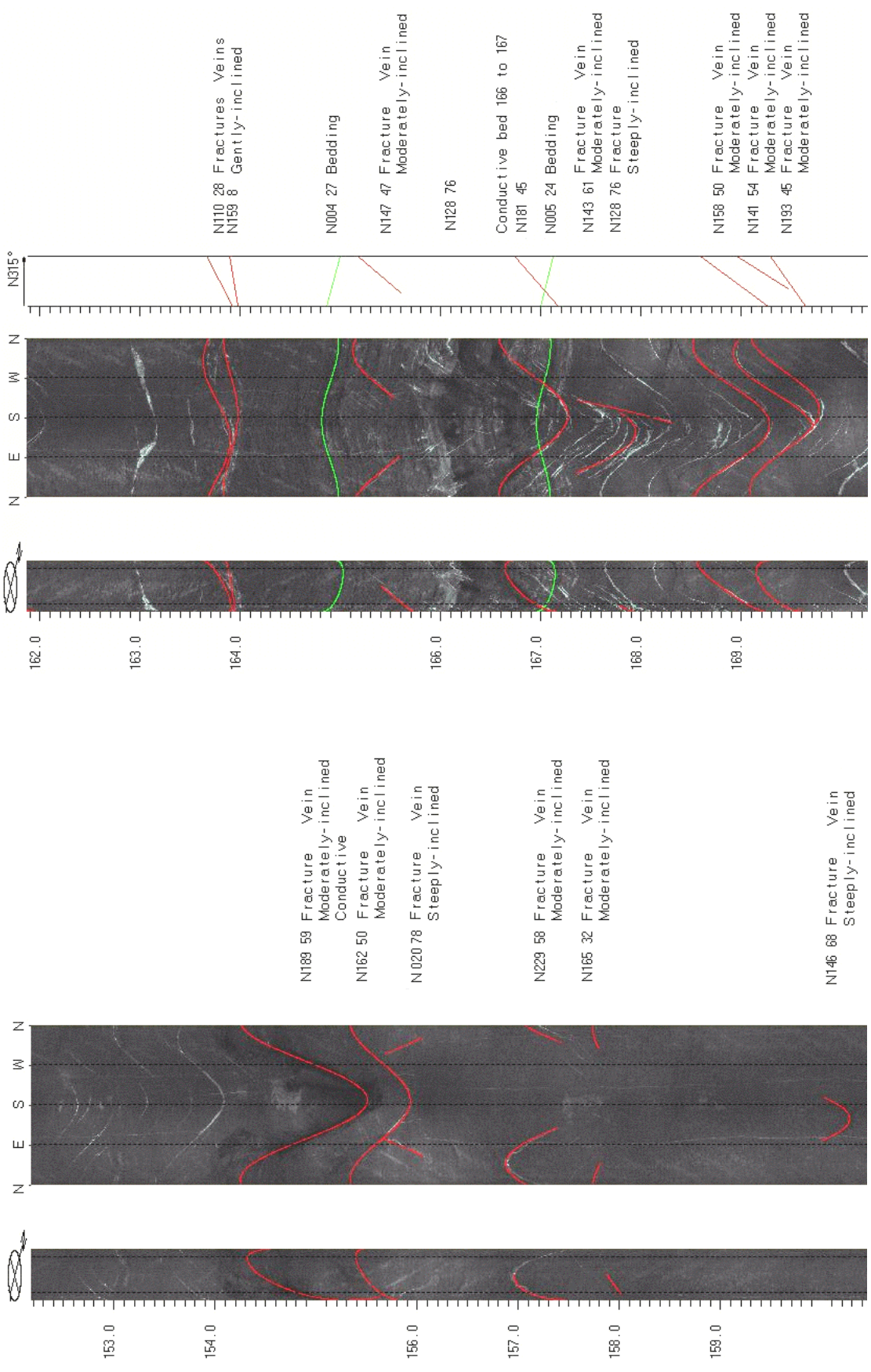


FIGURE 3D8. OPTV records of the 6-inch diameter well 52 at 79 Dunkard Church Rd., Delaware Twp., Hunterdon County, NJ showing geologic structures and conductive features in red and gray mudstone and gray shale. Depth values are in feet below land surface.

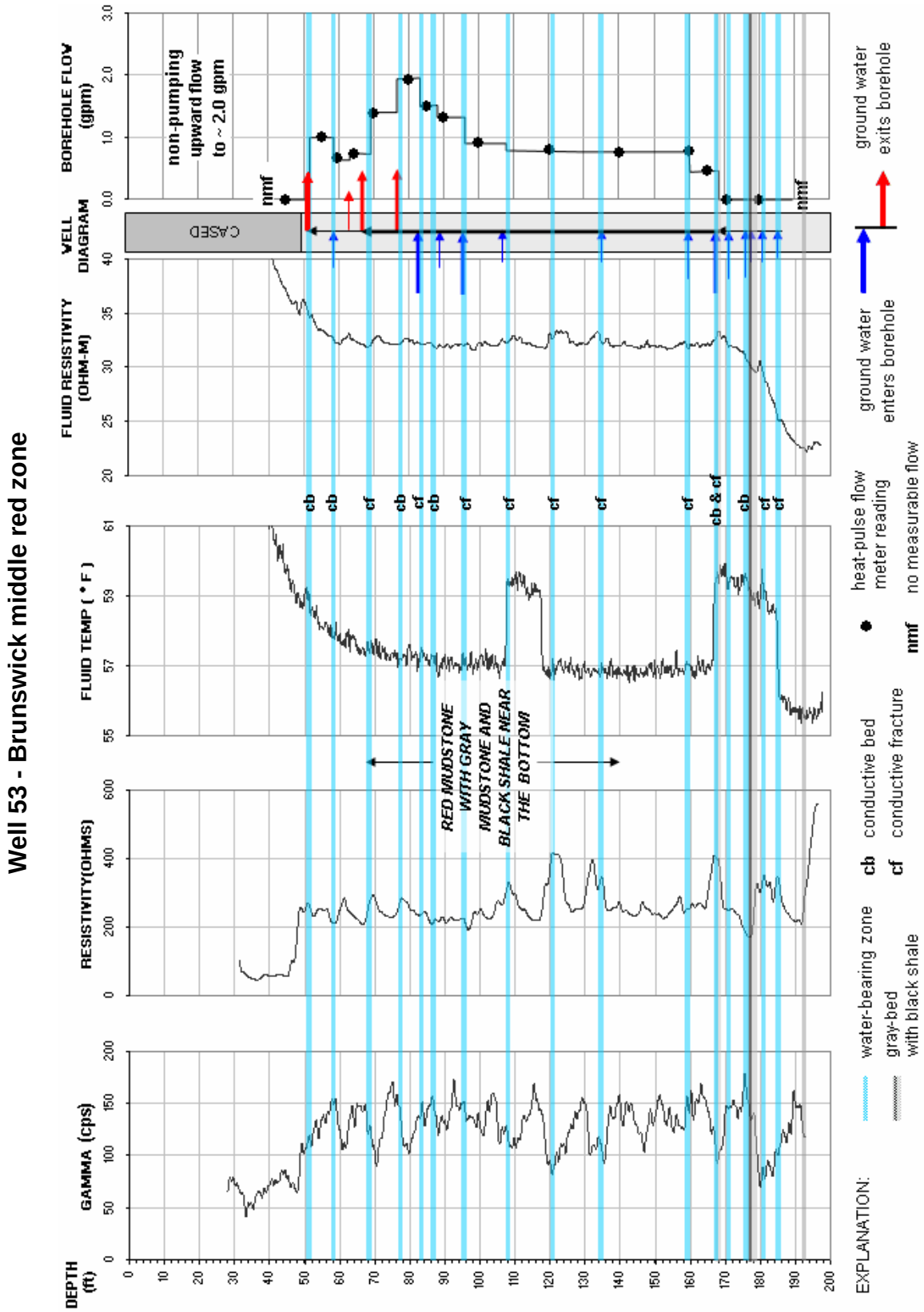


FIGURE 3D9. Hydrogeologic section based on geophysical logs for well 52 at 77 Dunkard Church Rd., Delaware Twp., Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and black shale. Depth values are in feet below land surface.

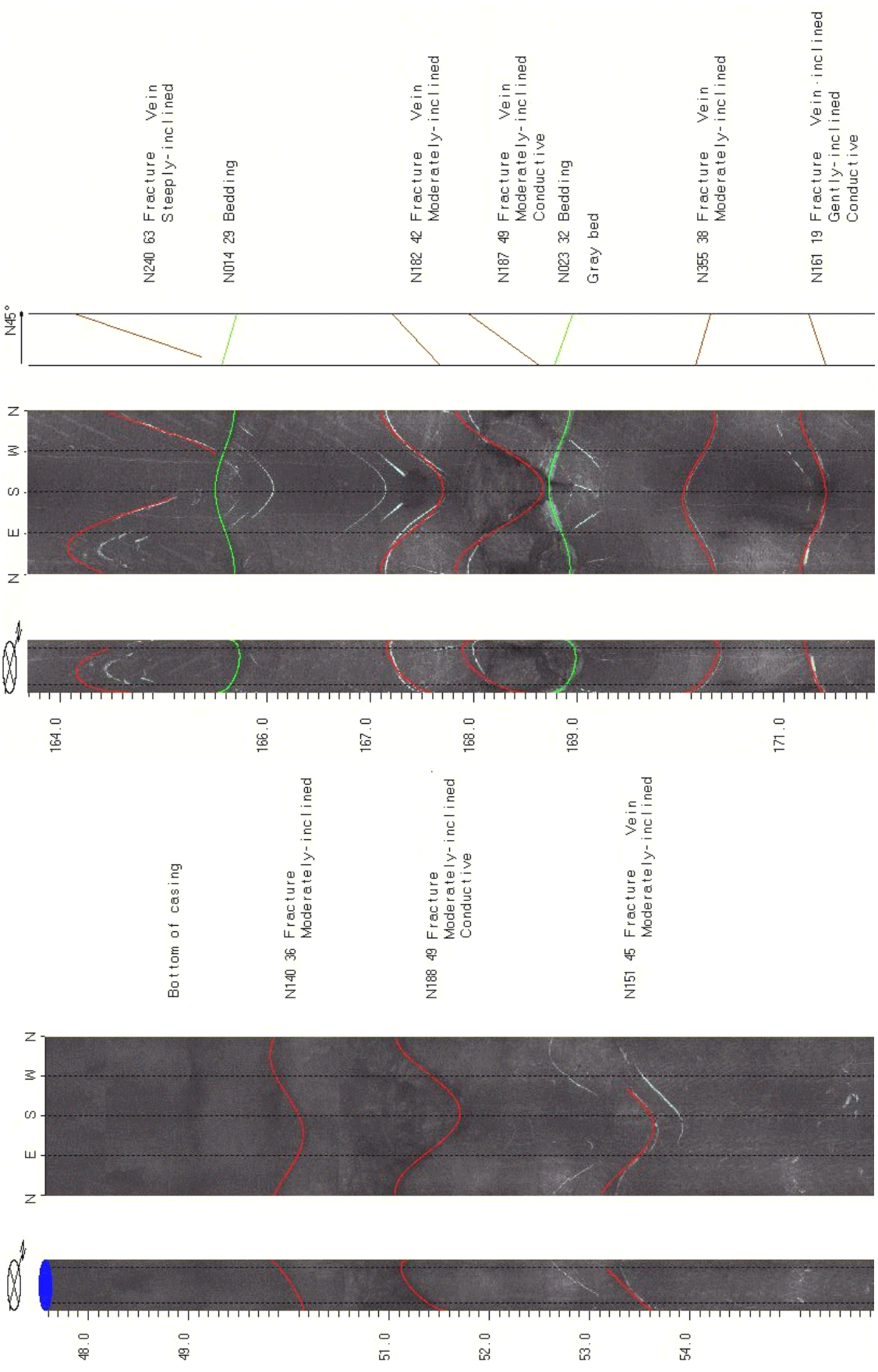


FIGURE 3D10. OPTV records of the 6-inch diameter well 51at 77 Dunkard Church Rd., Delaware Twp., Hunterdon County, NJ showing geologic structures and conductive features in red and gray mudstone and gray shale. Depth values are in feet below land surface.

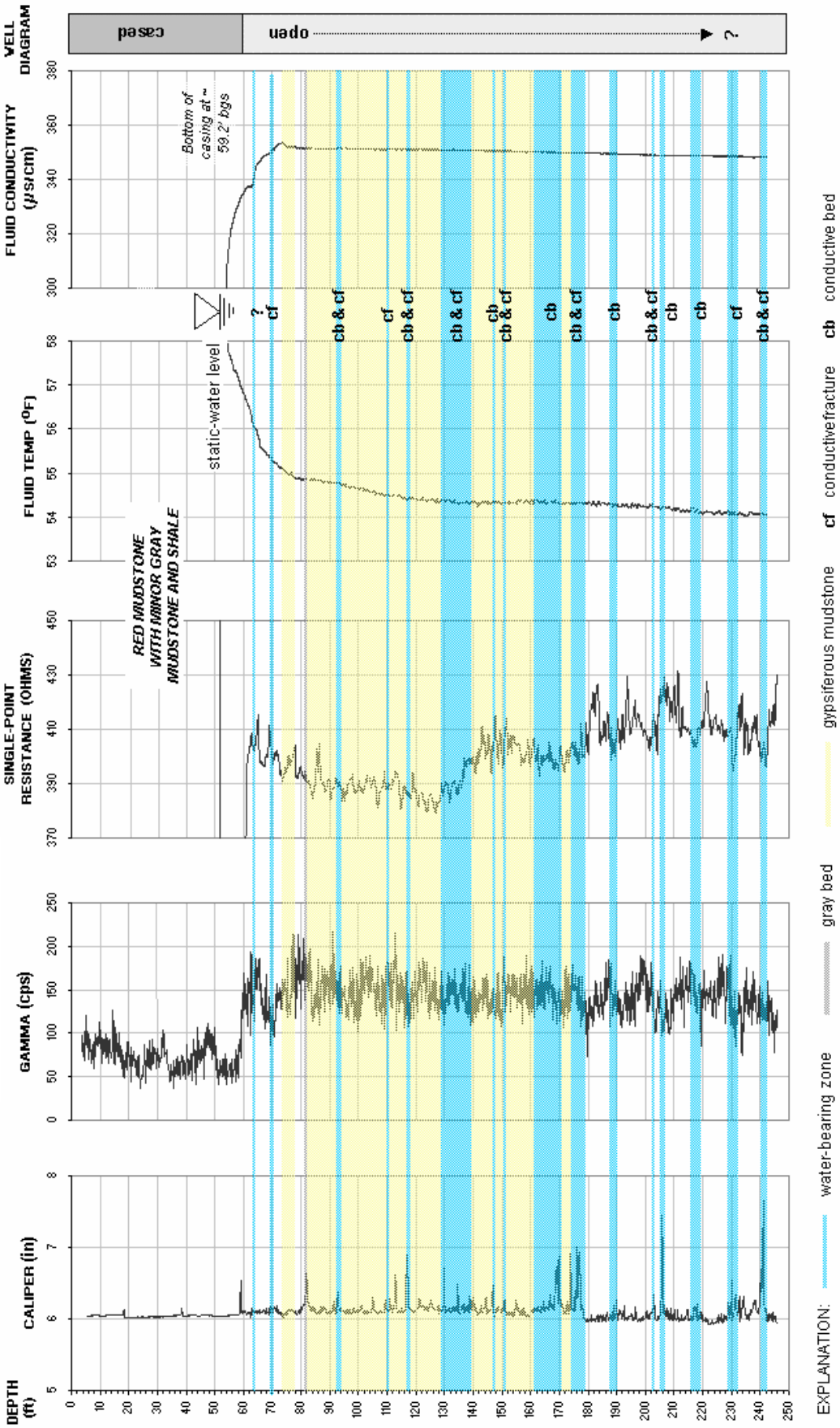


FIGURE 3D11. Hydrogeologic section based on geophysical logs for well 54 at 32-34 Haines Rd., East Amwell Twp., Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray shale. Depth values are in feet below land surface.

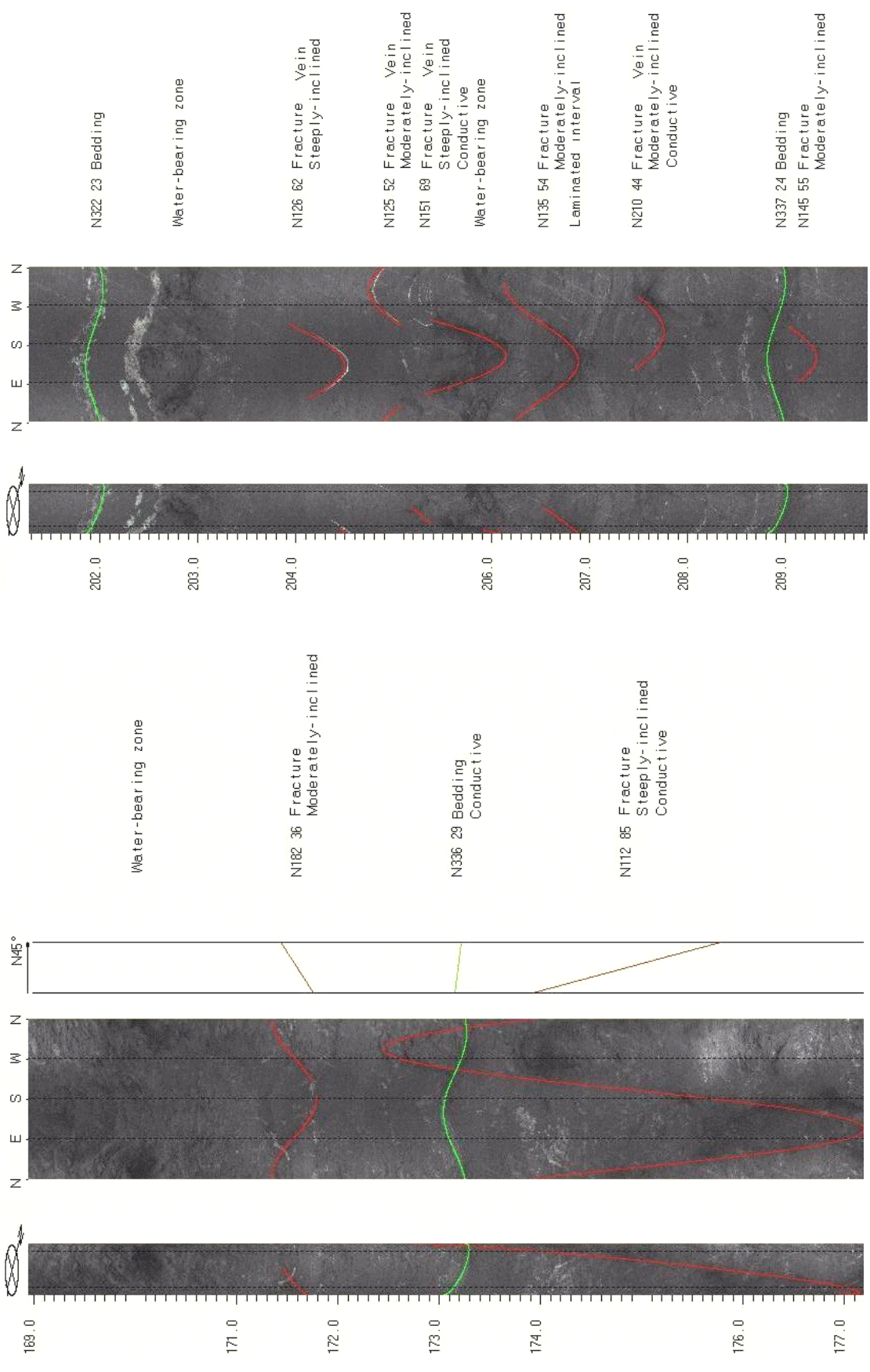


FIGURE 3D12. OPTV records of the 6-inch diameter well 54 at 32-34 Haines Rd., East Amwell Twp., Hunterdon County, NJ shows geologic structures and conductive features in red mudstone. Depth values are in feet below land surface.

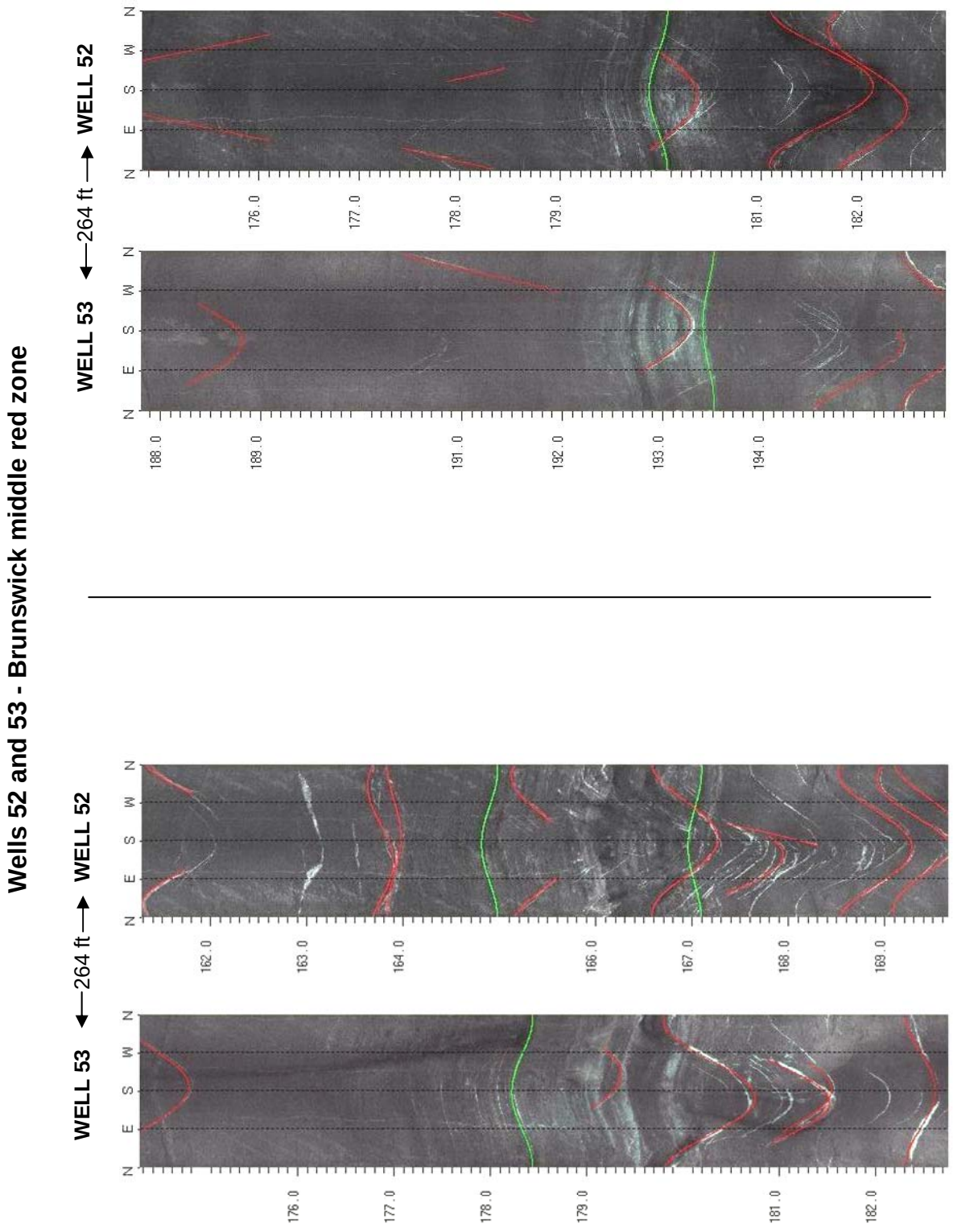


FIGURE 3D13. Stratigraphic correlation of wells 52 and 53 based on OPTV records, Dunkard Church Rd. Delaware Twp., Hunterdon County, NJ. Note the similar fracture sets occurring in the same stratigraphic intervals. Depth values are in feet below land surface.

Wells 52 to 54 - Brunswick middle red zone

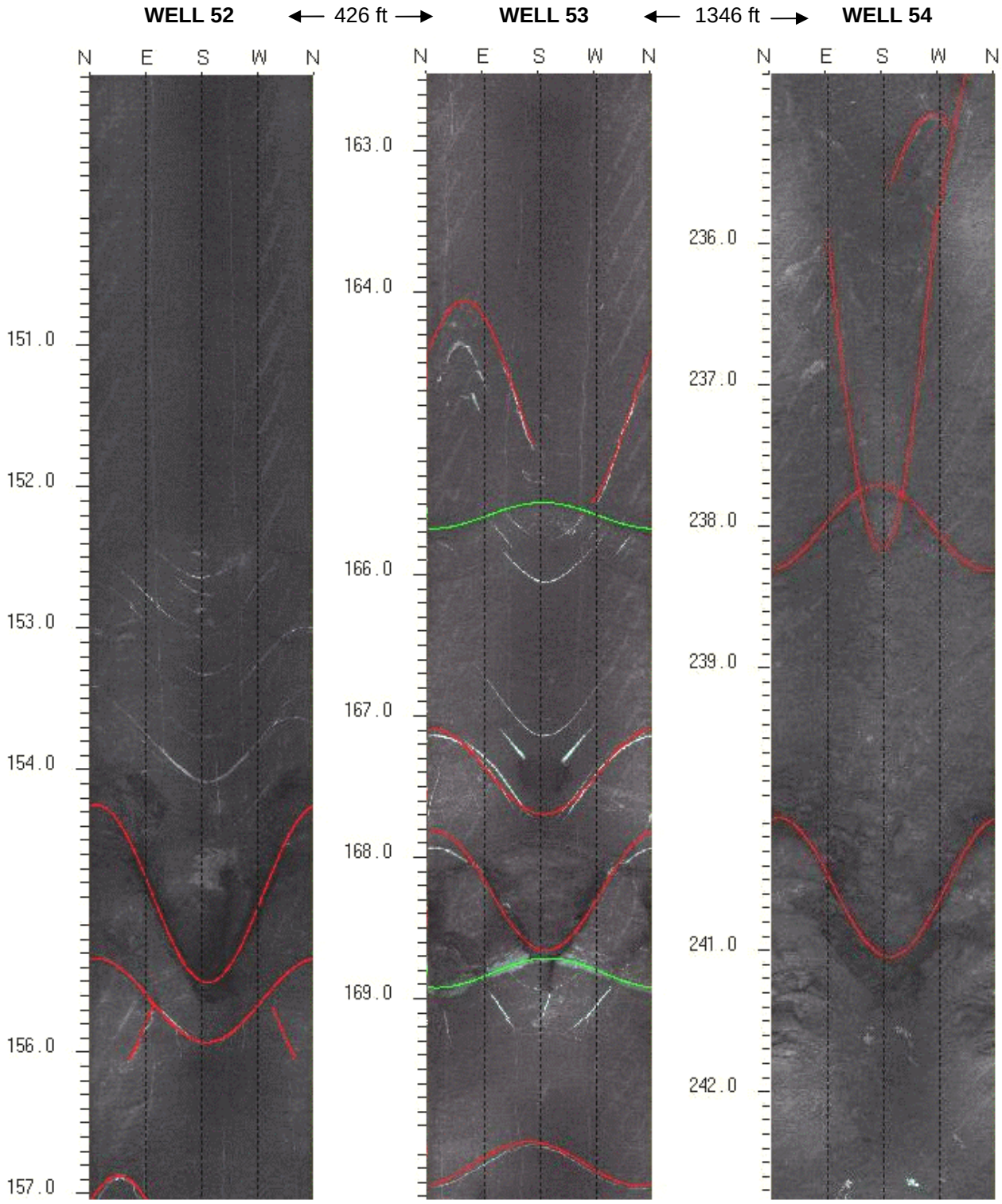
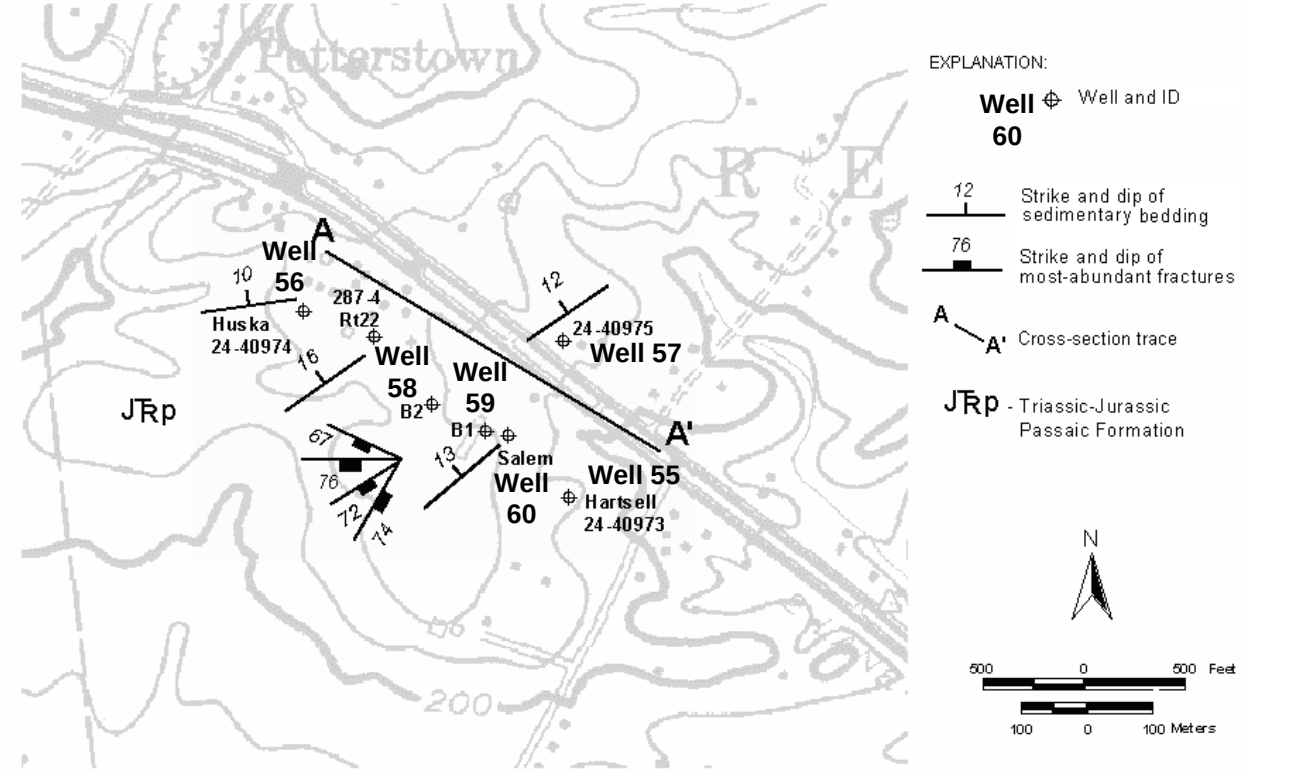


Figure 3D14. Stratigraphic correlation of wells based on OPTV records for wells 52 through 54, Dunkard Church Rd. Delaware Twp. and Lambert Rd., East Amwell Twp., Hunterdon County, NJ. Note the similar fracture sets occurring in the same stratigraphic intervals. Depth values are in feet below land surface.

Wells 55 to 60 - Brunswick middle red zone



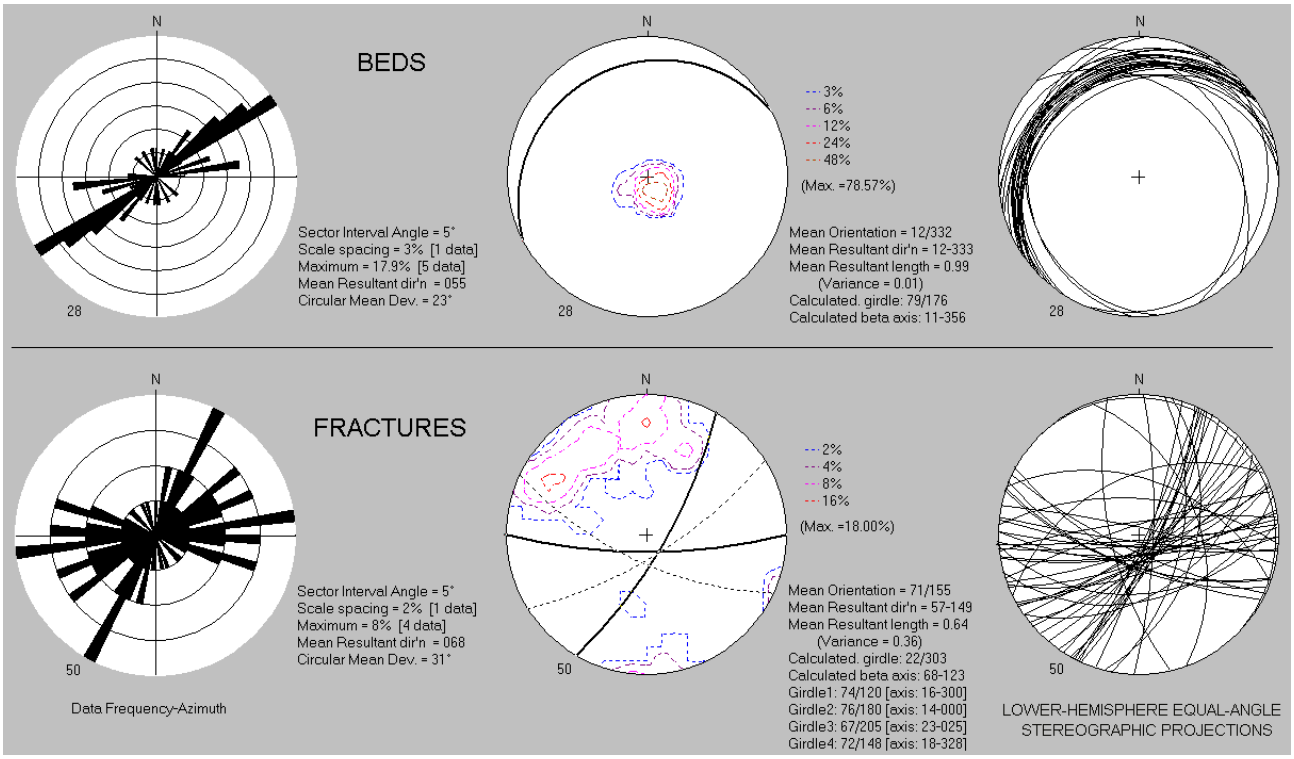
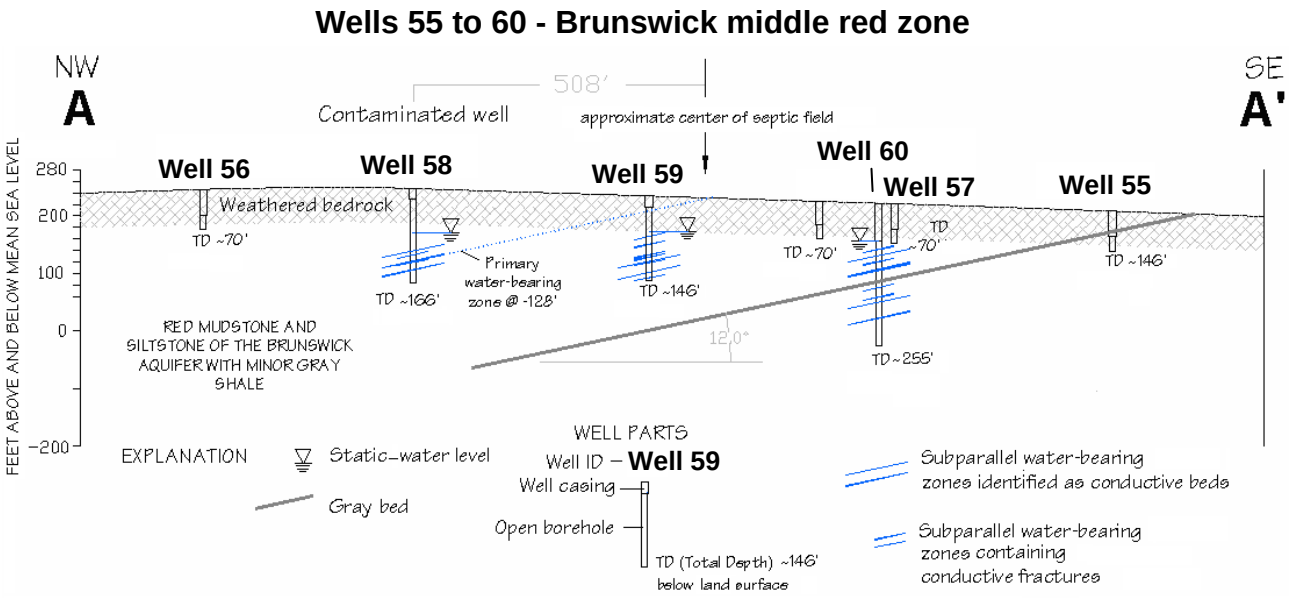


Figure 3E1. Map (above) shows wells 55 to 60 along Rt.22 near Potterstown, Readington Twp., Hunterdon County, NJ. Mapped bedrock structures are based on a structural analysis of beds and fractures (bottom) measured in OPTV records.



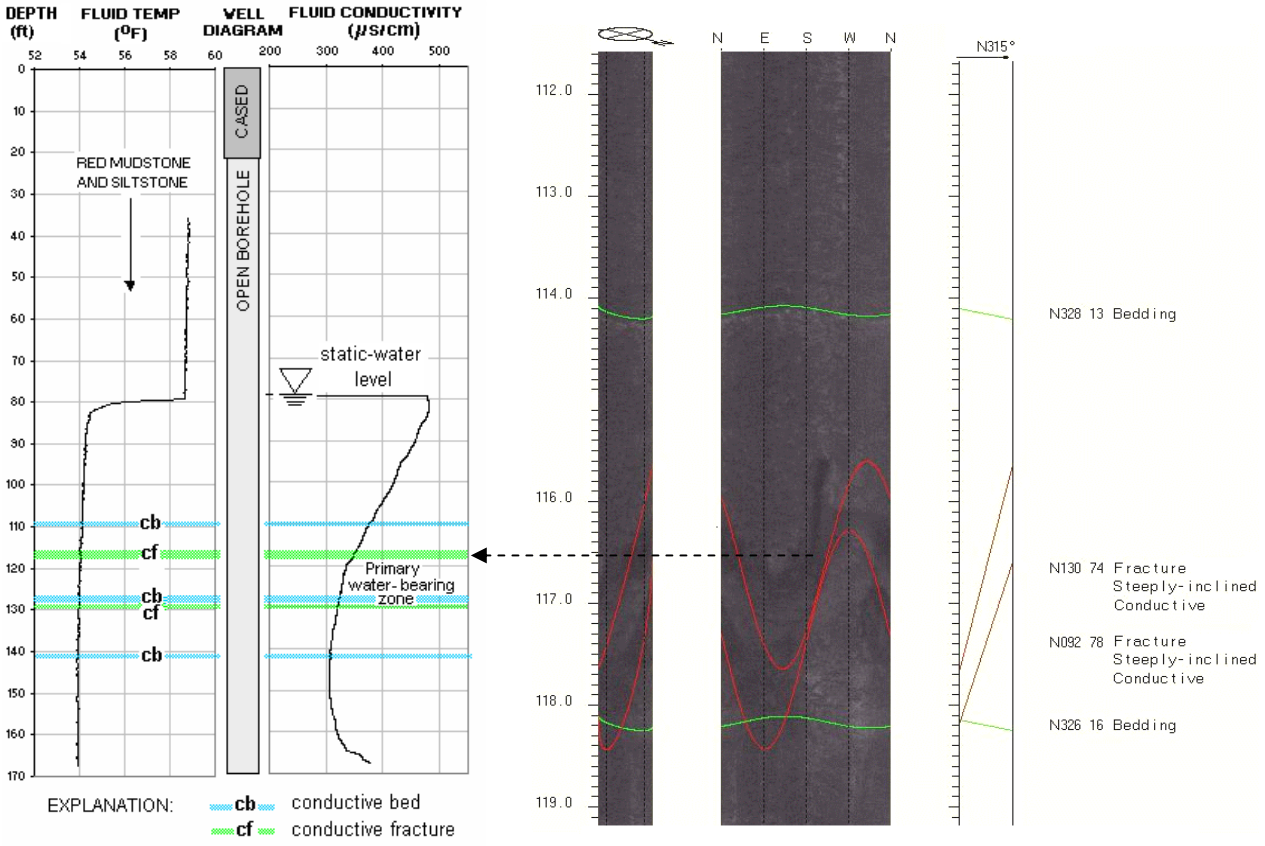


Figure 3E2. Hydrogeologic section (above) is based on geophysical logs for six wells along Rt.22 near Potterstown, Readington Twp, Hunterdon County, NJ. The hydrogeologic section for well 58 (below left) shows hydraulically-conductive features and water-bearing zones in red mudstone and siltstone. An OPTV record for well 58 (below right) shows conductive, steeply-dipping fractures in the 6-inch diameter domestic well. Depth values are in feet below land surface.

Well 59 - Brunswick middle red zone

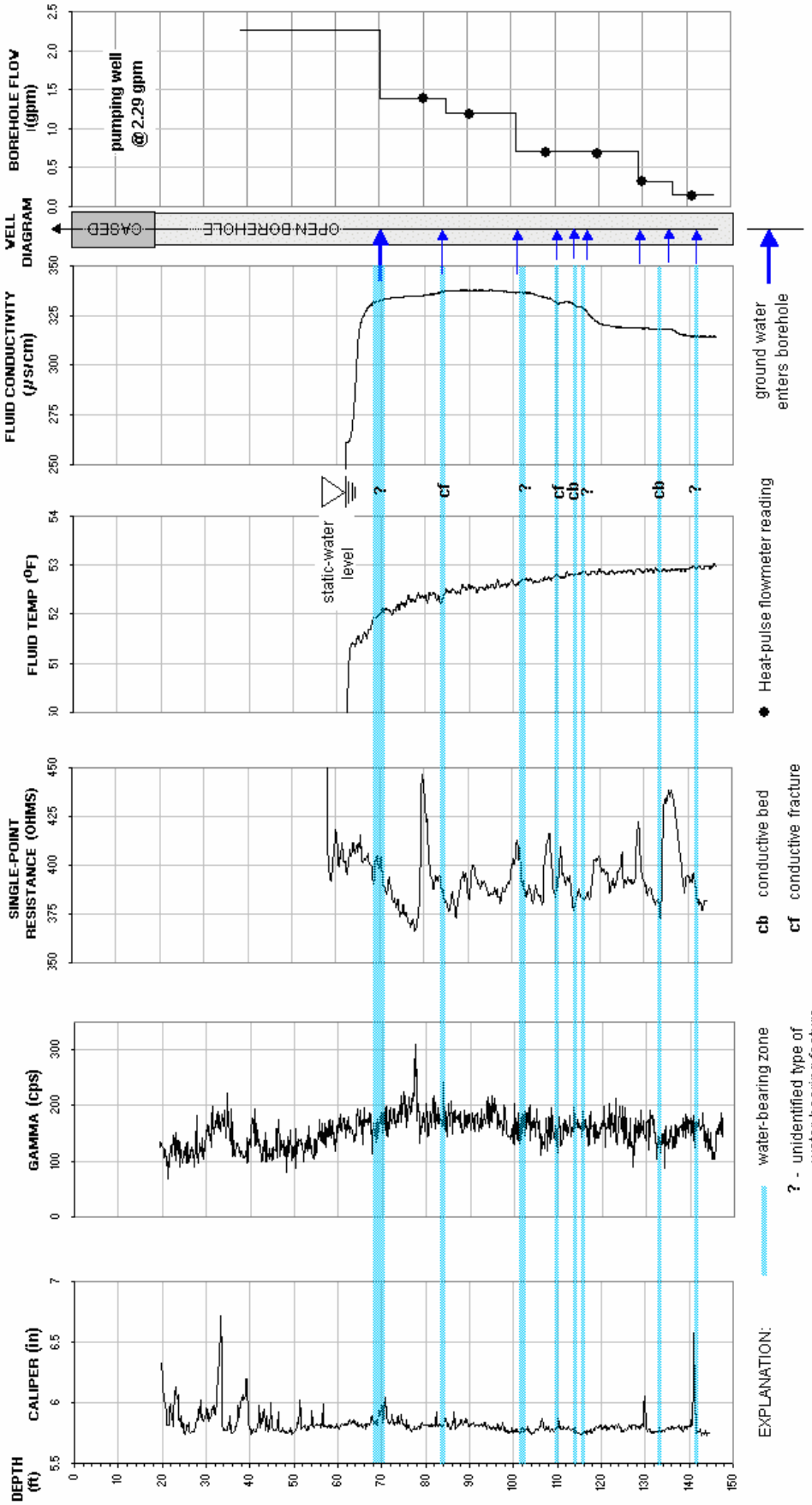


FIGURE 3E3. Hydrogeologic section based on geophysical logs for well 59 at Salem Industrial Park, Rt. 22 East, Readington Twp., Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red mudstone and siltstone. Depth values are in feet below land surface.

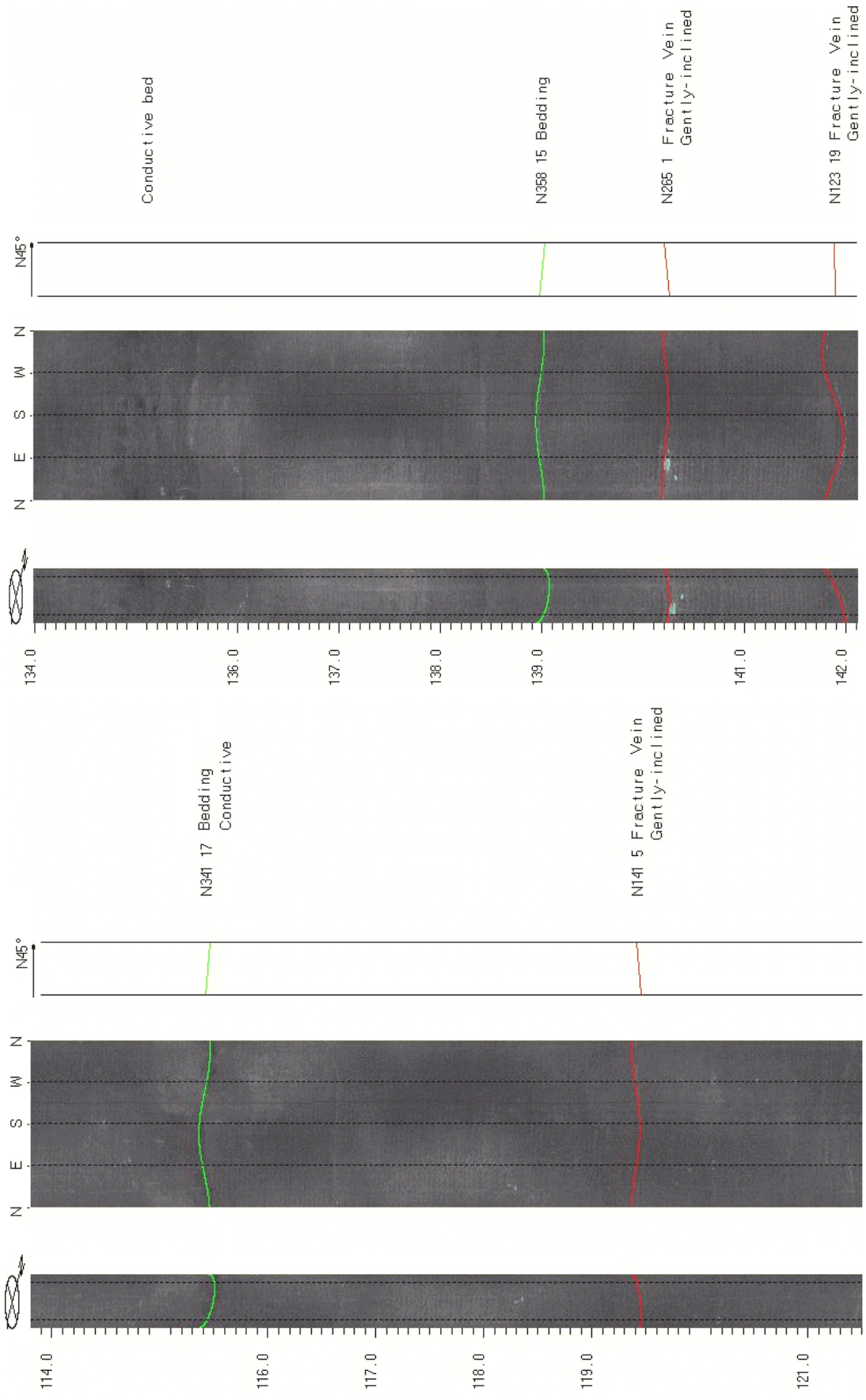


FIGURE 3E4. OPTV records of the 6-inch diameter well 59 at Salem Industrial Park, Rt. 22 East, Readington Twp., Hunterdon County, NJ showing geologic structures and conductive features in red mudstone. Depth values are in feet below land surface.

Well 60 - Brunswick middle red zone

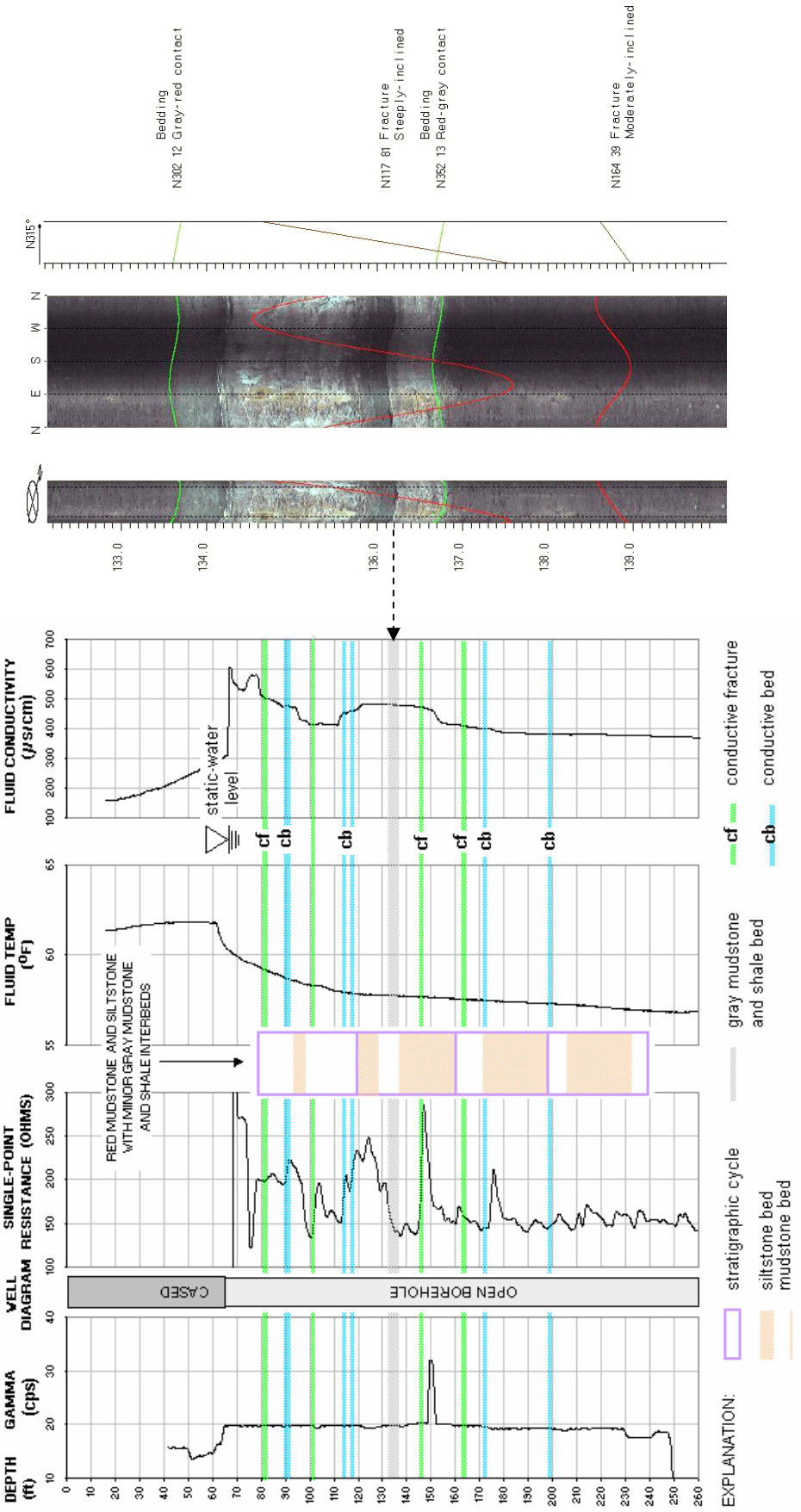


FIGURE 3E5. Hydrogeologic section (left) based on geophysical logs for well 60 at Salem Industrial Park, Rt. 22 East, Readington Twp., Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red mudstone. An OPTV record for the 6-inch diameter well (right) shows a gray mudstone and shale bed. Depth values are in feet below land surface.

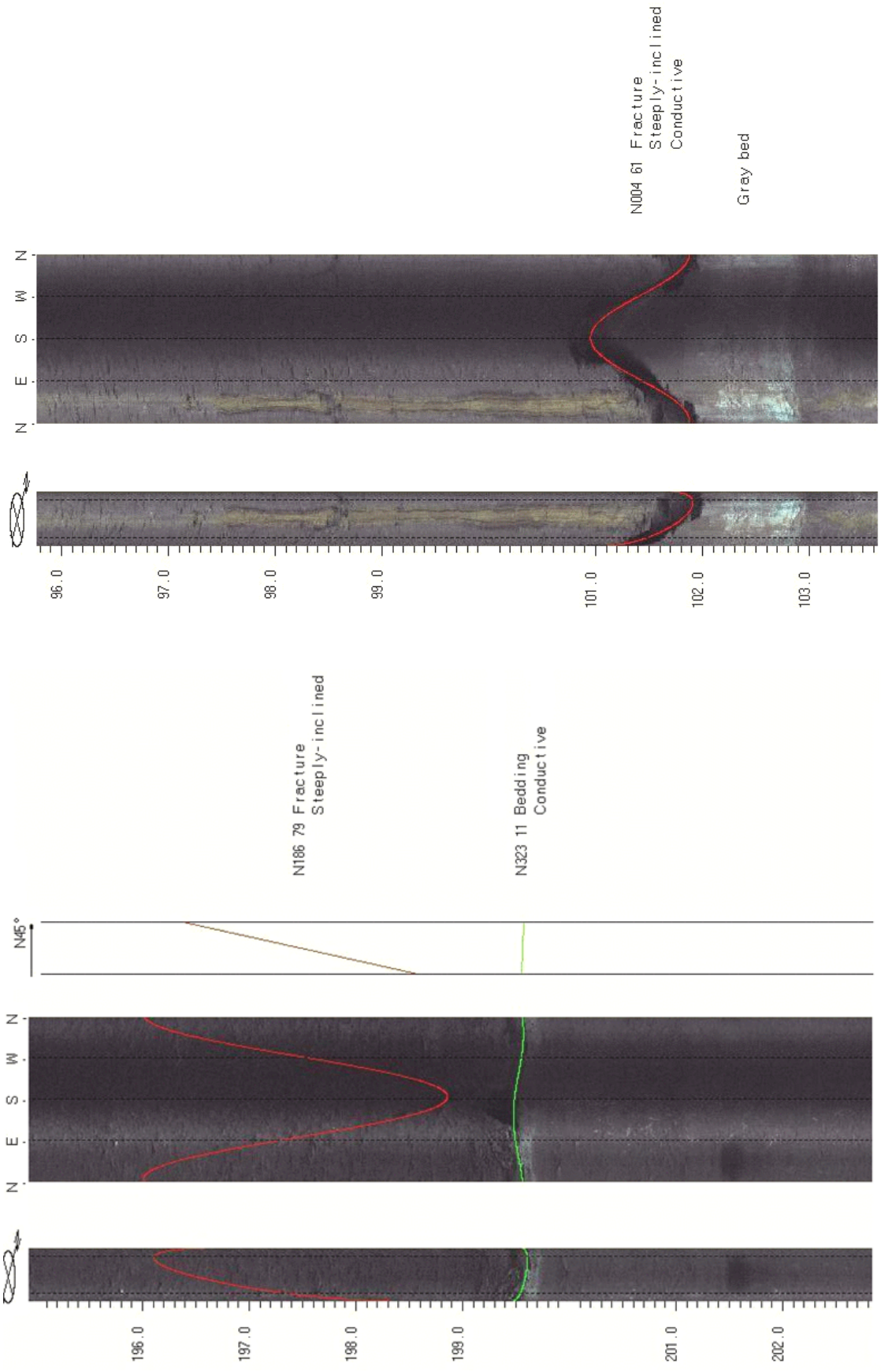


FIGURE 3E6. OPTV records of the 6-inch diameter well 60 at Salem Industrial Park, Rt. 22 East, Readington Twp., Hunterdon County, NJ showing geologic structures and conductive features in red mudstone and siltstone and a gray bed. Depth values are in feet below land surface.

Wells 61 to 67 - Brunswick middle red zone

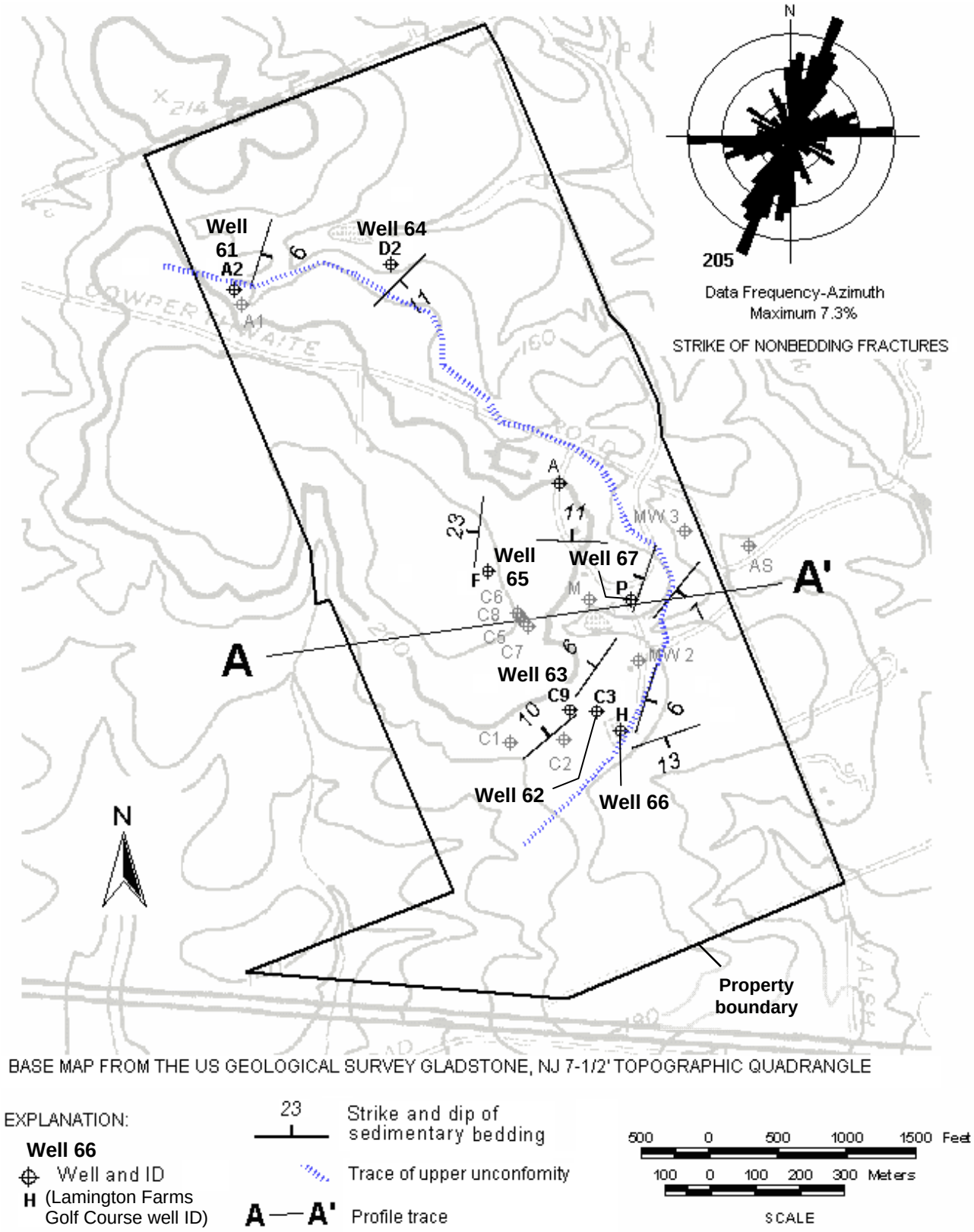
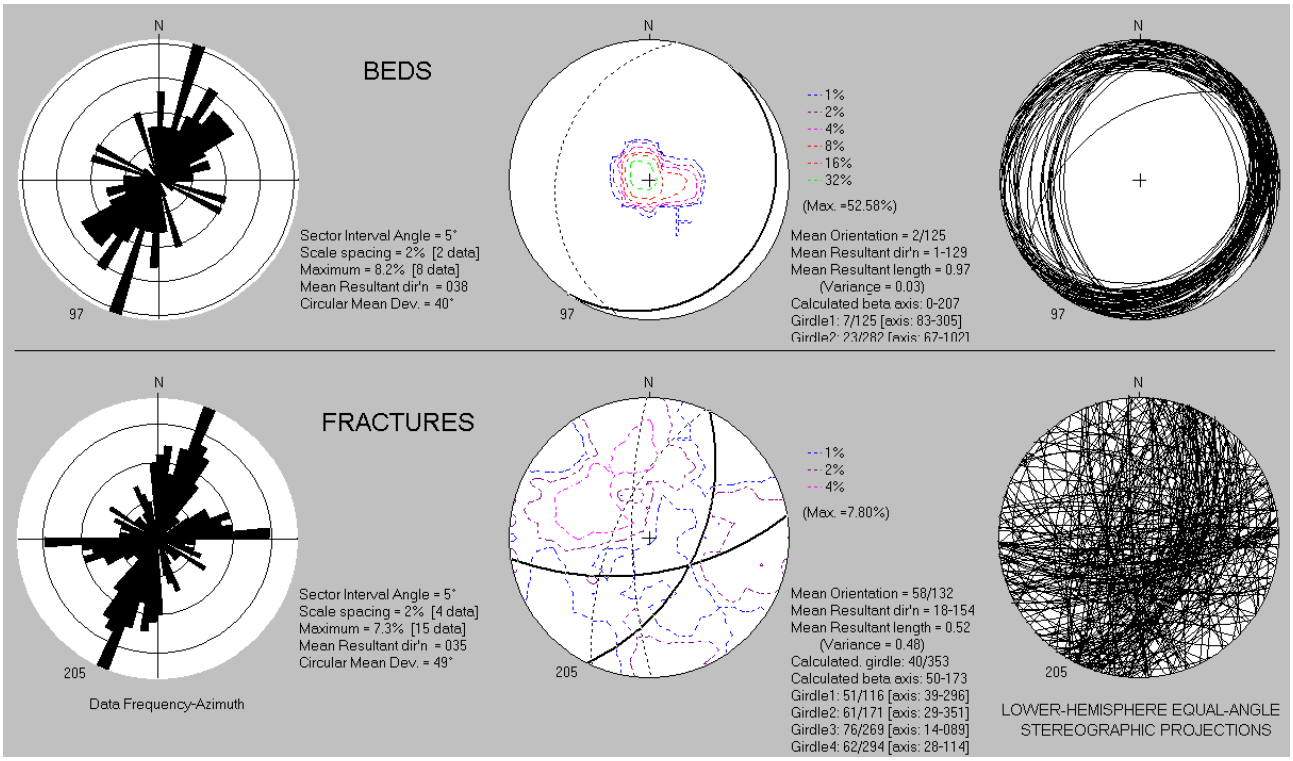


Figure 3F1. Map showing the location of wells 60 to 67 at Trump National Golf Course (formerly Lamington Farms Golf Course), Bedminster Twp., Somerset County, NJ.

Wells 61 to 67 - Brunswick middle red zone



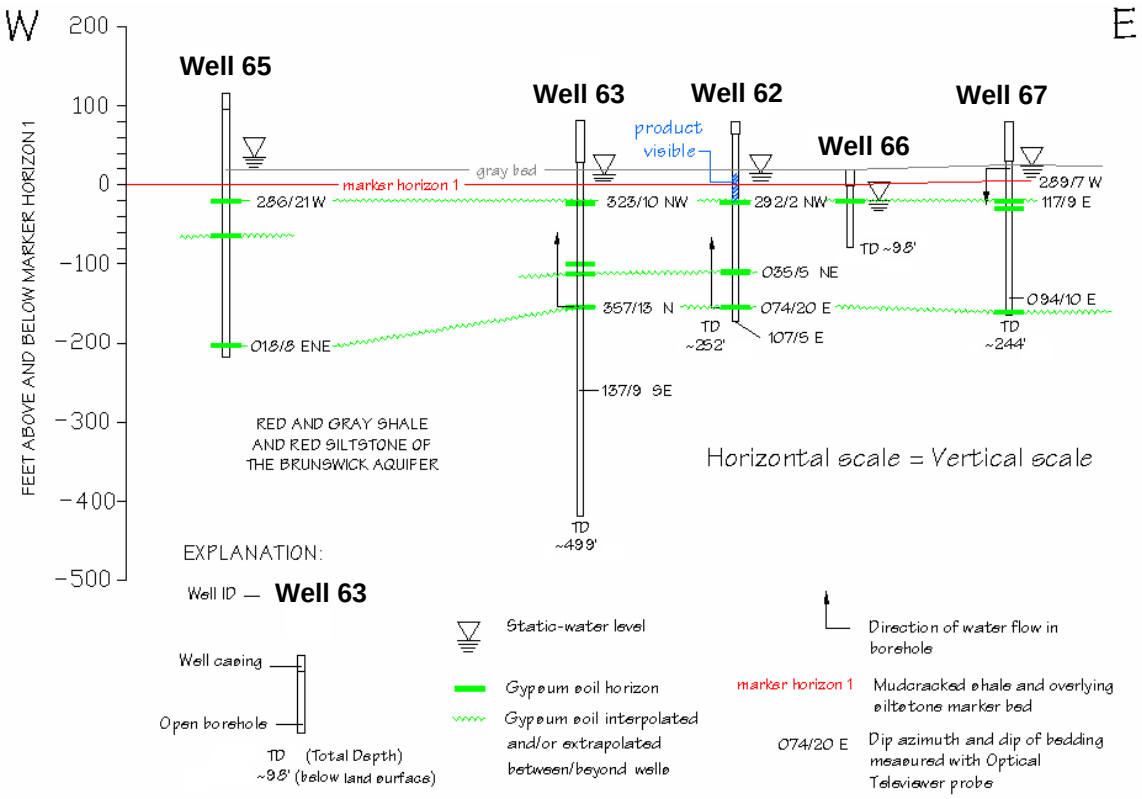


FIGURE 3F2. A structural analysis (above) of beds and fractures measured in OPTV records for wells 61 through 67. The geologic cross section (below) shows a correlation of gypsum-soil horizons identified in OPTV records and interpreted as stratigraphic unconformities. Note the opposing dips for strata above and below the soil horizons.

Wells 61 to 67 - Brunswick middle red zone

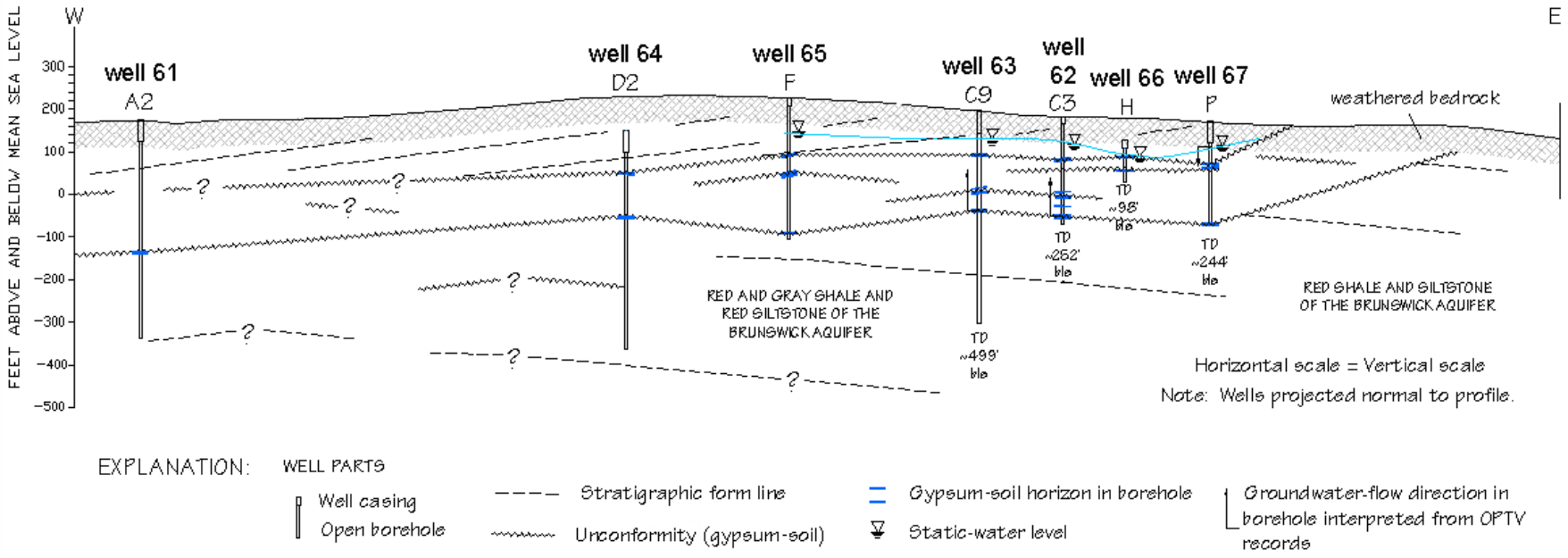


FIGURE 3F3. Hydrogeologic section based on seven wells at Trump National Golf Course, Bedminster Twp., Somerset County, NJ. Wells penetrate stratigraphic unconformities along extensive gypsum-soil beds. Stratigraphic sequences above and below the many unconformities dip in different directions.

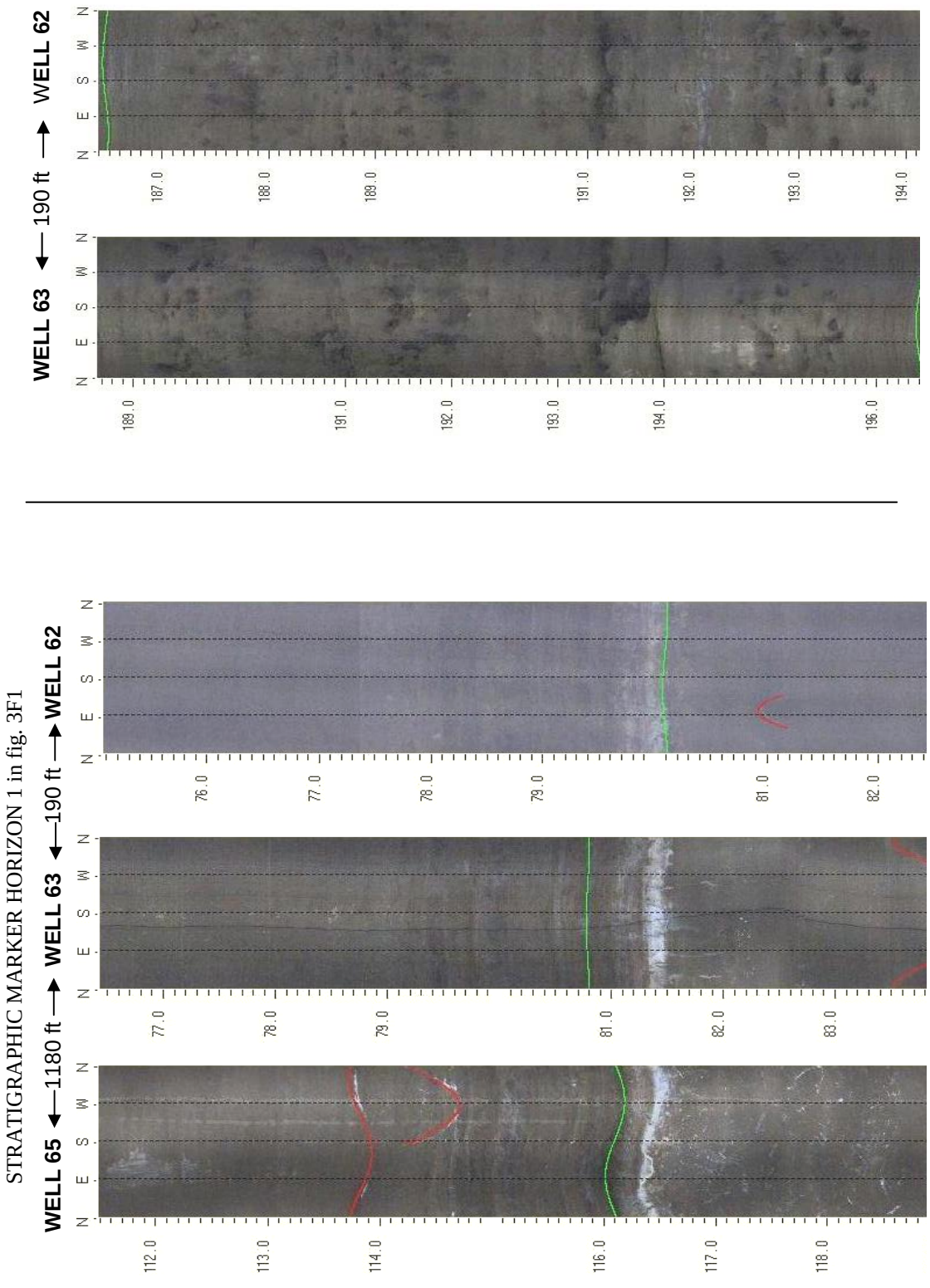


FIGURE 3F4. OPTV records for wells 62, 63 and 65 at Trump National Golf Course, Bedminster Twp., Somerset County, NJ showing stratigraphic marker horizon 1(left and fig. 3F2) and a correlation of a gypsum -soil horizon for wells 62 and 63 (right). Depth values are in feet below land surface.

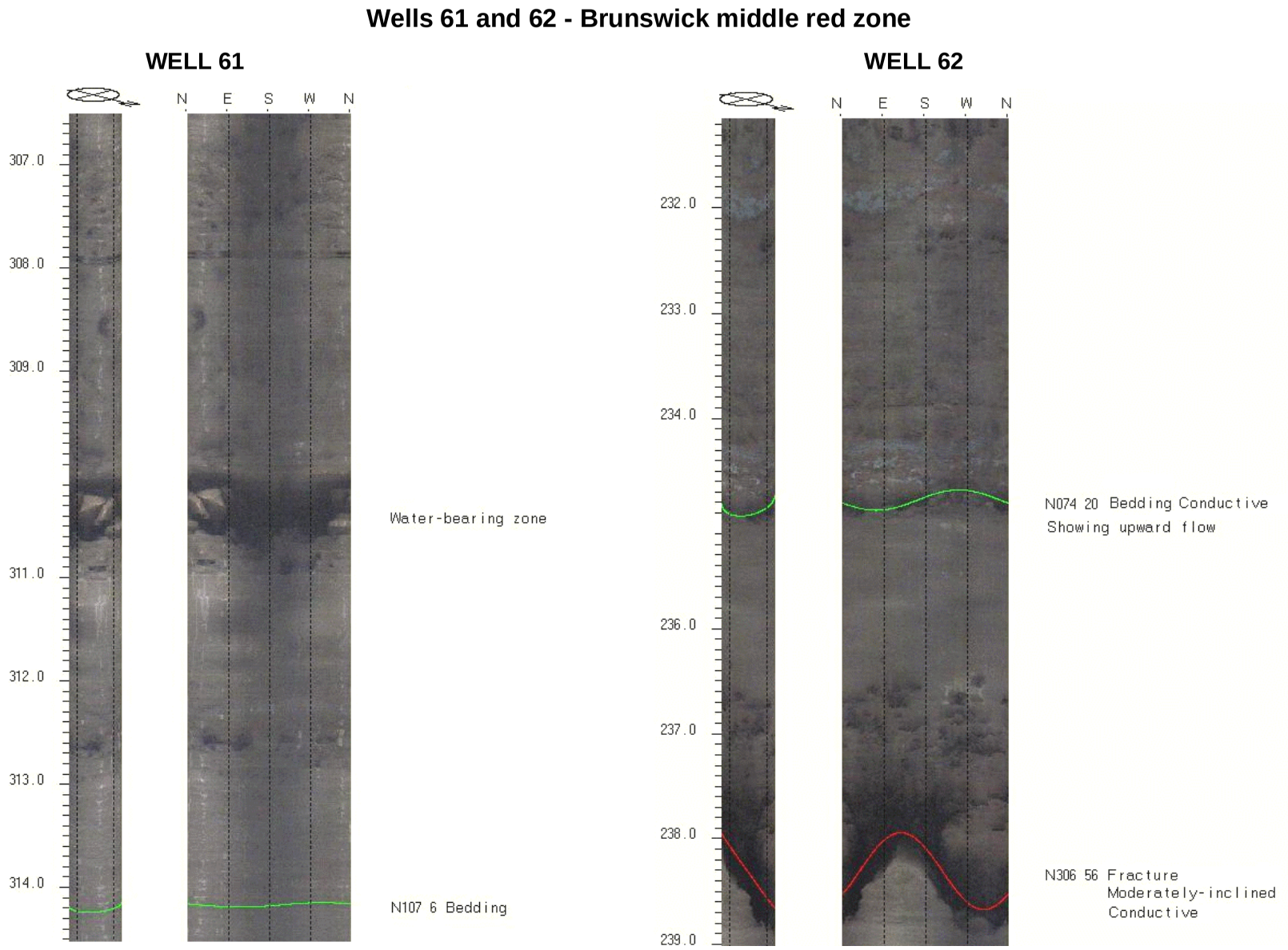


FIGURE 3F5. OPTV records of t6-inch diameter wells 61 and 62 showing geologic structures and hydraulically-conductive features in red mudstone with gypsum soils. Depth values are in feet below land surface.

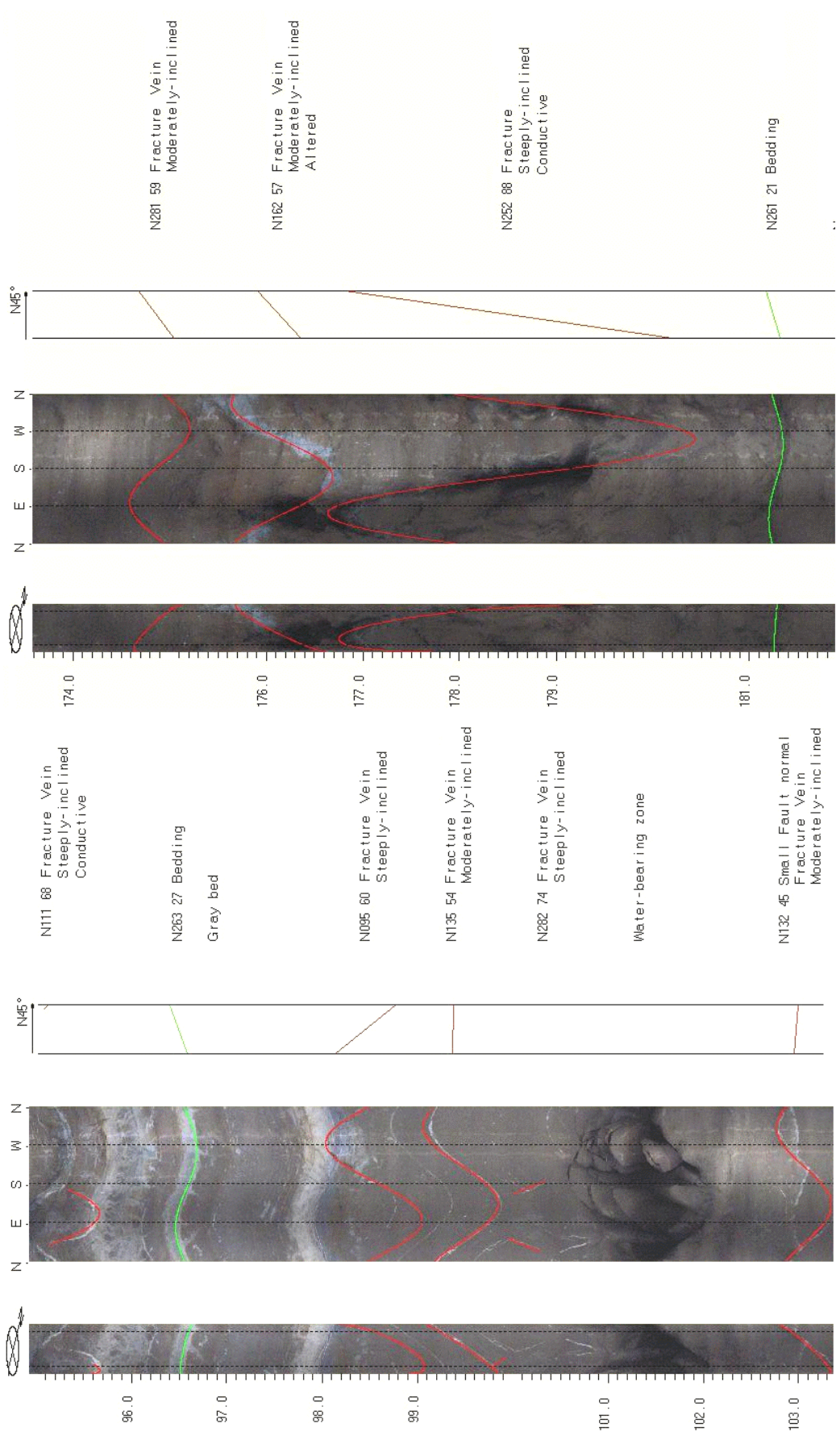
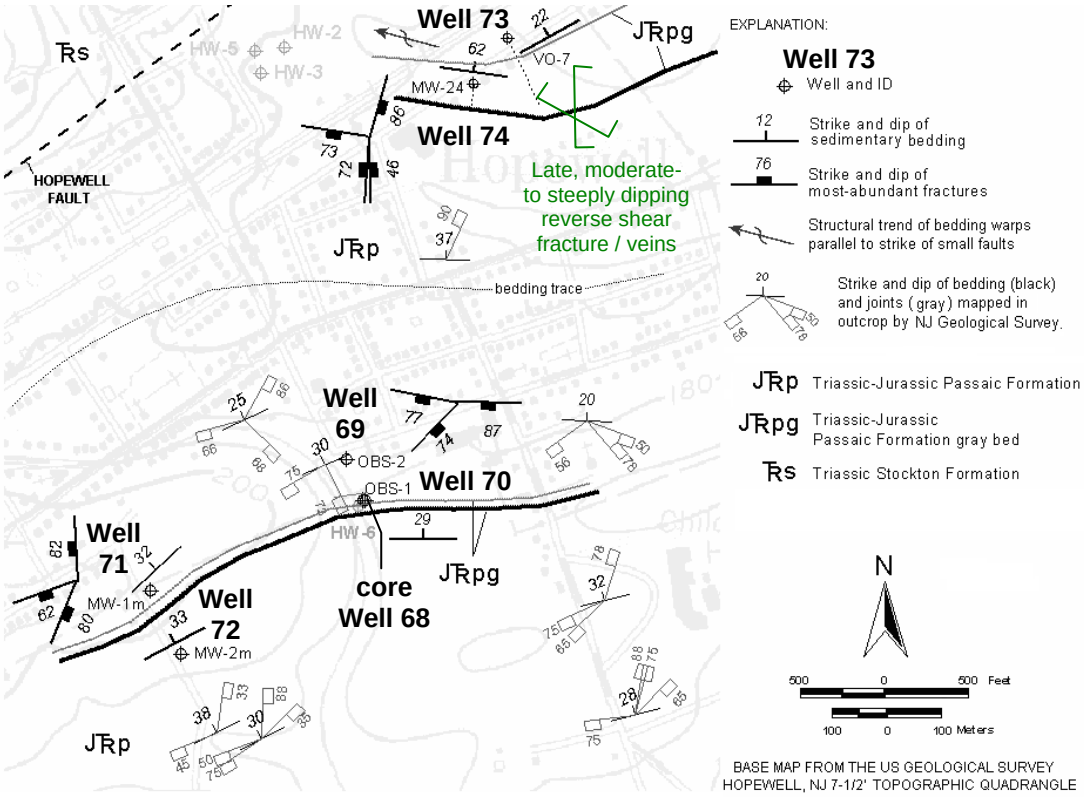


FIGURE 3F6. OPTV records of the 6-inch diameter well 65 at Salem Industrial Park, Rt. 22 East, Readington Twp., Hunterdon County, NJ showing geologic structures and hydraulically conductive features in red and gray mudstone. Depth values are in feet below land surface.

Wells 68 to 74 - Brunswick middle red and middle gray zones



Wells 69 and 70 - Brunswick middle red and middle gray zones

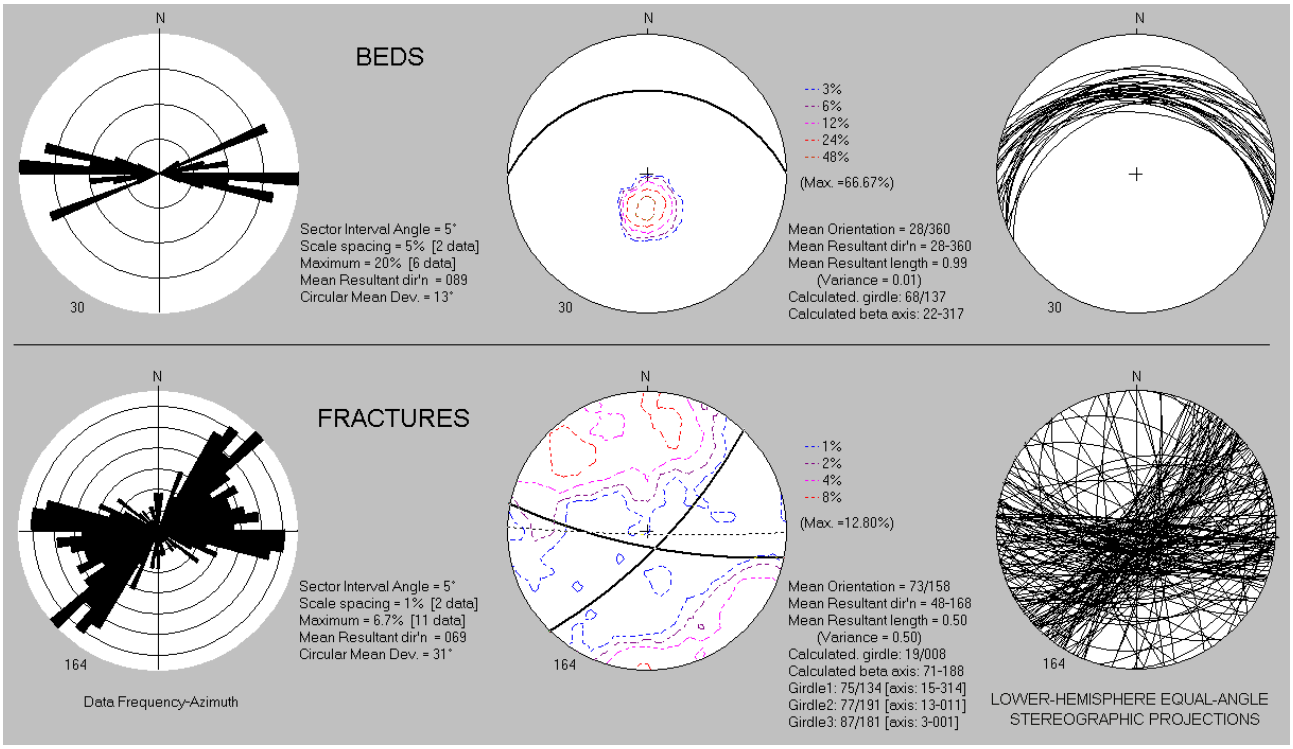
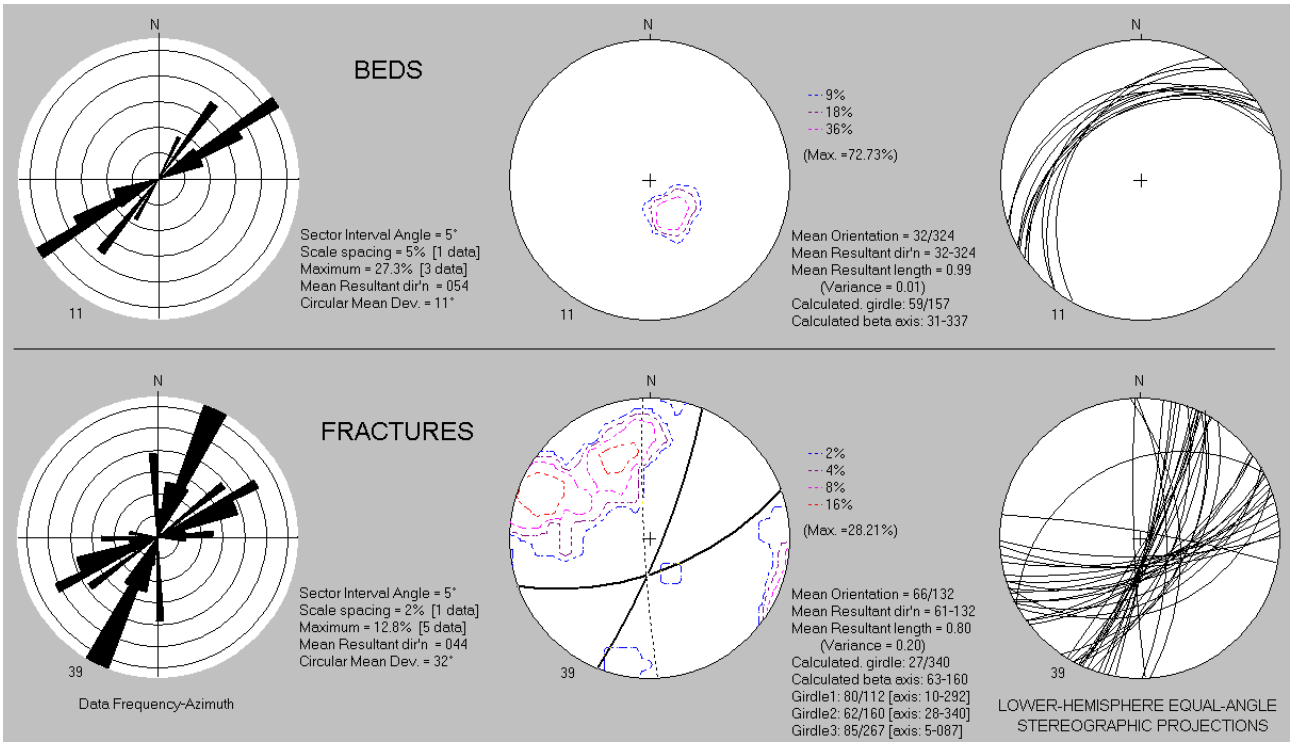


Figure 3G1. Map (above) shows wells 68 through 74 and nearby geological structures in Hopewell Borough, Mercer County, NJ. The strike and of bedding and fractures near each well are based on structural analyses of OPTV records. The structural analysis for wells 69 and 70 is shown below.

Wells 71 and 72 - Brunswick middle red and middle gray zones



Wells 73 and 74 - Brunswick middle red and middle gray zones

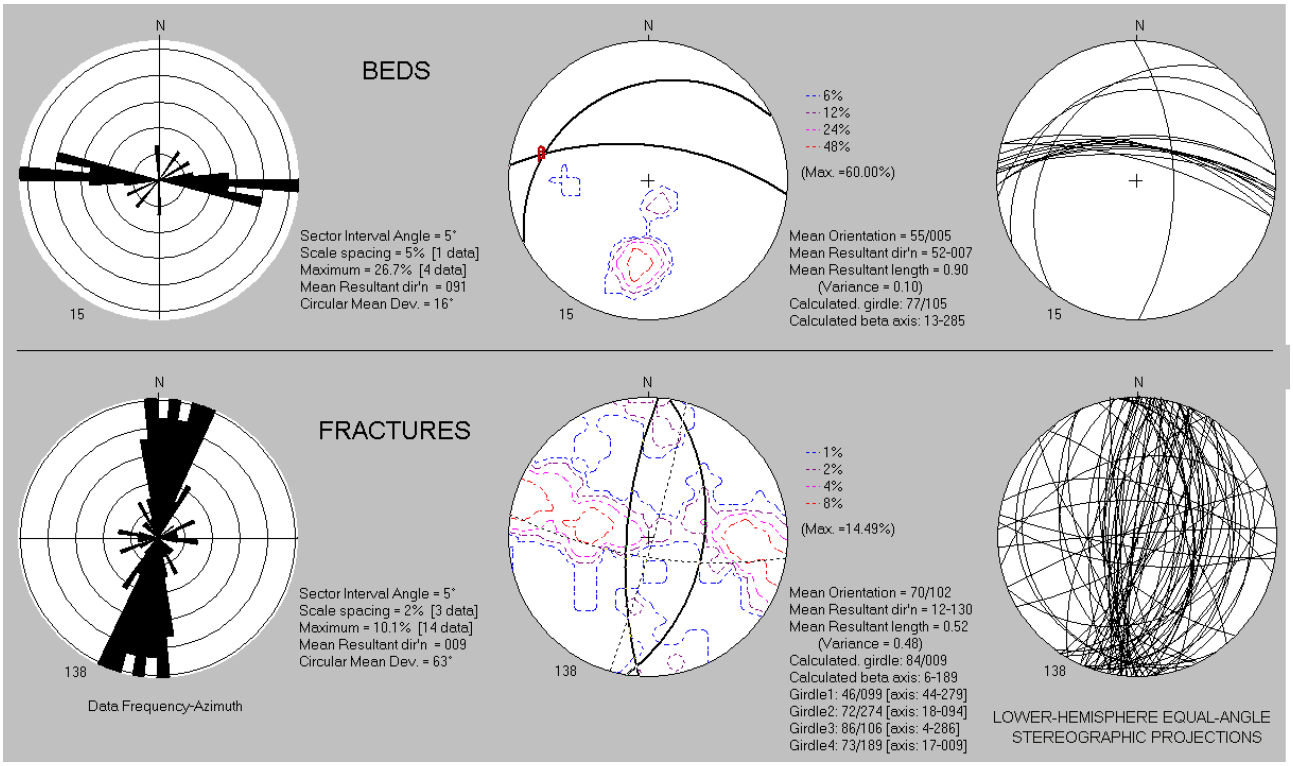


FIGURE 3G2. Structural analyses of beds and fractures measured in OPTV records for wells 71 and 72 (above) and wells 73 and 74 (below).

Wells 68 to 70 - Brunswick middle red and middle gray zones

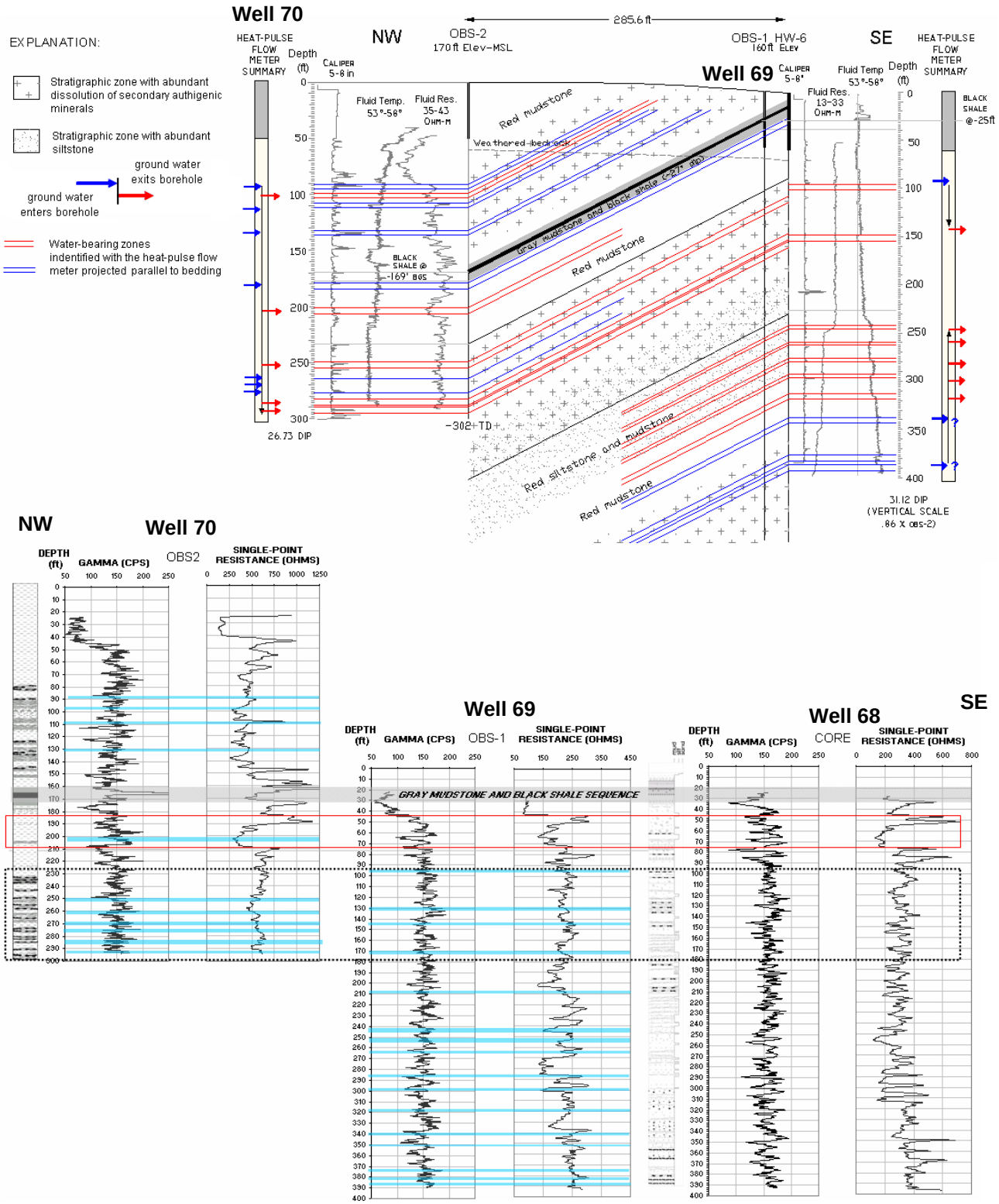


FIGURE 3G3. Hydrogeologic section (above) based on geophysical logs for wells 68 through 70 near Hopewell Borough supply well HW-6, Mercer County, NJ. Note the two directions of cross flow in well 68 under non-pumping conditions. Section below shows a stratigraphic correlation of wells 68 through 70 based on natural gamma-ray and single-point resistance logs. Depths are in feet below land surface.

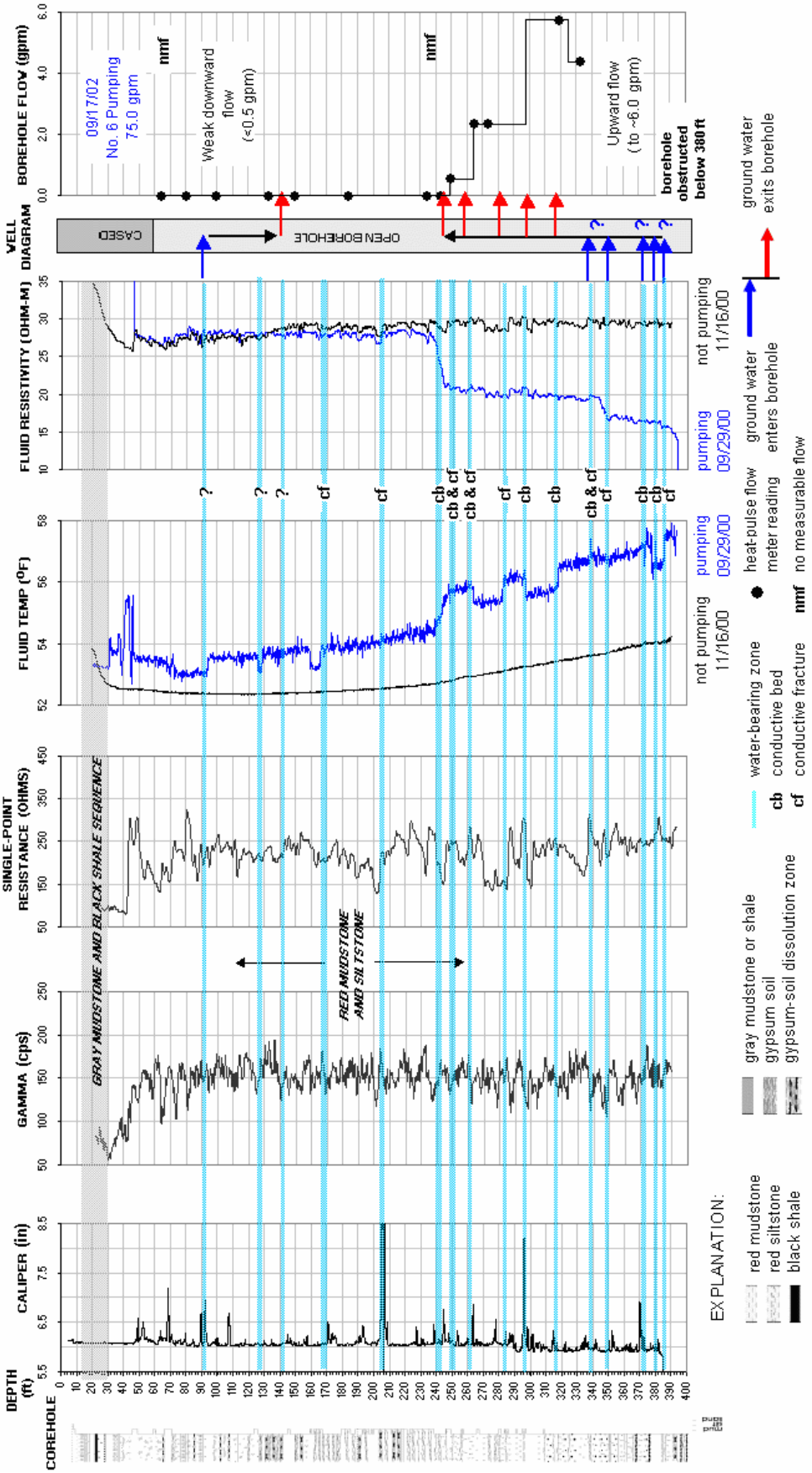


FIGURE 3G4. Hydrogeologic section based on geophysical logs for well 69, Hopewell Borough, Mercer County, NJ. County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and siltstone with gray and black shale. Depths are in feet below land surface.

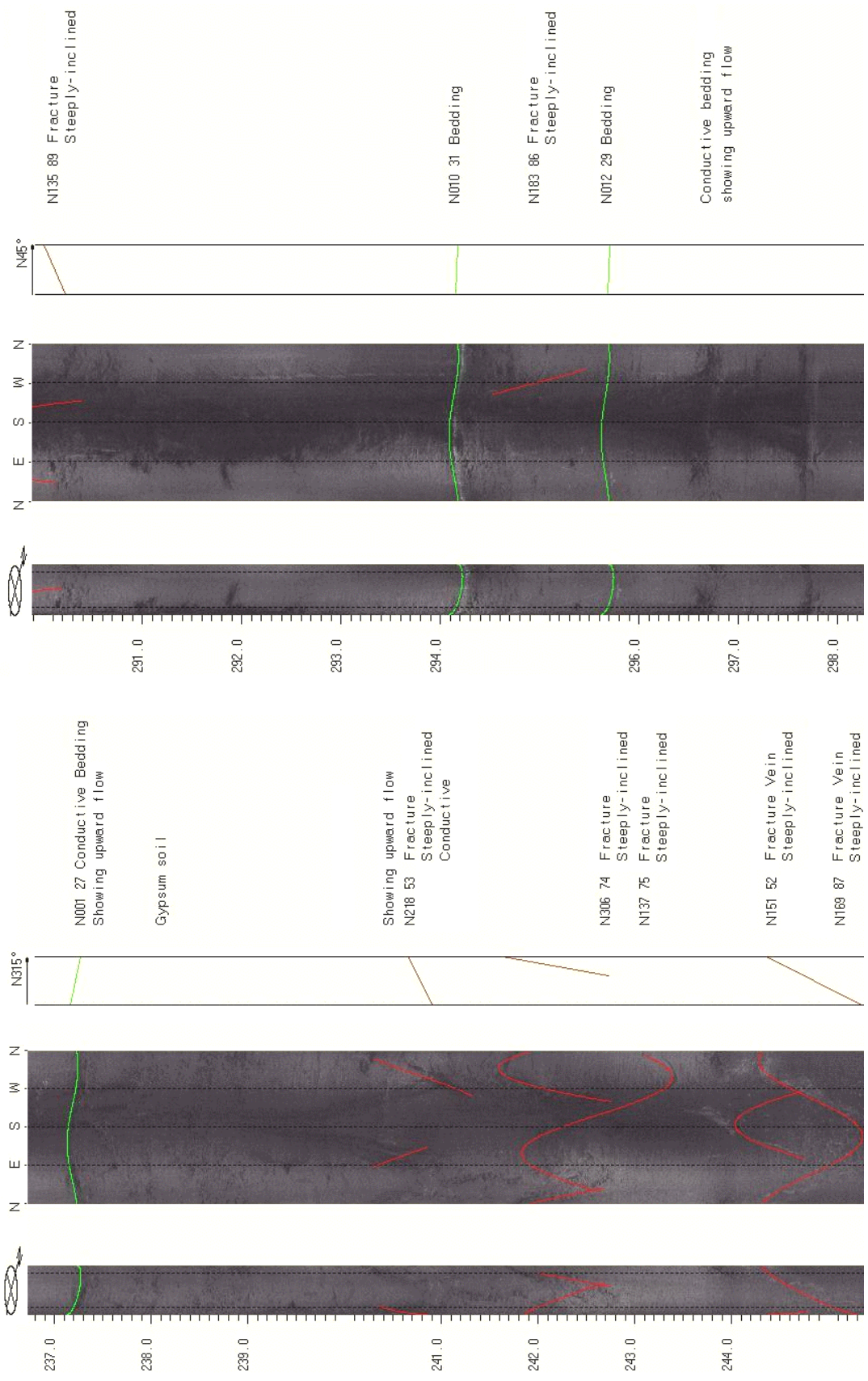


FIGURE 3G5. OPTV records of 6-inch diameter well 69 showing geologic structures and conductive features in red mudstone with gypsum soils. Mineral deposits seen as dark stains on the borehole wall emanate from conductive features and taper upward in the direction of natural cross flow. Depth values are in feet below land surface.

Well 70 - Brunswick middle red and middle gray zones

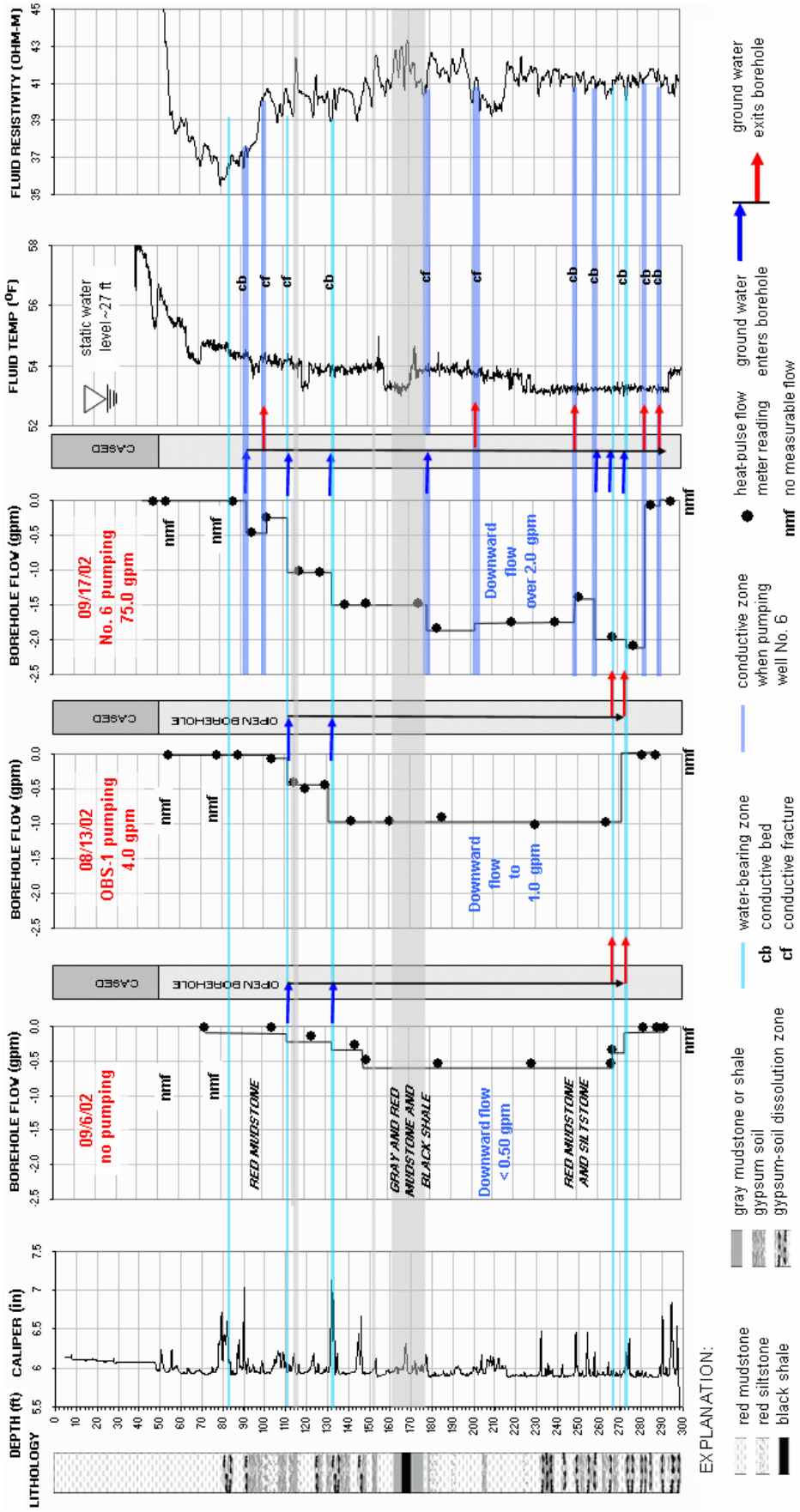


FIGURE 3G6. Hydrogeologic section based on geophysical logs for Well 70. A comparison of heat-pulse flow meter logs collected under pumping and non-pumping conditions shows that water-bearing zones have variable flow rates under variable-pumping conditions. Depth values are in feet below land surface.

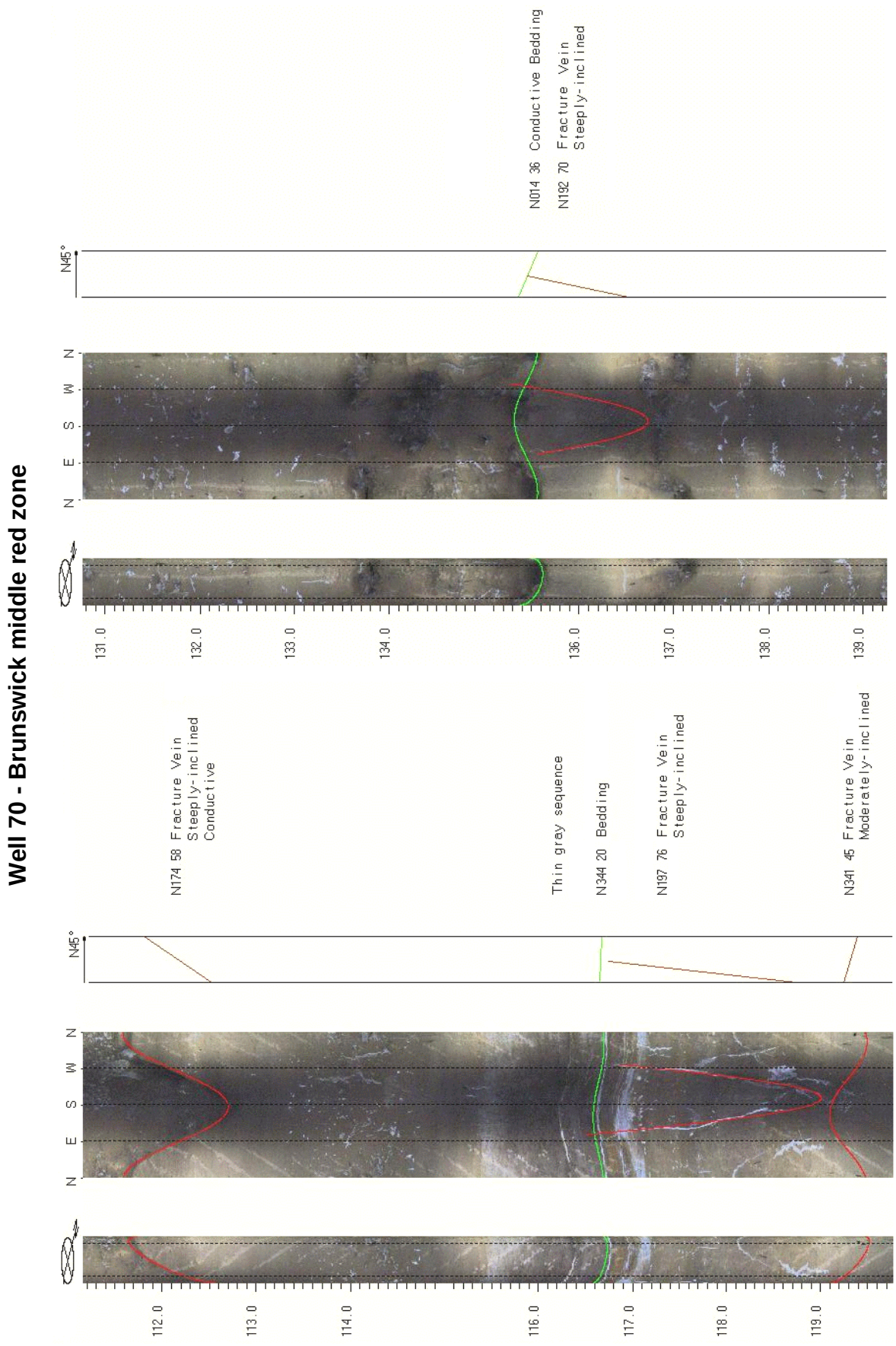


FIGURE 3G7. OPTV records of 6-inch diameter well 70 showing geologic structures and conductive features in red mudstone with gypsum soils and gray shale. Depth values are in feet below land surface.

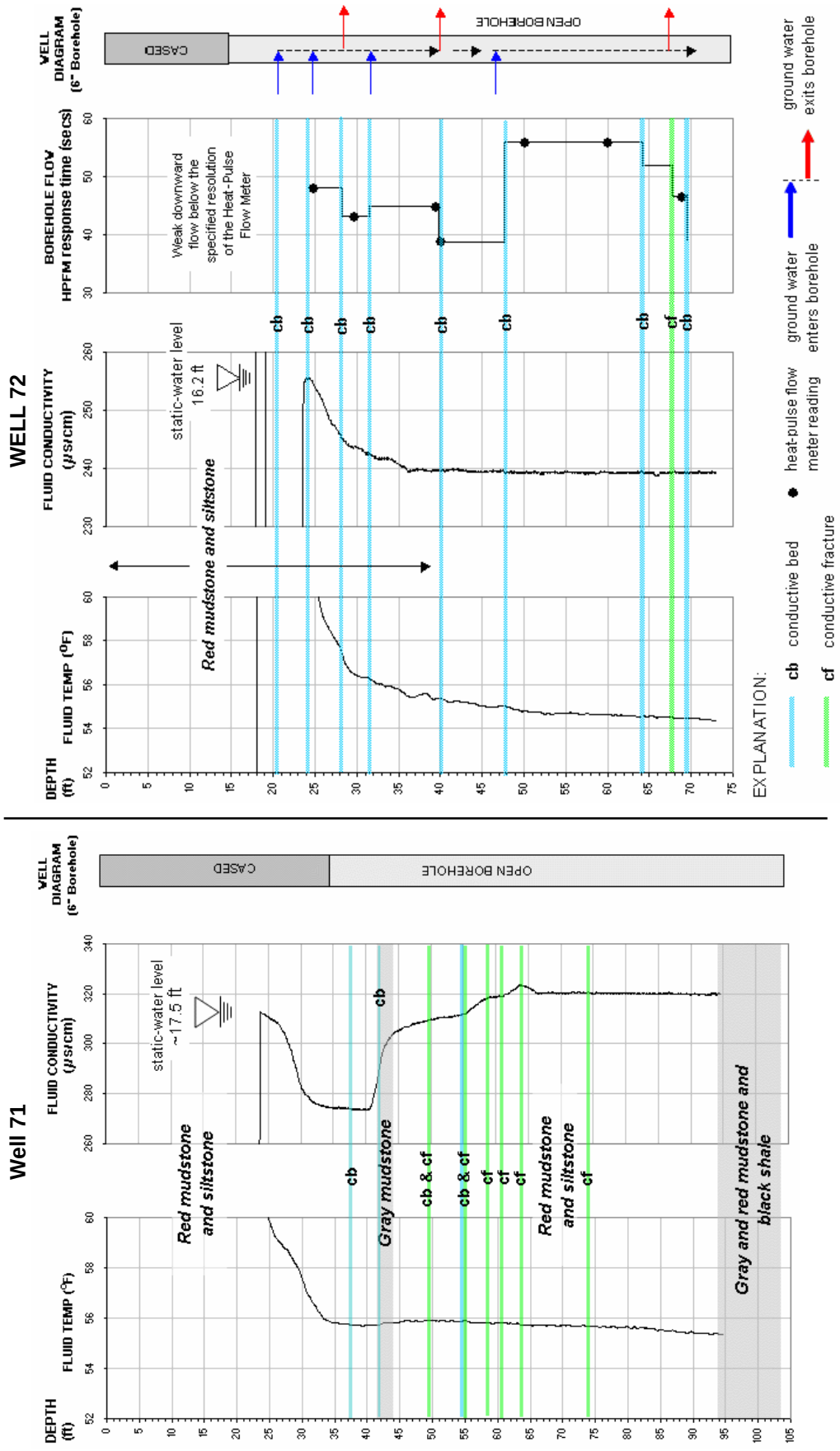


FIGURE 3G8. Hydrogeologic sections based on geophysical logs for wells 71(left) and 72 (right). The sections show the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and siltstone with gray and black shale. Depth values are in feet below land surface.

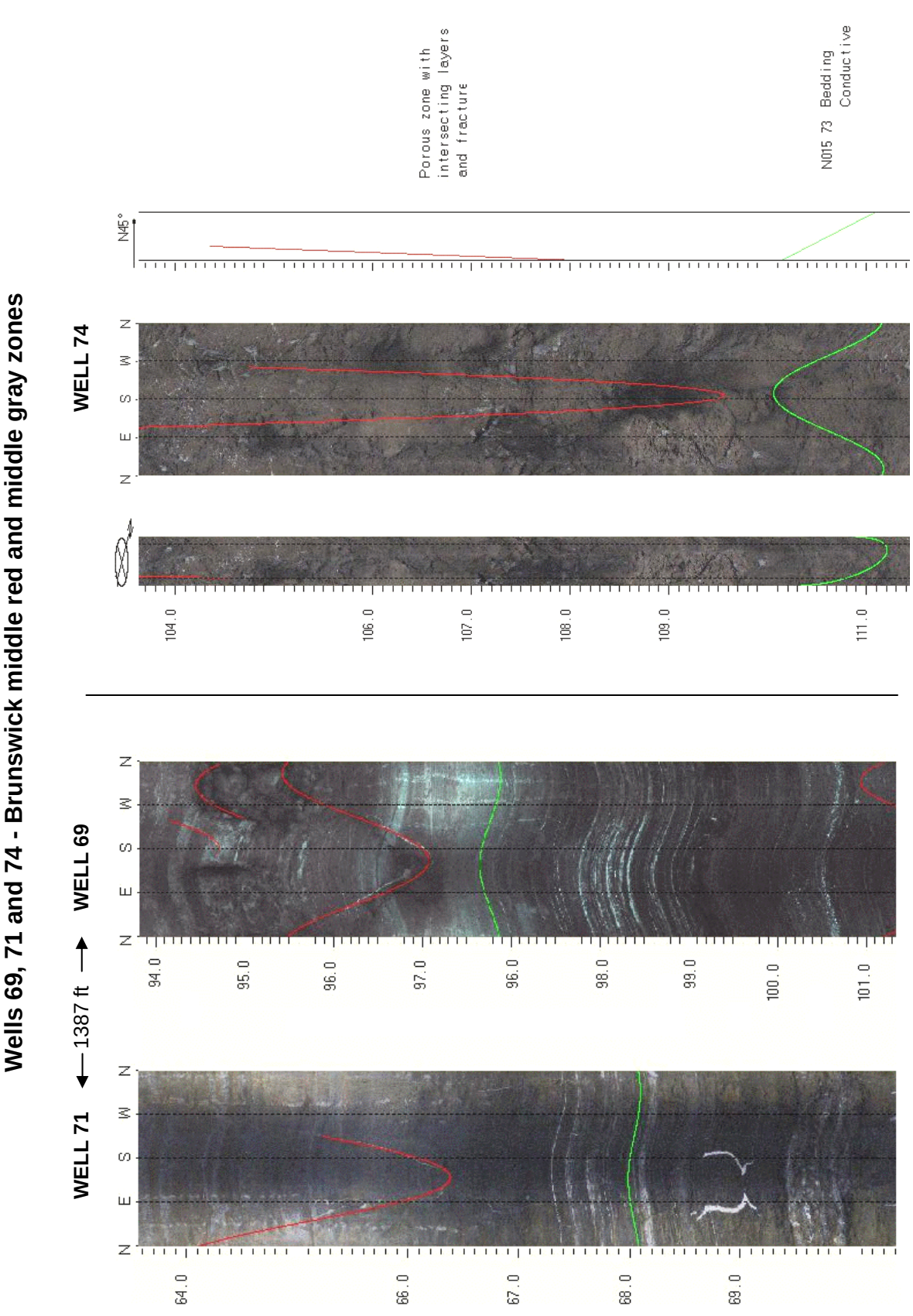


FIGURE 3G9. OPTV records for wells 69 and 71 (left) and well 74 (right). Left records show a stratigraphic correlation of gray- and black shale beds The right record shows a thick, conductive interval formed by the intersections of steeply-dipping fractures and moderately-dipping beds. Depth values are in feet below land surface.

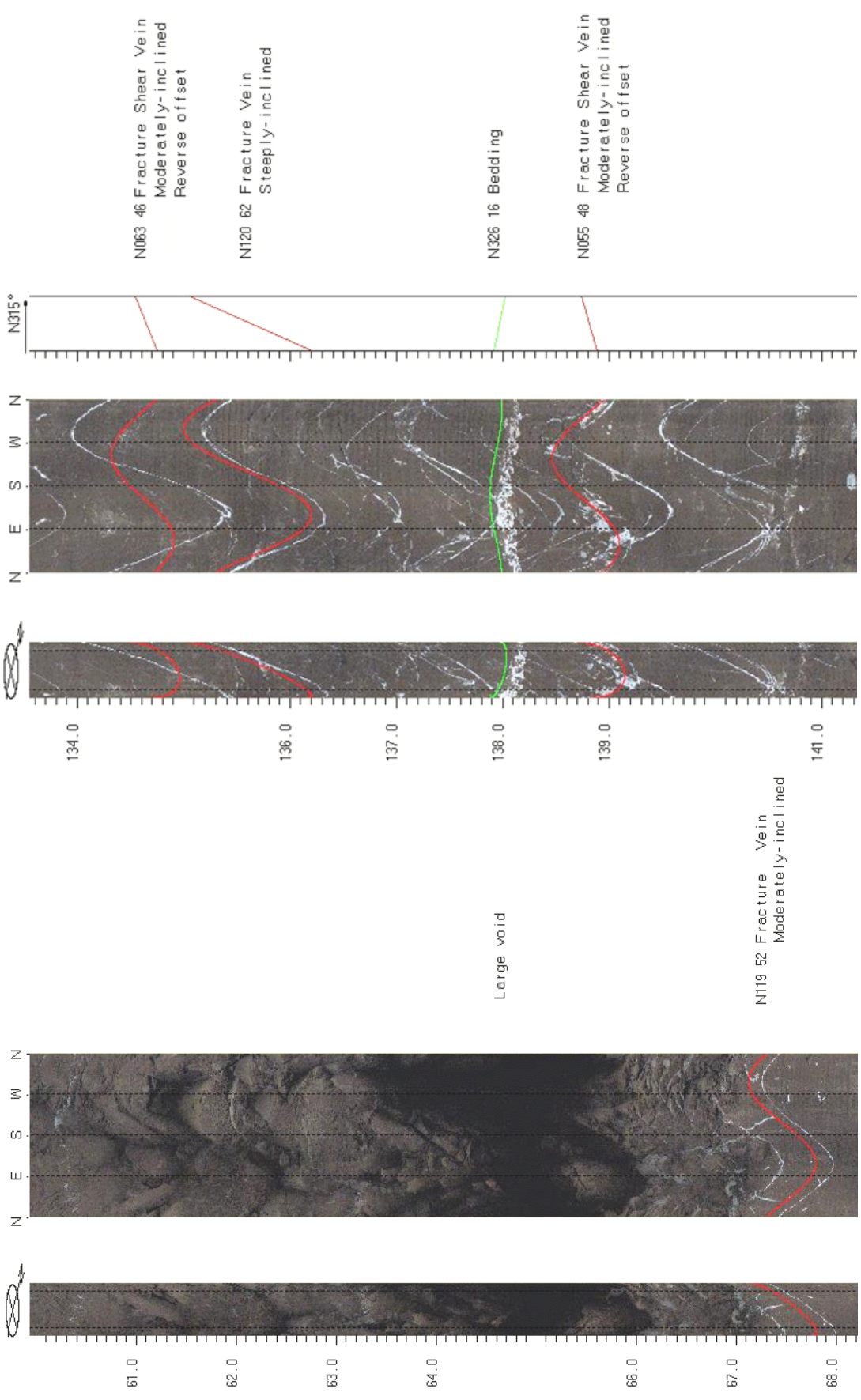
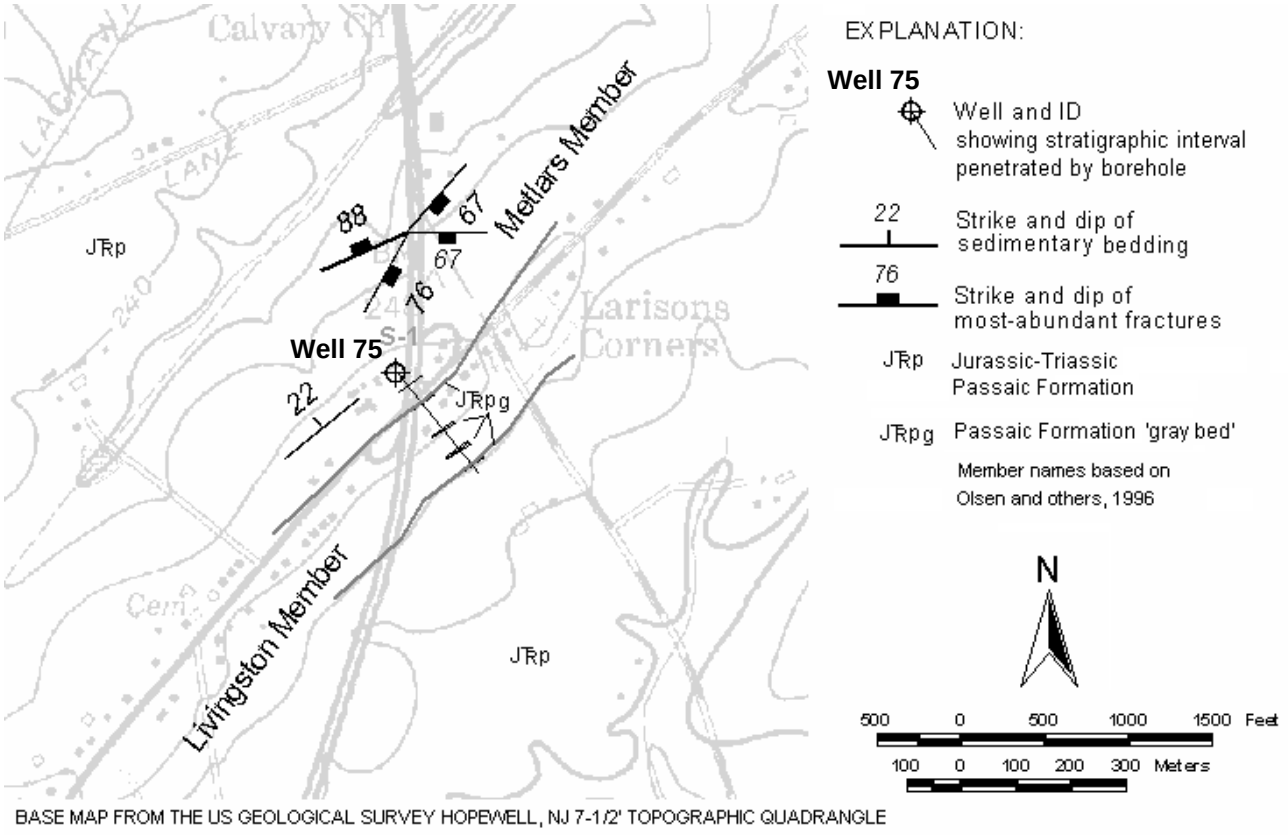


FIGURE 3G10. OPTV records for well 73 showing a large, bed-parallel void in red mudstone (left) and moderately dipping reverse-shear veins cutting steeply-dipping extension fractures in red mudstone (right). Depth values are in feet below land surface.

Well 75 - Brunswick middle gray zone



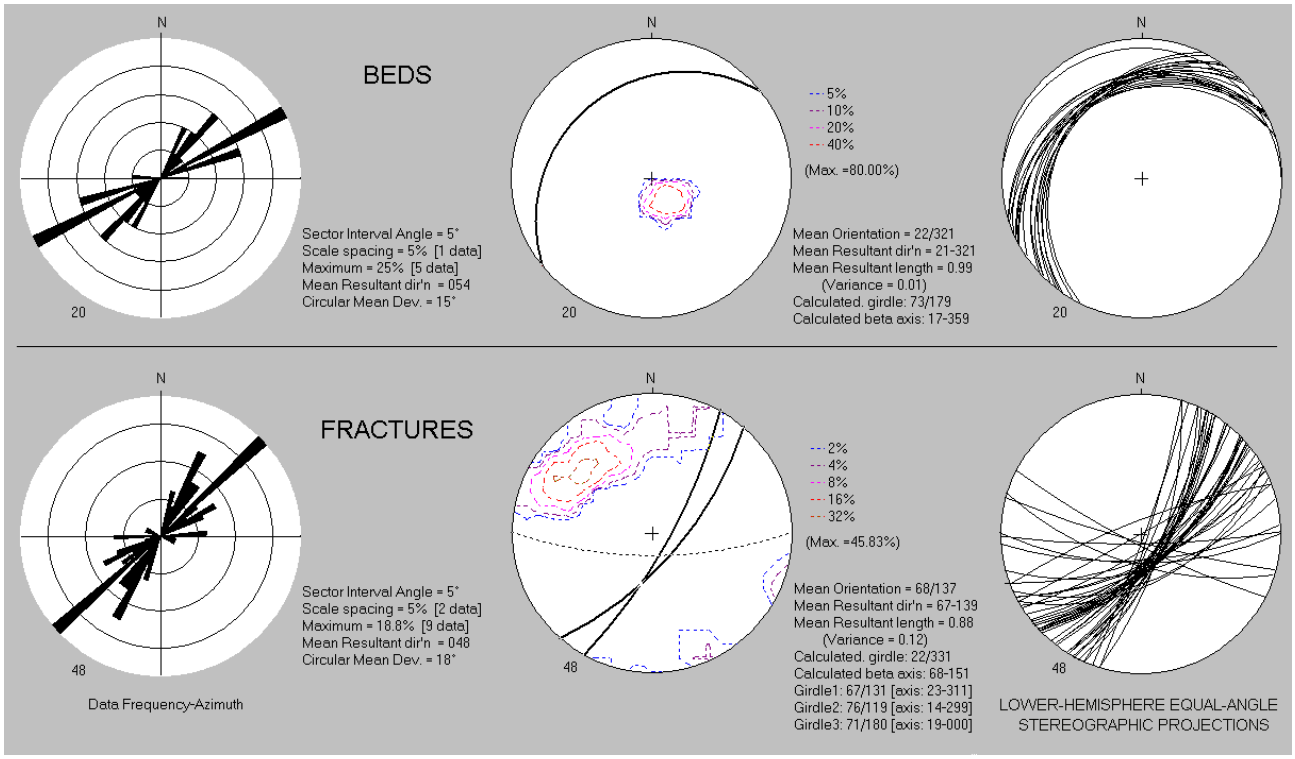
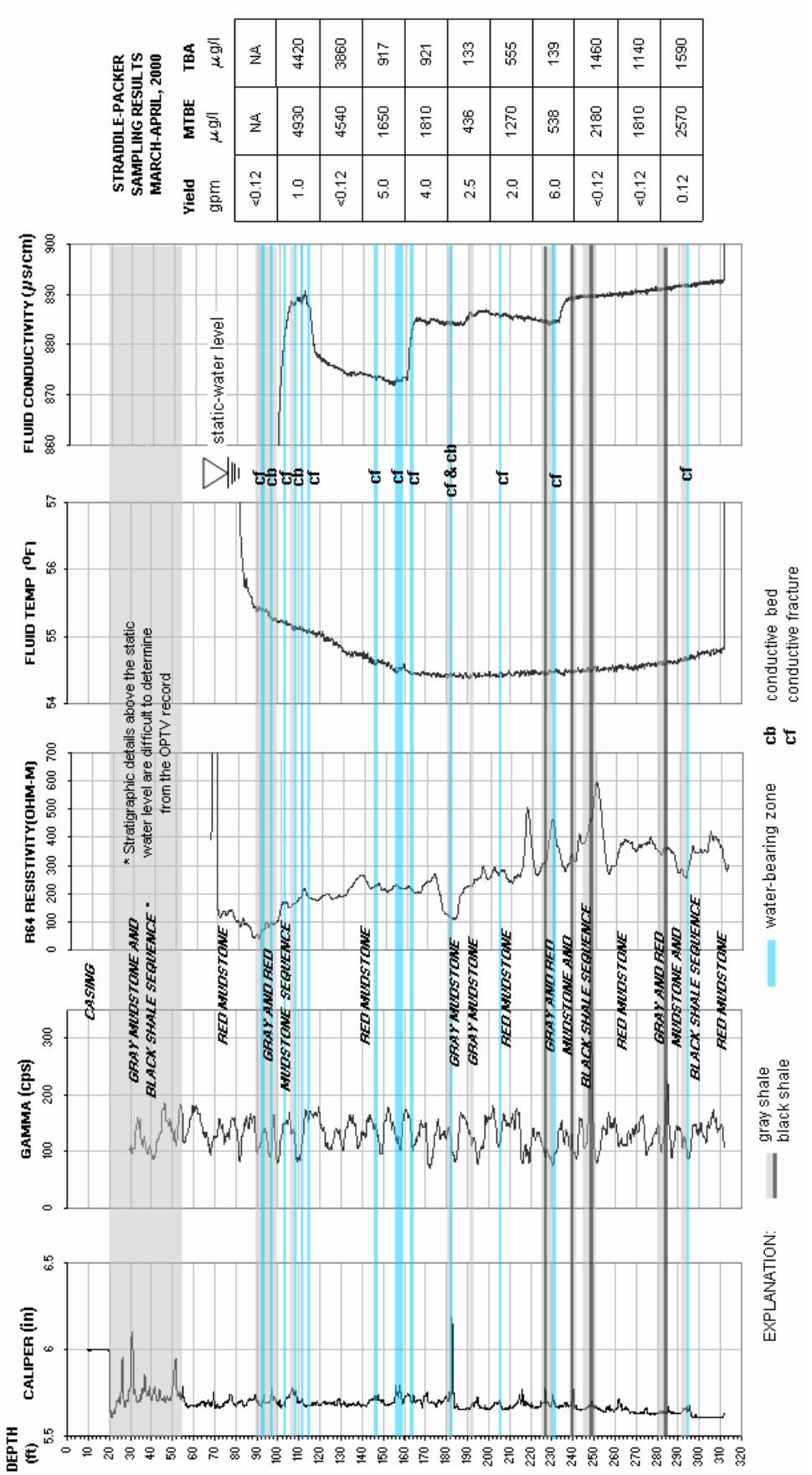


Figure 3H1. Map (above) shows well 75 at Larison's Corner, Rt. 202/31 N, East Amwell Twp., Hunterdon County, NJ. Mapped bedrock structures are based on a structural analysis of beds and fractures (bottom) measured in OPTV records.



STRADDLE-PACKER SAMPLING RESULTS MARCH-APRIL, 2000

Yield gpm	MTBE µg/l	TBA µg/l
<0.12	NA	NA
1.0	4930	4420
<0.12	4540	3860
5.0	1650	917
4.0	1810	921
2.5	436	133
2.0	1270	555
6.0	538	139
<0.12	2180	1460
<0.12	1810	1140
0.12	2570	1590

FIGURE 3H2. Hydrogeologic section based on geophysical logs for well 57 at Schaffernoth Nursery, Larison's Corner, East Amwell Twp., Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray and black shale. The straddle-packer results are part of a NJDEP BTEX investigation. Depth values are in feet below land surface. MTBE - Methyl tert-butyl ether, TBA - Tertiary butyl alcohol.

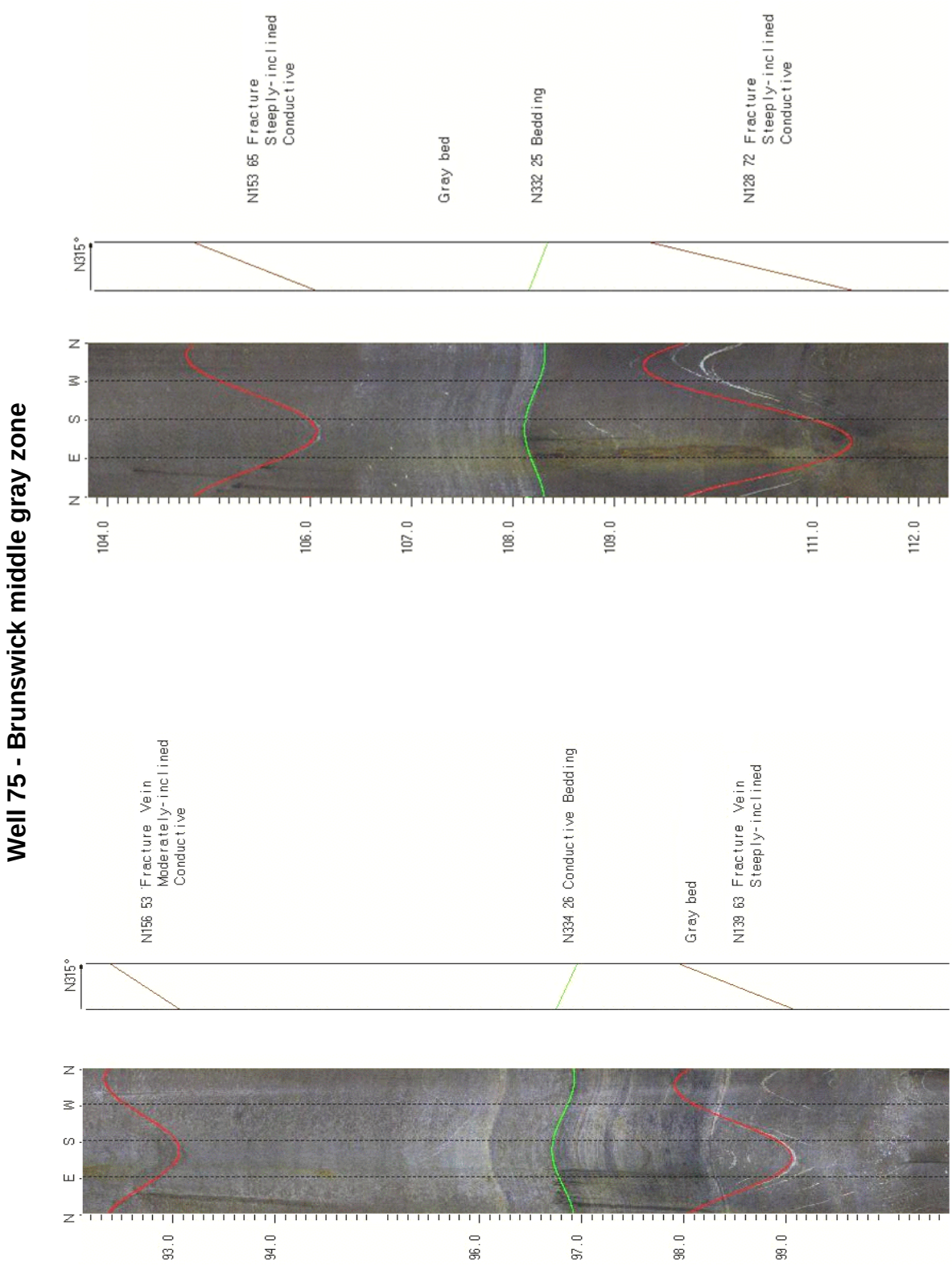


FIGURE 3H3. OPTV records of the 6-inch diameter well 75 showing geologic structures and conductive features in gray and black shale and red mudstone. Depth values are in feet below land surface.

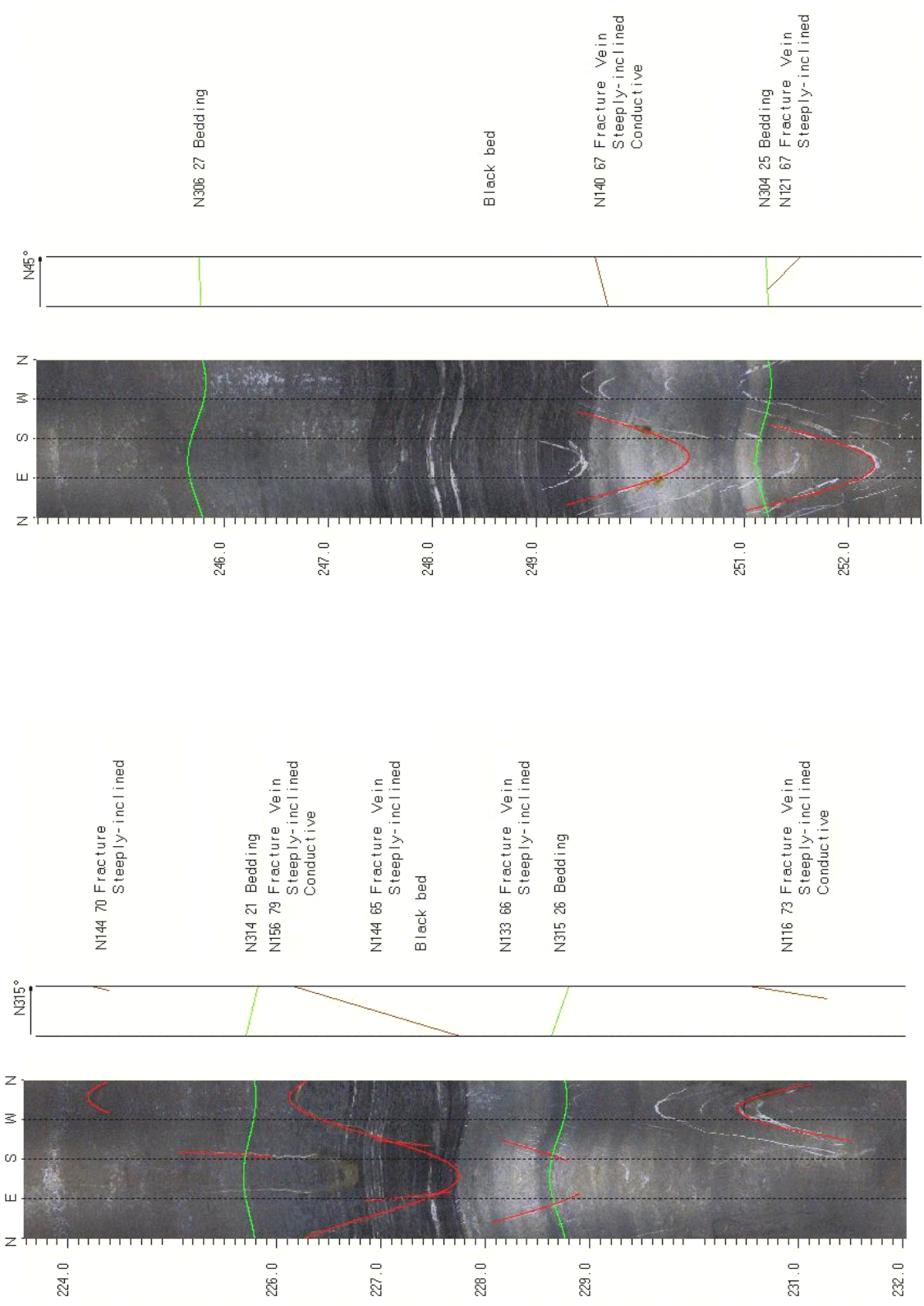
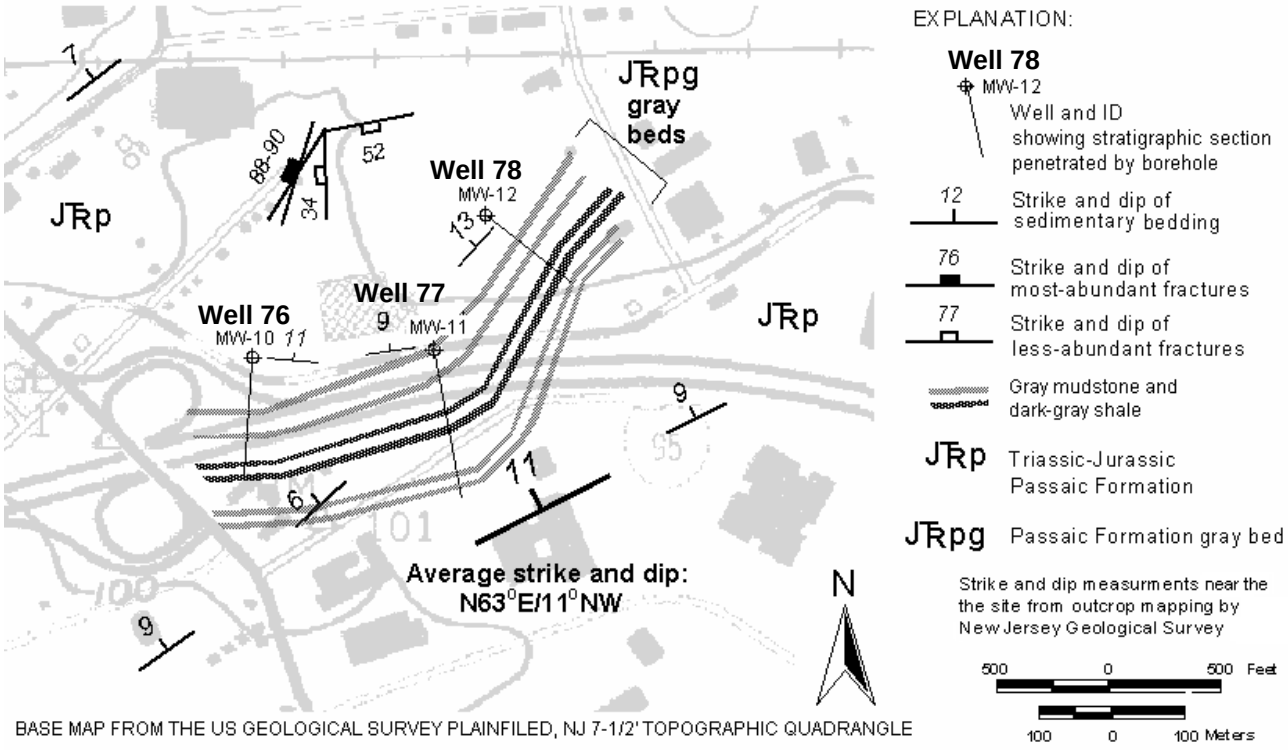


FIGURE 3H4. OPTV records of the 6-inch diameter well 75 showing geologic structures and conductive features in gray and black shale and red mudstone. Depth values are in feet below land surface.

Wells 76 to 78 - Brunswick middle gray zone



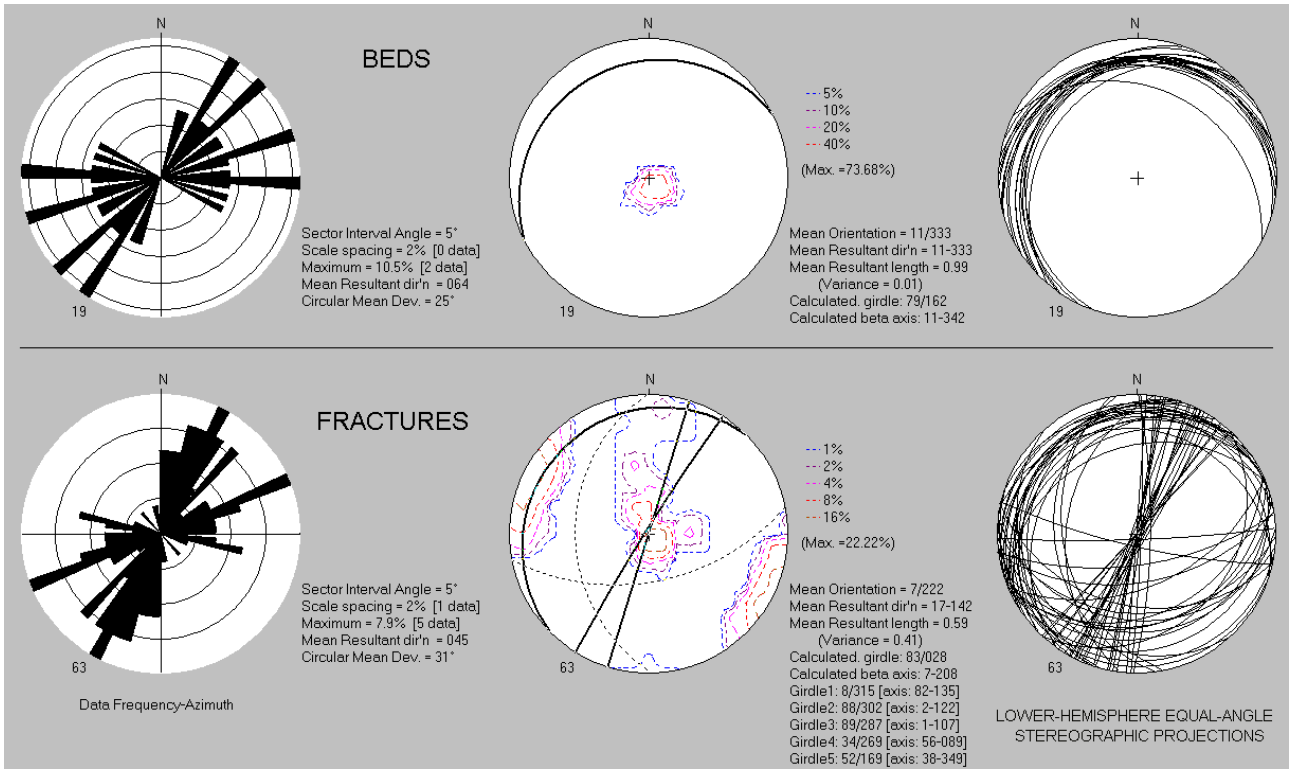


Figure 3I1. Map (above) shows wells 76 to 78 at the Home Depot, South Plainfield Boro, Middlesex County, NJ. Bedding and fractures mapped near the wells are based on a structural analysis (below) of the OPTV records for three monitoring wells.

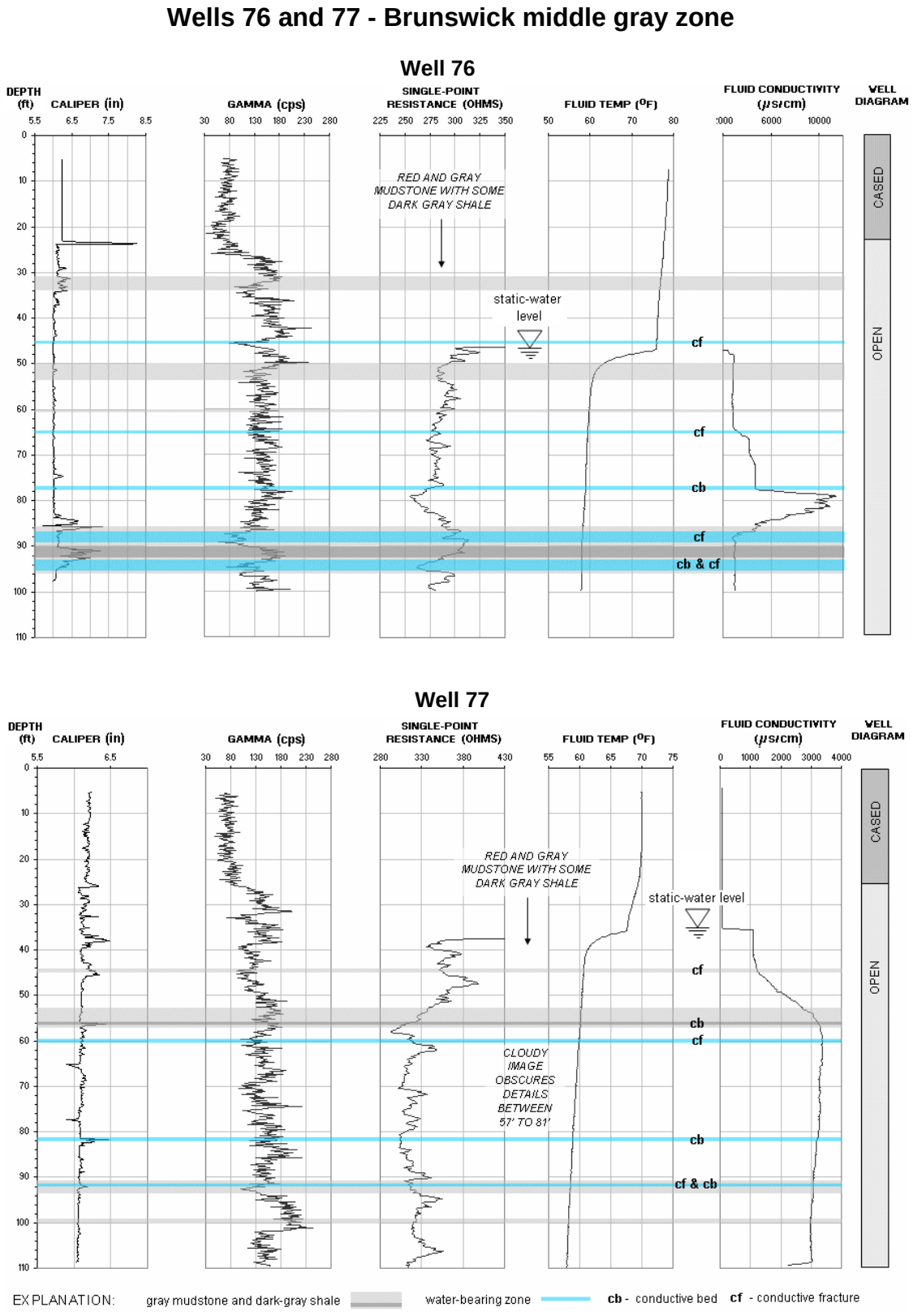


Figure 3I2. Hydrogeologic sections based on geophysical logs for wells 76 and 77 at the Home Depot, South Plainfield Boro, Middlesex County, NJ. The sections show the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red, gray and black mudstone and shale. Depth values are in feet below land surface.

Wells 76 to 78 - Brunswick middle gray zone

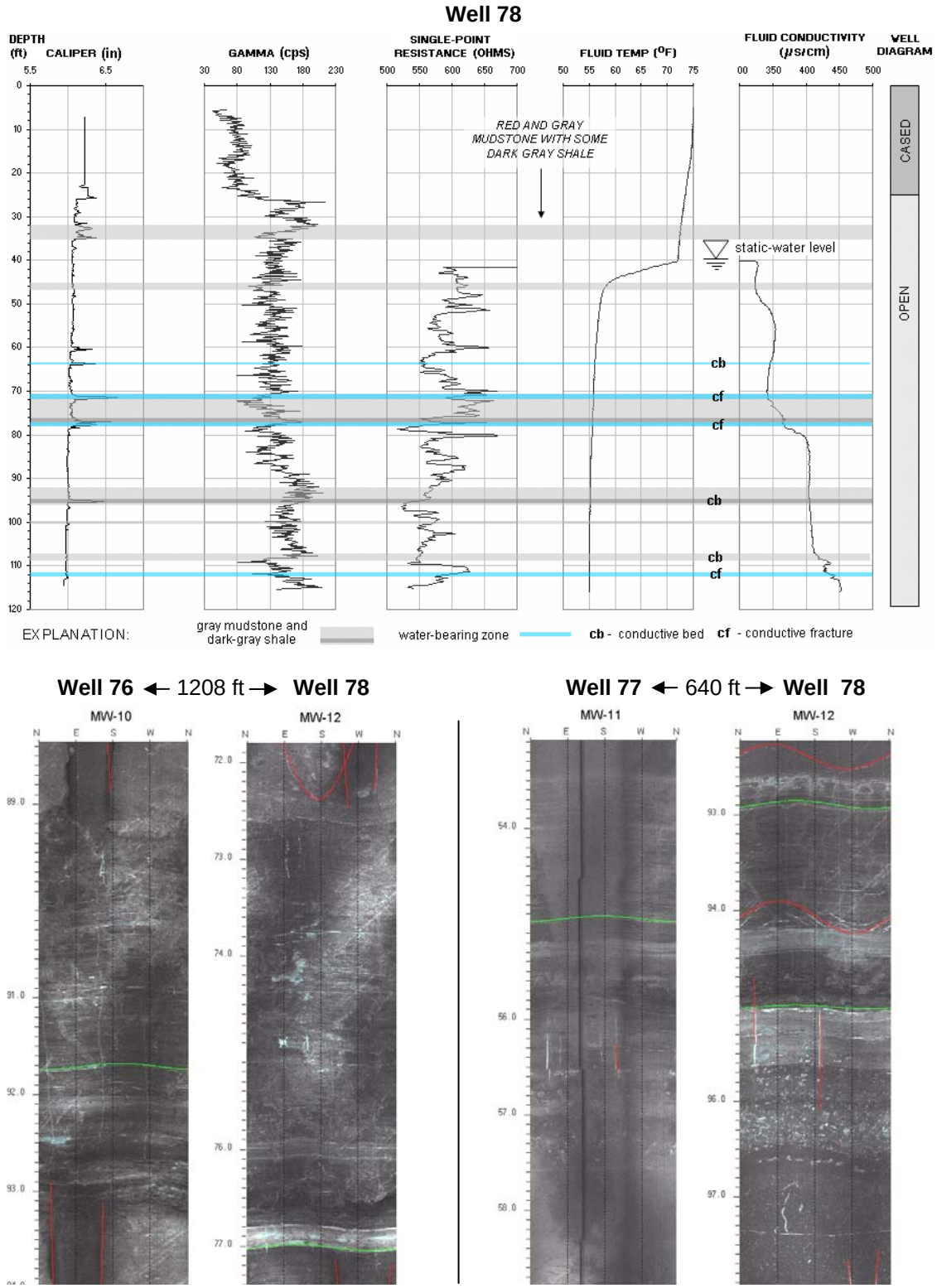


Figure 3I3. Hydrogeologic section (above) based on geophysical logs for well 78 at the Home Depot, South Plainfield Boro, Middlesex County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray shale. Stratigraphic correlations (below) are based on OPTV records for wells 76 to 78. Depth values are in feet below land surface.

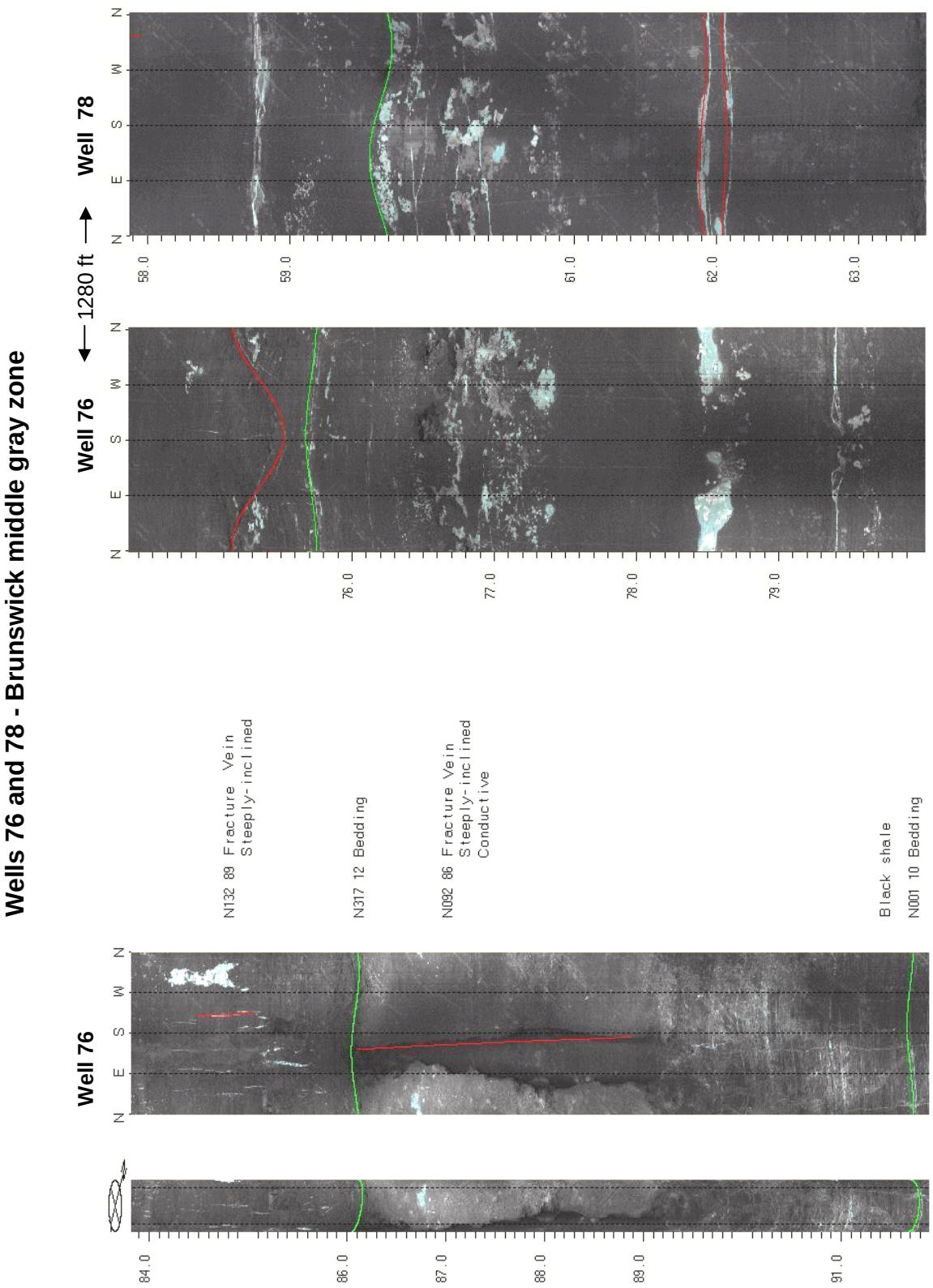
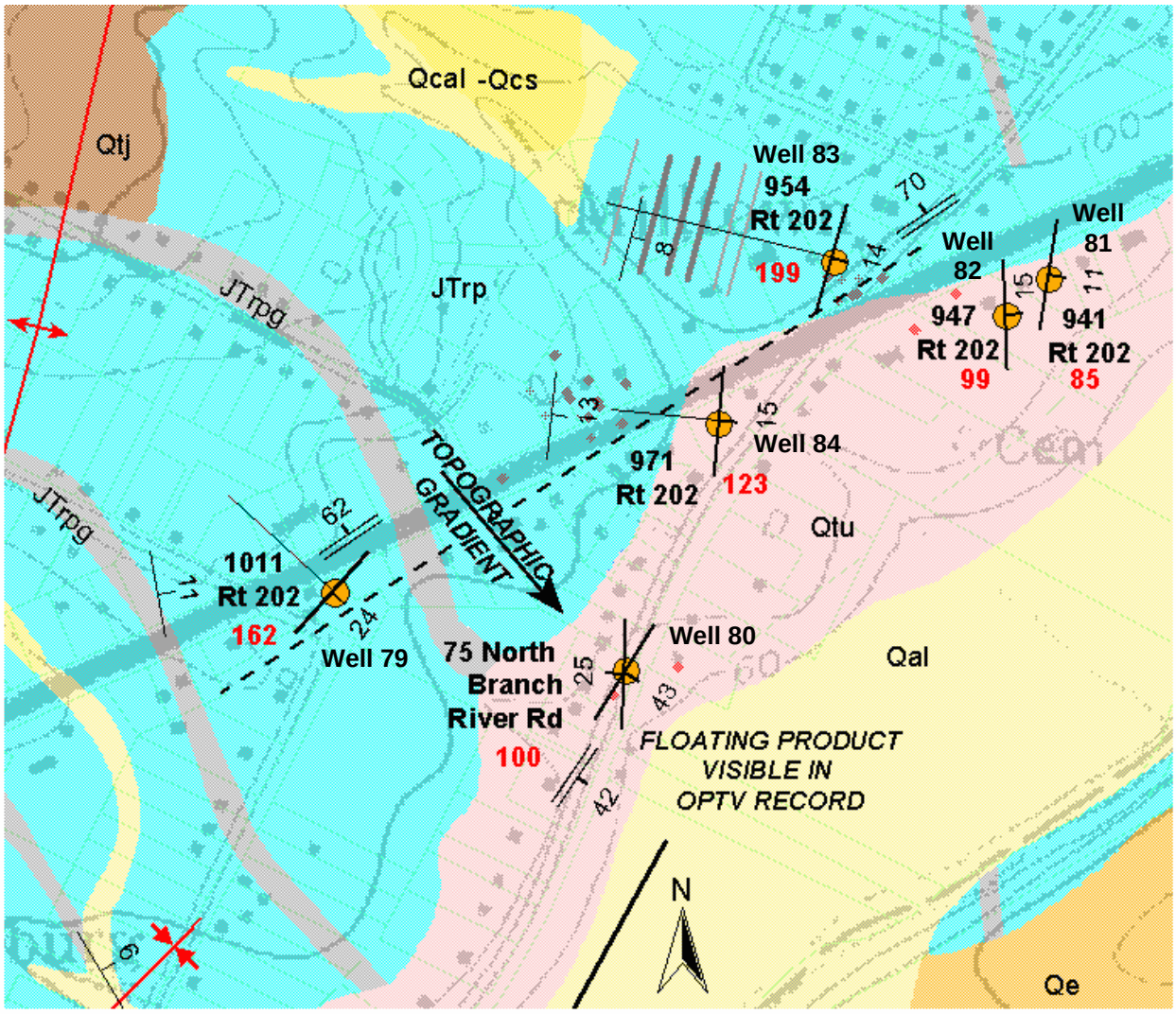


FIGURE 314. OPTV record of 6-inch diameter well 76 (left) showing geologic structures and conductive features in red and gray mudstone and gray shale. A stratigraphic correlation of wells 76 and 78 is shown at right. Depth values are in feet below land surface.

Wells 79 to 84 - Brunswick middle gray zone



BASE MAP FROM THE US GEOLOGICAL SURVEY RARITAN, NJ 7-1/2' TOPOGRAPHIC QUADRANGLE

EXPLANATION:

Well 83 — Well with optical televiewer survey by the NJGS. Line trace shows the map distance of inclined strata that the well intercepts. Address and depth noted for each well. Projected map trace of gray and black shale beds intercepted by well shown.

24 — Bedding strike and dip

42 — Small fault strike and dip

Normal fault, dashed where inferred

Axial trace of anticline

Axial trace of syncline

500 0 500 Feet

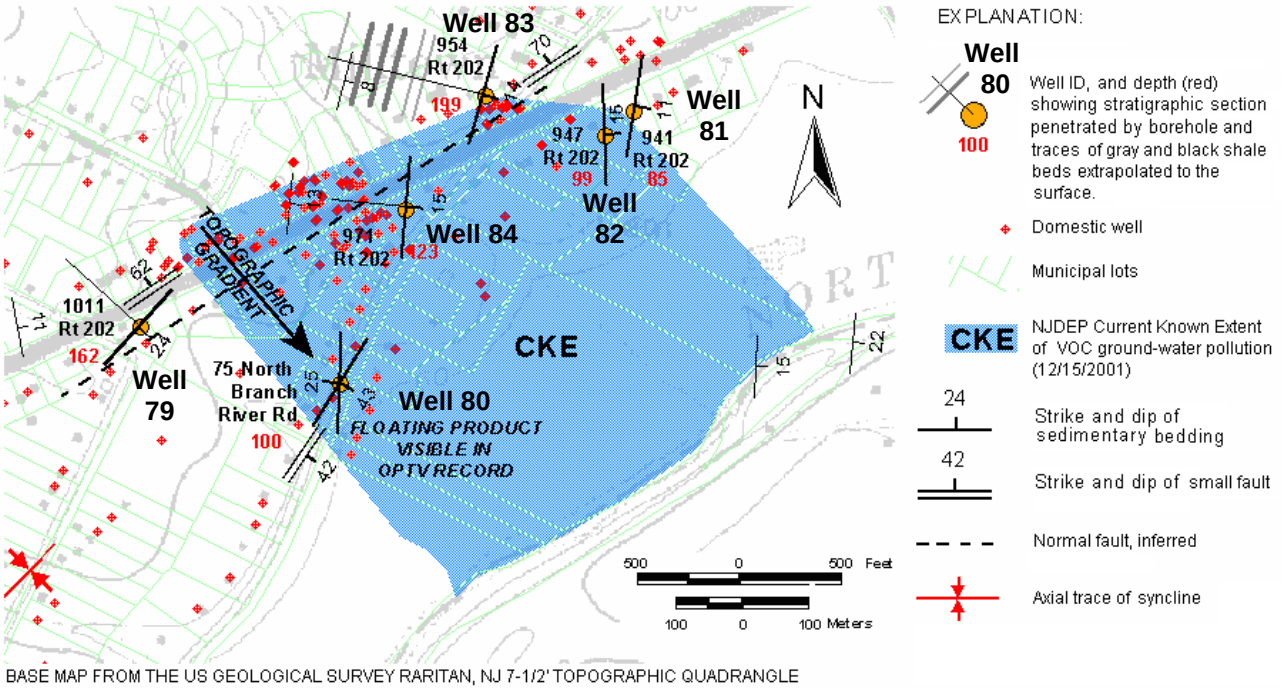
100 0 100 200 Meters

Jurassic-Triassic bedrock	JTrp	Passaic Formation
	JTrpg	Passaic Formation gray bed sequence
Quaternary sand and gravel	Qal	Alluvium
	Qcal	Colluvium and alluvium
	Qcs	Shale colluvium
	Qe	Eolian deposits
	Qtj	Till
	Qtu	Upper terrace deposits

From NJGS Geologic Map Series GMS 03-2, Geologic Map of the Raritan Quadrangle, Hunterdon and Somerset Counties, New Jersey, Monteverde, D.H., Stanford, S.D., and Volkert, R.A., 2003.

Figure 3J1. Bedrock geology map showing wells 79 to 84 along Route 202, Branchburg Twp., Somerset County, NJ.

Wells 79 to 84 - Brunswick middle gray zone



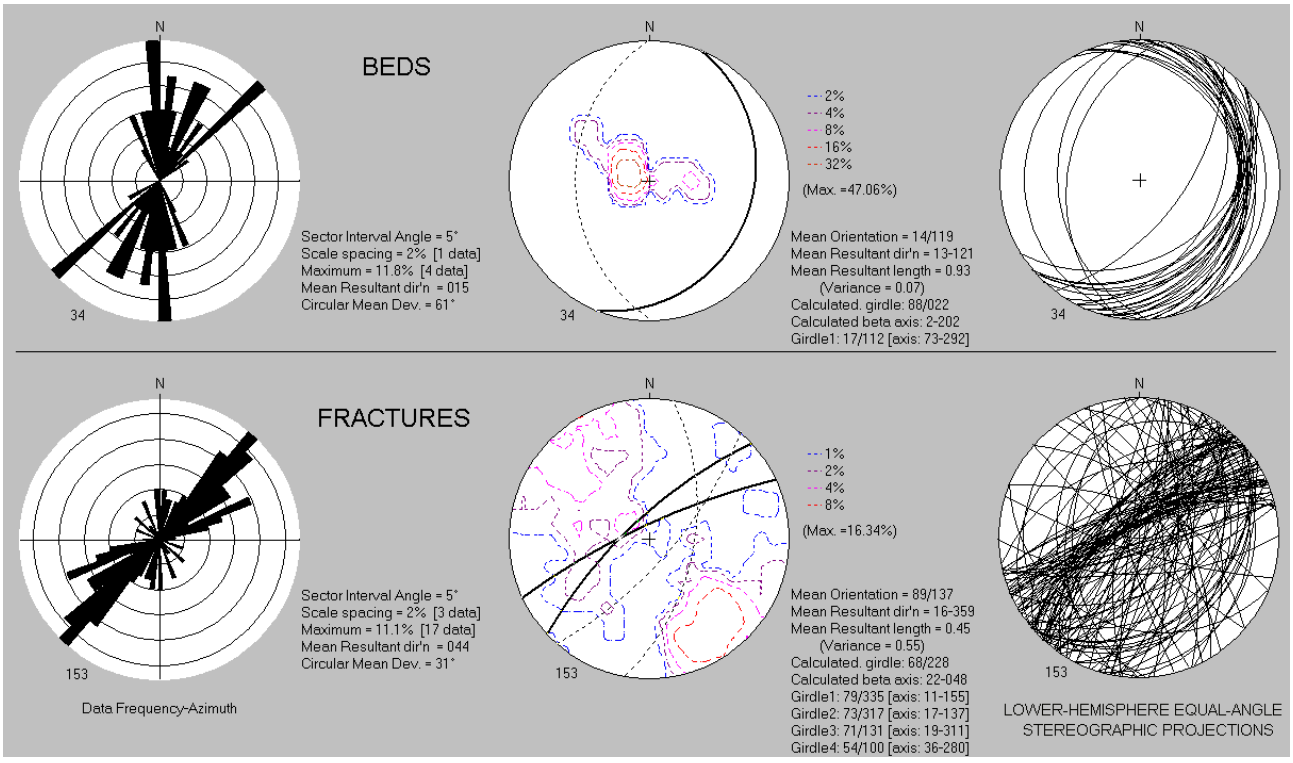


Figure 3J2. Map (above) showing the location of domestic wells and a volatile-organic-compound (VOC) plume near Route 202, Branchburg Twp., Somerset County, NJ. Structural analysis of OPTV records (below) shows bed and fracture orientations for wells 79 to 84.

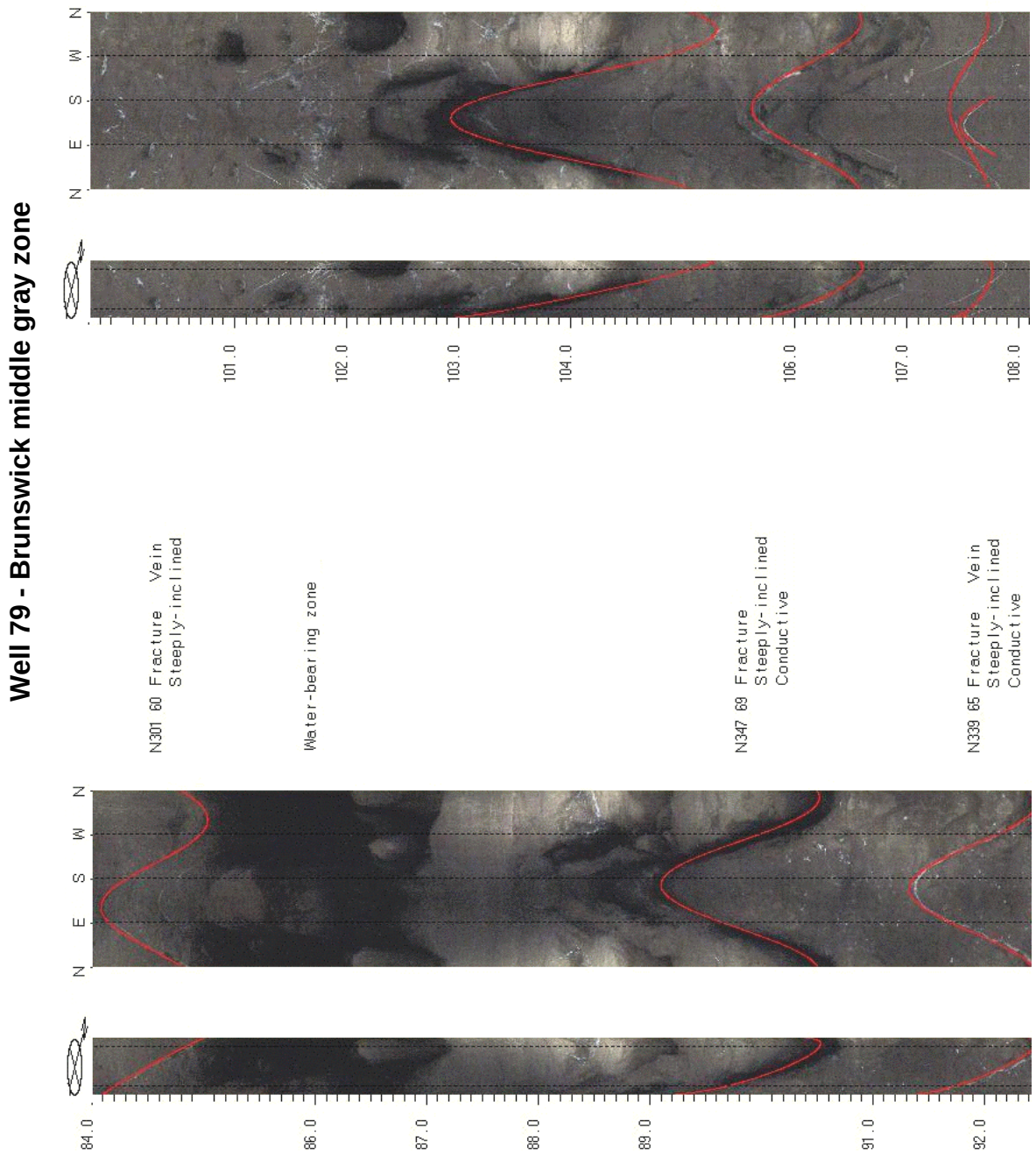


FIGURE 3J3. OPTV records of 6-inch diameter well 79 showing geologic structures and hydraulically-conductive features in red mudstone. Depth values are in feet below land surface.

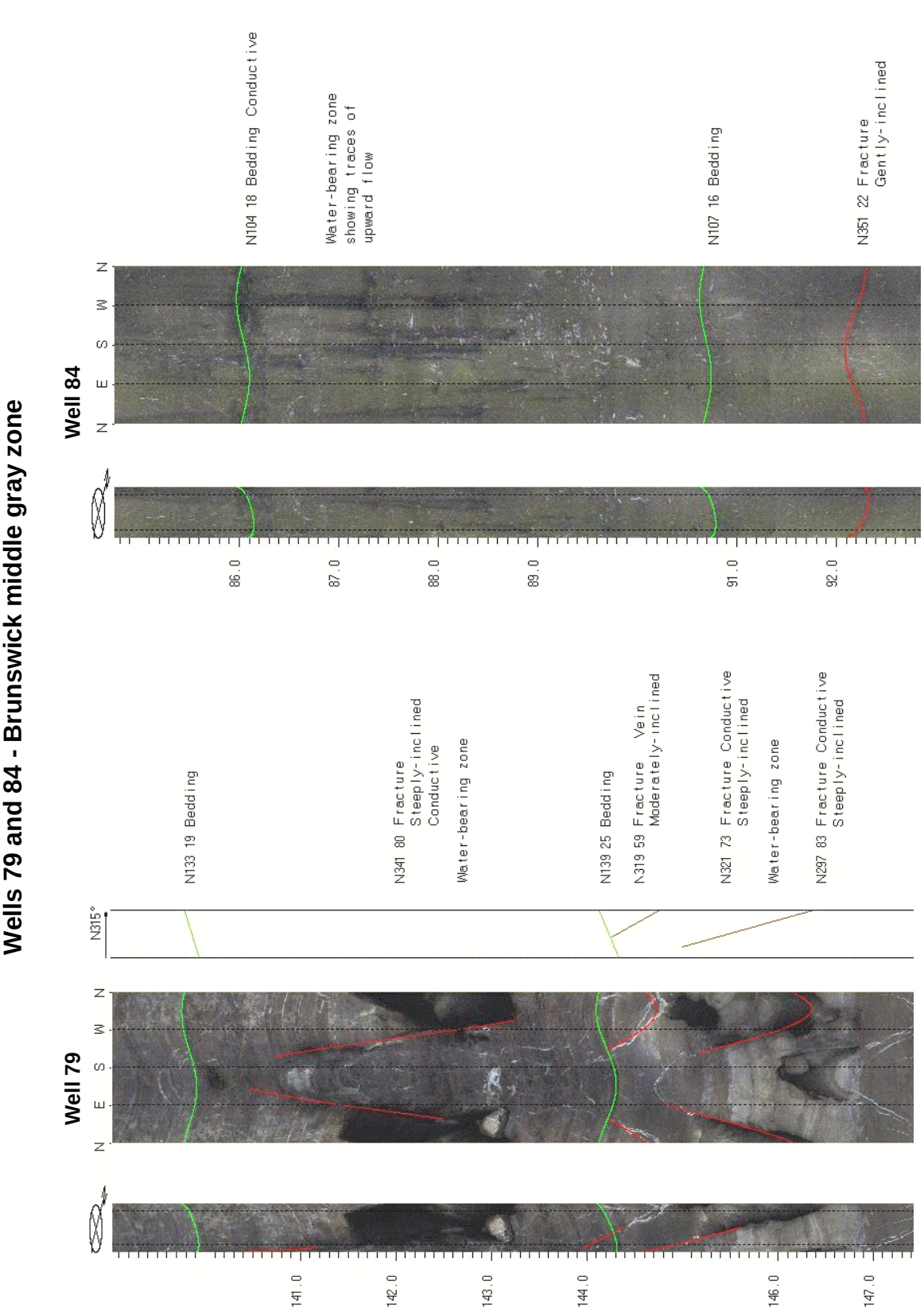


FIGURE 3J4. OPTV records of 6-inch diameter wells 79 (left) and 84 *right) showing geologic structures and hydraulically-conductive features in red mudstone and gray shale. Upward-tapering mineral stains emanating from conductive pores (right) indicate upward, non-pumping cross flow in well 84. Depth values are in feet below land surface.

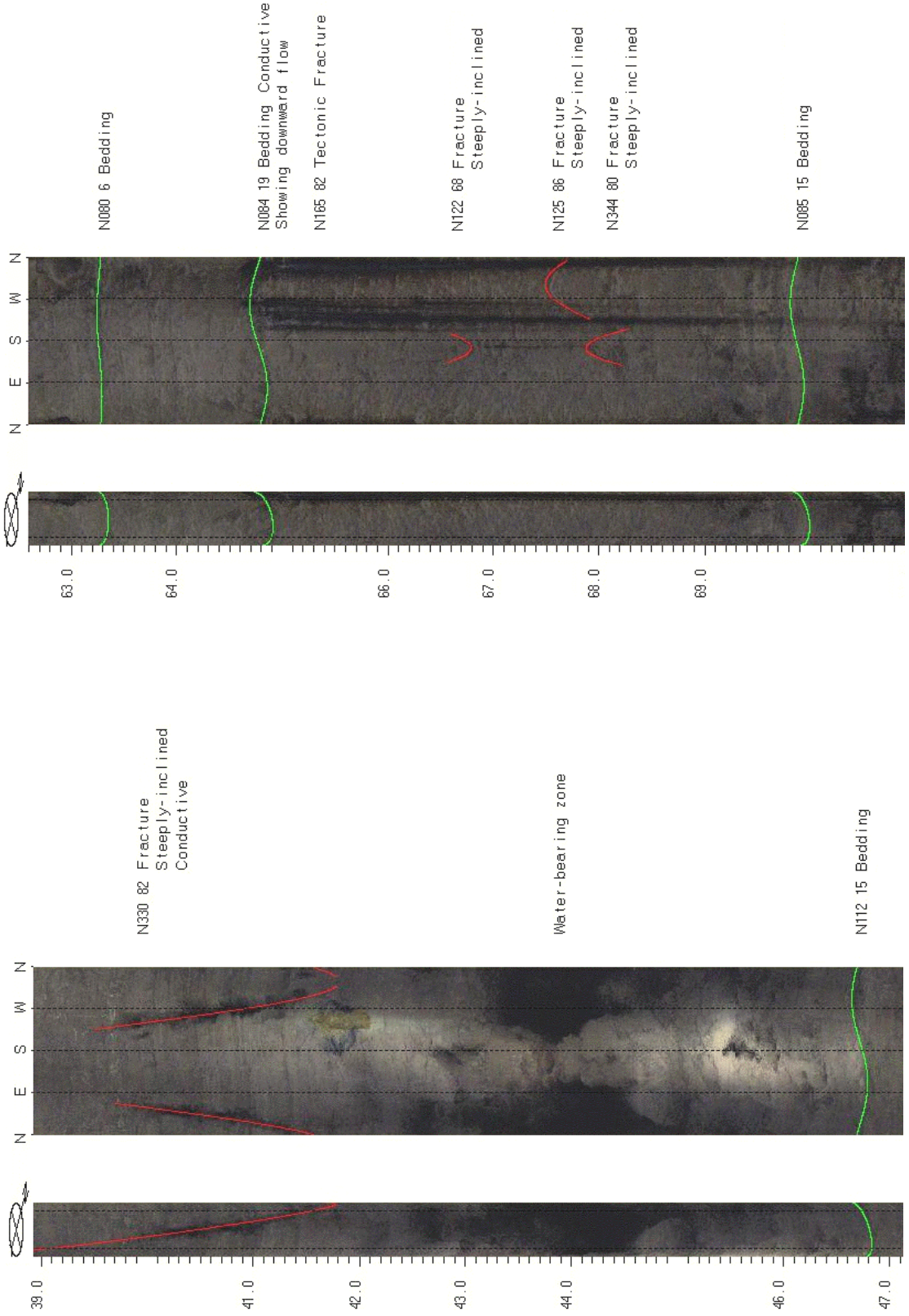


FIGURE 3J5. OPTV records of 6-inch diameter well 81showing geologic structures and hydraulically-conductive features in red and gray mudstone. Downward-tapering stains emanating from pores (right) may indicate pumping-induced flows. Depth values are in feet below land surface.

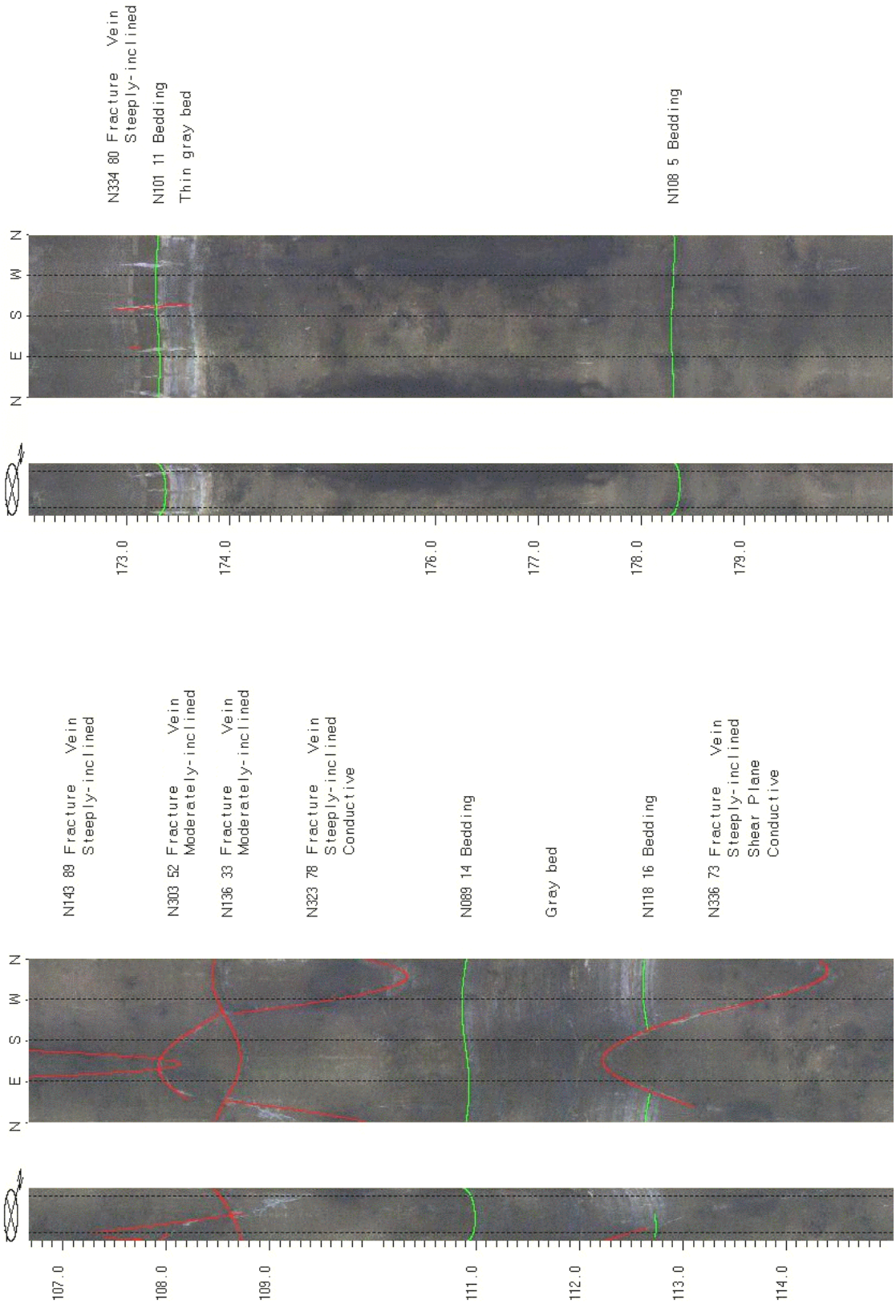
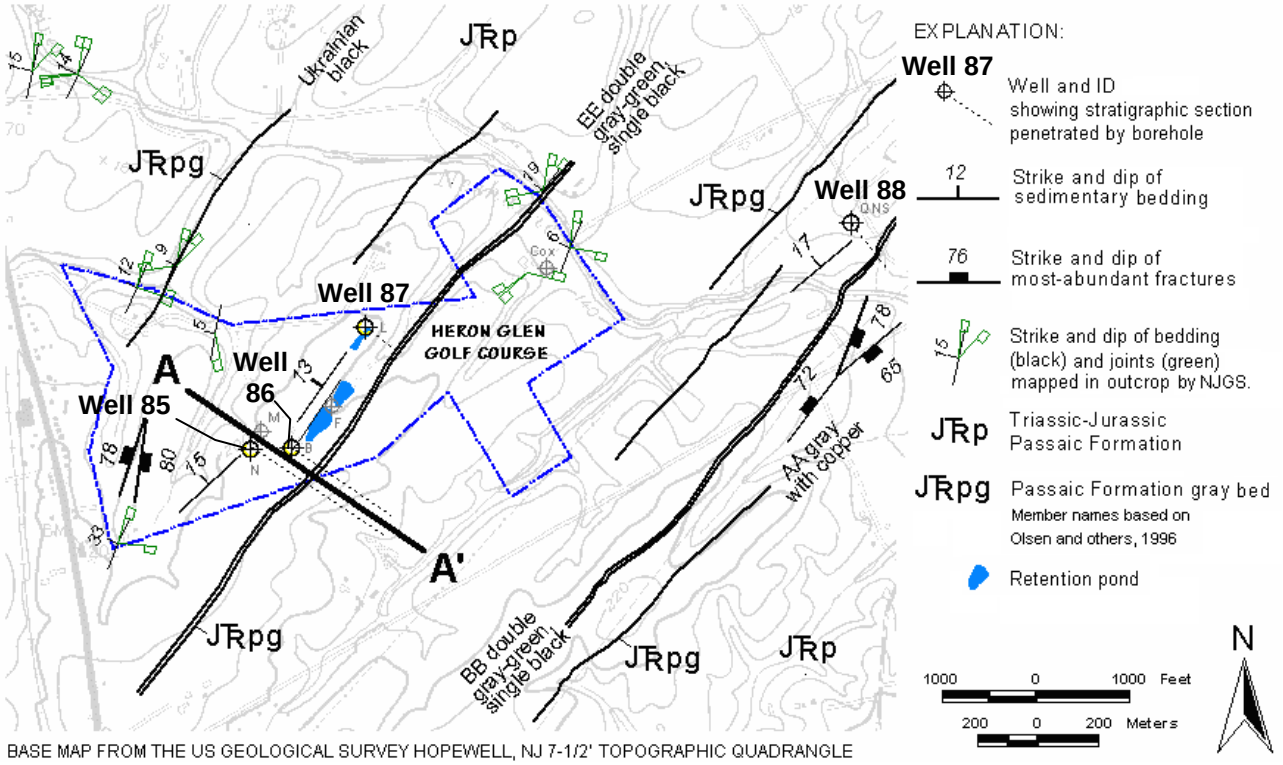


FIGURE 3J6. OPTV records of 6-inch diameter well 83 showing geologic structures and hydraulically-conductive features in red mudstone and gray shale. Note the shear plane (lower left) corresponding to the small-fault symbol mapped on figure 3J1. Depth values are in feet below land surface.

Wells 85 to 88 - Brunswick middle gray and lower red zones



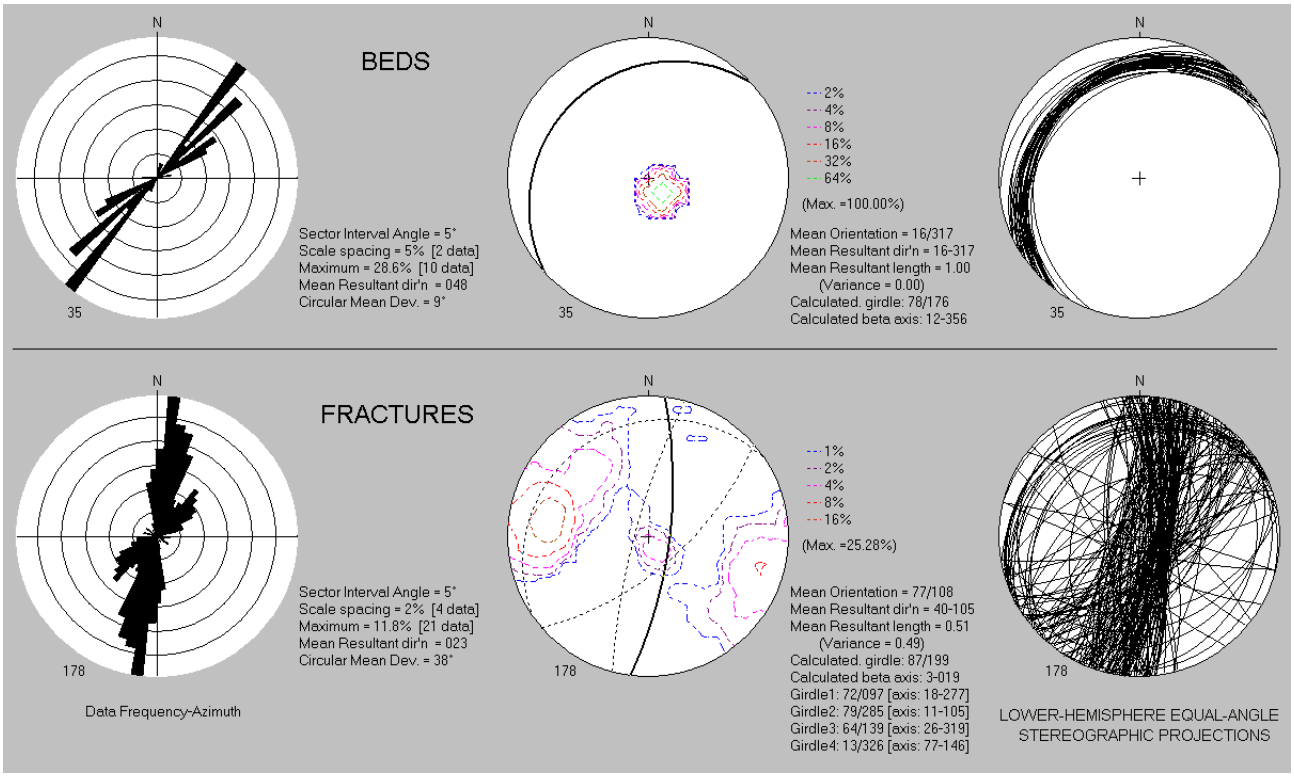


Figure 3K1. Map (above) showing wells 85 to 88 on and near the Heron Glen Golf Course, Rt. 202/31 N, Raritan Twp., Hunterdon County, NJ. Bedrock structures mapped near wells based on a structural analysis of OPTV data for wells 85 and 88 (below).

Wells 85 through 87 - Brunswick middle gray zone

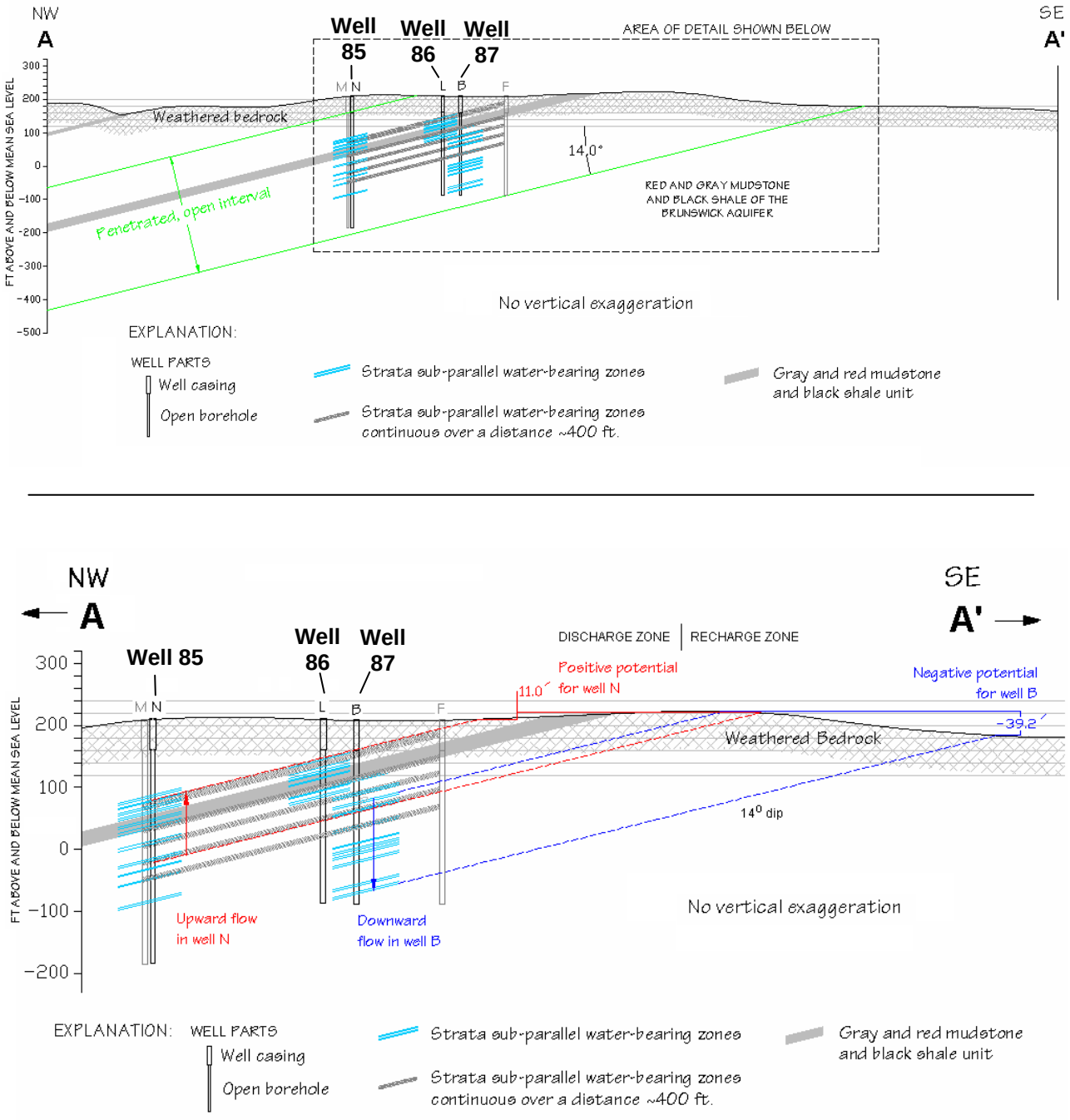


Figure 3K2. Hydrogeologic sections of the Heron Glen Golf Course well field, Rt. 202/31 N, Raritan Twp., Hunterdon County, NJ. Location of generalized section (above) shown on figure 3K1. Section details (below) show different cross-flow directions in wells 85 and 87 while pumping irrigation wells M and F at a combined rate of ~500 gpm. Flowing intervals are projected to land surface and shown in relation to topographic variations in the ground-water discharge and recharge zones.

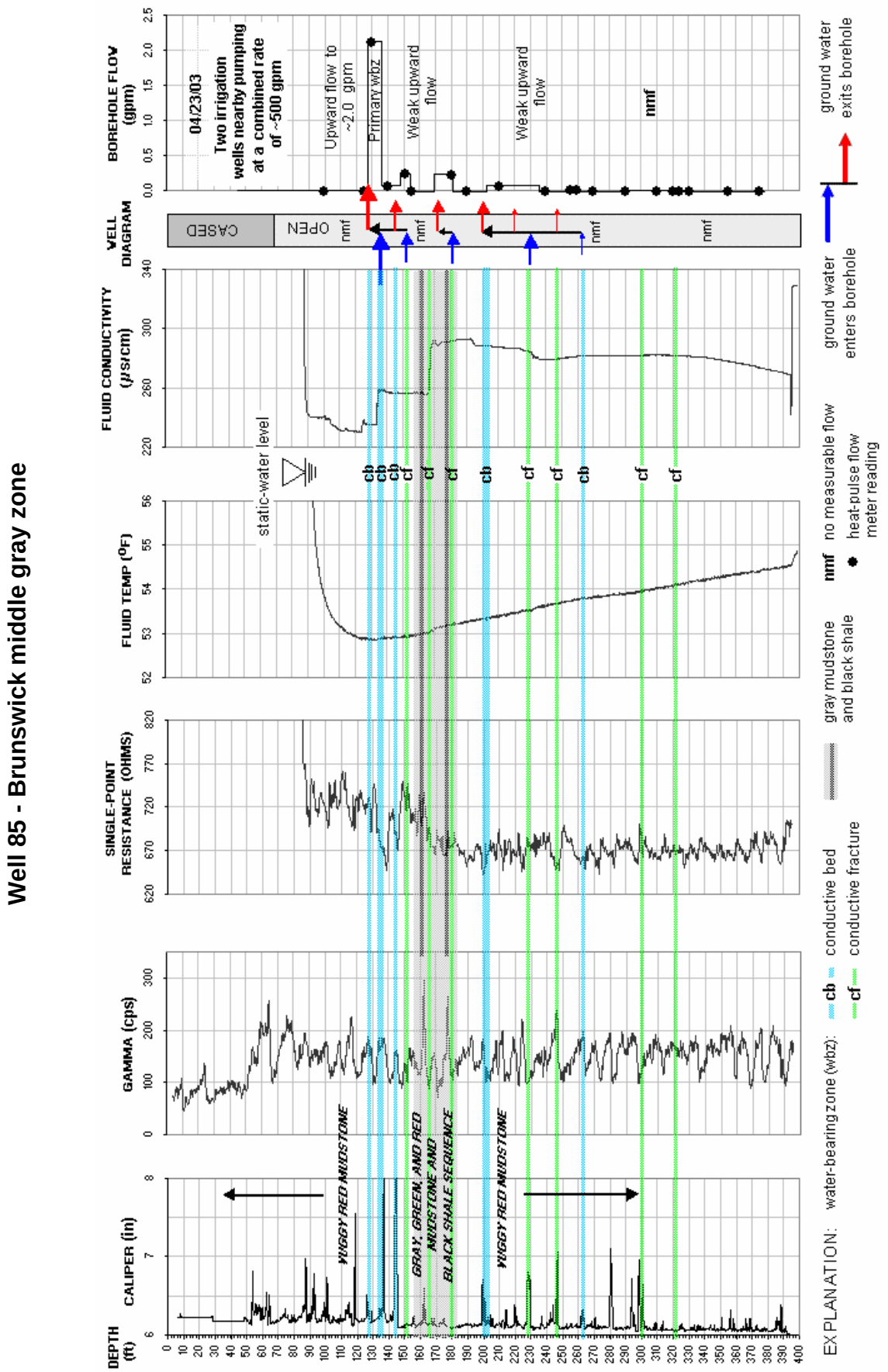


FIGURE 3K3. Hydrogeologic section based on geophysical logs for well 85 at the Heron Glen Golf Course, Rt. 202/31 N, Raritan Twp., Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray and black shale. Depth values are in feet below land surface.

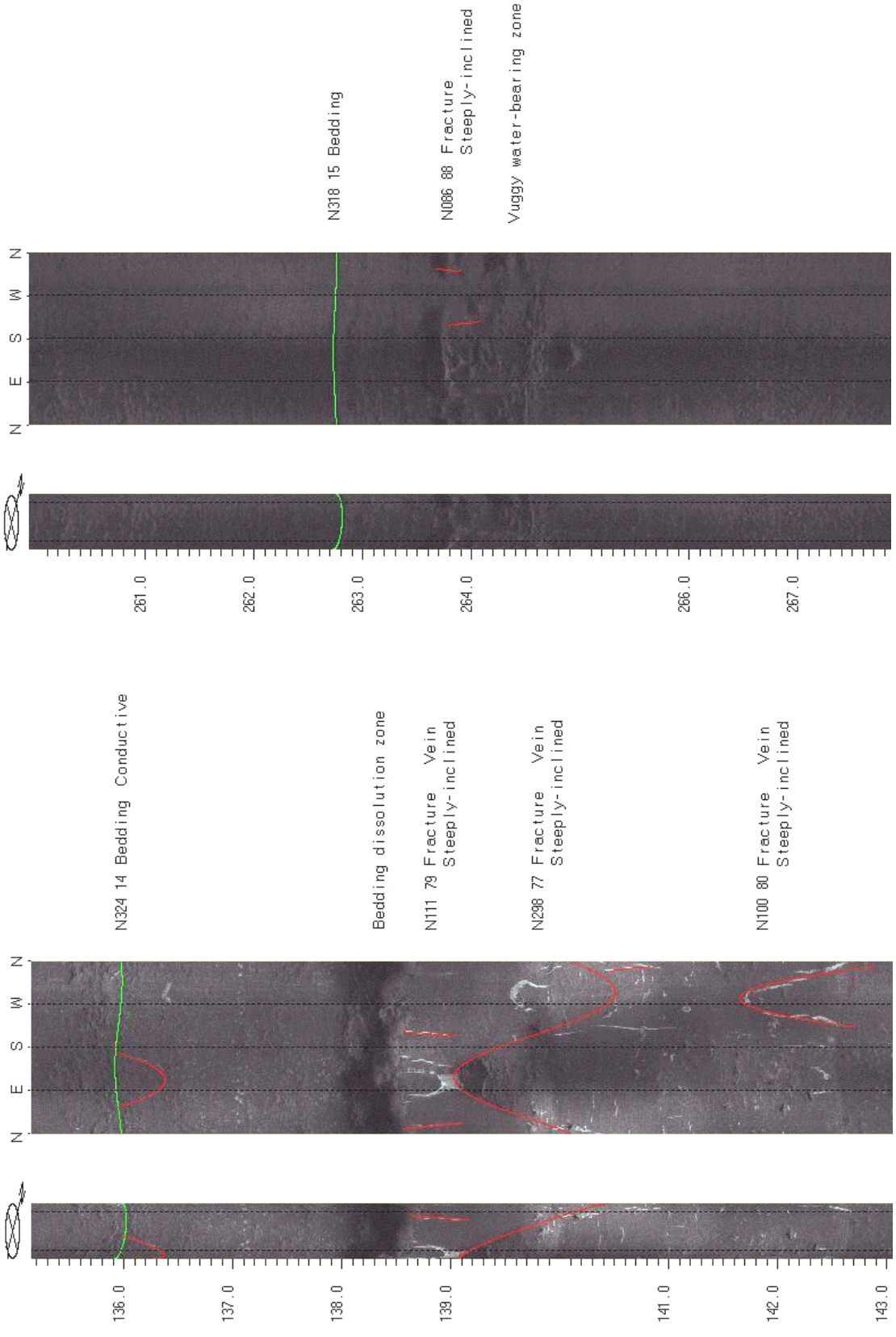


FIGURE 3K4. OPTV records of 6-inch diameter well 85 showing geologic structures and hydraulically-conductive features in red mudstone. Depth values are in feet below land surface.

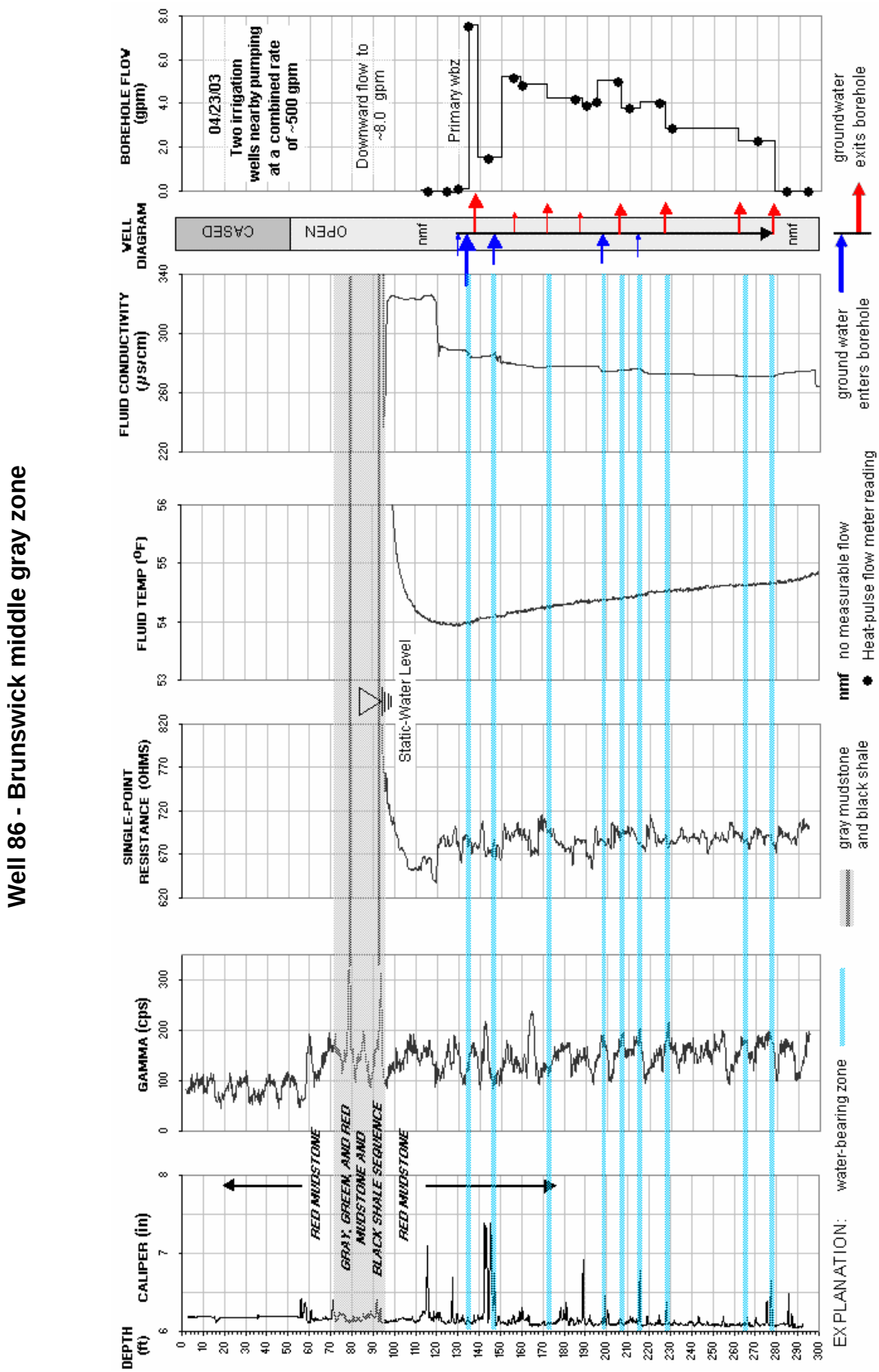


FIGURE 3K5. Hydrogeologic section based on geophysical logs for well 86 at the Heron Glen Golf Course, Rt. 202/31 N, Raritan Twp., Hunterdon County, NJ. The section shows the vertical distribution of water-bearing zones in red and gray mudstone and black shale. Depth values are in feet below land surface.

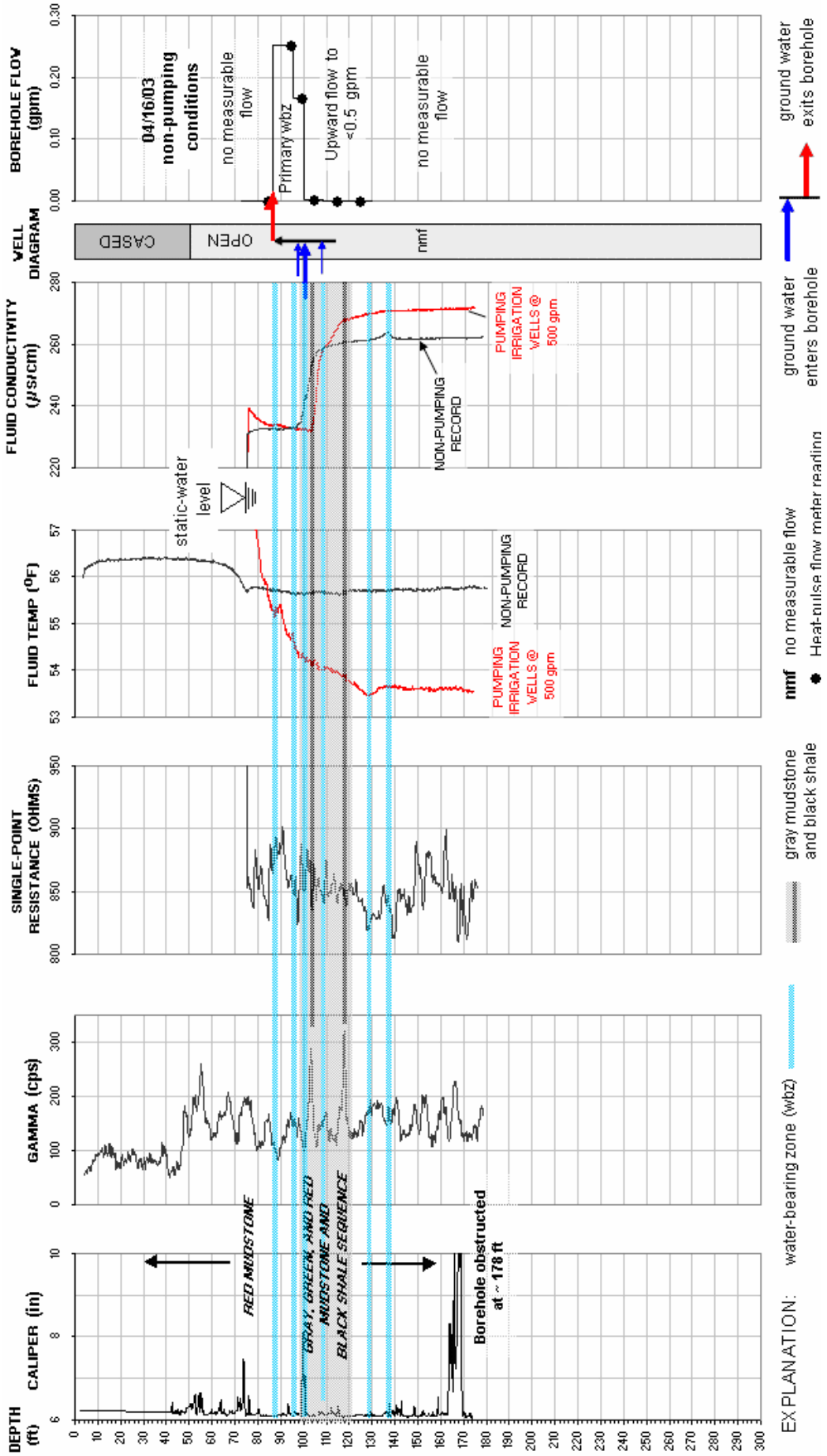


FIGURE 3K6. Hydrogeologic section based on geophysical logs for well 87 at the Heron Glen Golf Course, Rt. 202/31 N, Raritan Twp., Hunterdon County, NJ. The section shows the vertical distribution of water-bearing zones in red and gray mudstone and black shale. Depth values are in feet below land surface.

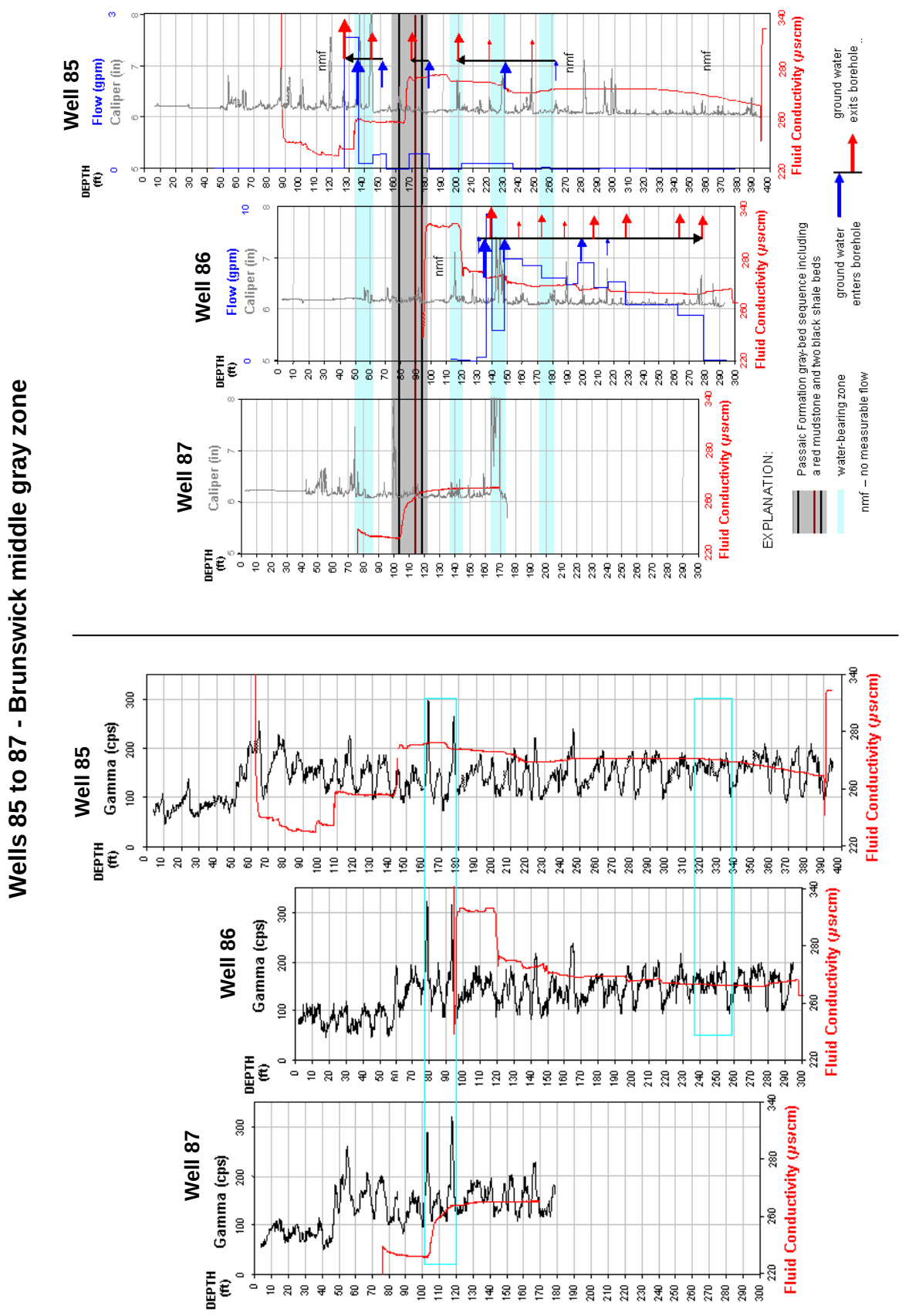


FIGURE 3K7. Stratigraphic correlation based on geophysical logs for wells 85 to 87 at the Heron Glen Golf Course, Rt. 202/31 N, Raritan Twp., Hunterdon County, NJ. The natural gamma logs (left) are used to establish the stratigraphic correlation. The caliper, fluid conductivity and flow logs (right) correlate water-bearing zones. Depth values are in feet below land surface.

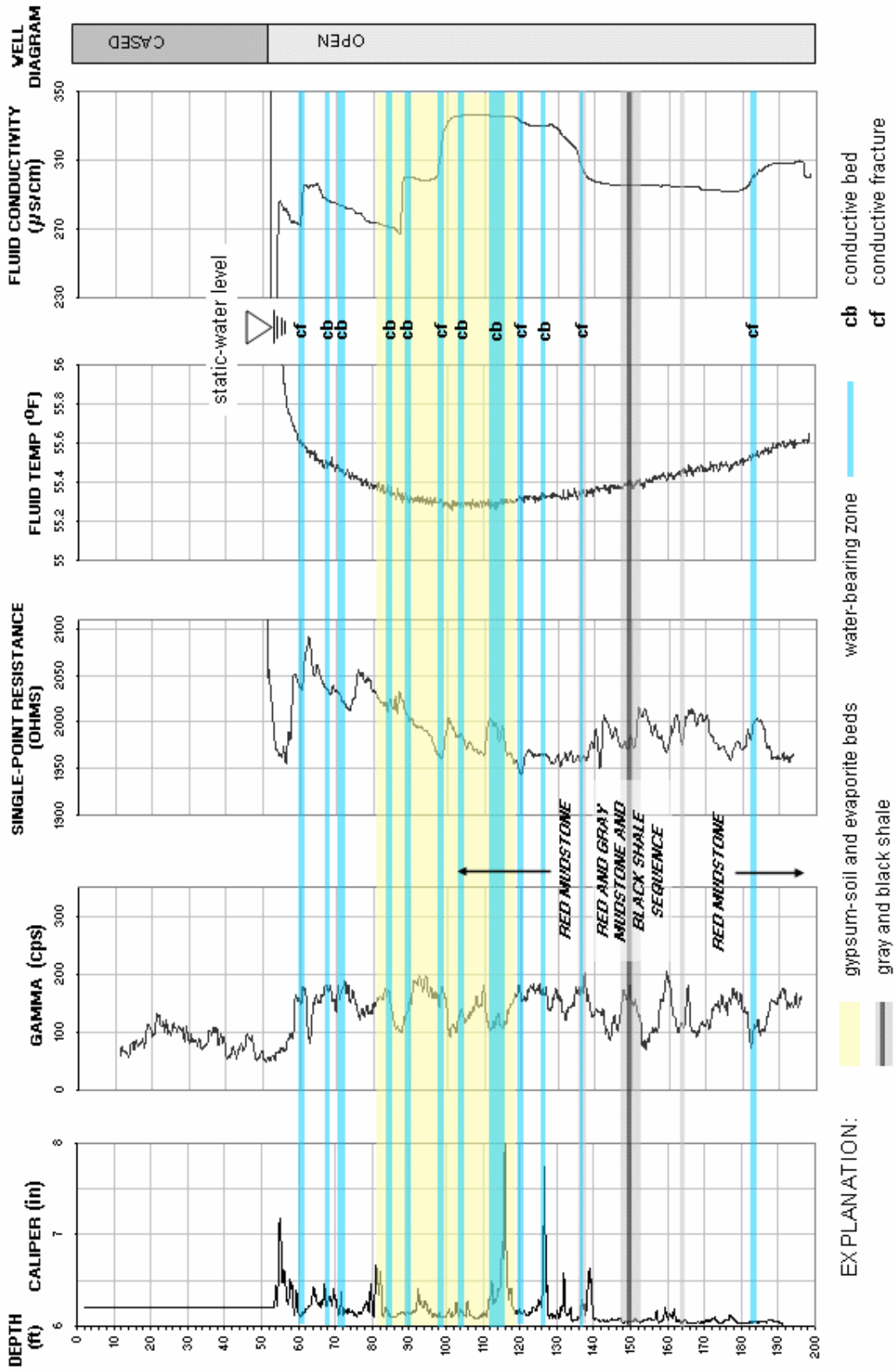


FIGURE 3K8. Hydrogeologic section based on geophysical logs for well 88, Reaville, Ave., Raritan Twp., Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray and black shale. Depth values are in feet below land surface.

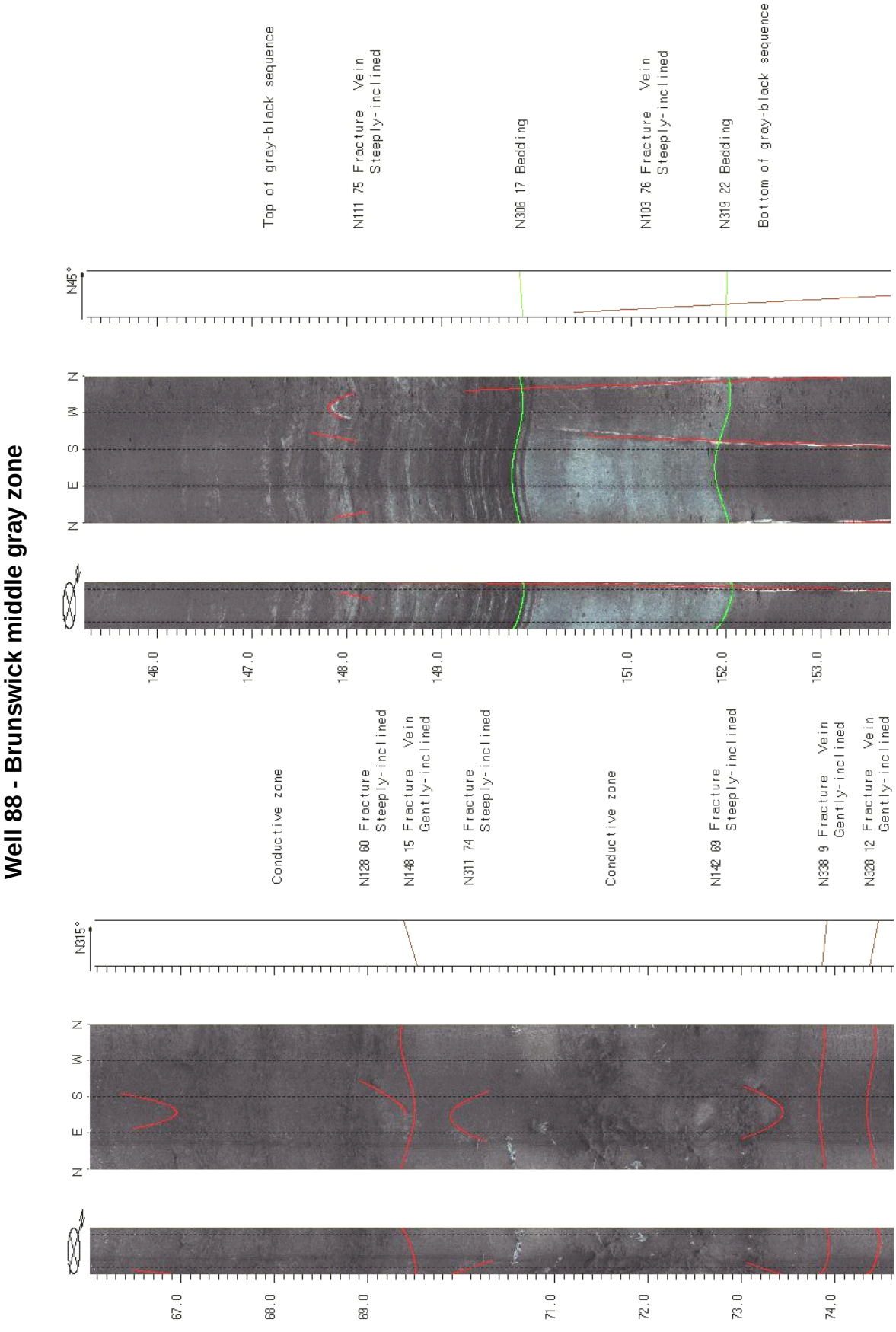


FIGURE 3K9. OPTV records of 6-inch diameter well 88 showing geologic structures and hydraulically-conductive features in red and gray mudstone and gray and black shale. Depth values are in feet below land surface.

Well 89 - Brunswick lower red zone

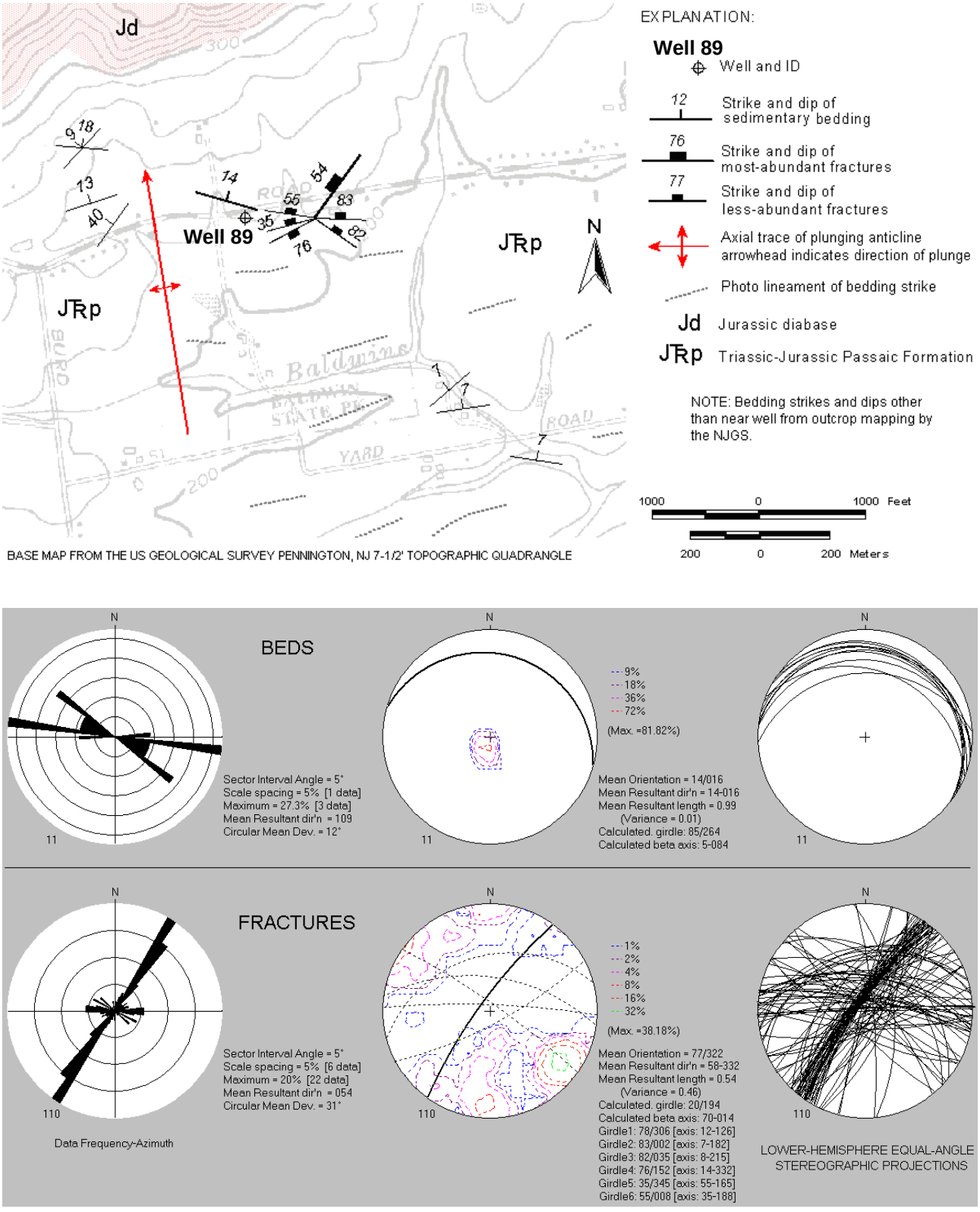


Figure 3L1. Map (above) showing well 89 off Woosamonsa Road at Harbat Farms, Hopewell Twp., Mercer County, NJ. Bedrock structures mapped near wells based on a structural analysis of OPTV data (below).

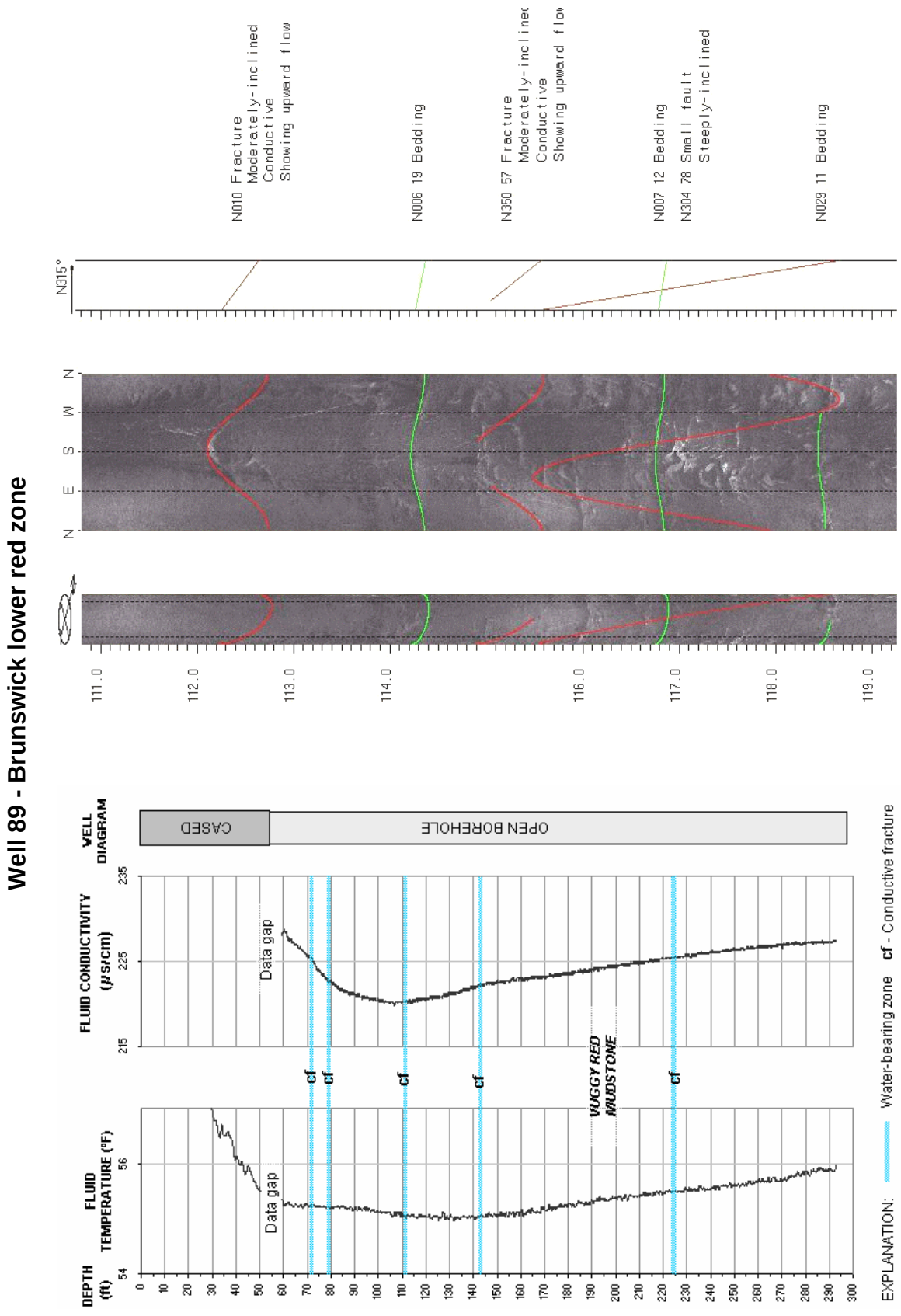


FIGURE 3L2. Hydrogeologic section (left) based on geophysical logs for well 89 at Harbat Farms, Woosamonsa Rd., Hopewell Twp., Mercer County, NJ., The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red mudstone. OPTV record (right) shows geologic structures and hydraulically -conductive fractures. Depth values are in feet below land surface.

Wells 90 to 99 - Brunswick lower red zone

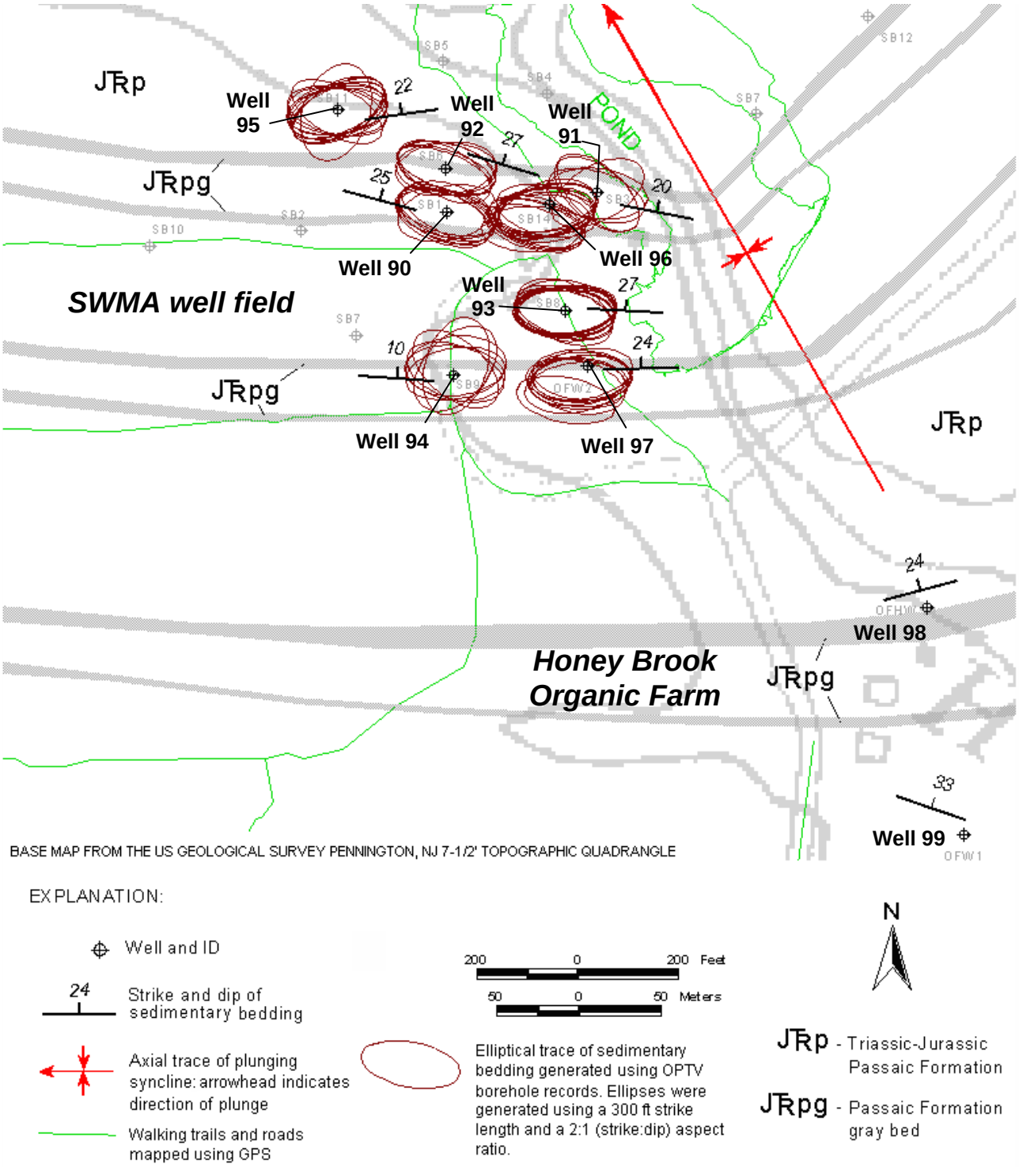
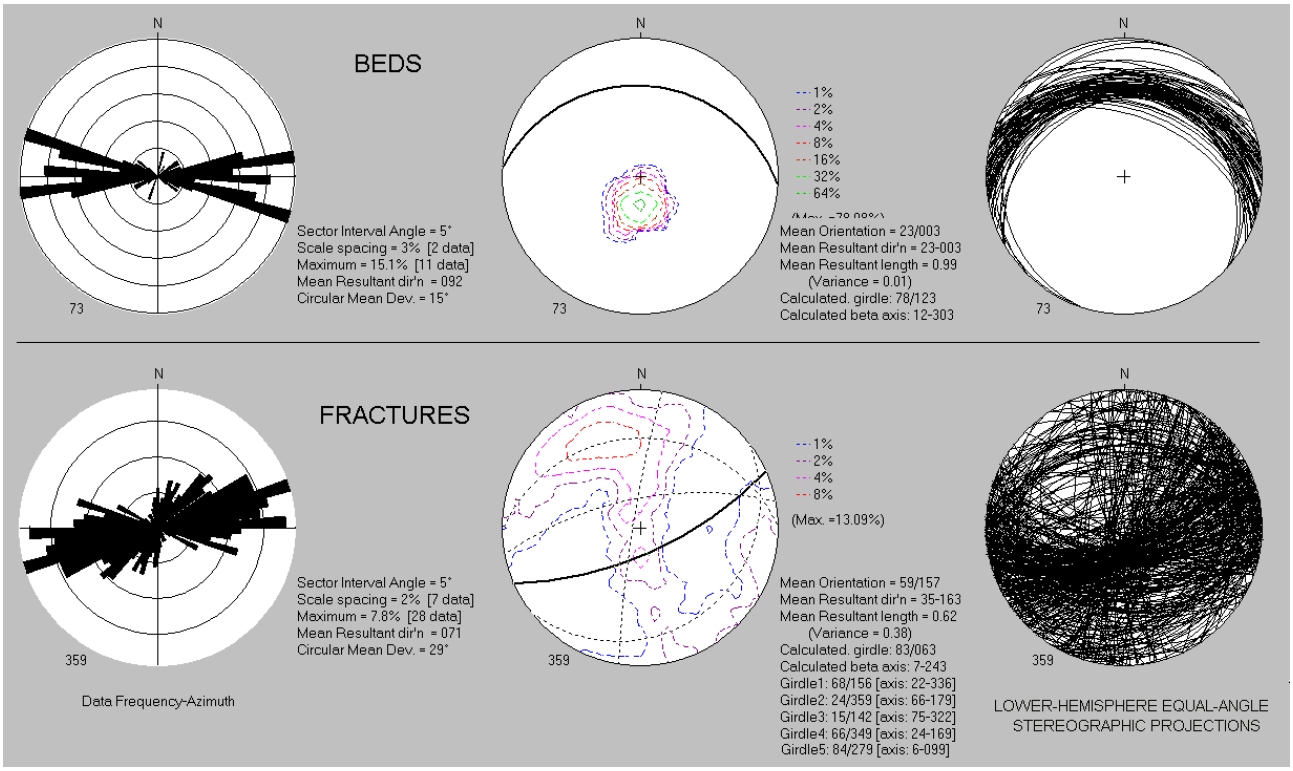


Figure 3M1. Map showing wells 90 to 99 at the Stony Brook-Millstone Watershed Association (SMWA) well field and the Honey Brook Organic Farm, Wargo Rd., Hopewell Twp., Mercer County, NJ. Bedding near wells based on structural analyses of OPTV data.

Wells 90 through 97 - Brunswick lower red zone



Wells 98 and 99 - Brunswick lower red zone

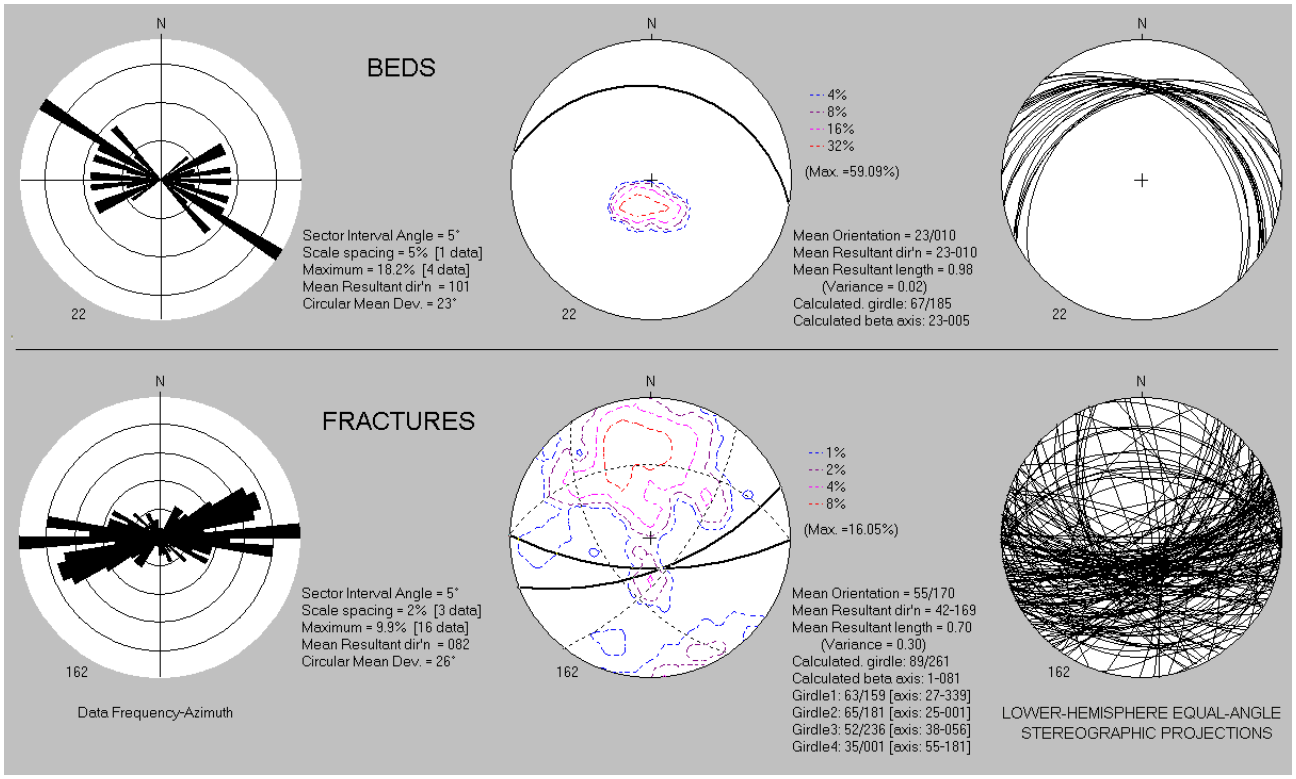


Figure 3M2. Structural analyses of OPTV records for wells 90 to 97 at the Stony Brook-Millstone Watershed Association well field (above) and wells 98 and 99 at the Honey Brook Organic Farm (below).

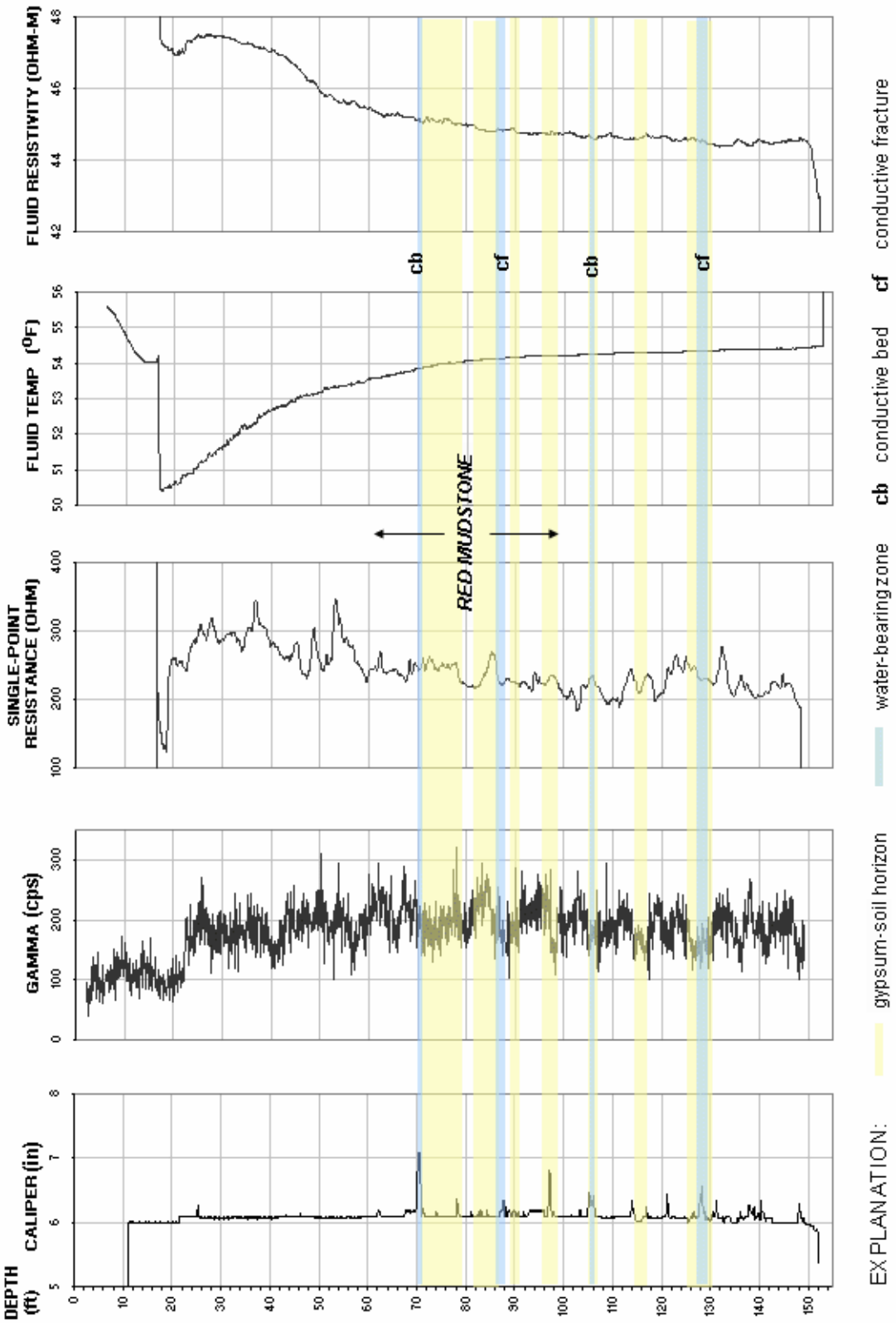


FIGURE 3M3. Hydrogeologic section based on geophysical logs for well 90 at the Stony Brook-Millstone Watershed Association well field, Wargo Rd., Hopewell Twp., Mercer County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red mudstone. Depth values are in feet below land surface.

Well 91 - Brunswick lower red zone

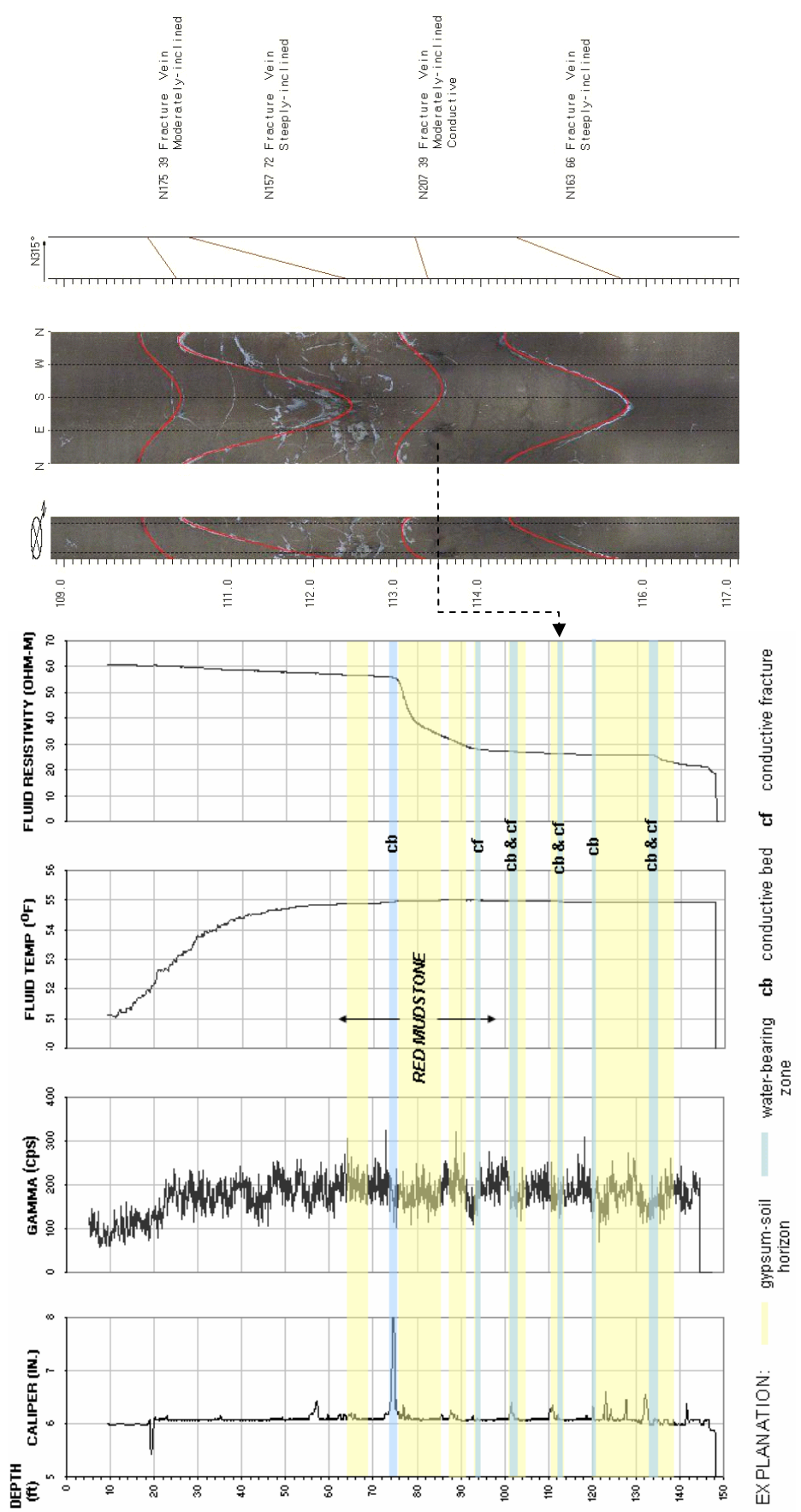


FIGURE 3M4. Hydrogeologic section (left) based on geophysical logs for well 91 at the Stony Brook-Millstone Watershed Association well field, Wargo Rd., Hopewell Twp., Mercer County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red mudstone. OPTV record (right) shows geologic structures and hydraulically-conductive features in red mudstone. Depth values are in feet below land surface.

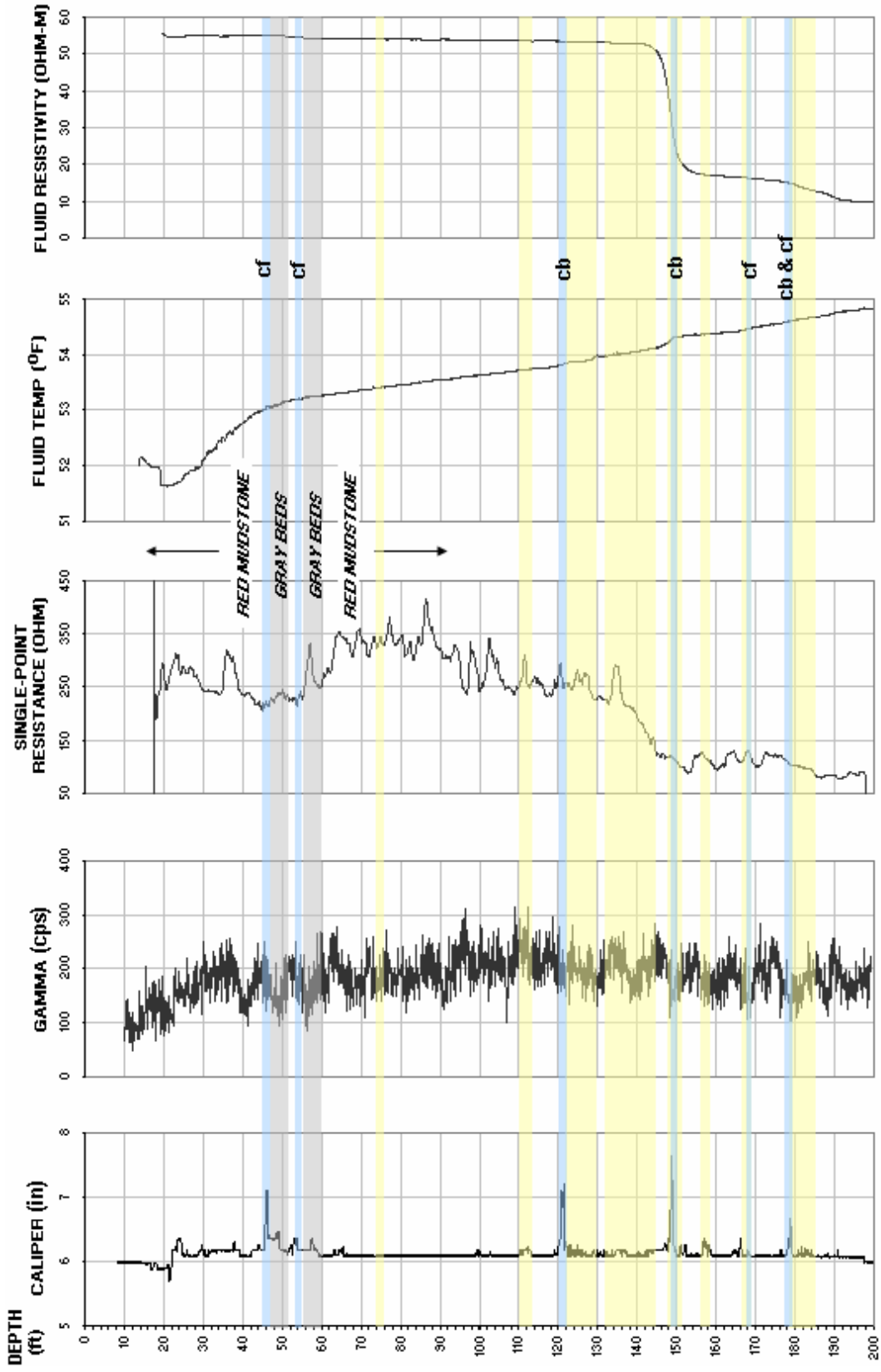


FIGURE 3M5. Hydrogeologic section based on geophysical logs for well 92 at the Stony Brook-Millstone Watershed Association well field, Wargo Rd., Hopewell Twp., Mercer County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray and shale. Depth values are in feet below land surface.

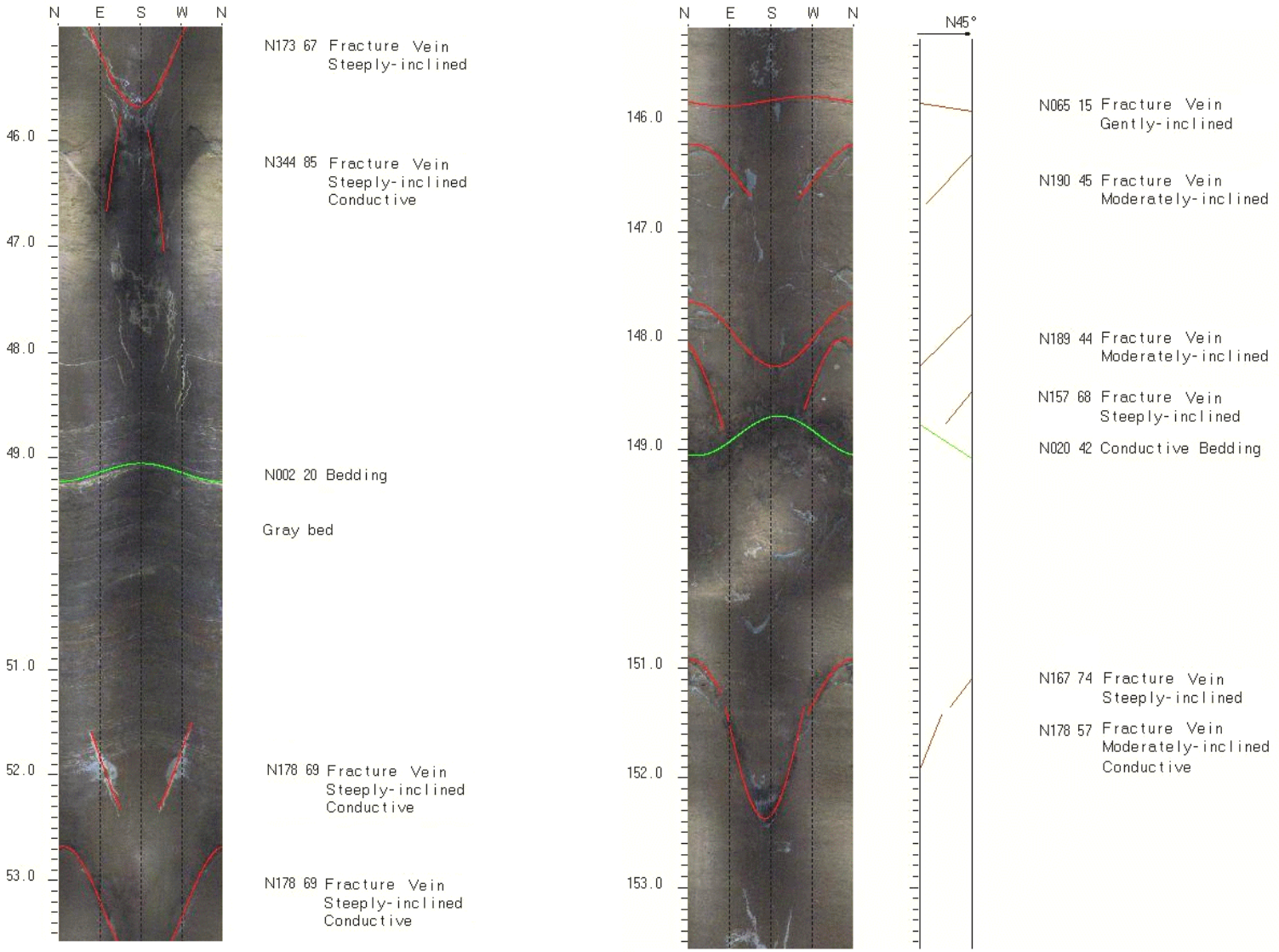


FIGURE 3M6. OPTV records of well 92 at the Stony Brook-Millstone Watershed Association well field showing geologic structures and hydraulically-conductive features in red and gray mudstone and gray shale. Depth values are in feet below land surface.

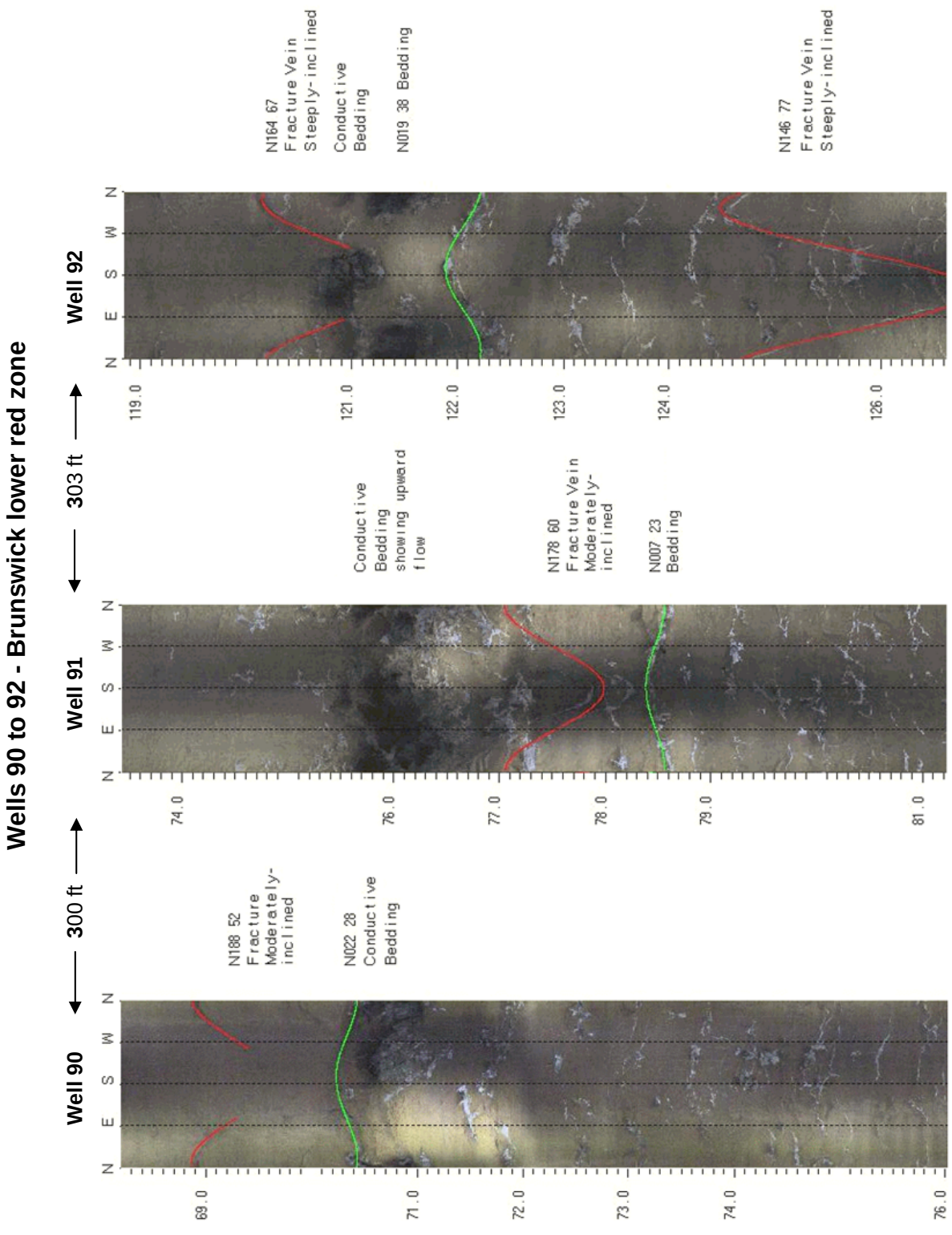


FIGURE 3M7. Stratigraphic correlation of wells 91 to 93 at the Stony Brook-Millstone Watershed Association well field based on OPTV records showing a major water-bearing zone in a gypsum-soil horizon and other geologic structures. Depth values are in feet below land surface.

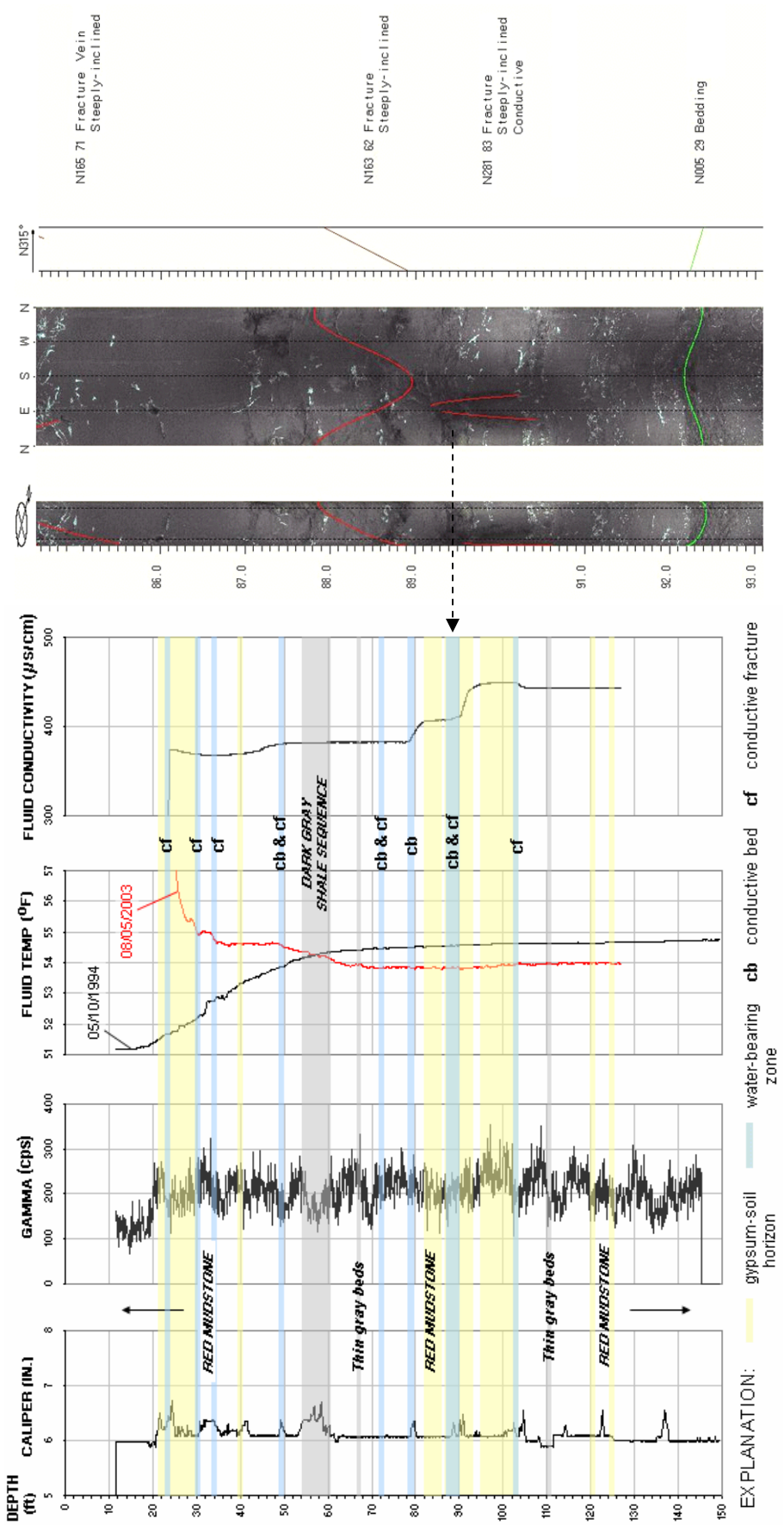


FIGURE 3M8. Hydrogeologic section (left) based on geophysical logs for well 93 at the Stony Brook-Millstone Watershed Association well field, Wargo Rd., Hopewell Twp., Mercer County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray shale. OPTV record (right) shows geologic structures and hydraulically-conductive dissolution features in red mudstone with gypsum-soil horizons. Depth values are in feet below land surface.

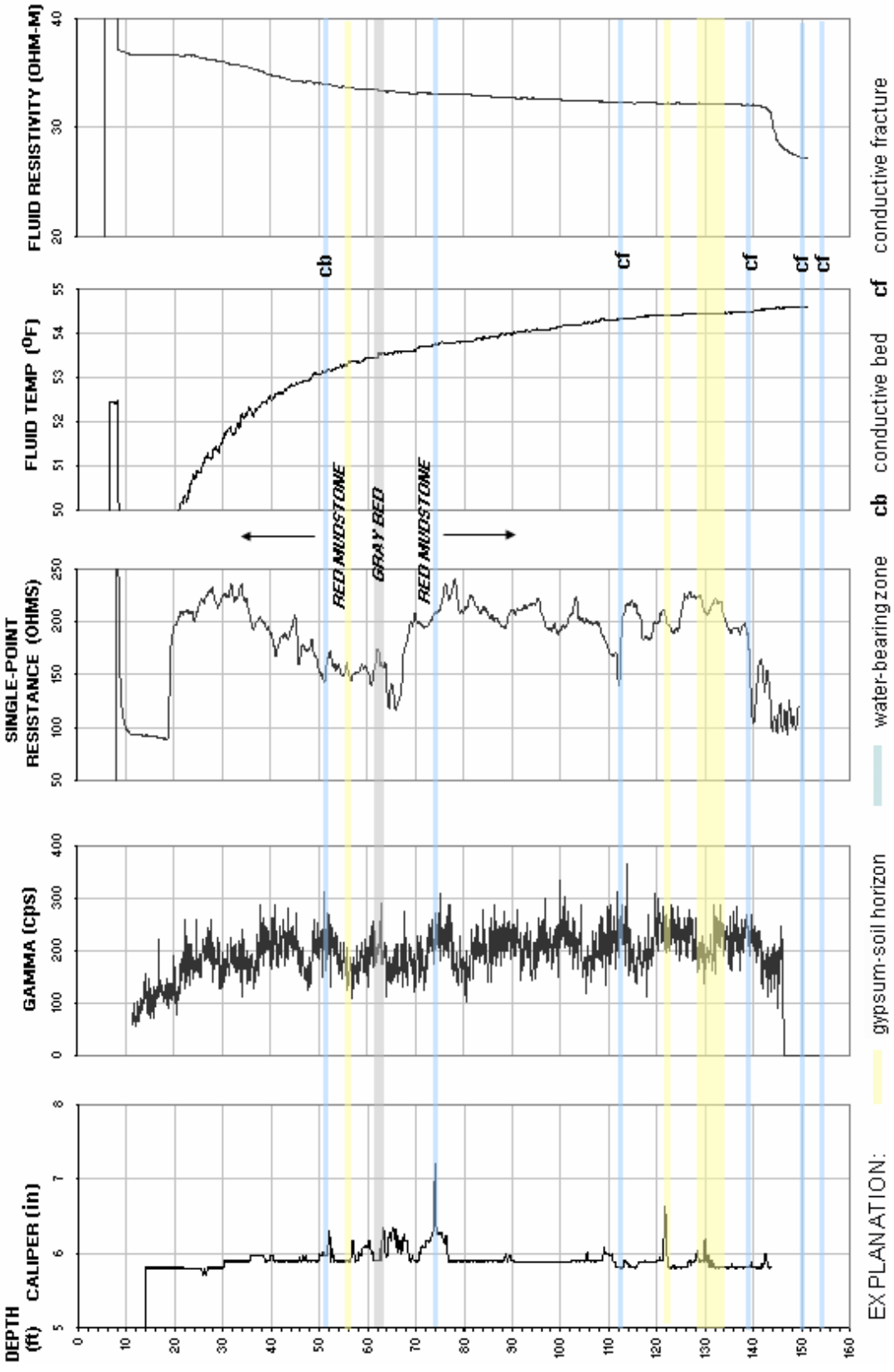


FIGURE 3M9. Hydrogeologic section based on geophysical logs for well 94 at the Stony Brook-Millstone Watershed Association well field, Wargo Rd., Hopewell Twp., Mercer County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray shale. Depth values are in feet below land surface.

Well 95 - Brunswick lower red zone

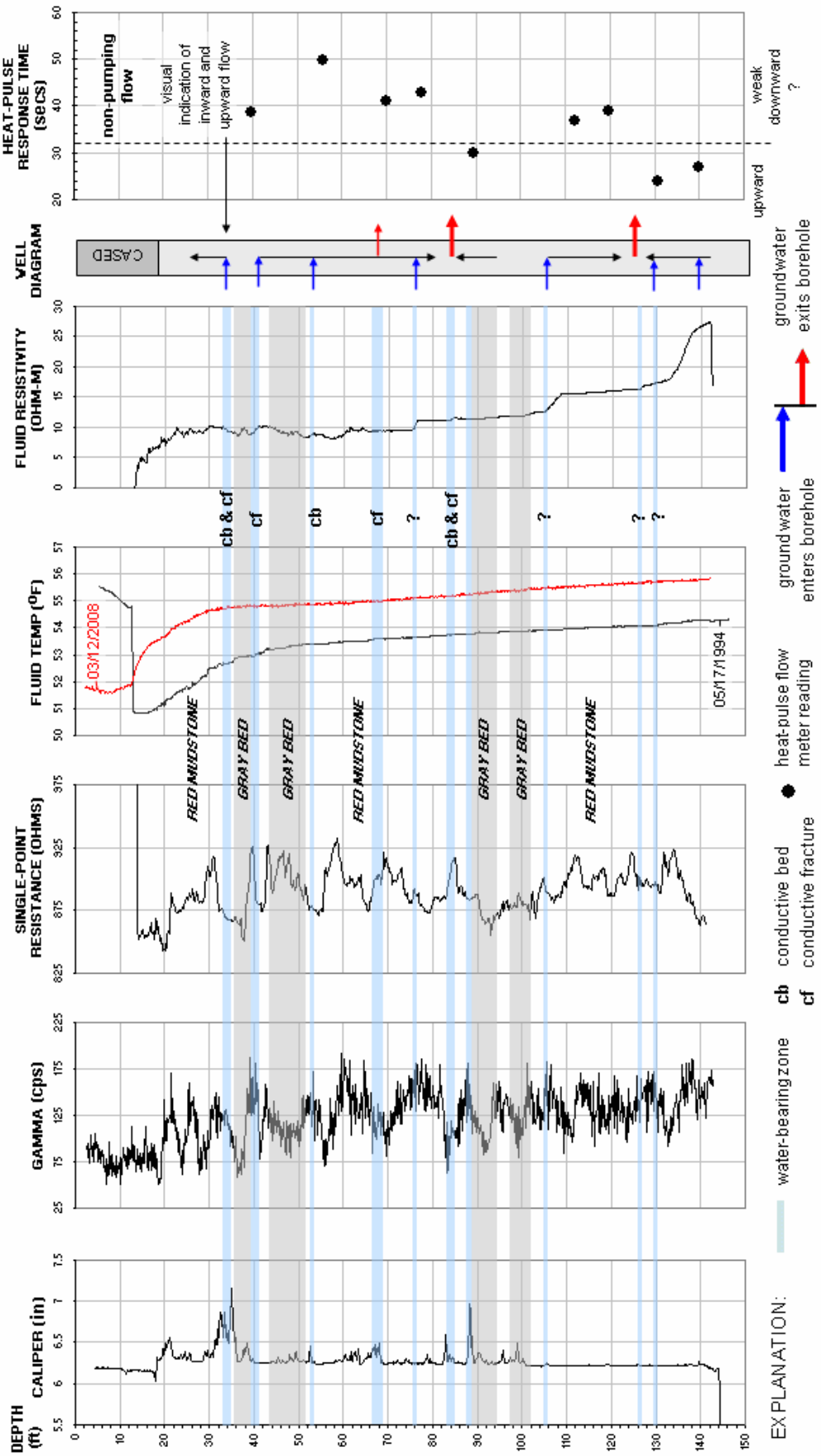


FIGURE 3M10. Hydrogeologic section based on geophysical logs for well 95 at the Stony Brook-Millstone Watershed Association well field, Wargo Rd., Hopewell Twp., Mercer County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray shale. Depth values are in feet below land surface.

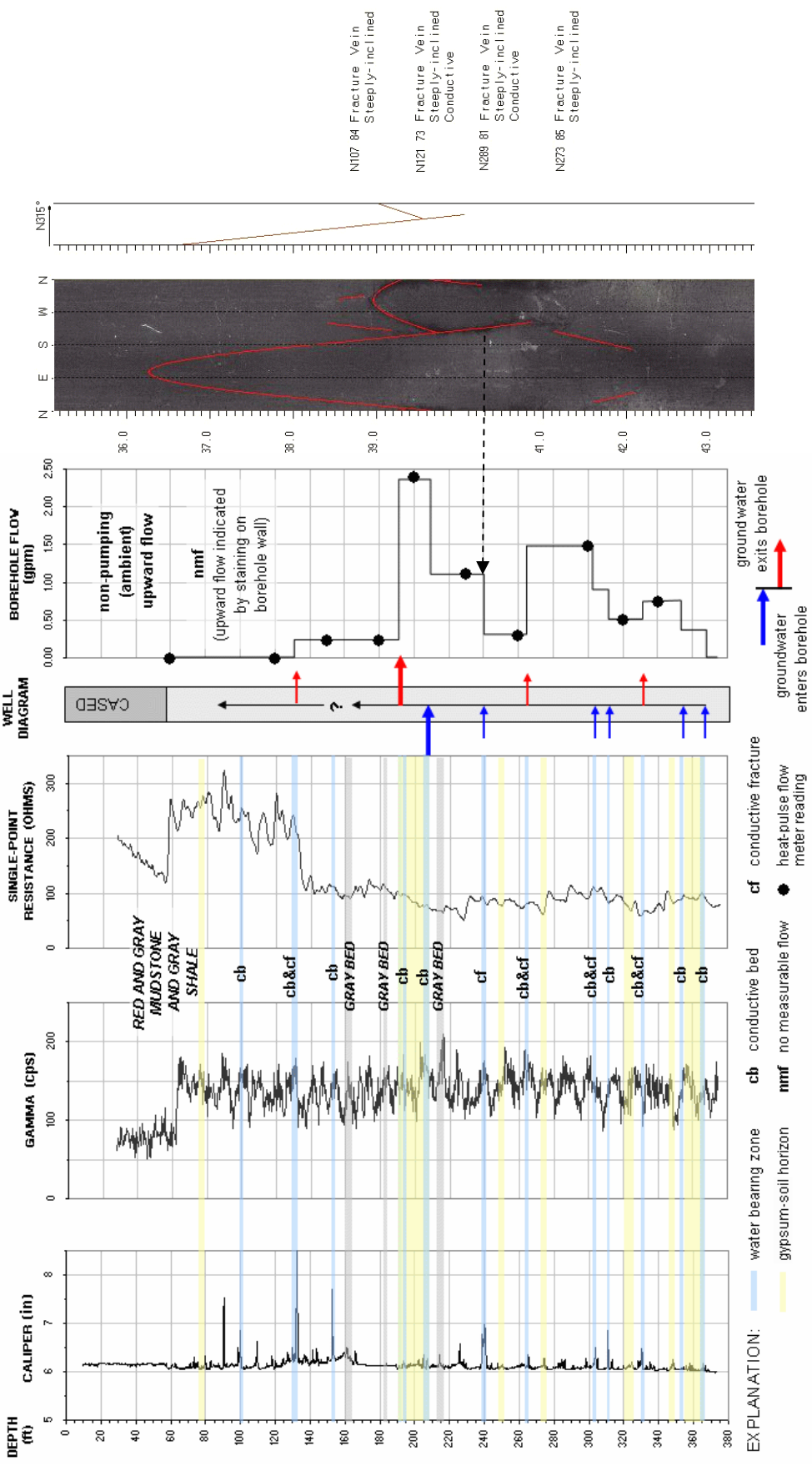


FIGURE 3M11. Hydrogeologic section (left) based on geophysical logs for well 93 at the Stony Brook-Millstone Watershed Association well field, Wargo Rd., Hopewell Twp., Mercer County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray shale. OPTV record (right) shows geologic structures and hydraulically-conductive fractures in red mudstone. Depth values are feet below land surface.

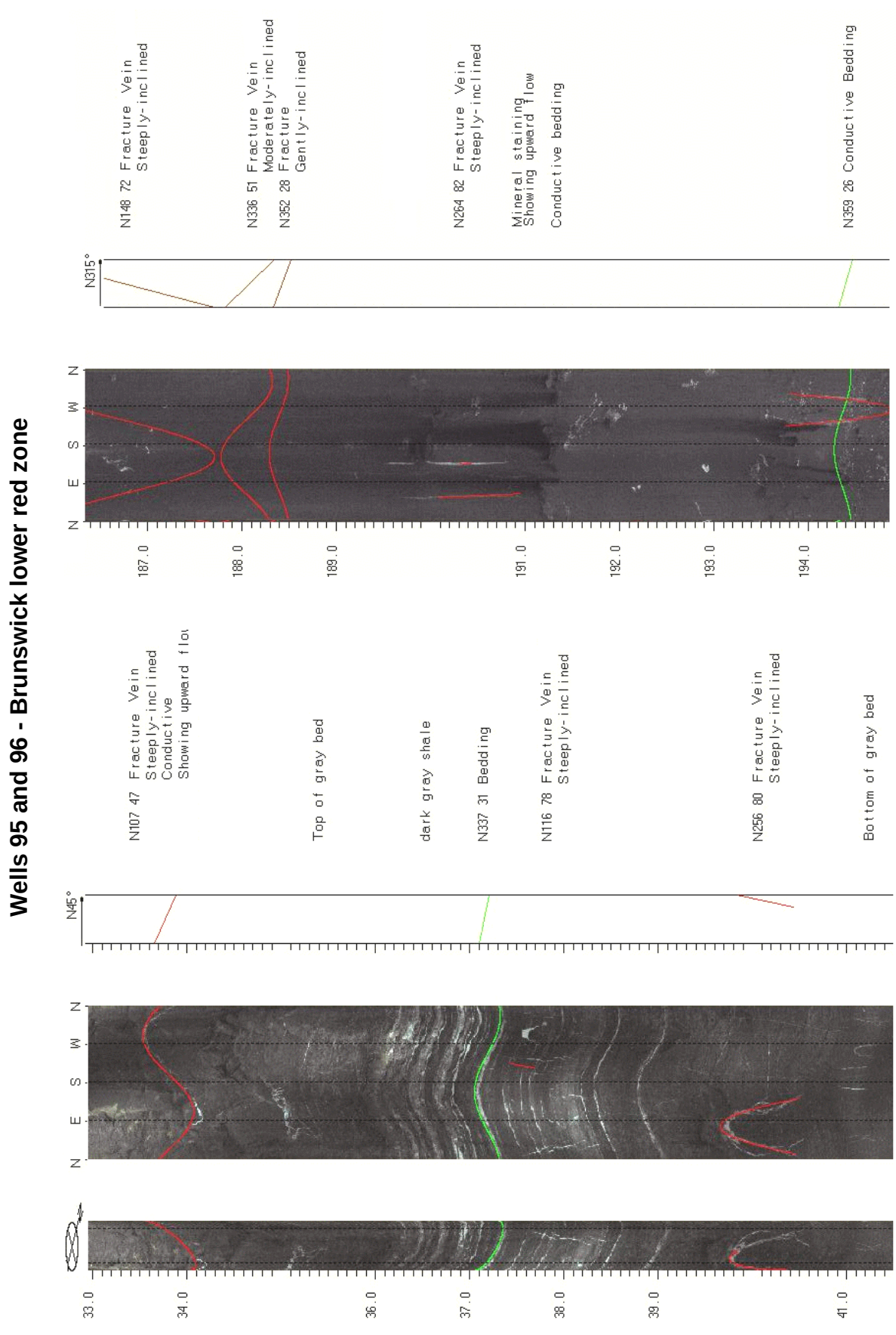


FIGURE 3M12. OPTV records of 6-inch diameter wells 95 (left) and 96 (right) at the Stony Brook-Millstone Watershed Association well field showing geologic structures and hydraulically-conductive features in red and gray mudstone and gray shale. Depth values are in feet below land surface.

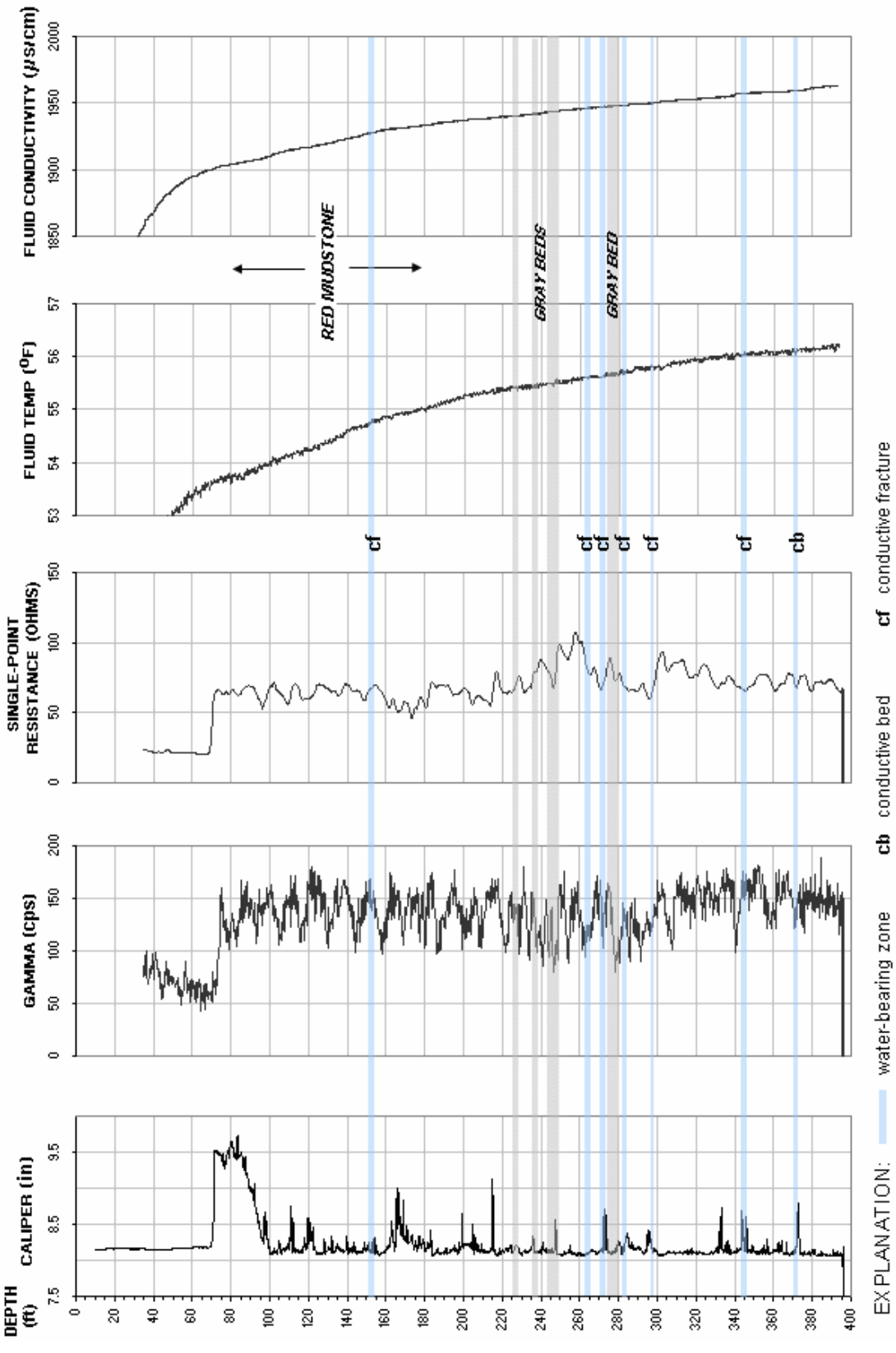


FIGURE 3M13. Hydrogeologic section based on geophysical logs for well 97 at the Stony Brook-Millstone Watershed Association well field, Wargo Rd., Hopewell Twp., Mercer County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray shale. Depth values are in feet below land surface.

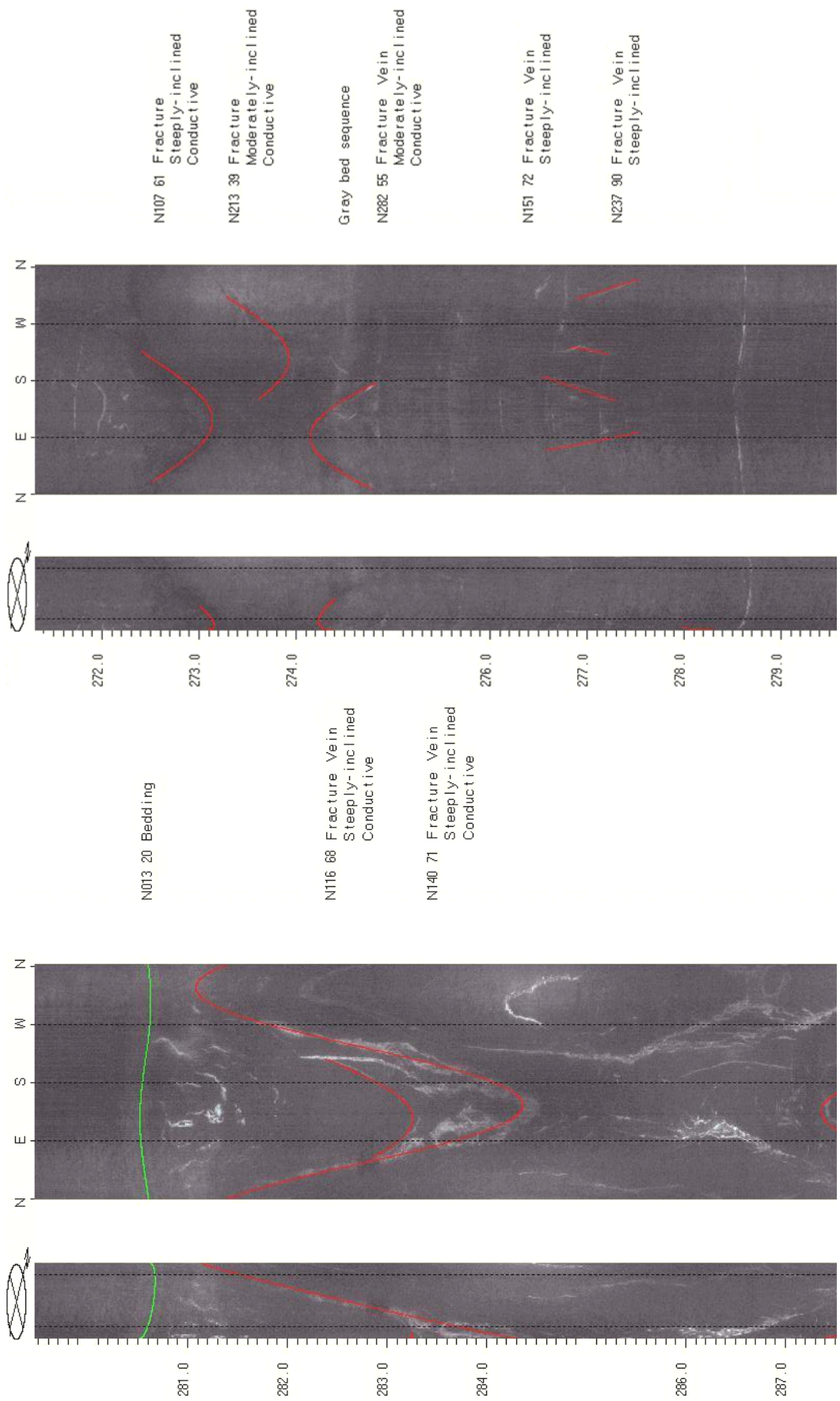


FIGURE 3M14. OPTV records of 8-inch diameter well 97 at the Stony Brook-Millstone Watershed Association well field showing geologic structures and hydraulically-conductive features in red and gray mudstone and gray shale. Depth values are in feet below land surface.

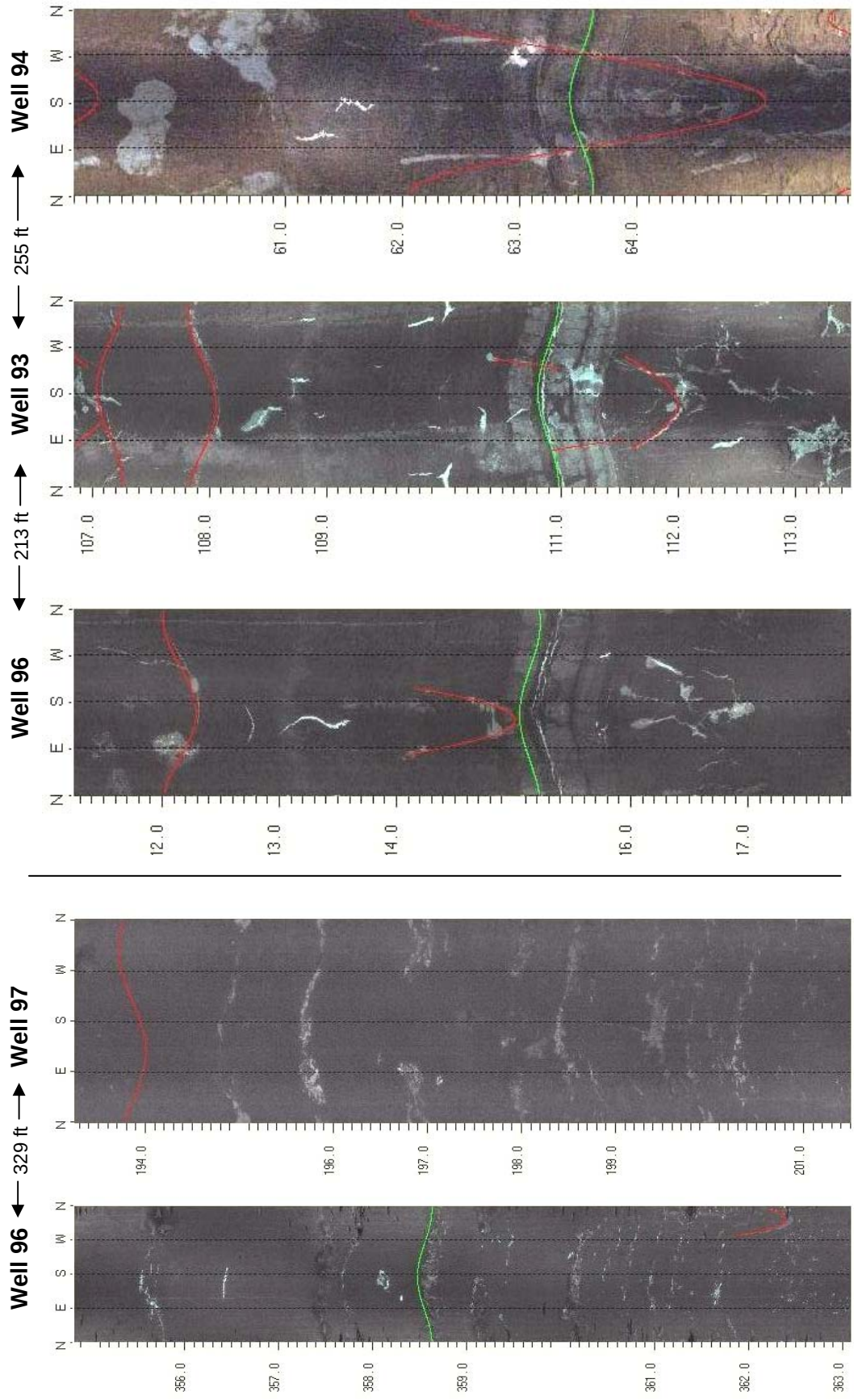


FIGURE 3M15. Stratigraphic correlation of wells 96 and 97 (left) and 96, 93 and 94 (right) based on OPTV records from the Stony Brook-Millstone Watershed Association well field. Depth values are in feet below land surface.

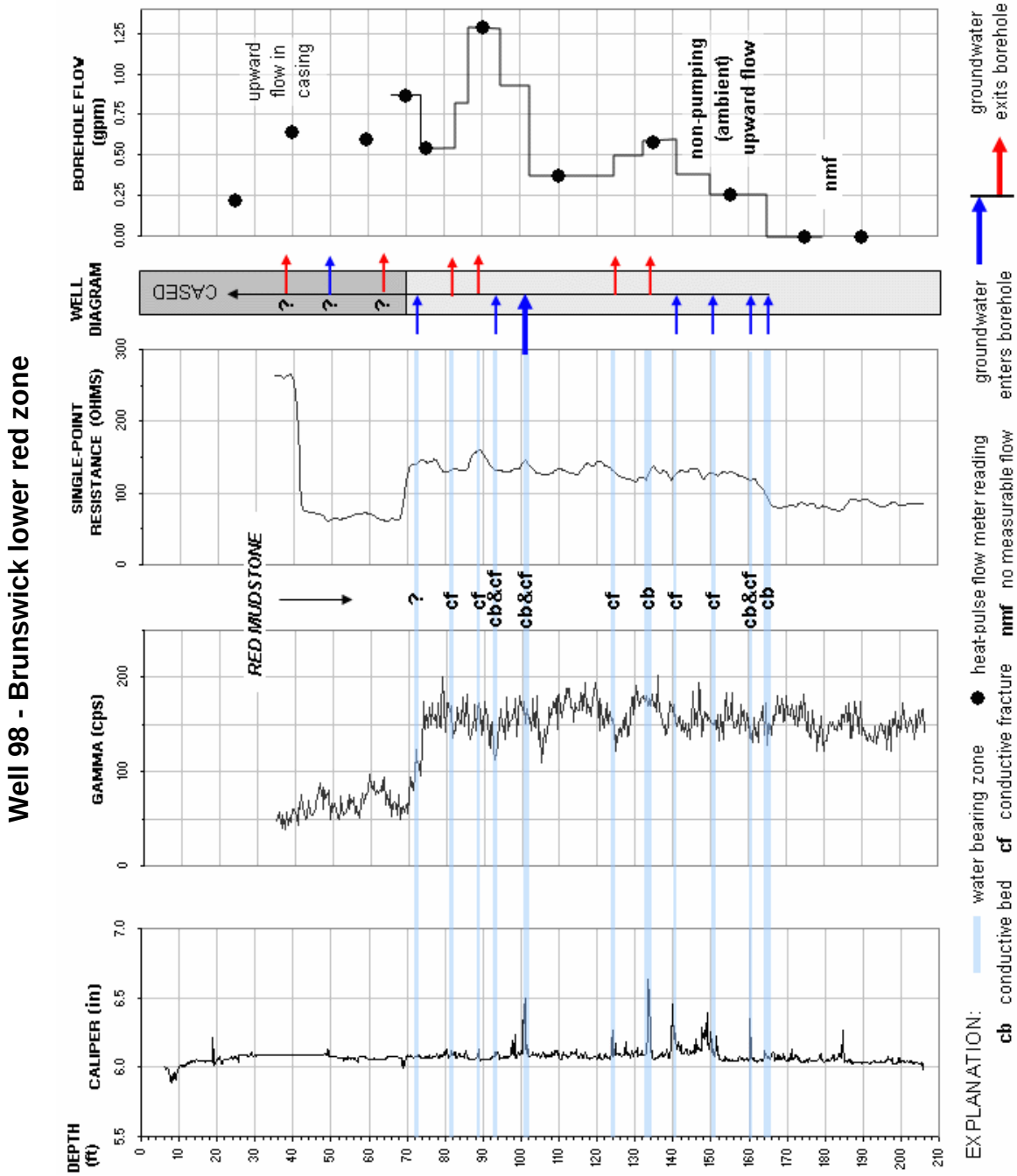


FIGURE 3M16. Hydrogeologic section based on geophysical logs for well 97 at the Stony Brook-Millstone Watershed Association well field, Wargo Rd., Hopewell Twp., Mercer County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray shale. Depth values are feet below land surface.

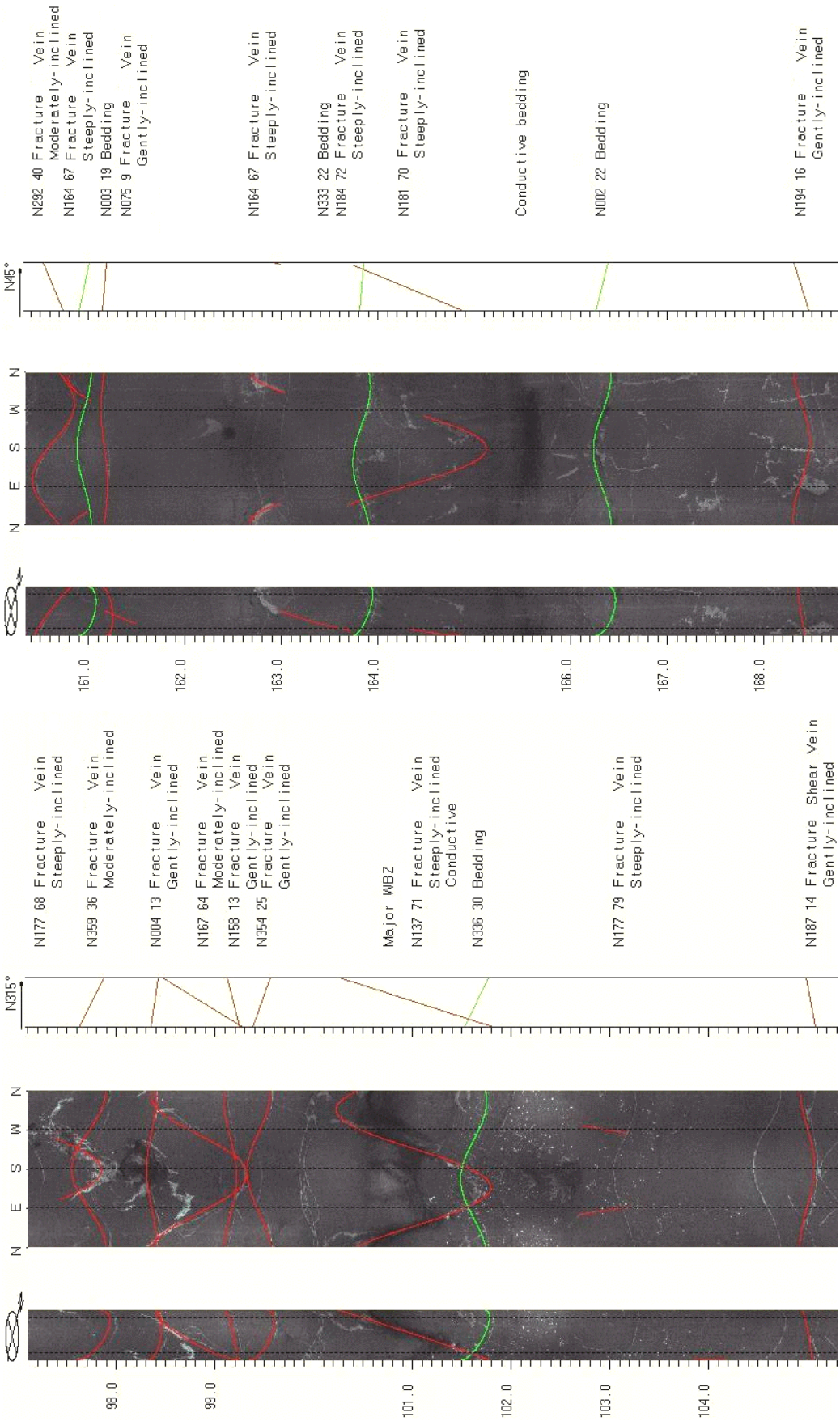


FIGURE 3M17. OPTV records of 6-inch diameter well 99 at the Honey Brook Organic Farm showing geologic structures and hydraulically-conductive features in red mudstone. Depth values are in feet below land surface.

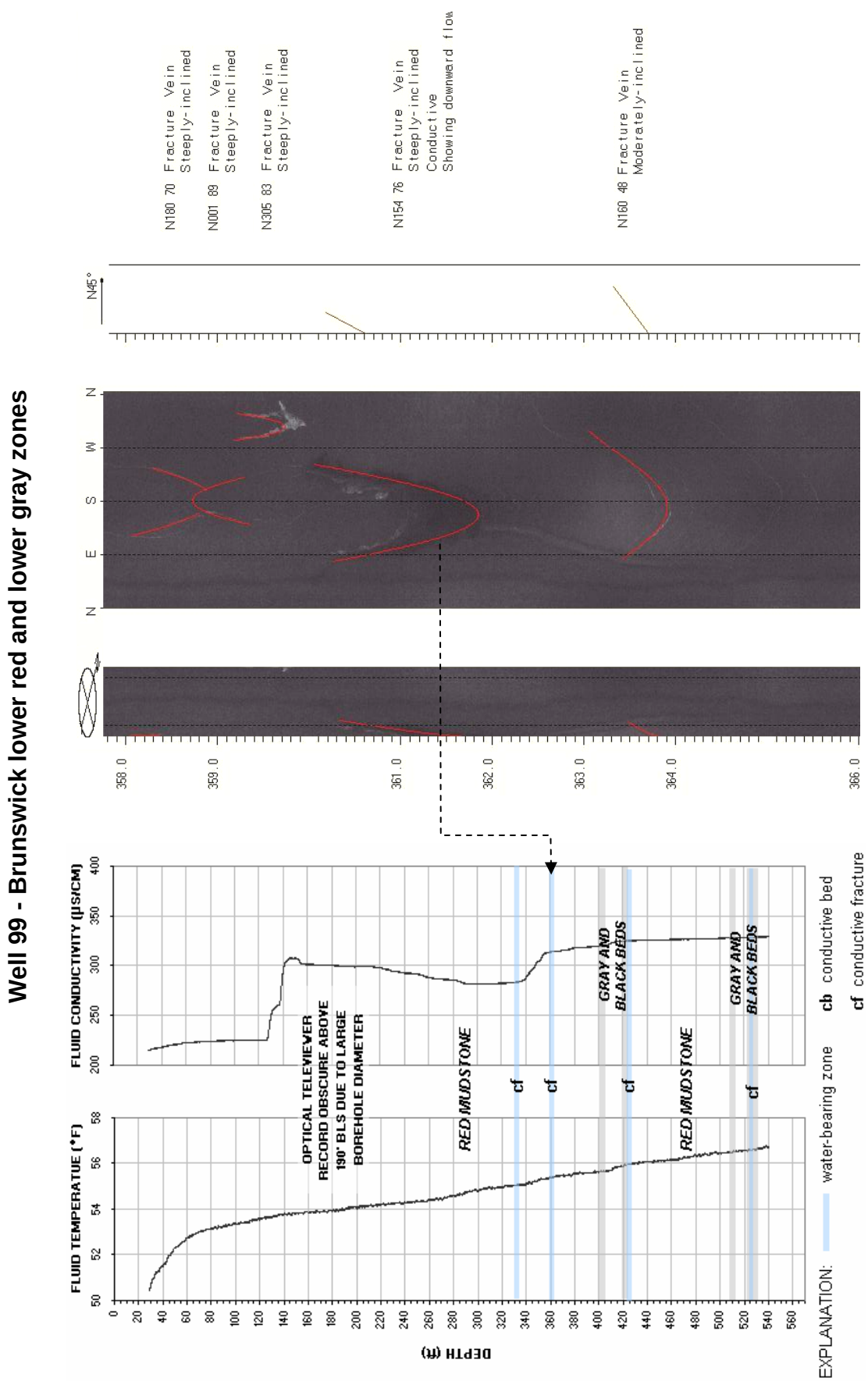


FIGURE 3M18. Hydrogeologic section (left) based on geophysical logs for well 99 at the Honey Brook Organic Farm, Wargo Rd., Hopewell Twp., Mercer County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray and black shale. OPTV record (right) shows geologic structures and hydraulically-conductive fractures in red mudstone. Downward-tapering mineral stain on borehole wall indicates downward, non-pumping flow. Depth values are in feet below land surface.

Wells 90 to 104 - Brunswick lower red and lower gray zones

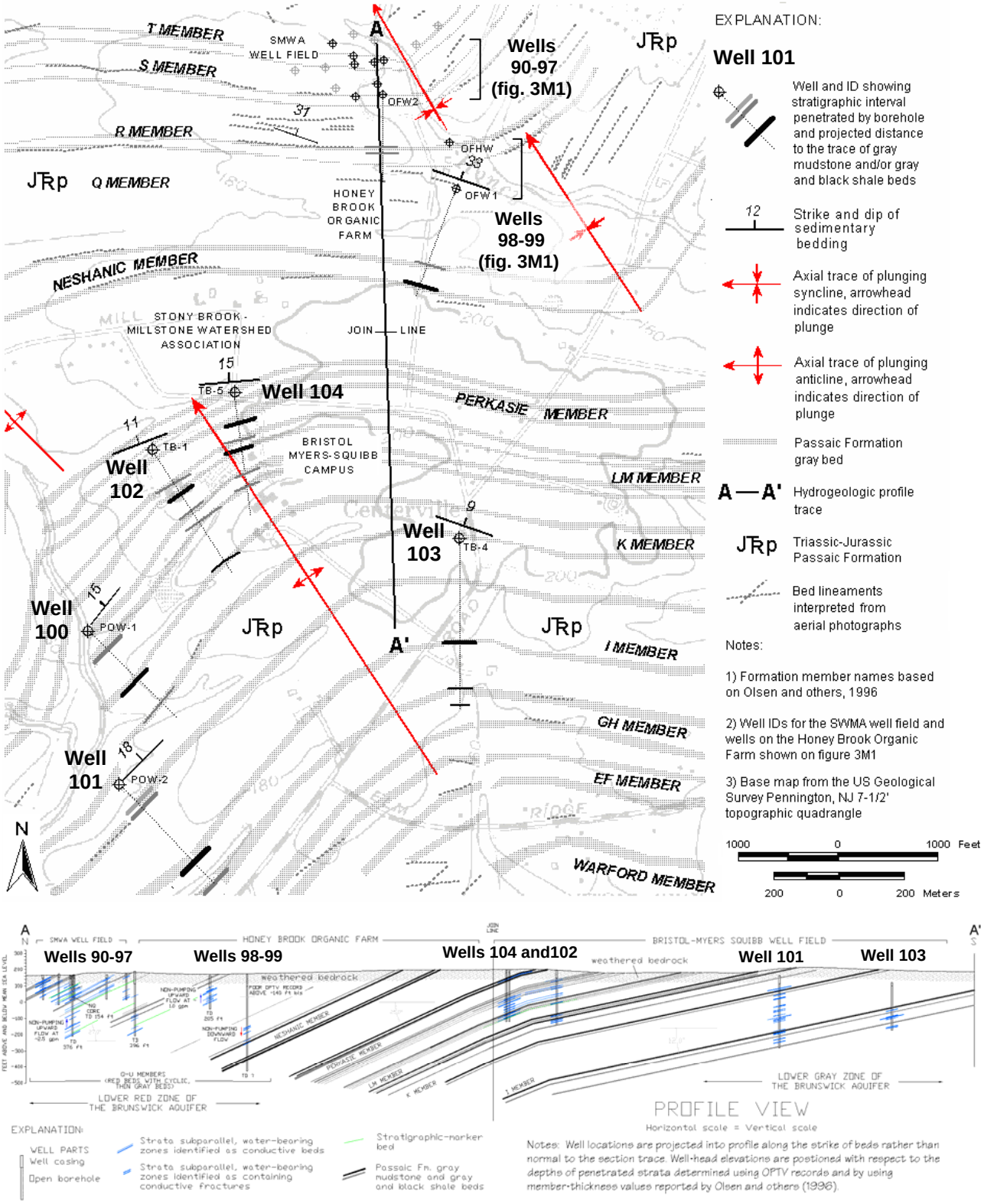
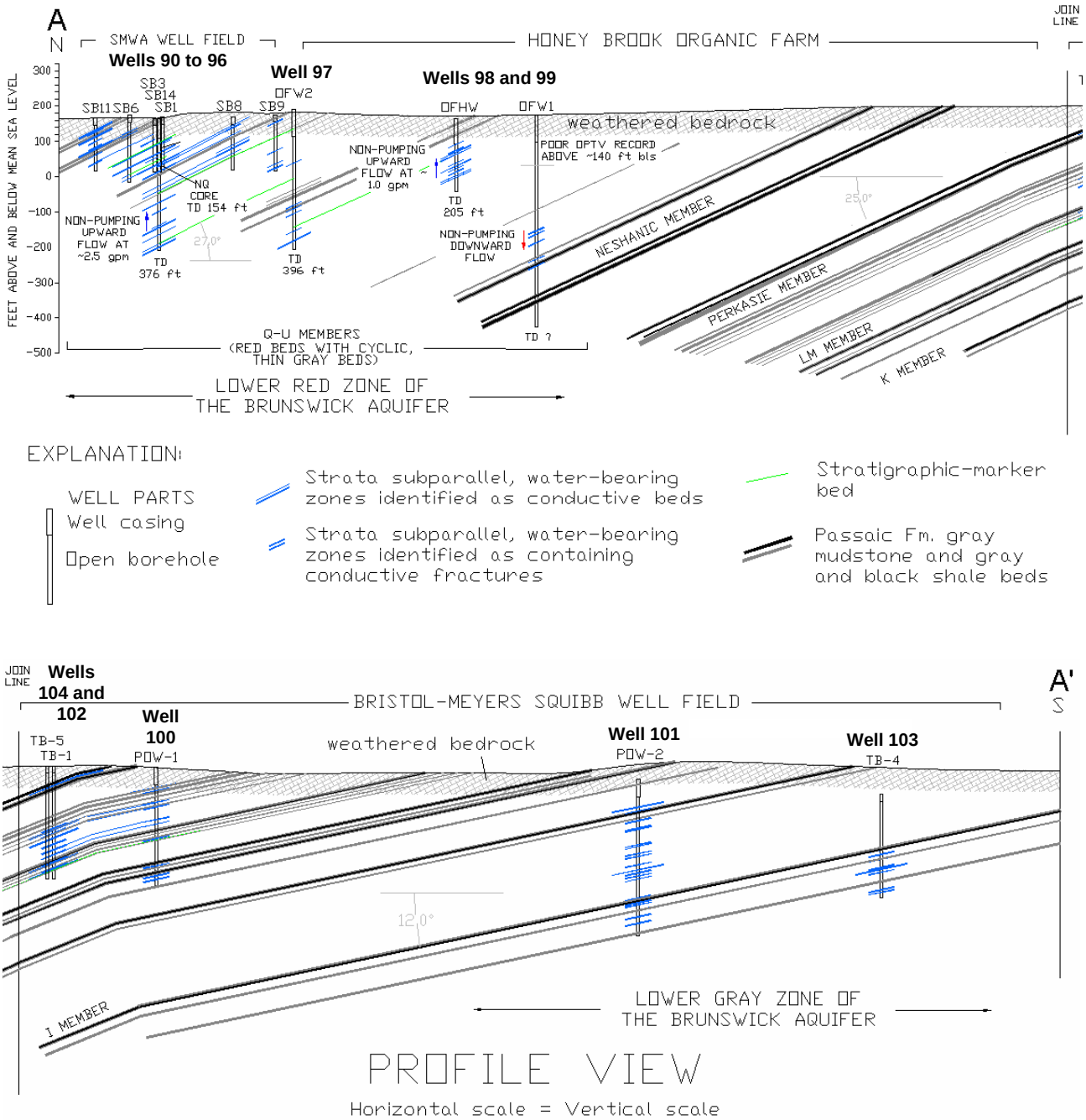


Figure 3N1. Map (above) shows wells 100 to 104 at the Bristol-Myers Squibb campus in Hopewell Twp., Mercer County, NJ in relation to wells at the Stony Brook-Millstone Watershed Association (SMWA) and the Honey Brook Organic Farm (Fig. 3M1). Details of hydrogeologic profile A-A' (below) are shown in figure 3N2.

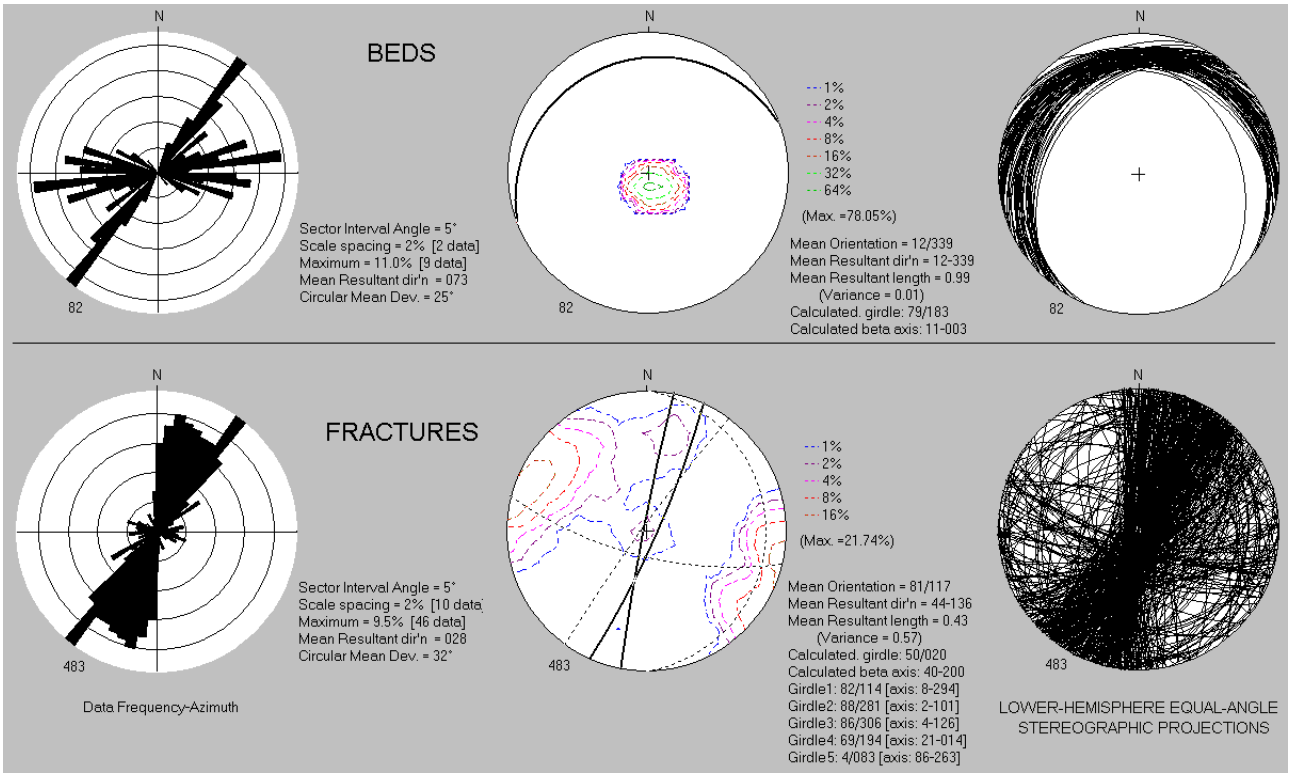
Wells 90 to 104 - Brunswick lower red and lower gray zones



Notes: Well locations are projected into profile along the strike of beds rather than normal to the section trace. Well-head elevations are postioned with respect to the depths of penetrated strata determined using OPTV records and by using member-thickness values reported by Olsen and others (1996).

Figure 3N2. Hydrogeologic section A-A' for well fields at the Stony Brook-Millstone Watershed Association and Honey Brook Organic Farm (above) and the Bristol-Myers Squibb campus in Hopewell Twp., Mercer County NJ. The profile location and a composite section are shown in figure 3N1. The section shows the distribution of wells having OPTV records and stratigraphic water-bearing zones interpreted as conductive beds and fractures in the lower red (above) and lower gray (below) zones of the Brunswick aquifer. Stratigraphic-marker beds identified in OPTV records aid in positioning wells with respect to penetrated strata.

Wells 100 to 104 - Brunswick lower gray zone



Wells 100 and 101 - Brunswick lower gray zone

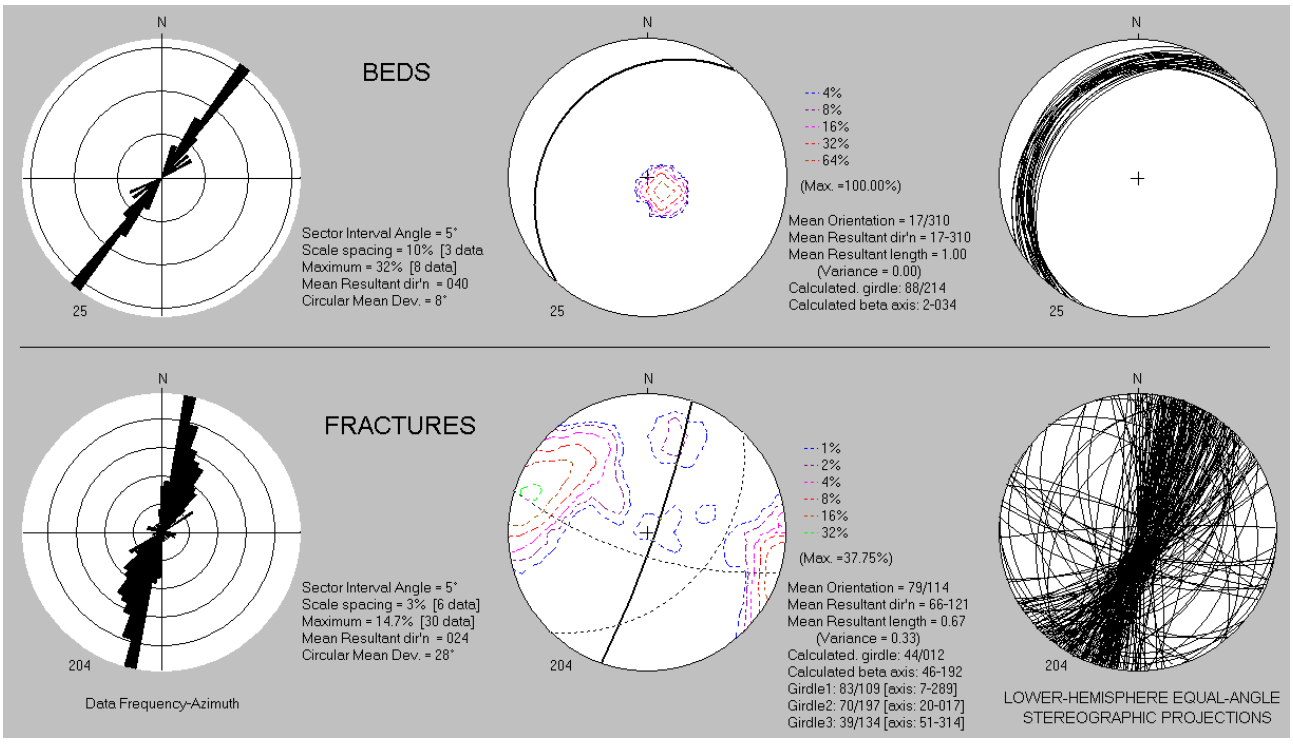
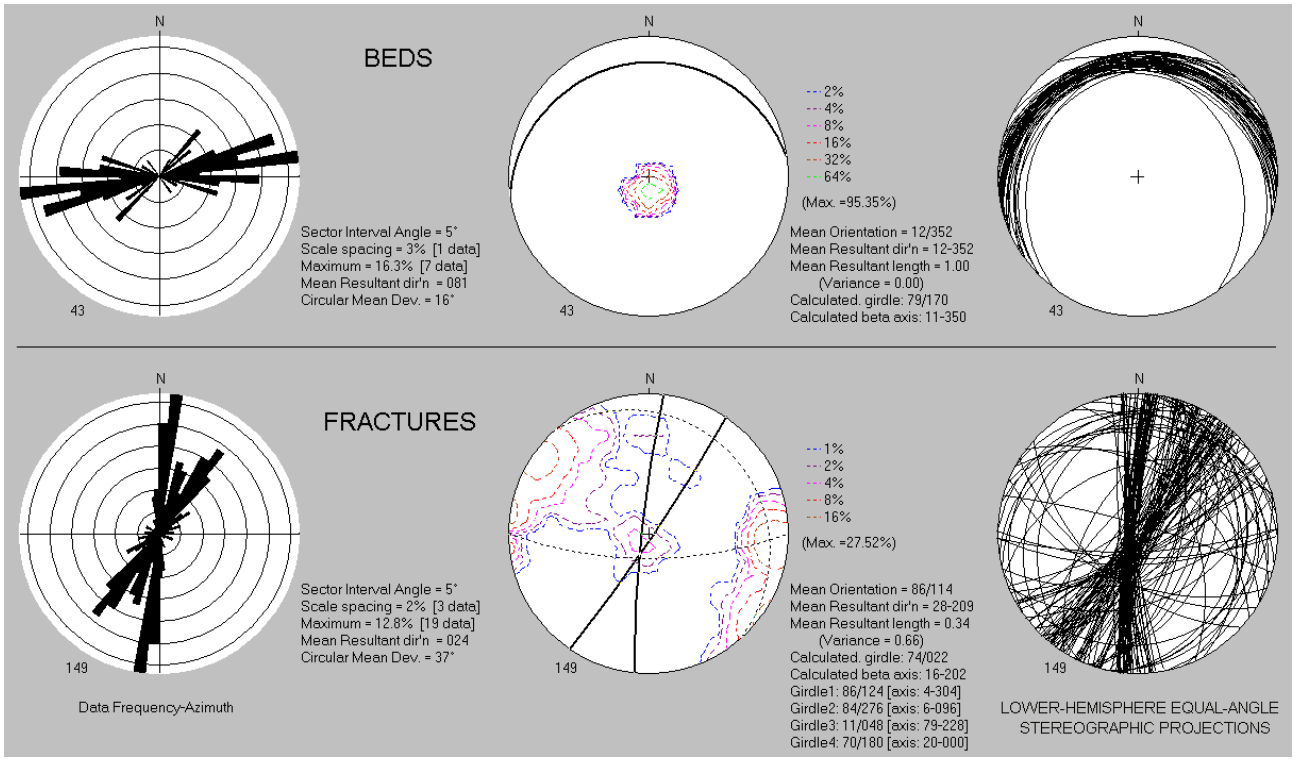


Figure 3N3. Structural analyses of OPTV for wells 100 to 104 (above) and wells 100 and 101 (below) at the Bristol-Myers Squibb campus in Hopewell Twp., Mercer County NJ.

Wells 102 and 104 - Brunswick lower gray zone



Well 103 - Brunswick lower gray zone

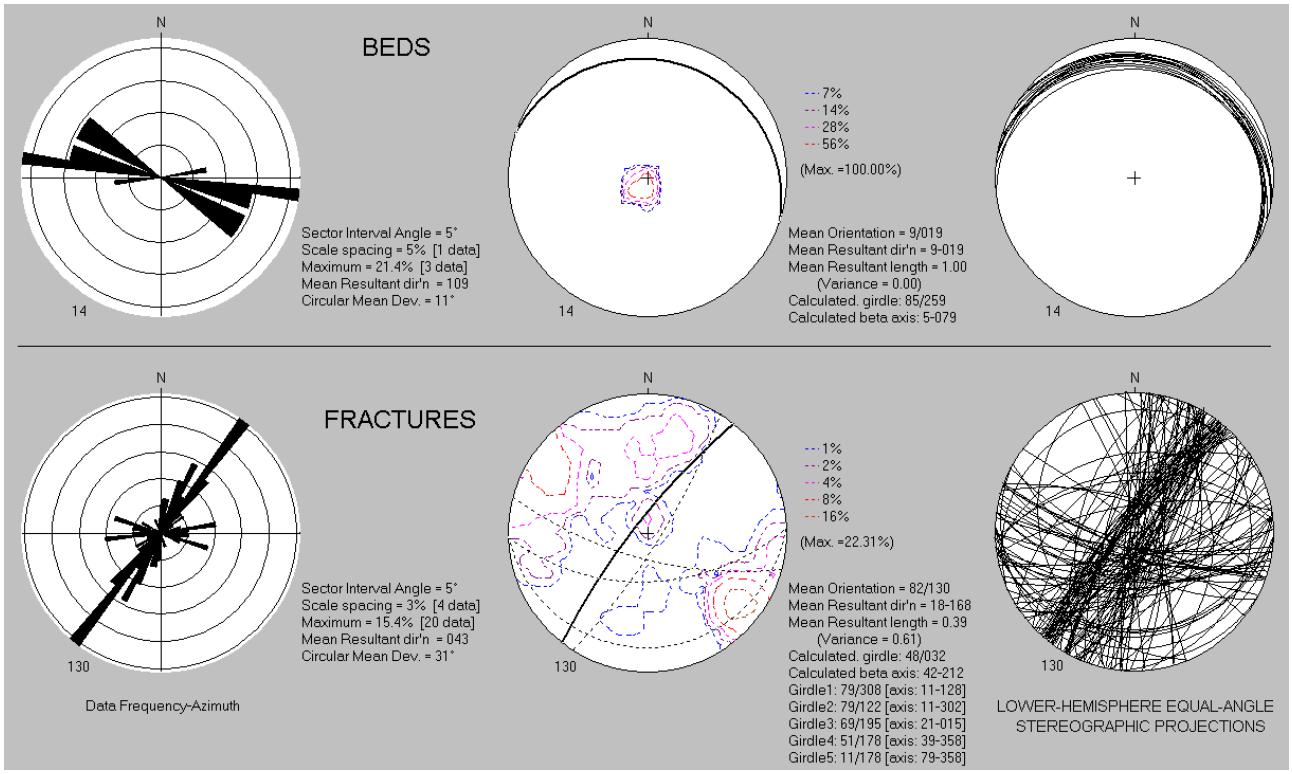


Figure 3N4. Structural analyses of OPTV for wells 100 and 104 (above) and wells 100 and 101 (below) at the Bristol-Myers Squibb campus in Hopewell Twp., Mercer County NJ.

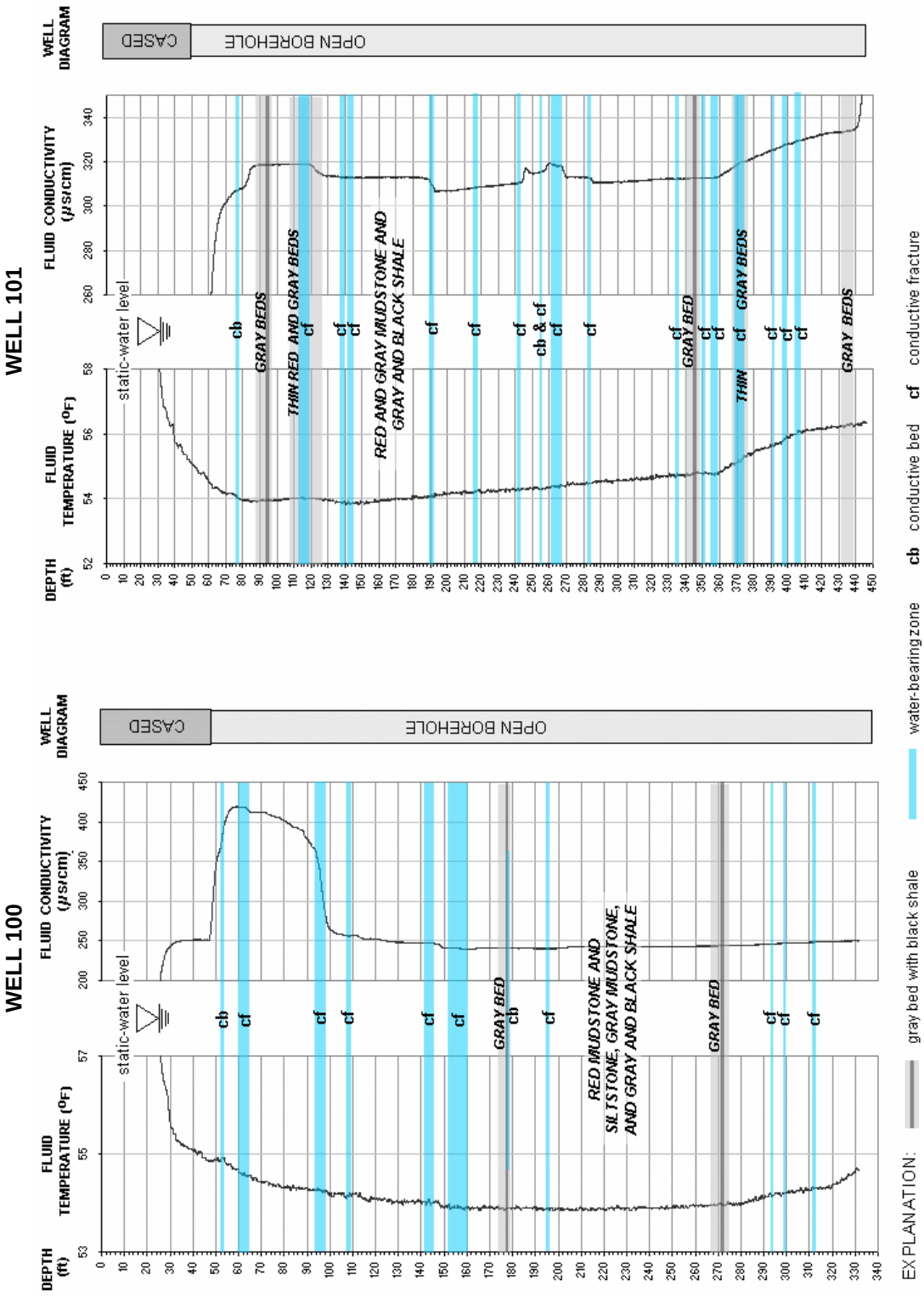


FIGURE 3N5. Hydrogeologic sections based on geophysical logs for wells 100 (left) and 101 (right) at the Bristol-Myers Squibb campus in Hopewell Twp., Mercer County NJ. The sections show the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red mudstone and siltstone, gray mudstone, and gray and black shale. Depth values are in in feet below land surface.

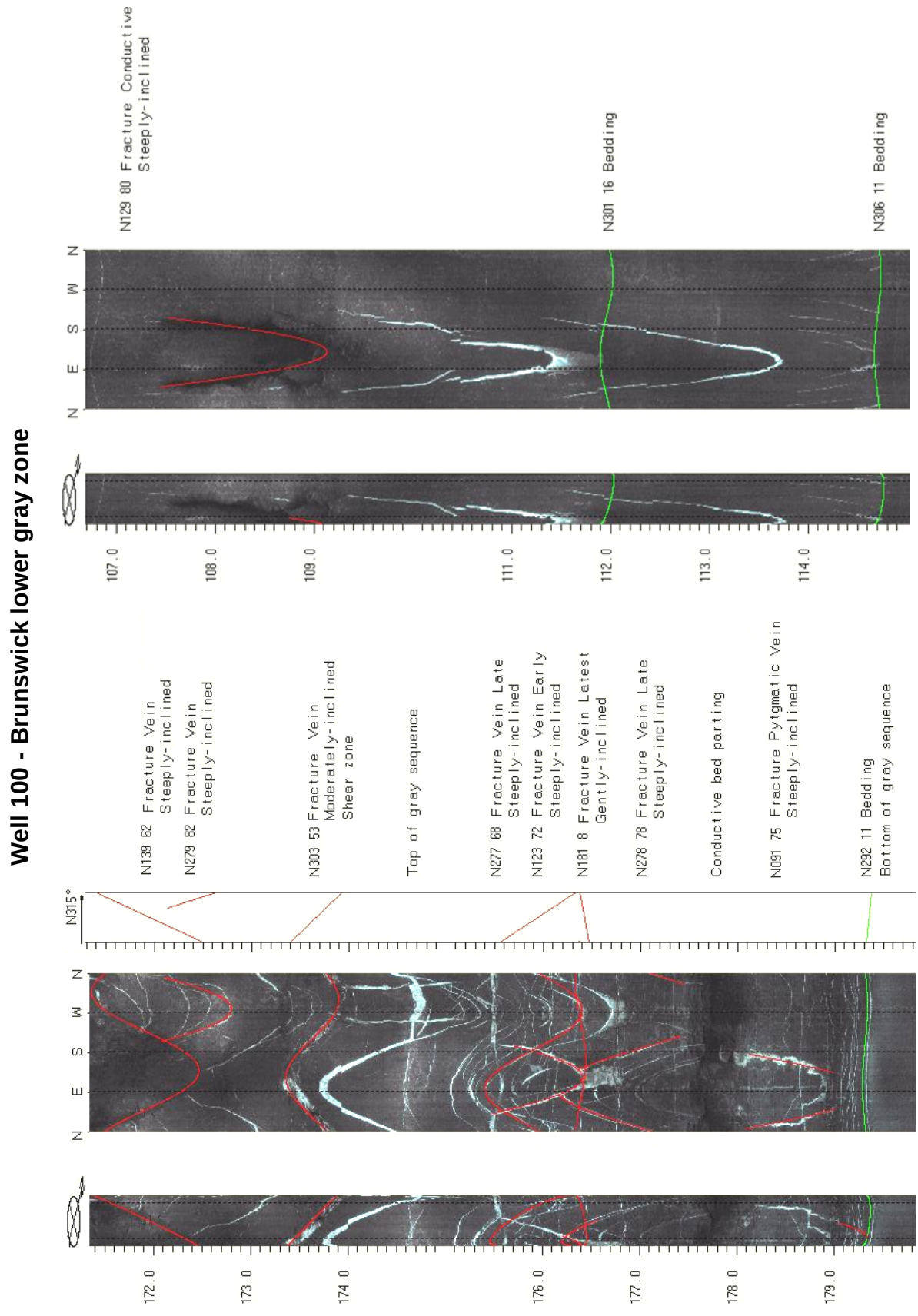


FIGURE 3N6. OPTV records of 6-inch diameter well 100 at the Bristol-Myers Squibb campus in Hopewell Twp., Mercer County NJ showing geologic structures and hydraulically-conductive features in red and gray mudstone and gray shale. Depth values are in feet below land surface.

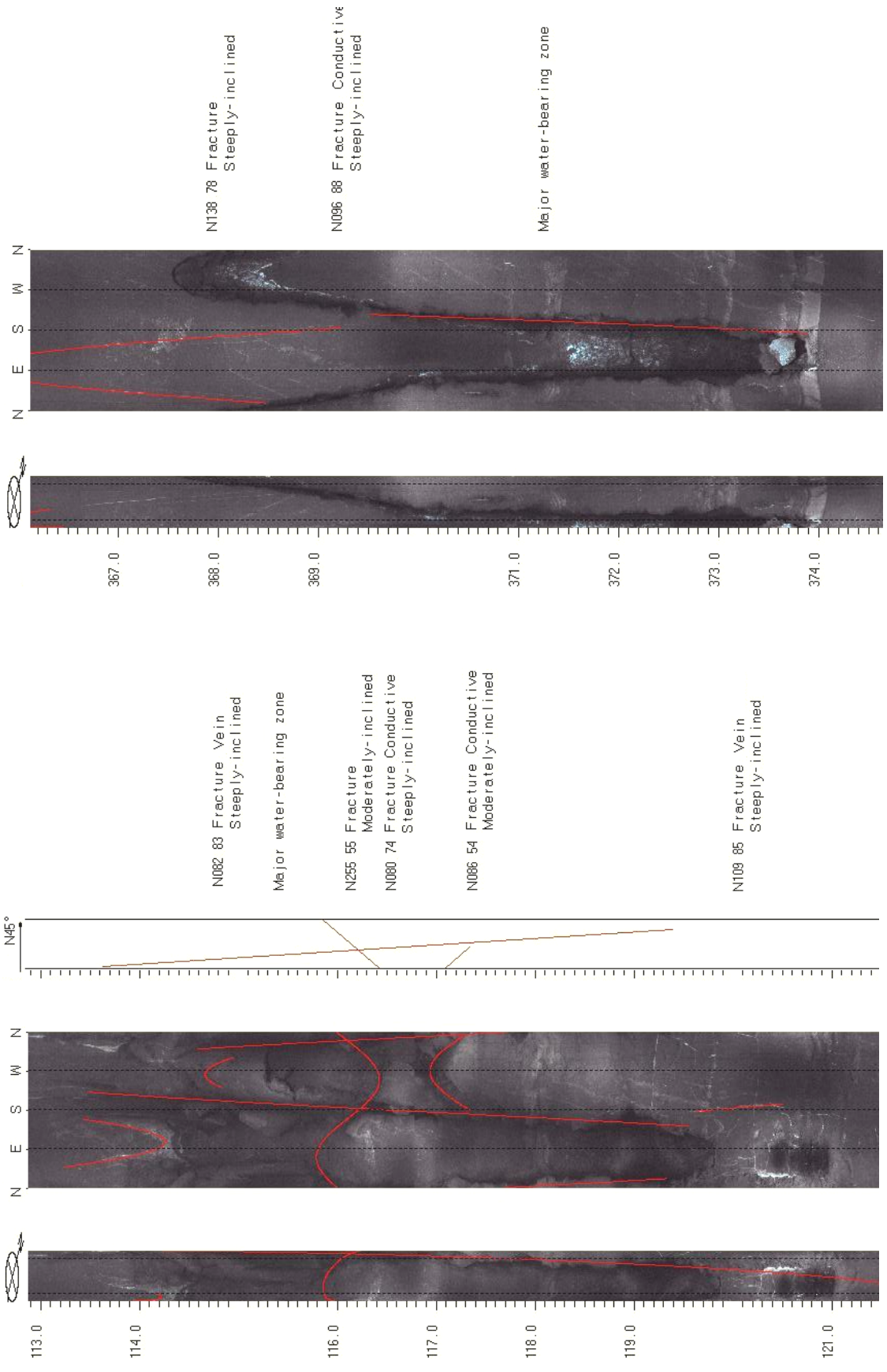


FIGURE 3N7. OPTV records of 6-inch diameter well 100 at the Bristol-Myers Squibb campus in Hopewell Twp., Mercer County NJ showing geologic structures and hydraulically-conductive features in red and gray mudstone and gray shale. Depth values are in feet below land surface.

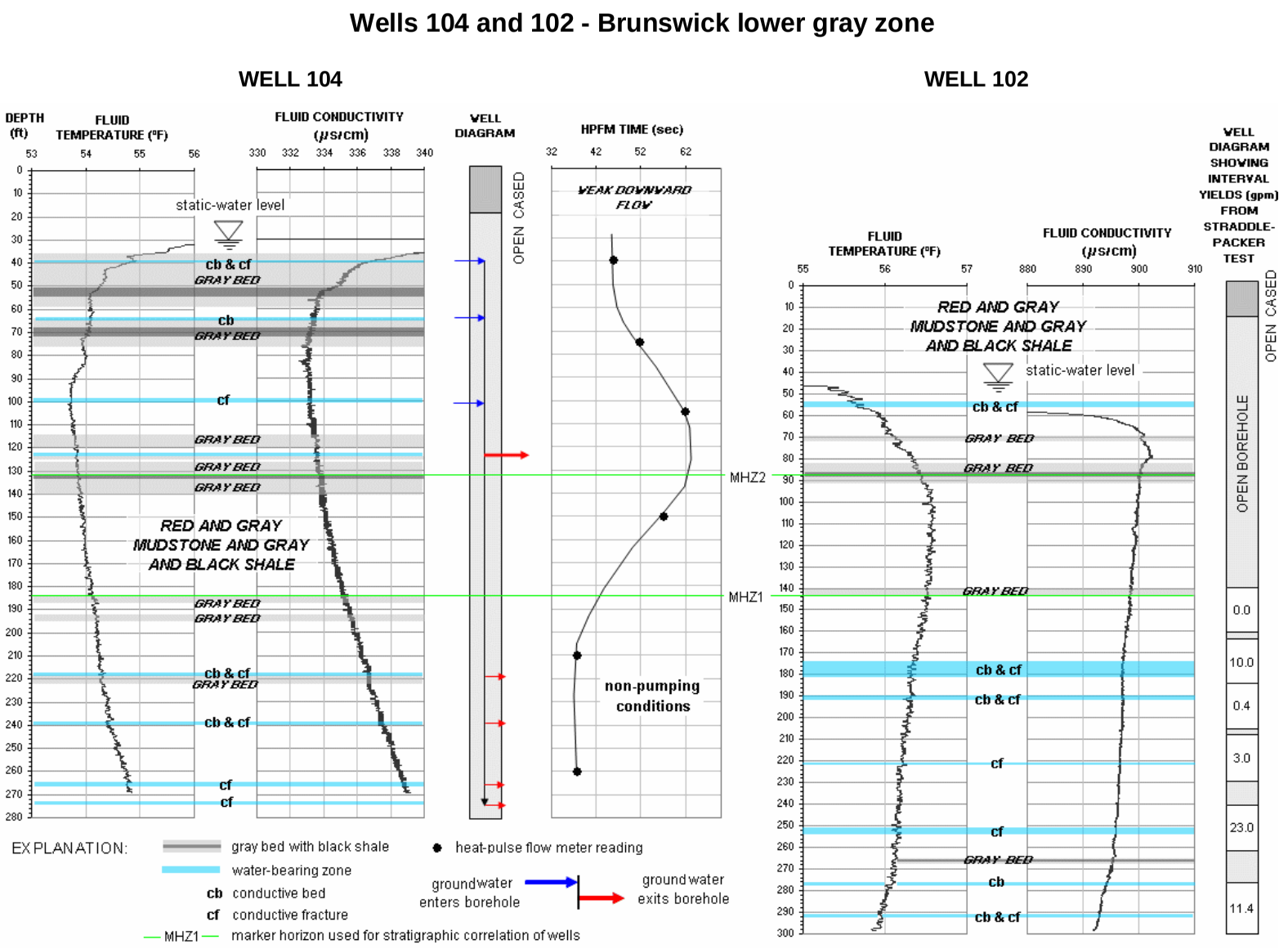


FIGURE 3N8. Hydrogeologic sections based on geophysical logs for wells 104 and 102 at the Bristol-Myers Squibb campus in Hopewell Twp., Mercer County NJ. The sections show the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray and black shale. Depth values are feet below land surface.

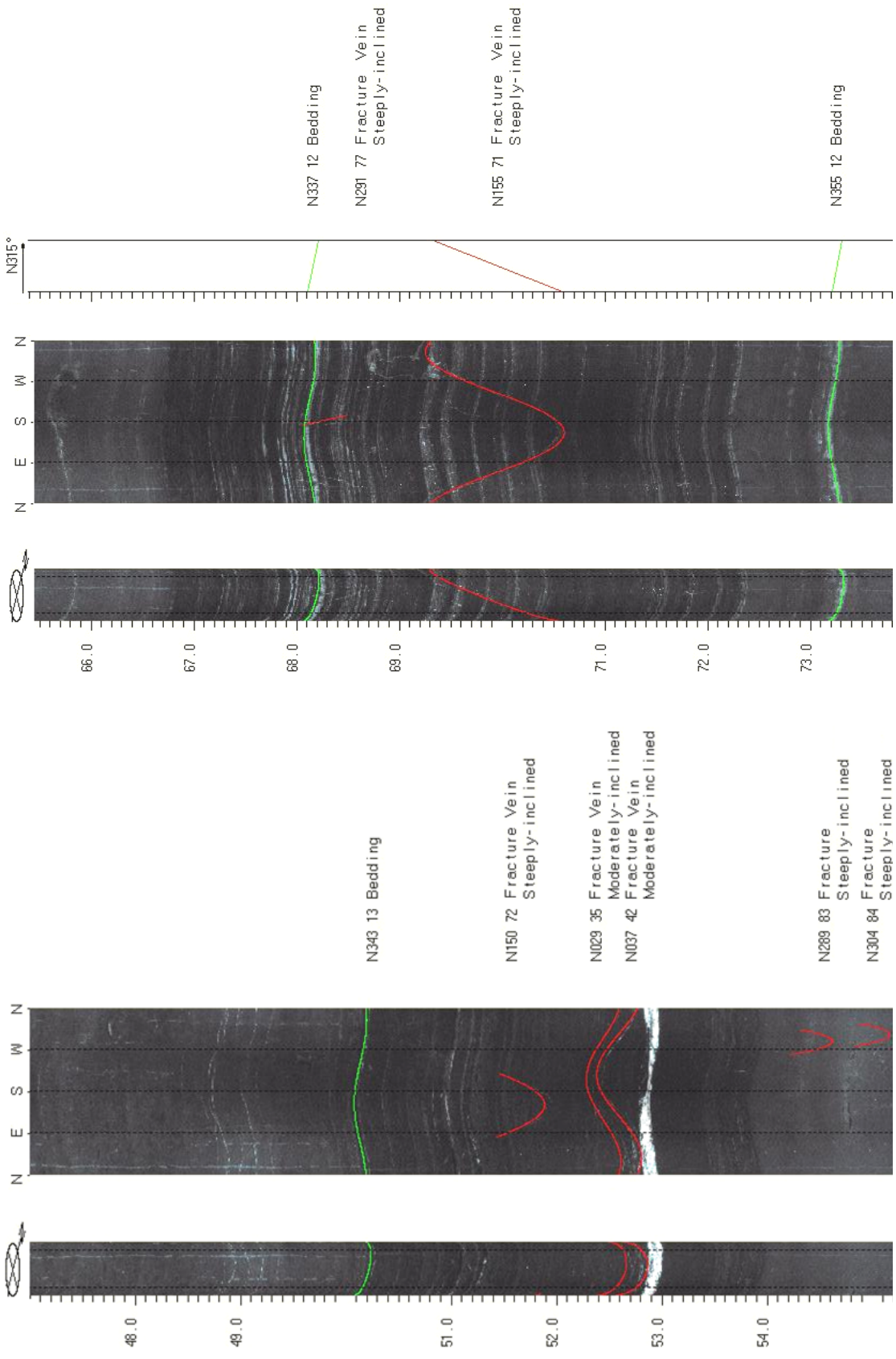


FIGURE 3N9. OPTV records of 6-inch diameter well 104 at the Bristol-Myers Squibb campus in Hopewell Twp., Mercer County NJ showing geologic structures in gray mudstone and gray and black shale. Depth values are in feet below land surface.

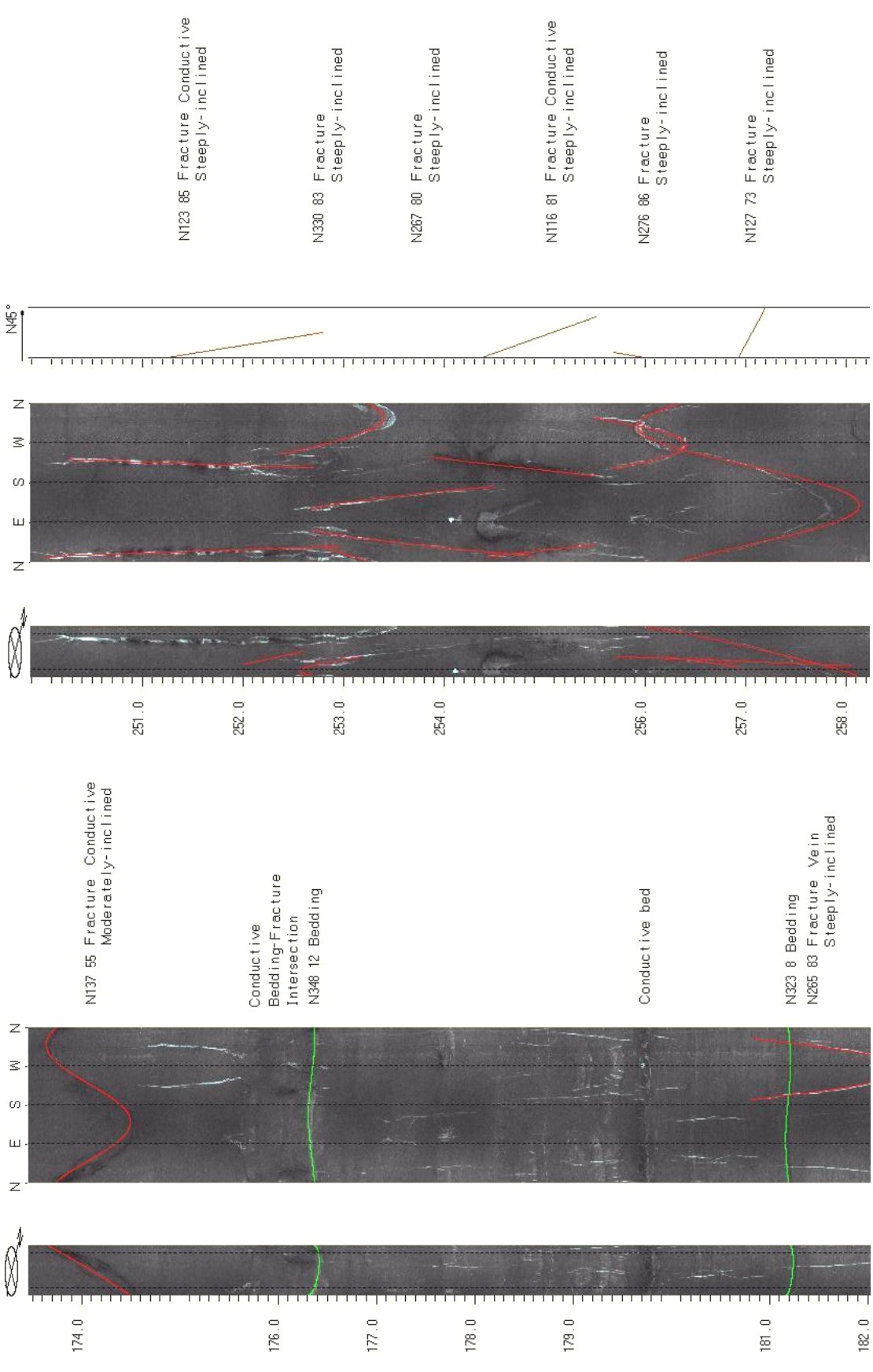


FIGURE 3N10. OPTV records of 6-inch diameter well 102 at the Bristol-Myers Squibb campus in Hopewell Twp., Mercer County NJ showing geologic structures and hydraulically-conductive features in red and gray mudstone. Depth values are in feet below land surface.

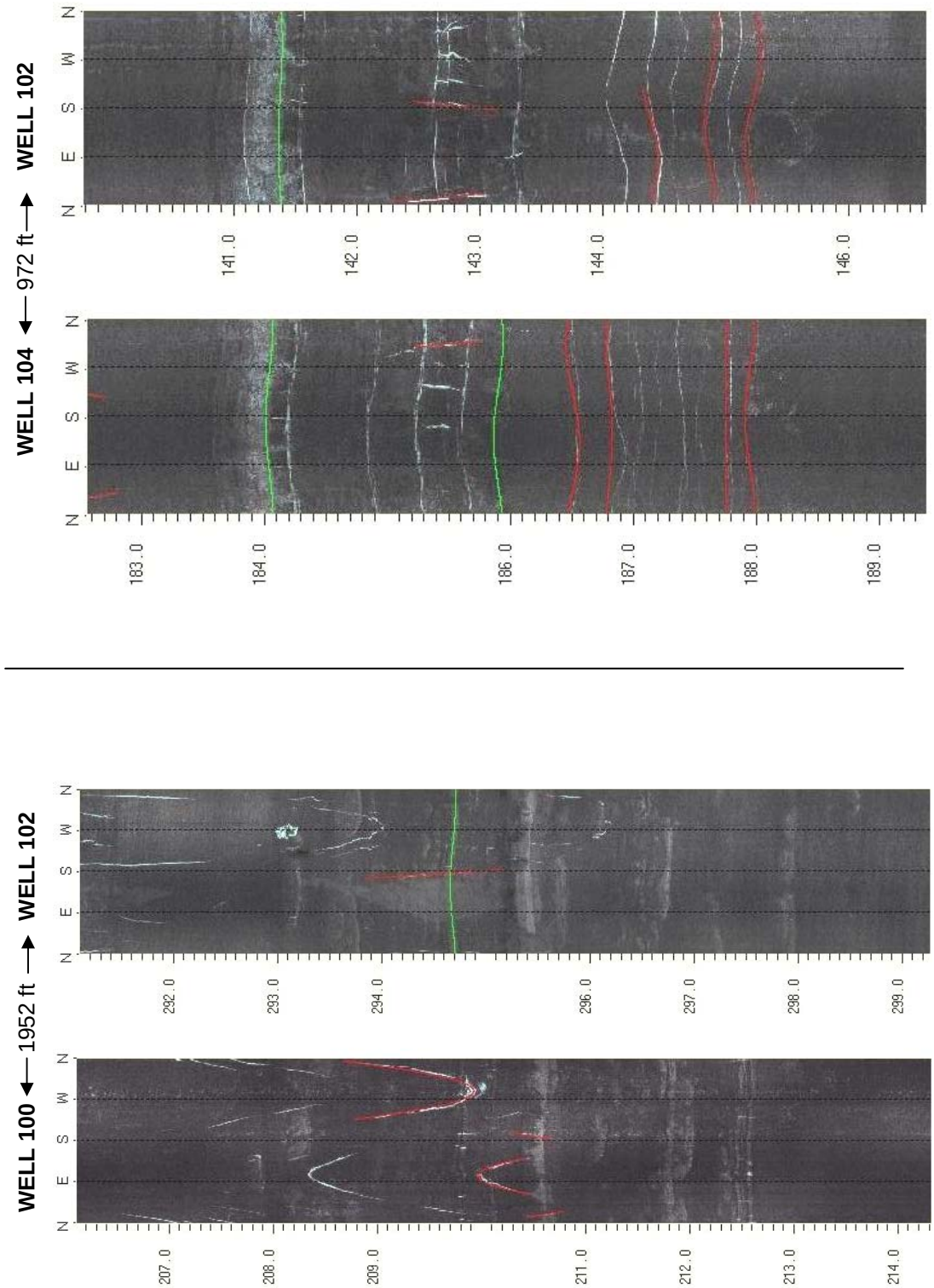


FIGURE 3N11. Stratigraphic correlation of wells 100, 102., and 104 based on OPTV records from the Bristol-Myers Squibb campus in Hopewell Twp., Mercer County NJ. Depth values are in feet below land surface.

Wells 101 and 103 - Brunswick lower gray zone

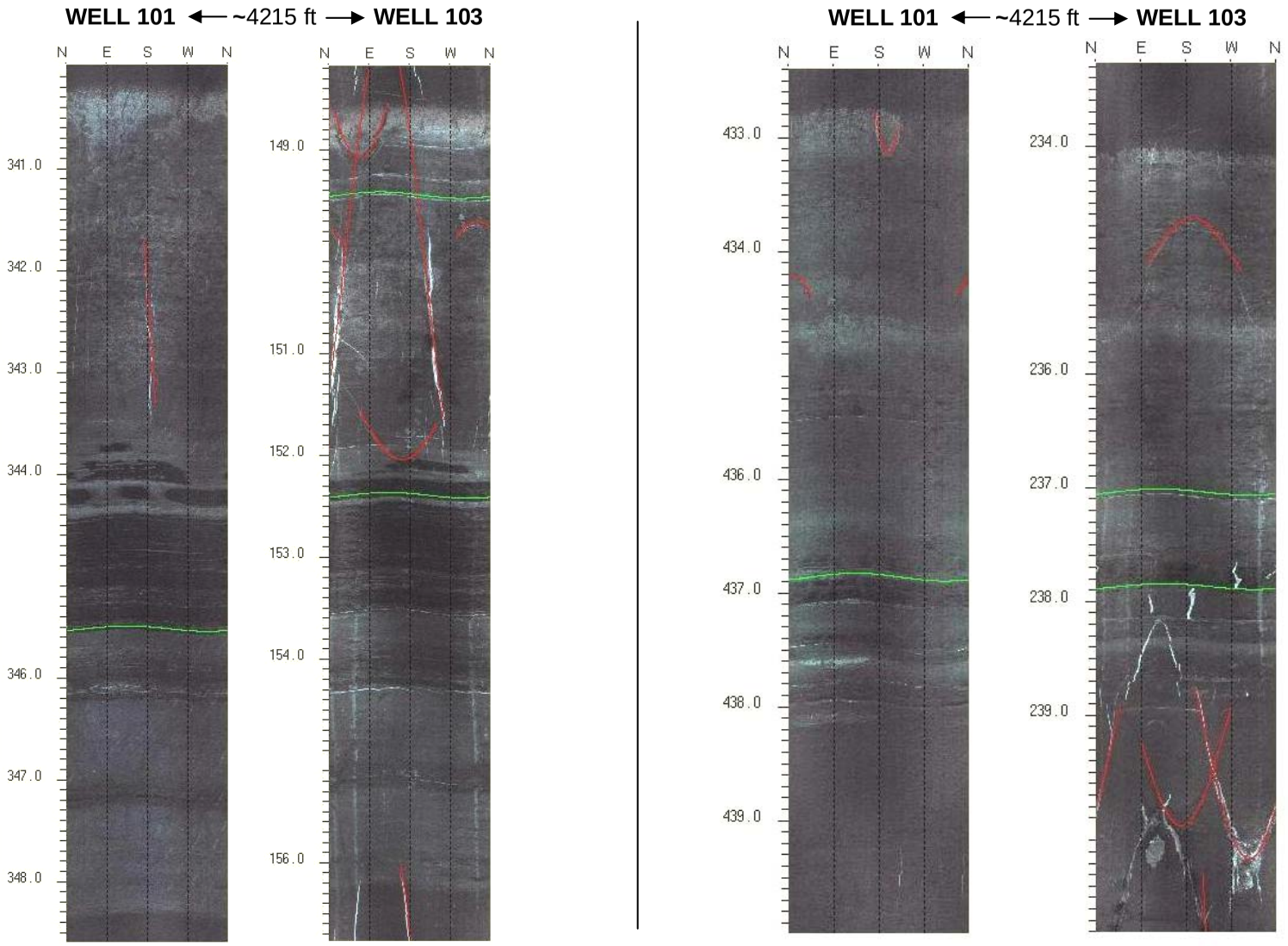


FIGURE 3N12. Stratigraphic correlation of wells 101 and 103 based on OPTV records from the Bristol-Myers Squibb campus in Hopewell Twp., Mercer County NJ. Depth values are in feet below land surface.

Wells 103 - Brunswick lower gray zone

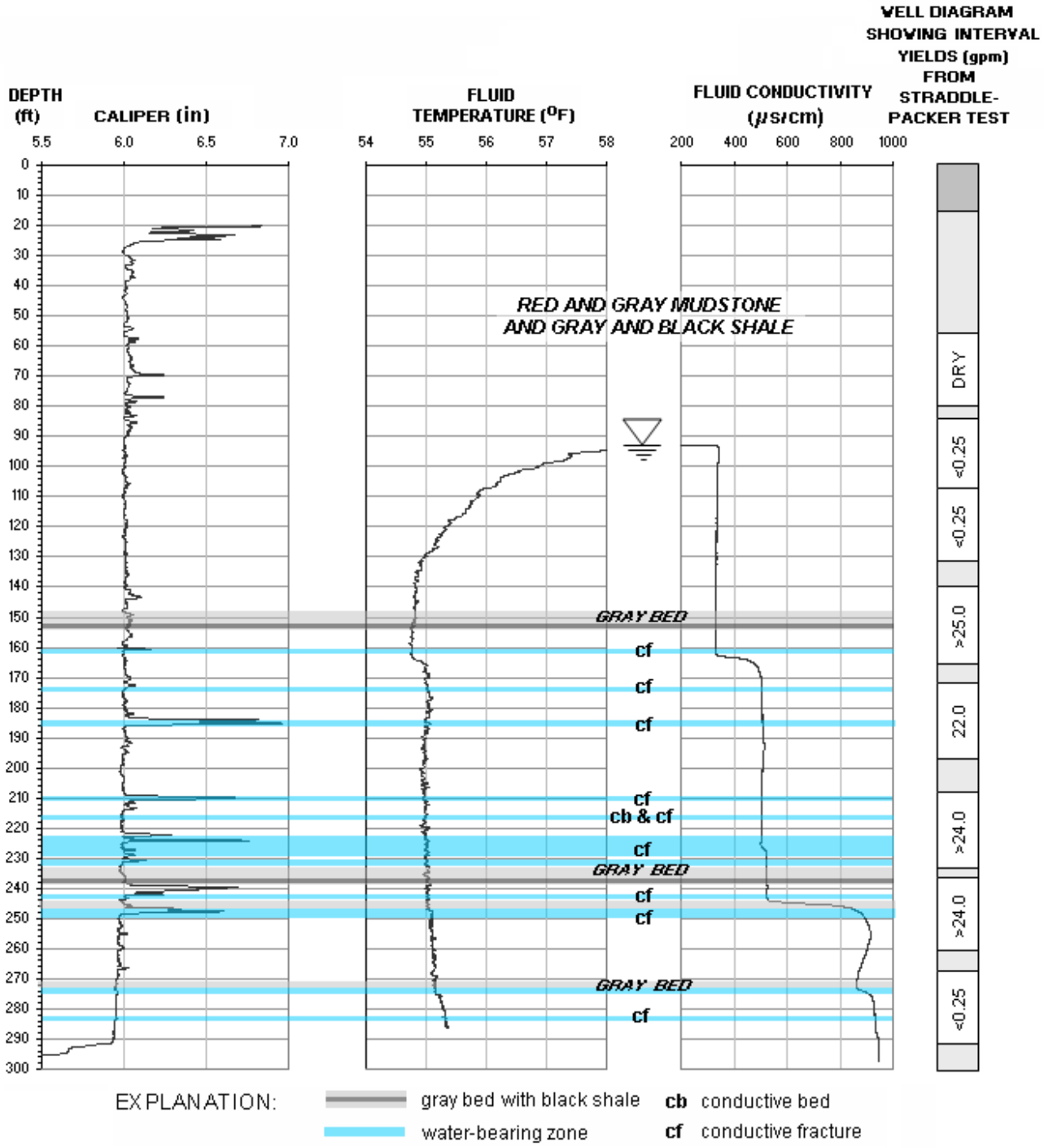


FIGURE 3N13. Hydrogeologic section based on geophysical logs for well 103 at the Bristol-Myers Squibb campus in Hopewell Twp., Mercer County NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray and black shale. Depth values are in feet below land surface.

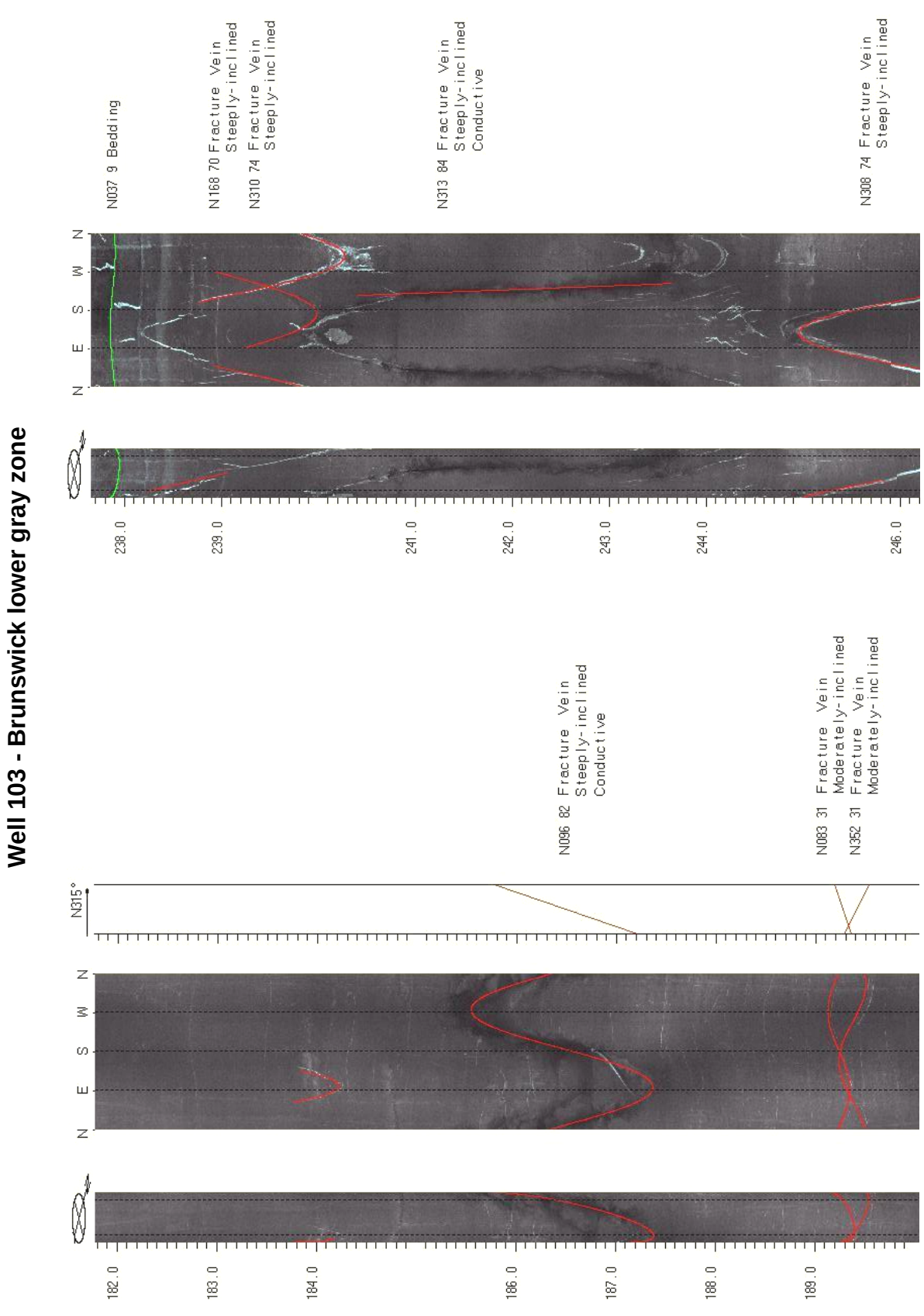
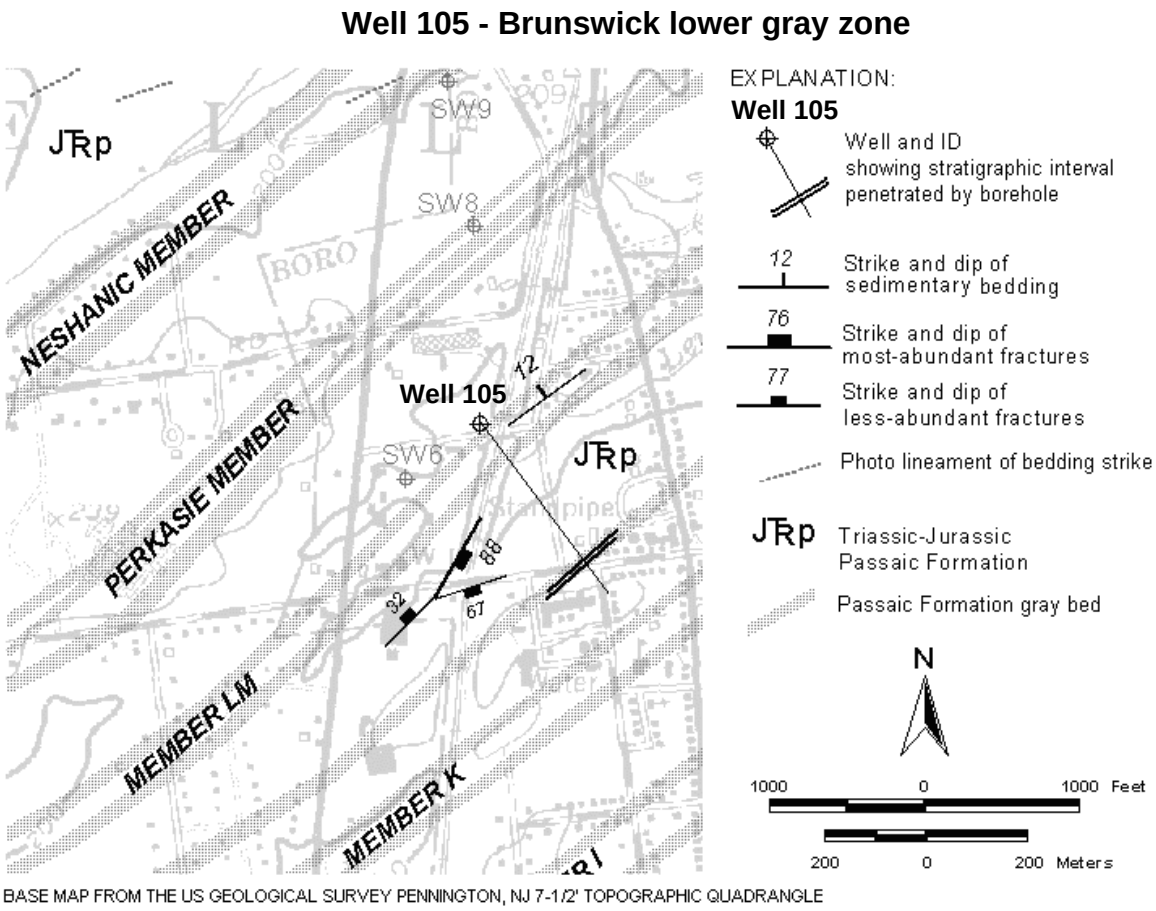


FIGURE 3N14. OPTV records of 6-inch diameter well 103 at the Bristol-Myers Squibb campus in Hopewell Twp., Mercer County NJ showing geologic structures and hydraulically-conductive features in red and gray mudstone and gray shale. Depth values are in feet below land surface.



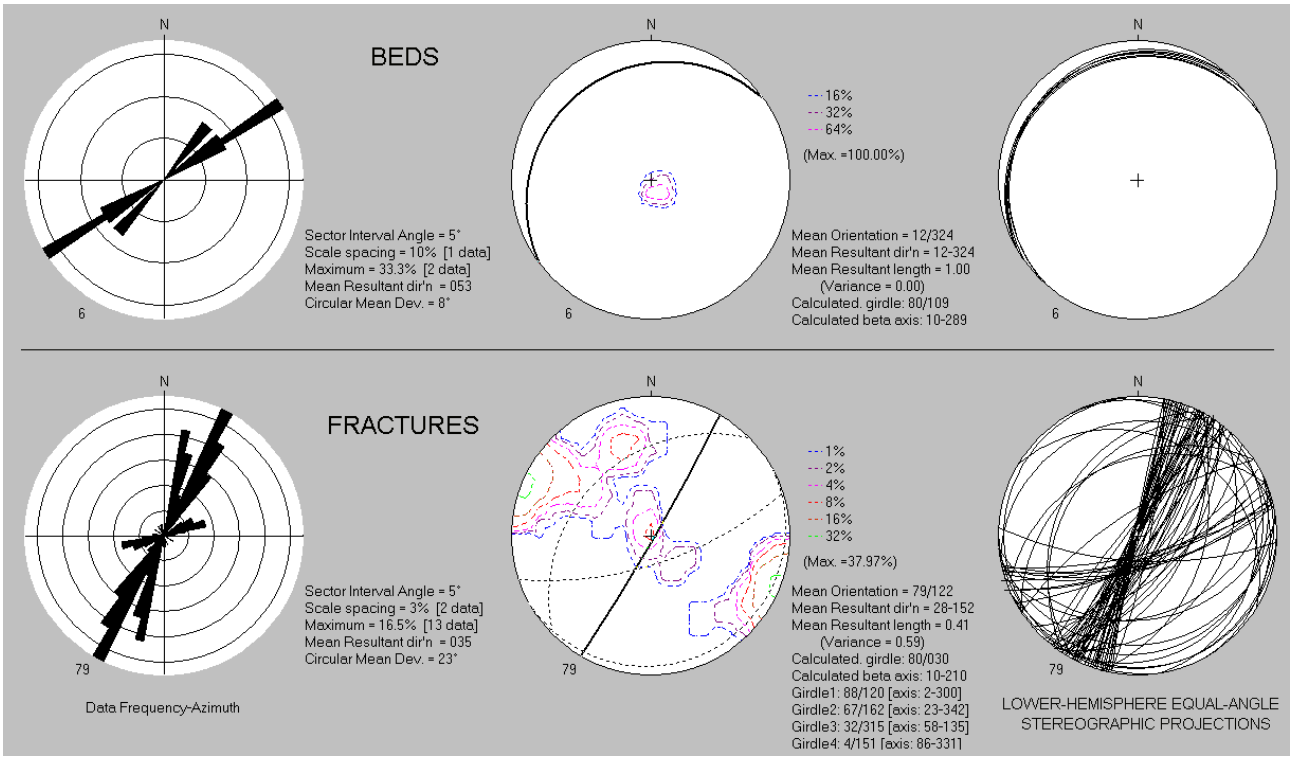


Figure 3O1. Map (above) showing well 105 in Pennington Boro, Mercer County, NJ. Bedrock structures mapped near wells based on a structural analysis of OPTV data (below).

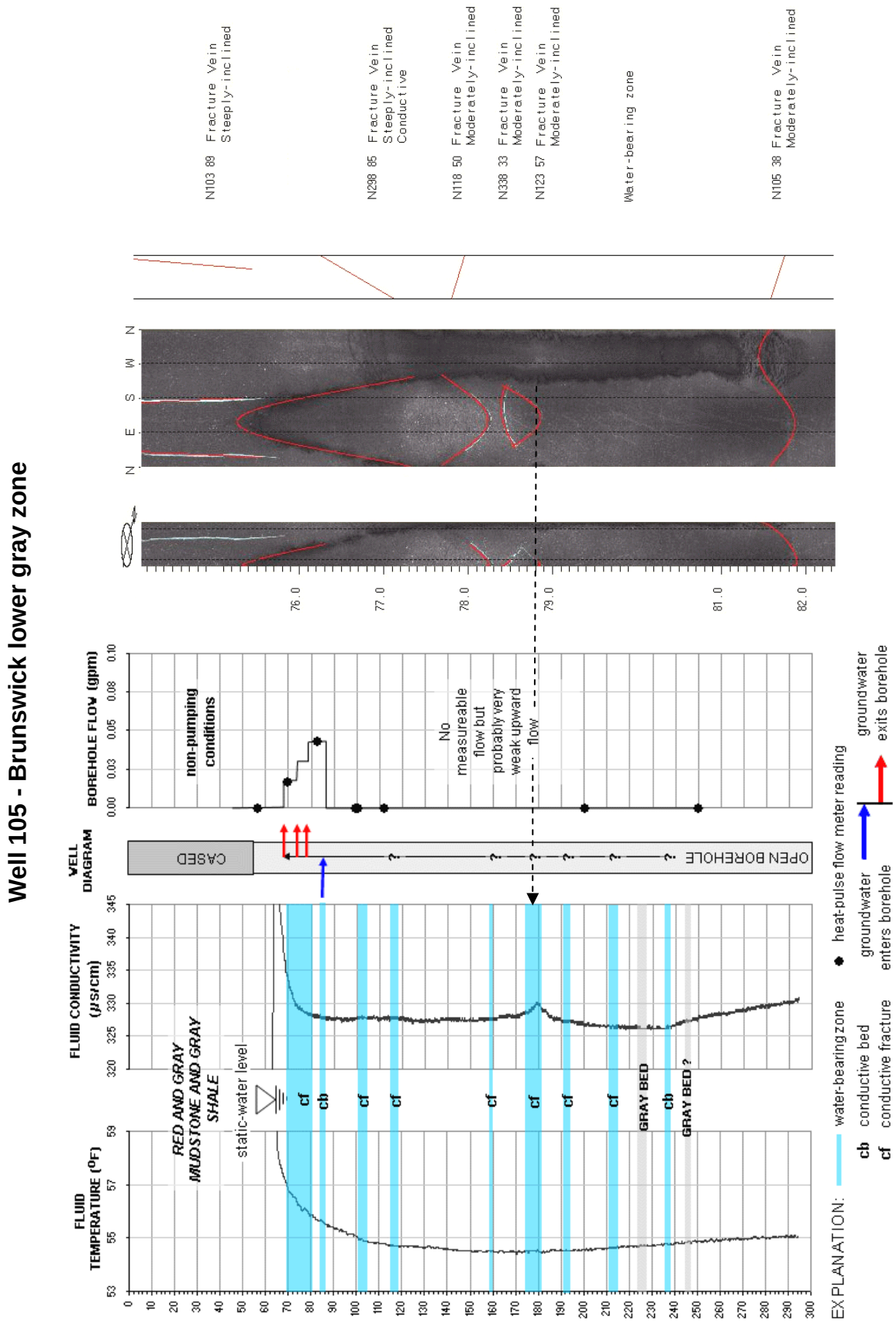
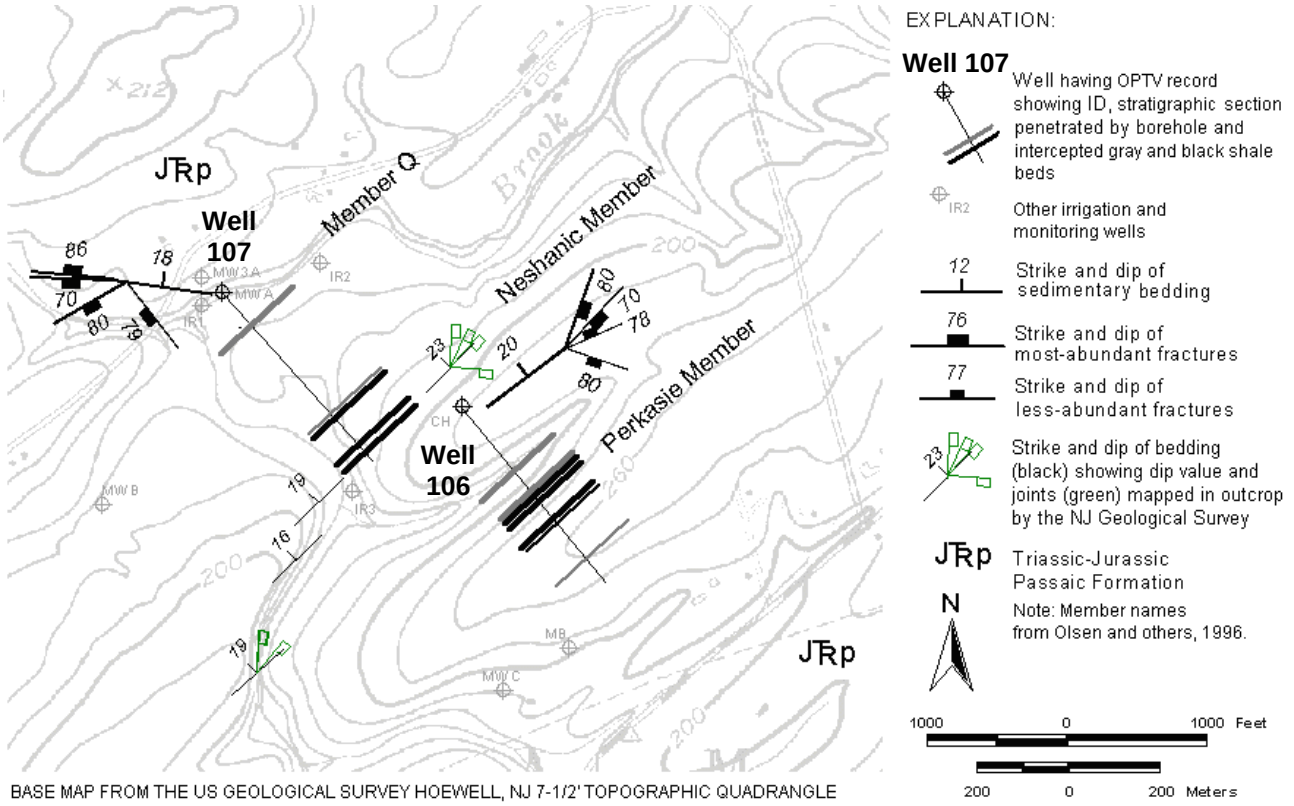


FIGURE 3O2. Hydrogeologic section (left) based on geophysical logs for well 105 in Pennington Boro, Mercer County, NJ, The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red mudstone. OPTV record (right) shows geologic structures and hydraulically-conductive fracture. Depth values are in feet below land surface.

Wells 106 and 107 - Brunswick lower gray zone



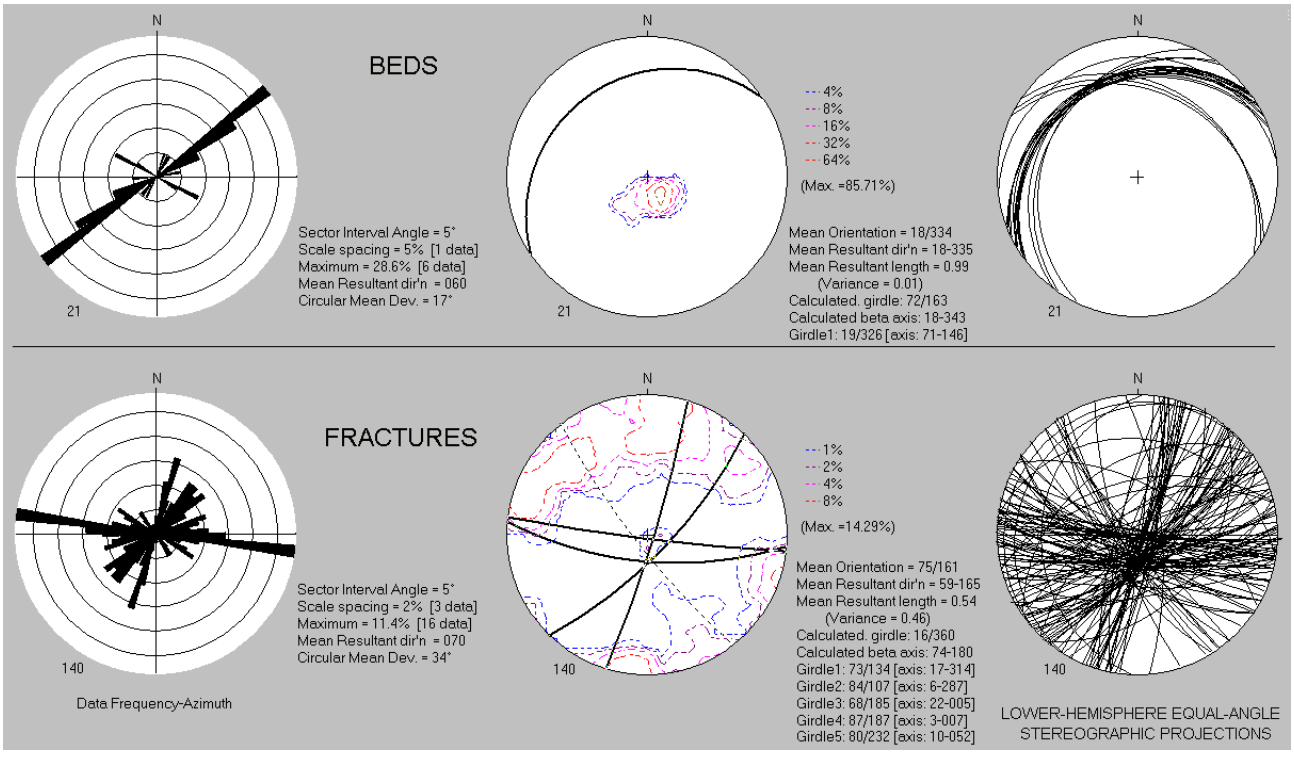


Figure 3P1. Map (above) showing wells 106 and 107 at the Ridge Golf Club, East Amwell Twp., Hunterdon County, NJ. Bedrock structures mapped near wells based on a structural analysis of OPTV data (below).

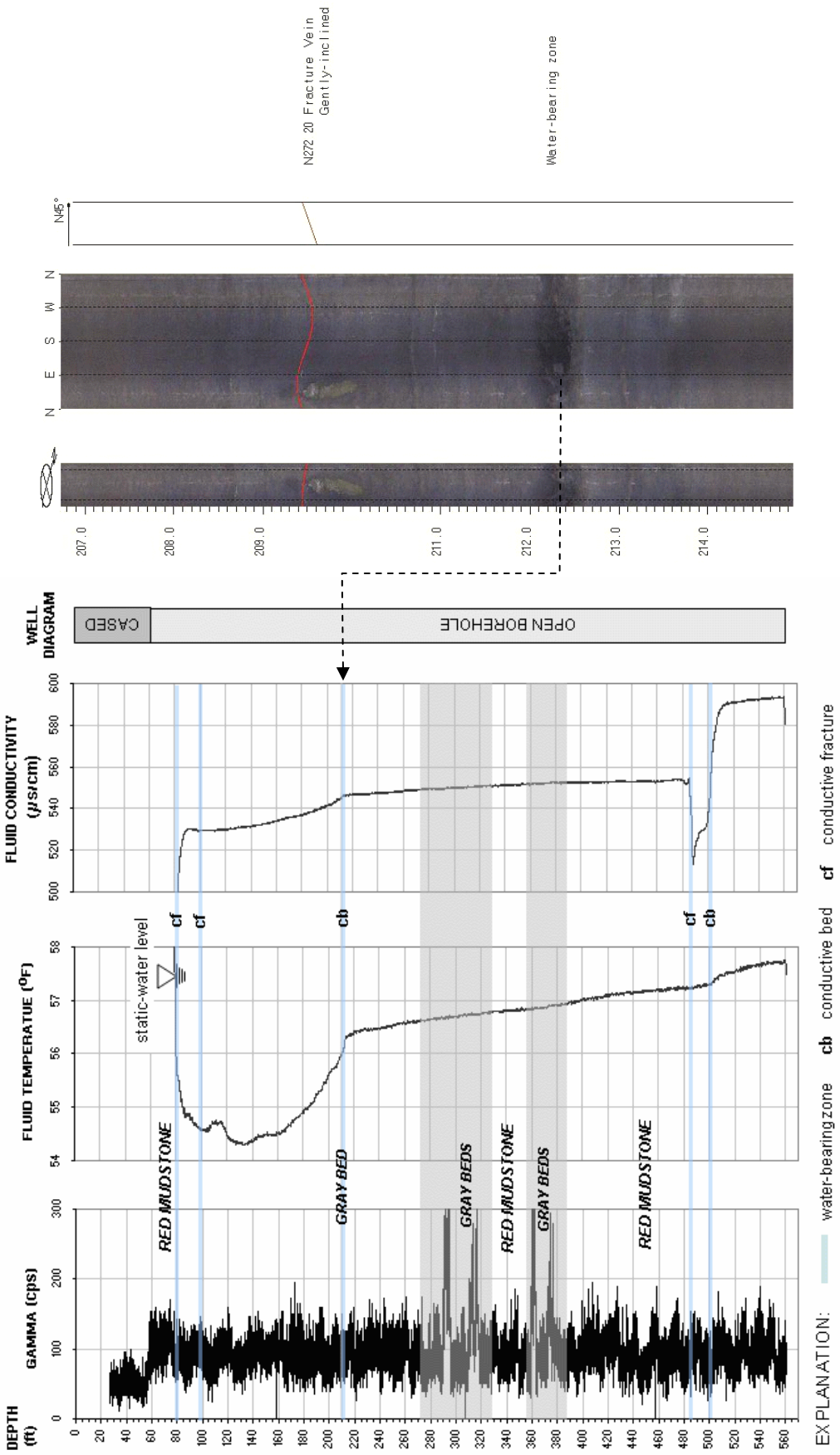


FIGURE 3P2. Hydrogeologic section (left) based on geophysical logs for well 106 at the Ridge Golf Club, East Amwell Twp., Hunterdon County, NJ., The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray and black shale. OPTV record (right) shows geologic structures and a hydraulically-conductive bed. Depth values are in feet below land surface.

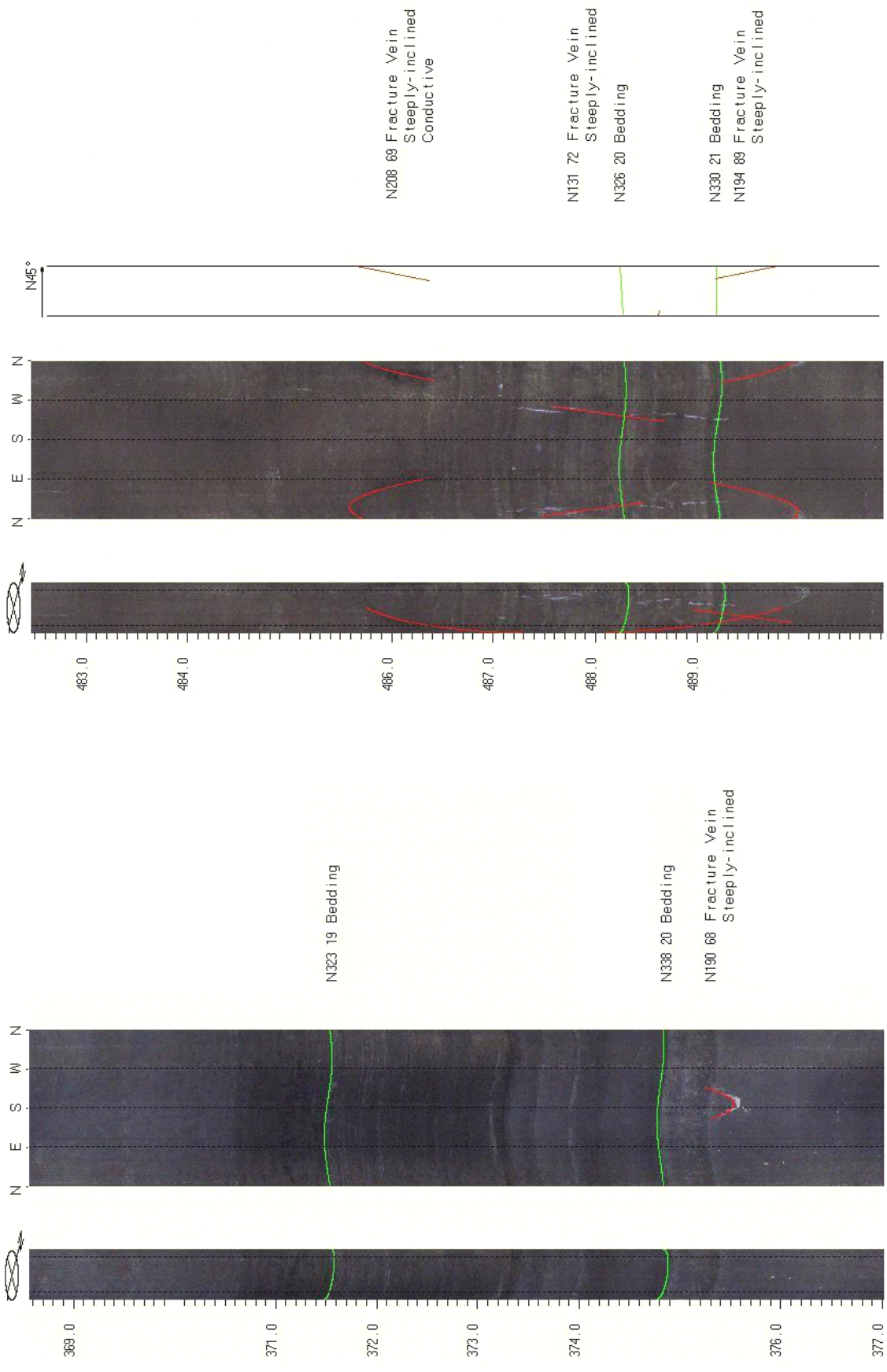


FIGURE 3P3. OPTV records of 6-inch diameter well 106 at the Ridge Golf Club, East Amwell Twp., Hunterdon County, NJ, showing geologic structures and hydraulically-conductive features in red and gray mudstone and gray and black shale. Depth values are in feet below land surface.

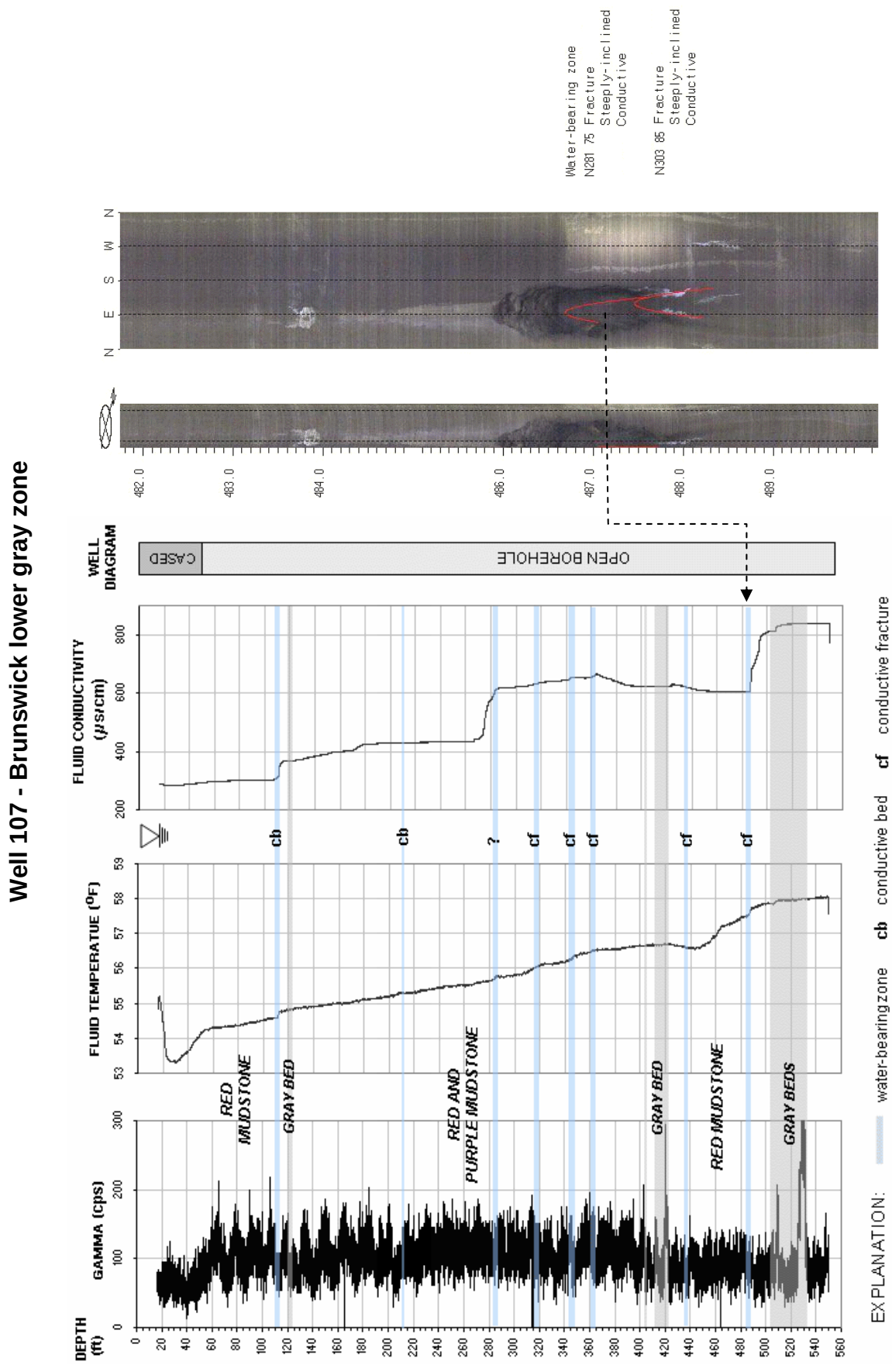


FIGURE 3P4. Hydrogeologic section (left) based on geophysical logs for well 107 at the Ridge Golf Club, East Amwell Twp., Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray and black shale. OPTV record (right) shows hydraulically-conductive fracture. Depth values are in feet below land surface.

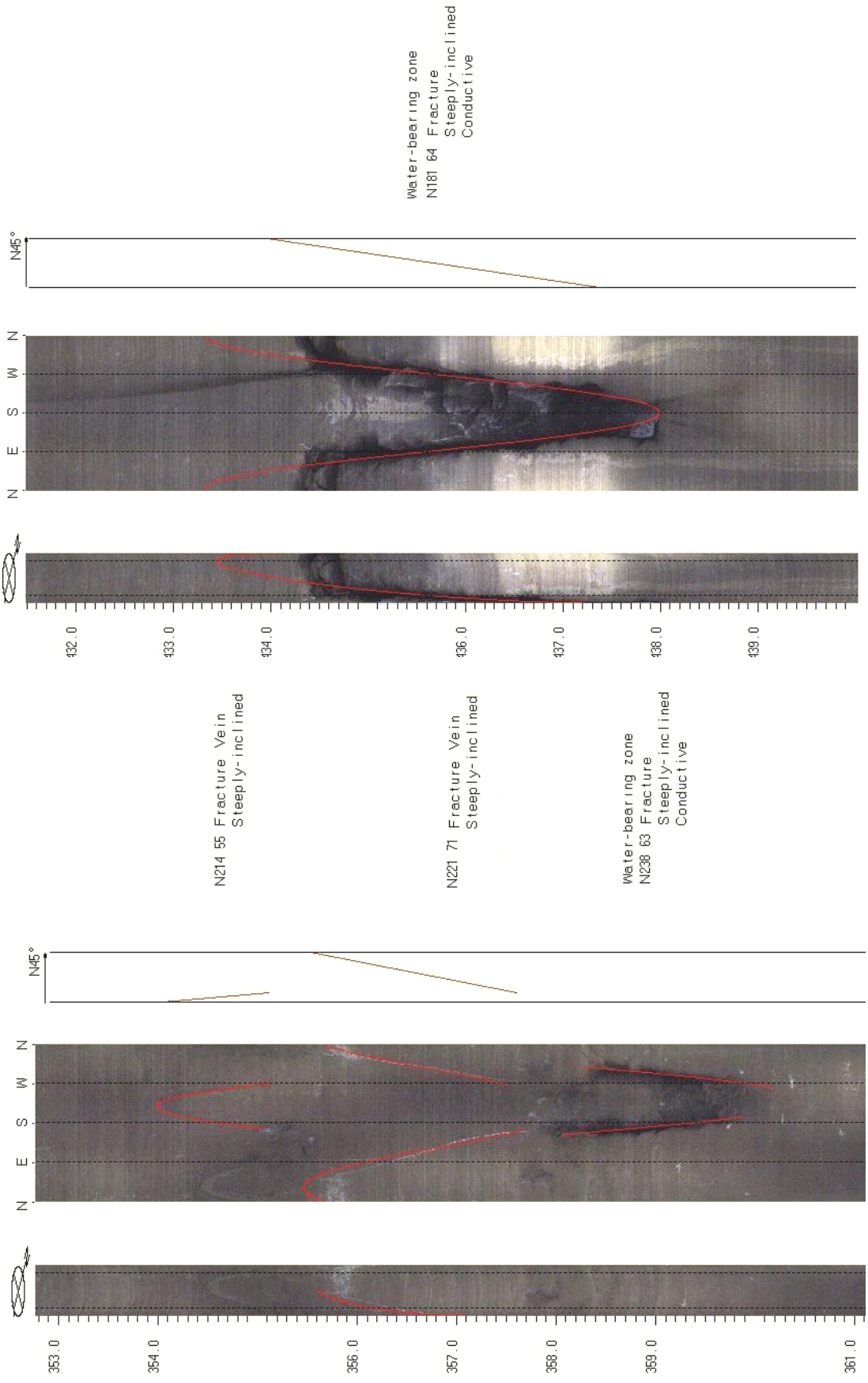
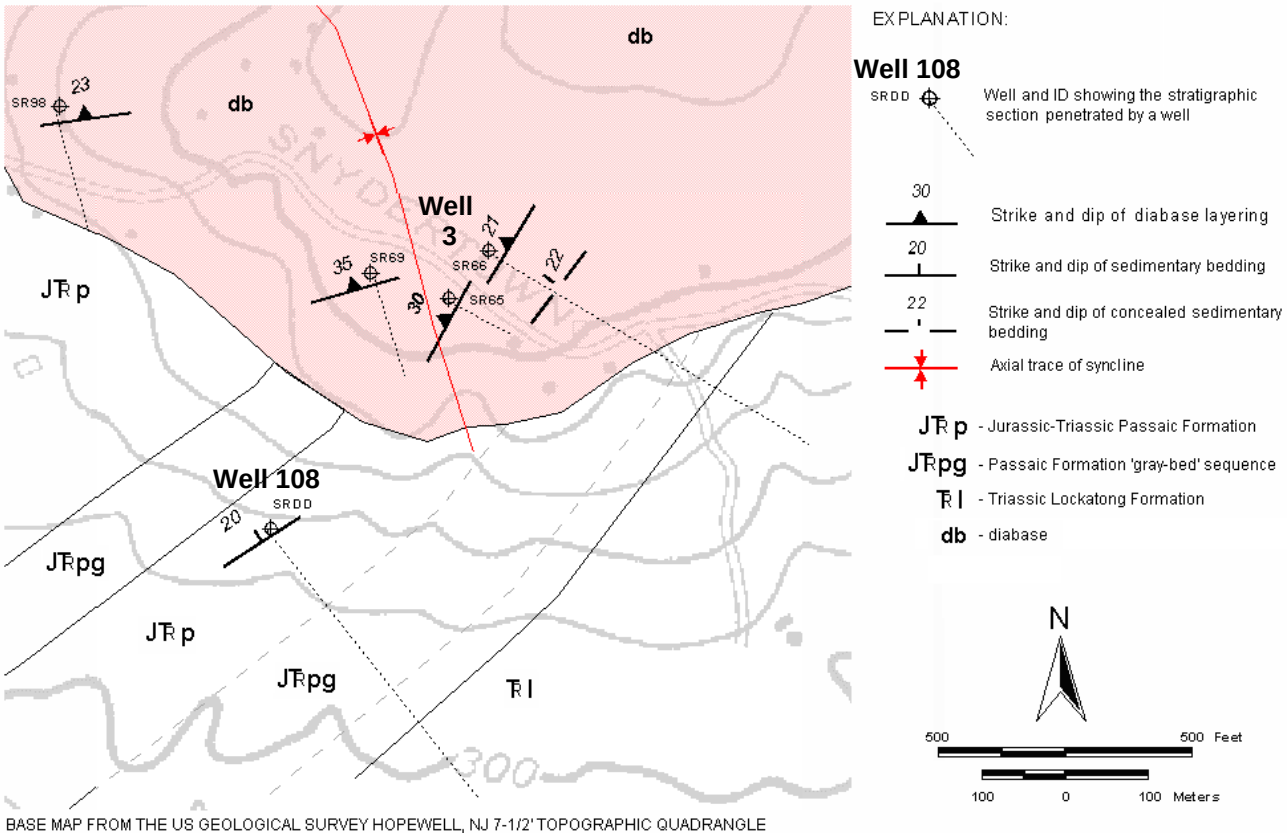


FIGURE 3P5. OPTV records of 6-inch diameter well 107 at the Ridge Golf Club, East Amwell Twp., Hunterdon County, NJ, showing geologic structures and hydraulically-conductive features in red and gray mudstone. Depth values are in feet below land surface.

Well 108 - Brunswick lower gray zone and Lockatong



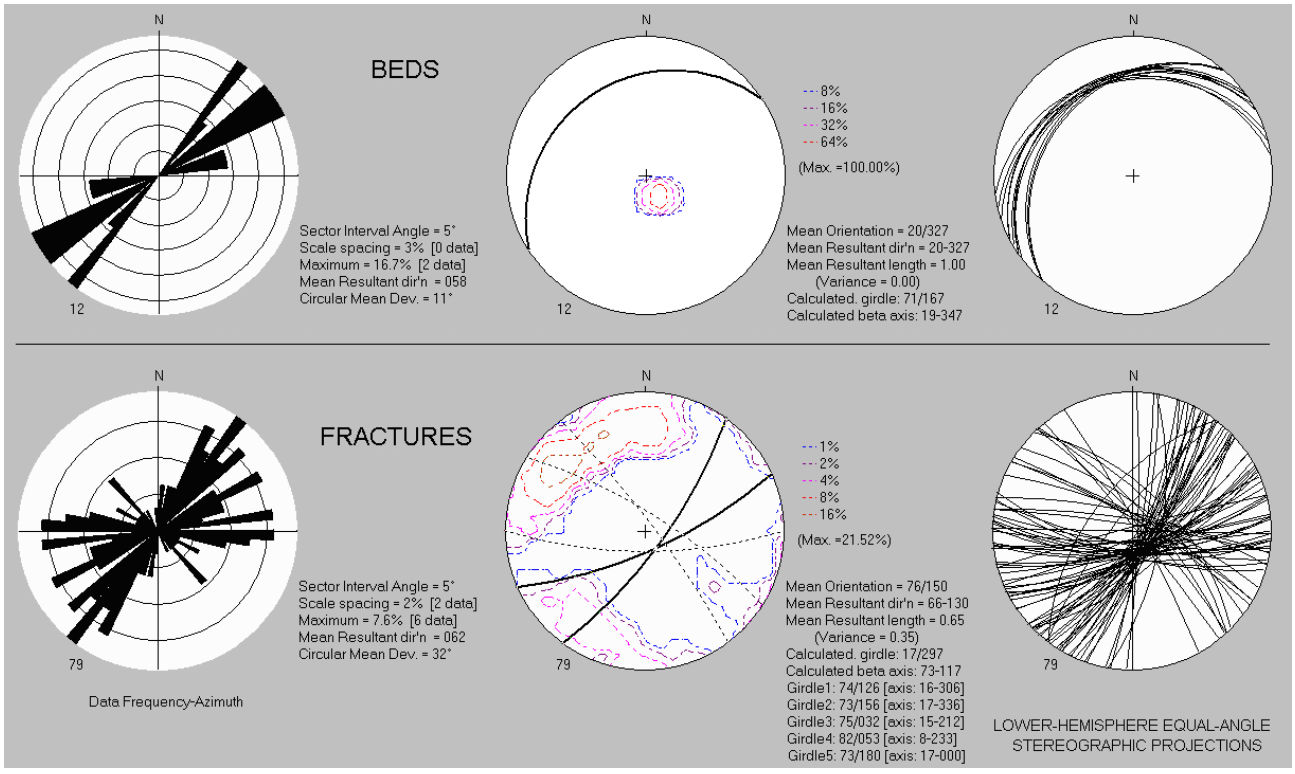


Figure 3Q1. Map (above) showing wells 108 and 3 off Snydertown Rd. in East Amwell Twp., Hunterdon County, NJ. Bedrock structures mapped near wells based on a structural analysis of OPTV data (below).

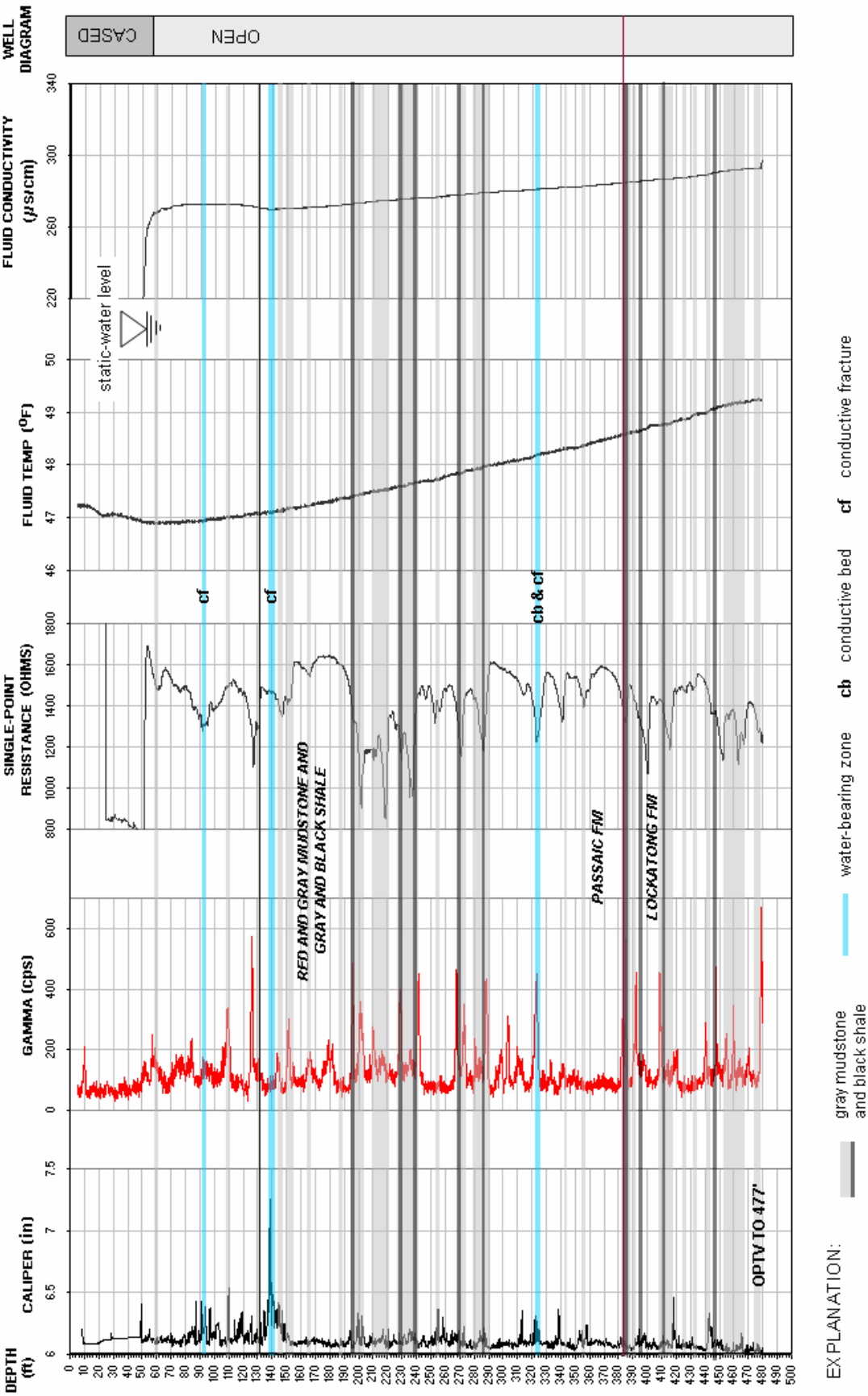


FIGURE 3Q2. Hydrogeologic section based on geophysical logs for well 108 off Snydertown Rd. in East Amwell Twp., Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray and black shale. Depth values are in feet below land surface.

Wells 108 and 3- Brunswick lower gray zone and Lockatong upper contact interval

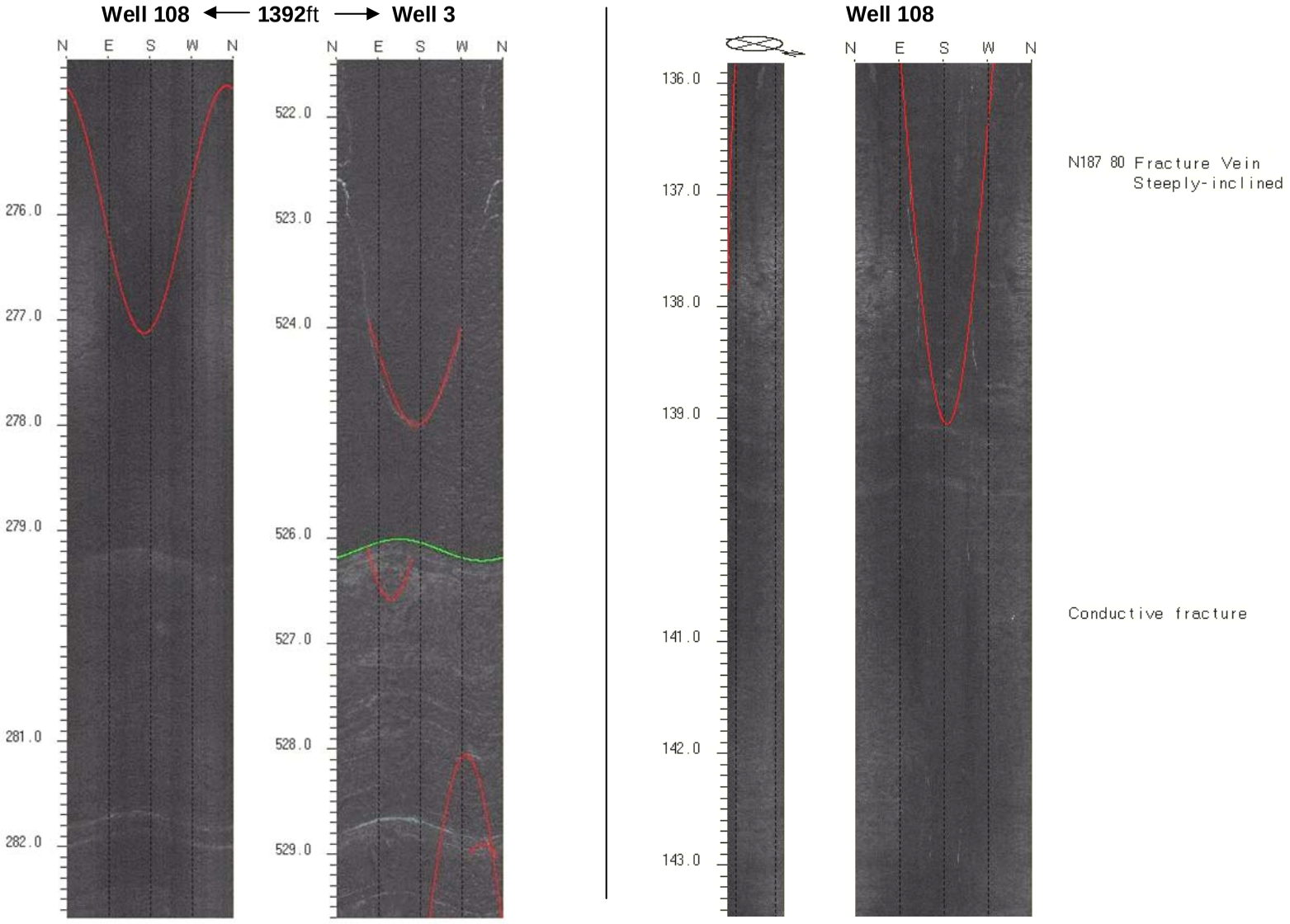


FIGURE 3Q3. Stratigraphic correlation based on OPTV records for wells 108 and 3 (left) near Snydertown Rd., East Amwell Twp., Hunterdon County, NJ. OPTV record (right) shows hydraulically-conductive fracture in 6-inch diameter well 108. Depth values are in feet below land surface.

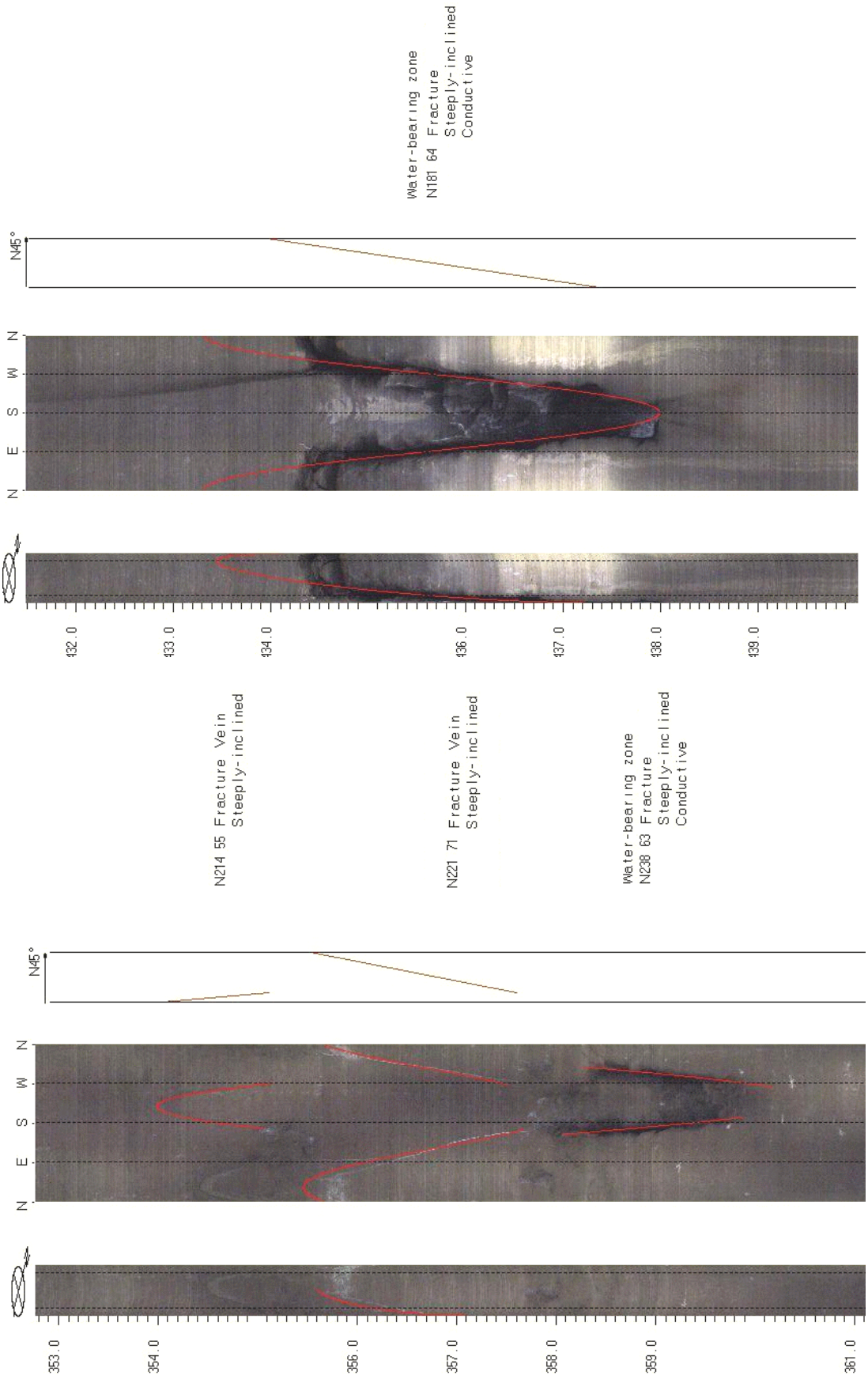
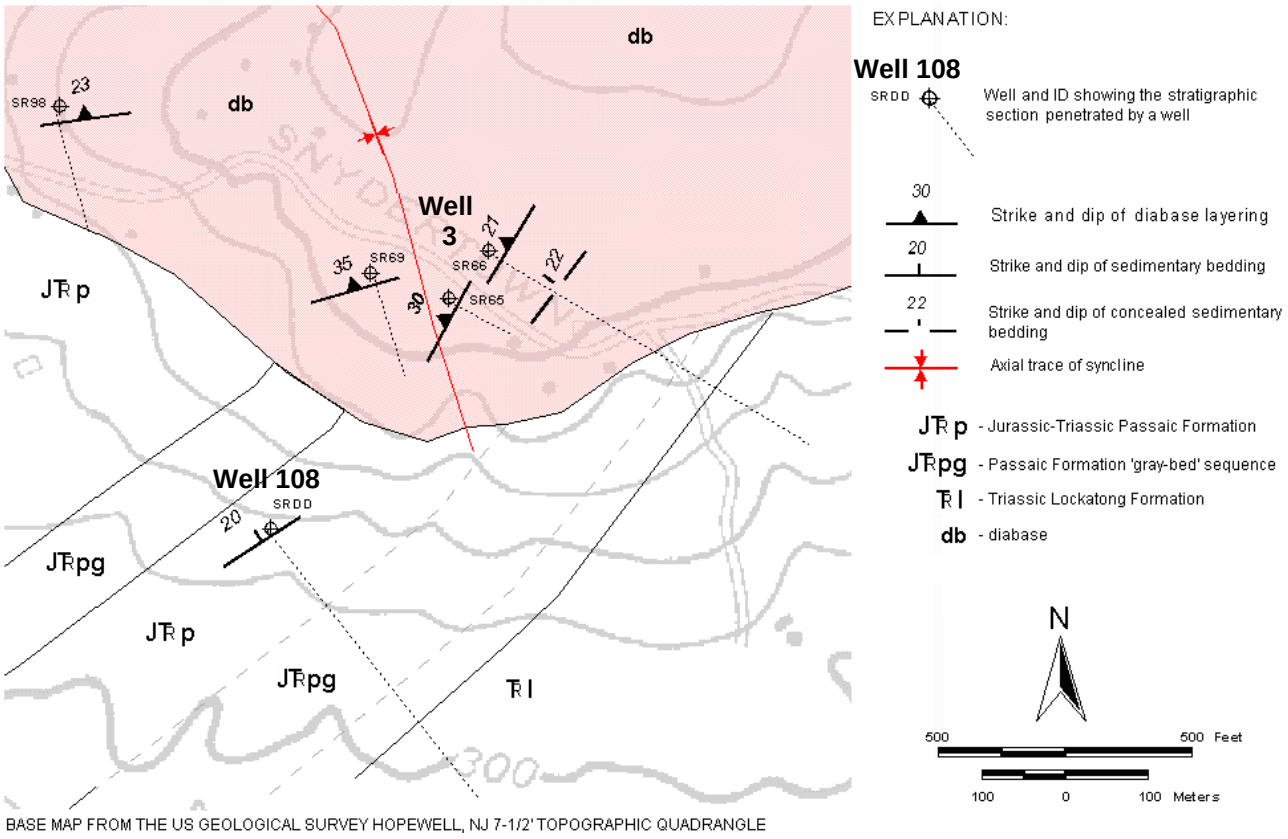


FIGURE 3P5. OPTV records of 6-inch diameter well 107 at the Ridge Golf Club, East Amwell Twp., Hunterdon County, NJ, showing geologic structures and hydraulically-conductive features in red and gray mudstone. Depth values are feet below land surface.

Well 108 - Brunswick lower gray zone and Lockatong



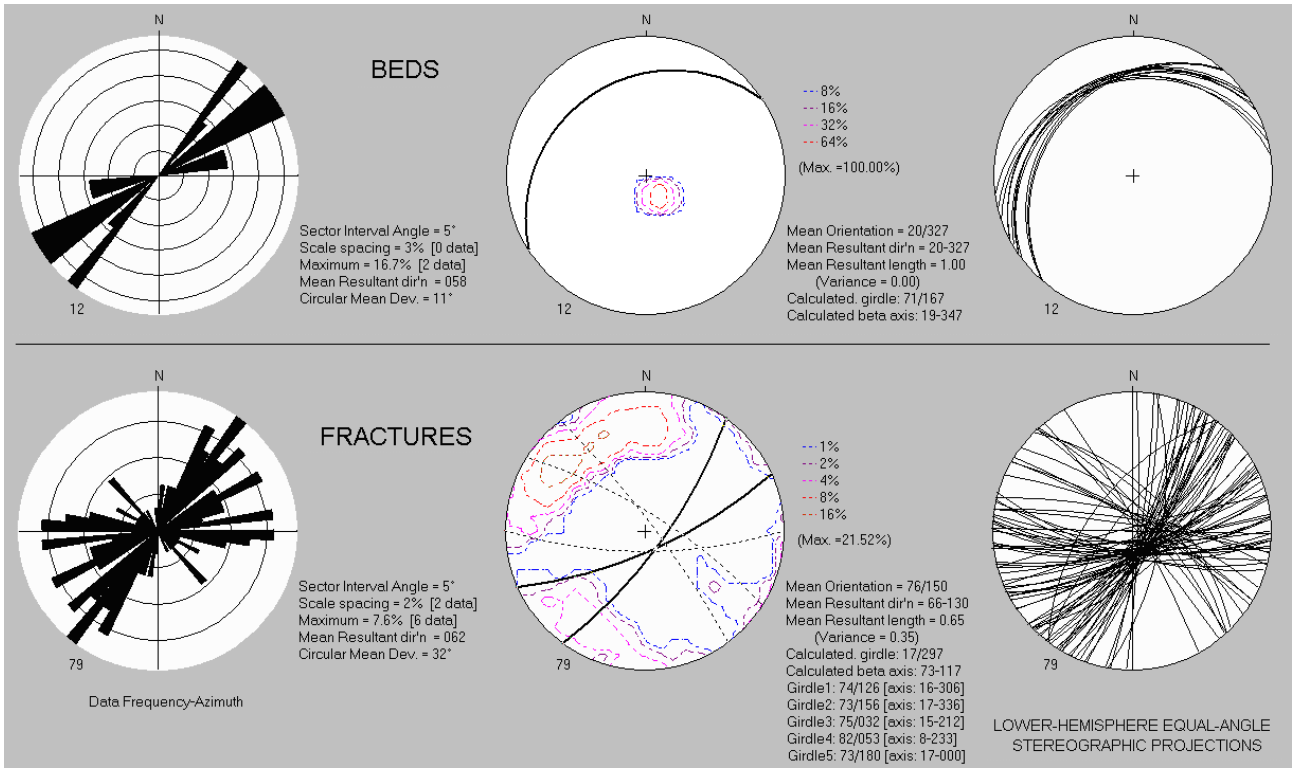


Figure 3Q1. Map (above) showing wells 108 and 3 off Snydertown Rd. in East Amwell Twp., Hunterdon County, NJ. Bedrock structures mapped near wells based on a structural analysis of OPTV data (below).

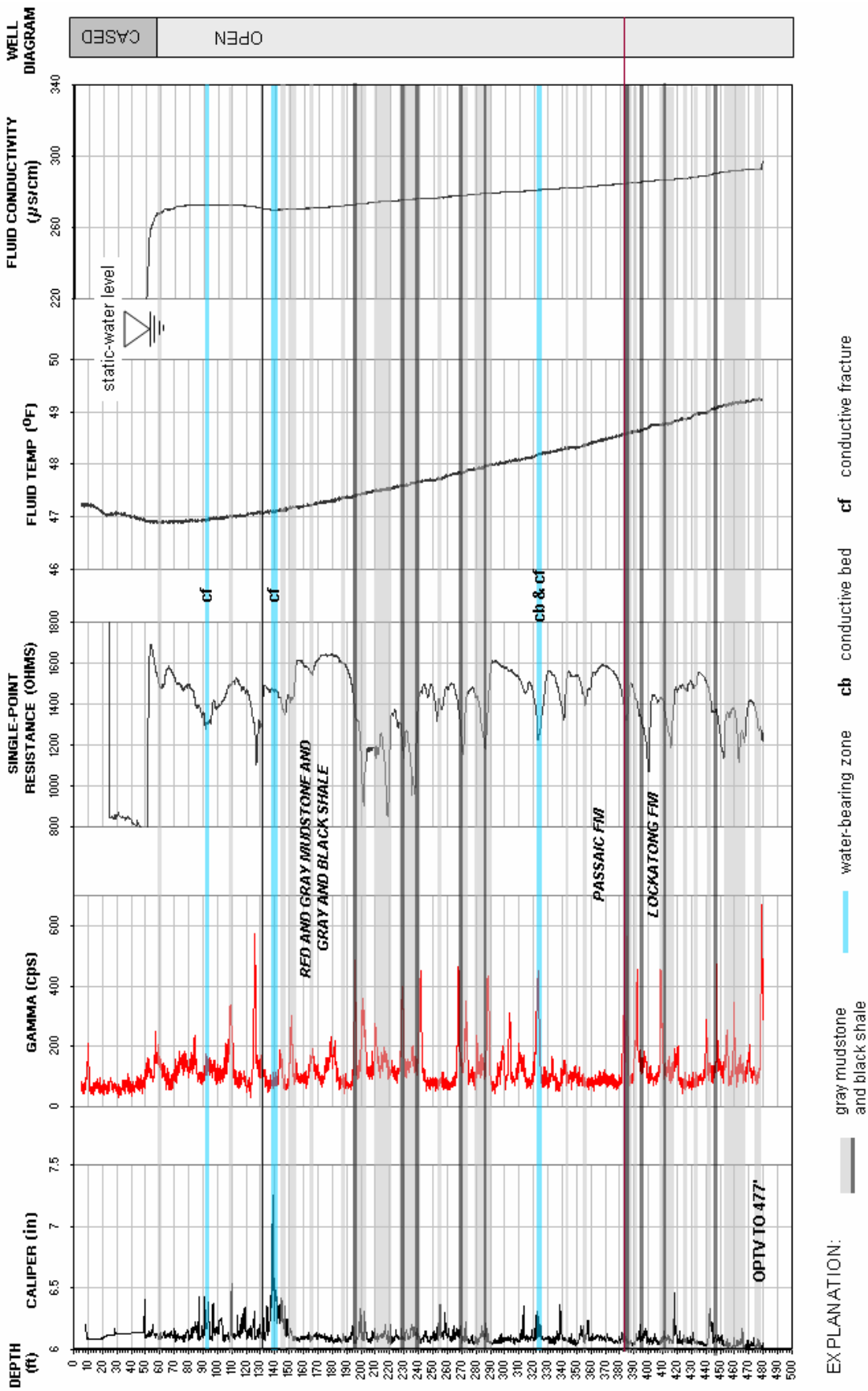


FIGURE 3Q2. Hydrogeologic section based on geophysical logs for well 108 off Snydertown Rd. in East Amwell Twp., Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray mudstone and gray and black shale. Depth values are in feet below land surface.

Wells 108 and 3- Brunswick lower gray zone and Lockatong upper contact interval

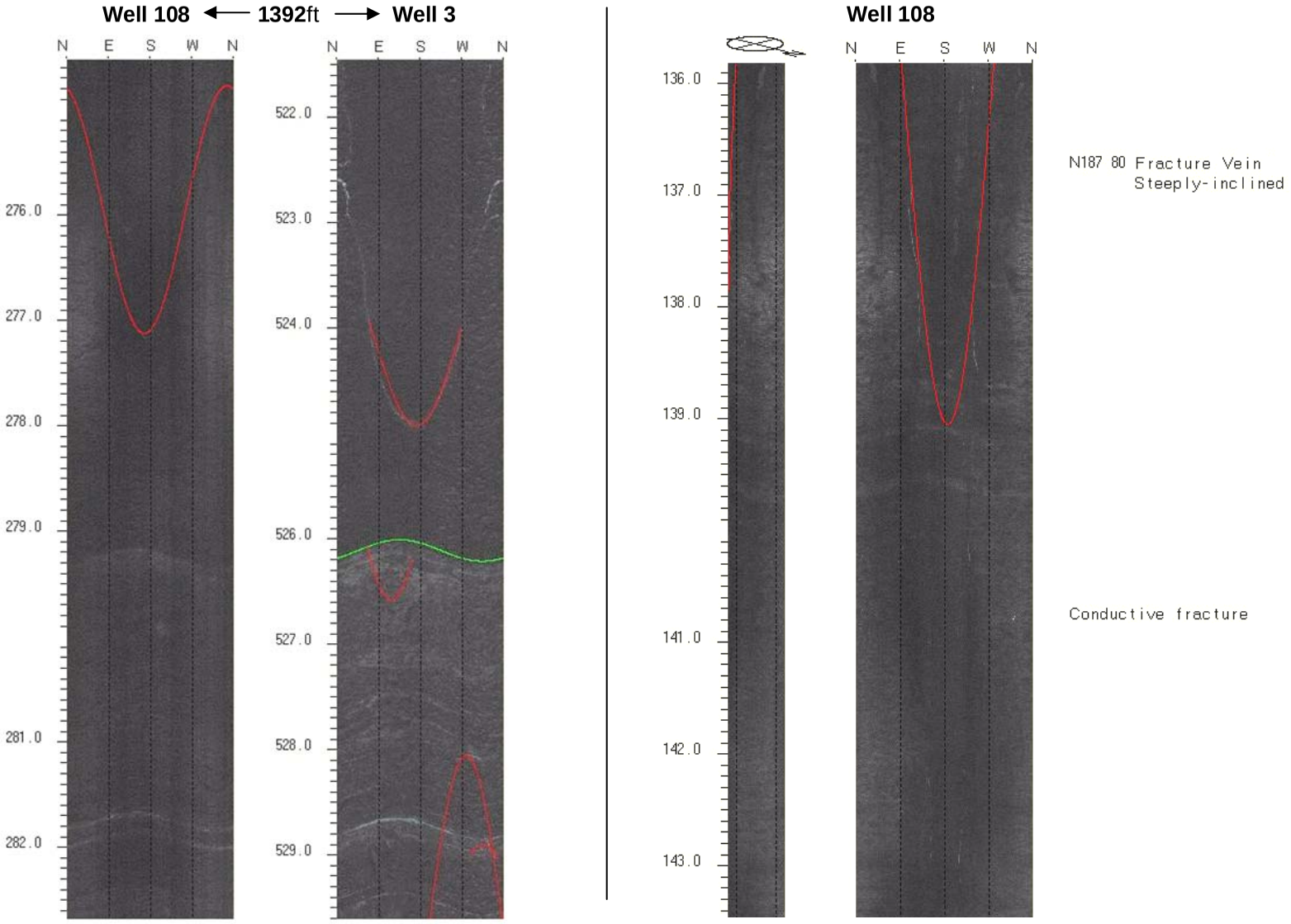


FIGURE 3Q3. Stratigraphic correlation based on OPTV records for wells 108 and 3 (left) near Snydertown Rd., East Amwell Twp., Hunterdon County, NJ. OPTV record (right) shows hydraulically-conductive fracture in 6-inch diameter well 108. Depth values are in feet below land surface.

Summary of Borehole Geophysical Studies in the Newark Basin, New Jersey:

Lockatong argillite and Stockton sandstone

By Gregory C. Herman and John F. Curran, N.J. Geological Survey

Appendix 4 of

Contributions to the Geology and Hydrogeology of the Newark Basin

N.J. Geological Survey Bulletin 77

State of New Jersey
Department of Environmental Protection
Water Resource Management
New Jersey Geological Survey
2010

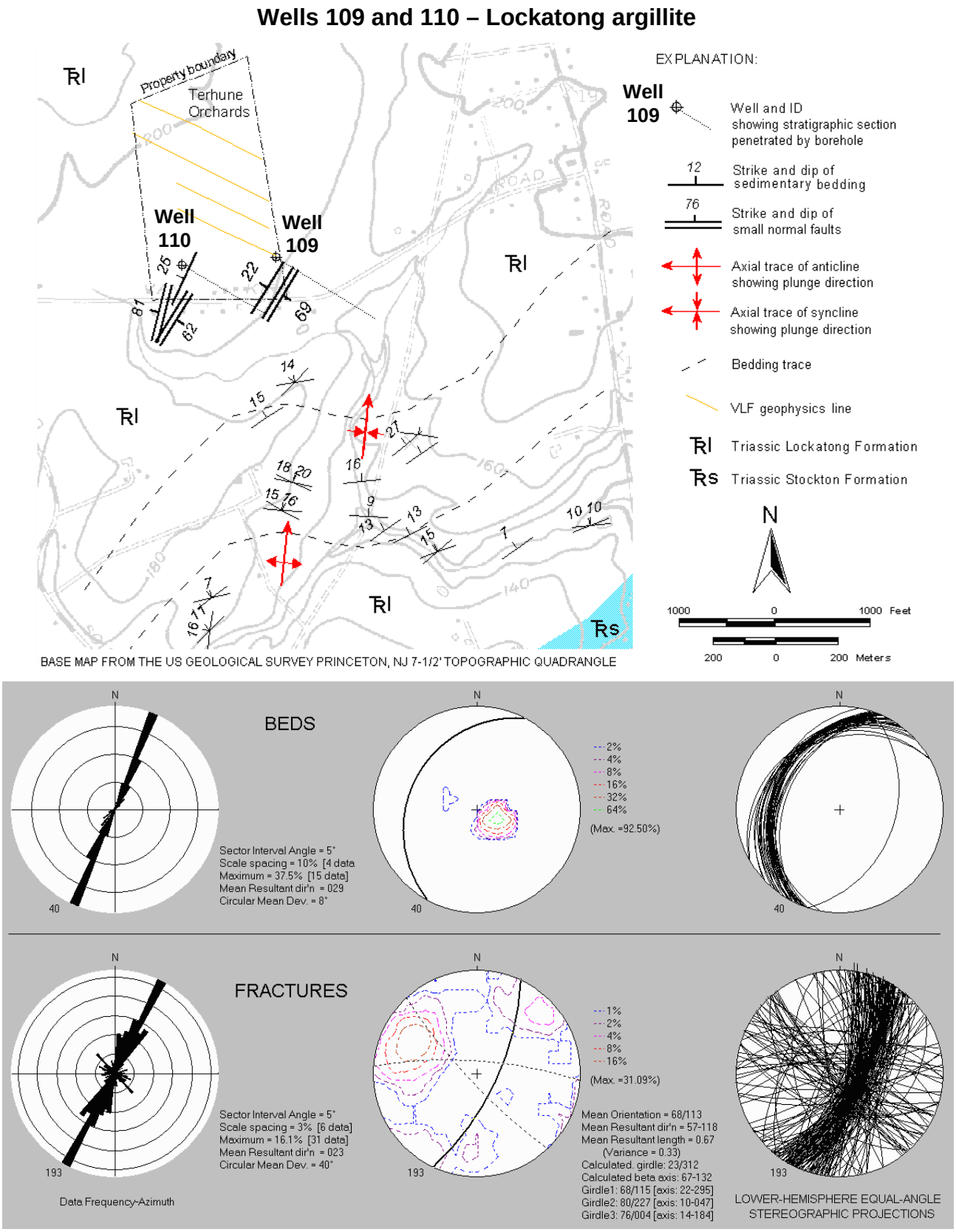


Figure 4A1. Map (above) showing wells 109 and 110 at Terhune Orchards, 42 Van Kirk Rd., Lawrence Twp., Mercer County, NJ. Bedrock structures mapped near wells based on a structural analysis of OPTV data (below).

Well 109 – Lockatong argillite

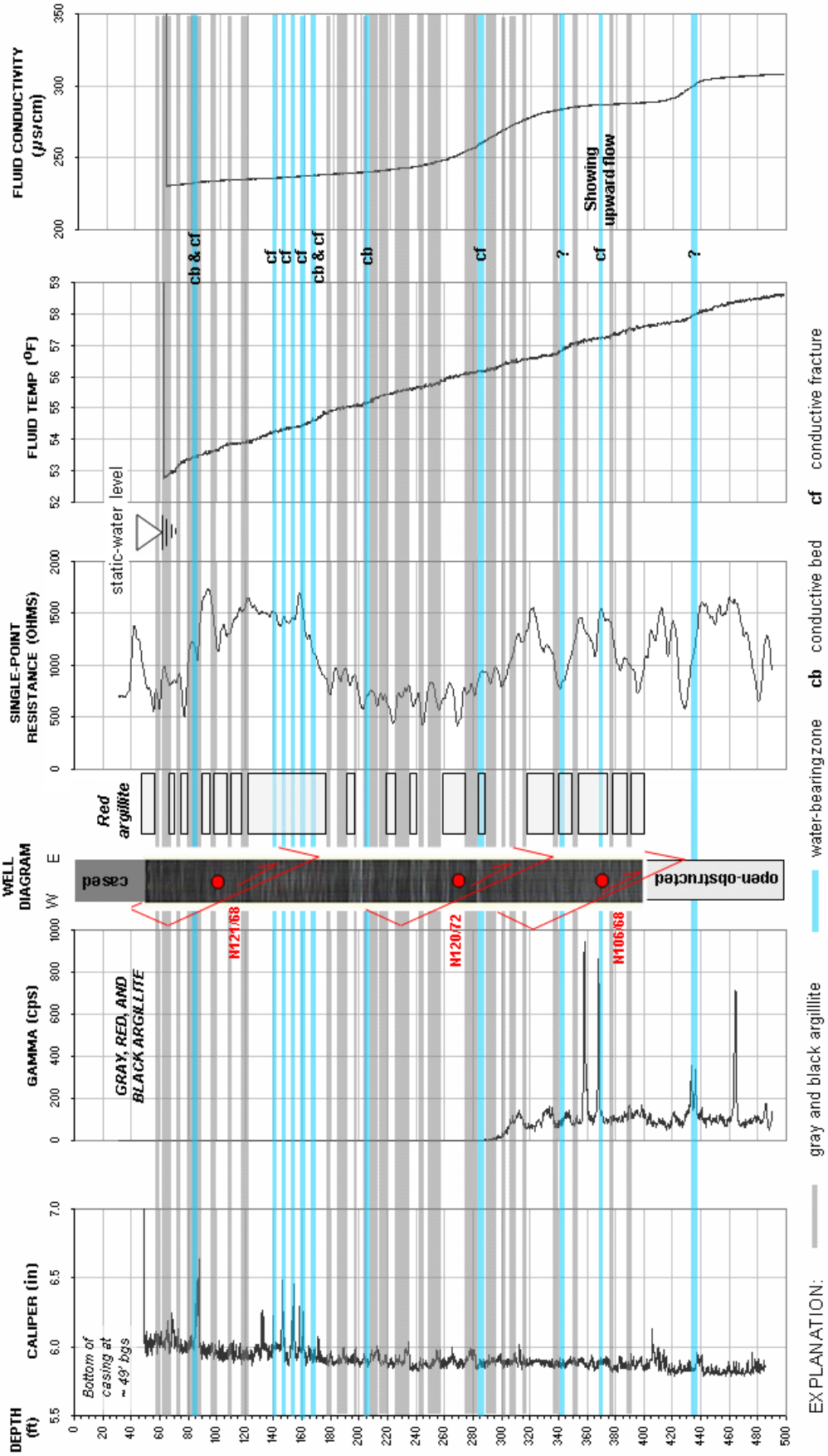


FIGURE 4A2. Hydrogeologic section based on geophysical logs for well 109 at Terhune Orchards, 42 Van Kirk Rd., Lawrence Twp., Mercer County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in Lockatong argillite. Depth values are in feet below land surface.

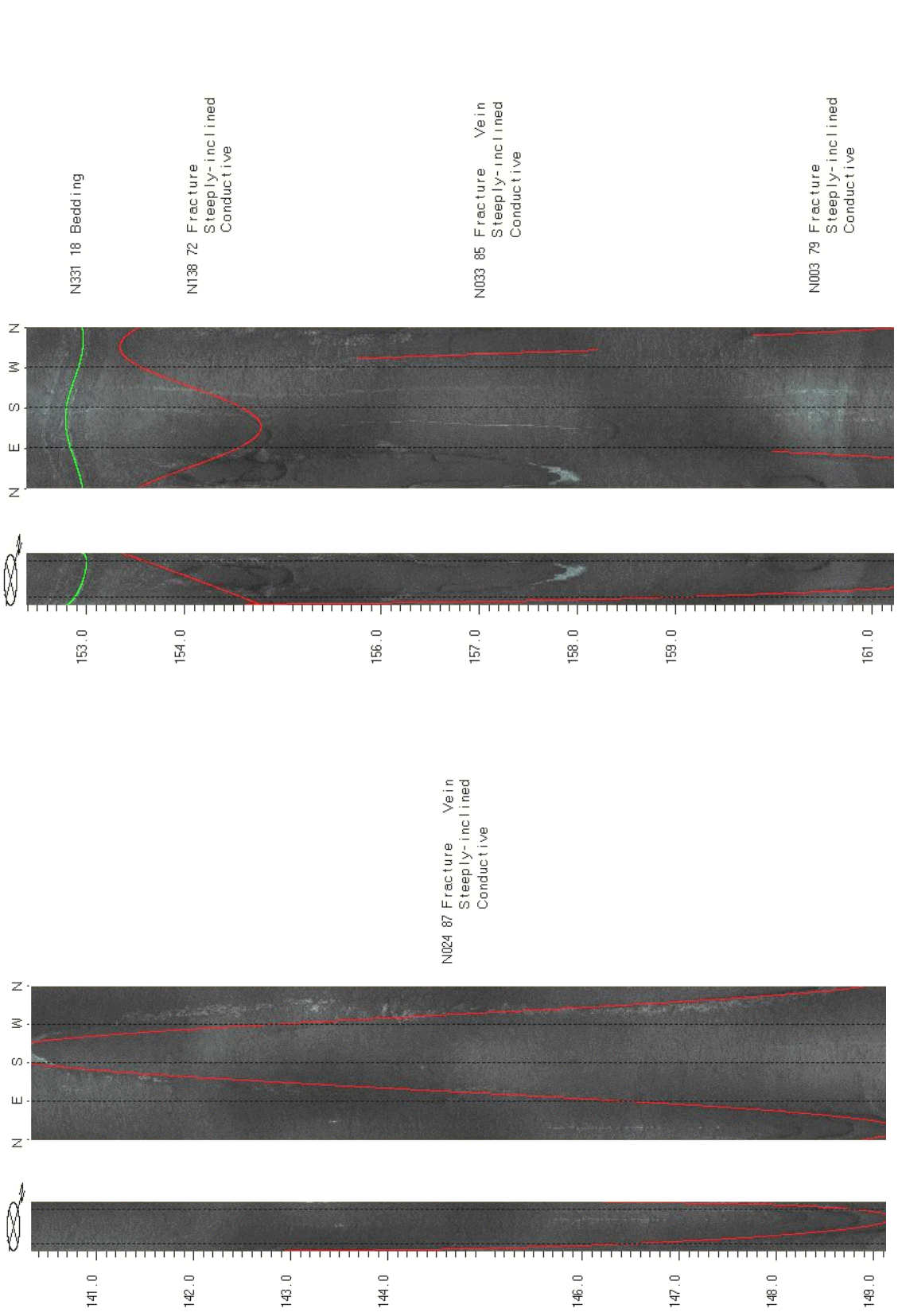


FIGURE 4A3. OPTV records of 6-inch diameter well 109 at Terhune Orchards, 42 Van Kirk Rd., Lawrence Twp., Mercer County, NJ showing geologic structures and hydraulically-conductive features in red argillite. Depth values are in feet below land surface.

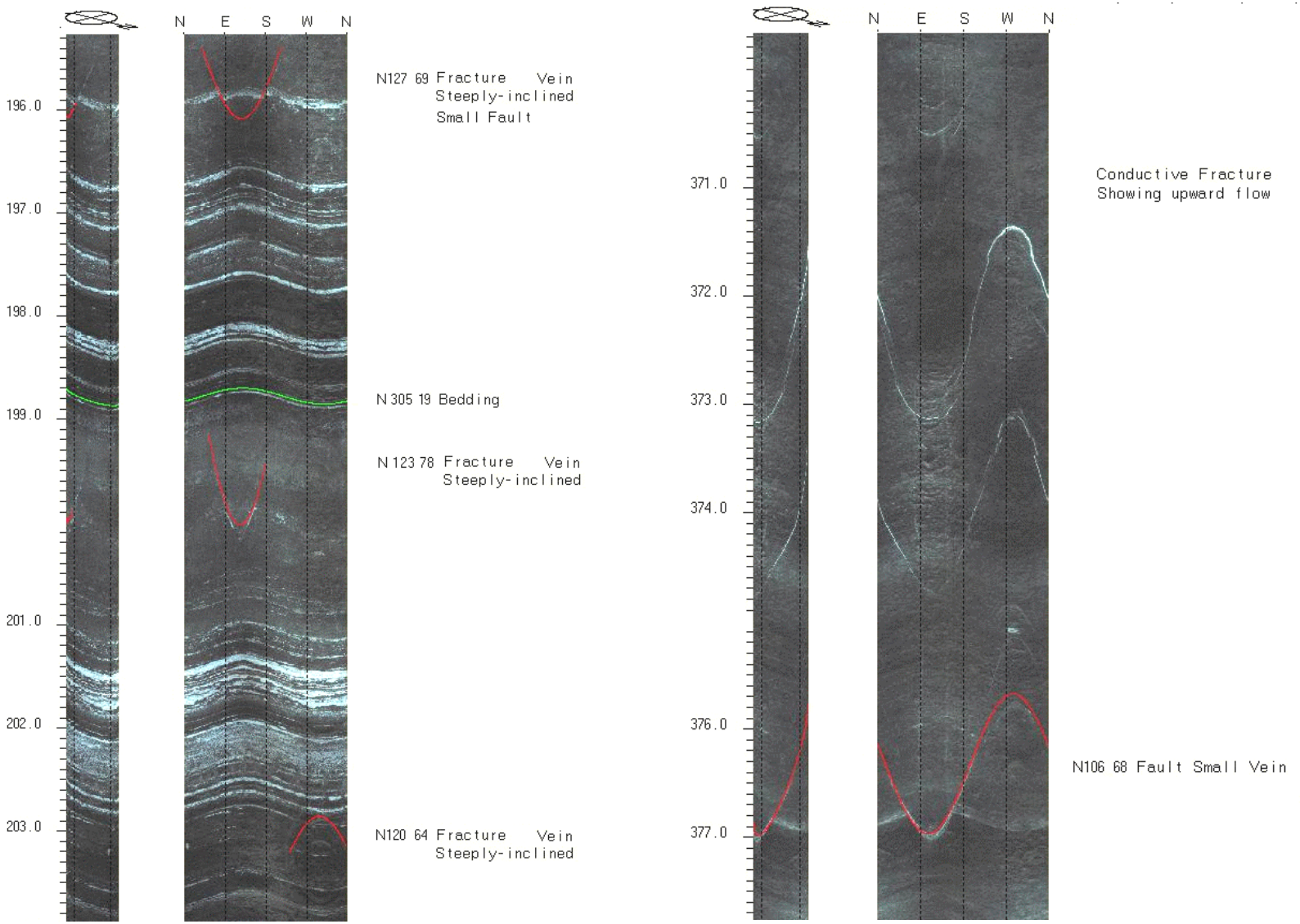


FIGURE 4A4. OPTV records of 6-inch diameter well 109 at Terhune Orchards, 42 Van Kirk Rd., Lawrence Twp., Mercer County, NJ showing geologic structures and hydraulically-conductive features in red argillite. Depth values are feet below land surface.

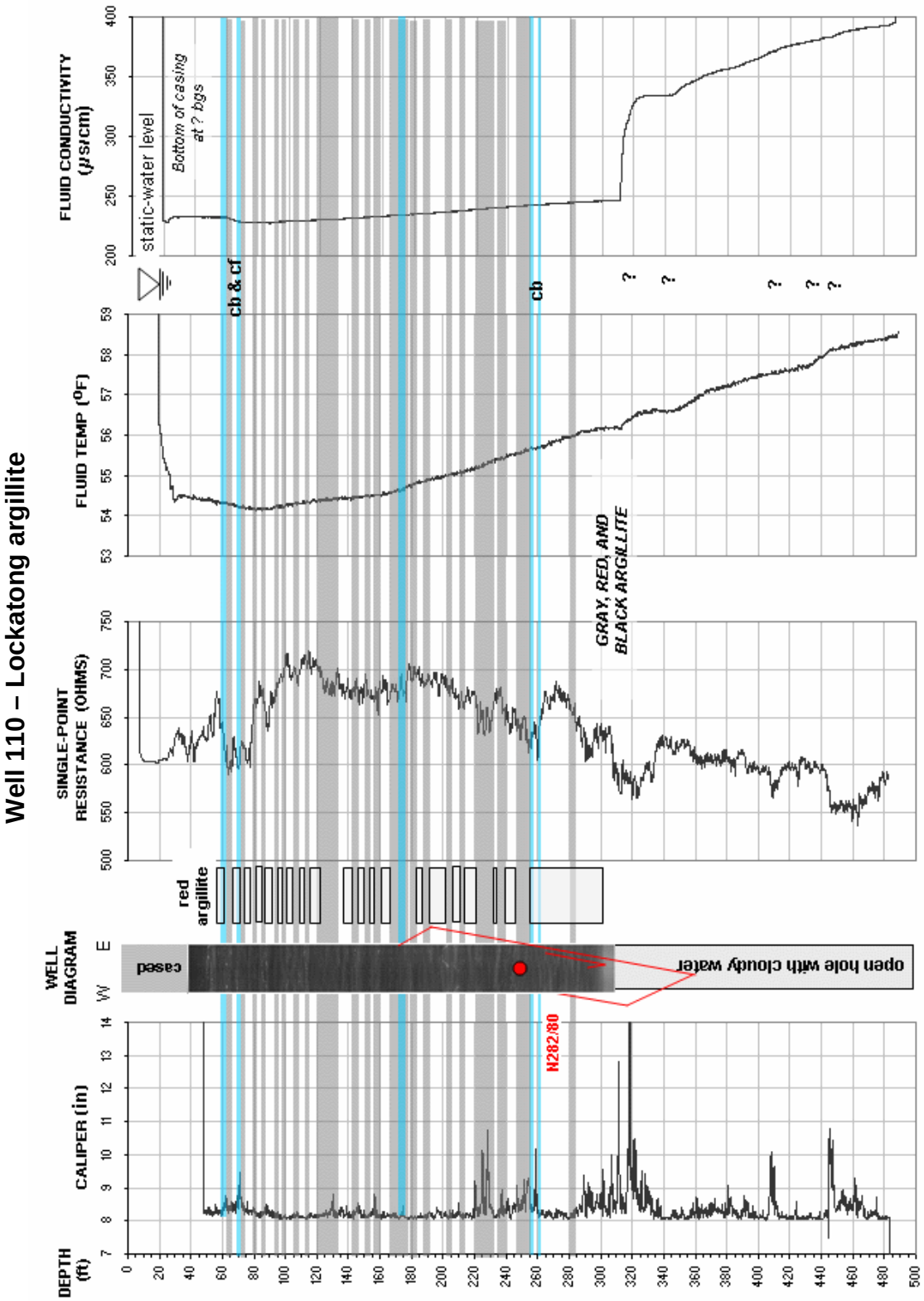


FIGURE 4A5. Hydrogeologic section based on geophysical logs for well 110 at Terhune Orchards, 42 Van Kirk Rd., Lawrence Twp., Mercer County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in Lockatong argillite. Depth values are in feet below land surface.

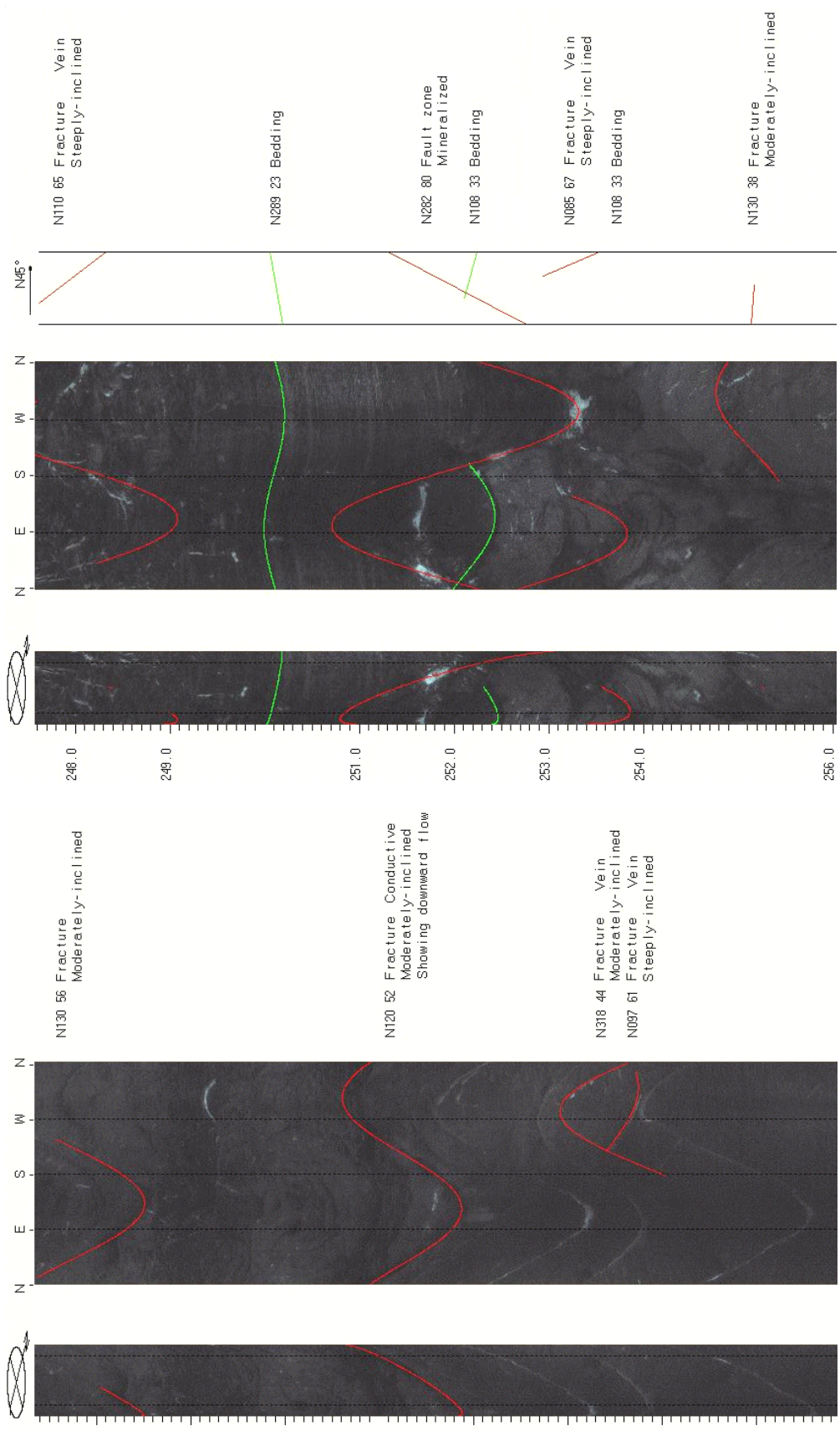


FIGURE 4A6. OPTV records of 8-inch diameter well 110 at Terhune Orchards, 42 Van Kirk Rd., Lawrence Twp., Mercer County, NJ showing geologic structures and hydraulically-conductive features in red and gray argillite. Depth values are in feet below land surface.

Wells 111 to 115 – Lockatong argillite

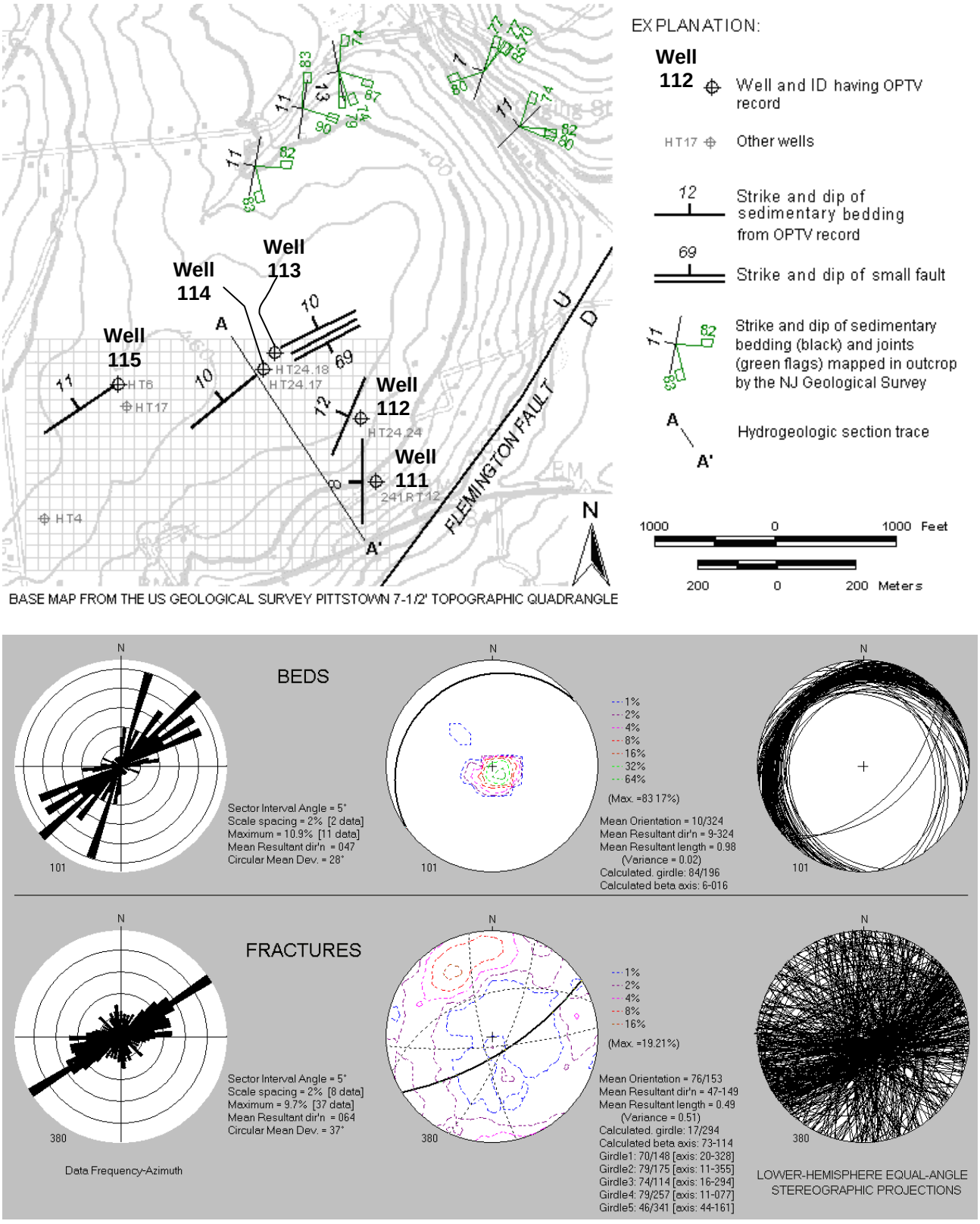


Figure 4B1. Map (above) showing wells 111 to115 at the Hilltop development, Raritan Twp., Hunterdon County, NJ. Bedrock structures mapped near wells based on structural analyses of OPTV data (below).

Wells 112 and 113 – Lockatong argillite

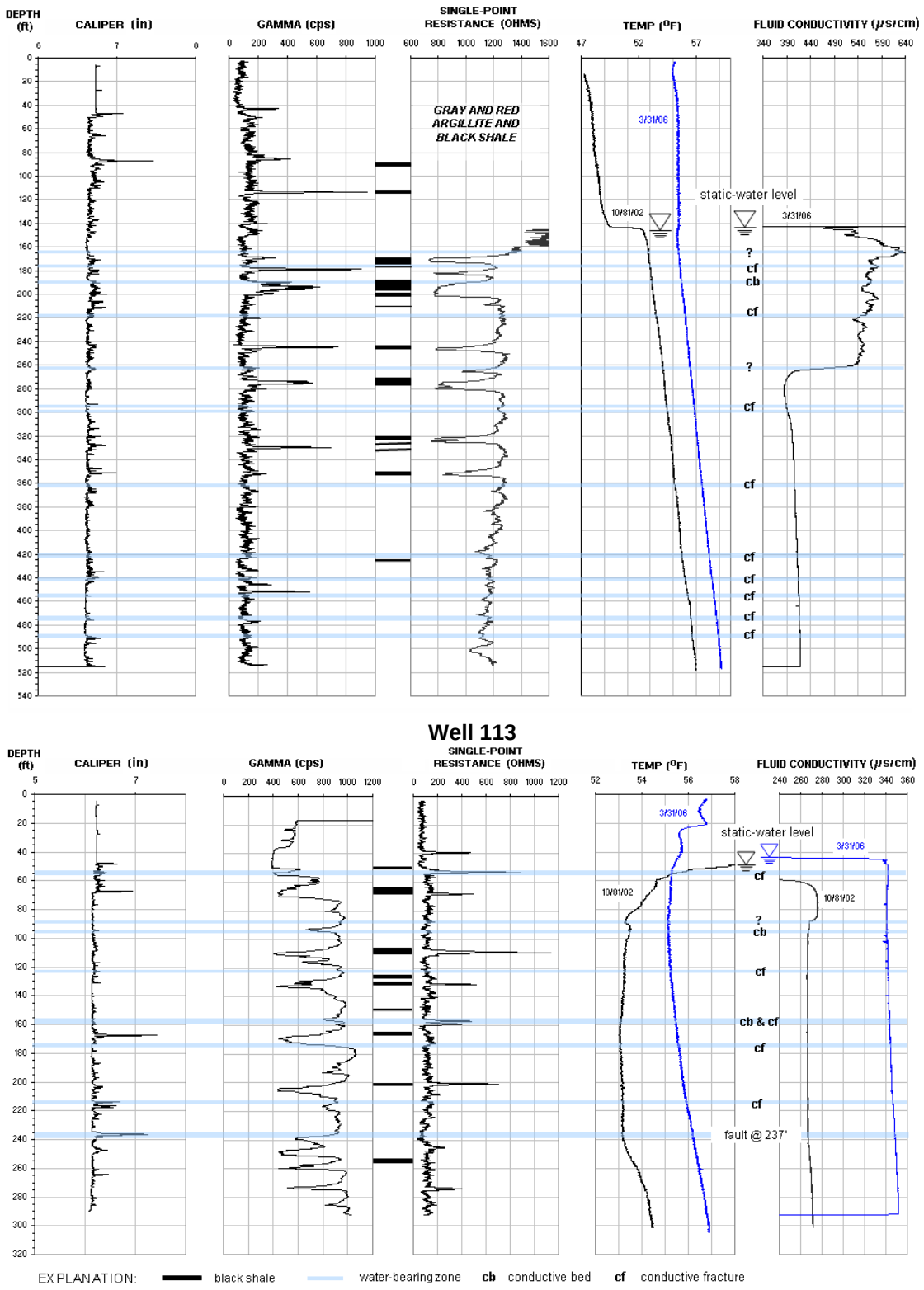


Figure 4B2. Hydrogeologic sections based on geophysical logs for wells 112 (above) and 113 (below). The sections summarize the profile distribution and types of hydraulically-conductive features in red and gray argillite and black shale. Depth values are in feet below land surface.

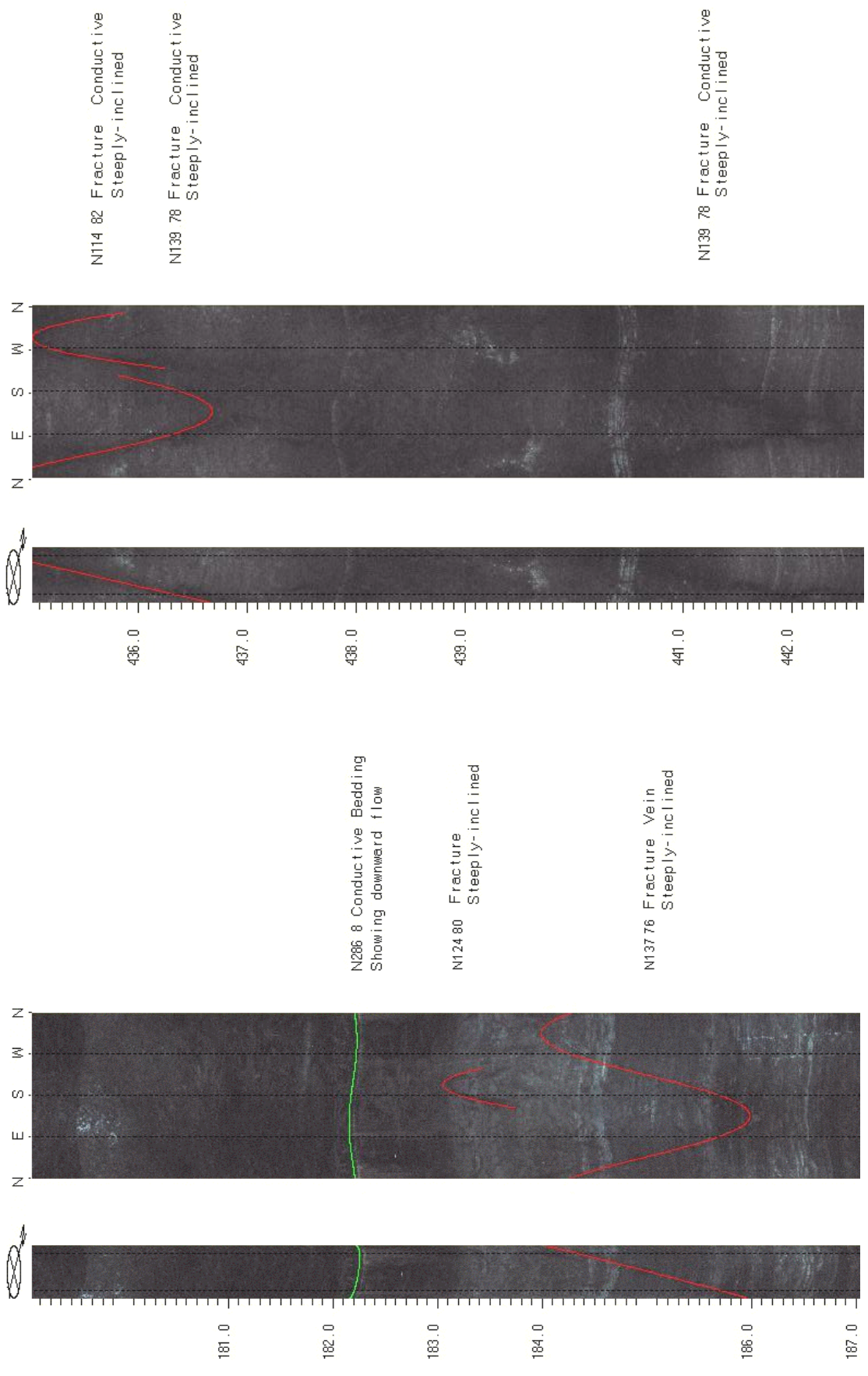


FIGURE 4B3 OPTV records of 6-inch diameter well 112 at the Hilltop development, Raritan Twp., Hunterdon County, NJ showing geologic structures and hydraulically-conductive features in gray and red argillite. Depth values are in feet below land surface.

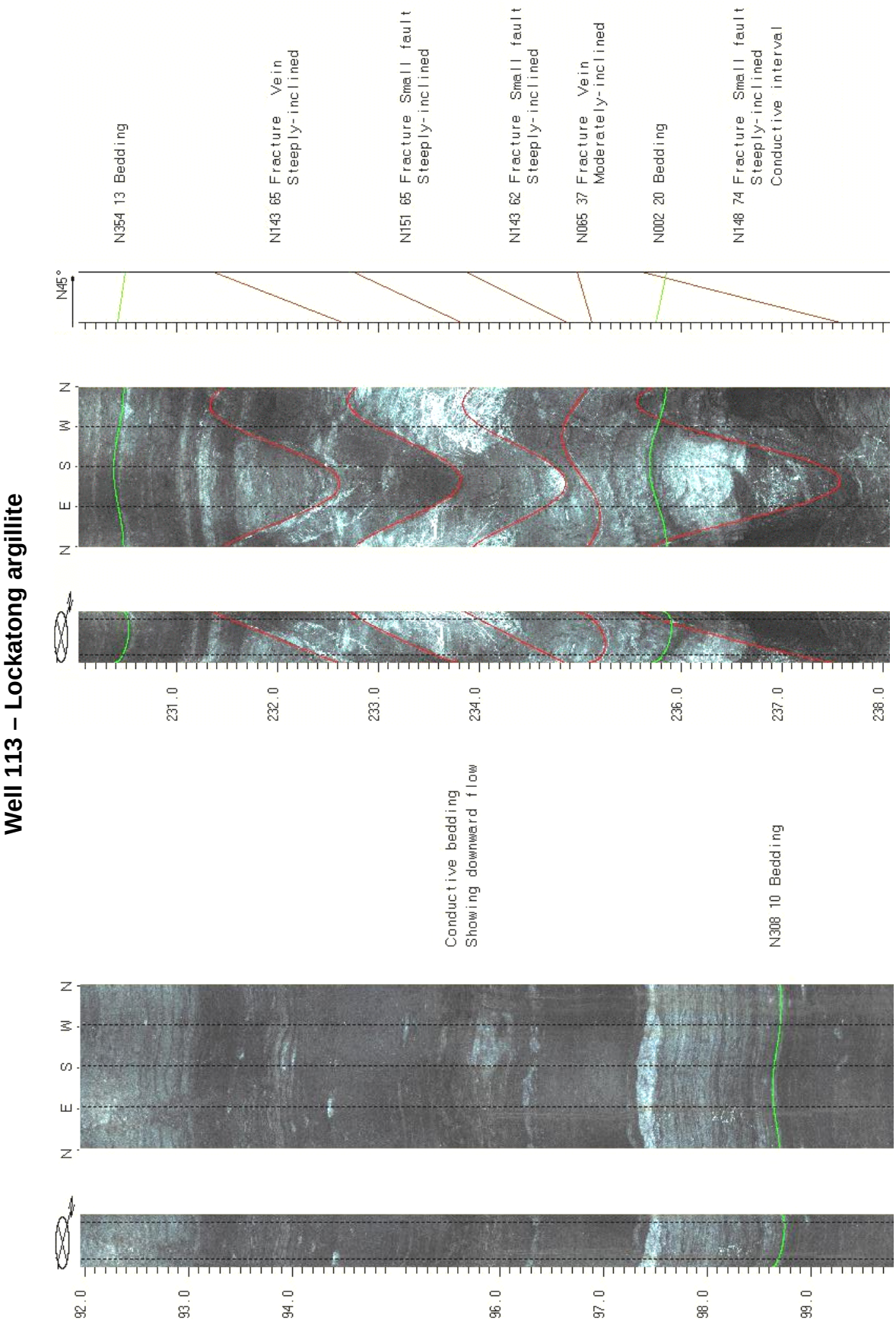


FIGURE 4B4. OPTV records of 6-inch diameter well 113 at the Hilltop development, Raritan Twp., Hunterdon County, NJ showing geologic structures and hydraulically-conductive features in gray and red argillite. Depth values are in feet below land surface.

Wells 114 and 115 – Lockatong argillite

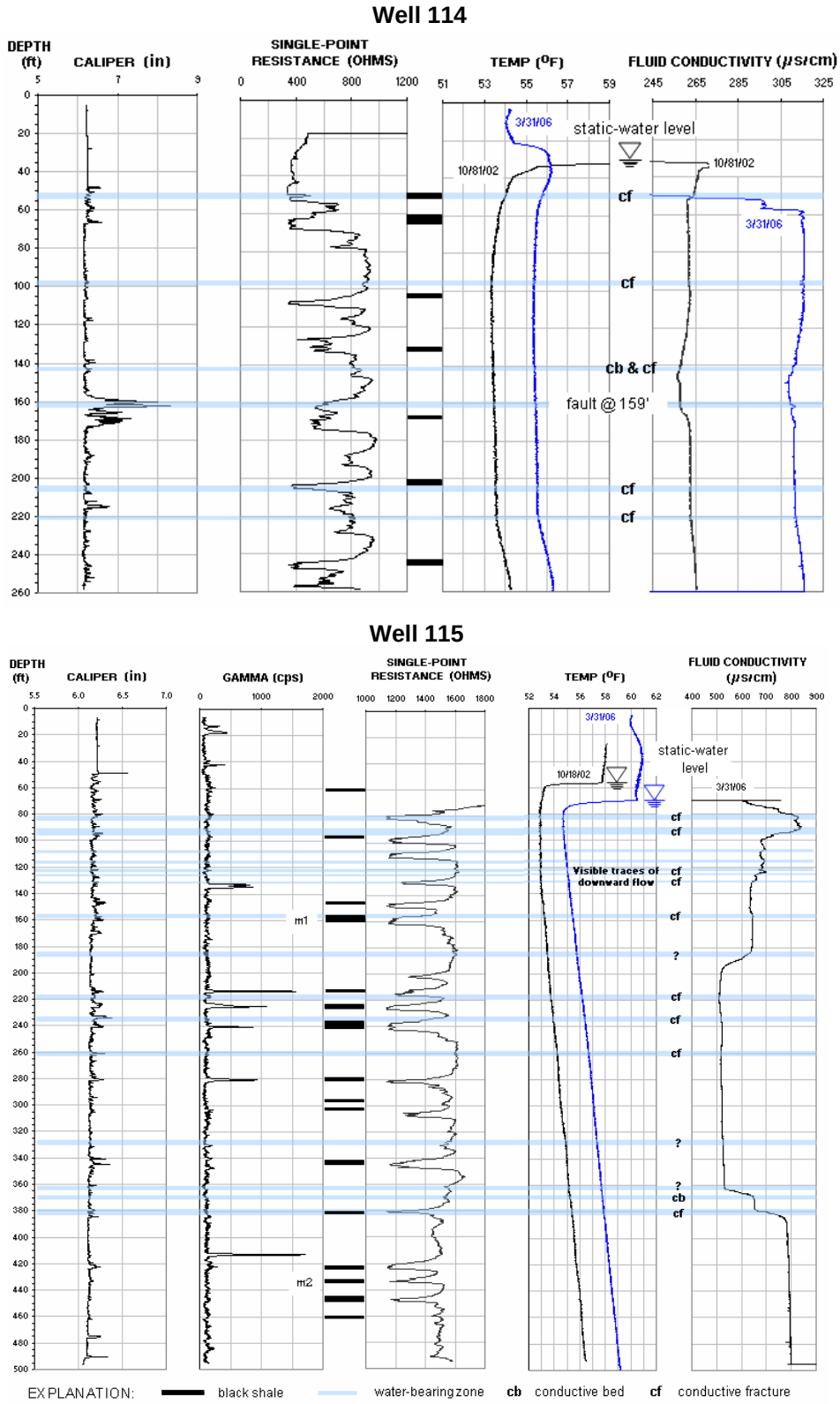


Figure 4B5. Hydrogeologic sections based on geophysical logs for wells 114 (above) and 115 (below). The sections summarize the distribution and types of hydraulically-conductive features in red and gray argillite and black shale. Depth values are in feet below land surface.

Well 114 – Lockatong argillite

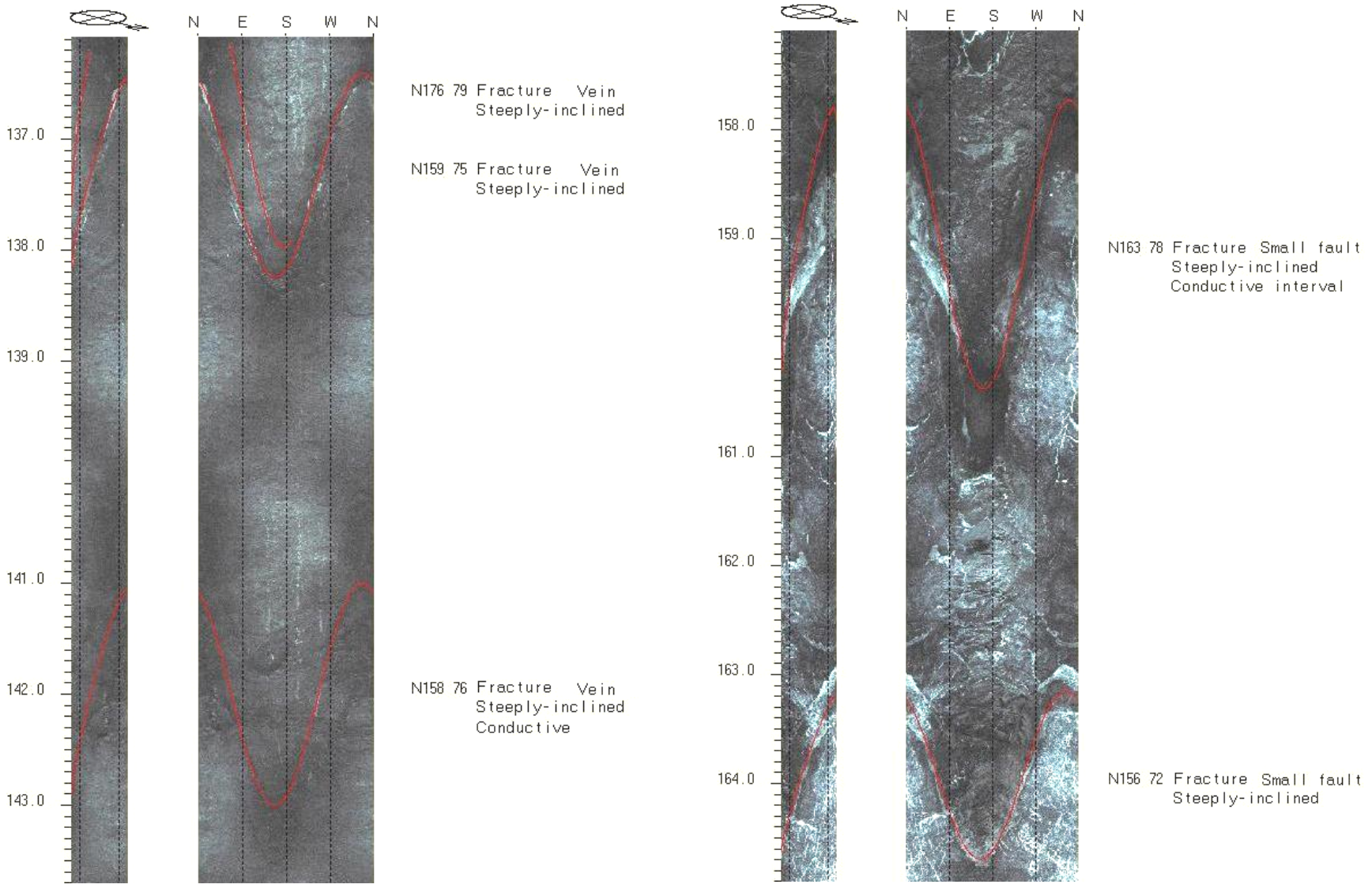


FIGURE 4B6. OPTV records of 6-inch diameter well 114 at the Hilltop development, Raritan Twp., Hunterdon County, NJ showing geologic structures and hydraulically-conductive features in gray and red argillite. Depth values are in feet below land surface.

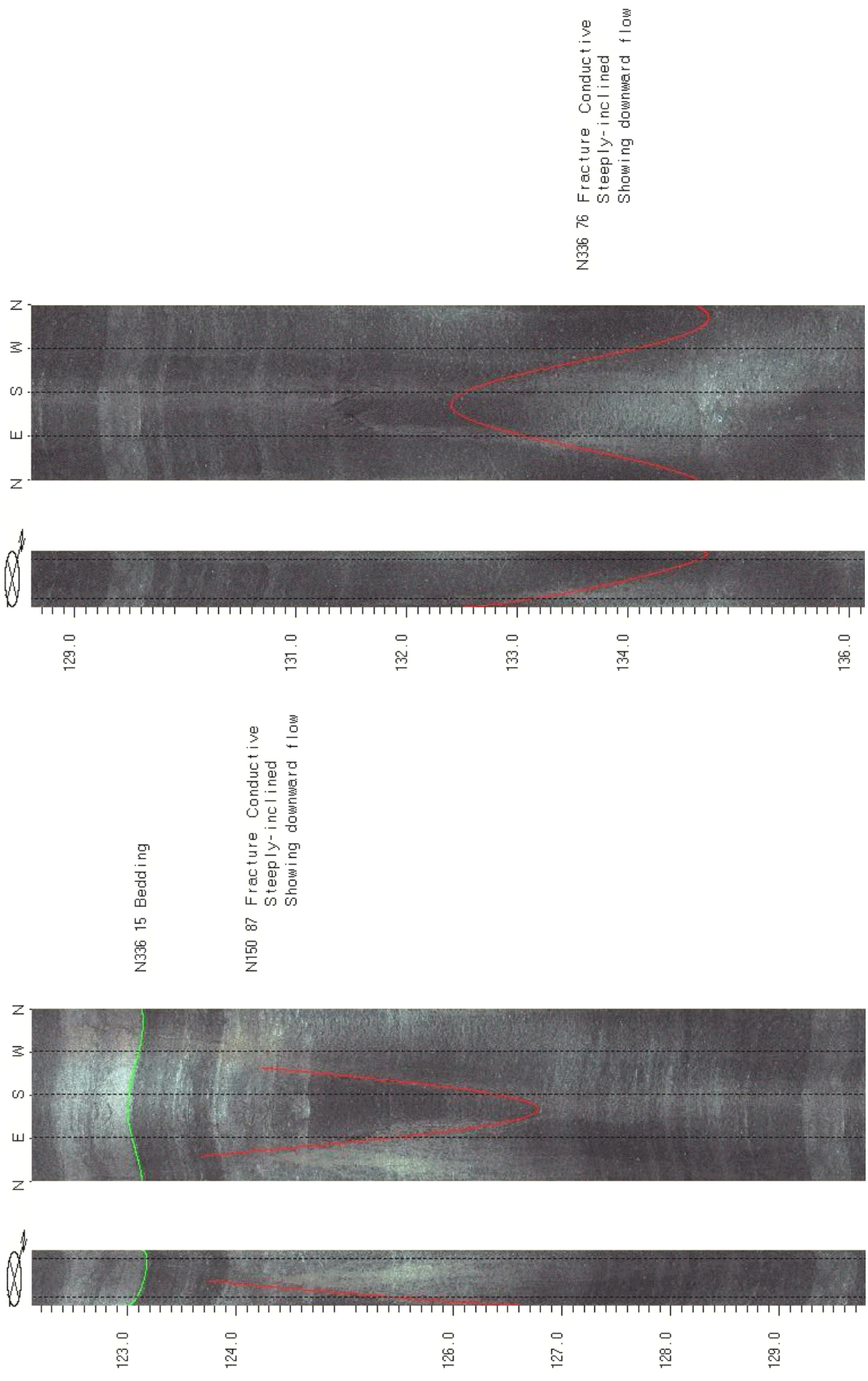


FIGURE 4B7. OPTV records of 6-inch diameter well 115 at the Hilltop development, Raritan Twp., Hunterdon County, NJ showing geologic structures and hydraulically-conductive features in gray and red argillite. Depth values are in feet below land surface.

Wells 111 to 115 – Lockatong argillite

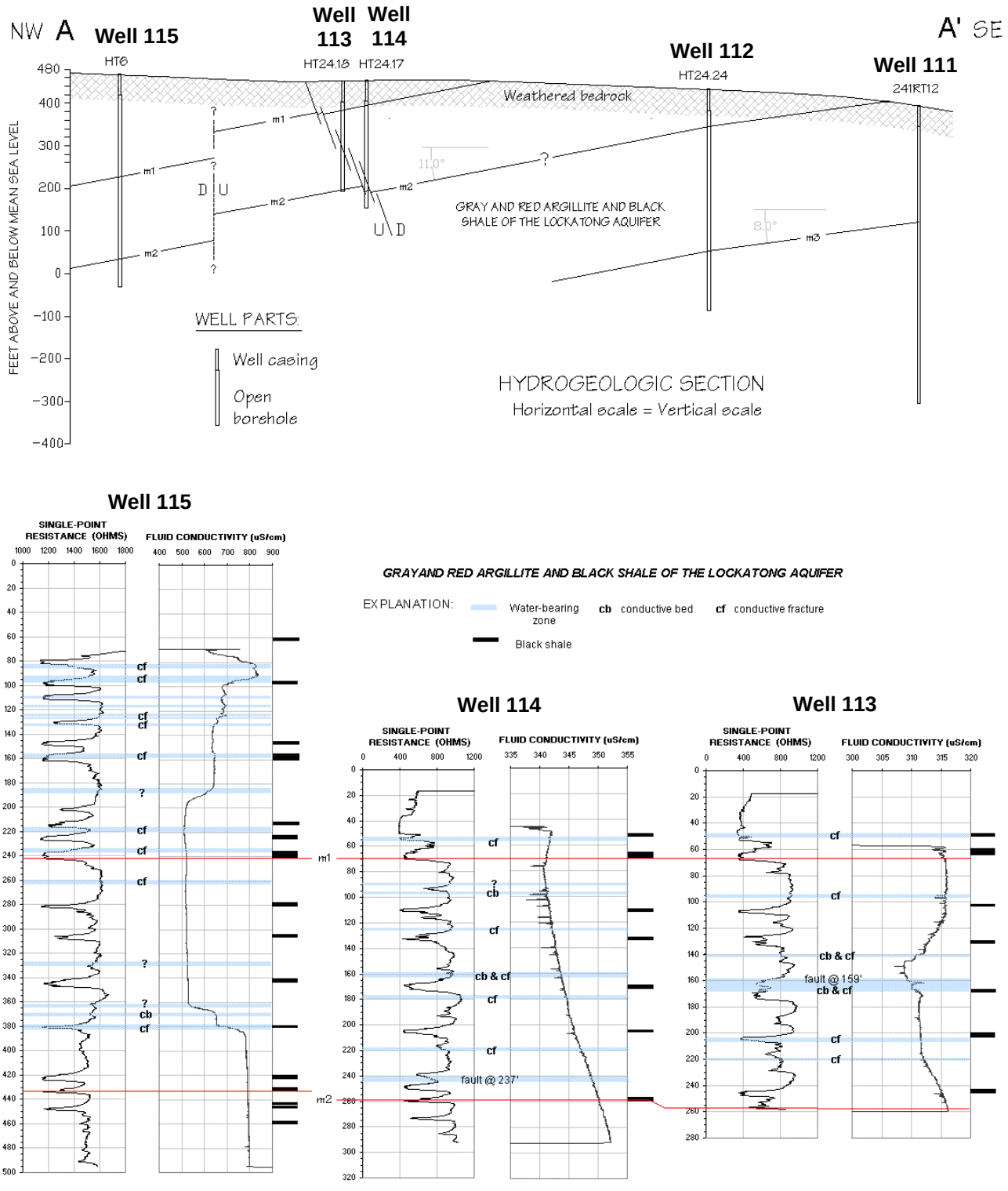


Figure 4B8. Hydrogeologic section (above) based on test wells 112 to 115 at the Hilltop development, Raritan Twp., Hunterdon County, NJ and a nearby domestic well. Stratigraphic marker horizons m1to m3 identified using OPTV records. Borehole geophysical records for well 112, 113 and 115 (below) show marker horizons m1 and m2 with respect to electrical resistance and fluid electrical-conductivity logs. Depth values (bottom) are in feet below land surface.

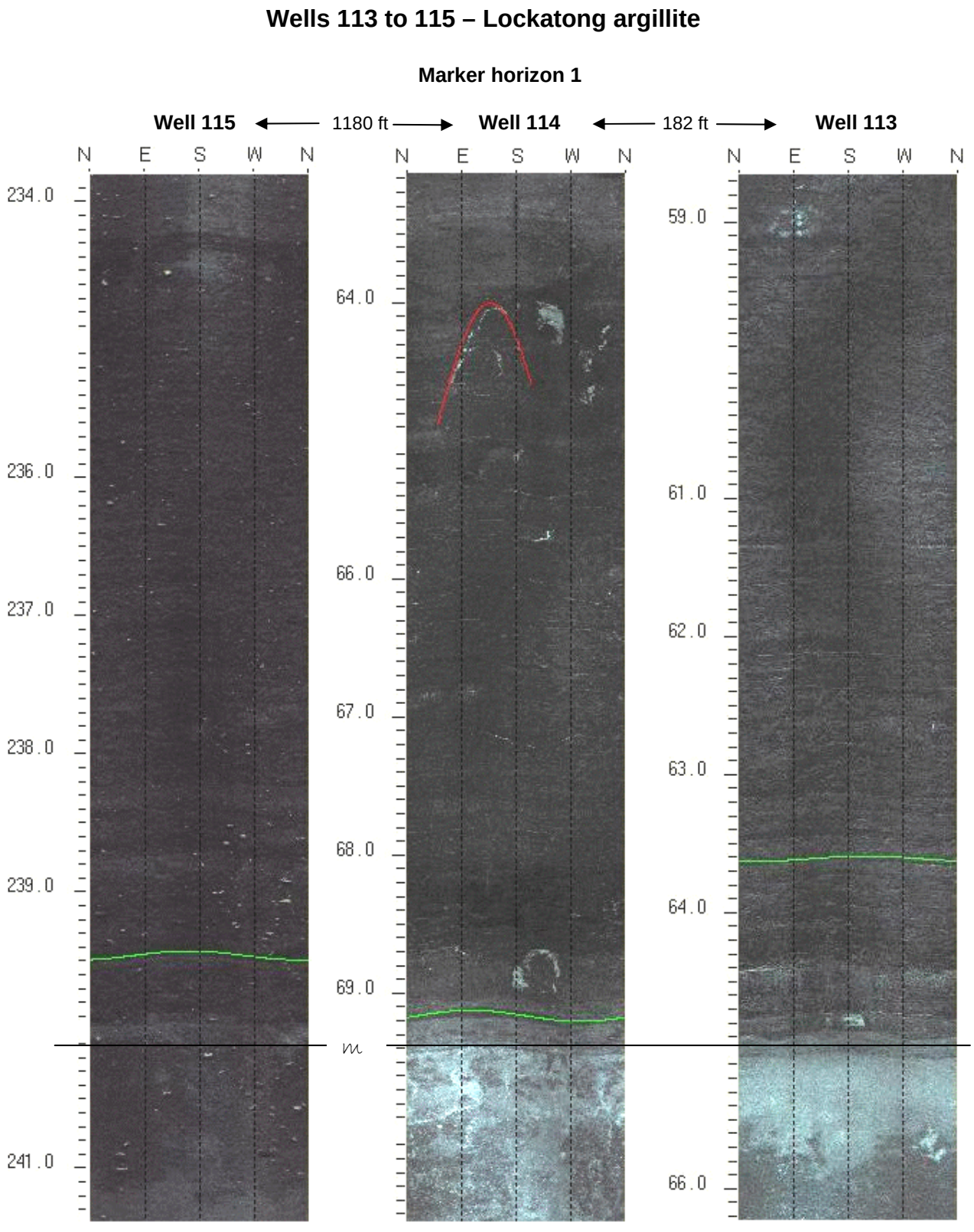


Figure 4B9. Stratigraphic correlation of wells 113 to115 at the Hilltop development, Raritan Twp., Hunterdon County, NJ based on OPTV records showing stratigraphic marker horizon m1in gray and red argillite. Depth values are in feet below land surface.

Wells 111 to 115 – Lockatong argillite

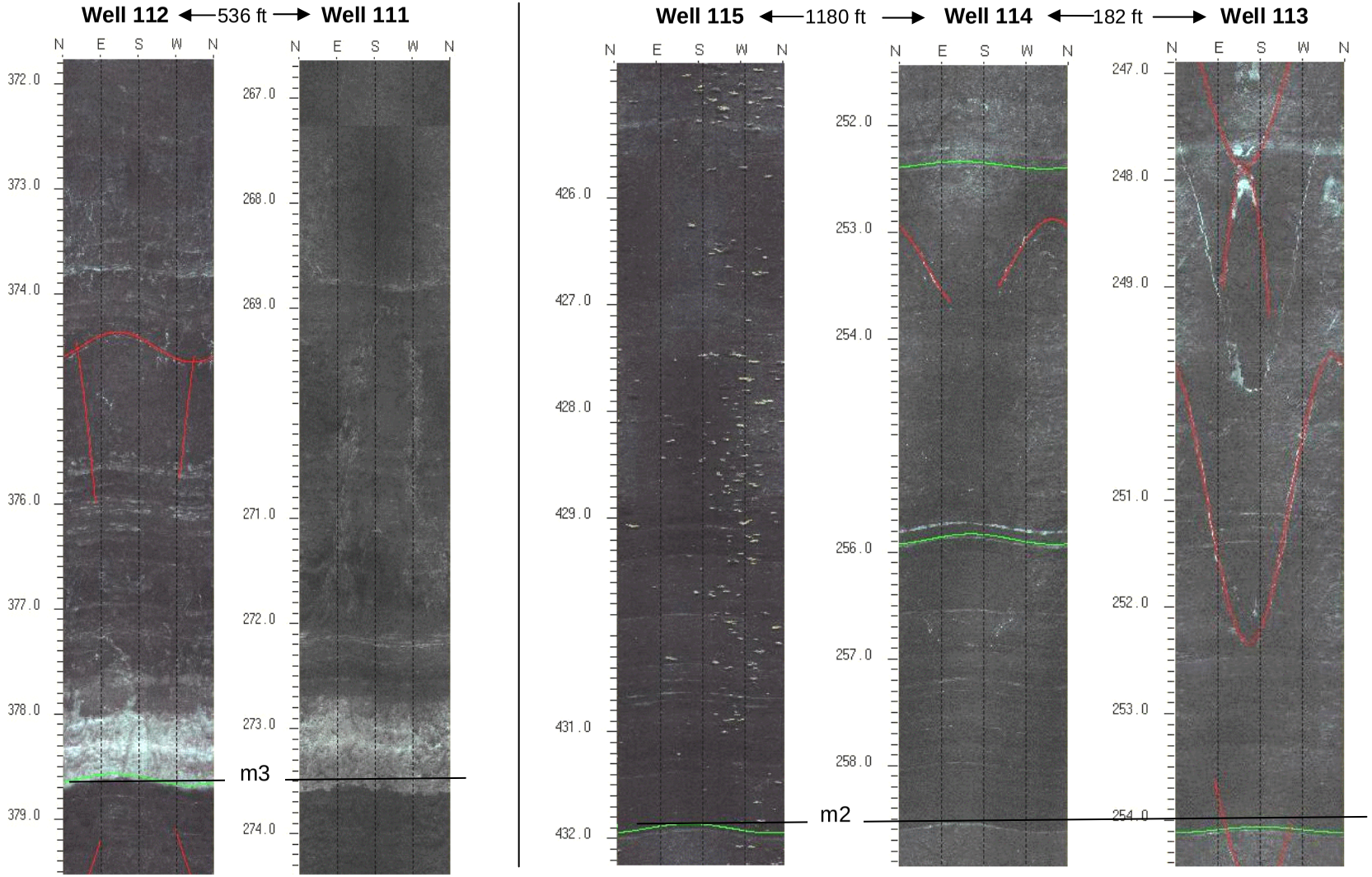
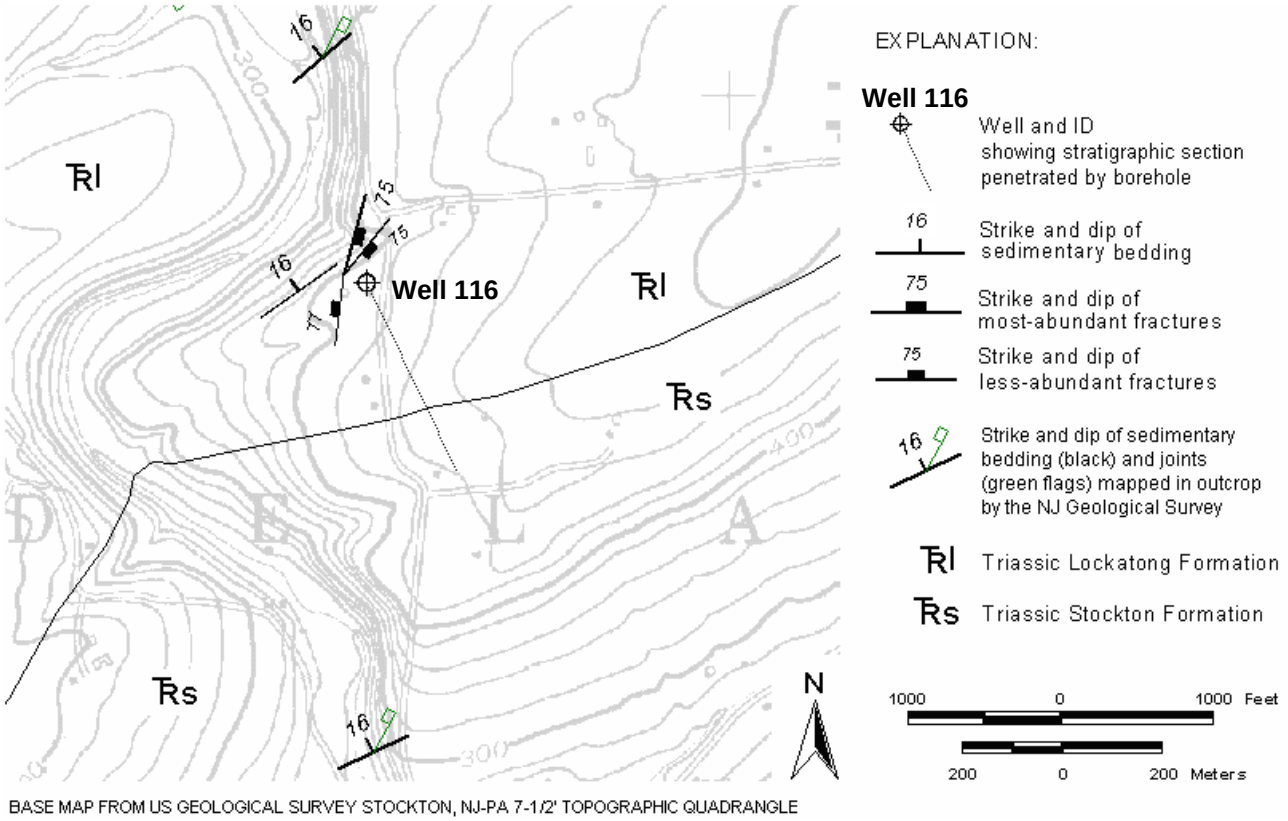


Figure 4B10. Stratigraphic correlation of wells 111and 112 (left, marker horizon m3) and wells 113 through 115 (right, marker horizon m2) at the Hilltop development, Raritan Twp., Hunterdon County, NJ. Correlations are based on OPTV records of gray and red argillite. Depth values are in feet below land surface.

Well 116 – Lockatong argillite overlying Stockton sandstone



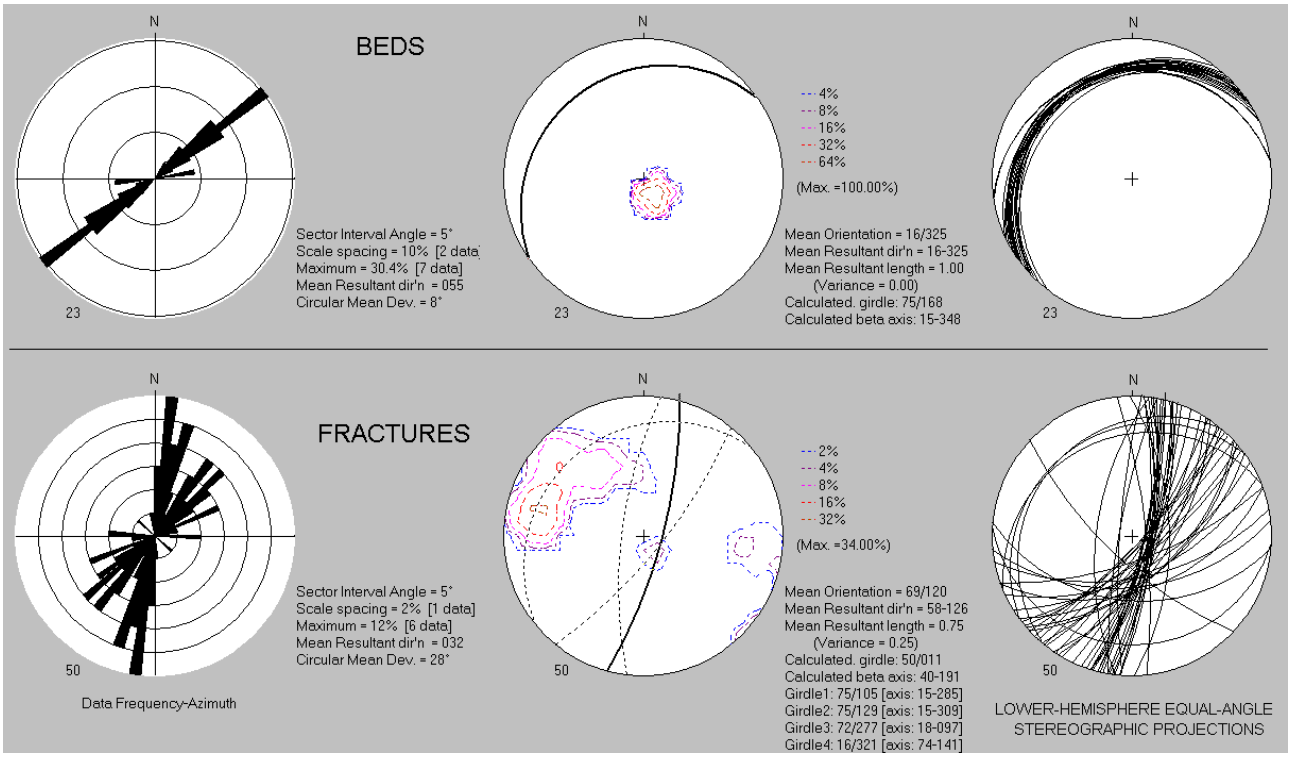


Figure 4C1. Map (above) showing wells 112 at Pine Hill Rd., Delaware Twp., Hunterdon County, NJ. Bedrock structures mapped near wells based on a structural analysis of OPTV data (below).

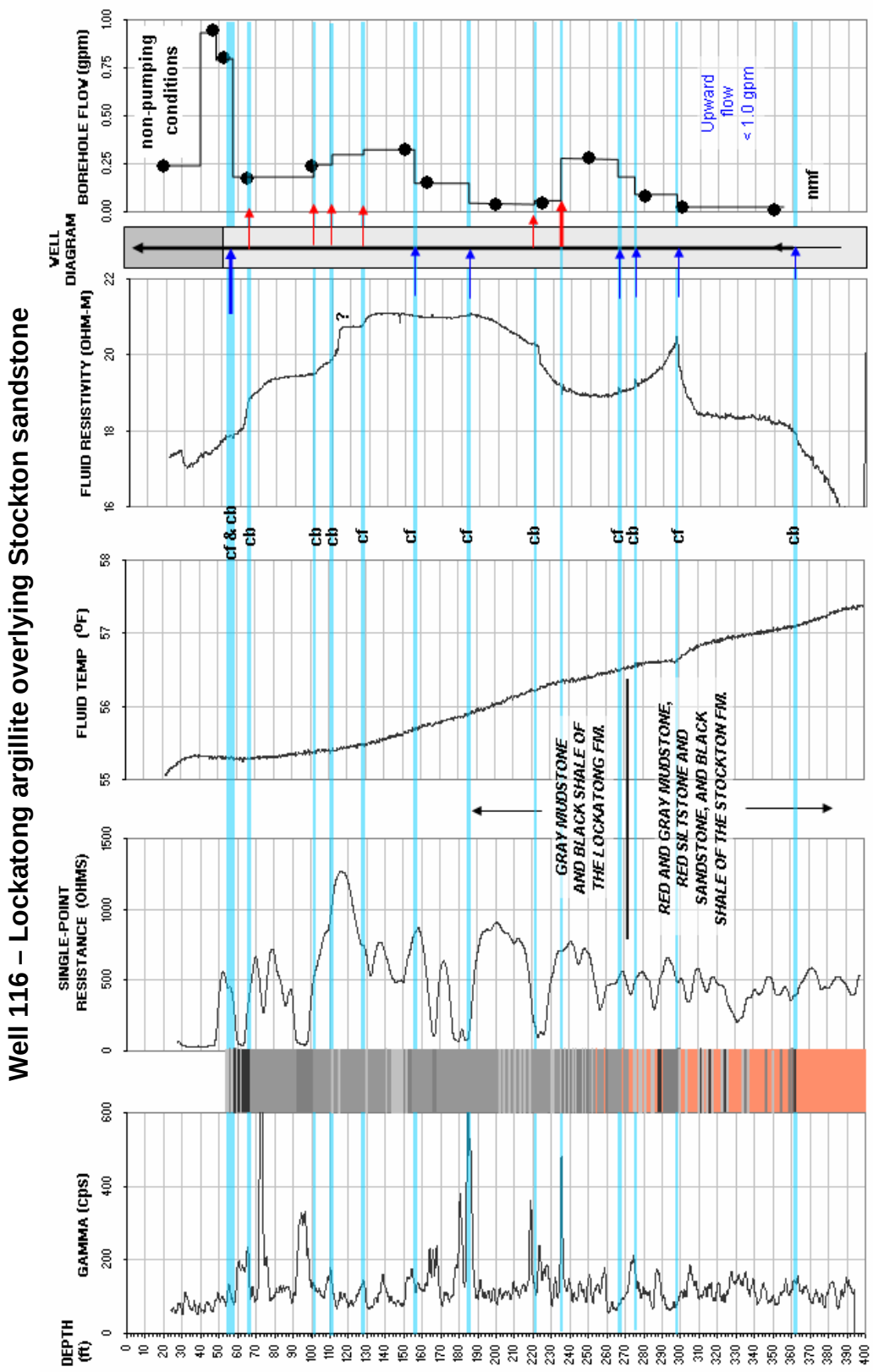


FIGURE 4C2. Hydrogeologic section based on geophysical logs for well 116 at Pine Hill Rd., Delaware Twp., Hunterdon County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray sandstone, siltstone and mudstone, and black shale. Depth values are in feet below land surface.

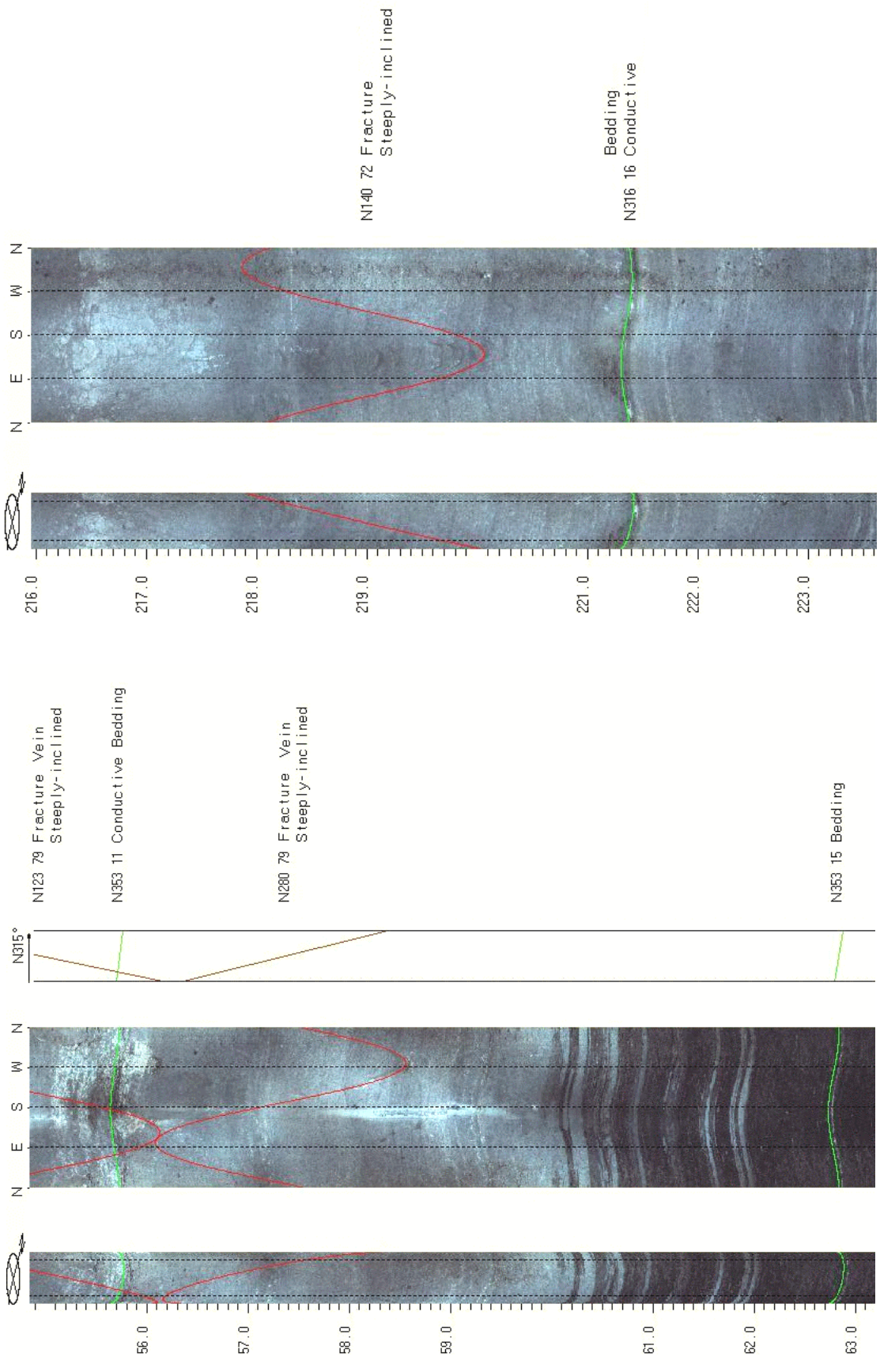


FIGURE 4C3. OPTV records of 6-inch diameter well 116 at Pine Hill Rd., Delaware Twp., Hunterdon County, NJ showing geologic structures and hydraulically-conductive features gray argillite siltstone, sandstone, argillite and black shale. Depth values are in feet below land surface.

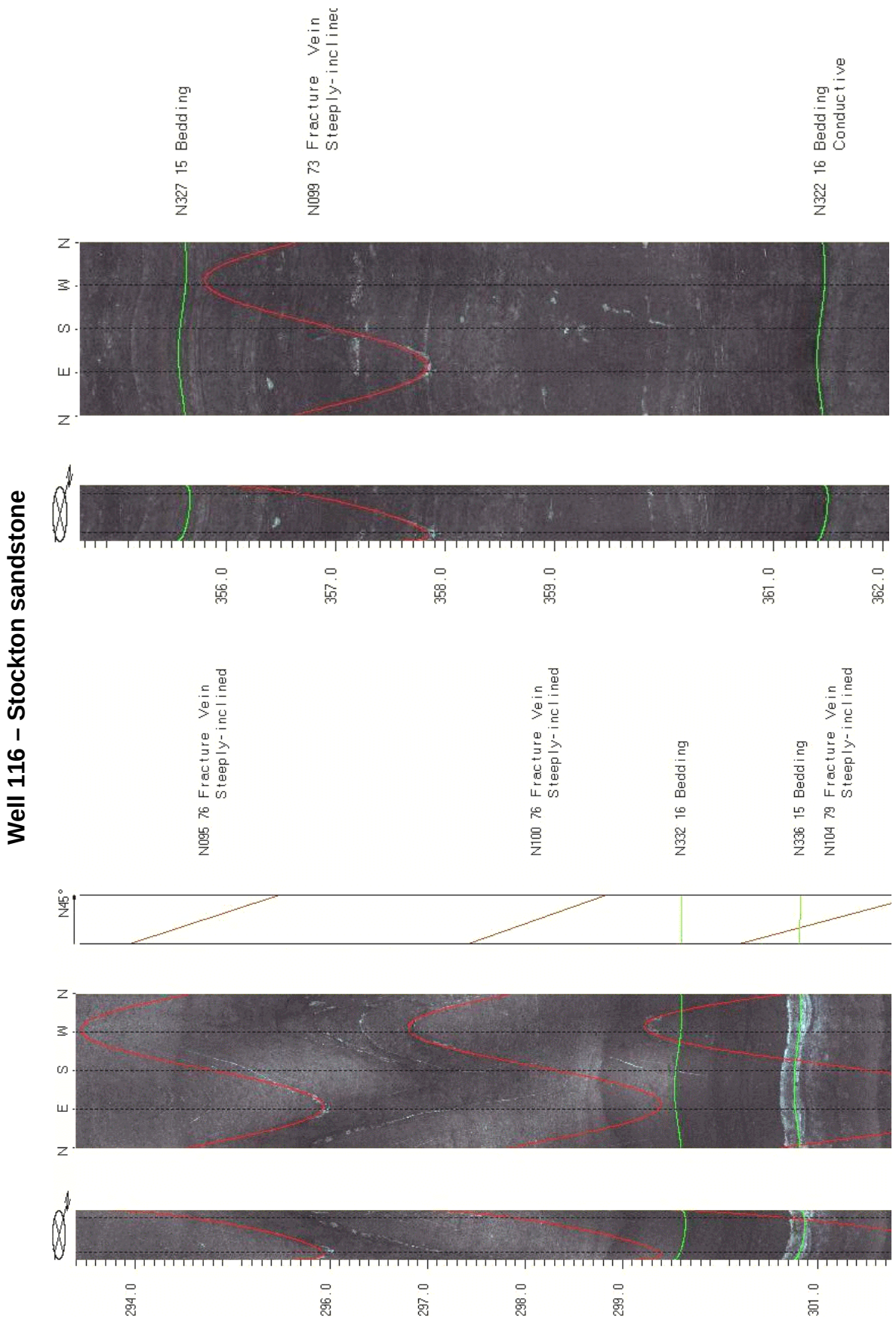
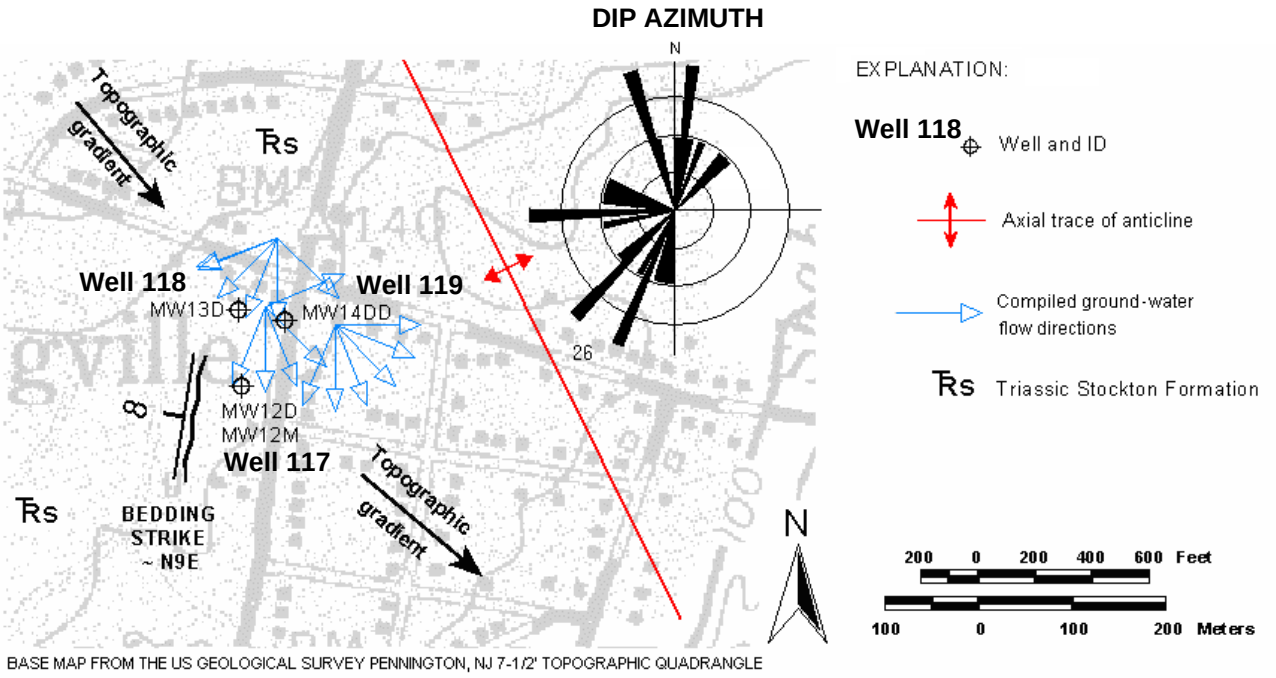


FIGURE 4C4. OPTV records of 6-inch diameter well 116 at Pine Hill Rd., Delaware Twp., Hunterdon County, NJ showing geologic structures and hydraulically-conductive features in red sandstone, siltstone, mudstone and gray siltstone. Depth values are in feet below land surface.

Wells 117 to 119 – Stockton sandstone



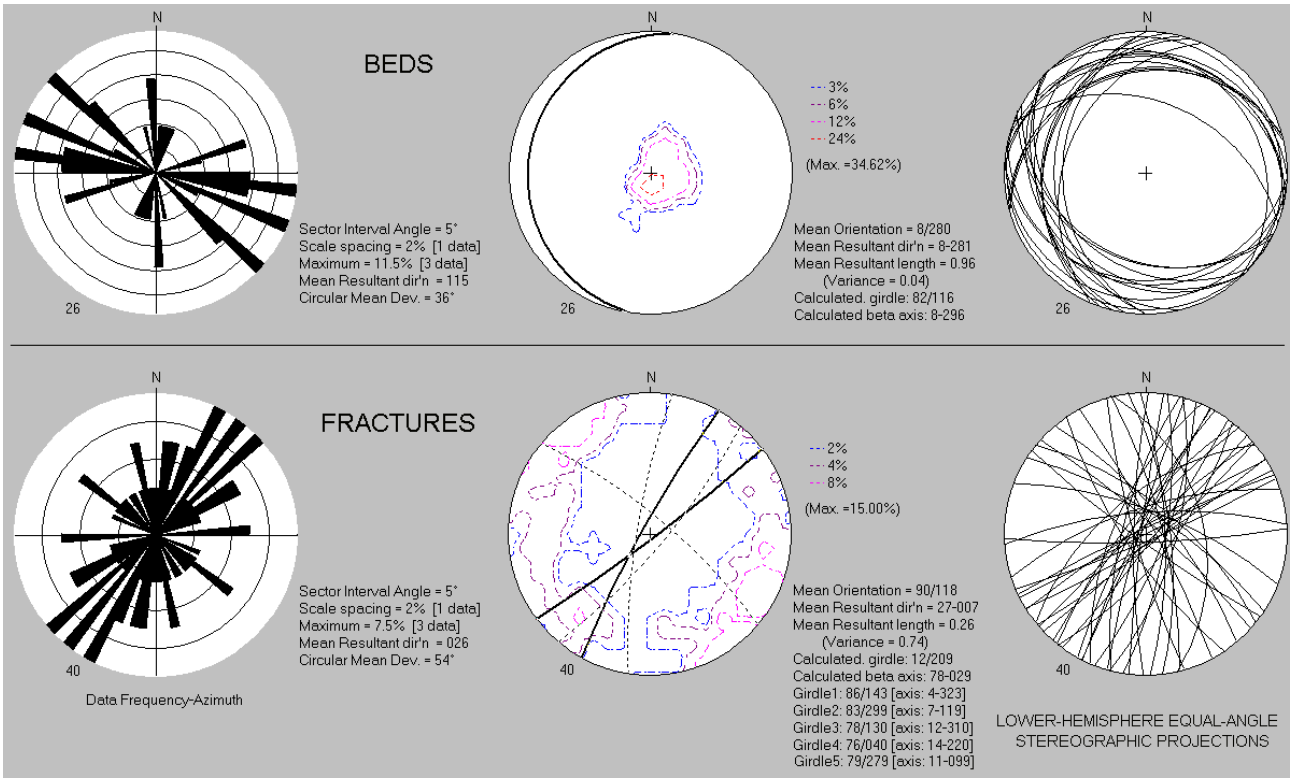


Figure 4D1. Map (above) shows wells 117 to 119 at Ewingville Rd. and Rt 31, Ewing Twp., Mercer County, NJ. Mapped structures based on structural analysis of OPTV records (below). Histogram on map shows dip azimuth of bedding for combined well records. Ground-water flow directions compiled from NJDEP case files for period 1987-2004.

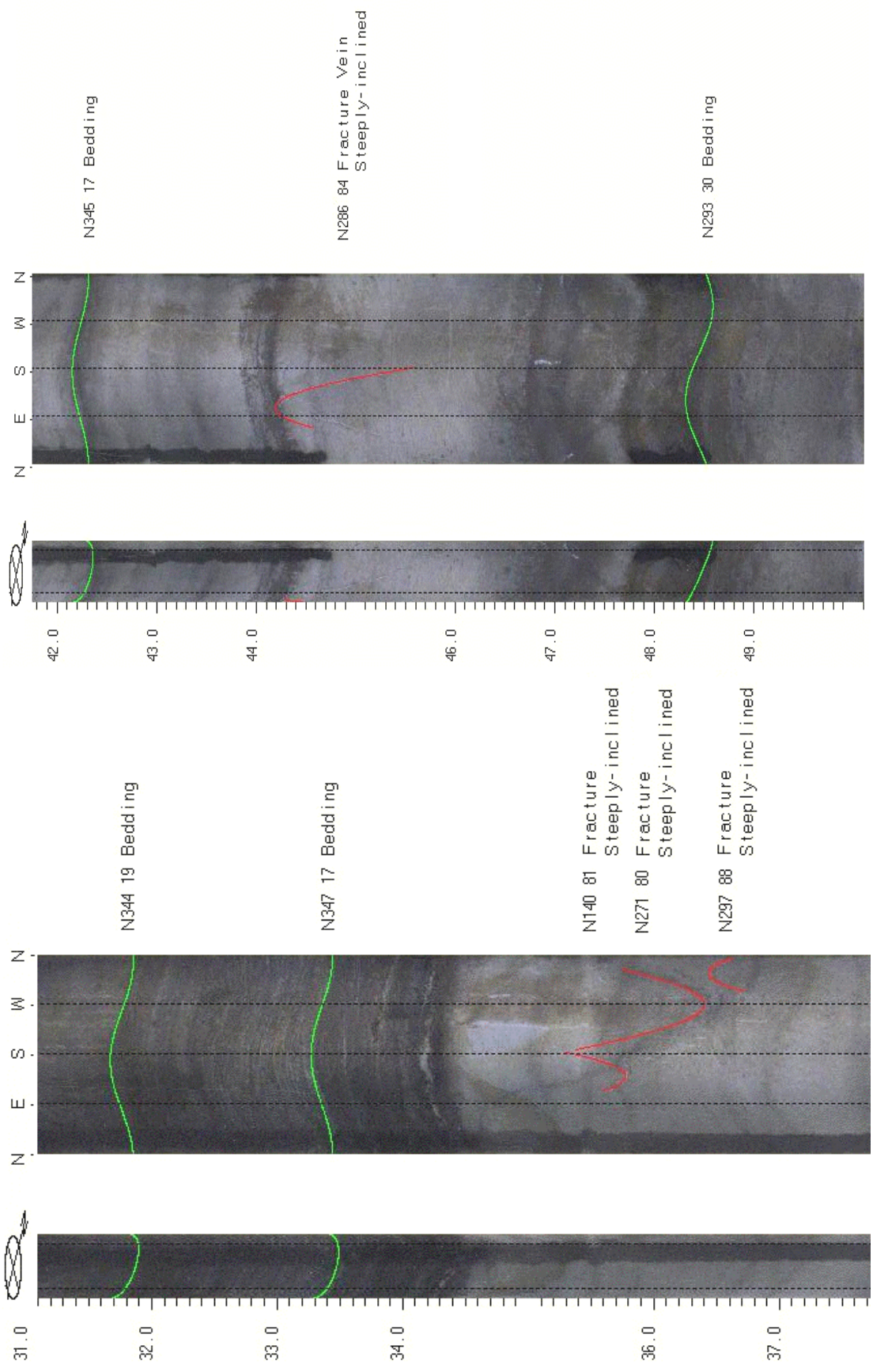


FIGURE 4D2. OPTV records of 6-inch diameter well 117 at Ewingville Rd. and Rt 31, Ewing Twp., Mercer County, NJ showing geologic structures and hydraulically-conductive features in sandstone and siltstone. Depth values are in feet below land surface.

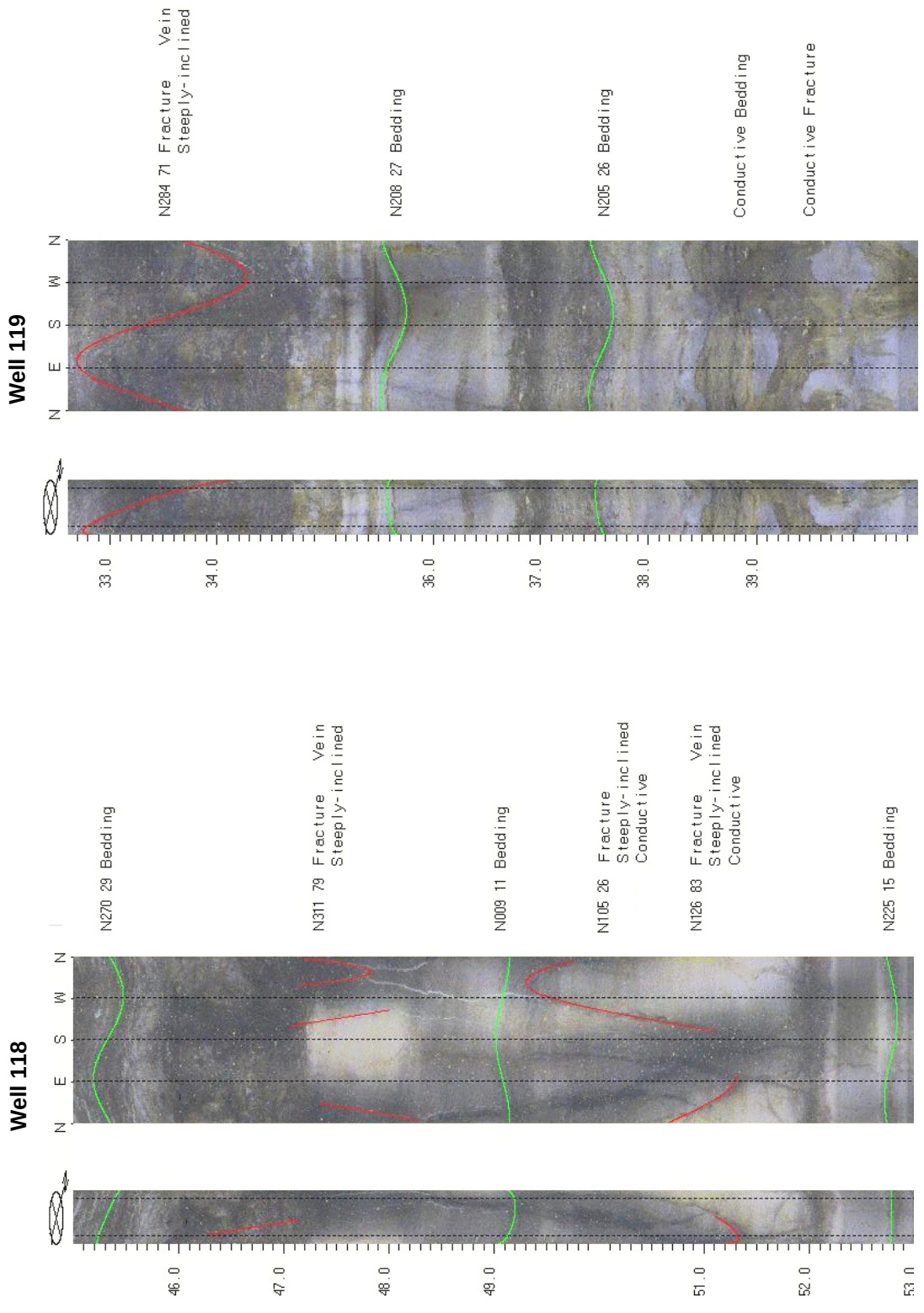


FIGURE 4D3. OPTV records of 6-inch diameter wells 118 and 119 at Ewingville Rd. and Rt 31, Ewing Twp., Mercer County, NJ showing geologic structures and hydraulically-conductive features in sandstone and siltstone. Depth values are in feet below land surface.

Wells 120 and 121 – Stockton sandstone

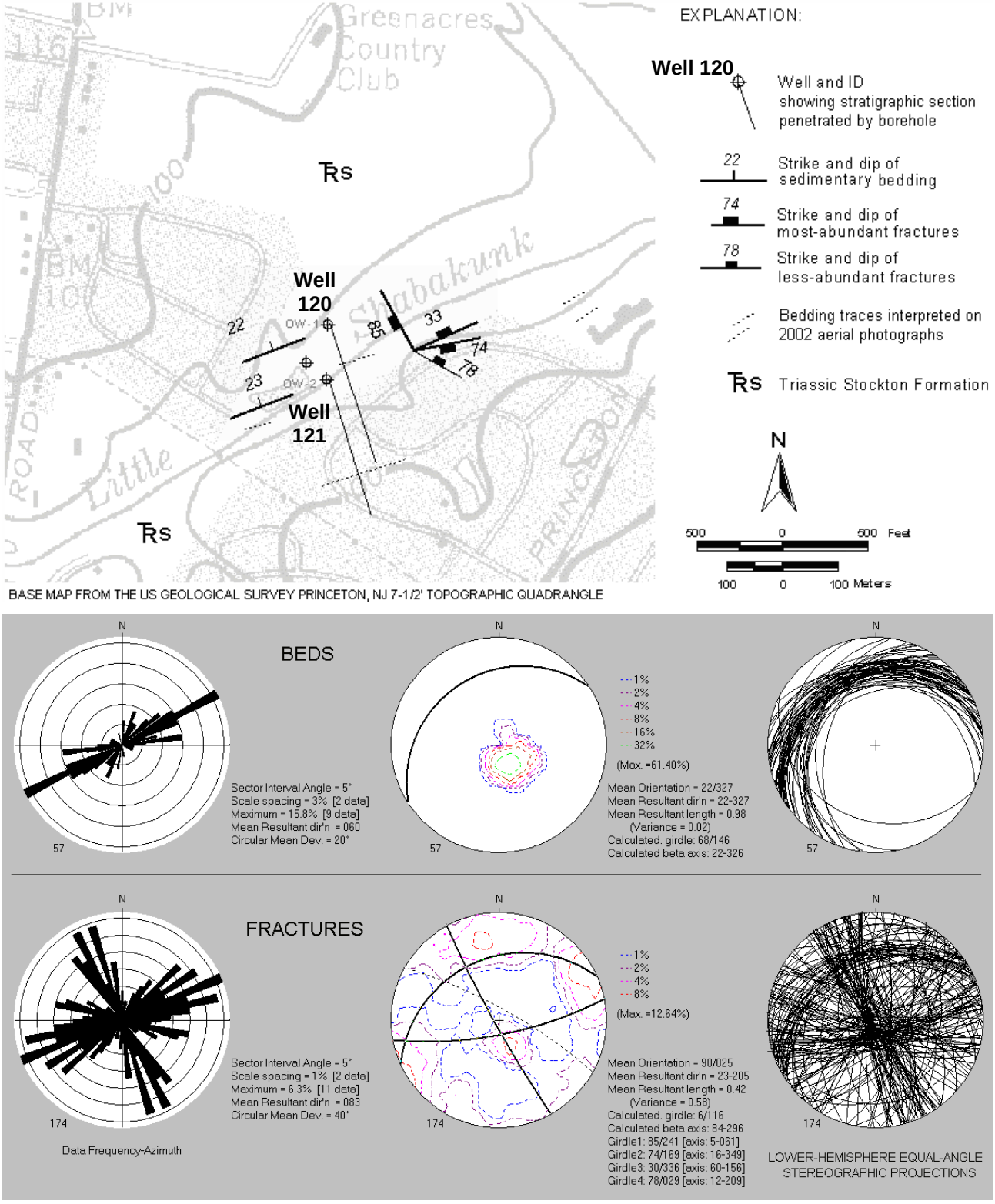


Figure 4E1. Map (above) shows wells 120 and 121 at the Greenacres Country Club, Rt. 206, Lawrence Twp., Mercer County, NJ. Structure strikes and dips on map based on structural analysis of beds and fractures in OPTV records (below).

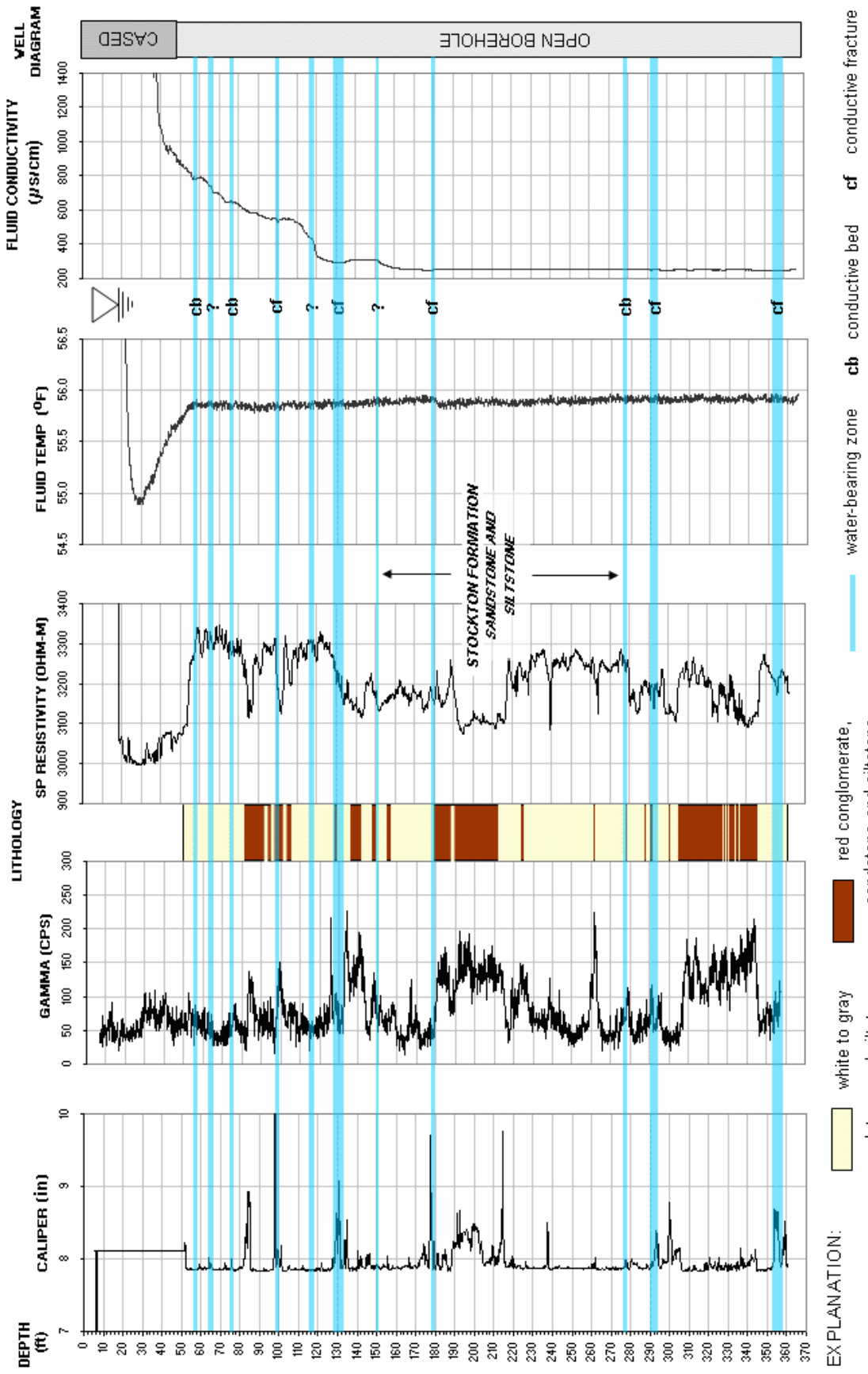


FIGURE 4E2. Hydrogeologic section based on geophysical logs for well 120 at the Greenacres Country Club, Rt. 206, Lawrence Twp., Mercer County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray sandstone, siltstone and mudstone and black shale. Depth values are in feet below land surface.

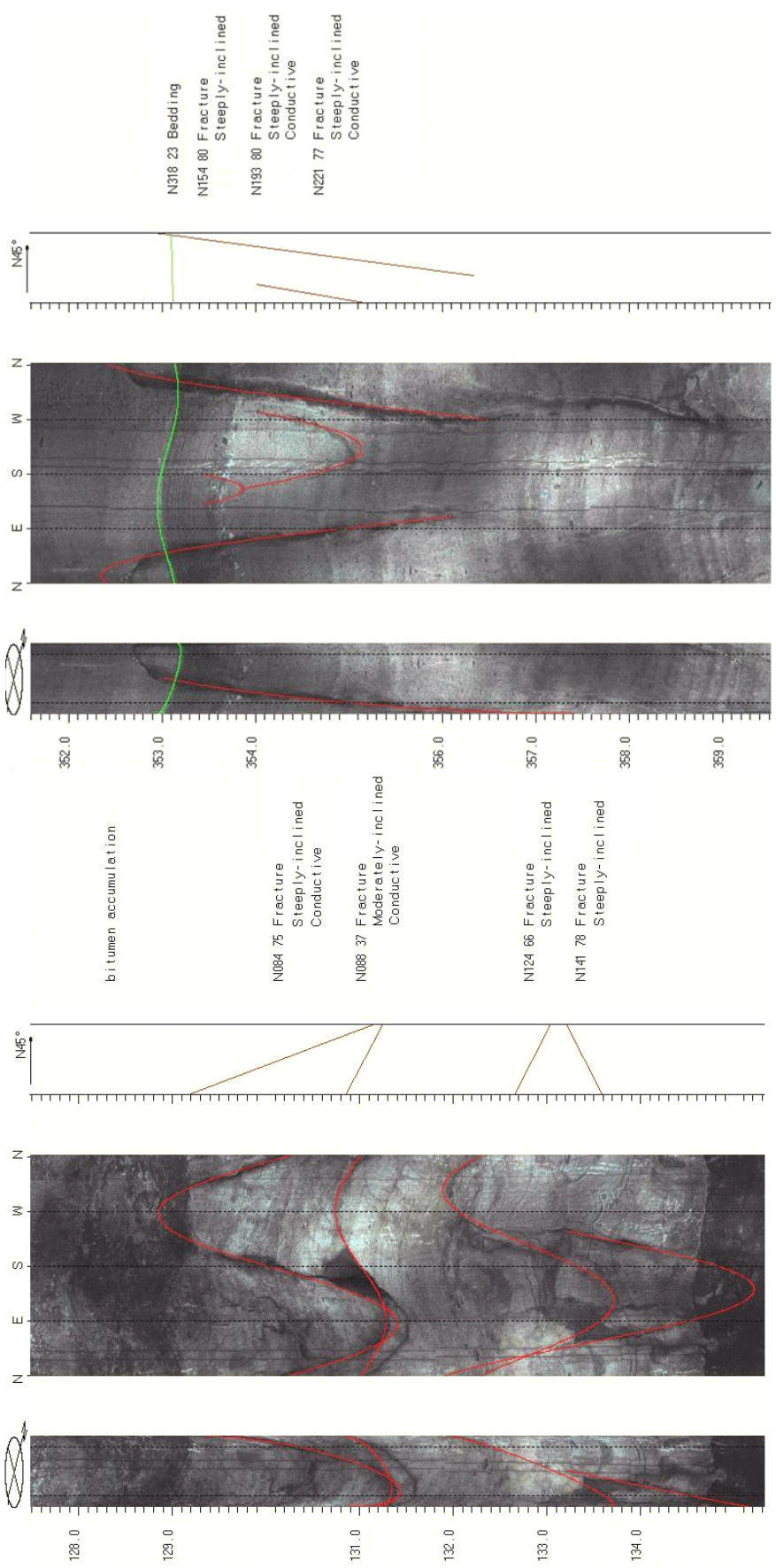


FIGURE 4E3. OPTV records of 8-inch diameter well 120 at the Greenacres Country Club, Rt. 206, Lawrence Twp., Mercer County, NJ showing geologic structures and hydraulically-conductive features in red gray sandstone and siltstone. Depth values are in feet below land surface.

Well 121 – Stockton sandstone

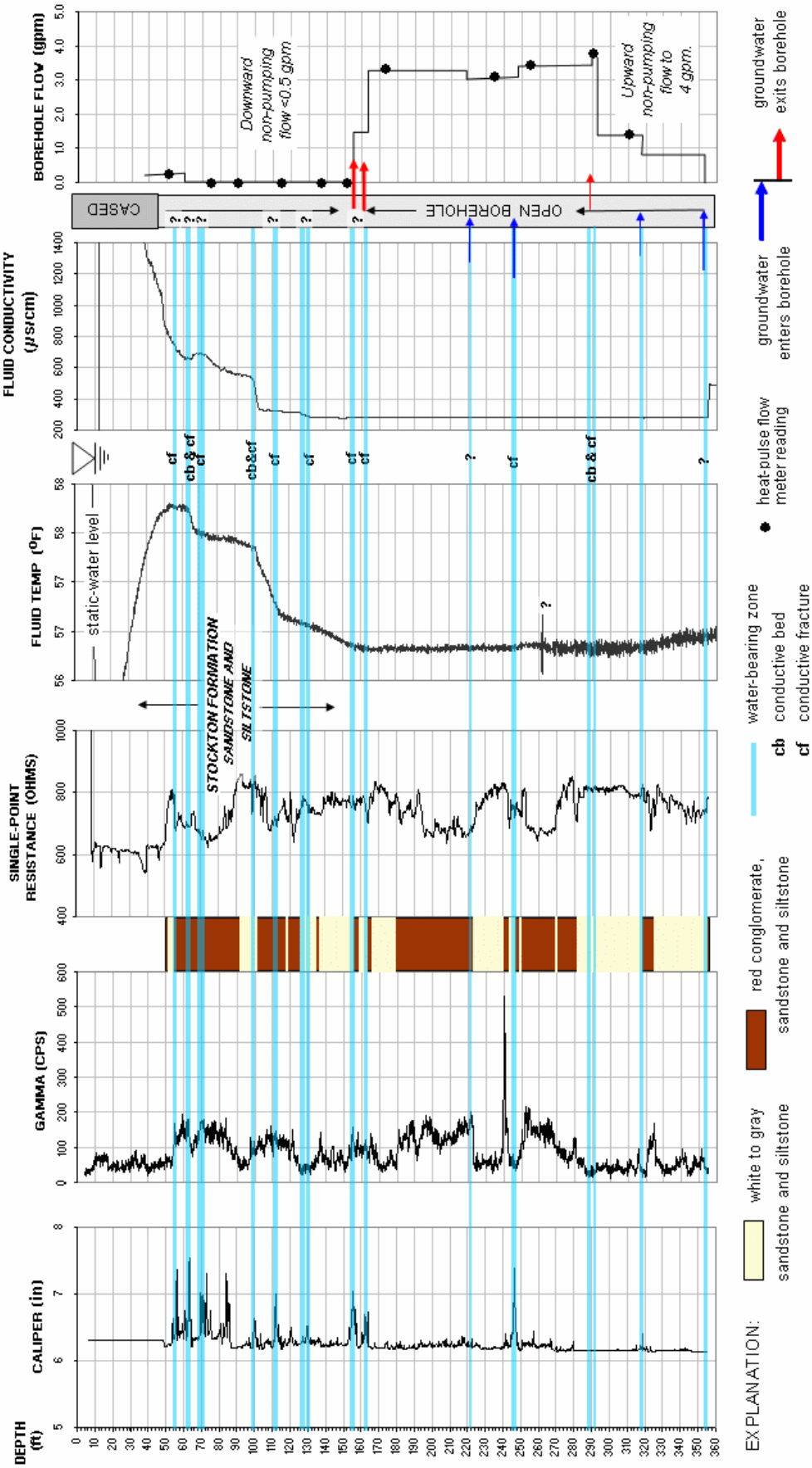


FIGURE 4E4. Hydrogeologic section based on geophysical logs for well 121 at the Greenacres Country Club, Rt. 206, Lawrence Twp., Mercer County, NJ. The section shows the vertical distribution and types of hydraulically-conductive features and water-bearing zones in red and gray sandstone, siltstone and mudstone and black shale. Depth values are in feet below land surface.

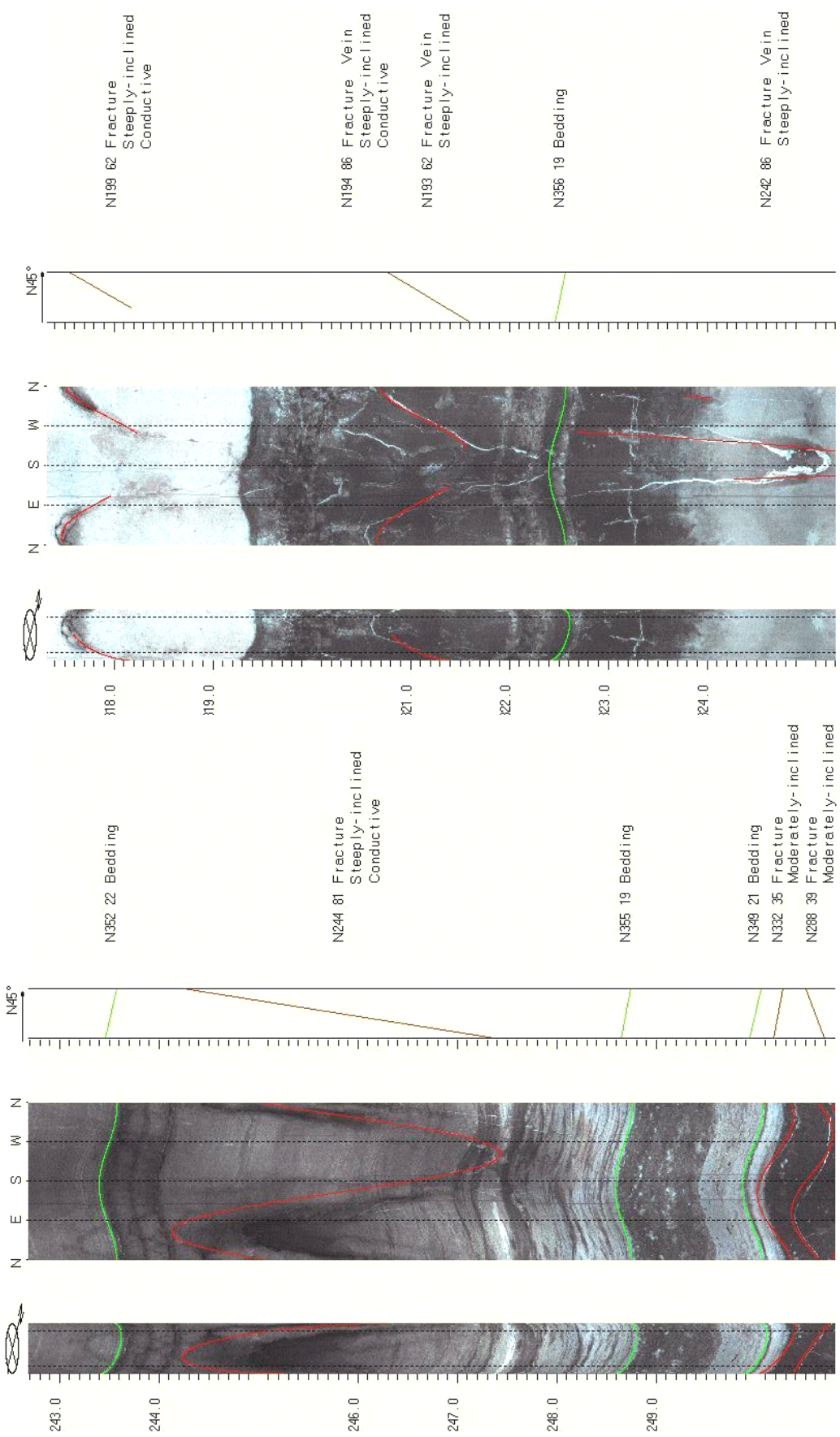


FIGURE 4E5. OPTV records of 6-inch diameter well 121 at the Greenacres Country Club, Rt. 206, Lawrence Twp., Mercer County, NJ showing geologic structures and hydraulically-conductive features in red gray sandstone and siltstone. Depth values are in feet below land surface.

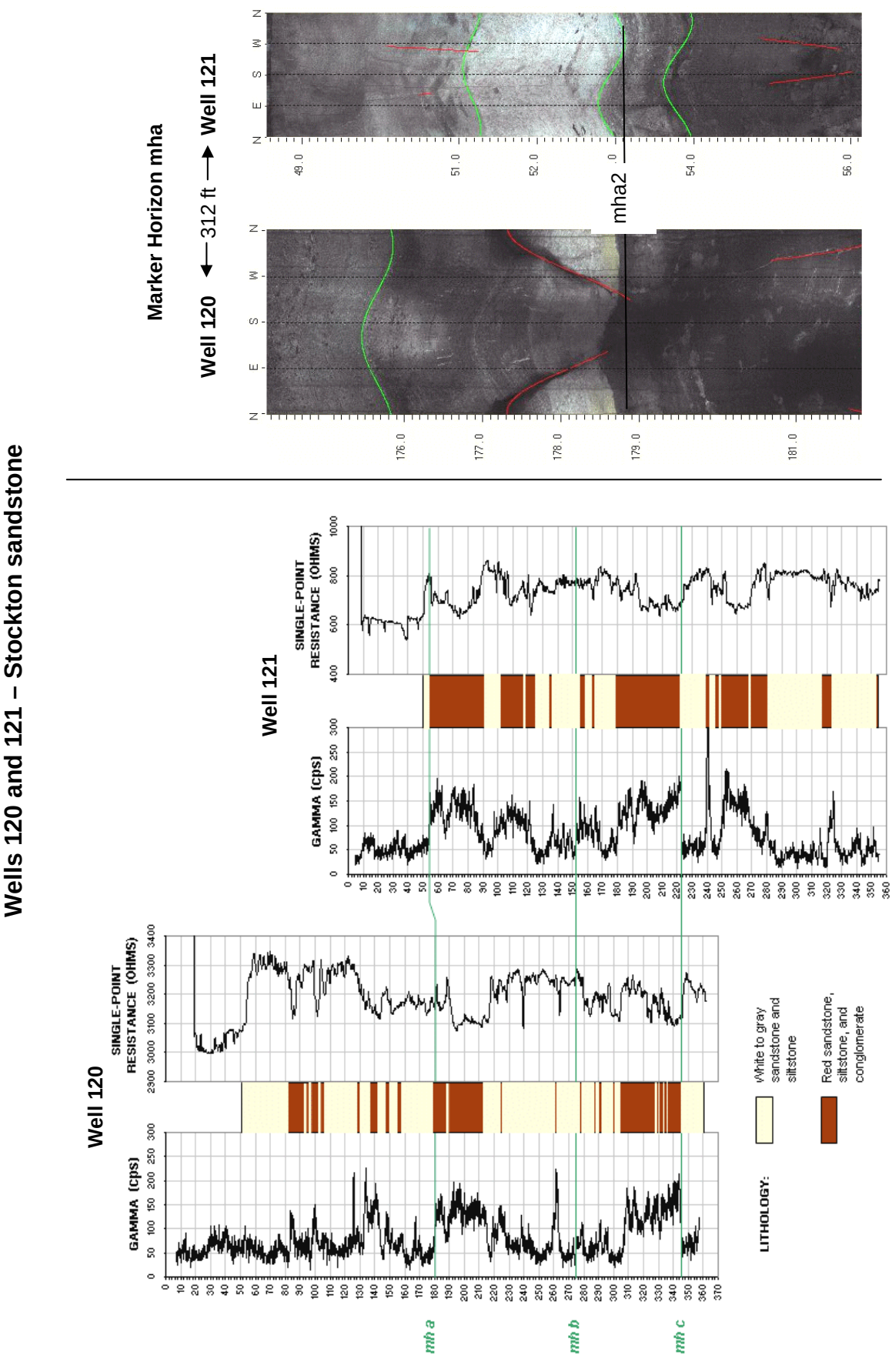


Figure 4E6. Stratigraphic correlation of wells 120 and 121 at the Greenacres Country Club, Rt. 206, Lawrence Twp., Mercer County, NJ based on natural gamma and electrical-resistivity logs (left) and OPTV records (right). Stratigraphic marker horizon mha is shown in both figures. Depth values are in feet below land surface.

Wells 120 and 121 – Stockton sandstone

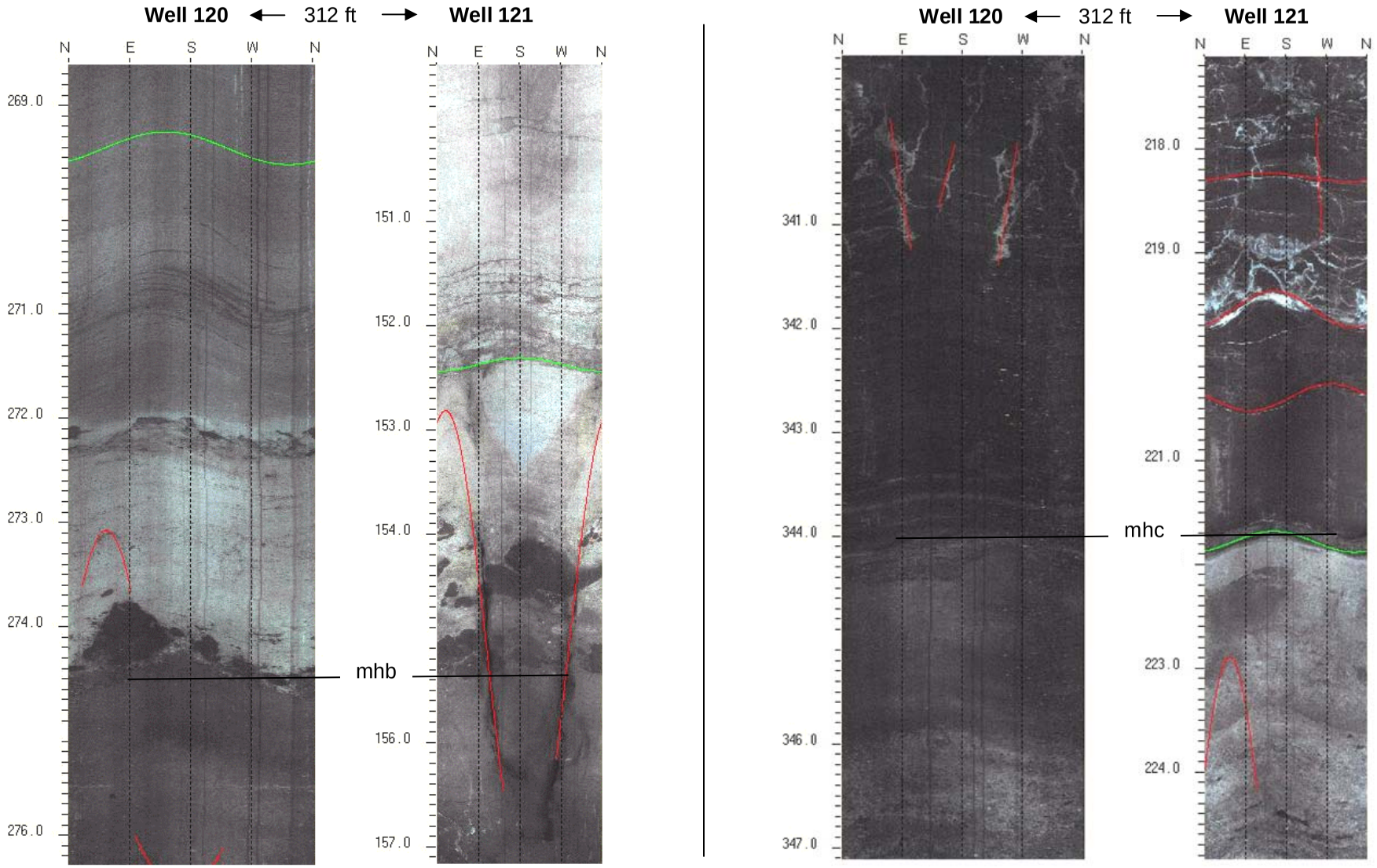
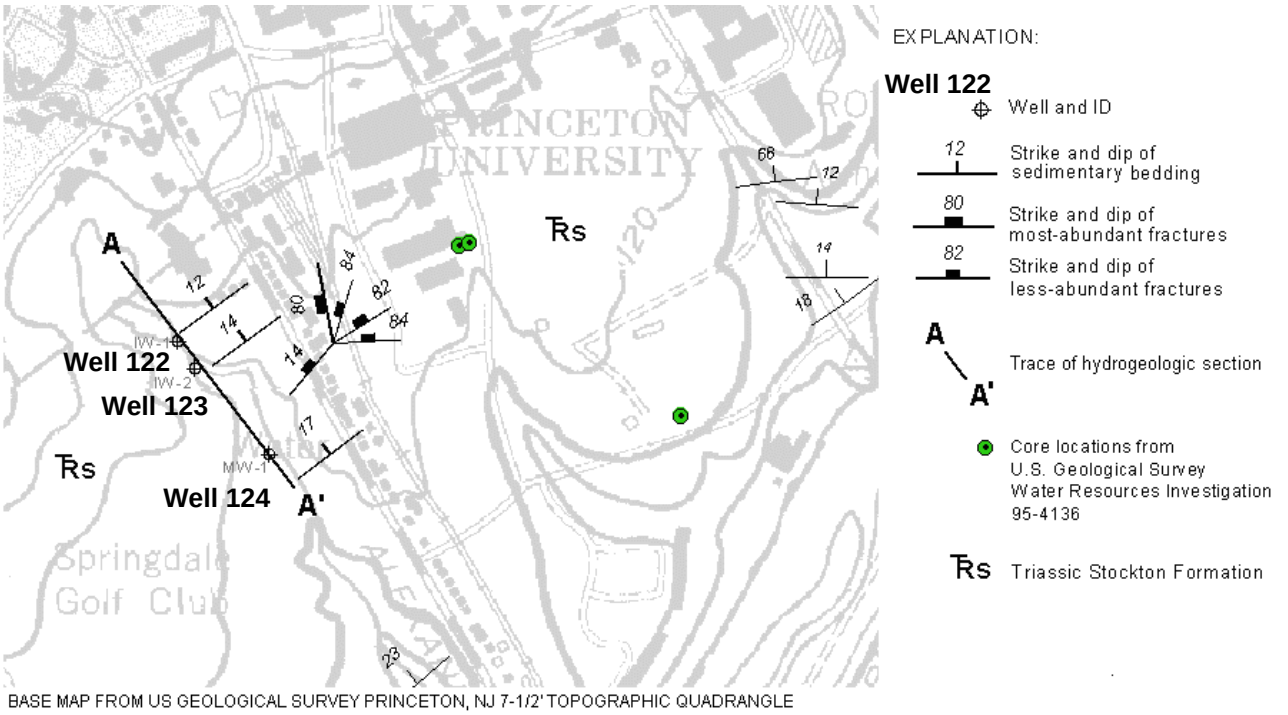


Figure 4E7. Stratigraphic correlation of wells 120 and 121 at the Greenacres Country Club, Rt. 206, Lawrence Twp., Mercer County, NJ based on OPTV records and showing stratigraphic marker horizons mhb (left) and mhc (right). Depth values are in feet below land surface.

Wells 122 to 124 – Stockton sandstone



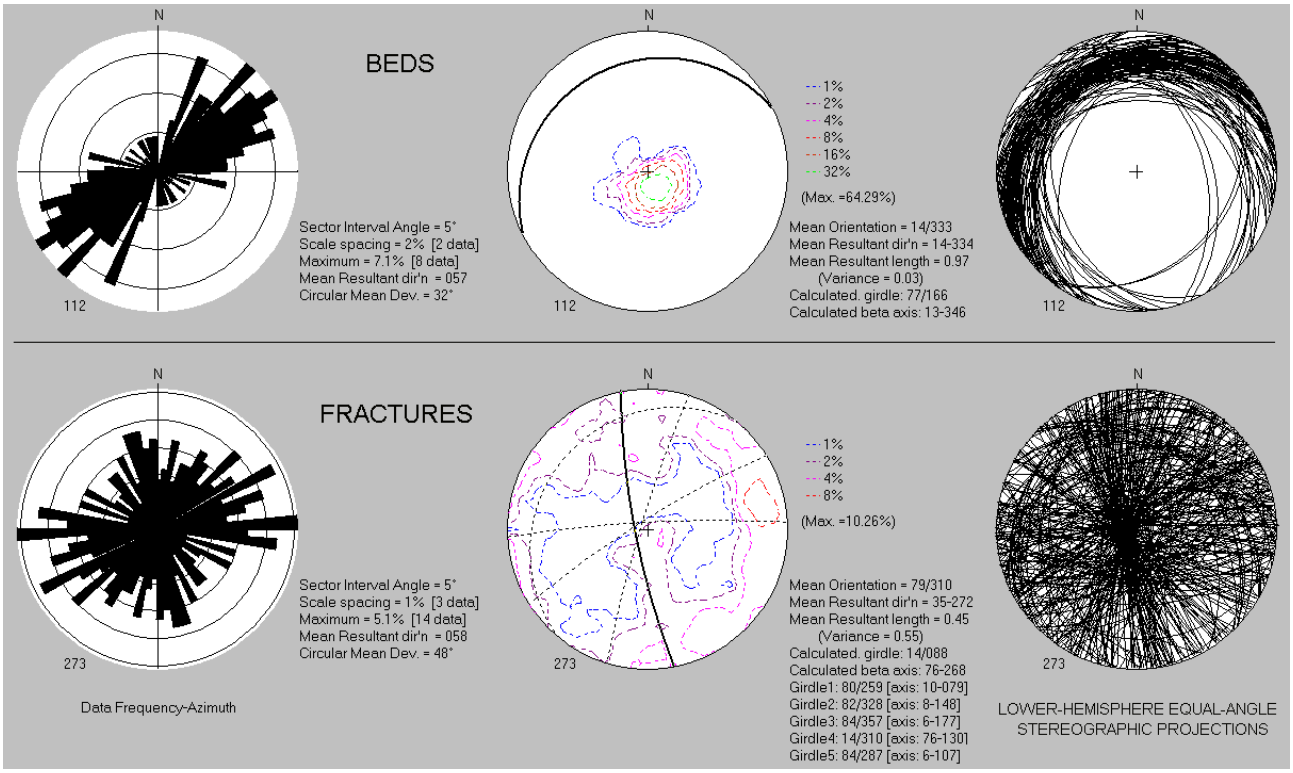


Figure 4F1. Map (above) shows wells 122 through 124 at the Springdale Golf Club, Princeton Twp., Mercer County, NJ. Structure strikes and dips near wells based on structural analysis of beds and fractures in OPTV records (below). Other bed orientations mapped in outcrop by the NJ Geological Survey.

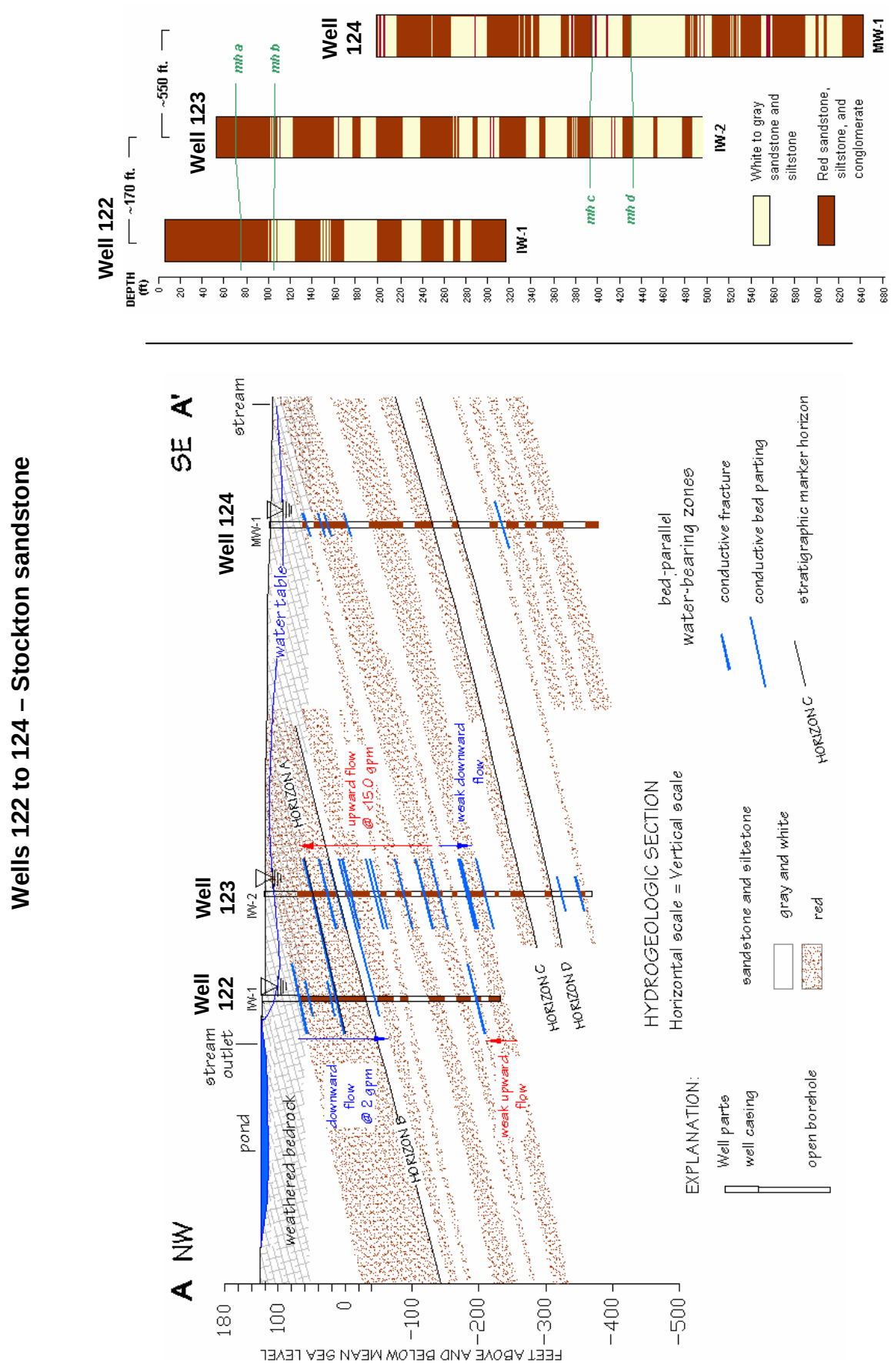


Figure 4F2. Hydrogeologic section (left) and stratigraphic section (right) showing stratigraphic correlation between wells 122 to 124 at the Springdale Golf Club, Princeton Twp., Mercer County, NJ. Depth valuyes for the sections on the right are in feet below land surface.

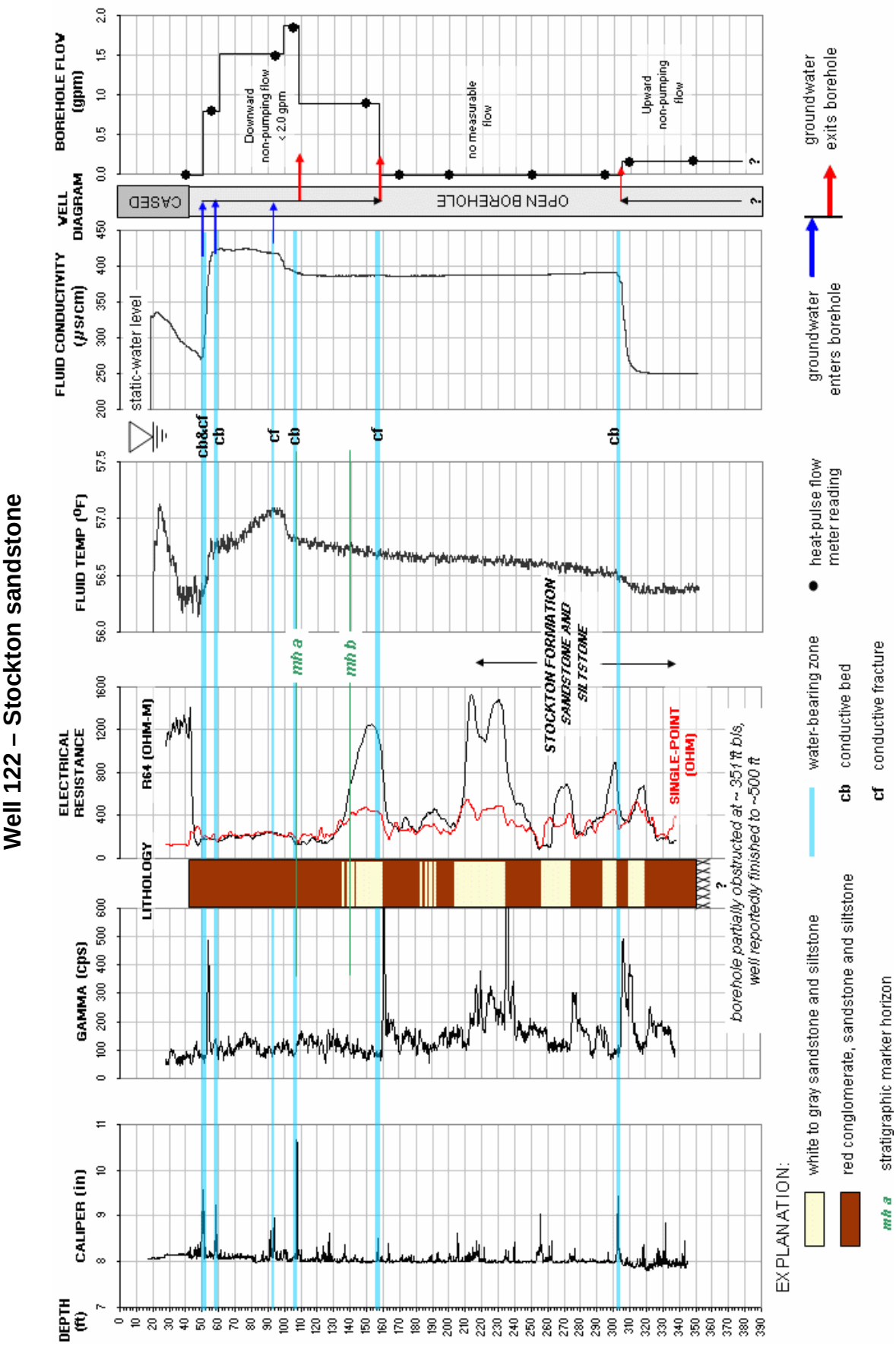


Figure 4F3. Hydrogeologic section based on geophysical logs summarizing the distribution and types of hydraulically-conductive features in well 122 at the Springdale Golf Club, Princeton Twp., Mercer County, NJ. Depth values are in feet below land surface.

Well 122 – Stockton sandstone

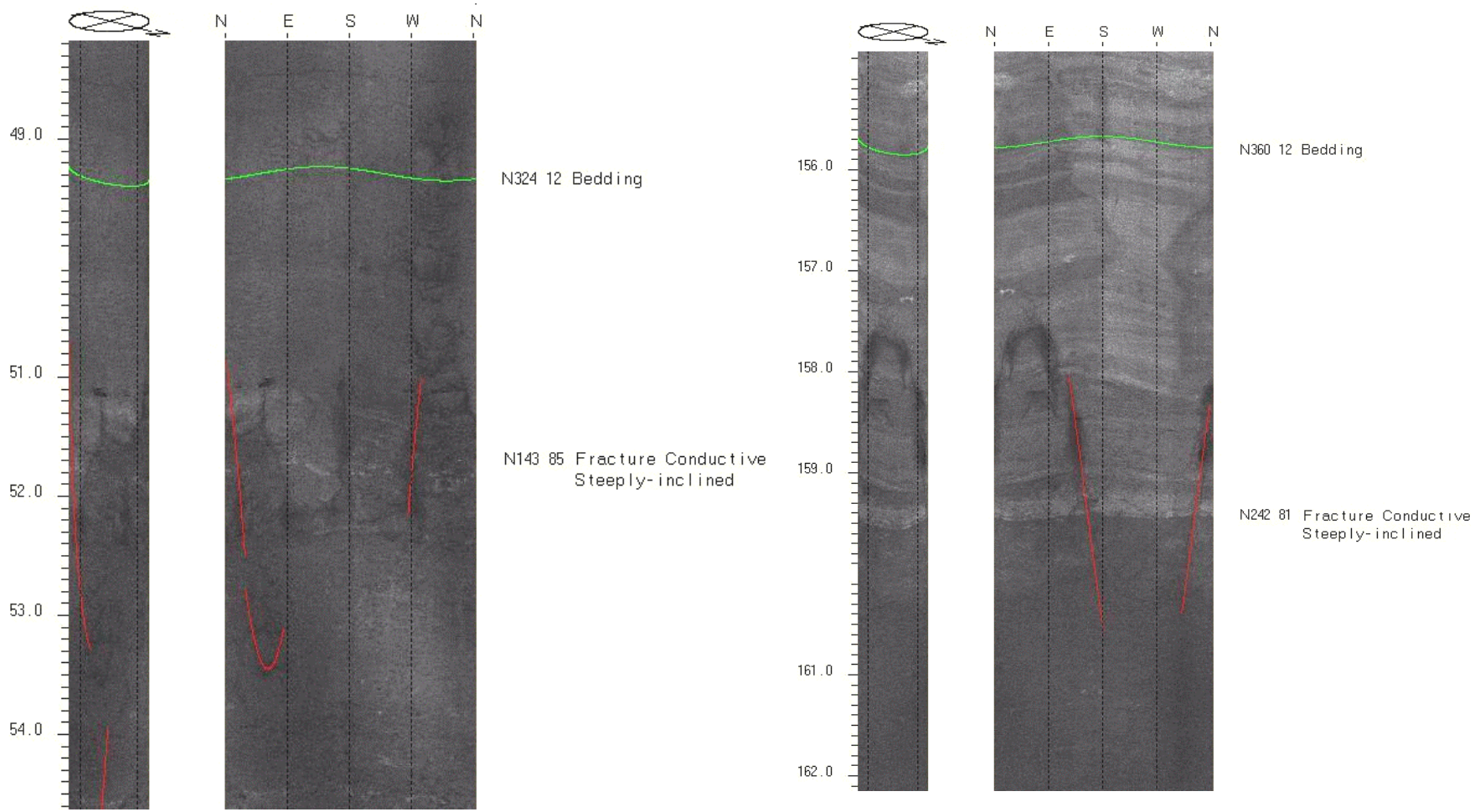


Figure 4F4. OPTV records of 8-inch diameter well 122 at the Springdale Golf Club, Princeton Twp., Mercer County, NJ showing geologic structures and hydraulically-conductive features in red gray and red sandstone and siltstone. Depth values are in feet below land surface.

S

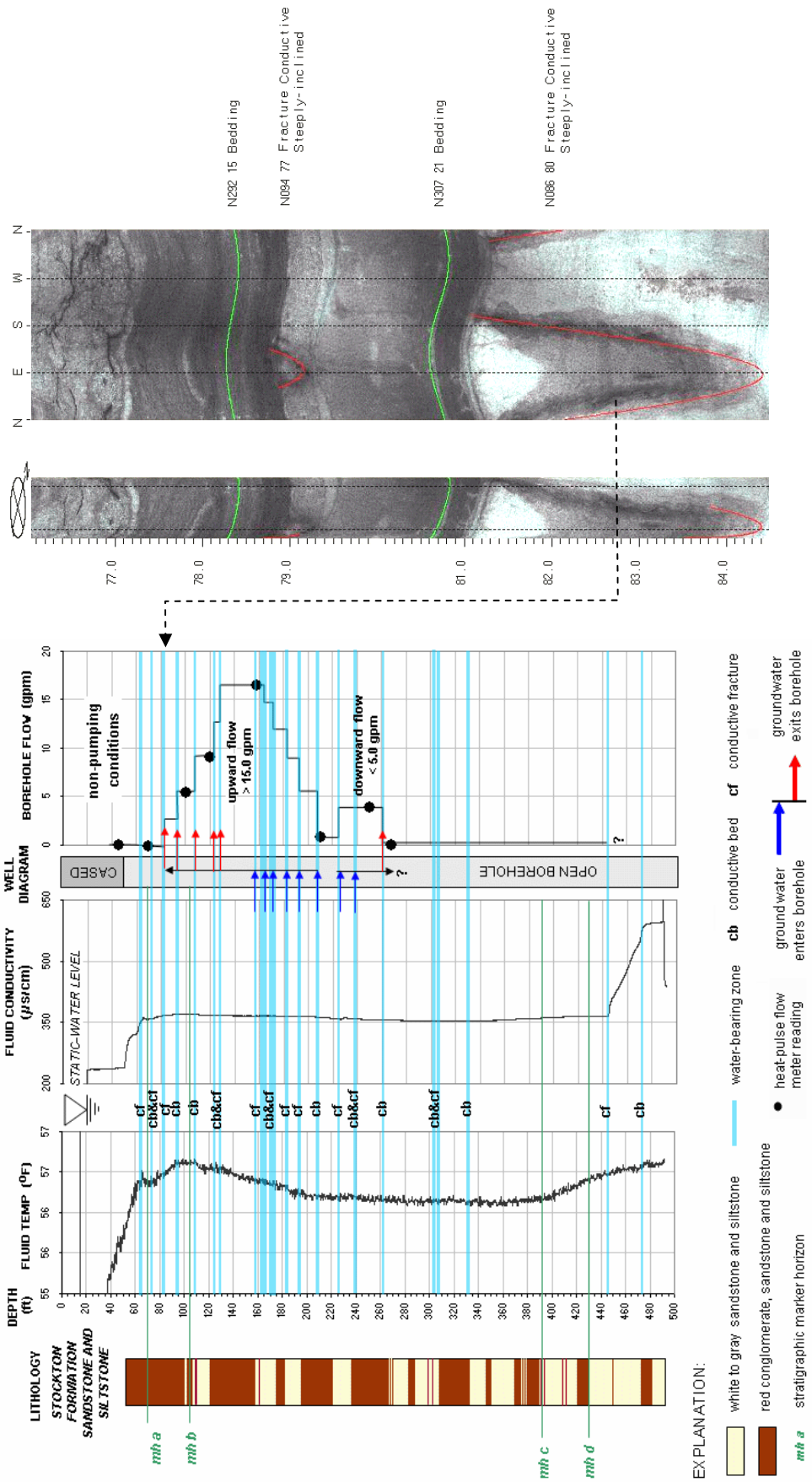


FIGURE 4F5. Hydrogeologic section based on geophysical logs (left) summarizing the distribution and types of hydraulically-conductive features in well 123 at the Springdale Golf Club, Princeton Twp., Mercer County, NJ. OPTV record of the 6-inch diameter well (right) shows geologic structures and hydraulically-conductive features in red and gray sandstone. Depth values are in feet below land surface.

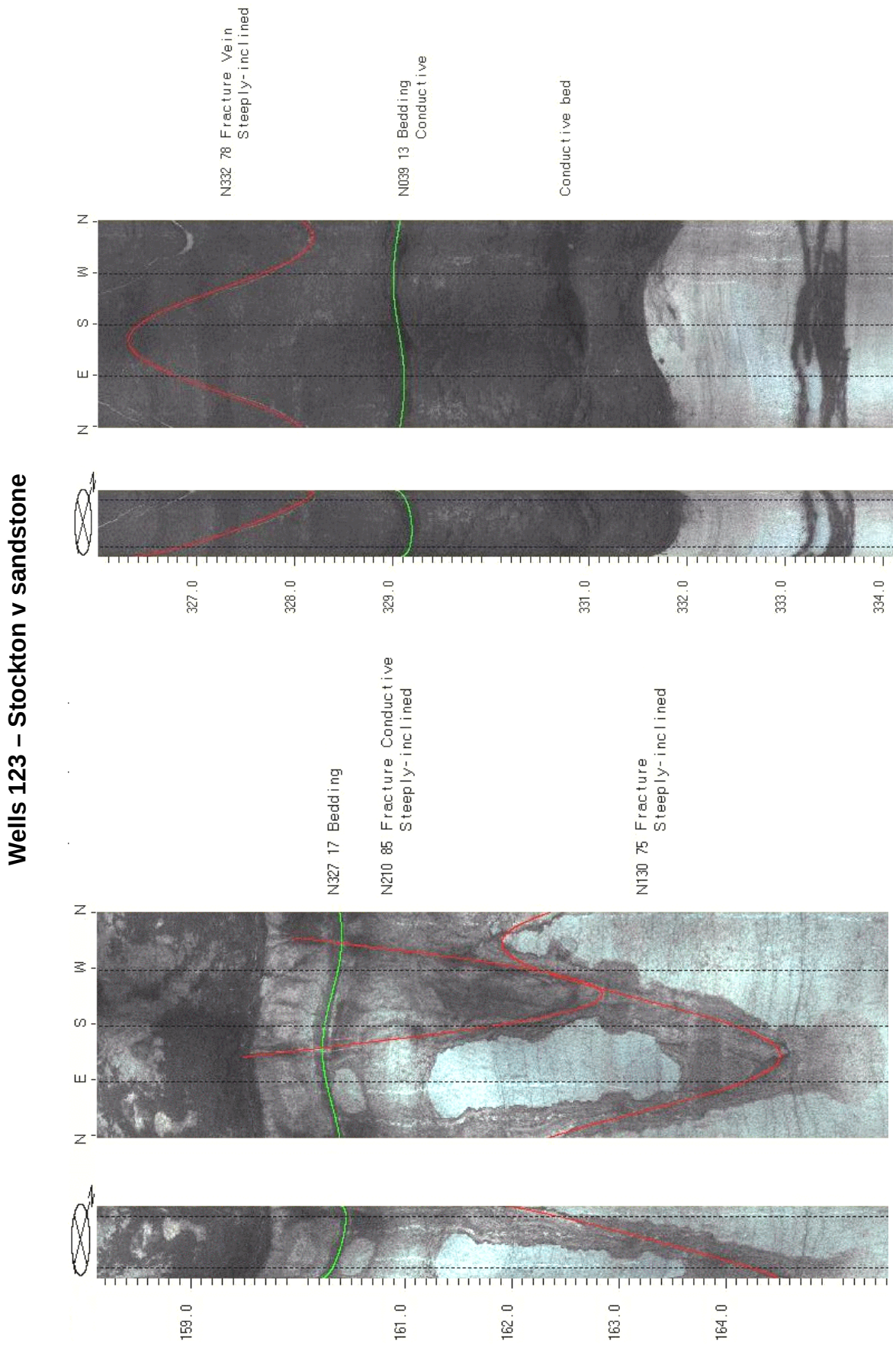


FIGURE 4F6. OPTV records of 8-inch diameter well 123 at the Springdale Golf Club, Princeton Twp., Mercer County, NJ showing geologic structures and hydraulically-conductive features in red gray and red sandstone and siltstone. Depth values are in feet below land surface.

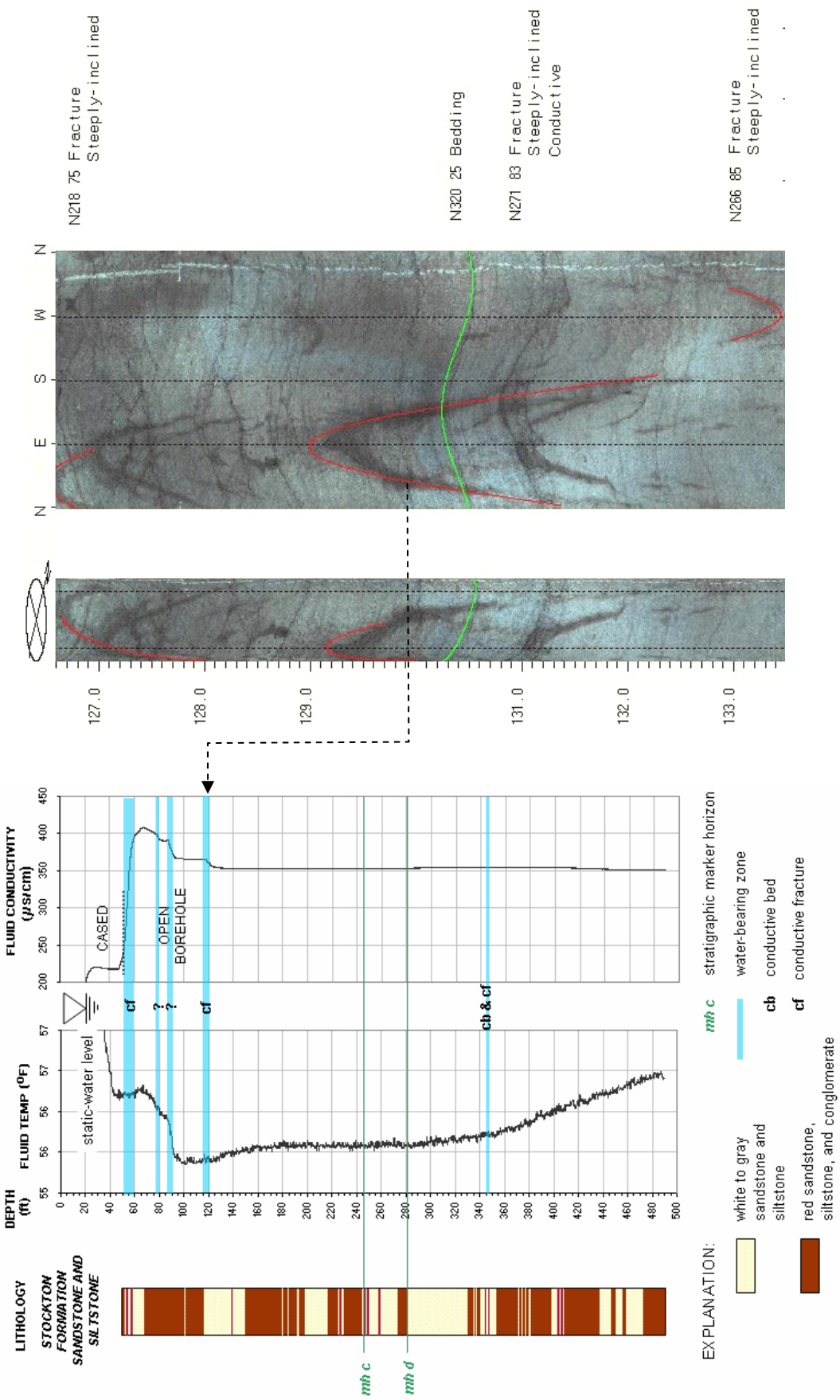


FIGURE 4F7. Hydrogeologic section based on geophysical logs (left) summarizing the distribution and types of hydraulically-conductive features in well 124 at the Springdale Golf Club, Princeton Twp., Mercer County, NJ. OPTV record of the 6-inch diameter well (right) shows geologic structures and hydraulically-conductive features in sandstone. Depth values are in feet below land surface.

Well 124 – Stockton sandstone

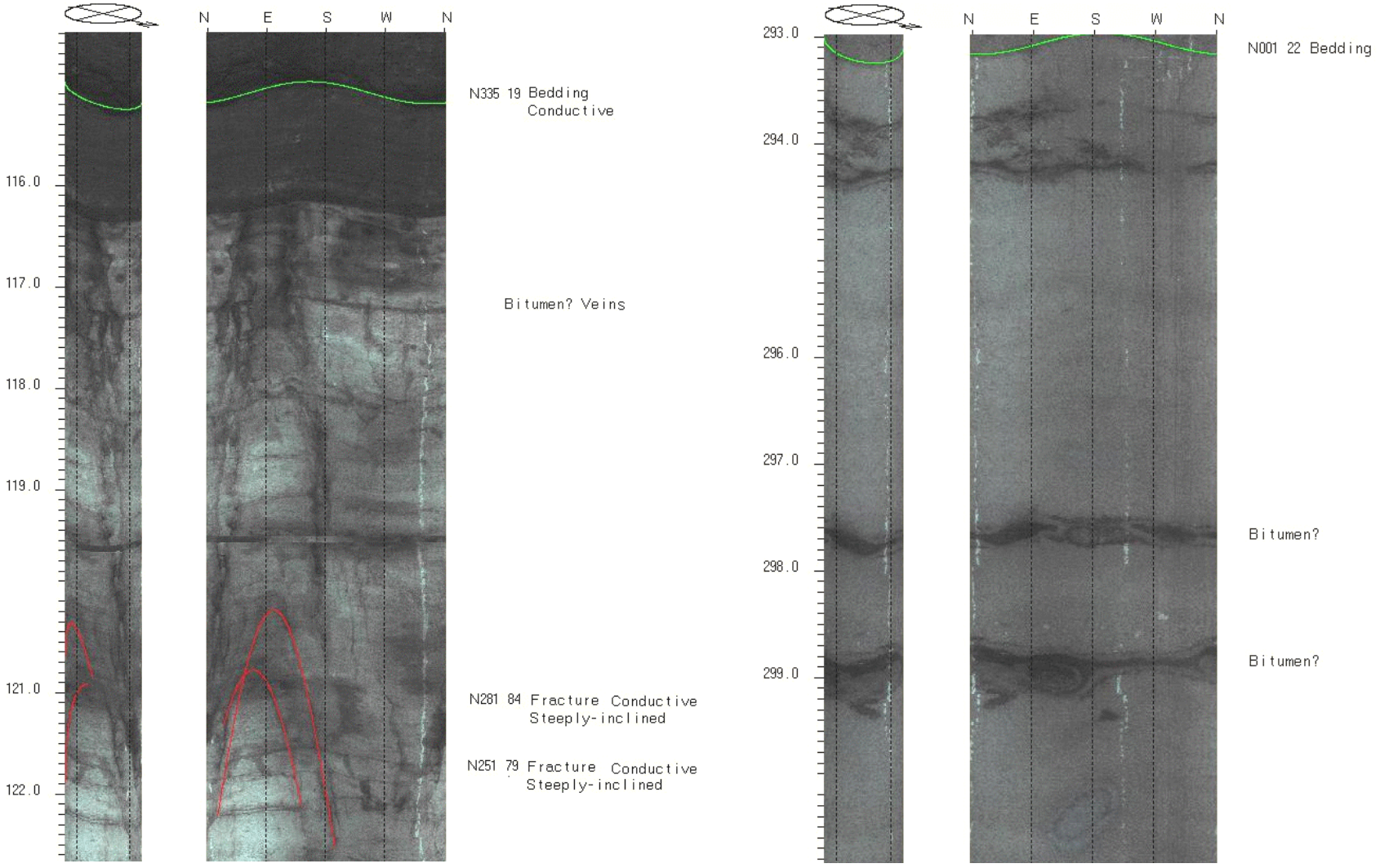


Figure 4F8. OPTV records of 6-inch diameter well 124 at the Springdale Golf Club, Princeton Twp., Mercer County, NJ showing geologic structures and hydraulically-conductive features in red gray and red sandstone and siltstone. Dark streaks and patches are probably relict hydrocarbons (bitumen) that highlight conductive paths. Depth values are in feet below land surface.

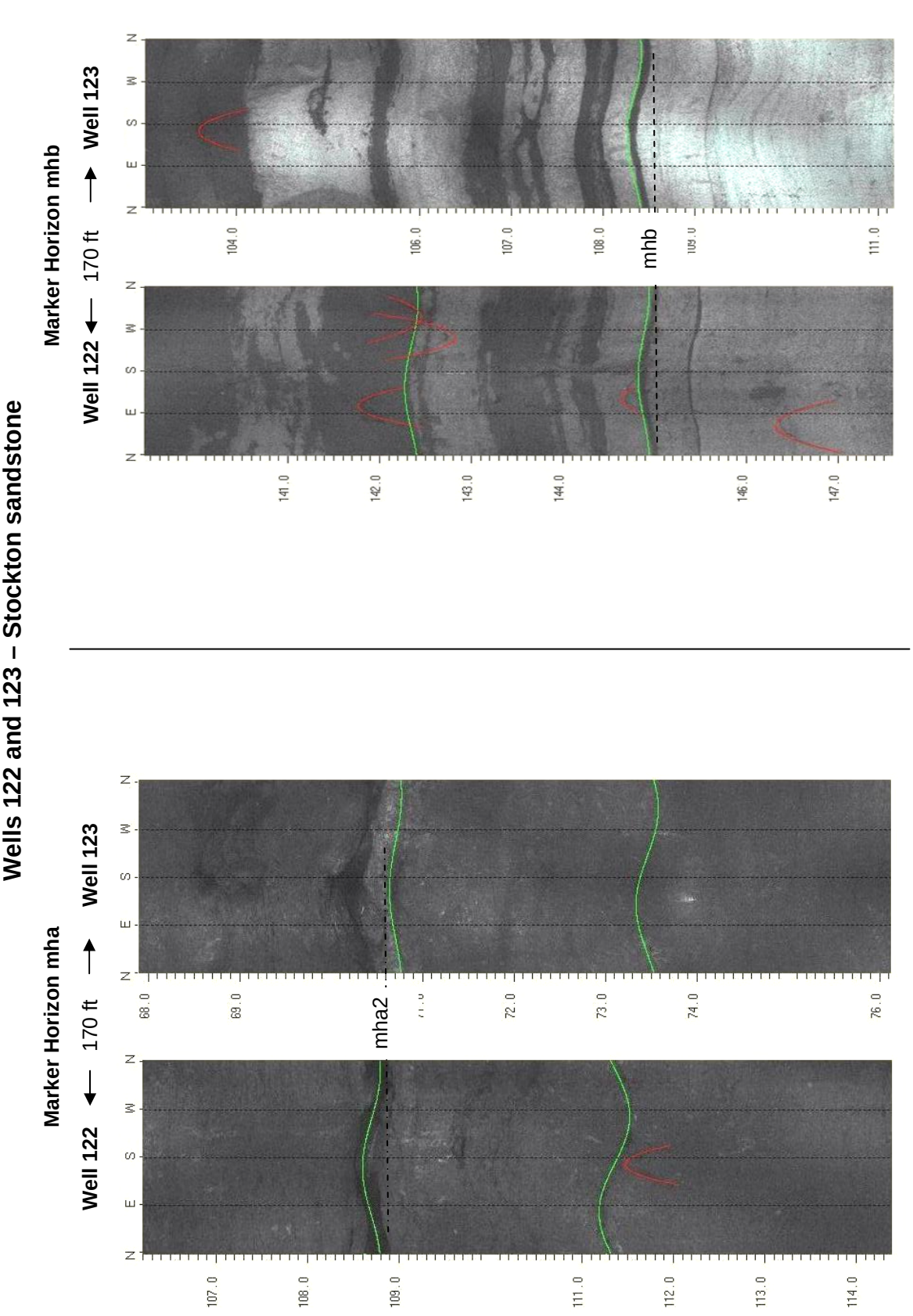


Figure 4F9. Stratigraphic correlation of wells 122 and 123 at the Springdale Golf Club, Princeton Twp., Mercer County, NJ based on OPTV records and showing stratigraphic marker horizons mha (left) and mhb (right). Depth values are in feet below land surface.

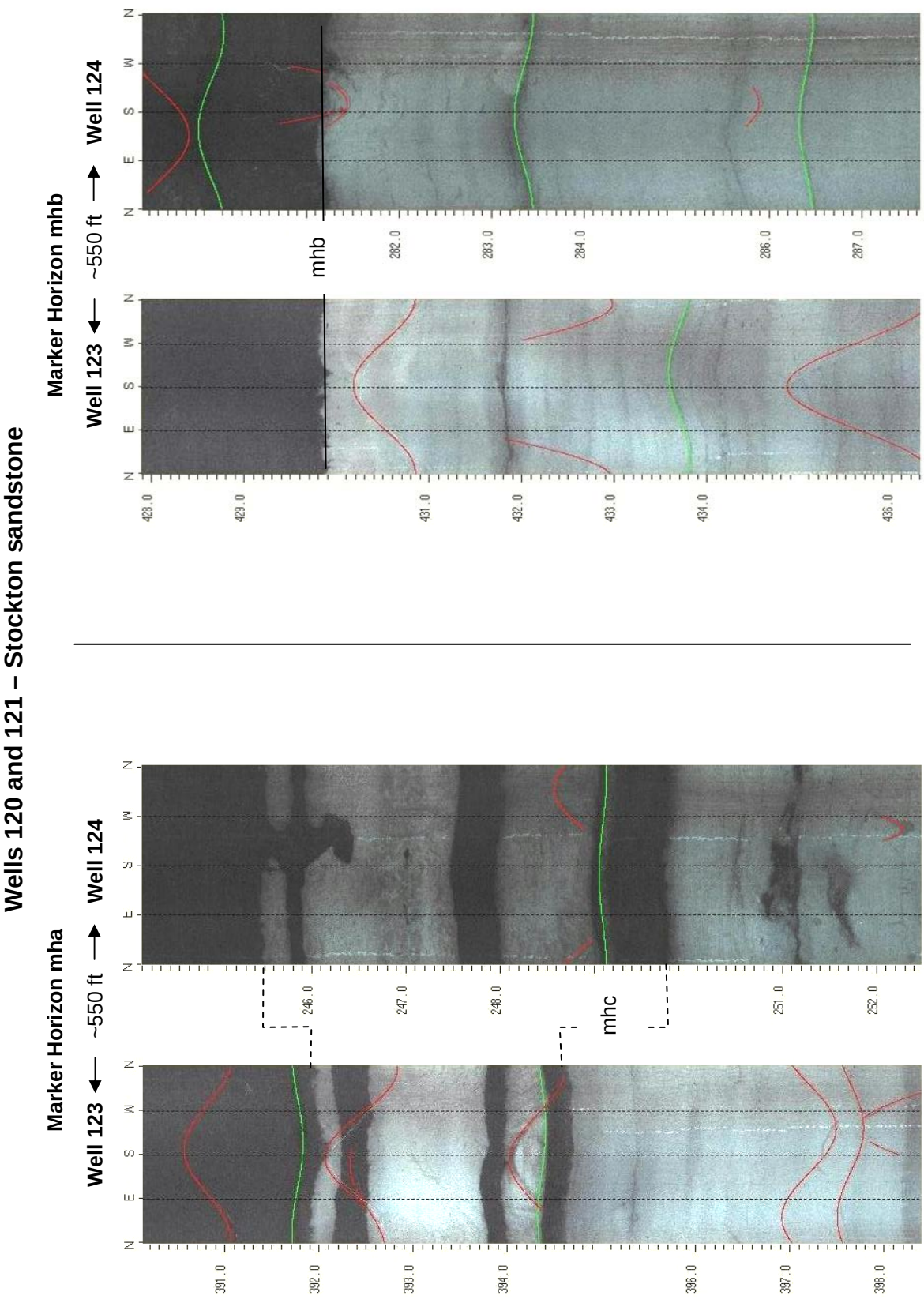


Figure 4F10. Stratigraphic correlation of wells 122 and 124 at the Springdale Golf Club, Princeton Twp., Mercer County, NJ based on OPTV records and showing stratigraphic marker horizons mhc (left) and mhd (right). Depth values are in feet below land surface.

Wells 125 to 127 – Stockton sandstone

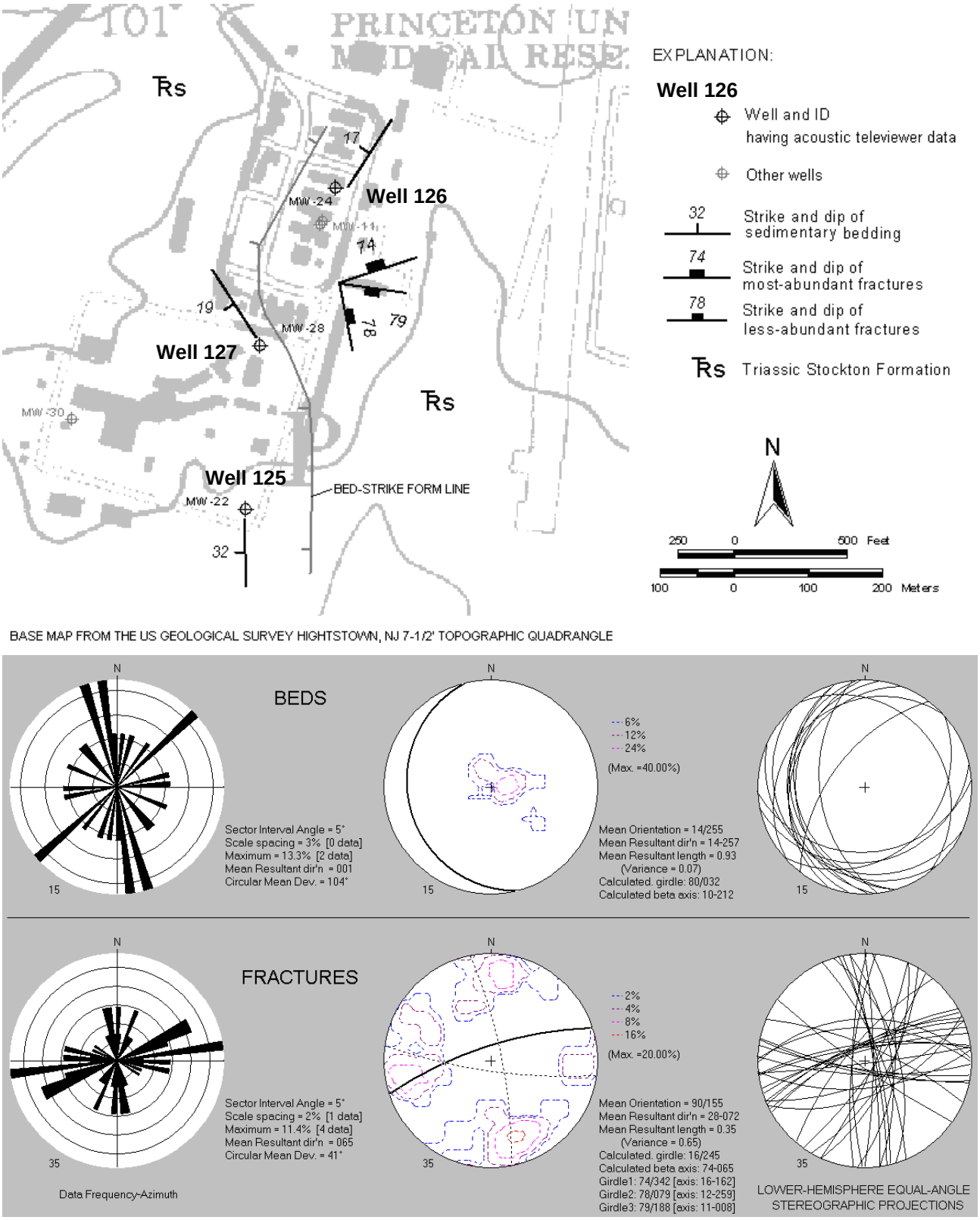


Figure 4G1. Map (above) showing wells 125 to127 at the Princeton Plasma Physics Laboratory, Princeton University Forrestal Campus, Plainsboro Twp., Mercer County, NJ. Mapped structures based on a structural analysis of ATV data (below).

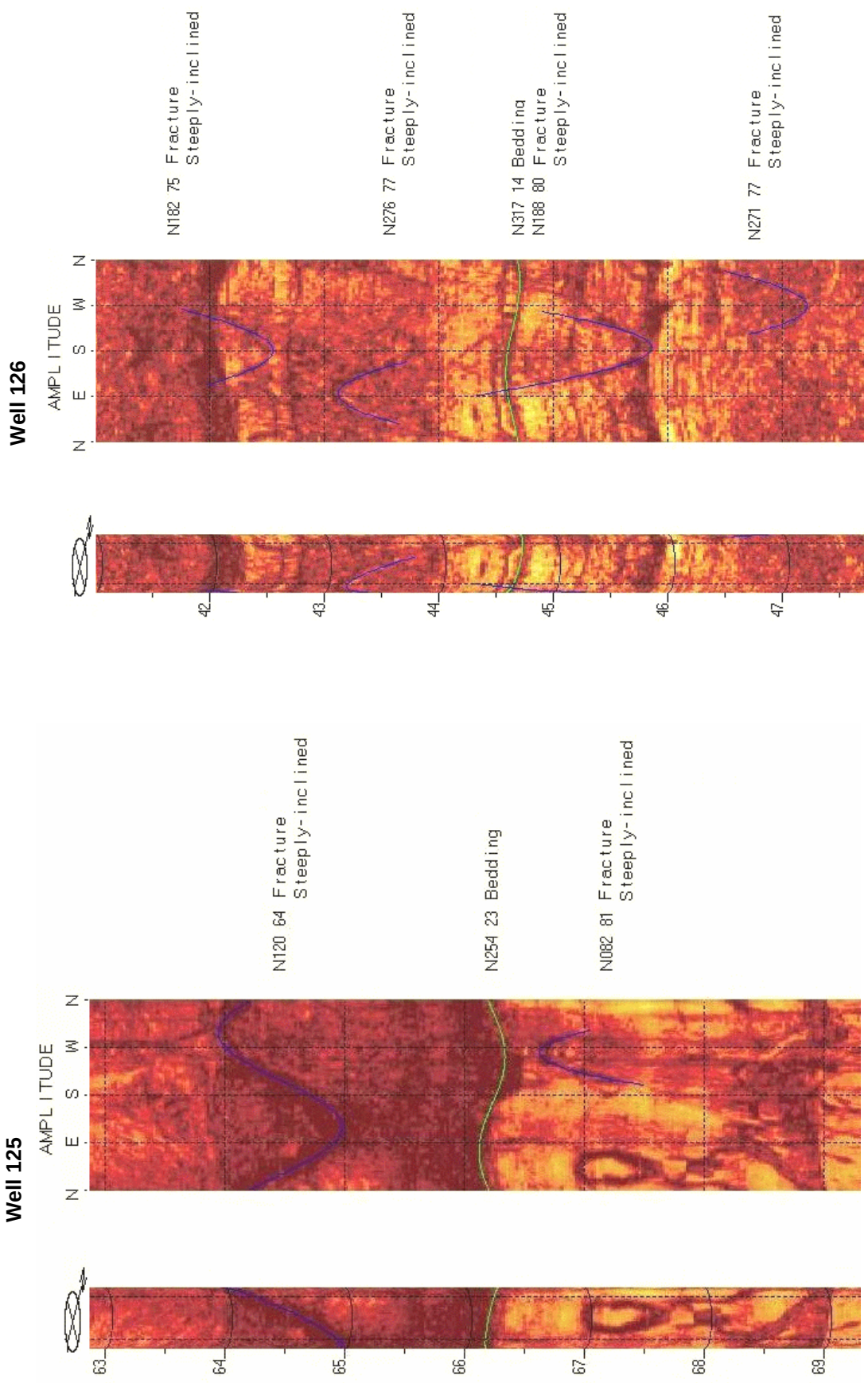


FIGURE 4G2. ATV records of 6-inch diameter wells 125 and 126 at the Princeton Plasma Physics Laboratory, Princeton University Forrestal Campus, Plainsboro Twp., Mercer County, NJ showing geologic structures in the Stockton aquifer. Depth values are in feet below land surface.

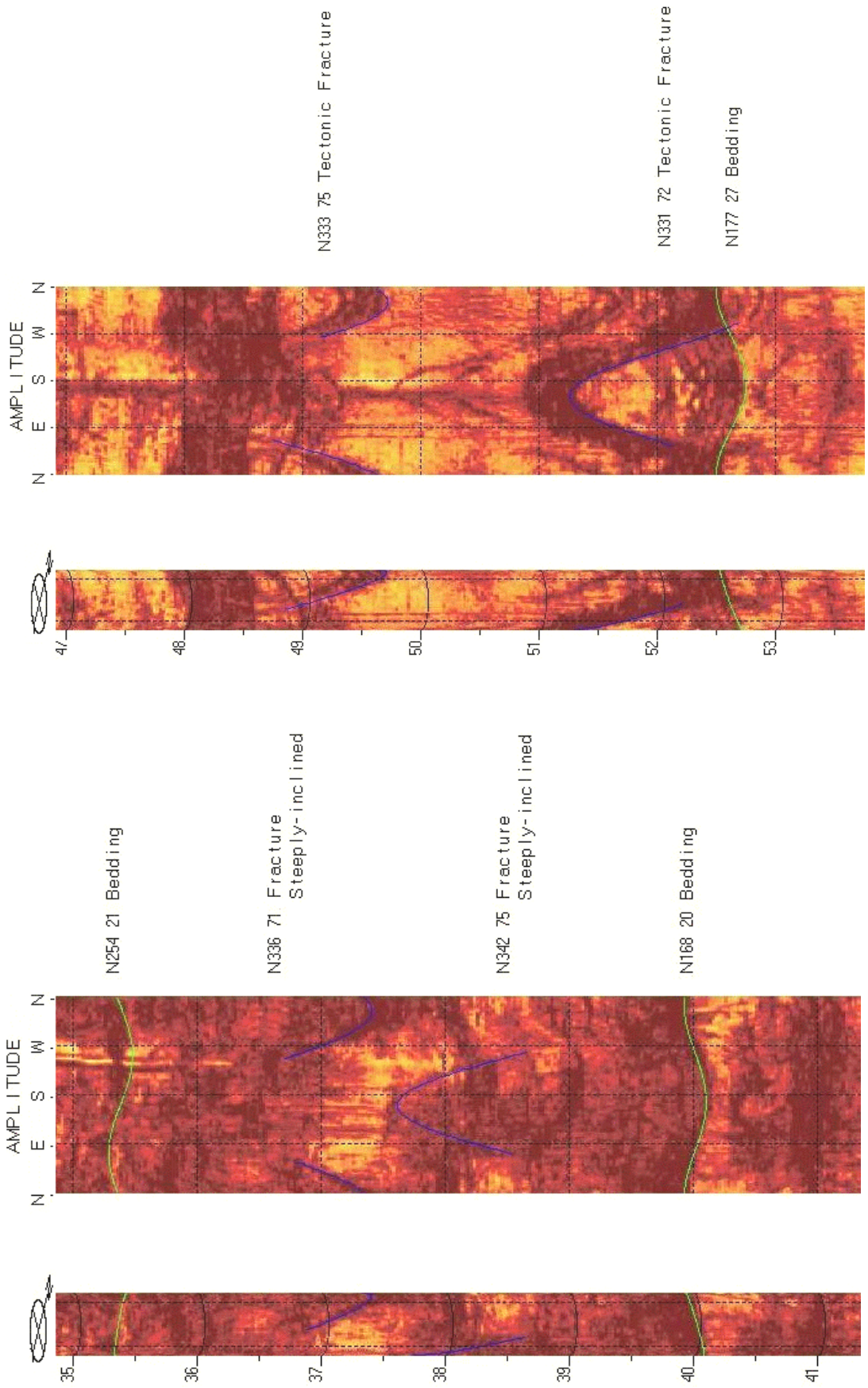


FIGURE 4G3. ATV records of 6-inch diameter well 127 at the Princeton Plasma Physics Laboratory, Princeton University Forrestal Campus, Plainsboro Twp., and Mercer County, NJ showing geologic structures in the Stockton aquifer. Depth values are in feet below land surface.