

# Log ASCII Standard (LAS) files for geophysical wireline well logs and their application to geologic cross sections through the central Appalachian basin

By Robert D. Crangle, Jr.

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# Log ASCII Standard (LAS) files for geophysical wire line well logs and their application to geologic cross sections through the central Appalachian basin

By Robert D. Crangle, Jr.<sup>1</sup>

#### Introduction

The U.S. Geological Survey (USGS) uses geophysical wireline well logs for a variety of purposes, including stratigraphic correlation (Hettinger, 2001, Ryder, 2002), petroleum reservoir analyses (Nelson and Bird, 2005), aquifer studies (Balch, 1988), and synthetic seismic profiles (Kulander and Ryder, 2005). Commonly, well logs are easier to visualize, manipulate, and interpret when available in a digital format.

In recent geologic cross sections E-E' and D-D', constructed through the central Appalachian basin (Ryder, Swezey, and others, in press; Ryder, Crangle, and others, in press), gamma ray well log traces and lithologic logs were used to correlate key stratigraphic intervals (Fig. 1). The stratigraphy and structure of the cross sections are illustrated through the use of graphical software applications (e.g., Adobe Illustrator). The gamma ray traces were digitized in Neuralog (proprietary software) from paper well logs and converted to a Log ASCII Standard (LAS) format. Once converted, the LAS files were transformed to images through an LAS-reader application (e.g., GeoGraphix Prizm) and then overlain in positions adjacent to well locations, used for stratigraphic control, on each cross section.

This report summarizes the procedures used to convert paper logs to a digital LAS format using a third-party software application, Neuralog. Included in this report are LAS files for sixteen wells used in geologic cross section E-E' (Table 1) and thirteen wells used in geologic cross section D-D' (Table 2).

#### History of LAS files and Neuralog

Prior to the introduction of the LAS format, geophysical well-log data were recorded on magnetic tape and reviewed in a non-standardized binary format. In 1990, the Canadian Well Logging Society designed the LAS ASCII-type system for local Canadian markets to standardize the binary format used to digitize well logs. The simplicity and flexibility of the LAS ASCII-type encoding quickly led to its worldwide acceptance and use (personal communication, Kenneth Heslop, Canadian Well Logging Society, 10/17/2005). As shown in figure 2, the LAS format often begins with a header, followed by columns of values that

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describe specific measurements (e.g., gamma ray log in API radiation units) at given depths (Canadian Well Logging Society, 1990, *http://cwls.org/docs/LAS12\_Standards.txt*).

The Neuralog software program (Neuralog, Inc., 1992), is an autovectorizing application used to create LAS files. The application is capable of generating an LAS file from a scanned well-log, imported as an image file (e.g., Tagged Image File Format) and digitized through a combination of an autovectorizing algorithm and user-defined manual edits. Once vectorized, Neuralog converts the digital image to an LAS file, which can then be used in a variety of other LAS-reader applications (e.g., GeoGraphix Prizm, Microsoft Excel, GeoTools QuickSyn, etc.). The conversion of a paper well log to a digital LAS file through Neuralog is quite useful, particularly for older logs where original digital data is limited or nonexistent.

#### **Procedures used to create LAS files**

Gamma ray logs, used to construct geologic cross sections E-E' and D-D' (Fig. 1), were converted to LAS-format files through Neuralog. The LAS files, included in Tables 1 and 2, were created from scanned Tagged Image File Format (TIFF) files (Fig. 3) that were in turn converted to an LAS format (text file) via Neuralog. Once transformed to an LAS format, the file was accessible in an LAS viewer (e.g., GeoGraphix Prizm) where it was exported as a Windows Metafile format (WMF) image file. A graphical illustration application (e.g., Adobe Illustrator), was used to import the WMF file for further editing, which included scaling and placement (Fig. 4). Multiple quality-check verifications were made throughout the process to insure consistency between the original paper logs and the newly created digital logs.

Prior to the development of Neuralog, non-digital geophysical well logs were scanned, saved as TIFF files, manually traced in a graphical illustration application and placed within an appropriate stratigraphic cross-section illustration (e.g., Hettinger, 2001, Ryder 2002). This process produced vectorized, editable images, but no usable coordinates (e.g., X,Y data). With Neuralog, a more accurate and fully editable image, coupled with a trans-application digital data file, is achieved. The Neuralog vectorization process offers a significant savings in time and the resultant LAS data file may be used in a variety of other applications.

#### **Results and Conclusion**

The autovectorization and LAS conversion of paper geophysical wireline well logs provides significant assistance in the correlation, creation, presentation, and digitization of geologic cross sections (Fig. 4). The integration of Neuralog, an LAS-file reader, and a graphical illustration application offers an effective and accurate process whereby non-digital paper well logs are converted to digital LAS files. These same procedures will be used to produce digital images of geophysical well logs for additional cross sections in the Appalachian basin and other localities.

## **References Cited**

Balch, A.H., ed., 1988, A seismic-stratigraphic investigation of the Madison and associated aquifer – Application to ground-water exploration, Powder River Basin, Montana-Wyoming: U.S. Geological Survey Professional Paper 1330, 99p., 1 plate.

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- Ryder, R.T., Swezey, C.S., Crangle, R.D., Jr., and Trippi, M.H., in press, Geologic cross section E-E' through the Appalachian basin from the Findlay arch, Wood County, Ohio, to the Allegheny structural front, Pendleton County, West Virginia, U.S. Geological Survey Scientific Investigations Series Map.



**Figure 1.** Location map for regional cross-sections D-D' and E-E' (red lines). Well locations represented as black dots, numbers correspond to well data listed in Tables 1 and 2.

# ~Version Information Block VERS. 2.00: CWLS LOG ASCII STANDARD - VERSION 2.000000

WRAP.	NO	: One Line Pe	er Depth Step
# ∼Well Inf	ormation Blo	ck	
#MNEM.	UNIT	Data	Information
# STRT.FT		0.000	0:
STOP.FT		4900.000	0:
STEP FT		0.5000	).
NULLI		-999 2500	).
COMP		-777.2300	COMPANY
WELL			. COMPANY
WELL.			: WELL
FLD.			: FIELD
CNTY.			: COUNTY
STAT.			: STATE
CTRY.			: COUNTRY
SRVC.			: SERVICE COMPANY
DATE.			: DATE
API .			: API NUMBER
UWI.			: UWI NUMBER
#			
~Curve In	formation Bl	ock	
#MNEM	UNIT AP	I CODE Cury	ve Description
#			-
" DEPT ET	· .	Denth in Feet	
GP GA	DT .	Gemme Bev	
		Gainina Kay	
~A DEP	117 OK		
120.300	116.650		
121.000	116.039		
121.500	115 507		
122.000	116 460		
123.000	117 800		
123,500	118.816		
124.000	120.412		
124.500	121.232		
125.000	120.870		
125.500	120.082		
126.000	117.829		
126.500	114.186		
127.000	110.841		
127.500	107.667		
128.000	105.404		
128.300	105.985		
129.000	107.165		
130.000	105.354		
130.500	103.670		
131.000	103.320		
131.500	102.851		
132.000	103.122		
132.500	105.247		
133.000	105.870		
133.500	105.277		
134.000	105.220		
134.500	103.033		
135.000	101./8/		
136.000	99 255		
136 500	97.193		
137.000	94.774		
137.500	91.366		
138.000	89.754		
138.500	89.344		
139.000	89.148		
139.500	90.939		
140.000	93.301		
140.500	95.354		

**Figure 2.** Example of an LAS file of gamma ray data for the #1 Windbigler well, Morrow County, OH. Selected data from a depth range of 120.5 to 140.5 feet.



**Figure 3.** Selected segment of the Windbigler #1 gamma ray log used to define lithology and correlate stratigraphy. The image file (left) was imported into Neuralog where it was traced, digitized (right), and converted to an LAS file. The resulting LAS file (Fig. 2) was imported into GeoGraphix Prizm, where it was converted to a digital image, exported as a WMF image file, then imported into Adobe Illustrator and included as part of the geologic cross section E-E'. The resolution for this figure is compromised due to the original condition of the paper well log and the original native resolution of the Neuralog screen-capture.



**Figure 4.** Selected segment of geologic cross section E-E' showing the location of the No. 1 Windbigler well and a digitized gamma ray log of the well (yellow). The area in blue corresponds to the data shown in figures 2 and 3.

Table 1. Sixteen Log ASCII Standard (LAS) files for geologic cross section E-E' through the Appalachian basin from Wood County. Ohio. to Pendleton County. West Virginia

Table I	<ol> <li>Sixteen Log ASCII Standa</li> </ol>	rd (LAS) mes for geor	ogic cross section E-E inrough the Apparachian basin from	wood Coun	ity, Onio,	to Penaleto	n Cour	ity, west virginia	
Well #	File Name	Well Name	Location	API No.	Latitude	Longitude	TD (ft)	Date(s) of log run(s)	LAS Interval (ft)
1	A_KM_ark_oil	Kin-Ark Oil Co. No.1 Carter	Center Township, Wood County, OH, Dunbridge, OH 7.5' quadrangle	34-173-20237	41.415	-83.609	2,821	1/11/1965 (Run 1, GR-N)	0-2,800
	A_Kerbel_1 (LAS file from Ohio								
	Geological Survey,								
	http://www.ohiodnr.com/geosurvey/ogci	Russell Maguire No.1 Paul	Woodville Township, Sandusky County, OH,						
2	m/petrol/dlg.htm)	Kerbel	Elmore, OH 7.5' quadrangle	34-143-20147	41.438	-83.317	2,785	11/29/1965 (Run 1, GR-N)	100.5-2,779.5
		Ohio Dept. of Nat. Resources	Liberty Township, Seneca County, OH,						
3	A_M_and_B_Asphalt	M and B Asphalt Co.	Tiffin North, OH 7.5' quadrangle	34-147-60840	41.226	-83.199	2,870	1985 (Run 1, GR-N)	0-2,850
	A_Leonhardt (LAS file from Ohio								
	Geological Survey,								
	http://www.ohiodnr.com/geosurvey/ogci	HL Hawkins & HL Hawkins, Jr.	Chatfield Township, Crawford County, OH,						
4	m/petrol/dlg.htm)	No.1 VE Leonhardt	Chatfield, OH 7.5' quadrangle	34-033-20050	40.910	-82.883	3,772	10/11/1965 (Run 1, GR-N)	100-3,772
		United Producing Co No.3	Canaan Township, Morrow County, OH,						
5	A_Myers_A	Orrie Myers (O & E Myers)	Denmark, OH 7.5' quadrangle	34-117-20012	40.571	-82.920	4,100	7/16/1965 (Run 1)	0-3,100
		United Producing Co No.3	Canaan Township, Morrow County, OH,						
5	A_Myers_B	Orrie Myers (O & E Myers)	Denmark, OH 7.5' quadrangle	34-117-20012	40.571	-82.920	4,100	7/26/1965 (Run 2)	2,900-4,100
		Pan American Petroleum Corp	Troy Township, Morrow County, OH,						
6	A_Windbigler	No.1 AC Windbigler	Blooming Grove, OH 7.5' quadrangle	34-117-20047	40.690	-82.682	4,890	10/13/1962 (Run 1) 11/3/1962 (Run 2)	0-4,100
_			Troy Township, Richland County, OH,						
7	A_Paimer	Pan American No.1 J Paimer	Manstield South, OH 7.5 quadrangle	34-139-20289	40.648	-82.590	4,775	2/28/1964 (Run 1, GR-N), 3/18/1964 (Run 2, GR-N)	0-4,900
-			Jefferson Township, Coshocton County, OH,					A 10 10 1 500 00	
8	A_Lee	Bob Tatum No.1 Edwin L Lee	Warsaw, OH 7.5 quadrangle	34-031-22053	40.323	-82.001	6,970	6/16/19/1 (RUN 1, FDC-GR)	100-6,970
		Lakeshore Pipeline No.1 WR	Adams Township, Guersey County, OH,		10.007	04 700	0.000		100.0.050
9	A_Maistall	Marshall	Biodinileid, OH 7.5 quadrangie	34-059-20762	40.037	-01.720	0,002	4/17-18/1961 (Rull 1, L-GR-N), 5/31/1961 (Rull 2, L-GR-N)	100-6,650
	A_Uliman (LAS file from Ohio								
	Geological Survey,							0/46/4066 (Burn 4, CR N), 40/40/4066 (Burn 3, EDC CR), 40/0/4066	
10	mip://www.oniodni.com/geosurvey/ogci	Amorada No 1 Robert I Illman	Filk Township, Noble County, OH, Daltell, OH 7.6' guadrangle	24 424 24270	20.644	04.247	44.440	(Pup 2 GR N)	0.44.450
10	neperoroig.nany	Amerada No. 1 Robert Omnan	Lik Township, Noble County, OT, Balzeli, OT 7.5 quadrangle	34-121-212/0	39.011	-01.34/	11,442	(Kuli 3, GK-N)	0-11,450
11	A Hono Rower	Rower Oil Co	Wolker District Wood County WV, Willow Island, WV/7 El guadrangla	47 107 00261	20.255	01 272	12 227	1/12 14/1066 (Run 2 GR)	100 12 200
	A_hope_rowei	Exxon Corporation No.1	Walker District, Wood County, WV, Willow Island, WV 7.5 quadrangle	47-107-00331	38.233	-01.272	13,327	10/12/1076 (Run 1 IGR), 10/29/1076 (Run 2, IGR), 11/22/1076	100-12,300
12	A Deem	Howard H Deem Et Lly	Steele District Wood County WV Rocknort WV 7.5' augdrepale	47 107 00756	20.091	91 609	12 266	(Run 3, IGR), 11/20/1076 (Run 4, IGR)	100 12 200
12	/_bcom	Exxon Corporation No.1	Stoole District, Wood County, WV, Robipoli, WV Ro quadrangic	47-107-00730	38.001	-01.500	13,200	10/12/1076 (Run 1 IGR) 10/28/1076 (Run 2 IGR) 11/22/1076	100-13,200
12	A Deem B	Howard H Deem Et Lly	Rockport WV 7.5' guadrande	47-107-00756	39.081	-81 508	13 266	(Run 3, IGR), 11/20/1076 (Run 4, IGR)	8 800-13 240
	/_bdom_b	Exxon Corporation No.1 Walte	Washington District Jackson County WV	47 107 00700	00.001	01.000	10,200	(1010, 1010, 1120 1010 (10114, 1010)	0,000 10,240
13	A McCov	McCov Et Al	Kentuck WV 7.5' quadrangle	47-035-01366	38 731	-81 560	17 675	4/21/1975 (Run 1 EDC-GR-N) 8/26/1975 (Run 2 EDC-GR-N)	0-17 700
10		Exxon Corporation No 1	Center District Calbour County WV	47 000 01000	00.701	01.000	11,010	10/2/1072 (Burn 1, ICB), 11/20/1072 (Burn 1, EDC, CB), 1/12/1074 (Burn 1, EDC	0 11,100
14	A Gainer Lee	Gainer-Lee	Grantsville WV 7.5' guadrangle	47-013-02503	38.875	-81 098	20 222	GR-N) 1/13/1974 (Run 2 EDC-GR) 2/10/1974 (Run 2 BCS-GR)	0-20 250
14			and the design of the design o	47 010 02000	00.070	01.000	LU,LLL	3/2/1974 (Run 3, BCS-GR), 3/2/1974 (Run 3, FDC-GR), 5/4/1974 (Run 4, BCS-	0 20,200
		Exxon Corporation No.1	Center District, Calhoun County, WV,					GR), 5/4/1974 (Run 4, FDC-GR), 1974 (Run 5, BCS-GR), 1974 (Run 5, FDC-	
14	A_Gainer_Lee_B	Gainer-Lee	Grantsville, WV 7.5' quadrangle	47-013-02503	38.875	-81.098	20,222	GR)	11,000-20,211
		Hope Natural Gas No.10228	Huttonsville District, Randolph County, WV,						
15	A_W_VA_Med_Security_Prison_A	WV Board or Control	Mill Creek, WV 7.5 quadrangie	47-083-00103	38.707	-79.969	13,121	5/8/1959 (Run 1, L-GR), 5/31/1959 (Run 2, GR)	0-6,300
		Hope Natural Gas No.10228	Huttonsville District, Randolph County, WV,	17 000 001	00.515		10.15		0.000 45
15	A_vv_vA_mea_security_Prison_B	WV Board or Control	Mill Creek, WV 7.5 quadrangle	47-083-00103	38.707	-79.969	13,121	11/1/1959 (Run 3, GR), 2/22/1960 (Run 2, L-GR-N)	ь,300-13,100
	A Commente	United Fuel Gas Co. 8800-1	Circleville District, Penaleton County, wv,	17 074 00000	00.540	70.540	40.000	ZINE MORE (Res 4 L C R N)	0.40.000
16	A_opunangie	INU. I Ray opunaugie	onowy with, wy 7.5 quadrangle	47-071-00006	38.548	-79.513	13,000	//15/1900 (Rull 1, L-G, R-N)	0-13,000

#### Scale, units, and depths for Gamma Ray logging runs:

eeule, um	to, and deptilo for Oanni	na ray logging rans.		
Well No.	Scale and Units	Depths of Selected Logged Intervals	Casing Shoe Location(s)	Notes
1	0-200 API units	About 74 feet below Kelly Busing (KB)		
	200-400 backup scale	to Total Depth (TD)		
2	0-200 API units	100 feet below KB to TD		
	200-400 backup scale			
3	0-200 API units	Ground level (GL) to TD		
4	0-200 API units	100 feet below KB to TD		
	200-400 backup scale			
5	0-10 (no units, probably	About 9 feet below KB to TD	1,245 feet below KB	
	in micrograms of Radium			
	equivalent per metric ton			
	(µgm Ra-eq/ton)			
	10-20 backup scale			
6	0-200 API units	About 12 feet below KB to TD	75 feet below KB	
	200-400 backup scale			
7	0-200 API units	100 feet below KB to TD	810 feet below KB	
	200-400 backup scale			
8	0-200 API units	100 feet below KB to TD	520 feet below KB	
	200-400 backup scale			
9	0-10 (µgm Ra-eq/ton?)	100 feet below KB to 4,790 feet	1,395 feet below KB	
	10-20 backup scale			
	0-8 (µgm Ra-eq/ton?)	4,790 feet to TD	4,790 feet below KB	
	8-16 backup scale			
10	0-200 API units	About 13 feet below KB to TD	116 feet below KB	
			2,006 feet below KB	
	200-400 backup scale		6,891 feet below KB	
11	0-10 µgm Ra-eq/ton	About 65 feet below KB to 12,330 feet		
		12,330 feet to TD		Spontaneous Potential log (milivolts) not shown
12				
	0-200 API units	logging run 2: 2,390 to 8,710 feet	4	
	200-400 backup scale	logging run 3: 8 730 to 12 810 feet		
	(no scale change noted		-	
	between logging runs)	logging run 4: 12,810 feet to TD		
13	0-150 API units 150-			
	300 backup scale	About 28 feet below KB to TD		
14	0-120 API units	About 27 feet below KB to 2,643 feet		
	0-250 API units	2,670 to 8,190 feet		
	0-200 API units	8,190 to 10,850 feet		
	0-250 API units	10,850 to 11,020 feet		
	0-150 API units	11,020 feet to TD		
15	0-15 (µgm Ra-eq/ton?)	About 14 feet below KB to 6,300 feet		
	0-16 (µgm Ra-eq/ton?)	6,300 feet to TD		
16	0-12.5 (µgm Ra-eq/ton?)	100 feet below KB to TD		

Well #         File Name         Well Name         Location         API No.           1         Haff_GRNeutron.las         East Ohio Gas Company No. 1-2171 Haff, V & I         TownsendTownship, Sandusky Co., OH         Clyde, OH 7.5 Quadrangle         34-143-20077           2         Wheeler GR.las         Pure Oil Company No. 1 Wheeler, I.M.         Willard, OH 7.5' Quadrangle         34-077-20025           3         Empire_Reeves.las         Empire Reeves Steel No. D-1 Empire Reeves Steel Division         MadisonTownship, Richland Co., OH         34-139-20448           4         Drake.las         Great Lakes Gas Corporation No. 1 Drake, Alonzo, Jr.         Woster, OH 7.5' Quadrangle         34-169-21419	Latitude 41.371 41.106 40.779 40.860	-82.907	TD (ft) 3,123 3,865	LAS Interval (ft) 0-3,200
TownsendTownship, Sandusky Co., OH           1 Haff_GRNeutron.las         East Ohio Gas Company No. 1-2171 Haff, V & I         Clyde, OH 7.5' Quadrangle         34-143-20077           2         Wheeler_GR.las         Pure Oil Company No. 1 Wheeler, I.M.         GreenfieldTownship, Richland Co., OH         34-077-20025           3         Empire_Reeves.las         Empire Reeves Steel No. D-1 Empire Reeves Steel Division         MadisonTownship, Richland Co., OH         34-139-20448           4         Drake.las         Great Lakes Gas Corporation No. 1 Drake, Alonzo, Jr.         Woster, OH 7.5' Quadrangle         34-169-21419	41.371 41.106 40.779 40.860	-82.907	3,123	0-3,200
1 Haff_GRNeutron.las         East Ohio Gas Company No. 1-2171 Haff, V & I         Clyde, OH 7.5' Quadrangle         34-143-20077           2         Wheeler_GR.las         Pure Oil Company No. 1 Wheeler, I.M.         Willard, OH 7.5' Quadrangle         34-077-20025           3         Empire_Reeves.las         Empire Reeves Steel No. D-1 Empire Reeves Steel Division         Mansfield North, OH 7.5' Quadrangle         34-139-20448           4         Drake.las         Great Lakes Gas Corporation No. 1 Drake, Alonzo, Jr.         Woster, OH 7.5' Quadrangle         34-169-21419	41.371 41.106 40.779 40.860	-82.907 -82.704	3,123	0-3,200
2         Wheeler GR.las         GreenfieldTownship, Huron Co., OH           2         Wheeler GR.las         Willard, OH 7.5' Quadrangle         34-077-20025           3         Empire_Reeves.las         Empire Reeves Steel No. D-1 Empire Reeves Steel Division         MadisonTownship, Richland Co., OH           4         Drake.las         Great Lakes Gas Corporation No. 1 Drake, Alonzo, Jr.         Woster, OH 7.5' Quadrangle         34-139-20448	41.106 40.779 40.860	-82.704	3,865	100.0.000
2         Wheeler_GR.las         Pure Oil Company No. 1 Wheeler, I.M.         Willard, OH 7.5 Quadrangle         34-077-20025           3         Empire_Reeves.las         Empire Reeves Steel No. D-1 Empire Reeves Steel Division         Marisfield North, OH 7.5' Quadrangle         34-139-20448           4         Drake.las         Great Lakes Gas Corporation No. 1 Drake, Alonzo, Jr.         Woster, OH 7.5' Quadrangle         34-169-21419	41.106 40.779 40.860	-82.704	3,865	100 0 000
3         Empire Reeves.las         Empire Reeves Steel No. D-1 Empire Reeves Steel Division         MadisonTownship, Richland Co., OH         Mansfield North, OH 7.5 Quadrangle         34-139-20448           4         Drake.las         Great Lakes Gas Corporation No. 1 Drake, Alonzo, Jr.         Woster, OH 7.5 Quadrangle         34-169-21419	40.779	-82.519		100-3,900
3 Empire_Reeves.las Empire Reeves Steel No. D-1 Empire Reeves Steel Division Mansfield North, OH 7.5' Quadrangle 34-139-20448 WayneTownship, Wayne Co., OH 4 Drake.las Great Lakes Gas Corporation No. 1 Drake, Alonzo, Jr. Wooster, OH 7.5' Quadrangle 34-169-21419	40.779	-82.519		
4 Drake.las Great Lakes Gas Corporation No. 1 Drake, Alonzo, Jr. Wayne Township, Wayne Co., OH 34-169-21419	40.860		5,085	0-5,100
4 Drake las Great Lakes Gas Corporation No. 1 Drake, Alonzo, Jr. Wooster, OH 7.5' Quadrangle 34-169-21419	40.860			
		-81.906	6,897	100-6,870
SaltcreekTownship, Holmes Co., OH				
5 Troyer first part.las Parker & Chapman No. 1 Dan E Troyer Fredericksburg, OH 7.5' Quadrangle 34-075-21283	40.657	-81.772	7,369	100-7,000
SaltcreekTownship, Holmes Co., OH		1		
5 No 1 Trover last 300 las Parker & Chapman No. 1 Dan E Trover Fredericksburg, OH 7.5' Quadrangle 34-075-21283	40.657	-81.772	7.369	7.000-7.350
RushTownship, Tuscarawas Co., OH				
6 HuebnerGR las Stocker & Sitler, Inc. No. 2 (1-2669) Huebner GRadenbutton, OH 7,5' Quadrangle 34-157-21030	40.304	-81.425	8.227	100-8.250
MoorefieldTownshin Harrison Co. OH	10.001	011120	0,227	100 0,200
ZZechman A las Red Hill Development No. 1 Zechman Thomas Piedmont OH 7.5 (Quadrangle 34-067-20737	40 195	-81 197	10 625	6 395-10 596
MoorefieldTownship Harrison Co. OH	10.100	0	10,020	0,000 10,000
ZZechman B las Red Hill Development No. 1 Zechman Thomas Piedmont OH 7.5 (Duadrangle 34-067-20737	40 195	-81 107	10 625	800-6 500
Tzechman_b.tas recommended to rzechman, monas recommended to organization of the organ	40.133	-01.137	10,023	000-0,000
Reinow, ALAS McCormick Sanford E.No. 1 Birroy, Poy	40.262	00.066	10 101	72 10 204
Bliney_ALAS Intervention and the Followy, rey Caut, of Follows Sanda and the Follows San	40.202	-60.900	10,101	72-10,204
Biggin Diagonal Conference Diagonal Conference Day     Control OLISE	40.000	00.000	10 101	0.000 40.050
8 Birney_blas Indecomick Saniord E No. 1 Birney, Roy Cadiz, OH 7.5 Quadrangie 34-067-20103	40.262	-60.966	10,101	8,900-10,050
Device Liberty District, Marshall Co., WV	00 700	00 500	10 510	50 40 500
9 Buney1.ias Santora E McCormick No. 1 John Buney Cameron, WV 7.5 Quadrangle 44-051-00539	39.762	-80.530	16,512	50-10,500
Liberty District, Marshall Co., WV				
9 Buney2.las Santora E McCormick No. 1 John Buney Cameron, WV 7.5 Quadrange 44-051-00539	39.762	-80.530	16,512	10,500-14,500
Liberty District, Marshall Co., WV				
9 Burley3.las Santord E McCormick No. 1 John Burley Cameron, WV 7.5 Quadrangle 47-051-00539	39.762	-80.530	16,512	14,500-16,500
Winfield District, Marion Co., WV				
10 Finch_A.las Phillips Petroleum Co. No. A-1 (A-1251) R.R. Finch Fairmont East, WV 7.5' Quadrangle 47-049-00244	39.432	-80.012	17,111	0-10,500
Winfield District, Marion Co., WV				
10 Finch_B.las Phillips Petroleum Co. No. A-1 (A-1251) R.R. Finch Fairmont East, WV 7.5' Quadrangle 47-049-00244	39.432	-80.012	17,111	10,000-12,100
Winfield District, Marion Co., WV				
10 Finch_C.las Phillips Petroleum Co. No. A-1 (A-1251) R.R. Finch Fairmont East, WV 7.5' Quadrangle 47-049-00244	39.432	-80.012	17,111	12,100-14,900
Winfield District, Marion Co., WV				
10 Finch_D.las Phillips Petroleum Co. No. A-1 (A-1251) R.R. Finch Fairmont East, WV 7.5' Quadrangle 47-049-00244	39.432	-80.012	17,111	14,800-16,000
Winfield District, Marion Co., WV				
10 Finch_E.las Phillips Petroleum Co. No. A-1 (A-1251) R.R. Finch Fairmont East, WV 7.5' Quadrangle 47-049-00244	39.432	-80.012	17,111	15,900-17,000
Winfield District, Marion Co., WV				
10 Finch_F.las Phillips Petroleum Co. No. A-1 (A-1251) R.R. Finch Fairmont East, WV 7.5' Quadrangle 47-049-00244	39.432	-80.012	17,111	16,900-17,100
Columbia Fuel Corp. No. USA Q-1, GW-1466 Monogahela National Union District, Preston Co., WV				
11 Q-1_A.las Forest Lead Mine, WV 7.5' Quadrangle 47-077-00119	39.238	-79.573	9,910	0-7,550
Columbia Fuel Corp. No. USA Q-1, GW-1466 Monogahela National Union District, Preston Co., WV				
11 Q-1 B.las Forest Lead Mine, WV 7.5' Quadrangle 47-077-00119	39.238	-79.573	9,910	7,700-10,000
Columbia Fuel Corp. No. USA Q-1, GW-1466 Monogahela National Union District, Preston Co., WV			1	
11 Q-1 GR D final las Forest Lead Mine, WV 7.5' Quadrangle 47-077-00119	39.238	-79.573	9.910	0-9.910
Shell Oil Co. (Consolidated Gas Supply Corp.) No. 1 Greenland Lodge. Union District, Grant Co., WV				
12 greenland GR las Inc. Greenland Gap. WV 7.5 Quadrangle 47-023-00002	39,195	-79.142	16.075	50-13.000
Moorefield District Hardy Co. WV				
13 Bean A las Exxon Corporation No. 1 Charles H. Bean, et al. Old Fields, WV 75 'Quadrande 47-031-00021	39,138	-78,990	16.075	100-5 300
Morefield District Hardy Co. WV	00.100		10,070	.00 0,000
13 Bean Blas Exxon Corroration No. 1 Charles H. Bean et al. Old Fields WV 7.5' Outgrangle 47-031-00021	39 138	-78 000	16 075	5 300-10 450
Morefield District Hardy Co. WV	00.100			0,000 10,400
13 Bean C las Exxon Corporation No. 1 Charles H. Bean, et al. Old Fields, WV 75 'Quadrande 47-031-00021	39 138	-78 990	16 075	10 450-16 050

Tab	ole 2. Log ASCII Standard	(LAS) files for geologic cross section D-D'	' through the Appalachian basin from Sandusky County, Ol	io, to Hardy	County, W	Vest Virgir	nia
			1				

Well No.	Scale and Units	Depths of Selected Logged Intervals	Casing Shoe Location(s)
1	0-12 micro Roentgens / hour (µR/hr)	10 feet below Kelly Bushing (KB) to Total depth (TD)	
2	0-200 API units 200-400 backup scale	100 feet below KB to TD	473 feet below KB
3	0-200 API units	About 7 feet below KB to TD	
4	0-200 API units 200-400 backup scale	100 feet below KB to TD	3,615 feet below KB
5	0-200 API units 200-400 backup scale	100 feet below KB to TD	1,220 feet below KB
6	0-200 API units 200-400 backup scale	100 feet below KB to TD	1,420 feet below KB
7	0-200 API units	828 feet below KB to TD	6,416 feet below KB
8	0-200 API units 200-400 backup scale	60 feet below KB to TD	1,590 feet below KB
9	0-250 API units 0-250 API units 0-250 API units Units not listed (probably 0-250 API units)	80 feet below KB to 3,870 feet 3,870 feet below KB to 10,505 feet 10,505 feet below KB to 14,475 feet 10,505 feet below KB to TD	100 feet below KB 3,903 feet below KB 10,505 feet below KB
10	0-150 API units 0-200 API units 0-150 API units 0-200 API units 0-150 API units	KB to 990 feet 990 feet below KB to 7,455 feet 7,455 feet below KB to 7,502 feet 7,502 feet below KB to 12,075 feet 12,075 feet below KB to TD	993 feet below KB
11	0-150 API units 150-300 backup scale 0-200 API units	KB to 7,710 feet 7,710 feet below KB to TD	1,215 feet below KB 4,925 feet below KB
12	0-200 API units 0-150 API units 0-200 API units	50 feet below KB to 480 feet 480 feet below KB to 10,021 feet 10,021 feet below KB to TD	336 feet below KB 5,255 feet below KB
13	0-200 API units Units not listed (probably 0-250 API units)	100 feet below KB to 1,490 feet 1,490 feet below KB to 5,920 feet	
	0-200 API units	5,920 feet below KB to TD	6,000 feet below KB

Scale, units, and depths for Gamma Ray logging runs. Abbreviations: API, American Petroleum Institute; KB, Kelly bushing; TD, total depth