Highland County Water Company Well Field No. 1
Seismic Investigation

Date: 6 November, 2008 **OGS File Number**: 341419000224

Survey Type: Compressional (P) and Shear (S) wave seismic refraction.
Survey Crew: Glenn Larsen, Greg Schumacher, and Chris Gordon.

Site Location: 1 mile west of Bainbridge on SR 50, and about ½ mile north of SR 50.
.
County: Ross **Township:** Paxton **USGS 7½' Quadrangle:** Bainbridge
Latitude: N 39° 13' 37.35" **Longitude:** W 83° 17' 25.5" **Reference Datum:** NAD83
Ohio State Plane, X: 2,027,907 ft. **Y:** 446,998 ft. **Zone:** South
Line Direction: N 73° E
Note: Coordinates were determined at location of geophone no. 1, line direction measured from geophone no.1.

Site Conditions: Sunny, dry, 61° to 67° F, 45 to 55% humidity, 3 mph southwest wind.

Purpose: The geology of the tri-county region of Highland, Ross, and Pike Counties is characterized by numerous buried valleys and buried bedrock gorges that have been backfilled with sediments transported by repeated advances of continental glaciers and the melt waters flowing from these glaciers. Thick sequences of water-bearing sand and gravel deposits are commonly found in these buried valleys and buried bedrock gorges. The Ohio Department of Natural Resources, Division of Geological Survey in cooperation the Highland County Water Company, Inc. conducted a seismic investigation of a buried gorge of Paint Creek, located 1 mile west of Bainbridge, to characterize the geometry of the gorge walls and floor, types of sediments filling the gorge.

Geologic Overview: The area of investigation lies within the Glaciated Allegheny Plateaus Section of the Appalachian Plateaus Physiographic Province (Brockman, 1998). The seismic survey was located 220 feet south of the well field on a Wisconsinan-age outwash terrace in Paint Valley, east of Paint Creek (Quinn and Goldthwait, 1985; Hamilton and Lucht, 2003), see figure 1. Boring records from three production wells show the outwash deposit is comprised of poorly sorted sand and gravel greater than 78 feet thick (boring records on open-file at the Ohio Department of Natural Resources, Division of Water). Bedrock was not encountered when the wells were drilled. Geologic mapping by Schumacher (1994) indicates the outwash sand and gravel deposit is underlain by Silurian-age dolomite, most likely the Peebles Dolomite. In the tri-county region of Highland, Ross, and Pike Counties, the Pebbles Dolomite is characterized by thick to massive bedding and forms vertical walled cliffs and gorges.

Seismic Refraction Survey: The seismic refraction survey was laid out along a straight, west to east, line 460 feet in length (figure 1). P- and S-wave refraction data were collected from a linear array of 24 geophones with distances of 20 feet between geophones. The data was collected from seven shot gathers located along the line, two of the shot gathers were acquired 50 feet off each end of the line. The other five gathers were taken along the line. The seismic data were stacked 5 times at each shot gather to increase the signal-to-noise ratio to overcome any background noise affecting the survey The digitally recorded data were stored in the SEG-2 format (Subcommittee of the SEG Engineering and Groundwater Geophysics Committee, 1990). Relative elevation for each geophone was determined using a stadia rod and a handlevel. The reference datum for the elevation data was set at the location of the first geophone. Location coordinates for the seismic survey were obtained with a Garmin eMap handheld GPS unit.

Seismic energy for the P-wave shot gathers were generated by a truck mounted 100-pound accelerated weight drop. The P-waves were detected by geophones that were sensitive to

vertical ground motion, and had a natural frequency of 4.5 Hz. Seismic energy for the S-wave shot gathers were generated by striking a 70-pound steel I-beam style plate sideways. The plate was struck with a 20-pound sledgehammer on one side (perpendicular to the line) to generate S-waves with one polarity. Then the source was struck on the opposite side (again, perpendicular to the line) to generate S-waves with a reversed polarity. The S-waves were detected by geophones sensitive to horizontal ground motion, and had a natural frequency of 28 Hz.

Results: Three distinct velocity layers in the subsurface were identified from the P- and S-wave travel time data (figures 2 and 3), and are interpreted as the soil horizon (weathered sand and gravel) underlain by sand and gravel overlying dolomite bedrock (figures 4 and 5). The P-wave velocity model (figure 4) identified three velocity layers. The upper 987 ft/s velocity layer is interpreted to represent 2 to 9 feet of soil and weathered sand and gravel. The middle 2,373 ft/s layer represents 15 to 50 feet of unweathered and unsaturated sand and gravel. The lower 16,411 ft/s layer represents dolomite bedrock. The S-wave velocity model (figure 5) identified two velocity layers. The upper 9,407 ft/s layer is interpreted to represent 24 to 54 feet of unsaturated sand and gravel, including the soil and weathered sand and gravel. The lower 7,808 ft/s layer represents dolomite bedrock.

As mentioned earlier, the well field was about 200 feet north the seismic line. Boring records from these wells showed the depth to bedrock there is greater than 78 feet. Depth to bedrock estimates derived from the P- and S-wave data have bedrock 23 to 27 feet deep on the east side of the line and 52 to 53 feet deep on the west side of the line. The rapid change in the depth to bedrock from the well field to the east side of the line suggests that the edge of the buried gorge is located somewhere between the well field and the seismic refraction survey.

References

Brockman, C.S., 1998, Physiographic regions of Ohio: Ohio Department of Natural Resources, Division of Geological Survey, page-size map.

Hamilton, S.J. and Lucht, T.E., 2003, Soil survey of Ross County, Ohio: U. S. Department of Agriculture, Soil Conservation Service, 722 p.

Quinn M.J. and Goldthwait, R.P., 1985, Glacial geology of Ross County, Ohio: Ohio Department of Natural Resources, Division of Geological Survey, Report of Investigations No. 127, 42 p.

Schumacher, G.A., 1994, Preliminary bedrock-geology of the Bainbridge, Ohio, quadrangle: Ohio Department of Natural Resources, Division of Geological Survey, Open-file Map BG-B4B3, Scale 1:24,000.

Subcommittee of the SEG Engineering and Groundwater Geophysics Committee, Pullan, S.E., Chairman, 1990, Recommended standard for seismic (/radar) files in the personal computer environment: Geophysics, vol. 55, no. 9, p. 1260-1271.

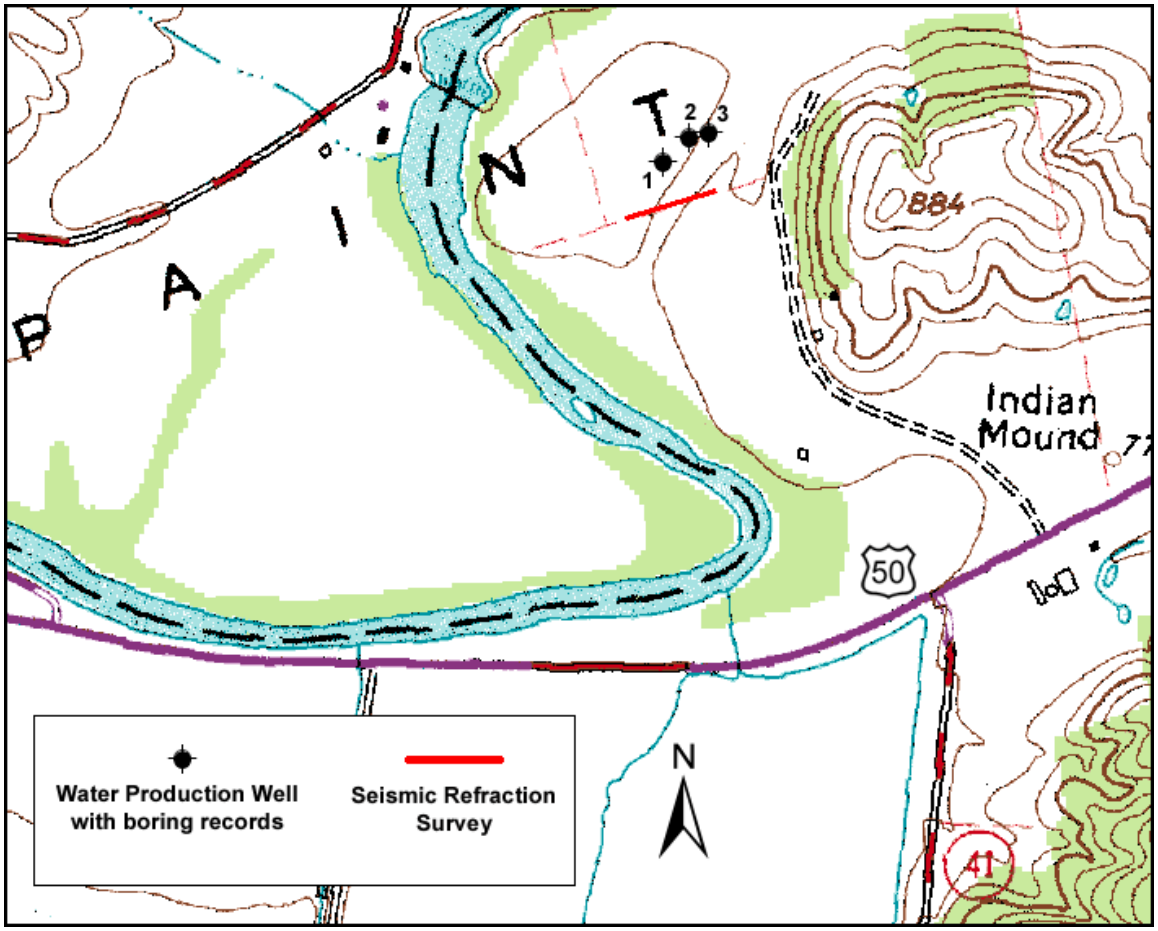


Figure 1. Location of Highland County Water Company's Well Field 1 and seismic refraction survey 341739000124 west of Bainbridge, Ohio.

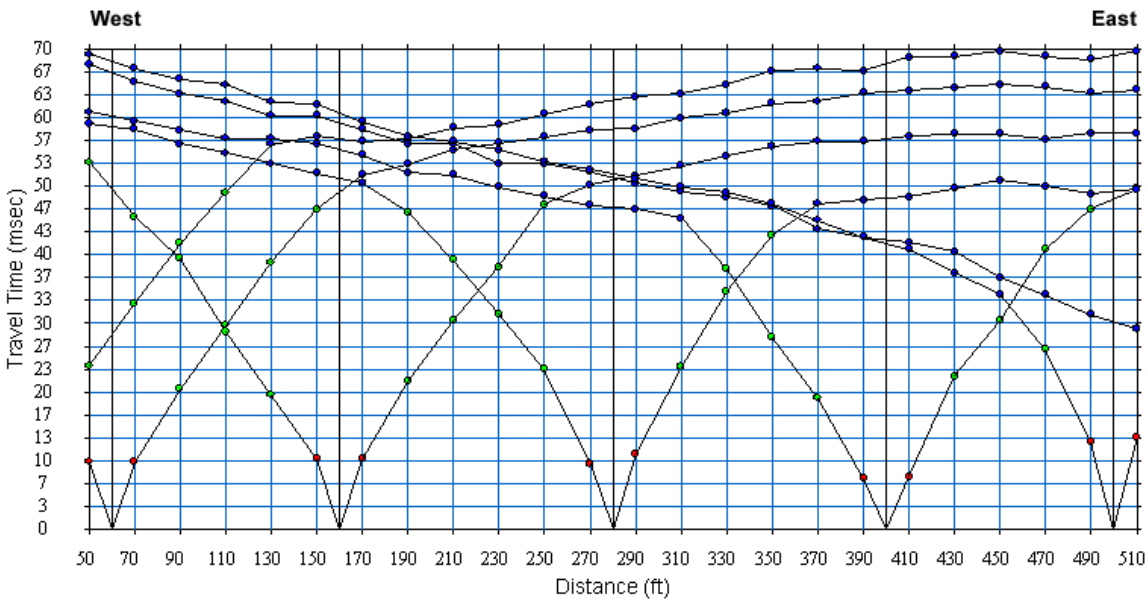


Figure 2. Travel time versus distance plot from the seven shot gathers of the P-wave survey.

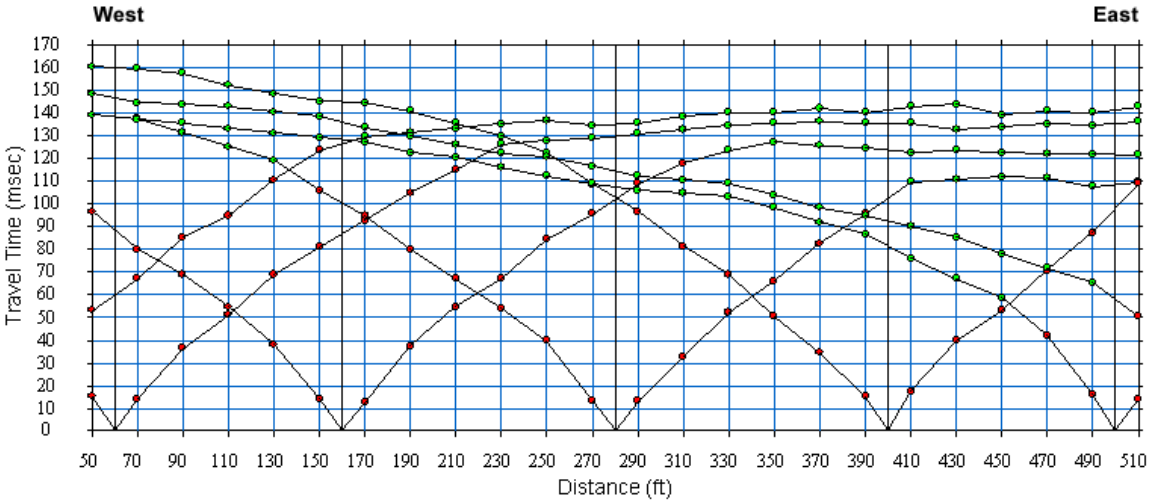


Figure 3. Travel time versus distance plot from the seven shot gathers of the S-wave survey.

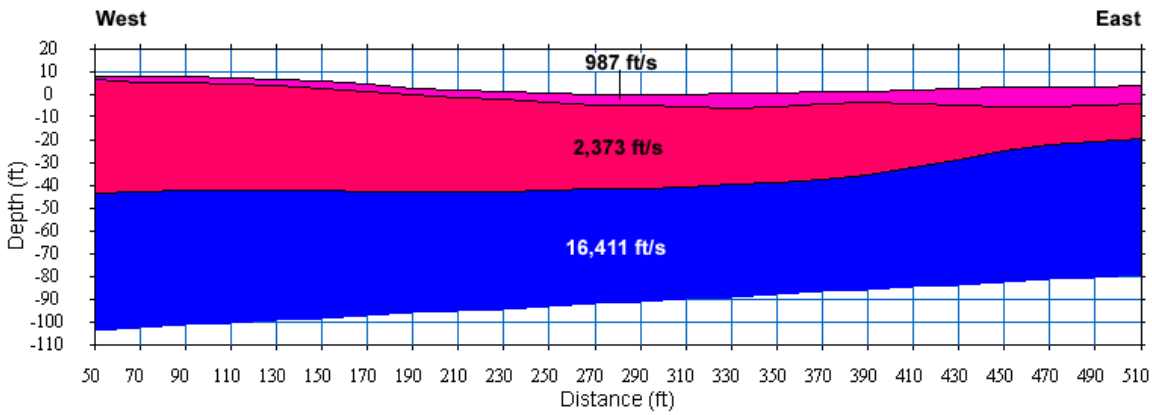


Figure 4. P-wave velocity model of the subsurface showing three distinct velocity layers. The upper most 987 ft/s layer represents the soil and weathered sand and gravel, the middle 2,373 ft/s layer represents unsaturated sand and gravel, the lower 16,411 ft/s layer represents dolomite bedrock.

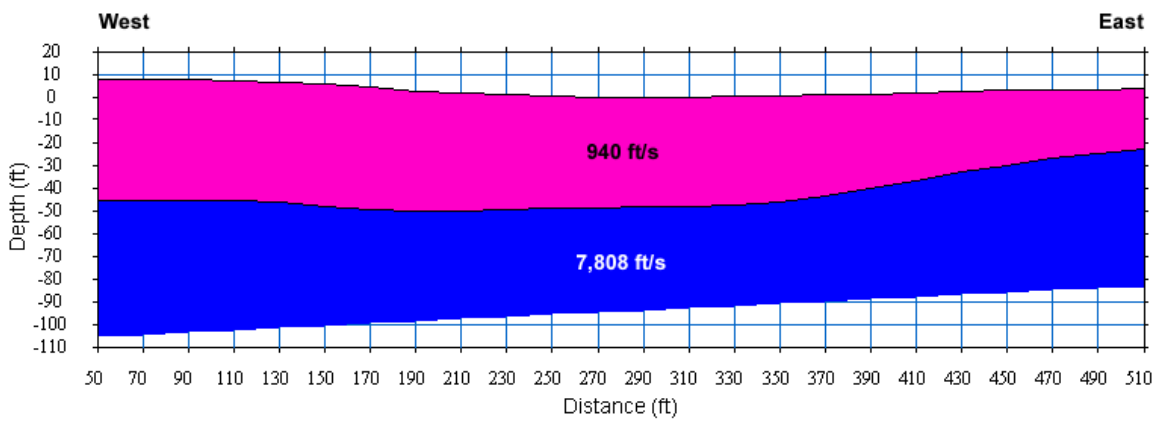


Figure 5. S-wave velocity model of the subsurface showing two distinct velocity layers. The upper most 9407 ft/s layer unsaturated sand and gravel and the lower 7,808 ft/s layer represents dolomite bedrock.

Elevation Data of Geophones

Line No: 341419000224 **Date:** 6 November, 2008

Location: Highland County Water Company Well Field No. 1, 1 mi. west of Bainbridge.

Inst. Height: 5.00 ft. **Lowest Δ H:** -8.10 **Ref. Elev:** 739 Topo. Estimate

Station	Rod Height (R.H.)			Δ R.H.	Δ H	Δ Elev.	Comments
	Feet	Inches	Dec. Ft.				
1	5.0		5.00	0.00	0.00	8.1	
2	5.2		5.20	-0.20	-0.20	7.9	
3	5.2		5.20	-0.20	-0.40	7.7	
4	5.4		5.40	-0.40	-0.80	7.3	
5	5.7		5.70	-0.70	-1.50	6.6	
6	6.0		6.00	-1.00	-2.50	5.6	
7	6.3		6.30	-1.30	-3.80	4.3	
8	6.4		6.40	-1.40	-5.20	2.9	
9	6.1		6.10	-1.10	-6.30	1.8	
10	5.6		5.60	-0.60	-6.90	1.2	
11	5.6		5.60	-0.60	-7.50	0.6	
12	5.5		5.50	-0.50	-8.00	0.1	
13	5.1		5.10	-0.10	-8.10	0.0	
14	4.9		4.90	0.10	-8.00	0.1	
15	4.8		4.80	0.20	-7.80	0.3	
16	4.5		4.50	0.50	-7.30	0.8	
17	4.6		4.60	0.40	-6.90	1.2	
18	4.5		4.50	0.50	-6.40	1.7	
19	4.5		4.50	0.50	-5.90	2.2	
20	4.4		4.40	0.60	-5.30	2.8	
21	4.5		4.50	0.50	-4.80	3.3	
22	4.8		4.80	0.20	-4.60	3.5	
23	4.9		4.90	0.10	-4.50	3.6	
24	4.8		4.80	0.20	-4.30	3.8	

Vertical measurements in U.S. Survey Feet

Δ R.H. = Inst. Height - Rod Height (R.H.)

Δ H is the difference in height relative to the starting point of the survey.

Δ Elev. is the difference in elevation relative to the lowest geophone height (Lowest ΔH). This value is used because the modeling software requires positive elevation values.

1, 2, 3,... = geophone no.

Geophone Location Data

Group Interval: 20 ft. P-wave

First Geophone No: 1 **X-Loc:** 50.0

Geophone Number	X-Location	Δ Elev.	Elevation
1	50.0	8.1	747.1
2	70.0	7.9	746.9
3	90.0	7.7	746.7
4	110.0	7.3	746.3
5	130.0	6.6	745.6
6	150.0	5.6	744.6
7	170.0	4.3	743.3
8	190.0	2.9	741.9
9	210.0	1.8	740.8
10	230.0	1.2	740.2
11	250.0	0.6	739.6
12	270.0	0.1	739.1
13	290.0	0.0	739.0
14	310.0	0.1	739.1
15	330.0	0.3	739.3
16	350.0	0.8	739.8
17	370.0	1.2	740.2
18	390.0	1.7	740.7
19	410.0	2.2	741.2
20	430.0	2.8	741.8
21	450.0	3.3	742.3
22	470.0	3.5	742.5
23	490.0	3.6	742.6
24	510.0	3.8	742.8

Group Interval: 20 ft. S-wave

First Geophone No: 1 **X-Loc:** 50.0

Geophone Number	X-Location	Δ Elev.	Elevation
1	50.0	8.1	747.1
2	70.0	7.9	746.9
3	90.0	7.7	746.7
4	110.0	7.3	746.3
5	130.0	6.6	745.6
6	150.0	5.6	744.6
7	170.0	4.3	743.3
8	190.0	2.9	741.9
9	210.0	1.8	740.8
10	230.0	1.2	740.2
11	250.0	0.6	739.6
12	270.0	0.1	739.1
13	290.0	0.0	739.0
14	310.0	0.1	739.1
15	330.0	0.3	739.3
16	350.0	0.8	739.8
17	370.0	1.2	740.2
18	390.0	1.7	740.7
19	410.0	2.2	741.2
20	430.0	2.8	741.8
21	450.0	3.3	742.3
22	470.0	3.5	742.5
23	490.0	3.6	742.6
24	510.0	3.8	742.8

Horizontal and vertical measurements in U.S. Survey Feet

Δ Elev. is the difference in elevation relative to the lowest geophone or shot point elevation.

Data Acquisition Parameters

Survey Type	P-Wave	S-wave
Recording System	Geometrics Geode	Geometrics Geode
Survey purpose	2-D V_p Profiling	2-D V_s Profiling
Data Format	SEG-2	SEG-2
Acquisition	24 channel	24 channel
Source	P-S 100 AWD	20 lb sledgehammer
Geophones	4.5 Hz Vertical	28 Hz Horizontal
Geophone Array	Linear	Linear
Line length	460 ft	460 ft.
Geophone spacing	20 ft.	20 ft.
Source Offset	2-50 ft. offend plus 5 inline	2-50 ft. offend plus 5 inline
Sampling Interval	0.250 msec	0.500 msec
Record Length	0.130 sec	0.300 sec
Preamp Gains	All geophones 36dB	All geophones 36 dB
Filters	None	None

P-wave Velocity Model Data

Geophone Location and Elevation Data			Velocity Layer Depth (Top)[1]		Velocity Layer Depth (Top)[2]		Velocity Layer Thickness	
Geo.	X-Loc.	Δ Elev.	2	3	2	3	1	2
1	50.0	8.1	6.24	-43.73	-1.9	-51.8	1.9	50.0
2	70.0	7.9	5.49	-42.84	-2.4	-50.7	2.4	48.3
3	90.0	7.7	5.02	-42.42	-2.7	-50.1	2.7	47.4
4	110.0	7.3	4.75	-42.33	-2.6	-49.6	2.6	47.1
5	130.0	6.6	4.01	-42.33	-2.6	-48.9	2.6	46.3
6	150.0	5.6	2.62	-42.39	-3.0	-48.0	3.0	45.0
7	170.0	4.3	1.27	-42.56	-3.0	-46.9	3.0	43.8
8	190.0	2.9	0.02	-42.78	-2.9	-45.7	2.9	42.8
9	210.0	1.8	-1.29	-42.86	-3.1	-44.7	3.1	41.6
10	230.0	1.2	-2.38	-42.70	-3.6	-43.9	3.6	40.3
11	250.0	0.6	-3.64	-42.36	-4.2	-43.0	4.2	38.7
12	270.0	0.1	-4.81	-41.90	-4.9	-42.0	4.9	37.1
13	290.0	0.0	-5.16	-41.26	-5.2	-41.3	5.2	36.1
14	310.0	0.1	-5.67	-40.48	-5.8	-40.6	5.8	34.8
15	330.0	0.3	-6.25	-39.71	-6.6	-40.0	6.6	33.5
16	350.0	0.8	-5.74	-38.94	-6.5	-39.7	6.5	33.2
17	370.0	1.2	-4.42	-37.72	-5.6	-38.9	5.6	33.3
18	390.0	1.7	-3.32	-35.54	-5.0	-37.2	5.0	32.2
19	410.0	2.2	-3.86	-32.31	-6.1	-34.5	6.1	28.4
20	430.0	2.8	-5.01	-28.53	-7.8	-31.3	7.8	23.5
21	450.0	3.3	-5.83	-25.05	-9.1	-28.3	9.1	19.2
22	470.0	3.5	-5.84	-22.48	-9.3	-26.0	9.3	16.6
23	490.0	3.6	-4.89	-20.82	-8.5	-24.4	8.5	15.9
24	510.0	3.8	-3.93	-19.52	-7.7	-23.3	7.7	15.6

[1] Datum 0.00 feet [2] Below surface (geophone elevation)
Horizontal and vertical measurements in U.S. Survey Feet.
Δ Elev. is the difference in elevation relative to the lowest geophone or shot point elevation.

S-wave Velocity Model Data

Geophone Location and Elevation Data			Velocity Layer Depth (Top)[1]		Velocity Layer Depth (Top)[2]		Velocity Layer Thickness	
Geo.	X-Loc.	Δ Elev.	2	3	2	3	1	2
1	50.0	8.1	-45.22		-53.3		53.3	
2	70.0	7.9	-45.59		-53.5		53.5	
3	90.0	7.7	-45.60		-53.3		53.3	
4	110.0	7.3	-45.34		-52.6		52.6	
5	130.0	6.6	-46.11		-52.7		52.7	
6	150.0	5.6	-47.93		-53.5		53.5	
7	170.0	4.3	-49.25		-53.6		53.6	
8	190.0	2.9	-49.84		-52.7		52.7	
9	210.0	1.8	-49.85		-51.7		51.7	
10	230.0	1.2	-49.41		-50.6		50.6	
11	250.0	0.6	-48.99		-49.6		49.6	
12	270.0	0.1	-48.55		-48.6		48.6	
13	290.0	0.0	-48.20		-48.2		48.2	
14	310.0	0.1	-48.08		-48.2		48.2	
15	330.0	0.3	-47.49		-47.8		47.8	
16	350.0	0.8	-45.88		-46.7		46.7	
17	370.0	1.2	-43.34		-44.5		44.5	
18	390.0	1.7	-40.23		-41.9		41.9	
19	410.0	2.2	-36.81		-39.0		39.0	
20	430.0	2.8	-33.10		-35.9		35.9	
21	450.0	3.3	-29.89		-33.2		33.2	
22	470.0	3.5	-27.16		-30.7		30.7	
23	490.0	3.6	-24.84		-28.4		28.4	
24	510.0	3.8	-23.17		-27.0		27.0	

[1] Datum 0.00 feet [2] Below surface (geophone elevation)
Horizontal and vertical measurements in U.S. Survey Feet.
Δ Elev. is the difference in elevation relative to the lowest geophone.

Difference Between Vp and Vs Refraction Depth to Bedrock Models

Geophone Number	X-Dist. (ft)	Vp Model Bedrock Depth (ft)	Vs Model Bedrock Depth (ft)	Difference Between Models (ft)
1	50	51.8	53.3	1.47
2	70	50.7	53.5	2.76
3	90	50.1	53.3	3.18
4	110	49.6	52.6	2.97
5	130	48.9	52.6	3.67
6	150	48.0	53.5	5.51
7	170	46.9	53.6	6.74
8	190	45.7	52.7	7.02
9	210	44.7	51.7	7.04
10	230	43.9	50.6	6.70
11	250	43.0	49.6	6.64
12	270	42.0	48.6	6.60
13	290	41.3	48.2	6.94
14	310	40.6	48.2	7.62
15	330	40.0	47.8	7.79
16	350	39.7	46.7	6.96
17	370	38.9	44.5	5.58
18	390	37.2	41.9	4.66
19	410	34.5	39.0	4.49
20	430	31.3	35.9	4.57
21	450	28.3	33.2	4.85
22	470	26.0	30.7	4.72
23	490	24.4	28.4	3.98
24	510	23.3	27.0	3.68

Average Diff. (ft)	5.26
Standard Dev. (± ft)	1.75
Minimum Diff. (ft)	1.47
Maximum Diff. (ft)	7.79

In-Situ Elastic and Seismic Properties of the Subsurface
Calculated from Vp and Vs Data at Midpoint (280 feet)

Seismic Refraction P-wave and S-wave Velocity Model Data							
Velocity Layer	Strata Type	P-wave Velocity		S-wave Velocity		Ave. Thickness	
		V_p (ft/s)	V_p (m/s)	V_s (ft/s)	V_s (m/s)	(ft)	(m)
1	S & G	2,373	723	940	287	45.0	13.7
2	Bedrock	16,411	5,002	7,808	2,380	55.0	16.8

Derived In-Situ Elastic Properties							
Velocity Layer	Vp/Vs	Density ρ (g/cm³)	σ	*G* (GPa)	*K* (GPa)	*E* (GPa)	λ (GPa)
1	2.52	1.61	0.41	0.13	0.66	0.37	0.58
2	2.10	2.60	0.35	14.74	45.48	39.92	35.65

Derived Seismic Properties From S-wave Model Data							
Period of Soil T_s (s)	Freq. (Hz)	Wave length		V_{s100} (ft/s)	V_{s30} (m/s)	NEHRP Site Class	Amp. Rating
		(ft)	(m)				
0.19	5.22	400.0	121.9	1,821	555	C	Low

To convert GPa to tsf multiply by 10440

Vs_{100} from S-wave Refraction Data

Geophone Number	X-Dist. (ft)	Vs_{100} (ft/s)	Vs_{30} (m/s)	NEHRP Site Class.
1	50	1,595	486	C
2	70	1,591	485	C
3	90	1,595	486	C
4	110	1,612	491	C
5	130	1,610	491	C
6	150	1,591	485	C
7	170	1,588	484	C
8	190	1,610	491	C
9	210	1,634	498	C
10	230	1,662	507	C
11	250	1,689	515	C
12	270	1,716	523	C
13	290	1,727	526	C
14	310	1,727	526	C
15	330	1,738	530	C
16	350	1,770	539	C
17	370	1,837	560	C
18	390	1,923	586	C
19	410	2,028	618	C
20	430	2,155	657	C
21	450	2,279	695	C
22	470	2,408	734	C
23	490	2,539	774	B
24	510	2,627	801	B

Average Vs_{100} (ft/s) 1,844
Standard Dev. (± ft/s) 322
Min. Vs_{100} (ft/s) 1,588
Max. Vs_{100} (ft/s) 2,627

Definitions of Elastic Properties of Soil and Rock

Constants	Expression	Units	Comments
Bulk Density	$\rho = \alpha V_p^{0.25}$	g/cm^3	where α=0.23 if V_p is in ft/s, α=0.31 if V_p is in m/s
Poisson's Ratio	$\sigma = \frac{(V_p/V_s)^2 - 2}{2(V_p/V_s)^2 - 2}$		Measures the compressibility of material perpendicular to applied stress, or the ratio of latitudinal to longitudinal strain. Poisson's ratio is a dimensionless number ranging from 0.0 to 0.5. Compressible materials (e.g. Cork) will have a ratio of 0 and incompressible materials (e.g. rubber) will have a ratio of 5.
Shear Modulus	$G = V_s^2\rho$	Pascals (Pa)	Rigidity modulus, 2nd Lamé constant, used for estimation of settlement from static loads. Density (ρ) is in kg/m^3 and V_s is in m/s.
Bulk Modulus	$K = \rho(V_p^2 - 4/3V_s^2)$	Pascals (Pa)	Incompressibility modulus, used to determine how much a material will compress under a given amount of external pressure. Density (ρ) is in kg/m^3, V_s and V_p are in m/s.
Young's Modulus	$E = 2G(1+\sigma)$	Pascals (Pa)	Elasticity modulus, used to measure a materials resistance to elastic deformation.
1st Lamé Constant	$\lambda = K - 2G/3$	Pascals (Pa)	The Lamé constants are material properties that are related to the elastic modulus and Poisson ratio. The second Lamé constant is identical to the shear modulus (G).

The elastic properties, Poisson's ratio, shear modulus, bulk modulus, Young's modulus, and Lamé modulus, defines the properties of soil and rock that undergoes stress, deforms, and then recovers and returns to its original shape after the stress ceases.

Gardner, G.H.F., Gardner, L.W., and Gregory, A.R., 1974, Formation velocity and density—the diagnostic basics for stratigraphic traps: Geophysics, v. 39, p. 770–780.

Grant, F.S., and West, G.F., 1965, Interpretation theory in applied geophysics: McGraw-Hill, 582 p.

Sheriff, R.E., 1991, Encyclopedic dictionary of exploration geophysics, Third Edition: Society of Exploration Geophysicists, 384 p.

U.S. Army Corp. of Engineers, 1995, Geophysical exploration for engineering and environmental investigation: Engineer Manual 1110-1-1802.

NEHRP Soil Hazard Classification

Soil Class	Soil Description	Shear-wave Velocity (ft/s)	Shear-wave Velocity (m/s)	Susceptibility to Amplification Rating
A	Hard rock	> 5,000	> 1,500	Nil
B	Firm to hard rock	2500 - 5,000	760 - 1,500	Very low
C	Dense soil and soft rock	1200 - 2,500	360 - 760	Low
D	Stiff soil	600 - 1,200	180 - 360	Moderate
E	Soft soil	< 600	< 180	High
F	Peat or highly organic clay	Special soils requiring site specific evaluation		Very high

The 1997 National Earthquake Hazards Reduction Program (NEHRP) soil-classification to determine the potential for shallow soils to amplify ground motion is based on an averaged shear-wave velocity to a depth of 100 feet (V_{s100}), or 30 meters (V_{s30}). This classification is then used to calculate the amplification factors for use in engineering design.

According to NEHERP guidelines the averaged shear-wave velocity can be calculated by:

$$V_{s100} = \frac{100\ \text{ft}}{\sum(d_i / V_{si})}$$

where d_i = depth of layer i, and V_{si} = s-wave velocity of layer i.

$$V_{s30} = \frac{30\ \text{m}}{\sum(d_i / V_{si})}$$

Building Seismic Safety Council, 1998, NEHRP recommended provisions for seismic regulations for new buildings and other structures, 1997 edition, Part 1: Provisions: Federal Emergency Management Agency Publication FEMA 302 / February 1998, 337 p.

Klohn-Crippen Consultants Ltd., 1994, Preliminary seismic microzonation assessment for British Columbia: Prepared for Resources Inventory Committee, Earth Sciences Task Force, 109 pages.

Monahan, P.A., Levson, V.M., Henderson, P., and Sy, A., 2000, Relative Amplification of Ground Motion Hazard Map of Greater Victoria: British Columbia Geological Survey, Ministry of Energy and Mines, Geoscience Map 2000-3a and 3b, Report and Expanded Legend, 25 p.

County Permit No. _____

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

ORIGINAL

579893
Well No. 1

COUNTY Ross TOWNSHIP Paxton SECTION OF TOWNSHIP _____

OWNER Highland County Water Co. ADDRESS _____

LOCATION OF PROPERTY 1/4 mile W of Bainbridge, 1/4 mile N of Route 50

CONSTRUCTION DETAILS

Casing diameter 16" Length of casing 56'

Type of screen Wirewound S.S. Length of screen 20'

Type of pump _____

Capacity of pump 800 GPM

Depth of pump setting 56'

Date of completion 4/1/94

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 1200 gpm Duration of test 24 hrs

Drawdown 10' ft Date 11/30/93

Static level (depth to water) 34'6" ft

Quality (clear, cloudy, taste, odor) _____

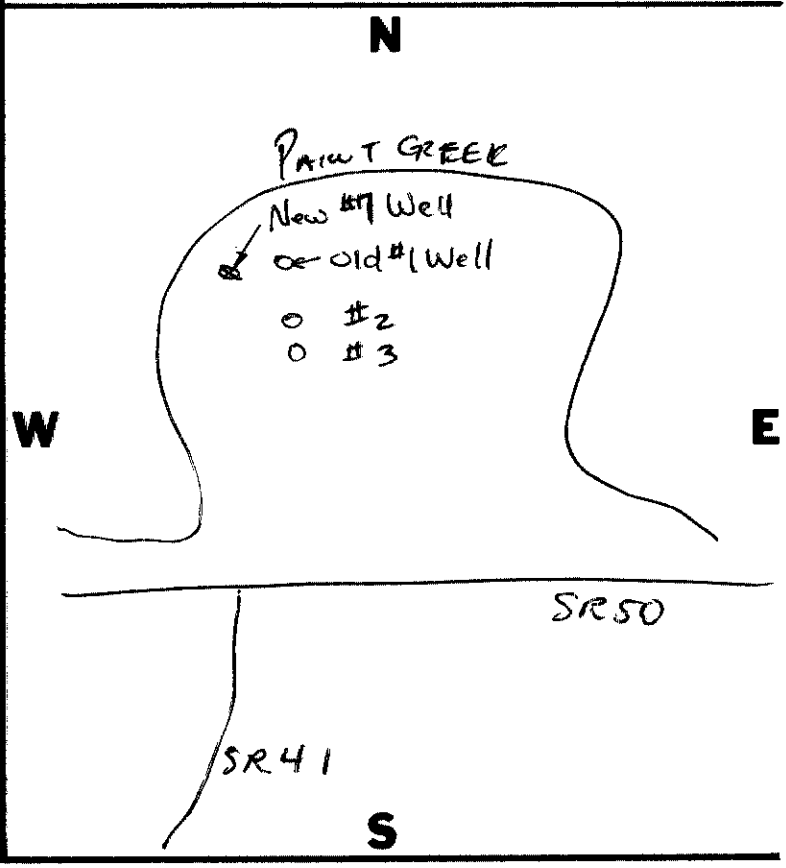
Pump installed by G.M. Baker & Son Co.

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Clay & Sand	0 ft	5 ft
Clay, Sand & Gravel w/ boulders	5	20
Sand & gravel w/ boulders	20	78
Well grouted by tremie method w/ cement grout from 40' to ground level		

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM G.M. Baker & Son Co DATE 3/11/94

ADDRESS 335 Hosack Columbus OH 5024 SIGNED John Wagner

*If additional space is needed to complete well log, use next consecutive numbered form.

WELL LOG AND DRILLING REPORT

ORIGINAL

NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 815 Phone (614) 469-2646
Columbus, Ohio 43215

No. 389516
Well No. 2

County ~~Highland~~ Ross Township Paxton Section of Township

Owner Highland County Water Co Address

Location of property 1/4 mile west of Bainbridge 1/4 mile north of Route 50

CONSTRUCTION DETAILS

Casing diameter 16" Length of casing ~~59~~ 63

Type of screen Johnson Length of screen 13

Type of pump P.W. Turbine

Capacity of pump 650 G.P.M.

Depth of pump setting 50'

Date of completion

BAILING OR PUMPING TEST
(Specify one by circling)

Test Rate 1080 G.P.M. Duration of test 48 hrs.

Drawdown 25' ft. Date Nov. 1970

Static level-depth to water 23 ft.

Quality (clear, cloudy, taste, odor) Clear

Pump installed by

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
Clay & Sand	0 Feet	4 Ft.
Clay, sand & gravel	4	23
Sand, gravel & silt	23	40
Coarse Sand & gravel	40	76

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.

N.

W. E.

S.

740
76+
664

Drilling Firm G. M. Baker & Son Date 11-25-70

Address Columbus Ohio Signed W. H. Boger

*If additional space is needed to complete well log, use next consecutive numbered form.

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WELL LOG AND DRILLING REPORT

ORIGINAL

NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 815 Phone (614) 469-2646
Columbus, Ohio 43215

No. 389517
Well No. 3

County ~~Highland~~ Ross Township Paxton Section of Township

Owner Highland County Water Co Address

Location of property ¼ mile west of Bainbridge ¼ mile North of Route 50

CONSTRUCTION DETAILS

Casing diameter 16 Length of casing 51
Type of screen Cook Length of screen 13
Type of pump D.W. Turbine
Capacity of pump 650 G.P.M.
Depth of pump setting 50
Date of completion

BAILING OR PUMPING TEST
(Specify one by circling)

Test Rate 1080 G.P.M. Duration of test 48 hrs.
Drawdown 9 ft. Date Nov. 1970
Static level-depth to water 23 ft.
Quality (clear, cloudy, taste, odor) Clear
Pump installed by

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
Clay & Sand	0 Feet	4 Ft.
Clay, Sand & gravel	4	20
Sand & gravel	20	40
Sand, gravel & Clay	40	48
Sand & gravel	48	70

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.

N.
W. E.
S.

Drilling Firm B. M. Baker Son
Address Columbus, Ohio

Date 11/25/70
Signed W. H. Boger

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*If additional space is needed to complete well log, use next consecutive numbered form.

Ohio Department of Natural Resources
Division of Geological Survey

Seismic Investigations

Explanation of Contents

The reports, analyses, documents, and data in this document were compiled as part of seismic investigations done in the state of Ohio by the Ohio Department of Natural Resources (ODNR), Division of Geological Survey. The seismic investigations measured compressional-wave (P-wave) and shear-wave (S-wave) velocities and surface wave phase velocities to produce depth models characterizing the subsurface geology of the buried bedrock surface and the overlying sediments. The data collected were also used to determine the in situ elastic and seismic properties of soils and bedrock.

The file numbering scheme used for these investigations follow an API code format:

File 341419000724

34 = API state code (Ohio in this example)
141 = API county code (Ross County in this example)
9 = blank
0007 = code for survey number (survey no. 7 in this example)
24 = code for refraction and MASW surveys

History

The seismic equipment was purchased in 2001 by the ODNR Division of Geological Survey, Geologic Mapping Group with grant monies from Central Great Lakes Geologic Mapping Coalition (CGLGMC). This equipment provides a rapid and inexpensive means of determining the depth to bedrock and characterizing the stratigraphy of surficial materials in geologically complex areas. The equipment is portable, can be used in a wide range of situations, requires no dedicated vehicle, and can be used with minimal personnel and travel expense. The ODNR Division of Geological Survey started using the seismic system July 2002

Data Set Credit

The seismic data was acquired for the Statewide Surficial Mapping Project, funded by STATEMAP Geologic Mapping Program, Central Great Lakes Geologic Mapping Coalition (CGLGMC), and Ohio Seismic Network (OhioSeis).

Use Constraints

This product of the ODNR Division of Geological Survey is intended to provide general geologic information only and should not be used for any other purpose. It is not intended for resale or to replace site-specific investigations. These data were compiled by the ODNR Division of Geological Survey, which reserves the publication rights to this material. If these data are used in the compilation of other data sets or maps for distribution or publication, this source must be referenced.

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