EMERGENCY SINKHOLE INVESTIGATION
WORK ORDER # 1

1400 BLOCK OF SOUTH 14TH STREET
HARRISBURG, PA

Prepared for:

City of Harrisburg

Prepared By:

Gannett Fleming

August 2014

Project Number: 59166

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1400 BLOCK OF SOUTH 14TH STREET

HARRISBURG, PENNSYLVANIA

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Gannett Fleming

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INTRODUCTION

This report presents the results of an office investigation of published geologic reports and historical records, coupled with field observations, a multi-channel analysis of surface waves (MASW) survey, and verification drilling for the 1400 block of South 14th Street between Magnolia Street and Cloverly Terrace. The location of the study area is shown on the Site Plan, Figure 1. The location of water, sanitary and stormwater pipes within the study area, as provided by the City are shown on Figure 3.

GEOLOGIC SETTING

South 14th Street is underlain by carbonate rocks of the Ordovician age St. Paul Group. The St. Paul Group is predominantly a thick-bedded, very fine-grained, high-calcium, light gray, limestone. Other lithologies occurring in this group are medium-gray granular limestones; limestones with black chert nodules; dolomite interbeds; and skeletal-detrital limestone. Thickness of the group is estimated to be about 1,000 feet in Dauphin County.

The St. Paul Group has undergone intensive folding and faulting which has created extensive fracturing of the rock. Most joints have a blocky pattern, are open, and are steeply dipping to vertical. The extensive jointing exposes a greater surface area of the carbonate rocks to groundwater movement, which can increase the potential for development of solution channels and sinkholes within the rocks. Pinnacle development at the bedrock/overburden interface is common in the St. Paul Group. A thrust fault is mapped crossing South 14th Street northwest of Magnolia Street. The exact location and angle of the fault is not known and could potentially be located further south in the area of the current sinkhole development. Fault zones are areas of intensely fractured rocks and often rapid groundwater movement, further increasing the possible development of sinkholes. The mapped fault location is beyond the limit of the site plans shown in Figures 1 and 3 and the entire areas covered by the site plans are within the St. Paul Group.

The bedrock is overlain by unconsolidated terrace deposits composed of gravely silts derived from glacial outwash. Thickness of these deposits is variable. A deposit of fill is mapped near the south end of South 14th Street. The fill deposits may be composed of soil not deposited naturally, quarry spoil, sanitary and structural landfill, or slag. The exact boundaries and thickness of the fill are not known and may extend into the project area.

Aerial photography from 1937, 1956, and 1958 show the area of South 14th Street to be undeveloped and in agricultural use. No karst related features or fracture traces were observed on the photographs, possibly due to urban development surrounding the project area. The photographs show that the areas to the west, north and east of South 14th Street were developed between 1937 and 1956. Property tax data for South 14th Street indicates that homes on the 1400 block were constructed in 1960. The 1958 photograph shows possible earthwork activity in the vicinity of the mapped fill discussed above.

SITE HISTORY AND OBSERVATIONS

Site features described below are shown on Figure 1, Site Plan. The limits of areas affected by previous sinkhole events are not known with accuracy, but are shown based on conversations with residents, newspaper reports and site observations of apparent repairs.

In March of 2014 a series of sinkholes opened-up concurrent with a water main break in the vicinity of the area between house numbers 1420 and 1422 on the south and 1421 and 1423 on the north. As a result of the sinkholes, nine residential properties were deemed structurally unsafe by the Harrisburg City Code Enforcement Officers. The locations of these properties are shown on Figure 1.

In 2007 a sinkhole occurred in the vicinity of the area between house numbers 1434 to 1440 on the south and 1435 to 1441 on the north. This sinkhole was large enough that an SUV fell into it.

In 1985 structural foundation repairs were reported to have been performed to house number 1421.

Site features related to sinkhole activity were observed by the staff performing the MASW survey and by a Geotechnical Engineer during a reconnaissance site visit. Photos of site observations are included in Appendix A. Observations included several closed depressions within repair areas, sags in the sidewalk, a sinkhole that opened-up during MASW testing and other sinkholes.

During drilling operations conducted on July, 31st 2014, a resident of the 1400 block of South 14th Street informed the Geotechnical Inspector of a potential surface depression on Scott Street. Scott Street runs parallel to South 14th Street along the north side of house numbers 1401 to 1451. The Geotechnical Inspector did not observe any surface depressions or sinkholes on Scott Street while onsite.

In the descriptions below, the terms sinkhole and closed depression are used in accordance with the definition by Kochanov (1989). Sinkholes and closed depressions are surface features that may result from downward movement of unconsolidated surface material by water into voids within the bedrock. A sinkhole is further characterized by a hole on the ground surface; a closed depression shows no discernible land surface break.

In the vicinity of the 2007 sinkhole event, the following observations are notable:

- Newer sidewalk, possibly replaced during the sinkhole repair, is present in front of house numbers 1430 to 1448.
- Sags in the sidewalk are present in front of house numbers 1440, 1435, and 1433.
- Closed depressions are present in the lawns in front of house numbers 1433 and 1435.
- A sinkhole opened up between house numbers 1436 and 1439 during the performance of the MASW survey.

In the vicinity of the 2014 sinkhole event and the 1985 structural foundation repair, additional observations include the following:

- Several surface depressions were observed in the vicinity of the sinkhole repair area.
- The entrance sidewalk to house numbers 1423 and 1425 was saw-cut during the sinkhole repair. A shallow void is present below the sawcut joint.
- A sinkhole, two closed depressions and a depressed sidewalk slab with void space below the joint is present in front of house numbers 1426.

MASW SURVEY AND VERIFICATION DRILLING

The multi-channel analysis of surface waves (MASW) survey was performed August 14-16, 2014 by Quantum Geophysics, a Division of Gannett Fleming, Inc. MASW is a geophysical method that produces a continuous profile of the subsurface based upon differences in shear wave velocity (V_s). V_s is a measure of material stiffness much like N-values from standard penetration test (SPT) borings. Higher V_s indicate stiffer materials; lower V_s indicate less stiff materials. This makes the method applicable to profiling top of rock (TOR) since rock is generally much stiffer than soil. MASW can also identify karst features because sinkhole activity tends to make materials less stiff. Voids are characterized by low V_s anomalies (localized decrease in V_s) because the materials within the voids (air, soil, or water) are less stiff than the surrounding rocks. Fractures are generally expressed as thin, near-vertical zones of lower V_s that are traceable across multiple survey lines.

MASW is not impacted by buried piping (unlike electrical resistivity methods) and can investigate to far greater depths than the maximum of approximately 3 feet characteristic of ground penetrating radar (GPR) for soils in and around Harrisburg. A further discussion of the MASW method, and how the data were acquired and processed, is provided in Appendix B.

Three MASW lines were run the length of South 14th Street from Magnolia Street to Cloverly Terrace as shown in Figure 1. The lines are designated A-A', B-B', and C-C'. B-B' is located in the street, offset approximately 5 feet from a water line mark-out. A-A' and C-C' are located on the sidewalks. The lines range from 500 to 520 feet long. The V_s profiles, shown in Figure 2, are stacked one above the other in order to more easily correlate features across multiple survey lines. The profiles were constructed with a horizontal scale of 1 inch = 50 feet and a vertical scale of 1 inch = 25 feet (vertical exaggeration = 2H:1V). The profiles utilize a color contour scheme whereby cooler colors indicate lower V_s (less stiff materials) and warmer colors indicate

higher V_s (stiffer materials). The profiles are tilted downwards from left-to-right because of topography. South 14th Street slopes downwards towards Cloverly Terrace.

One verification boring was performed to recover soil and rock samples for visual classification, and to help correlate the data obtained from the MASW survey. The boring, designated B-1, was drilled on July 21, 2014. The boring was located on South 14th Street approximately 65 feet from the intersection with Magnolia Street, and was drilled between MASW survey lines A-A, and B-B' in order to avoid buried utilities. The plan location of the boring is shown in Figure 1, and a graphic log of the boring is shown in Figure 2 on profiles A-A' and B-B'. Consideration was given to drilling the verification boring closer to the area of the vacated homes where sinkhole features are more prevalent. However, considering that a sinkhole was exposed during the MASW survey and drilling is considerably more intrusive than the MASW survey, it was deemed prudent for safety reasons to locate the boring closer to Magnolia Street.

A representative from Gannett Fleming observed the drilling, classified soil and rock samples, and prepared a boring log. The typed log and photograph of the core box are included in Appendix C. The boring was advanced to a depth of 48.8 feet. Approximately 38 feet of soil, described primarily as sandy/gravelly clay was sampled, and approximately 10 feet of limestone bedrock was cored. The soil was sampled with a 2-inch O.D. split-spoon sampler. Continuous Standard Penetration Testing (SPT) was performed in 18-inch increments by dropping a 140 pound hammer from a height of 30 inches onto the split-spoon sampler. The number of hammer blows to advance the sampler was recorded on the boring log for each 6-inch increment. The number of blows to drive the sampler the last 1-foot is known as the "N-value". N-values are used to gauge the relative stiffness (density) of materials. Higher N-values indicate stiffer (more dense) materials.

Soils are characterized by shear wave velocities that are nominally 400-600 fps to depths of about 20 feet. At depths greater than 20 feet, velocities increase to almost 1200 fps indicating stiffer soils. This increase in material stiffness is also observed in B-1 which reports higher N-values between 21 and 27 feet.

In general, top of rock is equivalent to a shear wave velocity of approximately 1,200 fps based upon the correlation of B-1 (limestone rock at 38.4 feet) with line B-B'. Top of rock can be less than 1,200 fps where potential fractures and voids are observed within the rock. Rock is described in B-1 as fresh to slightly weathered, intensely bedded, with closely to medium spaced fractures. The description is consistent with the velocities observed on B-B' which are upwards of about 2,400 fps. A similar correlation is not observed on line A-A'. This may be because of the influence of potential voids in the rock. An alternative, although related, explanation is that top of rock along A-A' near B-1 is locally much deeper because a void (solution channel) daylights (intersects) top of rock.

Along most of South 14th Street, top of rock is nominally about 30 to 40 feet deep. Depth to rock increases to upwards of 55 to 60 feet as South 14th Street approaches within 50 to 100 feet of Cloverly Terrace.

Sixteen (16) fracture-like anomalies were observed. They are designated #1 through #16. Four fracture-like anomalies are located on line A-A', seven are located on line B-B', and five are located on line C-C'. They all appear to daylight (intersect) top of rock. Fracture-like anomalies #2, #3, #4, #5, #6, #8, #9, #10, #12, #13, #15 and #16 are associated with narrow, vertical zones of lower shear wave velocities in the overlying clay soils which are indicative of piping. Soil piping or raveling is defined as laterally limited, vertical areas of loose soil often caused by downward vertical movement of the soil. Indications of piping are also observed in B-1 which reports weight of hammer (WOH) at depths of 30 to 32 feet and 34.5 to 36 feet. B-1 is located within approximately 20 feet of fracture-like anomaly #5.

There are five potential fractures based upon a best straight-line fit through a plot of the fracture-like anomalies. They are designated PF#1 though PF#5. The potential fractures trend approximately N28^{o}E.

Eleven zones of potential voids were identified. They are designated PV#1 through PV#11. All but PV#2 are intersected by fracture-like anomalies.

Fracture-like anomalies, potential fractures, indications of soil piping, and zones of potential voids are located at/near the sinkhole repairs of 2014 and 2007 (see Site History and Observations) and at/near signs of sink activity observed during the MASW survey (e.g., closed depressions, sags in the sidewalk). Fractures are open spaces or gaps in the rock. Fractures that intersect the top of rock represent a pathway for soils to migrate downwards into voids at depth (soil piping). It appears that soil piping into fractures in the bedrock is the probable means of sinkhole activity along South 14th Street. Soil movement is generally triggered by water, and it can be in the form of stormwater or water from a leaky or broken water line (there is no sanitary in South 14th Street).

CONCLUSIONS

The results of the investigations described in this report indicate that the 1400 block of South 14th Street between Magnolia Street and Cloverly Terrace overlies limestone bedrock which is characterized by fracture-like features and voids. These features allow the overburden soil to migrate downwards and sinkholes and closed depressions to develop. Despite backfilling of past sinkholes, areas of subsidence continue to develop, and the potential for future sinkhole activity is high.

REFERENCES

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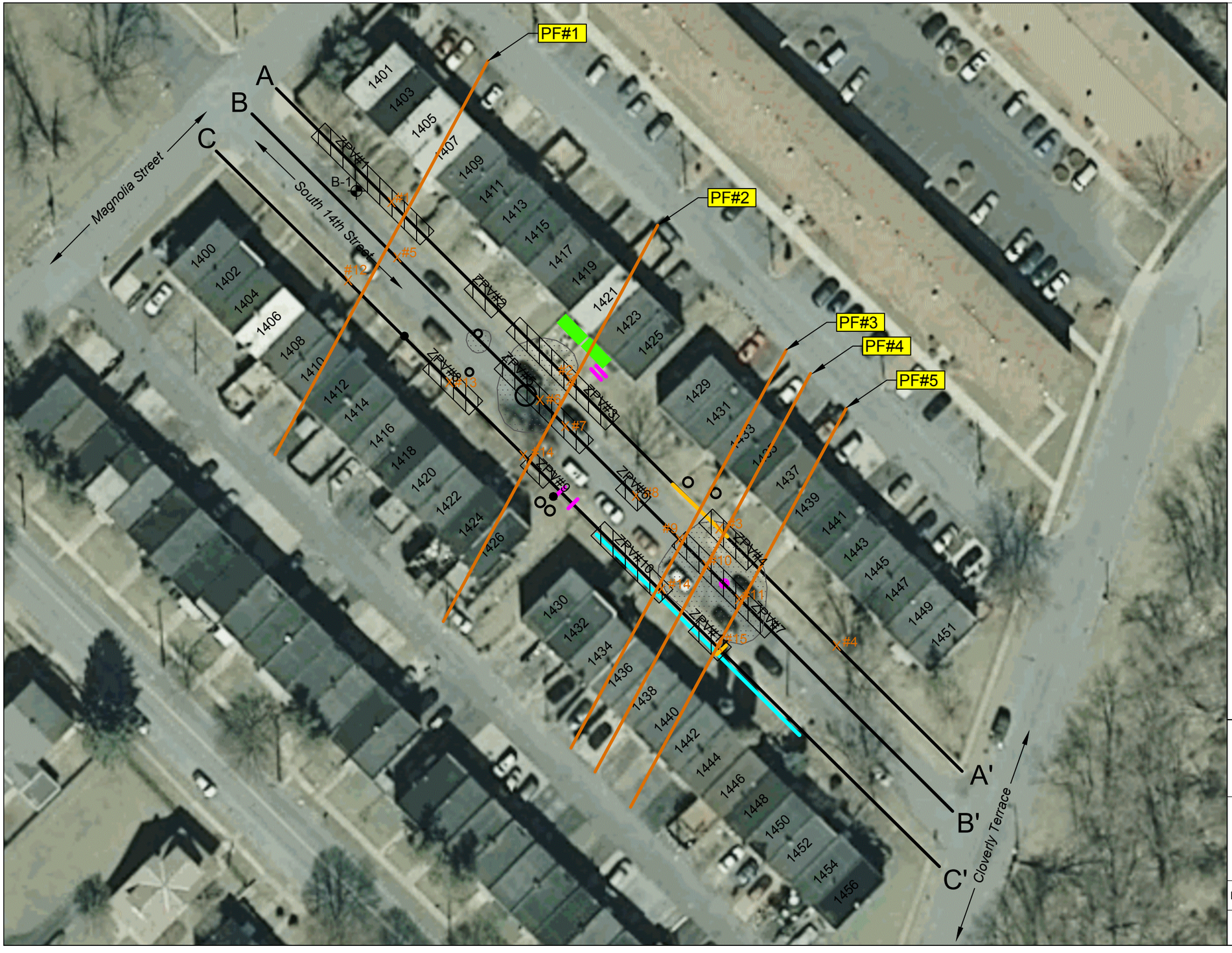
McGlade, W.C. and Geyer, A.R. (1976), *Environmental Geology of the Greater Harrisburg Metropolitan Area, Pennsylvania*, Pa. Geol. Survey, 4th ser., Environmental Geology Report 4, 42p.

Penn Pilot website, Aerial Photographs: AHE-15-30 (9/20/1937), AHE-4R-44 (11/6/1956), AHD-2V-51 (5/27/58), http://www.pennpilot.psu.edu/

Root, S. I. (1977), *Geology and mineral resources of the Greater Harrisburg West Area, Cumberland and York Counties, Pennsylvania*, Pa. Geol. Survey, 4th ser., Atlas 148ab, 106 p.

Figures



LEGEND

A——A'	MASW Line.
	Apparent Sinkhole Repair (approx.).
	Sinkhole.
	Sinkhole Opened During MASW Testing.
	Closed Depression.
X #1	Fracture-Like Anomaly and Designation.
PF#1	Potential Fracture.
ZPV#8	Zone of Potential Voids.
	Structural Foundation Repair.
	Sag in Sidewalk.
	Newer Sidewalk.
	Sag in Sidewalk and/or Void Beneath Sidewalk.
B-1	Verification Boring (approx. location).
1427	House Number.

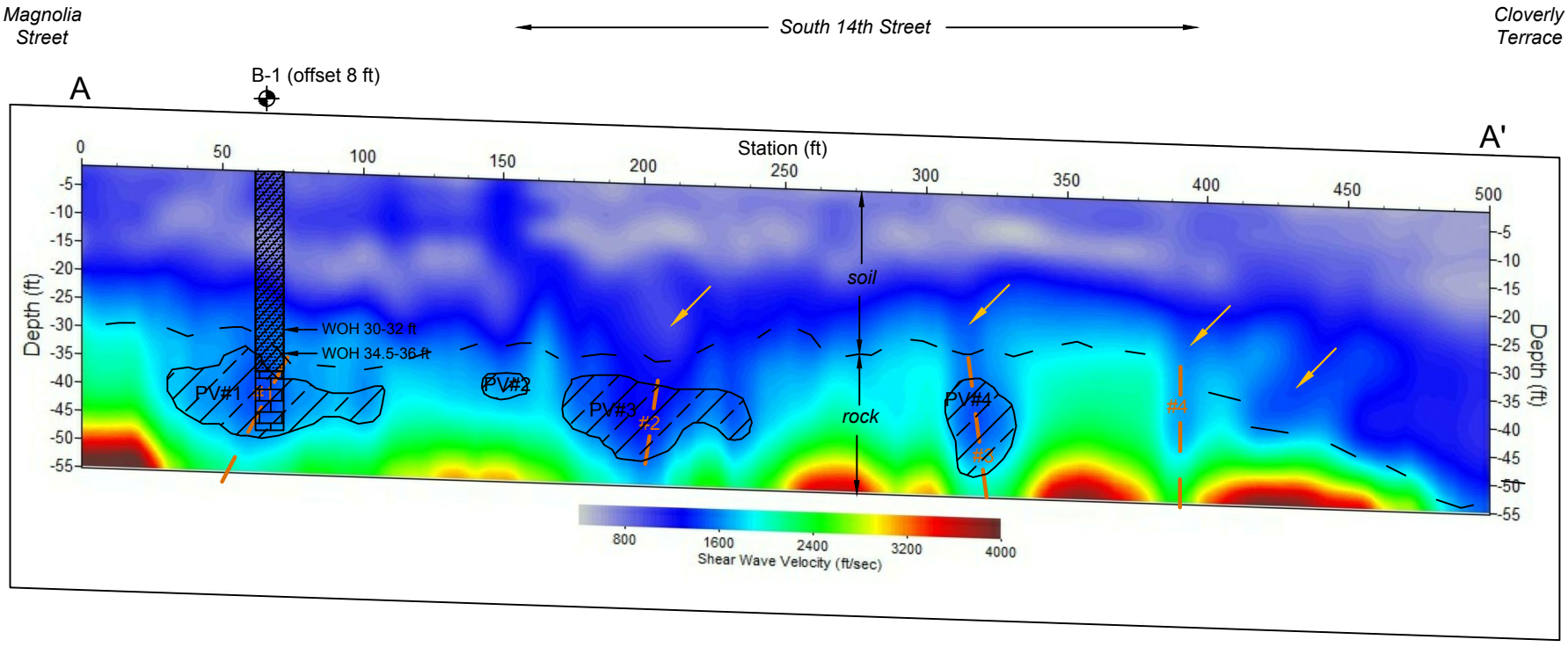
0 50 100
Scale (ft)

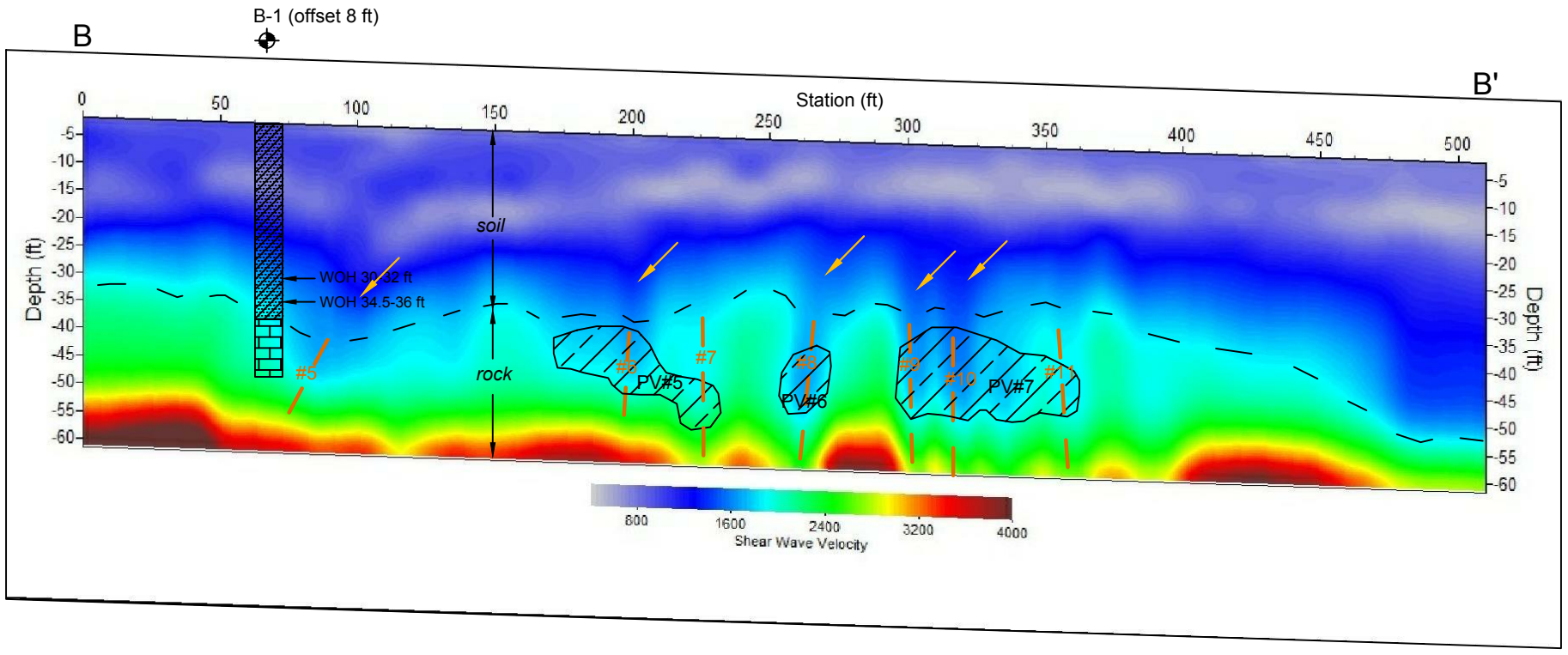
Basemap: CRW_Export.gdb provided by the City of Harrisburg.

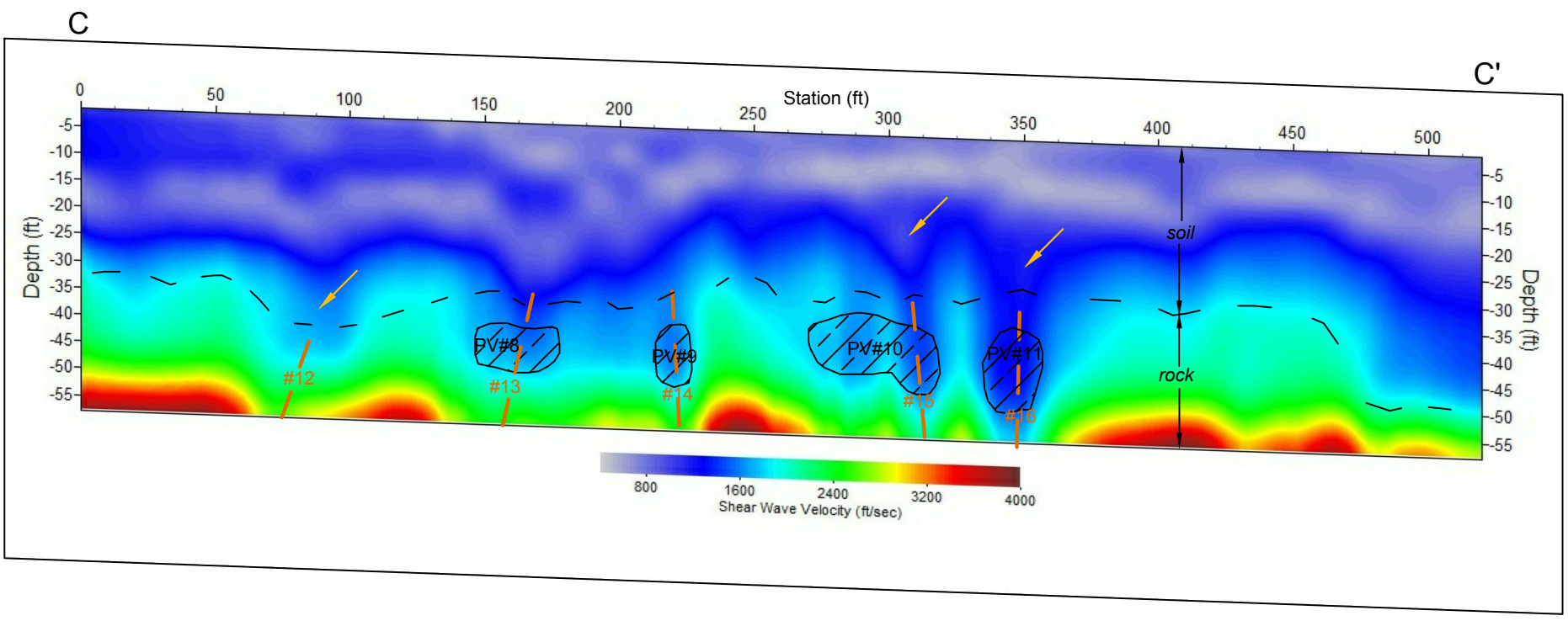
QUANTUM GEOPHYSICS
A Division of Gannett Fleming, Inc.
Engineering, Groundwater, and Environmental Geophysics
29 Richard Lee Lane, Phoenixville, PA 19460

Site Plan
South 14th Street
Harrisburg, Pennsylvania

For:			Figure
City of Harrisburg			1
Date: 7-07-14	Project No.: 059166.WO1QTM	File: O:\City of Harrisburg\Fig 1.dwg	







0 50 100 150

Scale (ft)

LEGEND

- Interpreted Top of Rock.
- #1 — Fracture-Like Anomaly.
- PV#10 — Zone of Potential Voids.
- B-1 — Verification Boring.
- Clay (CL).
- Limestone
- Potential Piping.

Vertical Exaggeration = 2H:1V.

QUANTUM GEOPHYSICS
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Engineering, Groundwater, and Environmental Geophysics
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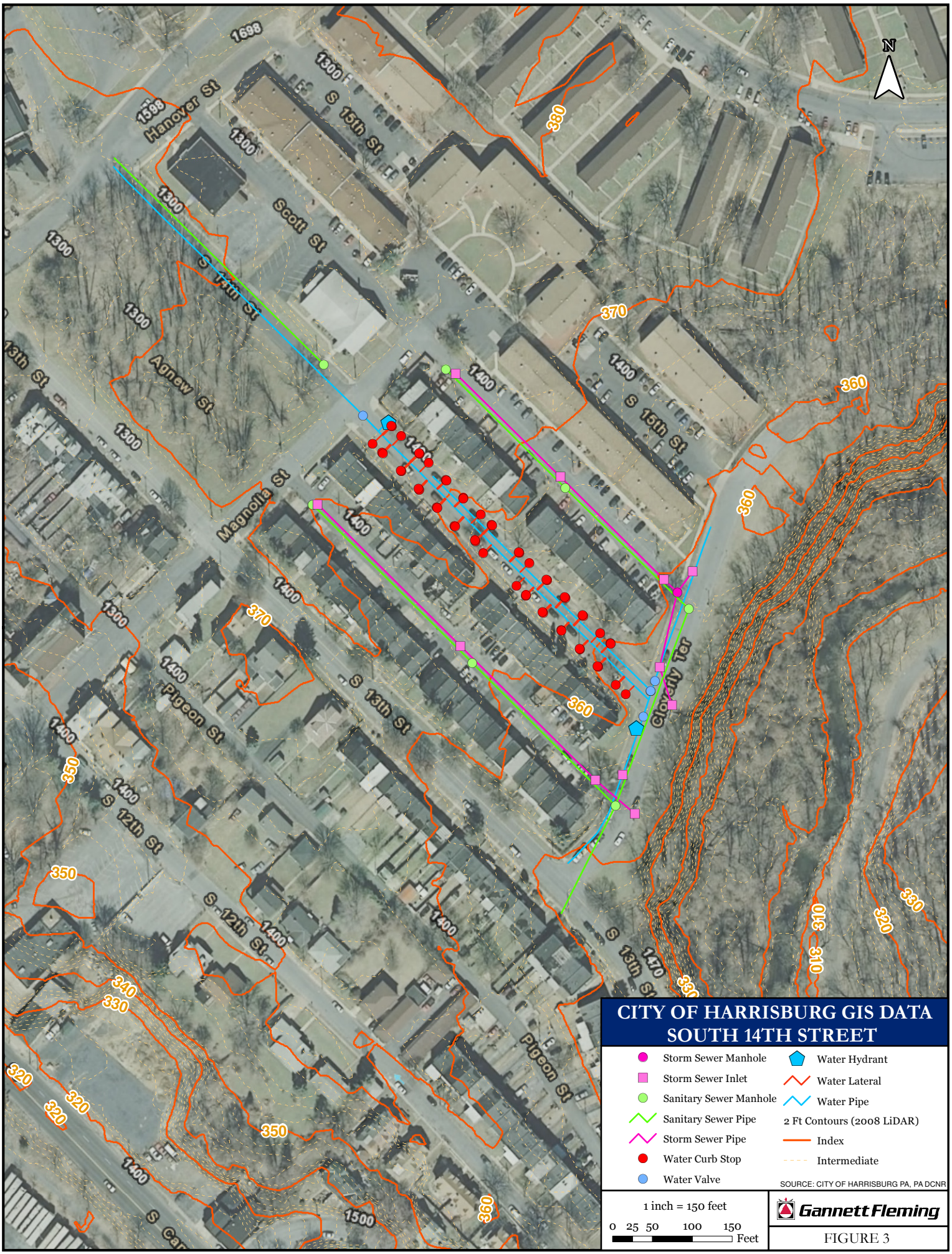
V_s Profiles A-A', B-B', and C-C'
South 14th Street
Harrisburg, Pennsylvania

For:	City of Harrisburg		Figure
Date: 7-07-14	Project No.: 059166.WO1QTM	File: O:\City of Harrisburg\Fig 2.dwg	2



Prepared by: bwitmer on 8/14/2014 NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet G:\Projects\59166_HarrisburgSinkHoles\05_Working\Utilities_bw.mxd

Appendix A

Description of the MASW Method

The MASW Method

MASW is a seismic method that determines the vertical distribution of shear wave velocities based upon the dispersion of surface waves (Rayleigh Wave). It was first described for engineering applications in the late 1990's by the Kansas Geological Survey (KGS). Seismic surveys generate two types of seismic waves – body waves (Compressional Wave and Shear Wav) and surface waves (Rayleigh Wave and Love Wave). Body waves penetrate into the earth; surface waves travel along the earth's surface. The different types of waves differ in how they displace particles with respect to the direction of wave propagation. P-waves displace particles in the direction of wave propagation; S-waves displace particles perpendicular to the direction of wave propagation. Rayleigh Waves displace particles in an elliptical motion in planes normal to the surface and in the direction of wave propagation. Surface waves are not limited to seismic waves. Ocean waves are also surface waves.

The penetration depth of the Rayleigh Wave depends on the wavelength which, in turn, depends on frequency. When the velocity of materials changes with depth, each frequency component of the surface wave is affected by the different velocities and, therefore, propagates with different phase velocities. This phenomenon is known as dispersion. By recording the fundamental-mode Rayleigh Waves propagating from the source to the receiver, the dispersive properties directly beneath the seismic spread can be measured and represented by a curve (dispersion curve). This curve is used to estimate the vertical variation of V_s through a process known as inversion.

The schematics shown below illustrate how MASW data are collected and processed:

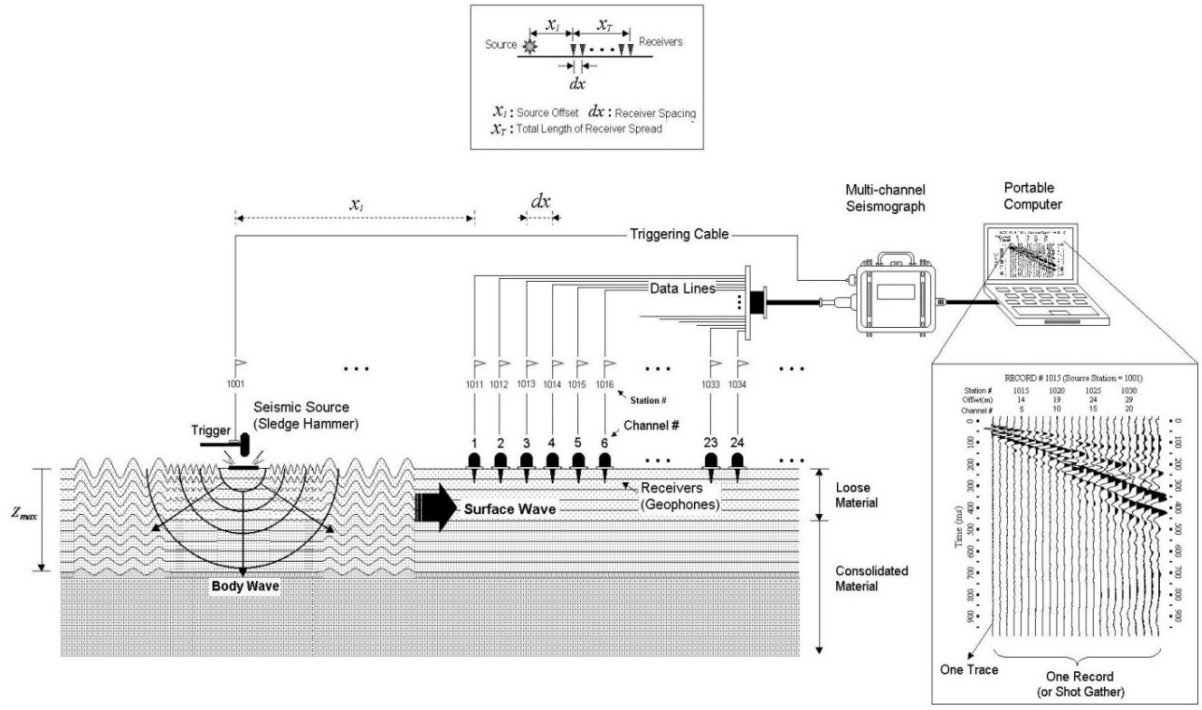


Exhibit 1 - MASW Data Acquisition.

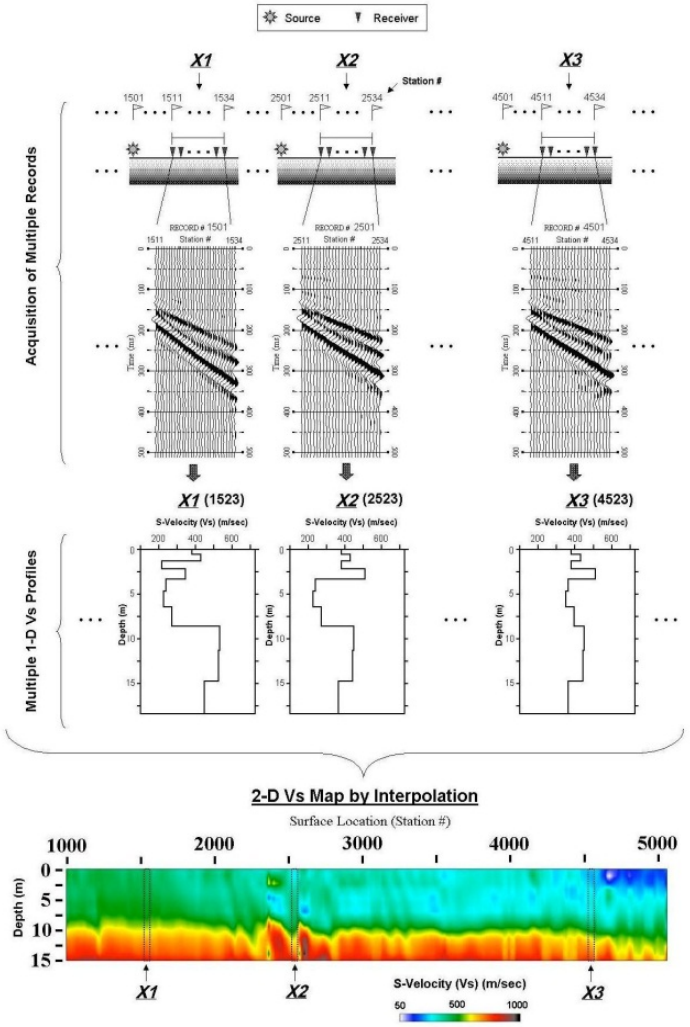


Exhibit 2 - MASW Data Processing

The MASW survey on S. 14th Street was carried-out using a Geometrics Stratavisor 24-channel seismograph and 4.5 Hz vertical geophones mounted on a landstreamer (Kevlar strip with adjustable metal plates). Seismic waves were generated by striking a metal plate coupled to the ground with a 12 lbs sledge hammer (lines A-A' and C-C' on the sidewalks) and a Peg Kg-40 accelerated weight drop (line B-B' on S. 14th Street). Data were acquired with geophones spaced 3 ft apart and a shot offset (distance between the source and the first in-line geophone) of 12 ft. The data were recorded as 0.7 second shot records at a sampling rate of 62.5 *u*sec. A shot record was acquired every 5 ft of traverse. Each shot record was created by stacking three shots (multiple impacts of the hammer & plate or Peg Kg-40) to increase the signal-to-noise ratio. An ATV was used to pull the landstreamer along the sidewalk, and a van was used to pull the landstreamer along the street with the Peg Kg-40 mounted in a 2 inch receiver hitch.

The data were processed using the Kansas Geologic Survey (KGS) software program ***Surfseis***. ***Surfseis*** converts the raw data (SEG-2) into KGS processing format, combines all shot records into a single file, assigns field geometry (geophone spacing and shot offset), recompiles the data

into a roll-along data set, identifies the range of surface wave velocities for each shot record, conducts dispersion curve analysis for all shot records, applies an inversion process to the dispersion curves to determine 1-D V_s, and constructs 2-D V_s profiles by interpolating the 1-D V_s profiles using a Bilinear algorithm.

Each 1-D V_s is plotted in the middle of the active receiver array because it is representative of conditions beneath the array.

The relative elevation along each line was measured using a 2X hand-level and a stadia rod, and entered into a field book for later use in adjusting the V_s profiles for changes in elevation.

Appendix B

Boring Log and Core Box Photos

FORM NO: D-481
(12/89)
REPRODUCE LOCALLY

ENGINEERS FIELD BORING LOG

BORING NO. WO1-B-1
SHEET 1 OF 3
DATE: START 7/31/14
END 7/31/14
O.G. ELEV.

PROJECT NAME City of Harrisburg COUNTY Dauphin
PROJECT LOCATION South 14th Street Sink Hole Investigation
STATION _____ OFFSET FROM CENTERLINE _____
NORTHING _____ EASTING _____
STATE RT. NO. _____ SECT. _____ SEGMENT _____ OFFSET _____
INSPECTOR G. Braun DRILLERS NAME/COMPANY D. Bolze/CGC
EQUIPMENT USED Acker XLS Track Rig with Automatic Hammer
DRILLING METHODS Spin Casing/Cont. SPT/NQ, Core
CASING: SIZE: 3.5" ; DEPTH: 38.8' ; WATER: DEPTH: 34.3' TIME: 14:00 DATE: 7/31/14
CHECKED BY: C. Schriner ; DATE: 8/7/14 DEPTH: _____ TIME: _____ DATE: _____
Checked = No Recorded Water Reading Measurements ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%) / RQD (%)	POCKET PENT/ TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
0.0	S-1	44 17 10 N=27	0.5'	33	-	gw		0.5 0.0'-0.5': Asphalt 0.5'-1.5': Subbase, Well graded GRAVEL (gw), gray, medium dense	Offset ~ 1.0' away from B-1 marker. Away from Magnolia Street.
1.5								1.5	
	S-2	4 5 6 N=11	1.3'	87	-	cl	Moist	Lean CLAY With Sand (cl), brown, moist, medium to stiff, homogeneous 1.5'-4.5': Fill	
3.0									
	S-3	5 6 7 N=13	1.0'	67	-	cl	Moist		
4.5								4.5'-9.0': Residual	
	S-4	2 3 3 N=6	0.7'	47	-	cl	Moist		
6.0									
	S-5	3 5 5 N=10	0.5'	33	-	cl	Moist		
7.5									
	S-6	2 5 4 N=9	0.5'	33	-	cl	Moist		
9.0								9.0	
	S-7	5 4 5 N=9	1.5'	100	-	cl	Moist	Gravelly Lean CLAY With Sand (cl), brown, moist, stiff, (residual)	
10.5									
	S-8	2 4 4 N=8	1.2'	80	-	cl	Moist		
12.0									
	S-9	2 6 6 N=12	0.5'	33	-	cl	Moist		
13.5									
	S-10	4 4 6 N=10	1.5'	100	-	cl	Moist		
15.0									
	S-11	3 4 4 N=8	1.0'	67	-	cl	Moist		
16.5									
	S-12	3 4 4 N=8	1.0'	67	-	cl	Moist		
18.0									
	S-13	3 4 5 N=9	1.5'	100	-	cl	Moist		
19.5									
		2		73		cl	Moist		

NOTE: DRAW STRATIFICATION LINES AT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES FOR THIS BORING LOCATION AND SHOW DEPTHS

FORM NO: D-481
(12/89)
REPRODUCE LOCALLY

ENGINEERS FIELD BORING LOG

BORING NO. WO1-B-1
SHEET 2 OF 3
DATE: START 7/31/14
END 7/31/14
O.G. ELEV.

PROJECT NAME City of Harrisburg COUNTY Dauphin
PROJECT LOCATION South 14th Street Sink Hole Investigation
STATION _____ OFFSET FROM CENTERLINE _____
NORTHING _____ EASTING _____

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%) / RQD (%)	POCKET PEN./ TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
21.0	S-14	4 8	1.1' N=12		-	cl	Moist	Gravelly Lean CLAY With Sand (cl), brown, moist, stiff, (residual) *(continued)*	
22.5	S-15	4 6 7	0.7' N=13	47	-	cl	Moist	Sandy Lean CLAY With Gravel (cl), brown to dark brown, moist, stiff, (residual)	
24.0	S-16	3 7 6	1.5' N=13	100	-	cl	Moist		
25.5	S-17	5 6 9	0.9' N=15	60	-	cl	Moist		
27.0	S-18	6 6 6	0.9' N=12	60	-	cl	Moist		
28.5	S-19	5 4 5	0.0' N=9	0	-				
30.0	S-20	4 2 3	1.2' N=5	80	-	cl	Moist	Sandy Lean CLAY (cl), brown, wet to moist, very soft to medium, homogeneous	
31.5	S-21	WOH WOH WOH	1.5'	100	-	cl	Moist		
33.0	S-22	WOH 2 3	1.5' N=5	100	-	cl	Moist		
34.5	S-23	3 4 4	0.0' N=8	0	-				
36.0	S-24	WOH WOH WOH	0.0'	0	-				
37.5	S-25	2 3 3	0.7' N=6	47	-	cl	Wet		S-25: Start using soil trap.
38.3	S-26	14 50/0.3	0.5'	63	-	sc	Wet		
38.4	Advanced Casing				-				38.3'-38.8': Advance casing.
40.8	R-1		2.4'	100 52				LIMESTONE, light gray, hard, fresh to slightly weathered, intensely bedded, RD=0°-5°, closely to medium spaced fractures, RD=0°-45°, RQD=81%	38.4': Start coring.
	R-2		3.0'	100					

NOTE: DRAW STRATIFICATION LINES AT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES FOR THIS BORING LOCATION AND SHOW DEPTHS

FORM NO: D-481
(12/89)
REPRODUCE LOCALLY

ENGINEERS FIELD BORING LOG

BORING NO. WO1-B-1
SHEET 3 OF 3
DATE: START 7/31/14
END 7/31/14
O.G. ELEV.

PROJECT NAME City of Harrisburg COUNTY Dauphin
PROJECT LOCATION South 14th Street Sink Hole Investigation
STATION _____ OFFSET FROM CENTERLINE _____
NORTHING _____ EASTING _____

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%) / RQD (%)	POCKET PENT/ TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
43.8				97				LIMESTONE, light gray, hard, fresh to slightly weathered, intensely bedded, RD=0°-5°, closely to medium spaced fractures, RD=0°-45°, RQD=81% *(continued)*	
	R-3		4.9'	98 / 85					
48.8								48.8	
								Bottom of borehole at 48.80 feet.	

NOTE: DRAW STRATIFICATION LINES AT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES FOR THIS BORING LOCATION AND SHOW DEPTHS

Boring B-1: Box 1 of 2

Boring B-1: Box 2 of 2

Appendix C

Site Photographs

S. 14th Street – Photo 1
Sidewalk Sag on Left in Front of House No. 1440

S. 14th Street – 2
Sinkhole Opened During MASW Testing Between House Nos. 1436 and 1439

S.14th Street – Photo 3
Sidewalk Sag Between House Nos. 1437 and 1439

S. 14th Street – Photo 4
Surface Depression in Front of House No. 1433

S. 14th Street – Photo 5
Sidewalk Sag in Front of House No. 1433

S. 14th Street – Photo 6
Surface Depression in Front of House No. 1435

S. 14th Street – Photo 7
Sidewalk Sag in Front of House No. 1435

S. 14th Street – Photo 8
Sinkhole in Front of House No. 1426

S. 14th Street – Photo 9
Depressed Sidewalk in Front of House No. 1426

S. 14th Street – Photo 10
Approximately 1’-1” Void Depth Below SW Slab in Front of House No. 1426

S. 14th Street – Photo 11
Surface Depressions on Top of Slope in Front of House No. 1426

S. 14th Street – Photo 12
House No. 1421, Location of 1985 Structural Foundation Repair with Evidence of Recent Subsidence

S. 14th Street – Photo 13
Approximate 11” Void Depth Below Entrance Sidewalk at House No. 1423