

April 20, 2021

Mr. David Shuey, Chair  
Board of Supervisors  
East Goshen Township  
1580 Paoli Pike  
West Chester, PA 19380-6199

Re: Report on subsidence issue, East Goshen Township, Chester County, Penna.

TRANSMITTED VIA E-MAIL ATTACHMENT

Dear Mr. Shuey:

Sasowsky Earth Science Consultants (SESC) has completed our desktop study of reported subsidence observed in East Goshen Twp., Chester County, Pennsylvania. This work was conducted based upon our agreement dated December 8, 2020. The letter report below describes our approach, findings and conclusions.

### **EXECUTIVE SUMMARY**

The reported subsidence was minimal and does not appear to be ongoing. A definitive cause cannot be ascertained based upon existing information. It seems likely that it may have been caused by decaying buried wood, or by on-site utility issues, possibly an unused water well. However, other causes cannot be definitively ruled out. The presence of a fracture trace crossing the pathway of the Mariner II pipeline, as well as going near the subsidence location, could provide a pathway for regolith migration, but it is unclear what mechanism might be invoked. Consequently, it is unlikely in our estimation that the pipeline installation is a direct cause of the observed subsidence. It is highly unlikely that karst conditions are present. Nonetheless, the Mariner I line and other utilities are active in the vicinity, so subsidence of any nature seems to warrant investigation for safety concerns. If greater clarification is desired, we recommend a) at least monthly visual monitoring (30-foot radius) to determine if further subsidence occurs, and b) further investigation of site conditions to determine if the abandoned on-site well or other relict infrastructure could be related to the subsidence. Proper remediation of any ongoing subsidence would require that the cause and conditions are clearly understood. For this reason, oversight by an independent qualified geologist during any future investigations/excavations is recommended.

### **PURPOSE**

The objective of the work was to produce a preliminary evaluation of the possible subsidence, with regard to geologic, hydrologic, and human-related conditions that could present safety issues with respect to environmental quality and human health. A particular concern was to evaluate if nearby ongoing construction activities for the Mariner East II pipeline project were correlated to the possible subsidence.

## OVERVIEW

This investigation was prompted by the reported observation of a low topographic spot (closed depression) at Strasburg Rd. and Bow Tree Dr. on January 4, 2020. Due to proximity to existing pipelines and other infrastructure, as well as active Horizontal Directional Drilling (HDD) for the Mariner East II pipeline, there was a concern that the subsidence could portend catastrophic failure and associated risks to property & health.

Before discussing the results of our investigation, we will review some general background information on nomenclature and processes.

Subsidence is a process involving the inwardly directed lowering of the land surface. The physical expression of subsidence is commonly a closed depression, which is a low topographic spot on the ground, where land rises in all surrounding directions. However, it should be noted that closed depressions can also form via non-subsidence processes, such as a blow-out between sand dunes, or a lake that formed through glacial excavation, or even “tree throw”, a process where a falling tree uplifts and displaces soil. When a closed depression occurs due to inward subsidence, the term sinkhole may be applied. Sinkholes and closed depressions can occur on scales ranging from a few inches to hundreds of feet or more. In areas such as this where regolith (loose natural material, including soil) is present, subsidence may express by lowering of the surface, or actual raveling (movement) of the material into a central opening.

There are numerous conditions and processes which can cause subsidence of the land surface and the development of sinkholes. In all cases, there needs to be “someplace to go” for the materials that are being lowered. This “place” is usually an existing void (empty space) below the surface. The existing space may be natural. Such is the case in karst regions where limestone rock beneath the soil can form caves or other openings into which overlying material may migrate. This is the most common setting for sinkholes and is demonstrated in such areas as the sinkhole plain east of Mammoth Cave, Kentucky. However, sinkholes can also be related to human activities/infrastructure such as a failed culvert or pipe, or a collapsing mine. Movement of the materials into existing voids can be driven by changes in water flow, or by gravity alone. It may be rapid, or slow.

In evaluating the observed closed depression, we sought to answer these questions:

Has subsidence occurred?

If so, is it ongoing?

What are potential, and most likely, causes?

What are the associated risks?

## APPROACH

The approach for this study was to review available information about the site including background documents, topography, hydrology, geology, infrastructure, and recent changes. This

was accomplished through examination of available data and publications, as well as discussions with persons having information about the site.

Specifically, the following were accomplished:

- Review of aerial photography from 1937 to 2019

- Review of documents associated with permitting and construction of the Mariner East II pipeline

- Review of documents associated with a “whistleblower” complaint.

- Review and analysis of various published map information including topography, soils, geology, hydrology.

- Email, phone discussions, and 2 video conferences with Township staff and members of the Pipeline Task Force

- Email and phone discussions with the PennDOT geologist involved in investigating the subsidence.

## **RESULTS**

### Site layout

The area is currently mostly built out as low-density suburban development, with residential buildings, yards, etc. A major road, Route 352, Chester Road, runs generally NW-SE. Figure 1 shows salient features. The noted depression occurred on the SW side of Chester road, between the roadway and a lot which currently has no structures on it.

### Geology & Soils

A detailed geologic map of the area was prepared in 2005 as part of the PA Geological Survey mapping program<sup>1</sup>. This shows the site to be underlain by the Baltimore Gneiss. The site is in the Piedmont Uplands Section of the Piedmont Physiographic Province, which has been geologically stable for circa 200 million years. Consequently, deep weathering of the surface has taken place, resulting in soils 15-56 feet deep (as indicated by borings).

### Hydrology

The site is in an upland position on the landscape, at elevation approximately 450 ft above mean sea level (amsl). Surface drainage is gently eastward towards Ridley Creek, at an elevation of about 370 feet. A small wetland (ID W-H31) was identified just north of the depression in laying out of the Mariner II project.

---

<sup>1</sup> Blackmer, G. C., 2005. Preliminary bedrock geologic map of a portion of the Wilmington 30- by 60-minute quadrangle, southeastern Pennsylvania: Pennsylvania Geological Survey, 4th ser., Open-File Report OFBM 05-01.0, 16 p.



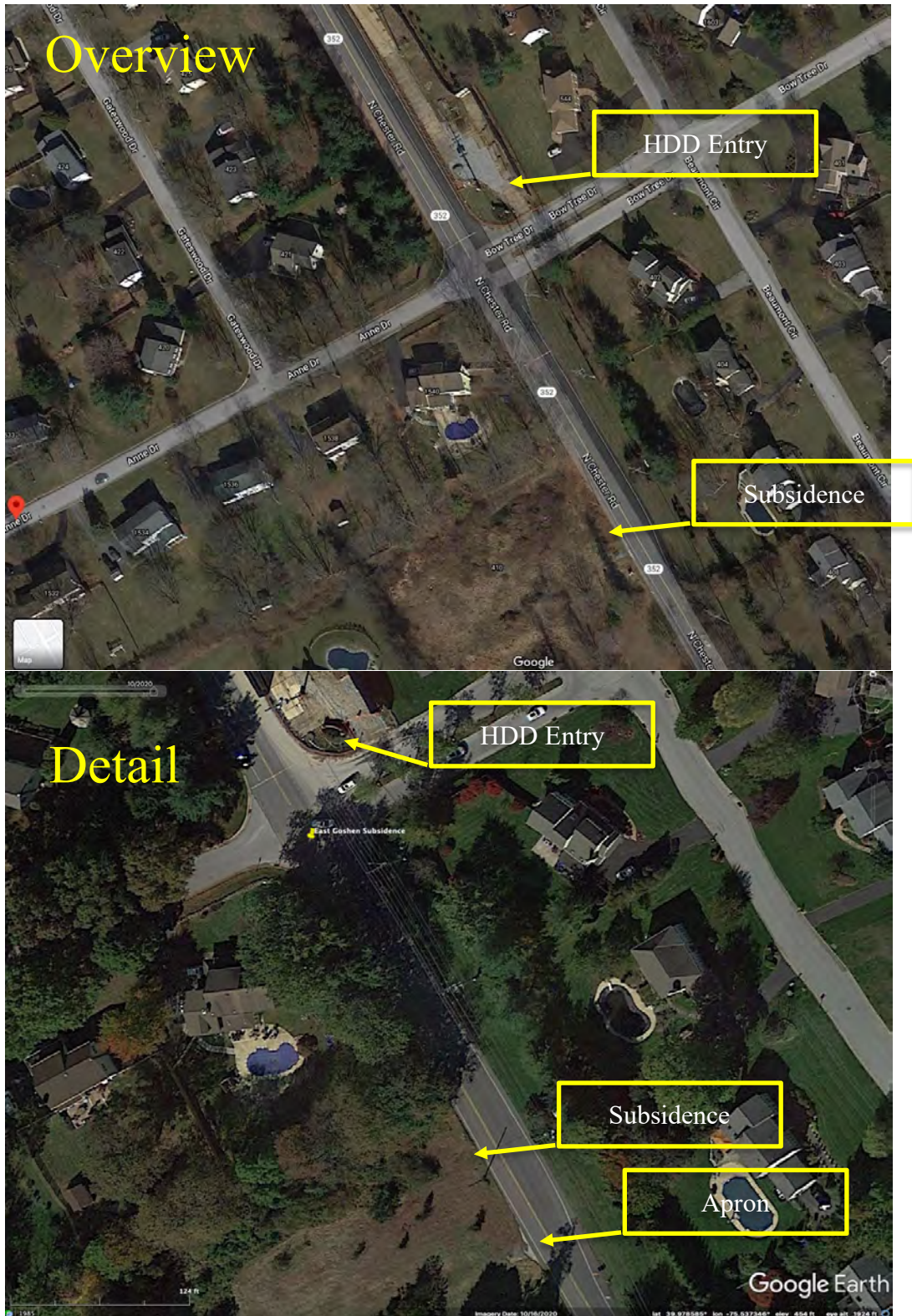


Figure 1: Aerial photographs of surroundings indicating major features (Google Earth, 2/2019, 10/2020). Apron is paved/stoned entry to former residence driveway.



### Reported depression/subsidence

A Professional Geologist (hereafter referred to as the whistleblower) reported subsidence “approximately two feet wide and two feet deep” at this location on January 4, 2020. A one-week investigation/monitoring period ensued. About 4.5 months later (May 18, 2020) the Geologist observed that the subsidence had doubled in size, and had gotten deeper. It was reported that “The active subsidence has been observed at the intersection of the fracture trace and a corner of the monitored wetland W-H31.” It was also noted that the “sides were opening”, which suggests active movement and failure.

### PennDOT Excavation

On December 23, 2020 Pennsylvania Department of Transportation excavated the depression in order to examine the cause and potential safety issues. This resulted in a report (6 pages) which is included as Attachment A of the current letter. I did have the opportunity to talk about the excavation with the performing geologist, Paula Callahan, on 2/23/21.

The PennDOT investigation was prompted by the whistleblower letter. The PennDOT report includes 2/3 page of text, 3 photographs, and 2 pages of field notes. It concludes that there is not a risk to safety or stability of the state roadway. The likely cause of the depression was also concluded to be moving surface water and a decaying tree stump. A silty clay layer at 2.3 feet depth was also cited as a cause. The report appears to be limited to evaluating road stability, and was not definitive in identifying subsidence cause, or where the regolith was going.

Discussion with performing geologist Callahan indicated that this sort of subsidence was very common in her experience. It looked like a stump, growing in clay-rich soil, had been left in place. She noted that this is adjacent to a wetland area, and that settlement might be expected. She indicated that the tree still had some branches on it, and that the unused well casing was ~20 feet or less away from the depression. After the investigation, the excavation was backfilled. This should not be considered as specific remediation. Remediation would require that a clear cause be identified, so that the repair could be designed to address underlying conditions.

### Historic aerial photography review

Aerial photography was examined to consider prior land use and conditions that could be linked to subsidence. Sixteen historical images from 12/1985 to 8/2019 are directly available via Google Earth. Additionally, we examined 11 other images which were available via PASDA and ESRI. These had dates 1937, 1946, 1958, 1959, 1965, 1971, 1975, 1980, 1985, 1990, and 1995. Clips from the older photos are included as Attachment B of this letter.

The photos show 3 items of interest. First, a residence, as well as several outbuildings, were present on the lot in various configurations from the earliest photo 1937 to 1992. In 1999 the structure is absent based on Google Earth photo. What remains observable is a paved/stoned apron leading from Chester Road on to the lot. Second, for much of the time period covered, there were trees of substantial size growing along the roadway including in the area of the depression. Finally, there is not apparent subsidence at the location historically.

### Virtual Visit

On January 8, 2021, Bill Wegemann and Christina Morley of the Pipeline Task Force visited the location of the depression at my request, to determine position of the feature and to examine surroundings, especially a well which was seen in photos from the PennDOT investigation. They took photographs, which are include here as Attachment C.

Based upon ground disturbance (recent fill), they confirmed that the feature was located ~15 feet northwest of an existing utility pole, directly adjacent to the roadway. On this date there was no depression present, and no indication of active subsidence. A steel well casing, covered with a plastic traffic cone, was found ~20 feet to the west. It appears to be unused and was likely associated with the residence that had been present at the site in older aerial photographs. That residence was apparently removed circa 1990s. Township maps indicate that the former house on the property was constructed between 1883 and 1912.

### Utilities in the area

Underground utilities may provide pathways for the movement of regolith, and therefore be causes of subsidence. This can occur within failed pipes, or within gravel-filled trenches holding the lines. Correspondence with Township Manager Rick Smith provided very comprehensive information on existing infrastructure possibly aligned with the roadway. He indicated the following utilities and depths.

#### Petroleum conveyances:

Mariner East II Spread 6 HDD S3-0520 project is currently installing a 16-inch and 20-inch pipeline crossing under Strasburg Rd. and Bow Tree Dr. Entries are at surface, and typical planned depths are ~ 50 feet.

Sunoco 8" existing line: Minimum of 48 inches at the tie ins/connections

Sunoco 12" existing line: Minimum of 48 inches at the tie ins/connections

The old Sunoco line (abandoned) would only have to be 36" deep.

#### Other utilities:

Utility Water: Minimum of 42-48 inches

Interstate Pipeline Minimum of 36 inches

Utility Gas: Minimum of 30 inches (believed flagged in yellow in Attachment C photos)

Storm Sewer: Minimum of 12 inches

Underground Electric: Minimum of 18 inches for a service line.

Underground Fiberoptic: Minimum of 12 inches.

Cable TV: Very shallow - 6 inches, but this usually only occurs in developments

Chronology of potentially significant events

<b>Date</b>	<b>Event/observation</b>	<b>Per</b>
1930's	2 uncoated steel pipelines installed under west shoulder of road.	Township manager
1930's	Uncoated lines replaced with coated lines, used until 2001, under west shoulder of road.	Township manager
1990's	Property acquired by Harold Renard	Township manager
1996	Property subdivided	Township manager
1996?	Existing house and garage demolished	Township manager
2001	Sunoco grouts and abandons coated lines from 1930's	Township manager
2001	Sunoco installs new lines under cartway.	Township manager
2003	Lot 3 sold, permitted for residential building	Township manager
2005	Stormwater management installed on lots 1 & 2	Township manager
2017-05	Pilot installation of 16-inch and 20-inch Mariner II pipeline crossing under Strasburg Rd. and Bow Tree Dr. commences	GES Report
2018-01	GES issues "HDD Hydro-geologic Reevaluation Report":	GES Report
2020-01-04	Subsidence noted by geologist, 2-feet across, 2 feet deep.	Whistleblower complaint
2020-05-18	Increased subsidence noted by geologist, 4-feet across, deeper than before. "Sides are opening"	Whistleblower complaint
2020-12-23	PennDOT excavates then backfills the depression	PennDOT
2021-01-08	Site visited for investigation of well and subsidence feature. No active subsidence seen. Photos taken, see Attachment C	Bill Wegemann & Christina Morley
2021-02-11	No new subsidence noted, since test pit of December 2020 was filled	Township manager
2021-04	Planned completion date of installation of new 16 & 20-inch pipelines in this vicinity.	Joe McGinn (as per Ron C.), via Bill Wegemann



## DISCUSSION

When subsidence is observed at any location, it is reasonable to consider if it is due to the presence of karst developed on soluble rocks such as limestone or marble. This is because sinkholes are a common feature in such settings. Eastern Pennsylvania does have significant karst areas, within which sinkholes are known as natural features and as safety hazards. However, this area in East Goshen Township does not lie within a known karst region, nor is it underlain by marble or limestone. Consequently, it is highly unlikely that karst is present, or is a concern, either with or without human activities such as HDD.

Having ruled out karst as a factor, it is reasonable to consider human activities and the presence of infrastructure as possibilities. Correlation in time and/or space can be used to seek causative factors or activities.

The cause of the observed closed depression is not fully clear to us with the available information. However, based upon the review, our answers to the questions posed are:

1. Has subsidence occurred?

Apparently, yes. This is based upon the description by the whistleblower, and the PennDOT excavation.

2. If so, is it ongoing?

This is unclear. From the period January to May 2020, it appears that subsidence was ongoing. Cracking of soil at the surface margins indicated activity. However, since that time, and post-excavation by PennDOT, it is reported that the ground surface has been stable. It would be good to continue monitoring in some manner.

3. What are potential, and most likely, causes?

In the absence of karst, some other factor(s) allowing for movement of regolith downward must be in play. Experience shows that this is commonly related to infrastructure failures (pipe collapse, etc.), or ongoing human activities. Migration along gravel-filled trenches which hold lines is also known. Correlation in space (i.e., nearby infrastructure) and/or correlation in time (activities ongoing when subsidence occurs) are good hints as to probable causes. For this reason, the installation activities for the Mariner II might be suspect. However, in the absence of karst conditions, and with low topographic gradients, it is difficult to visualize how fluids under pressure might lead to subsidence so far from the course of the drilling. Although the mapped fracture trace (Figure 2) could serve as a pathway for breakout or inadvertent returns (IR), even this would not typically manifest as subsidence. For these reasons, and considering the evidence given in Results above, it is unlikely that Mariner II activities are related to the subsidence.

Based on proximity, infrastructure either aligned with the road, or on the former residential property become the main suspects. Collapse of the nearby unused well, stormwater infrastructure, gravel-filled trenches, unknown abandoned tanks, etc. are potential causes.

4. What are the associated risks?

Because the actual cause has not been confirmed as of yet, it is hard to answer this with much certainty. However, based upon the observed rate of subsidence, the fact that it appears to have abated, and the expected small size of any possible local infrastructure, the risk seems relatively low. However, we understand that the currently active Sunoco (Mariner I) pipelines underlie the roadbed. Therefore, it would be prudent to determine a bit more robustly what is happening at this site. We suggest that some additional characterization and monitoring be carried out, as discussed below, in order to better understand the risk, and to resolve the situation if it is indeed ongoing.

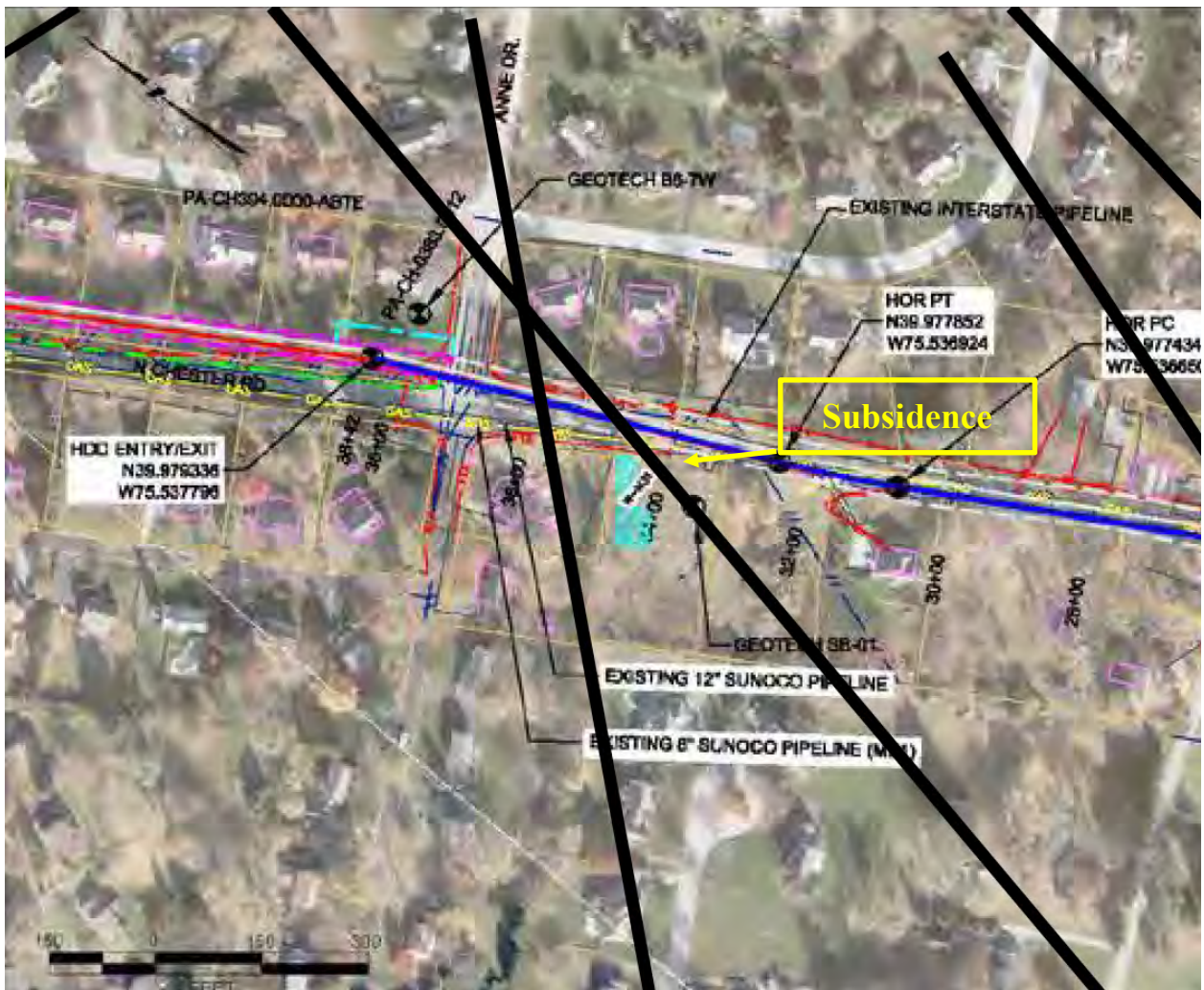


Figure 2: Enlargement of plan view showing fracture traces (black lines) from “Mariner East II HDD Hydrogeologic Reevaluation Report – HDD S3-0520 January 2018” prepared by GES (Groundwater & Environmental Services, Inc.) Approx. point of reported subsidence added.

## SUMMARY & RECOMMENDATIONS

When subsidence is observed it is always prudent to examine the feature and the surroundings, and to characterize the underlying causes, and triggers, when possible. This is especially applicable in cases where potential magnifiers of harm such as leakage of flammable fluids may be possible.

It does not appear that there is a significant danger of accelerated subsidence in the area. It seems likely that a) The installation of the Mariner II East Line is not a cause, and b) settlement due to vegetation decay and water seepage may be causes of subsidence. However, this cannot be stated with high certainty, because evidence to date does not point to a distinct cause of the subsidence.

Therefore, it is recommended:

1. That monthly visual observation of the site (30-foot radius) takes place to see if subsidence continues. If it does, we suggest excavation with independent geologist oversight to determine cause.
2. That the unused water well be examined by a qualified professional to a) determine if it has structurally failed and might be receiving regolith from the region of the subsidence, and b) that it be properly repaired and capped, or that it be properly abandoned in order to protect against aquifer contamination and collapse.
3. That the possibility of other causes for subsidence be investigated by further review of site infrastructure, and/or excavation and detailed examination of the subsidence. This might be undertaken in order to determine where the material is moving to, and whether vegetative decay is causative. For example, is it possible that an underground storage tank (UST) is present, or that failure of a sewer pipe is occurring?

Respectfully submitted,

Sasowsky Earth Science Consultants, Ltd.



Sasowsky Earth Science Consultants, Ltd.  
by Ira D. Sasowsky, Ph.D. (Secretary)



### List of Attachments

Attachment A (6 p.) PennDOT, undated, “Depression adjacent to Route 352 near Anne Drive/Bow Tree Drive, East Goshen Township, Chester County”

Attachment B (11 p.) Historic aerial photographs 1937-1995

Attachment C (4 p.) Site photographs taken January 28 by Christina Morley



Attachment A (6 p.)  
PennDOT Report



## **Depression Adjacent to Route 352 near Anne Drive/Bow Tree Drive East Goshen Township, Chester County**

The Pennsylvania Department of Transportation performed excavation of a depression on the west side of Route 352 just south of the intersection of Anne Drive/Bow Tree Drive in East Goshen Township, Chester County, on Wednesday, December 23, 2020.

The subsidence adjacent to the southbound shoulder of Route 352 appears to be caused by the presence of silty clay at a depth of 2.3 feet below the road grade. This conclusion was reached based on careful excavation of a 7-foot-by-11-foot test pit (TP-1) roughly centered on the location of the depression. In addition to the silty clay, a tree stump was excavated from the test pit. Decay of the stump may also have contributed to the subsidence at this location. During the excavation, surface water was observed running along the top of the silty clay layer. Perched surface water can also potentially contribute to subsidence. Additionally, there was no evidence of subsidence or distress on the adjacent roadway.

The result of the investigation found that moving surface water and a decaying tree stump were likely the causes of the depression. In the department's professional view, the subsidence was not a risk to the safety and stability of the state roadway.

Any questions can be directed to Sarah McInnes, P.E., PennDOT District 6 Geotechnical Engineer at (610) 205-6544 or Paula Callahan, P.G., PennDOT District 6 Geologist at (610) 205-6543.



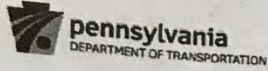












**ENGINEER'S TEST PIT LOG**

Sheet 1 of 2

Test Pit No: **TP-.1**

Project Information

ECMS# **CR 352**  
 District **6**  
 County: **Chester**  
 SR/Sect.: **252**  
 Seg./Off.:  
 Baseline:  
 Station/Offset: **1**

Coordinates:

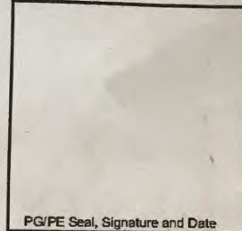
N  
 E  
 Latitude  
 Longitude

Pit Dimension  
 Ground Elevation (ft.): **2.0** ft.  
 Depth: **2.7**  
 Width: **7**  
 Length: **7**

Water Level Reading  $\nabla$  0 hr.  $\nabla$  24 hr.  
 Depth: **NR** 0 hr. **NR** 24 hr. **1, 3**

Field Logged By:  
 Inspector: **Paula Callahan**  
 Cert. Number: **020-013**  
 Drilling Company: **PennDOT**

Equipment: **Small size excavator**  
 Excavation Date: **12-23-2020**  
 Backfill Date: **12-23-2020**



Final Log Checked By:  
 Name:  
 Date:

NOTE: All graphical plots are for information only.

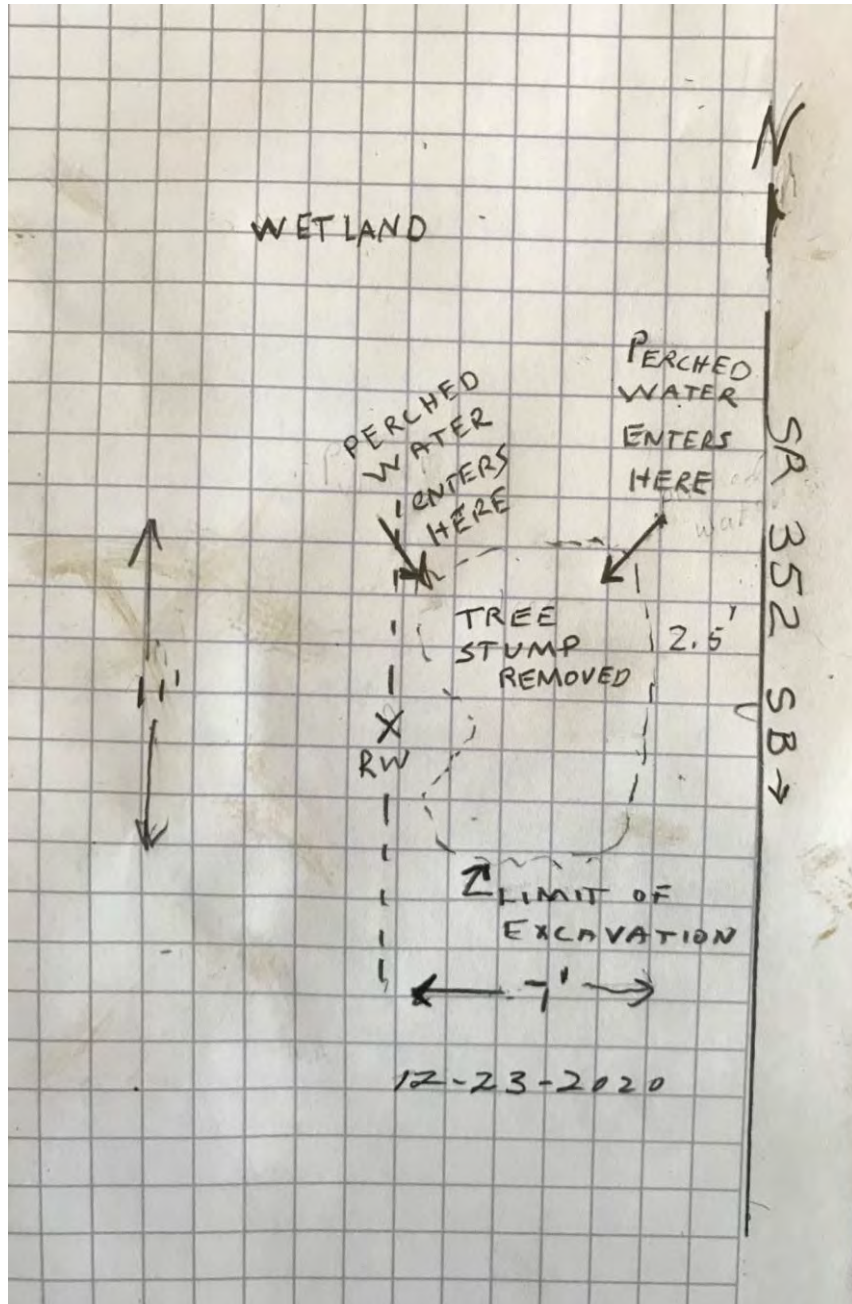
DEPTH (ft.)	GRAPHIC	MATERIAL DESCRIPTION	ASHTO/USCS	DEPTH (ft.)	BAG SAMPLE NUMBER	POCKET PEN. (lbf.)	TORVANE (lbf.)
		START 1' below ROAD GRADE 2.4 from road grade to top of alluvium					
1.3		SILT, dark brown, topsoil, wet					
2.7		SILT, light brown, some clay, moist + tree stump same		2			
		2.7' BOTTOM OF TEST PIT		3			
		Ease of Excavation = easy with moderate cutting due to water seeping in		4			
				5			
				6			
				7			
				8			
				9			
10				10			

WATER level of monitoring well = 7.0'  
 29' from edge of hole

BOTTOM OF HOLE = 3.3' 3-60  
 FROM GRADE

PENNDOT TEST PIT LOG - PENNDOT GINT 12-18-2013 PM 6:07 - 12/19/13 13:47 - SUBBUREAU OF CONSTRUCTION & MATERIALS/PROJECTS/FILE TO PRINT BLANK FORMS - FULL ROCK LEGEND - FULL SOIL LEGEND - 12-19-2013 GPJ





Attachment B (11 p)  
Historic aerial photographs 1937-1995

North is up on all images  
Scale varies – refer to roads for scale

1937





1958





1959



1965



1971



1975





1980



1985



1990



1995





Attachment C (4 p)  
Site photographs taken January 28 by Christina Morley













