SUBSURFACE INVESTIGATION &
GEOTECHNICAL RECOMMENDATIONS

PRELIMINARY INVESTIGATION - 400 ACRE WEST SITE
PETERSBURG, INDIANA
A&W PROJECT NO.: 17IN0796

PREPARED FOR:
BOWMAN FAMILY HOLDINGS, INC.
INDIANAPOLIS, INDIANA

PREPARED BY:
ALT & WITZIG ENGINEERING, INC.
GEOTECHNICAL DIVISION

APRIL 27, 2018
FINALIZED OCTOBER 26, 2018

Alt & Witzig Engineering, Inc.
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April 27, 2018
Finalized October 26, 2018

Bowman Family Holdings, Inc.
6755 Gray Road
Indianapolis, Indiana 46237
Attn: Mr. John Mandabach

Report of Subsurface Investigation and Geotechnical Recommendations

RE: Preliminary Investigation 400 Acre West Site
Petersburg, Indiana
Alt & Witzig File: 17IN0796

Dear Mr. Mandabach:

In compliance with your request, we have conducted a subsurface investigation and geotechnical evaluation for the above referenced project. It is our pleasure to transmit one (1) electronic copy of the report.

The results of our test borings and laboratory tests completed to date are presented in the appendix of the report. Our recommendations for the project are presented in the "Geotechnical Analysis and Recommendations" section of the report.

Often, because of design and construction details that occur on a project, questions arise concerning the soil conditions. If we can give further service in these matters, please contact us at your convenience.

Very truly yours,
Alt & Witzig Engineering, Inc.

BRIAN A. WIRT REGISTERED PE11300272 STATE OF INDIANA PROFESSIONAL ENGINEER

Brian A. Wirt, P.E.

David C. Harness, P.E.

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Executive Summary

Alt & Witzig Engineering, Inc. has performed a subsurface investigation and geotechnical analysis for the 400-acre site located on the west side on Interstate 69, north of West County Road 150 North in Petersburg, Indiana (Site) in conformance with the scope and limitations of our proposal dated October 11, 2017 (*A&W Proposal 1710G016*). This investigation was performed for Bowman Family Holdings, Inc. Authorization to perform this investigation was in the form of an Alt & Witzig Engineering, Inc. proposal that was accepted by the Bowman Family Holdings, Inc..

In compliance with your request, we have completed a total of sixteen (16) soil borings at the above referenced site. As you know, the borings were widely spaced and the design loads, building sizes, utility and pond depths, and building elevations are unknown at this time. Therefore, these recommendations must be considered preliminary in nature. Structure specific borings and recommendations should be prepared as design progresses.

Findings and Conclusions

From 1985 to 1997, site was surface mined for coal. The former surface mined land was reclaimed in 1997. One boring was conducted for every 25 acres of the site. Four of these borings were extended to the natural bedrock, four were extended to a depth of fifty (50) feet, and eight (8) were extended to a depth of twenty (20) feet. All of the borings encountered mine spoils or disturbed soils. The deepest borings encountered mine spoils to depths ranging between sixty (60) and eighty-six (86) feet. Most of the borings were terminated within the spoils/disturbed soils at depths of twenty (20) and fifty (50) feet, the predetermined termination depths.

It should be noted that the borings were widely spaced and that subsurface conditions should be expected to vary across the site due to the previous mining history. This report provides general subsurface conditions and outlines the construction processes anticipated for development.

INTRODUCTION

This report presents the results of a subsurface investigation for the 400-acre site located on the west side of Interstate 69, north of West County Road 150 North in Petersburg, Indiana. This investigation was conducted for Bowman Family Holdings, Inc. of Indianapolis, Indiana. Authorization to perform this investigation was in the form of a proposal prepared by Alt & Witzig that was signed by Mr. John Mandabach with Bowman Family Holdings, Inc.

The purpose of this subsurface investigation was to determine the soil profile and the engineering characteristics of the subsurface materials in order to provide criteria for use by design engineers and architects for site evaluation.

The scope of this investigation included a review of geological maps of the area; a review of geologic and related literature; a reconnaissance of the immediate sites; a subsurface exploration; field and laboratory testing; and an engineering analysis and evaluation of the encountered materials.

Our subsurface investigation was conducted in accordance with guidelines set forth in the scope of services and applicable industry standards. Due to the varying composition and depth of the mine deposits, in order to fully understand the subsurface conditions, Ground Penetrating Radar (GPR) and seismic studies would be beneficial.

The scope or purpose of this geotechnical investigation did not, either specifically or by implication, provide any environmental assessment of the site.

DESCRIPTION OF SITE

The 400-acre site is located on the west side of Interstate 69, north of West County Road 150 North in Petersburg, Indiana. The site may be located using the Petersburg, Indiana 7-½ Minute Topographic Map in Sections 3 & 10, Townships 1 South, Range 8 West. The general vicinity of the site is shown on the enclosed *Site Location Map* (Appendix A). An aerial photograph of the site taken in 2016 is provided in *Exhibit 1* below.

Exhibit 1 – 2016 Aerial Photograph of Site

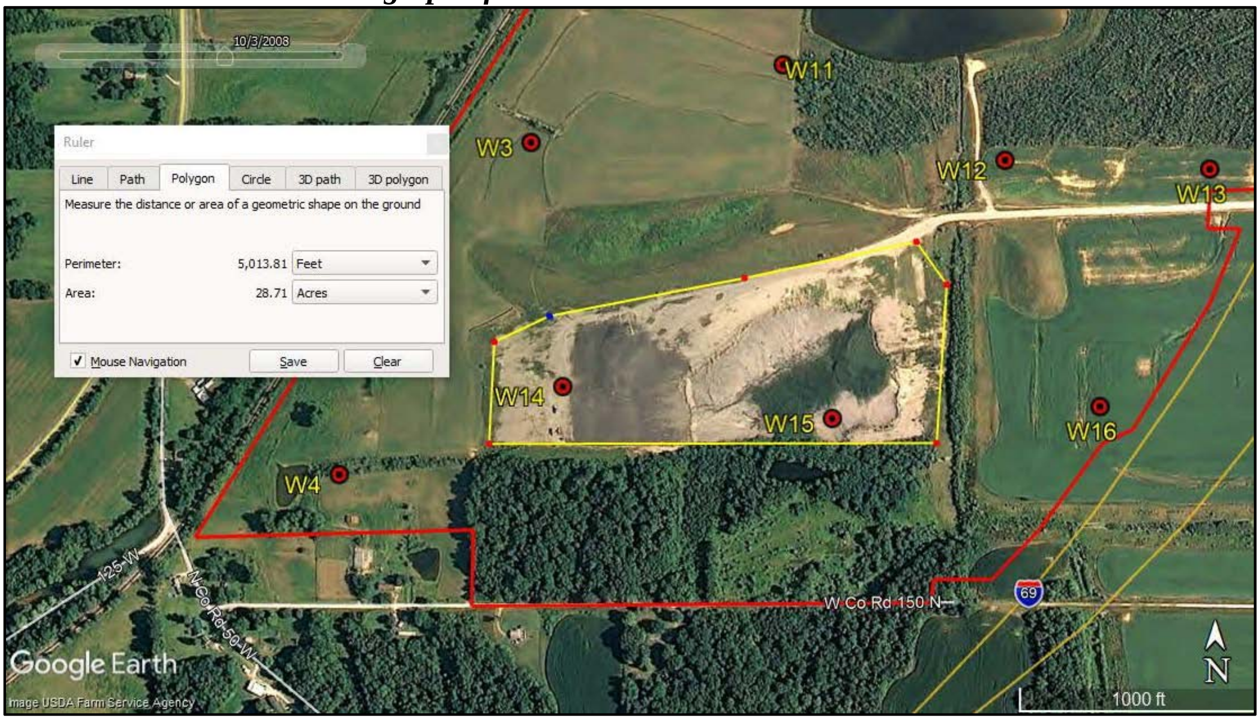
The surface of the site is sloping with an estimated relief of approximately eighty (80) feet. Drainage on the site is primarily along the ground surface into low lying areas, ditches, and ponds. The site currently consists of mostly agriculture fields with some grass, weeds, and woods. Corn stubble was present in the agricultural fields.

<u>Site History</u>

According to information obtained from Indiana DNR, from 1985 to 1997, the site was surface mined for coal. Based on observations from historical aerial photographs dating back to 1998, it appears that filling operations were being conducted on the southern end of the site until 2010.

Exhibit 2 shows that these filing operations we conducted across an approximately thirty (30) acre area.

Exhibit 2 – 2008 Aerial Photograph of Site



FIELD INVESTIGATION

Boring Locations

Alt & Witzig Engineering, Inc. staked the locations of the borings using the provided site location. The provided location was projected onto aerials provided by the Google Earth website allowing for the correlation of the approximate latitude and longitude coordinates with each boring location. These coordinates were then assigned as waypoints and uploaded into a handheld GPS unit. Utilizing the handheld GPS unit, the locations referred to on our boring logs and presented on the *Boring Location Plan* (Appendix A), were drilled in the field.

Drilling and Sampling Procedures

The soil borings were drilled using a track-mounted drilling rig equipped with a rotary head. Hollow-stem augers were used to advance the holes. The advancement of the borings was temporarily stopped at regular intervals in order to perform standard penetration tests in accordance with ASTM Procedure D-1586 to obtain the standard penetration value of the soil.

The standard penetration value is defined as the number of blows a 140 lb hammer, falling 30 inches, required to advance the split-spoon sampler 12 inches into the soil. The results of the standard penetration tests indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

The soil samples retained in the split-spoon sampling device as a result of the penetration tests were obtained, classified, and labeled for further laboratory investigation. Unless notified to the contrary, all samples will be disposed of two (2) months after the drilling date.

Water Level Measurements

Groundwater depths, during drilling operations, were estimated based on where water was observed on the sampling rods. Upon completion, the depth to water was measured using a 100-foot tape measure with a weighted end. It shall be noted that in granular soils, borings often experience caving or ‘plugging’ of the borehole opening due to sloughing of the granular soils after removal of the augers. The depth of cave/plug is also recorded on the Boring Logs. The depths presented on the Boring Logs are accurate only for the day on which they were recorded. The exact location of the water table shall be anticipated to fluctuate depending upon normal seasonal variations in preparation and surface runoff.

Ground Surface Elevation

Ground surface elevations were obtained from Google Earth™. All depths and elevations referred to in this report are assumed to be accurate to within +/- five (5) feet.

LABORATORY INVESTIGATION

A laboratory investigation was conducted to ascertain additional pertinent engineering characteristics of the subsurface materials at the site of the site. All phases of the laboratory investigation were conducted in general accordance with applicable ASTM Specifications. The laboratory testing program included:

- Visual classification of soils in accordance with ASTM D-2488.
- Moisture content determination in accordance with ASTM D-2216.

SUBSURFACE CONDITIONS

Regional Setting

The 400-acre site is located within the Southern Hills and Lowlands of Indiana at an approximate elevation of 445 to 525 feet. According to the Indiana Geological Survey, bedrock is located at elevation ranging from 400 to 450 feet consisting of mostly shale and sandstone of Pennsylvanian Age. Per a review of geologic maps, no Karst activity or mapped faults are located on or near the site. According to the *Custom Soil Resource Report for Pike County, Indiana* published by the United States Department of Agriculture Soil Conservation Service (USDS SCS), the majority of the soils covering this site are classified as Alford Silt Loam (AdC2), Belknap Silt Loam (Bg), Bonnie Silt Loam (Bo), Dumps, Mines (Du), Fairpoint Silt Loam, Reclaimed (FaB), Fairpoint-Bethesda Complex (FbG), Hosmer Silt Loam (HoB2), Wellston Silt Loam (We), Apalona-Zanesville Silt Loams (ZaC3), and Zanesville Silt Loam (ZaD3). The *Custom Soil Resource Report for Pike County, Indiana* has been included in Appendix B of this report.

Site-Specific Geologic Results

The types of foundation materials encountered have been visually classified and are described in detail on the *Boring Log* included in Appendix A of this report. The results of the field penetration tests, strength tests, water level observations and laboratory water contents are also presented on the *Boring Logs* in numerical form.

As previously mentioned, the site was previously surface mined. The soils encountered in the borings are characterized as mine spoils. The mine spoils are most likely native to the site or vicinity and have physical properties that are comparable to native soils and bedrock, thus the exact depths of the mine spoils were difficult to determine.

One boring was conducted for every 25 acres of the site. Four of these borings were extended to the natural bedrock, four were extended to a depth of fifty (50) feet, and eight (8) were extended to a depth of twenty (20) feet. All of the borings encountered mine spoils or disturbed soils. Topsoil ranged between five (5) and seven (7) inches in thickness. The deepest borings encountered mine spoils to depths ranging between sixty (60) and eighty-six (86) feet. Most of the borings were terminated within the spoils/disturbed soils at depths of twenty (20) and fifty (50) feet, the predetermined termination depths. Auger refusal was encountered between thirty-two (32) and eighty-six (86) feet below the ground surface. The mine spoils consisted of both cohesive and non-cohesive soils of varying layer thicknesses and depths. With the exception of boring W-1, moisture contents of the mine spoils ranged between 5 and 35 percent. Boring W-1 exhibited moisture contents ranging between 20 and 50 percent. Additionally, boring W-1 encountered possible marly soils, which are likely related to the former Prides Creek that ran through the site. Boring W-6 encountered an obstruction at a depth of fifteen (15) feet. This obstruction was likely a boulder.

Site-Specific Groundwater Elevations

The *Custom Soil Resource Report for Pike County, Indiana* indicates a seasonal high groundwater as shallow as the ground surface. However, the mining history of the site may have influenced the natural groundwater table.

Groundwater level measurements taken during and upon completion of the drilling operations indicate groundwater ranging from twenty-two (22) to forty-two (42) feet below the ground surface when encountered, which corresponds to elevations ranging between 438 and 450 feet. However, a majority of the borings did not encounter groundwater. The exact location of the water table should be anticipated to fluctuate somewhat depending upon normal seasonal variations in precipitation and surface runoff. It should be noted that the groundwater level measurements recorded on the individual *Boring Logs* included in Appendix A of this report, are accurate only for the dates on which the measurements were performed.

Seismic Parameters

Due to the variable nature of the subsurface conditions, in order to accurately determine the seismic site classification, it is recommended that a Multichannel Analysis of Surface Waves (MASW) be conducted. The MASW method first measures seismic surface waves generated from various types of seismic sources, analyzes the propagation velocities of those surface waves, and then finally deduces shear-wave velocity (v_s) variations below the surveyed area that is most responsible for the analyzed propagation velocity pattern of surface waves.

GEOTECHNICAL ANALYSIS & RECOMMENDATIONS

Project Description

The following recommendations are general in nature and intended solely for site evaluation purposes.

For our preliminary analysis, it is assumed that structures will be lightly to moderately loaded and founded on medium stiff cohesive mine spoil material. It is expected that these structural loads will be transferred to the soils by conventional spread footings or continuous wall footings, if possible. Once building layouts and design loads have been developed, it is recommended that structure specific borings be conducted in order to provide building specific recommendations.

Grading plans were not available at the time of this report. Due to the size of the site, it is anticipated that cuts and fills will be necessary to prepare building pads. Therefore, the foundation soils will vary with the elevation changes across the site, making our recommendations general in nature.

Concerns of Developing Reclaimed Mine Lands

As previously stated, it is known that the site was used a surface coal mine from 1985 to 1997. The former surface mined land was reclaimed in 1997. However, as previously discussed, based on observations from historical aerial photographs dating back to 1998, it appears that filling operations were being conducted on the southern end of the site until 2010.

Much of the mined land consists of filled land in the form of deep deposits of mining spoils produced by the mining operation. Even when carefully placed with compaction, such fills continue to settle under their own weight for many years. In general, most mine spoils are merely dumped and that no compaction effort is provided. For a particular fill, the amount of settlement will depend on a variety of factors, including fill depth, moisture, compaction conditions during placement, and groundwater conditions after placement.

Structures suffer minimal damage from uniform settlement. For filled land, however, a large proportion of ground settlement is of the uneven, differential settlement type, which is dictated by the depth of fill. In order to minimize the effects of differential settlement, buildings should be placed where spoil depth is relatively uniform. Ideally, buildings will also be placed where underlying spoil depth is relatively shallow. If spoil depths under a building site are even and uniform, ground settlement is more likely to be even and uniform.

Pre-construction precautions can be made in an effort to minimize the effects of total and differential settlement. Unless one of the recommended pre-construction items are implemented, it is not recommended that the site be developed within ten (10) years of final closure of the mine. It is understood that a majority of the approximately 400 acre mined area is beyond 10 years as it were reclaimed in 1997. However, as previously discussed, based on observations from historical aerial photographs dating back to 1998, it appears that filling operations were being conducted on the southern end of the site until 2010.

The first step in determining development feasibility is to determine if the mine soils are still settling under their own weight. In areas where settlement is observed, it may be beneficial to apply a surcharge load. In areas where no settlement in observed, it would then be necessary to proceed to the next step of development which would consist of ground modification. Types of ground modification are discussed later in this report. Based on the soil conditions encountered in the area of boring W-1, it is not recommended that development take place in this area.

Settlement Monitoring

It is understood that approximately 400 acres, including the mined areas, were reclaimed over ten (10) years ago. It is anticipated the spoils are continuing to settle under their own weight, especially in the areas of the deepest fills. In order to determine the rate and magnitude in which these fills are settling, it is recommended to establish a settlement monitoring program. Grade stakes consisting of six (6) foot long, #8 rebar should be driven four (4) feet into the soil in locations indentified to consist of mine spoils. The tops of the stakes should be monitored monthly by a surveyor. This data should be provided to Alt & Witzig Engineering, Inc. for review.

Surcharge and Monitoring

To reduce the potential for settlements post construction, it would be advantageous to implement surcharge loading. Placing a surcharge load pre-consolidates mine spoils beneath proposed development areas. For best performance and lowest risk of future settlement, the surcharge load must exceed the anticipated loading from the future mass fills, buildings, and roadways. Compaction of the surcharge material need not exceed a certain limit, nor be of select material. However, the density of the surcharge material will determine the required thickness. The use of subsurface drainage and a surcharge load may be considered for the site if the construction schedule can allow for the necessary timeframe. Once the surcharge material is applied, settlement stakes should be installed to observe the movement.

The surcharge fill material should be placed over the entire area and a minimum of ten (10) feet beyond the limits of the spoil soils within the building area and other areas as deemed necessary. Thus, the initial building pad, at a minimum, must be enlarged horizontally in this area to accommodate for the placement of the surcharge. The thickness and size of the surcharge load would be based on the proposed development.

The surcharge fill material may be comprised of nearly any material due to the fact that the function is to consolidate the underlying soils and then to be removed. The height and weight of the surcharge and time of the surcharge is left in place will depend on several factors. To monitor the rate and quantity of settlement, settlement plates, or grade stakes at the least, must be installed prior to the placement of the surcharge material. Elevations on each of the stakes should be obtained on a monthly basis by a licensed surveyor. The elevations should be provided to Alt & Witzig Engineering, Inc. The length of monitoring would be dependent on settlement rates and the limits of settlement dictated by the proposed structure.

Foundation Discussion

Provided settlement monitoring is performed prior to construction and movement has subsided, preparation of foundation areas may then commence. In order to support foundations, dynamic compactions, rammed-aggregate piers, or placement of compacted structural fill will be necessary. In some cases, it may be necessary to implement surcharge loading in conjunction with the preparation of foundation areas.

Ground Modification – Dynamic Compaction

Ground modification using dynamic compaction appears to be feasible at this site. Dynamic compaction consists of using a crane to drop a weight multiple times within the area of a structure to compact and soils. A ground modification specialist may be consulted to evaluate the site conditions and approximate costs of modification. Additionally, the ground modification specialist will be able to determine if additional subsurface information is necessary.

The specialty contractor should provide the drop location layout, drop height, and number of drops per location, as well as the design bearing capacity for foundations.

Ground Modification – Rammed-Aggregate Piers

Alternatively, the use of a soil modification system, such as a rammed aggregate piers or stone columns, would allow construction of conventional foundations while greatly reducing potential settlement in the fills immediately below the structure.

Rammed aggregate piers and stone columns densify the surrounding soil and provide a column of stone founded in a competent soil layer on which to base footings. After proper soil modification has taken place, conventional shallow footings may be utilized. Bearing capacities achieved through this type of ground modification will be dictated by tolerable settlement criteria. A contractor specializing in this type of work should determine specific details as to the exact number, spacing, and placement of the elements, as well as the final resulting bearing capacity and settlement estimates.

Conventional Foundations on Compacted Structural Fill

Provided the above recommended settlement monitoring and ground modification have been conducted, it may then be feasible to construct conventional foundations. Based on the anticipated lightly to moderately loaded structures, net allowable soil bearing pressures ranging from 1,500 to 3,500 psf may be possible for design of conventional foundations founded on compacted fill. Borings W-14 and W-15 encountered soft and/or loose soils. Therefore, soil bearing pressures in these areas should be expected to be on the lower end of the above recommended bearing pressure range. It is recommended that additional subsurface investigations be conducted once structure sizes and locations are determined across the site.

Due to the size of the site and the limited investigation conducted, it is recommended that each structure proposed for construction at this site have a structure specific geotechnical investigation conducted.

STATEMENT OF LIMITATIONS

This report is solely for the use of Bowman Family Holdings, Inc. and any reliance of this report by third parties shall be at such party's sole risk and may not contain sufficient information for purposes of other parties for other uses. This report shall only be presented in full and may not be used to support any other objectives than those set out in the scope of work, except where written approval and consent are provided by or Bowman Family Holdings, Inc. and Alt & Witzig Engineering, Inc.

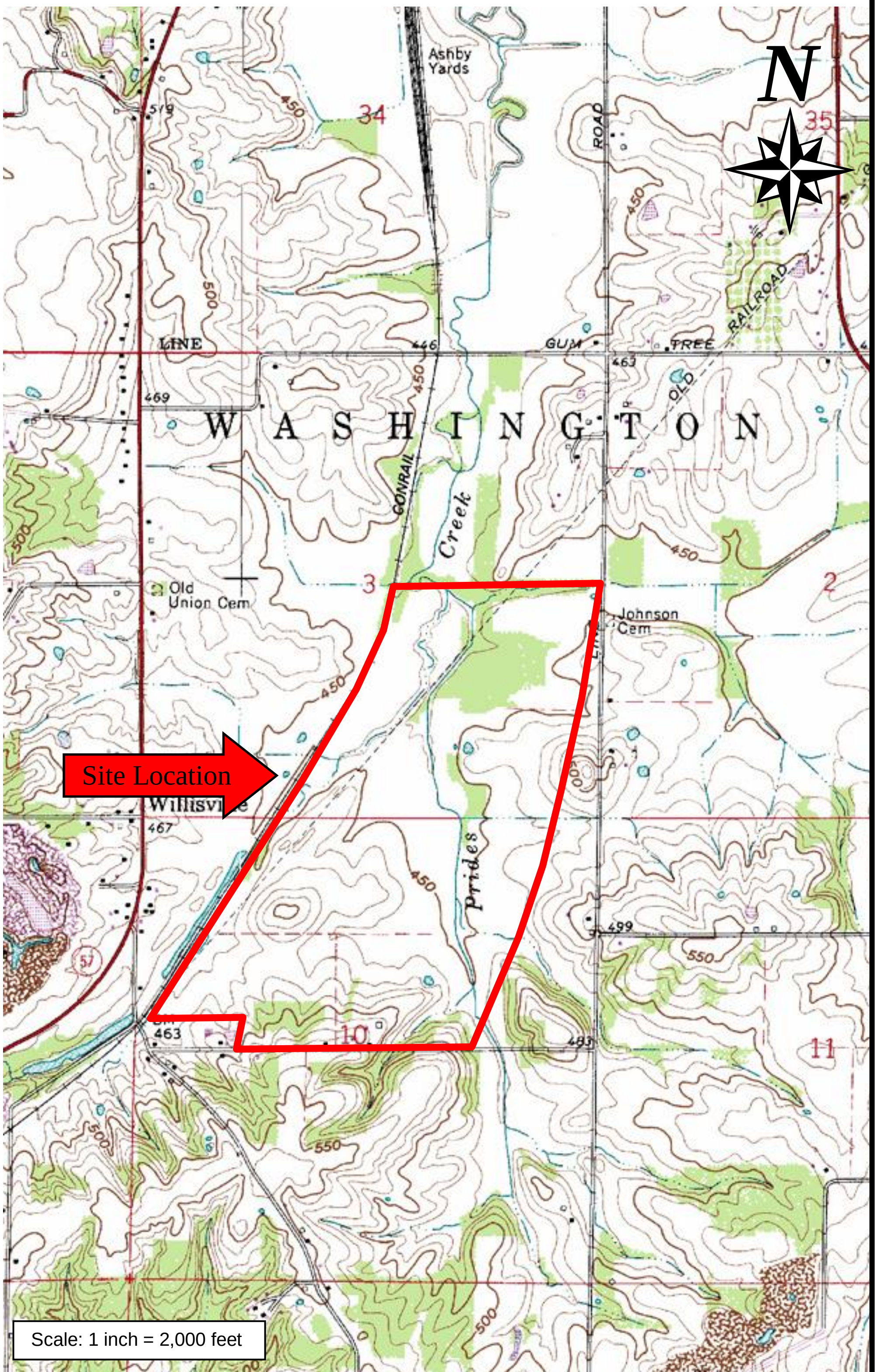
An inherent limitation of any geotechnical engineering study is that conclusions must be drawn on the basis of data collected at a limited number of discrete locations. The geotechnical parameters provided in this report were developed from the information obtained from the test borings that depict subsurface conditions only at these specific locations and on the particular date indicated on the boring logs. Soil conditions at other locations may differ from conditions encountered at these boring locations and groundwater levels shall be expected to vary with time. The nature and extent of variations between the borings may not become evident until the course of construction.

The exploration and analysis reported herein is considered in sufficient detail and scope to form a reasonable basis for preliminary site evaluation. The recommendations submitted are based on the available soil information and assumed design details enumerated in this report. If actual design details differ from those specified in this report, this information should be brought to the attention of Alt & Witzig Engineering, Inc. so that it may be determined if changes in the foundation recommendations are required. If deviations from the noted subsurface conditions are encountered during construction, they should also be brought to the attention of Alt & Witzig Engineering, Inc.

APPENDIX A

Site Location Map
Boring Location Plan
Boring Logs
General Notes

SITE LOCATION MAP



USGS Topographic Map:
Petersburg Quadrangle

Township: T 1 S.
Range: R 8 W.
Section: 3 & 10

PROJECT: **Preliminary Investigation-400 Acre West Site**
LOCATION: Petersburg, Indiana
CLIENT: **Bowman Family Holdings, Inc.**
A&W File No.: 17IN0796

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Last Modified: 3/16/2018 11:43 AM

BORING LOCATION PLAN

Prepared For: Bowman Family Holdings, Inc.	A&W	**Prepared By:** Alt & Witzig Engineering, Inc.	
Project Name: Preliminary Investigation - 400 Acre Site		**Project No:** 17IN0796	**Date:** 03/18

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **Bowman Family Holdings, Inc.**

BORING # **W-01**

PROJECT NAME **Preliminary Investigation - 400 Acre West Site**

ALT & WITZIG FILE # **17IN0796**

PROJECT LOCATION **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started **2/20/18** Hammer Wt. **140** lbs.

Date Completed **2/20/18** Hammer Drop **30** in.

Boring Method **HSA** Spoon Sampler OD **2** in.

Driller **M. Winkler** Rig Type **D-50 Track ATV**

TEST DATA

SURFACE ELEVATION 473.0

STRATA ELEV.	SOIL CLASSIFICATION	Strata Depth	Sample No.	Sample Type	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % *Dry Unit Weight (pcf)*	Remarks
472.6	TOPSOIL	0.4								
466.0	Brown and Gray Silty Sandy CLAY *(FILL)*	7.0	1	SS		12			20.5	
			2	SS		20			21.0	
450.0	Gray SHALE and SANDSTONE Fragments *(FILL)*	23.0	3	SS		50/5"				
			4	SS		11				
			5	SS		14				
			6	SS		50/5"				
431.5	Gray Silty CLAY with Organic Matter and Shells *(FILL, Possible Marl)*	41.5	7	SS		5			25.7	
			8	SS	○	9			25.9	
			9	SS		6			24.9	
			10	SS		7			38.7	
420.0	Brown and Gray Silty CLAY *(FILL)*	53.0	11	SS		7			29.0	
			12	SS		8			22.0	
401.5	Gray Silty CLAY with Organic Matter and Shells *(FILL, Possible Marl)*	71.5	13	SS		10			40.2	
			14	SS		9			23.5	
			15	SS		10			25.0	
			16	SS		9			50.5	
389.5	Gray CLAY with a Trace of Sand and Silt *(FILL)*	83.5	17	SS		8			37.5	
			18	SS		7			17.8	
387.0	Gray Clayey SHALE *(FILL)*	86.0	19	SS		50/4"			8.3	

Auger Refusal at 86.0 feet.
End of Boring at 86 feet

Sample Type

SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater

○ During Drilling *29.0 ft.*
▽ At Completion *ft.*

Boring Method

HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **Bowman Family Holdings, Inc.**

BORING # **W-02**

PROJECT NAME **Preliminary Investigation - 400 Acre West Site**

ALT & WITZIG FILE # **17IN0796**

PROJECT LOCATION **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started	**2/22/18**	Hammer Wt.	**140** lbs.
Date Completed	**2/22/18**	Hammer Drop	**30** in.
Boring Method	**HSA**	Spoon Sampler OD	**2** in.
Driller	**M. Winkler**	Rig Type	**D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION / SURFACE ELEVATION 477.0	Strata Depth	Depth Scale	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % / *Dry Unit Weight (pcf)*	Remarks
476.5	TOPSOIL	0.5										
				1	SS			13			16.6	
472.0	Brown Silty Sandy CLAY with Gravel *(FILL)*	5.0	5	2	SS			46				
468.5	Gray SILT with a Trace of Clay and Coal Fragments *(FILL)*	8.5		3	SS			41				
			10	4	SS			20				
			15	5	SS			12				
			20	6	SS			36				
456.0	Gray SANDSTONE Fragments *(FILL)*	21.0										
	End of Boring at 21 feet											

Sample Type

SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater

○ During Drilling *Dry ft.*
∇ At Completion *Dry ft.*

Boring Method

HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **Bowman Family Holdings, Inc.**
BORING # **W-03**
PROJECT NAME **Preliminary Investigation - 400 Acre West Site**
ALT & WITZIG FILE # **17IN0796**
PROJECT LOCATION **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started **2/26/18**
Hammer Wt. **140** lbs.
Date Completed **2/26/18**
Hammer Drop **30** in.
Boring Method **HSA**
Spoon Sampler OD **2** in.
Driller **M. Winkler**
Rig Type **D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION / SURFACE ELEVATION 470.0	Strata Depth	Depth Scale	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % *Dry Unit Weight (pcf)*	Remarks
469.5	TOPSOIL	0.5										
	Brown Silty Sandy CLAY *(FILL)*			1	SS			5			19.7	
465.0		5.0	5	2	SS			9			14.4	
461.5	Gray Silty Sandy CLAY with Sandstone Fragments *(FILL)*	8.5		3	SS			23				
			10	4	SS			77				
	Gray, Dry SANDSTONE Fragments *(FILL)*		15	5	SS			20				
450.0		20.0	20	6	SS			4			24.1	
449.0	Brown and Gray Silty CLAY with a Trace of Sand *(FILL)*	21.0										
	End of Boring at 21 feet											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater
○ During Drilling *Dry ft.*
▽ At Completion *Dry ft.*

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **Bowman Family Holdings, Inc.**

BORING # **W-04**

PROJECT NAME **Preliminary Investigation - 400 Acre West Site**

ALT & WITZIG FILE # **17IN0796**

PROJECT LOCATION **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started	**2/27/18**	Hammer Wt.	**140** lbs.
Date Completed	**2/27/18**	Hammer Drop	**30** in.
Boring Method	**HSA**	Spoon Sampler OD	**2** in.
Driller	**M. Winkler**	Rig Type	**D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION / SURFACE ELEVATION 465.0	Strata Depth	Depth Scale	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % / *Dry Unit Weight (pcf)*	Remarks
464.4	TOPSOIL	0.6										
				1	SS			5			21.2	
459.0	Brown Silty Sandy CLAY *(FILL)*	6.0	5	2	SS			11			20.0	
				3	SS			12			21.5	
			10	4	SS			15			22.7	
449.0	Brown and Gray Silty Sandy CLAY *(FILL)*	16.0	15	5	SS			50/2"			14.3	
444.0	Brown and Gray SHALE *(FILL)*	21.0	20	6	SS			42			12.2	
439.0	Gray SILTSTONE *(FILL)*	26.0	25	7	SS			50/5"				
			30	8	SS			50/5"				
			35	9	SS			50/1"				
			40	10	SS			50/2"				
			45	11	SS			50/3"				
414.0	Gray, Dry SANDSTONE *(FILL)*	51.0	50	12	SS			50/3"				
	End of Boring at 51 feet											

Sample Type
- SS - Driven Split Spoon
- ST - Pressed Shelby Tube
- CA - Continuous Flight Auger
- RC - Rock Core
- CU - Cuttings
- CT - Continuous Tube

Groundwater
- ○ During Drilling *Dry ft.*
- ⊻ At Completion *ft.*

Boring Method
- HSA - Hollow Stem Augers
- CFA - Continuous Flight Augers
- DC - Driving Casing
- MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT: **Bowman Family Holdings, Inc.**
BORING #: **W-05**
PROJECT NAME: **Preliminary Investigation - 400 Acre West Site**
ALT & WITZIG FILE #: **17IN0796**
PROJECT LOCATION: **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started	**2/15/18**	Hammer Wt.	**140** lbs.
Date Completed	**2/15/18**	Hammer Drop	**30** in.
Boring Method	**HSA**	Spoon Sampler OD	**2** in.
Driller	**M. Winkler**	Rig Type	**D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION / SURFACE ELEVATION 471.0	Strata Depth	Depth Scale	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % / *Dry Unit Weight (pcf)*	Remarks
470.5	TOPSOIL	0.5										
	Brown and Gray Silty Sandy CLAY *(FILL)*			1	SS			8			19.0	
			5	2	SS			6			20.1	
				3	SS			13			12.8	
461.0		10.0	10	4	SS			39			10.2	
	Gray SHALE *(FILL)*		15	5	SS			9			6.5	
			20	6	SS			6			10.4	
450.0		21.0										
	End of Boring at 21 feet											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater
○ During Drilling *Dry ft.*
▽ At Completion *Dry ft.*

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **Bowman Family Holdings, Inc.**
BORING # **W-06**
PROJECT NAME **Preliminary Investigation - 400 Acre West Site**
ALT & WITZIG FILE # **17IN0796**
PROJECT LOCATION **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started	**2/19/18**	Hammer Wt.	**140** lbs.
Date Completed	**2/19/18**	Hammer Drop	**30** in.
Boring Method	**HSA**	Spoon Sampler OD	**2** in.
Driller	**J. Livingston**	Rig Type	**D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION / SURFACE ELEVATION 482.0	Strata Depth	Depth Scale	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % / *Dry Unit Weight (pcf)*	Remarks
481.5	TOPSOIL	0.5										
				1	SS			14			21.9	
	Brown and Gray Silty CLAY *(FILL)*		5	2	SS			10			17.0	
474.0		8.0		3	SS			46			5.8	
			10	4	SS			14				
	Gray SHALE *(FILL)*		15	5	SS			50/3"				Auger refusal encountered at 15.0 feet. Boring offset and redrilled.
462.0		20.0	20	6	SS			13			22.7	
461.0	Gray Clayey SHALE *(FILL)*	21.0										
	End of Boring at 21 feet											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater
○ During Drilling *Dry ft.*
▽ At Completion *Dry ft.*

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **Bowman Family Holdings, Inc.**
BORING # **W-07**
PROJECT NAME **Preliminary Investigation - 400 Acre West Site**
ALT & WITZIG FILE # **17IN0796**
PROJECT LOCATION **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started **2/19/18** Hammer Wt. **140** lbs.
Date Completed **2/19/18** Hammer Drop **30** in.
Boring Method **HSA** Spoon Sampler OD **2** in.
Driller **J. Livingston** Rig Type **D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION / SURFACE ELEVATION 477.0	Strata Depth	Depth Scale	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % / *Dry Unit Weight (pcf)*	Remarks
476.6	TOPSOIL	0.4										
	Brown Sandy CLAY *(FILL)*			1	SS			8			17.9	
471.5		5.5	5	2	SS			27			9.2	
	Gray SHALE *(FILL)*			3	SS			35			10.0	
			10	4	SS			17			9.1	
			15	5	SS			15			8.0	
			20	6	SS			7			5.9	
452.0		25.0	25	7	SS			7			19.9	
	Gray Clayey SHALE *(FILL)*		30	8	SS			8			16.4	
442.0		35.0	35	9	SS			9			25.0	
	Brown and Gray Silty CLAY *(FILL)*		40	10	SS			11			21.2	
			45	11	SS			14			20.8	
429.5		47.5		12	SS			50/0"				
	Auger Refusal at 47.5 feet. End of Boring at 47.5 feet											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater
○ During Drilling *Dry ft.*
▽ At Completion *Dry ft.*

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **Bowman Family Holdings, Inc.**
BORING # **W-08**
PROJECT NAME **Preliminary Investigation - 400 Acre West Site**
ALT & WITZIG FILE # **17IN0796**
PROJECT LOCATION **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started	**2/19/18**	Hammer Wt.	**140** lbs.
Date Completed	**2/19/18**	Hammer Drop	**30** in.
Boring Method	**HSA**	Spoon Sampler OD	**2** in.
Driller	**J. Livingston**	Rig Type	**D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION / SURFACE ELEVATION 493.0	Strata Depth	Depth Scale	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % *Dry Unit Weight (pcf)*	Remarks
492.5	TOPSOIL	0.5										
	Brown Silty Sandy CLAY *(FILL)*			1	SS			12			20.8	
488.0		5.0	5	2	SS			17			17.1	
	Gray SILT with a Trace of Clay *(FILL)*			3	SS			23			13.0	
484.5		8.5										
	Gray, Dry SANDSTONE *(FILL)*		10	4	SS			34				
			15	5	SS			15				
			20	6	SS			50/0"				
472.0	End of Boring at 21 feet	21.0										

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater
○ During Drilling *Dry ft.*
∇ At Completion *Dry ft.*

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **Bowman Family Holdings, Inc.**
BORING # **W-09**
PROJECT NAME **Preliminary Investigation - 400 Acre West Site**
ALT & WITZIG FILE # **17IN0796**
PROJECT LOCATION **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started	**2/20/18**	Hammer Wt.	**140** lbs.
Date Completed	**2/20/18**	Hammer Drop	**30** in.
Boring Method	**HSA**	Spoon Sampler OD	**2** in.
Driller	**M. Winkler**	Rig Type	**D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION / SURFACE ELEVATION 490.0	Strata Depth	Sample No.	Sample Type	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % / *Dry Unit Weight (pcf)*	Remarks
489.5	TOPSOIL	0.5							
	Brown Silty Sandy CLAY *(FILL)*		1	SS	8			20.1	
483.0		7.0	2	SS	24				
	Brown, Dry SANDSTONE *(FILL)*		3	SS	28				
			4	SS	12				
			5	SS	16				
			6	SS	14				
463.5		26.5	7	SS	13				
	Brown and Gray, Dry SANDSTONE with SHALE *(FILL)*		8	SS	13				
			9	SS	5				
			10	SS	8				
			11	SS	50/0"				
439.0		51.0	12	SS	50/0"				
	End of Boring at 51 feet								

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater
○ During Drilling *Dry ft.*
▽ At Completion *Dry ft.*

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **Bowman Family Holdings, Inc.**
BORING # **W-10**
PROJECT NAME **Preliminary Investigation - 400 Acre West Site**
ALT & WITZIG FILE # **17IN0796**
PROJECT LOCATION **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started	**2/22/18**	Hammer Wt.	**140** lbs.
Date Completed	**2/22/18**	Hammer Drop	**30** in.
Boring Method	**HSA**	Spoon Sampler OD	**2** in.
Driller	**M. Winkler**	Rig Type	**D-50 Track ATV**

TEST DATA

SURFACE ELEVATION 482.0

STRATA ELEV.	SOIL CLASSIFICATION	Strata Depth	Depth Scale	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % / *Dry Unit Weight (pcf)*	Remarks
481.5	TOPSOIL	0.5										
				1	SS			26			9.6	
			5	2	SS			27			11.6	
				3	SS			10			6.3	
	Gray Silty Sandy CLAY *(FILL)*		10	4	SS			8			11.5	
			15	5	SS			9			13.3	
461.0		21.0	20	6	SS			9			19.1	
456.0	Gray Silty CLAY with a Trace of Sand *(FILL)*	26.0	25	7	SS			8				
			30	8	SS			15				
	Gray SANDSTONE *(FILL)*		35	9	SS			19				
441.0		41.0	40	10	SS		○	15			16.5	
436.0	Gray Silty Sandy CLAY *(FILL)*	46.0	45	11	SS			12			24.9	
431.0	Brown and Gray Silty Sandy CLAY *(FILL)*	51.0	50	12	SS			50/4"				
426.0	Black Silty CLAY, COAL and SANDSTONE *(FILL)*	56.0	55	13	SS			11				
422.0	Gray, Moist SANDSTONE *(FILL)*	60.0	60	14	SS			50/3"				
	Auger Refusal at 60 feet. End of Boring at 60 feet											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater
○ During Drilling *42.0 ft.*
▽ At Completion *ft.*

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **Bowman Family Holdings, Inc.**
BORING # **W-11**
PROJECT NAME **Preliminary Investigation - 400 Acre West Site**
ALT & WITZIG FILE # **17IN0796**
PROJECT LOCATION **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started **2/26/18**
Hammer Wt. **140** lbs.
Date Completed **2/26/18**
Hammer Drop **30** in.
Boring Method **HSA**
Spoon Sampler OD **2** in.
Driller **M. Winkler**
Rig Type **D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION / SURFACE ELEVATION 460.0	Strata Depth	Depth Scale	Sample No.	Sample Type	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % *Dry Unit Weight (pcf)*	Remarks
459.4	TOPSOIL	0.6									
	Gray Silty CLAY with SHALE			1	SS		8			14.9	
454.0	*(FILL)*	6.0	5	2	SS		8				
				3	SS		50/6"				
	Gray SANDSTONE *(FILL)*		10	4	SS		29				
445.0		15.0	15	5	SS		50/6"				
			20	6	SS	○	21				
	Gray SHALE *(FILL)*		25	7	SS		23				
			30	8	SS		22				
425.0		35.0	35	9	SS		50/6"			16.3	
421.5	Gray SANDSTONE *(FILL)*	38.5									
			40	10	SS		17				
	Gray SHALE *(FILL)*		45	11	SS		16				
410.0		50.0	50	12	SS		25				
405.0	Gray SHALE and SANDSTONE with a Trace of Clay *(FILL)*	55.0	55	13	SS		16				
399.0	Black, Wet SHALE and SANDSTONE *(FILL)*	61.0	60	14	SS		35				
397.0	Black and Gray, Moist SHALE and SANDSTONE with a Trace of Clay *(FILL)*	63.0		15	SS		50/0"				
	Auger Refusal at 63.0 feet. End of Boring at 63 feet										

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater
○ During Drilling *22.0 ft.*
▽ At Completion *ft.*

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **Bowman Family Holdings, Inc.**
BORING # **W-12**
PROJECT NAME **Preliminary Investigation - 400 Acre West Site**
ALT & WITZIG FILE # **17IN0796**
PROJECT LOCATION **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started	**2/27/18**	Hammer Wt.	**140** lbs.
Date Completed	**2/27/18**	Hammer Drop	**30** in.
Boring Method	**HSA**	Spoon Sampler OD	**2** in.
Driller	**M. Winkler**	Rig Type	**D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION / SURFACE ELEVATION 459.0	Strata Depth	Depth Scale	Sample No.	Sample Type	Sampler Graphics Recovery Graphics	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % *Dry Unit Weight (pcf)*	Remarks
458.5	TOPSOIL	0.5										
	Brown Silty Sandy CLAY with Sandstone Fragments *(FILL)*			1	SS			9			17.5	
455.5		3.5										
	Brown Silty Sandy CLAY *(FILL)*		5	2	SS			14			15.3	
453.0		6.0										
451.8	Brown and Gray Silty Sandy CLAY *(FILL)*	7.3		3	SS			20			14.9	
450.5	Gray SANDSTONE with SHALE *(FILL)*	8.5										
449.0	Brown and Gray Silty Sandy CLAY *(FILL)*	10.0	10	4	SS			19			18.4	
448.0	Gray SHALE and SANDSTONE *(FILL)*	11.0										
	Gray SILT with Some Clay *(FILL)*		15	5	SS			5			22.5	
443.0		16.0										
	Brown and Gray Silty CLAY with a Trace of Sand *(FILL)*		20	6	SS			6			34.1	
438.0		21.0										
	End of Boring at 21 feet											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater
○ During Drilling *Dry ft.*
∇ At Completion *Dry ft.*

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **Bowman Family Holdings, Inc.**
BORING # **W-13**
PROJECT NAME **Preliminary Investigation - 400 Acre West Site**
ALT & WITZIG FILE # **17IN0796**
PROJECT LOCATION **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started	**2/27/18**	Hammer Wt.	**140** lbs.
Date Completed	**2/27/18**	Hammer Drop	**30** in.
Boring Method	**HSA**	Spoon Sampler OD	**2** in.
Driller	**M. Winkler**	Rig Type	**D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION / SURFACE ELEVATION 466.0	Strata Depth	Depth Scale	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % / *Dry Unit Weight (pcf)*	Remarks
465.4	TOPSOIL	0.6										
	Brown Silty Sandy CLAY *(FILL)*			1	SS			4			23.1	
460.5		5.5	5	2	SS			35			16.1	
	Gray SHALE and SANDSTONE *(FILL)*			3	SS			14			9.1	
			10	4	SS			14				
			15	5	SS			8				
			20	6	SS			6				Driving on a Rock
445.0	End of Boring at 21 feet	21.0										

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater
○ During Drilling *Dry ft.*
∇ At Completion *Dry ft.*

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **Bowman Family Holdings, Inc.**
PROJECT NAME **Preliminary Investigation - 400 Acre West Site**
PROJECT LOCATION **Petersburg, Indiana**

BORING # **W-14**
ALT & WITZIG FILE # **17IN0796**

DRILLING and SAMPLING INFORMATION

Date Started	**2/26/18**	Hammer Wt.	**140** lbs.
Date Completed	**2/26/18**	Hammer Drop	**30** in.
Boring Method	**HSA**	Spoon Sampler OD	**2** in.
Driller	**M. Winkler**	Rig Type	**D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION — SURFACE ELEVATION 470.0	Strata Depth	Depth Scale	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % / *Dry Unit Weight (pcf)*	Remarks
469.4	TOPSOIL	0.6										
	Brown Sandy CLAY *(FILL)*			1	SS			7			16.9	
			5	2	SS			10			17.4	
462.5		7.5		3	SS			9				
	Gray SHALE and SANDSTONE *(FILL)*		10	4	SS			9				
455.0		15.0	15	5	SS			3			24.3	
449.0	Black Silty CLAY *(FILL)*	21.0	20	6	SS			7			12.6	
	Gray Sandy CLAY *(FILL)*		25	7	SS		○	7			21.9	
			30	8	SS			6			23.6	
434.0		36.0	35	9	SS			7			23.8	
	Black CLAY and SHALE Fragments *(FILL)*		40	10	SS			10			18.8	
			45	11	SS			8				
419.0		51.0	50	12	SS			9			23.7	
	End of Boring at 51 feet											

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater
○ During Drilling *25.0 ft.*
∇ At Completion *ft.*

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT: **Bowman Family Holdings, Inc.**

BORING #: **W-15**

PROJECT NAME: **Preliminary Investigation - 400 Acre West Site**

ALT & WITZIG FILE #: **17IN0796**

PROJECT LOCATION: **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started	**2/26/18**	Hammer Wt.	**140** lbs.
Date Completed	**2/26/18**	Hammer Drop	**30** in.
Boring Method	**HSA**	Spoon Sampler OD	**2** in.
Driller	**M. Winkler**	Rig Type	**D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION — SURFACE ELEVATION 456.0	Strata Depth	Depth Scale	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % / *Dry Unit Weight (pcf)*	Remarks
455.5	TOPSOIL	0.5										
	Brown Silty Sandy CLAY *(FILL)*			1	SS			7			20.9	
451.0		5.0	5	2	SS			10				
	Gray SANDSTONE *(FILL)*			3	SS			4				
			10	4	SS			3				
			15	5	SS			3				
			20	6	SS			4			31.4	
435.0		21.0										
	End of Boring at 21 feet											

Sample Type
- SS - Driven Split Spoon
- ST - Pressed Shelby Tube
- CA - Continuous Flight Auger
- RC - Rock Core
- CU - Cuttings
- CT - Continuous Tube

Groundwater
- ○ During Drilling: *Dry ft.*
- ▽ At Completion: *Dry ft.*

Boring Method
- HSA - Hollow Stem Augers
- CFA - Continuous Flight Augers
- DC - Driving Casing
- MD - Mud Drilling

BORING LOG

Alt & Witzig Engineering, Inc.

CLIENT **Bowman Family Holdings, Inc.**
BORING # **W-16**
PROJECT NAME **Preliminary Investigation - 400 Acre West Site**
ALT & WITZIG FILE # **17IN0796**
PROJECT LOCATION **Petersburg, Indiana**

DRILLING and SAMPLING INFORMATION

Date Started	**2/27/18**	Hammer Wt.	**140** lbs.
Date Completed	**2/27/18**	Hammer Drop	**30** in.
Boring Method	**HSA**	Spoon Sampler OD	**2** in.
Driller	**M. Winkler**	Rig Type	**D-50 Track ATV**

TEST DATA

STRATA ELEV.	SOIL CLASSIFICATION / SURFACE ELEVATION 474.0	Strata Depth	Depth Scale	Sample No.	Sample Type	Sampler Graphics / Recovery Graphics	Ground Water	Standard Penetration Test, N - blows/foot	Qu-tsf Unconfined Compressive Strength	PP-tsf Pocket Penetrometer	Moisture Content % / *Dry Unit Weight (pcf)*	Remarks
473.5	TOPSOIL	0.5										
	Brown Silty CLAY *(FILL)*			1	SS			6			18.1	
			5	2	SS			6			18.1	
				3	SS			37			18.6	
464.0		10.0	10	4	SS			50/1"				
	Gray CLAY with Shale, Sandstone, and Limestone Fragments *(FILL)*		15	5	SS			31				
			20	6	SS			29				
450.0		24.0					○					
	Gray and Black, Wet Sandy LIMESTONE Fragments *(FILL)*		25	7	SS			50/0"				
			30	8	SS			18				
442.0	Auger Refusal at 32.0 feet. End of Boring at 32 feet	32.0										

Sample Type
SS - Driven Split Spoon
ST - Pressed Shelby Tube
CA - Continuous Flight Auger
RC - Rock Core
CU - Cuttings
CT - Continuous Tube

Groundwater
○ During Drilling *24.0 ft.*
∇ At Completion *ft.*

Boring Method
HSA - Hollow Stem Augers
CFA - Continuous Flight Augers
DC - Driving Casing
MD - Mud Drilling

MATERIAL GRAPHICS LEGEND

FILL: Fill (made ground)

TOPSOIL

SOIL PROPERTY SYMBOLS

N: *Standard "N" penetration value. Blows per foot of a 140-lb hammer falling 30" on a 2" O.D. split-spoon.*

Qu: *Unconfined Compressive Strength, tsf*

PP: *Pocket Penetrometer, tsf*

LL: *Liquid Limit, %*

PL: *Plastic Limit, %*

PI: *Plasticity Index, %*

DRILLING AND SAMPLING SYMBOLS

GROUNDWATER SYMBOLS

○ *Apparent water level noted while drilling.*

▽ *Apparent water level noted upon completion.*

▼ *Apparent water level noted upon delayed time.*

SAMPLER SYMBOLS

☒ SS: Split Spoon

RELATIVE DENSITY & CONSISTANCY CLASSIFICATION (NON-COHESIVE SOILS)

TERM	*BLOWS PER FOOT*
Very Loose	0 - 5
Loose	6 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	>51

RELATIVE DENSITY & CONSISTANCY CLASSIFICATION (COHESIVE SOILS)

TERM	*BLOWS PER FOOT*
Very Soft	0 - 3
Soft	4 - 5
Medium Stiff	6 - 10
Stiff	11 - 15
Very Stiff	16 - 30
Hard	>31

Alt & Witzig Engineering, Inc.
4105 West 99th St.
Carmel, IN 46032
Telephone: 317-875-7000
Fax:

GENERAL NOTES

Project: Preliminary Investigation - 400 Acre West Site

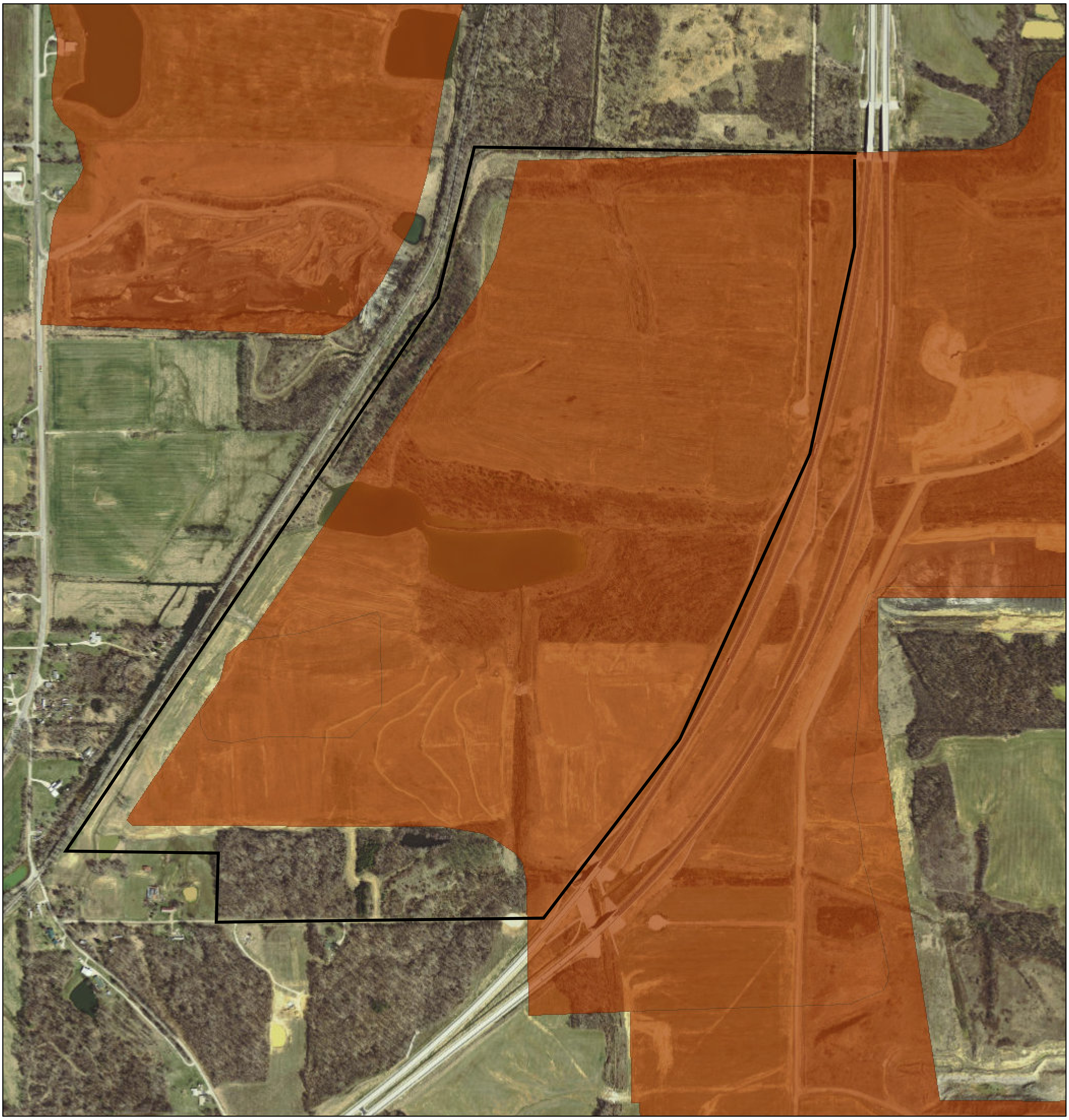
Location: Petersburg, Indiana

Number: 17IN0796

APPENDIX B

Indiana GIS Mine Map
Custom Soil Resource of Pike County, Indiana

Indiana AML Sites



3/15/2018, 8:28:14 AM

Surface Mine

1:8,000

0 0.075 0.15 0.3 mi

0 0.075 0.15 0.3 km

Indiana Office of Information Technology, Indiana University Spatial Data Portal, UITS, Woolpert Inc., United States Department of Agriculture

NRCS

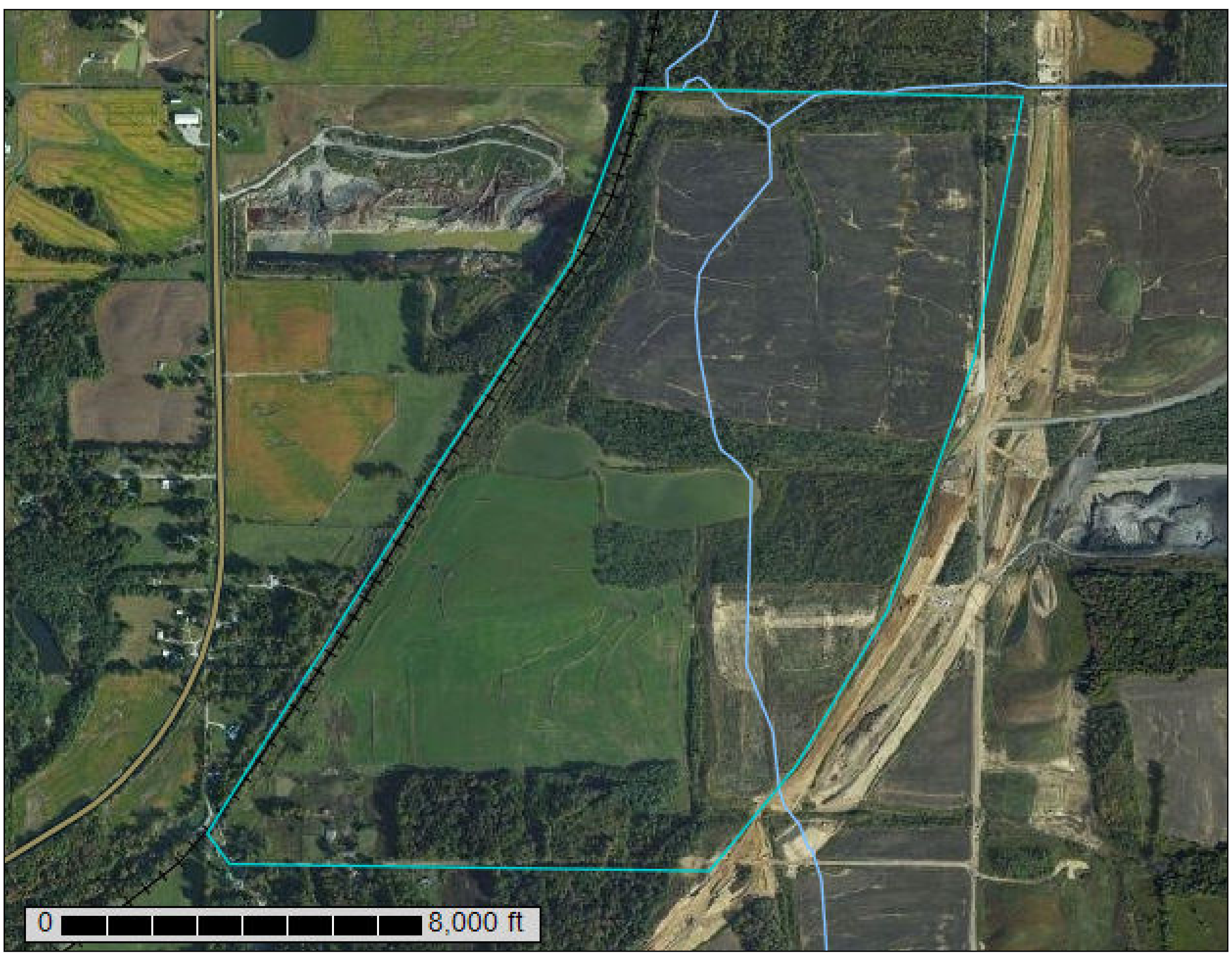
Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Pike County, Indiana

17IN0796



March 14, 2018

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map

Map Scale: 1:13,800 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 200, 400, 800, 1200

Feet: 0, 500, 1000, 2000, 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Pike County, Indiana
Survey Area Data: Version 18, Sep 13, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 27, 2011—Oct 5, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AdC2	Alford silt loam, 5 to 10 percent slopes, eroded	0.1	0.0%
Bg	Belknap silt loam, 0 to 2 percent slopes, frequently flooded	2.3	0.6%
Bo	Bonnie silt loam, 0 to 2 percent slopes, frequently flooded	31.8	7.9%
Du	Dumps, mine	11.6	2.9%
FaB	Fairpoint silt loam, reclaimed, 1 to 15 percent slopes	300.9	74.4%
FbG	Fairpoint-Bethesda complex, 25 to 70 percent slopes	0.0	0.0%
HoB2	Hosmer silt loam, 2 to 5 percent slopes, eroded	15.7	3.9%
W	Water	14.0	3.5%
WeE	Wellston silt loam, 15 to 30 percent slopes	4.5	1.1%
ZaC3	Apalona-Zanesville silt loams, 6 to 12 percent slopes, severely eroded	9.2	2.3%
ZaD3	Zanesville silt loam, 12 to 18 percent slopes, severely eroded	14.6	3.6%
Totals for Area of Interest		**404.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Pike County, Indiana

AdC2—Alford silt loam, 5 to 10 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2x06b
Elevation: 330 to 850 feet
Mean annual precipitation: 41 to 48 inches
Mean annual air temperature: 52 to 59 degrees F
Frost-free period: 170 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Alford, eroded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Alford, Eroded

Setting

Landform: Loess hills
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loess over gritty loess

Typical profile

Ap - 0 to 6 inches: silt loam
Bt1 - 6 to 26 inches: silty clay loam
Bt2 - 26 to 73 inches: silt loam
2BC - 73 to 79 inches: silt loam

Properties and qualities

Slope: 5 to 10 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Hosmer, eroded

Percent of map unit: 6 percent
Landform: Loess hills
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Alvin

Percent of map unit: 2 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Wakeland, frequently flooded

Percent of map unit: 2 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Bg—Belknap silt loam, 0 to 2 percent slopes, frequently flooded

Map Unit Setting

National map unit symbol: 2tbrv
Elevation: 330 to 490 feet
Mean annual precipitation: 35 to 46 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 175 to 200 days
Farmland classification: Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season

Map Unit Composition

Belknap, frequently flooded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Belknap, Frequently Flooded

Setting

Landform: Flood plains
Landform position (three-dimensional): Talf

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium

Typical profile
Ap - 0 to 7 inches: silt loam
Bw - 7 to 59 inches: silt loam
Bg - 59 to 79 inches: silt loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very high (about 12.7 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: B/D
Hydric soil rating: No

Minor Components

Bonnie, frequently flooded
Percent of map unit: 5 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Piopolis, frequently flooded
Percent of map unit: 5 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Bo—Bonnie silt loam, 0 to 2 percent slopes, frequently flooded

Map Unit Setting

National map unit symbol: 2tbrr
Elevation: 330 to 490 feet
Mean annual precipitation: 35 to 46 inches
Mean annual air temperature: 54 to 57 degrees F
Frost-free period: 175 to 195 days
Farmland classification: Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season

Map Unit Composition

Bonnie, frequently flooded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bonnie, Frequently Flooded

Setting

Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

Ap - 0 to 10 inches: silt loam
Cg1 - 10 to 27 inches: silt loam
Cg2 - 27 to 79 inches: silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: Frequent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very high (about 12.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Belknap

Percent of map unit: 10 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Du—Dumps, mine

Map Unit Setting

National map unit symbol: 5fgl
Elevation: 350 to 1,000 feet
Mean annual precipitation: 40 to 46 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 170 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Dumps: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Dumps

Setting

Parent material: Coal extraction mine spoil

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: Unranked

FaB—Fairpoint silt loam, reclaimed, 1 to 15 percent slopes

Map Unit Setting

National map unit symbol: 5fgn
Elevation: 340 to 1,000 feet
Mean annual precipitation: 40 to 46 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 170 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Fairpoint and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fairpoint

Setting

Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Coal extraction mine spoil

Typical profile

Ap - 0 to 2 inches: silt loam
CA - 2 to 5 inches: silt loam
Cd - 5 to 27 inches: silt loam
2C - 27 to 80 inches: very parachannery silt loam

Properties and qualities

Slope: 1 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.01 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: No

FbG—Fairpoint-Bethesda complex, 25 to 70 percent slopes

Map Unit Setting

National map unit symbol: 5fgq
Elevation: 340 to 1,000 feet
Mean annual precipitation: 40 to 46 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 170 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Fairpoint and similar soils: 60 percent
Bethesda and similar soils: 40 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fairpoint

Setting

Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Coal extraction mine spoil

Typical profile

A - 0 to 3 inches: very parachannery silty clay loam
C - 3 to 60 inches: very parachannery loam

Properties and qualities

Slope: 25 to 70 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Available water storage in profile: Low (about 3.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: No

Description of Bethesda

Setting

Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Coal extraction mine spoil

Typical profile

A - 0 to 3 inches: parachannery silt loam
C - 3 to 60 inches: very parachannery loam

Properties and qualities

Slope: 25 to 70 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Calcium carbonate, maximum in profile: 5 percent
Available water storage in profile: Low (about 3.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: No

HoB2—Hosmer silt loam, 2 to 5 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2x06n
Elevation: 330 to 850 feet
Mean annual precipitation: 38 to 48 inches
Mean annual air temperature: 52 to 59 degrees F
Frost-free period: 170 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Hosmer, eroded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hosmer, Eroded

Setting

Landform: Loess hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loess over gritty loess

Typical profile

Ap - 0 to 7 inches: silt loam
Bt - 7 to 29 inches: silt loam
Btx - 29 to 65 inches: silt loam
2Bt - 65 to 79 inches: silt loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: 17 to 33 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately high (0.01 to 0.20 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None

Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Alford, eroded

Percent of map unit: 10 percent
Landform: Loess hills
Landform position (two-dimensional): Shoulder, summit, backslope
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

W—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Interpretive groups

Land capability classification (irrigated): None specified
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: No

WeE—Wellston silt loam, 15 to 30 percent slopes

Map Unit Setting

National map unit symbol: 5fj2
Elevation: 340 to 1,000 feet
Mean annual precipitation: 40 to 46 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 170 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Wellston and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wellston

Setting

Landform: Structural benches, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loess over loamy residuum over shale

Typical profile

A - 0 to 8 inches: silt loam
Bt - 8 to 26 inches: silt loam
2Bt - 26 to 41 inches: loam
2BC - 41 to 54 inches: parachannery fine sandy loam
2Cr - 54 to 60 inches: weathered bedrock

Properties and qualities

Slope: 15 to 30 percent
Depth to restrictive feature: 40 to 60 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: No

ZaC3—Apalona-Zanesville silt loams, 6 to 12 percent slopes, severely eroded

Map Unit Setting

National map unit symbol: 2s2d4
Elevation: 360 to 930 feet
Mean annual precipitation: 39 to 53 inches
Mean annual air temperature: 41 to 67 degrees F
Frost-free period: 165 to 224 days
Farmland classification: Not prime farmland

Map Unit Composition

Apalona, severely eroded, and similar soils: 45 percent
Zanesville, severely eroded, and similar soils: 40 percent
Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Apalona, Severely Eroded

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Fine-silty loess over clayey residuum weathered from shale over loamy residuum weathered from sandstone and shale

Typical profile

Ap - 0 to 4 inches: silt loam
Bt - 4 to 22 inches: silt loam
Btx - 22 to 41 inches: silt loam
2Bt - 41 to 63 inches: clay
3BCt - 63 to 79 inches: loam
3Cr - 79 to 89 inches: bedrock

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: 16 to 27 inches to fragipan; 69 to 85 inches to paralithic bedrock
Natural drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 14 to 25 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: No

Description of Zanesville, Severely Eroded

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Thin fine-silty noncalcareous loess over loamy residuum weathered from sandstone and siltstone

Typical profile

Ap - 0 to 4 inches: silt loam
Bt - 4 to 23 inches: silt loam
Btx - 23 to 34 inches: silty clay loam
2C - 34 to 56 inches: clay loam

2R - 56 to 66 inches: bedrock

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: 20 to 28 inches to fragipan; 38 to 75 inches to lithic bedrock
Natural drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.13 in/hr)
Depth to water table: About 17 to 26 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C/D
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: No

Minor Components

Deuchars, severely eroded

Percent of map unit: 10 percent
Landform: Hillslopes, structural benches
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: No

Wellston, severely eroded

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: No

ZaD3—Zanesville silt loam, 12 to 18 percent slopes, severely eroded

Map Unit Setting

National map unit symbol: 5fj6
Elevation: 340 to 1,000 feet
Mean annual precipitation: 40 to 46 inches

Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 170 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Zanesville, severely eroded, and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Zanesville, Severely Eroded

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loess over loamy residuum over shale

Typical profile

Ap - 0 to 4 inches: silt loam
Bt - 4 to 19 inches: silty clay loam
Btx1 - 19 to 28 inches: silty clay loam
2Btx2 - 28 to 42 inches: silt loam
2Bt - 42 to 68 inches: loam
2Cr - 68 to 80 inches: weathered bedrock

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: 12 to 24 inches to fragipan; 60 to 80 inches to paralithic bedrock
Natural drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf