Karst Survey Report

Forsee Investments LLC
Lots 11+12 Blankenbaker Station II
Wood Project No. 7382213423

Prepared by:
Wood Environment & Infrastructure Solutions, Inc.

Prepared for:

Forsee Investments, LLC
5405 Morehouse Drive Suite 320, San Diego CA 92121

9/23/2021

23 September 2021

Foresee Investments, LLC
5405 Morehouse Drive, Suite 320
San Diego, CA 92121

c/o Mr. Ben T. Taylor, PE
Hollenbach-Oakley

Wood Environment & Infrastructure Solutions, Inc.
11003 Bluegrass Parkway
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Louisville, Kentucky 40299
USA
T: 502-267-0700
www.woodplc.com

Re: Karst Survey
Blankenbaker Station II Lots 11+12
Schutte Station Place, Jefferson County, KY
Wood Project Number: 7382213423

Dear Mr. Taylor:

Wood Environment & Infrastructure Solutions, Inc., (Wood) is pleased to provide this survey report for the above referenced property. The report presents data from a document review of the site soil and geology as well as a description of observed site conditions encountered during our September 16th, 2021 site visit.

Wood appreciates the opportunity to have provided these services and we look forward to serving as your geotechnical consultant throughout the project execution. Please contact us if you have any questions regarding the information presented.

Sincerely,
Wood Environment & Infrastructure Solutions, Inc.

William A. Modrall , PE (KY License 35184)
Project Engineer

Mark J. Schuhmann, PE (KY License 12500)
Senior Principal

Enclosure: Report

9/23/2021

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1.0 Purpose and Scope of Exploration

Wood Environment & Infrastructure Solutions, Inc. (Wood) has completed a karst survey in support of the proposed development of Lots 11 + 12 at Blankenbaker Station II, near the intersection Plantside Drive and Schutte Station Place, in Jefferson County, Kentucky. The purpose of this survey was to meet the requirements for developments in Karst Prone Areas of Jefferson County, as mapped by the Louisville Metro Land Development Code. Figure 1 below contains a portion of this map. Our survey includes a review of current and historical aerial photographs, The USDA National Resource Conservation Service Web Soil Survey, Kentucky Geologic Survey Geologic Quadrangle Mapping, and Louisville/Jefferson County Information Consortium (Lojic) Topographic Data, as well as provided site plans. Additionally, our report contains recommendations to treat karst features if they are encountered during site development.

Wood's scope of service is described in our Proposal number 2021-0067, dated 19 August 2021.

2.0 Project Information

The proposed warehouse/manufacturing facility site is located at Lots 11+12 in Blankenbaker Station II, off Plantside Drive and Schutte Station Place in Louisville, Kentucky, as shown on the attached "*Pre-Application Plan*" labeled Figure 1.

The proposed development property is a 7.2 acre tract, cut from a larger 15.6 plot in East Jefferson County, Kentucky. Per Louisville Metro Land Development Code "Where the proposed land disturbing activity is located within the Karst Prone area of Jefferson County as indicated on the Karst Prone Area Map, the applicant shall conduct a karst survey of the property". The image below shows the Land Development Code's Karst Prone Area Map, with the location of the subject property highlighted.

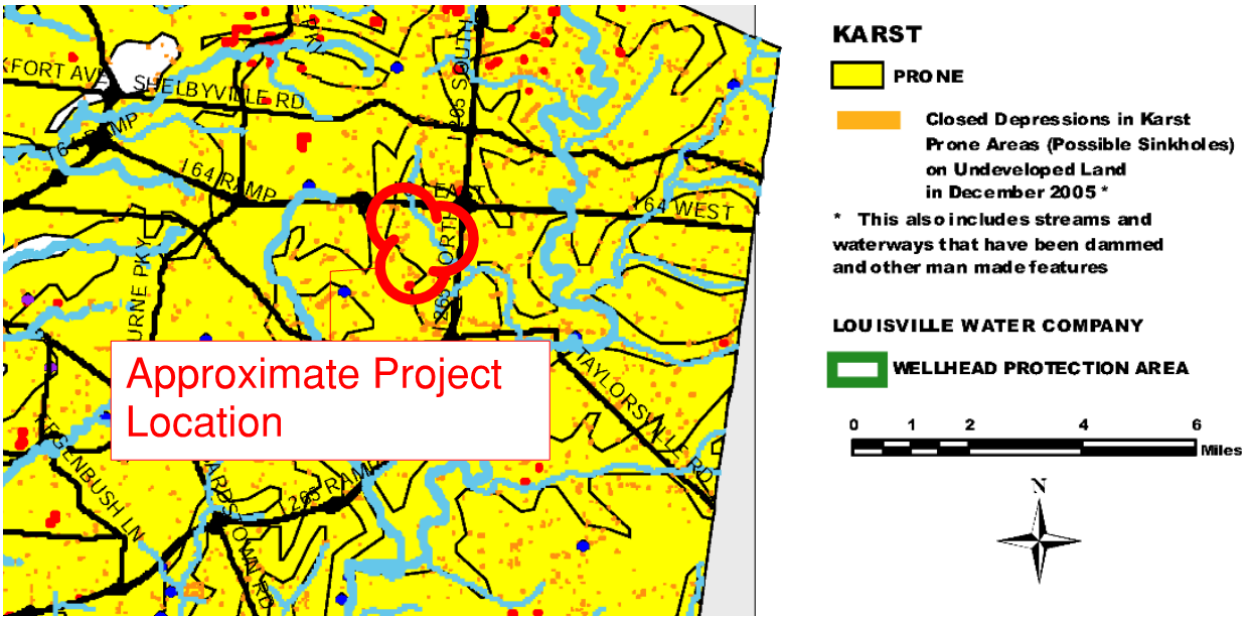


Figure 1. Louisville Metro Land Development Code Karst Prone Areas of Jefferson County

Based on Lojic mapping the property has approximately 40 feet of topographic relief ranging from a high elevation of 700 feet to 660 feet NGVD; within the proposed building area the relief is approximately 25 feet. Site drainage is generally to the southwest.

3.0 Document Review

3.1 Published Site Geology

A review of the Geologic Map of the Jeffersontown quadrangle, Jefferson County, Kentucky, published by the United States Geological Survey (USGS), indicates two separate rock formations are mapped underlying the site. These formations are listed below in descending order.

The Osgood Formation (Sob) (approximate elevations 690 to 700 feet NGVD) consists of horizontally bedded shales and dolomite. This formation is ranked with a low Karst risk. The shale is dark to light greenish gray, locally black to olive black, and is interbedded with grayish to pale red shale in the lower 10 feet weathering to same yellowish gray or grayish yellow. Muddy dolomite and dolomitic limestone are light olive gray to greenish gray, weathering to yellowish gray or grayish yellow to yellowish orange prisms or chips, which is more common in the upper part of the formation than the lower. Fossils are rare and the basil contact is conformable.

The Brassfield formation (Sob) is mapped in the lower portion of the slopes and consists of limestone of three types, each generally two feet or less thick any of which may be missing at a given locality (approximate elevations 690 to 700 feet NGVD). At the top is an orange-yellow medium grained fossil fragmental limestone, in the middle is a medium to dark gray fine grained non-fossiliferous limestone, at the base is a light olive gray coarse grained highly fossiliferous limestone. Exposures are mostly limited to stream channels and a few road cuts. This formation is mapped with the Osgood Formation. This formation is listed as having no karst risk.

The Saluda member (Od) consists of dolomite, dolomitic mud stone, limestone and minor shale (660 to 690 NGVD). The dolomite is greenish gray to olive gray and grades to a rocky weathered dolomitic limestone. The shale is light gray to olive gray to olive black and locally carbonaceous. This formation is listed as having low karst risk.

Figure 2 below shows the geologic quadrangle map.

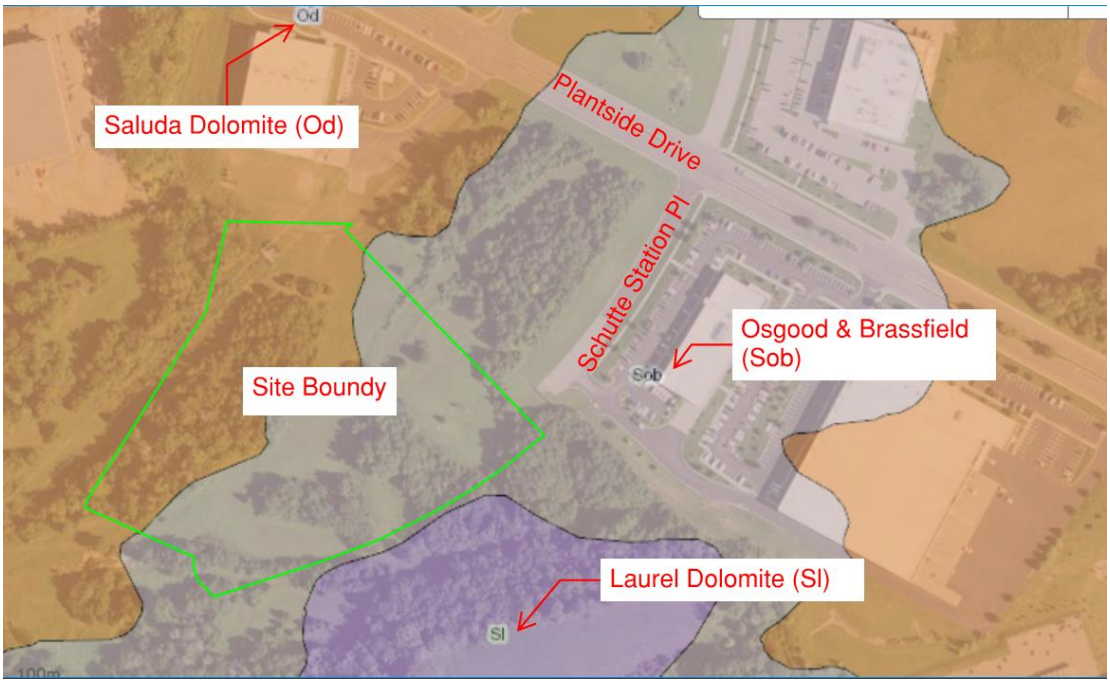


Figure 2. Geologic Mapping

The southeastern property line is near the Laurel Dolomite Formation (Sl). This formation is listed as having medium karst risk, and where a karst prone and a non karstic formation meet, may be a potential area for karst to form. The Kentucky Geologic Survey produced a Karst Risk Map, with LIDAR derived closed depressions (blue). This map shows that the Laurel Dolomite formation has medium karst risk, and the Drakes Formation (Saluda Dolomite) has low karst risk. The Osgood Brassfield Formation mostly contains shale, and therefore is listed as not having karst risk. The KGS karst risk map is shown in Figure 3.

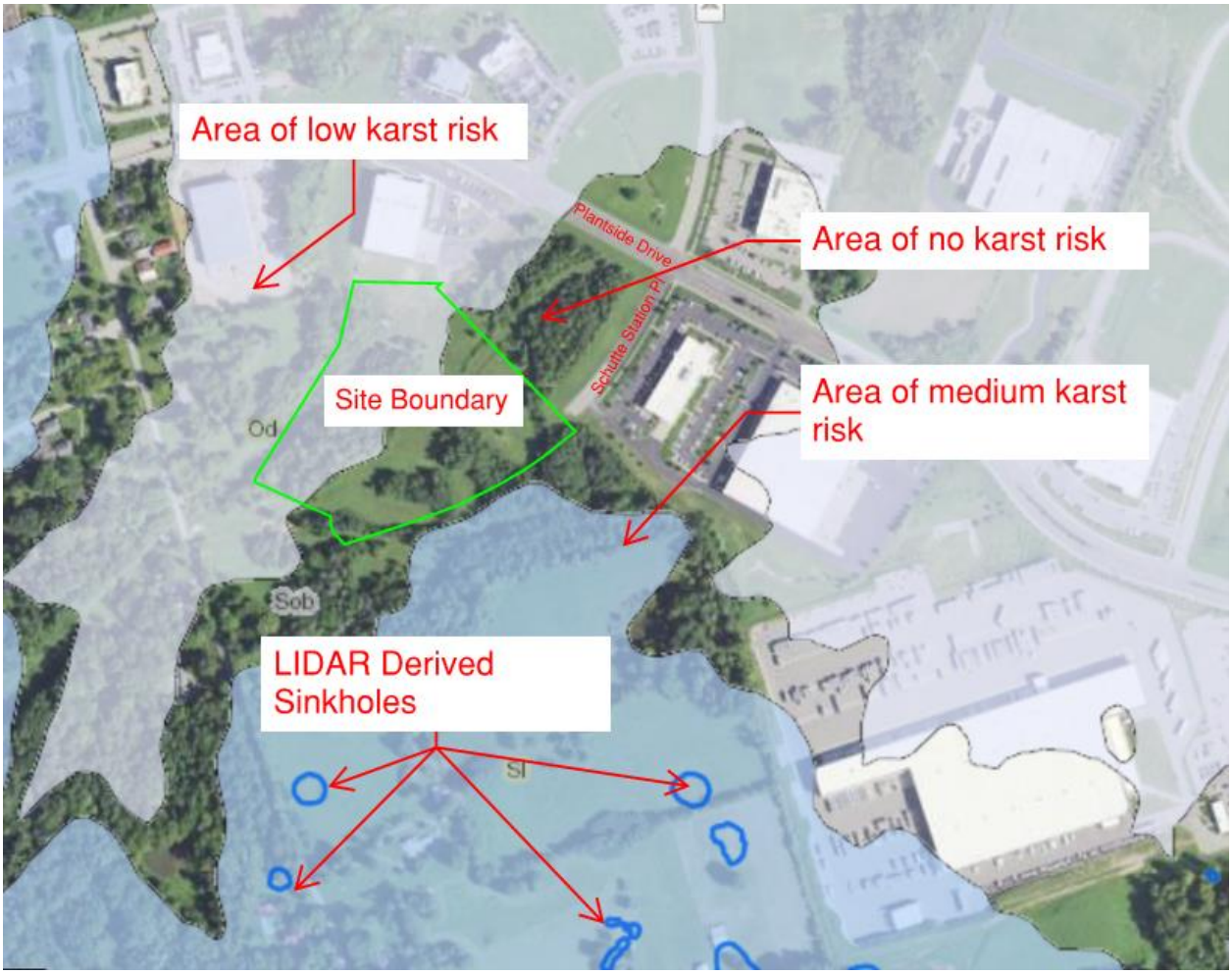


Figure 3. Kentucky Geologic Survey Karst Risk Map

3.2 Published Soil Survey

The Natural Resources Conservation Service's soil survey maps provide site specific soil information. An approximate site map with the soil types is shown below.

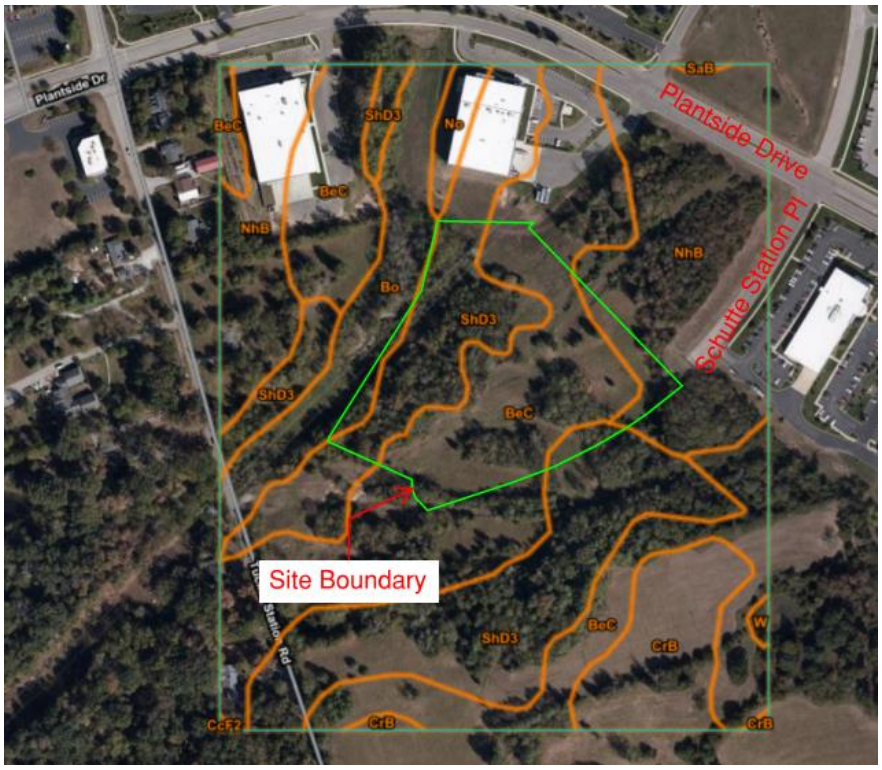


Figure 4. USDA NRCS Soil Map

The site soils are mapped as Beasley Silt Loams (BeC), and Shrouts Silt Loam (ShD3). The site soil formations are classified under the USDA soil classification system as Silt Loams, meaning they contain between 12% to 27% clay and 50% or more silt. The USDA NRCS Web Soil Survey reports the predominant soil types display the following vertical soil profile:

Beasley Silt Loams: 0-6 inches (silt loam)
6 to 48 inches (silty clay)
48-58 inches (weathered bedrock)
Water table depth is listed as greater than 80 inches

Shrouts Silt Loam: 0-2 inches (silt loam)
2 to 20 inches (silty clay)
20 to 35 inches (silty clay)
35-40 inches (weathered bedrock)
Water table depth is listed as greater than 80 inches.

The soil survey also provides ratings for how site soils will perform during typical construction or development activities. The site soils are listed as very limited in regard to construction of, shallow foundations, local roads and streets and small commercial buildings. Limiting factors include low strength, shrink swell potential, steep slopes, and depths to restrictive feature (bedrock). Site soils are rated as having low corrosion to concrete, but high corrosion to steel. The soil survey did not provide any data in regard to Karst activity on the site.

3.3 Aerial Photography

Historic aerial and satellite imagery was reviewed for previous development or the presence of karst activity. Karst activity may be indicated in photos by visible depressions, ponded water, or areas of unusually lush vegetation. Publicly available historical imagery is available as far back as 1993. A 2000 Lojic historical image indicated 2 areas of ponded water, just south of the North property boundary in an area of a proposed Storm and Drainage Easement. See Figure 5 below. The two depressions are shown on subsequent photos until 2017, at which time they appear to have been filled/covered during construction of the Office Resources building to the north. Older aerial photos revealed that the site has had some historical clearing/logging and grading activities (cutting roads, and used as a borrow source), but did not reveal any karst activity.

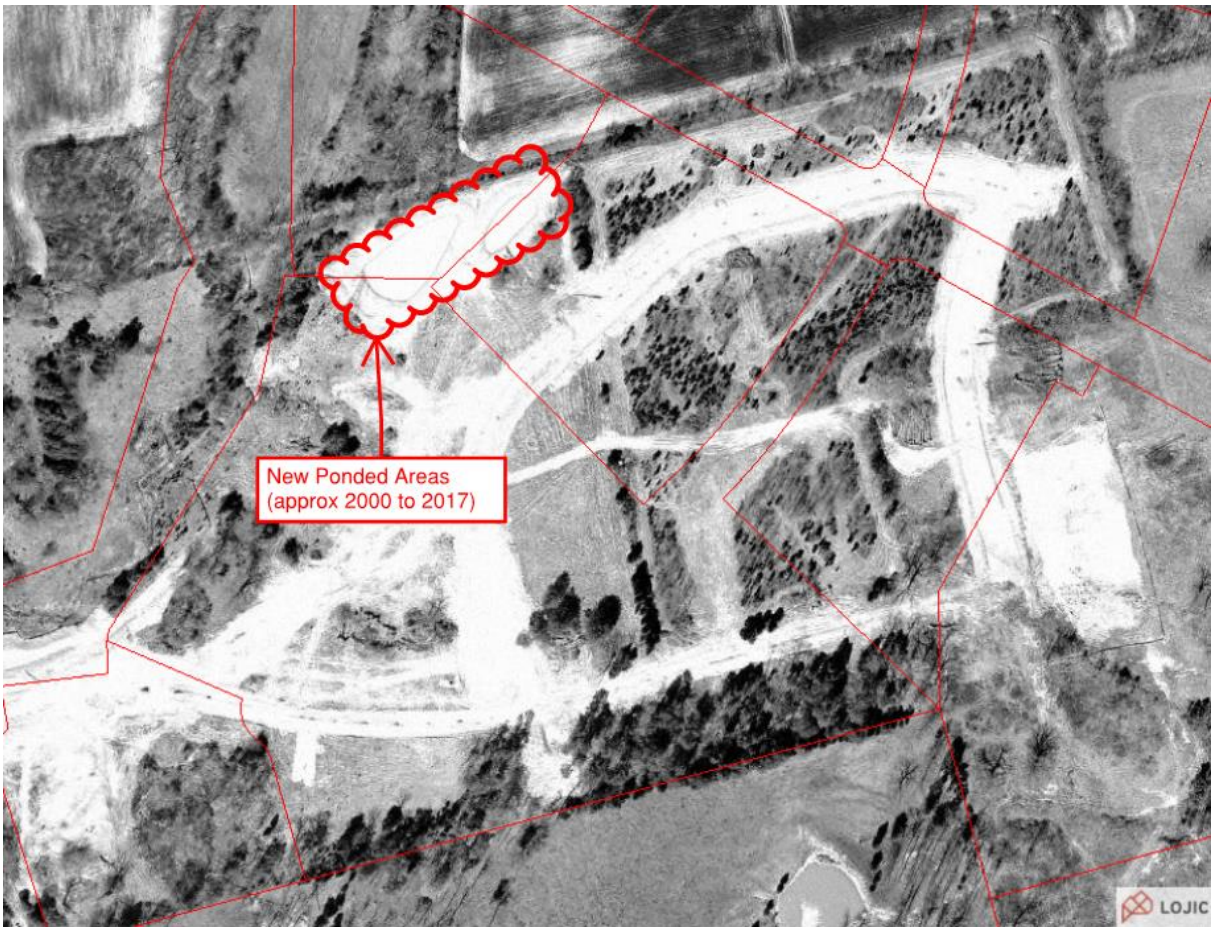


Figure 5. LOJIC Photo (2000)

3.4 Topographic Mapping

The site ground surface ranges in elevation from 660 feet to 700 feet, generally draining to the southwest towards a ravine/creek along the west property line. Topographic mapping was reviewed for indications of surficial Karst which is often illustrated by closed topographic depressions. The image below shows the LOJIC topographic map, with one closed loop topographic area highlighted.

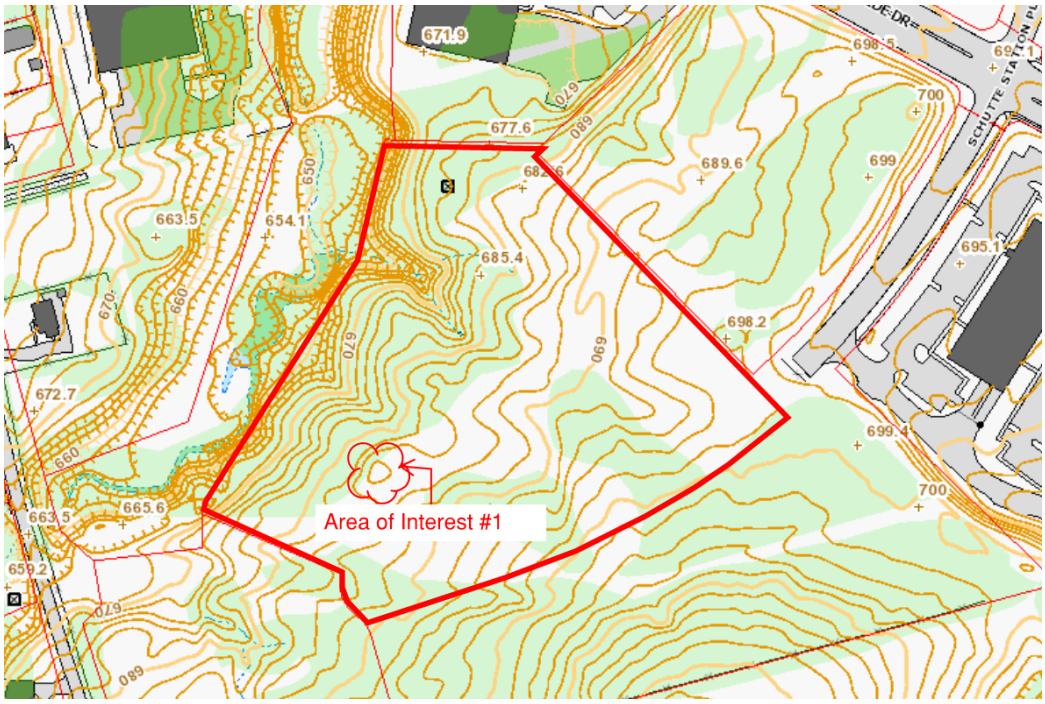


Figure 6. Lojic Topographic Map

Additionally, the Pre-application site plan indicated one additional closed topographic depression area.

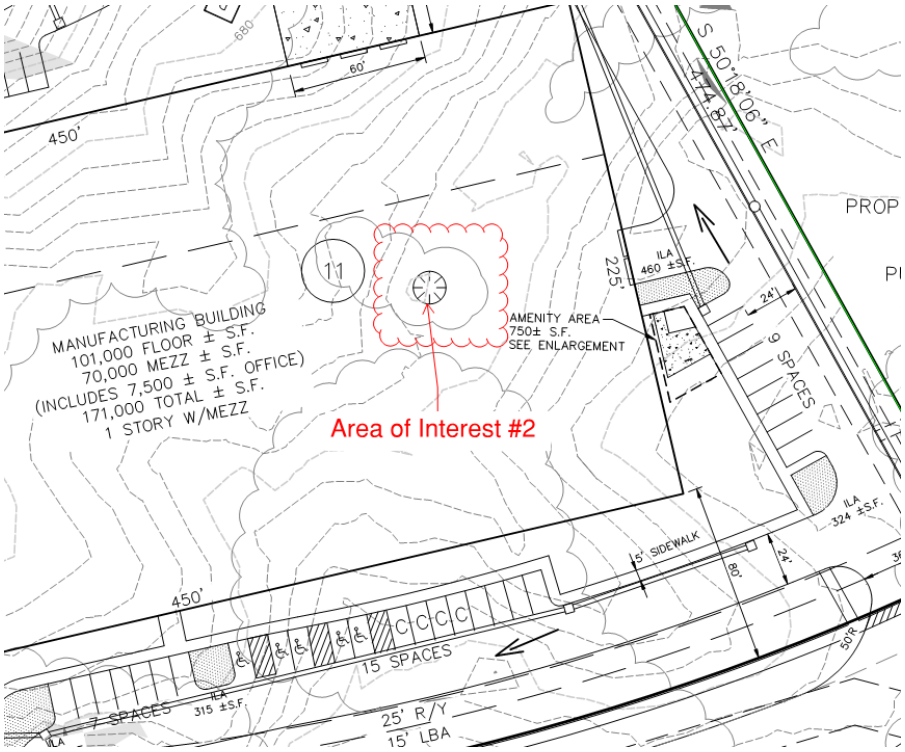


Figure 7. Pre-Application Plan Area of Interest

4.0 Field Visit

A field visit was completed by William Modrall on September 16th, 2021. William walked the site looking for any signs of potential karst activity. Special attention was given to areas of concern as discussed in the document review above. The attached photo log provides a general site overview, as well as photos of specific features. The closed loop labeled Area of Interest 1 from the topographic map review was observed to be a highpoint, and therefore not a depression of an active karst feature. Area of Interest 2 from the provided application plan was observed, and it is not an active karst feature. Historic grading and road cut, terminates at this location causing an abrupt grade change, but this is due to site grading, not karst.

A third area of interest was observed during our field visit. This area is confirmed to be an open throat of a karst feature. The feature is located at 38.209299, -85.527179. The location is shown in Figure 8. The feature has the following characteristics. It is an approximately 8ft long by 4ft wide open throat, with a visible depth of about 6 feet. The throat is of low significance, meaning that it can be cleaned and plugged. No rock is visible from the surface, however bedrock is generally shallow at the site. It is estimated that depth to bedrock at this feature is less than 10 feet. A photo of the feature is included in Figure 8 below. Additional site photos are included in the Appendix.

Figure 8. Area of interest 3 - location

Figure 9. Site photo at Area of Interest #3 - Open Throat

5.0 Project Limitations

Descriptions of the surface conditions only apply to those areas accessible without any clearing or cutting at the time of our site visit. It should be noted approximately 4 acres of the site is heavily wooded and therefore was not fully accessible for our field visit. Efforts were made with hand clearing equipment to enter and survey these areas, however areas not explored may differ significantly between the explored locations. It should be noted that no karst survey can fully assure that all incipient sinkholes or dropouts will be discovered. Therefore, there is always some risk occurring in limestone terrain. To manage the risks associated with unanticipated conditions, a qualified geotechnical consultant should be retained during the final design and construction phases for guidance.

6.0 Geotechnical Recommendations

6.1 Karst Risk

Our document review confirmed that the proposed site is located in a Karst prone area of Jefferson County. More detailed Geologic mapping by the Kentucky Geologic Survey (Figure 3) indicates the site is underlain by rock formations that have a karst risk ranging from none to low, however the site is bordered to the south by a contact with a medium risk karst formation (Laurel Dolomite). Our experience indicates border zones between formations are often areas where karst features form. Our field visit confirmed the presence of one karst feature (Area 3). This feature is relatively small and the depth to rock appears to be less than 10 feet so this feature appears to be a candidate for remedial repair during construction. The following sections provide recommendations for the encountered karst feature, as well as others that may be uncovered during development of the site.

6.2 General Site Preparation

Site preparation activities will generally involve establishing good site drainage; stripping topsoil; possible karst treatment; and earthwork cut/fill. We recommend the following measures within areas designated for structures or pavements:

6.3 Clearing and Grubbing Subgrade

Site preparation should include stripping organic materials and topsoil from the construction area.

- Establish and maintain a positive site drainage prior to the start of clearing and grubbing.
- Strip organic material, topsoil, debris and any old fill containing deleterious material from the construction area.
- Remove any buried structures or abandoned utilities encountered during construction and backfill appropriately.
- Proofroll the exposed soil subgrades with heavily loaded rubber-tired construction equipment to attempt to locate areas of wet soil, deflecting subgrades and or dropouts, all of which could indicate potential karst features.

6.4 Site Drainage

Water seeping through the soil mass is a primary trigger for sinkhole development. The proposed site grading should direct surface water runoff away from known sinkhole areas and away from structural and paved areas to reduce the risk of future sinkhole development.

Water from man-made sources can accelerate the rate of solutioning activity if directed into sinkholes. Water collected in the roofing gutter system should be piped away from the structure to existing drainage features and away from any adjacent sinkholes. Precautions should be taken to prevent subgrade pipes from leaking. These precautions might include using watertight joints, and in areas of known karst activity placing pipes in concrete or enclosing the primary pipe within a secondary pipe.

6.5 Karst Treatment

Area of interest #3 was confirmed as an open throat Karst feature. The location of this feature using handheld GPS equipment with an approximate accuracy of 20 feet, indicates under the current development plan, this feature will be situated under a landscaping/parking area, and should not directly affect the proposed structure. This feature may be repaired in the following manner:

Sinkhole Treatment Method Sinkhole Treatment Method A - When the throat is greater than 2 feet in diameter or the throat consists of cracks or joints within the limestone rock, an inverted filter should be constructed (Figure 3). Inverted filter construction is also recommended when evidence of flowing water is observed. To plug the throat, a zone of rip-rap or boulders should be placed and wedged into the throat. Using the large stone pieces as a base, place an 18-inch layer of No. 3 and/or No. 57 crushed limestone tamped or otherwise compacted into place. Next, construct a layer of dense-graded aggregate 12 inches thick tamped into place with hand tampers. The entire throat area and 10 feet of the surrounding area should be covered with a geotextile filter fabric. The resulting excavation may then be properly backfilled with engineered fill material compacted to at least 95 percent of the standard Proctor (ASTM D-698) maximum-dry density. Sketches indicating the treatment schemes are included in the Appendix.

Karst features not identified during our exploration at the site could be encountered during earthwork activities. Any newly exposed solution features should be observed by the geotechnical engineer. The engineer will make specific recommendations dependent on the characteristics of the feature and the area usage. If springs or evidence of flowing water are encountered in construction areas, Wood should be contacted to make specific recommendations dependent on the characteristics of the feature and the area usage.

We recommend the topographic depressions be explored for indications of sinkhole activity and the depressions along with sinkholes exhibiting throat areas be treated prior to earthwork construction in these areas.

It is generally recommended that no structures be located over known sinkhole locations. The closed topographic depressions (sinkholes) observed at the property and scheduled to be filled should be treated according to the size either Method A or B.

Closed topographic depressions, existing sinkholes and soil dropout exposed during construction should be filled with clay in accordance with the soil specific compaction requirements. Site drainage should be directed away from these filled depression areas.

Should smaller karst features be encountered they may be treated with the following method.

Sinkhole Treatment Method B - When the throat is less than 2 feet in diameter and no evidence of flowing water is present a concrete plug may be utilized (Figure 2). The plug should be constructed of high slump concrete and be 1½ to 2 times as tall or long as it is wide to facilitate the filling of voids and crevices. It is essential that a good concrete to rock bond be created by the plug, and the plug increase in diameter with elevation. After the concrete plug has set up, we recommend the resulting excavation be lined with a geotextile filter fabric and backfilled with engineered fill material compacted to at least 95 percent of the standard Proctor (ASTM D-698) maximum-dry density. Sketches indicating the treatment schemes are included in the Appendix.

7.0 Basis for Recommendations

The recommendations provided are based in part on project information provided to Wood and only apply to the specific project and site discussed in this report. If the project information section in this report contains incorrect information or if additional information is available, you should convey the correct or additional information to us and retain us to review our recommendations. We can then modify our recommendations if they are inappropriate for the proposed project.

The assessment of site environmental conditions or the presence of contaminants in the soil, rock, surface water or groundwater of the site was beyond the scope of this exploration. It should be noted that no karst survey can fully assure that all incipient sinkholes or dropouts will be discovered. Therefore, there is always some risk occurring in Limestone terrain.

We recommend this complete report be provided to the various design team members and the project owner for use in completing the final design. This is a Karst Survey, not a full geotechnical report and should be used as intended.

Karst Survey

Lots 11+ 12 Site Photographs, 09/16/2020

Photo 1: Photo Locations

Photo 2: North end of property looking south

Photo 3: Middle of property looking East

Photo 4: Middle of property looking South towards Area of Interest #1

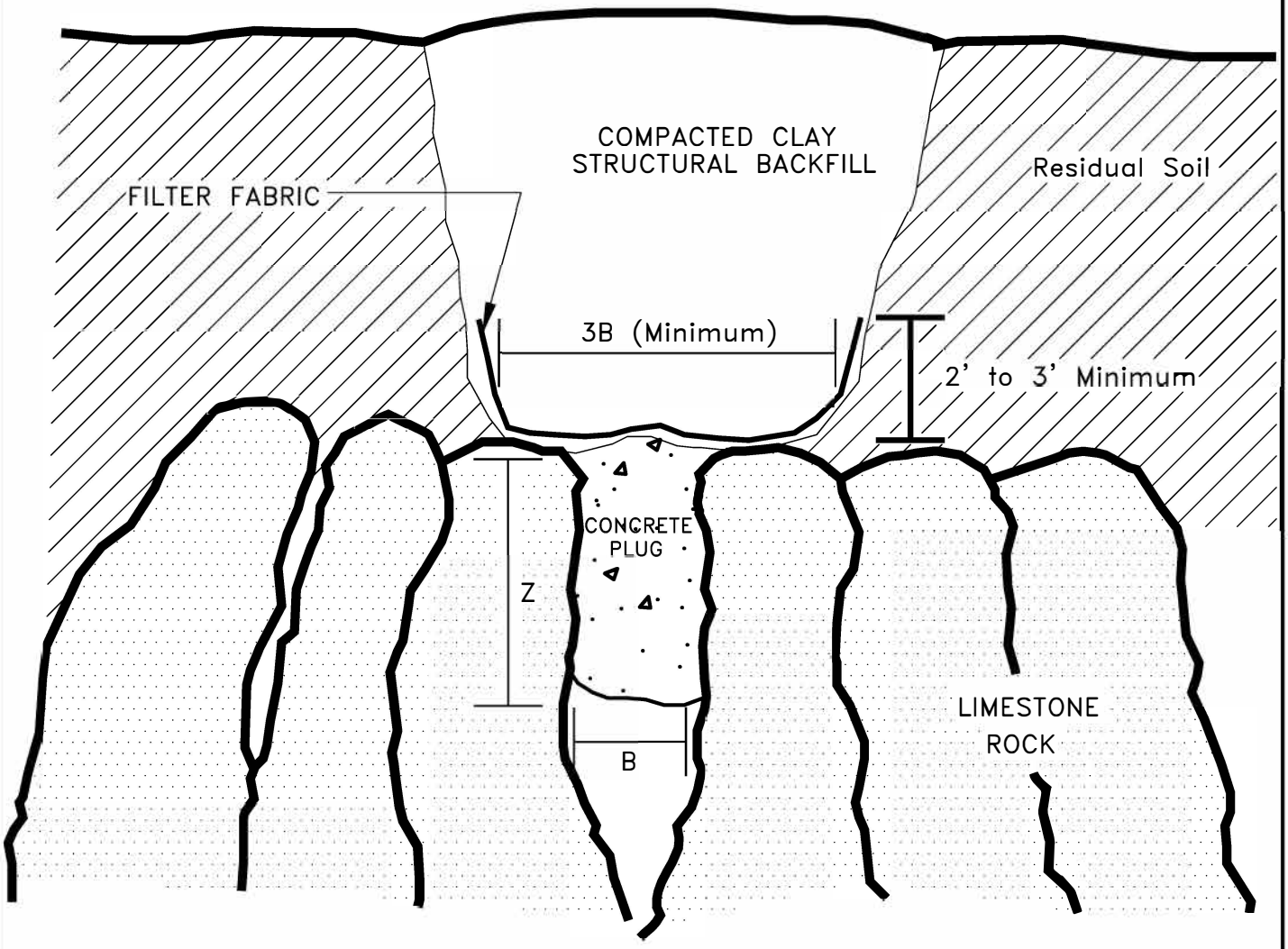
Photo 5: Area of Interest #3 – Open Throat

Photo 6: Area of Interest #3 – Open Throat – Alternate View

Photo 7: Area of interest #2

Photo 8: Area of interest #2 – Road Grading Ridge

NOTE: Good concrete to rock bond is essential (Z=1.5 to 2 times B)



Wood
690 Commonwealth Center
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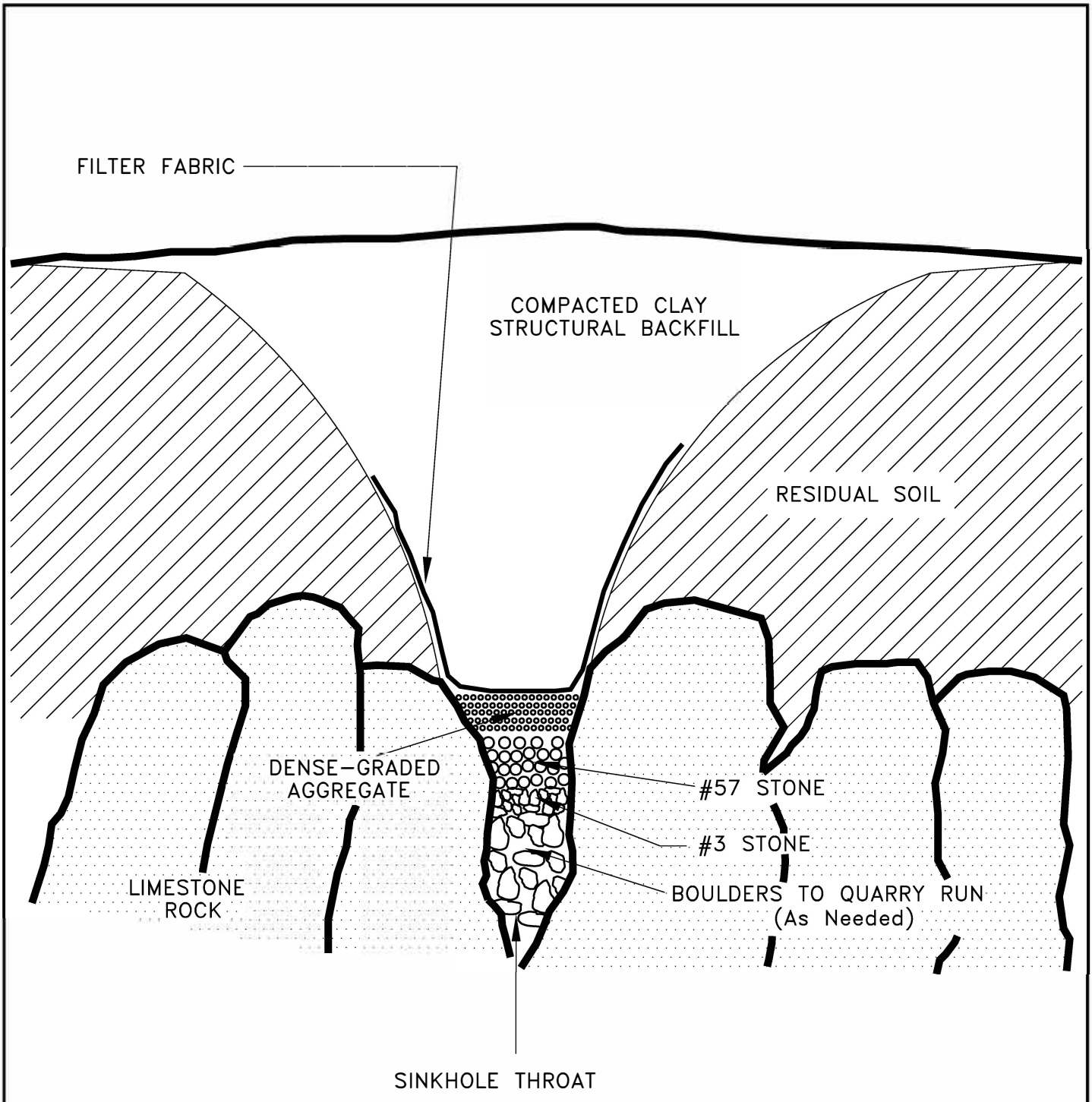
wood.

CLIENT: Forsee Investments, LLC

PROJECT: Blankenbaker Station II Lots 11 + 12		DWN BY: CAE	DATUM:	DATE: 9/23/2021
TITLE: SINKHOLE REPAIR METHOD A CONCRETE PLUG		CHK'D BY: SEB	REV. NO.:	PROJECT NO: 7382-21-3423
		PROJECTION:	SCALE: NOT TO SCALE	FIGURE No. B-1



Wood 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	wood.		CLIENT Forsee Investments, LLC
PROJECT Blankenbaker Station II Lots 11 + 12		DWN BY: CAE	DATUM:
			DATE: 9/23/2021
TITLE SINKHOLE REPAIR METHOD B GRADED FILTER		CHK'D BY: SEB	REV. NO.:
			PROJECT NO: 7382-21-3423
		PROJECTION:	SCALE: NOT TO SCALE
			FIGURE No. B-2