REPORT OF

SUBSURFACE EXPLORATION AND
GEOTECHNICAL ENGINEERING SERVICES

PROPOSED WATER TOWER
LEBANON VA MEDICAL CENTER
1700 SOUTH LINCOLN AVENUE
LEBANON, PENNYSLVANIA

FOR

KBA ENGINEERING, PC

March 30, 2012

March 30, 2012

Mr. Dennis Kutch
KBA Engineering, PC
25 South Washington Avenue
Jermyn, PA 18433

ECS Job No. 18.2573

Reference: Report of Subsurface Exploration and Geotechnical Engineering Services, Lebanon VA Medical Center Water Tower Replacement
1700 South Lincoln Avenue
Lebanon, Pennsylvania

Dear Mr. Kutch:

ECS Mid-Atlantic, LLC (ECS) has completed the subsurface exploration and geotechnical engineering services for the proposed new water tower in accordance with ECS Proposal No. 18.3371-GP dated March 13, 2012.

The following sections discuss the subsurface exploration procedures, present the results of our subsurface exploration and present our recommendations with regard to the design and construction of the foundation for the proposed tower.

PROJECT OVERVIEW

Project Location and Proposed Construction

We understand that the project consists of the design and construction of a new single pedestal water tower located approximately 100 feet south of the existing multicolumn water tank on the eastern end of the Veterans Administration (VA) Medical Center near Lebanon, PA. The proposed water tower is anticipated to be a single pedestal tank with a ringwall foundation bearing on either a continuous footing or a full circular slab.

The proposed tower location and equipment compound is located in an open lawn area.

The specific project boundaries, including both the existing and proposed site features, along with the location of the boring performed by ECS in the subsurface exploration program are shown on the Boring Location Diagram, attached to this report. The Boring Location Diagram was developed from the site plan prepared by KBA Engineering.

Scope of Work

The conclusions and recommendations contained in this report are based on field subsurface exploration, laboratory testing and review of in house geologic and/or geotechnical data. Five soil borings, referenced as Boring B-1 through B-4, including B-2A, were drilled by Connelly Drilling (a subcontractor of ECS) on March 15, 2012. Auger refusal was encountered in of the borings at depths varying between 0.7 ft and 5.5 ft below existing grade. Auger refusal materials were explored further through rock coring techniques at Boring B-1 for a length of 5 feet and at Boring B-2A for length of 10 feet.

The tower boring locations were staked in the field by ECS using dimensions from the existing tank compound provided by KBA Engineering. The Boring Location Diagram included in the Appendix of the report reflects the location of the borings.

EXPLORATION PROCEDURES

Subsurface Exploration Procedures

The soil boring was performed with an all-terrain vehicle (ATV) mounted, auger drilling rig. The drilling rig utilized continuous flight, hollow stem augers to advance the boreholes. Drilling fluid was not used during the soil drilling operations.

Representative soil samples were obtained by means of the split-barrel sampling procedure in accordance with ASTM Specification D-1586. In this procedure, a 2-inch O.D., split-barrel sampler is driven into the soil a distance of 18 inches by a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler through a 12-inch interval is termed the Standard Penetration Test (SPT) value and is indicated for each sample on the boring logs. This value can be used as a qualitative indication of the in-place relative density of noncohesive soils. In a less reliable way, it also indicates the consistency of cohesive soils. This indication is qualitative, since many factors can significantly affect the standard penetration resistance value and prevent a direct correlation between drill crews, drill rigs, drilling procedures, and hammer-rod-sampler assemblies.

Following auger refusal, rock coring techniques using a NQ-diamond drilling bit were utilized to advance the boring to the desired termination depth and to obtain intact rock samples. Varying lengths of rock coring were performed at the above noted locations. The termination depth in each boring was dependent on several factors, including the quality of the rock obtained and the consistency of the recovered rock samples.

A field log of the soils and rock encountered in the boring was maintained by the drill crew. After recovery, representative portions of each soil sample were sealed and brought to our laboratory for visual examination and classification. Rock core samples were placed in a wooden core box.

The ECS engineer classified each of the rock samples obtained on the basis of rock type, rock quality, discontinuity spacing, weathering, and hardness of the core sample.

Upon completion of soil boring operations, the boring was backfilled with the auger spoils generated during the drilling process.

Laboratory Testing Program

A soils engineer/geologist classified each soil sample on the basis of texture and plasticity in accordance with the Unified Soil Classification System. The group symbols for each soil type are indicated in parentheses following the soil descriptions on the boring logs. A brief explanation of the Unified System is included with this report. The soils engineer/geologist grouped the various soil types into the major zones noted on the boring log. The stratification lines designating the interfaces between earth materials on the boring log are approximate; in situ, the transitions may be gradual.

The soil samples will be retained in our laboratory for a period of 60 days, after which, they will be discarded unless other instructions are received as to their disposition.

EXPLORATION RESULTS

Regional Geology

The proposed site is underlain by solution prone karst topography. According to the *Sinkholes and Karst-Related Features of Lebanon County, Pennsylvania, Lebanon Quadrangle, 1988-89 (Open File Report: 88-02)*, the project site is underlain by the Snitz Creek Formation (Csc), although geologic contacts with the Millbach and Schafferstown Formations (Cms) border the site to both the east and west, respectively.

The Open File Report indicates the presence of numerous closed depressions within a quarter mile of the site, generally concentrated to the south and west of the site. It should also be noted that ECS has been involved in the remediation of several sinkholes on the Lebanon VAMC campus within the past two years.

The *Engineering Characteristics of the Rocks of Pennsylvania*, 1982, states that the Snitz Creek Formation consists of gray medium to coarsely crystalline dolomite with sandstone interbeds, while the adjacent Millbach and Schafferstown Formations consist of crystalline limestone. These formation have moderately to highly abundant fracturing and are slightly to moderately weathered to a shallow depth. Bedrock pinnacles characterize the soil-bedrock interface. Excavation is generally difficult. This bedrock is prone to solution activity.

Soil Conditions

The test borings encountered a thin soil mantle overlying intact limestone bedrock. Natural soils consisting of sandy SILT (ML), clayey SILT (ML), and silty fine SAND (SM) soils were present beneath a thin (3-4 inch) layer of topsoil. Auger refusal was encountered in all of the borings between depths of 0.7 ft and 5.5 ft. The fluctuation in bedrock elevation is common in limestone geology. Borings B-1 and B-2A were sampled using rock coring techniques. The bedrock in Boring B-1 was cored for a length of 5 feet and in Boring B-2A for length of 10 feet. The bedrock was found to consist of intact limestone bedrock, with very good rock recovery values of between 92% and 100%. The Rock Quality Designation (RQD) values were more variable, indicating varying degrees of fracturing/brokenness, with values varying between 12% and 83%, ranging from very poor to excellent quality.

Groundwater Conditions

Groundwater seepage was not encountered during drilling operations, and based on the local topography, is not anticipated to be encountered within the anticipated depths of excavation.

It should be noted that the presence of perched water tables can occur in this geologic setting. Groundwater conditions that are different than those noted during our recent subsurface exploration may be encountered during construction. The groundwater table may fluctuate due to variations in precipitation, rate of evaporation, surface water runoff and other factors not immediately apparent at the time of this exploration. The highest groundwater observations are normally encountered in the late winter and early spring.

It should be noted that limestone and dolomite geology is known for having perched water table conditions. Excavations encountering perched water conditions should be able to be managed with an aggressive sump pit and pumping operation. Also, adequate site drainage away from open excavations will also reduce the impact of water during construction and work areas. It should also be noted that if blasting is anticipated, groundwater flows in limestone bedrock can be dramatically altered by blasting operations. Areas that were previously dry and devoid of groundwater can suddenly be inundated with water. Therefore, blasting should be carefully considered prior to moving forward with this process.

We expect that normal construction dewatering operations consisting of sump pits and pumps may need to be employed to handle surface water that may enter trenches or perched water that may be encountered. Deep trenches for utilities such as sewer lines should anticipate groundwater.

RECOMMENDATIONS

Tower Foundations

The proposed water tower is anticipated to be a single pedestal tank with a ringwall foundation bearing on either a continuous footing or a full circular slab. Based on the subsurface conditions encountered during our subsurface exploration and based on the anticipated structural loads, it is anticipated that the most economical foundation for the proposed tower will be a structural ring-wall or mat foundation bearing on the limestone bedrock that is present at shallow depths through the footprint of the proposed tank foundation.

Design information was not provided to us for detailed foundation recommendations. We have also provided a table of soil properties anticipated for the bearing stratum for use in the final foundation design. We recommend that the results of our subsurface exploration be forwarded to the design engineer for final foundation design.

Shallow/Mat Foundation

Alternatively, the water tower should be supported by a structural ring wall or mat foundation. A net allowable bearing pressure of 10,000 psf can be utilized to proportion the foundation system. It is anticipated that the overall dimensions of the foundation system will be controlled more by the overturning and lateral force resistance requirements, rather than limitations associated with the foundation bearing material.

In order for the foundation to utilize the allowable bearing pressure of 10,000 psf, it is essential that the entire foundation bear on a consistent bedrock surface throughout its extents. Due to the uneven nature of the limestone bedrock, the potential for variable bearing strata at the design foundation bearing elevation does exist at this site. Excavation for the foundation is anticipated to require rock removal to achieve the design bottom of footing elevation, likely to be several feet below existing grade. Based on the results of the test borings, acceptable bearing conditions appear to be achievable at depths of 5.5 feet or greater. Excavation efforts should be anticipated to require heavy-duty hoe rams to remove bedrock. The removal of the bedrock will likely result in an uneven bearing surface once the rough footing elevation is established. In order to establish a uniform working platform and bearing subgrade, it is recommended that the bottom of the foundation excavation be leveled with lean (2,000 psi) concrete (PennDOT Class C).

Prior to the placement of the lean concrete, the bottom of the foundation excavation should be observed by qualified ECS personnel to verify that the bottom consists of intact bedrock consistent with the results and recommendations of this report. Any soil filled seams or voids will require remediation prior to commencing foundation construction, and should be overexcavated and remediated at the direction of the ECS Engineer.

For evaluation of the applied bearing pressures under wind or seismic loading conditions, up to a 1/3 increase in the allowable soil bearing pressure can be accommodated by the bearing materials.

Based on our analysis, we anticipate that foundations designed in accordance with the recommendations outlined above will result in negligible total settlements, well below the standard threshold of 1 inch.

It is anticipated that resistance to sliding and overturning of the foundation will be provided through a combination of friction and lateral earth pressure. General design parameters based on the average conditions at boring locations are provided in the table below.

Soil	**Est. Friction Angle, ϕ (deg)**	**Equivalent Unit Weight (pcf)**	**Equivalent Fluid Pressure Active Condition (psf/ft)**	**Equivalent Fluid Pressure – Passive Condition (psf/ft)**	**Sliding Resistance**	**Bearing Capacity (psf)**
Natural Soil	30	120	37	390	-	-
Broken Limestone Bedrock	40	145	32	670	N tanϕ (N=wt of block)	10,000

Seismic Site Class

The subsurface exploration at this site included drilling of borings to depths on the order of 15$\pm$ feet below the existing site grades. The International Building Code (IBC) 2009 and Table 25 of AWWA D100-05 requires site classification for seismic design based on the upper 100 ft of a soil profile. Where site specific data are not available to a depth of 100 ft, appropriate soil properties are permitted to be estimated by the registered design professional preparing the soils report based on known geologic conditions. Three methods are utilized in classifying sites, namely the shear wave velocity (v_s) method, the unconfined compressive strength (s_u) method, and the Standard Penetration Resistance (N-Value) method. The latter method was used in classifying this site.

Based on our interpretation of International Building Code, it is our opinion that the site soils can be characterized as Site Class B. ECS can provide additional analysis and testing, if desired, to further evaluate the site class or to develop site specific response spectra.

Closing

This report has been prepared to aid in the evaluation of this site and to assist the design team with the design of the proposed tower foundation. The report scope is limited to this specific project and the location described. The project description represents our current understanding of the significant aspects of the proposed improvements relevant to the geotechnical considerations.

We recommend that the construction activities be monitored by the Geotechnical Engineer of Record to provide the necessary overview and to check the suitability of the subgrade soils for supporting the tower foundation. We would be most pleased to provide these services.

Respectfully,

ECS MID-ATLANTIC, LLC.

J. Matthew Carroll, P.E.
Geotechnical Group Manager

William D. Friedah, P.E.
Principal Engineer/Branch Manager

APPENDIX

REFERENCE NOTES FOR BORING LOGS

I. Drilling Sampling Symbols:

SS	Split Spoon Sampler	ST	Shelby Tube Sampler
RC	Rock Core, NX, BX, AX	PM	Pressuremeter
DC	Dutch Cone Penetrometer	RD	Rock Bit Drilling
BS	Bulk Sample of Cuttings	PA	Power Auger (no sample)
HAS	Hollow Stem Auger	WS	Wash Sample

II. Correlation of Penetration Resistances to Soil Properties:

Standard Penetration (Blows/Ft) refers to the blows per foot of a 140 lb. Hammer falling 30 inches on a 2-inch OD split spoon sampler, as specified in ASTM D-1586. The blow count is commonly referred to as the N value.

A. Non-Cohesive Soils (Silt, Sand, Gravel and Combinations)

Density		*Relative Properties*	
Under 3 blows/ft.	Very Loose	Adjective Form	36% to 49%
4 to 10 blows/ft.	Loose	With	21% to 35%
11 to 30 blows/ft.	Medium Dense	Some	11% to 20%
31 to 50 blows/ft.	Dense	Trace	1% to 10%
51 to 80 blows/ft.	Very Dense		
Over 80 blows/ft.	Extremely Dense		

Particle Size Identification

Boulders		8 inches or larger
Cobbles		3 to 8 inches
Gravel	Coarse	1 to 3 inches
	Medium	½ to 1 inch
	Fine	¼ to ½ inch
Sand	Coarse	2.00mm to ¼ inch (dia. of lead pencil)
	Medium	0.42 to 2.00mm (dia. of broom straw)
	Fine	0.074 to 0.42mm (dia. of human hair)
Silt and Clay		0 .0 to 0.074mm (particles cannot be seen)

B. Cohesive Soils (Clay, Silt, and Combinations)

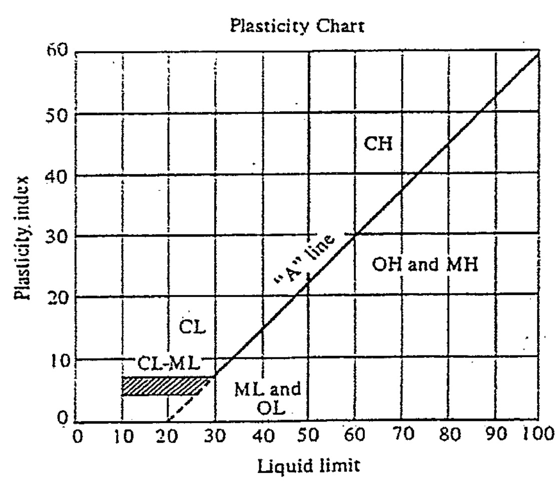
Blows/Ft	*Consistency*	*Unconfined Comp. Strength Q_P(tsf)*	*Degree of Plasticity*	*Plasticity Index*
Under 4	Very Soft	Under 0.25	None to Slight	0 - 4
4 to 5	Soft	0.25-0.49	Slight	5 – 7
6 to 10	Medium Stiff	0.50-0.99	Medium	8- 22
11 to 15	Stiff	1.00-1.99	High to Very High	Over 22
16 to 30	Very Stiff	2.00-3.00		
31 to 50	Hard	4.00-8.00		
Over 51	Very Hard	Over 8.00		

III. Water Level Measurement Symbols

WL	Water Level	BCR	Before Casing Removal
WS	While Sampling	ACR	After Casing Removal
WD	While Drilling	WCI	Wet Cave-In
		DCI	Dry Cave-In

The water levels are those water levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in a granular soil. In clay and plastic silts, the accurate determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally applied.

Unified Soil Classification System (ASTM D-2487)

Major Divisions			*Group Symbols*	*Typical Names*	*Laboratory Classification Criteria*		
Coarse-grained soils (More than half of material is larger than No. 200 sive size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean Gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP; More than 12 percent GM, GC, SM, SC; 5 to 12 percent *Borderline* cases requiring dual symbols [b]	$C_u = D_{60}/D_{10}$ greater than 4; $C_c = (D_{30})^2/D_{10} \times D_{60}$ between 1 and 3	
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciablle Amount of fines)	GM[a] d / u	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are *borderline* cases requiring the use of dual symbols
			GC	Clayey Gravels, gravel-sand-clay mixtures		Atterberg Limits below "A" line with P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines		$C_u = D_{60}/D_{10}$ greater than 6; $C_c = (D_{30})^2/D_{10} \times D_{60}$ between 1 and 3	
			SP	Poorly-graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a] d / u	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are *borderline* cases requiring the use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine Grained Soils (More than half of material is smaller than No. 200 sieve size)	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		Pt	Peat and other highly organic soils			

[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L is 28 or less and the P.I. is 6 or less; the suffix u is used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing the characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

From Winterkorn and Fang, 1975

CLIENT	JOB #	BORING #	SHEET
KBA Engineering, pc	2573	B-1	1 OF 1

PROJECT NAME: Lebanon VAMC Water Tower

ARCHITECT-ENGINEER:

SITE LOCATION: 1700 South Lincoln Avenue, Lebanon, Lebanon County

CALIBRATED PENETROMETER TONS/FT2: 1, 2, 3, 4, 5+

PLASTIC LIMIT — WATER CONTENT % — LIQUID LIMIT %

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — REC.% (20%, 40%, 60%, 80%, 100%)

STANDARD PENETRATION BLOWS/FT: 10, 20, 30, 40, 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT
0	S-1	SS	18	12	Topsoil Depth [4"] Fine Sandy SILT, Orangish-Brown, Moist, Loose (ML)			3 5 5	10
	S-2	SS	4	5				50/5	120
5	S-3	RC	60		LIMESTONE, Gray with Calcite Seams, Broken (Rec = 92%, RQD = 12%)				
					End of Boring @ 8.5'				
10									
15									
20									
25									
30									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS☐ WD☐	BORING STARTED 03/15/12	
WL(BCR) WL(ACR)	BORING COMPLETED 03/15/12	CAVE IN DEPTH
WL	RIG T-4 ATV FOREMAN Bob	DRILLING METHOD 3.25" HSA

CLIENT	JOB #	BORING #	SHEET
KBA Engineering, pc	2573	B-2	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Lebanon VAMC Water Tower	

SITE LOCATION

1700 South Lincoln Avenue, Lebanon, Lebanon County

CALIBRATED PENETROMETER TONS/FT2: 1, 2, 3, 4, 5+

PLASTIC LIMIT — WATER CONTENT % — LIQUID LIMIT %

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — REC.%: 20%, 40%, 60%, 80%, 100%

STANDARD PENETRATION BLOWS/FT: 10, 20, 30, 40, 50+

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS; BOTTOM OF CASING; LOSS OF CIRCULATION; SURFACE ELEVATION)	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Depth [3"]			
					Silty Fine SAND (SM), Brown, Moist, Medium Dense			
					AUGER REFUSAL @ 0.7' Boring Offset and Redrilled as B-2A			
5								
10								
15								
20								
25								
30								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS☐ WD☐	BORING STARTED 03/15/12	
WL(BCR) WL(ACR)	BORING COMPLETED 03/15/12	CAVE IN DEPTH
WL	RIG T-4 ATV FOREMAN Bob	DRILLING METHOD 3.25" HSA

CLIENT	JOB #	BORING #	SHEET
KBA Engineering, pc	2573	B-3	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Lebanon VAMC Water Tower	

SITE LOCATION

1700 South Lincoln Avenue, Lebanon, Lebanon County

CALIBRATED PENETROMETER TONS/FT2: 1, 2, 3, 4, 5+

PLASTIC LIMIT — WATER CONTENT % — LIQUID LIMIT %

ROCK QUALITY DESIGNATION & RECOVERY (RQD%, REC.%): 20%, 40%, 60%, 80%, 100%

STANDARD PENETRATION BLOWS/FT: 10, 20, 30, 40, 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT
0					Topsoil Depth [3"]				
	S-1	SS	18	12	Clayey SILT with Fine Sand, Orangish Brown, Moist, Loose (ML)			3 6 4	10
	S-2	SS	5	5	Weathered Limestone sampled as GRAVEL with Sand (GP)			50/5	120
					AUGER REFUSAL @ 3.50'				
5									
10									
15									
20									
25									
30									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS☐ WD☐	BORING STARTED 03/15/12	
WL(BCR) WL(ACR)	BORING COMPLETED 03/15/12	CAVE IN DEPTH
WL	RIG T-4 ATV FOREMAN Bob	DRILLING METHOD 3.25" HSA

CLIENT	JOB #	BORING #	SHEET
KBA Engineering, pc	2573	B-2A	1 OF 1
PROJECT NAME: Lebanon VAMC Water Tower	ARCHITECT-ENGINEER		
SITE LOCATION: 1700 South Lincoln Avenue, Lebanon, Lebanon County			

CALIBRATED PENETROMETER TONS/FT2: 1, 2, 3, 4, 5+

PLASTIC LIMIT — WATER CONTENT % — LIQUID LIMIT %

ROCK QUALITY DESIGNATION & RECOVERY — RQD% — REC.%: 20%, 40%, 60%, 80%, 100%

STANDARD PENETRATION BLOWS/FT: 10, 20, 30, 40, 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Augered to 2.0' Silty Fine SAND, Brown, Moist			
2					LIMESTONE, Gray with Calcite Seams (Rec = 97%, RQD = 83%)			
5	S-1	RC	60	58				
7					LIMESTONE, Gray with Calcite Seams, Broken (Rec = 100%, RQD = 28%)			
10	S-2	RC	60	60				
12					END OF BORING @ 12.00'			

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL — WS☐ WD☐	BORING STARTED 03/22/12	
WL(BCR) — WL(ACR)	BORING COMPLETED 03/22/12	CAVE IN DEPTH
WL	RIG T-4 ATV — FOREMAN Matt	DRILLING METHOD 3.25" HSA

CLIENT	JOB #	BORING #	SHEET
KBA Engineering, pc	2573	B-4	1 OF 1
PROJECT NAME: Lebanon VAMC Water Tower	ARCHITECT-ENGINEER		
SITE LOCATION: 1700 South Lincoln Avenue, Lebanon, Lebanon County			

CALIBRATED PENETROMETER TONS/FT2: 1 2 3 4 5+

PLASTIC LIMIT — WATER CONTENT % — LIQUID LIMIT %

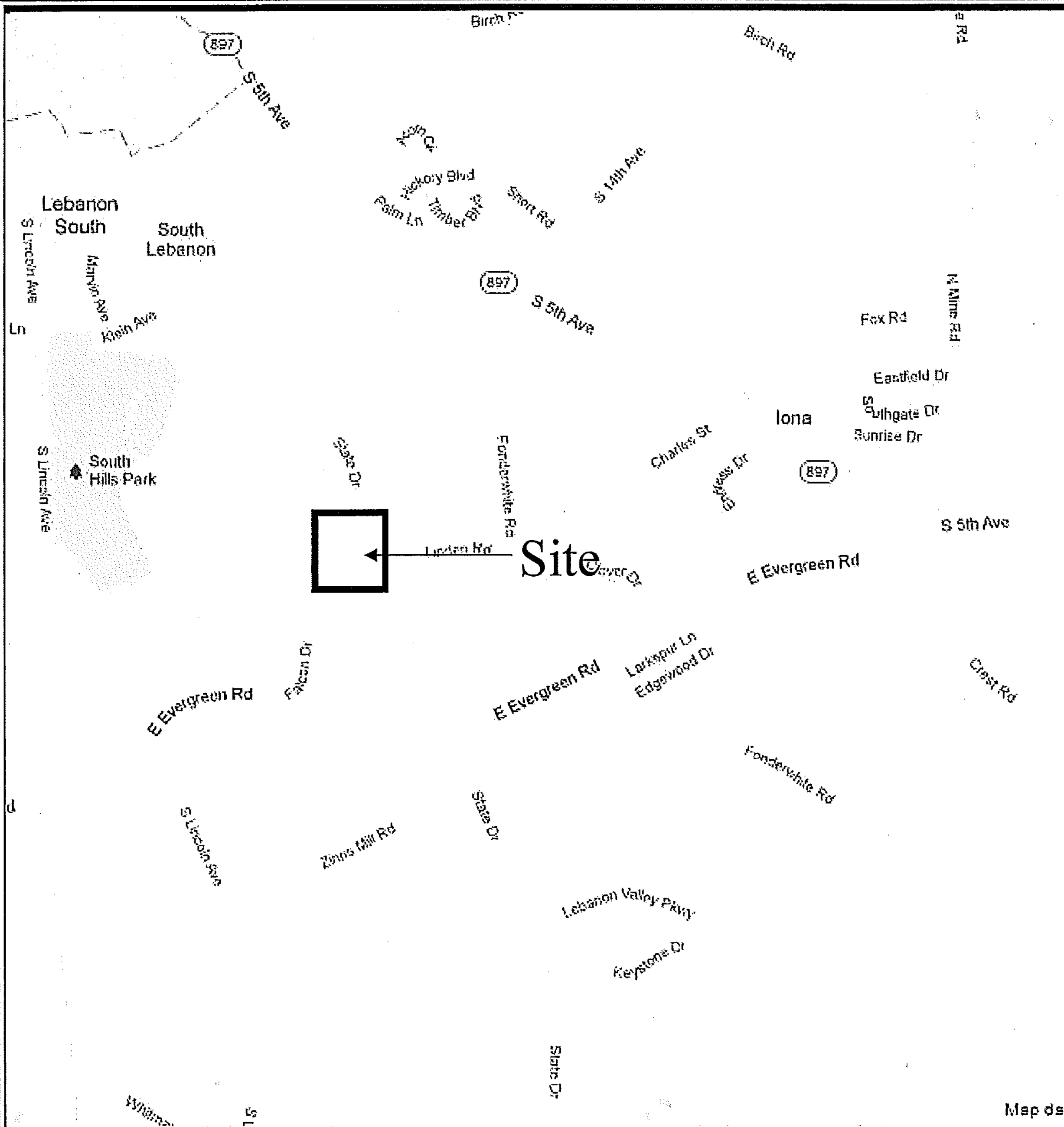
ROCK QUALITY DESIGNATION & RECOVERY — RQD% — REC.%: 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT: 10 20 30 40 50+

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS) — BOTTOM OF CASING — LOSS OF CIRCULATION — SURFACE ELEVATION	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Depth [4"]			
					Augered to Rock			
					Clayey SILT, With Rock Fragments, Orangish Brown, Moist,			
5.5					AUGER REFUSAL @ 5.50'			

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS☐ WD☐	BORING STARTED 03/22/12	
WL(BCR) WL(ACR)	BORING COMPLETED 03/22/12	CAVE IN DEPTH
WL	RIG T-4 ATV FOREMAN Matt	DRILLING METHOD 3.25" HSA



Source: Maps.Google.com, 2012 Google Maps
Scale: 1" = 2000'

NORTH

0 2000 3000

Lebanon VAMC Water Tower

1700 S. Lincoln Ave.
Lebanon, Pa.

ECS LLC MID-ATLANTIC

Site Location Diagram
ECS Project 18-2563-A
March 2012

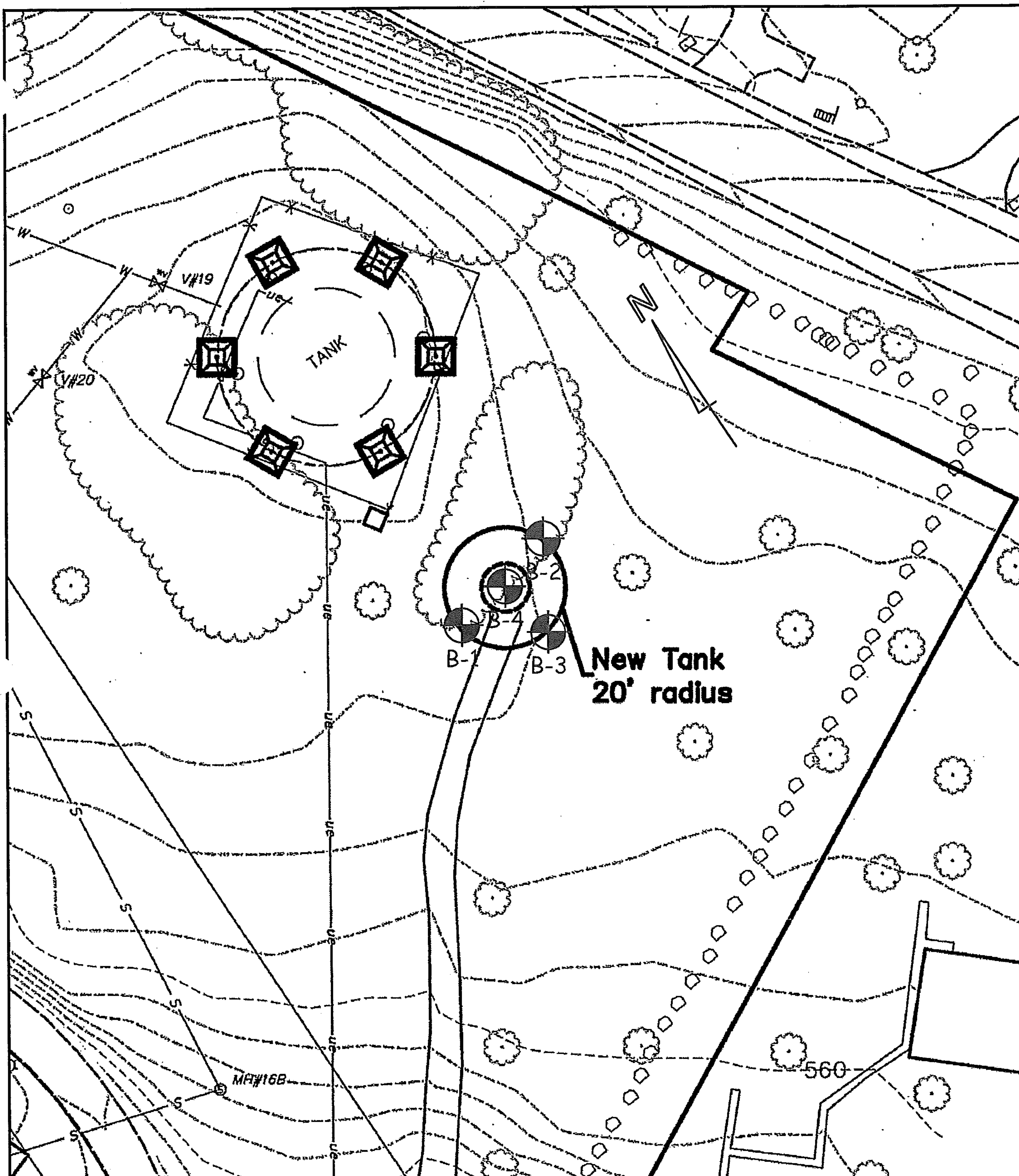
Karst Features DIAGRAM

KBA Engineering, PC

Lebanon VAMC Water Tower

Lebanon, Pa.

ENGINEER JMC	SCALE NTS
DRAFTSMAN PJS	PROJECT NO. 18.2573
REVISIONS	SHEET 1
	DATE 03-23-12



BORING LOCATION DIAGRAM KBA Engineering, PC	ECS	Lebanon VAMC Water Tower Lebanon, Pa.	ENGINEER: JMC	SCALE: NTS
			DRAFTSMAN: PJS	PROJECT NO. 18.2573
			REVISIONS	SHEET: 1
				DATE: 03-23-12