ALLENDER BUTZKE ENGINEERS INC.
GEOTECHNICAL • ENVIRONMENTAL • CONSTRUCTION Q. C.

June 15, 2020 **PN 191288**

PRELIMINARY GEOTECHNICAL EXPLORATION

FIVE FLAGS CENTER
ARENA AND THEATRE RENOVATION
405 MAIN STREET
DUBUQUE, IOWA

PERFORMED FOR

CITY OF DUBUQUE - ENGINEERING DEPARTMENT
50 WEST 13TH STREET
DUBUQUE, IA 52001

3660 109TH STREET • URBANDALE, IOWA 50322 • PHONE 515-252-1885 • FAX 515-252-1888

ALLENDER BUTZKE ENGINEERS INC.
GEOTECHNICAL • ENVIRONMENTAL • CONSTRUCTION Q. C.

June 15, 2020

City of Dubuque - Engineering Department
50 West 13th Street
Dubuque, IA 52001
Attn: Steve Sampson-Brown

RE: Preliminary Geotechnical Exploration
Five Flags Civic Center
Arena and Theatre Renovation
405 Main Street
Dubuque, Iowa
PN 191288

Dear Mr. Sampson-Brown:

As authorized by Michael C. Van Milligen, Dubuque City Manager, Allender Butzke Engineers Inc. (ABE) has completed the geotechnical exploration for the above referenced project. The preliminary geotechnical exploration was conducted to evaluate physical characteristics of subsurface conditions for initial geotechnical analysis and development of preliminary design options for building foundations and floor slabs. The enclosed report summarizes the project characteristics as we understand them, presents the findings of the borings and laboratory tests, discusses the observed subsurface conditions, and provides preliminary geotechnical engineering recommendations for this project.

We appreciate the opportunity to provide our geotechnical engineering services for this project. If you have any questions or need further assistance, please contact us at your convenience. We are also staffed and equipped to provide construction testing and inspection services on this project as well as environmental site assessments.

Respectfully submitted,
ALLENDER BUTZKE ENGINEERS INC.

Matt Drummond, P.E.
Project Engineer

David Logemann, P.E.
Principal Engineer

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

6/15/2020

Matthew J. Drummond, P.E. License Number 21407 Date
My license renewal date is December 31, 2020.
Pages covered by this seal: All Pages .

1 PC and 1 Email Above

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PN 191288

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PROJECT INFORMATION

The City of Dubuque is planning major renovation of the existing Five Flags Center in Dubuque, Iowa. Proposed renovations include a major expansion of the existing civic center building to include an arena/structure addition extending northward approximately 200 to 250 feet into the area currently occupied by W 5th Street, a surface parking lot, and gas/service station buildings. The existing civic center building may remain in place as part of the renovation, or portions of the existing structure could be demolished and replaced during renovation. The proposed arena structure/addition will generate moderate to heavy loads with column loads on the order of 50 to 410 kips as provided by Mr. Ken Betsch, AIA with Betsch Associates. Preliminary floor loads on the order of 100 pounds per square foot (psf) were provided by David Campbell P.E., with Geiger Engineers for the arena floor. Heavier floor loads on the order of 300 psf were provided for the stage and back of house areas. It is our understanding that the proposed finish floor of the addition will match that of the existing building finish floor near elevation 100 feet.

Plans of the existing Five Flags Civic Center (from 1977) provided by the City of Dubuque indicate existing spread foundations for the multi-story building were designed to be supported on compacted granular fill overlying natural sands. The existing building construction incorporated a historic theater structure which is present in the southeast portion of the building. The southern 1/3 or more of the existing building, including the theater structure, includes a basement level.

Proposed construction will include demolition of the existing surface parking lot, gas/service station buildings, canopies, below grade storage tanks, and relocation of utilities associated with occupying W 5th Street. Review of historical Sanborn fire maps of the site indicates that several 2- to 4-story storefront and residential structures formerly occupied the site. The Sanborn maps do not clearly indicate whether or not these former structures had basements; however, based on our experience in this area of Dubuque, we assume these past structures likely had basements.

FIELD EXPLORATION

Six borings were conducted at this site to depths of 41 and 81 feet below existing grades on July 9 and 10, 2019. Approximate locations of the borings are shown on the enclosed Site Plan and were measured in the field from existing landmarks. The boring surface elevations, indicated on the enclosed Boring Logs, were determined by differential leveling and referenced to the finish floor elevation of the existing Five Flags Center building. For reference in this report, we have assigned this temporary benchmark location an elevation of 100.0 feet. Methods of drilling, sampling, standard laboratory testing, and classifying of subsurface materials are discussed in the Boring Log Description/Legend pages of the Appendix.

Cone Penetration Tests (CPT) were conducted in the sand fill between depths of 7.5 and 11 feet in Boring No. 2 and within the natural sand between depths of 10 and 26.5 feet in Boring No. 4. Results of CPT tests are included following the respective Boring Logs in the Appendix of this report.

LABORATORY TESTING

Grain size analyses tests (washed over #200 sieve) of the fill and natural sand from Boring Nos. 3, 4, and 6 were conducted to determine the fines content (percent finer than 0.075 mm) of the on-site sands. Laboratory test results have been included in the Appendix of this report as Figure GS-1. Laboratory testing provided on the Boring Logs also includes moisture content of samples obtained during drilling operations. The soil types shown on the Boring Logs were visually classified utilizing the Unified Soil Classification System (USCS).

SUBSURFACE CONDITIONS

Soil Profile

Detailed descriptions of soils encountered by this exploration are provided on the Boring Logs enclosed in the Appendix. The Profile of Borings (Plate A-1) presented in the Appendix depicts the relative deposit elevations in the borings. Following is a discussion of the subsurface materials encountered in the borings. Unless otherwise indicated, the depths of soil stratum and groundwater levels are referenced from below existing grade at the individual boring locations at the time of drilling.

The borings encountered HMA and PCC wearing surface overlying sand fill with varying amounts of silt and clay (SW, SP, SM, and SC). Brick fragments were observed within the deeper portions of the fill between depths of 10 and 12 feet in Boring Nos. 2 and 5. The damp to moist and loose fill extended to various depths between 7 and 12.5 feet and is underlain by brown and gray fine to medium sand (SP) alluvium. The moist and loose to medium dense alluvium became denser below depths of approximately 20 to 30 feet. Borings terminated in medium dense to dense sand alluvium near depths of 41 and 81 feet.

Groundwater Level Observations

The borings were monitored during and shortly after drilling operations to detect moisture seepage and groundwater accumulation. The results of our water level observations are noted on the Boring Logs enclosed in the Appendix.

During drilling operations, saturated sands were noted below depths of 34 to 38 feet. Groundwater accumulation was observed within the sand alluvium at similar depths at the completion of drilling operations. The observed groundwater levels appear to be comparable to the stage of the Mississippi River at the time of drilling (near elevation 611 feet), as measured at the Mississippi River gage located at 4th Street, adjacent to the right abutment of the Illinois Central Railroad Bridge.

It should be recognized that these short-term water levels are not necessarily a true indication of the groundwater table. Long-term observations would be necessary to accurately define the groundwater variations at this site. Fluctuation of groundwater levels can occur due to seasonal variations in the amount of rainfall, surface drainage, subsurface drainage, site topography, irrigation practices, ground cover (pavement or vegetation), and stage of the nearby Mississippi River.

PRELIMINARY ANALYSES AND RECOMMENDATIONS

The loose sand fill encountered in the upper 7 to 12 feet of the borings would not provide reliable support for the future building foundations and floor slabs. Future demolition to remove existing building foundations, below ground tanks from the gas/service station site, and utilities from below current W 5th Street corridor will increase variability below the future structure. Furthermore, structures formerly present at the site may have had basements which would have been filled in during demolition of these former structures and/or construction of the existing parking lots, gas station area, and other existing site features. Therefore, to provide reliable support for future building foundations and floor slabs, we recommend one of the following options be considered:

1) Complete over-excavation of the variable existing fill and replacement with controlled engineered compacted fill below foundations and floor slabs
2) Use aggregate piers (such as Geopiers, stone columns, or equivalent) to improve ground support conditions beneath proposed footings and floor slabs
3) Support the new structure on a deep foundation system of augered cast-in-place (ACIP) or Auger Pressure Grouted (APG) piles extending through the fill to develop support in the underlying sand.

Selection of the appropriate option will depend upon acceptable costs and flexibility of the construction schedule. The following report sections provide general geotechnical recommendations for these preliminary foundation options.

Preliminary Foundation Options

Shallow Spread Foundations with Complete Over-Excavation and Compaction of Existing Fill - One option to provide reliable support of spread foundations and floor slabs would be to over-excavate all of the existing fill soils down to natural soils, then moisture condition the suitable onsite soils and recompact in controlled lifts to 98 percent of the material's maximum dry density as determined by Standard Proctor (ASTM D698). Based on preliminary boring information, we recommend the over-excavation extend down to a minimum elevation of 90 feet or approximately 10 feet deep near Locust Street in the western portion of the site. Fill soils extended deeper in Boring Nos. 2 and 5 to near elevation 86 feet, or approximately 12 feet deep near Main Street in the eastern portion of the site. Over-excavations should extend a minimum 9-inches laterally beyond foundation edges for every foot of over-excavation. Therefore, this option should consider the need to extend the excavation 5 feet or more beyond the footing edge and accommodate a backslope (1.5:1 or flatter) around the building perimeter.

We recommend that continuous and isolated spread foundations bearing on 5 feet or more of new engineered compacted fill placed in association with complete over-excavation of variable existing fill be designed preliminarily for a maximum net allowable soil bearing pressure of 4,000 pounds per square foot. Final design will depend on final structural loads, foundation bearing elevation, and settlement tolerances.

While the preliminary borings indicate the majority of material would be suitable for reuse as engineered fill, there will likely be portions of the fill that are unsuitable. Considering the history of the site, we assume possibly 20 to 25 percent of on-site materials could be unsuitable. The on-site soils will also experience shrinkage when excavated and compacted to the recommended 98 percent of the material's Standard Proctor (ASTM D698) maximum dry density. We estimate shrinkage could be on the order of 15 to 20 percent. Considering possible unsuitable soils and lower fill volume due to shrinkage it may be prudent to include some import of crushed rock for use as engineered fill to achieve the final desired grades.

Aggregate Pier Ground Improvement – A ground improvement system of aggregate piers (Geopiers, stone columns, or equivalent) could be constructed beneath on-grade slabs and footings to densify and improve reliability and support of variable existing fill and loose sand present in the upper 10 to 15 feet. The sand fill and alluvial soils at this site would be conducive to ground improvement using displacement methods typically conducted by driving a hollow mandrel into the ground, feeding aggregate through the mandrel, and compacting the aggregate in thin lifts.

Compacted aggregate piers would be designed and installed under the direction of a specialty contractor. Spread foundations supported on compacted aggregate piers that improve the fill and upper loose sand for the proposed parking structure could typically be proportioned for bearing pressures in the range of about 6,000 to 8,000 pounds per square foot, dependent upon the specialty contractor pier design.

Augered Cast-in-Place (ACIP) Pile Deep Foundation Design – In our opinion, the loose to medium dense sand deposits at this site would be conducive to augered cast-in-place (ACIP) or auger pressure grouted (APG) pile deep foundation systems. The following Table A provides recommendations for allowable skin friction and end bearing values for ACIP pile deep foundations. The APG pile system uses a proprietary construction method and would be designed and installed by Berkel & Company Contractors. Due in part to displacement (densification) of the surrounding soils during pile installation, similar diameter and capacity APG piles are typically much shorter than conventional ACIP piles.

TABLE A
SOIL PARAMETERS
AUGERED CAST-IN-PLACE (ACIP) PILE

Soil Formation or Deposit	Approximate Elevation (feet)[1]	Allowable Skin Friction (psf)	Allowable End Bearing (psf)
Existing Fill	Above 86	NA [2]	
Alluvium (Sand)	Below 86	600	10,000[3]

1) Finish Floor of existing Five Flags Center near assumed elevation 100.0 feet
2) Ignore skin friction in existing variable fill
3) Allowable end bearing applicable for ACIP pile tips bearing below elevation 70 feet

As examples, our calculations using the above recommended soil parameters indicate that 14, 16, and 18-inch diameter ACIP piles constructed to bear in medium dense sand approximately 45 feet below the building floor level (overall pile length on the order of 40 feet) would have individual pile capacities on the order of 80, 90, and 100 kips, respectively. Shorter pile lengths on the order of 20 to 25 feet would be required for ACIP piles with capacities on the order of 50 kips. These are example calculations based on preliminary boring data, actual design of deep foundations will depend upon soil conditions, anticipated loads, and the configuration which will be most economical to construct. As previously discussed, similar diameter displacement piles (APG piles) would likely result in similar capacity with much shorter pile lengths than the example ACIP capacities provided.

Group reduction factors applied to the skin friction portions alone should be used for deep foundation members established closer than 3 times the pile diameter. Deep foundation groups with closer spacing should have the skin friction reduced (on the order of 10 percent) to account for group action. End bearing is not reduced by group action. Uplift reactions due to wind can be resisted by skin friction and buoyant weight of the foundation. We recommend that skin friction values for uplift be limited to 75 percent of the compression skin friction values as provided in Table A.

General - We recommend that spread foundations and deep foundations not be utilized together within the same interconnected structural units because of the potential differential settlement. We estimate long-term total settlement due to structural loads will be less than 1 inch and differential settlement may be on the order of ½ of the total settlement when foundations bear on newly placed engineered compacted fill or a ground improvement system of compacted aggregate piers. With a deep foundation system of ACIP or AGP piles, we estimate long term settlement due to structural loads will be less than ½ inch and differential settlement will be negligible. Structural and architectural connections should be designed to accommodate the differential settlement that may occur between the proposed arena and existing structure.

Although not encountered in the borings, heavy concentrations of brick rubble or other debris could slow the installation of aggregate pier ground improvement systems or deep foundation

systems of ACIP or AGP piles. If present, areas of fill not conducive to auger or mandrel type installation methods may require over-excavation of rubble fill to allow final construction of ground improvement or deep foundation systems.

It should be recognized that the sand fill and underlying natural sand will be easily disturbed by construction traffic. Foundation soils loosened during construction should be adequately recompacted and densified prior to footing construction. It may be beneficial to construct a clean coarse granular working mat at the bottom of excavations in order to limit construction disturbance of the sand foundation soils. Excavations should be conducted in a manner that avoids disturbance of soils below the existing foundations.

Floor Slab Support

The variable fill encountered in the upper portions of the borings would not provide reliable support for slab-on-grade floors. Therefore, similar to building foundations, on-grade floor slabs should be supported on newly placed engineered compacted fill to replace variable existing fill, a ground improvement system of aggregate piers, or structurally supported floors on grade beams and ACIP or AGP pile deep foundations. Sand fill and underlying natural sand will be easily disturbed by construction traffic. Therefore, we recommend compacted crushed rock fill be utilized for the final 1 foot of fill placed below floor slab level.

Seismic Design Factors

Boring information indicates that the soil profile at this site to depths of 80± feet below existing grades is comprised of loose to medium dense granular alluvium. Based on SPT blow counts in the borings, we estimate the project site to be Site Class D as defined in the 2018 International Building Code (IBC) and 2010 ASCE-7 Standard.

GENERAL

The analyses and recommendations in this report are based in part upon the data obtained from the soil borings performed at the indicated locations and from any other information discussed in this report. This report does not reflect any variations which may occur between borings or across the site. The nature and extent of such variations may not become evident until construction. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report.

It is recommended that the geotechnical engineer be provided the opportunity to review the plans and specifications so that comments can be made regarding the interpretation and implementation of our geotechnical recommendations in the design and specifications. It is further

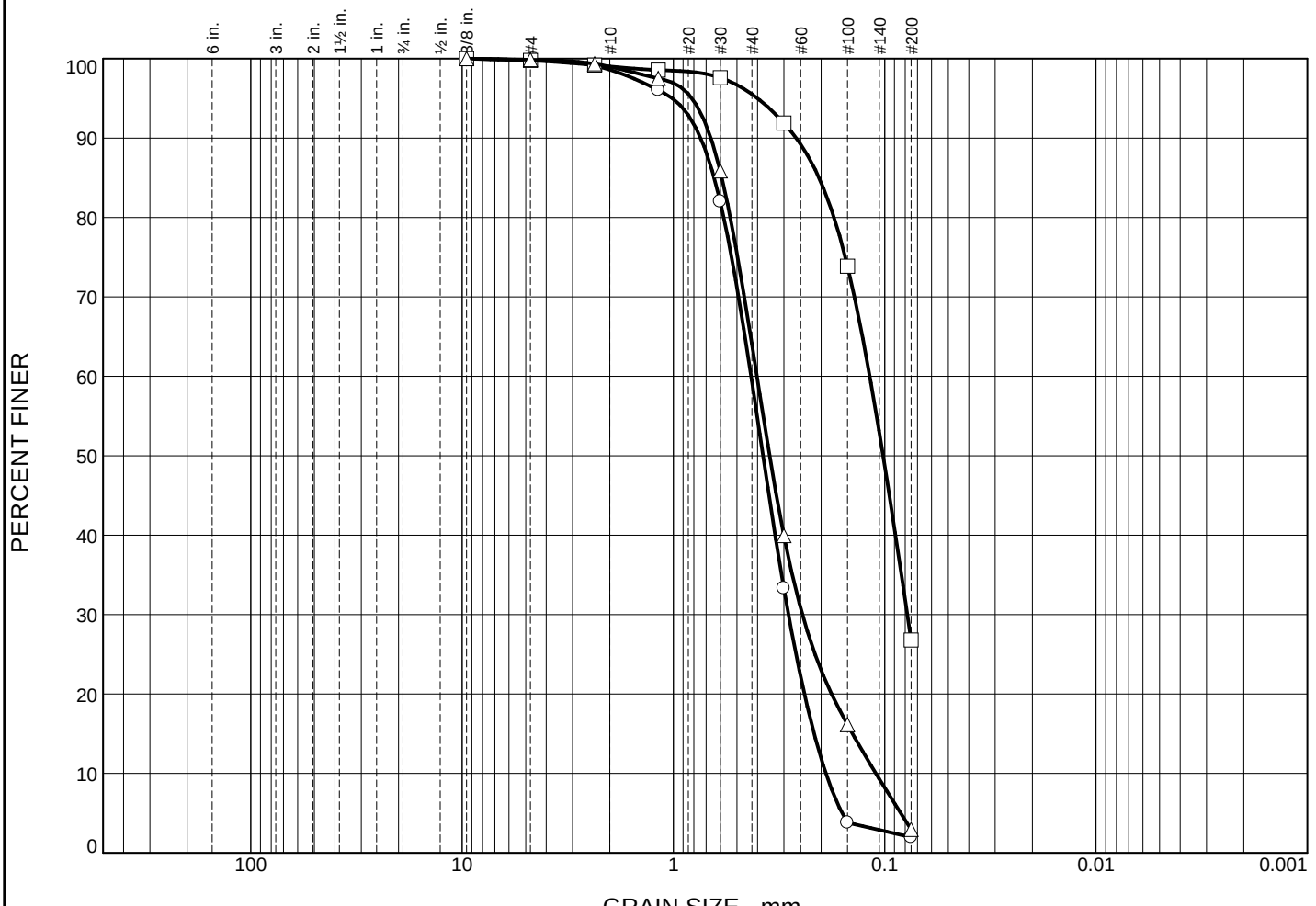
recommended that the geotechnical engineer be retained for testing and observation during earthwork and foundation construction phases to help determine that the design requirements are fulfilled.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranty, expressed or implied, is made. In the event that any changes in the nature, design or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report modified or verified in writing by the geotechnical engineer.

The scope of our service was not intended to include any environmental assessment or exploration for the presence of hazardous or toxic materials in the soil, surface water, groundwater or air on, below or adjacent to this site.

APPENDIX

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.2	1.2	39.3	57.3	2.0	
□	0.0	0.0	0.2	0.8	3.5	68.7	26.8	
△	0.0	0.0	0.1	0.9	35.0	61.0	3.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.6408	0.4287	0.3764	0.2853	0.2157	0.1898	1.00	2.26
□			0.2045	0.1177	0.1018	0.0781				
△			0.5893	0.4023	0.3503	0.2451	0.1420	0.1101	1.36	3.65

MATERIAL DESCRIPTION	USCS	AASHTO
○ Gray fine to medium sand, trace gravel, moist	SP	
□ Gray-brown clayey sand	SC	
△ Brown fine to medium sand	SP	

Project No. 191288 **Client:** City of Dubuque - Engineering Department

Project: Five Flags Center - Arena and Theater Renovations

○ **Location:** Boring 3 **Depth:** (11' - 21') **Sample Number:** 3

□ **Location:** Boring 4 **Depth:** (5.5' - 8') **Sample Number:** 4

△ **Location:** Boring 6 **Depth:** (3.5' - 7.5') **Sample Number:** 6

Remarks:

○ALLUVIUM

□FILL

△FILL

ALLENDER BUTZKE ENGINEERS, INC.

Figure GS-1

BORING LOG DESCRIPTION/LEGEND

The material types encountered during the drilling operations were recorded on field logs. The profile represented on the Boring Log is based on final classification performed by a geotechnical engineer using the field logs, laboratory observation and testing. The material stratigraphy demarcation lines shown on the Boring Logs indicate changes in soil characteristics, however, actual soil changes or variations may occur as a gradual transition. Soil profile discussion, Log Boring information, water levels and recommendations presented in this report are based upon measured depths below ground levels existing at time of the field exploration, unless otherwise specified.

DRILLING AND SAMPLING

The borings were conducted with either a truck or all-terrain rotary drill rig using the drilling methods indicated on each Boring Log. Soil sampling and/or in-situ testing such as Shelby Tube (ST), split-spoon (SS), drive cone (DC), or core (C) was conducted at depth intervals which were selected in consideration of the characteristics of the proposed construction. Generally undisturbed soil samples are taken at 5 foot depth intervals or change in soil types. Disturbed soil samples from the auger, either jar size or bulk size samples, may be taken at intermediate intervals for the purpose of soil classification or laboratory testing. Borings conducted for soil classification only, will show no designation of sampling although disturbed sampling is performed. Soil samples obtained in the field were identified and sealed for transportation to the laboratory for performance of pertinent physical testing and engineering classification.

Drilling Methods

CFA - Continuous Flight Auger: 4, 6, or 8-inch diameter (ASTM D1452).
RD - Rotary Drilling: Using drilling fluid in cased or uncased boring (ASTM D2113).
HSA - Hollow Stem Auger: 6 or 8-inch diameter, continuous flight auger remains in boring with soil removed from the hollow stem through which undisturbed sampling is conducted.
HA - Hand Auger: 4-inch or less diameter.

Sample Types

ST - Shelby Tube: Thin-walled tube samples of cohesive soils (ASTM D1587).
SS - Split Spoon with 140 lb. manual hammer: Standard penetration test and split-barrel samples (ASTM D1586).
SSA - Split Spoon with 140 lb. automatic hammer: Standard penetration test and split-barrel samples (ASTM D1586).
DC - Drive Cone: Dynamic in-place testing of soil using a 2-inch diameter cone with a 60 degree point driven into the soil for continuous 1-foot intervals in the same manner as Split Spoon, no sample is obtained.
C - Core: Sampling hard soil or bedrock with a diamond core barrel in a rotary drill boring (ASTM D2113).
SPT - Standard Penetration Test: Number of blows required to drive sampler (split spoon or drive cone) into the soil with a 140-pound weight dropping a distance of 30-inches (ASTM D1586), number of blows recorded for each 6-inch interval in an 18-inch (or more) penetration depth, values shown are for each 6-inch interval (if series of number sets are shown) or a total of the last two 6-inch intervals (if only one number is shown) which is commonly referred to as "N" in blows per foot. High resistance is indicated by a high number of blows for a lesser penetration depth listed in inches.
BS - Bulk Sample: Disturbed.
CPT - Cone Penetration Test: Quasi-static in-place testing of soils using a 60 degree cone and friction sleeve which are steadily pushed into the soil and measure skin friction and end bearing (ASTM D3441).

STANDARD LABORATORY TESTING

Representative undisturbed soil samples obtained by the Shelby Tube sampler were tested for moisture content (ASTM D2216), density (dry) and unconfined compressive strength (ASTM D2166) in the laboratory. Results of these tests appear on the respective Boring Logs. Additional soil testing including particle size analysis (ASTM D422) and Atterberg Limits (ASTM D4318) may be conducted, if necessary, to define in more detail pertinent soil characteristics for classification in accordance with the Unified Soil Classification System. Specialized laboratory tests (if conducted) to determine pertinent soil characteristics are discussed in the "Laboratory Testing" section of the report.

WATER LEVEL MEASUREMENT

Water levels indicated on the Boring Logs are the levels measured in the borings at the times indicated. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels is not possible with short term observations.

BORING LOG DESCRIPTION/LEGEND

(page 2 of 3)

DESCRIPTIVE SOIL CLASSIFICATION

Soil description is based on the Unified Classification System as outlined in ASTM Designations D-2487 and D-2488. This classification is primarily based upon visual and apparent physical soil characteristics, comparison with other soil samples, and our experience with the soil. Additional laboratory testing may be conducted, if necessary to define in more detail pertinent soil characteristics. The Unified Soil Classification group symbol shown on the boring logs corresponds with the group names listed below. The description includes soil constituents, moisture conditions, color and any other appropriate descriptive terms.

Group Symbol	Group Name	Group Symbol	Group Name	Group Symbol	Group Name	Group Symbol	Group Name
GW	Well-Graded Gravel	SW	Well-Graded Sand	CL	Lean Clay	CH	Fat Clay
GP	Poorly-Graded Gravel	SP	Poorly-Graded Sand	ML	Silt	MH	Elastic Silt
GM	Silty Gravel	SM	Silty Sand	OL	Organic Clay Organic Silt	OH	Organic Clay Organic Silt
GC	Clayey Gravel	SC	Clayey Sand			PT	Peat

RELATIVE PROPORTIONS			GRAIN SIZE TERMINOLOGY	
Descriptive Term(s) (Of components also present in sample)	Sand and Gravel % of Dry Weight	Fines % of Dry Weight	Major Component of Sample	Size Range
Trace	<15	<5	Cobbles	12 in. to 3 in. (300mm to 75mm)
With	15-30	5-12	Gravel	3 in. to #4 sieve (75mm to 4.75mm)
Modifier	>30	>12	Sand	#4 to #200 sieve (4.75mm to 0.074mm)
			Silt or Clay	Passing #200 sieve (.074 mm)

CONSISTENCY OF FINE-GRAINED SOILS			RELATIVE DENSITY OF COARSE-GRAINED SOILS	
Unconfined Compressive Strength, Qu, psf	Consistency	SPT, bpf	SPT, bpf	Relative Density
< 500	Very Soft	0-2	0-4	Very Loose
500-1,000	Soft	2-4	4-10	Loose
1,000-2,000	Medium Stiff	4-8	10-30	Medium Dense
2,000-4,000	Stiff	8-15	30-50	Dense
4,000-8,000	Very Stiff	15-30	50-80	Very Dense
8,000-16,000	Hard	30-100	80+	Extremely Dense
> 16,000	Very Hard	>100		

BORING LOG DESCRIPTION/LEGEND

ABBREVIATIONS

COMMONLY USED ABBREVIATIONS	
ft. or ' - feet	elev. - Elevation
in. or " - inches	% - Percent
psf - pounds per square foot	No. - Number
plf - pound per lineal foot	TB - Test Boring
pcf - pounds per cubic feet	N - blow count (SPT, bpf)
kip - 1000 pounds	USCS - Unified Soil Classification System
ksf - 1000 pounds per square foot	LL - Liquid Limit
klf - 1000 pounds per lineal foot	PL - Plastic Limit
tsf - tons per square foot	PI - Plasticity Index
bpf - blows per foot (SPT, N)	WOH - Weight of Hammer

BORING LOG NO. 1

Project No.: **191288**

Project: **Five Flags Center**
405 Main Street
Dubuque, Iowa

Client: **City of Dubuque - Engineering**
50 West 13th Street
Dubuque, Iowa 52001

Surface Elevation: **101.2'**
Datum: **BM Main Floor of 5 Flags Center = 100.0'**

Date Drilled: **7/10/2019**
Drilling Depth, ft.: **81**

Drilling Method: **HSA**
Page: **1** of **1**

Elevation ft.	Depth ft.	Sample No.	Type	SPT bpf	Moisture Content, %	Dry Density pcf	Unconfined Compressive Strength psf	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0							**1.5" HMA underlain by 8" PCC Pavement**				0.9
		1	SSA	3	13.2			Brown fine sand, moist		SP		100.3
96		2	SSA	5				Brown silty fine sand, very moist, after 2'		SM		
		3	SSA	7				**FILL**				7
		4	SSA	9				Gray fine sand, moist		SP		94.2
	12	5	SSA	11				Gray clayey sand seam, from 8.5' to 9'				
		6	SSA	7								
84								Gray medium sand, trace gravel, after 17'				
		7	SSA	12								
	24											
		8	SSA	21								
72												
		9	SSA	14								
								Gray very sandy clay layer, moist, after 33'		SC		
	36	10	SSA	20				Gray silty fine sand layer, very moist, after 35'		SM		
								Gray medium sand, saturated, after 37'		SP	▽	
60		11	SSA	17								
								ALLUVIUM		SP		
		12	SSA	51								
	48											
		13	SSA	7								
48												
		14	SSA	26								
	60	15	SSA	23				Brown silty fine sand, after 60'		SM		
36												
		16	SSA	7								
		17	SSA	8								
	72											
								Brown clayey sand		SC		
		18	SSA	24								
24								Gray, after 77'				
		19	SSA	23				Gray fine to medium sand, after 80.5'		SP		81
								End of Boring				20.2

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs. _____ days
Depth to water: **37** ft. ▽ _____ ft. ▼ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

BORING LOG NO. 2

Project No.: **191288**

Project: **Five Flags Center**
405 Main Street
Dubuque, Iowa

Client: **City of Dubuque - Engineering**
50 West 13th Street
Dubuque, Iowa 52001

Surface Elevation: **97.3'**
Datum: **BM Main Floor of 5 Flags Center = 100.0'**

Date Drilled: **7/10/2019**
Drilling Depth, ft.: **41**

Drilling Method: **HSA**
Page: **1** of **1**

Elevation ft.	Depth ft.	Sample No.	Type	SPT bpf	Moisture Content, %	Dry Density pcf	Unconfined Compressive Strength psf	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
96	0							**7" PCC Pavement**				0.6
		1	SSA	9				Brown silty sand with crush rock, trace brick, damp		SM		96.7
		2	SSA	6								
		3	SSA	3				Brown medium sand, moist, after 5.5'		SW		
								FILL				
								Interbedded brick rubble near 10'				11
84	12							Brown medium sand, moist		SP		86.3
		4	SSA	15				Gray coarse sand, trace gravel, after 15.5'				
								Gray medium sand, after 17'				
		5	SSA	9								
72	24	6	SSA	9	4.4							
								ALLUVIUM				
		7	SSA	41	4.6			Gray fine sand, after 27'				
								Gray medium sand, after 33'				
		8	SSA	7				Saturated , after 34'			▽	
60	36											
		9	SSA	14								41
								End of Boring				56.3
48	48											
36	60											
24	72											

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs. _____ days
Depth to water: **35** ft. ▽ _____ ft. ▼ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

BORING LOG NO. 2-CPT

Project No.: **191288**

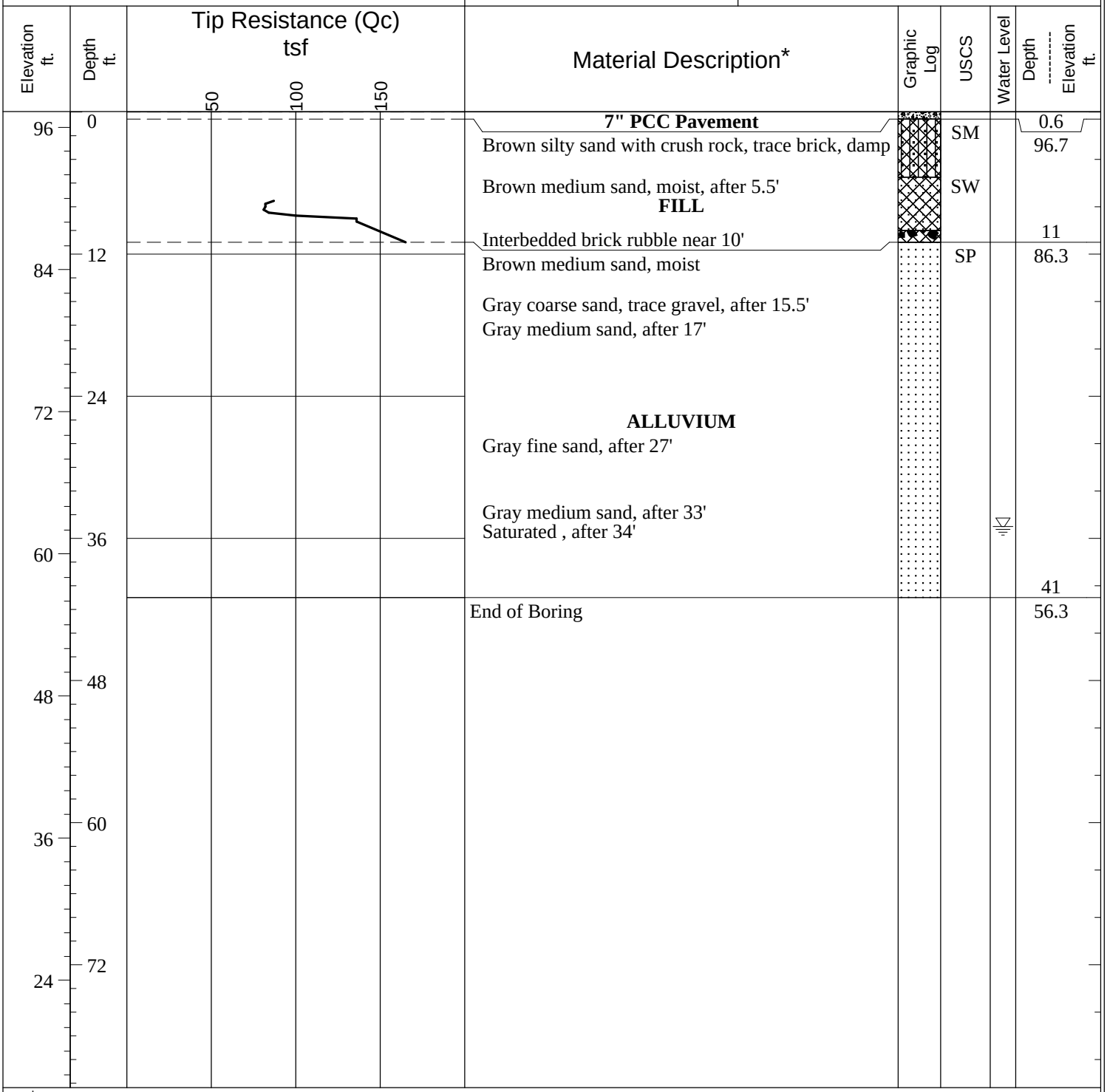
Project: **Five Flags Center**
405 Main Street
Dubuque, Iowa

Client: **City of Dubuque - Engineering**
50 West 13th Street
Dubuque, Iowa 52001

Surface Elevation: **97.3'**
Datum: **BM Main Floor of 5 Flags Center = 100.0'**

Date Drilled: **7/10/2019**
Drilling Depth, ft.: **41**

Drilling Method: **HSA**
Page: **1** of **1**



*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs. _____ days
Depth to water: **35** ft. _____ ft. _____ ft.

ALLENDER BUTZKE ENGINEERS, INC.

Geotechnical | Environmental | Construction Q.C.

BORING LOG NO. 3

Project No.: **191288**

Project: **Five Flags Center**
405 Main Street
Dubuque, Iowa

Client: **City of Dubuque - Engineering**
50 West 13th Street
Dubuque, Iowa 52001

Surface Elevation: **100.2'**
Datum: **BM Main Floor of 5 Flags Center = 100.0'**

Date Drilled: **7/11/2019**
Drilling Depth, ft.: **81**

Drilling Method: **HSA**
Page: **1** of **1**

Elevation ft.	Depth ft.	Sample No.	Type	SPT bpf	Moisture Content, %	Dry Density pcf	Unconfined Compressive Strength psf	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0							Dark brown silty medium sand, trace gravel, moist		SM		
		1	SSA	4	8.7			Brown, very moist, after 3"				
96		2	SSA	2	13.1			**FILL**				
		3	SSA	5	4.1			Sandy lean clay seam, after 5'		SP		
		4	SSA	5	3.4			Fine to medium sand, after 6'				8.5
	12	5	SSA	6	3.8			Gray fine to medium sand, trace gravel, moist		SP		91.7
		6	SSA	9	4.2							
84												
		7	SSA	9	4.3							
	24											
		8	SSA	21	4.7							
72												
		9	SSA	13								
								Gray fine sand with silt layers, after 33'		SM		
	36	10	SSA	14				Saturated at 35'			▽	
60		11	SSA	21				Gray fine to medium sand, after 39.5		SP		
								Saturated at 40.5'				
										SP		
		12	SSA	8				**ALLUVIUM**				
	48											
		13	SSA	18								
48												
		14	SSA	18								
								Trace gravel, after 57'				
	60	15	SSA	10				Brown silty fine sand, interbedded with silt layers,		SM		
36								throughout, after 60'				
		16	SSA	23								
		17	SSA	26								
	72											
24		18	SSA	74								
		19	SSA	28								81
								End of Boring				19.2

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs. _____ days
Depth to water: **35** ft. ▽ _____ ft. ▼ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

BORING LOG NO. 4

Project No.: **191288**

Project: **Five Flags Center**
405 Main Street
Dubuque, Iowa

Client: **City of Dubuque - Engineering**
50 West 13th Street
Dubuque, Iowa 52001

Surface Elevation: **102.0'**
Datum: **BM Main Floor of 5 Flags Center = 100.0'**

Date Drilled: **7/10/2019**
Drilling Depth, ft.: **41**

Drilling Method:
Page: **1** of **1**

Elevation ft.	Depth ft.	Sample No.	Type	SPT bpf	Moisture Content, %	Dry Density pcf	Unconfined Compressive Strength psf	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0							**3" HMA underlain by 4" PCC Pavement**				0.6
		1	SSA	5	6.8			Brown fine sand, moist		SP		101.4
		2	SSA	5				Reddish brown lean clay from 4' to 5'		CL		
96		3	SSA	3				**FILL**		SC		
		4	SSA	11				Gray-brown clayey sand, after 5'				9.3
								Gray medium sand, very moist		SP		92.7
	12											
84												
	24							**ALLUVIUM**				
72		5	SSA	23				Gray fine sand, after 30'				
								Clayey sand layer from 32' to 35'		SC		
		6	SSA	24				Trace gravel, after 35'		SP		
	36							Brown medium sand, saturated, after 38'			▽	
		7	SSA	12								41
60								End of Boring				61
	48											
48												
	60											
36												
	72											
24												

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs. _____ days
Depth to water: **38** ft. ▽ _____ ft. ▼ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

BORING LOG NO. 4-CPT

Project No.: **191288**

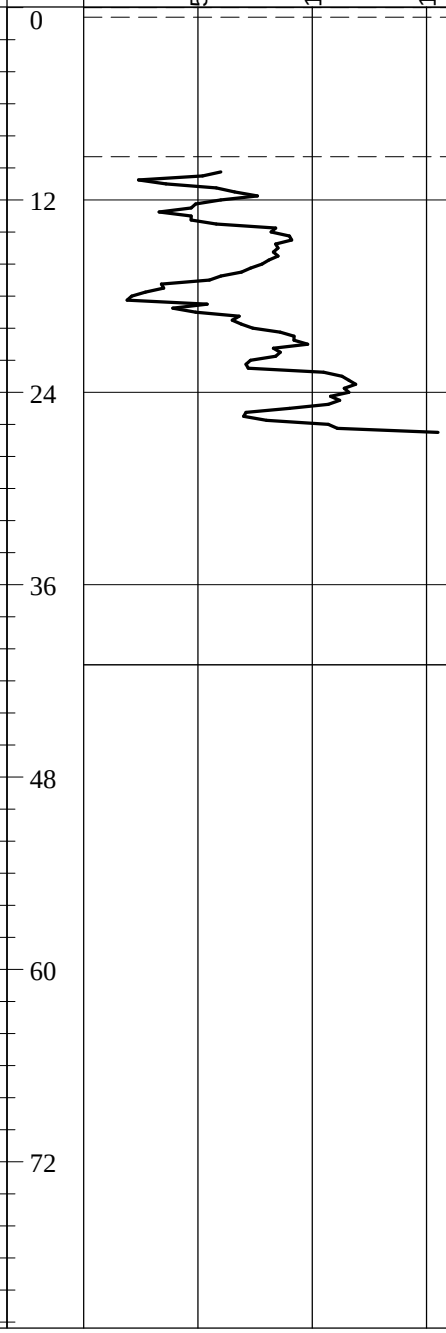
Project: **Five Flags Center**
405 Main Street
Dubuque, Iowa

Client: **City of Dubuque - Engineering**
50 West 13th Street
Dubuque, Iowa 52001

Surface Elevation: **102.0'**
Datum: **BM Main Floor of 5 Flags Center = 100.0'**

Date Drilled: **7/10/2019**
Drilling Depth, ft.: **41**

Drilling Method:
Page: **1** of **1**



Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
3" HMA underlain by 4" PCC Pavement				0.6
Brown fine sand, moist		SP		101.4
Reddish brown lean clay from 4' to 5'		CL		
FILL		SC		
Gray-brown clayey sand, after 5'				9.3
Gray medium sand, very moist		SP		92.7
ALLUVIUM				
Gray fine sand, after 30'				
Clayey sand layer from 32' to 35'		SC		
Trace gravel, after 35'		SP		
Brown medium sand, saturated, after 38'			▽	41
End of Boring				61

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs. _____ days
Depth to water: **38** ft. ▽ _____ ft. ▼ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.

Geotechnical | Environmental | Construction Q.C.

BORING LOG NO. 5

Project No.: **191288**

Project: **Five Flags Center**
405 Main Street
Dubuque, Iowa

Client: **City of Dubuque - Engineering**
50 West 13th Street
Dubuque, Iowa 52001

Surface Elevation: **98.2'**
Datum: **BM Main Floor of 5 Flags Center = 100.0'**

Date Drilled: **7/9/2019**
Drilling Depth, ft.: **41**

Drilling Method:
Page: **1** of **1**

Elevation ft.	Depth ft.	Sample No.	Type	SPT bpf	Moisture Content, %	Dry Density pcf	Unconfined Compressive Strength psf	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
96	0	1	SSA	5	20.7			Dark brown silt with sand, moist Dark gray, after 1.5'		ML		
		2	SSA	5	14.5			Brown medium sand, moist, after 4'		SP		
		3	SSA	1	6.7 3.7			**FILL**				
		4	SSA	7	3.1							
	12	5	SSA	8	15.6			Dark clayey sand,very moist, after 11'		SC		12.3
84					13.0			Interbedded brick rubble near 12.3'		SP		85.9
		6	SSA	9	15.0			Brown fine sand, moist				
					5.2			Medium to coarse sand, after 15.5'				
					4.4			Trace of gravel after, 18'				
		7	SSA	10	3.0							
	24							Gray medium sand, after 23'				
72		8	SSA	11	3.5			**ALLUVIUM**				
		9	SSA	13	3.1			Light gray fine sand, moist, after 30'			▽	
								Interbedded with clay seams, saturated, after 34'				
	36	10	SSA	18								
60		11	SSA	10				Gray medium to coarse sand,trace gravel, after 39.5'				41
								Strong petroleum odor and dark discoloration of sand, after 40'				57.2
								End of Boring				
	48											
48												
	60											
36												
	72											
24												

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs. _____ days
Depth to water: **33** ft. ▽ _____ ft. ▼ _____ ft. ▼

ALLENDER BUTZKE ENGINEERS, INC.
Geotechnical | Environmental | Construction Q.C.

BORING LOG NO. 6

Project No.: **191288**

Project: **Five Flags Center**
405 Main Street
Dubuque, Iowa

Client: **City of Dubuque - Engineering**
50 West 13th Street
Dubuque, Iowa 52001

Surface Elevation: **101.2'**
Datum: **BM Main Floor of 5 Flags Center = 100.0'**

Date Drilled: **7/9/2010**
Drilling Depth, ft.: **81**

Drilling Method:
Page: **1** of **1**

Elevation ft.	Depth ft.	Sample No.	Type	SPT bpf	Moisture Content, %	Dry Density pcf	Unconfined Compressive Strength psf	Material Description*	Graphic Log	USCS	Water Level	Depth / Elevation ft.
	0							**3" HMA underlain by 5" PCC PAVEMENT**				0.7
		1	SS	2	17.8			Dark brown clayey sand, trace gravel, very moist		SC		100.5
96		2	SSA	4	15.8			Brown fine to medium sand, after 4'		SP		
		3	SSA	5	14.6			**FILL**				
		4	SSA	4	5.2			With interbedded with clay seams, after 5'		CL		8
								Dark brown lean clay, after 7'		SP		93.2
	12	5	SSA	5	5.9			Brown medium sand, moist,				
		6	SSA	11	6.1			Trace of gravel, after 13'				
84												
		7	SSA	7	4.7							
	24											
		8	SSA	7	4.6							
72												
		9	SSA	14	2.3							
	36	10	SSA	21	1.9							
								Brown fine to medium sand, saturated, after 37'		SP	▽	
60		11	SSA	38								
								ALLUVIUM		SP		
		12	SSA	15								
	48											
		13	SSA	23								
48												
		14	SSA	8								
	60	15	SSA	14				Brown silty fine sand, after 60'		SM		
36		16	SSA	19								
		17	SSA	24								
	72											
		18	SSA	34								
24												
		19	SSA	37								81
								End of Boring				20.2

*The stratification lines represent the approximate boundary lines between material types: in-situ, the transition may be gradual.

Water Level Observation
Time: at completion _____ hrs. _____ days
Depth to water: **37** ft. ▽ _____ ft. ▼ _____ ft. ▼

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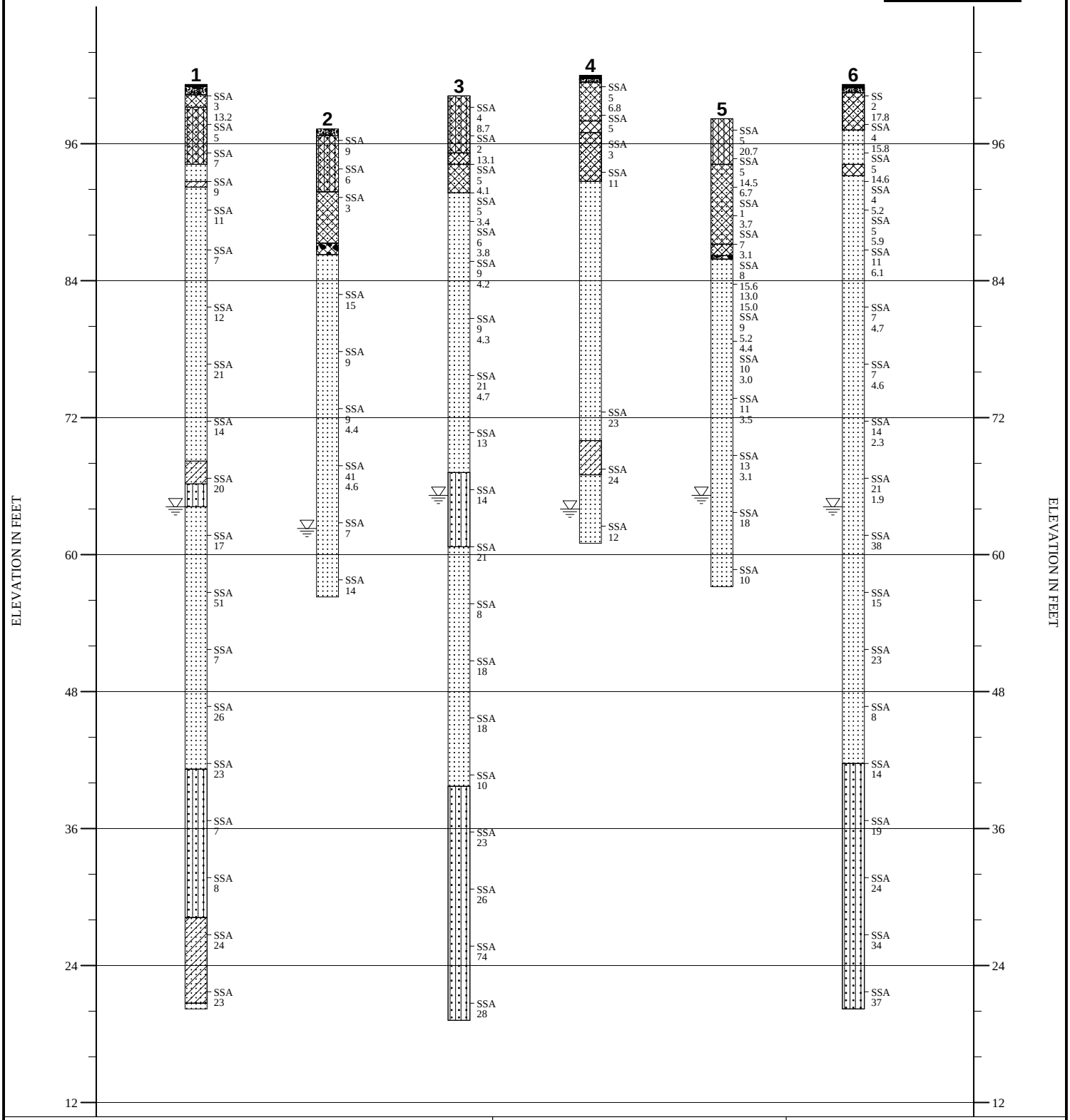
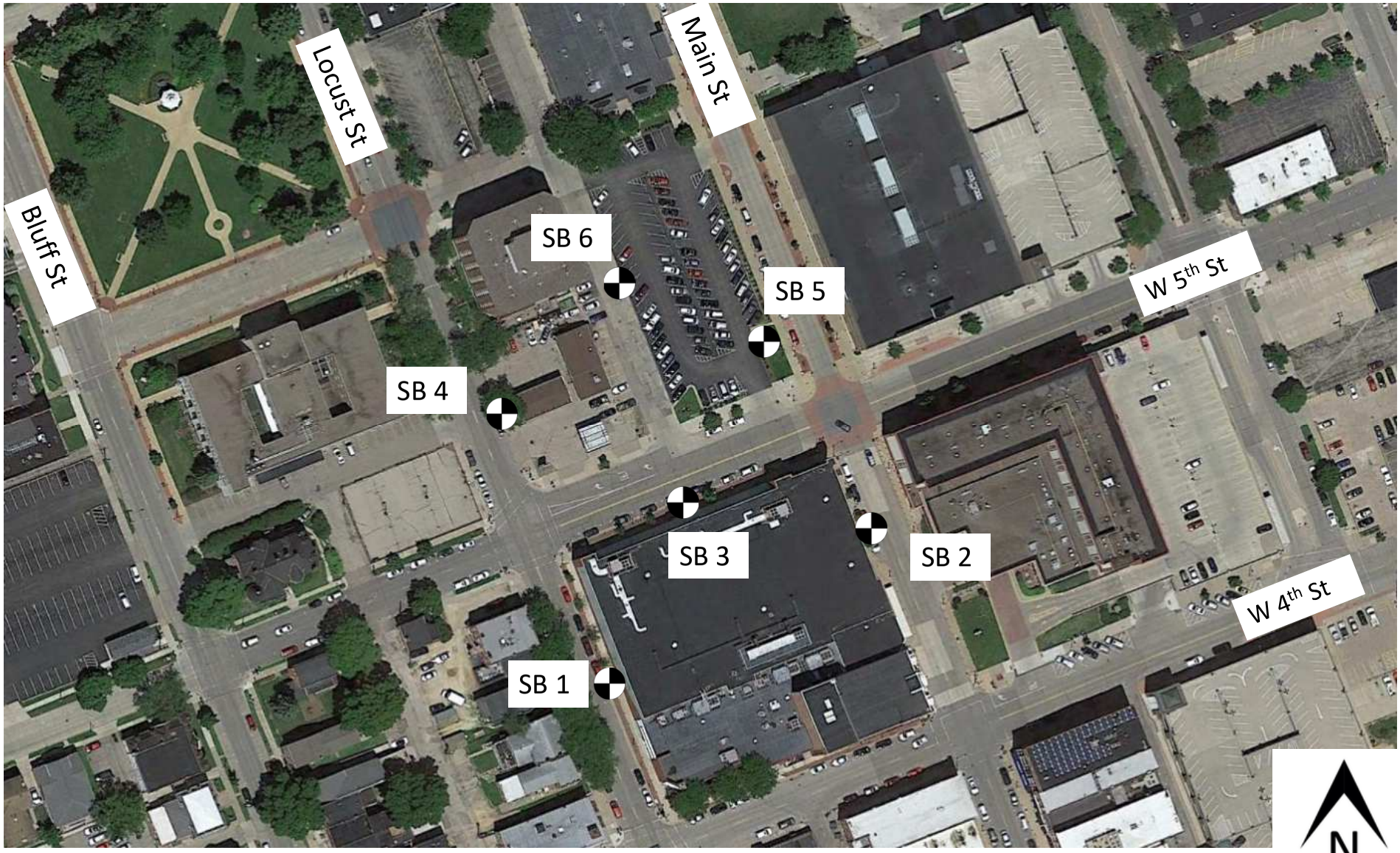
PROFILE OF BORINGS



- Paving
- PC Concrete
- Sand Fill
- Silty Fine Sand Fill
- Poorly Graded Sand
- Poorly Graded Sand With Clay
- Silty Sand
- Fill with Rubble
- Sand Fill with Clay Layers
- Lean Clay Fill

PROJECT NO.: 191288	DATE: 6/15/2020
PROJECT: Five Flags Center 405 Main Street Dubuque, Iowa	
PLATE: A-1	SCALE: 12 feet/in.

ALLENDER BUTZKE ENGINEERS, INC.



Approximate Soil Boring Locations

Not to Scale

ALLENDER BUTZKE ENGINEERS INC. **3660 - 109th Street** **Urbandale, IA 50322**	**Five Flags Center Arena and Theatre Renovation** **405 Main Street** **Dubuque, Iowa**	**PN 91288** **Site Plan**

NOTES