VANN ENGINEERING INC

GEOTECHNICAL INVESTIGATION REPORT

Proposed Multi-Family Residential Development on ±0.76 Acres
APN 133-34-827B
3250 South Country Club Way
Tempe, Arizona 85282

Prepared for:

Edmir Dzudza
E-Project LLC
917 West Kathleen Road
Phoenix, Arizona 85023

March 1, 2023

Project 30593

1980 – 2023
43rd ANNIVERSARY
VANN ENGINEERING INC.

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CONSTRUCTION TESTING & OBSERVATION

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March 1, 2023 Project 30593

Edmir Dzudza
E-Project LLC
917 West Kathleen Road
Phoenix, Arizona 85023

RE: Geotechnical Investigation Report
Proposed Multi-Family Residential Development on ±0.76 Acres
APN 133-34-827B
3250 South Country Club Way
Tempe, Arizona 85282

Edmir,

Transmitted herewith is a copy of the final report of the geotechnical investigation on the above-mentioned project. The services performed provide an evaluation at selected locations of the subsurface soil conditions throughout the zone of significant foundation influence. The materials encountered on the site are believed to be representative of the total area; however, soil and rock materials do vary in character between points of investigation. The recommendations contained in this report assume that the soil conditions do not deviate appreciably from those disclosed by the investigation. Should unusual material or conditions be encountered during construction, this firm must be notified so that we may make any required supplemental recommendations.

As an additional service, this firm would be pleased to review the project plans and structural notes for conformance to the intent of this report. We trust that this report will assist you with the proposed project. Vann Engineering, Inc. appreciates the opportunity to provide our services on this project and looks forward to collaborating with you during construction and on future projects. This firm possesses the capability of performing testing and inspection services during construction. Such services include, but are not limited to, compaction testing as related to fill control, foundation inspections and concrete sampling. Please notify this firm if a proposal for these services is desired. Should any questions arise concerning the content of this report, please feel free to contact this office as soon as possible.

Respectfully submitted,

VANN ENGINEERING, INC.

Registered Professional Engineer (Geological)
CERTIFICATE NO.
15206
JEFFRY D.
VANN
Date Signed 3/1/2023
ARIZONA, U.S.A.

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SECTION I

1.0 INTRODUCTION

Vann Engineering, Inc. understands that a new multi-family residential development is proposed for construction at the above-mentioned site, with no planned basement levels. This document presents the results of a geotechnical investigation conducted by Vann Engineering, Inc. for the:

Proposed Multi-Family Residential Development on ±0.76 Acres
APN 133-34-827B
3250 South Country Club Way
Tempe, Arizona 85282

Refer to the following aerial photograph, depicting the site (outlined in cyan) and the immediate vicinity:

Figure 1: Aerial photograph depicting the site (outlined in cyan) and the immediate vicinity

The services performed provide an evaluation at selected locations of the subsurface soil conditions throughout the zone of significant foundation influence.

1.1 Purpose

The purpose of the investigation was two-fold: 1) to determine the physical characteristics of the soil underlying the site, and 2) to provide final recommendations for safe and economical foundation considerations and slab support. For purposes of foundations, the maximum column and wall loads have been assumed to be as summarized in the following table:

Table 1: Anticipated Design Loads

Foundation Type	Maximum Column Load (kips)	Maximum Wall Load (KLF)
Conventional, surface-level spread foundations bearing on native undisturbed soil or engineered fill as outlined herein	150	7.5
Post-tensioned slabs		

Anticipated structural loads in excess of those stated above will need to be addressed in an addendum, since they are not covered by the scope of services of this effort.

1.2 Scope of Services

The scope of services for this project includes the following:

- Description of the subject site
- Description of the major soil layers
- Site Plan indicating the locations of all points of exploration
- Recommendations for surface-level conventional spread foundations; allowable bearing capacity based on settlement analysis of ½ inch total settlement and ¼ inch differential settlement (allowable bearing pressure and depth for shallow spread foundations)
- Recommendations for post-tensioned slabs
- General excavation conditions
- Lateral stability analyses including active pressure, passive pressure, and base friction
- Recommendations for fixed-end and free-end retaining walls
- Recommendations for safe cut slopes
- Recommendations for site grading - necessary earthwork for conventional systems
- Recommendations for drainage and slab support
- Anticipated shrinkage of the surface soil
- Limited corrosion discussion
- IBC site classification
- Recommendations for on-site pavement

Note: This report does not include, either specifically or by implication, any environmental assessment of the site or identification of contamination or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken. We are available to discuss the scope of work of such studies with you. Recommendations for basement-level facilities have not been included in our scope of services.

Vann Engineering is not a corrosion engineering firm, but if desired, this firm may be engaged to perform corrosion related laboratory testing on selected samples at specific locations and elevations and provide a comparison of the corrosion related laboratory testing results to selected criteria. A corrosion engineer must be consulted if the potential corrosion of construction materials, underground utilities, and structures is a concern. Additionally, any corrosion related laboratory testing must be provided to the on-site contractors and material specifiers to obtain recommendations on corrosion from the suppliers of the materials that will be used.

1.3 Authorization

The obtaining of data from the site and the preparation of this geotechnical investigation report have been carried out according to this firm's proposal (VE23GT0201KM5 dated February 1, 2023), authorized by Edmir Dzudza on February 1, 2023 to proceed with the work. Our efforts and report are limited to the scope and limitations set forth in the proposal.

1.4 Standard of Care

Since our investigation is based upon review of background data, observation of site materials, and engineering analysis, the conclusions and recommendations are professional opinions. Our professional services have been performed using that degree of skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in this or similar localities. These opinions have been derived in accordance with current standards of practice and no other warranty, express or implied, is made. The limitations of this report and geotechnical issues which further explain the limitations of the information contained in this report are listed at 7.0.

2.0 PROJECT DESCRIPTION

2.1 Proposed Development

Vann Engineering, Inc. understands that a new multi-family residential development is proposed for construction at the above-mentioned site, with no planned basement levels.

2.2 Site Description

A review of historical aerial photography indicates that the subject property was utilized for agriculture through at least 1969 (Figure 2). By 1976, the fields were allowed to go fallow (Figure 3). The site was mass graded in 1996 during development of the surrounding properties (Figure 4). In 2000, a parking lot was constructed within the southern portion of the property (Figure 5). Please see the following historical aerial photographs:

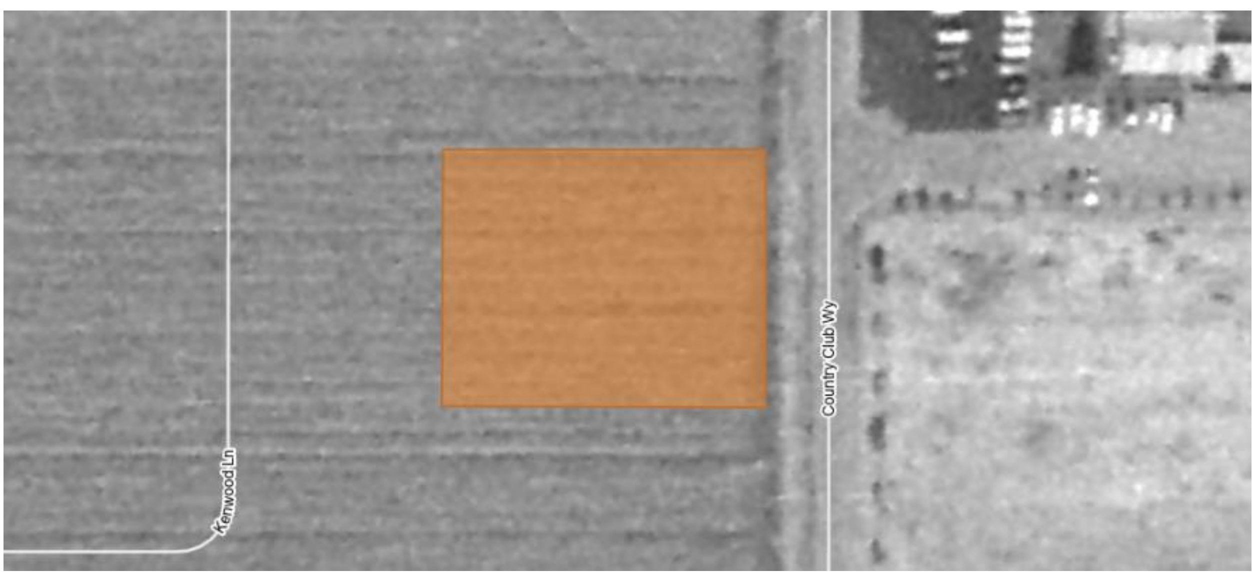


Figure 2: 1969 Historical aerial photograph showing agricultural activity.

Figure 3: 1976 Historical aerial photograph showing agricultural activity had ceased and the fields were allowed to go fallow.

Figure 4: 1996 Historical aerial photograph showing that the area was rough graded as a part of the adjacent developments.

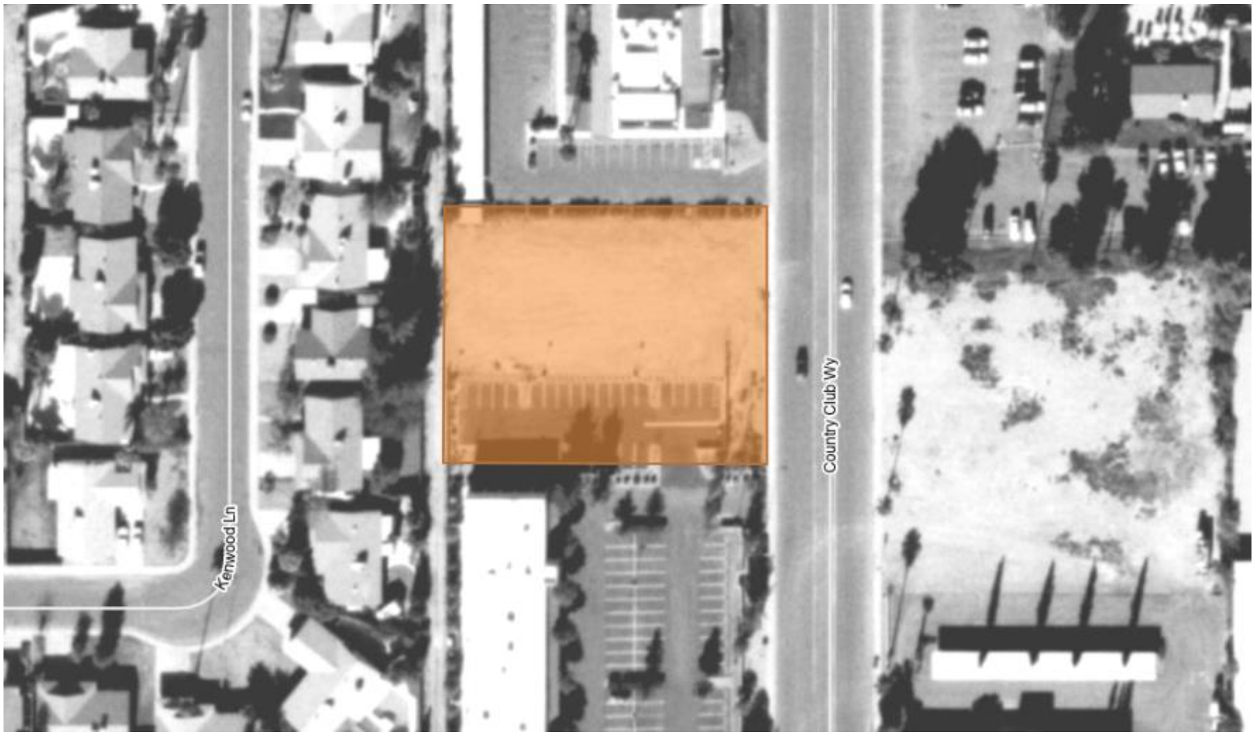


Figure 5: 2000 Historical aerial photograph showing that the southern portion of the site was developed with a parking lot.

At the time of the site investigation, the subject property is currently vacant, with generally flat topography and sparse vegetation in the form of weeds and shrubs. The paved area at the southern portion of the property features, asphalt, concrete, light poles, and landscaped areas. At the locations of the test borings, approximately 11.0 to 12.0 inches of spread fill were encountered. Greater thicknesses of spread fill may be encountered at locations not explicitly explored by this firm. Refer to the following images depicting the nature of the site at the time of the investigation:

Figure 6: General site conditions

Figure 7: General site conditions

Figure 8: General site conditions

3.0 SUBSURFACE INVESTIGATION AND LABORATORY TESTING

3.1 Subsurface Investigation

The site was explored through the utilization of three (3) exploratory test borings advanced to a depth 15.0 feet utilizing 4.5-inch continuous flight auger. The locations of the test borings are shown on the Site Plan in Section II of this report and are presented as TB-1 through TB-3.

The soils encountered were examined, visually classified and wherever applicable, sampled. Field logs were prepared for each test boring. The field logs contain visual classifications of the materials encountered during drilling as well as interpolation of the subsurface conditions between samples. Final logs, included in Section II, represent our interpretation of the field logs and may include modifications based on laboratory observation and tests of the field samples. The final logs describe the materials encountered, their thicknesses, and the locations where samples were obtained. The sample locations are noted graphically on the final logs. The Unified Soil Classification System was used to classify soils. The soil classification symbols are presented on the final logs and are briefly described in Section II.

The materials encountered on the site are believed to be representative of the total area; however, soil and rock materials do vary in character between points of investigation. The recommendations contained in this report assume that the soil conditions do not deviate appreciably from those disclosed by the investigation. Should unusual materials or conditions be encountered during construction, the soil engineer must be notified so that they may make supplemental recommendations if required.

3.2 Laboratory Testing

Laboratory analyses were performed on representative soil samples to aid in material classification and to estimate pertinent engineering properties of the on-site soils in preparation of this report. Testing was performed in general accordance with applicable test methods. Representative samples obtained during the field investigation were subjected to the following laboratory analyses:

Table 2: Laboratory Testing

Test	Sample(s)	Purpose
Response to Wetting, Moisture Content, and Dry Density	Undisturbed native soil (3)	Foundation bearing capacity and settlement analysis
Expansion	Remolded subgrade soil (6)	Potential for heave upon wetting
Sieve Analysis, Atterberg Limits, and Moisture Content	Native subgrade soils (3)	Soil classification and pavement thickness
Chlorides and Soluble Sulfates	Native subgrade soils (1)	Corrosion potential to concrete and metals
Hydrometer	Native subgrade soils (1)	Percent finer than 0.002mm

Refer to Section III of this report for the complete results of the laboratory testing. The samples will be stored for 30 days from the date of issue of this report, and then disposed of unless otherwise instructed in writing by the client.

4.0 SUBSURFACE CONDITIONS

4.1 Engineering Properties of the Site Soils

Expansive soils are soils that expand or swell and are typically known to have a shrink/swell potential. Cohesive soils, or clay soils, tend to shrink as they are dried, and swell as they become wetted. The clay content of the soil determines the extent of the shrink/swell potential. Expansive soils are soils that expand or swell and are typically known to have a shrink/swell potential. Cohesive soils, or clay soils, tend to shrink as they are dried, and swell as they become wetted. The surface soils encountered to an approximate depth of 5.0 feet are considered to be cohesive based on the laboratory testing (i.e., plasticity index of 17). Based on the laboratory data and measured soil properties, this firm has determined that the potential for soil expansion in conjunction with conventional applications is moderate for the surface soils encountered within the upper 5.0 feet (mitigated by the recommendations presented herein).

Highly expansive soils exhibiting plasticity index values on the order of 21 and 22 were encountered below a depth of 5.0 feet. These soils must have an imposed limitation on their usage as slab and foundation support fill. By definition in this report, the highly expansive soils shall be those exhibiting a plasticity index greater than or equal to 18. As such, any soils with a plasticity index greater than or equal to 18 must not be utilized for slab support fill within the upper 24 inches of the completed building pad fill (below the slab support ABC for structures). Such soils should be exported or utilized in landscape areas. This material may only be utilized in the upper 24.0 inches of building pads in conjunction with 5-inch full thickness conventional slabs that are reinforced with #4 rebar spaced at 24 inches on center, each way. The slab reinforcement must be chaired, 100% tied, and connected to the footing steel.

Collapsible soils are typically comprised of silt and sand size grains with small amounts of clay. The collapse potential of a soil depends on the in-situ density, depth of the deposit and the extent of a porous structure. When loading is applied to collapsible soils, originating from the weight of the structure, along with wetting, settlement occurs. Wetting sources are most commonly associated with landscape irrigation, inadequate surface drainage, utility line leakage, proximity of retention basins and water features to a structure, and long-term ponding next to the structure. Based on laboratory test data and standard penetration test data, the soils encountered at the site are considered to have a moderate potential for collapse and excessive differential soil movement (mitigated by the foundation recommendations contained herein).

4.2 Groundwater

No groundwater was encountered during the course of this firm's site investigation to a depth of 15.0 feet. Groundwater is expected to be at a depth of approximately 161 feet according to local well data (Site ID: 332614111503901). Refer also to the following 2005 groundwater map for an approximate location of the site in relation to surrounding wells and associated groundwater contour lines:

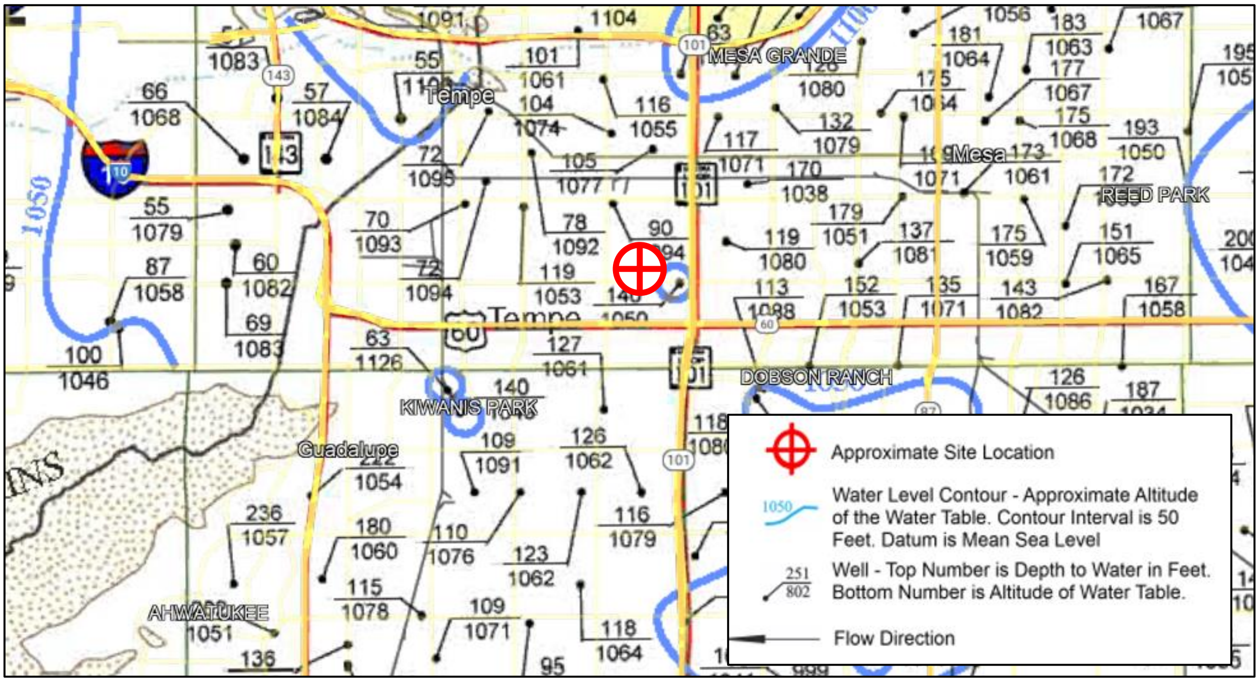


Figure 9: Groundwater Map

4.3 Limited Soil Corrosion Potential

The values presented for corrosion related laboratory testing should be used to determine potentially corrosive characteristics of the on-site soils tested with respect to their contact with the various construction materials that will be used at the subject property. The corrosion related laboratory testing results are specific to the locations and elevations sampled and no other inference is implied. If the actual on-site soils that will be in contact with structures and construction materials are from different locations and elevations than those presented herein, additional corrosion testing must be performed.

Table 3: Corrosion Test Results Summary

Sample Location	Depth Interval (feet)	Chlorides (ppm)	Sulfate (%)
TB-1	2.5'-3.5'	174	0.036

The project structural engineer should cross reference the soluble sulfate testing results from the locations and depth intervals presented with Table 19.3.1.1 of Section 318 of the American Concrete Institute (ACI) Building Code Requirements for Structural Concrete to determine the appropriate exposure class to utilize for the project.

All concrete for the project should be specified in accordance with the provisions presented in Section 318, Chapter 19 of the ACI Building Code Requirements for Structural Concrete. All corrosion related laboratory testing presented herein must be provided to the on-site contractors and material specifiers to obtain recommendations on corrosion from the suppliers of the materials that will be used. Corrosion can result from many combinations of environmental conditions, materials, construction, landscaping, and other factors, and no single guideline addresses all corrosion possibilities. Nevertheless, important corrosion information can be obtained from the American Wood Protection Association (AWPA), the International Building Code (IBC), International Residential Code (IRC), and local building codes.

Landscape material, including but not limited to decorative gravel, sand, and fill soils, may contain substantially higher concentrations of corrosive elements than the native site soils. The landscaping contractor must have all materials to be utilized in the landscape design tested for corrosion properties and submit the test results to the project general contractor for review prior to their use at the site.

Vann Engineering is not a corrosion engineering firm, and the scope of our work was limited to performing corrosion related laboratory testing on selected samples at specific locations and elevations, presenting the results herein, and providing a brief comparison of the corrosion related laboratory testing results to selected criteria. A registered corrosion engineer must be consulted if the potential corrosion of construction materials, underground utilities, and structures is of concern.

5.0 RECOMMENDATIONS

The recommendations contained herein are based upon the properties of the surface and subsurface soils and rocks as described by the field evaluation, the results of which are presented and discussed in this report. Alternate recommendations may be possible and will be considered upon request. The following recommendations are presented as a guide in the compilation of construction specifications. The recommendations are not comprehensive contract documents and should not be utilized as such.

5.1 Excavating Conditions

Excavations into the site surface and subsurface soils extending to a depth of 5.0 feet should be possible with conventional excavating equipment. Heavier excavating equipment (hard dig) will be required below an approximate depth of 5.0 feet due to the presence of hard and weakly to strongly cemented soils with an N-Value in excess of 50 (the standard when determining a hard dig scenario).

Excavations greater than 4.0 feet should be sloped or braced as required to provide personnel safety and satisfy local safety code regulations. Temporary construction slopes should be designed (by others) and excavated in strict compliance with the rules and regulations of the Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA), 29 CFR, Part 1926. This document was prepared to better ensure the safety of workers entering trenches or excavations and requires that all excavations conform to new OSHA guidelines. The contractor is solely responsible for protecting excavations by shoring, sloping, benching or other means as required to maintain stability of both the excavation sides and bottom. Vann Engineering, Inc. does not assume any responsibility for construction site safety or the activities of the contractor.

The subsurface soils encountered are considered to be OSHA Type B soil. Excavations into Type B soils are to be configured at no steeper than a 1H:1V incline. The maximum trench depth, without the use of shoring, is 20.0 feet (OSHA maximum). Deviation from these recommendations will necessitate a trench support system or shielding.

5.2 Site Preparation

Although underground facilities such as septic tanks, cesspools, basements, and dry wells were not encountered, such features might be encountered during construction. These features should be demolished or abandoned in accordance with the recommendations of the geotechnical engineer. Such measures may include backfill with 2-sack ABC/cement slurry.

It is recommended that vegetation, ABC and asphalt within the pavement areas, concrete, landscaping, and all other deleterious materials be removed at the commencement of site grading activities. An inspection of the site should be performed during the grubbing process to ensure that all applicable materials have been removed.

All spread fill soils must be stripped from the proposed structure, pavement, and hardscape areas. According to the field investigation, this will include the removal of 11.0 to 12.0 inches of spread fill at the locations of the test borings. Greater thicknesses of spread fill may be encountered at locations not explicitly explored by the test borings. Native undisturbed soils must be exposed at the bottom and sides of the spread fill removal excavations. The presence of native undisturbed soils at the base of the spread fill removal excavations must be verified by a representative of this firm prior to backfilling.

Following the removal of the above listed items, at a minimum, the uppermost 8.0 inches of the native soils must be reworked to establish a stable condition. All final compaction shall be as specified herein. The scarification and compaction requirements apply to cut situations as well as fill situations. Any site cut material may be reused as structural supporting fill provided that it is free of all vegetation, the maximum particle size is 3.0 inches, and a suitable percentage of fines will be generated to ensure a stable mixture.

Special note for post-tensioned systems:

Subgrade preparation in post tensioned slab areas must consist of at least 1.0 feet of processed soil underlying the footings (minimum thickness of 18.0 inches) for an allowable soil bearing capacity of 1250 psf. The pads may be constructed of on-site soil. The thickness of engineered fill is referenced from the bottom of the perimeter turndown and must encompass the entire building footprint with a lateral extent of at least 3.0 feet from the edge of the perimeter. The base of the zone of subexcavation (cut surface below foundations) must be moisture processed and compacted to a depth of 8.0 inches.

Special note for conventional surface-level systems:

It is necessary that a minimum of 1.0 feet of engineered fill lie beneath all conventional foundations for the structures to utilize the bearing capacity for engineered fill. The engineered fill should have a lateral extent of at least 2.0 feet beyond the edges of wall or column footing pads. If there is less than 1.0 feet of engineered fill beneath the footings, consider the bearing condition to be unacceptable. The base of the zone of subexcavation (cut surface below foundations) must be moisture processed and compacted to a depth of 8.0 inches.

Highly expansive soils exhibiting plasticity index values on the order of 21 and 22 were encountered below a depth of 5.0 feet. These soils must have an imposed limitation on

their usage as slab and foundation support fill. By definition in this report, the highly expansive soils shall be those exhibiting a plasticity index greater than or equal to 18. As such, any soils with a plasticity index greater than or equal to 18 must not be utilized for slab support fill within the upper 24 inches of the completed building pad fill (below the slab support ABC for structures). Such soils should be exported or utilized in landscape areas. This material may only be utilized in the upper 24.0 inches of building pads in conjunction with 5-inch full thickness conventional slabs that are reinforced with #4 rebar spaced at 24 inches on center, each way. The slab reinforcement must be chaired, 100% tied, and connected to the footing steel.

Complete removal and cleaning of any undesirable materials and proper backfilling of depressions will be necessary to develop support for the proposed facilities. Widen all depressions as necessary to accommodate compaction equipment and provide a level base for placing any fill. All fills shall be properly moistened and compacted as specified in the section on compaction and moisture recommendations. All subbase fill required to bring the structure areas up to subgrade elevation should be placed in horizontal lifts not exceeding 6.0 inches compacted thickness or in horizontal lifts with thicknesses compatible with the compaction equipment utilized. Fill placement in wash areas, trench areas, or sloped topography should involve horizontal layers placed in 6-inch lifts; such that each successive lift is benched into the native site soils a minimum lateral distance of 5.0 feet.

Any tree removal efforts made to accommodate the new structure must include removal of the root systems, followed by backfilling of the volume occupied by the root ball. Typically, to remove all significant roots such that the maximum diameter of any root is no greater than ½ inch, it is required to excavate to a depth of 4.0 feet to capture all applicable roots. Further, the lateral extent of each tree root excavation is generally 8.0 feet (twice the depth).

It is the understanding of this firm that various utility trenches may traverse the completed pad. The backfill of all utility trenches, if not in conformance with this report, may adversely impact the integrity of the completed pad. This firm recommends that all utility trench backfill crossing the pads be inspected and tested to ensure full conformance with this report. Untested utility trench backfill will nullify any as-built grading report regarding the existence of engineered fill beneath the proposed building foundations and place the owner at greater risk in terms of potential unwanted foundation and floor slab movement.

Compaction of backfill, subgrade soil, subbase fill, and base course materials should be accomplished to the following density and moisture criteria prior to concrete placement:

Table 4: Compaction Requirements

Material	Building Area	Percent Compaction (ASTM D698)	Compaction Moisture Content Range (%)
On-site soils with PI $\geq$ 15	Below Foundation Level	95 min	optimum to optimum +4
	Above Foundation Level[1,2]	85 - 90	optimum to optimum +4
	Below Pavements	95 min	optimum -3 to optimum +1
On-site native and fill soils with 12 $\leq$ PI < 15	Below Foundation Level	95 min	optimum to optimum +4
	Above Foundation Level[1]	92 - 97	optimum to optimum +4
	Below Pavements	95 min	optimum -3 to optimum +1

Material	Building Area	Percent Compaction (ASTM D698)	Compaction Moisture Content Range (%)
On-site native and fill soils with PI < 12	Below Foundation Level	95 min	optimum -2 to optimum +2
	Above Foundation Level[1]	95 min	optimum -2 to optimum +2
	Below Pavements	95 min	optimum -3 to optimum +1
Imported fill material	Below Foundation Level	95 min	optimum -2 to optimum +2
	Above Foundation Level[1]	90 min	optimum -2 to optimum +2
	Below Pavements	95 min	optimum -3 to optimum +1
Base course	Below Interior Concrete Slabs	95 min	-
	Below Pavements	100 min	-

[1]Also applies to the subgrade in exterior slab, sidewalk, curb, and gutter areas.
[2]Do not use in the uppermost 24.0 inches of the building pad, unless PT slabs are used. Additionally, this material may only be utilized in the upper 24.0 inches of building pads in conjunction with 5-inch full thickness conventional slabs that are reinforced with #4 rebar spaced at 24 inches on center, each way. The slab reinforcement must be chaired, 100% tied, and connected to the footing steel.

Any soil disturbed during construction shall be compacted to the applicable percent compaction as specified herein. Increase the required degree of compaction to a minimum of 98 percent for fill materials greater than 5.0 feet below final grade. Natural undisturbed soils or compacted soils subsequently disturbed or removed by construction operations should be replaced with materials compacted as specified above. All imported (engineered) fill material to be used as structural supporting fill should be free of vegetation, debris and other deleterious material and meet the following requirements:

Table 5: Imported Fill Soil Parameters

Soil Parameter	Requirement (Maximum Allowable)
Plasticity Index:	14
Particle Size:	3 inches
Passing #200 Sieve:	60 %
Expansion Potential*:	1.5 %
Sulfates:	0.19 %

*Performed on a sample remolded to 95 percent of the maximum ASTM D698 density at 2 percent below the optimum moisture content, under a 100 PSF Surcharge.

Please note that all imported fill material is to be tested for soluble sulfate content (corrosion testing). Results of the corrosion testing must be presented to the project structural engineer in order to utilize the appropriate exposure class per Table 19.3.1.1 of Section 318 of the American Concrete Institute (ACI) Building Code Requirements for Structural Concrete. All concrete for the project should be specified in accordance with the provisions presented in Section 318, Chapter 19 of the ACI Building Code Requirements for Structural Concrete.

Water settling and/or slurry shall not, in any case, be used to compact or settle surface soils, fill material, or trench backfill within 10.0 feet of a structure area or within an area, which is to be paved. When trench backfill consists of permeable materials that would allow percolation of water into a structure or pavement area, water settling shall not be used to settle such materials in any part of the trench.

5.3 Fill Slope Stability

Maximum fill slopes may conform to a 2.5:1 (horizontal: vertical) ratio if fill is placed in accordance with the recommendations contained herein.

5.4 Shrinkage

For balancing grading plans, the estimated shrink of on-site soils has been provided below. The calculated shrink assumes oversized material will be processed and used on the project (i.e., oversized material is crushed and used in engineered fill). Assuming the average degree of compaction will approximate 97 percent of the standard maximum density, the approximate shrinkage of the reworked native undisturbed soils are as follows:

Table 6: Shrinkage

Material	Estimated Shrinkage (Based on ASTM D698A)
On-site Soil	15% ± 3

The above value does not consider losses due to erosion, waste, variance of on-site soils, over-excavation, re-compaction of zones disturbed by demolition, previous site usage or the screening of oversized particles and/or debris. In other words, additional factors can and will create situations where seemingly balanced grading and drainage plans do not balance during construction.

5.5 Site Classification

This project is not located over any known active faults or fault associated disturbed zones. Please refer to the following table contained in ASCE 7-16:

Table 7: ASCE 7-16 Section 20.3 Table 20.3-1 Site Classification

Site Class		$\overline{V}_s$	$\overline{N}$ or $\overline{N}_{ch}$	$\overline{S}_u$
A	Hard Rock	>5,000 ft/s	NA	NA
B	Rock	2,500 to 5,000 ft/s	NA	NA
C	**Very Dense Soil and Soft Rock**	**1,200 to 2,500 ft/s**	**>50 blows/ft**	**>2,000 lb/ft^2**

Site Class		$\bar{V}_s$	$\bar{N}$ *or* $\bar{N}_{ch}$	$\bar{S}_u$
D	Stiff Soil	600 to 1,200 ft/s	15 to 50 blows/ft	1,000 to 2,000 lb/ft^2
E	Soft Clay Soil	<600 ft/s	<15 blows/ft	<1,000 lb/ft^2
		Any profile with more than 10 feet of soil that has the following characteristics: • Plasticity Index PI>20 • Moisture Content w≥40% • Undrained Shear Strength $\bar{S}_u$ <500 lb/ft^2		

The formula to determine the shear wave velocity is defined below:

$$\bar{V}_s = \frac{d_s}{\sum_{i=1}^{n} \frac{d_i}{V_{si}}}$$

Where d_s is the total thickness (uppermost 100 feet), N_i is the standard penetration tests measured in the field, and d_i is the thickness of any layer between 0 and 100 feet. Utilizing the field data and the known geologic conditions at the site, the calculation for the representative N-Value is shown below.

$$\bar{N} = \frac{100\,ft}{\frac{5ft}{10} + \frac{5ft}{58} + \frac{90ft}{68}} \qquad \bar{N} = 52$$

By calculation of N-Value, the representative N-value equals 52 for the uppermost 100 feet. Based on the above calculation, an IBC Site Class of **C** may be utilized.

5.6 Post-Tensioned Slabs

The following values for e_m and y_m may be utilized (based on a PTI 3rd Edition VOLFLO analysis):

Table 8: VOLFLO Results (PTI 3rd Edition)

Parameter	Swell (Edge)	Shrink (Center)
y_m	0.59 inches	0.29 inches
e_m	4.6 feet	9.0 feet

The minimum recommended perimeter foundation thickness is **18.0 inches** in conjunction with 12.0 inches of subgrade preparation beneath the perimeter footings for a 1250 psf bearing. The thickness of engineered fill is referenced from the bottom of the perimeter turndown/foundations but must encompass the entire building footprint with a lateral blowup of at least 3.0 feet from the edge of the perimeter. Native soils may be used to construct the pads. The base of the zone of subexcavation (cut surface below foundations) must be moisture processed and compacted to a depth of 8 inches.

The uniform thickness slab shall be designed by the project structural engineer. Embedment depth for uniform thickness post-tensioned slab systems is referenced from finish floor for both interior and perimeter footings. Greater bearing pressures can be obtained through an increase in the thickness of engineered fill beneath the foundation.

Table 9: Post-Tension Slab Bearing

Allowable Soil Bearing Capacity	Thickness of Prepared Subgrade Beneath the Foundations	Modulus of Subgrade Reaction
1250 PSF	1.0 Feet	156 pci
1500 PSF	1.5 Feet	188 pci
1750 PSF	2.0 Feet	219 pci

Aggregate base course shall not be required beneath post-tensioned slabs unless desired as a leveling course. The use of vapor retarders may be considered for any slab-on-grade where the floor will be covered by moisture sensitive floor coverings.

The following additional parameters can be used by the Project Structural Engineer in the post-tension slab design:

Subgrade Friction Coefficient	To be determined by the project structural engineer based on the contact surface anticipated
Soil Modulus of Elasticity	1000 psi

PT stressing should be completed as soon as the concrete compressive strength has reached 75% of the project structural engineer's design compressive strength.

5.7 Conventional Surface-Level Spread Foundations

It is recommended that all perimeter foundations and isolated exterior foundations bearing on 1.0 feet of engineered fill be embedded a minimum of 1.5 feet below the lowest adjacent finish pad grade within 5.0 feet of proposed exterior walls. Interior footings bearing on 1.0 feet of engineered fill should be founded a minimum of 1.5 feet below finish floor level. Foundations bearing on native undisturbed soil must be embedded a minimum depth of 3.0 feet for an allowable soil bearing capacity of 1500 psf.

For all construction, 2.0 feet and 1.33 feet are recommended as the minimum width of spread and continuous footings, respectively. The following table represents options for allowable bearing capacity values and corresponding embedment conditions.

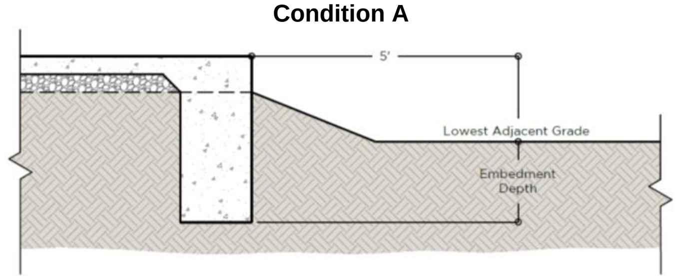
Table 10: Conventional Surface Level Foundations

Foundation Embedment Depth[1]	Bearing Stratum[2]	Allowable Soil Bearing Capacity[3]
3.0 Feet	Native Undisturbed Soil[4, 6]	1500 PSF
3.5 Feet	Native Undisturbed Soil[4, 6]	1750 PSF
4.0 Feet	Native Undisturbed Soil[4, 6]	2000 PSF
1.5 Feet	1.0 Feet of Engineered Fill[5.6]	1500 PSF
2.0 Feet	1.0 Feet of Engineered Fill[5.6]	1750 PSF
2.5 Feet	1.0 Feet of Engineered Fill[5.6]	2000 PSF

[1]Conditions for foundation embedment depth:

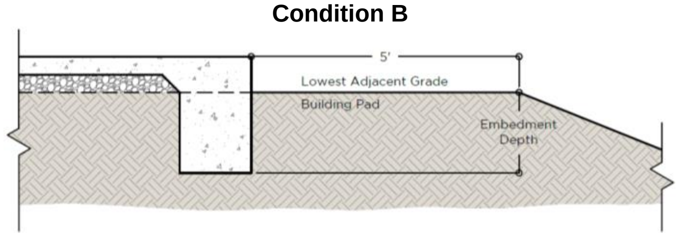
a) The depth below the lowest adjacent exterior pad grade within 5.0 feet of proposed exterior walls.

Condition A



b) The depth below finished compacted pad grade provided that a sufficient pad blow-up (the lateral extent to which the building pad is constructed beyond the limits of the exterior walls or other structural elements, inclusive of exterior column foundations) has been incorporated into the grading and drainage scheme (5.0 feet or greater);

Condition B



c) The depth below finish floor level for interior foundations.

[2]Refers to the soil layer that the footing pad rests on and does not mean to imply that the foundation be fully embedded into that stratum.

[3]The allowable soil bearing capacity value and associated allowable loads are based on a total settlement of ½ inch and a differential settlement of ¼ inch.

[4]A mixture of 2-sack ABC/cement slurry may be utilized in the lower portions of the foundation excavations for footings bearing on native undisturbed soil. The preceding table shall govern the thickness of 2-sack ABC/cement slurry depending on the allowable soil bearing capacity selected.

[5]It is necessary that a minimum of 1.0 feet of engineered fill lies beneath all foundations for the structures to utilize the bearing capacity for engineered fill. The engineered fill should have a lateral extent of at least 2.0 feet beyond the edges of all footings. If there is less than 1.0 feet of engineered fill beneath the footings, consider the bearing condition to be unacceptable. The base of the zone of subexcavation (cut surface below foundations) must be moisture processed and compacted to a depth of 8 inches.

[6]Due to the highly expansive nature of the surface soils, it is recommended that 24.0 inches of low expansion potential import soils, or suitable on-site soils, lie beneath ABC for all interior and exterior slabs. As such, the site soils with a Plasticity Index greater than or equal to 18 should be utilized in the upper 24.0 inches of the building pads and surrounding fills. This will not be required if 5-inch full-thickness slabs are used that are reinforced with #4 rebar spaced at 24 inches on center, each way. The slab reinforcement must be chaired, 100% tied, and connected to the footing steel.

The weight of the foundation below grade may be neglected in dead load computations. The above recommended bearing capacities should be considered allowable maximums for dead plus live loads. The maximum allowable foundation bearing pressure for foundation toe pressures may be increased by ⅓ for resistance to short-term/temporary wind loads and or eccentric or lateral loading.

Retaining wall or building foundations to be constructed in close proximity to retention basins (*within 5.0 feet*) should be embedded 1.0 feet deeper than the stated depths in the preceding bearing capacity tables.

We recommend that continuous footings and stem walls are reinforced and bearing walls be constructed with frequent joints to better distribute stresses in the event of localized settlements. Similarly, all masonry walls should be provided with both vertical and horizontal reinforcement.

It is recommended that the footing excavations be inspected by the Vann Engineering Inc. project geotechnical engineer or their representative to ensure that they are free of loose soil which may have blown or sloughed into the excavations. It will also be necessary for the geotechnical engineer to verify that the footing embedment depths and bearing stratum adhere to the recommendations presented herein.

All concrete for the project should be designed (by others) in accordance with the provisions presented in Section 318, Chapter 19 of the ACI Building Code Requirements for Structural Concrete. A maximum 4-inch slump should be used for footings and stem walls and a maximum 6-inch slump should be used for floor slabs.

5.8 Lateral Stability Analyses

All on-site retaining walls must be constructed to resist the anticipated lateral earth pressures. Unrestrained (free-end) retaining walls should be constructed for active earth pressures (K_a) and are assumed to allow small movement of the wall. Restrained (fixed-end) retaining walls should be constructed for at-rest earth pressures (K_o) with no assumed wall movement. Soil or rock present in front of the toe of the retaining wall will provide resistance to movement and should be modeled as passive earth pressure (K_p).

The following presents recommendations for lateral stability analyses for native undisturbed soil and engineered fill:

Table 11: Lateral Stability

Parameter	Wall Type	Engineered Fill	Native Undisturbed Soil
Active (K_a) Pressure[1]	Free-end retaining conditions	34 psf/ft	40 psf/ft
At-Rest (K_o) Pressure[1]	Fixed-end retaining conditions[2]	52 psf/ft	58 psf/ft
Passive (K_p) Resistance	Free-end conditions, and Fixed-end conditions that are entirely independent of base friction	358 psf/ft	305 psf/ft
	Fixed-end conditions in conjunction with base friction	240 psf/ft	204 psf/ft
Coefficient of Base Friction (μ)	Free-end conditions, and Fixed-end conditions that are entirely independent of passive resistance	0.62	0.53
	Fixed-end conditions in conjunction with passive resistance	0.42	0.36

[1]Equivalent fluid pressures for vertical walls and horizontal backfill surfaces (*maximum 12.0 feet in height*). Pressures do not include temporary forces during compaction of the backfill, expansion pressures developed by over-compacted clayey backfill, hydrostatic pressures from inundation of backfill, or surcharge loads. Walls should be suitably braced during backfilling to prevent damage and excessive deflection.

[2]The backfill pressure can be reduced to the unrestrained lateral pressure if the backfill zone between the wall and cut slope is a narrow wedge (*width less than ½ the height*)

The equivalent fluid pressures presented herein do not include the lateral pressures arising from the presence of:

- Hydrostatic conditions, submergence, or partial submergence
- Sloping backfills, positively or negatively
- Surcharge loading, permanent or temporary
- Seismic or dynamic conditions

Fill against footings, stem walls, and any retaining walls should be compacted to the densities specified in Site Preparation. High plasticity clay soils should not be used as backfill against retaining walls. Compaction of each lift adjacent to walls should be accomplished with hand-operated tampers or other lightweight compactors. Overcompaction may cause excessive lateral earth pressures that could result in wall movements. We recommend a free-draining soil layer or manufactured geosynthetic material, be constructed adjacent to the back of any retaining walls serving as basement walls. A filter fabric may be required between the soil backfill and drainage layer. The drainage zone should help prevent development of hydrostatic pressure on the wall. This vertical drainage zone should be tied into a gravity drainage system at the base of the wall.

5.9 Conventional Slab Support

Site grading within the building areas should be accomplished as recommended herein. Four inches of aggregate base course (ABC) floor fill should immediately underlie interior grade floor slabs. The aggregate base material should conform to the requirements of local practice. The use of vapor retarders may be considered for any slab-on-grade where the floor will be covered by products using water-based adhesives, wood, vinyl backed carpet, impermeable floor coatings (urethane, epoxy, or acrylic terrazzo). When used, the design (by others) and installation should be in accordance with the recommendation given in ACI 302.1R.

Building pads for conventional systems may be constructed with sufficient lateral pad “blow-up” to accommodate the entire perimeter slab width. To further reduce the potential for slab related damage in conjunction with conventional systems, we recommend the following:

1. Placement of effective control joints on relatively close centers.
2. Proper moisture and density control during placement of subgrade fills.
3. Provision for adequate drainage in areas adjoining the slabs.
4. Use of designs (by others) that allow for the differential vertical movement described herein between the slabs and adjoining structural elements, i.e., ¼ inch.
5. 2-sack ABC/cement slurry should be utilized as backfill at the intersection of utility trenches with the building perimeter.

Special note:

> **Due to the highly expansive nature of the surface soils, it is recommended that 24.0 inches of low expansion potential import soils, or suitable on-site soils, lie beneath ABC for all interior and exterior slabs. As such, the site soils with a Plasticity Index greater than or equal to 18 should be utilized in the upper 24.0 inches of the building pads and surrounding fills. This will not be required if 5-inch full-thickness slabs are used that are reinforced with #4 rebar spaced at 24 inches on center, each way. The slab reinforcement must be chaired, 100% tied, and connected to the footing steel.**

All concrete for the project should be designed (by others) in accordance with the provisions presented in Section 318, Chapter 19 of the ACI Building Code Requirements for Structural Concrete. A maximum 4-inch slump should be used for footings and stem walls and a maximum 6-inch slump should be used for floor slabs.

5.10 Drainage

The major cause of soil problems in this locality is moisture increase in soils below structures. Therefore, it is extremely important that positive drainage be provided during construction and maintained throughout the life of any proposed development. In no case should long-term ponding be allowed near structures. Infiltration of water into utility or foundation excavations must be prevented during construction. Planters or other surface features that could retain water adjacent to buildings should not be constructed. In areas where sidewalks or paving do not immediately adjoin structures, protective slopes should be provided with an **outfall of at least 6.0 percent for at least 10 feet from perimeter walls.**

Backfill against footings, exterior walls, retaining walls, and in utility or sprinkler line trenches should be well compacted and free of all construction debris to minimize the possibility of moisture infiltration through loose soil. Roof drainage systems, such as gutters or rain dispenser devices, are recommended all around the roofline. Rain runoff from roofs should be discharged at least 10.0 feet from any perimeter wall or column footing. If a roof drainage system is not installed, rainwater will drip over the eaves and fall next to the foundations resulting in sub-grade soil erosion, creating depressions in the soil mass, which may allow water to seep directly under the foundations and slabs.

5.11 Landscaping Considerations

The potential for unwanted foundation and slab movements can often be reduced or minimized by following certain landscape practices. The main goal for proper landscape design (by others) should be to minimize fluctuations in the moisture content of the soils surrounding the structure. In addition to maintaining positive drainage away from the structure, appropriate plant/tree selections and sprinkler/irrigation practices are extremely important to the long-term performance of the foundations and slabs. The conventional practice of planting near foundations is not recommended. Flower, shrub, and tree distances should be maintained according to the following table. Note that for planting distances less than 5.0 and 10.0 feet for flowers/shrubs and trees respectively, the adjoining foundation embedment depths will need to increase.

Table 12: Foundation Alterations Due to Landscaping

Construction Type	Flowers and Shrub Planting Distance	Tree Planting Distance	Foundation Alterations Due to Landscaping
Conventional	5 feet	10 feet	-
Post-Tensioned			-
Conventional	4 feet[1]	9 feet	Increase footing embedment depth by 6.0 inches[2]
Post-Tensioned			Increase perimeter beam thickness by 6.0 inches[2]
Conventional	3 feet[1]	8 feet	Increase footing embedment depth by 12.0 inches[2]
Post-Tensioned			Increase perimeter beam thickness by 12.0 inches[2]
Conventional	2 feet[1]	7 feet	Increase footing embedment depth by 18.0 inches[2]
Post-Tensioned			Increase perimeter beam thickness by 18.0 inches[2]

[1]Verification from the landscape architect that low water consumption plants are being installed must be submitted to this office for approval.

[2]The use of 2-sack ABC cement slurry may be implemented to provide the requisite embedment depth increase below a more conventional foundation detail.

Ground cover plants with low water requirements may be acceptable for landscaping near foundations. Ground cover vegetation helps to reduce fluctuations in the soil moisture content. Limit the watering to the minimum needed to maintain the ground cover vegetation near foundations. For greater moisture control, water these areas by hand.

For planters and general landscaping, we recommend the following:

- Planters should be sealed.
- Grades should slope away from the structures.
- Only shallow rooted landscaping material should be used.
- Watering should be kept to a minimum.

Some trees may have extensive shallow root system that may grow under and displace shallow foundations. In addition, tree roots draw moisture from the surrounding soils, which may exacerbate shrink/swell cycles of the surface soils. The amount of moisture drawn out of the soil will depend on the tree species, size, and location. If trees are planted well away from foundations in irrigated areas, the chances of foundation damage are greatly reduced. If irrigation/sprinkler systems are to be used, we recommended installing the system all around the structure to provide uniform moisture throughout the year. The sprinkler system should be checked for leakages once per month. Significant foundation movements can occur if the soils under the foundations are exposed to a source of free water.

In lieu of deepened footings, a root barrier system can be implemented on individual trees. In order to reduce the minimum distance of tree installation to 7.0 feet from the foundation of adjacent structures, UB 24-2 root barriers from DeepRoot Green Infrastructure, LLC (or equivalent) may be implemented in box formations, surrounding the protection sides of installed trees. A minimum depth of embedment of 23.5 inches of the DeepRoot UB 24-2 (or equivalent) root barriers, is required by this firm in order to redirect root growth downward and prevent moisture by landscape irrigation from entering the foundation zone of the adjacent structures. A minimum 0.5 inch of the root barrier must extend above the soil surface to prevent tree roots from growing over the top of the barrier. A minimum protection barrier around 3 sides of all installed trees must be utilized as a root barrier.

5.12 On-Site Pavement Thickness

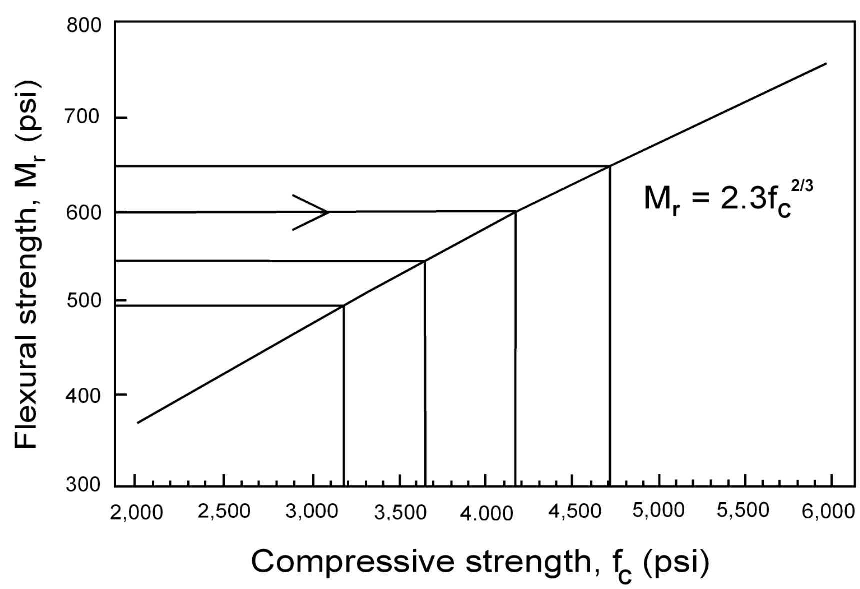
Site grading within pavement areas should provide requisite subgrade support for flexible pavements. A compacted subgrade of on-site soils or soils with comparable properties is assumed. Pavement materials and placement requirements should be in accordance with the Maricopa Association of Government Standard Specifications, or equivalent.

The stability of compacted pavement subgrade soils is reduced under conditions of increased soil moisture. Therefore, base course or pavement materials should not be placed when the surface is in a wet condition. Adequate surface drainage should be provided away from the edge of paved areas to minimize lateral moisture transmission into the subgrade. The following presents minimum recommended pavement sections for anticipated traffic conditions.

Table 13: On-Site Pavement Criteria

Traffic Loads	Alternate	Prepared Subgrade (Inches)	ABC (Inches)	Asphaltic Concrete (Inches)	Concrete Pavement (Inches)
Light Vehicles or Low Volume Traffic Areas (0 to 45 psi tire pressures)	A[a]	8.0	6.0	2.0	
	B[a]	8.0		4.0	
	C[b]	8.0			5.5[c]
Heavy Vehicle Areas **(45 to 90 psi tire pressures)**	A[a]	8.0	6.0	3.0	
	B[a]	8.0		5.0	
	C[b]	8.0			6.5[c]
Very Heavy Vehicle Areas (90 to 135 psi tire pressures)	A[a]	8.0	6.0	4.0	
	B[a]	8.0		6.0	
	C[b]	8.0			8.0[c]

[a] 10-year design life, with typical maintenance
[b] 20-year design life, with typical maintenance
[c] Based on a modulus of rupture of 600 PSI. The recommended concrete thicknesses should be increased in increments of 0.5 inch for every 50 PSI decrease in the modulus of rupture. The following chart relates rupture modulus to compressive strength.



Compaction of subbase fill, and base course materials should be accomplished to the density criteria listed herein. Compaction of asphalt surfacing should be accomplished to 95% minimum using the 75-blow method. Asphalt concrete material should conform to the local practice.

5.13 Foundations and Risks

The factors that aid in the design (by others) and construction of lightly loaded foundations include economics, risk, soil type, foundation shape and structural loading. It should be noted that some levels of risk are associated with all foundation systems and there is no such thing as a “zero-risk” foundation. It also should be noted that the previous foundation recommendations are not permitted to resist soil movements as a result of sewer/plumbing leaks, excessive irrigation, poor drainage, and water ponding near the foundation system.

It is recommended that the owner implement a foundation maintenance program to help reduce potential future unwanted foundation/slab movements throughout the useful life of the structure. The owner should conduct yearly observation of foundations and slabs and perform any maintenance necessary to improve drainage and minimize infiltrations of water from precipitation and/or irrigation. Irrigation/sprinkler systems should be periodically monitored for leaks and malfunctioning sprinkler heads, which should be repaired immediately. Post-construction landscaping must preserve initial site grading.

6.0 ADDITIONAL SERVICES

As an additional service, this firm would be pleased to review the project plans and structural notes for conformance to the intent of this report. Vann Engineering, Inc. should be retained to provide documentation that the recommendations set forth are met. These include but are not limited to documentation of site clearing activities, verification of fill suitability and compaction, and inspection of footing excavations. Relative to field density testing, a minimum of 1 field density test should be taken for every 2500 square feet of building area, per 6.0-inch layer of compacted fill. This firm possesses the capability of performing testing and inspection services during the course of construction. Such services include, but are not limited to, compaction testing as related to fill control, foundation inspections and concrete sampling. Please notify this firm if a proposal for these services is desired.

7.0 LIMITATIONS

This report is not intended as a bidding document, and any contractor reviewing this report must draw their own conclusions regarding specific construction techniques to be used on this project. The scope of services carried out by this firm does not include an evaluation pertaining to environmental issues. If these services are required by the lender, we would be most pleased to discuss the varying degrees of environmental site assessments.

This report is issued with the understanding that it is the responsibility of the owner to see that its provisions are carried out or brought to the attention of those concerned. In the event that any changes of the proposed project are planned, the conclusions and recommendations contained in this report shall be reviewed and the report shall be modified or supplemented, as necessary.

The materials encountered on the site are believed to be representative of the total area; however, soil and rock materials do vary in character between points of investigation. The recommendations contained in this report assume that the soil conditions do not deviate appreciably from those disclosed by the investigation. Should unusual material or conditions be encountered during construction, the soil engineer must be notified so that supplemental recommendations may be considered if they are required.

Prior to construction, we recommend the following:

1. Consultation with the design team in all areas that concern soils and rocks to ensure a clear understanding of all key elements contained within this report.
2. Review of the General Structural Notes to confirm compliance to this report and determination of which allowable soil bearing capacity has been selected by the project structural engineer (this directly affects the extent of earthwork and foundation preparation at the site).
3. This firm be notified of all specific areas to be treated as special inspection items (designated by the architect, structural engineer, or governmental agency).

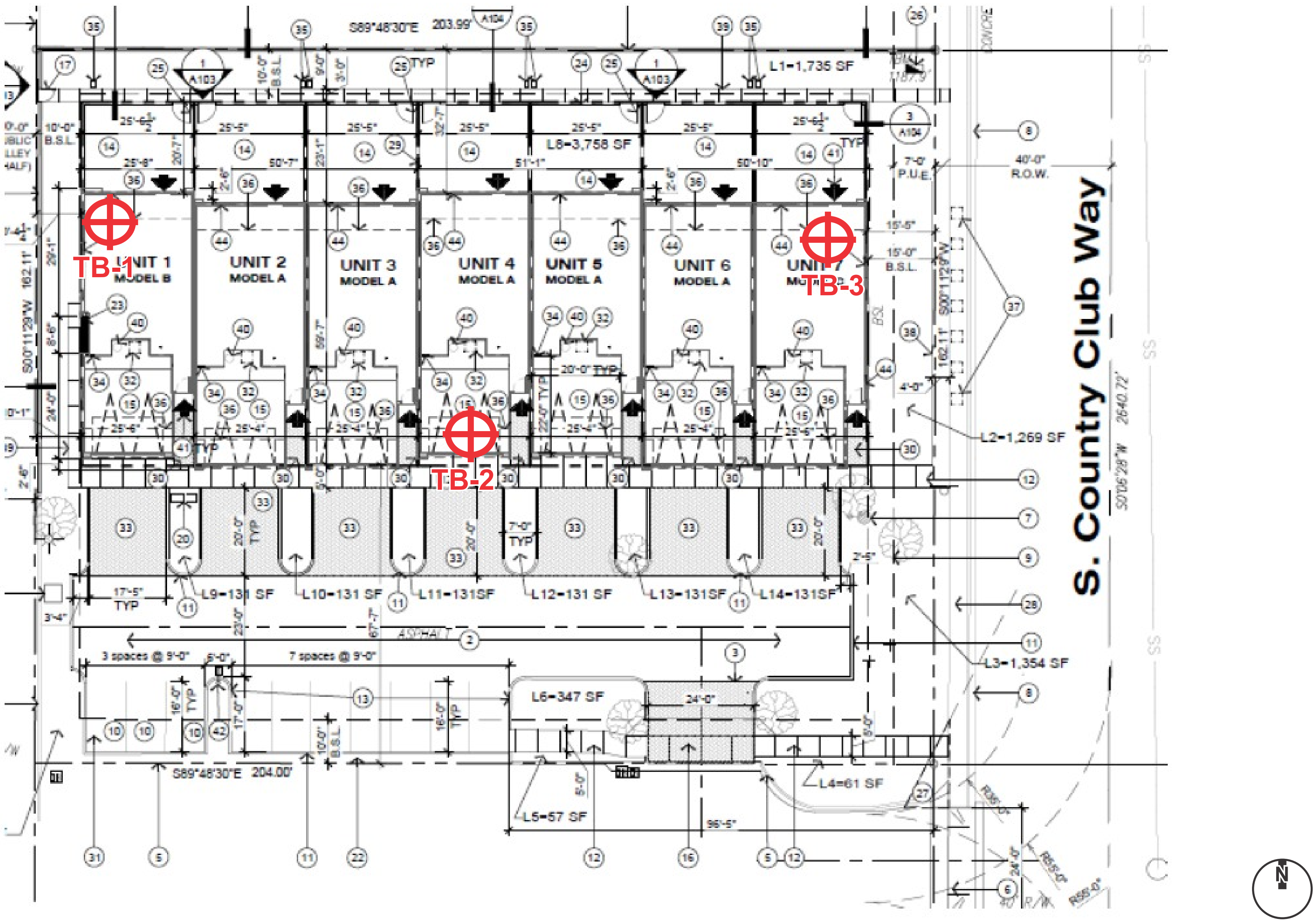
Relative to this firm's involvement with the project during the course of construction, we offer the following recommendations:

1. The site or development owner should be directly responsible for the selection of the geotechnical consultant to provide testing and observation services during the course of construction.
2. This firm should be contracted by the owner to provide the course of construction testing and observation services for this project, as we are most familiar with the interpretation of the methodology followed herein.
3. All parties concerned should understand that there exists a priority surrounding the testing and observation services completed at the site.

DEFINITION OF TERMINOLOGY

Allowable Soil Bearing Capacity Allowable Foundation Pressure	The recommended maximum contact stress developed at the interface of the foundation element and the supporting material.
Aggregate Base Course (ABC)	A sand and gravel mixture of specified gradation, used for slab and pavement support.
Backfill	A specified material placed and compacted in a confined area.
Base Course	A layer of specified material placed on a subgrade or subbase.
Base Course Grade	Top of base course.
Bench	A horizontal surface in a sloped deposit.
Caisson	A concrete foundation element cased in a circular excavation, which may have an enlarged base. Sometimes referred to as a cast-in-place pier.
Concrete Slabs-on-Grade	A concrete surface layer cast directly upon a base, subbase, or subgrade.
Controlled Compacted Fill	Engineered Fill. Specific material placed and compacted to specified density and/or moisture conditions under observation of a representative of a soil engineer.
Differential Settlement	Unequal settlement between or within foundation elements of a structure.
Existing Fill	Materials deposited through the action of man prior to exploration of the site.
Expansive Potential	The potential of a soil to increase in volume due to the absorption of moisture.
Fill	Materials deposited by the action of man.
Finish Grade	The final grade created as a part of the project.
Heave	Upward movement due to expansion or frost action.
Native Grade	The naturally occurring ground surface.
Native Soil	Naturally occurring on-site soil.
Overexcavate	Lateral extent of subexcavation.
Rock	A natural aggregate of mineral grains connected by strong and permanent cohesive forces. Usually requires drilling, wedging, blasting, or other methods of extraordinary force for excavation.
Scarify	To mechanically loosen soil or break down the existing soil structure.
Settlement	Downward movement of the soil mass and structure due to vertical loading.
Soil	Any unconsolidated material composed of disintegrated vegetable or mineral matter, which can be separated by gentle mechanical means, such as agitation in water.
Strip	To remove from present location.
Subbase	A layer of specified material between the subgrade and base course.
Subexcavate	Vertical zone of soil removal and recompaction required for adequate foundation or slab support
Subgrade	Prepared native soil surface.

SECTION II



SITE PLAN | PROJECT 30593

PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT ON ±0.67 ACRES
APN 133-34-827B
3250 SOUTH COUNTRY CLUB WAY
TEMPE, ARIZONA 85282

TEST BORING LOCATION

Vann Engineering, Inc.
9013 North 24th Avenue
Phoenix, Arizona
602-943-6997

TEST BORING 1

CLIENT E-Project, LLC
PROJECT NAME MFRD on ±0.67 Acres
PROJECT NUMBER 30593
PROJECT LOCATION 3250 South Country Club Way
DATE STARTED 2/13/23 **COMPLETED** 2/13/23
GROUND ELEVATION **HOLE SIZE** 4.5 inches
DRILLING CONTRACTOR VEI
LOGGED BY MM **CHECKED BY** CM
DRILLING METHOD 4.5 Inch Continuous Flight Auger CME 55
NOTES

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	REMARKS	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	SPT N VALUE □ (0 10 20 30 40 50 60) / MOISTURE (%) △ (0 5 10 15 20 25 30) / PLASTICITY INDEX ○ (0 9 18 27 36 45 54)
0.0		SPREAD FILL, 11 inches, with gravel, slightly damp to damp, 15% gravel, 30% sand, 55% fines, poorly graded, subangular coarse-grained particles, firm, PI of 16, no cementation				
		(CL) SANDY CLAY, trace gravel, light-brown, damp, 5% gravel, 30% sand, 65% fines, poorly graded, subangular coarse-grained particles, stiff, PI of 17, no cementation				
		Weak cementation below 2 feet		R	7-9	
2.5				GB		
5.0		Tan, hard, PI of 21 below 5 feet		GB SPT	14-23-35 (58)	□
7.5						
10.0		Whitish-tan, 25% sand, 75% fines, PI of 22 below 10 feet		GB SPT	21-32-36 (68)	>>□
		Medium to strong cementation below 11 feet				
12.5						
15.0						

Discontinued test boring at 15.0 feet.

Vann Engineering, Inc.
9013 North 24th Avenue
Phoenix, Arizona
602-943-6997

TEST BORING 2

CLIENT E-Project, LLC
PROJECT NAME MFRD on ±0.67 Acres
PROJECT NUMBER 30593
PROJECT LOCATION 3250 South Country Club Way
DATE STARTED 2/13/23 **COMPLETED** 2/13/23
GROUND ELEVATION **HOLE SIZE** 4.5 inches
DRILLING CONTRACTOR VEI
LOGGED BY MM **CHECKED BY** CM
DRILLING METHOD 4.5 Inch Continuous Flight Auger CME 55
NOTES

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	REMARKS	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	SPT N VALUE □ 0 10 20 30 40 50 60 / MOISTURE (%) △ 0 5 10 15 20 25 30 / PLASTICITY INDEX ○ 0 9 18 27 36 45 54
0.0		SPREAD FILL, 11 inches, with gravel, slightly damp to damp, 15% gravel, 35% sand, 50% fines, poorly graded, subangular coarse-grained particles, firm, PI of 16-18, no cementation				
		(CL) SANDY CLAY, trace gravel, light-brown, damp, 5% gravel, 30% sand, 65% fines, poorly graded, subangular coarse-grained particles, stiff, PI of 17, no cementation		R	6-10	
		Weak cementation below 2 feet				
2.5						
5.0		Tan, hard, PI of 21 below 5 feet				
7.5						
		Medium cementation below 9 feet				
10.0		Whitish-tan, 25% sand, 75% fines, PI of 22 below 10 feet				
12.5						
15.0						

Discontinued test boring at 15.0 feet.

Vann Engineering, Inc.
9013 North 24th Avenue
Phoenix, Arizona
602-943-6997

TEST BORING 3

PAGE 1 OF 1

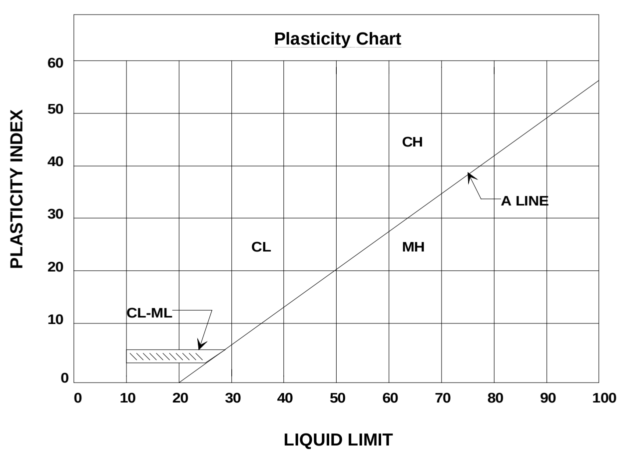
CLIENT E-Project, LLC
PROJECT NAME MFRD on ±0.67 Acres
PROJECT NUMBER 30593
PROJECT LOCATION 3250 South Country Club Way
DATE STARTED 2/13/23 **COMPLETED** 2/13/23
GROUND ELEVATION
HOLE SIZE 4.5 inches
DRILLING CONTRACTOR VEI
LOGGED BY MM
CHECKED BY CM
DRILLING METHOD 4.5 Inch Continuous Flight Auger CME 55
NOTES

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	REMARKS	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	SPT N VALUE □ 0 10 20 30 40 50 60 / MOISTURE (%) △ 0 5 10 15 20 25 30 / PLASTICITY INDEX ○ 0 9 18 27 36 45 54
0.0		SPREAD FILL, 12 inches, with gravel, slightly damp to damp, 15% gravel, 30% sand, 55% fines, poorly graded, subangular coarse-grained particles, firm, PI of 16, no cementation				
		(CL) SANDY CLAY, trace gravel, light-brown, damp, 5% gravel, 30% sand, 65% fines, poorly graded, subangular coarse-grained particles, stiff, PI of 17, no cementation		R	7-8	
2.5		Weak cementation below 3 feet				
5.0		Tan, hard, PI of 21 below 5 feet				
7.5						
10.0		Whitish-tan, 25% sand, 75% fines, PI of 22, medium cementation below 10 feet				
12.5						
15.0						

Discontinued test boring at 15.0 feet.

LEGEND

<table>
<tr><th colspan="4">Major Divisions</th><th>Group Symbol</th><th>Typical Names</th></tr>
<tr><td rowspan="8">Coarse-Grained Soils (Less than 50% passes No. 200 sieve)</td><td rowspan="4">Gravels (50% or less or coarse fraction passes No. 4 sieve)</td><td colspan="2" rowspan="2">Clean Gravels (Less than 5% passes No. 200 sieve)</td><td>GW</td><td>Well graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.</td></tr>
<tr><td>GP</td><td>Poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.</td></tr>
<tr><td rowspan="2">Gravels with Fines (More than 12% passes No. 200 sieve)</td><td>Limits plot below "A" line & hatched zone on Plasticity Chart.</td><td>GM</td><td>Silty gravels, gravel-sand-silt mixtures.</td></tr>
<tr><td>Limits plots above "A" line & hatched zone on Plasticity Chart.</td><td>GC</td><td>Clayey gravels, gravel-sand-clay mixtures.</td></tr>
<tr><td rowspan="4">Sands (More than 50% of coarse fraction passes No. 4 sieve)</td><td colspan="2" rowspan="2">Clean Sands (Less than 5% passes No. 200 sieve)</td><td>SW</td><td>Well graded sands, gravelly sands.</td></tr>
<tr><td>SP</td><td>Poorly graded sands, gravelly sands.</td></tr>
<tr><td rowspan="2">Sands with Fines (More than 12% passes No. 200 sieve)</td><td>Limits plots below "A" line & hatched zone on Plasticity Chart.</td><td>SM</td><td>Silty sands, sand-silt mixtures.</td></tr>
<tr><td>Limits plots above "A" line & hatched zone on Plasticity Chart.</td><td>SC</td><td>Clayey sands, sand-clay mixtures.</td></tr>
<tr><td rowspan="4">Fine-Grained Soils (50% or more passes No. 200 sieve)</td><td rowspan="2">Silts-Plot below "A" line & hatched zone on Plasticity Chart</td><td colspan="2">Silts of Low Plasticity (Liquid Limit Less Than 50)</td><td>ML</td><td>Inorganic silts, clayey silts with slight plasticity.</td></tr>
<tr><td colspan="2">Silts of High Plasticity (Liquid Limit More Than 50)</td><td>MH</td><td>Inorganic silts, micaceous or diatomaceous silty soils, elastic silts.</td></tr>
<tr><td rowspan="2">Clays-Plot above "A" line & hatched zone on Plasticity Chart</td><td colspan="2">Clays of Low Plasticity (Liquid Limit Less Than 50)</td><td>CL</td><td>Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.</td></tr>
<tr><td colspan="2">Clays of High Plasticity (Liquid Limit More Than 50)</td><td>CH</td><td>Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity.</td></tr>
<tr><td colspan="6">Note: Coarse grained soils with between 5% & 12% passing the No. 200 sieve and fine grained soils with limits plotting in the hatched zone on the Plasticity Chart to have double symbol.</td></tr>
</table>



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Cobbles	Above 3 in.
Gravel	3 in. to No. 4 sieve
Coarse gravel	3 in. to 3/4 in.
Fine gravel	3/4 in. to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

TEST DRILLING EQUIPMENT & PROCEDURES

Drilling Equipment

VANN ENGINEERING INC uses a CME-55 drill-rig capable of auger drilling to depths of 150 feet in southwestern soils. The drill is truck-mounted for rapid, low cost mobilization to the jobsite and on the jobsite. The CME-55 owned by this firm is powered by a 300 cubic inch, 6-cylinder Ford industrial engine that produces 124 horsepower. This energy is transmitted through a rugged mechanical drive that provides 7,000 foot-lbs of torque on the drillstring. Two 72-inch hydraulic cylinders develop 16,000 lbs of downward thrust and 24,000 lbs of retractive force. Two hydraulic cable hoists and a mechanical cathead allow downhole sampling and testing at any depth to be accomplished with great speed and accuracy. For drilling operations, the truck is stabilized with platform mounted vertical hydraulic jacks with a 48-inch stroke. Drilling through soil or softer rock is performed with 6¾ inch O.D. hollow-stem, or 4½-inch continuous flight auger. Carbide insert teeth are normally used on the auger bits so they can often penetrate rock or very strongly cemented soils that require blasting or very heavy equipment for excavation. The operation of well-maintained equipment by an experienced crew allows VANN ENGINEERING INC to complete any type of drilling job with minimum downtime and maximum efficiency.

Sampling Procedures

Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 procedure. In many cases, 2 inch O.D., $1^{3}/_{8}$-inch I.D. samplers are used to obtain the standard penetration resistance. “Undisturbed” samples of firmer soils are often obtained with 3-inch O.D. samplers lined with 2.42 inch I.D. brass rings. The driving energy is generally recorded as a number of blows of a 140-pound hammer, utilizing a 30-inch free fall drop, per foot of penetration. However, in stratified soils, driving resistance is sometimes recorded in 2 or 3-inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per foot on the logs. Undisturbed sampling of softer soils is sometimes performed with thin-walled Shelby tubes (ASTM D1587). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing from auger cuttings.

Continuous Penetration Tests

Continuous penetration tests are performed by driving a 2-inch O.D. blunt nosed penetrometer adjacent to or in the bottom of test borings. The penetrometer is attached to $1^{5}/_{8}$-inch O.D. drill rods to provide clearance and thus minimize side friction so that penetration values are as nearly as possible a measure of end resistance. Penetration values are recorded as the number of blows of a 140 pound hammer, utilizing a 30-inch drop required to advance the penetrometer in one foot increments or less.

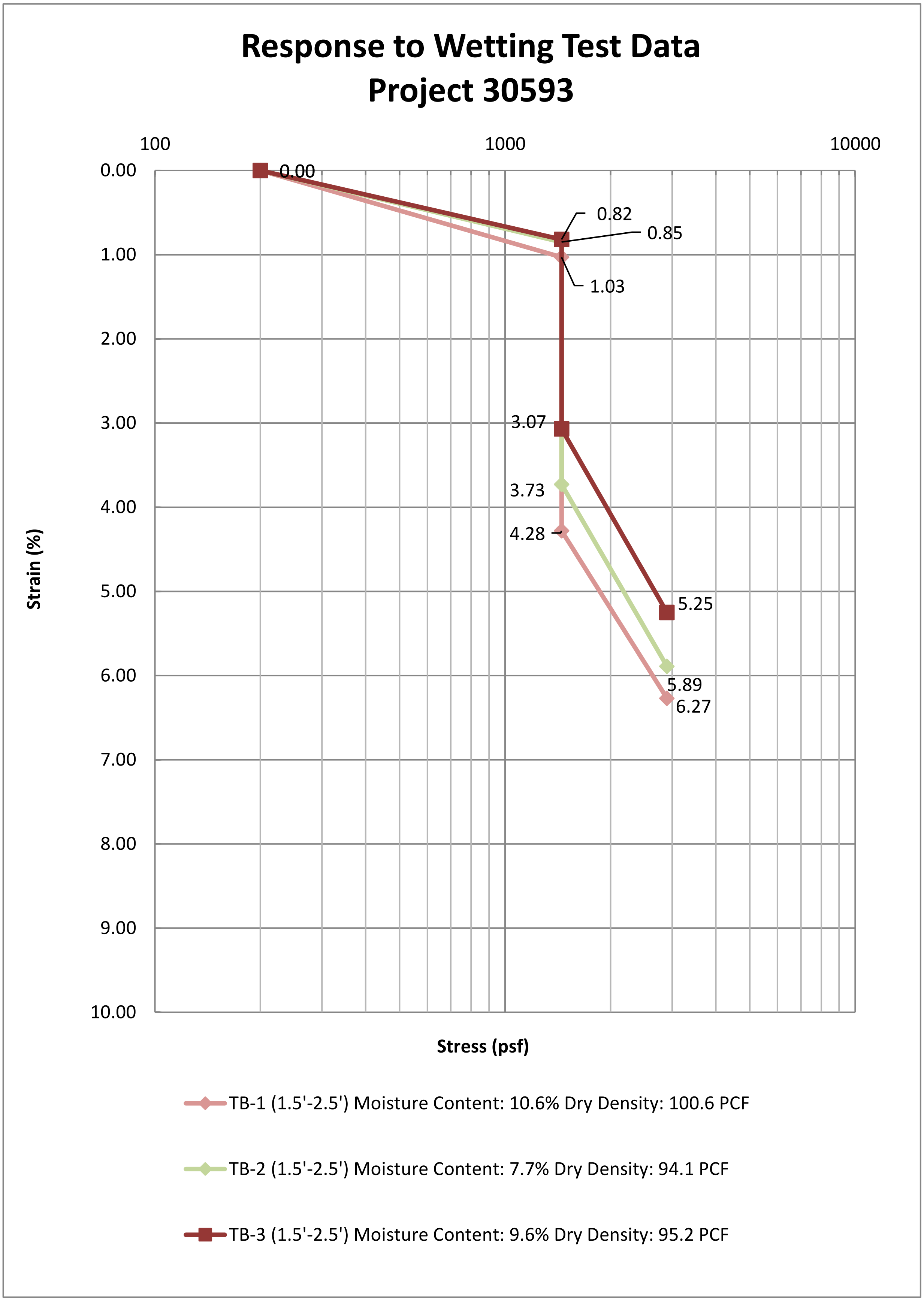
As an alternate, Cone Penetration Testing may be utilized in an effort to determine the point capacity of the cone tip, and skin friction measured on the cone sleeve.

Boring Records

Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares boring logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487) with appropriate group symbols being shown on the logs.

SECTION III

9013 NORTH 24TH AVENUE, SUITE 7, PHOENIX, ARIZONA 85021
PHONE: 602.943.6997 ▪ VANNENGINEERINGINC.COM



Response to Wetting Test Data
Project 30593
100
1000
10000
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
0.00
0.82
0.85
1.03
3.07
3.73
4.28
5.25
5.89
6.27
Strain (%)
Stress (psf)
TB-1 (1.5'-2.5') Moisture Content: 10.6% Dry Density: 100.6 PCF
TB-2 (1.5'-2.5') Moisture Content: 7.7% Dry Density: 94.1 PCF
TB-3 (1.5'-2.5') Moisture Content: 9.6% Dry Density: 95.2 PCF

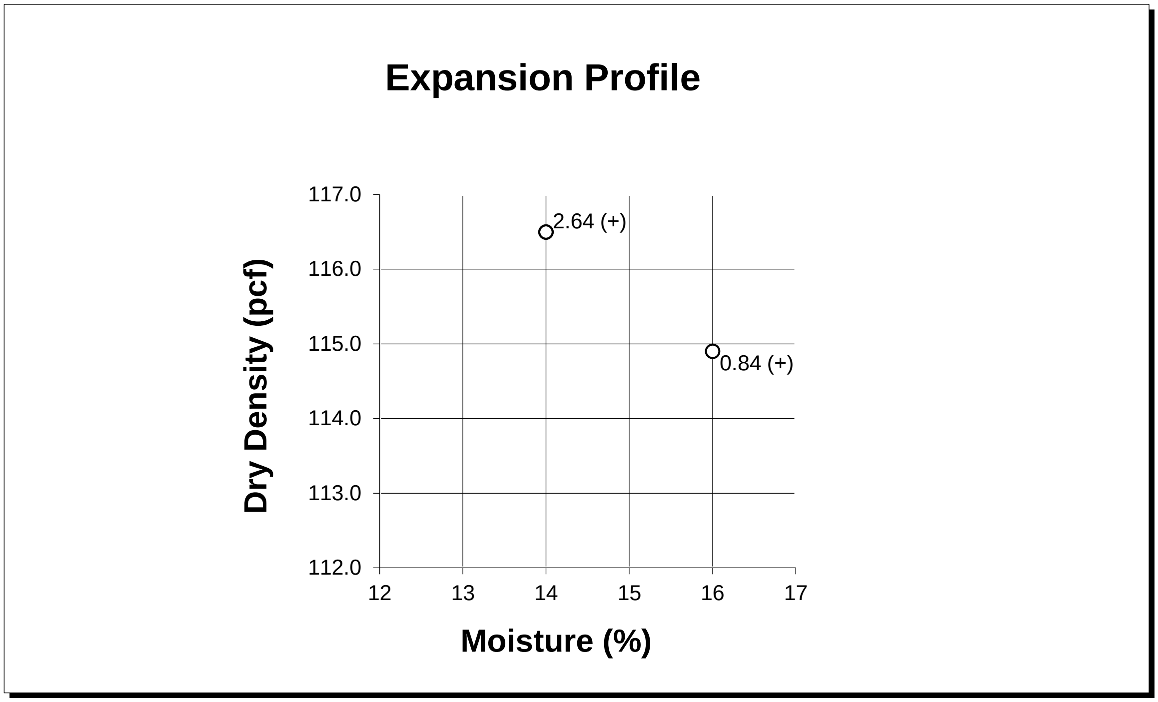
EXPANSION TEST DATA

PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT ON ±0.67 ACRES
APN 133-34-827B
3250 SOUTH COUNTRY CLUB WAY
TEMPE, ARIZONA 85282

Sample Location	*Remolded Moisture Content (%)*	*Dry Density (PCF)*	*Volume Change After Saturation (%)*	*Adjusted Volume Change After Saturation (%)*
TB-1 (2.5'-3.5')	16.0	114.9	0.94 (+)	0.84 (+)
TB-1 (2.5'-3.5')	14.0	116.5	2.78 (+)	2.64 (+)

(+) denotes expansion

(-) denotes compression

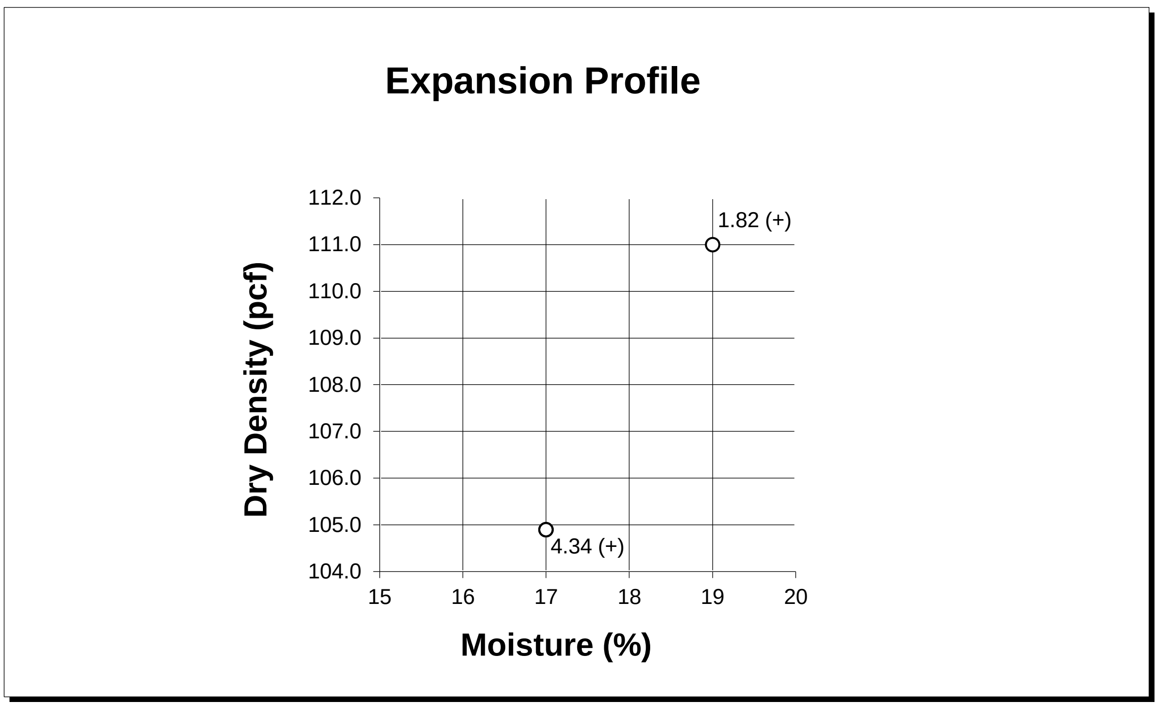


EXPANSION TEST DATA

PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT ON ±0.67 ACRES
APN 133-34-827B
3250 SOUTH COUNTRY CLUB WAY
TEMPE, ARIZONA 85282

Sample Location	*Remolded Moisture Content (%)*	*Dry Density (PCF)*	*Volume Change After Saturation (%)*	*Adjusted Volume Change After Saturation (%)*
TB-1 (5.0'-6.0)	19.0	111.0	1.91 (+)	1.82 (+)
TB-1 (5.0'-6.0)	17.0	104.9	4.55 (+)	4.34 (+)

(+) denotes expansion
(-) denotes compression



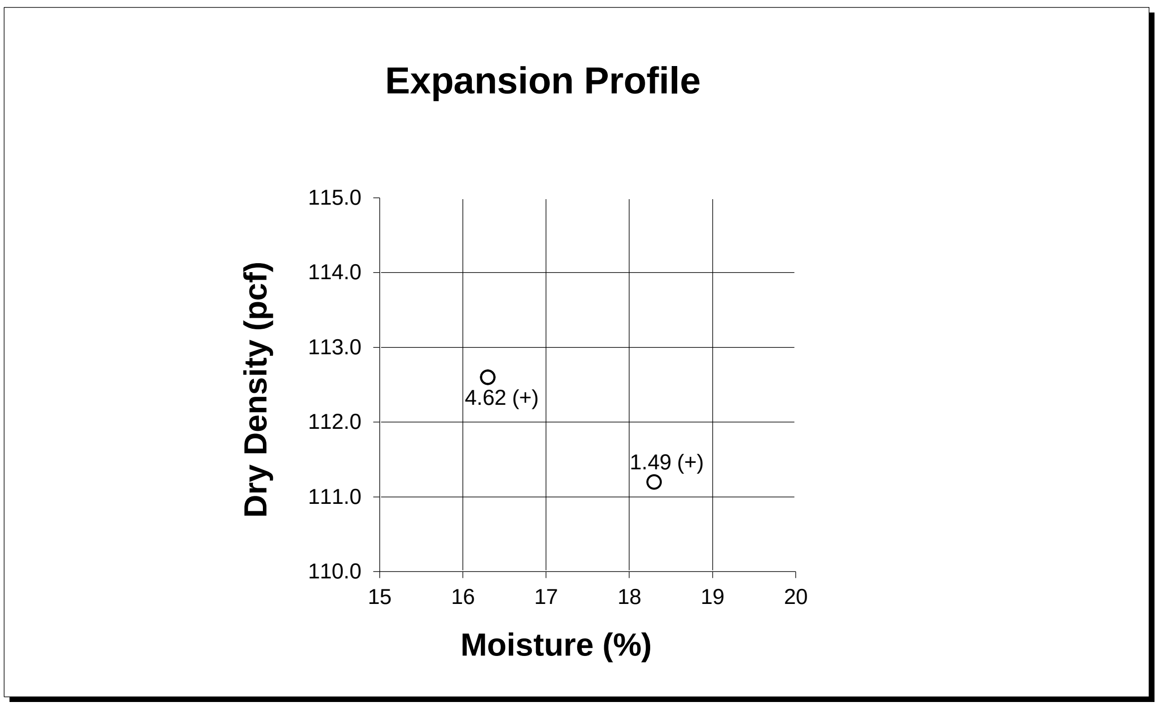
EXPANSION TEST DATA

PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT ON ±0.67 ACRES
APN 133-34-827B
3250 SOUTH COUNTRY CLUB WAY
TEMPE, ARIZONA 85282

Sample Location	*Remolded Moisture Content (%)*	*Dry Density (PCF)*	*Volume Change After Saturation (%)*	*Adjusted Volume Change After Saturation (%)*
TB-1 (10.0'-11.0')	18.3	111.2	1.50 (+)	1.49 (+)
TB-1 (10.0'-11.0')	16.3	112.6	4.62 (+)	4.62 (+)

(+) denotes expansion

(-) denotes compression



CLASSIFICATION TEST DATA

PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT ON ±0.67 ACRES
APN 133-34-827B
3250 SOUTH COUNTRY CLUB WAY
TEMPE, ARIZONA 85282

Sample Location	Sieve Analysis (% Passing Sieve Size) 3"	2"	1"	#4	#10	#40	#100	#200	Atterberg Limits LL	PI	USCS	Moisture Content %
TB-1 (2.5'-3.5')	-	-	100	95	92	84	-	64	34	17	CL	7.5
TB-1 (5.0'-6.0')	-	-	100	95	90	79	-	65	38	21	CL	10.5
TB-1 (10.0'-11.0')	-	-	100	100	98	91	-	75	38	22	CL	8.4

SULFATES AND CHLORIDES TEST RESULTS

PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT ON ±0.67 ACRES
APN 133-34-827B
3250 SOUTH COUNTRY CLUB WAY
TEMPE, ARIZONA 85282

Sample Location	***Test Interval (feet)***	***Sulfate (%)***	***Chloride (ppm)***
TB-1	2.5’-3.5’	0.036	174

HYDROMETER TEST DATA

PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT ON ±0.67 ACRES
APN 133-34-827B
3250 SOUTH COUNTRY CLUB WAY
TEMPE, ARIZONA 85282

Sample Location	*Sample Depth (Feet)*	*Actual Percent Finer Than 0.002 mm*
TB-1	2.5'-3.5'	20.5