

**GEOTECHNICAL INVESTIGATION REPORT
NEW CLASSROOM BUILDING D4
CATALINA FOOTHILLS HIGH SCHOOL
TUCSON, ARIZONA**

Submitted To:

Catalina Foothills School District
C/O John R Kulseth Associates Ltd.
476 South Stone Avenue
Tucson, Arizona 85701

Submitted By:

AGRA Earth & Environmental, Inc.
1425 East Apache Park Place
Tucson, Arizona 85714

6 April 1998
AEE Job No. 8-127-000-012

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Catalina Foothills School District
C/O John R. Kulseth Associates, Ltd.
476 South Stone Avenue
Tucson, Arizona 85701

Attention: Mr. Bill Porter
Project Architect

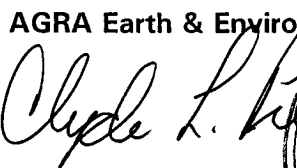
Re: Geotechnical Investigation
New Classroom Building D4
Catalina Foothills High School
Tucson, Arizona

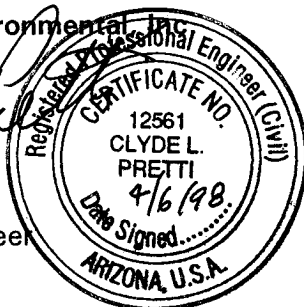
Gentlemen:

Our Geotechnical Investigation Report on the referenced project is herewith submitted. The report includes the results of test drilling, laboratory analyses, and engineering analyses. Recommendations for site grading, foundation, and slab-on-grade design, based on the analyses, are presented.

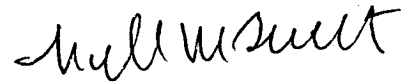
Should any questions arise concerning this report, we would be pleased to discuss them with you.

Respectfully submitted,
AGRA Earth & Environmental, Inc.


Clyde L. Pretti P.E.
Geotechnical Engineer



Reviewed by:



Lyle M. Tweet P.E.
Vice President

Copies: Addressee (2)
John R. Kulseth Architects (3)
File (1)

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- APPENDIX A FIELD INVESTIGATION
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1. INTRODUCTION

This report presents the results of a geotechnical investigation by AGRA Earth & Environmental (AEE) of the site of the proposed new classroom building D4 located at Catalina Foothills High School at 4300 East Sunrise Drive in Tucson, Arizona. The purpose of this investigation was to evaluate the physical properties of the soils underlying the site, in order to develop recommendations for site grading, foundation and slab-on-grade design.

2. PROJECT DESCRIPTION

Preliminary details of the project were provided by Mr. Bill Porter of John R. Kulseth Associates, in the form of a site plan, showing the planned layout of the new building. The two story building will occupy a footprint area of approximately 17,000 square feet. The building will be constructed with masonry block walls, concrete cast-on-grade ground floor slab and a metal roof. Finish grade for the ground floor slab is 2679.0 feet and exterior grade is no lower than 2678.0.

Maximum wall loads are anticipated to be 8 kips per lineal foot (klf) and maximum column loads are anticipated to be 80 kips. There are no retaining walls although some of the perimeter building walls may retain up to 1 foot of soil due to the elevation differential from the inside floor slab to the outside finish grade. There are no basements or sublevels in the new building.

3. INVESTIGATION

3.1 SUBSURFACE EXPLORATION

Three exploratory borings were drilled to depths of approximately 20 feet below existing grade. The borings were drilled with a CME-75 truck-mounted drill rig advancing a 6 5/8-inch continuous hollow-stem flight auger. Standard penetration testing and sampling, and open-end drive sampling were performed at selected intervals in the borings. Upon completion of the drilling operation, the boreholes were backfilled with the drill cuttings.

Three backhoe test pits were excavated to depths of approximately 2 to 9 feet below the existing grade. The test pits were excavated with a John Deere 300D backhoe. Upon completion of the excavations, the test pits were backfilled with the excavated soils.

The results of the field investigation are presented in Appendix A, which includes a brief description of drilling and sampling equipment and procedures. Also presented are a site plan showing the boring and test pit locations and logs of the test borings and test pits.

3.2 LABORATORY INVESTIGATION

The moisture content of selected samples recovered from the borings was determined. The results of these tests are shown on the boring logs. Grain-size analysis and Atterberg limits tests were performed on representative samples. The results of these tests are presented in Appendix B.

4. SITE CONDITIONS AND GEOTECHNICAL PROFILE

4.1 SITE CONDITIONS

There is an existing earthwork pad in the area of this new building which was constructed during the original campus construction. During discussions with some of the site maintenance personnel, they indicated the grade of the original pad was recently raised to improve surface drainage. Based on this conversation, the depth of new fill placed on the original pad is estimated to be approximately 1 to 2 feet.

The site is bordered on the north by the existing classroom building D3, on the east by a sidewalk, on the south by the football/track athletic field and on the west by native desert land. A concrete curb runs along a portion of the south side. Beyond this curb, the ground slopes down to the athletic field. This sloping ground appears to have been graded after construction of the original pad.

The area is used for faculty parking. There is a drainage pipe at the northwest corner of the site. There was no vegetation on the site but there is native desert vegetation at the west side including some brush and trees. The land to the north and east is higher than the site and the land to the west and south is lower. Drainage is to the west although the site is fairly flat. There are buried utility pipes on the west end of the site.

4.2 GEOTECHNICAL PROFILE

Based on our onsite discussions with the site personnel, the exploratory borings/test pits and the results of the laboratory analyses, the geotechnical profile underlying the project site can be generalized as a three-strata system as follows:

- A. A surface layer of fill placed during the last few years to raise the site grade to improve drainage. The depth of this fill is estimated to be 1 to 2 feet but may be deeper. The actual depth, composition and extent of this material should become evident during construction. No compaction records are available for this new fill.
- B. Below the new fill, there is a layer of structural fill comprised of silty and clayey sand with gravel. The fill materials varied in thickness from approximately 5 to 6 feet. This fill material was placed during the original earthwork performed to develop the high school campus site. This fill material generally consists of the on-site soils compacted

*Spaced and
Depth 1m
1/2*

to at least 95 percent of the maximum dry density (determined in accordance with ASTM D1557, Modified Proctor) at a moisture content during compaction maintained within the limits of 1 percent below to 3 percent above the optimum moisture condition.

- C. Native soils were encountered below the original fill materials. The underlying native soils generally consist of silty sands with varying amounts of gravel. These soils are generally moderately to strongly cemented with calcium carbonate (lime). As a result of the cementation and intermixed gravel material, the native soils were encountered in a very firm to hard condition.

No free groundwater was encountered in the borings advanced for this project. Soil moisture contents throughout the depths explored were found to be relatively low.

5. DISCUSSION & RECOMMENDATIONS

5.1 EXISTING EARTHWORK PAD

The original earthwork pad was constructed during the original campus construction. AGRA Earth and Environmental personnel provided observation and testing services for the pad construction. After removal of native surface soils during the original project earthwork, compacted structural fills were placed that were suitable for support of the planned building. Additional fills were recently placed to raise the grade of the original pad to improve drainage. No compaction records are available for the new fill.

We believe the original earthwork pad extended south of the present parking area into the sloping ground between the concrete curb and the athletic field. The pad was cut back and now slopes down to the athletic field.

The surface of the site and the sloping ground on the south side of the site have become loosened due to exposure to the elements. The loosened soils and the new fills placed to raise the grade of the original pad should be removed and replaced with compacted structural fill-see the **SITE GRADING** portion of this report concerning this work.

When overlaying the footprint of the new building on the existing pad, it is evident the new building is larger than the pad. It will be necessary to enlarge the pad to accommodate the size of the new building.

5.2 ANALYSIS OF RESULTS

Based on the results of this evaluation and our knowledge of the earthwork previously performed on the site, the compacted structural fill and underlying cemented native soils are sufficiently firm at in-situ moisture contents to support the anticipated structure loads. The recently placed fills and any soils loosened by exposure to the elements should be removed from below new foundations and slabs.

Shallow spread- or mat-type foundations are recommended to support the proposed new building, provided site drainage and moisture protection measures are implemented in the design and construction.

5.3 SHALLOW FOUNDATIONS

5.3.1 Design Criteria for Downward Loads

Based on our understanding of the proposed building configuration, the new building foundations will be constructed on compacted structural fill material.

For foundations bearing on structural fill, the following design criteria should be used:

<u>Loading Conditions</u>	<u>Safe Soil Bearing Pressure</u>
Dead loads	2,500 psf
Dead plus live loads	3,000 psf
Dead plus live plus wind or seismic loads	4,000 psf

The recommended minimum depth of footings below the lowest adjacent finished grade is 1.5 feet. Lowest adjacent finished grade is defined as finished floor elevation or the lowest exterior finished grade within 5 feet of the foundation elements, whichever is lower. The minimum recommended widths of square and continuous footings are 24 and 16 inches, respectively. Criteria for selection and placement of structural fill material are presented in the **SITE GRADING** section of this report.

5.3.2 Lateral Loads

The passive resistance of properly compacted backfill or undisturbed native soils against the edges of footings, stem walls, and similar vertical foundation elements should be considered equivalent to the forces exerted by a fluid of 300 pounds per cubic foot (pcf) unit weight.

The active earth pressure for properly compacted backfill or undisturbed native soils against the edges of footings, stem walls, and similar vertical foundation elements should be considered equivalent to the forces exerted by a fluid of 30 pcf for unrestrained walls and 50 pcf for restrained walls.

A coefficient of friction of 0.45 is recommended for computing lateral resistance between the bases of footings and slabs and the soil in analyzing lateral loads.

The above lateral load values do not include the effects of submerged or hydrostatic loading conditions and are for level backfill conditions. No allowance has been made in the above loads for surcharge or swelling soil pressures on walls.

5.3.3 Estimated Settlements

It is estimated that total and differential settlements of foundations designed in accordance with the criteria presented in this report should not exceed ½ inch for the soil moisture conditions encountered in the native and fill soils at the time of our field investigation, or for specified moisture contents anticipated in compacted structural fill placed for this project. It is further anticipated that about 50 percent of the anticipated settlement will occur during construction.

Moisture increases in the supporting soils could result in additional settlements of approximately 50 percent of the estimated settlement. Therefore, recommendations for controlling site drainage and moisture protection, as presented in this report, are considered critical elements of design.

5.4 CONCRETE CAST-ON-GRADE SLABS

5.4.1 Slab Support

To provide adequate and uniform support of interior and exterior cast-on-grade concrete slabs, the upper 8 inches of the site soils underlying slabs (or below structural fills placed during this project to support slabs) should be scarified, moisture-conditioned and compacted. The moisture content should be maintained within 1 percent below to 3 percent above optimum moisture content. The scarified and moisture-conditioned site soils should be compacted to at least 95 percent of the maximum dry density (determined in accordance with ASTM D1557).

Provided site grading and earthwork are carried out as recommended, structural fill maintained at or slightly below compaction moisture content should provide adequate support for lightly-loaded, cast-on-grade concrete slabs. Thus, the use of granular base is not necessary for the structural support of slabs. However, granular base provides a more desirable working surface, reduces capillary rise of moisture to slabs, and reduces warping stresses in concrete. Accordingly, a 4-inch course of material meeting the gradation requirements shown below is recommended.

<u>Sieve Size</u> <u>(square openings)</u>	<u>Percent Passing</u> <u>by Dry Weight</u>
1 1/8-inch	100
1/4 inch	38-70
No. 200	0-12

The plasticity index of the fraction of material passing the No. 40 sieve should be nonplastic when tested by ASTM D4318. Granular base should be free of vegetation, debris and other deleterious material. All granular base should be compacted to at least 95 percent of maximum dry density as determined by ASTM D1557. It is noted that the site soils will not be suitable for use as granular base.

5.4.2 Structural Design of Slabs

A modulus of subgrade reaction (k) of 300 pounds per square inch per inch of deflection (pci) is recommended for the structural design of cast-on-grade concrete slabs constructed on structural fill or a combination of fill and native soils. This recommended value is dependent on completion of the site grading as recommended in this report.

Additional Portland cement concrete flatwork design and construction recommendations are as follows:

- Positive separations and/or isolation joints should be provided between slabs and all foundations, columns or utility lines to allow independent movement.
- Slab thickness and reinforcing should be in accordance with the recommendations of the project structural engineer and in accordance with the guidelines established by the American Concrete Institute (ACI).
- Construction joints should be placed at intervals as designed by the structural engineer, and in accordance with ACI recommendations.
- Trench backfill placed beneath slabs should be compacted in accordance with recommendations outlined in this report.
- Slabs should not be constructed on wet, soft, or otherwise unsuitable material.
- Other design and construction considerations, as outlined in Section 302 of the ACI Manual of Concrete Practice, are recommended.

5.4.3 Concrete Placement

In order to reduce the potential for shrinkage cracks in concrete flatwork during curing, and to provide concrete strength in accordance with project specifications, it is recommended that the concrete for the foundations and the flatwork be placed with a maximum slump of 4 inches. The slump should be checked at the site by a representative of a qualified materials testing laboratory prior to placement. We recommend that AGRA Earth & Environmental, Inc. be retained to perform this service. All structural concrete should be placed in accordance with ACI recommendations and project specifications.

5.4.4 Moisture Protection of Slabs

Granular base would tend to act as a capillary break to moisture, but would not provide a positive barrier against the rise of moisture through the slabs. If impervious or moisture-sensitive floor coverings are used, an impervious membrane vapor barrier placed

below the granular base course is recommended. The barrier construction should conform to the recommendations of the manufacturer(s) of the floor covering components.

5.5 SITE GRADING

5.5.1 Surface Preparation and Existing Earthwork Pad Recompaction

All vegetation, existing construction, concrete curbing, drain pipe, sidewalk, utilities, loose dumped debris and any soft or wet soils encountered within the perimeter of the proposed structure, or beneath areas designated for fill placement or exterior slabs, should be removed. The unsuitable materials should be replaced with compacted structural fill in accordance with the recommendations presented below.

Remove the new fills placed on the original earthwork pad and any soils loosened by exposure to the elements. The depth of this removal is estimated to be approximately 1 to 2 feet. The actual depth of removal should be determined by inspection during construction by the soil engineer. The exposed surface should then be proof rolled with a loaded 10 wheel dump truck with the soil engineer present to observe. If any soft or loose spots are found, they should be removed.

Where the existing earthwork pad is to be enlarged, the recently placed fills and any loosened soils should be removed down to the original compacted structural fills. If native soils are to be removed, the native soils should be removed to a minimum depth of 5 feet below the original undisturbed, native desert ground surface which existed prior to the construction of the original earthwork pad. For native soils, the depth of removal is estimated to be approximately 7 feet below the existing pad surface but may be deeper. This depth of removal can be lessened if sufficiently cemented native materials are encountered. The final depth of excavation will be determined by the soil engineer by inspection during construction. The edge of the new earthwork structural fill should be at least 5 feet laterally beyond the perimeter of the new building.

*New
Struct
fill*

IF

Prior to placing new fill materials, the exposed soils below all foundation, slab and new fill areas should be scarified, moisture conditioned and compacted. The depth of scarification should be a minimum 8 inches. The scarified soils should be brought to within the limits of 1 percent below to 3 percent above optimum moisture content and compacted to at least 95 percent of maximum dry density as determined by ASTM D1557.

Spec

5.5.2 Structural Fill

All fill used as backfill or used as fill to raise the site to subgrade elevation, should be free of vegetation, debris and other deleterious material and contain no particles larger than 3 inches

Spec

in diameter. Structural fill should have a plasticity index of no more than 12 when tested by ASTM D4318 and contain no more than 40 percent fine material (passing the no. 200 sieve). *Spe*

All fill materials should be compacted to at least 95 percent of maximum dry density, as determined by ASTM D1557. Moisture content during compaction should be maintained within the limits of 1 percent below to 3 percent above optimum moisture content. Fill material should be placed in compacted lifts no thicker than 8 inches. *Spe*

Where new fills are placed against existing fills, the existing fill surface should be "benched". Benches should be a minimum 4 feet wide and not deeper than one foot or as approved by the soil engineer. *Benched cuts Spe*

It appears the soils that are expected to be excavated from the project site are suitable for use as structural fill. However, areas of unsuitable material may be encountered. Therefore, any site soils that may be utilized as structural fill should be tested prior to placement. Selection and placement of structural fills should be performed under the direction of a qualified geotechnical engineer. *Spe*

5.5.3 Excavation Conditions

Based on the results of this evaluation, excavation of the site materials may be performed with normal construction techniques using heavy-duty earthmoving equipment (such as a larger track-mounted backhoe or dozer). It is noted that the native soils are very firm to hard and have a moderate to strong degree of cementation. As a result, excavation of these materials may require ripping to facilitate removal.

All prospective contractors and/or subcontractors should visit the site and determine the proper equipment and excavation techniques.

All excavations should be sloped or braced in accordance with the applicable state or federal regulations.

It is recommended that the geotechnical engineer or his representative observe excavation of the site materials prior to placement of structural fill or construction of foundations. The purpose of this observation will be to evaluate if unsuitable and disturbed materials have been removed and that the exposed bearing conditions are similar to those anticipated for support of the foundations and slabs. Any soft, loose or unacceptable materials should be removed and replaced in accordance with the recommendations contained in this report.

5.6 SITE DRAINAGE & MOISTURE PROTECTION

Proper site drainage and moisture protection are critical design considerations. Positive site drainage should be provided during construction and maintained thereafter. Slabs, pavements and ground surface areas adjacent to the building or other structural elements, should be sloped away from the perimeter of the structure at a minimum grade of 2 percent for a distance of at least 15 feet.

Landscaping within 15 feet of the structure should be restricted to short rooted vegetation requiring only light watering. Below-grade plumbing outside of service and utility tunnels should be minimized. Roof runoff should be carried away from the building by erosion-reducing devices at the ground surface. In no case should long-term ponding of water be allowed near the foundations and slabs during the life of the facility.

5.7 EROSION CONSIDERATIONS

The site soils and existing fill materials are predominantly granular and of relatively low plasticity. As a result, these materials will be very susceptible to erosion by rainfall or runoff waters. To resist the effects of slope erosion, we recommend that permanent cut and fill slopes have an angle no greater than 3H:1V (Horizontal to Vertical), and that vegetation be established on the slopes to the extent practical.

5.8 LIMITATIONS

The subsurface exploration, laboratory testing, and geotechnical analyses presented in this report have been conducted in general accordance with the current engineering practice and standard of care exercised by reputable geotechnical consultants performing similar tasks in the area. No other warranty, either expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report.

Variations may exist and conditions not observed or described in this report may be encountered during construction. Our conclusions and recommendations are based on an analysis of the observed conditions and apply to the specific project discussed in this report. Therefore, any changes in location or configuration of the building, or site grades should be provided to us so we may review our conclusions and recommendations and make any necessary modifications.

If conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if required, will be provided upon request. In the event of any changes in the nature, design, or locations of the proposed improvements, the conclusions and recommendations presented herein may not be valid unless the changes are evaluated and the conclusions of this report are modified in writing.

Our scope of services did not include an environmental assessment or evaluation for the presence or absence of hazardous or toxic materials in the soil, rock, groundwater or air, on, above, or below the surface of this site. Identification of such substances requires alternative exploration techniques and analyses which were beyond the scope of this evaluation.

We have prepared this report as an aid in design of the proposed project. This report is not a bidding document. Contractors reviewing this report must draw their own conclusions regarding site conditions and specific construction techniques to be used.

Our conclusions and recommendations are based on observation and testing of the earthwork and foundation preparations by a qualified and reputable geotechnical engineer. Since we have prepared this report and are familiar with the project and the field conditions at the site, it is recommended that AGRA Earth & Environmental, Inc. provide these services

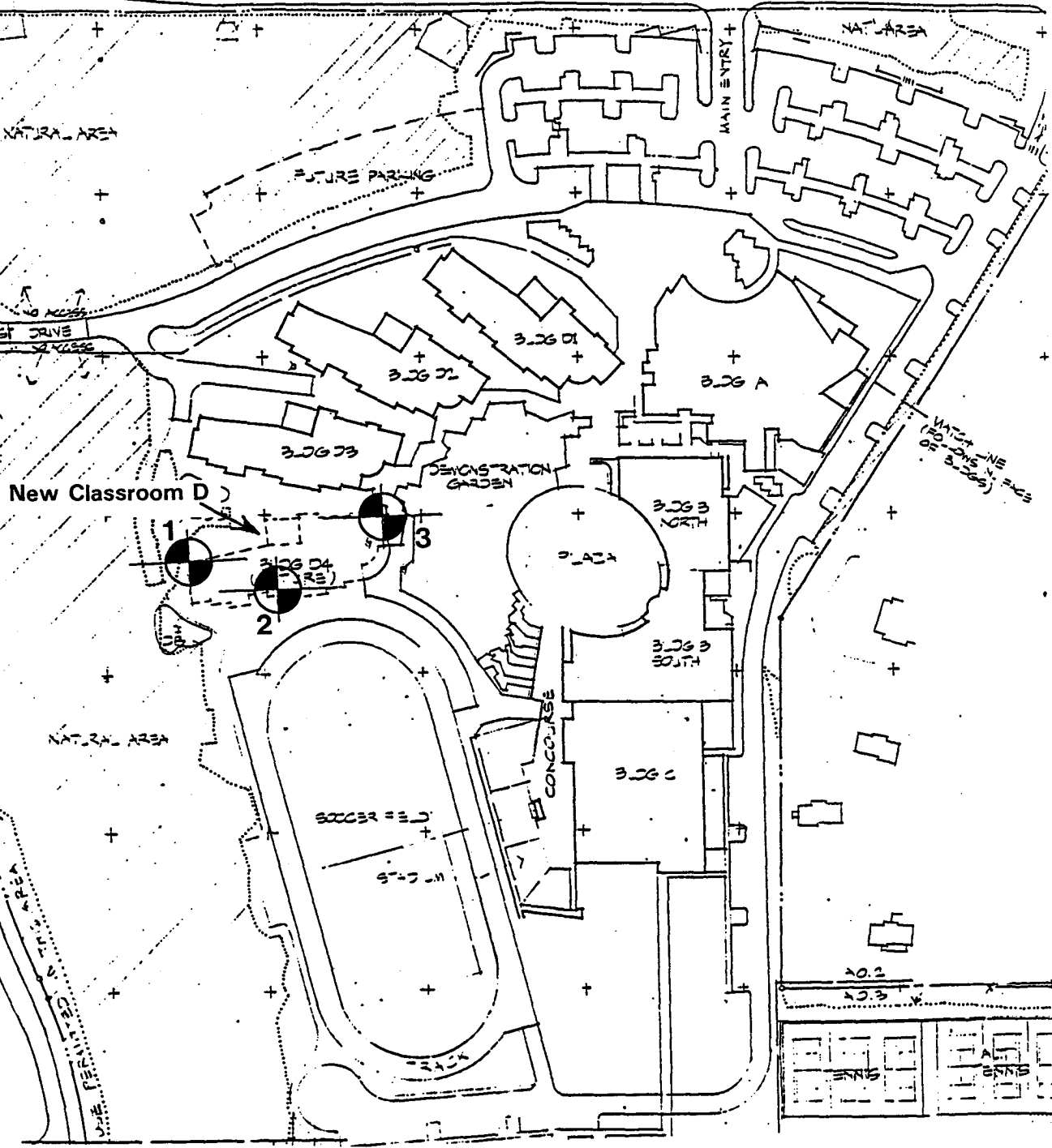
Deviations from our recommendations by the plans, written specifications, or field applications will require our written concurrence.

Changes to site geotechnical conditions can be influenced by nearby development. Also, the broadening of knowledge in engineering applications affects the information and recommendations of the profession. Accordingly, this document should not be used for design or construction after a period of three years beyond the report date.

Sunrise Drive

Proposed New Classroom D

Pontatoc Road



denotes approximate boring location

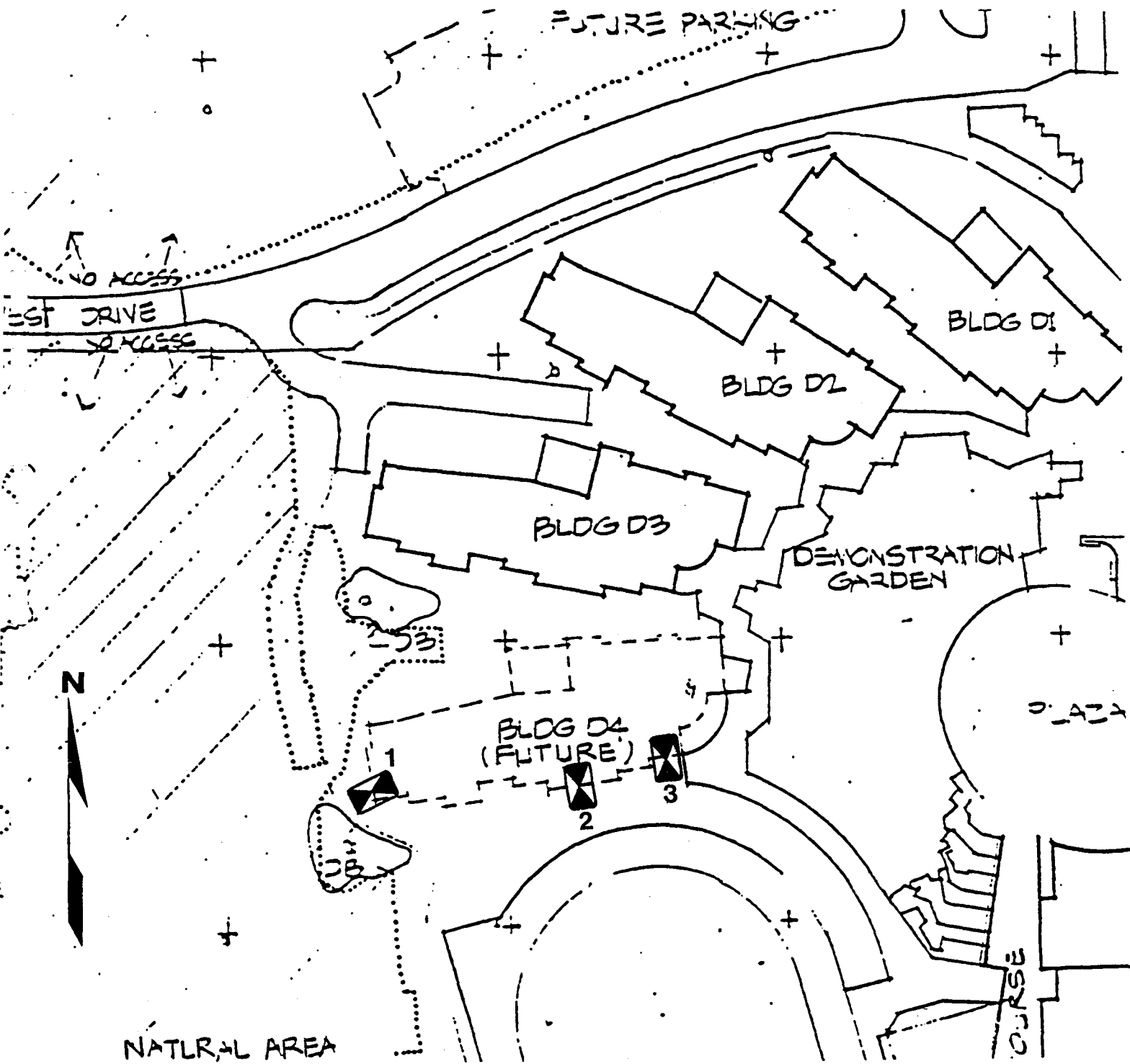
Scale 1' = 200' (approximately)

Site Plan
Showing Approximate Boring Locations

New Classroom Building D4
Catalina Foothills High School
Tucson, Arizona

AEE Job No. 8-127-000-012





Site Plan
Showing Approximate Test Pit Locations

 denotes approximate test pit location

New Classroom Building D4
Catalina Foothills High School
Tucson, Arizona

AEE Job No. 8-127-000-012

JOB NO. 8-127-012 DATE 2/12/98

NOTES Boring located on existing earthwork pad

LOGGED BY CLP
RIG TYPE CME 75
BORING TYPE HSA
SURFACE ELEV. 2678.0 DATUM SJV & Assoc. Survey

Depth in Feet	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			U	37				moist, firm to very firm	Existing Fill silty and clayey sand with gravel, predominantly medium to coarse grained, non to low plasticity, light brown
			U	43 50/4"					
5			U	53					
							SM	slightly moist, very firm to hard	Silty Sand small amount of to considerable gravel, moderate to strong lime cementation, non to low plastic, light brown
10				U 50/4" NR					
15			U	50/6"					
20			U	62					
									stopped auger at 20 feet stopped sampler at 21 feet
25									

BL 98012 4/6/98

GROUNDWATER		
DEPTH	HOUR	DATE
▽	None	
▽		
▽		
▽		

- SAMPLE TYPE
- A - Drill cuttings
 - NR - No Recovery
 - S - 2" O.D. 1.38" I.D. tube sample
 - T - 3" O.D. thin-walled Shelby tube
 - U - 3" O.D. 2.42" I.D. tube sample

PROJECT New Classroom Building D4
Catalina Foothills High School
Tucson, Arizona

LOG OF TEST BORING NO. 2

JOB NO. 8-127-012 DATE 2/12/98

NOTES Boring located on existing earthwork pad

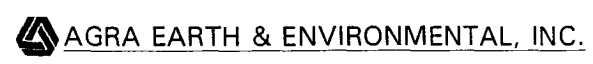
LOGGED BY CLP
 RIG TYPE CME 75
 BORING TYPE HSA
 SURFACE ELEV. 2678.0 DATUM SJV & Assoc. Survey

Depth in Feet	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION	
0			S	5		8		firm to very firm Existing Fill silty and clayey sand with gravel, predominantly medium to coarse grained, non to low plasticity, light brown		
				6						
				14						
			S	22		8				
				19						
				20						
5			S	15		8				
				17						
				25						
							SM		slightly moist, very firm to hard	Silty Sand small amount of to considerable gravel, moderate to strong lime cementation, non to low plastic, light brown decrease in cementation below 18' stopped auger at 20 feet stopped sampler at 21.5 feet
10			S	33						
				34						
			27							
15		S	18		3					
			25							
			27							
20		S	10		2					
			13							
			10							
25										

BL 98012 4/6/98

GROUNDWATER		
DEPTH	HOUR	DATE
▽	None	
▽		
▽		
▽		

- SAMPLE TYPE
- A - Drill cuttings
 - NR - No Recovery
 - S - 2" O.D. 1.38" I.D. tube sample
 - T - 3" O.D. thin-walled Shelby tube
 - U - 3" O.D. 2.42" I.D. tube sample



JOB NO. 8-127-012 DATE 2/12/98

NOTES Boring located on existing earthwork pad

Depth in Feet	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	LOGGED BY <u>CLP</u>	
								REMARKS	VISUAL CLASSIFICATION
0			U	17				LOGGED BY <u>CLP</u>	
			U	50/6"				RIG TYPE <u>CME 75</u>	
5			U	47				BORING TYPE <u>HSA</u>	
								SURFACE ELEV. <u>2680.0</u> DATUM <u>SJV & Assoc. Survey</u>	
							SM	moist, firm to very firm	
								slightly moist, very firm to hard	
10			U	53				Existing Fill silty and clayey sand with gravel, predominantly medium to coarse grained, non to low plasticity, light brown	
15				U	30 NR			Silty Sand some gravel, moderate to strong lime cementation, non to low plastic, light brown	
							decrease in cementation at 15'		
20			U	50/3" NR				stopped auger at 20 feet stopped sampler at 20'-3"	
25									

BL 98012 4/6/98

GROUNDWATER		
DEPTH	HOUR	DATE
▽	None	
▽		
▽		
▽		

- SAMPLE TYPE
- A - Drill cuttings
 - NR - No Recovery
 - S - 2" O.D. 1.38" I.D. tube sample
 - T - 3" O.D. thin-walled Shelby tube
 - U - 3" O.D. 2.42" I.D. tube sample

PROJECT New Classroom Building D4
Catalina Foothills High School
Tucson, Arizona

LOG OF TEST PIT NO. TP 1

JOB NO. 8-127-012 DATE 4/2/98

LOGGED BY JJC
 BACKHOE TYPE JD 300D
 LOCATION _____
 SURFACE ELEV. 2678.0 DATUM SJV & Assoc. Survey

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0	[Cross-hatched pattern]						<p>Existing Fill silty and clayey sand with gravel, predominantly medium to coarse grained, non to low plastic, light brown</p> <hr style="border-top: 1px dashed black;"/> <p>stopped excavation at 2' encountered buried water pipe</p>
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

TP 98012 4/6/98

GROUNDWATER		
DEPTH	HOUR	DATE
▽ None		4-2-98
▼		

- SAMPLE TYPE
- B - Undisturbed Block Sample
 - D - Disturbed Bulk Sample
 - U - 3" O.D. 2.42" I.D. tube sample

LOGGED BY JJC
 BACKHOE TYPE JD 300D
 LOCATION _____
 SURFACE ELEV. 2678.0 DATUM SJV & Assoc. Survey

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0							Existing Fill silty and clayey sand with gravel, predominantly medium to coarse grained, non to low plastic, light brown
1							
2							
3							
4							
5							
6							
7					SM		Silty Sand small amount of to considerable gravel, moderate to strong lime cementation, non to low plastic, light brown
8							
9							stopped excavation at 9'
10							

TP 98012 4/6/98

GROUNDWATER		
DEPTH	HOUR	DATE
None		4-2-98

- SAMPLE TYPE
- B - Undisturbed Block Sample
 - D - Disturbed Bulk Sample
 - U - 3" O.D. 2.42" I.D. tube sample

PROJECT New Classroom Building D4
Catalina Foothills High School
Tucson, Arizona

LOG OF TEST PIT NO. TP 3

JOB NO. 8-127-012 DATE 4/2/98

LOGGED BY JJC
 BACKHOE TYPE JD 300D
 LOCATION _____
 SURFACE ELEV. 2678.0 DATUM SJV & Assoc. Survey

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0							Existing Fill silty and clayey sand with gravel, predominantly medium to coarse grained, non to low plastic, light brown
1							
2							
3							
4							
5							
6							
7					SM		Silty Sand small amount of to considerable gravel, moderate to strong lime cementation, non to low plastic, light brown
8							
9							
10							stopped excavation at 9'

TP 98012 4/6/98

GROUNDWATER		
DEPTH	HOUR	DATE
None		4-2-98

- SAMPLE TYPE
- B - Undisturbed Block Sample
 - D - Disturbed Bulk Sample
 - U - 3" O.D. 2.42" I.D. tube sample

TEST DRILLING EQUIPMENT & PROCEDURES

Description of Subsurface Exploration Methods

Auger Boring Drilling through overburden soils is performed with 6 5/8" O.D., 3 1/4" I.D. hollow stem auger or 4 1/2" solid stem continuous flight auger. Carbide insert teeth are normally used on bits so they can penetrate soft rock or very strongly cemented soils. A CME-55 or CME-75 truck-mounted drill rig is used to advance the auger. The drill rigs are powered with six-cylinder Ford industrial engines capable of delivering about 7,000 to 8,400 foot-pounds torque to the drill spindle. The spindle is advanced with twin hydraulic rams capable of exerting 16,000 to 20,000 pounds downward force.











Generally, refusal to penetration of the auger is adopted as top of the SGC or river-run material, which normally requires other techniques for penetration. Grab samples or auger cuttings may be taken as necessary. Standard penetration tests or 2.42" diameter ring samples are taken in conjunction with the auger borings as needed, with the sampling interval and type being indicated on the boring logs.

Sampling Procedures Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 test procedure. In many cases, 2" O.D., 1 3/8" I.D. samplers are used to obtain the standard penetration resistance. "Undisturbed" samples of firmer soils are often obtained with 3" O.D. samplers lined with 2.42" I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140-pound, 30-inch free fall drop hammer required to advance the samplers in 6-inch increments. 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 6 inches on the boring logs. "Undisturbed" sampling of softer soils is sometimes performed with thin walled Shelby tubes (ASTM D1587), pitcher samplers, Denison samplers or continuous CME samplers. Where samples of rock are required, they are obtained by NQ diamond core drilling (ASTM D2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings. Also, representative samples are obtained from the cuttings from the hammer and Schramm drill rig.

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

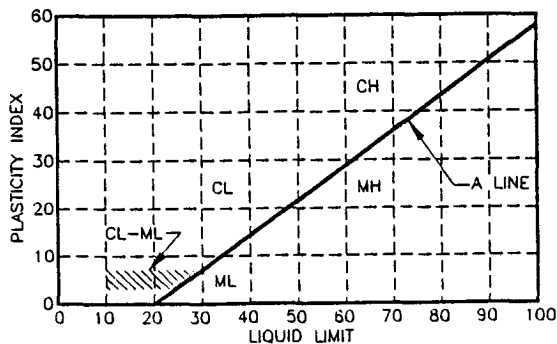
UNIFIED CLASSIFICATION SYSTEM FOR SOILS

Soils are visually classified by the Unified Soil Classification System on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System" ASTM Designation: D2487.

MAJOR DIVISION		GRAPH SYMBOL	GROUP SYMBOL	TYPICAL DESCRIPTION		
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW Well graded gravels, gravel-sand mixtures or sand-gravel-cobble mixtures.	
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)		Limits plot below "A" line & hatched zone on plasticity chart		GP poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
				Limits plot above "A" line & hatched zone on plasticity chart		GM Silty gravels, gravel-sand-silt mixtures.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)		Limits plot above "A" line & hatched zone on plasticity chart		GC Clayey gravels, gravel-sand-clay mixtures.
	CLEAN SANDS (Less than 5% passes No. 200 sieve)				SW Well graded sands, gravelly sands.	
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)		CLEAN SANDS (Less than 5% passes No. 200 sieve)			SP Poorly graded sands, gravelly sands.
					SANDS WITH FINES (More than 12% passes No. 200 sieve)	
	SANDS WITH FINES (More than 12% passes No. 200 sieve)		Limits plot above "A" line & hatched zone on plasticity chart			
			FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS LIMITS PLOT BELOW "A" LINE & HATCHED ZONE ON PLASTICITY CHART	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50)	
	SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50)					MH Inorganic silts of high plasticity, silty soils, elastic silts.
CLAYS LIMITS PLOT ABOVE "A" LINE & HATCHED ZONE ON PLASTICITY CHART	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50)				CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	
	CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50)				CH Inorganic clays of high plasticity, fat clays, silty and sandy clays of high plasticity.	

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 dual symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Boulders	Above 300mm (12in.)
Cobbles	300mm to 75mm (12in. to 3in.)
Gravel	75mm (3in.) to No. 4 sieve
Coarse gravel	75mm to 19mm (3in. to 3/4in.)
Fine gravel	19mm (3/4in.) 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

**TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY,
CONSISTENCY OR FIRMNESS OF SOILS**

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

1. **Relative Density.** Terms for description of relative density of cohesionless, uncemented sands and sand-gravel mixtures.

<u>N</u>	<u>Relative Density</u>
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
50+	Very dense

2. **Relative Consistency.** Terms for description of clays which are saturated or near saturation.

<u>N</u>	<u>Relative Consistency</u>	<u>Remarks</u>
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.
16-30	Very stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

3. **Relative Firmness.** Terms for description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

<u>N</u>	<u>Relative Firmness</u>
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-50	Very firm
50+	Hard

Job No. 8-127-000-012
Project New Classroom Building D
Source Boring 1 at 0' to 5'
Material Existing Fill

SIEVE ANALYSIS
ASTM C-136

SIEVE SIZE	% PASSING
6"	100
3"	100
2 1/2"	100
2"	100
1 1/2"	100
1"	97
3/4"	95
1/2"	90
3/8"	86
1/4"	77
#4	71
#8	57
#10	54
#16	45
#30	36
#40	32
#50	29
#100	22
#200	17.2

Liquid Limit 24
Plasticity Index 5

Job No. 8-127-000-012
Project New Classroom Building D
Source Boring 2 at 10'
Material Native Soils

SIEVE ANALYSIS
ASTM C-136

SIEVE SIZE	% PASSING
6"	100
3"	100
2 1/2"	100
2"	100
1 1/2"	100
1"	100
3/4"	100
1/2"	98
3/8"	94
1/4"	91
#4	88
#8	76
#10	72
#16	60
#30	46
#40	40
#50	35
#100	26
#200	19.3

Liquid Limit NV
Plasticity Index NP

LABORATORY TESTING PROCEDURES

Consolidation Tests Soiltest or Clockhouse apparatus of the "floating-ring" type are employed for the one-dimensional consolidation tests. They are designed to receive one inch high 2.5 inch O.D. brass liner rings with soil specimens as secured in the field. Procedures for the tests generally are those outlined in ASTM D2435. Loads are applied in several increments to the upper surface of the test specimen and the resulting deformations are recorded at selected time intervals for each increment. For soils which are essentially saturated, each increment of load is maintained until the deformation versus log of time curve indicates completion of primary consolidation. For partially saturated soils, each increment of load is maintained until the rate of deformation is equal or less than 1/10,000 inch per hour. Applied loads are such that each new increment is equal to the total previously applied loading. Porous stones are placed in contact with the top and bottom of the specimens to permit free addition or expulsion of water. For partially saturated soils, the tests are normally performed at in situ moisture conditions until consolidation is complete under stresses approximately equal to those which will be imposed by the combined overburden and foundation loads. The samples are then submerged to show the effect of moisture increase and the tests continued under higher loadings. Generally, the tests are continued to about twice the anticipated load due to overburden and structural loads with a rebound curve then being established by releasing loads.

Expansion Tests The same type of consolidometer apparatus described above is used in expansion testing. Undisturbed samples contained in brass liner rings are placed in the consolidometers, subjected to appropriate surcharge loads and submerged. The loads are maintained until the expansion versus log of time curve indicates the completion of "primary swell".

Direct Shear Tests Direct shear tests are run using a Clockhouse or Soiltest apparatus of the strain-control type at a rate of approximately 0.05 inches per minute. The machine is designed to receive one of the one inch high 2.42 inch diameter specimens obtained by tube sampling. Generally, each sample is sheared under a normal load equivalent to the effective overburden pressure at the point of sampling. In some instances, samples are sheared at several normal loads to obtain the cohesion and angle of internal friction. When necessary, samples are saturated and/or consolidated before shearing in order to approximate the anticipated controlling field loading conditions.

**GEOTECHNICAL INVESTIGATION
NEW MUSIC HALL
CATALINA FOOTHILLS HIGH SCHOOL
TUCSON, ARIZONA**

Submitted To:

John R. Kulseth Associates, Ltd.
476 South Stone Avenue
Tucson, Arizona 85701

Submitted By:

AGRA Earth & Environmental, Inc.
1870 West Prince Road, Suite 64
Tucson, Arizona 85705

11 April, 1996
AEE Job No. 6-129-000011



AGRA Earth &
Environmental, Inc.
1870 West Prince Road,
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Tucson, Arizona 85705
Tel (520) 792-2779
Fax (520) 888-0014

April 11, 1996
AEE Job No. 6-129-000011

John R. Kulseth Associates, Ltd.
476 South Stone Avenue
Tucson, Arizona 85701

Attention: Mr. Bill Porter

**Re: Geotechnical Investigation
New Music Hall
Catalina Foothills High School
Tucson, Arizona**

Gentlemen:

Our Geotechnical Investigation Report on the referenced project is herewith submitted. The report includes the results of test drilling, laboratory analyses, and engineering analyses. Recommendations for site grading, foundation, and slab-on-grade design, based on the analyses, are presented.

The new Music Hall will be located adjacent to and northeast of the existing Building A (Administration and Performing Arts). Two borings, located within the proposed "footprint" of the building area, were drilled and sampled to depths of about 25 feet below existing ground surface. The attached site plan shows the boring locations. The logs of the exploratory borings are included with this report, and illustrate the soil profile encountered at each location.

As planned, the new Music Hall will be a single-story structure with masonry block walls, concrete cast-on-grade floor slabs and a metal roof. It is understood that the floor slabs in the seating area will slope downward toward the stage area, with an anticipated elevation difference of approximately 30 inches. The stage floor will be raised about 30 inches above the lowest portion of the seating area. According to current plans, balconies will be located above and along both sides of the lower level seating area. The balcony areas will be supported by retained structural fill. Accordingly, portions of the exterior walls will be required to support as much as 10 feet of structural backfill.

Engineering & Environmental Services

Wall loads for the new Music Hall are expected to range from 2 kips per lineal foot (klf) to a maximum of 16 klf. Column loads are anticipated to range from about 70 kips to a maximum of 100 kips.

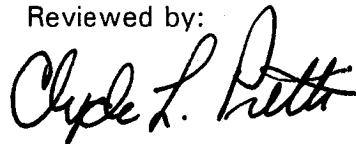
Should any questions arise concerning this report, we would be pleased to discuss them with you.

Respectfully submitted,
AGRA Earth & Environmental, Inc.

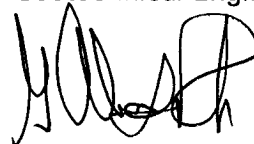


Brandon Squire, E.I.T.

Reviewed by:



Clyde L. Pretti, P.E.
Geotechnical Engineer



G. Alexander Rush, P.E.
Senior Engineer



c: Addressee (3)

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APPENDICES

APPENDIX A FIELD INVESTIGATION

APPENDIX B LABORATORY TEST RESULTS

1. INTRODUCTION

This report presents the results of a geotechnical investigation by AGRA Earth & Environmental (AEE) of the site of the proposed Music Hall, located at Catalina Foothills High School in Tucson, Arizona. The purpose of this investigation was to evaluate the physical properties of the soils underlying the site, in order to develop recommendations for site grading, foundation, and slab-on-grade design.

2. PROJECT DESCRIPTION

Preliminary details of the project were provided by Mr. Bill Porter of John R. Kulseth Associates, in the form of a site plan, showing the planned layout of the music hall. The single-story building will occupy an area of approximately 8,280 feet. The new Music Hall will be constructed with masonry block walls, concrete cast-on-grade floor slabs and a conventional truss-type metal roof system. It is understood that the floor slabs in the seating area will slope downward toward the stage area, with an anticipated elevation difference of approximately 30 inches. The stage floor will be raised about 30 inches above the lowest portion of the seating area. According to current plans, balconies will be located above and along both sides of the lower level seating area. The balcony areas will be supported by retained structural fill. Accordingly, portions of the exterior walls will be required to support as much as 10 feet of structural backfill.

Wall loads for the new Music Hall are expected to range from 2 kips per lineal foot (klf) to a maximum of 16 klf. Column loads are anticipated to range from about 70 kips to a maximum of 100 kips.

3. INVESTIGATION

3.1 SUBSURFACE EXPLORATION

Two exploratory borings were drilled to depths of approximately 25 feet below existing grade. The exploratory borings were drilled with a CME-75 truck-mounted drill rig advancing a 6 5/8-inch continuous hollow-stem flight auger. Standard penetration testing and sampling, and open-end drive sampling were performed at selected intervals in the borings. Upon completion of the drilling operation, the boreholes were backfilled with the drill cuttings.

The results of the field investigation are presented in Appendix A, which includes a brief description of drilling and sampling equipment and procedures, a site plan showing the boring locations and logs of the test borings.

3.2 LABORATORY INVESTIGATION

The moisture content of selected samples recovered from the borings was determined. The results of these tests are shown on the boring logs. Grain-size analysis and Atterberg limits tests were performed on representative samples. In addition, a consolidation test was performed on a selected soil sample. The results of these tests are presented in Appendix B.

4. GEOTECHNICAL PROFILE

Based on the exploratory borings and the results of the laboratory analyses, the geotechnical profile underlying the project site can be generalized as a two-strata system as follows:

- A. A surface layer of clayey sand fill material was encountered at the location of Boring No. 1. The fill material was found to extend to a depth of approximately 4½ feet below existing ground surface. It is noted that this fill material was placed during the original earthwork performed to develop the high school campus site. The fill soils are predominantly fine to medium grained, low in plasticity and intermixed with a trace amount to some gravel.

The fill material generally consists of the on-site soils compacted to at least 95 percent of the maximum dry density (determined in accordance with ASTM D1557, Modified Proctor). In general, the moisture content of the fill material during compaction was maintained within the limits of 1 percent below to 3 percent above the optimum moisture condition. As a result of the higher relative compaction and close moisture control, the fill materials have undergone a natural cementing process. Accordingly, the fill material was encountered in a moderately cemented, very firm to hard condition.

- B. Native soils were encountered below the fill material in Boring No. 1 and below present ground surface in Boring No. 2. The native soils consist of a stratified deposit of silty sand and clayey sand. The strata of native sands were encountered to the final depths of the exploratory borings. The native sand soils are predominantly fine grained, low in plasticity, intermixed with trace to considerable amounts of gravel, and strongly cemented with calcium carbonate. As a result of the cementation and intermixed coarse material, the native soils were encountered in a relatively hard condition.

No free groundwater was encountered in the borings advanced for this project. Soil moisture contents throughout the depths explored were found to be relatively low, ranging from 5 to 7 percent.

5. DISCUSSION & RECOMMENDATIONS

5.1 ANALYSIS OF RESULTS

Based on the results of this evaluation and our knowledge of the earthwork previously performed on the site, the native and fill soils underlying the proposed structure are sufficiently firm at in-situ moisture contents to support the anticipated structure loads. Shallow spread- or mat-type foundations are recommended to support the proposed music hall, provided site drainage and moisture protection measures are implemented in the design and construction. The upper 8 inches of exposed soils beneath cut surfaces, and upon which slabs, sidewalks, pavements, foundations or additional fill is to be placed, should be scarified, brought to within 1 percent below to 3 percent above optimum moisture content, and compacted to at least 95 percent of the maximum dry density (determined in accordance with ASTM D1557).

5.2 SHALLOW FOUNDATIONS

5.2.1 Design Criteria for Downward Loads

Based on our understanding of the proposed building configuration, the new Music Hall will be constructed on both native soils and existing fill material. It is emphasized that, beginning from existing ground surface elevation, both strongly cemented native soils and existing, moderately cemented, compacted fill material are likely to be encountered in excavations made for construction of the project facilities. It is further noted that no determination has been made of the extent of either the native soils or the existing fill material present at the ground surface.

Accordingly, two design criteria for shallow spread- or mat-type foundations are recommended. The first is applicable to foundations bearing on the native soils 5 feet or deeper below existing ground surface. The second is intended for foundations bearing on native soils less than 5 feet below existing grade, existing fill material, compacted structural fill material placed for this project, or a combination of fill and native soils. Foundations which are underlain by both native soils and fill material (both existing and new) should be designed in accordance with the second set of criteria.

The recommended design criteria for shallow foundations bearing directly on native soils 5 feet or deeper below existing ground surface are as follows:

<u>Loading Conditions</u>	<u>Safe Soil Bearing Pressure</u>
Dead loads	4,000 psf
Dead plus live loads	5,000 psf
Dead plus live plus wind or seismic loads	7,000 psf

For foundations bearing on structural fill (either existing or new) or a combination of native and fill soils above a depth of 5 feet from existing grade, the following criteria should be used:

<u>Loading Conditions</u>	<u>Safe Soil Bearing Pressure</u>
Dead loads	2,500 psf
Dead plus live loads	3,000 psf
Dead plus live plus wind or seismic loads	4,000 psf

The recommended minimum depth of footings below the lowest adjacent finished grade is 1.5 feet. Lowest adjacent finished grade is defined as finished floor elevation or the lowest exterior finished grade within 5 feet of the foundation elements, whichever is lower. The minimum recommended widths of square and continuous footings are 24 and 16 inches, respectively. Criteria for selection and placement of structural fill material are presented in Section 5.5.

5.2.2 Lateral Loads

The passive resistance of properly compacted backfill or undisturbed native soils against the edges of footings, stem walls, and similar vertical foundation elements should be considered equivalent to the forces exerted by a fluid of 300 pounds per cubic foot unit weight. A coefficient of friction of 0.45 is recommended for computing lateral resistance between the bases of footings and slabs and the soil in analyzing lateral loads.

5.2.3 Estimated Settlements

It is estimated that total and differential settlements of foundations designed in accordance with the criteria presented in above and in Section 5.1 will not exceed 3/8 inch for the soil moisture conditions encountered in the native and fill soils at the time of our field investigation, or for specified moisture contents anticipated in compacted structural fill placed for this project. It is further anticipated that about 50 percent of the anticipated settlement will occur during construction.

Moisture increases in the supporting soils could result in additional settlements (approximately 50 percent of the estimated settlement), particularly in areas where existing and new fills are greater than 18 inches in thickness. Therefore, recommendations for controlling site drainage and moisture protection, as presented in Section 5.6 of this report, are considered critical elements of design.

5.3 BELOW-GRADE AND RETAINING WALLS

5.3.1 Lateral Earth Pressure

The earth pressure against below-grade and retaining walls depends upon the degree of restraint. Walls of rigid, reinforced concrete that are restrained from movement at the top, should be designed to resist earth pressures equivalent to a hydrostatic pressure of 50 pounds per cubic foot. Retaining walls which are free to move at the top, such as free-standing walls, with a rotation of 0.001 times the height of the wall, should be designed to resist an active earth pressure equivalent to the hydrostatic pressure exerted by a fluid with a unit weight of 30 pounds per cubic foot. These values apply to walls with horizontal backfill; recommendations can be provided by this office for walls with sloping backfill if they occur.

5.3.2 Wall Backfill and Drainage

Soils meeting the criteria for structural fill, as presented in Section 5.5 of this report, may be used as backfill, provided substantial postconstruction moisture increases are prevented. Large moisture increases would substantially increase earth pressures above those recommended for design. Compaction of backfill should be performed in accordance with the recommendations presented in Section 5.5 for structural fill.

Because of the possibility of seepage of surface water into the soils immediately behind below-grade and retaining walls, drainage systems should be provided. Drainage can efficiently be provided by a grid of geocomposite drains utilizing a material such as Enkadrain, Miradrain, C-Drain, or equivalent materials. For the case of retaining walls, it will be necessary to connect the drainage system to a series of weep holes at the base of the walls. Drainage material installed behind below-grade walls should be connected to a drain pipe at the base of the walls, which conveys collected water away from the foundation area, or to small sumps or drywells. In addition to a drainage system, waterproofing should be provided on below-grade walls. For conventional, cast-in-place walls with an open cut, the geotextile drains and waterproofing could be bonded to the back of the cast-in-place concrete prior to backfilling.

As an alternative to the use of geocomposite drainage fabric, a layer of free-draining granular material (see below for gradation requirements) placed adjacent to the wall could be used rather than geotextile drains.

<u>Sieve Size</u> <u>(square openings)</u>	<u>Percent Passing</u> <u>by Dry Weight</u>
3-inch	100
no. 4	30-70
no. 200	0-5

The layer of granular material should extend to at least 12 inches beyond the back of the wall. If granular material is used for drainage, the upper 24 inches of the compacted retaining wall backfill should consist of selected fine-grained soils to minimize surface infiltration. Sloping of the ground surface and other surface drainage control recommendations are presented in Section 5.6.

5.4 CONCRETE CAST-ON-GRADE SLABS

5.4.1 Slab Support

To provide adequate and uniform support of interior and exterior cast-on-grade concrete slabs, the upper 8 inches of the site soils underlying slabs (or below structural fills placed during this project to support slabs) should be scarified, moisture-conditioned and compacted. The moisture content should be maintained within 1 percent below to 3 percent above optimum moisture content. The scarified and moisture-conditioned site soils should be compacted to at least 95 percent of the maximum dry density (determined in accordance with ASTM D1557).

Provided site grading and earthwork are carried out as recommended, structural fill maintained at or slightly below compaction moisture content should provide adequate support for lightly-loaded, cast-on-grade concrete slabs. Thus, the use of granular base is not necessary for the structural support of slabs. However, granular base provides a more desirable working surface, reduces capillary rise of moisture to slabs, and reduces warping stresses in concrete. Accordingly, a 4-inch course of material meeting the gradation requirements shown below is recommended.

<u>Sieve Size</u> <u>(square openings)</u>	<u>Percent Passing</u> <u>by Dry Weight</u>
1 1/8-inch	100
1/4 inch	38-70
No. 200	0-12

The plasticity index of the fraction of material passing the No. 40 sieve should be nonplastic when tested by ASTM D4318. Granular base should be free of vegetation, debris and other deleterious material. All granular base should be compacted to at least 95 percent of maximum dry density as determined by ASTM D1557. It is noted that the site soils will not be suitable for use as granular base.

5.4.2 Structural Design of Slabs

A modulus of subgrade reaction (k) of 250 pounds per square inch per inch of deflection (pci) is recommended for the structural design of cast-on-grade concrete slabs constructed on structural fill or a combination of fill and native soils. This recommended value is dependent on completion of the site grading as recommended in Section 5.5.

Additional Portland cement concrete flatwork design and construction recommendations are as follows:

- Positive separations and/or isolation joints should be provided between slabs and all foundations, columns or utility lines to allow independent movement.
- Slab thickness and reinforcing should be in accordance with the recommendations of the project structural engineer and in accordance with the guidelines established by the American Concrete Institute (ACI).
- Construction joints should be placed at intervals as designed by the structural engineer, and in accordance with ACI recommendations.
- Trench backfill placed beneath slabs should be compacted in accordance with recommendations outlined in this report.
- Slabs should not be constructed on wet, soft, or otherwise unsuitable material.
- Other design and construction considerations, as outlined in Section 302 of the ACI Manual of Concrete Practice, are recommended.

5.4.3 Concrete Placement

In order to reduce the potential for shrinkage cracks in concrete flatwork during curing, and to provide concrete strength in accordance with project specifications, it is recommended that the concrete for the foundations and the flatwork be placed with a maximum slump of 4 inches. The slump should be checked at the site by a representative of a qualified materials testing laboratory prior to placement. We recommend that AGRA Earth & Environmental, Inc. be retained to perform this service. All structural concrete should be placed in accordance with ACI recommendations and project specifications.

5.4.4 Moisture Protection of Slabs

Granular base would tend to act as a capillary break to moisture, but would not provide a positive barrier against the rise of moisture through the slabs. If impervious or moisture-sensitive floor coverings are used, an impervious membrane vapor barrier placed below the granular base course is recommended.

5.5 SITE GRADING

5.5.1 Surface Preparation

All vegetation, existing construction, loose dumped debris and any soft or wet soils encountered within the perimeter of the proposed structure, or beneath areas designated for fill placement or exterior slabs, should be removed. The unsuitable materials should be replaced with compacted structural fill in accordance with the recommendations presented below. The preparation of exposed soils below all foundation, slab and new fill areas should consist of scarification, moisture conditioning and compaction of the upper 8 inches. The scarified soils should be brought to within the limits of 1 percent below to 3 percent above optimum moisture content and compacted to at least 95 percent of maximum dry density as determined by ASTM D1557.

5.5.2 Structural Fill

All fill used to raise the site to subgrade elevation, including fill placed behind below-grade and retaining walls, should be free of vegetation, debris and other deleterious material and contain no particles larger than 3 inches in diameter. Structural fill should have a plasticity index of no more than 12 when tested by ASTM D4318 and contain no more than 40 percent fine material (passing the no. 200 sieve).

All structural fill, including wall backfill, should be compacted to at least 95 percent of maximum dry density, as determined by ASTM D1557. Moisture content during compaction should be maintained within the limits of 1 percent below to 3 percent above optimum moisture content. Fill material should be placed in compacted lifts no thicker than 8 inches.

It appears that the existing, near-surface site soils that are expected to be excavated from the project site are suitable for use as structural fill. However, areas of unsuitable material may be encountered. Therefore, any site soils that may be utilized as structural fill should be tested prior to placement. Selection and placement of structural fills should be performed under the direction of a qualified geotechnical engineer.

5.5.3 Excavation and Temporary Slopes

Based on the results of this evaluation, excavation of the site materials may be performed with normal construction techniques using heavy-duty earthmoving equipment (such as a larger track-mounted backhoe or dozer). It is noted that the native soils are hard and strongly cemented. As a result, excavation of these materials may require ripping to facilitate removal. It is estimated that temporary excavations in the more competent existing fill material can be made at slopes of approximately 1:1 (horizontal to vertical). The strongly cemented native soils below the existing fill material can be excavated safely using temporary cut slopes of 1/2:1 or flatter.

The above estimates of temporary cut slopes are based on geotechnical considerations only. They do not consider requirements that might be imposed by OSHA. OSHA regulations should be reviewed during the construction planning process.

It is recommended that the geotechnical engineer or his representative observe excavation of the site materials prior to placement of structural fill or construction of foundations. The purpose of this observation will be to evaluate if unsuitable and disturbed materials have been removed and that the exposed bearing conditions are similar to those anticipated for support of the foundations and slabs. Any soft, loose or unacceptable materials should be removed and replaced in accordance with the recommendations contained in this report.

5.6 SITE DRAINAGE & MOISTURE PROTECTION

Proper site drainage and moisture protection are critical design considerations. Positive site drainage should be provided during construction and maintained thereafter. Slabs, pavements and ground surface areas adjacent to the building or other structural elements, should be sloped away from the perimeter of the structure at a minimum grade of 2 percent for a distance of at least 15 feet.

Landscaping within 15 feet of the structure should be restricted to short rooted vegetation requiring only light watering. Below-grade plumbing outside of service and utility tunnels should be minimized. Roof runoff should be carried away from the building by erosion-reducing devices at the ground surface. In no case should long-term ponding of water be allowed near the foundations and slabs during the life of the facility.

5.7 EROSION CONSIDERATIONS

The site soils and existing fill materials are predominantly granular and of relatively low plasticity. As a result, these materials will be very susceptible to erosion by rainfall or runoff waters. To resist the effects of slope erosion, we recommend that permanent cut and fill slopes have an angle no greater than 3:1, and that vegetation be established on the slopes to the extent practical.

5.8 LIMITATIONS

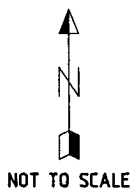
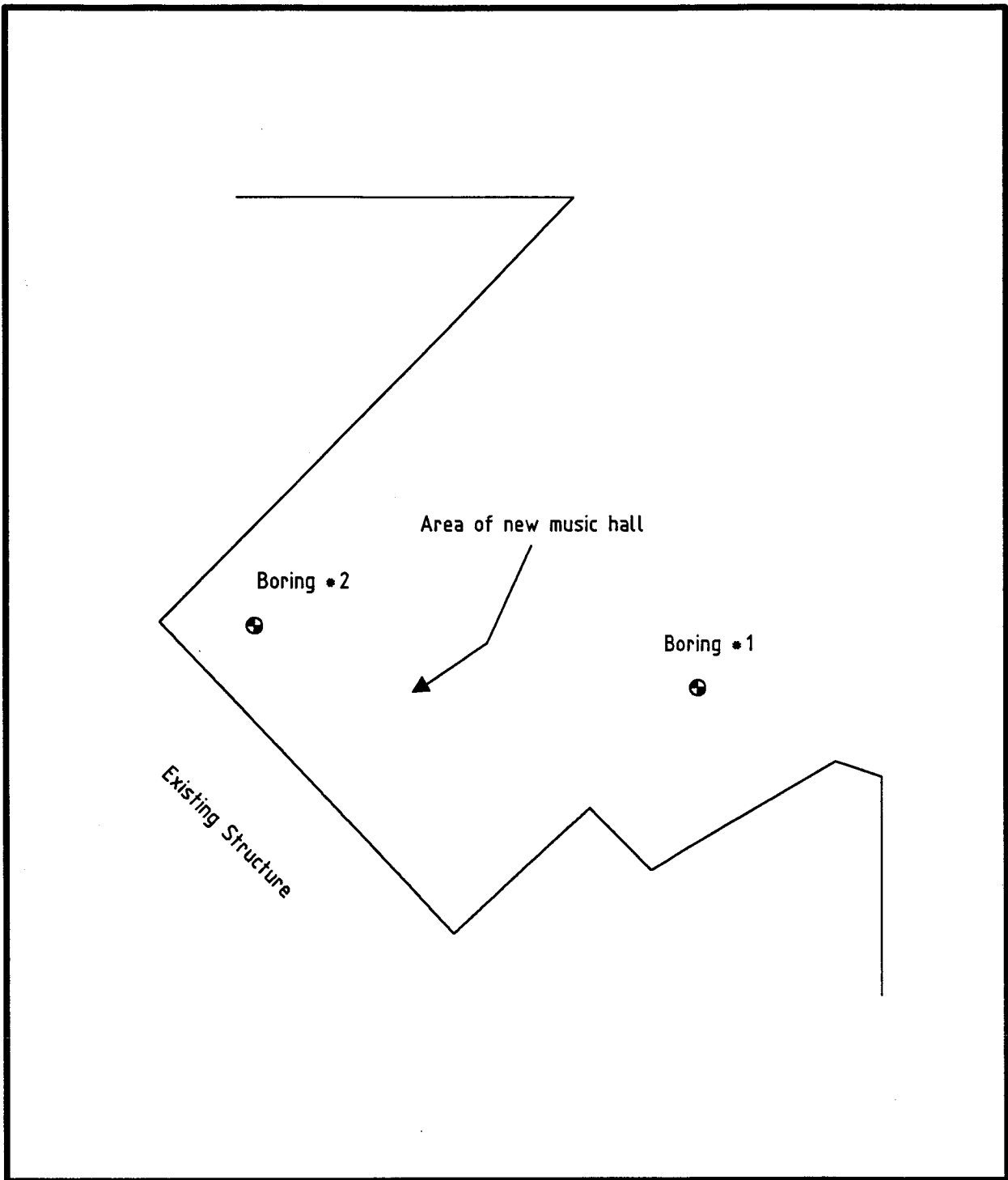
The subsurface exploration, laboratory testing, and geotechnical analyses presented in this report have been conducted in general accordance with the current engineering practice and standard of care exercised by reputable geotechnical consultants performing similar tasks in the area. No other warranty, either expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. Variations may exist and conditions not observed or described in this report may be encountered during construction. Our conclusions and recommendations are based on an analysis of the observed conditions and apply to the specific project discussed in this report. Therefore, any changes in location or configuration of the building, or site grades should be provided to us so we may review our conclusions and recommendations and make any necessary modifications. If conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if required, will be provided upon request. In the event of any changes in the nature, design, or locations of the proposed improvements, the conclusions and recommendations presented herein may not be valid unless the changes are evaluated and the conclusions of this report are modified in writing.

Our scope of services did not include an environmental assessment or evaluation for the presence or absence of hazardous or toxic materials in the soil, rock, groundwater or air, on, above, or below the surface of this site. Identification of such substances requires alternative exploration techniques and analyses which were beyond the scope of this evaluation.

We have prepared this report as an aid in design of the proposed project. This report is not a bidding document. Contractors reviewing this report must draw their own conclusions regarding site conditions and specific construction techniques to be used.

Our conclusions and recommendations are based on observation and testing of the earthwork and foundation preparations by a qualified and reputable geotechnical engineer. Since we have prepared this report and are familiar with the project and the field conditions at the site, it is recommended that AGRA Earth & Environmental, Inc. provide these services

Deviations from our recommendations by the plans, written specifications, or field applications will require our written concurrence.



LEGEND

⊕ Approximate location of boreholes

<p>Drawn By: BLS Date: 3/22/96 Reviewed By: CLP Date: Scale: NTS</p>	<p>FIGURE 1</p> <p>Geotechnical Investigation Catalina Foothills High School New Music Hall Tucson, Arizona</p> <p>AEE Job No. 6-129-000011</p>
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TEST DRILLING EQUIPMENT & PROCEDURES

Description of Subsurface Exploration Methods

Auger Boring Drilling through overburden soils is performed with 6 5/8" O.D., 3 1/4" I.D. hollow stem auger or 4 1/2" solid stem continuous flight auger. Carbide insert teeth are normally used on bits so they can penetrate soft rock or very strongly cemented soils. A CME-55 or CME-75 truck-mounted drill rig is used to advance the auger. The drill rigs are powered with six-cylinder Ford industrial engines capable of delivering about 7,000 to 8,400 foot-pounds torque to the drill spindle. The spindle is advanced with twin hydraulic rams capable of exerting 16,000 to 20,000 pounds downward force.

Generally, refusal to penetration of the auger is adopted as top of the SGC or river-run material, which normally requires other techniques for penetration. Grab samples or auger cuttings may be taken as necessary. Standard penetration tests or 2.42" diameter ring samples are taken in conjunction with the auger borings as needed, with the sampling interval and type being indicated on the boring logs.

Sampling Procedures Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 test procedure. In many cases, 2" O.D., 1 3/8" I.D. samplers are used to obtain the standard penetration resistance. "Undisturbed" samples of firmer soils are often obtained with 3" O.D. samplers lined with 2.42" I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140-pound, 30-inch free fall drop hammer required to advance the samplers in 6-inch increments. 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 6 inches on the boring logs. "Undisturbed" sampling of softer soils is sometimes performed with thin walled Shelby tubes (ASTM D1587), pitcher samplers, Denison samplers or continuous CME samplers. Where samples of rock are required, they are obtained by NQ diamond core drilling (ASTM D2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings. Also, representative samples are obtained from the cuttings from the hammer and Schramm drill rig.

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

**TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY,
CONSISTENCY OR FIRMNESS OF SOILS**

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

1. **Relative Density.** Terms for description of relative density of cohesionless, uncemented sands and sand-gravel mixtures.

<u>N</u>	<u>Relative Density</u>
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
50+	Very dense

2. **Relative Consistency.** Terms for description of clays which are saturated or near saturation.

<u>N</u>	<u>Relative Consistency</u>	<u>Remarks</u>
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.
16-30	Very stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

3. **Relative Firmness.** Terms for description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

<u>N</u>	<u>Relative Firmness</u>
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-50	Very firm
50+	Hard

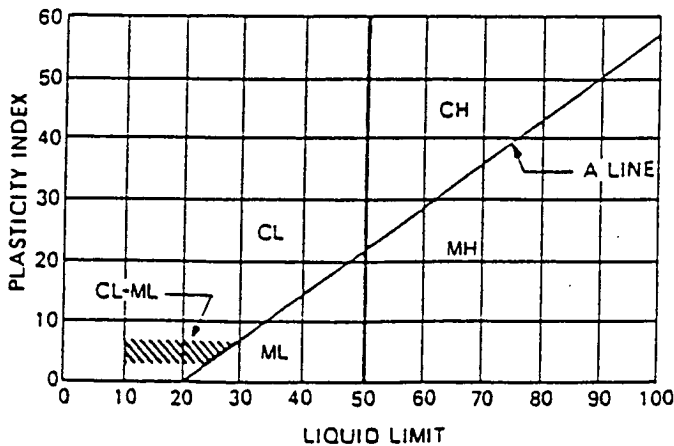
UNIFIED SOIL CLASSIFICATION SYSTEM

Soils are visually classified by the Unified Soil Classification system on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System" Corp of Engineers, US Army Technical Memorandum No. 3-357 (Revised April 1960) or ASTM Designation: D2487-66T.

MAJOR DIVISIONS		GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES	
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)	GW	Well graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.	
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	GP	Poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.	
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart	GM	Silty gravels, gravel-sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart	GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)	SW	Well graded sands, gravelly sands.	
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	SP	Poorly graded sands, gravelly sands.	
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart	SM	Silty sands, sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart	SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS (LIMITS PLOT BELOW "A" LINE & HATCHED ZONE ON PLASTICITY CHART)	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50)	ML	Inorganic silts, clayey silts with slight plasticity.	
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50)	MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts.	
	CLAYS (LIMITS PLOT ABOVE "A" LINE & HATCHED ZONE ON PLASTICITY CHART)	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50)	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	
		CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50)	CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity.	

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.

PLASTICITY CHART



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 ½ in.
Fine gravel	½ 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

PROJECT New Music Hall
Catalina Foothills High School
Tucson, Arizona

LOG OF TEST BORING NO. 1

JOB NO. 6-129-0011 DATE 3/12/96 NOTES

LOGGED BY ADM
RIG TYPE CME-75
BORING TYPE HSA 6 5/8" O.D.
SURFACE ELEV. 2696.6 DATUM Mean Sea Level

Depth in Feet	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION	
0			S	9 16 18		7		slightly moist very firm to hard	FILL: CLAYEY SAND (SC) trace of gravel, predominantly fine to medium grained, low plasticity, moderately cemented, red brown NOTE: decreasing amounts of clay, some gravel below 4 feet	
			S	22 28 50/5"			SC			
5			U	50/5"						slightly moist hard
10			S	50/3"						
15			S	50/2"						SM
20			S	50/1/2"						
25			S	50/6"				slightly moist hard	CLAYEY SAND SC some silt, predominantly fine grained, moderately to strongly cemented, low plasticity, red brown stopped auger at 25 feet sampler refused at 25 feet 6 inches	
30										

BL 60011 4/12/96

GROUNDWATER

SAMPLE TYPE

DEPTH	HOUR	DATE
▽	NONE	-----
▽		
▽		
▽		

- A - Drill cuttings
- NR - No Recovery
- S - 2" O.D. 1.38" I.D. tube sample
- T - 3" O.D. thin-walled Shelby tube
- U - 3" O.D. 2.42" I.D. tube sample

PROJECT New Music Hall
Catalina Foothills High School
Tucson, Arizona

JOB NO. 6-129-0011 DATE 3/12/96

LOG OF TEST BORING NO. 2

NOTES

LOGGED BY ADM
RIG TYPE CME-75
BORING TYPE HSA 6 5/8" O.D.
SURFACE ELEV. 2696.6 DATUM Mean Sea Level

Depth in Feet	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per. Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		X	S	10 20 40				slightly moist hard	SILTY SAND (SM) trace of clay, trace to some gravel, predominantly fine grained, moderately to strongly cemented, low plasticity, red brown
		X	S	50/4"					
5		X	S	50/4"					NOTE: strongly cemented below 5 feet
10		X	S	50/4"		5			
							SM		
15		X	S	50/3"					
20		X	S	50/4"					NOTE: some cobbles below 20 feet
25		X	S	50/2"					stopped auger at 25 feet sampler refused at 25 feet 2 inches
30									

BL 60011 4/12/96

GROUNDWATER

SAMPLE TYPE

DEPTH	HOUR	DATE
-----	NONE	-----

- A - Drill cuttings
- NR - No Recovery
- S - 2" O.D. 1.38" I.D. tube sample
- T - 3" O.D. thin-walled Shelby tube
- U - 3" O.D. 2.42" I.D. tube sample

LABORATORY TESTING PROCEDURES

Consolidation Tests Soiltest or Clockhouse apparatus of the "floating-ring" type are employed for the one-dimensional consolidation tests. They are designed to receive one inch high 2.5 inch O.D. brass liner rings with soil specimens as secured in the field. Procedures for the tests generally are those outlined in ASTM D2435. Loads are applied in several increments to the upper surface of the test specimen and the resulting deformations are recorded at selected time intervals for each increment. For soils which are essentially saturated, each increment of load is maintained until the deformation versus log of time curve indicates completion of primary consolidation. For partially saturated soils, each increment of load is maintained until the rate of deformation is equal or less than 1/10,000 inch per hour. Applied loads are such that each new increment is equal to the total previously applied loading. Porous stones are placed in contact with the top and bottom of the specimens to permit free addition or expulsion of water. For partially saturated soils, the tests are normally performed at in situ moisture conditions until consolidation is complete under stresses approximately equal to those which will be imposed by the combined overburden and foundation loads. The samples are then submerged to show the effect of moisture increase and the tests continued under higher loadings. Generally, the tests are continued to about twice the anticipated load due to overburden and structural loads with a rebound curve then being established by releasing loads.

Expansion Tests The same type of consolidometer apparatus described above is used in expansion testing. Undisturbed samples contained in brass liner rings are placed in the consolidometers, subjected to appropriate surcharge loads and submerged. The loads are maintained until the expansion versus log of time curve indicates the completion of "primary swell".

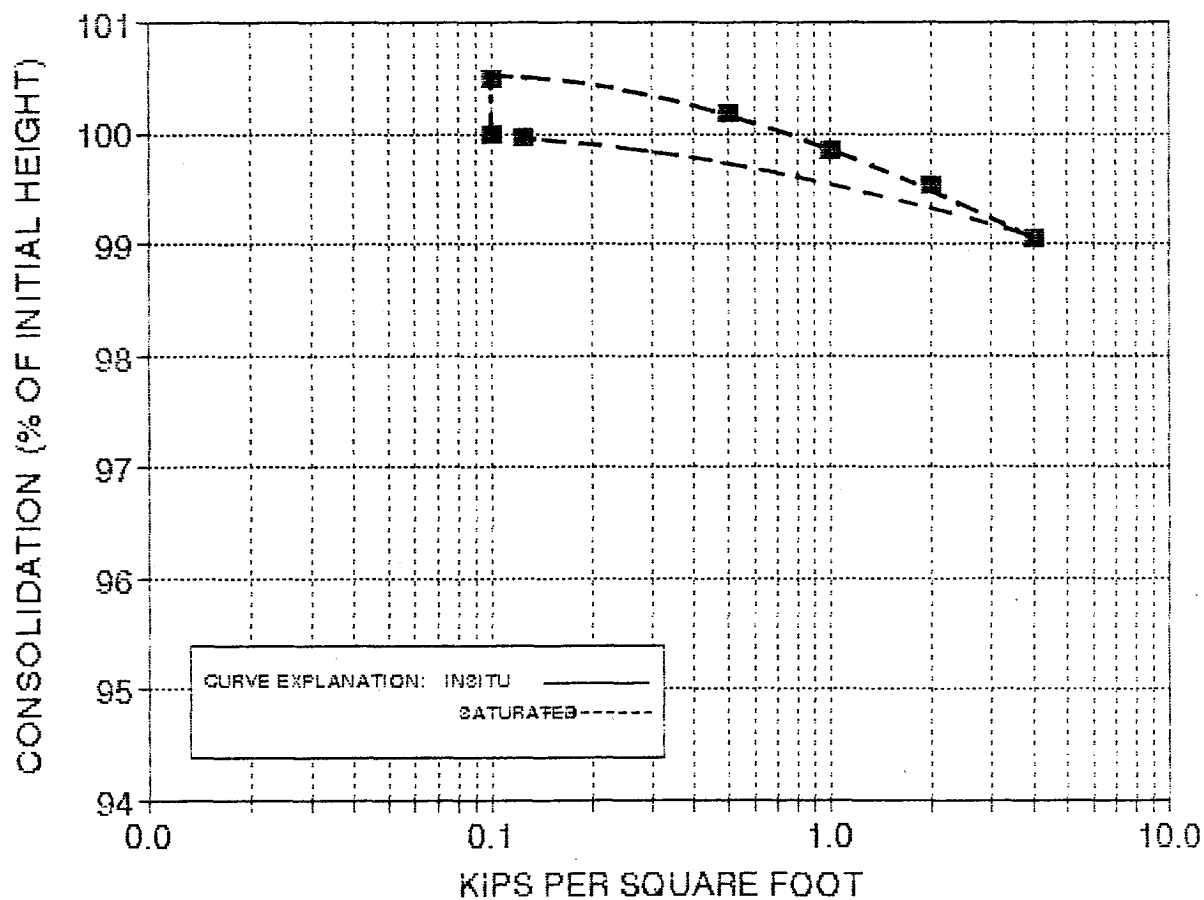
Direct Shear Tests Direct shear tests are run using a Clockhouse or Soiltest apparatus of the strain-control type at a rate of approximately 0.05 inches per minute. The machine is designed to receive one of the one inch high 2.42 inch diameter specimens obtained by tube sampling. Generally, each sample is sheared under a normal load equivalent to the effective overburden pressure at the point of sampling. In some instances, samples are sheared at several normal loads to obtain the cohesion and angle of internal friction. When necessary, samples are saturated and/or consolidated before shearing in order to approximate the anticipated controlling field loading conditions.

CONSOLIDATION TEST

PROJECT: CATALINA FOOTHILLS HIGH SCHOOL
AGRA JOB N 6-129-000-011
ORDER NO.: 01

SAMPLE NO.: B-1 @2.5'-4'
DATE SAMPL 3-14-96
LABORATORY 2

INSITU MOISTURE CONTENT 7.4%
SATURATED MOISTURE CONTE 13.0%
MOISTURE PICK-UP 5.6%
DRY DENSITY 125.5 pcf



JOB NO. 6-129-000-011
PROJECT: CATALINA FOOTHILLS HIGH SCHOOL
LAB NO. 1
MATERIAL: B-1 0'-1.5'
DATE: 3-13-96

SIEVE ANALYSIS

SIEVE SIZE	% PASSING
3"	100
2 1/2"	100
2"	100
1 1/2"	100
1"	100
3/4"	96
1/2"	94
3/8"	91
1/4"	85
#4	81
#8	70
#10	67
#16	58
#30	48
#40	44
#50	39
#100	30
#200	21.8
L.L.	28
P.I.	10

JOB NO. 6-129-000-011
PROJECT: CATALINA FOOTHILLS HIGH SCHOOL
LAB NO. 4
MATERIAL: B-2 10'-10'4"
DATE: 3-13-96

SIEVE ANALYSIS

SIEVE SIZE	% PASSING
3"	100
2 1/2"	100
2"	100
1 1/2"	100
1"	100
3/4"	100
1/2"	100
3/8"	97
1/4"	94
#4	88
#8	72
#10	68
#16	56
#30	43
#40	38
#50	33
#100	23
#200	15.4
L.L.	25
P.I.	3