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TIMP VIEW HIGH SCHOOL ADDITION

PHASE 2

Provo, Utah

Soil and Foundation Investigation

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1990

RB&G ENGINEERING INC.

Professional Engineers

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November 1, 1990

Eric Sandstrom
Sandstrom & Associates Architects
930 South State Street
Orem, UT

Dear Eric:

A soil and foundation investigation has been completed at the proposed site of the Phase 2 addition to the Timp View High School in Provo, Utah. The investigation was performed to define the characteristics of the subsurface material throughout the proposed site so that satisfactory substructures could be designed to support the proposed facility. The proposal for the soil and foundation investigation for both the Phase 1 and 2 studies was sent to your office in one package. The Phase 1 study was recently completed and has been submitted to your organization. The work performed during this investigation has been completed in accordance with the scope of work outlined in the proposal indicated above. The results of the investigation for the Phase 2 addition is outlined in the following sections of this report.

The information contained in the report is discussed under the following headings: (1) Existing Site Conditions, (2) Subsurface Soil and Water Conditions, (3) Foundation Considerations and Recommendations, (4) Site Preparation and Compacted Fill Requirements, and (5) The Results of Field and Laboratory Tests.

1. EXISTING SITE CONDITIONS

The area where the Phase 2 addition will be located is part of an alluvial fan formed when lake sediments east of the site were eroded and subsequently re-deposited. The drainage channel from which the sediments eroded is located immediately northeast of the site and presently accommodates Quail Valley Drive. The site is located between two southerly wings of the existing Timp View High School approximately as shown in Figure 1. The topography of the existing site is essentially flat and is presently planted in grass. A large retaining wall exists on the westerly side of the site and it appears that a considerable amount of fill material has been placed throughout the area. No information is available relative to the manner in which the fill material has been placed.

It should be noted that the natural subsurface materials throughout the area where the Timp View High School is located were collapsible type soils. The foundations for the existing facility are supported using spread foundations on compacted fill. Insofar as we can determine, the foundation performance for the existing structure has been satisfactory; however, minor structures, such as sidewalks, curbs and gutters, and roadways supported directly on the natural material have experienced some settlement.

No groundwater was encountered throughout the site during the original investigation and it is not anticipated that the zone of significant stress for the foundations for the proposed structure will be saturated by natural groundwaters.

The site is located several hundred yards west of the Wasatch Fault and the general area is located in Seismic Zone III according to the Uniform Building Code.

Other than the information provided above, no environmental factors appear to exist at this site, which would adversely affect foundation performance.

2. SUBSURFACE SOIL AND WATER CONDITIONS

The characteristics of the subsurface material throughout the area where the proposed facility will be located were defined by drilling four test borings to a depth of between 20 and 32 feet at locations as shown in Figure 1. The logs for these four test borings are presented in Figures 2, and 3 and it will be noted that approximately 7 to 9 feet of fill material exists in the upper portion of the soil profile. The surface fill zone generally consists of a brown silty sandy gravel to a brown silty clay with some gravel. The surface fill zone is underlain by a brown silty clay, which extended to a depth of approximately 19 feet below the existing ground surface. The remainder of the soil profile throughout the depth investigated consisted of a brown sandy silt to silty sand.

During the subsurface investigation, sampling was performed at three-foot intervals in the upper 15 feet of the soil profile and at five-foot intervals thereafter. Both disturbed and undisturbed samples were obtained during the field investigations.

Disturbed samples were obtained by driving a 2 inch split spoon sampling tube through a distance of 18 inches using a 140-pound weight dropped from a distance of 30 inches. The number of blows to drive the sampling spoon through each 6 inches of penetration is shown on the boring logs. The sum of the last two blow counts, which represents the number of blows to drive the sampling spoon through 12 inches, is defined as the standard penetration value. The standard penetration value provides a good indication of the in-place density of sandy material; however, it only provides an indication of the relative stiffness of cohesive material, since the penetration resistance of materials of this type is a function of the moisture content. Considerable care must be exercised in interpreting the standard penetration value in gravelly-type soils, particularly where the size of the granular particle exceeds the inside diameter of the sampling spoon. If the spoon can be driven through the full 18 inches with a reasonable core recovery, the standard penetration value provides a good indication of the in-place density of gravelly-type material.

Undisturbed samples were obtained by pushing a 2.5-inch, thin walled shelby tube into the subsurface material using the hydraulic pressure on the drill rig. The location at which the undisturbed samples were obtained are shown on the boring logs.

The results of the standard penetration tests indicate that considerable variation occurs in the density of the surface fill zone. For example, in Drill Hole 4 the standard penetration values in the silty sandy fill varied from 18 to 25 blows per foot. In Drill Hole 5, the standard penetration value of the silty clay with some gravel was only 3 blows per foot at depths of 3 and 6 feet below the ground surface. Based on the results of the standard penetration tests in the fill material, it is our opinion that this material is not capable of supporting spread foundations without the likelihood of adverse differential settlement.

Each sample obtained in the field was classified in the laboratory according to the Unified Soil Classification System. The symbol designating the soil type according to this system, is presented on the boring logs. A description of the Unified Soil Classification System is presented in Figure 4, and the meaning of the various symbols shown on the boring logs can be obtained from this figure. It will be observed that the fill material in the upper portion of the soil profile classified as either an SM, a GM, a CL-ML, or a Cl-1 type material. The silty clay underlying the surface fill zone generally classified as a CL-1 type soil. The silty sand to sandy silt in the lower portion of the soil profile classified as either an ML, or an SM type material.

3. FOUNDATION CONSIDERATIONS AND RECOMMENDATIONS

The general configuration of the proposed addition is presented in Figure 1. We understand that this facility will be a two level structure with no floors below the existing ground surface. The magnitude of the structural loads are not known as of the preparation of this report; however, it is assumed that wall loads will not likely exceed 3500 plf and that column loads will not likely exceed 150 kips.

The fill material which existed in the upper 7 to 9 feet of the soil profile at this site is not capable of supporting structural foundations without considerable uncertainty as to their performance. Furthermore, the settlement of the existing structure is essentially complete. Under these conditions, the settlement of the proposed addition should be kept to a minimum to eliminate the consequence associated with differential movement.

The above conditions dictate that spread foundations on the natural material not be used to support the proposed addition. It is recommended, therefore, that the proposed facility be supported using spread foundations on compacted fill. The depth of compacted fill beneath continuous footings should not be less than 3 feet and the depth of compacted fill beneath spot footings should not be less than 4 feet.

It should be recognized that in order for spread foundations on compacted fill to be effective, the width of the compacted fill should be twice the width of the footing. The depth of compacted fill beneath non-load bearing walls should not be less than 18 inches. All exterior footings should be located at a depth of at least 2.5 feet below the existing ground surface to provide frost protection.

If the above recommendations are followed, continuous footings may sized using the allowable soil bearing pressures shown in Figure 5, while spot footings may be sized using an allowable soil bearing pressures presented in Figure 6. Recommendations relative to material types and densification requirements for compacted fill are outlined in a subsequent section of this report.

We recommend that at least one foot of the existing material throughout the site be excavated and replaced with compacted granular fill. The compacted granular fill should conform to the recommendations outlined in the following sections of this report. If the above action is taken, no free draining granular material will be required beneath floor slabs at this site.

4. SITE PREPARATION AND COMPACTED FILL REQUIREMENTS

Stripping requirements throughout the proposed addition area should conform to the recommendations outlined in the previous section of this report. Compacted fill placed beneath floor slabs and foundations should be a well graded sandy gravel material with a maximum size less than 3 inches and with not more than 15 percent passing at 200 sieve. All compacted fill supporting floor slabs should be densified to an in-place unit weight equal to 90 percent of the maximum laboratory density indicated above, while compacted fill supporting structural foundations should be densified to 95 percent of the maximum laboratory density indicated herein.

Grading around the structure should be performed in such a manner that all surface waters will flow freely from the area to insure that no ponding will occur adjacent to the structure which will permit deep percolation into the foundation soils. Shrubs which require irrigation should be avoided. Where possible, an asphalt surface should be placed adjacent to the outside of the building to reduce the likelihood of deep percolation into the foundation area.

It is not anticipated that any new parking areas will be included in the proposed development. In the event that new parking areas are required, we are prepared to provide recommendations for flexible pavement design. Sufficient quality control should be performed on all compacted earth materials to insure that the specifications indicated above are complied with.

5. THE RESULTS OF FIELD AND LABORATORY TESTS

Field and laboratory tests performed during this investigation to define the characteristics of the subsurface material throughout the proposed site included standard penetration tests, in-place unit weight, natural moisture content, Atterberg Limits, mechanical analyses, unconfined compressive strength, and consolidation tests.

The standard penetration tests have been previously discussed and the results of these tests indicate that the density of the fill material in the upper portion of the soil profile varies considerably and that the natural clay material varies from a relatively soft to a medium stiff condition. A summary of all test data performed during this investigation, with the exception of the consolidation tests, is presented in Table 1 Summary of Test Data.

The in-place unit weight varies from 94.6 to 101.4 pcf, while the natural moisture content is generally greater than 20 percent. The results of the Atterberg Limits indicates that the silty clay throughout the profile at this site has low plasticity characteristics and classifies as an ML to CL-ML, or a CL-1 type material.

The unconfined compressive strength varies from about 1200 to 2400 psf. Compressibility characteristics of the cohesive material was valued by performing six consolidation tests on samples of the natural material in both Drill Holes 4 and 6. The results of these tests indicate that most of the samples are not highly compressible; however, the sample obtained at depth of 20 feet in Drill Hole 6 indicated moderately high compressibility characteristics. None of the consolidation tests indicated any collapse characteristics, however, and it is possible that the natural moisture content is sufficiently high that this material has settlement under the existing overburden load plus the fill load.

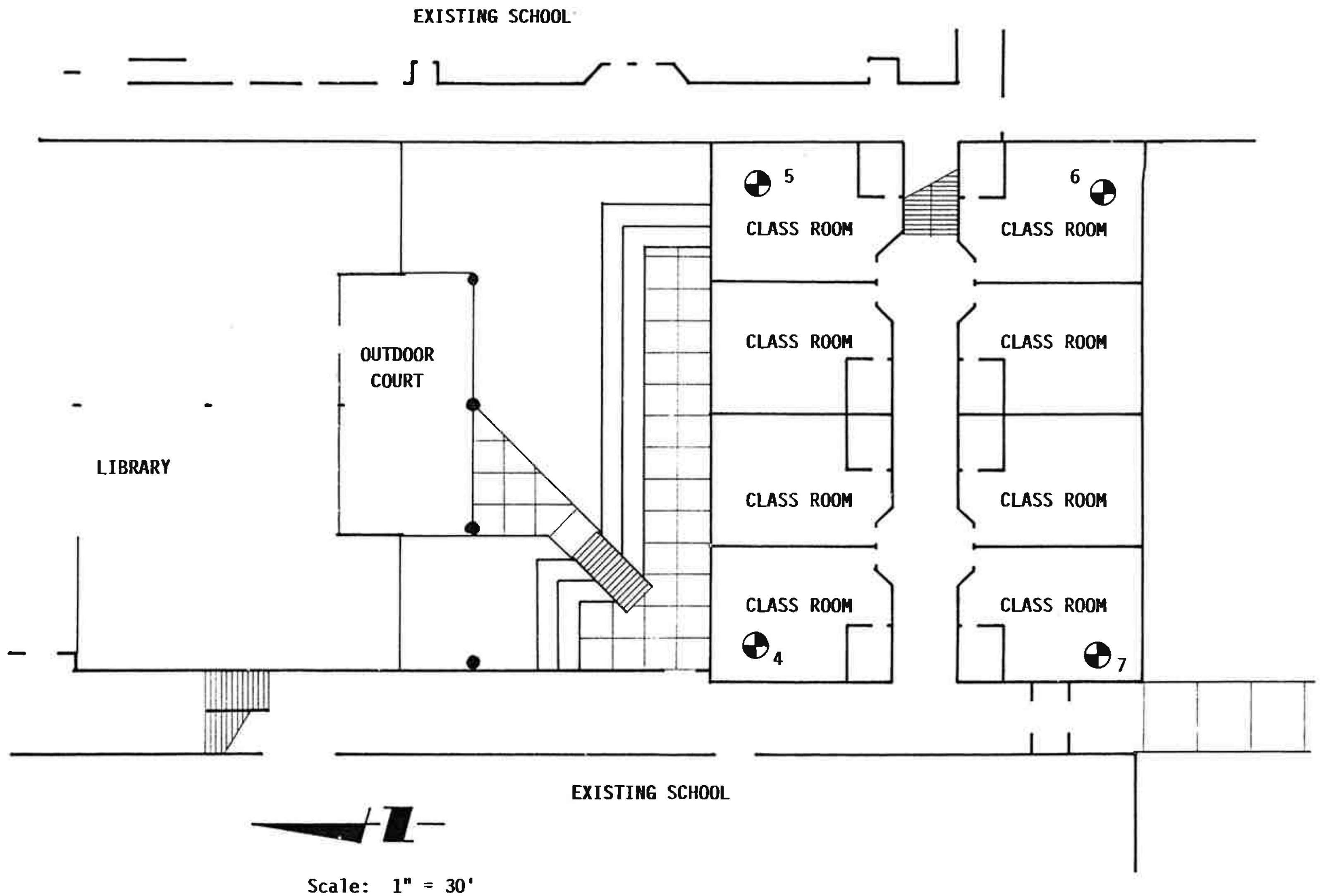
The conclusions and recommendations presented in this report are based upon the results of the field and laboratory tests, which in our opinion, define the characteristics of the subsurface material throughout the site in a satisfactory manner. It should be recognized, that soil materials are inherently heterogeneous and that conditions may exist throughout this site which could not be defined during this investigation. If during construction, conditions are encountered which appear to be different than those presented in this report, it is requested that we be advised in order that appropriate action may be taken.

Yours truly,

RB&G ENGINEERING, INC.

Ralph L. Rollins, Ph.D., P.E.

rlr/jag



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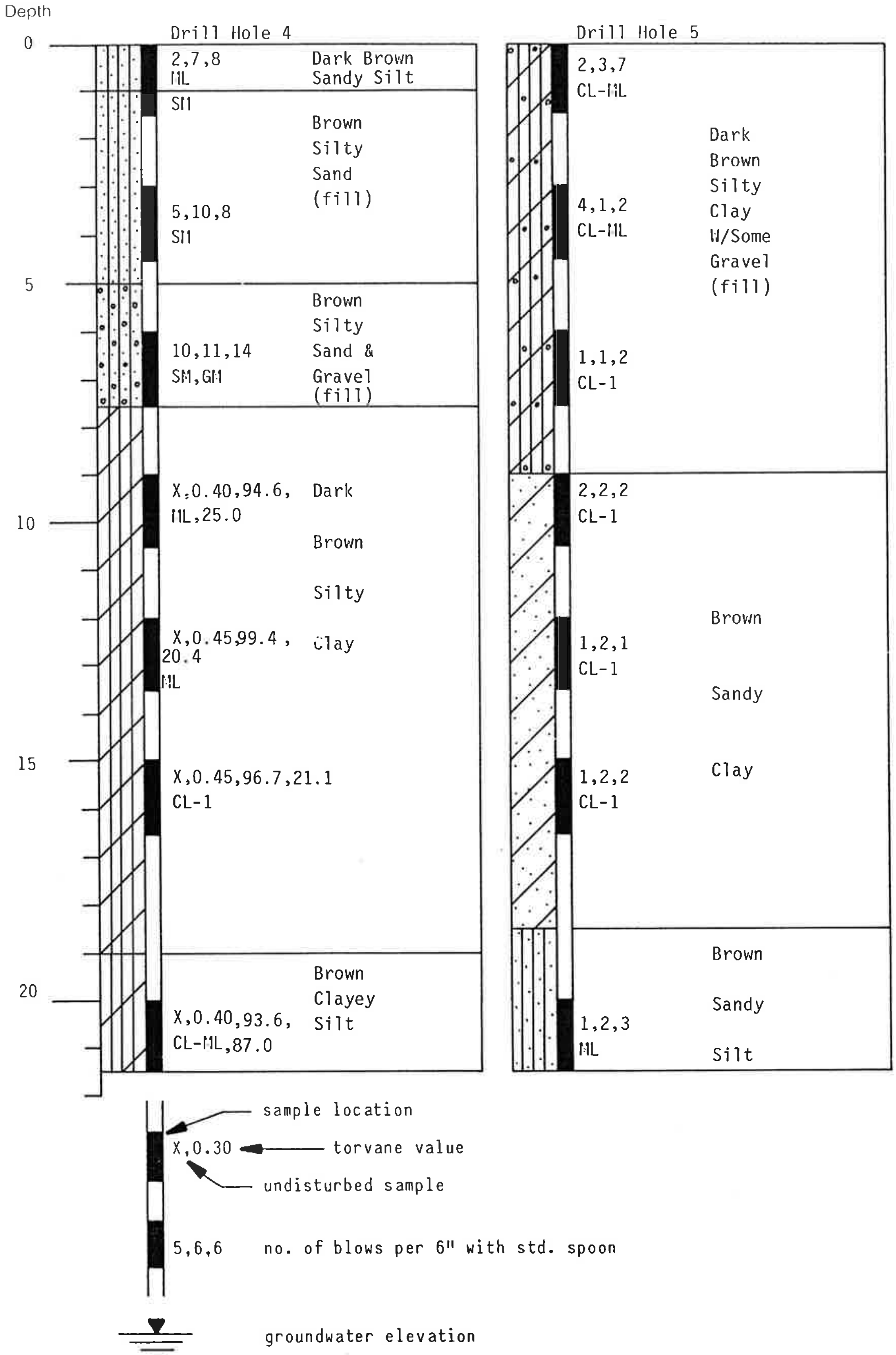
SITE PLAN AND LOCATION OF DRILL HOLES
Timp View High School Addition, Phase II
Provo

FIGURE
NO. 1



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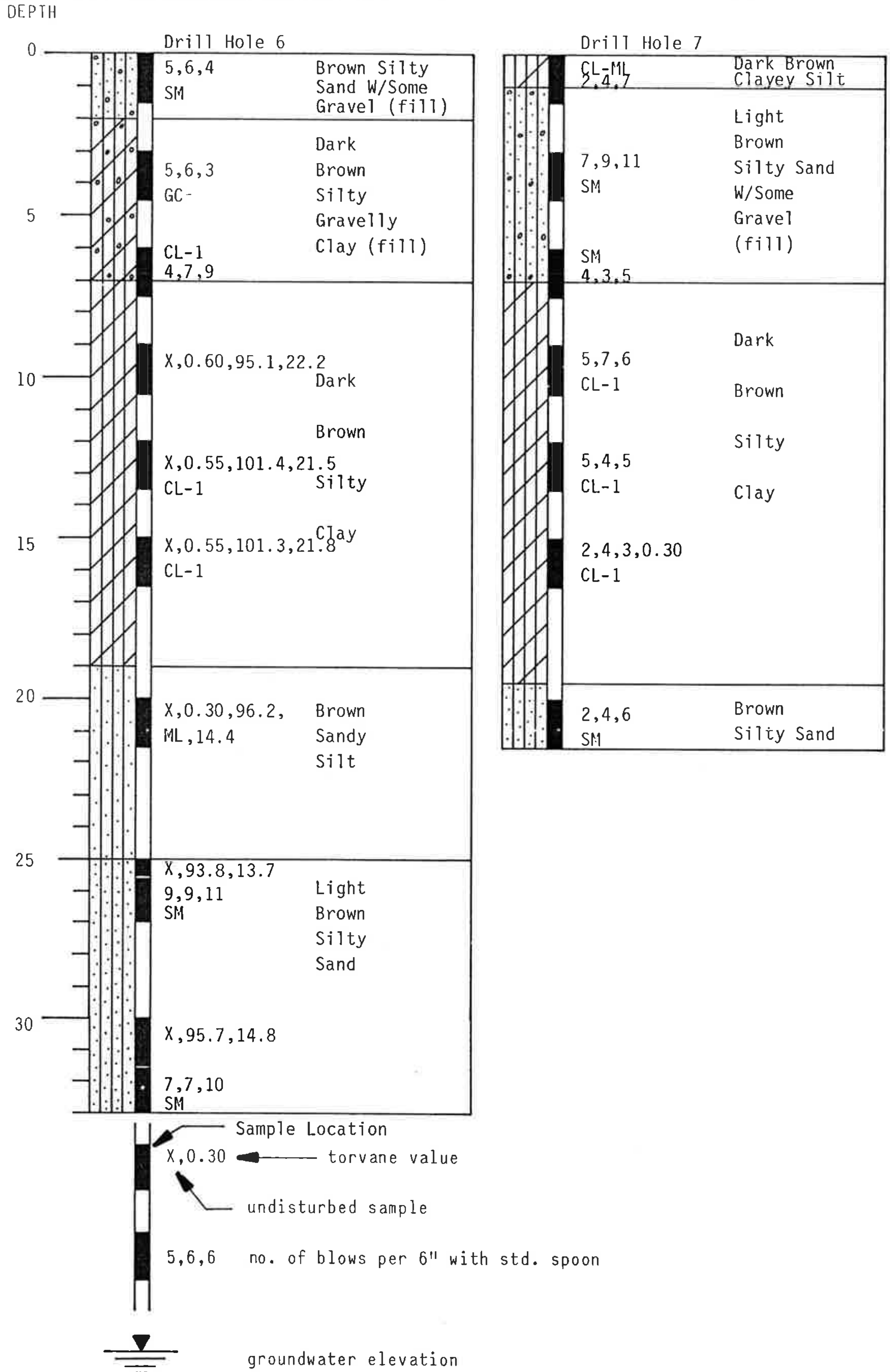
Log of Borings for:
Timp View High School Addition, Phase 2
Provo

Figure No. 2



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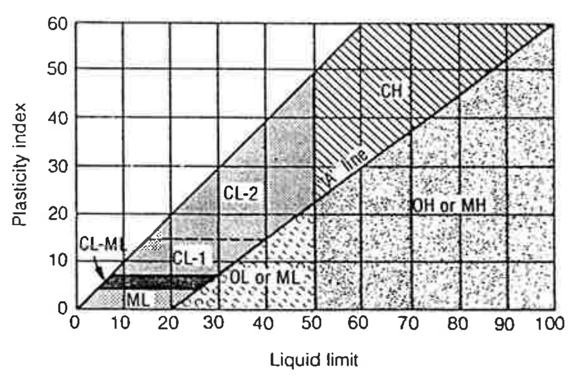
Log of Borings for:
Timp View High School Addition, Phase 2
Provo

Figure No. 3

Unified Soil Classification System

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

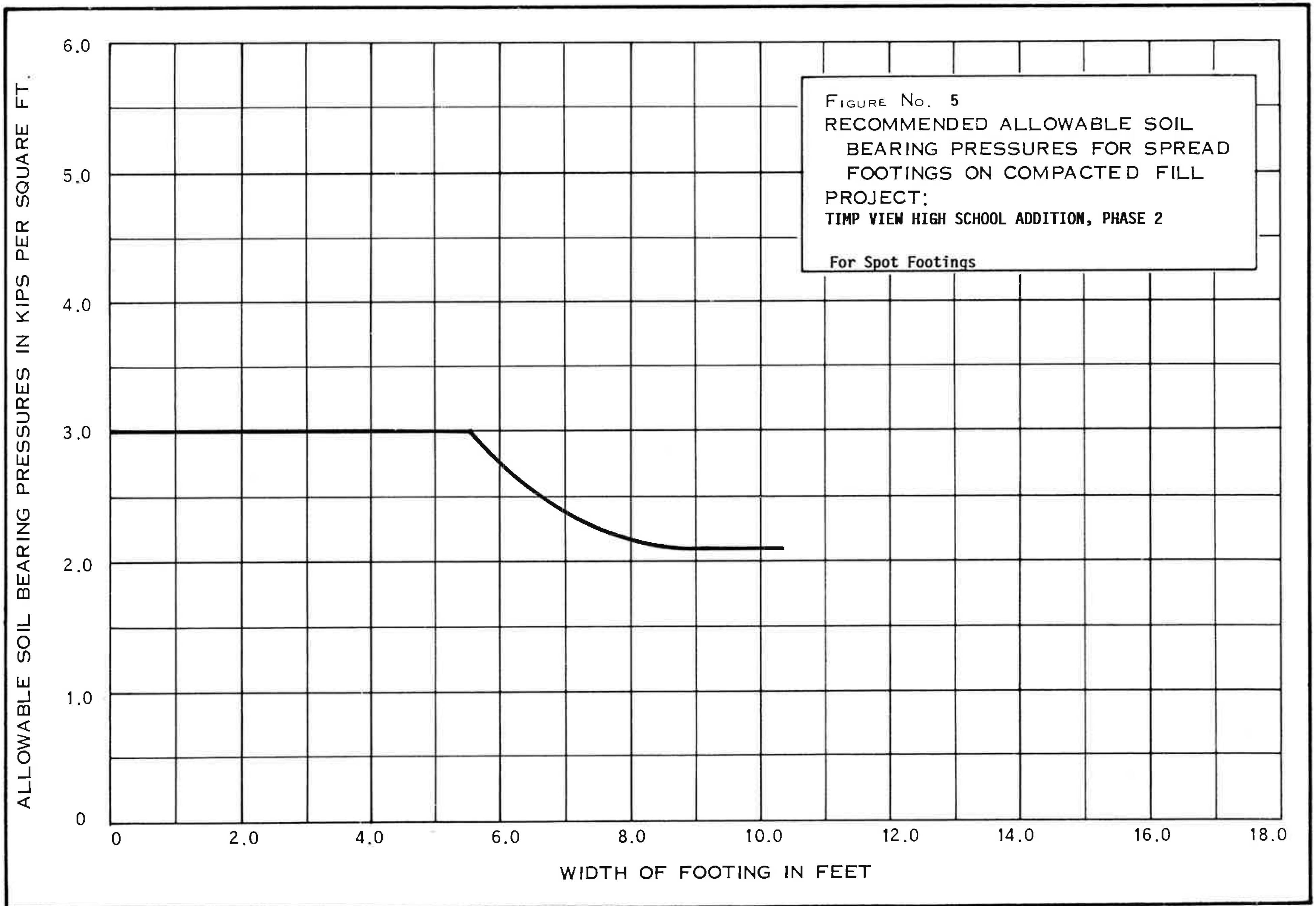


Plasticity Chart
For laboratory classification of fine-grained soils

*Division of *GM* and *SM* groups into subdivisions of d and u for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when liquid limit is 28 or less and the *PI* is 6 or less, the suffix u used when liquid limit is greater than 28.

***Borderline classification:* Soils possessing characteristics of two groups are designated by combinations of group symbols. For example *GW-GC*, well graded gravel-sand mixture with clay binder.

Figure No. 4



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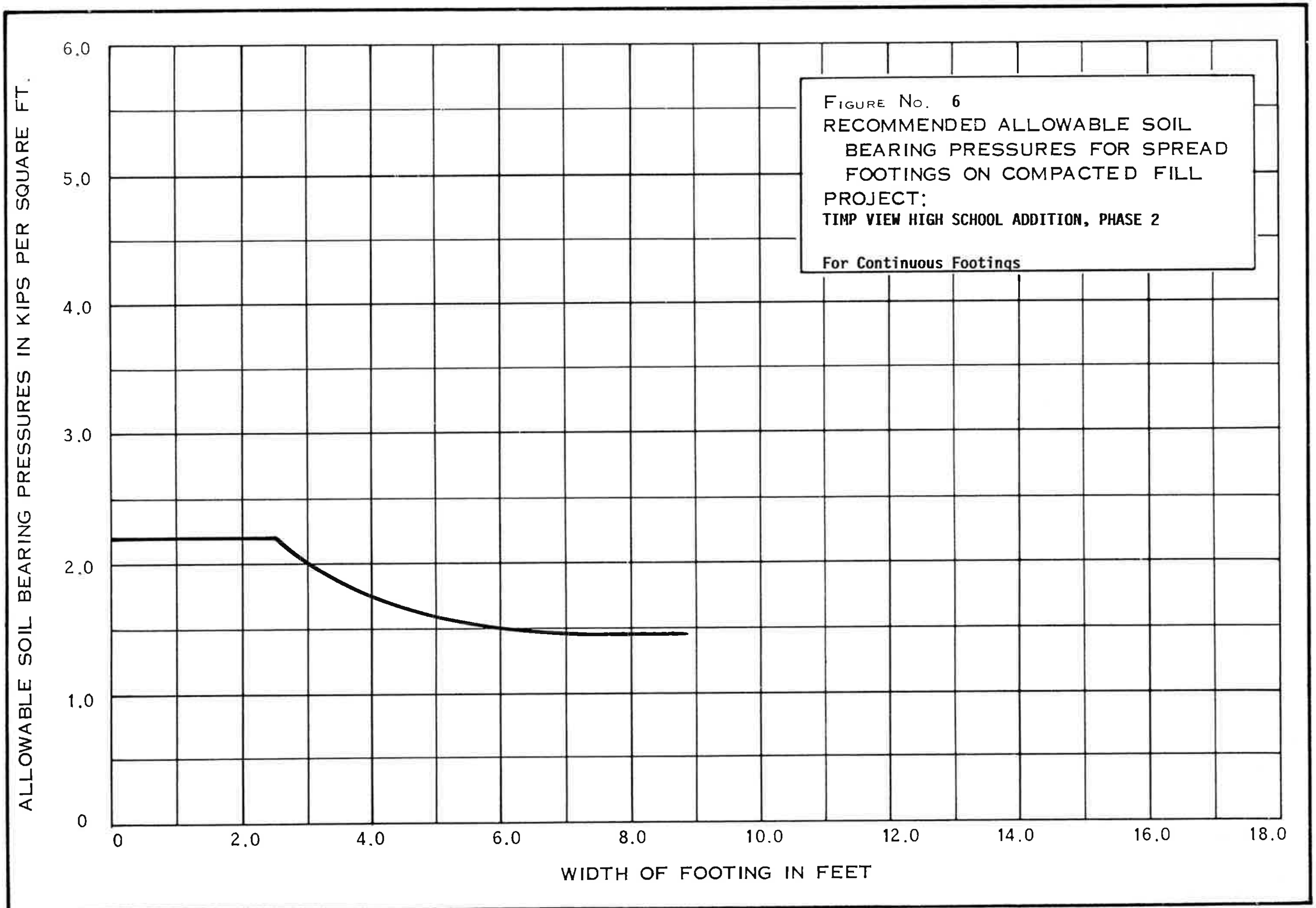

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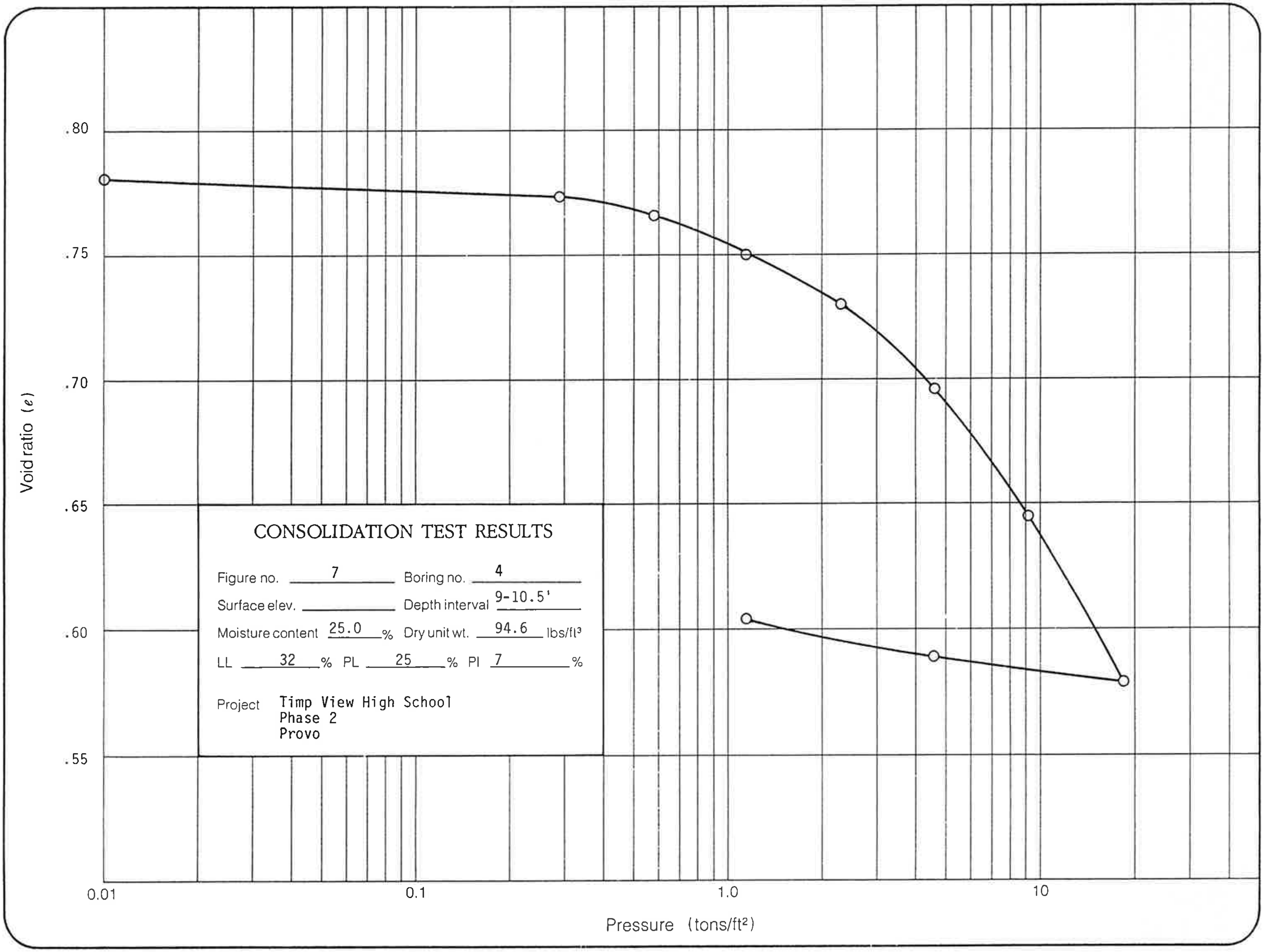
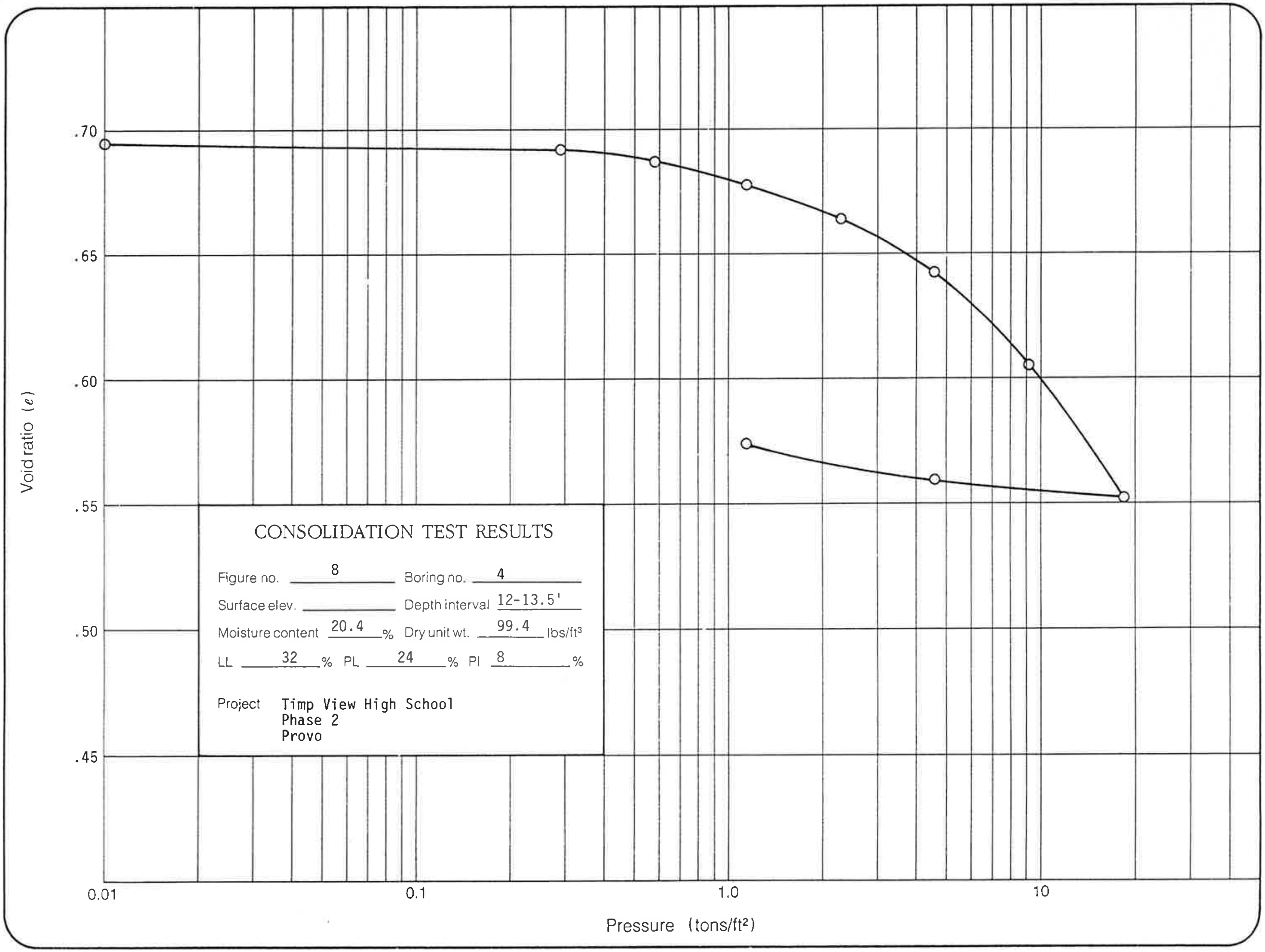
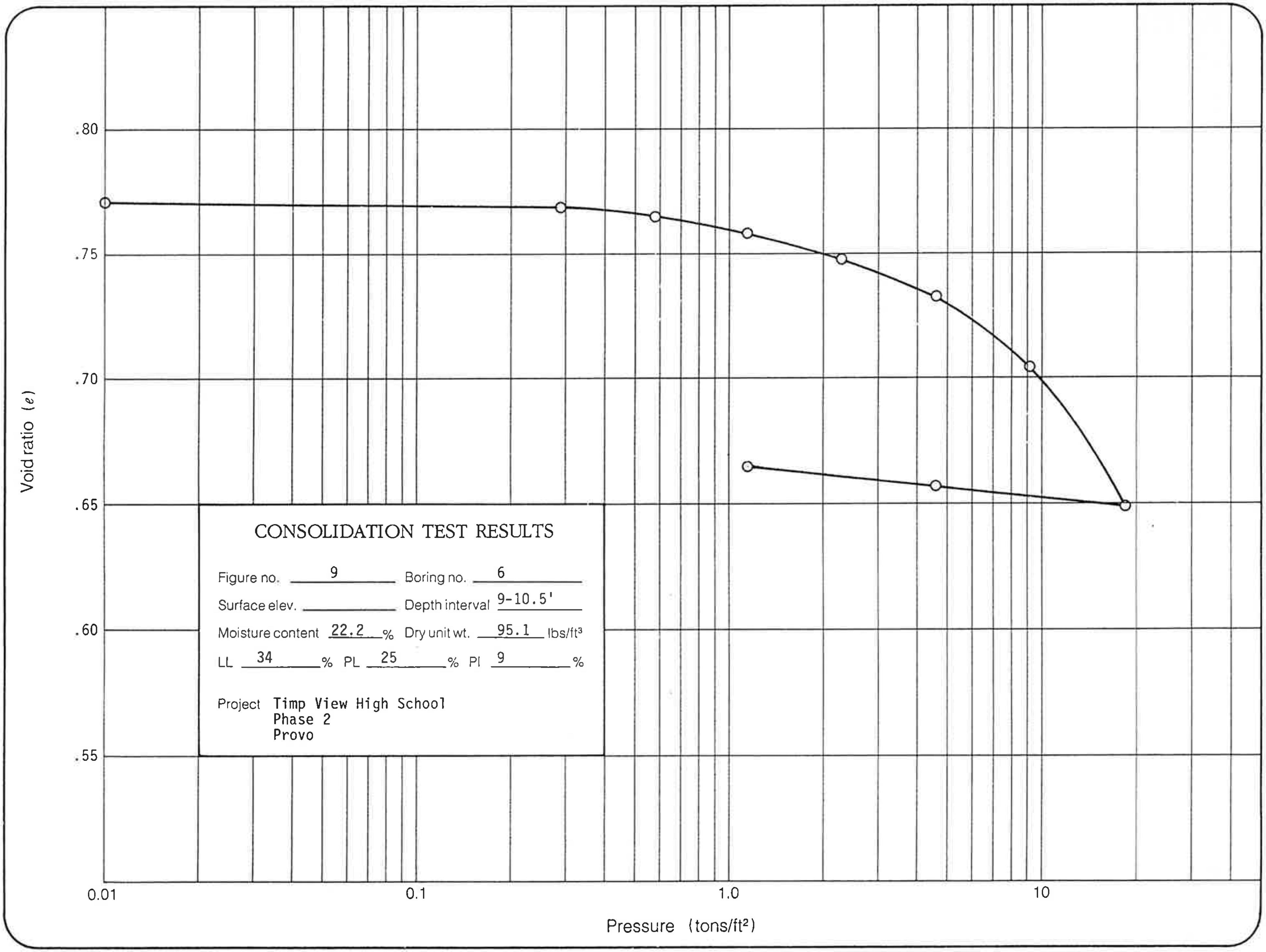
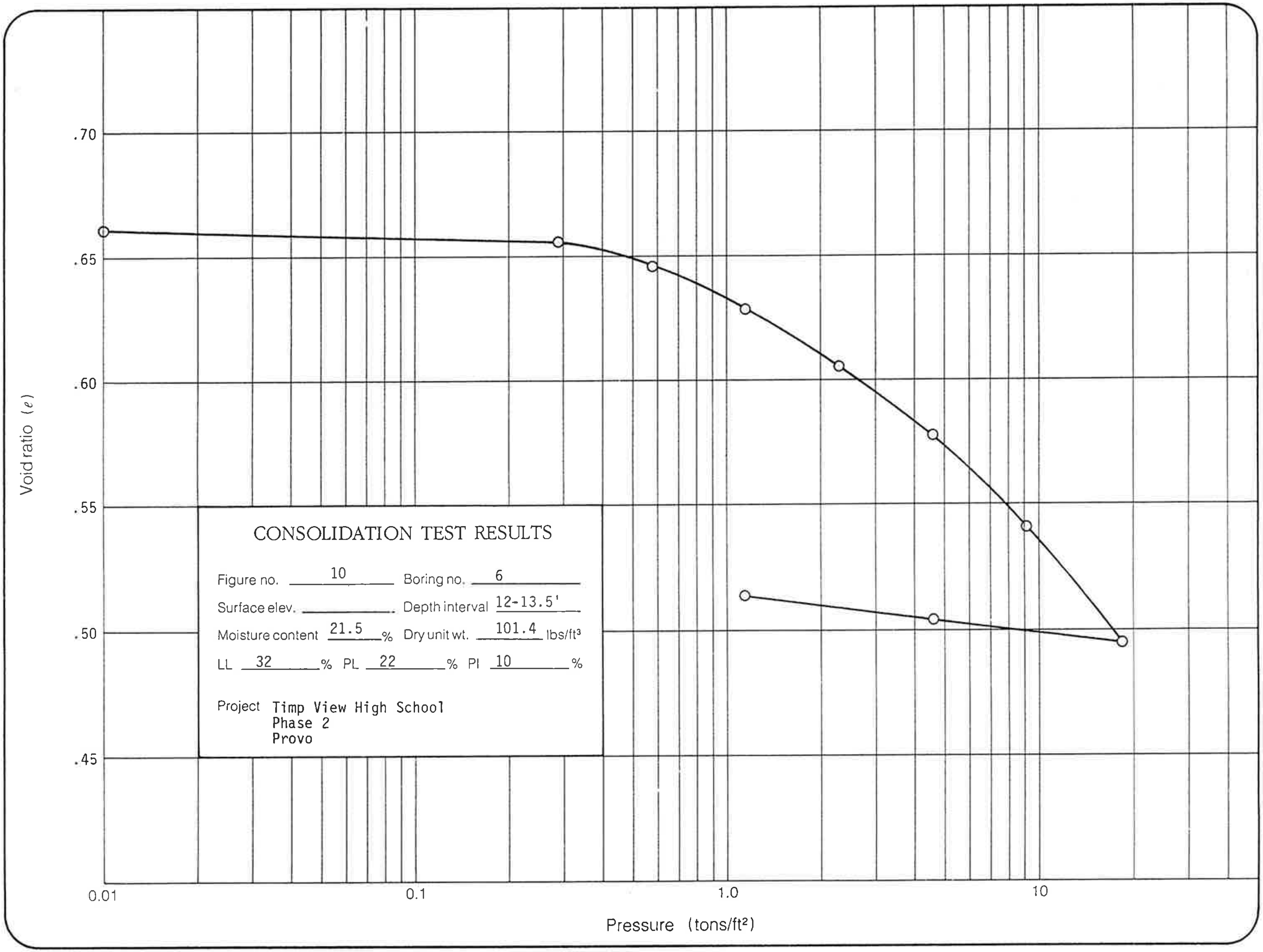

.80
.75
.70
.65
.60
.55
Void ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
CONSOLIDATION TEST RESULTS
Figure no. 7
Boring no. 4
Surface elev.
Depth interval 9-10.5'
Moisture content 25.0 %
Dry unit wt. 94.6 lbs/ft³
LL 32 % PL 25 % PI 7 %
Project Timp View High School
Phase 2
Provo



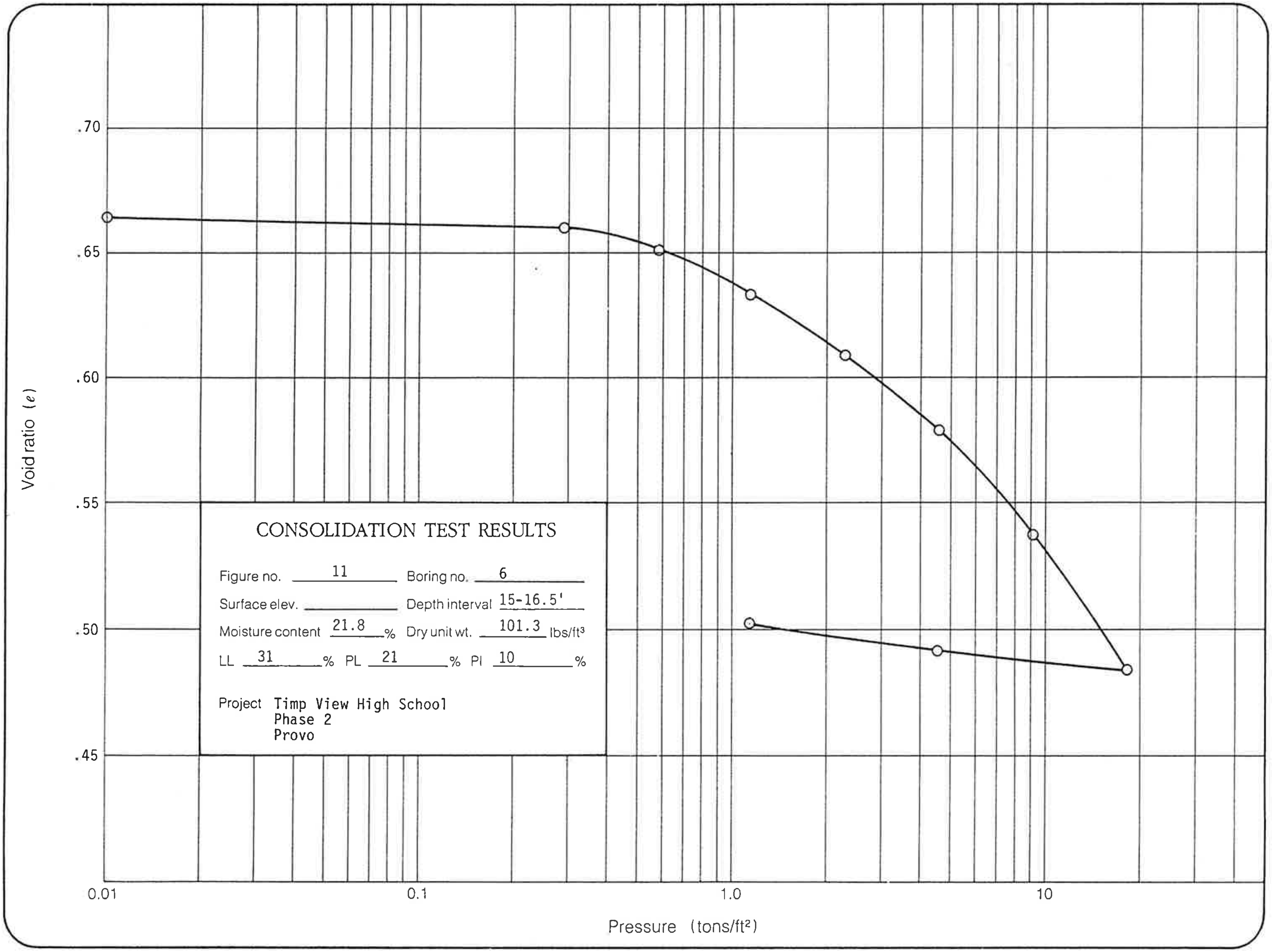
.70
.65
.60
.55
.50
.45
Void ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
CONSOLIDATION TEST RESULTS
Figure no. 8
Boring no. 4
Surface elev.
Depth interval 12-13.5'
Moisture content 20.4 %
Dry unit wt. 99.4 lbs/ft³
LL 32 %
PL 24 %
PI 8 %
Project Timp View High School
Phase 2
Provo



.80
.75
.70
.65
.60
.55
Void ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
CONSOLIDATION TEST RESULTS
Figure no. 9
Boring no. 6
Surface elev.
Depth interval 9-10.5'
Moisture content 22.2 %
Dry unit wt. 95.1 lbs/ft³
LL 34 %
PL 25 %
PI 9 %
Project Timp View High School
Phase 2
Provo



.70
.65
.60
.55
.50
.45
Void ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
CONSOLIDATION TEST RESULTS
Figure no. 10
Boring no. 6
Surface elev.
Depth interval 12-13.5'
Moisture content 21.5 %
Dry unit wt. 101.4 lbs/ft³
LL 32 %
PL 22 %
PI 10 %
Project Timp View High School
Phase 2
Provo



CONSOLIDATION TEST RESULTS

Figure no. 11 Boring no. 6

Surface elev. ______ Depth interval 15-16.5'

Moisture content 21.8 % Dry unit wt. 101.3 lbs/ft³

LL 31 % PL 21 % PI 10 %

Project Timp View High School
Phase 2
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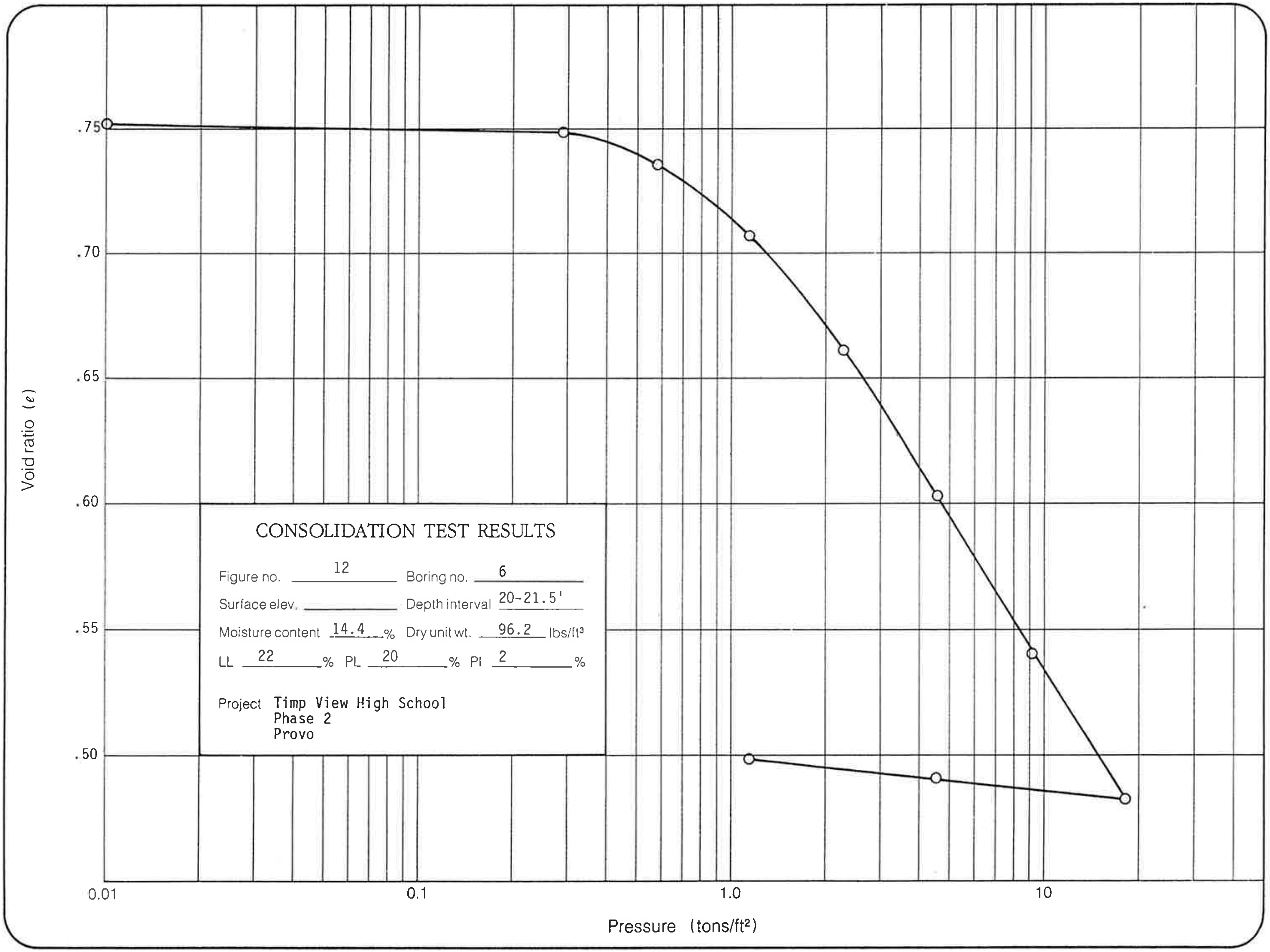

CONSOLIDATION TEST RESULTS
Figure no. 12
Boring no. 6
Surface elev.
Depth interval 20-21.5'
Moisture content 14.4 %
Dry unit wt. 96.2 lbs/ft³
LL 22 %
PL 20 %
PI 2 %
Project Timp View High School Phase 2 Provo
Void ratio (e)
.75
.70
.65
.60
.55
.50
Pressure (tons/ft²)
0.01
0.1
1.0
10

Table No. 1 **SUMMARY OF TEST DATA**

Project Timp View High School Addition, Phase 2 Feature Foudnations Location Provo, Utah

HOLE NO.	DEPTH BELOW GROUND SURFACE	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE			UNCONFINED COMPRESSIVE STRENGTH (lb/ft^2)	FRICTION ANGLE ϕ	CONSISTENCY LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM
			Dry Unit Weight (lb/ft^3)	Moisture (%)	Void Ratio			L.L. (%)	P.L. (%)	P.I. (%)	% Gravel	% Sand	% Silt & Clay	
4	3-4.5'	18									2.2	60.2	37.6	SM
	6-7.5'	25									45.9	18.4	35.7	GM,SM
	9-10.5'		94.6	25.0		2080		32	25	7				ML
	12-13.5'		99.4	20.4		2120		32	24	8				ML
6	9-10.5'		95.1	22.2		2400		34	25	9				ML
	12-13.5'		101.4	21.5		2200		32	22	10				CL-1
	15-16.5'		101.3	21.8		2200		31	21	10				CL-1
	20-21.5'		96.2	14.4		1200		22	20	2				ML