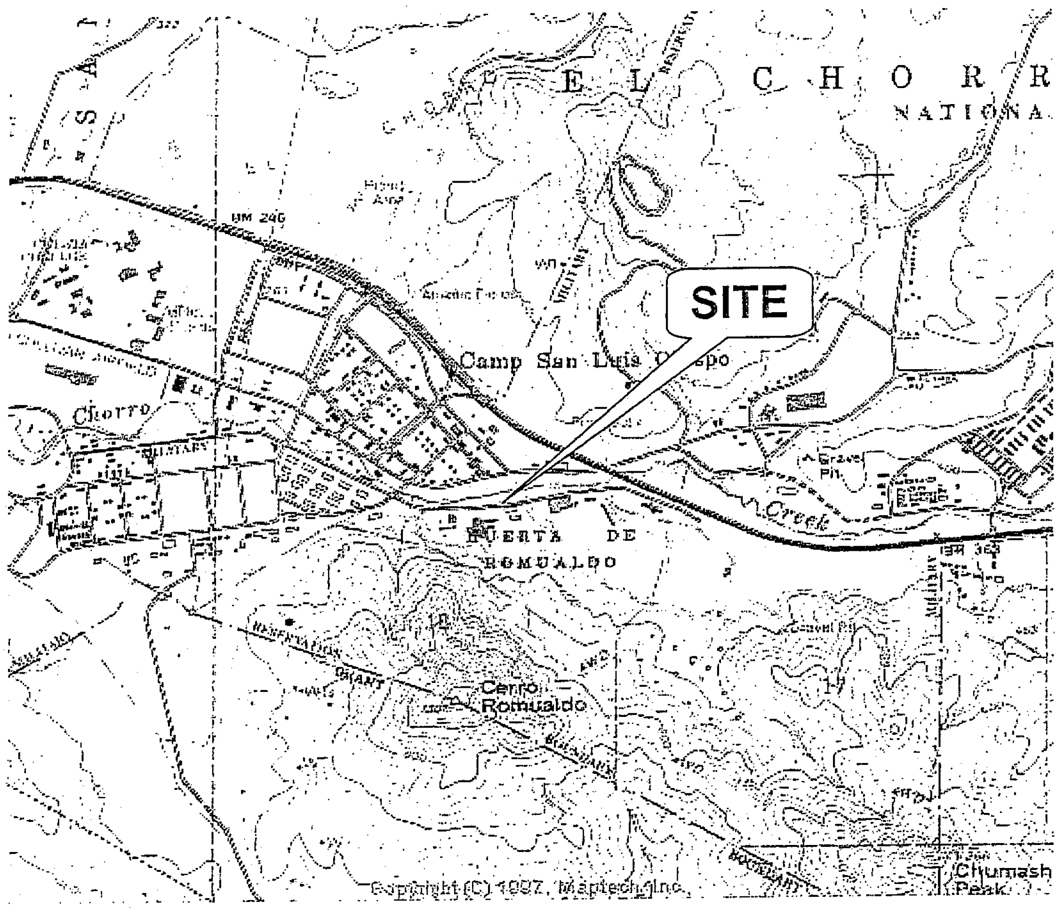
GEOTECHNICAL INVESTIGATION
SEWER LINE REPLACEMENT PROJECT
KANSAS AVENUE
SAN LUIS OBISPO, CALIFORNIA

October 29, 2002

PROJECT 2-1254



PREPARED BY:

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1.0 INTRODUCTION

This report presents the results of our geotechnical investigation, for the proposed sewer line project to be located along Kansas Avenue in San Luis Obispo County, California. A site location map is presented in Figure 1.

The project site extends from Oklahoma Avenue to Camp San Luis Obispo (SLO). Kansas Avenue is relatively level varying from 310 feet above mean sea level (MSL) at Oklahoma Ave. to 267 feet above MSL at Camp SLO. The new line will run within the existing asphalt concrete roadway.

It is our understanding that the improvements will include a sewer line located 8 to 10 feet below existing grades. The sewer line will be 8 inches in diameter with a total length of approximately 3400 feet. Ten (10) manholes will also be constructed on concrete pads.

The project description is based on a site reconnaissance performed by a GSI SOILS, engineer and information provided by the county of San Luis Obispo. The plan provided forms the basis for the "Site Plan", Figure 2.

In the event that there is change in the nature, design or location of improvements, or if the assumed loads are not consistent with actual design loads, the conclusions and recommendations contained in this report should be reviewed and modified, if required. Evaluations of the soils for hydrocarbons or other chemical properties are beyond the scope of the investigation.

2.0 PURPOSE AND SCOPE

The purpose of this study was to explore and evaluate the surface and subsurface soil conditions at the site and to develop geotechnical information and design criteria for the proposed project. The scope of this study included the following items:

1. A review of available published and unpublished geotechnical and geologic data pertinent to the project site.

2. A field study consisting of a site reconnaissance and an exploratory boring program to formulate a description of the subsurface conditions.

3. A laboratory testing program performed on representative soil samples collected during our field study.

4. Engineering analysis of the data gathered during our field study, laboratory testing, and literature review. Development of recommendations for site preparation and grading, and geotechnical design criteria for sewer line installation.

5. Preparation of this report summarizing our findings, conclusions, and recommendations regarding the geotechnical aspects of the project site.

3.0 SUBSURFACE SOIL CONDITIONS

Approximately 18 inches of asphalt concrete, base, and subase material were found along Kansas Ave. The near surface soils encountered below the pavement generally consisted of olive to dark brown sandy clays to a depth of 3 to 4 feet. These materials were encountered in a slightly moist state and in a soft to firm condition. The surface materials were underlain by similar sandy clays and silty clays in a very soft condition particularly from Oklahoma Ave. to approximately the Detective Bureau (borings B-1 to B-5). The exception was boring B-4 where silty sand soils were encountered to a depth of 15 feet. These soils were loose to very loose and maybe old fill. Along the remainder of Kansas Avenue to Camp SLO (borings B-6 to B-8) the sandy and silty clays were in a firm to stiff condition.

Free ground water was encountered at depths varying from 5 to 14 feet below grade in borings B-1 through B-5. Groundwater was not found in borings B-6 through B-8. Higher groundwater elevations can be expected to develop during winter months at all boring locations. A more detailed description of the soils encountered is presented graphically on the "Exploratory Boring Logs", B-1 through B-8, Appendix A. An explanation of the symbols and descriptions used on these logs are presented on the "Soil Classification Chart".

The soil profile described above is generalized; therefore, the reader is advised to consult the boring logs (Appendix A) for soil conditions at specific locations. Care should be exercised in interpolating or extrapolating subsurface conditions between or beyond trenches and borings. On the boring logs we have indicated the soil type, moisture content, grain size, dry density, and the applicable United Soil Classification System Symbol.

The locations of our exploratory borings, shown on Site Plan, Figure 2, were approximately determined from features at the site. Hence, accuracy can be implied only to the degree that this method warrants. Surface elevations at boring locations were not determined.

4.0 SEISMIC CONSIDERATIONS

The site is in a seismically active region of California, and strong ground shaking should be expected during the life of the structure. Seismicity analyses were conducted to evaluate strong ground motion hazards and to develop input parameters to be used for the seismic design of the proposed structures. The analyses essentially consisted of a review of quakes on nearby faults, and the level of strong ground motion that each active or potentially active fault is capable of generating at the site.

4.1 General

The San Andreas fault, located approximately 35 miles northeast of the site, dominates both the structure and seismicity of this region. However, faults reflecting a closer source, also have a significant potential to generate earthquakes and strong shaking at the project site. These include: 1) the offshore group, including the Hosgri and Santa Lucia Bank (Purisma and

Lompoc) faults; and 2) the Los Osos fault. In addition, the Rinconada and San Luis Range faults may be active or potentially active and pose a significant potential to generate earthquakes.

4.2 San Andreas Fault

The San Andreas Fault zone (Mojave section) is the largest active fault zone within a 100-mile radius of the site (located 35 miles northeast). The San Andreas fault is recognized as a major transform fault of regional dimensions that forms an active boundary between the Pacific and North American crustal plates. Cumulative slip along the San Andreas fault has amounted to several hundred miles, and a substantial fraction of the total slip has occurred during late Cenozoic time. The fault has well-defined topographic expression, generally lying within a rift valley or along an escarpment mountain front, and having associated sag ponds, low scarps, right-laterally deflected streams and related manifestations of recent activity. The most recent episode of large-scale movement along the reach of the San Andreas fault that is closest to the San Luis Range occurred during the great Fort Tejon earthquake of 1857. Geologic evidence pertinent to the behavior of the fault during this and earlier seismic events was studied in great detail by Wallace (1968 & 1975). Other active and potentially active faults have been identified in the vicinity of the proposed site. A list of the faults discussed above and other local faults are presented in Table 1 - Seismicity Table.

4.3 Earthquake Magnitudes and Accelerations

We have analyzed the possible earthquake magnitudes and accelerations at the site and, in our opinion, the largest ULE at the site would be a 7.8 moment magnitude earthquake on the San Andreas Fault. Such an event could produce a peak horizontal ground acceleration on the order of 0.19g. The largest LLE at the site would be a 7.6 moment magnitude earthquake, also on the San Andreas Fault. Such an event could produce a peak horizontal ground acceleration on the order of 0.17g. Due to the relative location of the Los Osos, Hosgri, San Luis Range, Rinconada and Cambria, faults to the site, higher ULE accelerations may be expected from these faults. Based on our study, accelerations of 0.47 (Los Osos), 0.29 (Hosgri), 0.43 (San Luis Range), 0.42 (Rinconada), and 0.37 (Cambria) could be anticipated. Based on these findings, it is our opinion, the most significant acceleration at the site would be 0.47g on the Los Osos Fault. This value is higher then the probabilistic value of 0.30 to 0.40g determined by

Peterson and others (1996) for this area, for 10% probability of exceedence in 50 years. The high acceleration from this fault is due to its close proximity to the site. Design of structures should comply with the requirements of the governing jurisdictions and standard practices of the Structural Engineer Association of California.

4.4 Liquefaction

Liquefaction is the phenomenon in which soil temporarily loses strength due to a buildup of excess pore-water pressure caused by seismic shaking. Liquefaction occurs in loose to medium dense saturated sand, typically within the upper 50 feet of ground surface.

Blow counts observed during our field exploration indicate that the density of the upper 20 feet of soil varies throughout the layer, but the layer can generally be described as soft and/or loose in the upper 5 feet and very loose below this depth in borings B-1 through B-5. In three borings groundwater was also encountered at 5 to 14 feet below grade. In the remaining borings (B-6 through B-8) the soils were predominately in a firm condition and no groundwater was found. Due to the predominately clay soils discovered during our field exploration the potential for liquefaction would be low over most of the alignment. However, around borings B-4 the potential would increase to the high category.

4.5 UBC Seismic Coefficients

A summary of the seismic factors applicable to this site is provided in Figure 4. The soil profile type would be considered an S_E, the seismic source is a Type B, and the near source factors N_a and N_v are 1.0 and 1.2 respectively. The seismic coefficients C_a and C_v would be 0.36 N_a and 0.96 N_v respectively.

5.0 CONCLUSIONS AND RECOMMENDATIONS

1. The site is suitable for the proposed sewer project provided the recommendations presented in this report are incorporated into the project plans and specifications.

2. All grading plans should be reviewed by GSI SOILS hereinafter described as the Geotechnical Engineer, prior to contract bidding. This review should be

performed to determine whether the recommendations contained within this report are incorporated into the project plans and specifications.

3. The Geotechnical Engineer should be notified at least two (2) working days before site clearing or grading operations commence, and should be present to observe the stripping of deleterious material and provide consultation to the Grading Contractor in the field.

4. Field observation and testing during the grading operations should be provided by the Geotechnical Engineer so that a decision can be formed regarding the adequacy of the site preparation, the acceptability of fill materials, and the extent to which the earthwork construction and the degree of compaction comply with the project geotechnical specifications. Any work related to grading performed without the full knowledge of, and under direct observation of the Geotechnical Engineer, may render the recommendations of this report invalid.

5.1 Clearing and Stripping

1. All surface and subsurface deleterious materials should be removed from the proposed sewer line and disposed of off-site. This includes, but is not limited to any buried utility lines, loose fills, septic systems, debris, building materials, and any other surface and subsurface structures within proposed alignment. Voids left from site clearing, should be cleaned and backfilled as recommended for structural fill.

2. Once the site has been cleared, the exposed ground surface should be stripped to remove surface vegetation and organic soil. The surface may be disced, rather than stripped, if the organic content of the soil is not more than three percent by weight. If stripping is required, depths should be determined by a member of our staff in the field at the time of stripping. Strippings may be either disposed of off-site or stockpiled for future use in landscape areas if approved by the landscape architect.

5.2 Conventional Sloped Trench Excavation

1. Conventional earth moving equipment should be adequate to excavate the soils along the alignment. We anticipate the use of a large backhoe or excavator to construct the trench. Excavated soils to a depth of 3 feet or less may be placed no closer than 2 feet from the edge of the trench. If 3 feet or thicker, the soils should be no closer than 5 to 7 feet. In addition, heavy equipment should be kept at a safe distance from trench sidewalls. At a minimum, equipment should be kept 5 feet from the edge of the trench.

2. From Oklahoma Avenue to the Detective Bureau (borings B-1 to B-5) soft soils were encountered in the upper 10 feet. The trench walls to a depth of 7 feet (average groundwater depth) should be sloped at an inclination of 1.5:1 (horizontal:vertical). However, below the water table to a depth of 10 to 12 feet slopes of 2:1 (H:V) of flatter are more likely. Dewatering will be required also to maintain the proposed slopes. Between the Detective Bureau and Camp SLO (borings B-6 to B-8) the 1:1 (H:V) slopes should be applicable for the firm to stiff clays encountered in the upper 8 to 10 feet. Due to the conditions encountered at the site alternative trenching or installation methods may be more appropriate. The following report sections discuss the use of micro tunneling and support shields.

3. It should be noted that it is the *Contractor's* responsibility to maintain safe cut slopes based on actual field conditions and according to OSHA requirements. The slopes presented are those we expect will be used in project design and we have assumed that in general the slopes will not be open for more than 2 to 3 days and occasionally for 5 days. The stability of the slopes may be compromised somewhat where these conditions exist due to softening or piping of the saturated materials.

4. As noted previously, surface water, ground water and shallow perched ground water should be anticipated along portions of the alignment. Dewatering will be necessary for installation of the sewer line. The *Contractor* should be

responsible for proper design, installation, and operation of dewatering facilities during construction.

5. Where the excavation bottom is locally wet, soft and yielding, it is recommended that the bottom of the trench be stabilized prior to placement of pipe bedding. Methods such as the use of a washed gravel along the trench bottom covered with a geotextile fabric such as Supac 8NP or placement of a Class I or II base material over a similar fabric could be used. The *Contractor* should be responsible for design and implementation of trench stabilization techniques.

6. Where the temporary trench slopes are inclined as described above, no shoring is required. However, in some locations where adjacent features such as roads, or structures are located, the *Contractor* may elect to use shoring in order to minimize the top width of the trench. In no case should personnel enter trenches with vertical sidewalls greater than 5 feet deep without proper shoring. Design and installation of the shoring should be the responsibility of the *Contractor* and should be performed according to OSHA requirements.

7. The areas around shored excavations will experience some amount of ground settlement. For the types of soils to be encountered along the pipeline alignment (assuming average to good workmanship in shoring), we anticipate a maximum settlement of about 0.4 percent of the depth of excavation, immediately adjacent to the shoring. For a 5 foot deep trench, this translates to nearly 1/4-inch settlement. The amount of settlement should decrease more or less linearly away from the trench wall, reaching zero settlement at a distance from the trench wall equal to twice the trench depth, or about 10 feet away for a 5 foot deep trench.

5.3 Shored Excavations

1. If vertical excavations are planned, the trenches should be shored. As indicated above, the trench will require dewatering. Lateral earth pressures to be used in the design of the shorings are presented in Figure 3.

2. Trench shoring products that could be considered are steel or corrugated aluminum hydraulic shoring devices, trench shields, and trench plates. The shallow depth to ground water, particularly from Oklahoma Avenue to the Detective Bureau will necessitate a dewatering system to be installed with the shores. The loose conditions of the possible fill sands (boring B-4) may also result in collapse of the trenches during excavation. Some form of excavation supports (slurry, etc.) may be required during digging.

3. The areas around shored excavations will experience some amount of ground settlement. For the types of soils to be encountered along the pipeline alignment (assuming average to good workmanship in shoring), we anticipate a maximum settlement of about 0.4 percent of the depth of excavation, immediately adjacent to the shoring. For a 10 foot deep trench, this translates to nearly 1/2-inch settlement. The amount of settlement should decrease more or less linearly away from the trench wall, reaching zero settlement at a distance from the trench wall equal to twice the trench depth, or about 20 feet away for a 10 foot deep trench.

5.4 Microtunneling

1. An alternative to trenching would be microtunneling. Microtunneling is a system of remotely controlled pipejacking that typically uses laser guides to accurately place the pipe. A slurry pressure balance system would be required for this site due to the high groundwater table.

2. Jacking and receiving pits will likely be vertically sided excavations with sheet piling and/or shoring and bracing systems. Due to the soft soils and shallow water table, sheet piling would likely be the preferred choice. As discussed above, ground water control will be required. Systems such as well points or deep wells could be considered. If sheet piling is used, they should be driven to a depth of approximately 20 to 25 feet below grade. The lateral pressures presented in Figure 3 could be used in the design of the piling.

3. It is unlikely that boulders or other natural obstructions would impede the advance of the equipment. However, the soft condition of the soils may result in loss of ground during tunneling. It this occurs, equipment that can exert a stabilizing pressure on the tunnel face may be required.

5.5 Pipe Zone Backfill

1. For purposes of the following discussion, Pipe Zone Backfill is defined as the material that extends from 6 inches below the pipe to 12 inches above. It forms the contact between the pipe and the foundation upon which it rests.

2. A common Pipe Zone Backfill (or compacted granular material) that GSI Soils typically recommends conforms to the following gradation:

Gradation for Pipe Zone Backfill	
Sieve Size	**Percent Passing by Weight**
3/4-inch	100
No. 4	29-90
No. 200	0-12

In addition to these gradation requirements, we recommend that the Pipe Zone Backfill have a minimum Sand Equivalent of 30 (California Standard Test No. 217). A Pipe Zone Backfill that meets the gradation and Sand Equivalent, will have good filter capability to prevent fines from migrating from the adjacent soils.

3. If the pipe manufacturers do not have special requirements to the contrary, Pipe Zone Backfill should be placed in loose lifts not exceeding 6 to 8 inches and compacted by mechanical means to at least 90 percent of the maximum dry density, as determined by ASTM Test Procedure D1557-91 or not less that 70 percent of relative density, as determined by ASTM D4253 and D4254. The pipe should be placed on the flat surface of compacted Pipe Zone Backfill material or

on bedding material that is shaped appropriately as required by design.

4. It should be noted that extra care should be taken to properly compact the backfill where the pipe enters or leaves appurtenant structures. This is sometimes the most difficult place to achieve proper compaction, but it is critical that the pipeline be properly supported so as to minimize differential movement between the pipe and structure. If welding pits are excavated adjacent to any structure or along the pipeline alignment, the pit should be backfilled with aggregate base material and/or lean concrete to ensure proper support. Another alternative would be to design flexible joints to accommodate the differential settlement adjacent to the structure.

5.6 Trench Backfill

1. Trench Backfill is the material that is placed in the pipeline trench above the Pipe Backfill, from 12 inches above the top of the pipe to 18 inches below final grade, or if the trench is under pavement, 18 inches below the pavement subgrade.

2. Trench Backfill should consist of native material excavated from the trench, with all deleterious material, such as organics, concrete, and asphalt removed. Materials which are classified as Pt, OH, CH, MH, or OL according to ASTM D2487, should not be used in the Trench Backfill. No particles larger than 3 inches should be allowed. The native materials primarily consist of sandy clays (CL). About 25 percent of materials excavated overall from the trench are estimated to be too highly plastic to serve as acceptable trench backfill material. This material should not be used as backfill, and should be replaced with less plastic material excavated from other portions of the trench.

3. Trench Backfill along all pipelines should be spread evenly in loose, horizontal layers not exceeding 8 inches in thickness. This thickness is recommended to facilitate compaction. The moisture content of the fill should be within +1 percent to +3 percent of the optimum moisture content and compacted using mechanical equipment. Each lift of trench backfill should be compacted to no less than 85

percent of the maximum dry density as determined by ASTM Test Procedure D1557-91.

4. If flooding/jetting is acceptable, it should be a free draining granular material as discussed above and adequately compacted. Based on our observation of the site materials, flooding and/or jetting of the trench backfill derived from most native materials will not be considered feasible.

5. The final 18 inches of backfill should be placed in the same manner and at the same percent of relative compaction specified for Trench Backfill. Within roadway or other vehicle traffic areas the backfill should be compacted to 95 percent of the maximum dry density as determined by the ASTM Test Procedure D1557-91.

5.7 Thrust Block Requirements

1. The pipe may require some thrust block supports where the pipeline will make relatively abrupt changes in elevation. For design, a passive earth pressure of 200 pcf should be used for all geotechnical terrain segments.

2. If frictional forces are required for thrust analyses in the design of steel pipes, a coefficient of friction between the pipe and the surrounding backfill soil may be considered. Unless otherwise specified by the manufacturer, the following general coefficient of friction/friction angles are provided.

Recommended Coefficient of Friction/Friction Angle	
	Recompacted Native Soils, Sandy Clays (CL)
Steel[1]	0.25/14°
Concrete or Mortar[1]	0.30/17°
PVC	0.18/10°
[1] NAFACDM7.02 (1986)	

5.8 Manholes

1. In order to help minimize potential settlement problems associated with manholes supported on soft soils, the soils engineer should be consulted for specific site recommendations during grading. At a minimum the manhole concrete pads should be supported on 2 feet of compacted crushed gravel. Where soft conditions are encountered a layer of fabric (Mirafi 600x or equivalent) should be placed below the crushed gravel.

2. An allowable dead plus live load bearing pressure of 1000 psf may be used for design of the manholes. For lateral loads a friction factor of 0.25 and a passive resistance of 250 pcf could be used.

5.9 Preparation of Paved Areas

1. Pavement areas should be scarified to a depth of 12 inches below existing grade or finished subgrade. The soil should then be wetted to slightly above optimum moisture content and compacted a minimum of 90 percent of maximum dry density.

2. The upper 6 inches of subgrade beneath all paved areas should be compacted to at least 95 percent relative compaction. Subgrade soils should not be allowed to dry out or have excessive construction traffic between the time of water conditioning and compaction, and the time of placement of the pavement structural section.

5.10 Structural Fill

1. On-site soils free of organic and deleterious material are suitable for use as structural fill. Structural fill should not contain rocks larger than 6 inches in greatest dimension, and should have no more than 15 percent larger than 2.5 inches in greatest dimension.

2. Import should be free of organic and other deleterious material and should have low expansion potential, with a plasticity index of 12 or less. Before delivery to

the site, a sample of the proposed import should be tested in our laboratory to determine its suitability for use as structural fill.

3. Structural fill using on-site inorganic soil or approved import should be placed in layers, each not exceeding eight inches in thickness before compaction. On-site inorganic or imported soil should be conditioned with water, or allowed to dry, to produce a soil water content at approximately optimum value, and should be compacted to at least 90 percent relative compaction based on ASTM D1557-91.

5.11 Pavement Design

1. The following table provides recommended pavement sections based on an estimated R-Value of 8 for the near surface clay soils encountered at the site.

2. All asphalt pavement construction and materials used should conform with Sections 26 and 39 of the latest edition of the Standard Specifications, State of California, Department of Transportation. Aggregate bases and sub-bases should also be compacted to a minimum relative compaction of 95 percent based on ASTM D1557-91.

RECOMMENDED MINIMUM ASPHALT CONCRETE PAVEMENT SECTIONS DESIGN THICKNESS

T.I.	A.C. (in.)	A.B. (in.)
4.0	2.0	8.5
4.5	2.5	9.0
5.0	2.5	10.5
5.5	3.0	11.0
6.0	3.0	14.0
7.0	3.5	16.0
8.0	4.5	17.5

T.I. = Traffic Index
A.C. = Asphaltic Concrete - must meet specifications for Caltrans Type B Asphalt Concrete
A.B. = Aggregate Base - must meet specifications for Caltrans Class II Aggregate Base (R-Value = minimum 78)

3. R-value samples should be obtained and tested at the completion of rough grading and the pavement sections confirmed or revised. A minimum of 6 inches of Class II aggregate base is recommended beneath all asphaltic concrete pavement sections and all sections should be crowned for good drainage.

4. Using the R-Value of 8, a Modulus of Rupture for concrete of 500 psi (based on a minimum strength of 3,000 psi) minimum pavement sections are presented in the following table for Traffic Indices (TI) of 4.0 to 8.0.

RECOMMENDED MINIMUM CONCRETE PAVEMENT SECTIONS		
Traffic Index (T.I.)	Concrete inches (ft)	Caltrans Class II Aggregate Base inches* (ft)
4.0	6.0 (.50)	4.0 (.33)
5.0	6.5 (.54)	4.0 (.33)
6.0	7.0 (.58)	4.0 (.33)
7.0	7.5 (.63)	4.0 (.33)
8.0	8.0 (.66)	4.0 (.33)

* A minimum of 4 inches of Class II aggregate base is recommended.

5. Concrete pavement construction should generally comply with the requirements of Sections 40 and 90 of the latest edition of the Standard Specifications, State of California, Department of Transportation.

6. Recommendations for mix design, curing, joints and reinforcement should be as promulgated by the Portland Cement Association. Control and construction joints should be used to separate the pavements into approximately square shaped areas at a spacing of no more than 20 feet on-center, each way. A concrete shrinkage of approximately 1/16-inch per 10 feet of length should be anticipated and joints should be designed accordingly.

7. It is recommended that all joints in and adjacent to the PCC pavement be sealed to preclude entry of water into the soils underlying paved areas.

5.12 Corrosion

1. Soil resistivity tests were performed on samples obtained from borings B-1 at 2-feet, boring B-8 at 5 feet. Resistivity values of 2400 and 1880 ohm-cm were measured respectively.

2. One (1) soil sample was also tested to measure pH, and the concentrations of chloride and sulfate. The results are presented in the following table.

Chemical Tests

Sample Location	Depth	Soil Type	pH	Sulfates (ppm)	Chloride (ppm)
B-8	2'	Silty Sand (SM)	7.0	45	170

3. The results indicate that sulfate salt concentrations should not effect normally formulated Type II concrete. Similarly the chloride concentrations and resistivity results indicate that the potential for corrosion of ferrous pipes is in the mildly corrosive to moderately corrosive range. We would recommend that a corrosion consultant be contacted regarding protection of ferrous pipes.

6.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

1. It should be noted that it is the responsibility of the owner or his/her representative to notify **GSI Soils** a minimum of 48 hours before any stripping, grading, or foundation excavations can commence at this site.

2. The recommendations of this report are based upon the assumption that the soil conditions do not deviate from those disclosed during our study. Should any variations or undesirable conditions be encountered during grading of the site,

GSI Soils will provide supplemental recommendations as dictated by the field conditions.

3. This report is issued with the understanding that it is the responsibility of the owner or his/her representative to ensure that the information and recommendations contained herein are brought to the attention of the architect and engineer for the project, and incorporated into the project plans and specifications. The owner or his/her representative is responsible for ensuring that the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field.

4. As of the present date, the findings of this report are valid for the property studied. With the passage of time, changes in the conditions of a property can occur whether they be due to natural processes or to the works of man on this or adjacent properties. Legislation or the broadening of knowledge may result in changes in applicable standards. Changes outside of our control may find this report to be invalid, wholly or partially. Therefore, this report should not be relied upon after a period of three (3) years without our review nor is it applicable for any properties other than those studied.

5. Validity of the recommendations contained in this report is also dependent upon the prescribed testing and observation program during the site preparation and construction phases. Our firm assumes no responsibility for construction compliance with these design concepts and recommendations unless we have been retained to perform continuous on-site testing and review during all phases of site preparation, grading, and foundation/slab construction.

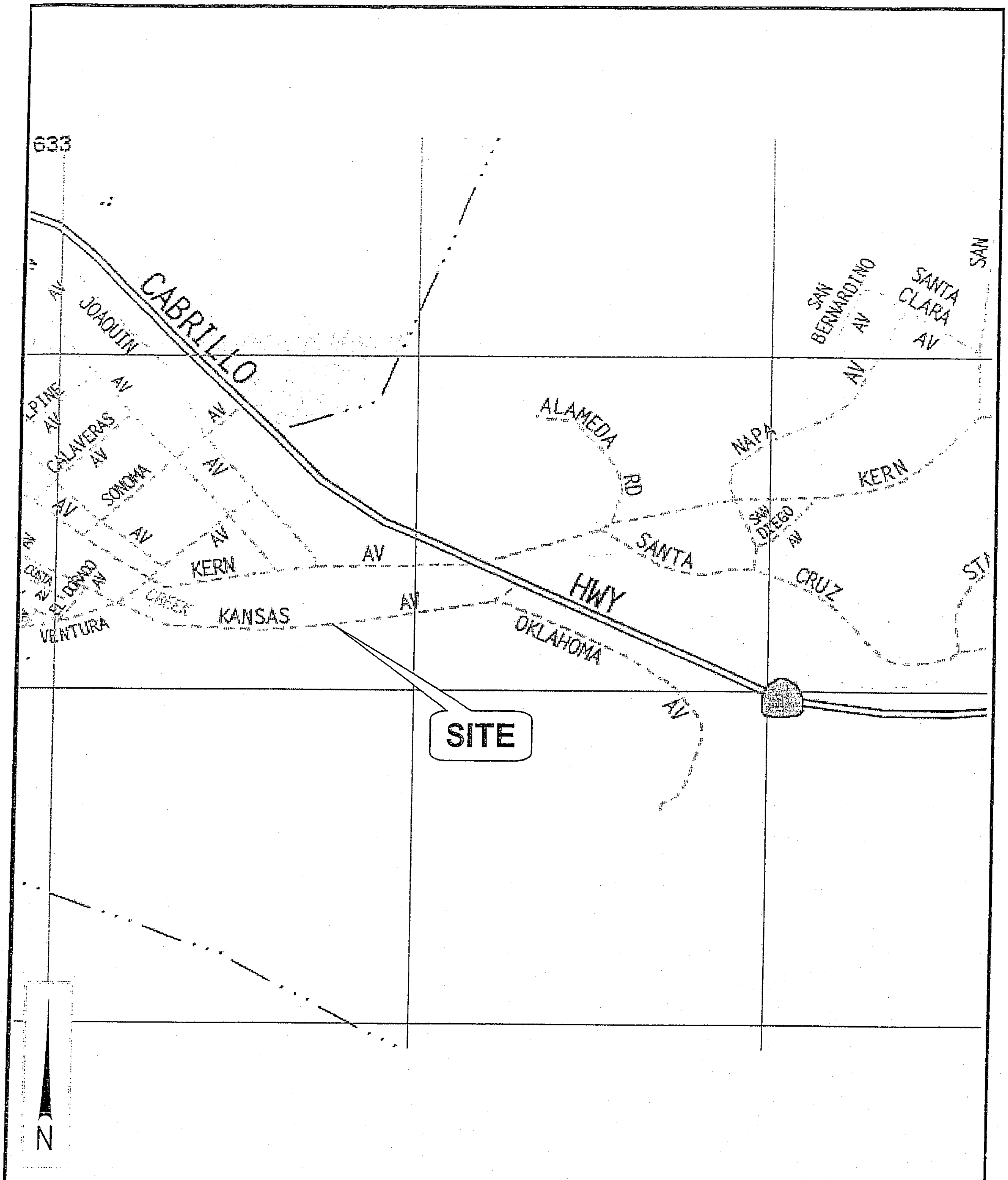
Thank you for the opportunity to have been of service in preparing this report. If you have any questions or require additional assistance, please feel free to contact the undersigned at (805) 543-5493.

Sincerely,

GSI SOILS

Ronald J. Church
Senior Engineer
GE #2184

FIGURES AND TABLES



	SITE MAP SEWER LINE REPLACEMENT PROJECT KANSAS AVENUE SAN LUIS OBISPO, CALIFORNIA	Project No.	Figure No.
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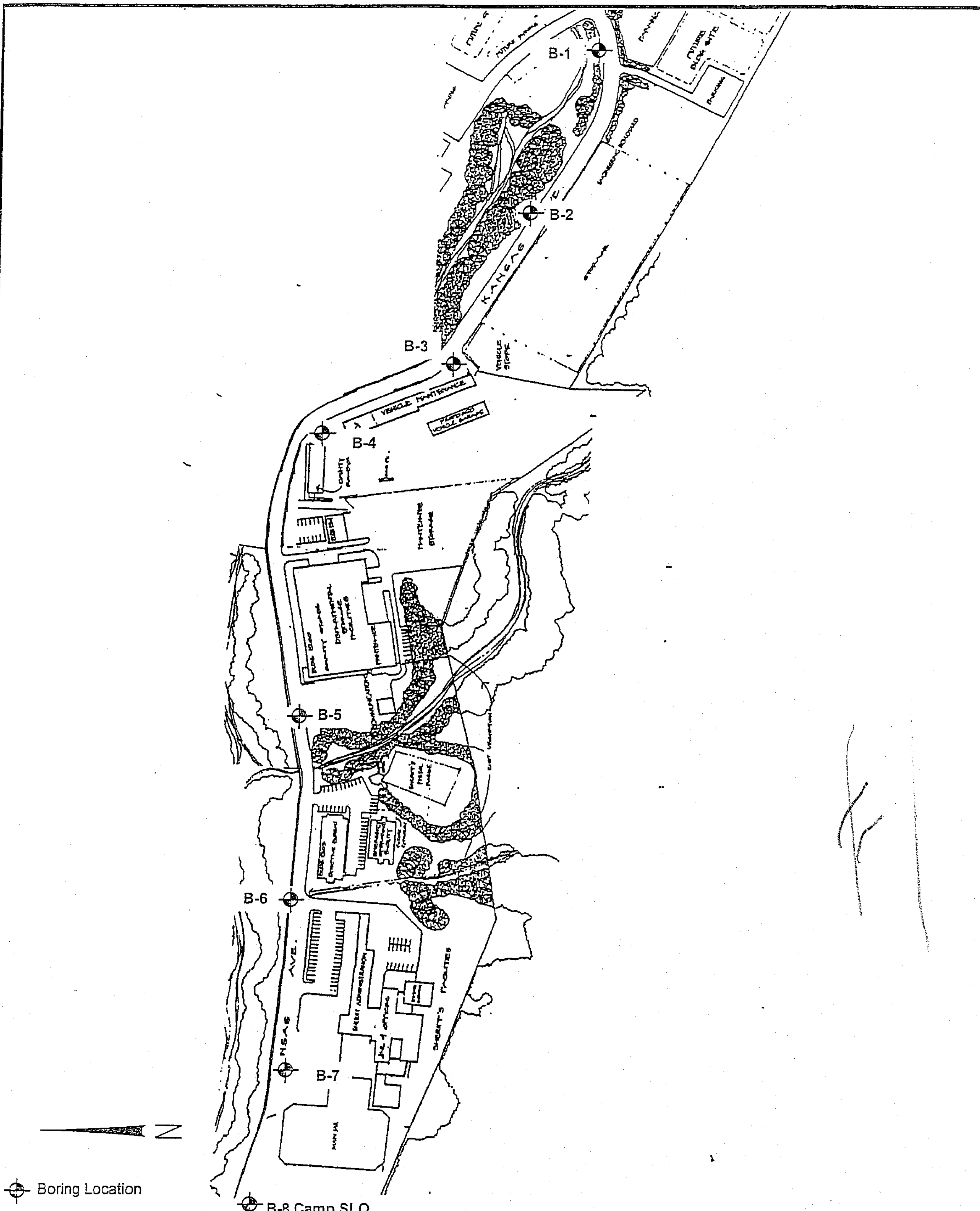
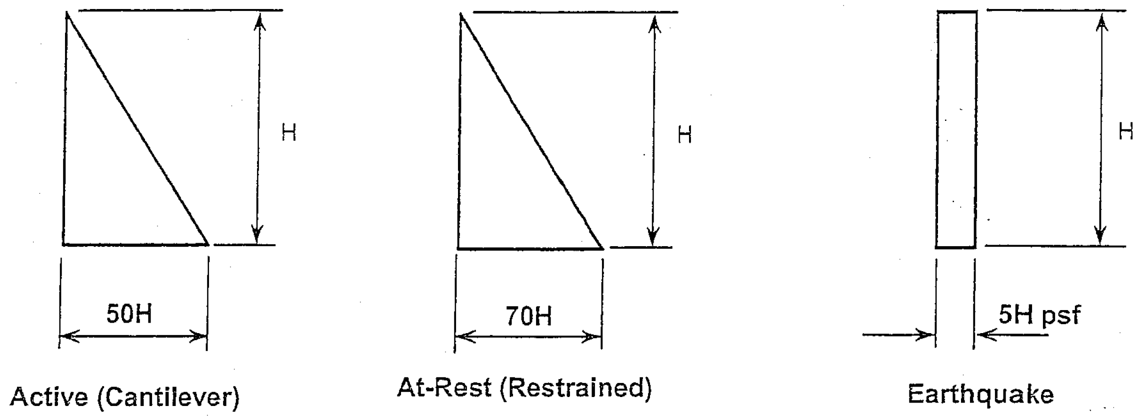
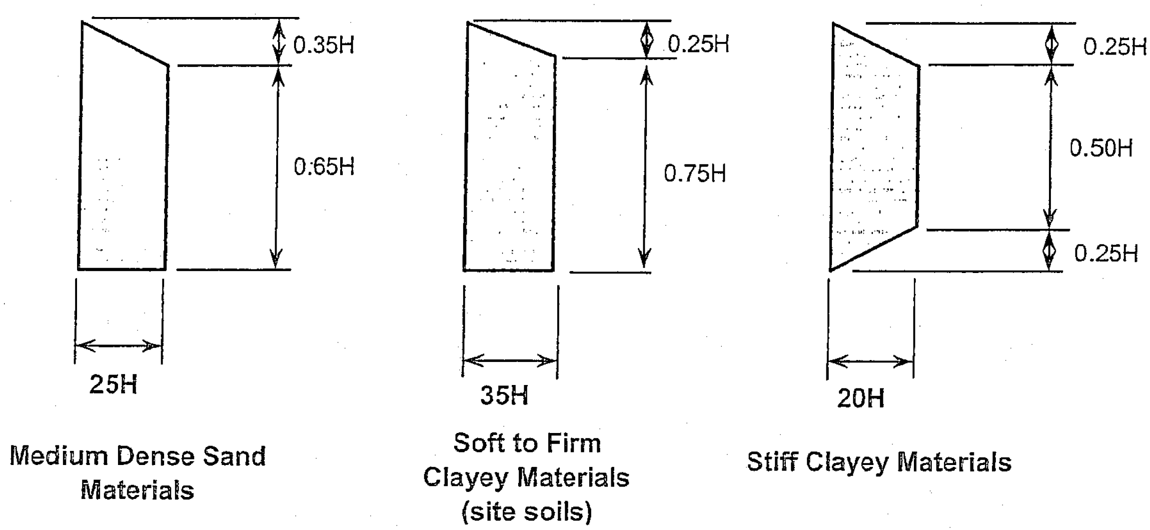


		Project No.	Figure No.
GSI	SITE PLAN SEWER LINE REPLACEMENT PROJECT KANSAS AVENUE SAN LUIS OBISPO, CALIFORNIA	2-1254	2

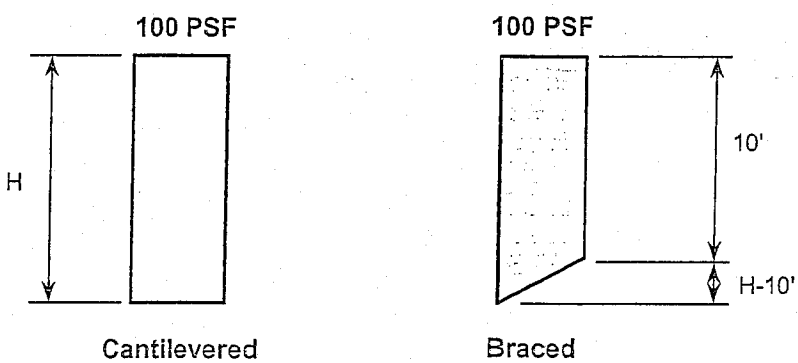
PERMANENT WALLS (DRAINED)



TEMPORARY WALLS (BRACED EXCAVATIONS, DRAINED)



ADDITIONAL LOADS DUE TO CONSTRUCTION[a]



[a] Based on surcharge load of 200 psf

GSI	LATERAL EARTH PRESSURES	Project No.	Figure No.
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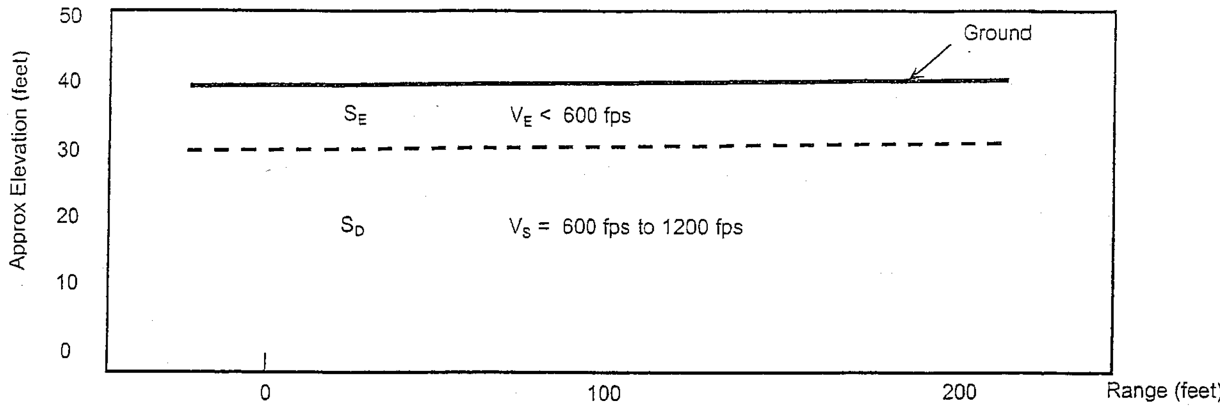


Soil Profile Type

- ○ S_E
- ◉ S_D
- ○ S_C
- ○ S_B
- ○ S_A

Seismic Source Type

- ○ Seismic Type A
- ◉ Seismic Type B
- ○ Seismic Type C

Closest Distance to Active Fault

- ○ < 2 km
- ◉ 5 km
- ○ 10 km
- ○ < 15 km

Seismic Coefficient

C_a (Seismic Coefficient) =	0.44 N_a
N_a (Near-Source Factor) =	1.0
C_v (Seismic Coefficient) =	0.64 N_v
N_v (Near-Source Factor) =	1.2

Soil Profile Type	Shear Wave Velocity, V_s (fps)
S_A = Hard Rock	> 5,000
S_B = Rock	2,500 to 5,000
S_C = Very Dense Soil and Soft Rock	1,200 to 2,500
S_D = Stiff Soil Profile	600 to 1,200
S_E = Soft Soil Profile	< 600

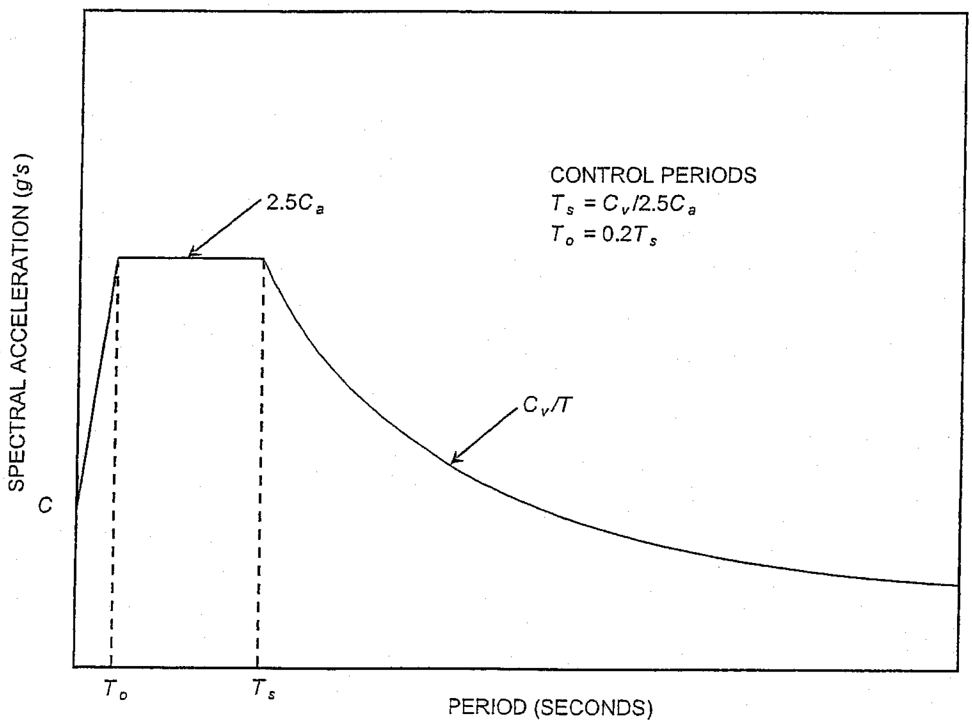


FIGURE 16.3 - DESIGN RESPONSE SPECTRA

	UBC SEISMIC FACTORS AND COEFFICIENTS, CHAPTER 16	Project No.	Figure No.
		2-1254	4

PROJECT:

SEWER LINE REPLACEMENT PROJECT

PROJECT NUMBER: 2-1254

DATE: October 29, 2002

LATITUDE: 35.3217 DEGREES

LONGITUDE: 12.7275 DEGREES

SOIL CLASS*: C Gb= 0

Gc= 1

TABLE 1
SEISMICITY TABLE

SOIL CLASSES* : A - HARD BEDROCK

B - SOFT BEDROCK & TERRACE

C - ALLUVIUM

D - BAY MUDS, PEAT

LOWER LEVEL EARTHQUAKE (LLE) and UPPER LEVEL EARTHQUAKE (ULE)

PEAK HORIZONTAL GROUND ACCELERATION (PHGA) ESTIMATE

(PREDICTIVE PHGA EQUATION FROM BOORE, JOYNER AND FUMAL, 1993*)

FAULT ZONE/ ACTIVITY LEVEL	LLE MOMENT MAGNITUDE (Mw)	ULE MOMENT MAGNITUDE (Mw)	DISTANCE TO SITE (km)	DIRECTION FROM SITE (COMPASS)	MAX. DURATION OF SHAKING** (seconds)	LLE PHGA* (g)	ULE PHGA* (g)
Los Osos [H]	6.6	6.8	4	SW	24	0.45	0.49
Hosgri [H]	6.8	7.3	21	SW	28	0.24	0.31
San Andreas [H]	7.6	7.8	58	NE	20	0.17	0.19
San Simeon [H]	6.6	7.3	56	NW	11	0.11	0.15
Oceanic [LQ]	6.7	6.9	10	SE	24	0.36	0.40
San Luis Range [LQ]	6.7	7.0	39	SE	24	0.15	0.17
Rinconada [LQ]	6.8	7.3	17	NE	26	0.27	0.35
Cambria [LQ]	6.1	6.3	21	NW	12	0.17	0.19
Wilmar Ave-SL Bay-Olson [LQ]	6.3	6.5	21	S	26	0.19	0.21
Oceano [LQ]	5.7	6.0	21	S	23	0.14	0.16
Casmalia [LQ]	6.3	6.5	44	S	17	0.11	0.12
Lion's Head [LQ]	6.3	6.6	50	S	17	0.10	0.12
Point San Luis [LQ]	6.5	7.0	19	SW	24	0.22	0.28
Big Pine [LQ]	6.5	6.9	124	SE	18	0.05	0.07
Los Alamos-Baseline [LQ]	6.6	6.8	98	SE	22	0.07	0.08
Santa Lucia Bank [Q]	6.8	7.3	64	W	20	0.11	0.14
La Panza [Q]	6.5	7.0	29	NE	23	0.17	0.21
San Juan [Q]	6.5	7.0	48	E	22	0.11	0.14
Ozena [Q]	6.5	7.0	108	SE	17	0.06	0.08

* BOORE, JOYNER AND FUMAL, 1993: U.S.G.S. OPEN-FILE REPORT 93-509

S.B. = SIERRA BLOCK

** BOLT, B.A., 1973: DURATION OF STRONG GROUND MOTION: PROC. FIFTH WORLD CONFERENCE ON EARTHQUAKE ENGINEERING, ROME, PAPER NO. 92, PP. 1304-1313.

Mw BASED ON PUBLISHED SLIP RATE DATA, WHERE AVAILABLE AND BRACKETED, i.e.

PETERSEN AND WESNOUSKY, 1994, BULLETIN OF THE SEISMOLOGICAL SOCIETY OF AMERICA, VOL 84, No. 5, pp. 1608 - 1649

WORKING GROUP ON CALIF. EARTHQUAKE PROBABILITIES, 1995, BULL. OF SEISMO. SOC. OF AM., VOL. 85, No. 2, pp. 379 - 439.

PETERSEN AND OTHERS, 1996, CALIF. DIV. OF MINES & GEOLOGY, OFR 96-08 // U.S. GEOLOGICAL SURVEY OFR 96-706

ALTERNATELY, WHEN SLIP RATE DATA IS ABSENT OR NON-BRACKETED Mw BASED ON:

(1) A POSTULATED RUPTURE L (M/ULE) OR L/seg (M/LLE) AND ASSOCIATED SLIP RATE, WHERE L IS TOTAL FAULT LENGTH (ALL SEGMENTS);

OR

(2) A PUBLISHED SOURCE CATALOG OF ESTIMATED LLE OR ULE EVENTS, i.e.:

SCHWARTZ, 1994, ATC 35-1 SEMINAR PROCEEDINGS, pp. 4-1 to 4-9.

MUALCHIN AND JONES, 1992, C.D.M.G. OPEN-FILE REPORT 92-1.

LLE = 10% EXCEEDENCE IN 50 YEARS ULE = Mmax [PETERSEN: CDMG OFR 96-08]

[Q] = QUATERNARY/POTENTIALLY ACTIVE; [LQ]= LATE QUATERNARY/POTENTIALLY ACTIVE; [H]= HOLOCENE/ACTIVE

APPENDIX A

Field Investigation
Key to Boring Logs
Boring Logs

FIELD INVESTIGATION

Test Hole Drilling

The field investigation was conducted on October 1 and 2, 2002. Eight (8) exploratory borings were drilled at the approximate locations indicated on the Site Plan, Figure 2. The locations of these borings were approximated in the field.

Undisturbed and bulk samples were obtained at various depths during test hole drilling. The undisturbed samples were obtained by driving a 2.4-inch inside diameter sampler into soils. Bulk samples were also obtained during drilling.

Logs of Boring

A continuous log of soils, as encountered in the borings was recorded at the time of the field investigation, by a Staff Engineer. The Exploration Boring Logs are attached.

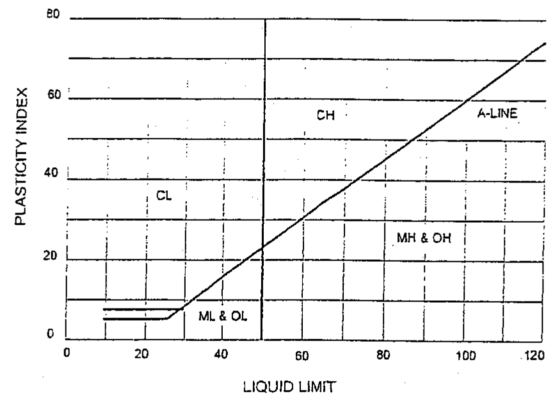
Locations and depth of sampling, in-situ soil dry densities and moisture contents are tabulated in the Boring Logs.

UNIFIED SOIL CLASSIFICATION SYSTEMS

MAJOR DIVISION			SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS Over 50% > #200 sieve	GRAVELS Over 50% > #4 sieve	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS Over 50% < #4 sieve	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS Over 50% < #200 sieve	SILTS AND CLAYS Liquid limit < 50		ML	INORGANIC SILTS, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS Liquid limit > 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS 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 CLAYS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

PLASTICITY CHART

USED FOR CLASSIFICATION OF FINE GRAINED SOILS



SOIL GRAIN SIZE

U.S. STANDARD SIEVE

	6"	3"	3/4"	4	10	40	200		
BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		
150	75	19	4.75	2.0	0.425	0.075	0.002	

SOIL GRAIN SIZE IN MILLIMETERS

SAMPLE DRIVING RECORD

BLOWS PER FOOT	DESCRIPTION
25	25 BLOWS DROVE SAMPLER 12 INCHES, AFTER INITIAL 6 INCHES OF SEATING
50/7"	50 BLOWS DROVE SAMPLER 7 INCHES, AFTER INITIAL 6 INCHES OF SEATING
Ref/3"	50 BLOWS DROVE SAMPLER 3 INCHES DURING OR AFTER INITIAL 6 INCHES OF SEATING

NOTE: TO AVOID DAMAGE TO SAMPLING TOOLS, DRIVING IS LIMITED TO 50 BLOWS PER 6 INCHES DURING OR AFTER SEATING INTERVAL

KEY TO TEST DATA

B	Bag Sample	CONS	Consolidation (ASTM D2435)
	Drive, No Sample Collected	DS	Cons. Drained Direct Shear (ASTM D3080)
	2 1/2" O.D. Mod. California Sampler, Not Tested	PP	Pocket Penetrometer
	2 1/2" O.D. Mod. California Sampler, Tested	GSD	Grain Size Distribution (ASTM D422)
	Standard Penetration Test	CP	Compaction Test (ASTM D1557)
O	Sample Attempted with No Recovery	EI	Expansion Index (ASTM D4829)
	Water Level at Time of Drilling	LL	Liquid Limit (in percent)
	Water Level after Drilling	PI	Plasticity Index

RELATIVE DENSITY

SANDS, GRAVELS, AND NON PLASTIC SILTS	BLOWS/FOOT
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	OVER 50

RELATIVE DENSITY

CLAYS AND PLASTIC SILTS	STRENGTH	BLOWS/FOOT
VERY SOFT	0 - 1/4	0 - 2
SOFT	1/4 - 1/2	2 - 4
FIRM	1/2 - 1	4 - 8
STIFF	1 - 2	8 - 16
VERY STIFF	2 - 4	16 - 32
HARD	OVER 4	OVER 32

GSI

PROJECT NO.:	2-1254	SOIL CLASSIFICATION CHART
DATE DRILLED:	10/2/02	AND BORING LOG LEGEND
SEWER LINE REPLACEMENT PROJECT		FIGURE NO.
SAN LUIS OBISPO, CALIFORNIA		A-1

LOGGED BY: PRF	DRILL RIG: Simco 2400	BORING NO.: B-1
ELEVATION: 360'	BORING DIAMETER (INCH): 4	DATE DRILLED: 2 October 2002
	GROUNDWATER DEPTH (FT): 8.0	

ELEVATION (FT)	DEPTH (FT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
			Baserock									
359	1											
358	2		Sandy Clay: dark grey, slightly moist to moist, fine to medium grained, soft	CL	B		37.3					
357	3											
356	4											
355	5		moist to very moist, firm			5	29.5					
354	6											
353	7											
352	8		saturated									
351	9				B		44.3					
350	10											
349	11		very soft			2	56.8					
348	12											
347	13				B		67.8					
346	14											
345	15		stiff			9						
			Boring Terminated at 15 feet									
344	16											
343	17											
342	18											
341	19											
340	20											

EXPLORATORY BORING LOGS

GSI

SEWER LINE REPLACEMENT PROJECT KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
2-1254	October-02	A-2

LOGGED BY: PRF	DRILL RIG: Simco 2400	BORING NO.: B-2
ELEVATION: 360'	BORING DIAMETER (INCH): 4	DATE DRILLED: 2 October 2002
	GROUNDWATER DEPTH (FT): 8.0	

ELEVATION (FT)	DEPTH (FT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
			Baserock/Redrock									
359	1											
358	2		Sandy Clay: dark brown, moist, fine to medium grained, trace gravels, soft	CL	B		22.4					
357	3											
356	4											
355	5		firm			10	22.8	88.3				
354	6											
353	7				B		24.0					
352	8		saturated									
351	9											
350	10					5	35.9					
349	11											
348	12				B		39.8					
347	13											
346	14											
345	15		stiff			9						
			Boring Terminated at 15 feet									
344	16											
343	17											
342	18											
341	19											
340	20											

EXPLORATORY BORING LOGS

GSI

SEWER LINE REPLACEMENT PROJECT
KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
2-1254	October-02	A-3

LOGGED BY: PRF	DRILL RIG: Simco 2400	BORING NO.: B-3
ELEVATION: 360'	BORING DIAMETER (INCH): 4	DATE DRILLED: 2 October 2002
	GROUNDWATER DEPTH (FT): 9.0	

ELEVATION (FT)	DEPTH (FT)	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
		AC Baserock									
359	1										
358	2	Sandy Clay: dark greyish brown, moist to moist, fine to medium grained, soft	CL	B		28.6					
357	3										
356	4										
355	5	very moist, firm		SPT	5	41.2		36	19		
354	6										
353	7			B							
352	8										
351	9	saturated (groundwater)									
350	10	very soft		SPT	2						
349	11										
348	12			B		56.7					
347	13										
346	14										
345	15	firm		SPT	5						
		Boring Terminated at 15 feet									
344	16										
343	17										
342	18										
341	19										
340	20										

EXPLORATORY BORING LOGS

GSI

SEWER LINE REPLACEMENT PROJECT
KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
2-1254	October-02	A-4

LOGGED BY: PRF	DRILL RIG: Simco 2400	BORING NO.: B-4
ELEVATION: 360'	BORING DIAMETER (INCH): 4	DATE DRILLED: 2 October 2002
	GROUNDWATER DEPTH (FT): 5.0	

ELEVATION (FT)	DEPTH (FT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
			Base/Redrock									
359	1											
358	2		Sand PG, brown, slightly moist, fine to medium grained, trace gravels, loose (fill)	SP	B		9.8					
357	3											
356	4											
355	5		saturated			4	20.3	97.2				
354	6											
353	7		greyish brown		B		30.2					
352	8											
351	9											
350	10		very loose			3	49.4					
349	11											
348	12											
347	13				B							
346	14											
345	15					2	62.6					
			Boring Terminated at 15 feet									
344	16											
343	17											
342	18											
341	19											
340	20											

EXPLORATORY BORING LOGS

GSI

SEWER LINE REPLACEMENT PROJECT
KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
2-1254	October-02	A-5

LOGGED BY: PRF | DRILL RIG: Simco 2400 | BORING NO.: B-5

ELEVATION: 360' | BORING DIAMETER (INCH): 4 | DATE DRILLED: 2 October 2002

GROUNDWATER DEPTH (FT): 14.0

ELEVATION (FT)	DEPTH (FT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
			AC Baserock									
359	1											
358	2		Silty Sandy Clay, yellow brown, slightly moist, soft	CL	B		13.7					
357	3											
356	4		Silty Clay, dark brown, slightly moist to moist, fine to medium grained, soft	CL								
355	5					5	9.7					
354	6											
353	7		moist, firm		B		20.0					
352	8											
351	9											
350	10		very stiff			18	28.3					
349	11											
348	12											
347	13				B		27.8					
346	14		saturated									
345	15		Boring Terminated at 15 feet									
344	16											
343	17											
342	18											
341	19											
340	20											

EXPLORATORY BORING LOGS

GSI

SEWER LINE REPLACEMENT PROJECT
KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
2-1254	October-02	A-6

LOGGED BY: PRF | DRILL RIG: Simco 2400 | BORING NO.: B-6

ELEVATION: 360' | BORING DIAMETER (INCH): 4 | DATE DRILLED: 2 October 2002

GROUNDWATER DEPTH (FT):

ELEVATION (FT)	DEPTH (FT)	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
		AC Baserock									
359	1	Sandy Clay, yellow brown, moist to moist, fine to medium grained, soft	CL								
358	2			B		26.2					
357	3										
356	4	Silty Clay, dark brown, moist, fine to medium grained, soft	CL								
355	5				10	23.2	105.0				
354	6										
353	7			B		21.2					
352	8										
351	9	moist									
350	10				6						
349	11	Clayey Sand, yellow brown, slightly moist, trace gravels, loose	SC								
348	12			B		9.6					
347	13										
346	14										
345	15				10	19.6					
344	16	Boring Terminated at 15 feet									
343	17										
342	18										
341	19										
340	20										

EXPLORATORY BORING LOGS

GSI

SEWER LINE REPLACEMENT PROJECT
KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
2-1254	October-02	A-7

LOGGED BY: PRF	DRILL RIG: Simco 2400	BORING NO.: B-7
ELEVATION: 360'	BORING DIAMETER (INCH): 4	DATE DRILLED: 2 October 2002
GROUNDWATER DEPTH (FT):		

ELEVATION (FT)	DEPTH (FT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
			AC Baserock									
359	1		Silty Clay, yellow brown, moist, fine to medium grained, soft	CL								
358	2				B		24.2		32	16		
357	3											
356	4											
355	5					8	29.2					
354	6		stiff									
353	7				B		22.0					
352	8											
351	9											
350	10		very stiff			24	11.0					
349	11		Clayey Sand, yellow brown, slightly moist, trace gravels, medium dense	SP								
348	12				B							
347	13											
346	14											
345	15					26	10.3					
			Boring Terminated at 15 feet									
344	16											
343	17											
342	18											
341	19											
340	20											

EXPLORATORY BORING LOGS

GSI

SEWER LINE REPLACEMENT PROJECT
KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
2-1254	October-02	A-8

LOGGED BY: PRF	DRILL RIG: Simco 2400	BORING NO.: B-8
ELEVATION: 360'	BORING DIAMETER (INCH): 4	DATE DRILLED: 2 October 2002
GROUNDWATER DEPTH (FT):		

ELEVATION (FT)	DEPTH (FT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
			Baserock									
359	1		Silty Sand, yellow brown, slightly moist, fine to medium grained, loose	SM								
358	2				B		9.8					
357	3		moist									
356	4											
355	5					11	10.4					
			Clayey Sand, brown, moist, trace gravels, medium dense	SC								
354	6											
353	7				B		14.0					
352	8											
351	9											
350	10					22						
349	11											
348	12				B		13.0					
347	13											
346	14		very dense									
345	15					70						
			Sandy Clay, yellow brown, moist to very moist, trace gravels, soft	CL								
344	16											
343	17											
342	18				B		23.3					
341	19											
340	20											
			Boring Terminated at 20 feet									

EXPLORATORY BORING LOGS

GSI

SEWER LINE REPLACEMENT PROJECT
KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
2-1254	October-02	A-9

APPENDIX B

Laboratory Testing
Moisture-Density Tests
Direct Shear Test
R-Value Test
Expansion Index
Atterberg Limits
Optimum-Moisture/Maximum Density

LABORATORY TESTING

Moisture-Density Tests

The field moisture content, as a percentage of the dry weight of the soil, was determined by weighing samples before and after oven drying. Dry densities, in pounds per cubic foot, were also determined for the undisturbed samples. Results of these determinations are shown in the Exploration Drill Hole Logs.

Direct Shear Test

Direct shear tests were performed on undisturbed samples, to determine strength characteristics of the soil. The test specimens were soaked prior to testing. Results of the shear strength tests are attached.

Resistance (R) Value Test

An R-Value test was estimated based on seive analysis and plasticity on a bulk sample obtained from boring B-2. The results of the tests indicate that the soils have an R-Value of 8.

Expansion Index Tests

Expansion index (EI) testing was performed on samples obtained from borings B-2 and B-5. EI values of 42 and 30 were obtained respectively. The test procedures were performed in accordance with Uniform Building Code Standard 29-2.

Atterberg Limits

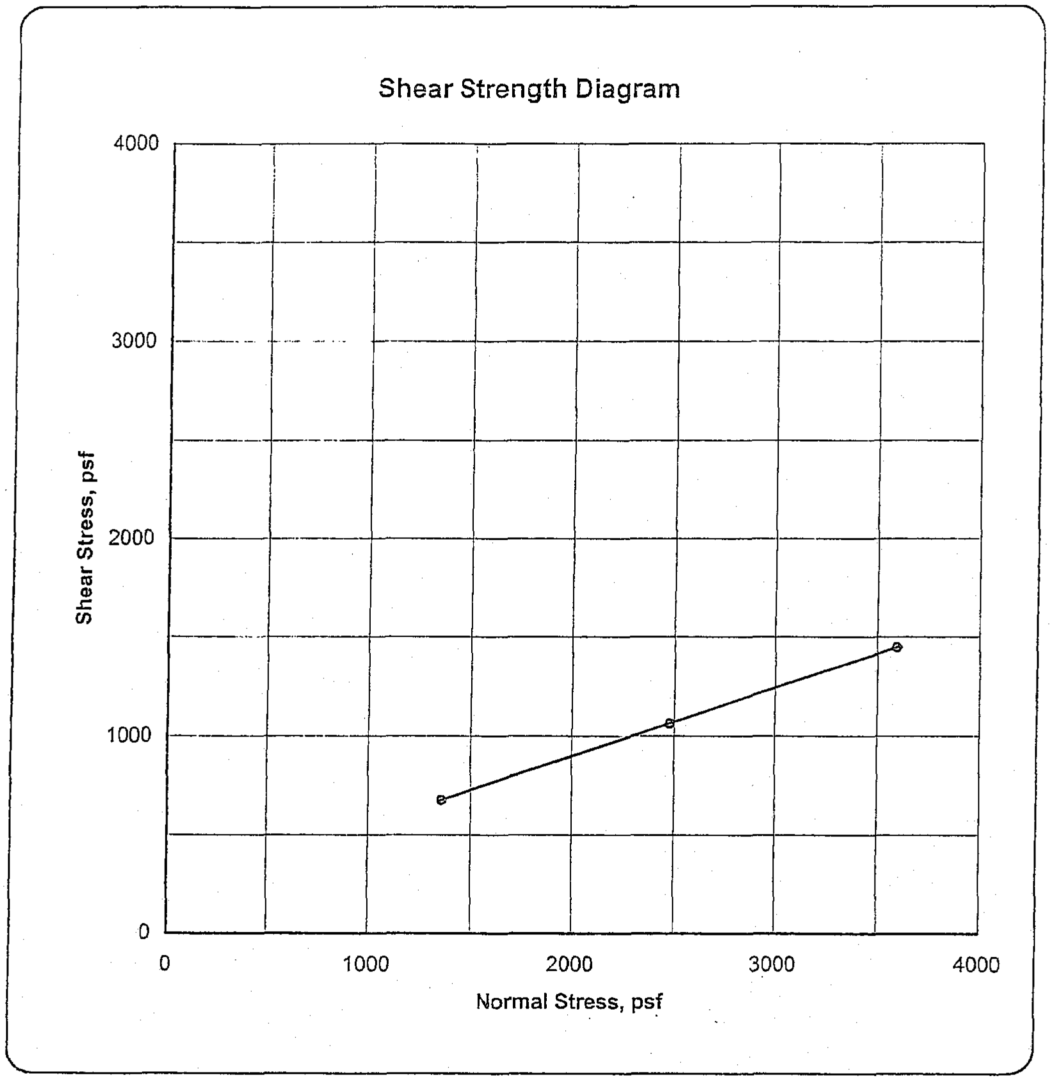
The liquid limit, plastic limit and plasticity index was determined for selected samples in accordance with ASTM D4318. The results are presented on the boring logs.

Optimum-Moisture/Maximum Density

A dry density of determination at predetermined moisture contents was obtained in the laboratory by compacting prepared soil specimens in accordance with ASTM Test Method D1557. Data for the test provide an indication of the increase in dry density, which can be obtained from the designated compactive effort, and establish the relationship of the water content to the maximum obtainable dry density. A zero air void curve developed for an assumed specific gravity is plotted concurrently with the compaction data to provide a measure of the degree of saturation of the compacted soil.

DIRECT SHEAR TEST

ASTM D3080-90 (Modified for unconsolidated-undrained conditions)



Project: KANSAS AVENUE

Project No. 2-1254

Sample Location: B-2 @ 5'

Initial Dry Density (pcf) 88.3

Soil Description: **Sandy Clay**

Initial Moisture (%) 22.8

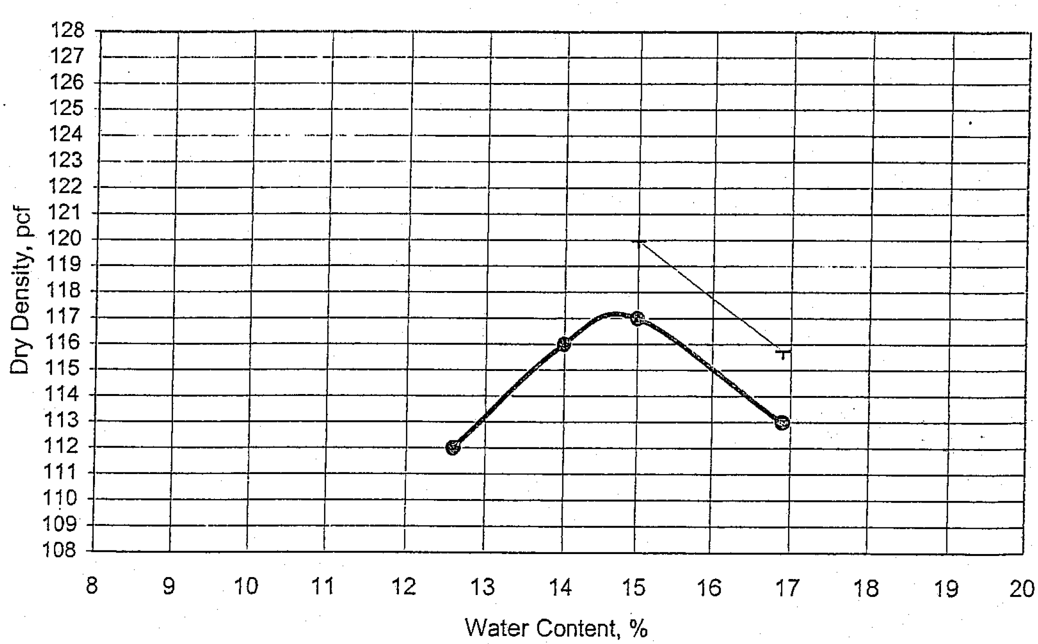
Sample Type: ○ Remolded ◉ Ring

Peak Shear Angle **19**

Cohesion (psf) **210**

MAXIMUM DENSITY/ OPTIMUM MOISTURE
ASTM D1557

DATE:	10/17/02
SOIL TYPE:	Silty Sand
LOCATION:	B-8, 1 to 3 feet
PROJECT:	2-1254
SITE LOCATION:	Kansas Ave, Camp Roberts
Max Dry Density:	117.3 pcf
Optimum Moisture:	14.80%



ADDENDUM TO GEOTECHNICAL INVESTIGATIONS – ADDITIONAL BORINGS

GSI SOILS INC.
141 Suburban Road, Suite D-1
San Luis Obispo, CA 93401
Tel: (805) 543-5493
Fax: (805) 543-2748

524 East Chapel Street
Santa Maria, CA 93454
Tel: (805) 349-0140
Fax: (805) 349-8861

February 9, 2006
Project 5-3576

Cesar Romero
Boyle Engineering Corporation
1194 Pacific Street, Suite 204
San Luis Obispo, CA 93401

Subject: Addendum to Geotechnical Investigation- Additional Borings
Sewer Line Replacement Project
Kansas Avenue
San Luis Obispo, California

Reference: Geotechnical Investigation, Sewer Line Replacement Project, Kansas Avenue, San Luis Obispo, California by GSI Soils Inc., dated October 29, 2002, Project 2-1215.

Dear Cesar:

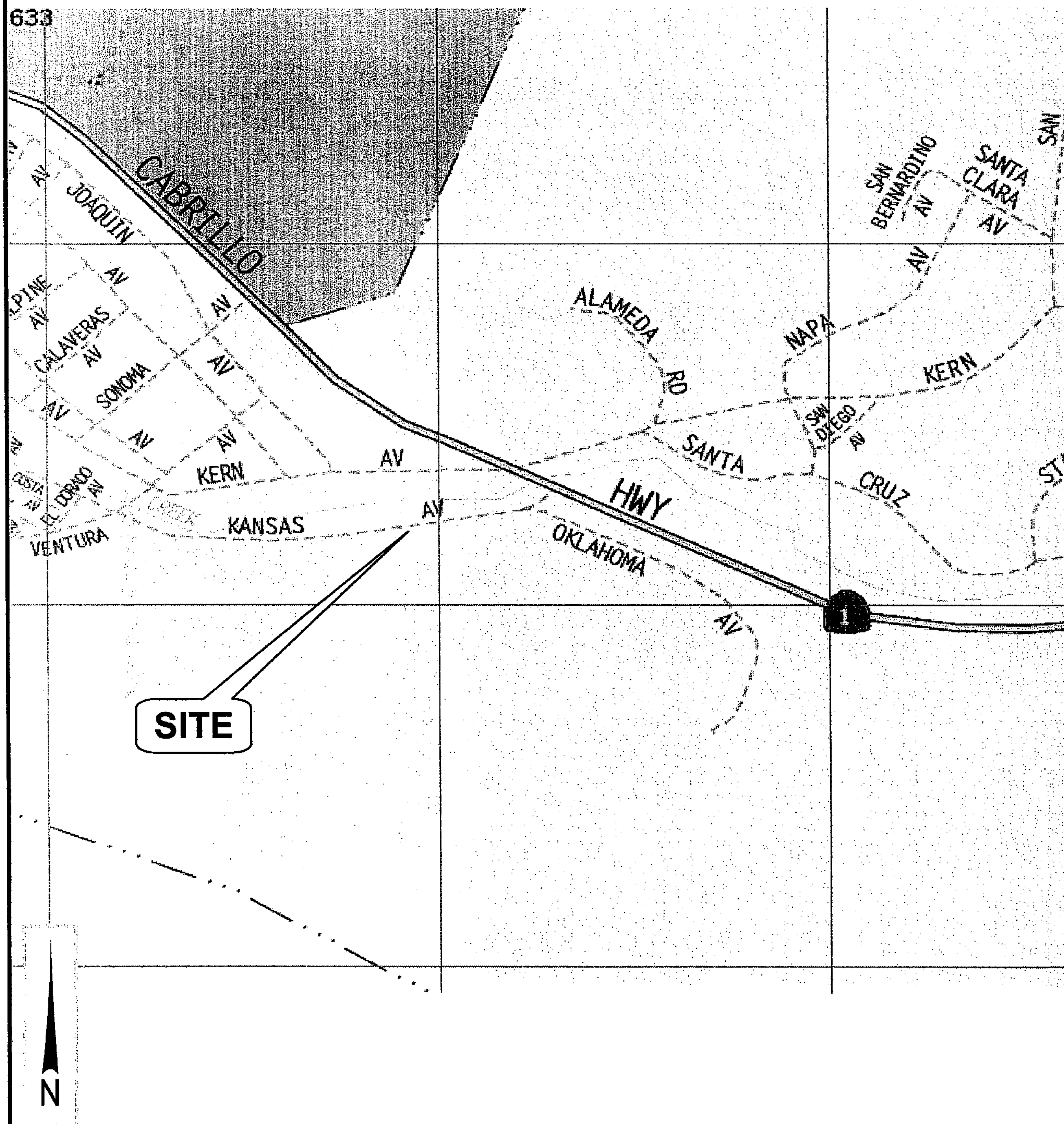
As requested, seven (7) additional exploratory borings were drilled at the above noted project on December 30, 2005, January 5 and 9, 2006. A site map, site plan, and logs of the borings are attached. Previous borings (reference report drilled 10/2/02) indicated that shallow groundwater (5 to 9 feet deep) was present over this section of Kansas Avenue.

Our recent borings (Dec. 2005/ Jan. 2006) show that the depth to groundwater varies from 4 to 9 feet. This indicates that the groundwater depth has change minimally since 2002. Further monitoring of the groundwater depths at boring locations B-4 and B-6 will be performed.

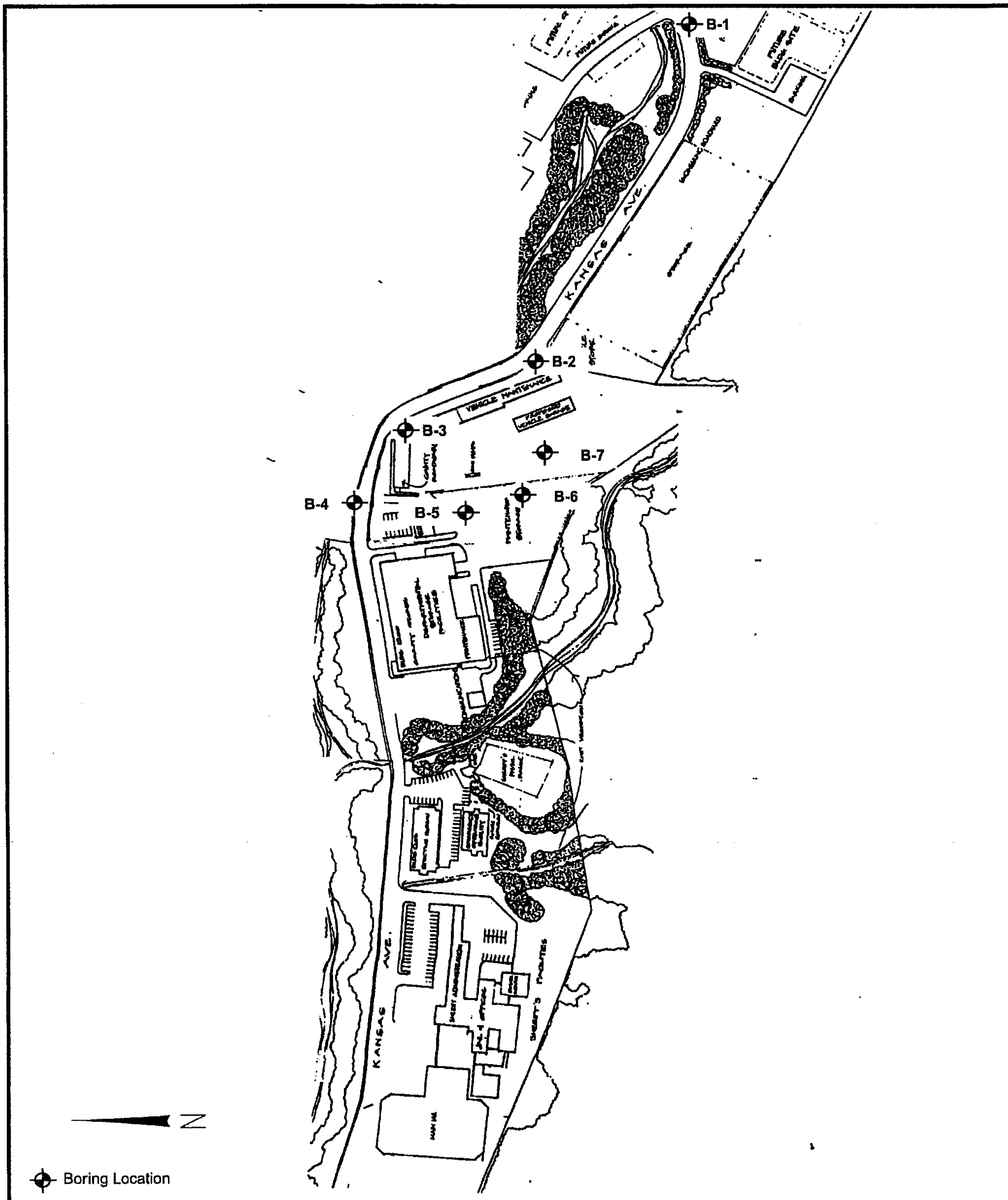
We appreciate the opportunity to have been of service. If you require additional assistance, please do not hesitate to contact me at (805) 543-5493.

Sincerely,
GSI SOILS INC.

Ron J. Church
Senior Engineer
GE #2184



	SITE MAP KANSAS AVENUE SEWER PROJECT KANSAS AVENUE SAN LUIS OBISPO, CALIFORNIA	Project No.	Figure No.
GSI		5-3576	1



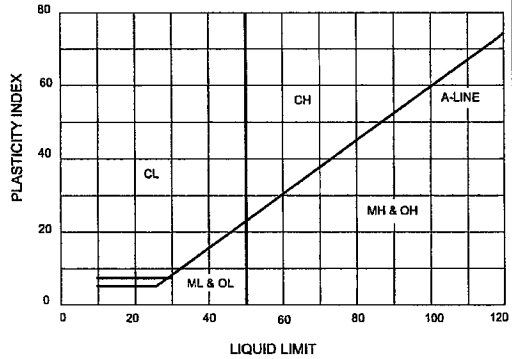
GSI	SITE PLAN KANSAS AVENUE SEWER PROJECT KANSAS AVENUE SAN LUIS OBISPO, CALIFORNIA	**Project No.** 5-3576	**Figure No.** 2

UNIFIED SOIL CLASSIFICATION SYSTEMS

MAJOR DIVISION			SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS Over 50% > #200 sieve	GRAVELS Over 50% > #4 sieve	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS Over 50% < #4 sieve	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS Over 50% < #200 sieve	SILTS AND CLAYS Liquid limit < 50		ML	INORGANIC SILTS, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS Liquid limit > 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS 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 CLAYS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

PLASTICITY CHART

USED FOR CLASSIFICATION OF FINE GRAINED SOILS



SOIL GRAIN SIZE

U.S. STANDARD SIEVE

	6"	3"	3/4"	4	10	40	200		
BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY	
		COARSE	FINE	COARSE	MEDIUM	FINE			
150		75	19	4.75	2.0	0.425	0.075	0.002	

SOIL GRAIN SIZE IN MILLIMETERS

SAMPLE DRIVING RECORD

BLOWS PER FOOT	DESCRIPTION
25	25 BLOWS DROVE SAMPLER 12 INCHES, AFTER INITIAL 6 INCHES OF SEATING
50/7"	50 BLOWS DROVE SAMPLER 7 INCHES, AFTER INITIAL 6 INCHES OF SEATING
Ref/3"	50 BLOWS DROVE SAMPLER 3 INCHES DURING OR AFTER INITIAL 6 INCHES OF SEATING

NOTE: TO AVOID DAMAGE TO SAMPLING TOOLS, DRIVING IS LIMITED TO 50 BLOWS PER 6 INCHES DURING OR AFTER SEATING INTERVAL

KEY TO TEST DATA

B	Bag Sample	CONS	Consolidation (ASTM D2435)
	Drive, No Sample Collected	DS	Cons. Drained Direct Shear (ASTM D3080)
	2 1/2" O.D. Mod. California Sampler, Not Tested	PP	Pocket Penetrometer
	2 1/2" O.D. Mod. California Sampler, Tested	GSD	Grain Size Distribution (ASTM D422)
	Standard Penetration Test	CP	Compaction Test (ASTM D1557)
	Sample Attempted with No Recovery	EI	Expansion Index (ASTM D4829)
	Water Level at Time of Drilling	LL	Liquid Limit (in percent)
	Water Level after Drilling	PI	Plasticity Index

RELATIVE DENSITY

SANDS, GRAVELS, AND NON PLASTIC SILTS	BLOWS/FOOT
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	OVER 50

RELATIVE DENSITY

CLAYS AND PLASTIC SILTS	STRENGTH	BLOWS/FOOT
VERY SOFT	0 - 1/4	0 - 2
SOFT	1/4 - 1/2	2 - 4
FIRM	1/2 - 1	4 - 8
STIFF	1 - 2	8 - 16
VERY STIFF	2 - 4	16 - 32
HARD	OVER 4	OVER 32

GSI

PROJECT NO.:	5-3576	SOIL CLASSIFICATION CHART
DATE DRILLED:	12/30/2005	AND BORING LOG LEGEND

KANSAS AVENUE SEWER PROJECT
SAN LUIS OBISPO, CALIFORNIA

FIGURE NO. **A-1**

LOGGED BY: **BP** | DRILL RIG: **Simco 2400** | BORING NO.: **B-1**

ELEVATION: **360'** | BORING DIAMETER (INCH): **4** | DATE DRILLED: **30 December 2005**

GROUNDWATER DEPTH (FT): **6.0**

ELEVATION (FT)	DEPTH (FT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
			Sandy Clay: dark brown, moist, fine to coarse grained, trace gravel and silt, firm	CL								
359	1											
358	2				B		25.6					
357	3		increasing sand and gravel		◢	8	36.1					
356	4											
355	5											
354	6		▽									
			saturated									
353	7											
352	8				B		51.7					
			decreasing sand and gravel, some organics									
351	9											
350	10											
349	11											
348	12											
347	13				B		60.9					
346	14		no organics									
345	15											
344	16											
			Boring terminated at 16 feet Groundwater encountered at 6 feet below grade and stabilized at that depth									
343	17											
342	18											
341	19											
340	20											

EXPLORATORY BORING LOGS

GSI

KANSAS AVENUE SEWER PROJECT
KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
5-3576	**February-06**	**A-2**

LOGGED BY: **BP** | DRILL RIG: **Simco 2400** | BORING NO.: **B-2**

ELEVATION: **360'** | BORING DIAMETER (INCH): **4** | DATE DRILLED: **30 December 2005**

GROUNDWATER DEPTH (FT): **3.5**

ELEVATION (FT)	DEPTH (FT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
			Sandy Clay: dark brown, moist, fine to coarse grained, trace gravel and silt, firm	CL								
359	1											
358	2				B		39.9					
357	3											
356	4		very moist									
355	5											
354	6		saturated									
353	7											
352	8		some organics		B		64.2					
351	9											
350	10											
349	11											
348	12											
347	13				B		54.7					
346	14											
345	15		Boring terminated at 15 feet Groundwater encountered at 6 feet below grade rising to 4 feet after 1 hour									
344	16											
343	17											
342	18											
341	19											
340	20											

EXPLORATORY BORING LOGS

GSI

KANSAS AVENUE SEWER PROJECT
KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
5-3576	**February-06**	**A-3**

LOGGED BY: **BP** DRILL RIG: **Simco 2400** BORING NO.: **B-3**

ELEVATION: **360'** BORING DIAMETER (INCH): **4** DATE DRILLED: **30 December 2005**

GROUNDWATER DEPTH (FT): **5.0**

ELEVATION (FT)	DEPTH (FT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
			Sandy Clay: dark brown, moist, fine to coarse grained, trace gravel and silt, firm	CL								
359	1				B							
358	2		decreasing sand, very moist									
357	3											
356	4				B		29.4					
355	5		saturated									
354	6											
353	7											
352	8				B		36.9					
351	9											
350	10											
349	11											
348	12											
347	13				B		41.7					
346	14											
345	15		Boring terminated at 15 feet Groundwater encountered at 5 feet below grade and stabilized at that elevation									
344	16											
343	17											
342	18											
341	19											
340	20											

EXPLORATORY BORING LOGS

GSI

KANSAS AVENUE SEWER PROJECT
KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
5-3576	**February-06**	**A-4**

LOGGED BY: PF	DRILL RIG: Simco 2400	BORING NO.: B-4
ELEVATION: 280'	BORING DIAMETER (INCH): 4	DATE DRILLED: 9 January 2006
GROUNDWATER DEPTH (FT): 9.0		

ELEVATION (FT)	DEPTH (FT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
			Asphalt Concrete over Baserock	GP								
279	1											
278	2		Silty Sandy Clay: yellow brown, slightly moist, fine to coarse grained, soft (fill)	CL-CH	B		13.8					
277	3											
276	4		Silty Clay: dark brown, moist, fine to medium grained, firm	CL		6	12.5					
275	5											
274	6											
273	7											
272	8				B		19.5					
271	9		saturated, stiff									
270	10											
269	11											
268	12											
267	13				B		33.1					
266	14		very stiff									
265	15											
264	16		Boring terminated at 16 feet Groundwater encountered at 9 feet below grade and stabilized at that elevation									
263	17											
262	18											
261	19											
260	20											

EXPLORATORY BORING LOGS

GSI

KANSAS AVENUE SEWER PROJECT
KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
5-3576	February-06	A-5

LOGGED BY: **BP**	DRILL RIG: **Simco 2400**	BORING NO.: **B-5**
ELEVATION: **360'**	BORING DIAMETER (INCH): **4**	DATE DRILLED: **5 January 2006**
	GROUNDWATER DEPTH (FT): **5.0**	

ELEVATION (FT)	DEPTH (FT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
			Silty Sand: yellow brown, moist, fine to coarse grained, some gravel and clay, medium dense	SM								
359	1											
358	2				B		7.3					
357	3		Sandy Clay: dark brown, very moist, fine to coarse grained, trace gravel and silt, firm	CL								
356	4											
355	5		saturated									
354	6											
353	7											
352	8				B		46.8					
351	9											
350	10		Boring terminated at 15 feet Groundwater encountered at 5 feet below grade and stabilized at that elevation									
349	11											
348	12											
347	13											
346	14											
345	15											
344	16											
343	17											
342	18											
341	19											
340	20											

EXPLORATORY BORING LOGS

GSI

KANSAS AVENUE SEWER PROJECT
KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
5-3576	**February-06**	**A-6**

LOGGED BY: **BP** DRILL RIG: **Simco 2400** BORING NO.: **B-6**

ELEVATION: **360'** BORING DIAMETER (INCH): **4** DATE DRILLED: **5 January 2006**

GROUNDWATER DEPTH (FT): **5.0**

ELEVATION (FT)	DEPTH (FT)	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
		Silty Sand: yellow brown, moist, fine to coarse grained, some gravel and clay, medium dense	SM								
359	1										
358	2			B		8.8					
357	3	Sandy Clay: dark brown, very moist, fine to coarse grained, trace gravel and silt, firm	CL								
356	4										
355	5	saturated									
354	6										
353	7										
352	8			B		50.9					
351	9										
350	10										
349	11										
348	12										
347	13			B		43.6					
346	14										
345	15	Boring terminated at 15 feet Groundwater encountered at 5 feet below grade and stabilized at that elevation									
344	16										
343	17										
342	18										
341	19										
340	20										

EXPLORATORY BORING LOGS

GSI

KANSAS AVENUE SEWER PROJECT
KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
5-3576	February-06	A-7

LOGGED BY: BP	DRILL RIG: Simco 2400	BORING NO.: B-7
ELEVATION: 360'	BORING DIAMETER (INCH): 4	DATE DRILLED: 5 January 2006
	GROUNDWATER DEPTH (FT): 5.0	

ELEVATION (FT)	DEPTH (FT)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLE	CONV. SPT BLOW COUNT	WATER CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT	PLASIT. INDEX	UNC. COMP. STRENGTH (PSF)	COMMENTS AND ADDITIONAL TESTS
			Silty Sand: yellow brown, moist, fine to coarse grained, some gravel and clay, medium dense	SM								
359	1											
358	2											
357	3		Sandy Clay: dark brown, very moist, fine to coarse grained, trace gravel and silt, firm	CL								
356	4											
355	5		saturated									
354	6											
353	7		Boring terminated at 7 feet Groundwater encountered at 5 feet below grade and stabilized at that elevation									
352	8											
351	9											
350	10											
349	11											
348	12											
347	13											
346	14											
345	15											
344	16											
343	17											
342	18											
341	19											
340	20											

EXPLORATORY BORING LOGS

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KANSAS AVENUE SEWER PROJECT
KANSAS AVENUE

PROJECT NO.	DATE	FIGURE NO.
5-3576	February-06	A-8