DRAFT REPORT

GEOTECHNICAL ENGINEERING STUDY

University of California Northern Regional Library Facility Phase 3, Richmond, California

Prepared for
University of California, Berkeley
Planning, Design and Construction
2000 Carleton Street
Berkeley, California 94720-0380

April 2, 2001

URS
500 12th Street, Suite 200
Oakland, CA 94612

5100111028.00

URS

April 2, 2001

Mr. Dave Johnson
University of California Berkeley
Planning, Design, and Construction
2000 Carleton Street
Berkeley, CA 94820-0380

Re: Draft Report Geotechnical Engineering Study
University of California Northern Regional Library Facility Phase 3
Richmond, California
Project No. 5100111028.00

Dear Mr. Johnson:

URS is pleased to present this draft report of our geotechnical engineering study for the University of California Northern Regional Library Facility Phase 3 project in Richmond, California. The study was performed in accordance with our proposal dated January 24, 2001 to U.C. Berkeley and was authorized by U. C. Berkeley on January 29, 2001.

The accompanying report presents the findings, conclusions and recommendations of our study. The geotechnical study was conducted with the assistance of Mr. Jennifer Benton and Mr. Mark Schmoll who supervised the drilling program and logged the materials encountered in the borings. Mr. Heinz Berger peer-reviewed the geotechnical report.

It has been a pleasure to be of service to U. C. Berkeley on this project. If you or other members of the design team have any questions regarding the geotechnical report, please do not hesitate to call us.

Sincerely,
URS CORPORATION

Philip Meymand, P.E.
Senior Project Engineer

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Enclosure

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This report presents the results of our study of the subsurface conditions at the site of the proposed Phase 3 addition to the Northern Regional Library Facility located at the University of California Richmond Field Station in Richmond, California. The existing Regional Library Facility site was previously studied by the former Woodward-Clyde Consultants (WCC), which is now part of URS, and several reports were prepared by our firm. These reports include the "Preliminary Geotechnical Exploration for the proposed U.C. Regional Library Compact Shelving Facility", dated March 23, 1979, "Geotechnical Exploration, Northern Regional Library Compact Shelving Facility", dated April 23, 1980, and the Supplemental Geotechnical Exploration, Northern Regional Library Compact Shelving Facility", dated December 16, 1980. Also completed by WCC was the "Geotechnical Engineering Study U.C. Northern Regional Library Facility, Phase 2 Richmond Field Station", dated June 3, 1988 and an addendum to the Phase 2 study dated October 18, 1988.

1.1 SCOPE OF WORK

The purpose of this geotechnical study was to provide geotechnical engineering information and recommendations for the design team, sufficient for the design of the proposed Phase 3 addition. The scope of work was described in detail in our proposal for the project dated January 24, 2001. The scope of work can be summarized as follows:

- Perform a field investigation consisting of 3 borings 30 to 50 feet deep each from which soil samples were to be collected for laboratory testing and boring logs prepared.
- Perform laboratory tests on selected soil samples including moisture content and dry density determinations, unconfined compression tests, sieve analyses, and plasticity index tests.
- Analyze the results of the field exploration and laboratory testing programs, along with the existing geotechnical data to develop geotechnical design criteria and foundation recommendations for the proposed structure. The analysis was to include consideration of the adjacent structures in the earthwork and foundation recommendations.
- Provide a final geotechnical report at the conclusion of the study which would include:
  - A site plan showing the proposed structures and approximate locations of the exploratory borings;
  - Logs of borings and laboratory test results;
  - Description of subsurface soil, bedrock, and groundwater conditions encountered in the borings;
  - Discussion of alternative foundations systems for support of the proposed building including consideration of the adjacent building(s).
  - Recommendations and criteria for foundation design including foundation type, design bearing pressures, and modulus of subgrade reaction;

- Settlement predictions relative to types of foundations and soils;
- Discussion of the groundwater conditions at the site and impact of groundwater to the proposed construction;
- Recommendations for grading and site earthwork including fill material criteria and compaction requirements;
- Design considerations for concrete floor slabs;
- Discussion of liquefaction potential at the site; and
- Classification of soil type and distance to earthquake faults to determine site coefficients required by the Uniform Building Code.

- Provide limited geotechnical consultation to the design team after issuance of the geotechnical report.

1.2 PROJECT DESCRIPTION

The proposed Northern Regional Library Facility, Phase 3 project will involve the construction of two new at-grade structures. The larger structure will be a 3-story stack block building approximately 124 feet by 163 feet in plan dimensions and will be located at the northern edge of the Phase 2 shelving area and 20 feet east of the existing water tank. The smaller structure will be a 1-story entry/reading room addition located at the eastern entrance of the existing Phase 1 building, and will be approximately 73 feet by 32 feet in plan dimensions. A site plan is provided which shows the locations of the proposed structures and the approximate locations of the exploratory borings. (Figure 1)

We understand that the structural engineer has selected a concrete framed structural system for the 3-story building. According to information supplied to us by Dom Campi of Rutherford and Chekene and Glennis Briggs of EHDD Architecture, the column grid is approximately 18 feet, with column loads estimated at 285 kips and a foundation bearing pressure of 1480 psf.

2.1 FIELD EXPLORATION

Three exploratory boreholes designated B-10, B-11, and B-12, were drilled for this study at the locations indicated on the Site and Boring Location Plan, Figure 1. Boring B-10 was drilled to a depth of 31.5 feet within the footprint of the proposed one-story addition and borings B-11 and B-12 were each drilled to a depth of 51.5 feet within the footprint of the proposed 3-story shelving facility. The borings were located in the field by measuring from the existing buildings. The borings were drilled using a truck-mounted drilling rig owned and operated by Pitcher Drilling Company of East Palo Alto, California. Boring B-10 was drilled with a Failing 750 drill rig, and borings B-11 and B-12 were drilled with a Failing 250 drill rig. Mud rotary-wash drilling methods were used to advance the boreholes. Jennifer Benton, a geologist with our firm, logged the soil cuttings and samples in the field and visually classified the soils as the drilling proceeded. Samples of the subsurface materials were obtained at selected depths in the borings using three types of samplers: a 2-inch I.D. Modified California sampler, a 2-inch O.D. standard split-spoon sampler, and a Shelby tube, as indicated in the Key to Log of Boring (Figure A-1 in Appendix A). The samples were taken to our geotechnical laboratory for further visual examination and testing. Logs of Borings were prepared based on the field logs, visual examination in the laboratory, and the laboratory testing results, and are presented in Figures A2 through A4. Detailed descriptions of the procedures used to drill the borings, and to obtain soil samples are given in Appendix A (Geotechnical Drilling and Sampling Program)

2.2 LABORATORY DATA

Representative soil samples obtained from the exploratory borings were tested in our Pleasant Hill geotechnical laboratory in order to evaluate their engineering properties for use in the analyses. The following laboratory tests were performed on selected soil samples:

- Water content (ASTM D2216)
- Dry density (ASTM D2850)
- Unconfined compressive strength (ASTM D2166)
- Atterberg limits (ASTM D4318)
- Grain size and hydrometer analyses (ASTM D422)

The results of the laboratory tests are summarized in the logs of borings at the corresponding sample depths. Detailed laboratory test results are presented in Appendix B (Geotechnical Laboratory Test Results).

3.1 SITE GEOLOGY AND SEISMICITY

The Northern Regional Library Facility site is located on relatively flat ground just east of the Richmond Inner Harbor. Knudsen et al. (1997) indicated that the site area is underlain by Holocene alluvium fan and alluvial fan levee deposits. Franciscan complex bedrock underlies the Holocene deposits.

The Hayward fault is the closest known active fault and is approximately 3.5 kilometers north-east of the site. Therefore, the potential for surface fault rupture at the site is very low. The Hayward fault is a major component of the San Andreas Fault system in the San Francisco Bay Area, and has been extensively studied. It extends about 100 kilometers from Mount Misery, east of San Jose (Bryant, 1982), to San Pablo Bay (Lienkaemper, 1992). The northern portion of the Hayward fault is particularly well expressed geomorphically where it coincides with a marked "rift" valley through the Oakland Hills. Systematic right-lateral stream offsets have been documented at several locations along the fault zone.

The Hayward fault generated a large earthquake in 1868. The earthquake has been estimated as a Richter magnitude 6.8 event, and produced several tens of kilometers of surface rupture (Lienkaemper and others, 1991).

The northern end of the 1868 surface rupture is believed to be located near San Leandro, although some discontinuous ruptures may have occurred as far north as Mills College in Oakland. The California Working Group on Earthquake Probabilities (1999) estimated a 32 percent probability of a magnitude 6.7 or greater earthquake in the next 30 years on the northern segment of the Hayward fault that is closer to the site. At the present time, microseismicity is associated with much of the northern segment of the fault (Oppenheimer and others, 1992).

3.2 SITE CONDITIONS

The site of the proposed 3-story shelving facility is an open field that gently slopes from east to west at approximate elevations +23 feet MSL to +21 feet MSL, and is covered by grass and short brush. The site of the 1-story addition is covered by a sidewalk, patio and an asphaltic concrete parking lot, and is at approximate elevation +23.5 feet MSL.

3.3 SUBSURFACE CONDITIONS

The subsurface soil conditions encountered in the exploratory borings drilled for the current study are summarized below. The complete boring logs are presented in Appendix A.

Boring B-10 was drilled through the existing parking lot and thus the surface consists of 2 inches of asphalt concrete and 4 inches of gravel base. Underlying the pavement section are 1.5 feet of dark brown, low plasticity, silty clay fill. The fill overlies alluvial sediments described as follows: the depth interval from 2.5 to 5 feet consists of a light brown and gray mottled, medium plasticity stiff silty clay with trace sand containing a layer of light brown well, graded sand. Fifteen feet of medium dense to dense, light brown, well-graded sand with fine to coarse gravel underlie this clay from 5 to 20 feet depth. The bottom 11.5 feet of the borehole from 20 to 31.5 feet below the ground surface consists of stiff, light brown, medium plasticity, silty clay with sand. This unit becomes very stiff with some fine to coarse gravel below 24.5 feet and stiff, low plasticity, with iron oxide staining and black organic specks with no gravel below 29 feet.

Boring B-11 has 3.5 feet of dark brown, high plasticity silty clay topsoil with occasional orange sandstone gravel near the surface. This is underlain by 20.5 feet of very stiff to hard, light brown, medium to high plasticity silty clay with sand, some black organic specks and iron oxide staining. Calcareous pockets were noted between 5.5 and 10 feet. The clay becomes stiff to very stiff with some fine gravel at 18 feet. This was underlain by very dense, light brown, fine to coarse, angular to sub-rounded sandy silty gravel from 24 to 28 feet. This gravel overlies 5.5 feet of stiff to very stiff, light brown, silty clay with trace fine gravel, some black organic specks and iron oxide staining which in turn overlies 5.5 feet of dense, medium brown, fine to coarse, angular, sandy gravel with silt. This is underlain by stiff to very stiff, light brown, silty clay with a trace fine gravel, some black organic specks and iron oxide staining which is the same as the clay that overlies the gravel layer. The bottom of the borehole from 40.5 to 51.5 feet is comprised of very stiff, dark gray, low plasticity, silty clay which becomes hard below 45 feet with some light orange iron oxide staining and white calcareous patches and occasional fine gravel.

Boring B-12 consists of 3 feet of dark brown, low plasticity silty clay topsoil at the surface as in boring B-11. This overlies 14.5 feet very stiff to hard, light brown, low plasticity silty clay with sand, some organic specks and trace iron oxide staining. Numerous calcareous pockets were noted from 4.5 to 5.5 feet. Below 6 feet there is increasing amounts of fine to coarse-grained sand and a gravel layer from 9.5 to 10 feet. Dense, light brown, clayey sand with some black organic specks and trace iron oxide staining is present from 17.5 to 28 feet with some gravel and increasing sand content below 23.5 feet. This overlies 15.5 feet of stiff to very stiff, light brown silty, low plasticity, silty clay with trace sand, some black organic specks, iron oxide staining, and white calcareous pockets. From 36 to 38.5 a gravelly layer is present and the color changes to a light olive brown at 40 feet. The bottom of the boring from 43.5 to 51.5 feet consists of dense, light olive brown, silty sand with clay and some gravel.

3.4 GROUNDWATER CONDITIONS

Groundwater could not be measured in this study due to the use of the mud-rotary drilling technique. However, the Phase 2 study installed a piezometer in well W-1 (the location of W-1 is indicated on Figure 1). Groundwater levels measured in this well ranged from about 16 to 17 feet below the ground surface. Groundwater levels measured in previous URS and WCC studies at the Richmond Field Station ranged from approximate elevation +4 feet MSL near the San Francisco Bay margin, to +15 feet MSL in the vicinity of the Forest Products Laboratory. Groundwater elevations may be expected to have tidal variations closer to the Bay, and are also expected to exhibit seasonal variations.

4.1 SUBSURFACE CONDITIONS

The borings performed for this study indicate similar subsurface conditions to those encountered in the previous explorations at the site. The borings indicate a dark, high plasticity, silty clay is found in the upper 3 to 5 feet across the site, and extends to between elevation +18 and +19 feet MSL. This is a described as highly expansive clay in previous studies, and was classified as soft to medium stiff based on field identification and laboratory tests. During our field investigation this material was saturated by heavy rainfall and was softened such that it could not support the drill rig. This material is unsuitable for providing direct foundation support of structures, and we recommend that it be excavated and replaced with compacted structural fill.

The underlying silty clay is much harder than the near surface clay. It is stiffest near the surface where it is classified as very stiff to hard. Samples of this clay from boring B-11 had an unconfined compressive strength (UCS) of 7300 psf at 6.5 feet and in B-12 the UCS was 8950 at 4.5 feet. The strength within this clay appears to decrease with depth to about 30 feet. In B-11 the UCS was measured at 1700 psf at 31.5 feet and 2150 psf at 31.5 feet in B-12. After this depth the strength then again increases to the bottom of the boreholes at a depth of 51.5 feet. This strength profile is consistent with an overconsolidated clay deposit. The strength values with depth correlate relatively well across the 3 boreholes. The stiffer clays are interbedded with varying amounts of sandy and gravelly clays as well as dense and very dense silty sand with gravel. These clays are to be evaluated for bearing capacity and settlement under the loads of the proposed structures.

Previous studies have shown that bedrock is encountered at depths of 85 to 108 feet below the surface. Bedrock was not encountered in the borings performed for this investigation. The bedrock encountered in the earlier borings was identified as moderately to highly weathered shale, clayey sandstone, or sandstone of the Franciscan formation.

4.2 DESIGN GROUNDWATER LEVEL

Due to seasonal fluctuation of groundwater and its critical role on the design of the building foundations, a conservative groundwater level is assumed. Based on the groundwater level measurements at the site, we recommend that the design groundwater elevation be assumed at elevation +15 feet MSL, or a depth of approximately 6 to 8 feet below existing grade. We do not expect that groundwater will effect the building design or construction activities.

4.3 LIQUEFACTION POTENTIAL

Liquefaction is a phenomenon during which loose, saturated, cohesionless soils (generally sands) temporarily lose shear strength during ground shaking induced by severe earthquakes. Significant factors known to affect the liquefaction potential of soils include grain size distribution, relative density, degree of saturation, the confining stresses acting on the soils, and the characteristics of the soil fines fraction. The exploratory borings indicated that the subsurface materials at this site are generally high in clay content or in sufficiently dense condition such that the soils are not considered to be susceptible to liquefaction.

5.1 FOUNDATION RECOMMENDATIONS

The structural engineer has indicated that a 24-inch thick mat foundation with a 36-inch wide and deep perimeter edge beam is the preferred foundation system for the proposed 3-story shelving facility. We have determined that the site conditions are suitable for construction of this foundation type for the proposed project. We expect that the one-story addition and a mechanical area adjacent to the shelving facility may be founded on shallow spread footings or slab-on-grade foundations. We recommend that the near-surface dark, high plasticity clay be excavated and replaced with compacted structural fill as required to meet the bottom of footing elevations. Specific recommendations for foundation design, construction, and earthwork, are provided below.

5.1.1 Mat Foundations

Preparation of areas beneath mat foundations should be performed in accordance with Section 5.3 – Site Grading and Earthwork. We recommend that the mat foundations bear on 36-inches of compacted structural fill which will replace unsuitable material at the site. Based on a preliminary mat thickness of 24 inches, we recommend that the following design bearing pressures be used for the mat and perimeter edge beam:

Dead load (F.S. = 3)	4000 psf
Dead and Live Load (F.S. = 2)	6000 psf
All loads, including wind or seismic (F.S. = 1.5)	8000 psf

The structural engineer has indicated that the finished floor elevation of the shelving facility will be at +24.2 feet MSL, which will require that the mat excavation must be to approximate elevation +21 to accommodate a 2.5-inch top slab, a 24-inch mat, a 2-inch waste slab, a vapor barrier system consisting of a geotextile-reinforced HDPE with 6-inches of crushed rock, and potentially a 2- to 3-inch mud slab.

In order to remove the unsuitable material, the mat excavation must extend from ground surface elevations ranging from +23 to +21 feet MSL to the anticipated bottom of unsuitable materials elevation at +18 MSL. The excavation limits should extend a minimum 4 feet beyond the building lines, except on the side adjacent to the Phase 2 shelving facility (see Section 5.4.2). This excavation will generate approximately 3500 to 4000 cubic yards of waste spoils. Following the mat excavation, the structural fill section will have to be built up to elevation +21 feet MSL to provide a bearing surface for the mat.

The mat foundation excavation and compacted fill should be free of loose or disturbed soil or standing water prior to concrete placement. The Geotechnical Engineer should observe the foundation excavation to verify that all unsuitable materials have been excavated. He or she should also observe the condition of the bearing materials prior to placing reinforcing steel.

We recommend that the foundation excavation be open only a minimal amount of time prior to concrete placement to reduce the potential for soil disturbance and infiltration of groundwater. If any groundwater infiltrates into the foundation excavation, the excavation should be pumped dry to allow proper cleaning. It is suggested that a layer of lean concrete or a mud slab be placed over the exposed subgrade immediately after the excavation has been approved. This mud slab will minimize the disturbance of the subgrade from traffic and other construction activities.

We anticipate that a modulus of subgrade reaction is needed to analyze the mat for bending. Based on the geometry of the mat that has been provided to us, we recommend that a uniform modulus of subgrade reaction of 40 tons per cubic foot (tcf) be used. For dynamic loading, this value may be increased to 50 tcf. These recommended values are based on the specific mat geometry, and if the shape of the mat is changed, we should be contacted to provide further recommendations

Some movement of the subgrade is expected to occur both during excavation and after construction of the structure. The magnitude of heave and settlements are limited by the relatively small thickness of clay overlying bedrock. Heave is likely to occur during the foundation excavation due to the reduction in stress (unloading) of the subsurface soils. The heave is expected to be negligible. Subsequent application of the building loads will reduce the tendency for future heave.

Recompression of the underlying soils and settlement of the mat foundation is expected to occur both during and after construction. Based on the estimated loads presented in this report, we estimate that the mat foundation will settle a total of up to 2 inches at the center and approximately 1 to 1½ inches at the edges. A maximum differential settlement of ¾ inch is expected within the mat foundation. We expect that the new construction may result in an additional ½ to 1 inches of settlement of the adjacent Phase 2 shelving facility.

5.1.2 Shallow Foundations

The proposed addition and/or the mechanical area adjacent to the shelving facility may be supported on shallow spread or strip footings bearing on undisturbed native stiff silty clay (at approximate elevation +18 feet MSL), or compacted structural fill that has replaced the unsuitable soils as described in section 5.1.1. If bearing on compacted structural fill, the footing excavation should include an overwidth of 5 feet, to be replaced with compacted structural fill. Unsuitable materials may be excavated and re-compacted between footing locations. Exterior and interior footings should be founded at least 24 inches below the lowest adjacent finished grades. Spread foundations should be a minimum of 24 and 18 inches wide for square and strip footings, respectively. To limit differential foundation settlements, the following allowable bearing pressures are recommended to determine the footing sizes:

Dead Load	4000 psf
Dead and Live Load	6000 psf
All Loads, including wind or seismic	8000 psf

Preparation of areas beneath footings should be performed in accordance with Section 5.3 – Site Grading and Earthwork. All footing excavations should be finished in a neat condition. Any softened or disturbed soil should be removed from the footing excavation prior to placing reinforcing steel bars. It is recommended that the time during which the prepared foundation bearing surface in footing excavations is exposed be kept to a minimum to reduce the potential for disturbance. It is recommended that the footing excavations be observed by the Geotechnical

Engineer prior to placing steel and concrete, to verify that the recommendations of this report have been followed, and that an appropriate bearing stratum is encountered. If unsuitable soils are encountered in the footing excavations, overexcavation and the placement of structural fill will be required.

5.1.3 Slab-On-Grade Foundations

Alternatively, the proposed addition and/or the mechanical area may be supported on slab-on-grade foundations. Slab-on-grade foundations should bear on a minimum thickness of 36 inches of compacted structural fill in order to provide uniform support of the concrete floor slabs. To limit differential foundation settlements, the following allowable bearing pressures are recommended for slab-on-grade foundations:

Dead Load	3000 psf
Dead and Live Load	4500 psf
All Loads, including wind or seismic	6000 psf

Preparation of areas beneath concrete slabs-on-grade should be performed in accordance with Section 5.3 – Site Grading and Earthwork. Structural fill material should be moisture conditioned to within 3 percent of optimum moisture content, and compacted to at least 95 percent maximum dry density in accordance with ASTM D 1557.

Concrete slabs-on-grade should be reinforced and should be integrated with a continuous perimeter footing. The thickness and reinforcing details of the slab-on-grade should be computed by the Structural Engineer. Where concrete slabs are designed as beams on an elastic foundation, the compacted subgrade should be assumed to have a modulus of subgrade reaction of 40 tcf.

5.1.4 Vapor Barrier

The structural engineer has proposed a vapor barrier system for all structures for this project consisting of 6-inches of capillary break material overlain by a geotextile-reinforced high density polyethelene (HDPE) membrane, topped by a 2-inch concrete waste slab. The capillary break material is proposed to consist of a minimum of 5 inches of free-draining, open-graded, crushed rock or gravel with a maximum particle size of ¾ inch, and with no more than 5 percent passing the No. 4 sieve. The 5-inches of ¾ inch stone is to be topped by 1-inch of #8 pea gravel, which is to be compacted in place. We find that this is a suitable system to provide a vapor barrier.

5.2 LATERAL LOAD RESISTANCE

Resistance to seismically or wind-induced transient lateral loads can be developed by passive earth pressure acting against the sides of the mat or spread footing foundations. To estimate resistance to lateral loads, we recommend that an equivalent fluid unit weight of 300 pcf be used to calculate the allowable passive pressure; however, the passive pressure should be limited to a maximum value of 2,000 psf. Base friction can be simultaneously mobilized on the bottom of slab-on-grade, spread footing, and mat foundations. An allowable friction coefficient of 0.35 is recommended for foundations poured neatly against native soil.

If additional lateral load resistance is required, pile foundations may be utilized to mobilize resistance through bending and pile-soil interaction. We should be consulted to develop such design information, if needed.

5.3 SITE GRADING AND EARTHWORK

It is recommended that site preparation, excavation, filling and foundation construction be done under the observation of the Geotechnical Engineer, and in accordance with the recommendations contained in this section.

5.3.1 Site Clearing and Earthwork

Site clearing will generally consist of removal of the existing asphalt pavement, concrete sidewalk, and vegetation at the site. The materials generated from site clearing and stripping should be hauled off site. If encountered, aggregate base rock below the existing pavement can be stockpiled and reused as select fill unless it contains concrete or other unsuitable materials, as approved by the Geotechnical Engineer.

5.3.2 Subgrade Preparation

We recommend that all foundation excavations be observed by the Geotechnical Engineer or his representative prior to the placement of reinforcing steel and concrete to confirm that the foundation bearing soils encountered in the excavations are those assumed in our analyses.

It is recommended that the time during which the foundation bearing surfaces are exposed be short to reduce the potential for soil disturbance and infiltration of groundwater. Any loosened soil in the bottom of the foundation excavations should be removed down to stiff, undisturbed silty clay prior to construction of the foundations. Any water in the foundation excavations should be removed to allow proper cleaning of the excavations. Recommendations regarding dewatering of the site during construction are presented in a separate section of this report.

A recommended option to protect undisturbed natural soils in foundation excavations during placement of reinforcing steel is to overexcavate the area about 2 to 3 inches in depth and place a concrete mud slab immediately after the foundation soils have been approved.

5.3.3 Fill Material Criteria

Depending on the depth of excavation to remove unsuitable soil and the finished foundation elevation, structural fill may be required. All fill materials should be approved by the Geotechnical Engineer. The material should be a soil or soil-rock mixture free of organic matter or other deleterious substances. It should not contain rocks or lumps over 6 inches in greatest dimension, and not more than 15 percent by weight larger than 2-1/2 inches. In addition to the above requirements, import fill material should not contain more than 40 percent by weight passing the No. 200 sieve and should have a maximum plasticity index of 15.

5.3.4 Compaction Requirements of Fill Materials

Fill should be spread in lifts not to exceed a maximum uncompacted thickness of 8 inches, be moisture conditioned, and compacted using appropriate compaction equipment. Structural fill material should be moisture conditioned to within 3 percent of optimum moisture content, and compacted to at least 95 percent maximum dry density in accordance with ASTM D 1557.

5.4 CONSTRUCTION CONSIDERATIONS

5.4.1 Construction Dewatering

It is our opinion, after reviewing the groundwater data, that the design groundwater level for the site be assumed at elevation +15 feet MSL. It is likely that, at most times of the year, the groundwater will probably be below this design level. However, it is possible that groundwater could rise to this level, particularly during a wet winter.

Based on the current building design and anticipated excavation depths, we do not expect that the Contractor will be required to dewater excavations, unless rainfall infiltrates into the excavations. If the construction is performed during wet weather, diversion berms and drainage ditches should be constructed to prevent water from entering excavations, sump pumps may be used to dewater excavations, and mud slabs should be placed at the bottom of excavations.

5.4.2 Adjacent Structures

Based on the information available to us at this time, we understand that the Phase 2 shelving facility is founded on spread footings bearing on the stiff silty clay material at approximate elevation +18 feet MSL. Based on the present site topography we also expect that the Phase 2 facility excavation extended approximately 5 feet beyond the building lines, and was likely replaced with compacted fill. Therefore we expect the mat excavation limit for the Phase 3 facility need to extend only to within 5 feet of the Phase 2 building. We recommend that the Contractor excavate test pits during the mat excavation, under the supervision of the Geotechnical Engineer, to verify the condition of the fill along this common side of the two buildings. As-built construction records for the Phase 2 facility should also be checked. If the fill material along this common edge is unsuitable or of insufficient density, we should be consulted to develop further recommendations for this area.

5.4.3 Construction Monitoring

Monitoring of the adjacent facilities is a critical aspect of the overall project quality assurance. It is recommended that a baseline survey of the adjacent Phase 2 building, structures, sidewalks and roadways be conducted prior to the start of construction to establish the existing conditions. During construction, the shoring and bench marks should be monitored on a regular basis to check for unusual movements.

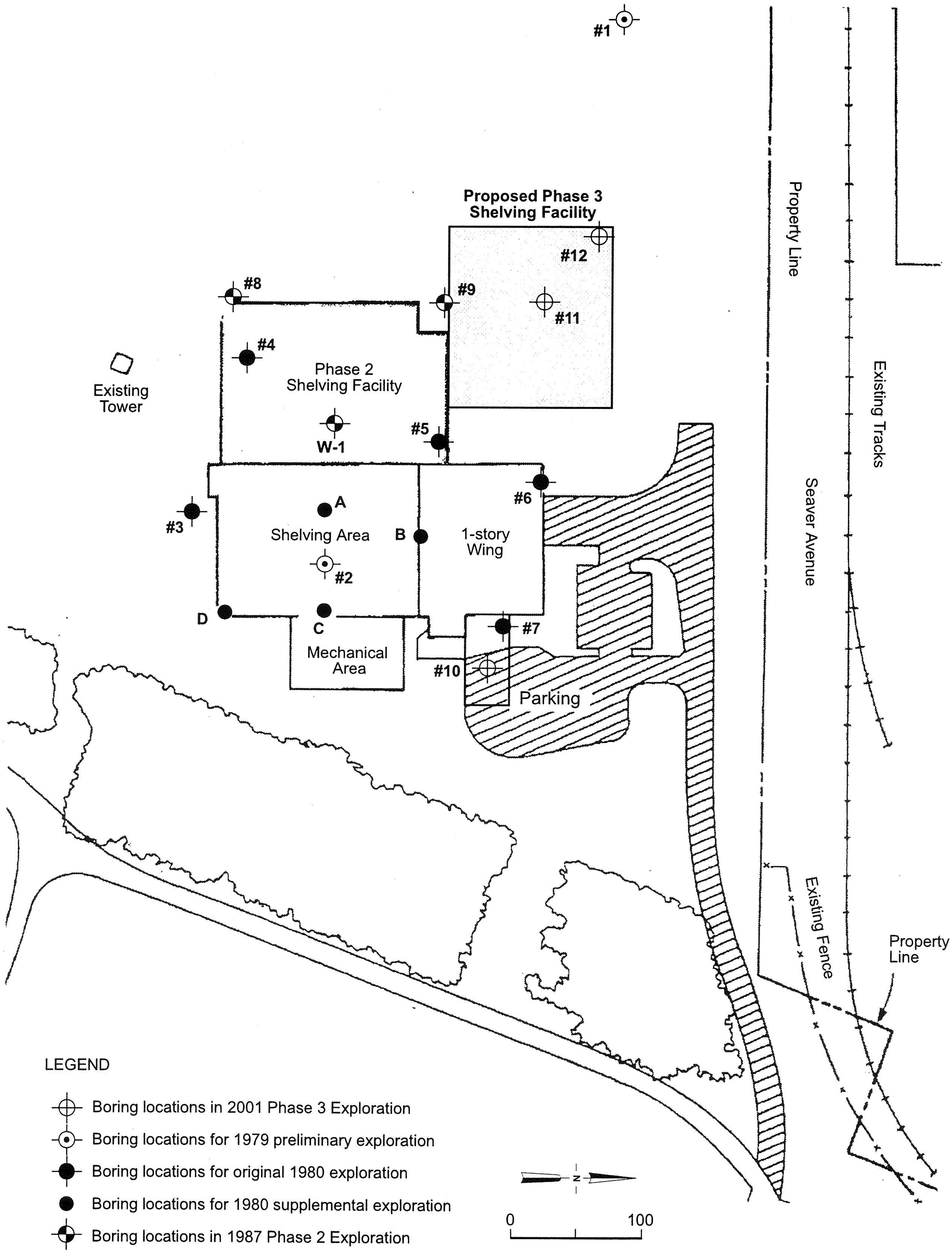
The data collected from the monitoring program should be made available to the Geotechnical Engineer and the Structural Engineer for evaluation. The data obtained should be plotted to assess the trends so that construction modifications can be made if necessary, to reduce the potential for damage to adjacent buildings, structures and streets.

5.5 SITE FACTOR

The proposed Phase 3 Shelving Facility at the University of California Richmond Field Station is located within Seismic Zone 4 and will likely be subjected to strong seismic ground shaking during its design life. The near-source factor of the Uniform Building Code (ICBO, 1997) should be applied due to the proximity of the Hayward fault. The subsurface conditions encountered in the exploratory borings indicate that the soil profile at the site consists of predominantly stiff to very stiff clayey soils and some sandy and gravelly soils with bedrock at a depth of about 100 feet below existing ground surface. In accordance with Table 16-J of the UBC, these subsurface conditions correspond to soil profile type S_D (stiff soil profile).

This geotechnical study has been conducted in accordance with the standard of care commonly used as state-of-practice in the profession. No other warranties are either expressed or implied. The recommendations made in this report are based on the assumption that the subsurface soil and groundwater conditions do not deviate appreciably from those disclosed in the exploratory borings. If any variations or undesirable conditions are encountered during construction, we should be notified so that additional recommendations can be made. The foundation recommendations presented in this report are developed exclusively for the proposed 3-story shelving facility and 1-story entry/addition described in this report and are not valid for other locations and construction in the project vicinity.

We should be informed of any changes that are made in the assumptions mentioned in this report (such as the location and configuration of the proposed structures, and the design loads) so that additional recommendations may be given, if necessary. We recommend that URS has the opportunity to review those portions of the project plans and specifications that are affected by the recommendations made in this report to verify that the intent of our recommendations are properly incorporated into the construction documents. We also recommend that URS be retained to observe the foundation excavation, earthwork, and the foundation construction.



URS	Project No. 51-00111028.00 U.C. Berkeley Northern Regional Library Facility Phase 3	SITE AND BORING LOCATION PLAN	Figure 1

51-00111028.00-00000/031601/gos

Appendix A

Geotechnical Drilling And Sampling Program

A.1 FIELD EXPLORATION

Three exploratory borings were drilled for the previous study to depths of about 31.5 to 51.5 feet to explore the subsurface conditions at the proposed building site. The borings were drilled on February 12, 2001 and March 6, 2001 under the supervision of Ms. Jennifer Benton with our firm. The borings were drilled using truck-mounted Failing 750 and Failing 250 rotary-wash drilling rigs owned and operated by Pitcher Drilling company of Palo Alto, California. The borings were advanced using a 4-7/8-inch-diameter drill bit on drill rods. Bentonite drilling mud was used to lift the cuttings and support the borehole while advancing the borings.

A.2 SOIL SAMPLING

Sampling Method

Soil samples were obtained at selected depths in the borings by advancing the sampler into the soils at the bottom of the borehole. Three types of sampling equipment were used:

- Split-Spoon Sampler - 1-3/8-inch I.D., 2-inch O.D., standard split-spoon sampler conforming to ASTM Designation D 1586.
- Modified California Sampler - 2-inch I.D., 2-½-inch O.D., split-barrel sampler equipped with four to six thin brass tube liners, each 4 inches long.
- Shelby Tube – 3-inch I.D. seamless thin walled tube to collect undisturbed samples.

The modified California and split-spoon samplers were threaded to fit a cutting shoe on one end and a check-valve connection at the other end. After the borehole was drilled to the specified depth, the sampler mounted on the drill rods was lowered to the bottom, seated, and then driven into the soil with a 140-pound hammer falling 30 inches for each blow. The hammer was controlled by a manual cathead-rope system. The number of hammer blows required to advance the sampler each of the three successive 6-inch increments was counted in the field. The number of blows required to advance the sampler the last 12 inches was recorded as the penetration resistance (blows-per-foot).

Sample Handling

Soil from the split-spoon sampler was removed by unscrewing the sampler from the shoe and check-valve connection, separating the two pieces of the split barrel, and scooping the soil into a container which was subsequently sealed. Soil recovered from the split-spoon sampler is disturbed and is of use only for soil identification purposes, index property testing and for determination of moisture content.

Soil recovered from the modified California sampler was retained in the thin brass liners; when the sampler was brought to the surface, the liners were taken from the sample barrel and sealed at both ends with plastic caps.

Soil recovered from the Shelby Tube sampler is retained in the Shelby Tube. After sample retrieval, the tube was sealed at both ends with plastic caps. The caps were then taped. Soil samples obtained from the Shelby Tube sampler are normally less disturbed and of a higher quality suitable for more accurate laboratory testing of strength and deformation characteristics.

A.3 LOGS OF BORINGS

The soil samples and cuttings were examined and classified in the field as the drilling proceeded. The samples were later taken to our geotechnical laboratory in Pleasant Hill, California, for further examination and testing. Preliminary visual soil classifications were made in accordance with the Unified Soil Classification System and verified by further inspection of the samples in the laboratory and by testing. Logs of borings were prepared from the field logs and laboratory test data.

The logs of borings show the soil classifications (according to the Unified Soil Classification System) of subsurface strata encountered, locations where soil samples were obtained, type of sampler used, sampling resistance, results of some of the laboratory tests, and the position of the groundwater level if it could be measured.

Project: UCB Richmond Field Station
Project Location: Richmond, California
Project Number: 51-00111028.00

Key to Log of Boring

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8	9	10	11	12

COLUMN DESCRIPTIONS

1 **Elevation:** Elevation in feet referenced to mean sea level (MSL) or site datum.

2 **Depth:** Depth in feet below the ground surface.

3 **Sample Type:** Type of soil sample collected at depth interval shown; sampler symbols are explained below.

4 **Sample Number:** Sample identification number.

5 **Sampling Resistance:** Number of blows to advance driven sampler 12 inches beyond first 6-inch interval, or distance noted, using a 140-lb hammer with a 30-inch drop; down-pressure for tube.

6 **Recovery:** Percentage of driven sample length recovered; "NA" indicates data not recorded.

7 **Graphic Log:** Graphic depiction of subsurface material encountered; typical symbols are explained below.

8 **Material Description:** Description of material encountered; may include color, moisture, grain size, and density/consistency.

9 **Water Content:** Water content of soil sample measured in laboratory, expressed as percentage of dry weight of specimen.

10 **Dry Unit Weight:** Dry density of soil sample measured in laboratory, expressed in pounds per cubic feet (pcf).

11 **Unconfined Compressive Strength:** Unconfined compressive strength of soil sample measured in laboratory, expressed in psf.

12 **Remarks and Other Tests:** Comments and observations regarding drilling or sampling made by driller or field personnel. Other field and laboratory test results, using the following abbreviations:

- **LL** Liquid Limit (from Atterberg Limits test), in percent
- **PI** Plasticity Index (from Atterberg Limits test), in percent
- **SA** Sieve analysis, percent passing #200 sieve
- **HD** Hydrometer analysis, percent finer than 2 microns

TYPICAL MATERIAL GRAPHIC SYMBOLS

- SAND (SP/SW)
- SILTY SAND (SM)
- CLAYEY SAND (SC)
- GRAVEL (GW)
- CLAY (CL)
- CLAY (CH)
- SILTY CLAY (CL)
- GRAVEL with SILT (GW-GM)
- SILT (ML)
- SILT (MH)
- CLAYEY SILT (ML)
- SILTY GRAVEL (GM)

TYPICAL SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test (SPT) unlined split spoon
- Shelby tube (3-inch OD, thin-wall, fixed head)
- Modified California (2-inch ID) with brass liners
- Pitcher barrel with Shelby tube liner
- California (2.5-inch ID) split barrel
- Bag (grab from hand auger)

OTHER GRAPHIC SYMBOLS

- First water encountered at time of drilling and sampling (ATD)
- Static water level measured after drilling and sampling completed
- Change in material properties within a lithologic stratum
- Inferred or transitional contact between lithologies

GENERAL NOTES

1. Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive; actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.

2. Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

Project: UCB Richmond Field Station	
Project Location: Richmond, California	**Log of Boring B-10**
Project Number: 51-00111028.00	Sheet 1 of 2

Date(s) Drilled	2/12/01	Logged By	J. Benton	Checked By	D. Simpson
Drilling Method	Mud Rotary	Drill Bit Size/Type	4-7/8-inch drag bit (?)	Total Depth of Borehole	31.5 feet
Drill Rig Type	Failing 750	Drilling Contractor	Pitcher Drilling Co.	Surface Elevation	Not available
Groundwater Level and Date Measured	Not measured	Sampling Method(s)	Modified California	Hammer Data	140 lbs, 30-inch drop
Borehole Backfill	Cement grout with 3% bentonite	Location	In front of entrance (see Figure __)		

Elevation feet	Depth, feet	Type (SAMPLES)	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
	0						2 inches asphalt concrete, 4 inches gravel base				
							SILTY CLAY (CL) [Fill] Moist(?), very dark brown				
							SILTY CLAY (CL) [.......?] Stiff, moist, light brown and gray mottled, medium plasticity, trace sand; contains layer of moist, light brown, well-graded sand at 2.6-3.2 feet				
			10-1	11	100						
	5						GRAVELLY CLAYEY SAND (SC) [Alluvium] Medium dense to dense, moist, light brown, well-graded sand, fine to coarse gravel				
			10-2	32	100			15.4	118		
	10		10-3	32	50			12.0			SA: 15%<#200 sieve 37%>#4 sieve
	15		10-4	73	30			13.6	119		
	20						SILTY CLAY with SAND (CL) [Alluvium] Stiff, moist, light brown, medium plasticity				
			10-5	17	0						Sample 10-5 contains only gravel from above; clean out hole and resample at 22 ft.
			10-6	14	50						
							Becomes very stiff, with some fine to coarse gravel				
	25		10-7	27	100			18.7	111	2980	
							Becomes stiff, low plasticity, with iron oxide staining and black organic specks, no gravel				
	30										

Report: GEO_10B1_OAK; File: UCBRICHM.GPJ; 3/17/2001 B-10

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Figure A-2

Project: UCB Richmond Field Station Project Location: Richmond, California Project Number: 51-00111028.00	Log of Boring B-10 Sheet 2 of 2

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
	30		10-8	15	NA		SILTY CLAY with SAND (CL), stiff, moist, light brown, low plasticity, with iron oxide staining and black organic specks [Alluvium] *(continued)*				
							Bottom of boring at 31.5 feet				End drilling at 1040.
	35										
	40										
	45										
	50										
	55										
	60										
	65										

Log of Boring B-11

Date(s) Drilled	**3/6/01**	Logged By	**J. Benton**	Checked By	**D. Simpson**
Drilling Method	**Mud Rotary**	Drill Bit Size/Type	**4-7/8-inch drag bit (?)**	Total Depth of Borehole	**51.5 feet**
Drill Rig Type	**Failing 250**	Drilling Contractor	**Pitcher Drilling Co.**	Surface Elevation	**Not available**
Groundwater Level and Date Measured	**Not measured**	Sampling Method(s)	**Modified California, SPT, Shelby tube**	Hammer Data	**140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout with 3% bentonite**	Location	**Center of grass area (see Figure __)**		

Elevation feet	Depth, feet	SAMPLES: Type	SAMPLES: Number	SAMPLES: Sampling Resistance, blows / foot	SAMPLES: Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
	0						SILTY CLAY (CH) [Fill?] Very stiff, moist(?), dark brown, high plasticity, occasional orange sandstone gravel				Start at 0755.
			11-1	24	0		SILTY CLAY with SAND (CH/CL) [.......?] Very stiff to hard, moist, light brown, medium to high plasticity, some black organic specks and iron oxide staining				No sample recovery.
	5		11-2	48	100		With calcareous pockets	19.3	106	7300	
	10		11-3	35	100		No calcareous pockets	23.2	103	3700	
	15		11-4	31	100						LL=53, PI=33
							Becomes stiff to very stiff, with some fine gravel				
	20		11-5	29	100			18.2	112	2100	
							SANDY SILTY GRAVEL (GM) [Alluvium] Very dense, wet, light brown(?), fine to coarse, angular to subrounded gravel				Gravel in cuttings at 24 ft.
	25		11-6	50/6"	100						
							SILTY CLAY (CL) [Alluvium] Stiff to very stiff, moist, light brown, trace fine gravel, some black organic specks and iron oxide staining				
	30										

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Figure A-3

Project: UCB Richmond Field Station	**Log of Boring B-11**
Project Location: Richmond, California	
Project Number: 51-00111028.00	

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
	30		11-7	28	100		SILTY CLAY (CL), stiff to very stiff, moist, light brown, trace fine gravel, some black organic specks and iron oxide staining [Alluvium] *(continued)*	27.3	98	1700	
							SANDY GRAVEL with SILT (GW-GM) [Alluvium?] Dense, wet, medium brown, fine to coarse angular gravel				
	35		11-8	50/4.5"	100						
							SILTY CLAY (CL) [Alluvium] Stiff to very stiff, moist, light brown, trace fine gravel, some black organic specks and iron oxide staining				
	40		11-9	Push 100 - 400 psi	100						Shelby tube met refusal after 18-inch push.
							SILTY CLAY (CL) [Alluvium?] Very stiff, moist(?), dark gray				
	45		11-10	43	100		Becomes hard, with some light orange iron oxide staining and white calcareous patches, occasional fine gravel				
	50		11-11	69	100			22.9	101	2020	
							Bottom of boring at 51.5 feet				End drilling at 1000.
	55										
	60										
	65										

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Figure A-3

Project: UCB Richmond Field Station Project Location: Richmond, California Project Number: 51-00111028.00	**Log of Boring B-12** Sheet 1 of 2

Date(s) Drilled	**3/5/01**	Logged By	**J. Benton**	Checked By	**D. Simpson**
Drilling Method	**Mud Rotary**	Drill Bit Size/Type	**4-7/8-inch drag bit (?)**	Total Depth of Borehole	**51.5 feet**
Drill Rig Type	**Failing 250**	Drilling Contractor	**Pitcher Drilling Co.**	Surface Elevation	**Not available**
Groundwater Level and Date Measured	**Not measured**	Sampling Method(s)	**Modified California, SPT**	Hammer Data	**140 lbs, 30-inch drop**
Borehole Backfill	**Cement grout with 3% bentonite**	Location	**Far corner of grass area (see Figure __)**		

Elevation feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance, blows / foot	SAMPLES Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
	0						SILTY CLAY (CL) [Topsoil] Moist(?), dark brown				
			12-1	32	100		SILTY CLAY with SAND (CL) [.......?] Very stiff to hard, moist, light brown, some black organic specks, trace iron oxide staining	17.9	107	8950	
	5						Numerous calcareous pockets				
			12-2	50	100		Increasing fine- to coarse-grained sand				
	10						Gravel layer				
			12-3	22	100						
	15		12-4	37	100			25.4	97	3350	
							CLAYEY SAND [Alluvium?] Dense, moist, light brown, some black organic specks, trace iron oxide staining				
	20		12-5	38	100						
							With some gravel, increasing sand content				
	25		12-6	73/10"	100			18.0			Sample 10-6 disturbed by rock pushed down with sample. SA: 22%<#200 sieve 37%>#4 sieve
							SILTY CLAY (CL) [Alluvium] Stiff to very stiff, moist, light brown, trace sand, some black organic specks, iron oxide staining, white calcareous pockets				
	30										

Report: GEO_10B1_OAK; File: UCBRICHM.GPJ; 3/17/2001 B-12

Project: UCB Richmond Field Station
Project Location: Richmond, California
Project Number: 51-00111028.00

Log of Boring B-12

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
	30		12-7	28	100		SILTY CLAY (CL), stiff to very stiff, moist, light brown, trace sand, some black organic specks, iron oxide staining, white calcareous pockets [Alluvium] *(continued)*	26.2	99	2150	LL=40, PI=19
	35		12-8	50/6"	0						No sample recovery.
							Gravelly layer				
	40						Becomes light olive brown				
			12-9	31	100			24.4	100	3070	
							SILTY SAND (SM) [Alluvium?] Dense, moist(?), light olive brown(?), with clay, some gravel				
	45		12-10	42	100						
	50		12-11	56	100			20.2	106	6700	
							Bottom of boring at 51.5 feet				End drilling at 1306.
	55										
	60										
	65										

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Figure A-4

Appendix B

Geotechnical Laboratory Test Results

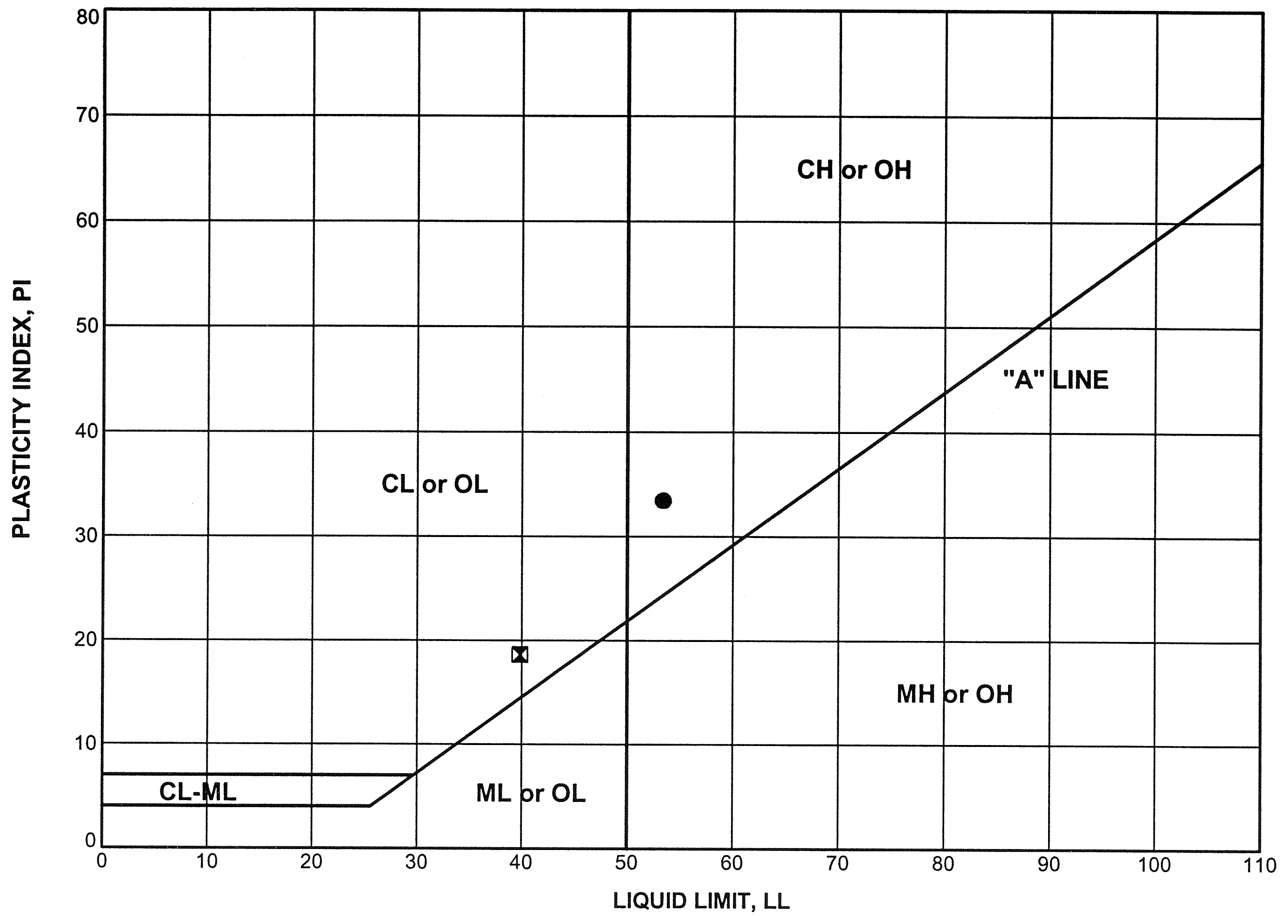
Appendix B
Geotechnical Laboratory Test Results

TABLE B-1
SUMMARY OF SOIL LABORATORY DATA

Sample Information				USCS Group Symbol	In Situ Water Content, %	In Situ Dry Unit Weight, pcf	Sieve			Atterberg Limits			Unconfined Compressive Strength, psf
Boring Number	Sample Number	Depth, feet	Elevation, feet MSL				Gravel, %	Sand, %	<#200, %	LL	PL	PI	
B-10	10-2-3	5.5-6	NA	SC	15.4	118							
B-10	10-3-3	10.5-11	NA	SC	12.0		37	48	15				
B-10	10-4-3	15.5-16	NA	SC	13.6	119							
B-10	10-7-3	25.5-26	NA	CL	18.7	111							2980
B-11	11-2-3	5.5-6	NA	CH	19.3	106							7300
B-11	11-3-3	10.5-11	NA	CH	23.2	103							3700
B-11	11-4-3	15.5-16	NA	CH						53	20	33	
B-11	11-5-3	20.5-21	NA	CH	18.2	112							2100
B-11	11-7-3	30.5-31	NA	CL	27.3	98							1700
B-11	11-11-3	50.5-51	NA	CL	22.9	101							2020
B-12	12-1-3	3.5-4	NA	CL	17.9	107							8950
B-12	12-4-3	15.5-16	NA	CL	25.4	97							3350
B-12	12-6-3	25.5-26	NA	SC	18.0		37	41	22				
B-12	12-7-3	30.5-31	NA	CL	26.2	99				40	21	19	2150
B-12	12-9-3	40.5-41	NA	CL	24.4	100							3070
B-12	12-11-3	50.5-51	NA	SM	20.2	106							6700

NOTE: The laboratory tests were performed in general accordance with the following standards:

Water Content - ASTM Test Method D2216
Dry Unit Weight - ASTM Test Method D2937
Grain Size Analysis by Mechanical Sieving - ASTM Test Method D422
Atterberg Limits - ASTM Test Method D4318
Unconfined Compressive Strength Test - ASTM Test Method D2166



Boring Number	Sample Number	Depth (feet)	Test Symbol	Water Content (%)	LL	PL	PI	Classification
B-11	11-4-3	15.5-16	●		53	20	33	Silty Clay with Sand (CH)
B-12	12-7-3	30.5-31	⊠	26	40	21	19	Silty Clay (CL)

Report: ATTERBERG_PLOT_12 PTS; File: UCBRICHM.GPJ; 3/17/2001 B-12

UCB Richmond Field Station
Richmond, California
51-00111028.00

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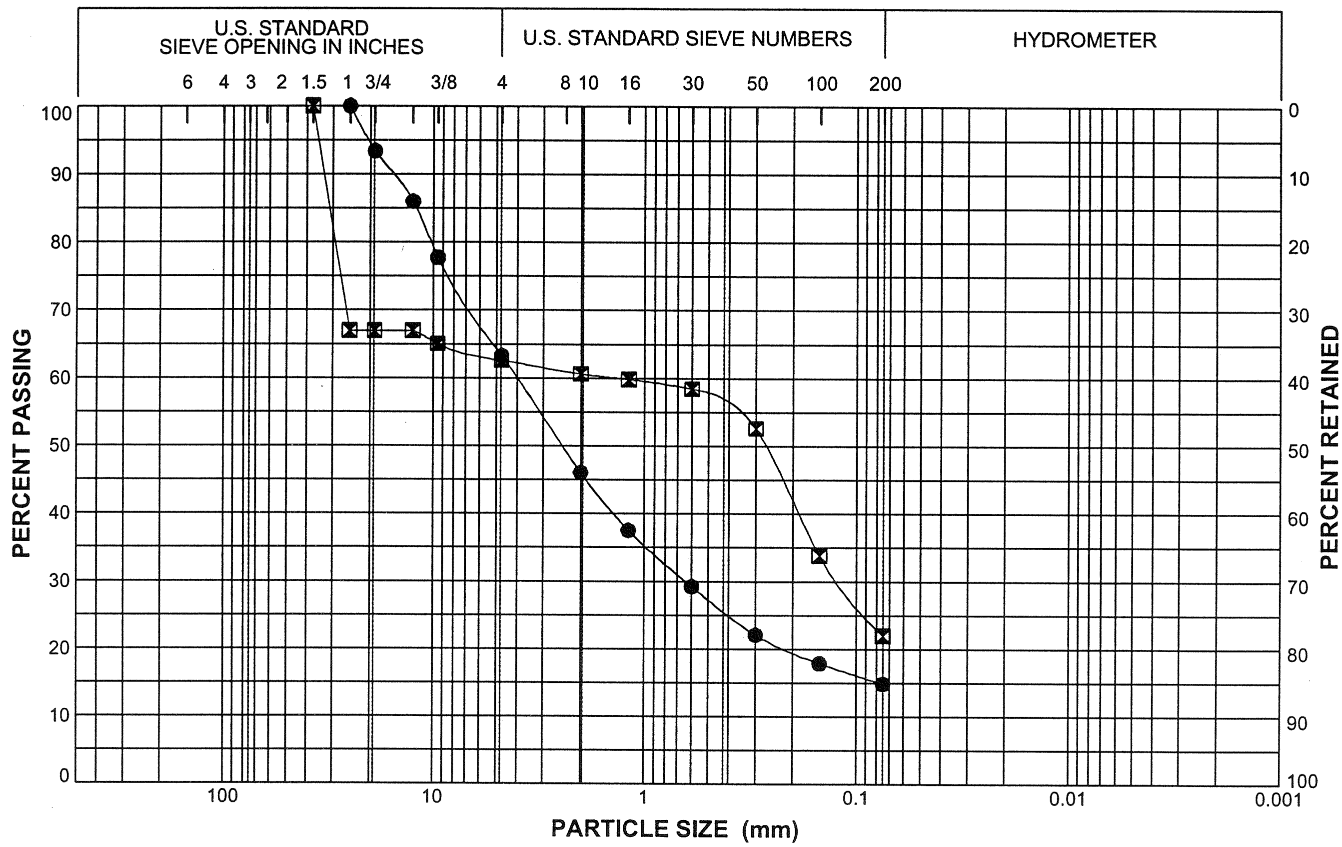
PLASTICITY CHART

Figure B-1

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Classification
B-10	10-3-3	10.5-11	●			Clayey Sand with Gravel (SC)
B-12	12-6-3	25.5-26	⊠			Clayey Sand with Gravel (SC)

Report: SIEVE_5_CURVES_OAK; File: UCBRICHM.GPJ; 3/17/2001 B-12

UCB Richmond Field Station
Richmond, California
51-00111028.00

PARTICLE SIZE DISTRIBUTION CURVES

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Figure B-2

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ASTM D2166
Unconfined Compressive Strength

Project Name: **UCB - Richmond Field Station**

Project Number: 51-00111028.00

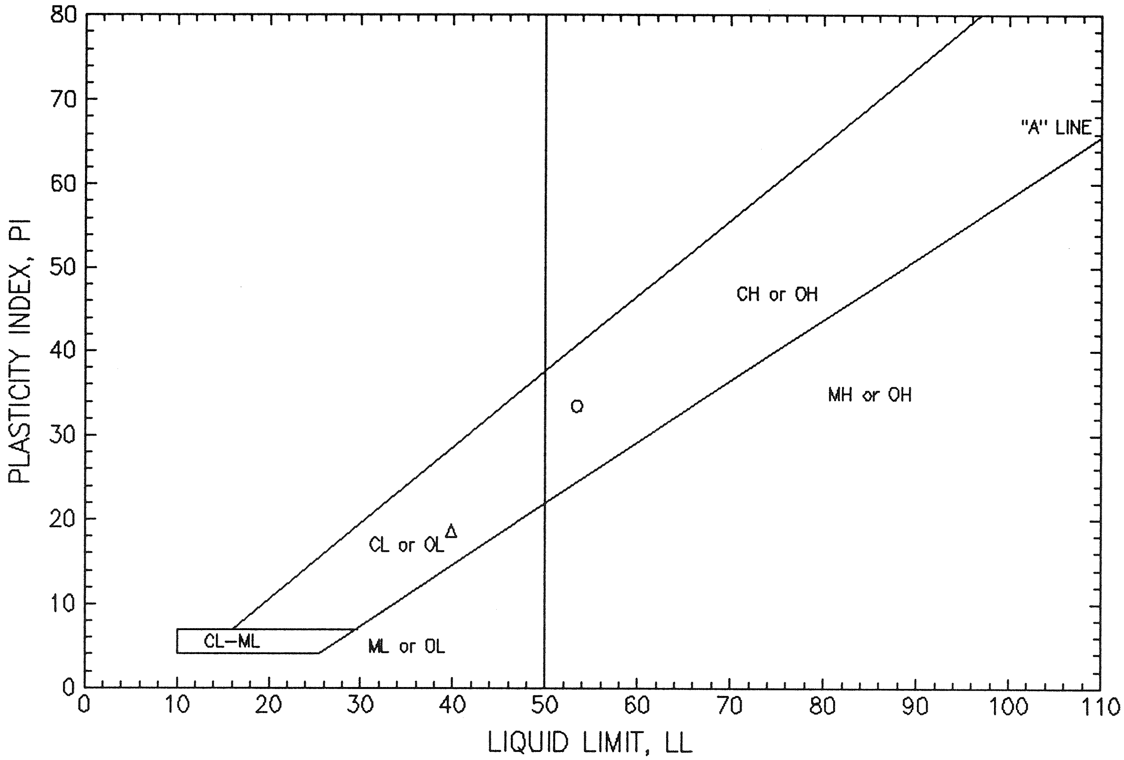
Location: **Richmond, CA**

Boring/ Sample Number	Moisture Content %	Wet Density pcf	Dry Density pcf	Unconfined Compressive Strength, psf	Strain at Failure	Sample Description
1-2-3	15.37	135.57	117.51	NA	NA	Olive brown sandy silty clay with gravel
1-4-3	13.55	135.62	119.44	NA	NA	Reddish brown gravelly silty sand/gravelly sand
1-7-3	18.69	131.94	111.16	2981	9.8%	Lt. grayish brown sandy silty clay with gravel
2-2-3	19.26	126.22	105.83	7296	10.0%	Lt. grayish brown sandy silty clay
2-3-3	23.16	126.28	102.54	3699	10.0%	Lt. grayish brown sandy silty clay
2-5-3	18.20	132.80	112.35	2099	10.0%	Brown sandy silty clay with gravel
2-7-3	27.31	124.30	97.63	1699	10.0%	Lt. grayish brown fine sandy silty clay
2-11-3	22.86	124.34	101.21	2023	8.9%	Gray fine sandy silty clay w/fractures
3-1-3	17.87	125.88	106.80	8948	10.0%	Grayish brown sandy silty clay with calc. nod.
3-4-3	25.42	121.25	96.67	3349	10.0%	Lt. brown silty clay with fine sand
3-7-3	26.19	124.98	99.04	2149	10.0%	Lt. Grayish brown sandy silty clay
3-9-3	24.37	124.52	100.12	3074	10.0%	Gray brown fine sandy silty clay
3-11-3	20.17	126.95	105.64	6697	10.0%	Grayish brown fine sandy silty clay w/calc. nod.

URS

Project : UCB – RICHMOND FIELD STATION
Project No. : 51-00111028.00
Location : UCB – RICHMOND, CA
Date : Wed Mar 14 2001

PLASTICITY CHART



Symbol	Boring No.	Sample No.	Liquid Limit	Plastic Limit	Plasticity Index
O	2-4	3	53.38	19.93	33.45
Δ	3-7	2	39.80	21.16	18.64

Figure 1

URS

ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
UCB - RICHMOND FIELD STATION	51-00111028.00	C. Wason	2-4
LOCATION UCB - RICHMOND, CA		CHECKED BY S. Capps	SAMPLE NUMBER 3
SAMPLE DESCRIPTION Olive Brown fine sa-silty Clay		DATE Tue Mar 13 2001	FILENAME 2-4-3

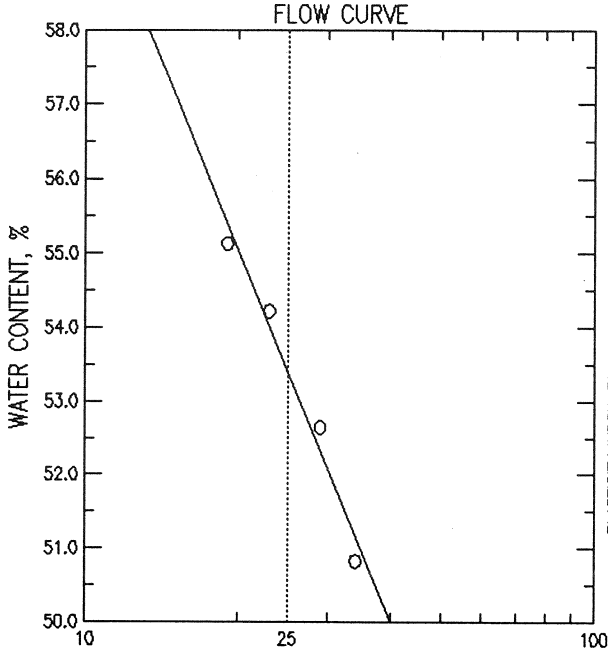
LIQUID LIMIT DETERMINATIONS

CONTAINER NUMBER	8	49	14	42	
WT. WET SOIL + TARE	23.94	23.49	22.89	21.72	
WT. DRY SOIL + TARE	19.62	19.1	18.65	17.85	
WT. WATER	4.32	4.39	4.24	3.87	
TARE WT.	11.12	10.76	10.83	10.83	
WT. DRY SOIL	8.5	8.34	7.82	7.02	
WATER CONTENT, W_N (%)	50.82	52.64	54.22	55.13	
NUMBER OF BLOWS, N	34	29	23	19	
ONE-POINT LIQUID LIMIT, LL	52.75	53.59	53.68	53.33	

PLASTIC LIMIT DETERMINATIONS

CONTAINER NUMBER	6				
WT. WET SOIL + TARE	26.25				
WT. DRY SOIL + TARE	24.51				
WT. WATER	1.74				
TARE WT.	15.78				
WT. DRY SOIL	8.73				
WATER CONTENT (%)	19.93				

FLOW CURVE



SUMMARY OF RESULTS	
NATURAL WATER CONTENT, W (%)	
LIQUID LIMIT, LL	53.4
PLASTIC LIMIT, PL	19.9
PLASTICITY INDEX, PI	33.4
LIQUIDITY INDEX, LI*	

*LI = (W − PL)/PI

PLASTICITY CHART

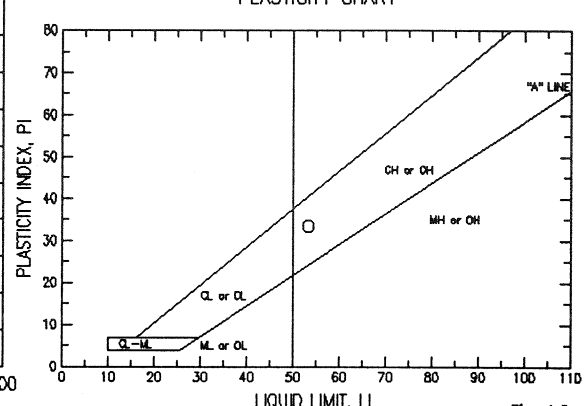


Fig. 1.0

URS

Tue Mar 13 11:02:49 2001

GEOTECHNICAL LABORATORY TEST DATA

Project : UCB - RICHMOND FIELD STATION
Project No. : 51-00111028.00
Boring No. : 2-4
Sample No. : 3
Location : UCB - RICHMOND, CA
Soil Description : Olive Brown fine sa-silty Clay
Remarks :

Depth : 15-16.5 feet
Test Date : 3/12/2001
Test Method : ASTM D4318

Filename : 2-4-3
Elevation : NA
Tested by : C. Wason
Checked by : S. Capps

Plastic Limit

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1) 6	15.78	26.25	24.51	19.93

Plastic Limit = 19.93

Liquid Limit

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Number of Drops	Moisture Content (%)
1) 8	11.12	23.94	19.62	34	50.82
2) 49	10.76	23.49	19.10	29	52.64
3) 14	10.83	22.89	18.65	23	54.22
4) 42	10.83	21.72	17.85	19	55.13

Liquid Limit = 53.38
Plastic Index = 33.45

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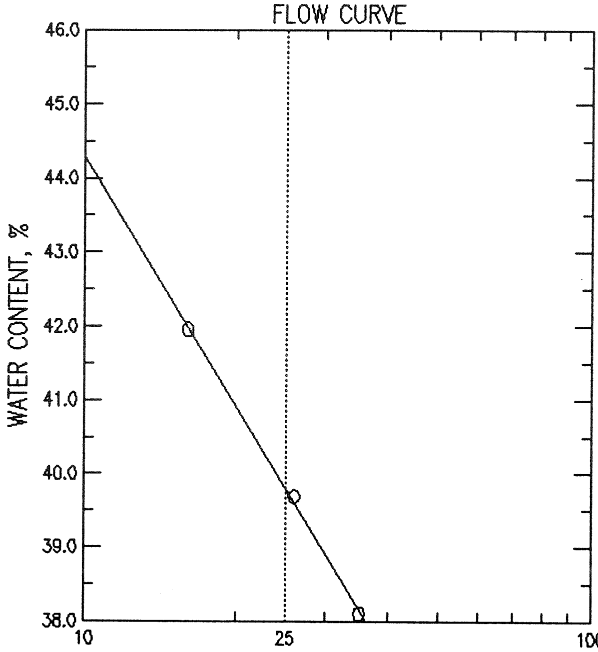
ATTERBERG LIMITS

PROJECT	PROJECT NUMBER	TESTED BY	BORING NUMBER
UCB – RICHMOND FIELD STATION	51-00111028.00	C. Wason	3-7
LOCATION UCB – RICHMOND, CA		CHECKED BY S. Capps	SAMPLE NUMBER 2
SAMPLE DESCRIPTION Lt. Brown silty Clay		DATE Wed Mar 14 2001	FILENAME 3-7-2

LIQUID LIMIT DETERMINATIONS					
CONTAINER NUMBER	112	133	320		
WT. WET SOIL + TARE	24.44	24.3	24.52		
WT. DRY SOIL + TARE	20.71	20.49	20.48		
WT. WATER	3.73	3.81	4.04		
TARE WT.	10.92	10.89	10.85		
WT. DRY SOIL	9.79	9.6	9.63		
WATER CONTENT, W_N (%)	38.10	39.69	41.95		
NUMBER OF BLOWS, N	35	26	16		
ONE-POINT LIQUID LIMIT, LL	39.68	39.88	39.75		

PLASTIC LIMIT DETERMINATIONS					
CONTAINER NUMBER	210				
WT. WET SOIL + TARE	27.01				
WT. DRY SOIL + TARE	25.08				
WT. WATER	1.93				
TARE WT.	15.96				
WT. DRY SOIL	9.12				
WATER CONTENT (%)	21.16				

FLOW CURVE



SUMMARY OF RESULTS	
NATURAL WATER CONTENT, W (%)	
LIQUID LIMIT, LL	39.8
PLASTIC LIMIT, PL	21.2
PLASTICITY INDEX, PI	18.6
LIQUIDITY INDEX, LI*	

*LI = (W – PL)/PI

PLASTICITY CHART

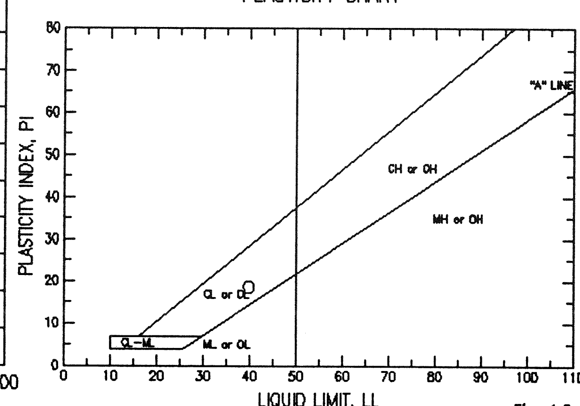


Fig. 1.0

URS

GEOTECHNICAL LABORATORY TEST DATA

Project : UCB - RICHMOND FIELD STATION
Project No. : 51-00111028.00
Boring No. : 3-7
Sample No. : 2
Location : UCB - RICHMOND, CA
Soil Description : Lt. Brown silty Clay
Remarks :

Depth : 35-36.5 feet
Test Date : 3/13/2001
Test Method : ASTM D4318

Filename : 3-7-2
Elevation : NA
Tested by : C. Wason
Checked by : S. Capps

Plastic Limit

	Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1)	210	15.96	27.01	25.08	21.16

Plastic Limit = 21.16

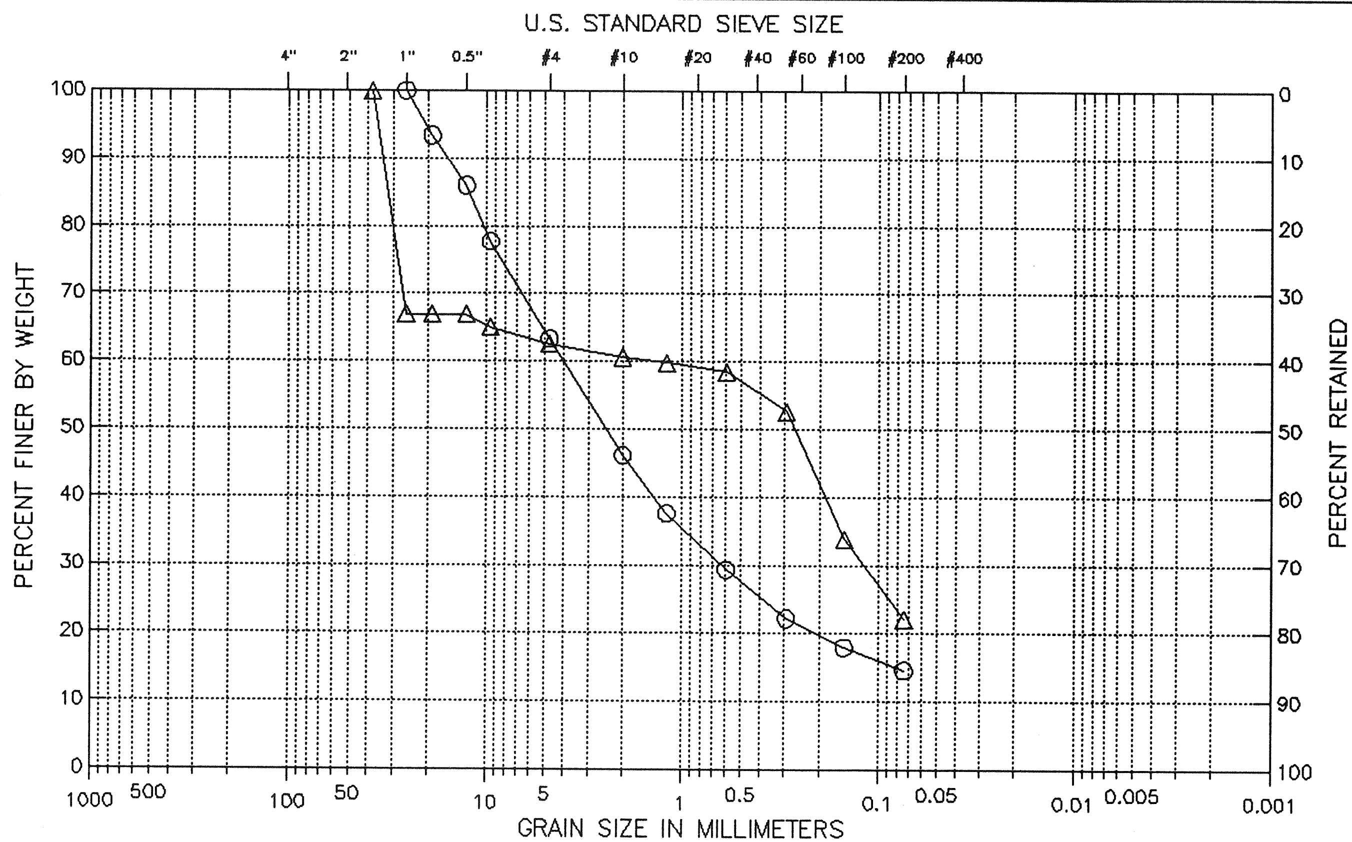
Liquid Limit

	Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Number of Drops	Moisture Content (%)
1)	112	10.92	24.44	20.71	35	38.10
2)	133	10.89	24.30	20.49	26	39.69
3)	320	10.85	24.52	20.48	16	41.95

Liquid Limit = 39.80
Plastic Index = 18.64

URS

Project : UCB – RICHMOND FIELD STATION
Project No.: 51-00111028.00
Location: UCB – RICHMOND, CA
Date : Tue Mar 13 2001

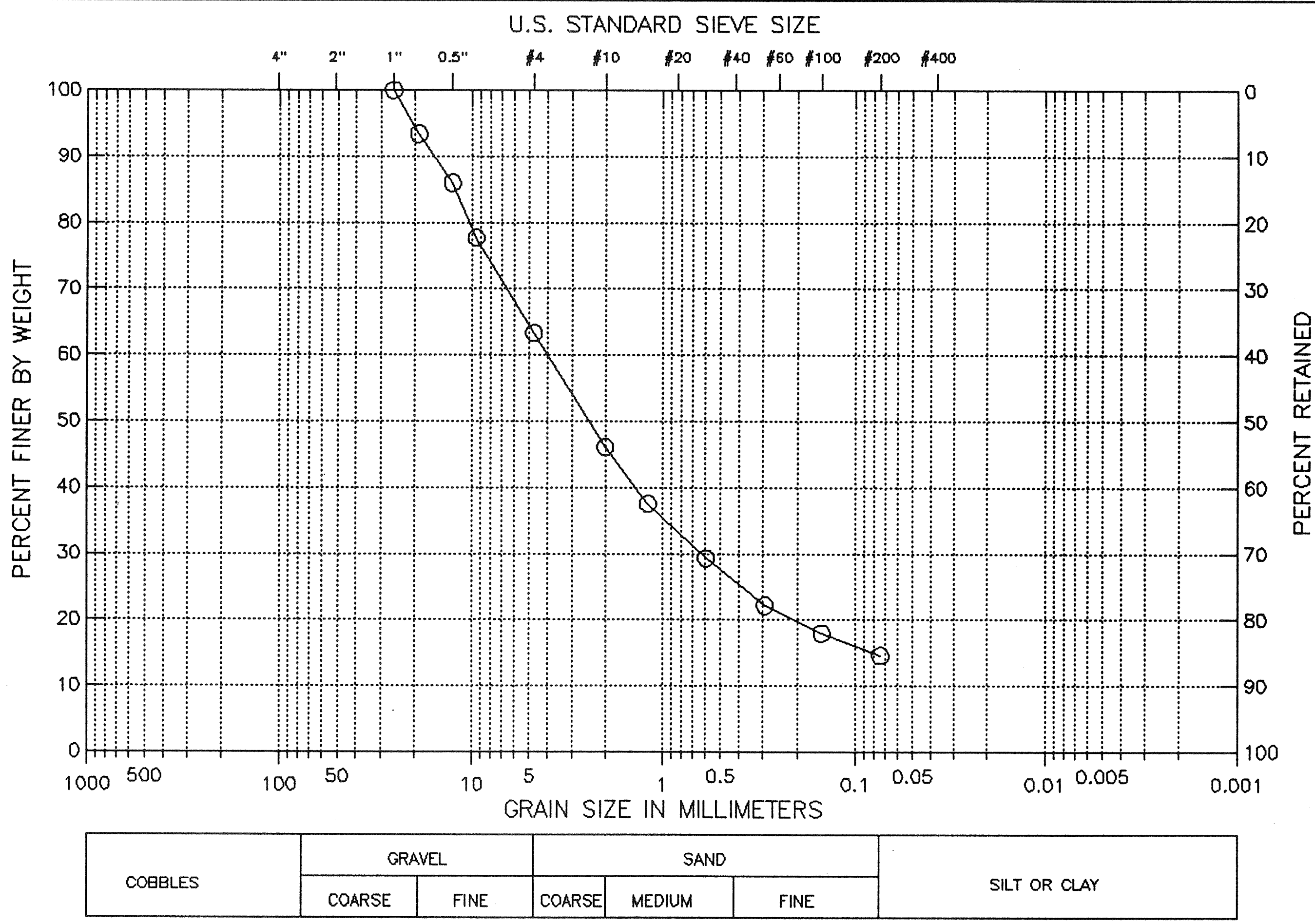


COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Boring No.	Sample No.	Depth	Filename	Classification / Description	
–○–	1-3	3	10-11.5 feet	1-3-3	SM	Silty sand with gravel
–△–	3-6	3	25-26.5 feet	3-6-3	SM	Silty sand with gravel

Figure 1

	Boring No. : 1–3 Sample No.: 3 Tested by : C. Wason Filename : 1–3–3	Project : UCB – RICHMOND FIELD STATION Project No.: 51–00111028.00 Location: UCB – RICHMOND, CA Date : Tue Mar 13 2001



Classification :
(SM) Silty sand with gravel
Visual Description :
Orange Brown gravelly clayey Sand

Remarks :
Depth: 10–11.5 feet

Figure 1

URS

GEOTECHNICAL LABORATORY TEST DATA

Project : UCB - RICHMOND FIELD STATION
Project No. : 51-00111028.00 Depth : 10-11.5 feet
Boring No. : 1-3 Test Date : 3/12/2001
Sample No. : 3 Test Method : ASTM D422
Location : UCB - RICHMOND, CA
Soil Description : Orange Brown gravelly clayey Sand
Remarks : Depth: 10-11.5 feet

Filename : 1-3-3
Elevation : NA
Tested by : C. Wason
Checked by : S. Capps

COARSE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1"	1.012	25.70	0.00	0.00	100
0.75"	0.748	19.00	36.82	36.82	93
0.5"	0.500	12.70	41.48	78.30	86
0.375"	0.374	9.51	46.10	124.40	78
#4	0.187	4.75	80.70	205.10	63
#10	0.079	2.00	96.40	301.50	46
#16	0.047	1.19	47.80	349.30	38
#30	0.023	0.60	46.30	395.60	29
#50	0.012	0.30	40.00	435.60	22
#100	0.006	0.15	23.50	459.10	18
#200	0.003	0.07	18.50	477.60	15

Total Dry Weight of Sample = 559.3

D85 : 12.2619 mm
D60 : 4.0191 mm
D50 : 2.4332 mm
D30 : 0.6326 mm
D15 : 0.0804 mm
D10 : 0.0279 mm

Soil Classification
ASTM Group Symbol : SM
ASTM Group Name : Silty sand with gravel
AASHTO Group Symbol : A-1-a(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

URS

GEOTECHNICAL LABORATORY TEST DATA

Project : UCB - RICHMOND FIELD STATION
Project No. : 51-00111028.00 Depth : 10-11.5 feet
Boring No. : 1-3 Test Date : 3/12/2001
Sample No. : 3 Test Method : ASTM D422
Location : UCB - RICHMOND, CA
Soil Description : Orange Brown gravelly clayey Sand
Remarks : Depth: 10-11.5 feet

Filename : 1-3-3
Elevation : NA
Tested by : C. Wason
Checked by : S. Capps

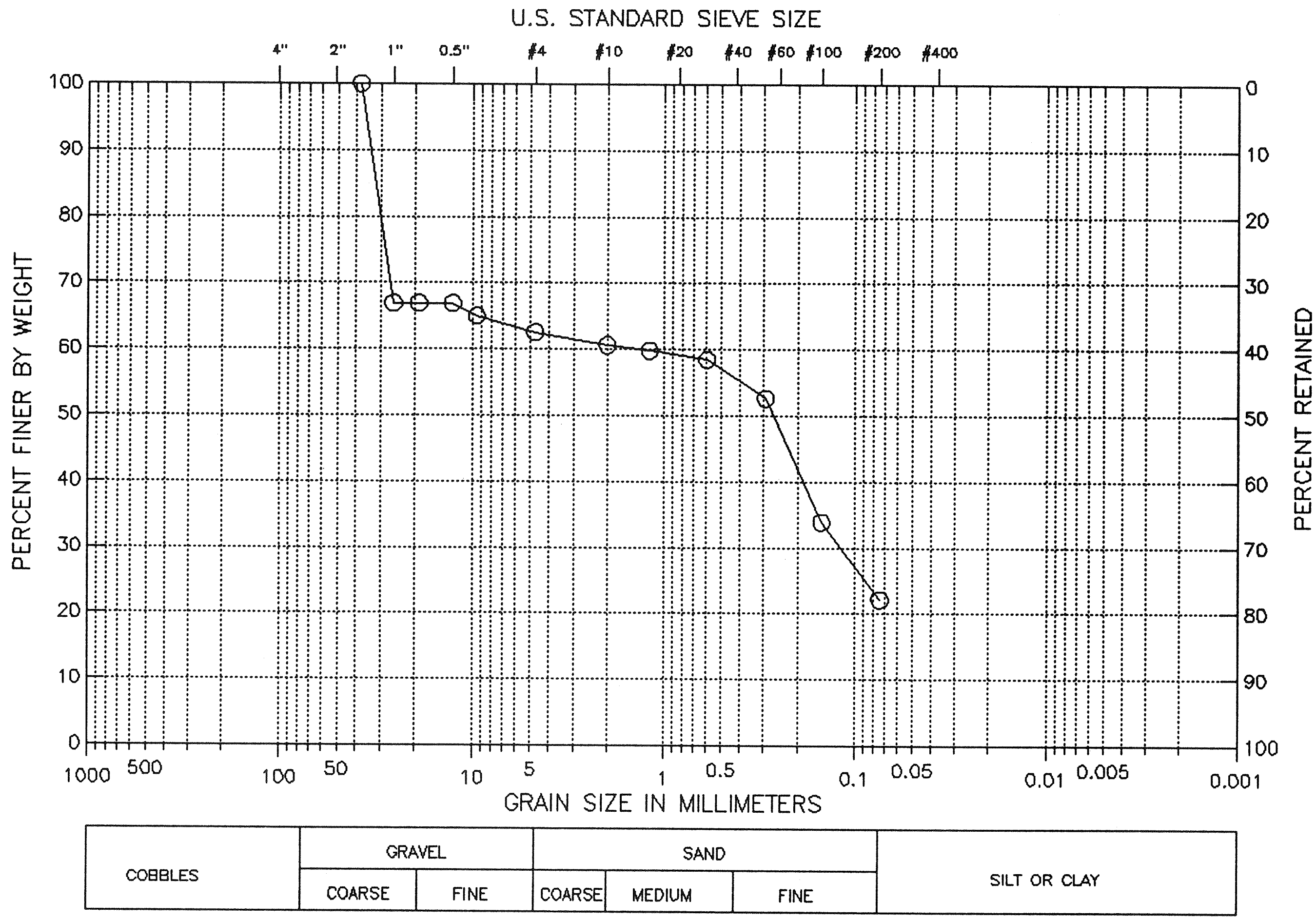
Natural Moisture Content

	Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1)	1-3-3	223.10	849.50	782.40	12.00

Average Moisture Content = 12.00

URS

	Boring No. : 3-6 Sample No.: 3 Tested by : C. Wason Filename : 3-6-3	Project : UCB – RICHMOND FIELD STATION Project No.: 51-00111028.00 Location: UCB – RICHMOND, CA Date : Tue Mar 13 2001



Classification :
(SM) Silty sand with gravel
Visual Description :
Brown clayey gravelly silty sand

Remarks :
Depth: 25-26.5 feet

Figure 1

URS

GEOTECHNICAL LABORATORY TEST DATA

Project : UCB - RICHMOND FIELD STATION
Project No. : 51-00111028.00 Depth : 25-26.5 feet
Boring No. : 3-6 Test Date : 3/12/2001
Sample No. : 3 Test Method : ASTM D422
Location : UCB - RICHMOND, CA
Soil Description : Brown clayey gravelly silty sand
Remarks : Depth: 25-26.5 feet

Filename : 3-6-3
Elevation : NA
Tested by : C. Wason
Checked by : S. Capps

COARSE SIEVE SET

Sieve Mesh	Sieve Openings Inches	Sieve Openings Millimeters	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percent Finer (%)
1.5"	1.500	38.10	0.00	0.00	100
1"	1.012	25.70	96.58	96.58	67
0.75"	0.748	19.00	0.00	96.58	67
0.5"	0.500	12.70	0.00	96.58	67
0.375"	0.374	9.51	5.64	102.22	65
#4	0.187	4.75	7.10	109.32	63
#10	0.079	2.00	5.77	115.09	61
#16	0.047	1.19	2.33	117.42	60
#30	0.023	0.60	3.98	121.40	58
#50	0.012	0.30	17.10	138.50	53
#100	0.006	0.15	54.89	193.39	34
#200	0.003	0.07	34.31	227.70	22

Total Dry Weight of Sample = 292.3

D85 : 31.8639 mm
D60 : 1.3303 mm
D50 : 0.2682 mm
D30 : 0.1185 mm
D15 : N/A
D10 : N/A

Soil Classification
ASTM Group Symbol : SM
ASTM Group Name : Silty sand with gravel
AASHTO Group Symbol : A-1-b(0)
AASHTO Group Name : Stone Fragments, Gravel and Sand

URS

GEOTECHNICAL LABORATORY TEST DATA

Project : UCB - RICHMOND FIELD STATION
Project No. : 51-00111028.00
Boring No. : 3-6
Sample No. : 3
Location : UCB - RICHMOND, CA
Soil Description : Brown clayey gravelly silty sand
Remarks : Depth: 25-26.5 feet

Depth : 25-26.5 feet
Test Date : 3/12/2001
Test Method : ASTM D422

Filename : 3-6-3
Elevation : NA
Tested by : C. Wason
Checked by : S. Capps

Natural Moisture Content

Moisture Content ID	Mass of Container (gm)	Mass of Container and Moist Soil (gm)	Mass of Container and Dried Soil (gm)	Moisture Content (%)
1) 3-6-3	221.10	566.00	513.40	18.00

Average Moisture Content = 18.00