SUBSURFACE INVESTIGATION
Sonoma County Water Agency
Secondary Clarifier Upgrade Project
Schellville, California

Sonoma County Water Agency
Owner

HDR Engineering, Inc.
Design Engineers

1P2/598/63
38122-C2:004N:188W

October 1998
INTRODUCTION

A limited study of foundation conditions has been completed at the above site in accordance with the agreement between HDR Engineering, Inc. and Taber Consultants. The purpose of investigation is to provide earth materials criteria for use in design and construction of foundations for two new secondary clarifiers. Limitations of this work are discussed in the attached "General Conditions".

Previous exploration at this at this site is summarized in our reports (prepared as Moore & Taber) of “Foundation Investigation – Sewage Treatment Facilities” (35161F) dated January 8, 1966, subsurface investigation (573/55F) dated June 26, 1977 and "Foundation Investigation" (577/38) dated September 29, 1977. Information from these studies was used in the preparation of this report, as appropriate. Relevant portions of site exploration and laboratory test results from these studies are attached to this document as discussed below. For details not included in this report, please refer to the referenced documents.
SITE AND PROJECT DESCRIPTION

General

The proposed project is shown on preliminary plan, section and detail drawings dated August 1998 by HDR Engineering, Inc. Proposed improvements are to encompass an area of about 0.8 acres located west of the existing Blower Room and north of the existing Sludge Storage and Decant Tanks.

Existing ground surface in the vicinity of proposed improvements ranges from approximately elev. 28± near the trickling filter (abandoned) on the northwest to about elev. 19± near the sludge storage and decant tanks on the southwest. Site topography varies from nearly level throughout most of the facility (slopes of 10:1 or flatter) to existing cut-slopes as steep as 3h:1v near the existing sludge storage pad.

Existing Structures/Demolition

Numerous structures and utilities associated with the existing wastewater treatment facility are located in areas of proposed construction. Demolition plans provided by HDR Engineering, Inc. (August 1998) indicate removal of the following facilities: secondary sedimentation basins, trickling filter, sludge storage pad, primary sedimentation tank, chlorine contact basin and various sections of associated utilities and pavement. The presence of other structures and associated fill within limits of planned demolition and excavation cannot be precluded.

Proposed Improvements

Two new 140±ft diameter secondary clarifiers are to be constructed to replace existing plant facilities. At the periphery of the new clarifiers, the bottom slab
(effectively a wall footing) is shown to be 18-inches thick with base at elev. 6.3±. From the perimeter, the slab slopes gently toward the center of the structure, transitioning to a 6-inch thick slab (about 9±ft inside the wall) with base as low as elev. 4.5± (as much as 21-23±ft below existing ground surface) near the center of the clarifier. Top of the peripheral walls is shown at elev. 26.5, retaining 13-20±ft of materials at-and-below proposed finished ground surface.

HDR indicates that net load at the base of clarifier wall “footing” is to be 2,000-2,100 psf. Maximum dead plus live loads within the slab area (including operating conditions with water loading) are anticipated to be 1,500-1,600± psf. A “column” for support of equipment located at the center of the clarifier is indicated to have an isolated footing element with total dead plus live loads to 500 psf.

Two other minor structures are also shown as a part of this project. Both structures are to be partially buried and located between the two new clarifiers. The “RAS/WAS Pumping Station” is a 49±ft by 25±ft structure with finished floor at elev. 16.5, approximately 10±ft below finished grade. Dead plus live load at exterior walls is indicated by HDR to be about 1,850 psf; floor loads are assumed to be less than 500 psf. The Flow Split Structure is a 25±ft by 15±ft building with finished floor at elev. 14.5, about 11±ft below finished grade. Dead plus live load at exterior walls for this structure is indicated by HDR to be about 1,100 psf; floor loads are similarly assumed to be less than 500 psf.
EXPLORATION AND TESTING

Previous Exploration

Exploration made in 1965, 1973 and 1977 included thirty-five auger/rotary drilled and sampled test borings penetrating to maximum depth 42±ft (elev. -18±) at various locations within the facility. Logs of test borings and results of associated field and laboratory testing for exploration performed in the vicinity of proposed improvements are included in the appendix of this report.

Current Exploration

Additional information on the nature and distribution of subsurface materials and conditions for study of current improvements was obtained by means of three auger drilled, logged and sampled test borings penetrating to maximum depth 32±ft (lowest elev. -5±). The borings were supplemented by means of one hammer-driven cone penetration boring to a maximum depth of 23±ft (elev. -1±).

Relatively "undisturbed" samples were recovered from the sampled borings by means of 2.0-inch OD "standard penetration" (ASTM D1586) and 2.5-inch ID "thin-wall" samplers. Samplers and cone penetrometers were advanced with standard 350 ft-lb striking force to provide a field estimate of soils consistency. Penetration resistance is correlated to soils strength and bearing characteristics.

The borings were logged and earth materials field-classified by an engineer as to consistency, color, gradation and texture on the bases of penetration resistance, examination of samples and observation of drill action and cuttings. Groundwater observations were made in the borings during drilling operations and after completion.
Following the completion of drilling, the test borings made for this study were backfilled with lean cement grout.

Portions of recovered samples were retained in moisture-proof containers for laboratory testing and reference. Laboratory testing on selected "undisturbed" soil samples included moisture content-dry density and shear strength determinations. Laboratory testing on a bulk sample of site soils included a remolded direct shear test.

Borings were located by cloth tape, referenced to existing features as shown on the site plans. Elevations were referenced to a temporary benchmark provided by HDR Engineering, Inc. Locations, elevations, details of borings and results of tests are shown on the Figures 1-3, attached. Hector C. Valencia was field engineer for this study.

EARTH MATERIALS AND FOUNDATION CONDITIONS

Previous Study

Subsurface exploration was performed in the vicinity of proposed improvements in 1965 and 1973. Earth materials encountered near Secondary Clarifier No. 2 consisted of soft to stiff sandy clay with gravel overlying semicompact clayey sandy gravel in-turn overlying stiff to hard silty clay and clayey silt with clayey and silty sand interbeds. Near Secondary Clarifier No.1, earth materials encountered consisted of semicompact clayey sandy gravel overlying soft sandy clay with clayey sand interbeds. Free groundwater level identified during these studies was measured as high as elev. +14 ±.
The 1977 exploration was not performed in the vicinity of proposed improvements. However, groundwater level at that time was measured at about elev. +2± to elev. +3±.

**Current Study**

Earth materials encountered in the test borings performed for the proposed improvements are consistent with previous site explorations. However, soils encountered near Secondary Clarifier No. 1 differ and are considered weaker and more compressible than those encountered near Secondary Clarifier No. 2. The number and location of test borings performed within the scope of this study was not sufficient to locate definite transition between the differing materials. Materials as encountered in each area are discussed below.

**Fill:** There are nominal amounts of surficial soil cover, organic sludge, levee/roadway fill and random fill stockpiles on-site. None appear to be of extent or depth to seriously affect facilities design or construction.

**Near Secondary Clarifier No. 1 (Borings-2 and -3, 1998; Boring-1, 1965):**

Three soils units considered applicable to proposed construction are identified in this area. Underlying a nominal depth of surficial fill, uppermost unit materials were penetrated to 11-12±ft depth (elev.+10±). They consist generally of semicompact clayey sandy gravel (with scattered cobbles) and of (stiff to very stiff) clayey silt and gravelly clayey silt. These materials are considered at least nominally compressible, and capable of supporting light to moderate intensity directly applied and/or superposed fill/foundation loads. Less competent materials underlying this unit may control actual
settlement and allowable bearing within this unit. Clayey soils are visually classified as having “medium” to “high” expansion potential (per UBC).

Middle unit soils were penetrated from the base of the uppermost unit (elev. +10±) to 20-25±ft depth (elev. +3± to elev. -4). They consist of soft clay and silty clay with a few (loose) clayey sand layers. These materials are considered relatively weak and significantly compressible under loading in excess of maximum past pre-consolidation pressures. Clayey soils are visually classified as having “medium” to “high” expansion potential (per UBC). Middle unit soils are capable of supporting only very light directly applied and/or superposed fill/foundation loads.

Lowermost unit soils were penetrated from the base of the middle unit (elev. +3± to elev. -4±) to the maximum depth explored (37±ft; elev. -16, per Boring-1, 1965). They consist of semicom pact to compact clayey gravelly sand, clayey sand and of stiff to hard (locally soft) silty clay, sandy and gravelly clay and clayey silt. Such materials are considered nominally compressible, but capable of supporting light to moderate intensity directly applied and/or superposed fill/foundation loads – controlled by the local presence of weaker layers. Clayey soils are visually classified as having “medium” to “high” expansion potential (per UBC).

Near Secondary Clarifier No. 2 (Borings-1 and -2, 1998; Boring-2, 1973; Boring-2, 1965): Two soils units considered applicable to proposed development are identified in this area. Underlying up to 3±ft of surficial fill, upper unit materials were penetrated to 9-14±ft depth (elev.+12± to elev. +15±). They consist generally of semicom pact to compact clayey sand and clayey sandy gravel (locally with cobbles)
and of soft to very stiff (locally soft or hard) sandy clay and sandy gravelly clayey silt and compact clayey sandy gravel. Such materials are considered nominally compressible, but capable of supporting light to moderate intensity directly applied and/or superposed fill/foundation loads – controlled by the local presence of weaker layers. Clayey soils are visually classified as having “medium” to “high” expansion potential (per UBC).

Lower unit materials were penetrated from the base of the upper unit (elev. +12± to elev. +15±) to the maximum depth of exploration (depth 32±ft; elev. -5, per Boring-1, 1998). They consist primarily of stiff to hard sandy silty clay and sandy clayey silt with local sandy gravelly clay and clayey sand interbeds. These materials are considered capable of supporting moderate to heavy intensity directly applied and/or superposed fill/foundation loads. Similar to the upper unit, clayey soils are visually classified as having “medium” to “high” expansion potential (per UBC).

**Groundwater:** Free groundwater was encountered at 9-16±ft depth (elev. 13± to elev. 11±) in Borings-1, 3 and 4, and was encountered at 24±ft depth (elev. 0±) in Boring-2. Seasonal groundwater levels slightly higher than those indicated above would not be unexpected. Excavations penetrating below groundwater level are expected to encounter seepage, heavier in any local less dense, more granular zones.
SITE SEISMIC CONDITIONS

In accordance with current Caltrans Division of Structures evaluation procedures (with reference to the "California Seismic Hazard Map, 1996"), "peak rock acceleration" 0.48 g is assigned the site associated with a controlling event of 7.0 magnitude on the Rodgers Creek-Healdsburg Fault located about 5.5 kilometers westerly. The site is classified as "Soil Profile Type D", per ATC-32, Table R3-3. A Site Soil Profile Type "Sd" is considered appropriate in accordance with the 1997 UBC Table 16-J. From on-site boring data obtained for this study, depth to "rock-like" material exceeds 42±ft. Although depths to rock shallower than 80-ft cannot be precluded, they are considered unlikely. Therefore, it is considered reasonable for seismic design to consider depth to rock in the ranges of "81-150 ft" and "greater than 150-ft". Should there be important structural and/or economic considerations associated with more closely defining this value or other site-seismicity characteristics, further study would be required.

Test borings performed at this site did not encounter any low-consistency granular soils (without clay content) considered susceptible to seismically induced liquefaction. No significant site soils defects with respect to seismic loading -- with the possible exception of potential compression of any uncontrolled (non-engineered) fill/backfill -- were noted from the limited borings and data obtained for this study.
CONCLUSIONS AND DISCUSSION

General

The site is considered stable with support available for the proposed structures.

Factors to consider in design and construction of the proposed project include:

- Differential soil support conditions across limits of improvements (particularly at/near Secondary Clarifier No. 1)
- At-least local presence of weak and compressible soils (particularly at/near Secondary Clarifier No. 1)
- Shallow groundwater/buoyancy
- Construction-term de-watering
- Construction-term excavations and shoring
- Construction-term support of existing structures
- Consolidation and compression of site soils materials due to structure loading and/or de-watering

The “medium” to “high” expansion potential of on-site native soils is not expected to be a significant factor in design of structures with foundation elements more than 18-inches below finished grade.

Weak and Compressible Soils

Test borings performed within the southern portion of Secondary Clarifier No.1 (Boring-1, 1965; Borings-3 and -4, 1998) indicate that soft to stiff clays are present from as high as elev. +10± to as low as elev. -4±. Field and laboratory testing indicates such materials to be relatively weak and capable of supporting only light magnitude directly applied and/or superposed fill and/or foundation loads.

Existing overburden pressures at the plan base of clarifiers is estimated to be in the range of 1,600±psf to 2,700±psf from the lowest to highest topographic areas, respectively. Consolidation testing on soft to stiff clays indicates such materials to be pre-consolidated to a stress level on order of 2,000 psf near the lowest topographic
area – suggesting at-least nominal over-consolidation. Such testing also indicates that soft to stiff clays are at-least moderately compressible under any fill and/or foundation loading incremental to pre-consolidation pressure.

Depending on length, width and depth of typical isolated or continuous footings, direct loading of soft clays would likely be limited to allowable bearing values on order of 1,000-1,500±psf. For large area slabs, allowable bearing in soft to stiff clays might be as high as 2,000±psf. Total and/or differential settlement tolerances might control allowable bearing pressure in any of these cases.

**Differential Support Conditions**

Establishing and maintaining uniformity of soil support throughout the entire structure limits is important to limit differential settlement. Encountered soils conditions in test borings (Boring-1, 1965; Borings-3 and -4, 1998) performed within the southern portion of Secondary Clarifier No.1 indicate that soft to stiff clays are present from as high as elev. +10± to as low as elev. -4±. North of that clarifier, materials at similar levels typically consist of very stiff to hard silty and sandy clay. Such differences, if/where occurring within limits of one structure, can lead to differential settlement unless suitably mitigated.

Encountered conditions suggest that a transition of support conditions occurs within proposed limits of Secondary Clarifier No. 1. Although not anticipated, similar conditions cannot be precluded within limits of Secondary Clarifier No. 2, the RAS/WAS Pumping Station and/or the Flow Split Structure. Further definition would require additional exploration and testing.
Mitigation of differential support conditions for foundations is expected to be available with one (or some combination) of the following typical alternatives:

- **Grading:** All or some portion of the weak materials below the clarifier and other structure footings and slabs could be excavated in order to place an engineered fill prism for structure support. In the case of Secondary Clarifier No. 1, full excavation of such materials might extend to as much as 8-9±ft below base of slab (elev. -4±), therefore, is not considered practical. However, partial subexcavation of weak materials is considered practical and feasible in order to place an engineered fill prism suitable to provide support for limited structure/fill loading.

- **Structural Slab/Mat Foundation:** The base of clarifier and other structures can be designed as a rigid or semi-rigid structural element to more-evenly distribute structure loads within tolerable limits, particularly along wall lines. At-least partial subexcavation and removal of weak materials could be beneficial for this alternative, as well. If the mat exceeds allowable bearing or settlement tolerances, then pile or pier support would be necessary, per below.

- **Pile or Pier Foundations:** All or some portion of the clarifier and other structures could be supported on piles or piers so that strength or compressibility limitations of soils immediately underlying the structures do not control design. Pile supported elements would necessarily be isolated from elements supported at grade (e.g. the slab) to allow for differential settlement. If it is not possible to isolate adjacent elements (e.g. due to leak protection requirements, etc.) then this option might only be feasible with the entire structure designed as a pile supported rigid mat.

### Shallow Groundwater/Buoyancy

As described above, free groundwater was encountered at 9-16±ft depth (elev. 13± to elev. 11±) in Borings-1, -3 and -4, and was encountered at 24±ft depth (elev. 0±) in Boring-2. Previous studies at this site have encountered groundwater at similar levels, and at-least seasonally at higher levels.

For consideration of buoyant uplift and/or de-watering, a design groundwater surface at elev. +18 has been used for design of previous structures at this site; this
level is also considered appropriate for design of currently proposed structures.

Resistance to buoyant uplift should be provided by means of adequate weight (e.g. structure weight and soil overburden), structural elements (e.g. piles, piers or soil anchors) and/or with hydrostatic pressure relief valves.

**Construction-Term De-Watering**

Construction excavations to the bottom of planned structures are expected to penetrate to as low as elev. +4.5±, as much as 21-23±ft below existing ground surface. Additional excavation may be required for any utilities or for subexcavation below the structure footings/slabs. Excavations to such levels are expected to penetrate as much as 8-9±ft below currently indicated groundwater level (elev. +11 to elev. +13±), although some variation of groundwater levels would not be unexpected at the time of construction. As such, de-watering will be necessary for construction. Methods of de-watering are anticipated to include sump pumping and/or well-points, however, specific design parameters for de-watering are not addressed by this report.

It should be noted that de-watering of the site increases effective stress on in-situ soils below previous groundwater levels which can in-turn cause settlement of ground and/or structures within the influence of such de-watering. In general, consolidation testing indicates that as much as 1-2±inches of total and/or differential settlement is possible in areas which are de-watered to as low as elev. +3± – which would suggest that structures and utilities within the influence of de-watering should be monitored and treated (if/as necessary) for the affects of settlement. Formation of de-watering plans, methods and structure/utility monitoring should take these issues
into account. Evaluation of de-watering and its effects would require specific review of site and de-watering details as provided by others.

**Construction-Term Excavations, Shoring and Support of Existing Structures**

Excavations of up to 23+ ft below existing ground surface can be expected for construction of proposed structures. Where feasible and practical, open excavations are expected to be stable at inclinations not steeper than 2h:1v below the groundwater level, and not steeper than 1.5h:1v above the groundwater table.

Conditions imposed by excavation-for and construction-of clarifier structures as proposed are considered a critical element, particularly with respect to continued performance of existing structures adjacent thereto. As such, typical considerations regarding ground support, imposed loading, de-watering and settlement relationships between new and existing structures/foundations/excavations will also be required in design and construction.

If/where construction excavations penetrate below a 2h:1v plane extended from the outside bottom edge of existing structure foundations or sensitive utilities, then shoring will be required to prevent deflection, settlement and/or bearing capacity failures induced by reduction in ground support. Similarly, if/as new structures penetrate the influence of existing structures, the new structure should be designed for loading imposed by the structure at the higher level.

Plan locations and elevations suggest that inadequate clearance for open excavations exists between the existing Blower Building and the planned excavation for
the proposed Secondary Clarifier No. 2. Shoring requirements implied by plan indicated structure/excavation relationships suggest that as much as 60±ft of shoring with variable heights to 16±ft (depending on location of shoring placement) above base of subgrade preparation will be required to provide adequate support for the existing structure.

At the new Secondary Clarifier No. 1, plan indicated clearance between the existing Sludge Storage and Decant Tanks (assuming implementation of plan-indicated foundations penetrating to elev. 14±) and proposed excavations is indicated to be marginally adequate, providing a 2:1 slope between the base of existing tank foundation and the base of proposed clarifier excavation.

The need for additional shoring beyond that outlined above cannot be precluded. Shoring should be designed and constructed based on actual loads, surcharges and clearances which are field confirmed.
RECOMMENDATIONS

General

Owing to the locally weak, potentially non-uniform and compressible nature of the materials within limits of Secondary Clarifier No. 1, it is recommended that the clarifier slab/footings be established within a prism of engineered fill to provide uniformity of structure support and to mitigate potential total and differential structure settlement. At Secondary Clarifier No. 2, similar conditions are not expected, but cannot be precluded. While support of Secondary Clarifier No. 2 might require lesser preparation if soft to stiff clays are not encountered, a reasonably conservative approach would be to plan for similar support at both clarifiers. Additionally, since slabs for the RAS/WAS Pumping Station and the Flow Split Structure are to be established only 3-4 ft above previously encountered levels of soft to stiff clay, similar site preparation and structure support is recommend for those structures.

The opportunity for a representative of this office to field-review soils exposed at slab/footing grades will be an important element in confirming that encountered materials/conditions are within anticipated ranges.

Grading

All site grading should be performed in accordance with the attached "Guide Specification" as modified herein. Preparation of the area for grading should include stripping and disposal of all debris and organic material and well as removal of the existing pavement structural sections at/near existing ground surface. All old fill and disturbed materials should be removed to full depth within limits and influence of project
subexcavation and filling. All existing facilities which are indicated to be demolished should be removed from the project area along with all soils disrupted by their removal.

Soils excavated for proposed improvements should be removed from the site or stockpiled in an approved area in such a manner that surcharges will not be imposed on existing or proposed structures, utilities or other facilities. It may, however, be beneficial to place uniform surcharges in areas of proposed future development. Special care should be taken so that surcharges are not placed in areas with existing buried structures and/or utilities.

Finished surfaces should be constructed and maintained at least 2% away from the structures to avoid ponding water.

**Site Preparation, Subexcavation and Engineered Fill Prisms for Structure Support**

Support of all slab and foundation elements for the clarifiers, the RAS/WAS Pumping Station and Flow Split Structure should be established in an engineered fill prism. As such, all soils within structure limits should be uniformly excavated to at least 12-inches below plan base of slab/footing in order to provide a granular engineered fill prism (and working pad) of at-least that thickness. Excavation may be established either parallel to slab slope or on the level so long as minimum fill thickness can be achieved below the slab. As discussed below, additional subexcavation (to minimum 18-inches below base of slab) might be required depending on actual soils conditions encountered.
As a minimum, lateral limits of all subexcavation should extend downward and outward on a plane of 1.5h:1v inclination from the base of the outside limits of the structure periphery (or isolated foundation element) to the base of subexcavation. Good practice would provide minimum lateral subexcavation to at least 3-ft outside structure/slab/footing limits, with exceptions to allow minimum limits (as described above) in areas where clearance to shoring and/or other structures is at a minimum.

The surface exposed by stripping and/or subexcavation should be field reviewed by a representative of this office with respect to uniformity and suitability as fill/structure foundation. The presence of unsuitable materials, differential conditions or other conditions adverse to structure support or grading shall be a field criterion for the engineer to identify areas requiring additional subexcavation, establishment/increase in engineered fill prism thickness and/or other supplemental measures for fill/structure support.

Materials exposed by subexcavation at the base of clarifiers and other minor structures are expected to be saturated, at/below the water table and not readily amenable to typical preparation by scarifying and compacting. They might also be susceptible to pumping and disturbance under even “light-weight” construction equipment. In this case, subgrade should be excavated and uniformly trimmed to a total of at-least 18-inches below the base of slab in lieu of typical scarification and compaction. Particular care should be taken to keep subgrade from pumping or becoming otherwise disturbed. At this level, a layer of reinforcing fabric should be placed on the uniformly trimmed, undisturbed subgrade as approved by a
representative of this office. Free-draining crushed rock (minimum 18-inch thickness) should be carefully spread over the fabric and lightly worked to reduce void space within the fill; no relative compaction is specified for the layer of crushed rock. Construction plans should show structure preparation in accordance with the method described above (e.g. 18-inches of crushed rock over reinforcement fabric).

Should local areas of initial lift exhibit excessive pumping and deflection, it may be necessary to re-excavate these areas, replace fabric at-or-below subgrade level and replace the layer of fill at a slightly greater thickness (say, 24-inches).

Fabric should meet minimum requirements for reinforcement fabric per Section 88 of Caltrans "Standard Specifications" (July, 1992) and should be either sewed at the seams or placed with at least 30-inch overlap of adjacent sheets.

If -- after excavation to the minimum of 12-inches below base of slab -- fill areas are amenable to original ground preparation by scarifying and compacting, subgrade will not require the additional 6-inches of subexcavation and placement of fabric as described above. In such cases, the approved subgrade should be scarified to at least 6-inches depth, conditioned to an appropriate over-optimum moisture content and compacted to at least 90% relative compaction (per ASTM D1557). Inability to achieve the required compaction on the scarified materials may be used as a field criterion for the engineer to identify areas requiring additional re-compaction, subexcavation, establishment/increase in engineered fill prism thickness and/or other supplemental measures for fill/structure support.
Fill and Backfill Placement

Clean crushed rock placed as sub-slab fill below clarifiers and other structures should be spread and compacted with light-weight equipment. Although no specific relative compaction is specified for clean crushed rock, it is important that such materials receive at-least nominal compactive effort (to the satisfaction of the engineer) in order to increase material density and reduce voids.

All other fill and backfill should be compacted to at least 90% relative compaction (per ASTM D1557) at an appropriate over-optimum moisture content. Inability to achieve the required compaction will be a field criterion identifying areas requiring additional moisture conditioning, re-compaction and/or subexcavation to establish appropriate fill foundation.

Sub-Slab and Wall Backfill Materials

Materials placed below the base of structure slabs should consist of materials commonly known as 1½-inch or ¾-inch crushed rock. Such materials should meet the following minimum qualities:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage Passing Sieve Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1½-inch</td>
<td>100</td>
</tr>
<tr>
<td>¾-inch</td>
<td>0-100</td>
</tr>
<tr>
<td>No. 4</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-2</td>
</tr>
</tbody>
</table>

Materials for wall backfill are recommended to consist of free-draining granular import materials consistent with "Structure Backfill" requirements (per Caltrans "Standard Specifications") or approved imported granular soils as defined below. If
"Structure Backfill" is not utilized as wall backfill, then imported granular materials — free of organics and other deleterious materials — meeting the following minimum qualities may be substituted for such use:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-inch</td>
<td>100</td>
</tr>
<tr>
<td>1½ -inch</td>
<td>85-100</td>
</tr>
<tr>
<td>¾-inch</td>
<td>65-100</td>
</tr>
<tr>
<td>No. 4</td>
<td>30-75</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-15</td>
</tr>
</tbody>
</table>

Test Compliance
Plasticity Index 15 Max.
Sand Equivalent 18 Min.

Vertical Limits of imported wall backfill should extend from base of wall to 2-ft below ground surface; lateral limits of imported wall backfill should be defined by a zone between the back of the wall and a 1.5h:1v plan extended upward away from the outside edge of slab/footing at the base of the wall.

Due to a high percentage of fines content, native on-site soils should not be used as fill below the base of structures (due to the potential for pumping). For similar reasons, native materials are not desirable for use as wall backfill. However, with specific design considerations as outlined below, native materials can be used as wall backfill. All native soils excavated from the project area not re-used should be disposed off-site, or to an approved on-site location.

All imported fill should be reviewed by the soils engineer (including laboratory testing) and approved in writing prior to furnishing and placing on-site. All imported fill
should be of low expansion potential (Expansion Index less than 20) and meet other quality and gradation requirements as addressed for specific uses, per above.

**Structure Footings**

As outlined in the “Grading” section above, support of structure walls should include grading and other measures to mitigate differential support conditions. Support of footings should be uniform throughout the entire structure, established entirely in an engineered fill prism. Reinforced concrete wall footings should be (effectively) at least 4-ft wide and established at least 18-inches below lowest adjacent grade. Such footings can be assigned allowable dead plus live soil bearing pressures to 2,100 psf.

Settlement of “footings” supported in an engineered fill prism per above overlying soft clay is estimated to be on order of 1-inch, or less; differential settlement estimated to be as much as one-half of total realized settlement over distances as short as 10±ft.

All footings should be poured neat (where possible) in clean and dry excavations. If footings are formed, over-excavations should be backfilled with lean concrete, slurry cement backfill or granular engineered fill placed to at least 90% relative compaction.

**Reinforced Concrete Slab**

As outlined in the “Grading” section above, support of structure slabs should including grading and other measures to mitigate differential support conditions. Support should be uniform throughout the entire slab area.

Net loading within the slab area is expected to be similar-to or less-than current soil overburden pressures. As such, total settlement or rebound at tank center
(supported in an engineered fill prism per above) is estimated to be nominal.

Differential settlement within the slab area is also expected to be nominal, attributed to any local irregularities in the native soils profile and/or structure loading.

**Lateral Earth Pressures/Uplift**

Magnitude of lateral earth pressures as discussed below is highly dependent on the type and limits of backfill placed behind retaining walls. Where lateral pressures for imported granular materials are to be used, it is important that limits of such backfill incorporate a volume as follows: vertical limits extend from base of wall to 2-ft below ground surface; lateral limits of imported wall backfill should be defined by a zone between the back of the wall and a 1.5h:1v plane extended upward away from the outside edge of slab/footing at the base of the wall. Where imported backfill will not extend to these limits, there is inadequate basis for use of their wall design parameters. For use of lateral pressures associated with native materials, no specific backfill limits are required.

Assuming the use of imported granular materials for wall backfill (meeting requirements as described above) and a capability for wall yield or rotation (say, ¼-½-inch horizontal movement at the top of a 20-ft high wall), an active equivalent fluid pressure of 36 pcf is considered appropriate for use at levels above elev. +18 (above design groundwater level); below elev. +18, an active equivalent fluid pressure of 21 pcf should be used in addition to hydrostatic pressures. If walls with imported granular backfill are restrained and incapable of yield as described above, “at-rest” pressures of
55 pcf should be used above elev. +18; below elev. +18, "at-rest" pressure of 28 pcf plus hydrostatic pressure is considered appropriate.

If it is desired to use native materials for wall backfill, higher active and/or "at-rest" pressures would be required. Selective excavation and stockpiling of the limited granular materials on-site (such as clayey sandy gravel) is not expected to be a straightforward or economical venture during construction -- vis-à-vis, suitable materials would need to be identified, tested, sorted and stockpiled. As such, if native materials are to be used as wall backfill and walls are capable of at least 1-1/2 inches of horizontal movement at top of wall, then active equivalent fluid pressures of 55 pcf would be required for design above elev. +18±, and 27 pcf plus hydrostatic pressure for design below that level. If walls with native soil backfill are restrained and incapable of sufficient yield as described above, then "at-rest" pressures of 76 pcf should be used above elev. +18; below elev. +18, "at-rest" pressure of 38 pcf plus hydrostatic pressure is considered appropriate.

Resistance to buoyant uplift may be calculated on the basis of the (buoyant) weight of the structure plus the weight of any soil directly overlying the edge of protrusions from the slab (or footing). Soil densities can be taken as 125 pcf above elev. +18 and 62 pcf below elev. +18.
Utilities/Trench Backfill

Utilities passing below the structures should be at least 18-inches below the bottom-of-slab. Where utilities parallel footings, they should not be placed on the footing side of a 1.5:1 (horizontal:vertical distance) plane extended downward from the nearest bottom edge of footing.

All utility trench backfill underlying structures and structure influence (e.g. extending outward to-and-below the plane defined in the above paragraph) should be compacted to at least 90% relative compaction (per ASTM D 1557).

Backfill within structure influence should consist of granular materials as outlined above. Materials meeting quality requirements for “Structure Backfill” per Caltrans “Standard Specifications”. All imported backfill materials should be specifically reviewed (including laboratory testing) and approved in writing by this office prior to being furnished and placed on the site.

TABER CONSULTANTS

Hector C. Valencia
Gary D. Avey

HCV/GDA/FPT
October 1, 1998
Attachments:
  "General Conditions"
  "Test Boring Logs" (4 pages)
  "Boring Legend"
  "Laboratory Results" (2 pages)
  "Guide Specification"
  "Location of Field Tests"
  "Results of Previous Exploration and Testing"
GENERAL CONDITIONS

The conclusions and recommendations of this study are professional opinion based upon the indicated project criteria and the limited data described herein. It is recognized there is potential for variation in subsurface conditions and that modification of conclusions and recommendations might emerge from further, more detailed study.

This report is intended only for the purpose, site location and project description indicated and assumes design and construction in accordance with applicable codes.

As changes in appropriate standards, site conditions and technical knowledge cannot be adequately predicted, review of recommendations by this office for use after a period of two years is a condition of this report.

A review by this office of any foundation and/or grading plans and specifications or other work product insofar as they rely upon or implement the content of this report, together with the opportunity to make supplemental recommendations as indicated therefrom is considered an integral part of this study and a condition of recommendations.

Subsequently defined construction observation procedures and/or agencies are an element of work which may affect supplementary recommendations.

Should there be significant change in the project or should soils conditions different from those described in this report be encountered during construction, this office should be notified for evaluation and supplemental recommendations as necessary or appropriate.

Opinions and recommendations apply to current site conditions and those reasonably foreseeable for the described development—which includes appropriate operation and maintenance thereof. They cannot apply to site changes occurring, made, or induced, of which this office is not aware and has not had opportunity to evaluate.

The scope of this study specifically excluded sampling and/or testing for, or evaluation of the occurrence and distribution of, hazardous substances. No opinion is intended regarding the presence or distribution of any hazardous substances at this or nearby sites.
TEST BORING LOG

BORING No 1

ELEVATION: 26.6

1.0

<table>
<thead>
<tr>
<th>Depth</th>
<th>ML</th>
<th>GW</th>
<th>CL</th>
<th>Bag A</th>
<th>Stiff brown slightly CLAYEY fine SANDY SILT</th>
</tr>
</thead>
<tbody>
<tr>
<td>114</td>
<td>16</td>
<td>15</td>
<td>1.4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>15</td>
<td>43</td>
<td>2.5</td>
<td>3</td>
<td>Dense/hard brown SILTY and CLAYEY fine-medium SANDY fine-coarse GRAVEL and fine-coarse GRAVELLY SANDY CLAYEY SILT</td>
</tr>
</tbody>
</table>

0.6

<table>
<thead>
<tr>
<th>Depth</th>
<th>CL / SM</th>
<th>Bag B</th>
<th>Stiff brown very fine SANDY SILTY CLAY and CLAYEY very fine-fine SAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>31</td>
<td>13</td>
<td>1.4</td>
</tr>
<tr>
<td>100</td>
<td>22</td>
<td>75</td>
<td>2.5</td>
</tr>
</tbody>
</table>

3.9

<table>
<thead>
<tr>
<th>Depth</th>
<th>S</th>
<th>Hard light brown very fine SANDY CLAYEY SILT</th>
</tr>
</thead>
<tbody>
<tr>
<td>95</td>
<td>27</td>
<td></td>
</tr>
</tbody>
</table>

3.2

<table>
<thead>
<tr>
<th>Depth</th>
<th>CL</th>
<th>Hard light brown to brown SILTY CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>85</td>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>

1.9

<table>
<thead>
<tr>
<th>Depth</th>
<th>CL</th>
<th>Very stiff brown SILTY CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>92</td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>

Groundwater encountered at 20.0 ft. depth during drilling. Groundwater measured at 16.5 ft. depth before backfilling. Boring grout backfilled 6-29-98.

LOGGED BY: H.C.V.  DATE: 6-29-98

Figure - 1  Page 1 of 4
**Test Boring Log**

**Boring No. 2**

**Elevation: 24.0**

<table>
<thead>
<tr>
<th>Material Class</th>
<th>Depth (ft)</th>
<th>Sample No.</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML</td>
<td>0.4</td>
<td>1</td>
<td>Coarse gravel on visqueen over very fine sandy clayey silt</td>
</tr>
<tr>
<td>ML/SM</td>
<td>1.4</td>
<td>2</td>
<td>Very stiff/compact fine gravelly sandy clayey silty clay and clayey sandy fine gravel</td>
</tr>
<tr>
<td>CL/GC</td>
<td>1.4</td>
<td>3</td>
<td>(Very stiff to stiff) brown silty clay</td>
</tr>
<tr>
<td>CL</td>
<td>2.0</td>
<td>4</td>
<td>Hard brown silty clay and very fine sandy silty clay with thin interbeds of clayey very fine sand</td>
</tr>
<tr>
<td></td>
<td>4.3</td>
<td>5</td>
<td>Groundwater measured at 23.0 ft. depth during drilling. Groundwater measured at 24.0 ft. depth after completion. Boring grout backfilled 6-29-98.</td>
</tr>
</tbody>
</table>

**Unconfined Compressive Strength (kSI)**

- Dry Density (lbs/ft³)
- Moisture (%)
- Blows/foot 350 ft-lb
- Sample Index
- Sample No.
- Depth in Feet
- Material Symbol
- Soil Class
- Logged By: H.C.V.
- Date: 6-29-98

The boring logs show subsurface conditions at the dates and locations indicated. It is not warranted that they are representative of subsurface conditions at other locations and times.
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Blows per foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
</tr>
<tr>
<td>53</td>
<td></td>
</tr>
<tr>
<td>53</td>
<td></td>
</tr>
<tr>
<td>72</td>
<td></td>
</tr>
<tr>
<td>73</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td></td>
</tr>
<tr>
<td>107</td>
<td></td>
</tr>
</tbody>
</table>

Boring grout backfilled 6-29-98.

The boring logs show subsurface conditions at the dates and locations indicated and it is not warranted that they are representative of subsurface conditions at other locations and times.

Logged by: H.C.V.  
Date: 6-29-98
(Stiff) brown CLAYEY SILT with scattered fine GRAVEL

(Soft to stiff) brown SILTY CLAY

Groundwater measured at 12.0 ft. depth during drilling. Groundwater measured at 9.3 ft. depth after completion. Boring grout backfilled 6-29-98.
UNIFIED SOIL CLASSIFICATION SUMMARY

<table>
<thead>
<tr>
<th>Pt</th>
<th>OH</th>
<th>CH</th>
<th>MH</th>
<th>OL</th>
<th>CL</th>
<th>ML</th>
<th>SC</th>
<th>SM</th>
<th>SP</th>
<th>SW</th>
<th>GC</th>
<th>GM</th>
<th>GP</th>
<th>GW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly organic soils</td>
<td>Silts and clays Liquid limit 50 or more</td>
<td>Silts and clays Liquid limit less than 50</td>
<td>Sands with fines &gt;12% fines</td>
<td>Clean sands &lt; 5% fines</td>
<td>Gravels with fines &gt; 12% fines</td>
<td>Clean gravels &lt; 5% fines</td>
<td>Sands - 50% or more of coarser fraction is smaller than No. 200 sieve</td>
<td>Gravels - more than 50% of coarser fraction is larger than No. 4 sieve</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fine grained soils (50% or more is smaller than No. 200 sieve)</td>
<td>Coarse grained soils (More than 50% is larger than No. 200 sieve)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LABORATORY CLASSIFICATION CRITERIA

GW and SW - Cu ≥ 4 for GW and 6 FOR SW; 1 ≤ Cc ≤ 3
GP and SP - Clean gravel or sand not meeting requirements for GW and SW.
GM and SM - Atterberg limits of fines below "A" line or P.I. less than 4.
GC and SC - Atterberg limits of fines above "A" line with P.I. greater than 7.

Fines (silt or clay) | Sand | Gravel | Cobble | Boulders |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve sizes</td>
<td>Fine</td>
<td>Medium</td>
<td>Course</td>
<td>Fine</td>
</tr>
<tr>
<td>200</td>
<td>40</td>
<td>10</td>
<td>4</td>
<td>3/4&quot;</td>
</tr>
</tbody>
</table>

Classification of earth materials shown on the test boring logs is based on field inspection and should not be construed to imply laboratory analysis unless so stated.

MATERIAL SYMBOLS

- Gravel
- Sand
- Silt
- Clay
- Sandstone
- Limestone
- Metamorphic rock
- Igneous rock
- Peat or organic matter
- Shale

CONSISTENCY CLASSIFICATION FOR SOILS

<table>
<thead>
<tr>
<th>No. of Blows</th>
<th>Granular</th>
<th>Cohesive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>Very loose</td>
<td>Very soft</td>
</tr>
<tr>
<td>6-10</td>
<td>Loose</td>
<td>Soft</td>
</tr>
<tr>
<td>11-20</td>
<td>Semicompact</td>
<td>Stiff</td>
</tr>
<tr>
<td>21-35</td>
<td>Compact</td>
<td>Very stiff</td>
</tr>
<tr>
<td>36-70</td>
<td>Dense</td>
<td>Hard</td>
</tr>
<tr>
<td>&gt; 70</td>
<td>Very dense</td>
<td>Very hard</td>
</tr>
</tbody>
</table>

* According to the Standard Penetration Test (ASTM D 1586)
*"*" Indicates extrapolated blow count
Where standard penetration test has not been performed, consistencies shown on logs are estimated.

KEY TO "OTHER TESTS" LABORATORY

- E - Expansion Index
- A - Atterberg Limits
- G - Gradation
- SE - Sand Equivalent
- C - Consolidation
- M - Maximum Dry Density
- R - Stabilometer Resistance Value
- S - Direct Shear
- T - Triaxial Shear
- P - Permeability
- Ch - Corrosivity Testing
- SG - Specific Gravity

LEGEND OF BORING

- Bulk Sample
- Drive Sample
- Casing Set
- Bottom of boring
- Conformable material change
- Approximate material change
- Unconformable material change

LEGEND OF PENETRATION TEST

- Graphic representation of driving rate
- Groundwater surface
- First encountered groundwater
- Blows per foot (using 140 lb. hammer with 30" drop)

Boring Legend
LABORATORY TEST RESULTS

Summary of Direct Shear Tests

<table>
<thead>
<tr>
<th>Boring/Sample</th>
<th>Test Condition</th>
<th>Normal Stress (psf)</th>
<th>Peak Values</th>
<th>Ultimate Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Shear Stress (psf)</td>
<td>Displacement (ins)</td>
</tr>
<tr>
<td>1/7</td>
<td>2</td>
<td>1500</td>
<td>2122</td>
<td>0.070</td>
</tr>
<tr>
<td>&quot;</td>
<td>2</td>
<td>3000</td>
<td>2927</td>
<td>0.070</td>
</tr>
<tr>
<td>&quot;</td>
<td>2</td>
<td>4500</td>
<td>3787</td>
<td>0.080</td>
</tr>
<tr>
<td>Bag A</td>
<td>1,3</td>
<td>500</td>
<td>1262</td>
<td>0.080</td>
</tr>
<tr>
<td>Bag A</td>
<td>1,3</td>
<td>1250</td>
<td>1879</td>
<td>0.080</td>
</tr>
<tr>
<td>Bag A</td>
<td>1,3</td>
<td>2000</td>
<td>2431</td>
<td>0.130</td>
</tr>
</tbody>
</table>

ALL SAMPLES SHEARED - SPECIMEN TEST CONDITION AS NOTED - IN STANDARD CIRCULAR SHEAR BOX UNDER STRAIN CONTROL = 0.025 INS/MIN.

Test Condition Notation

1. Submerged, unconsolidated
2. Saturated, consolidated at test load
3. Remolded to ±90% relative compaction (ASTM D 1557)

Surcharge Volume Change Tests
(2 ½" dia x 1" thick specimen, 24-hr saturation at indicated surcharge)

<table>
<thead>
<tr>
<th>Boring No./Sample No.</th>
<th>Surcharge (psf)</th>
<th>Initial Dry Density (pcf)</th>
<th>Initial Moisture (%)</th>
<th>Final Moisture (%)</th>
<th>Compression (-) Expansion (+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/7</td>
<td>1500</td>
<td>93</td>
<td>26.6</td>
<td>27.0</td>
<td>0.6(-)</td>
</tr>
<tr>
<td>1/7</td>
<td>3000</td>
<td>93</td>
<td>26.6</td>
<td>27.2</td>
<td>1.1(-)</td>
</tr>
<tr>
<td>1/7</td>
<td>4500</td>
<td>93</td>
<td>26.6</td>
<td>26.6</td>
<td>1.6(-)</td>
</tr>
</tbody>
</table>

Figure-2
Page 1 of 2
<table>
<thead>
<tr>
<th>Boring/Sample No.</th>
<th>Depth (ft.)</th>
<th>Classification</th>
<th>NaWc</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>SE</th>
<th>MDD</th>
<th>OM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bag C</td>
<td>0-10.0</td>
<td>SM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GRADATION CURVES**

**Figure 2**

**Project** Sonoma County W.W.T.P.

**Client** HDR Engineering

**Date** August 1998
GUIDE SPECIFICATION

for

PREPARATION OF FILL FOUNDATION

and

PLACEMENT OF ENGINEERED FILL

A. Site Preparation

1. All trees, brush, logs and other debris shall be removed from the area to be filled. The area to receive fill shall be free of all roots and other organic material. Underground structures shall be removed or otherwise abandoned in accordance with public agency requirements and as determined by the Soils Engineer. The fill foundation shall be stripped exposing firm foundation material capable of achieving specified compaction. For fills to be placed on sloping surfaces, adequate fill foundation shall be exposed to the toe of fill slope extended to base of stripping level, unless otherwise specified or permitted by the Soils Engineer.

2. The exposed fill foundation shall be favorably field-reviewed by the Soils Engineer, then scarified to a depth of at least 6-inches. Where fills are to be placed on hillslopes, scarifying shall be to depths adequate to provide bond between fill and fill foundation. Where considered necessary by the Soils Engineer, the fill foundation surface shall be stepped or benched to achieve this bond. Vertical dimension of required benches shall be determined by the Soils Engineer, based upon location, degree and condition of hillslope.

3. The exposed and scarified fill foundation shall be watered as necessary and compacted to not less than 90% of maximum dry density per ASTM D1557 unless otherwise specified.

B. Fill Material

1. All materials proposed for use in the fill shall be favorably reviewed by the Soils Engineer prior to placement. Review may include laboratory testing.

2. Fill materials shall be free from organic matter and other deleterious substances and shall not contain rocks or lumps larger than 4-inch maximum dimension.
C. Placement of Fill

1. Fill material shall be spread in uniform layers not exceeding 6-inches compacted thickness. Water shall be added to the fill, or the fill allowed to dry, and mixed as necessary to obtain a moisture content which is uniform and which is adequate to achieve compaction as specified.

2. Each layer of fill shall be compacted to not less than 90% of maximum dry density per ASTM D1557 unless otherwise specified. Compaction shall be by sheepsfoot roller, multiple-wheel pneumatic roller or other acceptable equipment of such design that the fill can be compacted as specified.

3. Work that has been suspended by weather, scheduling or for any other reason, shall be protected against the effects of such weather or other conditions. Grading which has been considered acceptable but which has been subsequently damaged shall be re-worked to meet the requirements of the specifications.

D. Observation and Testing

1. A minimum of 24-hours notice shall be given the Soils Engineer by the superintendent of grading prior to commencing or recommencing any grading operations; additional time may be required for review/testing of materials proposed for fill. No fill shall be placed prior to favorable field review of fill foundation or previously graded surface by the Soils Engineer.

2. Preparation of fill foundation and placement of fill shall be observed by the Soils Engineer so that he can render a professional opinion as to the conformance of the completed fill to the specifications.

3. Field density tests shall be made at locations determined by the Soils Engineer. Sufficient tests shall be made to adequately support a professional opinion of the Soils Engineer that the required compaction has been achieved throughout the fill. When tests indicate that the specified compaction has not been achieved, that portion of the fill shall be re-worked until the required density has been attained.
APPENDIX

"Results of Previous Exploration and Testing"
## Test Boring Log

### Type 4" Auger

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Moisture (%)</th>
<th>Blows/ft</th>
<th>Sample Size (Inches)</th>
<th>Sample No.</th>
<th>Dry Density (lbs/cu.ft)</th>
<th>Soil Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>91.0</td>
<td>21.9</td>
<td>17</td>
<td>1.4</td>
<td>1</td>
<td></td>
<td>CL</td>
</tr>
<tr>
<td>95.3</td>
<td>16.3</td>
<td>30</td>
<td>1.4</td>
<td>2</td>
<td></td>
<td>GC</td>
</tr>
<tr>
<td>93.0</td>
<td>21.1</td>
<td>49</td>
<td>1.4</td>
<td>3</td>
<td></td>
<td>CL</td>
</tr>
<tr>
<td>88.7</td>
<td>25.4</td>
<td>55</td>
<td>1.4</td>
<td>4</td>
<td></td>
<td>ML</td>
</tr>
<tr>
<td>47</td>
<td>1.4</td>
<td>5</td>
<td>1.4</td>
<td></td>
<td></td>
<td>ML</td>
</tr>
</tbody>
</table>

**Material:**
- Semi-compact to dense brown clayey fine to coarse SAND & GRAVEL
- Hard brown silty CLAY with numerous seams of SILT
- Hard brown clayey SILT

**Notes:**
1. Minor caving of boring walls.
2. Ground water surface:

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 May 73</td>
<td>1130</td>
<td>11.7</td>
</tr>
<tr>
<td>9 May 73</td>
<td>1200</td>
<td>11.3</td>
</tr>
<tr>
<td>10 May 73</td>
<td>1415</td>
<td>11.2</td>
</tr>
<tr>
<td>30 May 73</td>
<td>1030</td>
<td>12.3</td>
</tr>
</tbody>
</table>

Logged By T.D.H.  
Date 7 May 1973
## TEST BORING LOG

<table>
<thead>
<tr>
<th>TYPE</th>
<th>3&quot; Rotary Drill</th>
<th>ELEVATION</th>
<th>BORING NO</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>20.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>1.6</th>
<th>25</th>
<th>8.1.4 2</th>
<th>20</th>
<th>4.2.5 4</th>
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<th>26.1.4 5</th>
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<th>93</th>
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<tr>
<td>% Moisture</td>
<td>104</td>
<td>20</td>
<td>19.1.4 1</td>
<td>30</td>
<td>37</td>
<td>4</td>
<td>1.4 5</td>
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<td>Btu/ft-lb</td>
<td>GWS e1=13.3 x12/27/64</td>
<td>10</td>
<td>8.1.4 2</td>
<td>20</td>
<td>4.2.5 4</td>
<td>25</td>
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<td>93</td>
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<td>93</td>
<td>15</td>
<td>17</td>
<td>35</td>
</tr>
</tbody>
</table>

**SOIL CLASSIFICATION**

1. **GC**
   - Semicompact brown clayey sandy very fine to coarse gravel with several clay layers and scattered small cobbles.

2. **CL**
   - Soft gray-brown sandy clay with several clayey sand layers.

3. **SC**
   - Compact brown clayey gravelly very fine to very coarse sand.

4. **CL**
   - Soft brown sandy clay.

5. **SC**
   - Semicompact brown clayey very fine to fine sand.

6. **ML**
   - Soft blue-gray clayey silt.

---

Logged By: ADB  Date: 12/23, 24/65

Job No. 35/61F, dated 1965
## TEST BORING LOG

**TYPE** 16" Auger  
**ELEVATION** 27.0  
**BORING NO.** 2

<table>
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<tr>
<th>Depth (Ft)</th>
<th>Moisture (%)</th>
<th>Blows/foot</th>
<th>Sample Size (Inches)</th>
<th>Sample No.</th>
<th>Dry Density (lbs/cu.ft)</th>
<th>Material Symbol</th>
<th>Description</th>
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<td>Very loose black organic clayey very fine to fine sand.</td>
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<td>CL</td>
<td>Soft to stiff brown sandy clay.</td>
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<td>15</td>
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<td></td>
<td>SC</td>
<td>Semicompact brown clayey sandy very fine to coarse gravel with few small cobbles.</td>
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<td></td>
<td>CL</td>
<td>Interbedded stiff and very stiff gray-brown sandy clay, clayey very fine. sand and silty sand with a few soft layers and hard cemented layers.</td>
</tr>
</tbody>
</table>

T.D. = 30 ft