Geotechnical Investigation Report

Stewart Street Reservoirs Replacement
Fortuna, California

Prepared for:

City of Fortuna

SHN Consulting Engineers & Geologists, Inc.

812 W. Wabash Ave.
Eureka, CA 95501-2138
707-441-8855

May 2009
009030.050

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Reference: 009030.050

May 29, 2009

Mr. Dennis Ryan, Public Works Director
City of Fortuna
P.O. Box 545
Fortuna, CA 95540

Subject: Geotechnical Investigation Report, Stewart Street Reservoirs Replacement, Fortuna, California

Dear Mr. Ryan:

The enclosed report documents the results of our investigations for your proposed project. In the report we discuss geological and geotechnical site characteristics, and provide specific recommendations for site preparation and grading, foundation design criteria and construction strategies for the proposed new 2-million-gallon reservoir.

Based on the results of our field and laboratory investigations, SHN believes that from a geologic and geotechnical engineering standpoint, the project can be developed as planned, and that the proposed reservoir can be constructed using conventional foundations, and conventional grading and cutslope support systems, provided our recommendations are followed, and that the noted conditions and risks are acknowledged.

This report concludes our work on this phase of the project in accordance with our current agreement. If you have any questions, please call me at 707-441-8855.

Sincerely,

SHN Consulting Engineers & Geologists, Inc.

Brian Freemen, P.E.
Project Manager

Roland S. Johnson, C.E.G.
Project Engineering Geologist

BAF:RSJ/SMB:lms
Enclosure: Report

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Reference: 009030.050

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Fortuna, California

Prepared for:

City of Fortuna

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QA/QC: RSJ

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Abbreviations and Acronyms

pcf	pounds per cubic foot
psf	pounds per square foot
ASTM	American Society for Testing and Materials-International
B-#	Boring-number
BGS	Below Ground Surface
BH-#	Borehole-number
CDMG	California Division of Mines and Geology
MRfz	Mad River Fault Zone
NR	No Reference
O.D.	Outside Diameter
P-#	Piezometer-number
SHN	SHN Consulting Engineers & Geologists, Inc.
USGS	United States Geological Survey

Introduction

This report presents the results of the geologic and geotechnical investigation conducted by SHN Consulting Engineers & Geologists, Inc. (SHN) for the construction of a new 2-million-gallon reinforced concrete potable water supply reservoir at the existing Stewart Street Reservoir site (Assessor's Parcel Number 040-050-01), in Fortuna, California, see Figure 1. The two existing reservoirs will be taken out of service, demolished, and replaced by the new larger reservoir. It is our understanding that the concrete reservoir will be supported by a steel reinforced concrete ring foundation and be approximately 110 feet in diameter, and 32 feet high. The reservoir is proposed to be partially embedded with the slab on grade base at a design elevation of 207 feet. We anticipated that excavation cut slopes up to 25 feet in height will be required.

Purpose and Scope of Services

This report is intended to provide the owner with findings, conclusions, and recommendations related to the geotechnical aspects of project feasibility, design, and construction. Our investigation was performed primarily to evaluate subsurface conditions at the site in order to develop geotechnical criteria for design and construction of the proposed structure such that it will not contribute or be subject to significant risk associated with the geologic environment of the site. Specifically, the scope of our services consisted of the following tasks:

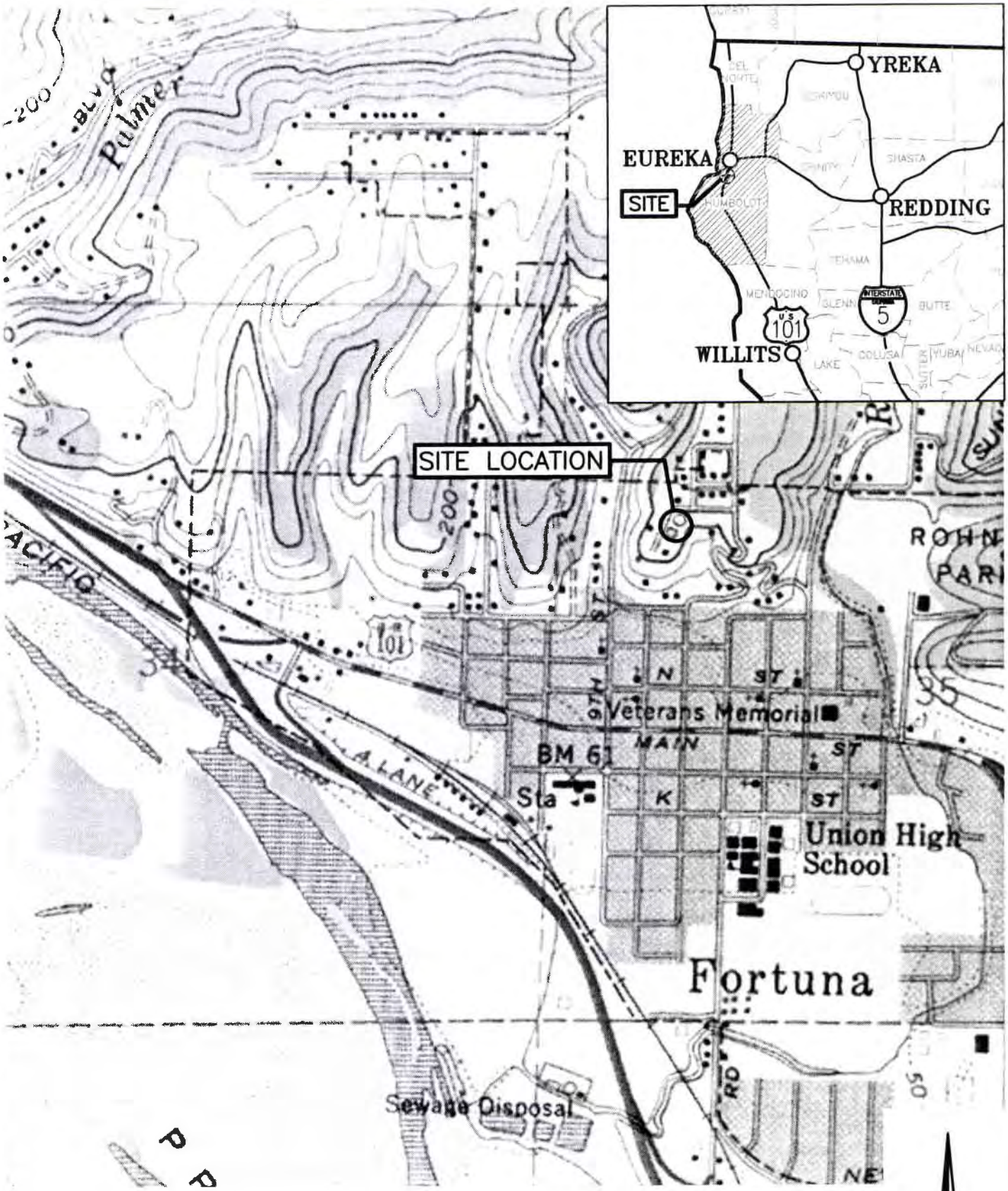
1. Review selected geotechnical and geological reports and maps pertinent to the project.
2. Perform a geologic reconnaissance of the project area. Supervise the advancement, logging, and soil sample collection from 10 exploratory test borings. Install and periodically measure four slope inclinometers and seven piezometers.
3. Perform laboratory tests on soil samples, evaluate geologic and geotechnical data collected from investigations, and formulate geotechnical conclusions and recommendations for design and construction of the proposed reservoir.
4. Present a report that includes location and site maps, exploratory test hole logs, laboratory test data, and our conclusions and recommendations.

The recommendations contained in this report are subject to the limitations presented herein. Attention is directed to the "Construction Phase Monitoring" and "Closure and Limitations" sections of this report.

Site Conditions

The proposed reservoir site is located along the flank of a broad southwest-trending divide in the northwest quadrant of Section 35, Township 3 North, Range 1 West of the Fortuna 7.5-minute quadrangle (Figure 1). The site slopes 10% to 45% to the southeast. The upper northwest corner of the site is at an elevation of approximately 234 feet above mean sea level. The northern and western boundaries of the project area are bound by Stewart Street, a two-lane paved city roadway. An unimproved, steep gradient access road (Barney Street) parallels the eastern edge of the site.

The site presently supports two, partially buried water supply reservoirs and a wood-frame pump house. The reservoirs consist of reinforced concrete water tanks, one circular and one rectangular, each having about 0.45 million gallons of storage. The reservoirs are old (70 to over 100 years) and are known to leak.



SOURCE: FORTUNA
USGS 7.5 MINUTE QUADRANGLES

1"=1000'±

SHN Consulting Engineers & Geologists, Inc.	Stewart Street Reservoirs Replacement City of Fortuna Fortuna, California	Site Location Map SHN 009030
	May 2009	009030-LOCATION	Figure 1

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The rectangular tank is in very poor condition. It is severely cracked and has been repaired numerous times. In 1992, the tank was lined with a hypalon (plastic) liner to stop the water leakage. Initially, the leakage appeared to be stopped, but now it is known to be leaking fairly seriously again.

The circular tank appears to be in relatively good condition. Although we did not conduct a detailed inspection, we understand that previous inspections have revealed little cracking and/or structural distress in the concrete sidewalls.

Below the existing structures, the project area is undeveloped and supports grass and patches of brush. A natural surfaced, unimproved roadway provides access to the existing reservoirs and pump station.

Field Investigation

SHN initiated a geotechnical investigation to evaluate and characterize geologic and geotechnical conditions in the project area in June 2008. Geologic reconnaissance of the project area was conducted prior to commencement of the subsurface investigations, which occurred over intermittent periods between February 2000 and May 2009. Our assessment of subsurface conditions in the project area involved the excavation of 13 mechanical borings (BH-1 through BH-4; BH-DRB-1; P-1 though P-5: and BH-10 through BH-13). Track-mounted drill rigs were used to advance the borings using 7-inch (Outside Diameter [O.D.]) hollow stem and 5-inch flight augers. Boring depths in the project area ranged from 17 to 46.5 feet Below Ground Surface (BGS). Soils encountered in the borings were logged in general accordance with the Unified Soil Classification System.

Penetration resistance tests were conducted as each boring was advanced. The sampler-driving hammer consisted of a 140-pound, 30-inch drop, above-ground, automatic hammer unit. The observed blow counts (total blows per 6-inch increment, for a total of 18 inches of penetration into the soil) are shown on the Field Boring Logs (Appendix A), and were used for shear strength correlation with other data. The sum of the blows for the second and third 6-inch increments shown on the boring logs are typically converted to standard penetration resistance, N value, and used for correlation with other data. Penetration resistance values are a useful index in estimating the consistency, relative density, and shear strength of the tested material.

Relatively undisturbed thin walled tube and disturbed bulk samples were collected from each of the exploratory borings using a modified California (3-inch O.D.) split spoon sampler or a 2-inch (O.D.) split spoon. A representative number of these samples were submitted for laboratory testing to determine index properties of the soils that underlie the site. Laboratory testing included in-place moisture content, dry density, gradation, plasticity, direct shear strength, and unconfined compressive strength.

Our evaluation of subsurface conditions at the site also included a review of eight (B1 through B8) shallow exploration borings excavated during a previous SHN site investigation (SHN, 2000). Piezometers were installed in these borings to evaluate groundwater level changes downslope of the old leaking reservoirs. Refer to Figure 2 for piezometer locations.

Piezometers were installed in borings P-1 though P-4, BH-5, BH-11 and BH-12 immediately following excavation of the borings. The piezometers consisted of 2-inch diameter slotted

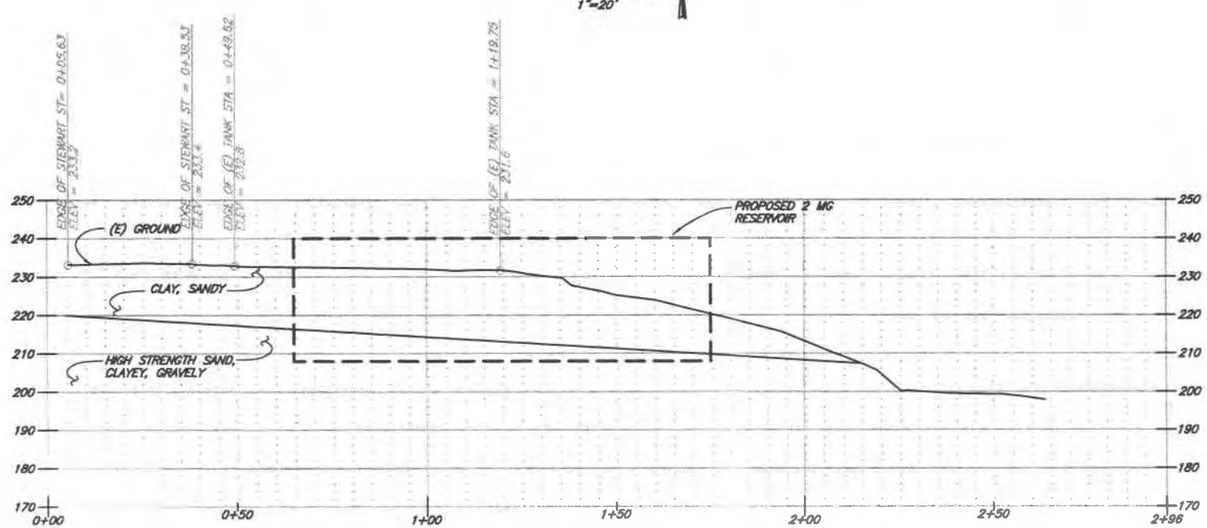
PLAN

1"=20'

EXPLANATION

- BH-11 — GEOTECHNICAL BORING
- B7, P-2 — PIEZOMETER
- BH-2 — INCLINOMETER IN GEOTECHNICAL BORING
- PROPOSED 2 MG RESERVOIR FOOTPRINT
- 212 — APPROXIMATE ELEVATION OF HIGH STRENGTH SAND MATERIALS

ALL LOCATIONS APPROXIMATE



PROFILE

V: 1"=20'
H: 1"=20'

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

SHN CONSULTING ENGINEERS & GEOLOGISTS, INC.
812 W. Wabash Eureka, CA 95501 FAX (707)441-8855 (707)441-8877

NO.	DATE	REVISION	BY

DSGN RJ/SB
DR DSL
CHK BAF
APVD

CITY OF FORTUNA
STEWART STREET RESERVOIRS REPLACEMENT
FORTUNA, CALIFORNIA

GEOTECHNICAL INVESTIGATION REPORT PLAN AND PROFILE

FIGURE 2

DATE 5/2009

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polyvinyl chloride pipe that extended to a maximum depth of 36.5 feet BGS. Each piezometer was installed with a surface seal to prevent overland flow from infiltrating into the well. Water elevations were measured on several occasions between June 2008 and May 2009.

Slope inclinometers were placed in borings BH-1 through BH-4 immediately following their completion. Each inclinometer was tremi-grouted with a bentonite-cement grout mix. Inclinometer casings were installed to depths ranging between 30.5 and 31.5 feet. Instrument readings were recorded from each site on three separate occasions between June 2008 and May 2009.

Regional Geology and Structure

Geologic maps of the region indicate the material underlying the project area and surrounding slopes is associated with the Middle to Late Pleistocene aged Hookton Formation (Kilbourne, 1985). The Hookton Formation is composed principally of non-marine gravel, sand, silt, and clay; however, some of the sediments along the western limits of this formation appear to have been deposited in shallow marine or marginal environments (Ogle, 1953). As a result of depositional diversity, Hookton Formation sediments can be extremely variable, both locally and regionally. As and example, in the Table Bluff area, Hookton Formation sediments are fine-grained, and clays and silts commonly dominate. The Hookton Formation in the project area is dominated by sands.

Our field site evaluation confirmed that the reservoir site is underlain by Hookton Formation sediments. Hookton Formation sandstone, mudstone, and gravel-bearing conglomerate were observed in samples collected during our subsurface investigation. These sediments are slightly to moderately indurated and typically consist of fine-grained sandy clays overlying clayey and gravelly, coarse sands.

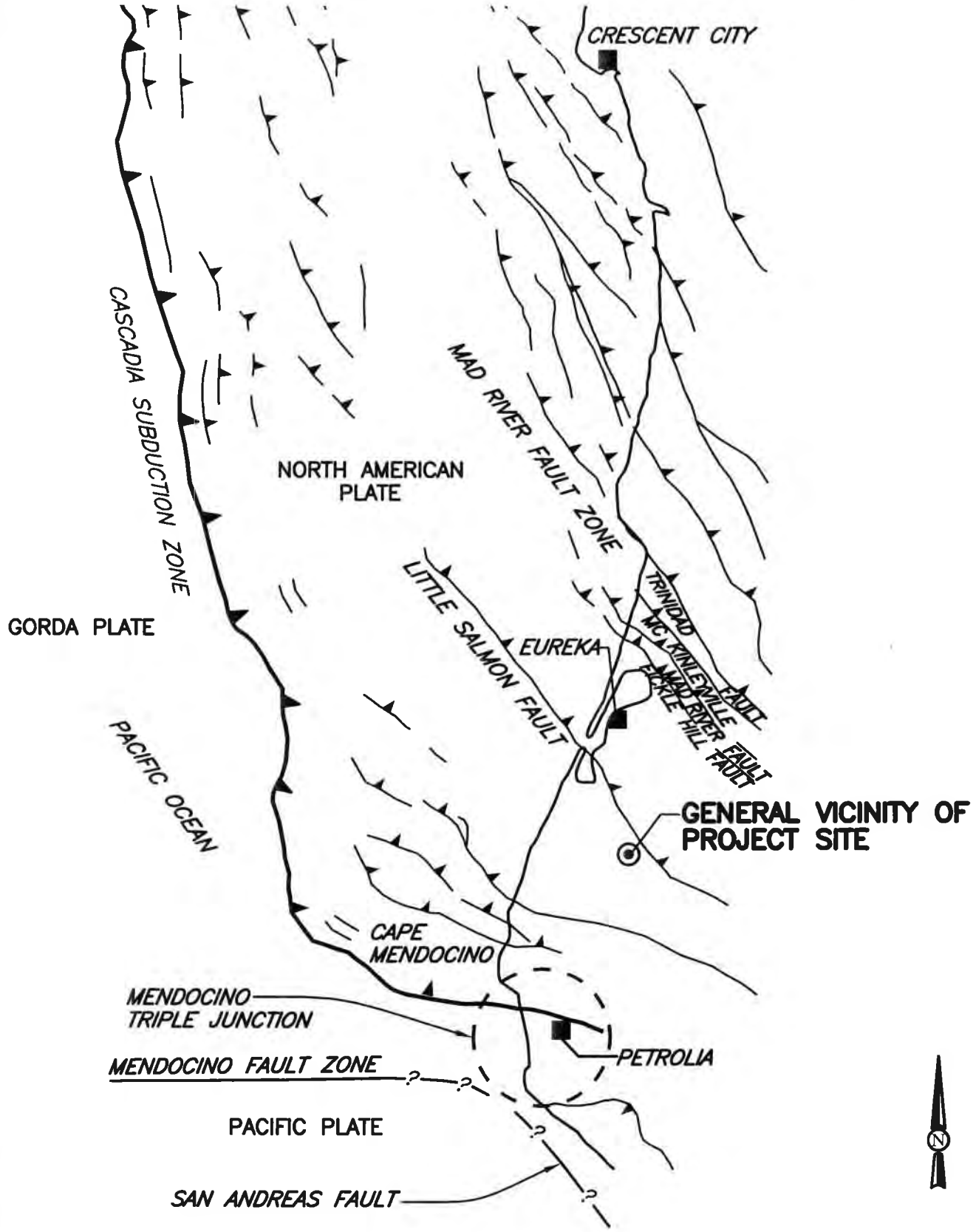
Hookton Formation sediments in the project area have experienced structural deformation in response to thrusting along the Little Salmon fault (see Seismic Setting for discussion). Oblique compression along this fault has resulted in the formation of several large, northwest-striking anticlines and corresponding synclines that trend subparallel to the fault (see Figure 3, Tectonic Setting). One of these northwest-striking structures (a syncline) dissects the project area. Regional geologic maps indicate Hookton Formation sediments along the southern limbs of the syncline have northwest strikes with southward dips that range from 10° to 20°.

Geologic Hazards

This section of the report is intended to provide the City with findings, conclusions, and recommendations related to geologic hazards that could potentially impact the proposed project area.

Slope Stability

The proposed reservoir site consists of a smooth, well-rounded convex slope along the southeastern flank of a low gradient divide. During our site investigation, we did not observe any evidence that the native slopes adjacent to the existing reservoirs had experienced mass movements recently or in the distant past. However, evidence of downslope soil creep was noted in fill material in the region east of the rectangular reservoir. In November 1999, SHN installed a series of eight hand-drilled exploratory borings to quantify soil and groundwater conditions on selective portions of the slope below the two existing reservoirs (B1 through B8)(SHN, 2000). See Figure 2 for borehole locations.



SHN Consulting Engineers & Geologists, Inc.	Stewart Street Reservoirs Replacement City of Fortuna Fortuna, California	Tectonic Setting SHN 009030.050
	May 2009	009030-050-GEO-FAULT-MAP	Figure 3

\2009\projects\009\009030-StewartStreetResRepair\050-GeoEvaluation\Dwgs , SAVED 5/29/2009 8:23 AM NDOWNEY, PLOTTED: 5/29/2009 8:23 AM, NATHAN DOWNEY

This investigation concluded that the low strength near surface (up to 10 feet thick) fill soils in the area adjacent to, and downslope of the eastern side of the rectangular reservoir and southeast of the circular reservoir are prone to chronic accelerated soil creep. The saturated fill soils and soft underlying native topsoils appear to be moving very slowly downslope under the influence of year-round excess soil moisture caused by reservoir leakage. The depth of downslope soil creep was not determined at that time, but it appeared to be deep enough to have removed support from the eastern edge of the rectangular reservoir and possibly to have shifted the pump house structure eastward.

In June 2008, SHN installed four inclinometers (BH-1 through BH-4) to a maximum depth of 31 feet BGS to characterize slope movement in the area downslope of the reservoirs. Our 9-month winter period monitoring program revealed no movement in the high strength native soils underlying the mid-slope portion of the site. Instrument readings at BH-2 through BH-4 indirectly indicated trace amounts of deformation in the upper 4 to 8 feet of the soil column (which corresponds to fill and topsoil deposits). Data from BH-1 was inconsistent and not incorporated into our evaluation. Downhole measurements at BH-1 appear to have been corrupted by either backfill expansion and/or settlement.

Seismic Setting

Northwestern California is located in a complex tectonic region dominated by northeast-southwest compression associated with collision of the Gorda and North American tectonic plates. The Gorda plate is being actively subducted beneath North America north of Cape Mendocino, along the southern part of what is commonly referred to as the Cascadia Subduction Zone. This plate convergence has resulted in a broad fold and thrust belt along the western edge of the accretionary margin of the North American plate. In the Humboldt Bay region, this fold and thrust belt is manifested as a series of northwest-trending, southeast-vergent thrust faults, including the Little Salmon fault and faults that comprise the Mad River fault zone (MRfz). These faults are active and are capable of generating moderate- to large-magnitude earthquakes.

No active faults are mapped passing through the project site, and no part of the site lies within an Alquist-Priolo Earthquake Fault Zone. Alquist-Priolo Earthquake Fault Zones are established by the State of California along "sufficiently active, well-defined" faults, to preclude the construction of certain structures across active faults. The nearest known (on-land) fault to the project area that is zoned by the State of California as active is the Little Salmon fault (Hart and Bryant, 1997). This particular fault represents the principle tectonic feature in the project area and consists of a northwest-trending, northeast-dipping thrust fault that dissects slopes along the northern valley wall of the Eel and Van Duzen River basins. The trace of the Little Salmon fault is mapped approximately ¾ of a mile northeast of the project area (McLaughlin and others, 2000).

The Little Salmon fault is capable of generating very large earthquakes. Offset relations within the upper Wildcat Group suggest that vertical separation exceeds 5,900 feet, representing about 4.4 miles of dip-slip motion on the Little Salmon fault since the Quaternary (that is, in the past 700,000 to 1 million years; Woodward-Clyde Consultants, 1980). The fault is associated with a slip rate that exceeds 6 millimeters per year (Carver and Burke, 1992). Paleoseismic studies of the Little Salmon fault indicate that the fault deforms late Holocene sediments at the southern end of Humboldt Bay (Clarke and Carver, 1992). Radiocarbon dating suggests that earthquakes have occurred on the Little Salmon fault about 300, 800, and 1,600 years ago (Carver and Burke, 1992). Average slip rate for the Little Salmon fault for the past 6,000 years is between 6 and 10 millimeters per year. Based on currently available fault parameters, the maximum magnitude earthquake for the Little Salmon

fault is thought to be between 7.0 (CDMG/USGS, 1996) and 7.3 (Geomatrix Consultants, 1994). Strong ground shaking associated with this fault is considered the principal geologic hazard associated with this site.

Other potential seismic ground shaking sources that could have an impact on the project area include:

- **The Gorda Plate**: This relatively small oceanic plate remnant is breaking up as it approaches the subduction zone. Frequent earthquakes are generated along left-lateral strike-slip faults within the plate itself. The plate is subducting in a northeastward direction.
- **The Mendocino Fracture Zone**: This high-angle, east-west trending fault represents the plate boundary between the Gorda and Pacific plates. It generates frequent predominantly right-lateral strike-slip earthquakes.
- **The Cascadia Subduction Zone:** This zone is the most significant potential seismic source in the region. A great subduction event, rupturing from Cape Mendocino to British Columbia could be up to magnitude 9.5. Recurrence intervals are estimated at 300 to 500 years. The last subduction event occurred just over 300 years ago. In general, Cascadia Subduction Zone earthquakes represent the most significant hazard to development throughout the Pacific Northwest. A great subduction event would generate very strong, long duration ground shaking, and is likely to trigger large-scale coseismic landsliding in landslide-prone areas.
- **The San Andreas Fault:** This fault represents the right lateral translational boundary between the Pacific and North American Plates. A magnitude 8.3 earthquake along the San Andreas fault in 1906 resulted in considerable damage along North Coast, with shaking intensities possibly as high as VIII or IX in Briceland, Eureka, Fortuna, Ferndale, and Petrolia (Dengler and others, 1992).

Considering the location of the reservoir site and the seismic history of the general region, there is a possibility that the area proposed for development could be subject to very strong ground shaking during the design life of the proposed structure.

Liquefaction

Liquefaction is a secondary seismic effect of earthquake shaking that can cause loose, water-saturated, and weakly cohesive or non-cohesive earth materials to temporarily lose shear strength due to an increase in pore-fluid pressures. Based on the published results of geotechnical testing and post-earthquake studies, the susceptibility of sediments to liquefaction can be directly correlated to the type, origin, and age of the deposits. Geologic materials most susceptible to liquefaction are geologically recent (late Holocene age) sand- and silt-rich deposits, located adjacent to streams, rivers, bays, or ocean shorelines. Liquefaction occurs only when susceptible materials are saturated. Susceptibility to liquefaction decreases with increasing geologic age, due to the effects of weathering, and the degree of densification, compaction, and/or cementation.

At this site, liquefaction is considered a negligible risk under all but rare, extreme seismic earthquake events due to the great age of the underlying materials and the lack of loose, clean sandy deposits.

Geological Hazards Conclusions and Recommendations

Based on the results of our field and laboratory investigations, it is SHN's opinion that the site can be developed as planned without being subject to or contributing to significant geologic hazards, provided our recommendations are followed and that the noted conditions and risks are acknowledged.

1. The principal geologic hazard at the site is strong to very strong levels of seismic shaking produced by earthquakes on the Little Salmon fault or any of the other earthquake sources in the North Coast region. Seismic shaking effects produced by large earthquakes from more distant sources are likely to be significantly less severe, but there are several sources near enough to the site to generate strong to very strong ground shaking. Strong seismic shaking should be anticipated for the project site within the design life of the structures. We recommend that the proposed reservoir be designed to withstand strong seismic shaking. The minimum standard for construction of the reservoir should be in accordance with the latest edition of the California Building Code for the most seismically active areas.
2. The proposed reservoir area is located along the crest of moderately steep ridgeline that is devoid of landslide morphology. In addition, the reservoir foundation will be constructed on high strength materials that are not prone to landslide processes; therefore, the risk that slope failure will adversely effect the new reservoir is very low.
3. The risk of liquefaction having an adverse effect on the proposed reservoir is negligible.
4. Significant soil erosion is not currently occurring on the subject site. However, erosion rates are likely to increase during and immediately after the installation of site improvements if not mitigated. Changes in land use, including construction of impervious surfaces (the reservoir roof, paved areas, and so on) will change existing runoff conditions. Increased concentrated runoff could result in accelerated erosion. Erosion control and drainage system design should be based on Best Management Practices during and following construction activities.

Geotechnical/Soils Engineering

This section of the report is intended to provide the City and facility designers with findings, conclusions, and recommendations related to geotechnical aspects of project planning, design, and construction.

Soils

Soils encountered in the 10 exploration borings are generally uniform in occurrence and composition. The general soil profile encountered consists of a layer of uncontrolled fill (generally 1 to 8 feet thick) commonly overlaying native topsoil, which in turns mantles weathered Hookton Formation sediments. The fill materials typically consist of moist to wet, medium stiff to soft, locally derived silty, sandy clays and clayey fine sands. Field observations and standard penetration blow counts recorded in these fill soils suggest that they were not compacted during placement and are therefore considered "uncontrolled" fill and not suitable for support of permanent structures.

In general, the 1- to 2.5-foot thick topsoil horizon encountered beneath the uncontrolled fill materials is typically black, soft to firm, wet to saturated, and primarily composed of silty to clayey fine sands. These low strength soils mantle a sequence of moist, moderately strong, sandy clays and medium dense, clayey fine sands; which in turn overlie an over consolidated, high strength, very dense, clayey to gravelly sand layer. Depths to the high strength sand strata range from approximately 13 to 19 feet BGS. All of our borings (deepest to 46.5 feet) terminated in this layer, so it can be considered "bedrock" in the project vicinity. It appears that the soil units that underlie the project area slope gently southeastward.

The clay and fine sand soils strata encountered above the high strength sand material generally contain a moderate to high plasticity clay layer that is characterized as low to moderately expansive (tendency to change volume with significant changes in moisture content). Dry densities for the fine-grained cohesive soils range from 80 to 125 pounds per cubic foot (pcf), with unconfined compressive strengths of up to 6,200 psf.

The very dense sand "bedrock" is characterized by low plasticity and a very low compressibility for the range of anticipated new structural loads. Dry densities for this granular material range from 100 to 138 pcf, with unconfined compressive strengths of up to 3,700 psf.

Refer to the boring logs presented in Appendix A of this report for detailed material descriptions, borehole surface elevations, specific soil layer contact depths, blow counts, laboratory test results, groundwater conditions, and other information.

Groundwater

Perched groundwater located in wet to saturated zones was encountered in each of our borings between 1.75 to 16 BGS (see boring logs in Appendix A). A majority of these perched zones were located at or immediately above the contact between the buried topsoils and the underlying medium stiff silty clays and medium dense clay fine sands. Previous groundwater monitoring studies (SHN, 2000) recorded static water table levels between 0.1 and 7.9 feet BGS (see Table B-1 in Appendix B for water table elevations). During this early study, SHN concluded that leakage from the existing reservoirs was directly influencing groundwater occurrence and soil moisture conditions in areas to the east and downslope. Our May 26, 2009, measurements imply that current leakage from the existing reservoirs is not influencing upslope water elevations, and that the groundwater conditions recorded at BH-11 and BH-12 are more indicative of the natural hydrogeology of the surrounding area (see Table B-1). We anticipate that once the existing tanks are removed, water levels in the excavation area will drop noticeably and be more consistent with those recorded at BH-11 and BH-12. However, it should be noted that groundwater levels do fluctuate in response to the rainy season and that the silt- and clay-rich soils at the site could be pre-disposed to perched groundwater layers or localized preferential flow paths particularly during the winter and spring seasons. Therefore, during and following periods of heavy precipitation or late season storm events, groundwater levels could be significantly higher than those observed during our investigations.

It is important to note that even small quantities of persistent seepage may complicate construction operations when excavations extend near or below areas of saturated soil. Construction difficulties resulting from near surface groundwater or excess soil moisture will be much less likely if grading activities are conducted during the dry season.

Conclusions

Based on the results of our field and laboratory investigations and analysis of collected data, SHN believes that from a geotechnical engineering standpoint, the project can be developed as planned, and that the proposed reservoir can be constructed using conventional foundations and conventional grading and cut slope support systems, provided our recommendations are followed, and that the noted conditions and risks are acknowledged.

Design Recommendations

Seismic Design

From our understanding of site geology, we estimate the site can be categorized as a Site Class D (stiff soil profile) for determining earthquake loads outlined in the 2007 California Building Code.

Based on a Site Class D (stiff soil profile), Occupancy category IV (Essential Facility), and a latitude and longitude of 40.6021 N and -124.1557 W, respectively, we calculated design spectral response acceleration parameters for the project area. A hand-held Global Positioning System was used to determine the site latitude and longitude.

We used the United States Geological Survey (USGS) seismic calculator software program, "Seismic Hazard Curves, Response Parameters, Design Parameters: Seismic Hazard Curves, and Uniform Hazard Response Spectra, v. 5.0.9," dated October 6, 2008. Calculated values are presented in Table 1.

Table 1
Seismic Design Criteria

S_S	2.481
S_1	0.896
F_a	1.0
F_v	1.5
S_{MS}	2.481
S_{M1}	1.345
S_{DS}	1.654
S_{D1}	0.896

For Occupancy IV structures, where S_1 is greater or equal to 0.75, the Seismic Design Category is F

Settlement Potential

Based on our laboratory test results and in situ penetration resistance values, we have determined that a 32-foot high, partially buried, reservoir founded on the high strength sand strata will not be subject to total or differential settlement amounts that require special design criteria. Therefore, the risk of significant post construction settlement is considered to be negligible.

Excavation Characteristics

Laboratory test results and drilling efforts required for the advance of the geotechnical borings indicate that the high strength sands (bedrock materials) that underlie the proposed reservoir site should be rippable using conventional heavy excavation machinery.

Site Preparation and Grading

We recommend the following, where cutting or filling operations are included in the project measures.

1. Prior to commencing site work, determine the precise location of underground utilities.

2. To prepare subgrade surfaces to support improvements or structural fill, strip and remove all existing improvements, surface debris, vegetation, and major root systems. Also strip existing uncontrolled fill, dark-colored organic-rich topsoil, and any disturbed/soft/loose soils. Stripping should extend out beyond the perimeter of the improvement far enough to ensure that unsuitable materials that could adversely effect the integrity of proposed improvements are removed. Additionally, excavate as required to accommodate design grades.

3. With the exception of vertical sides or steps, subgrade surfaces to receive structural fill should be cut-graded to slope no steeper than 10%.

4. Conduct a geotechnical engineering review of exposed subgrade surfaces that will support structures, or that will receive structural fill to support structures. The geotechnical engineer will recommend that remaining unsuitable soils (such as, overly weak, compressible, or disturbed soils,)be additionally stripped. This evaluation may include in-place soil density testing, as well as proofrolling as described in the following paragraph.

5. Scarify and compact (90% minimum relative compaction[1] American Society for Testing Materials-International [ASTM] 1557) the upper 6 inches of exposed subgrade soils that are to receive structural fills. Alternatively, the subgrade surface may be proofrolled using a loaded 10-wheel, 10-cubic yard dump truck, or equivalent. The proofrolling should be accomplished under the observation of the geotechnical engineer with the soil damp or moist (not wet or dry), and a firm, non-yielding surface should be evident during the proofrolling. If a yielding surface is observed (pumping, weaving under wheel loads), additionally excavate the yielding area, and replace the overexcavated material with Caltrans specification Class 2 baserock, in a manner that will result in a stable subgrade surface under the proofrolling, following the overexcavation and replacement.

6. Structural fill material should consist of relatively non-plastic (Liquid Limit less than 30, Plasticity Index less than 10) material containing no organic material or debris, and no individual particles over 3 inches across. If gravel is used, it should be well-graded, to include a variety of particle sizes to minimize relatively large void spaces, into which fine- grained soils can migrate. We suggest the use of well-graded granular soils (sand, gravel) for fill, because these soils are relatively easy to moisture condition and compact.

7. Structural fill should be placed to design grades and compacted to a minimum of 90% of the maximum relative dry density as determined by the current ASTM D1557 test method. If structural fill is required beneath the reservoir floor slab, it should be compacted to a minimum of 95% of the maximum relative dry density.

8. Permanent cut-and-fill slopes not associated with excavation and backfill of the reservoir should be placed no steeper than 1.5:1 and 2:1 (horizontal to vertical), respectively. Cuts and fills should be designed, or foundations deepened, so that hypothetical lines extending outward and downward from the perimeters of existing or new footing bases, at slopes of 1:1, remain embedded within competent, undisturbed, native soils or structural fill, and do not encounter cut or fill slopes.

---

[1] Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil, as determined by the American Society for Testing and Materials-International D1557 compaction test procedure. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

Structure and utility trench backfill should be moisture conditioned, placed in lifts 8 inches or less in loose thickness, and mechanically compacted to at least 90% relative compaction; jetting is not appropriate.

Reservoir Foundation/Wall

Following site preparation as recommended, foundations may be constructed. We anticipate that the perimeter of the reservoir will be supported by a concrete ring footing structure embedded into the reservoir base pad. The ring footing foundation should be embedded at least 12 inches below adjacent grade. This footing may be poured directly onto the subgrade soils as long as the subgrade surface is free of loose material and is in an undisturbed condition. Foundations may be designed so they do not exceed an allowable bearing capacity of 5,000 psf for dead plus long-term live loads. This value may be increased by one-third to account for the short-term effects of wind and/or seismic loading.

A horizontal friction coefficient of 0.35 times the net vertical dead load may be used for the footing/soil contact. Frictional resistance may be calculated in conjunction with an allowable lateral passive pressure represented by an equivalent fluid weighing 350 pcf for short-term loadings, such as lateral foundation resistance in response to wind or earthquake loadings. Lateral pressure can be calculated where footings bear laterally against firm soil; however, passive pressure should be neglected within the upper ½ foot, unless confined by other concrete structures.

Reservoir walls should be designed to resist active lateral soil pressures represented by an equivalent fluid weighing 35 pcf providing the walls are backdrained as recommended below. Lateral forces may be resisted by the passive pressure exerted on the side of the ring footing and by friction along the base. The passive pressure can be taken as that pressure exerted by an equivalent fluid weighing 300 pcf for the steady state lateral loadings that will be applied by the reservoir wall foundations, which can be increased to 350 pcf under dynamic loadings including earthquake forces. The sliding friction coefficient may be taken as 0.35.

Where the finished grade elevation difference across the reservoir is 6 feet or greater, the tank should be designed to additionally resist a seismic force increment. The seismic force increment can be considered applied to the reservoir wall by the portion of the higher-side soils, which are above the ground surface elevation on the lower side. The seismic force increment, per horizontal foot, can be calculated as P=35 H2, where H (in feet) is the difference in ground surface elevation across the reservoir and P is in pounds. This incremental force need only be applied where H>6 feet. The resultant of this force should be applied at 0.6H up from the ground surface elevation on the lower side of the reservoir.

The design active pressures presented above are predicated on positive drainage being provided behind the reservoir walls, to mitigate the potential for hydrostatic pressure build-up. The wall backfill shall be free draining aggregate, or equivalent, with an underdrain piping system designed to preclude the build-up of hydrostatic pressure. The underdrain collector pipes shall be sloped to exterior outlets capable of containing the relatively low flows expected to be produced. Following completion of construction activities, the total underdrain system discharge should not exceed 10 gallons per minute.

Backfill Materials and Placement Criteria

Structural backfill should consist of free draining material, such as river run gravel or equivalent. All fill material should be free of perishable material, have no particles larger than 3 inches in maximum dimension, and have no more than 15% greater than 2 inches. Additionally, the compacted fill should remain stable during placement, without pumping or weaving.

In areas where wall backfill settlement is not tolerable, backfill should be compacted to between 87 and 92% of the maximum relative dry density as determined by the American Society for Testing and Materials-International (ASTM) D1557-91 test method. To avoid settlement of the backfill, backfill should not be undercompacted. To avoid excess pressure against the reservoir walls, backfill should not be overcompacted.

A minimum of a 2-foot thick layer of relatively "impermeable" soil should be placed above the free draining material to prevent infiltration of surface water into the structural backfill surrounding the reservoir. The surface of the engineered backfill and impermeable cap should be graded such that runoff is not allowed to pond above reservoir backfill.

Site grading during and shortly after the rainy season is typically problematic. On-site soils will have moisture contents well above that where the specified compaction will be obtained; therefore, we do not recommend using any on-site native soils as fill material.

It must be the contractor's responsibility to select equipment and procedures that will accomplish the grading as described above. The contractor must organize the work in such a manner that the engineer can test and/or observe each element of grading.

Temporary Unsupported Cut Slopes

Temporary cut slopes excavated into the native, clay-rich soil materials should be graded no steeper than 1:1 (horizontal:vertical) without installation of appropriate shoring systems. Cuts in the underlying high strength sands should be graded no steeper than 1/10:1 (see Figure 1, Appendix C). Some areas of old reservoir backfill may be too weak or wet to stand at a 1:1 gradient. We anticipate that these materials will be removed during excavation of the new reservoir base pad, but if some remain, we recommend that they be over excavated or laid back to a gradient no steeper than 2:1.

Stability analyses were conducted to determine acceptable temporary cut slope configurations using the computer program SLOPE/W. The analysis is based on the results of in situ penetration resistant tests and the laboratory shear strength tests on relatively undisturbed samples obtained during our subsurface explorations. A minimum safety factor of 3.4 for Cut Slope Section 1 as shown on Figure 1 Appendix C was calculated for dynamic conditions. Increases in cut slope angles resulted in less than acceptable safety factors; therefore, steeper cuts will require artificial support. Summaries of soil properties used in modeling the underlying material and the stability analysis results are included in Appendix C.

Although a high groundwater level is not anticipated, construction-phase monitoring should include close observation for indications of perching or high groundwater conditions, which could adversely affect temporary cut slope stability. The nature of the soil materials exposed in the cut slope excavations, the location of the groundwater table, and any evidence of creep, ground cracking, or incipient landsliding should be closely monitored until backfill operations begin.

The engineering geologist should observe all cut slopes to check the exposed soil conditions and provide additional stability and drainage recommendations, if required. If subsurface conditions are encountered that vary significantly from those described in this report, during excavation of the cut slopes, SHN must be contacted immediately to review exposed soil and evaluate whether there is an increased risk of cut bank instability.

Excess moisture loss across the cut slope faces could result in shrinkage of the clay dominant materials resulting in dry ravel and slaking. Sloughing of the fine-grain material will likely require periodic maintenance and could potentially reduce the stability of the cut slope. Therefore, we recommend that mitigative treatments be implemented, such that the moisture levels of the exposed clay materials are maintained.

A berm or V-ditch should be established at both the tops and toes of cut slopes that will provide good surface drainage away from the temporary cut slope to protect against erosion.

Supported Cut Slopes

Temporary cut slopes excavated into the native, clay-rich materials that are artificially stabilized should be graded no steeper than 1/4:1 (horizontal:vertical). Passive reinforcement techniques such as soil nailing would probably be the most effective method for stabilization. Soil nailing stabilizes in-situ soils through the installation of steel reinforcements. Nails are installed as construction proceeds in a top down construction method. As the ground deforms laterally in response to excavation, nails are placed in tension. Nail tensile force acting across potential failure surfaces through the ground increases the soil's shearing resistance. This produces a block of reinforced ground which can support itself, external loadings, and the unreinforced ground behind the reinforced block.

Site Drainage

Surface drainage measures should be provided to divert water away from proposed cut-and-fill slopes. All concentrated flows should be collected in a lined-channel system and discharged at a suitable location well away from fill slopes. Culverts and other drainage devices should not be positioned so that they discharge onto or concentrate runoff in areas of existing erodible soils. Provisions should be made to provide routine maintenance of surface drainage facilities, so that debris can be removed and repairs made, as required.

Drainage and Erosion

To mitigate erosion potential, we recommend the following measures:

1. Wherever possible, design finished grade to allow sheet runoff rather than concentrated runoff.
2. Where concentrated runoff will occur, minimize its velocity by controlling slopes, and protect the channel and discharge area by dissipating flow energy, using rock or other erosion resistant surfacing as appropriate.
3. Compact exposed fill slopes, and protect both cut and fill slopes from concentrated runoff or heavy sheet runoff by utilizing brow ditches or other drainage control facilities.

4. Erodable cut or fill slopes, or other soil surfaces, should be protected by using vegetative cover, jute mesh and straw, rock slope protection, or other measures to provide erosion resistance.
5. Perform site work and vegetation establishment during seasons not subject to repeated or prolonged rainfall.
6. Provide periodic maintenance of erosion control measures.
7. Fiber rolls or hay bales should be placed around the downhill perimeter of the freshly graded area, if the grading is completed between October 1 and April 30th.

Construction Phase Monitoring

In order to assess construction conformance with the intent of our recommendations, it is important that a representative of our firm:

1. Monitor adequate site stripping and removal of old reservoir backfill, including removal of vegetation, root-filled soils, upper dark-colored organic topsoils, and uncontrolled existing fill soils.
2. Determine methods for and monitor adequate subgrade preparation.
3. Monitor placement of structural fill.
4. Monitor foundation excavations.
5. Monitor backdrains.

This construction phase monitoring is important because it provides the City and SHN the opportunity to verify anticipated site conditions, and recommend appropriate changes in design or construction procedures if site conditions encountered during construction vary from those described in this report. It also allows SHN to recommend appropriate changes in design or construction procedures if construction methods adversely affect the competence of onsite soils to support the structural improvements.

Construction Considerations

The following construction considerations are presented to aid in project planning. These considerations are not intended to be comprehensive; other issues may arise which will require coordination between the owner, the engineer, and the contractor's construction methods and capabilities.

It is important to note that even small quantities of persistent seepage may substantially complicate construction operations if the proposed excavation extends near or below areas of saturated soil. Construction difficulties resulting from near surface groundwater or excess soil moisture will tend to become less likely if grading activities are conducted during the dry season.

Subsurface investigations, laboratory analysis, experience with a previous construction cut slope at a nearby site, and stability analyses, indicate that an adequate safety factor for construction cut slope stability exists. However, subsurface conditions may be variable, and there is a risk that portions of the construction cut slopes, which are planned at nominal slopes of 1:1 (horizontal: vertical), may be unstable. Due to the general cohesiveness of site materials encountered, and their inferred moderate permeability, sudden (less than a minute, for example) slope failures with large movements (more than 5 feet, for example) are not anticipated. As a construction precaution,

however, any personnel in the open excavation should have the ability to move away from the slope face at any time on short notice. Groundwater conditions in these slopes should be monitored and the work area carefully monitored frequently for any evidence of incipient construction cut slope failures, such as creep, ground deformations, ground cracking, or changes in groundwater seepage patterns.

We consider it possible that groundwater may exist in shallow perched layers, or may follow preferential flow paths, and that a consistent water table may or may not be encountered during excavation for the project. There may be isolated seepage areas. Some sandy strata could be cohesionless enough to pipe or flow into the excavation if groundwater seepage exists at that location, although this is not considered likely. If piping or flowing sandy soils conditions begin to degrade the slope face, remedial procedures, such as the placement of filter fabric and associated buttressing, may have to be quickly implemented to prevent piping or flowing of soil materials from the slope face.

The excavation is planned to proceed relatively quickly, and if evidence of high groundwater conditions is encountered, such as groundwater seepage from high up the face of the excavation cut slope, it may be necessary to stop or slow the excavation temporarily to allow time for water to drain from the groundmass behind the exposed cut slope face. It may be necessary to allow time to draw down a water table, a perched water table, or water in a preferential flow path, to reduce risk of slope instability during construction.

Exposed soil subgrade in the reservoir base pad area may be difficult to compact if natural moisture contents are over optimum or the soil materials are coarse or contain hard "clods." Proofrolling to demonstrate firm subgrade may be more practical than nuclear gage tests under these conditions.

Occupational Safety and Health Administration trench and excavation safety regulations should be acknowledged and followed. Compliance with safety regulations is the responsibility of the contractor.

Closure and Limitations

The analyses, conclusions, and recommendations contained in this report are based on site conditions that we observed at the time of our investigation, data from our subsurface explorations and laboratory tests, our current understanding of proposed project elements, and on our experience with similar projects in similar geotechnical environments. We have assumed that the information obtained from our limited subsurface explorations is representative of subsurface conditions throughout the site.

We recommend a representative of our firm confirm site conditions during the construction phase. If subsurface conditions differ significantly from those disclosed by our investigation, we should be given the opportunity to re-evaluate the applicability of our conclusions and recommendations. Some alteration of recommendations may be appropriate.

If the scope of the proposed construction, including the proposed loads, grades, or structural locations, changes from that described in this report, our recommendations should also be reviewed.

If there is a substantial lapse of time between the submission of our report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or

adjacent to the site, we should review our report to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse. This report is applicable only to the project and site studied.

The conclusions and recommendations presented in this report are professional opinions derived in accordance with current standards of professional practice. Our recommendations are tended on the assumption that design of the improvements will conform to their intent. No warranty is expressed or implied.

The field and laboratory work was conducted to investigate the site characteristics specifically addressed by this report. Assumptions about other site characteristics, such as hazardous materials contamination, or environmentally sensitive or culturally significant areas, should not be made from this report.

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Appendix A

Field Boring Logs and Lab Data

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Fortuna, Stewart Street Tank Site
JOB NUMBER: 007147.620
LOCATION: Slope Below Tanks
DATE DRILLED: 06/03/08
GROUND SURFACE ELEVATION: ~222.5 Feet
TOTAL DEPTH OF BORING: 30.5 Feet
EXCAVATION METHOD: 7" Hollow Stem Auger and 6" Flight Auger
SAMPLER TYPE: CA/SPT
LOGGED BY: SMB
Supervised by RSJ

BORING NUMBER **BH-1**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				SC		FILL: FINE SAND, and mix of clay, with silt, medium dense, dry to moist, yellowish-brown.							Slope inclinometer placed in boring following completion.
-1.0		■	8, 7										
-2.0		■	7, 6										
-3.0		■	6, 7				21	100					P-1 placed immmediately adjacent to boring.
-4.0			5										
-5.0		■	5, 4	ML		SILT, fine sandy, with clay, soft, moist to wet, black, minor organics.							Topsoil
-6.0			4										
-7.0		■	6, 9	CL		CLAY, sandy, trace fine gravels, moist to wet, yellowish-brown.	22.5	103	1480	75			
-8.0			9			CLAY, silty, medium stiff, moist, bluish-gray.							Ground water level measurements from P-1*
-9.0		■	11, 14	CH		CLAY, sandy, medium stiff to stiff, plastic, moist, yellowish-brown.	24.5	125		70	57	32	06/09/08 7.30'
-10.0		■	6, 12	CL		CLAY, silty, with fine sand, stiff, moist, light yellowish-brown.							03/06/09 1.20'
-11.0		■	15										04/21/09 4.10'
-12.0			11										05/26/09 5.30'
-13.0		■	19, 25										* Feet below adjacent ground surface
-14.0			17	SC		FINE SAND, clayey, with fine gravels, with silt, dense, moist, dark yellowish-brown.							
-15.0			17										

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Fortuna, Stewart Street Tank Site
JOB NUMBER: 007147.620
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DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-15.0			22										
-16.0			20	SC		FINE SAND, clayey, with fine gravels, with silt, very dense, moist, dark yellowish-brown.							Soils described at sample locations only
			20										
-17.0			25										
-18.0			19	SC		FINE SAND, clayey, with fine gravels, with silt, very dense, moist, dark yellowish-brown.	7.5			18	26	7	Liquid Limit and Plasttic Index tests performed on portion of sample passing #40 sieve (41% of sample) % Pass / Sieve 100 / 3/8" 68 / #4 56 / #10 41 / #40 28 / #100
			30										
-19.0			25										
-20.0													
-21.0													Soils described at sample locations only
-22.0													
-23.0													
-24.0													
-25.0			24	SC		FINE SAND, clayey, with fine gravels, with silt, very dense, moist, dark yellowish-brown.							
			21										
-26.0			23										
-27.0													
-28.0													
-29.0			19	SC		FINE SAND, clayey, with fine gravels, with silt, very dense, moist, dark yellowish-brown.							
			31										
-30.0													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Fortuna, Stewart Street Tank Site
JOB NUMBER: 007147.620
LOCATION: Slope Below Tanks
DATE DRILLED: 06/03/08
GROUND SURFACE ELEVATION: ~222.5 Feet
TOTAL DEPTH OF BORING: 30.5 Feet
EXCAVATION METHOD: 7" Hollow Stem Auger and 6" Flight Auger
SAMPLER TYPE: CA/SPT
LOGGED BY: SMB
Supervised by RSJ

BORING NUMBER **BH-1**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-30.0			31	SC		FINE SAND, clayey, with fine gravels, with silt, very dense, moist, dark yellowish-brown.							
-31.0													
-32.0						Bottom of boring at 30.5 feet. No free groundwater observed at time of investigation.							
-33.0													
-34.0													
-35.0													
-36.0													
-37.0													
-38.0													
-39.0													
-40.0													
-41.0													
-42.0													
-43.0													
-44.0													
-45.0													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Stewart Street Tank Site
LOCATION: Fortuna
GROUND SURFACE ELEVATION: ~226 Feet
EXCAVATION METHOD: 6" Flight Auger
LOGGED BY: SMB

JOB NUMBER: 007147.620
DATE DRILLED: 06/04/08
TOTAL DEPTH OF BORING: 30.5 Feet
SAMPLER TYPE: CA/SPT
Supervised by RSJ

BORING NUMBER BH-2

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				Fill		FILL: FINE SAND, and mix of clay, with silt, medium dense, dry to moist, yellowish-brown.							Slope inclinometer placed in boring following completion.
-1.0													
-2.0													
-3.0				CL/ ML		FILL: CLAY, silty, with fine sand, trace fine gravels, soft, moist, yellowish-brown to black.							P-2 placed immmediately adjacent to boring.
			4										Soils logged based on cuttings
-4.0			5										
-5.0				ML		SILT, clayey, with fine sand, trace fine gravel, soft, wet, brown to black.							Topsoil.
-6.0			1										
			2	CL		CLAY, silty, fine to coarse sandy, soft, wet, yellowish-brown.	24	99					
-7.0			3										
-8.0			6	CL		CLAY, silty, trace fine sand, stiff, moist, yellowish-brown.							Ground water level measurements from* P-2
			9										
-9.0			12				39	80	2700	95.5			06/09/08 7.05'
-10.0			8										03/06/09 5.31'
			10										
-11.0			19										04/21/09 6.40'
-12.0			12										05/26/09 6.35'
			23				22	105	6200	83			
-13.0			50										* Feet below adjacent ground surface
-14.0			14	SM		FINE TO COARSE SAND, silty, with clay, with fine gravel, dense to very dense, moist, dark yellowish-brown.							
			20										
-15.0													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location Subsurface conditions may differ at other locations and with the passage of time

FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Stewart Street Tank Site
LOCATION: Fortuna
GROUND SURFACE ELEVATION: ~226 Feet
EXCAVATION METHOD: 6" Flight Auger
LOGGED BY: SMB

JOB NUMBER: 007147.620
DATE DRILLED: 06/04/08
TOTAL DEPTH OF BORING: 30.5 Feet
SAMPLER TYPE: CA/SPT
Supervised by RSJ

BORING NUMBER BH-2

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-15.0			19	SM		FINE TO COARSE SAND, silty, with clay, with fine gravel, dense to very dense, moist, dark yellowish-brown.							Soils described at sample locations only
-16.0													
-17.0													
-18.0													
-19.0			23	SM		FINE TO COARSE SAND, silty, with clay, with fine gravel, dense to very dense, moist, dark yellowish-brown.							
			32										
-20.0			40										
-21.0													
-22.0													
-23.0													
-24.0			20	SC		FINE TO COARSE SAND, gravelly, with clay, very dense, moist, dark yellowish-brown.	7.7			13	28	10	Near CL/ML for portion of sample passing #40 sieve (29% of total sample)
			30										
-25.0			25										% Pass / Sieve: 100 / 3/8"; 58 / #4; 44 / #10; 29 / #40; 18 / #100
-26.0													
-27.0													
-28.0													
-29.0			17	SC		FINE TO COARSE SAND, gravelly, with clay, very dense, moist, dark yellowish-brown.							
			22										
-30.0													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location Subsurface conditions may differ at other locations and with the passage of time

FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Stewart Street Tank Site
LOCATION: Fortuna
GROUND SURFACE ELEVATION: ~226 Feet
EXCAVATION METHOD: 6" Flight Auger
LOGGED BY: SMB

JOB NUMBER: 007147.620
DATE DRILLED: 06/04/08
TOTAL DEPTH OF BORING: 30.5 Feet
SAMPLER TYPE: CA/SPT
Supervised by RSJ

BORING NUMBER **BH-2**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-30.0			24	SC		FINE TO COARSE SAND, gravelly, with clay, very dense, moist, dark yellowish-brown.							
-31.0													
-32.0						Bottom of boring at 30.5 feet. No free groundwater observed at time of investigation.							
-33.0													
-34.0													
-35.0													
-36.0													
-37.0													
-38.0													
-39.0													
-40.0													
-41.0													
-42.0													
-43.0													
-44.0													
-45.0													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location Subsurface conditions may differ at other locations and with the passage of time

FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Stewart Street Tank Site
LOCATION: Fortuna
GROUND SURFACE ELEVATION: ~224.5 Feet
EXCAVATION METHOD: 6" Flight Auger
LOGGED BY: SMB

JOB NUMBER: 007147.620
DATE DRILLED: 06/04/08
TOTAL DEPTH OF BORING: 30.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER BH-3

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				Fill		FILL: FINE SAND, and mix of clay, with silt, medium dense, dry to moist, yellowish-brown.							Slope inclinometer placed in boring following completion.
-1.0													
-2.0			2	ML		SILT, clayey, with fine sand, soft, wet, black, organics.							Topsoil.
			2										P-3 placed immmediately adjacent to boring.
-3.0			3										
													Soils logged based on cuttings
-4.0			3	CL		CLAY, silty, fine sandy, medium stiff, moist to wet, yellowish-brown, roots.	31	89		73	38	16	% Pass Sieve 99.9 #40 95 #100
			4										
-5.0			7										
-6.0			8	CL		CLAY, silty, with fine sand, stiff, moist, yellowish-brown.							
			15										
-7.0			20										
-8.0			7	SC		FINE SAND, clayey, with silt, medium dense, moist to wet, light yellowish-brown.							Ground water level measurements from* P-3
			10	CL									
-9.0			12			CLAY, silty, trace fine sand, medium stiff, moist, light bluish-gray.							06/09/08 5.20'
-10.0			6										03/06/09 6.40'
			11										
-11.0			30										04/21/09 9.80'
-12.0			11										05/26/09 8.51'
			16			Becomes light yellowish-brown.	23	103	4000	84			
-13.0			25										* Feet below adjacent ground surface
-14.0			22	SC		FINE TO COARSE SAND, with clay, with fine gravel, dense, moist, light gray.							
			40				8	125					
-15.0													

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FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Stewart Street Tank Site
LOCATION: Fortuna
GROUND SURFACE ELEVATION: ~224.5 Feet
EXCAVATION METHOD: 6" Flight Auger
LOGGED BY: SMB

JOB NUMBER: 007147.620
DATE DRILLED: 06/04/08
TOTAL DEPTH OF BORING: 30.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER **BH-3**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-15.0			31	SC		FINE TO COARSE SAND, with clay, with fine gravel, dense, moist, light gray.							Soils described at sample locations only
-16.0													
-17.0													
-18.0													
-19.0			14	SC		FINE TO COARSE SAND, with clay, with fine gravel, dense, moist, light yelowish-browrn.							
			15										
-20.0			12										
-21.0													
-22.0													
-23.0													
-24.0			20	SC		FINE TO COARSE SAND, with clay, with fine gravel, dense, moist, light yelowish-browrn.							
			28										
-25.0			34										
-26.0													
-27.0													
-28.0													
-29.0			30	SC		FINE TO COARSE SAND, with clay, with fine gravel, dense, moist, light yelowish-browrn.							
			36										
-30.0													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Stewart Street Tank Site
LOCATION: Fortuna
GROUND SURFACE ELEVATION: ~224.5 Feet
EXCAVATION METHOD: 6" Flight Auger
LOGGED BY: SMB

JOB NUMBER: 007147.620
DATE DRILLED: 06/04/08
TOTAL DEPTH OF BORING: 30.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER **BH-3**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-30.0			44	SC		FINE TO COARSE SAND, with clay, with fine gravel, dense, moist, light yelowish-browrn.							
-31.0													
-32.0						Bottom of boring at 30.5 feet. No free groundwater observed at time of investigation.							
-33.0													
-34.0													
-35.0													
-36.0													
-37.0													
-38.0													
-39.0													
-40.0													
-41.0													
-42.0													
-43.0													
-44.0													
-45.0													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time

FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Stewart Street Reservoir Site
LOCATION: Fortuna
GROUND SURFACE ELEVATION:
EXCAVATION METHOD: 6" Flight Auger
LOGGED BY: SMB

JOB NUMBER: 007147.640
DATE DRILLED: 06/05/08
TOTAL DEPTH OF BORING: 31.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER BH-4

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				Fill		FILL: FINE SAND, and mix of clay, with silt, medium dense, dry to moist, yellowish-brown.							
-1.0													
-2.0		■	6	CL		CLAY fine sandy, silty, medium stiff, moist, yellowish-brown.							
			7										
-3.0		■	10				24	97		73			
-4.0			4	ML		SILT, sandy fine, with clay trace, gravel fine and organics, medium stiff, wet, black.							Topsoil
			5										
-5.0		■	4										P-4 placed immmediately adjacent to boring
-6.0			4										
		■	5	CL		CLAY fine, sandy, silty, medium stiff, wet to moist, yellowish-brown.							
-7.0		■	8				27	95	2200	69	39	17	
-8.0			9	CL		CLAY fine, sandy, silty, medium stiff, wet to moist, yellowish-brown.							Ground water level measurements from P-4*
		■	14										
-9.0		■	21										06/09/08 5.20'
-10.0			6	CL		CLAY fine, sandy, silty, medium stiff, wet to moist, yellowish-brown.							03/06/09 0.15'
			11	CH		CLAY with silt, stiff, moist, blue gray.							
-11.0		■	15										04/21/09 2.50'
-12.0			9	CH		CLAY with silt, very stiff, moist, yellowish-brown.							05/26/09 3.65'
		■	12				43	80	4100		71	42	
-13.0		■	16										* Feet below adjacent ground surface
-14.0			13	CL CH		CLAY with silt, very stiff, moist, yellowish-brown.							
		■	27										
-15.0													

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FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Stewart Street Reservoir Site
LOCATION: Fortuna
GROUND SURFACE ELEVATION:
EXCAVATION METHOD: 6" Flight Auger
LOGGED BY: SMB

JOB NUMBER: 007147.640
DATE DRILLED: 06/05/08
TOTAL DEPTH OF BORING: 31.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER **BH-4**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-15.0			39	SC		FINE TO COARSE SAND, clayey with gravel fine, dense, moist, dark gray.							
-16.0			20	SC									Soils described at sample locations only
			24										
-17.0			28										
-18.0													
-19.0													
-20.0													
-21.0			23	SC		FINE TO COARSE SAND, clayey with gravel fine, dense, moist, dark gray.							
			25										
-22.0			23										
-23.0													
-24.0													
-25.0													
-26.0			24	SC		FINE TO COARSE SAND, clayey with gravel fine, dense, moist, dark gray.							
			29										
-27.0			23										
-28.0													
-29.0													
-30.0													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Stewart Street Reservoir Site
LOCATION: Fortuna
GROUND SURFACE ELEVATION:
EXCAVATION METHOD: 6" Flight Auger
LOGGED BY: SMB

JOB NUMBER: 007147.640
DATE DRILLED: 06/05/08
TOTAL DEPTH OF BORING: 31.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER **BH-4**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-30.0			32	SC		FINE TO COARSE SAND, clayey with gravel fine, dense, moist, dark gray.							
-31.0			39										
			39										
-32.0						Bottom of boring at 31.5 feet. No free ground water observed at time of investigation							
-33.0													
-34.0													
-35.0													
-36.0													
-37.0													
-38.0													
-39.0													
-40.0													
-41.0													
-42.0													
-43.0													
-44.0													
-45.0													

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FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Stewart Street Tank Site
LOCATION: Fortuna
GROUND SURFACE ELEVATION: ~230.5 Feet
EXCAVATION METHOD: 6" Flight Auger
LOGGED BY: SMB

JOB NUMBER: 007147.620
DATE DRILLED: 06/05/08
TOTAL DEPTH OF BORING: 17.5 Feet
SAMPLER TYPE: SPT

BORING NUMBER **BH-5**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				CL		FILL: CLAY, silty, with fine sand, medium stiff, moist, yellowish-brown.							10' peizometer placed in boring following completion (backfilled boring between 10-17.5' BGS)
-1.0													
-2.0													
-3.0													
-4.0													Soils logged based on cuttings
-5.0													
-6.0													
-7.0				ML		SILT, clayey, with fine sand, soft, moist to wet, black.							Topsoil
-8.0				CL		CLAY, silty, trace fine sand, medium stiff, moist, light yellowish-brown.							Ground water level measurements from installed peizometer*
-9.0													06/09/08 8.05'
-10.0													03/06/09 2.80'
-11.0													04/21/09 5.80'
-12.0			6										05/26/09 6.75'
-13.0			7 9										CL/CH in tip
-14.0			6	SM		FINE SAND, silty, with clay, medium dense, moist, yellowish-brown.							* Feet below ground surface
-15.0			7	CL		CLAY, with silt, medium stiff, moist,							

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FIELD LOG

Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Stewart Street Tank Site
LOCATION: Fortuna
GROUND SURFACE ELEVATION: ~230.5 Feet
EXCAVATION METHOD: 6" Flight Auger
LOGGED BY: SMB

JOB NUMBER: 007147.620
DATE DRILLED: 06/05/08
TOTAL DEPTH OF BORING: 17.5 Feet
SAMPLER TYPE: SPT

BORING NUMBER **BH-5**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-15.0			10			dark yellowish-brown.							
-16.0			9	SC		FINE SAND, clayey, with silt, medium dense, moist, yellowish-brown.							
			12										
-17.0			22										
				SC		FINE TO COARSE SAND, with clay, with fine gravel, dense, moist, light gray.							
-18.0													
-19.0						Bottom of boring at 17.5 feet. No free groundwater observed at time of investigation.							
-20.0													
-21.0													
-22.0													
-23.0													
-24.0													
-25.0													
-26.0													
-27.0													
-28.0													
-29.0													
-30.0													

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FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Fortuna: Stewart Street Tank Site
LOCATION: Street Surface
GROUND SURFACE ELEVATION: ~236 Feet
EXCAVATION METHOD: 6" Hollow Stem Auger
LOGGED BY: SMB

JOB NUMBER: 009030.050
DATE DRILLED: 04/20/09
TOTAL DEPTH OF BORING: 46.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER **BH-10**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				ML		FILL: SILT, fine sandy, with clay, medium stiff, moist, black.							Hand auger to 2.0 feet
-1.0													
-2.0			2	CL		CLAY, fine sandy, with silt, medium stiff, moist, dark yellowish-brown, prominent mottles.							
			4										
-3.0			5				30	94		93			Wet lens
			4										Soils logged based on cuttings
-4.0			4			Becomes very moist.							
			7										
-5.0													
-6.0													
			5	CL		CLAY, fine sandy, with silt, medium stiff, moist, dark yellowish-brown, prominent mottles.							
-7.0			9										
			14	SC			24	104		31			
-8.0			4			FINE SAND, clayey, with silt, medium dense, moist, dark yellowish-brown.							
			5										
-9.0	▽		5			Becomes saturated.							Perched water at time of investigation
			5	CL		CLAY, silty, with fine sand, stiff, moist, dark yellowish-brown, distinct mottles.							
-10.0			9										
			15										
-11.0			4	CL to SC		CLAY, sandy, with silt, TO SAND, clayey with silt, medium dense, moist to wet, gray, distinct mottles.							Interbedded
			6										
-12.0			6										
			4	CL		CLAY, silty, minor fine sand, stiff, moist, gray, distinct mottles.							
-13.0			9				28	98	3200	95			
			11	CL/ CH		CLAY, silty, medium stiff, moist, bluish-gray.							
-14.0			4	CL									
			7			CLAY, fine sandy, medium stiff, moist, dark yellowish-brown.							
-15.0													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location Subsurface conditions may differ at other locations and with the passage of time

FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Fortuna: Stewart Street Tank Site
LOCATION: Street Surface
GROUND SURFACE ELEVATION: ~236 Feet
EXCAVATION METHOD: 6" Hollow Stem Auger
LOGGED BY: SMB

JOB NUMBER: 009030.050
DATE DRILLED: 04/20/09
TOTAL DEPTH OF BORING: 46.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER BH-10

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-15.0			10			moist, bluish gray.							
-16.0			8	SC		CLAY, sandy, with silt, to SAND, clayey with silt, medium dense, moist to wet, gray, distinct mottles.	37	85	3700*		53	30	
			13	CL/ CH									
-17.0			26										
			10	SW/ GW		CLAY, silty, medium stiff, moist, bluish-gray.				24			Pass # % #4 58 8 52 16 47 30 44 50 39 100 31 Coarse gravel in shoe
-18.0			44										
			55/ 5.5"	SC		FINE TO COARSE SAND, fine to medium gravelly, with clay, very dense, moist, dark yellowish-brown.							
-19.0						FINE TO MEDIUM SAND, with fine to coarse gravel, with clay, very dense, moist, dark yellowish-brown.							
-20.0			35										
			50/ 5"	SC		FINE TO MEDIUM SAND, clayey, with fine to coarse gravel, very dense, moist, dark yellowish-brown.							* Only top 1/2 of sample deformed. Unconfined compressive strength is therefore artificially high
-21.0													
			18										
-22.0			25										
			27										
-23.0													Soils described at sample locations only
-24.0													
-25.0			21	SC		FINE TO MEDIUM SAND, fine to medium gravelly, with clay, very dense, moist, dark yellowish-brown.	11	121	2400*	16			Pass # % 4 68 8 45 16 35 30 31 50 27 100 22 (32% gravel)
			38										
-26.0			50/ 5.75"										
			28										
-27.0			35										
			36										
-28.0													* Sample broke apart due to presence of large gravels
-29.0													
-30.0													

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FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Fortuna: Stewart Street Tank Site
JOB NUMBER: 009030.050
LOCATION: Street Surface
DATE DRILLED: 04/20/09
GROUND SURFACE ELEVATION: ~236 Feet
TOTAL DEPTH OF BORING: 46.5 Feet
EXCAVATION METHOD: 6" Hollow Stem Auger
SAMPLER TYPE: CA/SPT
LOGGED BY: SMB

BORING NUMBER BH-10

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-30.0			20	SC/SW		FINE TO MEDIUM SAND, fine to medium gravelly, with clay, very dense, moist, dark yellowish-brown.							
			35										
-31.0			50/5.75"										
			29										
-32.0			44										
			50/5.75"										
-33.0													
-34.0													
-35.0			30	SC/SW		FINE TO MEDIUM SAND, fine to medium gravelly, with clay, very dense, moist, dark yellowish-brown.							
			50/6"										
-36.0													
-37.0													
-38.0			34	SC/SW		FINE TO MEDIUM SAND, fine to medium gravelly, with clay, very dense, moist, dark yellowish-brown.							
			50/5.75"										
-39.0													
-40.0			21	SC/SW		FINE TO MEDIUM SAND, fine to medium gravelly, with clay, very dense, moist, dark yellowish-brown.							
			30										
-41.0			41										
-42.0													
-43.0													
-44.0													
-45.0													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Fortuna: Stewart Street Tank Site
LOCATION: Street Surface
GROUND SURFACE ELEVATION: ~236 Feet
EXCAVATION METHOD: 6" Hollow Stem Auger
LOGGED BY: SMB

JOB NUMBER: 009030.050
DATE DRILLED: 04/20/09
TOTAL DEPTH OF BORING: 46.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER **BH-10**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-45.0			30	SC/ SW		FINE TO MEDIUM SAND, fine to medium gravelly, with clay, very dense, moist, dark yellowish-brown.							
-46.0			31										
			29										
-47.0						Bottom of boring at 46.5 feet.							
-48.0													
-49.0													
-50.0													
-51.0													
-52.0													
-53.0													
-54.0													
-55.0													
-56.0													
-57.0													
-58.0													
-59.0													
-60.0													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time

FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Fortuna, Stewart Street Tank Site
JOB NUMBER: 009030.050
LOCATION: Street surface
DATE DRILLED: 04/21/09
GROUND SURFACE ELEVATION: ~234.25 Feet
TOTAL DEPTH OF BORING: 36.5 Feet
EXCAVATION METHOD: 6" Hollow Stem Auger
SAMPLER TYPE: CA/SPT
LOGGED BY: SMB

BORING NUMBER BH-11

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0						Base Rock							35' Peizometer placed in boring following completion
-1.0			3	SC/ CL		FILL: SAND fine, clayey with silt, medium dense, moist, yellowish-brown to light gray							
			3										
-2.0			4	CL		CLAY, fine sandy, with silt, medium stiff, moist, yellowish-brown, distinct mottles.							
			3										
-3.0			4										
			5										Soils logged based on cuttings
-4.0			6	CL		CLAY, silty with fine sand, medium stiff, moist, yellowish-brown, distinct mottles.							
			9				31	94		86	40	18	Direct Shear Phi = 11 deg C = 1000 Psf
-5.0			14										
			3										Groundwater measurements from installed peizometer*
-6.0			5										
			7										
-7.0			6			Wet lens.							04/29/09 Dry
			9	CL		CLAY, fine sandy, with silt, medium stiff, moist, dark yellowish-brown.	26	100	2400				
-8.0			12										05/26/09 Dry
			5	SC		FINE SAND, clayey, with silt, medium dense, wet, dark yellowish-brown, prominent mottles, charcoal.							
-9.0			7	CL									
			8			CLAY, fine sandy, with silt, medium stiff, moist to wet, dark yellowish-brown.							
-10.0			5										Interbedded
			8										
-11.0			13	SC		FINE SAND, clayey, medium dense, wet, dark yellowish-brown.	23	100	700	23			
			3										
-12.0			5	CL		CLAY, fine sandy, with silt, medium stiff, moist to wet, dark yellowish-brown.							
			6	CH									
-13.0			6	CL		CLAY, silty, medium stiff, moist, bluish-gray, distinct mottles.							* Feet below adjacent ground surface
			9	CL									
-14.0			13			CLAY, fine sandy, medium stiff, moist, yellowish-brown.							
			6										
-15.0						CLAY, silty, stiff, moist, dark							

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FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Fortuna, Stewart Street Tank Site
LOCATION: Street surface
GROUND SURFACE ELEVATION: ~234.25 Feet
EXCAVATION METHOD: 6" Hollow Stem Auger
LOGGED BY: SMB

JOB NUMBER: 009030.050
DATE DRILLED: 04/21/09
TOTAL DEPTH OF BORING: 36.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER **BH-11**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-15.0			15			reddish-brown.							
			32										
-16.0	▽			SC		FINE TO MEDIUM SAND, clayey, with fine gravel, dense, saturated, dark yellowish-brown.							Perched water at time of investigation
-17.0			16										
			20										
-18.0			31										
-19.0													
-20.0			27	SC/ SW		FINE TO COARSE SAND, fine to medium gravelly, with clay, very dense, moist, yellowish-brown.	6	138		12			Soils described at sample locations only
			50/ 5.75"										
-21.0													Coarse gravel in shoe of sampler
-22.0													
-23.0			14	SC/ SW		FINE TO COARSE SAND, fine to medium gravelly, with clay, very dense, moist, yellowish-brown.							
			24										
-24.0			28										
-25.0			21	SC/ SW		FINE TO COARSE SAND, fine to medium gravelly, with clay, very dense, moist, yellowish-brown.							
			28										
-26.0			30										
-27.0													
-28.0			19	SC/ SW		FINE TO COARSE SAND, fine to medium gravelly, with clay, very dense, moist, yellowish-brown.							
			31										
-29.0			38										
-30.0													

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PROJECT: Fortuna, Stewart Street Tank Site
LOCATION: Street surface
GROUND SURFACE ELEVATION: ~234.25 Feet
EXCAVATION METHOD: 6" Hollow Stem Auger
LOGGED BY: SMB

JOB NUMBER: 009030.050
DATE DRILLED: 04/21/09
TOTAL DEPTH OF BORING: 36.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER **BH-11**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-30.0	X		23	SC/SW		FINE TO COARSE SAND, fine to medium gravelly, with clay, very dense, moist, yellowish-brown.							
			34										
-31.0			44										
-32.0													
-33.0	X		20	SC/SW		FINE TO COARSE SAND, fine to medium gravelly, with clay, very dense, moist, yellowish-brown.							
			53/6"										
-34.0													
-35.0			24	SC/SW		FINE TO COARSE SAND, fine to medium gravelly, with clay, very dense, moist, yellowish-brown.							
			37										
-36.0			29										
-37.0						Bottom of boring at 36.5 feet.							
-38.0													
-39.0													
-40.0													
-41.0													
-42.0													
-43.0													
-44.0													
-45.0													

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FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Fortuna, Stewart Street Tank Site
LOCATION: Near AC Curb
GROUND SURFACE ELEVATION: ~235 Feet
EXCAVATION METHOD: 6" Hollow Stem Auger
LOGGED BY: SMB

JOB NUMBER: 009030.050
DATE DRILLED: 04/21/09
TOTAL DEPTH OF BORING: 36.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER **BH-12**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0						Road Base.							35' Peizometer placed in boring following completion
-1.0													
-2.0			P	SC		FILL: FINE SAND, clayey, with silt, medium dense, moist to wet, dark yellowish-brown to yellow brown.							
			7										
-3.0			9										
			3	SC		FINE SAND, clayey, with silt, medium dense, moist to wet, dark yellowish-brown, distinct mottles.							Soils logged based on cuttings
-4.0			3										
			4										
-5.0			4										
			7	SC		CLAY, silty, fine sandy, medium stiff, moist, dark yellowish-brown, faint mottles.	27	98	3300	76			Groundwater measurements from installed peizometer*
-6.0			11										
			3										
-7.0			4										04/29/09 33'
			5										
-8.0			4										05/26/09 Dry
			7				27	98	2400	70			
-9.0			10										
				SC to CL		FINE SAND, clayey, with silt, medium dense, moist, yellowish-brown, distinct mottles, TO CLAY, silty, with fine sand, medium stiff, moist, yellowish-brown, distinct mottles.							
-10.0			3										
			4										Interbedded
-11.0			6										
				CL		CLAY, fine sandy, medium stiff, moist to wet, brown, distinct mottles.							
-12.0			3				27	97		79			
			6										
-13.0			8										
	▽		6										Perched water at time of investigation
-14.0			6										
			7	CL/ CH		CLAY, silty, medium stiff, moist, bluish-gray.							
-15.0													

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PROJECT: Fortuna, Stewart Street Tank Site
LOCATION: Near AC Curb
GROUND SURFACE ELEVATION: ~235 Feet
EXCAVATION METHOD: 6" Hollow Stem Auger
LOGGED BY: SMB

JOB NUMBER: 009030.050
DATE DRILLED: 04/21/09
TOTAL DEPTH OF BORING: 36.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER **BH-12**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-15.0			3										
			8				34	89		100			
-16.0			17	CL to CL/CH		CLAY, silty, medium stiff, medium plasticity, moist, dark brown.							
			3										
-17.0			4										
			10										
-18.0			16										
			18	SC		FINE SAND, with clay, with silt, medium dense, moist, light yellowish-brown.	22	108					
-19.0			48	SC		FINE TO MEDIUM SAND, clayey, with fine to medium gravel, with silt, very dense, yellowish-brown.							Soils described at sample locations only
-20.0			24										
			40										
-21.0			43										
-22.0													
-23.0													
-24.0													
-25.0			18	SC		FINE TO MEDIUM SAND, clayey, with fine to medium gravel, with silt, very dense, yellowish-brown.							
			37										
-26.0			33	SC/SW		FINE TO COURSE SAND, fine to course gravelly, with clay, very dense, moist, yellowish-brown.							
-27.0													
-28.0													
-29.0													
-30.0													

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PROJECT: Fortuna, Stewart Street Tank Site
LOCATION: Near AC Curb
GROUND SURFACE ELEVATION: ~235 Feet
EXCAVATION METHOD: 6" Hollow Stem Auger
LOGGED BY: SMB

JOB NUMBER: 009030.050
DATE DRILLED: 04/21/09
TOTAL DEPTH OF BORING: 36.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER **BH-12**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-30.0													
			19			FINE TO COURSE SAND, fine to course gravelly, with clay, very dense, moist, yellowish-brown.							
-31.0			25										
			33										
-32.0													
-33.0													
-34.0													
-35.0			15			FINE TO COURSE SAND, fine to course gravelly, with clay, very dense, moist, yellowish-brown.							
			27										
-36.0			43										
-37.0						Bottom of boring at 36.5 feet.							
-38.0													
-39.0													
-40.0													
-41.0													
-42.0													
-43.0													
-44.0													
-45.0													

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FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Fortuna, Stewart Street Tank Site
JOB NUMBER: 009030.065
LOCATION: New Tank Footprint
DATE DRILLED: 04/24/09
GROUND SURFACE ELEVATION: ~226.5 Feet
TOTAL DEPTH OF BORING: 31.5 Feet
EXCAVATION METHOD: 6" Hollow Stem Auger
SAMPLER TYPE: CA/SPT
LOGGED BY: SMB

BORING NUMBER BH-13

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				SM/ ML		FILL: FINE SAND, silty, with clay, medium dense, moist, dark yellowish-brown.							
-1.0			3 3										
-2.0			2	SM		FINE SAND, silty, with clay, loose, moist, black.							Variagated colors
-3.0			1 1										Topsoil
-4.0	▽		1										Perched water at time of investigation
-5.0			1 P	SC		FINE SAND, clayey, with silt, rare gravels, loose, wet with saturated zones, dark yellowish-brown, distinct mottles.							
-6.0			1										
-7.0													
-8.0			5 10	CL/ CH		CLAY, silty, fine sandy, medium stiff, moist, light gray.	25	102	5600*	87			* Sample too undersized for accurate results.
-9.0			13	CH		CLAY, silty, stiff, moist, light gray.							
-10.0			3 6	CH		CLAY, silty, medium stiff, moist, plastic, dark yellowish-brown, distinct mottles.	35	87			72		
-11.0			10										
-12.0			20 50/ 5"	SC		FINE TO MEDIUM SAND, clayey, with fine to medium gravel, very dense, moist, dark yellowish-brown.							
-13.0													
-14.0													
-15.0													

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FIELD LOG

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PROJECT: Fortuna, Stewart Street Tank Site
LOCATION: New Tank Footprint
GROUND SURFACE ELEVATION: ~226.5 Feet
EXCAVATION METHOD: 6" Hollow Stem Auger
LOGGED BY: SMB

JOB NUMBER: 009030.065
DATE DRILLED: 04/24/09
TOTAL DEPTH OF BORING: 31.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER **BH-13**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-15.0	X		6	CL		CLAY, fine sandy, stiff, moist, dark yellowish-brown.							Soils described at sample locations only
			16										
-16.0			20										
-17.0													
-18.0													
-19.0													
-20.0	X		17	SC/SW		FINE TO MEDIUM SAND, fine to medium gravelly, with clay, very dense, moist, dark yellowish-brown.							
			28										
-21.0			29										
-22.0													
-23.0													
-24.0													
-25.0	X		15	SC/SW		FINE TO MEDIUM SAND, fine to medium gravelly, with clay, very dense, moist, dark yellowish-brown.							
			28										
-26.0			29										
-27.0													
-28.0													
-29.0													
-30.0													

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FIELD LOG

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PROJECT: Fortuna, Stewart Street Tank Site
LOCATION: New Tank Footprint
GROUND SURFACE ELEVATION: ~226.5 Feet
EXCAVATION METHOD: 6" Hollow Stem Auger
LOGGED BY: SMB

JOB NUMBER: 009030.065
DATE DRILLED: 04/24/09
TOTAL DEPTH OF BORING: 31.5 Feet
SAMPLER TYPE: CA/SPT

BORING NUMBER **BH-13**

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-30.0			20	SC/SW		FINE TO MEDIUM SAND, fine to medium gravelly, with clay, very dense, moist, dark yellowish-brown.							
-31.0			41										
			54										
-32.0						Bottom of boring at 31.5 feet.							
-33.0													
-34.0													
-35.0													
-36.0													
-37.0													
-38.0													
-39.0													
-40.0													
-41.0													
-42.0													
-43.0													
-44.0													
-45.0													

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FIELD LOG

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812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Stewart Street Tank Site
LOCATION: Fortuna
GROUND SURFACE ELEVATION: ~223 Feet
EXCAVATION METHOD: Hand Auger/ 6" Hollow Stem Auger
LOGGED BY: DRB

JOB NUMBER: 00207.640
DATE DRILLED: 02/13/00
TOTAL DEPTH OF BORING: 21.5 feet
SAMPLER TYPE: CA/SPT

BORING NUMBER
BH-DRB-1

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0				Fill		FILL: PEA GRAVEL.							Hand Auger to 5 feet
				ML		FILL: SILT, sandy, soft, wet, yellowish-brown.							
-1.0													
-2.0													
-3.0				CL		CLAY, stiff, damp-moist, yelowish-brown.							
-4.0													
-5.0			10	CL		CLAY, stiff, moist, reddish-brown to yellowish-brown.							Soils described at sample locations only
			11										
-6.0			17										
-7.0													
-8.0						Becomes wet.							
-9.0													
-10.0			9	CL		ASSUMED: CLAY, medium stiff, moist, reddish-brown to yellowish-brown.							Sample not retained, wet to saturated.
			9										
-11.0			10										
-12.0													Soils described at sample locations only
-13.0													
-14.0													
-15.0 ▽													Perched water at time of investigation.

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FIELD LOG

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PROJECT: Stewart Street Tank Site
JOB NUMBER: 00207.640
LOCATION: Fortuna
DATE DRILLED: 02/13/00
GROUND SURFACE ELEVATION: ~223 Feet
TOTAL DEPTH OF BORING: 21.5 feet
EXCAVATION METHOD: Hand Auger/ 6" Hollow Stem Auger
SAMPLER TYPE: CA/SPT
LOGGED BY: DRB

BORING NUMBER
BH-DRB-1

DEPTH (FT)	BULK SAMPLES	SPLIT SPOON	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-15.0			23	CL		CLAY, vey stiff, moist, reddish-brown to yellowish-brown.							
			27										
-16.0			40										
-17.0													Sand catcher used
-18.0													
-19.0													
-20.0			22	GW		MEDIUM TO FINE GRAVEL, fine to coarse sandy, silty, dense, dry, yellowish brown.							Switched to SPT
			28										
-21.0			25										Drilling near refusal
-22.0						Bottom of boring at 21.5 feet. No free ground water observed at time of investigation							
-23.0													
-24.0													
-25.0													
-26.0													
-27.0													
-28.0													
-29.0													
-30.0													

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FIELD LOG

CONSULTING ENGINEERS & GEOLOGISTS, INC.
812 W. Wabash Eureka, CA 95501-2138 Tel: 707/441-8855 FAX: 707/441-8877 E-mail: shninfo@shn-engr.com

DENSITY BY DRIVE- CYLINDER METHOD (ASTM D2937)

Project Name:	Stewart St Tank	Project Number:	009030.050
Performed By:	LA	Date:	5/26/2009
Checked By:	DL	Date:	5/26/09
Project Manager:	RSJ		

Lab Sample Number	9-823	9-824	9-825	9-833	9-835
Boring Label	BH10	BH10	BH11	BH12	BH12
Sample Depth (ft)	3-3.5	7.5-8	7.5-8	12.5-13	16-16.5
Diameter of Cylinder, in	2.40	2.40	2.42	2.40	2.38
Total Length of Cylinder, in.	5.96	6.00	5.96	6.00	6.02
Length of Empty Cylinder A, in.	0.67	0.60	1.46	0.00	0.40
Length of Empty Cylinder B, in.	0.00	0.00	0.00	0.00	0.00
Length of Cylinder Filled, in	5.29	5.40	4.50	6.00	5.62
Volume of Sample, in^3	23.93	24.43	20.70	27.14	25.00
Volume of Sample, cc.	392.16	400.32	339.18	444.80	409.71

Pan #	SS3	SS9	SS8	SS14	SS6
Weight of Wet Soil and Pan	964.4	1023.2	876.4	1074.8	982.2
Weight of Dry Soil and Pan	786.1	862.1	736.2	886.5	783.0
Weight of Water	178.3	161.1	140.2	188.3	199.2
Weight of Pan	197.1	196.6	193.3	192.8	196.2
Weight of Dry Soil	589.0	665.5	542.9	693.7	586.8
Percent Moisture	30.3	24.2	25.8	27.1	33.9
Dry Density, g/cc	1.50	1.66	1.60	1.56	1.43
Dry Density, lb/ft^3	93.8	103.8	99.9	97.4	89.4

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DENSITY BY DRIVE- CYLINDER METHOD (ASTM D2937)

Project Name:	Stewart St Tank	Project Number:	009030.050
Performed By:	LA	Date:	5/26/2009
Checked By:	DG	Date:	5/27/09
Project Manager:	RSJ		

Lab Sample Number	9-836	9-840	9-828	9-837	
Boring Label	BH12	BH13	BH11	BH13	
Sample Depth (ft)	18.5-19	10-11.5	20.5-21	8-8.5	
Diameter of Cylinder, in	2.38	1.39	2.38	2.38	
Total Length of Cylinder, in.	6.00	4.71	6.00	6.00	
Length of Empty Cylinder A, in.	0.66	0.00	1.30	2.22	
Length of Empty Cylinder B, in.	0.00	0.00	0.00	0.00	
Length of Cylinder Filled, in	5.34	4.71	4.70	3.78	
Volume of Sample, in^3	23.76	7.15	20.91	16.82	
Volume of Sample, cc.	389.30	117.12	342.64	275.57	

Pan #	SS10	S29	SS1	S32	
Weight of Wet Soil and Pan	1019.8	368.5	994.3	642.7	
Weight of Dry Soil and Pan	870.6	311.7	950.2	529.7	
Weight of Water	149.2	56.8	44.1	113.0	
Weight of Pan	195.5	149.4	194.9	80.3	
Weight of Dry Soil	675.1	162.3	755.3	449.4	
Percent Moisture	22.1	35.0	5.8	25.1	
Dry Density, g/cc	1.73	1.39	2.20	1.63	
Dry Density, lb/ft^3	108.3	86.5	137.6	101.8	

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SIEVE ANALYSIS WORKSHEET ASTM C136

JOB NAME:	**Stewart St Tank**	JOB NUMBER:	**009030**	DATE:	**5/18/2009**
PROJECT MANAGER:	**RSJ**	PERFORMED BY:	**JMA**	CHECKED BY:	JB 7/9/09
SAMPLE I.D.:	**BH10 25.5-26.0**	LAB SAMPLE NO:	**9-760**		

TOTAL SAMPLE WEIGHT BEFORE WASH: 521.0 SAMPLE WEIGHT AFTER WASH: 439.9

PERCENT PASSING # 200: **15.6**

PERCENT LOST= **0.11** MUST BE 0.3% OR LESS TO COMPLY W/ ASTM C136-01 AND AASHTO T 27-93

SIEVE #	WEIGHT RETAINED SCREEN	WEIGHT RETAINED TOTAL	% PASSED
#4 (4.75mm)	168	168	**67.8**
Pan	272	440	

FINE FRACTION GRADING WEIGHT 272.0

	WEIGHT RETAINED REDUCED PORTION	WEIGHT RETAINED SCREEN	WEIGHT RETAINED TOTAL	%PASSED
#8 (2.36mm)	117.4	117	285	**45.2**
#16 (1.18mm)	52.5	53	338	**35.2**
#30 (600um)	22.3	22	360	**30.9**
#50 (300um)	22.2	22	382	**26.6**
#100 (150um)	24.2	24	407	**22.0**
#200 (75um)	30.5	31	437	**16.1**
PAN	3.4	3	440	

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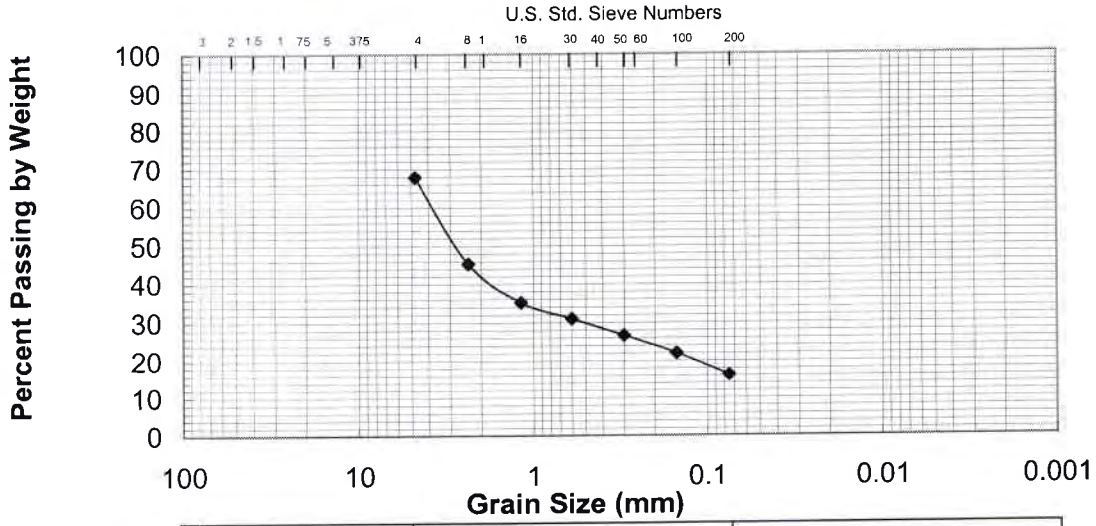
PROJECT NAME: Stewart St Tank
SAMPLE ID: BH10 25.5-26.0
DATE TESTED: 5/18/2009

PROJECT NUMBER: 009030
Lab Sample#: 9-760

SIEVE	3"	2 1/2"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#10	#16	#30	#40	#50	#60	#100	#200
SIEVE SIZE (mm)	76.2	63.5	50.8	38.1	25.4	19.1	12.7	9.53	4.75	2.36	2.00	1.18	0.600	0.425	0.300	0.250	0.150	0.075
PERCENT PASSING									67.8	45.2		35.2	30.9		26.6		22.0	16.1
SPEC REQUIRED																		

Gradation Test Results



	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

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SIEVE ANALYSIS WORKSHEET ASTM C136

JOB NAME:	**Stewart St. Tank**	JOB NUMBER:	**009030**	DATE:	**5/13/09**
PROJECT MANAGER:	**RSJ**	PERFORMED BY:	**LA**	CHECKED BY:	DB 5/19/09
SAMPLE I.D.:	**BH-10 17.5-19.0'**	LAB SAMPLE NO:	**9-763**		

TOTAL SAMPLE WEIGHT BEFORE WASH: 313.2 SAMPLE WEIGHT AFTER WASH: 238.6

PERCENT PASSING # 200: **23.8**

PERCENT LOST= **0.33** MUST BE 0.3% OR LESS TO COMPLY W/ ASTM C136-01 AND AASHTO T 27-93

#4 (4.75mm)	132	132	**57.8**
Pan	107	239	

FINE FRACTION GRADING WEIGHT 106.5

	WEIGHT RETAINED			
	REDUCED PORTION	SCREEN	TOTAL	**%PASSED**
#8 (2.36mm)	19.3	19	151	**51.7**
#16 (1.18mm)	14.2	14	166	**47.1**
#30 (600um)	10.5	11	176	**43.8**
#50 (300um)	15.7	16	192	**38.8**
#100 (150um)	22.6	23	214	**31.5**
#200 (75um)	22.3	22	237	**24.4**
PAN	2.7	3	239	

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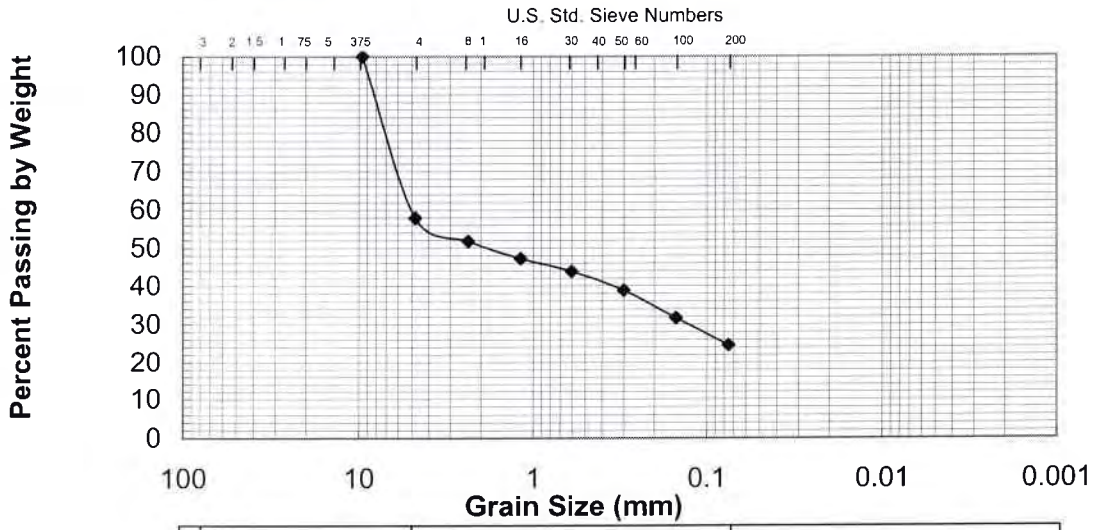
PROJECT NAME: Stewart St. Tank
SAMPLE ID: BH-10 17.5-19.0'
DATE TESTED: **5/13/09**

PROJECT NUMBER: 009030
Lab Sample#: 9-763

SIEVE	3"	2 1/2"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#10	#16	#30	#40	#50	#60	#100	#200
SIEVE SIZE (mm)	76.2	63.5	50.8	38.1	25.4	19.1	12.7	9.53	4.75	2.36	2.00	1.18	0.600	0.425	0.300	0.250	0.150	0.075
PERCENT PASSING								100	57.8	51.7		47.1	43.8		38.8		31.5	24.4
SPEC REQUIRED																		

Gradation Test Results



	GRAVEL		SAND			SILT or CLAY
	Coarse	Fine	Coarse	Medium	Fine	

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PERCENT PASSING # 200 SIEVE (ASTM - D1140)

Project Name:	Stewart St Tank	Project Number:	009030.050
Performed By:	LA	Date:	5/26/2009
Checked By:	DG	Date:	5/26/09
Project Manager:	RSJ		

Lab Sample Number	9-823	9-824	9-826	9-828	9-831
Boring Label	BH10	BH10	BH11	BH11	BH12
Sample Depth (ft)	3-3.5	7.5-8	11-11.5	20.5-21	5.5-6
Pan Number	SS3	SS9	SS10	SS1	S17
Dry Weight of Soil & Pan	259.6	267.3	265.1	949.8	310.6
Pan Weight	197.1	196.6	195.5	194.8	231.9
Weight of Dry Soil	62.5	70.7	69.6	755.0	78.7
Soil Weight Retained on #200&Pan	201.7	245.3	248.9	857.9	250.5
Soil Weight Passing #200	57.9	22.0	16.2	91.9	60.1
Percent Passing #200	**92.6**	**31.1**	**23.3**	**12.2**	**76.4**

Lab Sample Number	9-832	9-833	9-835	9-837	
Boring Label	BH12	BH12	BH12	BH13	
Sample Depth (ft)	8.5-9	12.5-13	16-16.5	8-8.5	
Pan Number	S18	SS8	SS6	S32	
Dry Weight of Soil & Pan	317.2	259.8	258.2	135.9	
Pan Weight	222.8	193.0	196.1	80.3	
Weight of Dry Soil	94.4	66.8	62.1	55.6	
Soil Weight Retained on #200&Pan	250.9	207.1	196.2	87.7	
Soil Weight Passing #200	66.3	52.7	62.0	48.2	
Percent Passing #200	**70.2**	**78.9**	**99.8**	**86.7**	

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PERCENT PASSING # 200 SIEVE (ASTM - D1140)

Project Name:	Stewart St. Tank	Project Number:	009030
Performed By:	LA	Date:	5/14/09
Checked By:	JB	Date:	5/19/09
Project Manager:	RSJ		

Lab Sample Number	9-764	9-756			
Boring Label	BH-11	BH-10			
Sample Depth (ft)	4.5-5	13-13.5			
Pan Number	ss1	ss3			
Dry Weight of Soil & Pan	301.5	289.8			
Pan Weight	195.0	197.2			
Weight of Dry Soil	106.5	92.6			
Soil Weight Retained on #200&Pan	210.0	201.9			
Soil Weight Passing #200	91.5	87.9			
Percent Passing #200	**85.9**	**94.9**			

Lab Sample Number					
Boring Label					
Sample Depth (ft)					
Pan Number					
Dry Weight of Soil & Pan					
Pan Weight					
Weight of Dry Soil					
Soil Weight Retained on #200&Pan					
Soil Weight Passing #200					
Percent Passing #200					

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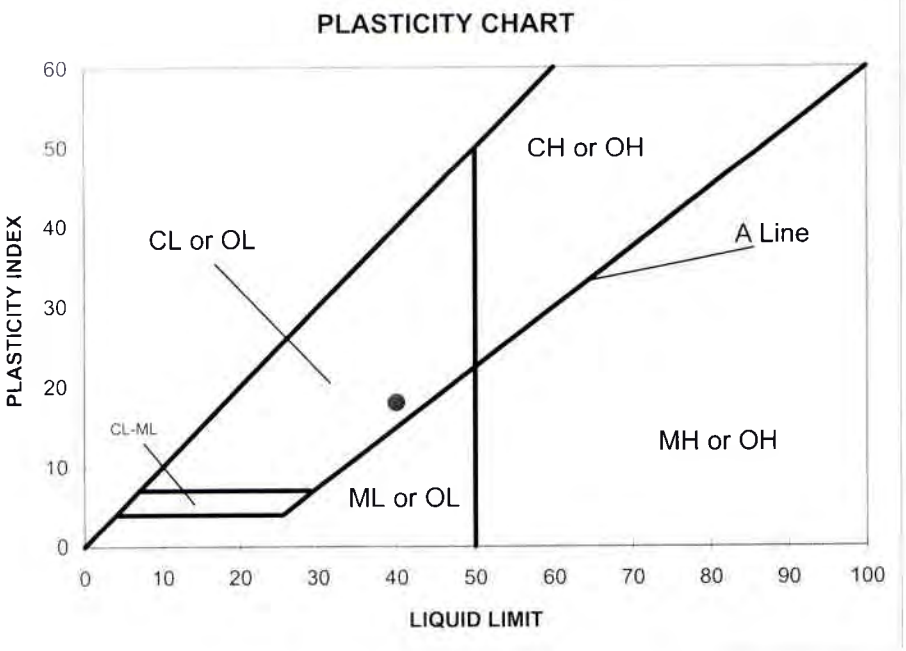
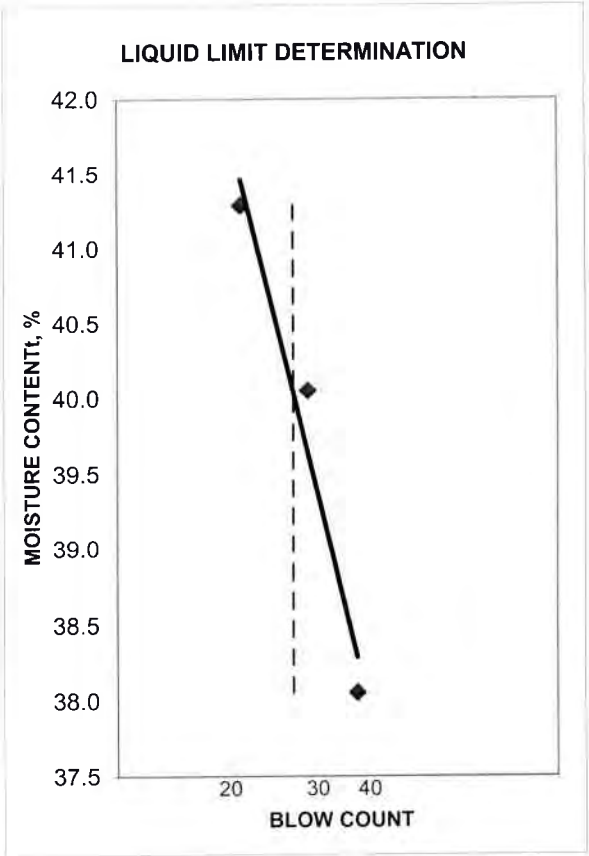
LIQUID LIMIT, PLASTIC LIMIT, and PLASTICITY INDEX (ASTM-D4318)

JOB NAME:	**Stewart St. Tank**	JOB #:	**009030**	LAB SAMPLE #:	**9-764**
SAMPLE ID:	**BH-11 4.5-5.0'**	PERFORMED BY:	**JMA**	DATE:	5/13/09
PROJECT MANGER:	**RSJ**	CHECKED BY:	JB	DATE:	5/19/09

LINE NO.		TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 3
A	PAN #	15	16	1	2	3
B	PAN WT. (g)	20.654	21.011	29.788	29.132	29.202
C	WT. WET SOIL & PAN (g)	27.276	27.860	38.665	36.727	36.710
D	WT. DRY SOIL & PAN (g)	26.067	26.643	36.218	34.555	34.516
E	WT. WATER (C-D)	1.209	1.217	2.447	2.172	2.194
F	WT. DRY SOIL (D-B)	5.413	5.632	6.430	5.423	5.314
G	BLOW COUNT	--	--	35	27	19
H	MOISTURE CONTENT (E/F*100)	22.3	21.6	38.1	40.1	41.3

LIQUID LIMIT	**PLASTIC INDEX**	PLASTIC LIMIT
40	**18**	22





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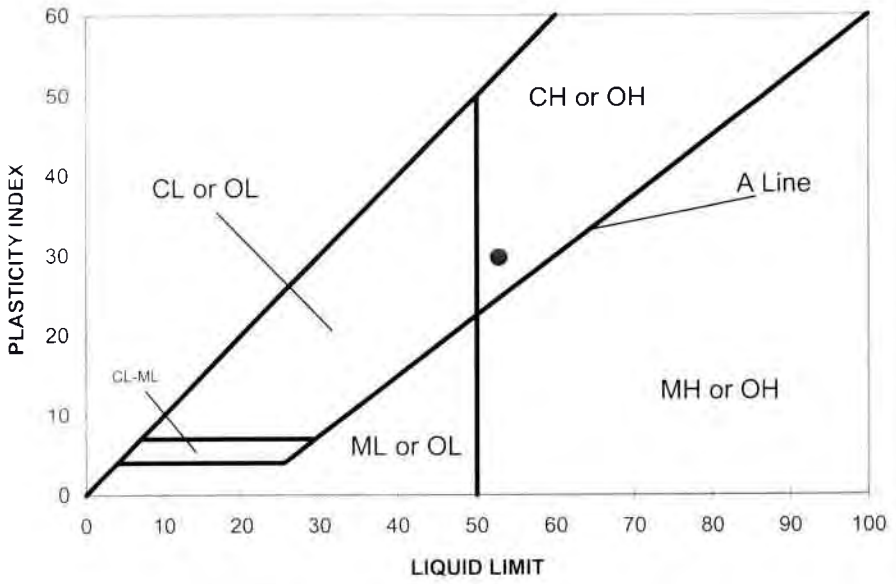
LIQUID LIMIT, PLASTIC LIMIT, and PLASTICITY INDEX (ASTM-D4318)

JOB NAME:	**Stewart St. Tank**	JOB #:	**009030**	LAB SAMPLE #:	**9-758**
SAMPLE ID:	**BH-10 16.5-17.0'**	PERFORMED BY:	**JMA**	DATE:	5/13/09
PROJECT MANGER:	**RSJ**	CHECKED BY:	JB	DATE:	5/19/09

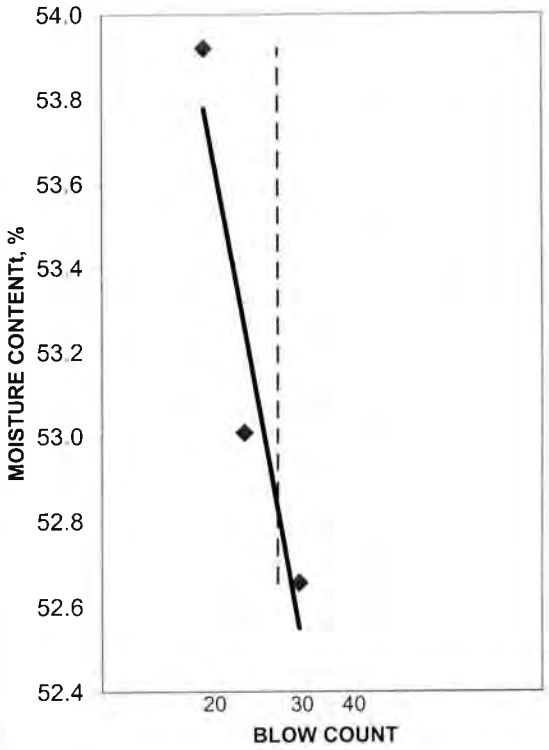
LINE NO.		TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 3
A	PAN #	22	23	A	B	C
B	PAN WT. (g)	17.241	16.959	29.377	29.610	28.717
C	WT. WET SOIL & PAN (g)	23.520	23.453	37.744	36.656	35.391
D	WT. DRY SOIL & PAN (g)	22.358	22.222	34.858	34.215	33.053
E	WT. WATER (C-D)	1.162	1.231	2.886	2.441	2.338
F	WT. DRY SOIL (D-B)	5.117	5.263	5.481	4.605	4.336
G	BLOW COUNT	--	--	28	21	17
H	MOISTURE CONTENT (E/F*100)	22.7	23.4	52.7	53.0	53.9

LIQUID LIMIT	**PLASTIC INDEX**	PLASTIC LIMIT
53	**30**	23

PLASTICITY CHART



LIQUID LIMIT DETERMINATION



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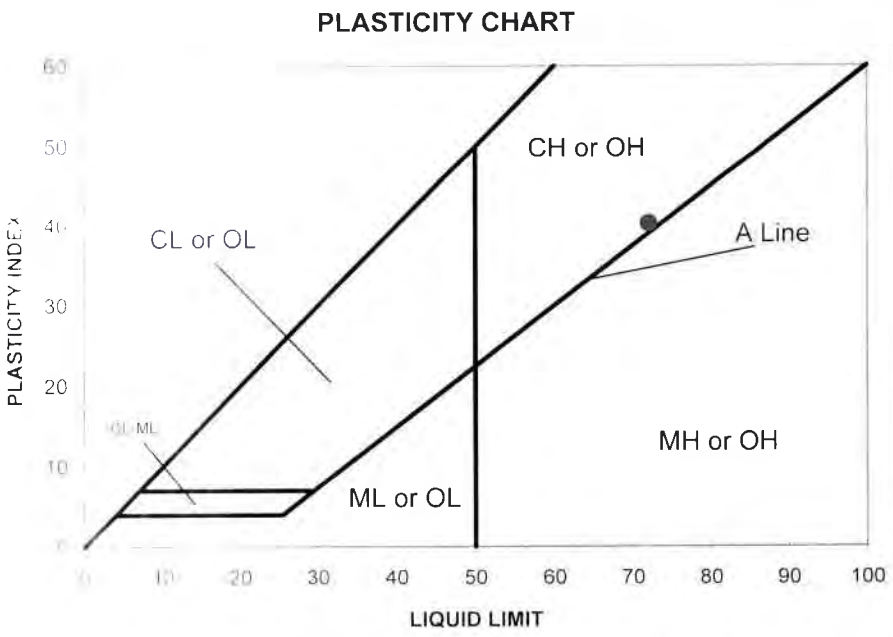
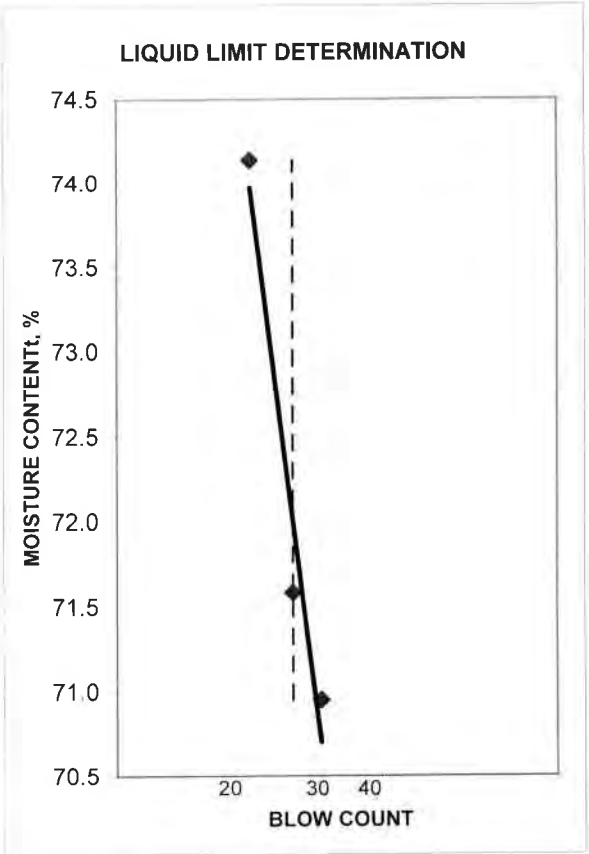
LIQUID LIMIT, PLASTIC LIMIT, and PLASTICITY INDEX (ASTM-D4318)

JOB NAME:	**Stewart St Tank**	JOB #:	**009030.050**	LAB SAMPLE #:	**9-840**
SAMPLE ID:	**BH 13 10-11.5**	PERFORMED BY:	**LA**	DATE:	**5/27/2009**
PROJECT MANGER:	**RSJ**	CHECKED BY:	DL	DATE:	5/27/09

LINE NO		TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 3
A	PAN #	22	23	1	2	3
B	PAN WT (g)	17.241	16.957	29.785	29.132	29.217
C	WT WET SOIL & PAN (g)	22.895	22.865	37.300	35.750	34.941
D	WT DRY SOIL & PAN (g)	21.525	21.453	34.181	32.989	32.504
E	WT WATER (C-D)	1.370	1.412	3.119	2.761	2.437
F	WT DRY SOIL (D-B)	4.284	4.496	4.396	3.857	3.287
G	BLOW COUNT	--	--	29	25	20
H	MOISTURE CONTENT (E/F*100)	32.0	31.4	71.0	71.6	74.1

LIQUID LIMIT	**PLASTIC INDEX**	PLASTIC LIMIT
72	**40**	32





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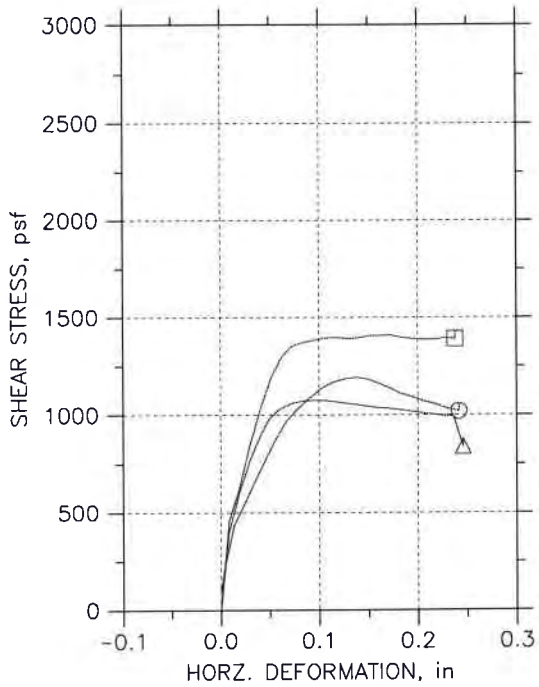
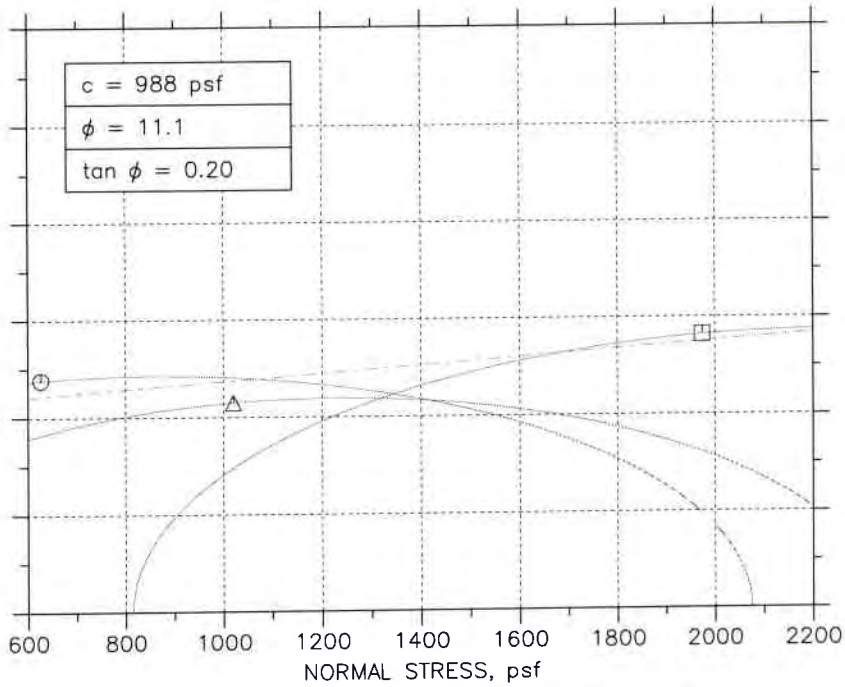
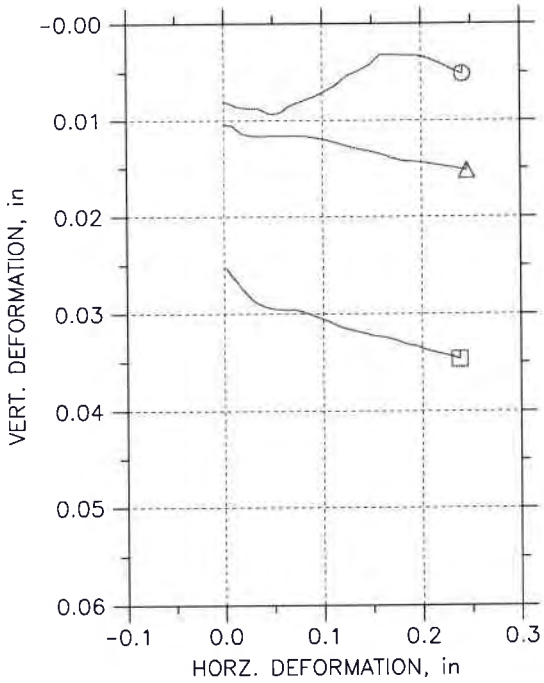
DIRECT SHEAR TEST REPORT





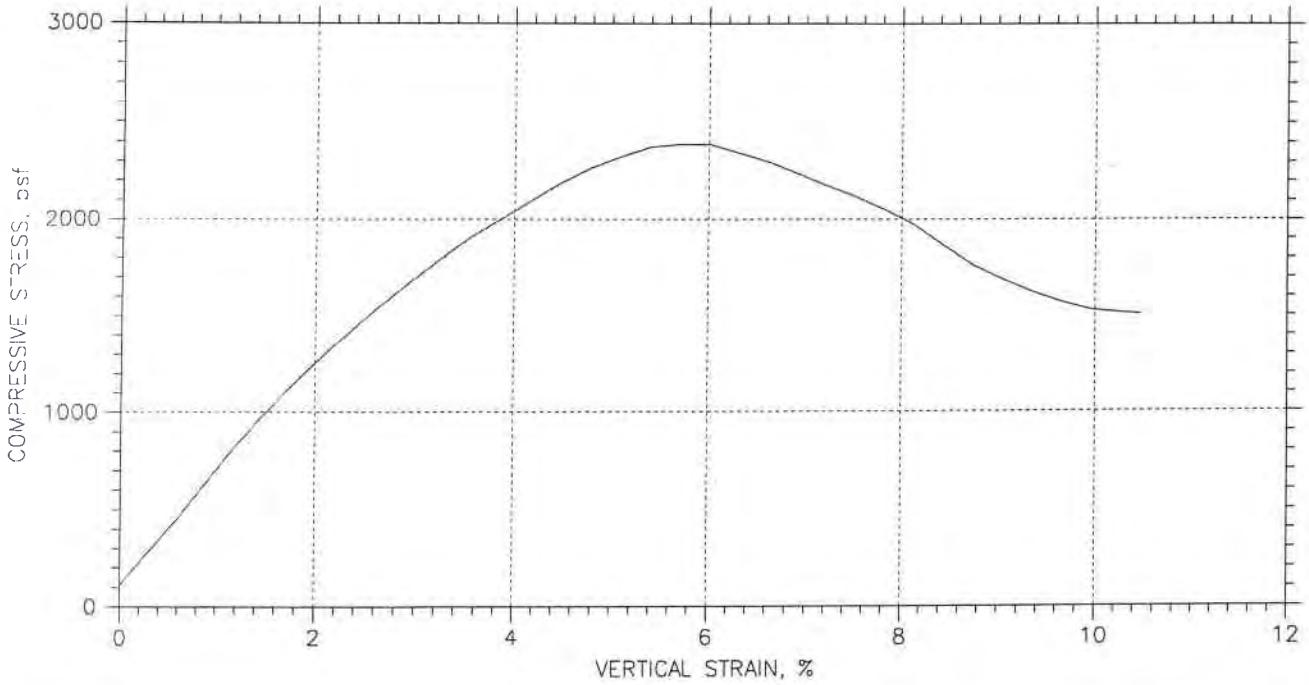


Symbol		◷	△	⊡	
Test No.		9-764A	9-764B	9-764C	
Sample No.		9-764	9-764	9-764	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2.415	2.415	2.415	
	Area, in^2	4.5806	4.5806	4.5806	
	Height, in	1	1	1	
	Water Content, %	31.01	32.43	29.31	
	Dry Density, pcf	94.15	92.57	96.47	
	Saturation, %	108.51	109.19	108.66	
	Void Ratio	0.75721	0.78721	0.7148	
Consol. Height, in		0.99198	0.98958	0.97473	
Consol. Void Ratio		0.74311	0.76859	0.67147	
Final	Water Content, %	31.18	32.35	28.45	
	Dry Density, pcf	94.64	94.	99.94	
	Saturation, %	110.46	112.79	115.04	
	Void Ratio	0.74812	0.75992	0.65533	
Normal Stress, psf		626.6	1020.3	1974.1	
Max. Shear Stress, psf		1191.3	1074.8	1409.2	
Ult. Shear Stress, psf		1018.4	838.03	1390.5	
Time to Failure, min		6.5042	4.504	8.0039	
Disp. Rate, in/min		0.002	0.002	0.002	
Estimated Specific Gravity		2.65	2.65	2.65	
Liquid Limit		0	0	0	
Plastic Limit		0	0	0	
Plasticity Index		0	0	0	

Project: Stewart St Tank
Location: Fortuna
Project No.: 009030
Boring No.: BH11@ 4.5-5
Sample Type: 2.5" Cal br
Description: CLAY
Remarks:

Thu, 21-MAY-2009 14:47:06

UNCONFINED COMPRESSION TEST REPORT

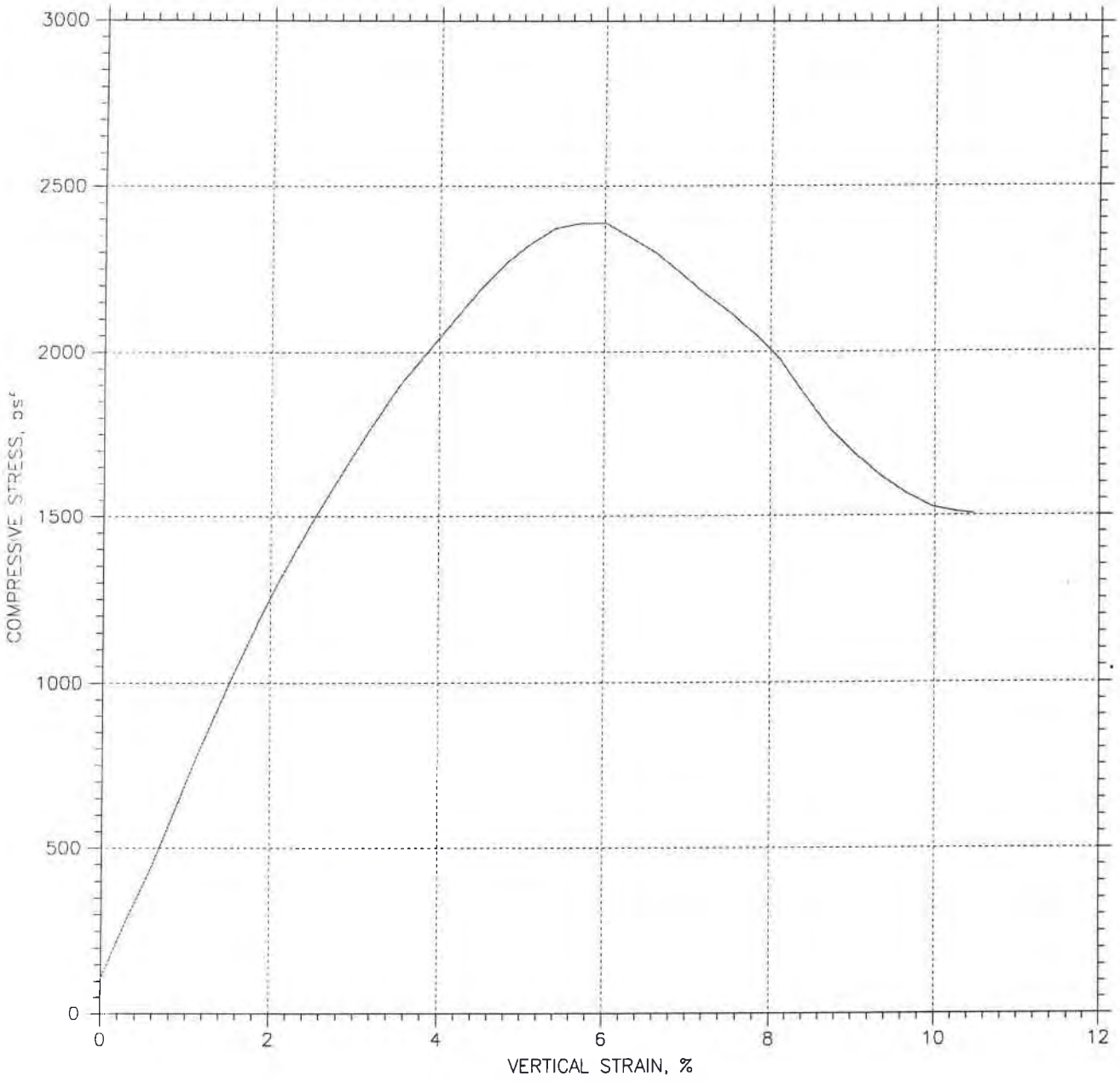


Symbol					
Test No.		9-825			
Initial	Diameter, in	2.42			
	Height, in	4.5			
	Water Content, %	25.82			
	Dry Density, pcf	99.923			
	Saturation, %	104.38			
	Void Ratio	0.65562			
Unconfined Compressive Strength, psf		2386.4			
Undrained Shear Strength, psf		1193.2			
Time to Failure, min		5			
Strain Rate, %/min		1			
Specific Gravity		2.65			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Stewart St. Tank
Location: Fortuna
Project No.: 009030.050
Boring No.: BH11
Sample Type: calbrl
Description: brown CLAY
Remarks: DH 5/26/09

Tue, 26 MAY 2009 14:47:06

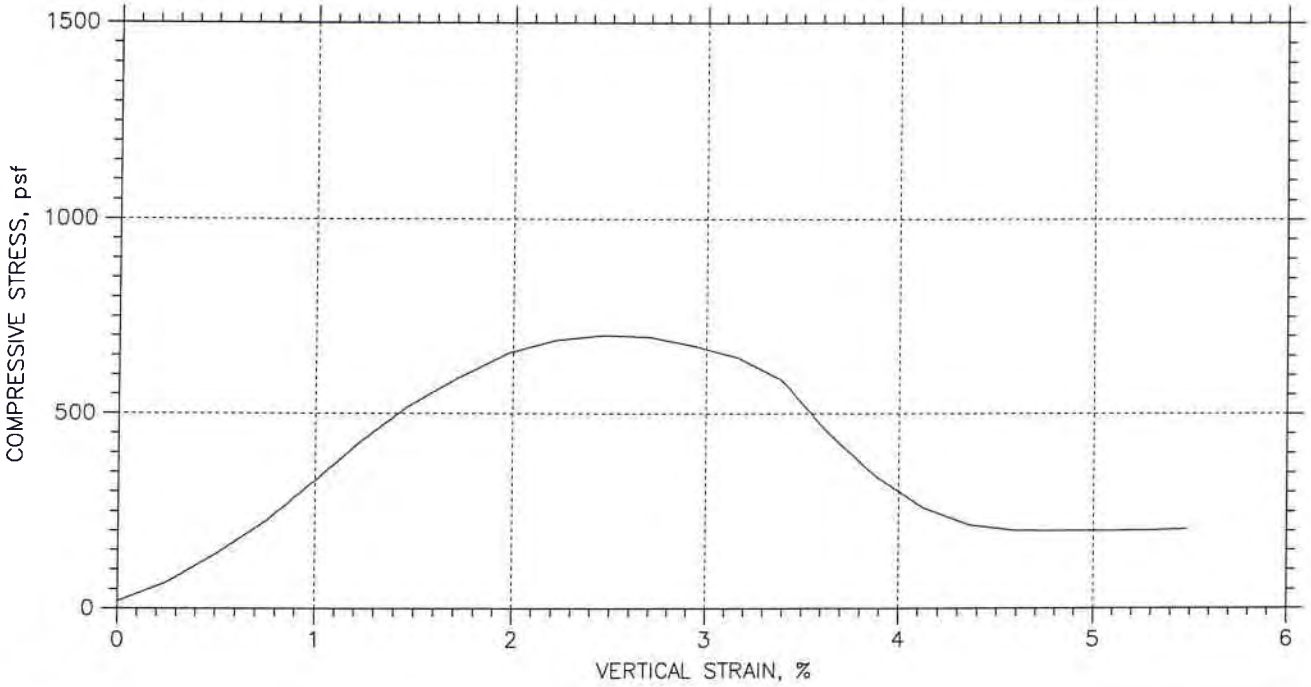
UNCONFINED COMPRESSION TEST REPORT



Project: Stewart St. Tank	Location: Fortuna	Project No.: 009030.050
Boring No.: BH11	Tested By: la	Checked By: DH 5/26/09
Sample No.: 9-825	Test Date: 5/22/09	Depth: 7.5-8.0
Test No.: 9-825	Sample Type: calbrl	Elevation:
Description: brown CLAY		
Remarks:		

Tue, 26-MAY-2009 14:47:06

UNCONFINED COMPRESSION TEST REPORT

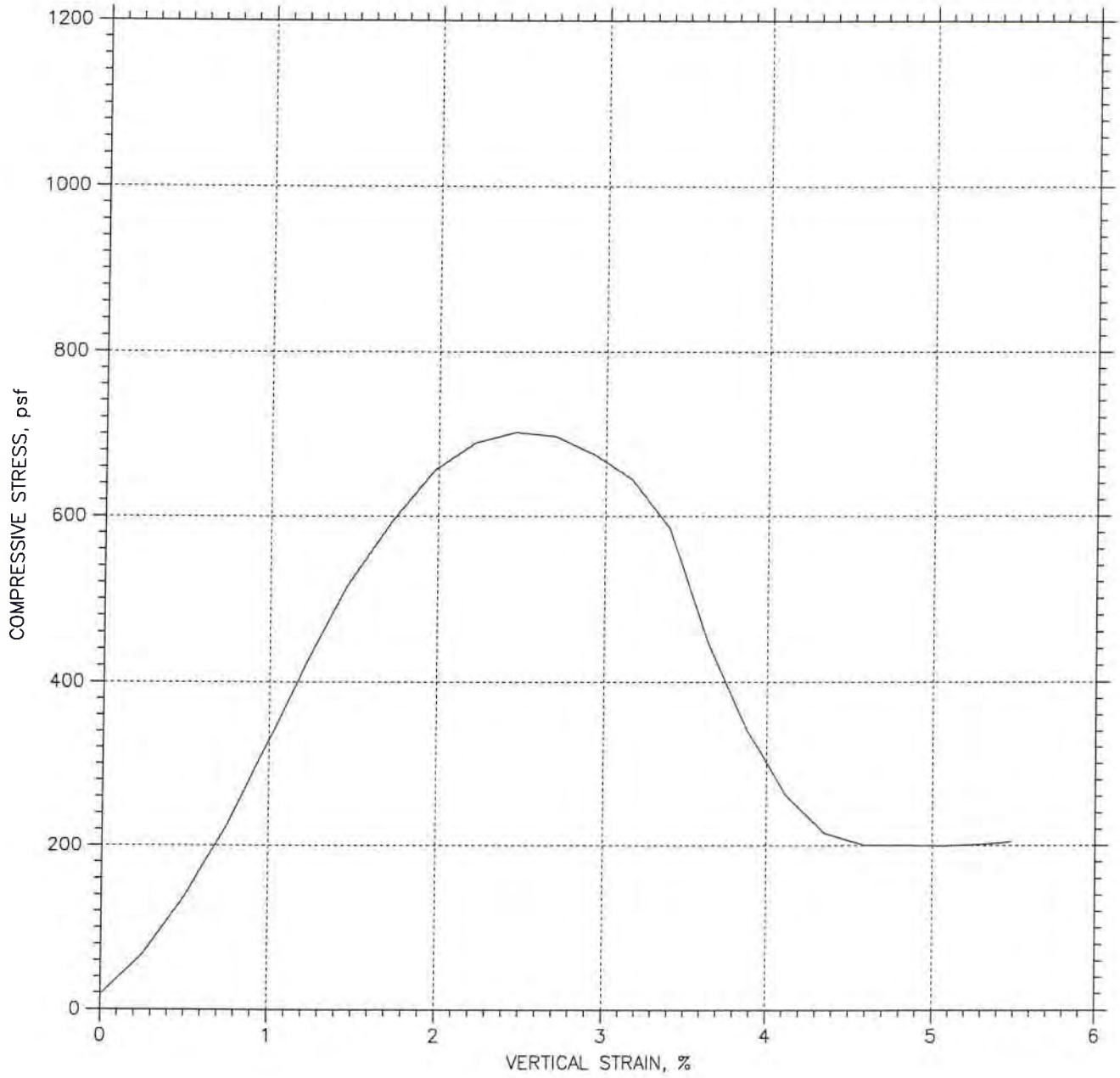


Symbol					
Test No.		9-826			
Initial	Diameter, in	2.42			
	Height, in	5.18			
	Water Content, %	22.82			
	Dry Density, pcf	99.997			
	Saturation, %	92.40			
	Void Ratio	0.6544			
Unconfined Compressive Strength, psf		701.39			
Undrained Shear Strength, psf		350.69			
Time to Failure, min		2.5			
Strain Rate, %/min		1			
Specific Gravity		2.65			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Stewart St. Tank
Location: Fortuna
Project No.: 009030.050
Boring No.: BH11
Sample Type: calbrl
Description: light brownish grey SILT
Remarks: DL 5/26/09

Tue, 26-MAY-2009 11:28:53

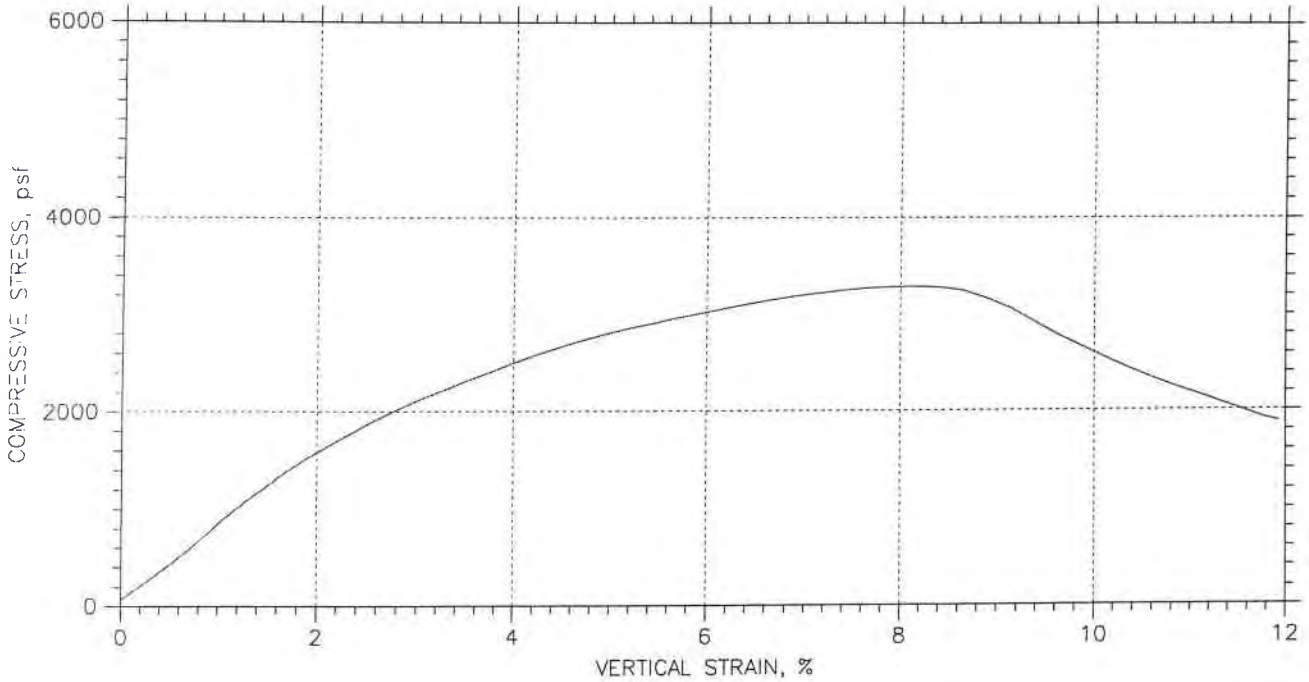
UNCONFINED COMPRESSION TEST REPORT



Project: Stewart St. Tank	Location: Fortuna	Project No.: 009030.050
Boring No.: BH11	Tested By: LA	Checked By: DL 5/26/09
Sample No.: 9-826	Test Date: 5/22/09	Depth: 11-11.5'
Test No.: 9-826	Sample Type: calbrl	Elevation:
Description: light brownish grey SILT		
Remarks:		

Tue, 26-MAY-2009 11:28:53

UNCONFINED COMPRESSION TEST REPORT

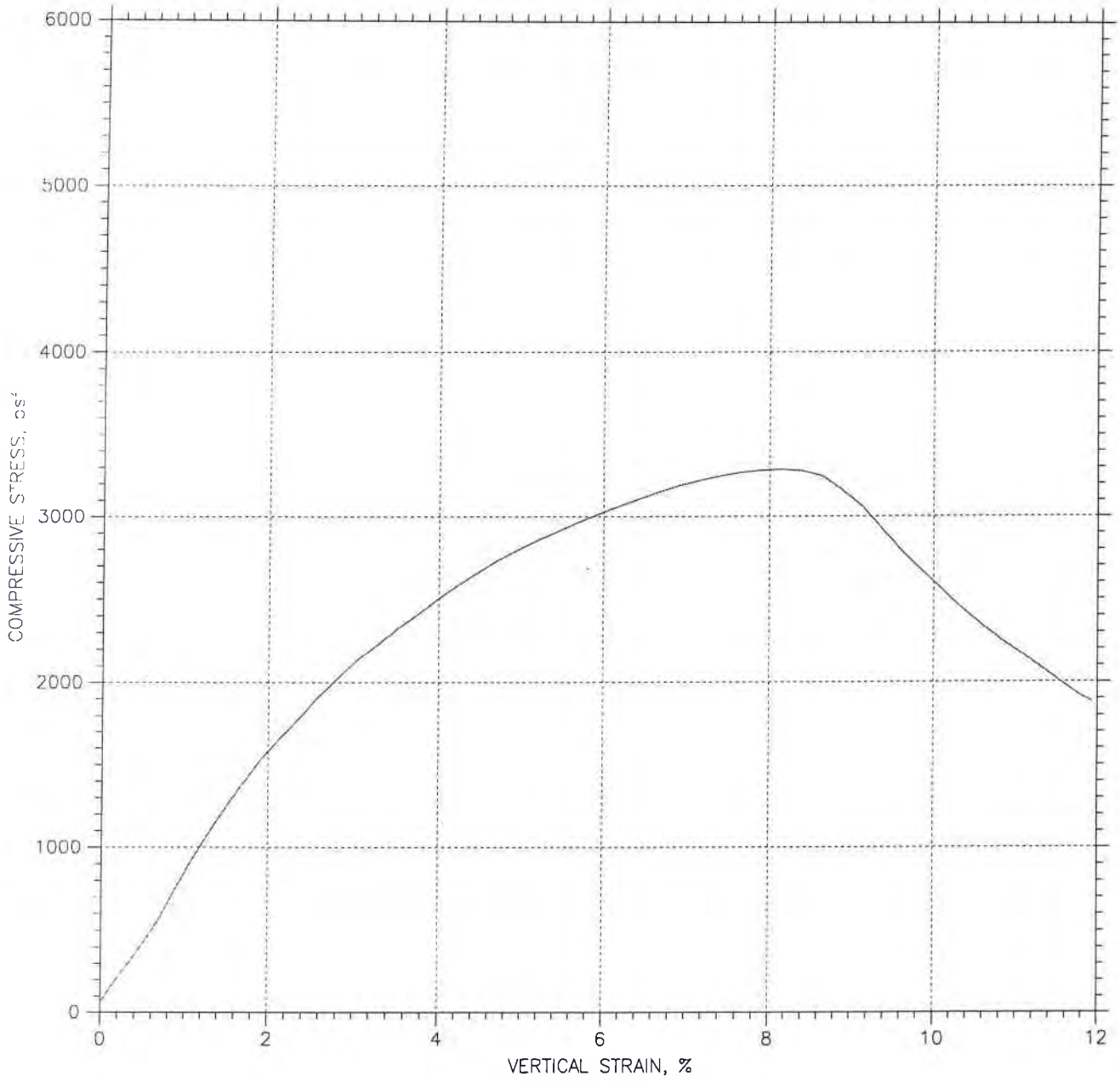


Symbol					
Test No.		9-831			
Initial	Diameter, in	2.4			
	Height, in	5.7			
	Water Content, %	27.11			
	Dry Density, pcf	97.669			
	Saturation, %	103.53			
	Void Ratio	0.69382			
Unconfined Compressive Strength, psf		3285.6			
Undrained Shear Strength, psf		1642.8			
Time to Failure, min		9			
Strain Rate, %/min		1			
Specific Gravity		2.65			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Stewart St Tank
Location: Fortuna
Project No.: 009030.050
Boring No.: BH12
Sample Type: calbrl
Description: yellowish brown CLAY
Remarks: DL 5/26/09

Tue, 26 MAY 2009 14:54:10

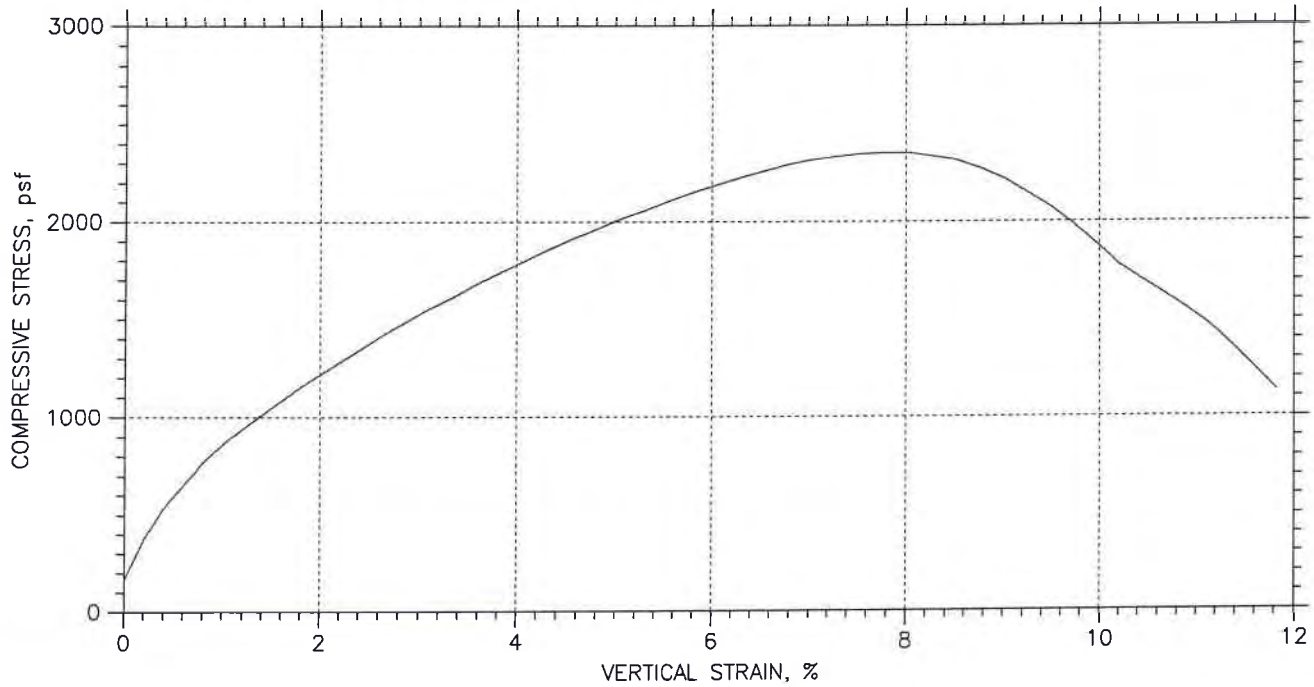
UNCONFINED COMPRESSION TEST REPORT



Project: Stewart St Tank	Location: Fortuna	Project No.: 009030.050
Boring No.: BH12	Tested By: LA	Checked By: DL 5/26/09
Sample No.: 9-831	Test Date: 5/22/09	Depth: 5.5-6.0'
Test No.: 9-831	Sample Type: calbrl	Elevation:
Description: yellowish brown CLAY		
Remarks:		

Tue, 26-MAY-2009 14:54:10

UNCONFINED COMPRESSION TEST REPORT

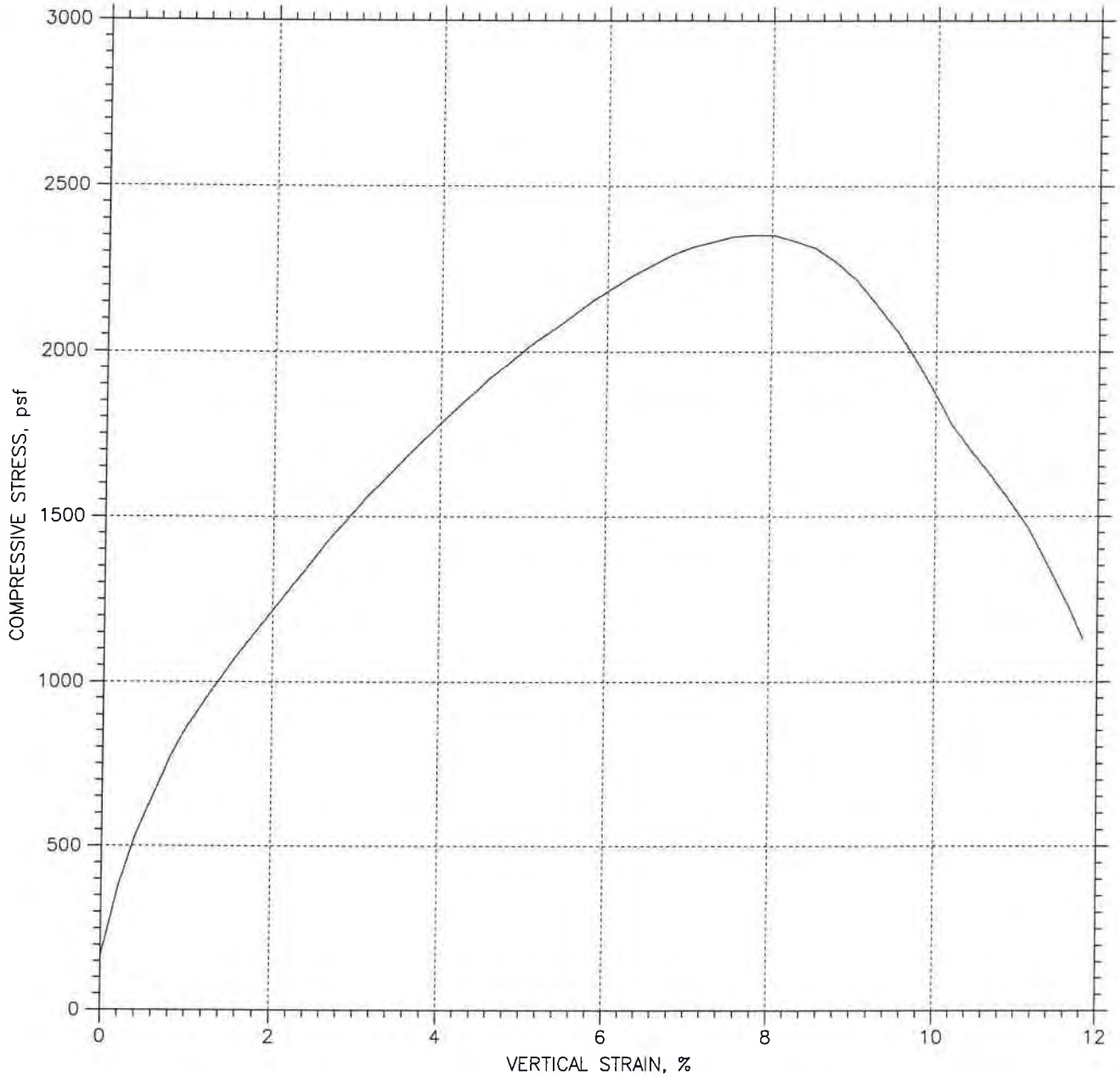


Symbol					
Test No.		9-832			
Initial	Diameter, in	2.4			
	Height, in	5.67			
	Water Content, %	27.45			
	Dry Density, pcf	97.755			
	Saturation, %	105.08			
	Void Ratio	0.69233			
Unconfined Compressive Strength, psf		2352.8			
Undrained Shear Strength, psf		1176.4			
Time to Failure, min		8.2503			
Strain Rate, %/min		1			
Specific Gravity		2.65			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Stewart St Tank
Location: Fortuna
Project No.: 009030.050
Boring No.: BH 12
Sample Type: calbrl
Description: yellowish brown CLAY
Remarks: DL 5/26/09

Tue, 26-MAY-2009 11:30:40

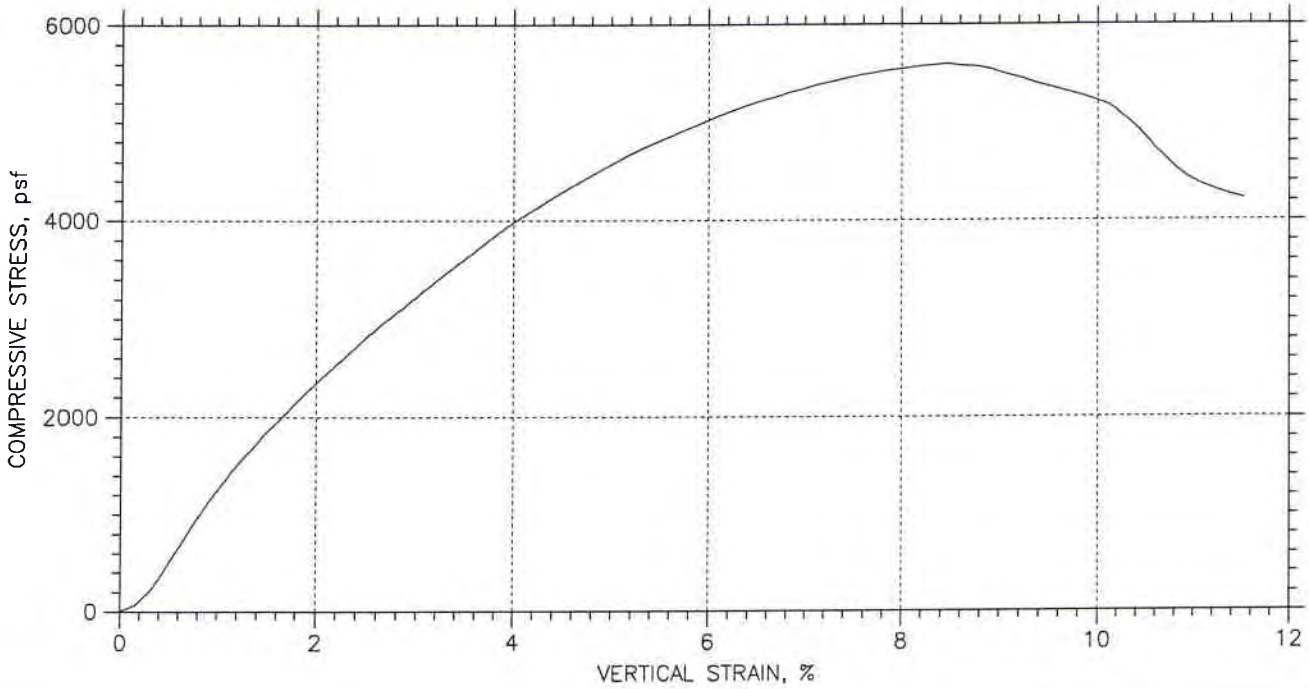
UNCONFINED COMPRESSION TEST REPORT



Project: Stewart St Tank	Location: Fortuna	Project No.: 009030.050
Boring No.: BH 12	Tested By: LA	Checked By: DL 5/26/09
Sample No.: 9-832	Test Date: 5/22/09	Depth: 8.5-9'
Test No.: 9-832	Sample Type: calbrl	Elevation:
Description: yellowish brown CLAY		
Remarks:		

Tue, 26-MAY-2009 11:30:40

UNCONFINED COMPRESSION TEST REPORT

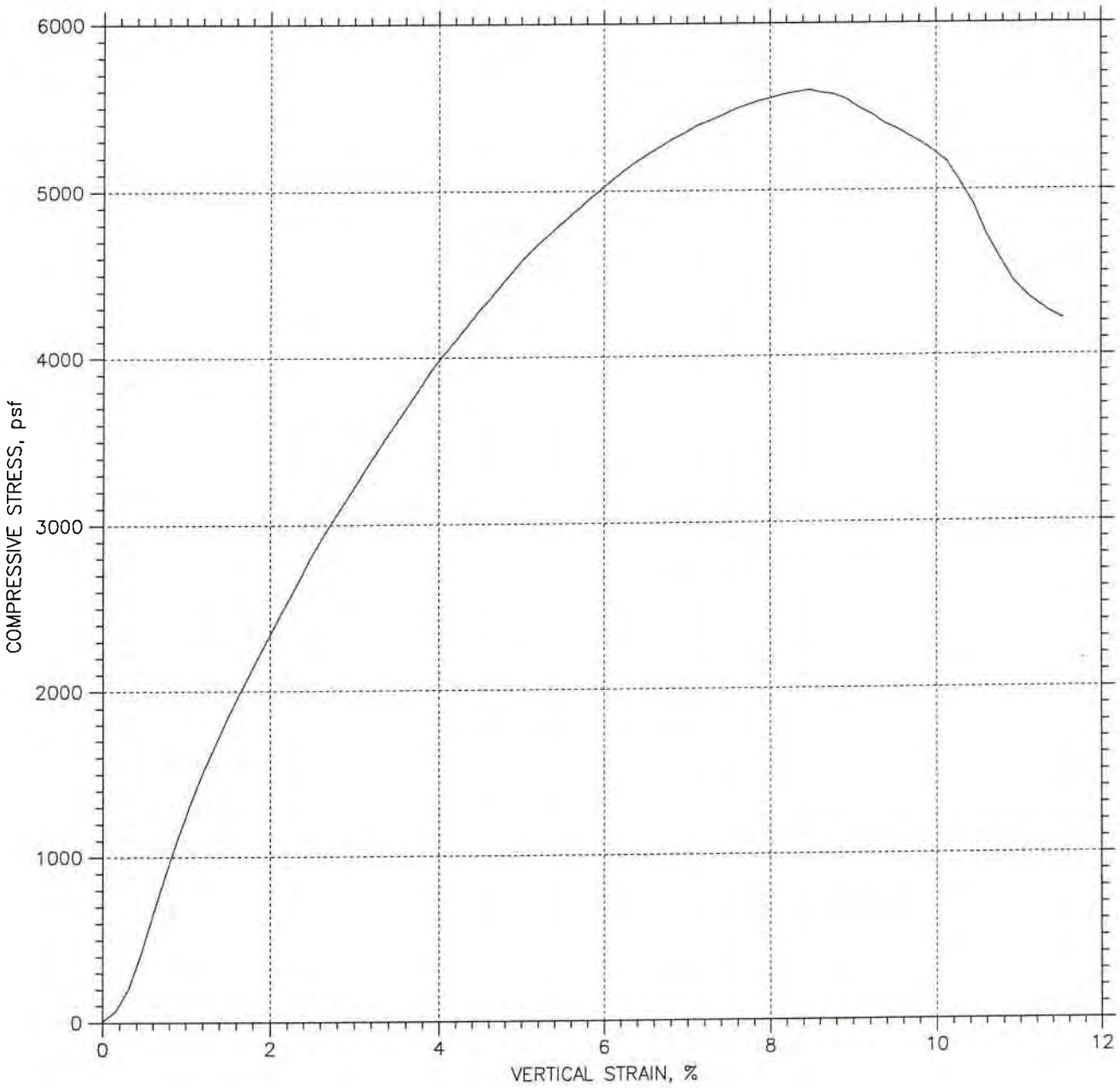


Symbol					
Test No.		9-837			
Initial	Diameter, in	2.4			
	Height, in	3.78			
	Water Content, %	25.14			
	Dry Density, pcf	100.12			
	Saturation, %	102.13			
	Void Ratio	0.65241			
Unconfined Compressive Strength, psf		5598.3			
Undrained Shear Strength, psf		2799.1			
Time to Failure, min		14.25			
Strain Rate, %/min		1			
Specific Gravity		2.65			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Stewart St Tank
Location: Fortuna
Project No.: 009030.050
Boring No.: BH 13
Sample Type: calbrl
Description: yellowish brown CLAY
Remarks: Sample height did not meet length/diameter ratio DL 5/26/09

Tue, 26-MAY-2009 14:36:50

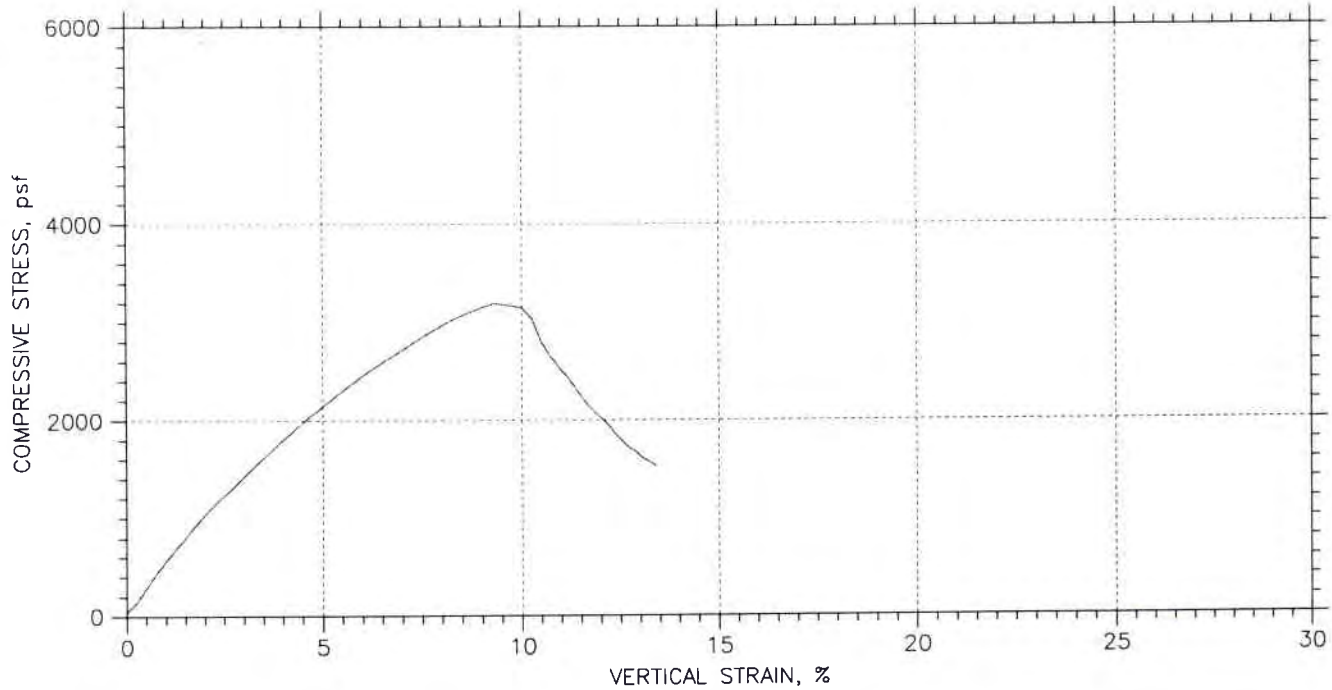
UNCONFINED COMPRESSION TEST REPORT



Project: Stewart St Tank	Location: Fortuna	Project No.: 009030.050
Boring No.: BH 13	Tested By: LA	Checked By: DH 5/26/09
Sample No.: 9-837	Test Date: 5/22/09	Depth: 8-8.5
Test No.: 9-837	Sample Type: calbrl	Elevation:
Description: yellowish brown CLAY		
Remarks: Sample height did not meet length/diameter ratio		

Tue, 26-MAY-2009 14:36:50

UNCONFINED COMPRESSION TEST REPORT

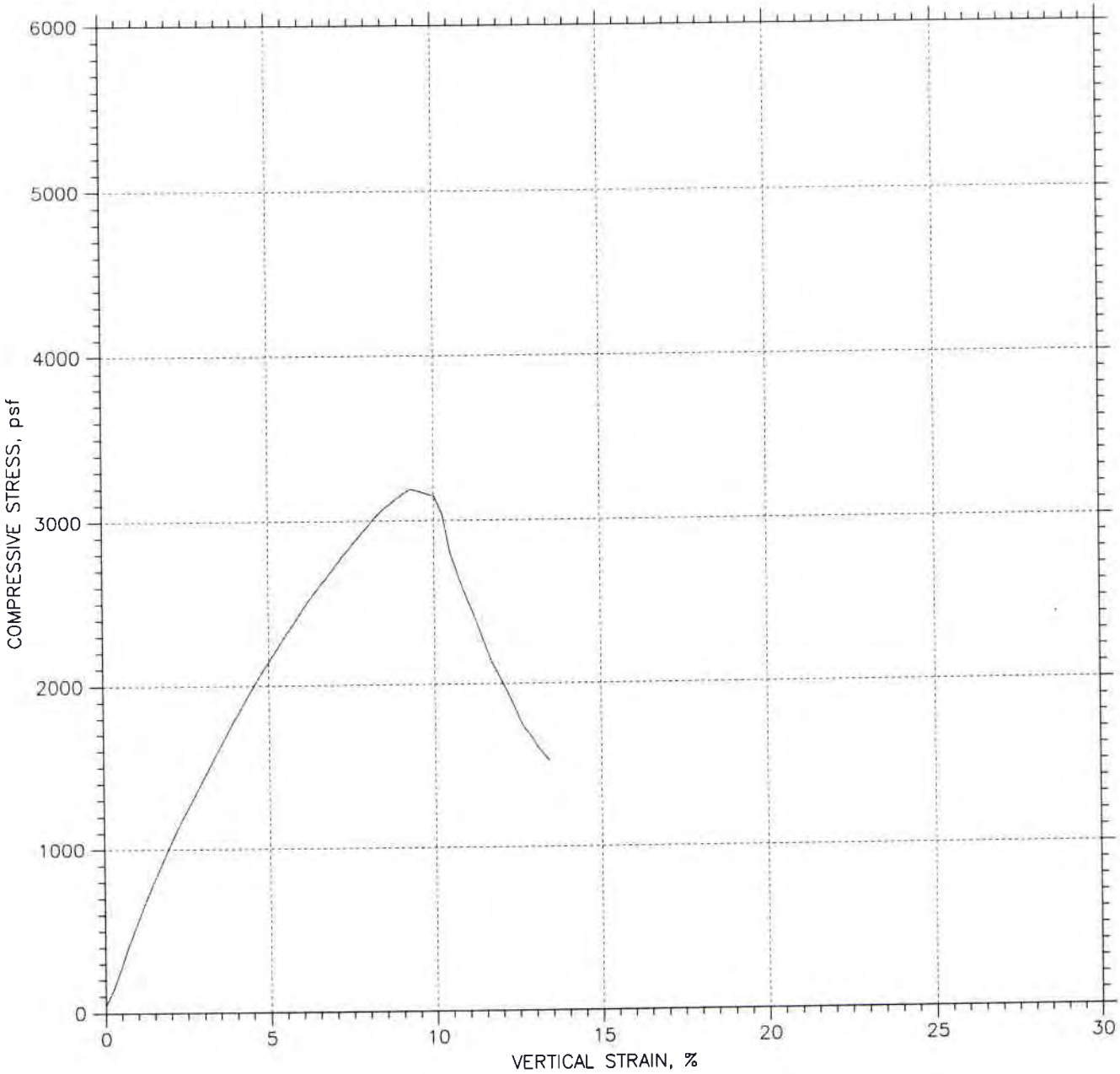


Symbol					
Test No.		9-756			
Initial	Diameter, in	2.42			
	Height, in	5.31			
	Water Content, %	27.51			
	Dry Density, pcf	98.207			
	Saturation, %	106.48			
	Void Ratio	0.68454			
Unconfined Compressive Strength, psf		3191.2			
Undrained Shear Strength, psf		1595.6			
Time to Failure, min		9.75			
Strain Rate, %/min		1			
Specific Gravity		2.65			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Stewart St Tank
Location: Fortuna
Project No.: 009030
Boring No.: BH10 @13'
Sample Type: 2.5" Calbrl
Description: Strong Brown Clay
Remarks:

Thu. 14-MAY-2009 09:44:10

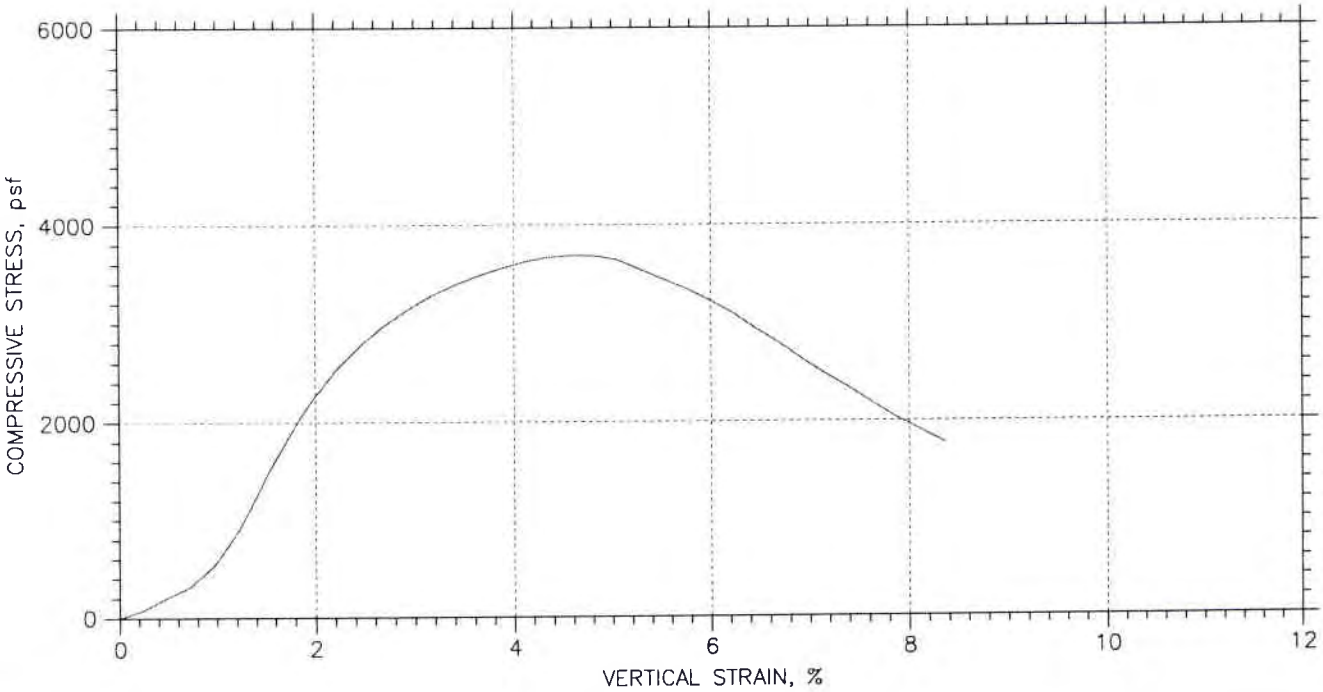
UNCONFINED COMPRESSION TEST REPORT



Project: Stewart St Tank	Location: Fortuna	Project No.: 009030
Boring No.: BH10 @13'	Tested By: JMA	Checked By:
Sample No.: 9-756	Test Date: 5/8/09	Depth: 13-13.5
Test No.: 9-756	Sample Type: 2.5" Calbrl	Elevation:
Description: Strong Brown Clay		
Remarks:		

Thu, 14-MAY-2009 09:44:11

UNCONFINED COMPRESSION TEST REPORT

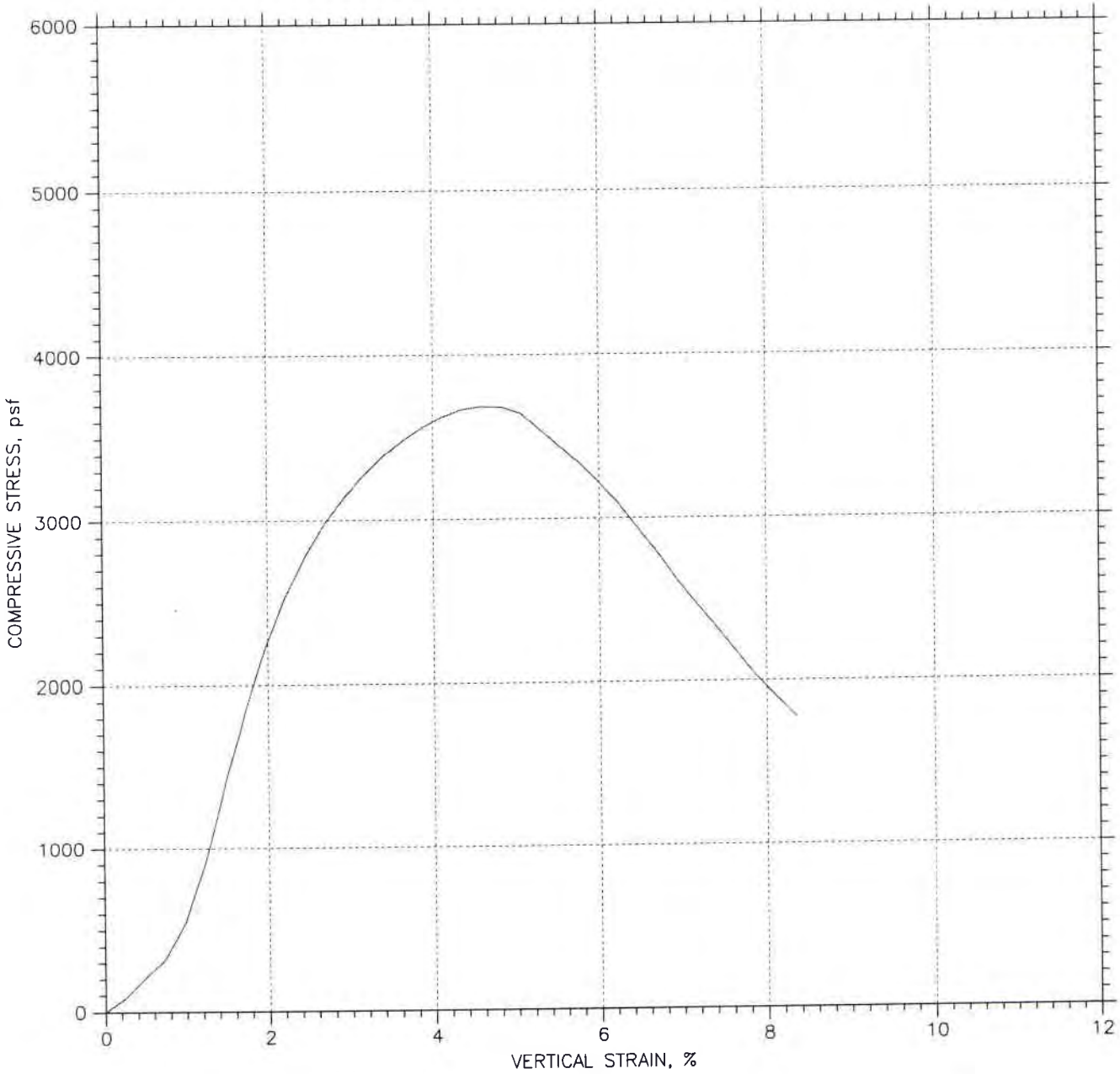


Symbol					
Test No.		9-758			
Initial	Diameter, in	2.42			
	Height, in	5.26			
	Water Content, %	36.85			
	Dry Density, pcf	85.176			
	Saturation, %	103.65			
	Void Ratio	0.94225			
Unconfined Compressive Strength, psf		3684.5			
Undrained Shear Strength, psf		1842.3			
Time to Failure, min		4.7537			
Strain Rate, %/min		1			
Specific Gravity		2.65			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Stewart St Tank
Location: Fortuna
Project No.: 009030
Boring No.: BH10 @16.5
Sample Type: 2.5" Calbrl
Description: Strong Brown Clay
Remarks:

Thu, 14-MAY-2009 09:46:30

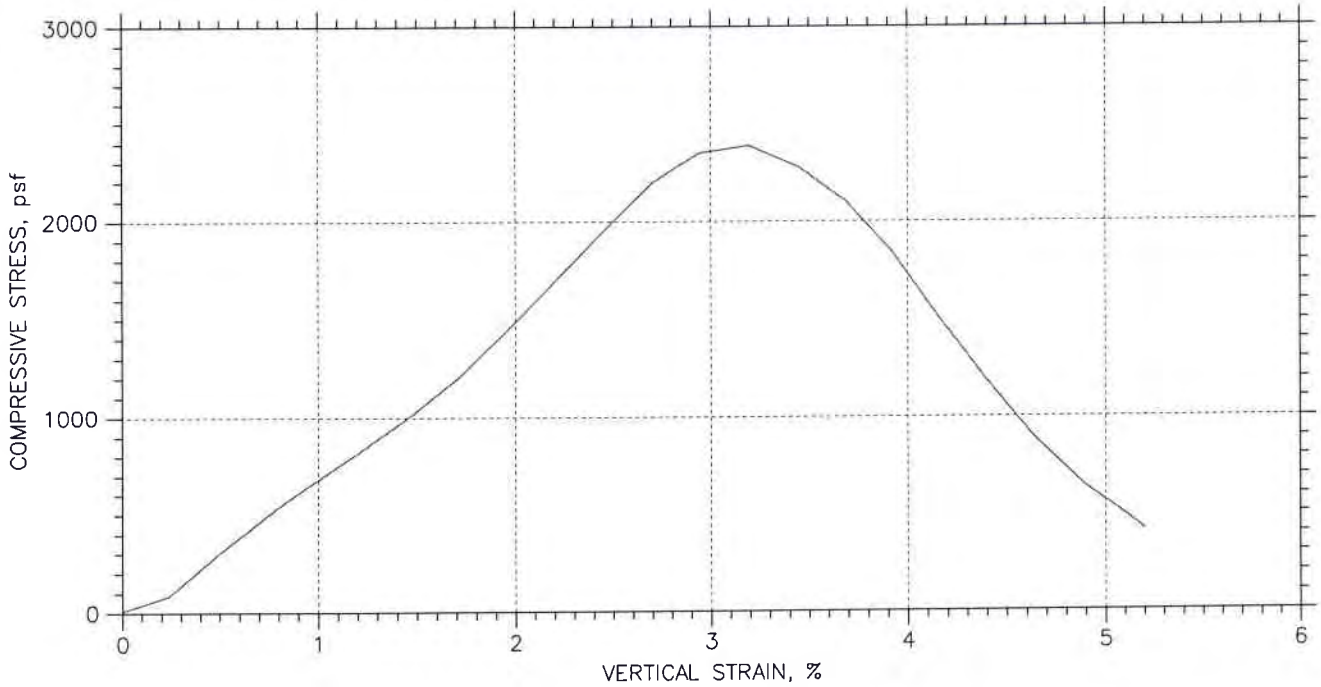
UNCONFINED COMPRESSION TEST REPORT



Project: Stewart St Tank	Location: Fortuna	Project No.: 009030
Boring No.: BH10 @16.5	Tested By: JMA	Checked By:
Sample No.: 9-758	Test Date: 5/8/09	Depth: 16.5-17.0
Test No.: 9-758	Sample Type: 2.5" Calbrl	Elevation:
Description: Strong Brown Clay		
Remarks:		

Thu, 14-MAY-2009 09:46:32

UNCONFINED COMPRESSION TEST REPORT



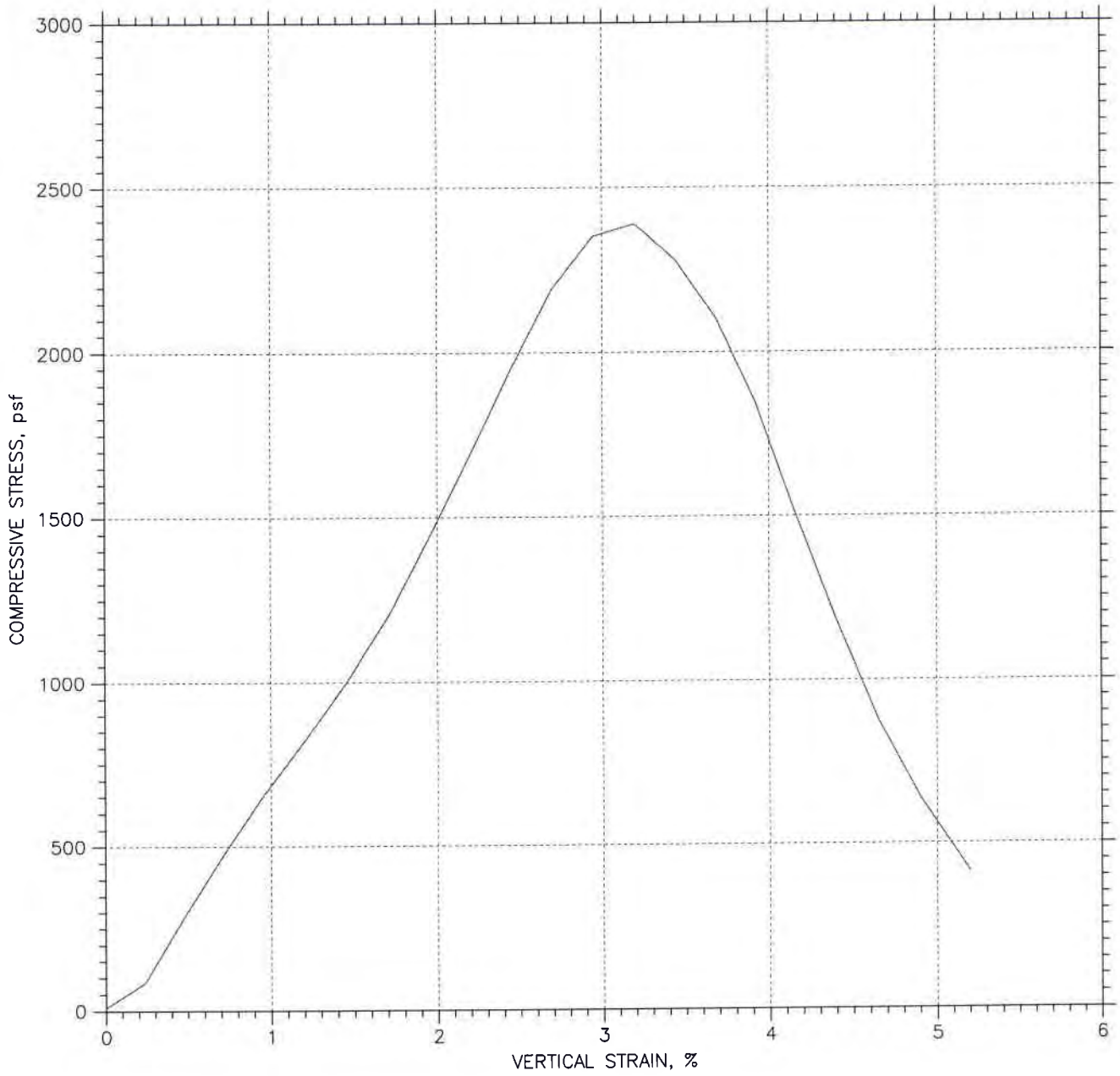
Symbol					
Test No.		9-760			
Initial	Diameter, in	2.42			
	Height, in	5.35			
	Water Content, %	10.55			
	Dry Density, pcf	120.57			
	Saturation, %	75.16			
	Void Ratio	0.37213			
Unconfined Compressive Strength, psf		2389.1			
Undrained Shear Strength, psf		1194.5			
Time to Failure, min		3.2518			
Strain Rate, %/min		1			
Specific Gravity		2.65			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

ROCKS IN SAMPLE

Project: Stewart St Tank
Location: Fortuna
Project No.: 009030
Boring No.: BH10 @25.5
Sample Type: 2.5" Calbrl
Description: Gravel
Remarks:

Wed, 20-MAY-2009 10:59:19

UNCONFINED COMPRESSION TEST REPORT



Project: Stewart St Tank	Location: Fortuna	Project No.: 009030
Boring No.: BH10 @25.5	Tested By: JMA	Checked By:
Sample No.: 9-760	Test Date: 5/14/09	Depth: 25.5-26
Test No.: 9-760	Sample Type: 2.5" Calbrl	Elevation:
Description: Gravel		
Remarks:		

Wed, 20-MAY-2009 10:59:19

Appendix B

Water Table Elevations

Table B-1
Depth to Groundwater Measurement Results
Stuart Street Tank Site, Fortuna, California

Sample Location	Depth of Casing (feet)	Depth to Water[1] (feet)				
		6/9/2008	3/6/2009	4/21/2009	4/29/2009	5/26/2009
P-1	10	7.30	1.20	4.10	5.80	5.30
P-2	10	7.05	5.30	6.40	6.40	6.35
P-3	10	9.40	6.40	9.80	8.75	8.50
P-4	10	5.20	0.15	2.50	3.20	3.65
B1	10	5.90	2.40	3.80	3.30	3.60
B2	10	5.80	1.45	4.00	4.10	4.95
B3	10	5.40	0.10	2.40	3.20	3.20
B4	10	6.10	1.80	5.10	5.50	5.60
B5	10	3.70	1.00	3.20	3.75	3.75
B6	10	4.20	2.90	3.30	3.70	3.80
B7	10	6.70	5.50	6.90	7.00	6.50
B8	10	7.90	4.40	7.10	7.30	7.50
BH-5	10	8.05	2.80	5.80	6.10	6.75
BH-11	35	n/a	n/a	n/a	dry	dry
BH-12	35	n/a	n/a	n/a	33.00	dry

1. Feet below adjacent ground surface

Appendix C

Stability Analysis

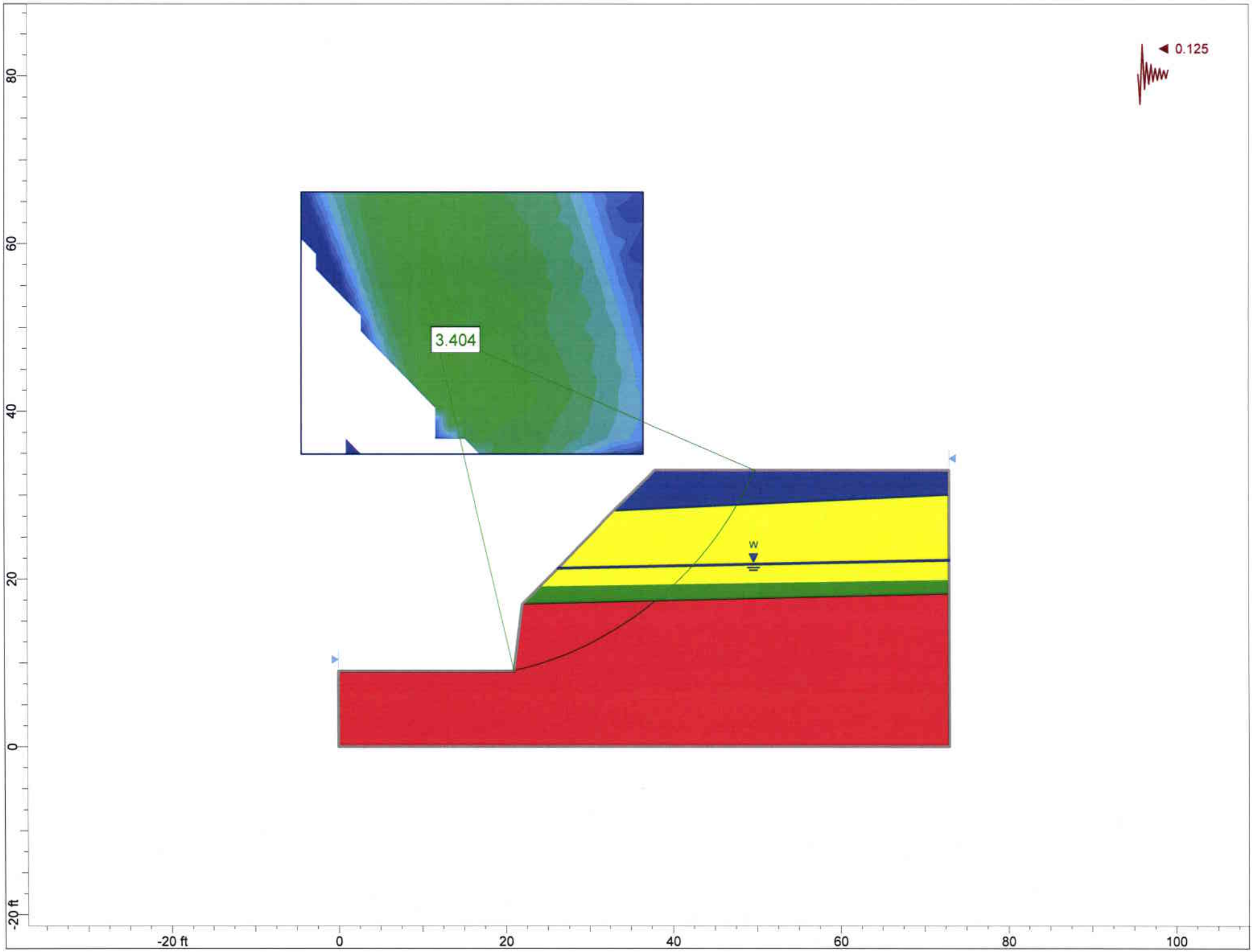
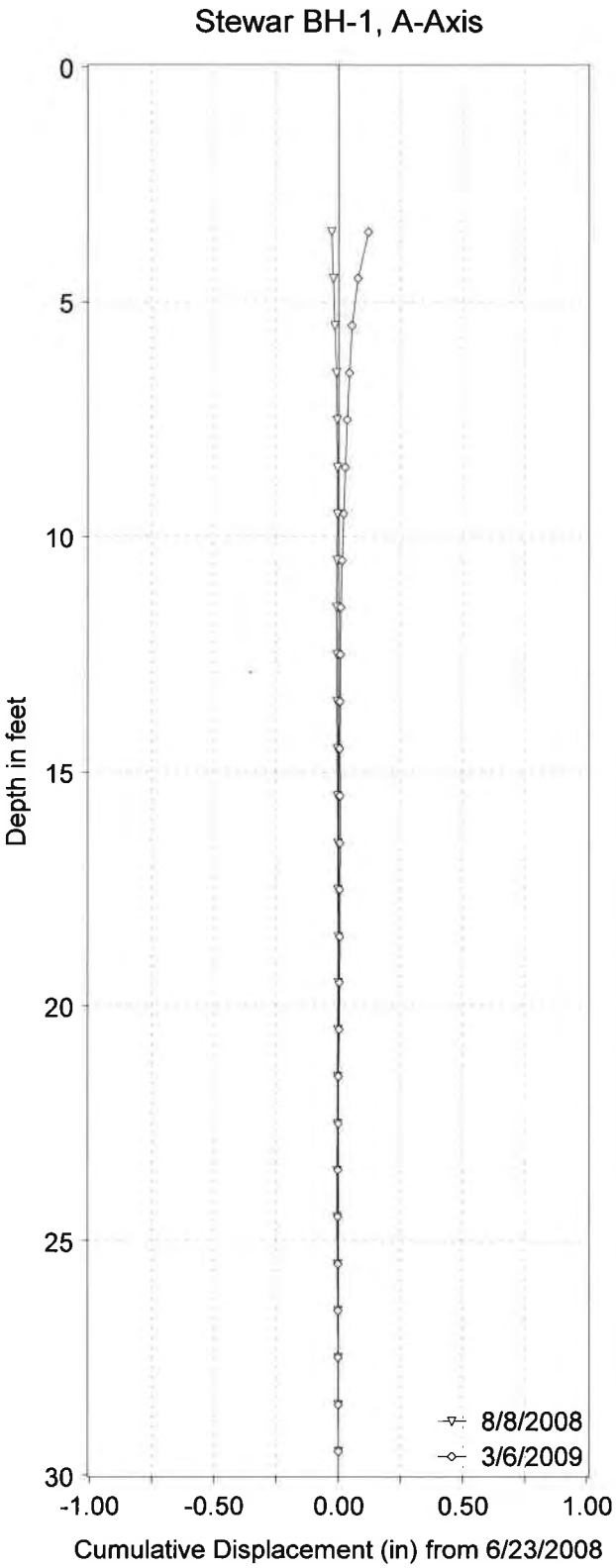
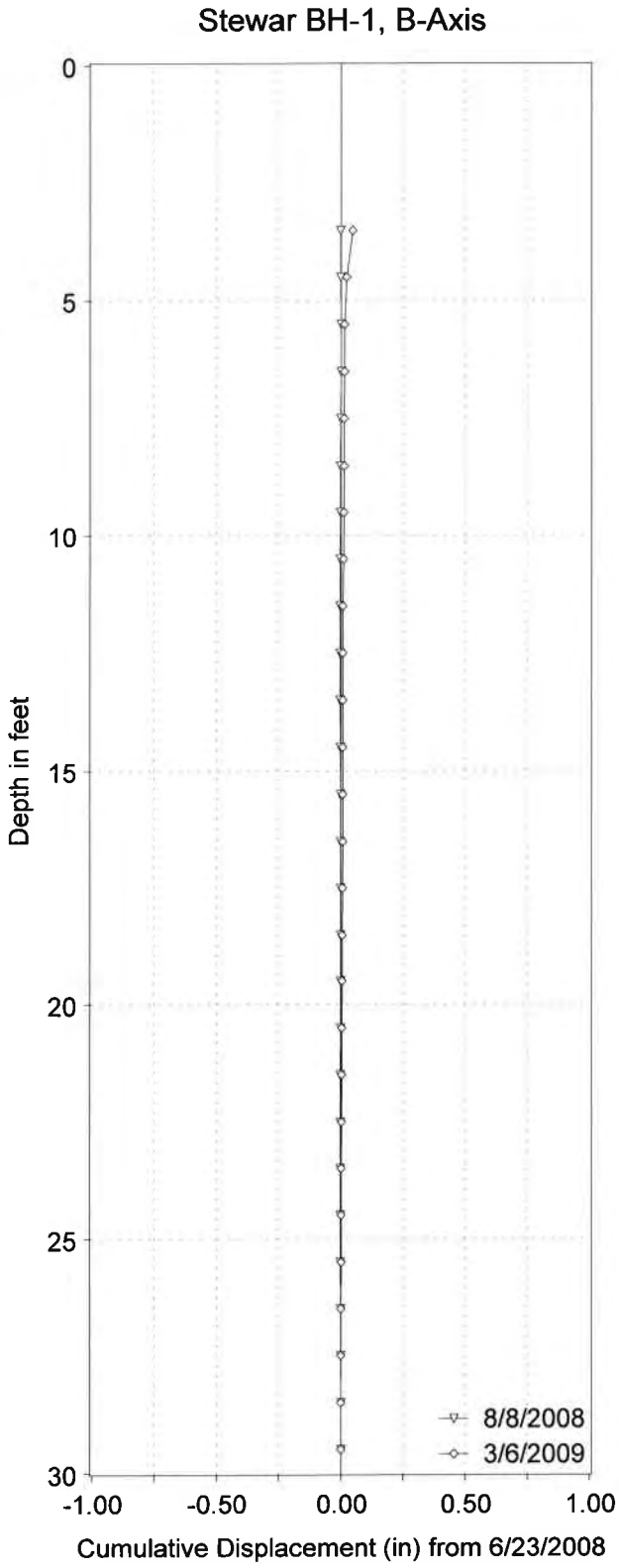

0.125
3.404
w
80
60
40
20
0
-20 ft
-20 ft
0
20
40
60
80
100

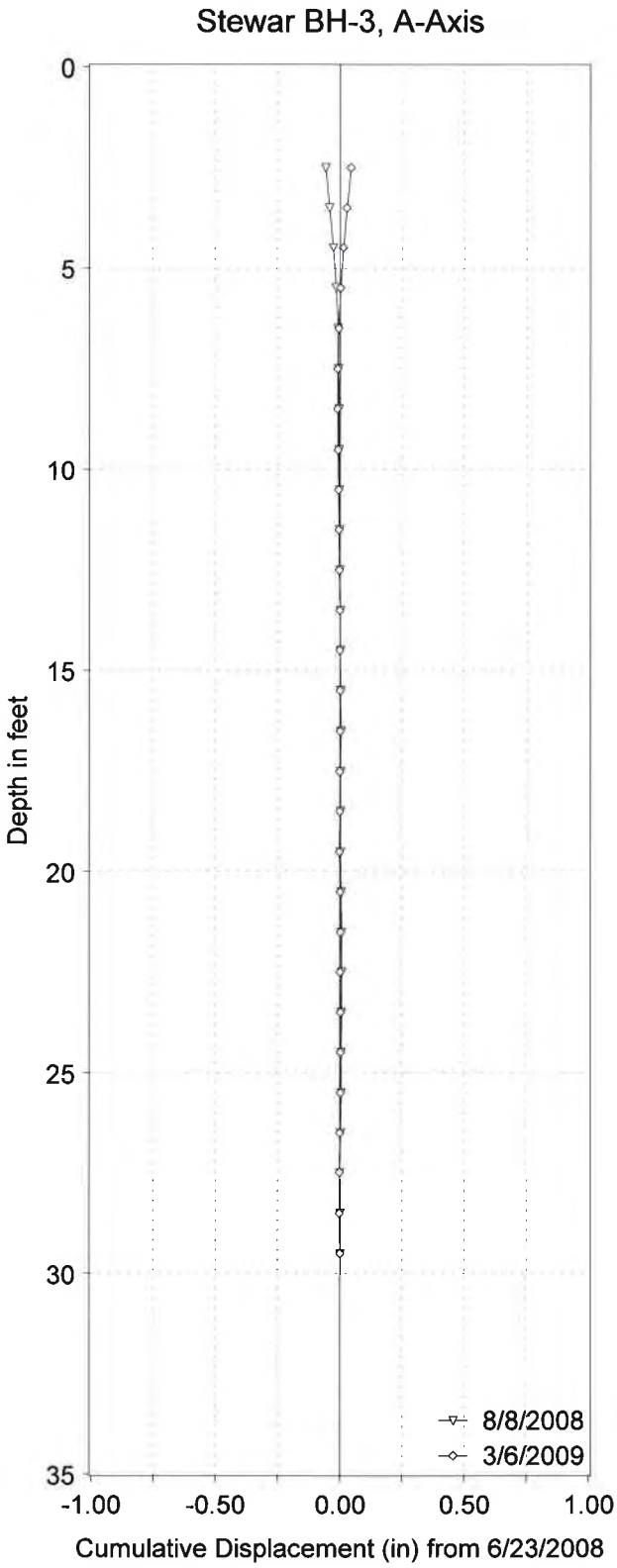
Table C-1
Steward Street Reservoirs Replacement Stability Analysis

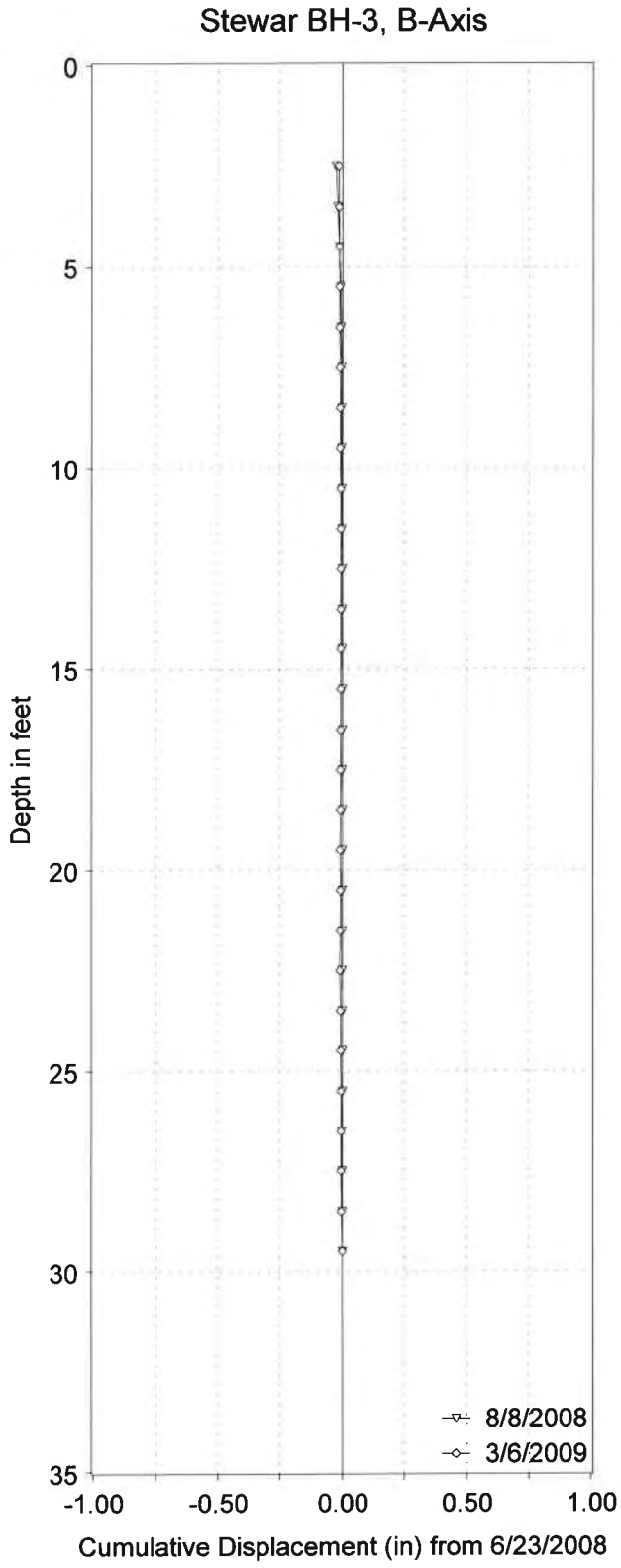
Soil Strata	Unit Weight Unsaturated (lb/ft^3)	Cohesion (psf)	Friction Angle (degrees)
Low Strength CLAY, Silty, Sandy[1]	110	500	11
CLAY, Silty, Sandy with Perched Ground Water[2]	125	1500	20
CLAY[3]	115	2500	8
High Strength SAND, Clayey, Gravelly[4]	135	2000	40

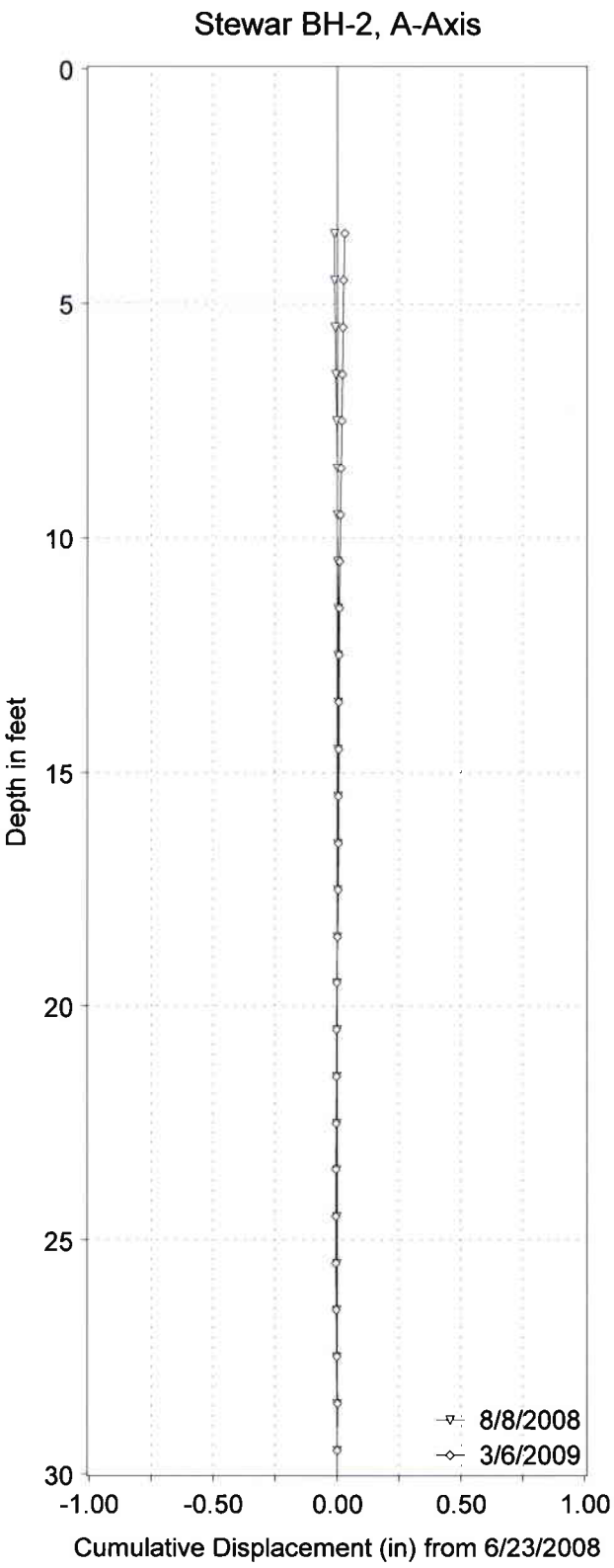
1. Blue
2. Yellow
3. Green
4. Red

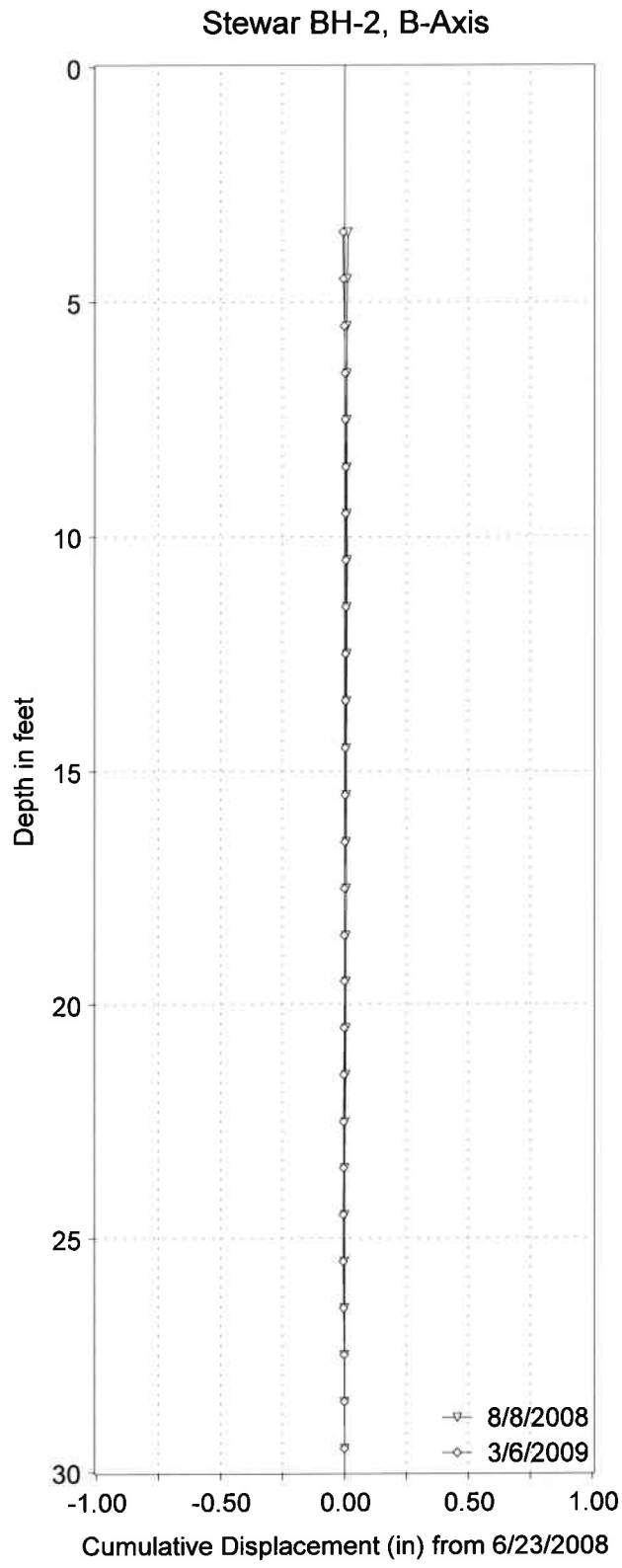

Stewar BH-1, A-Axis
Depth in feet
0
5
10
15
20
25
30
-1.00
-0.50
0.00
0.50
1.00
Cumulative Displacement (in) from 6/23/2008
8/8/2008
3/6/2009


Stewar BH-1, B-Axis
Depth in feet
0
5
10
15
20
25
30
-1.00
-0.50
0.00
0.50
1.00
Cumulative Displacement (in) from 6/23/2008
8/8/2008
3/6/2009


Stewar BH-3, A-Axis
Depth in feet
0
5
10
15
20
25
30
35
-1.00
-0.50
0.00
0.50
1.00
Cumulative Displacement (in) from 6/23/2008
8/8/2008
3/6/2009


Stewar BH-3, B-Axis
Depth in feet
0
5
10
15
20
25
30
35
-1.00
-0.50
0.00
0.50
1.00
Cumulative Displacement (in) from 6/23/2008
8/8/2008
3/6/2009


Stewar BH-2, A-Axis
Depth in feet
0
5
10
15
20
25
30
-1.00
-0.50
0.00
0.50
1.00
Cumulative Displacement (in) from 6/23/2008
8/8/2008
3/6/2009


Stewar BH-2, B-Axis
Depth in feet
0
5
10
15
20
25
30
-1.00
-0.50
0.00
0.50
1.00
Cumulative Displacement (in) from 6/23/2008
8/8/2008
3/6/2009