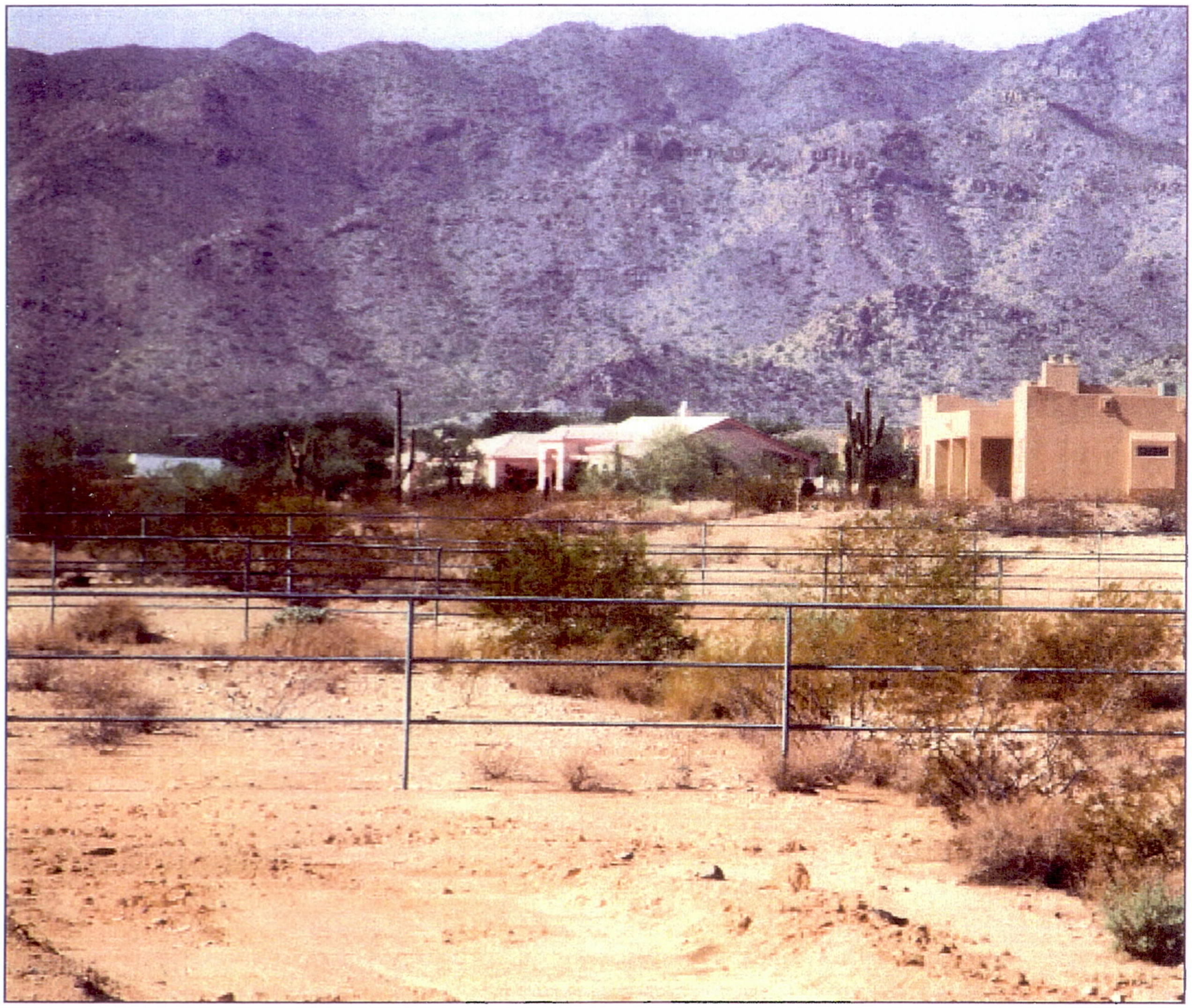
White Tanks FRS No. 3
Outfall Channel Final Design

FCD 2009C012 - GEOTECHNICAL REPORT



Prepared for:

Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, AZ 85009
(602) 506.1501

August 4, 2010

Prepared by:

Alpha Geotechnical & Materials, Inc.

In association with:

Hoskin • Ryan Consultants, Inc.

White Tanks FRS No. 3
Outfall Channel Final Design
FCD 2009C012 - GEOTECHNICAL REPORT

Prepared for:
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, AZ 85009
(602) 506.1501

August 4, 2010

Prepared by:
Alpha Geotechnical & Materials, Inc.

In association with:
Hoskin • Ryan Consultants, Inc.

GEOTECHNICAL EXPLORATION
WHITE TANKS FRS NO.3 OUTFALL CHANNEL
BETWEEN WHITE TANK FRS NO.3 AND WHITE TANKS FRS NO.4
MARICOPA COUNTY, ARIZONA
FCD 2009C012

AUGUST 4, 2010

Prepared for:
Flood Control District of Maricopa County

Prepared by:
Alpha Geotechnical & Materials, Inc.
2504 W. Southern Avenue
Tempe, Arizona 85282

In Association with
Hoskin Ryan Consultants, Inc.
201 W. Indian School Road
Phoenix, AZ 85013

Job # 09-G-1597

Registered Professional Engineer (Civil)
CERTIFICATE NO.
39511
ARMANDO
ORTEGA
Date Signed 8/4/10
ARIZONA, U.S.A.

Expires 9/30/2012

Alpha
Geotechnical & Materials, Inc.

August 4, 2010
Alpha Project #09-G-1597

Hoskin Ryan Consultants, Inc.
201 W. Indian School Road
Phoenix, AZ 85013

Attention: Mr. Paul W. R. Hoskin, P.E.

RE: GEOTECHNICAL EXPLORATION
White Tanks FRS NO.3 Outfall Channel
Between White Tank FRS NO.3 and White Tanks FRS NO.4
Maricopa County, Arizona

Dear Mr. Hoskin:

In accordance with your request and authorization, Alpha Geotechnical & Materials, Inc. (Alpha) has performed a geotechnical subsurface exploration for the proposed White Tanks FRS No. 3 Outfall Channel located between White Tank FRS No.3 and White Tank FRS No.4 in Maricopa County, Arizona. The purpose of this report is to provide recommendations relative to the geotechnical aspects of design and construction for the above referenced project. The recommendations contained within this report are dependent on the provisions provided in the Limitations and Recommended Additional Services sections of this report.

Based on our findings, the site is considered suitable for the proposed construction using conventional grading and construction techniques. Specific recommendations regarding the geotechnical aspects of project design and construction are presented in the following report.

We appreciate the opportunity of providing our services for this project. If you have questions regarding this report or if we may be of further assistance, please contact the undersigned.

Sincerely,
ALPHA GEOTECHNICAL & MATERIALS, INC.

Registered Professional Engineer (Civil) CERTIFICATE NO. 45609 JAMES P. FLOYD Date Signed 8/4/10 ARIZONA, U.S.A.
Expires 9/30/2011

Registered Professional Engineer (Civil) CERTIFICATE NO. 39511 ARMANDO ORTEGA Date Signed 8/4/10 ARIZONA, U.S.A.
Expires 9/30/2012

James P Floyd, P.E.
Project Manager

Armando Ortega, P.E.
Vice-President, Engineering

Dist: Addressee (3)

TABLE OF CONTENTS

Registered Professional Engineer (Civil)
CERTIFICATE NO. 39511
ARMANDO ORTEGA
Date Signed 8/4/10
ARIZONA, U.S.A.
Expires 9/30/2012

Registered Professional Engineer (Civil)
CERTIFICATE NO. 39511
ARMANDO ORTEGA
Date Signed 8/4/10
ARIZONA, U.S.A.
Expires 9/30/2012

Registered Professional Engineer (Civil)
CERTIFICATE NO. 39511
ARMANDO ORTEGA
Date Signed 8/4/10
ARIZONA, U.S.A.
Expires 9/30/2012

1 INTRODUCTION

1.1 General

Alpha Geotechnical and Materials, Inc., and Geological Consultants, Inc. in association with Hoskin-Ryan Consultants, Inc., have been contracted by the Flood Control District of Maricopa County (District) to prepare a Geotechnical Report for the White Tanks FRS No. 3 (FRS#3) Outfall Channel project. The District is in the process of performing rehabilitation to FRS#3, including a new principal outlet that discharges adjacent to the Beardsley Canal. The project provides a channel along the Jackrabbit Trail corridor, to convey the principal outlet flows from FRS#3 to FRS#4 (Figure 1). The outfall channel will extend south from the principal outlet at FRS#3 to the existing FRS#4 inlet channel north of McDowell Road, and lies within the Town of Buckeye and unincorporated Maricopa County.

The goals of the project include:

- Provide an outfall for the FRS#3 principal outlet flows.
- Intercept and convey the 100-year flood flows reaching the channel to the planned outfall at FRS#4.
- Reduce the effective FEMA 100-year floodplain along Jackrabbit Trail.
- Accommodate the future widening of Jackrabbit Trail.
- Provide an opportunity to implement trail linkage as part of the Maricopa County Regional Trail System.

The existing FRS#4 inlet channel is a concrete-lined channel which extends from south of Interstate 10 to north of McDowell Road. North of the existing concrete-lined channel, the existing Jackrabbit Channel and Wash are a series of unlined channels and ditches of varying dimensions and capacities. Between Missouri Avenue and the Bethany Home Road alignment, natural drainage patterns continue across the Jackrabbit Trail alignment from west to east. North of the Bethany Home Road alignment to FRS#3, the predominant land slope is to the east, towards the Beardsley Canal.

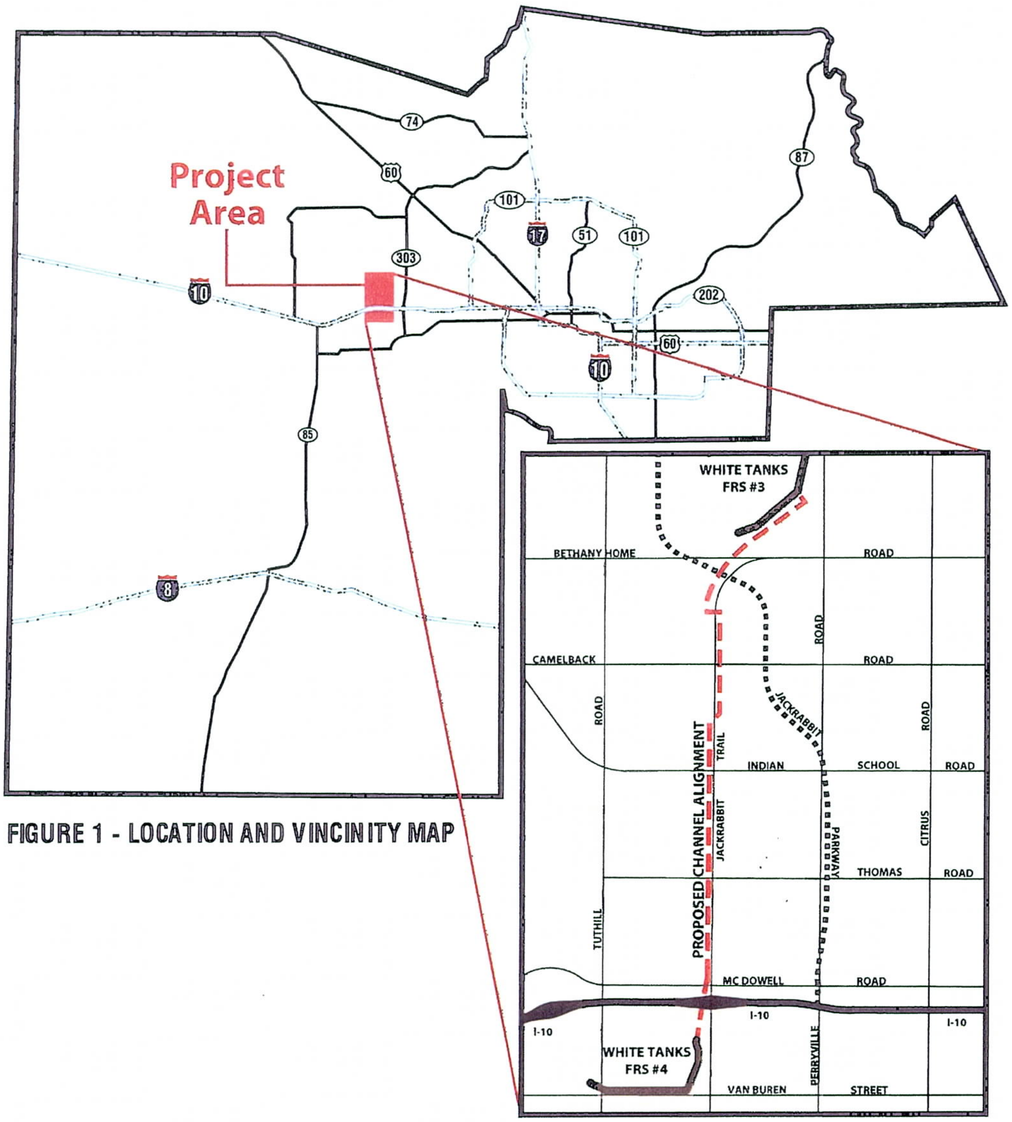


FIGURE 1 - LOCATION AND VINCINITY MAP

1.2 Purpose

The purpose of this geotechnical exploration was to evaluate the general surface and subsurface conditions at the referenced site, and to present recommendations related to geotechnical aspects of design and construction of the White Tanks FRS No. 3 Outfall Channel. Results of our laboratory testing are also presented within the appendix of this report. Our scope of services was in general accordance with the Scope of Work prepared by the District dated September 2009. This geotechnical report is based on available project information and the plan set dated July 7, 2009 (Hoskin Ryan 2009) and our experience with similar construction and soil conditions.

Our study included a site reconnaissance, subsurface exploration, soil sampling, field and laboratory testing, engineering analyses, and preparation of this report. This report presents recommendations for design of suitable foundation types, site grading and structural fill placement, moisture protection, and other construction considerations. The recommendations contained in this report are subject to the limitations presented herein.

1.3 Site Surface Conditions

The proposed project is located adjacent to the Jackrabbit Trail Alignment in the central portion of Maricopa County, within portions of the Town of Buckeye and unincorporated Maricopa County within the State of Arizona. The project will connect FRS No.4 in the south, near Interstate I-10, to FRS No.3 in the north. The proposed construction for this project is bounded in the south by McDowell Road and in the north by the existing FRS No. 3. Jackrabbit Trail is paved with asphaltic concrete from Interstate I-10 north to the Mission Road alignment for distance of approximately 4.5 miles. Site topography varies slightly across the site, generally sloping downhill from northwest to southeast. At the time of our study, the area of the proposed channel construction had a light to moderate growth of native desert vegetation and an existing channel was located along the western edge of Jackrabbit Trail.

1.4 Proposed Project

This project includes approximately 4.3 miles of new channel construction between FRS No.3 and FRS No. 4 in Maricopa County, Arizona. Construction for this project will begin approximately 1,000 feet north of McDowell Road on the west side of Jackrabbit Trail. The proposed channel will tie into the existing channel and travel north for approximately 1.2 miles (6,568 feet) where the newly constructed channel will connect to an existing earthen lined channel (Pasqualetti Mountain Ranch). The existing channel continues north for approximately 0.4 of a mile (2,137 feet) where construction for this project will again take over.

Proposed 30% Design

The new channel will travel north for approximately 0.6 of a mile (3,437 feet) where two, 8-foot by 6-foot concrete box culverts will allow the proposed channel to cross from the west to the east side of Jackrabbit Trail near Minnezona Avenue. On the east side of Jackrabbit Trail construction will revert back to an open earthen channel and travel north for approximately 0.8 of a mile (4,397 feet) where three, 8-foot by 6-foot concrete box culverts will cross from the east to the west side of Jackrabbit Trail. Back on the west side of Jackrabbit Trail an earthen channel will be constructed north for approximately 0.5 of a mile (2,500 feet) to a point near the proposed Bethany Home Road Alignment. A future emergency spillway is proposed north of the Bethany Home Road Alignment.

Two, ten-foot by 6-foot concrete box culverts will be constructed between station 256+06 and station 278+26. The concrete box culverts will allow water, released from FRS No. 3, to drain drown stream across the emergency spillway towards White Tanks FRS No. 4. North of the emergency spillway an open earthen channel will again be used to connect the channel to the principle outlet of FRS No. 3, for a distance of approximately 0.6 of a mile (3,475 feet).

In addition to the above referenced scope this project will include the construction of eight box culverts to allow traffic to cross the channel at various intersections, numerous maintenance ramps, and new asphalt concrete pavement along Jackrabbit Road as well as the intersected roadways. Vehicular traffic is expected to be a relatively low volume of mainly passenger cars and light trucks.

2 FIELD EXPLORATION

Twenty-five soil test pits were advanced along the proposed and existing wash alignment to depths ranging between seven (7) feet and thirteen (13) feet below the existing ground elevation. The soil test pits were advanced using a Case 580 Super Ram backhoe fitted with a 5-tooth, 24-inch wide bucket. Backhoe refusal was encountered at test pit TP-48 and TP-49. Test pit TP-49 was advanced using a 4-tooth 16-inch wide bucket. A hydraulic powered rock hammer (1,100 energy class: model T425X) was used to brake through the relatively thin layer of refusal material.

Fifty-two soil test borings were advanced at the subject site to a depth ranging between approximately five (5) feet and thirty (30) feet below existing ground level with a Dirdrick D-120 and a CME-45 power drill rig. The soil test borings were advanced using 8-inch hollow stem augers. Auger refusal was encountered at borings B-35, B-36, B-38, B-39, B-41, and B-46 between eight (8) feet and thirteen (13) feet below the existing ground surface.

The soil test pits and borings were advanced to develop information relative to foundation deign recommendations, pavement design recommendations, ease of excavation, and earthwork shrinkage estimates. The sample locations were determined in the field at the approximate locations shown on the sample location plan (figures 3A-3M) included in the Appendix A of this report. Prior to the start of excavating and drilling, the Arizona Blue Stake Center was contacted to locate existing utilities at the sample locations. Upon completion of the test pits and borings, the sample locations were backfilled with excavated materials.

Soil classifications made during our field exploration from excavated soil samples were confirmed in the laboratory after further examination. The site soils were classified in accordance with the Unified Soil Classification System presented, along with the soil test logs, in Appendix B. Sample classifications and other related information are recorded on the soil boring logs which are presented in Appendix B.

3 LABORATORY TESTING

Selected soil samples from the borings were tested in the laboratory for classification purposes and to evaluate their engineering properties.

The laboratory tests included:

- Gradation;
- Atterberg limits;
- Moisture content;
- One-dimensional consolidation;
- Undisturbed ring density;
- Sulfate content;
- Chloride content;
- Proctor tests
- Swell tests
- Hydrometer;

- pH tests;
- Resistivity tests;
- And agronomy tests.

A brief description of each test preformed on the soil samples and the results are presented in **Appendix C**.

4 GEOLOGIC INFORMATION

4.1 Geological Setting (GCI, 2010, Appendix E and Appendix F)

Numerous geological and geotechnical investigations have been conducted in the vicinity of the FRS #3 Outfall Channel. Reports documenting these investigations, conducted by agencies including the District, Arizona Geological Survey (AzGS), Arizona Department of Water Resources, U.S. Geological Survey, National Resources Conservation Service, US Army Corps of Engineers, and by private consultants, provide descriptions of the surface geological and soils conditions present along the Outfall Channel alignment. For additional discussions of the regional geology and the West Salt River Basin stratigraphy, readers are referred to recent reports by AMEC (2004, and 2009), AzGS (2009), and Geological Consultants Inc. (GCI) (2002, 2004, 2008, and 2009)

4.1.1 Regional Geology

The FRS #3 Outfall Channel is located approximately 1.5 miles east to about 2.2 miles southeast of the eastern flanks of the White Tank Mountains. The Outfall Channel begins at the FRS #3 principal spillway outlet and parallels the Jackrabbit Trail alignment throughout most of its length, terminating downstream at the FRS #4 inlet. The FRS #3 Outfall Channel is located within the Sonoran Desert section of the Basin and Range Physiographic Province. This portion of the Basin and Range is characterized by northwest, north, and northeast trending mountains that rise abruptly to form broad, elongated, deep, sediment-filled valleys produced by block faulting and folding during past episodes of mountain and basin bounding fault movements (Cooley, 1977).

The White Tank Mountains are composed predominately of old, Pre-Cambrian age (570 million years ago (mya)) metamorphic and granitic crystalline bedrock, intruded by younger dikes. A portion of the White Tank metamorphic core complex, the oldest rock units, are high-grade Proterozoic (2,000 million year ago (mya)) metamorphic rocks that include gabbros (iron-rich granitic rocks) and local ultramafic (dark colored) rocks. Two Proterozoic plutons, a tonalite to the south and a granodiorite-granite to the north, intruded into the older unit as a series of sills parallel to foliation in the metamorphic rocks (Reynolds, 2002). The bedrock is locally overlain by Tertiary age (66 mya to 1.6 mya) volcanic rock and Quaternary age (younger than 1.6 mya) alluvium. The basin fill within the valley composed of both fine and coarse grained alluvial sediments commonly makes up the principle groundwater aquifer of the region.

4.1.2 General Basin Stratigraphy

The basin stratigraphy beneath the FRS #3 Outlet Channel alignment is typical of the stratigraphy found in the portion of the West Salt River Valley that parallels the margin of the White Tank Mountains pediment. Three distinct alluvial units underlie the study area: a lower, middle, and an upper alluvial unit. Granitic and metamorphic bedrock underlies the lower alluvial unit. The exact thickness of these units under the study area is unknown. However, gravity surveys in the area are used to calculate the approximate depth to bedrock that is estimated to range from about 600 feet below the ground surface at FRS #3 to about 1,200 feet below the ground surface near FRS #4.

- Upper Alluvial Unit: Gravel, and sand with lesser amounts of silt and clay. Mostly unconsolidated with locally moderate to strong cementation near mountain fronts and major stream courses (SGC, 1998; Alpha, 2009). Along the Outfall Channel alignment, the thickness of this unit is estimated to range from about 300 to 400 feet (GCI, 2004 & 2008).

- Middle Alluvial Unit: Silt, and clay with thin interbeds of silty sand and gravel. Mostly weakly consolidated, but moderately to well-cemented. Grades to fine grained mudstone and evaporite deposits in the central part of the basin near Luke Air Force Base (Schumann, 1995). Although the estimated thickness of the Middle Alluvial Unit (MAU) is estimated to be about approximately 600 feet thick near the center of the West Salt River Valley (BOR, 1976; Schumann, 1995), the MAU probably pinches out to the west near the White Tank Mountains and therefore it may not underlie the Outfall Channel alignment.

- Lower Alluvial Unit: Silt, gravel, and conglomerate. The lower and older part of this unit is moderately to well-consolidated. Toward the margins of the West Salt River Valley basin within the project area, this unit is very coarse grained and relatively thin whereas. Near the center of the basin, east of the project area, the basing fill sediments grade to fine-grained sand, silt, and clay (BOR, 1976), mudstone, and evaporite deposits (Schumann, 1995) and the unit could reach a thickness of more than 1,000 feet. A relatively thin coarser-grained section of the Lower Alluvial Unit, ranging from less than 100 feet to possibly 200 feet thick, may underlie the Outfall Channel alignment. It is not expected that the Outfall Channel excavation would encounter this unit.

4.1.3 Outfall Channel Alignment Geology

The FRS #3 Outfall Channel parallels the Jackrabbit Trail alignment from FRS #3 to FRS #4 near the eastern margin of the White Tank Mountains. The Outfall Channel traverses older, Pleistocene age (10 ka to 300 ka) alluvial fan terrace deposits that are coarse grained and locally dissected. Along this route, the detritus, resulting from the erosion from the White Tank Mountains, was deposited to form a series of coalesced alluvial fans on the mountain pediment that sloped toward the basin center. The older, dissected alluvial fan deposits are commingled with accumulations of younger, Holocene age (less than 3 ka to 10 ka) alluvial fan deposits and stream channel alluvium (Field & Pearthree, 1991). Brief geologic descriptions, supplemented with information gathered during the field investigation conducted for this project, are provided in the following sections. Table 1 summarizes the distribution of the geomorphic surfaces and the associated alluvial deposits traversed by the the Outfall Channel. The approximate limit, or locations, where the contacts (or boundaries) of the various geologic units are keyed to the Outfall Channel (30-percent design) control line stationing (HRC, 2009).

Based on our interpretation of the surface geological mapping data, aerial photographs, and test pit explorations along the Outfall Channel alignment, we expect the majority of the Outfall Channel invert to be founded in the moderate to well-cemented Late or Middle Pleistocene age (10 to 300 ka) alluvial fan deposits. Along the southern portions of the alignment between McDowell Road and Indian School Road, geologically Recent age to Late Holocene age (0 to 10 ka) could be encountered at the Outfall Channel invert grade.

4.1.3.1 Alluvial Fans, Low Terraces, and Active Stream Channels (QY2; Holocene, <3ka)

Recent alluvial fan deposits are composed of fine silts and sands near the distal portions of the fan. Active stream channels grade toward the southeast and dissect the fan surfaces in response to infrequent flow events. Stream channel deposits consist of erosional detritus composed of loose to dense, unconsolidated, and poorly sorted silt, sand, and gravel. This geologic unit is susceptible to erosion when subjected to sustained flow.

4.1.3.2 Alluvial Fans and Terraces (QY1; Late to Early Holocene, 1 to 10 ka)

These deposits are composed of moderately dense to dense, coarse grained, poorly sorted mixtures of silt, sand, and gravel with angular to subangular granitic and metamorphic rock fragments. A poorly developed, pebble to granule desert pavement may be present. As these deposits approach the distal ends of the fans, they typically consist of finer grained silt and sand. Where soil profiles are well developed, the underlying deposits are slightly calcareous resulting from accumulations of Stage I to II caliche. This unit is expected to be slightly susceptible to erosion.

Table 1a
Surficial Distribution of Geologic Units Along Outfall Channel Alignment
White Tanks FRS No. 3 Outfall Channel

<table>
<tr><td colspan="2">Outfall Channel Station</td><td rowspan="2"></td><td rowspan="2">Geologic Symbol</td><td rowspan="2">Geologic Name</td><td rowspan="2">Age
(ka=1,000 years ago)</td></tr>
<tr><td>From</td><td>To</td></tr>
<tr><td colspan="6">Beginning of Project</td></tr>
<tr><td>63+21</td><td>66+80</td><td>1</td><td>QY</td><td>Undifferentiated Alluvial Fan</td><td>Holocene
(0-10)</td></tr>
<tr><td>66+80</td><td>72+00</td><td rowspan="4">2</td><td>QM12</td><td>Alluvial Fan (Distal)</td><td>Middle to Late Pleistocene
(10-300)</td></tr>
<tr><td>72+00</td><td>74+95</td><td>QY1</td><td>Alluvial Fan & Terraces</td><td>Late to Early Holocene (1-10)</td></tr>
<tr><td>74+95</td><td>84+00</td><td>QM1b</td><td>Alluvial Fans</td><td>Middle to Late Pleistocene
(150-300)</td></tr>
<tr><td rowspan="2">84+00</td><td rowspan="2">127+45</td><td rowspan="2">QY1</td><td rowspan="2">Alluvial Fan & Terraces</td><td rowspan="2">Late to Early Holocene (1-10)</td></tr>
<tr><td>3</td></tr>
<tr><td colspan="6">Thomas Road Alignment</td></tr>
<tr><td rowspan="2">127+45</td><td rowspan="2">141+90</td><td>3</td><td rowspan="2">QY2</td><td rowspan="2">Alluvial Fan, Low Terraces, & Active Stream Channels</td><td rowspan="2">Recent to Late Holocene
(<3)</td></tr>
<tr><td rowspan="3">4</td></tr>
<tr><td>141+90</td><td>146+70</td><td>QM2</td><td>Alluvial Fans</td><td>Latest to Late Pleistocene
(10-150)</td></tr>
<tr><td>146+70</td><td>159+45</td><td>QM1b</td><td>Alluvial Fans</td><td>Middle to Late Pleistocene
(150-300)</td></tr>
<tr><td colspan="6">Indian School Road Alignment</td></tr>
<tr><td>159+45</td><td>185+45</td><td>5</td><td>QY</td><td>Undifferentiated Alluvial Fan</td><td>Holocene
(0-10)</td></tr>
<tr><td>185+45</td><td>212+40</td><td>6</td><td>QM2</td><td>Alluvial Fans</td><td>Latest to Late Pleistocene
(10-150)</td></tr>
</table>

Note: Geologic symbol, geologic name, and age from Field and Pearthree (1991).

Table 1b
Surficial Distribution of Geologic Units Along Outfall Channel Alignment
White Tanks FRS No. 3 Outfall Channel

Outfall Channel Station		Reach	Geologic Symbol	Geologic Name	Age (ka=1,000 years ago)
From	To				
Camelback Road Alignment					
212+40	216+45	7	QY	Undifferentiated Alluvial Fan	Holocene (0-10)
216+45	242+65		QM1b	Alluvial Fans	Middle to Late Pleistocene (150-300)
242+65	244+15		QY	Undifferentiated Alluvial Fan	Holocene (0-10)
244+15	249+35		QM1b	Alluvial Fans	Middle to Late Pleistocene (150-300)
249+35	250+95		QY	Undifferentiated Alluvial Fan	Holocene (0-10)
250+95	263+65	8	QM1b	Alluvial Fans	Middle to Late Pleistocene (150-300)
Bethany Home Road Alignment					
263+65	266+70	8	QY	Undifferentiated Alluvial Fan	Holocene (0-10)
266+70	277+70		QM1b	Alluvial Fan	Middle to Late Pleistocene (150-300)
277+70	285+95		QY	Undifferentiated Alluvial Fan	Holocene (0-10)
285+95	295+95		QM1b	Alluvial Fan	Middle to Late Pleistocene (150-300)
295+95	2299+70		QY	Undifferentiated Alluvial Fan	Holocene (0-10)
289+90	313+00	9	Fill/QM1b	Fill/Alluvial Fan	Recent/Middle to Late Pleistocene (150-300)
End of Project - White Tanks FRS No. 3 Principal Spillway Outlet					

Note: Geologic symbol, geologic name, and age from Field and Pearthree (1991).

4.1.3.3 Undifferentiated Alluvial Fan Deposits (QY; Recent to Early Holocene, 0 to 10 ka)

This geologic unit designation is used for areas that include extensively commingled QY1 and QY2 units. This designation also includes areas where the geologic units have been be disturbed by agricultural activity and urban development but are also believed to the Holocene age. Refer to report Section 2.3.1 and 2.3.2 for a description of this designated geologic unit.

4.1.3.4 Alluvial Fans (QM2; Latest to Late Pleistocene, 10 to 150 ka)

The alluvial fan deposits are mapped at three intervals along the Outfall Channel alignment, one near the intersection of Jackrabbit Road and Clarendon Avenue and at two others locations along Jackrabbit Road between Indian School Road and Camelback Road. Where undisturbed, a gravel to cobble desert pavement is poorly to moderately developed. The deposits consist of a poorly sorted, angular to subangular admixtures of silt, sand, and gravel with localized layered accumulations of cobble- to boulder-size granitic and metamorphic rock fragments. The surface soils of this unit are commonly dark brown to brown but below the surface, where the unit is slightly to moderately cemented with caliche, the formation is very light orange brown. This unit is dense to very dense and slightly to moderately indurated due to the caliche cementation. Where exposed in test pits, the unit exhibits poorly to moderately stratified layers of silty sandy gravel and silty gravelly sand with some layers containing a high (greater that 50 percent) cobble to boulder-size rock fragments. Estimated unconfined compressive dry strength of the finer grained constituents of this unit, measure with a pocket penetrometer, is greater than 4.5 tons per square foot. Based on the observed Stage II caliche cementation, the interlocking character of the angular to subangular coarse fraction, and the very high dry strength, we would expect soils in this alluvial fan unit to be very slightly to non-erosive and moderately difficult to excavate.

4.1.3.5 Alluvial Fans (QM1b; Middle to Late Pleistocene, 150 to 300 ka)

The older alluvial fan deposits are mapped at a couple of locations along the Outfall Channel alignment, one near the intersection of Jackrabbit Road and Encanto Boulevard and along Jackrabbit Road between Clarendon Avenue and Camelback Road. Unit QM1b is also extensively mapped along the Outfall Channel alignment north of Camelback Road to the north side of the FRS #3 emergency spillway. Where undisturbed, a well-preserved gravel to cobble desert pavement has formed on the elevated, locally dissected fan surfaces separated by shallow, incised stream channels. The deposits also consist of a poorly sorted, angular to subangular admixture of silt, sand, and gravel with localized layered accumulations of cobble- to boulder-size granitic and metamorphic rock fragments. The surface soils of this unit are commonly dark brown to brown but below the surface, where the unit is cemented with caliche, the formation is a mottled very light orange brown to cream color whereas the excavated soil appears whitish in color. This unit is dense to very dense and moderately indurated due to the caliche cementation. Where exposed in test pits, the unit also exhibits poorly to moderately stratified layers of silty sandy gravel and silty gravelly sand with some layers containing a high percentage (greater that 50 percent) of cobble to boulder-size rock fragments. Estimated unconfined compressive dry strength of the finer grained constituents of this unit, measure with a pocket penetrometer, is greater than 4.5 tons per square foot. The wet strength of cemented soils was determined by saturating two samples for a 12-day period, a cemented sandy gravel/gravelly sand and cemented silty sand. The samples were obtained from a test pit TP-48 at the depth approximating the outfall channel invert elevation in Reach 9. At the end of the test period, the unconfined compressive strengths measured with a pocket penetrometer were 4.5 tons per square foot in the cemented sandy gravel/gravelly sand sample obtained at a depth of about 8 feet below existing grade and 3.7 tons per square foot in the cemented silty sand obtained at a depth of about 10 feet below existing grade. Based on the observed Stage II to III caliche cementation, the interlocking character of the angular to subangular coarse fraction, and the very high dry and wet strengths, we would expect soils in this alluvial fan unit to be non-erosive and difficult to excavate.

4.1.3.6 Distal Alluvial Fans (QM12; Late to Middle Pleistocene, 10 to 300 ka)

This undifferentiated alluvial fan unit is mapped in one area of the Outfall Channel alignment along Jackrabbit Road between Palm Lane and Monte Vista Road. This map unit designation is used to identify areas believed to be underlain by geologic units M1b and M2 that have been disturbed by agricultural activity or urban development. Refer to report Sections 2.3.4 and 2.3.5 for the description of the units that may be encountered where this unit is mapped. In the agriculturally disturbed area, the competency of the upper few feet of the soil structure has been destroyed by tillage and as a result, this near-surface zone could be susceptible to erosion.

4.2 Subsidence and Earth Fissures

4.2.1 Land Subsidence

Land subsidence due to the excessive removal of groundwater from the West Salt River Valley sub-basin aquifer is well documented in the vicinity of the FRS #3 Outfall Channel (GCI, 2002, 2004, 2008; AMEC, 2004, 2009: Schumann, 1974, 1995; Schumann & Genualdi, 1986; Dames & Moore, 1998; and others). With the development of groundwater resources for agricultural purposes beginning in the early 1920s and with increased agricultural activity and urban development following World War II, significant declines of regional groundwater levels of 100 to 200 feet have resulted in the consolidation of compressible basin fill sediments along with the subsequent lowering of the ground surface (land subsidence). About 17 feet of land subsidence has taken place in the Luke Air Force Base area, almost 4 feet at FRS #3, and about one to 1.5 feet near FRS #4. In the late 1970s and early 1980s the downward trend in water levels abated due to increased recharge to the aquifer and to the greater availability of surface water. As a result, the water level conditions today are essentially static or slightly increasing.

Level line survey data from the National Geodetic Survey (NGS) provided some of the earliest indication of land subsidence in the project area. Level survey data obtained in 1948 was compared with surveys conducted in 1967. Almost two feet of subsidence was documented along the Beardsley Canal alignment in the vicinity of FRS #3. Total land subsidence documented from 1948 though 2004 using NGS data adjusted by the District from their surveys at FRS #3 ranged from about 2.5 feet to 3.7 feet. To the best or our knowledge there have been no level line surveys in the area (personal communication (NGS, 2008)) other than the survey data prepared by the District in 2004. In early 1990s, a remote radar survey technique became available that can measure changes in land surface elevations using low orbit satellite platforms. The technique is referred to as repeat pass Synthetic Aperture Radar Interferometry, or InSAR.

4.2.1.1 InSAR Data

Interferometric Synthetic Aperture Radar (InSAR) is a remote sensing technique that uses radar satellite images. A radar satellite shoots constant beams of radar waves toward earth and records them after they bounce back off the Earth's surface. The intensity of the wave bounced back to the satellite indicates how much of the wave has been absorbed and how much has reflected back to the satellite. The phase of the wave indicates the time necessary for the radar wave to hit the ground and return to the satellite. The intensity information is used to characterize the material the wave bounced off. The phase information is used to determine any changes that have occurred over time. A phase reading taken at the same point over time should be identical. If there is a difference in readings from successive radar passes over time this is an indication that a change has taken place. By using both the intensity and phase data, differential ground movement can be located and measured.

InSAR data can depict vertical land movement (potentially subsidence) at locations where the land would have otherwise remained undisturbed for the period of time during which the data was collected. This technology does not provide useful data in areas where the land surface changes on a somewhat regular basis (i.e. agricultural lands, rivers, etc.). In these areas, the data decorrelates and is unreadable.

InSAR imaging is available from the Arizona Department of Water Resources (Conway, 2009) that documents the land surface deformation as measured by differential interferometric synthetic aperture radar (DifSAR) that includes the FRS #3 Outfall Channel alignment area for the period of 1992 through 2000 (ADWR, 2004) and from 2003 through 2009 (Conway, 2009). To evaluate the near-term historic land subsidence along the Outfall Channel alignment, we examined and plotted DifSAR data set obtained along a satellite track closest to the Jackrabbit Trail alignment which parallels from Outfall Channel Reach 1 through a portion of Reach 9 (Figure 2) including the FRS #3 emergency spillway. We also examined and plotted the DifSAR data set along satellite track that parallels the Beardsley Canal alignment including the area near the FRS #3 principal spillway outlet structure.

Interpretation of the DifSAR data indicates that land subsidence, albeit at a very low rate, continues in the project area. Interpretation of the 1992 through 2000 Beardsley Canal alignment DifSAR data set indicates that land subsidence ranging from about 0.16 feet (at a rate of about 0.02 feet per year) took place near the FRS #3 principal spillway outlet. The Jackrabbit Trail DifSAR data set indicates about 0.15 feet of subsidence occurred in the FRS #3 emergency spillway area and about 0.17 feet of subsidence occurred near the Missouri Avenue alignment. About 0.025 feet was recorded at the Camelback Road intersection with the Outfall Channel and about 0.02 feet south of Indian School Road near its intersection with

Clarendon Avenue. Examination of the 2003 through 2009 DifSAR data suggests similar subsidence trends but the total subsidence is nil to about 10 percent of the 1992 to 2000 measured subsidence (Figure 4, Appendix G).

Figure 4, Appendix G, can be used to identify areas along the Outfall Channel alignment that could potentially experience a grade changed due to differential land subsidence taking place over time. For example, at the northern terminus of the Outfall Channel, using the latest (2003-2009) DifSAR subsidence data assuming a 50-year life of the facility, approximately 0.2 feet of subsidence (down-dropping to north) might take place. Using the 1992 to 2000 InSAR data, approximately one foot of land subsidence could take place. For the purpose of assessing potential outfall channel grade reversal due to land subsidence over the 50-year useful life of the facility, it is our opinion, the year 1992 to year 2000 historic land subsidence determined from the InSAR/DifSAR data should be used to estimate future potential land subsidence. Our reasons for using these data include considerations of ongoing residual land subsidence, continued development and related groundwater demand from the basin aquifer, and the application of nominal conservatism to accommodate unforeseen circumstances that could exacerbate land subsidence in the West Salt River Valley during the useful life of the FRS #3 outfall channel. Considering the very low design flow line gradient of the Outfall Channel invert that ranges from 0.001 feet/foot to 0.005 feet/foot and if the estimated year 1992 to year 2000 rate of land subsidence continues at the same rate, or at an increased rate, throughout the useful life of the facility, the differential land subsidence could cause a reversal of the channel invert grade.

4.2.2 Earth fissures

Earth fissures form in response to settlement or subsidence caused by the natural or human-induced removal of solid, liquid, or gas material from near-surface ore bodies, aquifers, or reservoirs. In the West Salt River Valley, earth fissures occur in unconsolidated sediments, typically near the margins of the alluvium-filled basin, in response to the removal of groundwater from the basin aquifer.

Earth fissures are initiated deep beneath the land surface once the tensile stresses, caused by the consolidation of the basin fill sediments induced by groundwater removal, exceed the strength of the soil. Tensile stresses, induced by the resulting land subsidence continue to increase until the ground breaks to form the earth fissure. The fissures then propagate upwards to intersect the ground surface. Although the initial earth fissure rupture may only have an aperture of one to two inches at depth, at the surface the fissure crack can grow in width and length creating fissure gullies that are one foot to more than 10 feet deep and from a few feet to as much as 40 feet wide when subjected to erosion caused by overland surface runoff. During their formation, the earth fissures can extend initially from a length of a few feet to reach a few thousand feet along the length of their surface expression. The earth fissure with the greatest reported length of more than nine mile is located near the west-central margin of the Picacho Basin near Eloy, Arizona. These features are easily recognized on aerial photographs and in the field unless the ground surface has been modified by agricultural activity or urban development.

Numerous earth fissures have been mapped in the West Salt River Valley. In February 2009, the Arizona Geological Survey published the Luke Study Area earth fissure map compiling the known and suspect earth fissures in the West Salt River Valley (AzGS, 2009). Also, several earth fissure investigations have been conducted in the project area by GCI (2002, 2004, 2008) and AMEC (2004, 2009). These investigations include detailed analysis and interpretation of aerial photographs, field geological reconnaissance to investigate identified suspect features, and, where deemed necessary, surface and subsurface explorations of selected suspect features that appear to have the greatest likelihood of being earth fissures. Also, as part of the design investigation conducted for the remediation of FRS #3 (GCI; 2004, 2004, & 2005; AMEC; 2004) and FRS #4 (GCI, 2008), geophysical seismic survey were conducted to assist in the selection of geotechnical design parameters for the site. The seismograms generated during these surveys were carefully examined to identify any anomalies that could be related to earth fissures. During the construction at FRS #3 earth fissure risk zone mitigation measure, additional seismic refraction surveys were conducted by AMEC and a detailed geological examination of the cutoff excavation was conducted by GCI to determine if any earth fissures existed (GCI, 2006). No earth fissure were identified within the FRS #3 earth fissure risk zone cutoff excavation during the construction inspections.

Based on the results of the previous investigations, no earth fissures are identified at or in the vicinity of the FRS #3 Outfall Channel alignment, FRS #3, or FRS #4 as of the date of this report. The closest earth fissures to the Outfall Channel alignment are located about three miles to the north near the south end of McMicken Dam, about three miles to the northeast near the intersection of

Northern Avenue and Cotton Lane, and about six miles to the east near Luke Air Force Base (AzGS, 2009).

4.2.2.1 Earth Fissure Risk

No earth fissures are identified along the FRS #3 Outfall Channel alignment. The relative earth fissure risk is believed to be low except for Reach 8 and 9 (Figure 2) (AMEC, 2009). During the site investigations conducted at FRS #3, an "earth fissure risk zone" was identified by AMEC (2009), which parallels a portion of Reach 9. No surface expressions of suspect fissures within the "zone" were observed by AMEC (2009) or by GCI during the geotechnical field investigation conducted for this outfall channel design project. Because of the documented history of differential land subsidence of almost four feet in the FRS #3 area and because InSAR data indicates residual land subsidence is continuing in the area at a low rate, a commensurate low risk potential exists for the build-up of tensile stresses in the vicinity that could cause an earth fissure to form. Therefore, this potential level of risk should be factored into the design and operation of the outfall channel. If the present trend of locally static to slightly rising water table condition is reversed and if groundwater withdrawal accelerates in the future, lowering of the water table within the West Salt River Valley, tensile stresses would increase at a more rapid rate to exacerbate future potential earth fissure development. Because of the apparent low level of earth fissure risk along FRS #3 Outfall Channel, "soft" mitigation measures, such as land subsidence and earth fissure monitoring should be considered by the District.

5 GENERAL SITE CONDITIONS

5.1 Subsurface Conditions

To gain an understanding of the existing surface and subsurface soil conditions, a combination of soil test pit and borings were advanced at various locations approximately at a 500 feet spacing across the proposed channel improvement area. For the purpose of this report the surface and subsurface soil profiles are divided into the following reaches (Figure 2, Appendix A).

5.1.1 Reaches 1 through 5

5.1.1.1 Existing Wash Conditions

The naturally occurring surface soils encountered on the surface of the existing wash areas within our field investigation were well graded subangular loose sand with and without gravel (SW) and gravel with silt and sand (GP-GM: TP-24, figure 3E, Appendix A). The underlying course grained subsurface soils were found to be sand with silt (SP-SM), silty sand with and without gravel (SM), and silty gravel with sand (GM). The underlying fine graded subsurface soils were sandy slit (ML). Moisture content ranged between 0.2 and 9.0 percent.

5.1.1.2 Native Desert Area

The naturally occurring coarse grained site surface and subsurface soils extending throughout depth of our investigation consisted of silty sand with and without gravel (SM), sand with and without gravel (SW and SP), and silty gravel with sand (GM). The relative densities of these soils ranged from loose to very dense. The naturally occurring fine grained site surface and subsurface soils extending throughout our investigation were found to be sandy silt (ML). Carbonate cementation (caliche) was found in several of the soil test borings and ranged from weak to moderate. Cementation generally increased with depth. No bedrock was encountered during our field investigation.

5.1.2 Reach 6

The naturally occurring coarse grained site surface and subsurface soils extending throughout depth of our investigation consisted of silty sand with and without gravel (SM), and silty gravel with sand (GM). The relative densities of these soils ranged from medium dense to very dense. The naturally occurring fine grained site surface and subsurface soil extending throughout our investigation was found to be sandy silt (ML). The relative firmness of these soils ranged from soft to firm. Weak to moderate carbonate cementation (caliche) was found throughout the soil test pits and borings and generally increased with depth. No bedrock was encountered during our field investigation. Auger refusal was encountered in soil borings B-35 and B-36 (figure 3H, Appendix A) on cobbles and boulders ranging in depth between 11 and 12 feet below the existing ground surface on the east side of Jackrabbit Trail.

5.1.3 Reach 7

The surface soils encountered within Reach 7 appeared to consist of man-made engineered fill material placed during the mass grading operations for the Jackrabbit Estates residential subdivision. The depth of the engineered fill ranged between one and a half (1.5) feet and seven (7) feet below the existing ground elevation. The fill material consisted of medium dense to very dense slightly damp silty sand (SM). The naturally occurring subsurface soils extending throughout the depth of our investigation consisted of sandy silt (ML), silty gravel with sand (GM), silty sand (SM), sand with silt and gravel (SP-SM), and gravel with silt and sand (GP-GM). The relative firmness/densities of these soils ranged from soft to firm and loose to very dense. Carbonate cementation (caliche) was in a few of the soil test pits and borings and ranged from weak to moderate. No bedrock was encountered during our field investigation. Auger refusal was encountered in soil borings B-41 (figure 3J, Appendix A) on weakly cemented cobbles at a depth of 13 feet below the existing ground surface.

5.1.4 Reach 8

The naturally occurring coarse grained site surface and subsurface soils extending throughout the depth of our investigation within Reach 8 consisted of silty gravel with sand (GM), silty sand with gravel (SM), gravel with sand (GP), silty sand with and without gravel (SM), gravel with sand (GP), gravel and sand silty (GP), silty clayey sand with gravel and cobbles (SC-SM), and gravel with silt sand, cobbles, and boulders (GP-GM). The relative densities of these soils ranged from medium dense to very dense. The naturally occurring fine grained site surface and subsurface soil extending throughout our investigation was found to be sandy silt (ML). The relative firmness of these soils ranged from firm to hard. Carbonate cementation (caliche) was found throughout our soil test pits and borings for this reach and ranged from weak to strong. Cementation generally increased with depth. No bedrock was encountered during our field investigation. Backhoe refusal was encountered using a Case 580 Super Ram backhoe in soil test pits TP-48 and TP-49 (figure 3K, Appendix A) on strongly cemented cobbles and/or boulders. A hydraulic rock hammer (energy class 1100: model TB425X) was used to loosen the subsurface soils within test pit TP-48 from a depth of three feet to a depth of five feet. The soil below the strongly cemented layer was weakly cemented and excavated using a 16-inch, 4-tooth bucket. Soil below a depth of six feet in test pit TP-49 was also strongly cemented with cobbles and boulders, however, the 16-inch, 4-tooth bucket was able to excavate the material to a depth of twelve feet.

5.1.5 Reach 9

5.1.5.1 Native Desert Area

The surface soils encountered within Reach 9 consisted primarily of course grained silty sand (SM), and silty gravel with sand (GM). Fine grained sandy silt (ML) was also encountered throughout our soil investigation. The relative density/firmness of these soils ranged from loose to very dense/soft to very firm. Weak carbonate cementation (caliche) was found in borings B-53 (figure 3C, Appendix A) and B-57 (figure 3M, Appendix A). No bedrock was encountered during our field investigation.

5.1.5.2 Stock Pile Soil

The surface soils encountered within the stock pile area within Reach 9 (figure 3M, Appendix A) appeared to be man-made fill material for a depth ranging between eighteen (18) feet and twenty-five (25) feet. The fill soils appeared to have been moisture conditioned and compacted during placement. The soils within Reach 9 were classified as course grained silty sand with and without gravel (SM), sand (SW), silty gravel with sand (GM), and fine grained sandy silt (ML). The relative density/firmness of these soils ranged from medium to very dense/moderately firm to hard. Weak carbonate cementation (caliche) was found in boring B-62 (figure 3M, Appendix A). No bedrock was encountered during our field investigation.

5.2 Groundwater Conditions

At the time of our field investigation, free groundwater was not encountered in our explorations. It should be noted that groundwater and soil moisture conditions within the area will vary depending on rainfall, irrigation practices, and/or runoff conditions not apparent at the time of our field investigation. USGS water level measurements from wells near the site indicate that the groundwater level ranges between 287 and 395 feet below the ground surface and generally flows from the White Tanks Mountains in the west downhill towards the east. This measurement was recorded in 1991-1992 by the United States Geological Survey (Hammett and Herther, 1992).

5.3 Seismic Considerations

A peak horizontal ground acceleration of 0.03g with a 90 percent (%) probability of nonexceedance in 50 years for the vicinity of the project alignment is presented in ADOT report AZ92-344 (Euge, et al, 1992). The project is located on or near the boundary of the Sonoran Zone (SZ) and the Arizona Mountain Zone (AMZ) of the ADOT report. The project area is not located near a significant source of seismic activity and the SZ is not considered to be a seismically active area. However, the AMZ is considered one of the most seismically active areas in the state.

The following values were developed using the 2006 International Building Code (IBC) and are based on knowledge of local geologic conditions, and subsurface soils encountered during our investigation. A 100 foot soil test boring was not advanced during our field investigation. A site class C (very dense soil and soft rock) may be used for design.

Central Latitude..33.50986°
Central Longitude...-112.47825°
S_s Spectral Acceleration for Short Period........................0.168g
S_1 Spectral Acceleration for a 1-Second Period.....................0.059g
F_a Site Coefficient for Short Period..............................1.20
F_v Site Coefficient for a 1-Second Period.......................1.70

5.4 Liquefaction Potential

Based on the site soils characteristic encountered throughout this investigation and low ground motion hazard (relatively low ground acceleration), the potential for soil liquefaction is considered to be negligible.

6 ENGINEERING ANALYSES AND RECOMMENDATIONS

6.1 Earthwork

6.1.1 Excavation

The field sampling and exploration was performed using a truck-mounted drill rig with 8-inch diameter hollow stem augers and a Case 580 Super Ram backhoe. We present the following general comments regarding excavatability with the understanding that they are opinions based on the test borings and excavations data. The project consultant and contractor should become familiar with this report including boring and test pit logs to evaluate potential hard dig conditions.

Excavations in the site soils can most likely be made by conventional earth moving equipment, though in localized areas a hydraulic rock hammer (energy class 1100: model TB425X) was used to excavate the test pits to the proposed depths. Auger and backhoe refusal was encounter in several of the boring/excavation locations at varying depths due to both the presence of strongly cemented soils and cobbles and boulders. Please refer to Section 5 and sample logs for more information.

6.1.2 Temporary Excavations

All excavations must comply with applicable local, state, and federal safety regulations including the current Occupational Safety Health Association (OSHA) Excavation and Trench Safety Standards. Construction site safety generally is the sole responsibility of the Contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations. We are providing the information below solely as a service to our client. Under no circumstances should the information provided be interpreted to mean that the consultant team or the District assumes responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.

Near-surface soils encountered during our field investigation consisted predominantly of silty sand and sandy silts. In our opinion, these soils would be considered a Type B soil when applying OSHA regulations. For this soils type OSHA recommends a maximum slope inclination of 1(h):1(v) or flatter for excavations 20 feet or less in depth. Steeper cut slopes may be utilized for excavations less than 5 feet deep depending on the strength, moisture content, and homogeneity of the soils as observed in the field. Flatter slopes and/or trench shields may be required if loose, cohesionless soils and/or water are encountered along the slope face.

Construction Considerations

Heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within one-third the slope height from the top of any excavation. Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning may be required to provide structural stability and to protect personnel working within the excavation. Shoring, bracing, or underpinning required for the project (if any) should be designed by a professional engineer registered in the State of Arizona.

During wet weather, earthen berms or other methods should be used to prevent runoff water from entering all excavations. All runoff water should be collected and disposed of outside the construction limits.

6.1.3 Permanent Excavations and Slopes

We recommend all permanent cut and fill slopes in soil be constructed at a gradient no steeper than 3(h):1(v). During wet weather, erosion could become a problem. Proper drainage and maintenance is recommended. To reduce the potential for surface erosion, a berm or "V" ditch may be located at the top of slopes subject to significant overland water flows in order to intercept and redirect surface runoff.

Fill placed on slopes steeper than 5(h):1(v) should be benched into the existing slope. It is recommended that the slope face be compacted as presented in the earthwork section of this report.

6.1.4 Earthwork Factors (Stockpile)

Based on the relevant information gathered during the performance of the field study and laboratory testing, the following earthwork factors are anticipated for the stockpile material located at sample locations B-61 through B-65 (figure 3M, Appendix A).

The dry density of the surface soils averaged 110 pounds per cubic foot at the time of our testing. Based on the relevant information gathered during the performance of the field study and laboratory testing the shrinkage of surface soils (top three feet) is estimated to range from 5 to 10 percent when native site soils are compacted to between 95 and 100 percent of maximum dry density as determined by ASTM D698. The actual shrinkage and compaction loss may vary and are provided as estimates only.

6.1.5 General Channel Grading

All existing structural remnants, undocumented man-made fill material, existing vegetation, and other deleterious material should be removed. Compaction of all exposed surfaces of the unlined channel is not considered necessary. Some areas that are subjected to heavy construction traffic during grading operations should be scarified for a depth of 12-inches and recompaction at a lower density to promote plant growth (90 percent of maximum dry density, with 2 percent of optimum moisture content).

6.1.6 Embankment

Overexcavation requirements are controlled by the height of embankment fill and the properties of the in-situ soil. The width of the overexcavation includes the zone within a projection outward of 1:1

from the base of the embankment. Overexcavation depth recommendations are presented in the following table:

Table 2

Embankment Overexcavation

Location	Embankment Height (ft)	Overexcavation Depth Below Existing Ground (ft)
Reach 8 and 9	4 or less	3.0
	More than 4	5.0

The soil below the embankment should be removed as presented above. The exposed subsurface soils should then be scarified to a depth of 8-inches: moisture conditioned to within 2 percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. In areas requiring five feet of over-excavation, the soils should be moisture conditioned to within 2 percent of optimum moisture content and compacted to a minimum of 100 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by ASTM D 698.

The HDPE pipe option may also require the construction of an embankment to cover the pipe in areas were it may be above existing or final grade. As an alternative to the overexcavation presented above these areas may be preloaded by stockpiling material along the pipeline alignment. The specific height, placement, and duration of the preloading should be designed once embankment and pipeline grades are finalized.

6.1.6.1 Settlement

Settlement of the embankment fills, using available site soils, should be in the order of a fraction of a percent of the embankment height. The majority of this settlement will occur during construction of the fill. However, if the embankments are placed below optimum moisture content and the embankments become saturated, post-construction settlements could be on the order of two to three percent of the embankment height.

6.1.7 Pavement Subgrade

All existing structures/structural remnants, fill, topsoil, vegetation and organic soils should be removed from below the pavement areas. The site soils tested have low expansive potentials and are considered suitable for use as engineered fill in the pavement areas. The native soils should be scarified to a depth of 12-inches: moisture conditioned to within 2 percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density or applicable governing municipal standards.

6.1.8 Grading Below Structures

For support of box culverts and structures embedded at least 4 feet below existing grade and the minimum depth indicated in foundation section, the exposed surface soils should be scarified to a minimum depth of 8-inches and moisture conditioned to within 2 percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. The exposed areas should be observed by a representative of the geotechnical engineer prior to scarification. Should unsuitable material be encountered it should be removed and replaced by controlled low strength material meeting the requirements of MAG 728.

6.1.9 Grading Below Grade Control Structures

All existing structures/structural remnants, fill, topsoil, vegetation and organic soils should be removed from below structure areas. The site soils tested have low expansive potentials and are considered suitable for use as engineered fill below concrete structures. The native soils should be scarified to a depth of 12-inches; moisture conditioned to within 2 percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density or applicable governing municipal standards.

6.1.10 Engineered Fill

Engineered fill materials should be composed of on-site soils or imported soils meeting the requirements for imported soils presented below. All engineered fills should be compacted as noted.

1. Native soils or imported soils with low expansive potentials could be used as fill material for the following:
   - general site grading
   - embankment construction

2. Structural backfill should be used against concrete structures designed to resist earth loads, such as box culverts, wingwalls and retaining walls. All Structural backfill should meet the material requirements of Section 206 MAG Uniform Standard Specification.

3. Imported soils (if required) should conform to the following:

Gradation	**Percent finer by weight (ASTM C136)**
3"	100
No. 200 Sieve	60 (max)

Expansion Index	**(ASTM D4829)**
Maximum expansive index	50

Additional requirements for import in contact with ferrous material or concrete:

Corrosion Potential	
Minimum Resistivity (ohm-cm)	2,000
Sulfate Content (percent)	0.1

4. Aggregate base should conform to MAG and/or local governing specifications.
5. The following are intended to guide in establishing adequate support for the conventional foundation elements:

   - Any natural washes, depressions or new excavations which are to be filled, should be widened as necessary to accommodate compaction equipment and provide a level base for placing fill.
   - Any engineered fill (backfill) materials placed beneath the foundations should meet the requirements for Engineered Fill Materials.
   - All footing excavations should be relatively level and free of loose or disturbed material and inspected by a qualified representative of the Geotechnical Engineer.

6. All fill soils to be used beneath the foundations; slabs and pavements should be approved by the Geotechnical Engineer. Fill should be placed in 8-inch loose lifts and should extend beyond the edge of the structure for a minimum distance of five (5) feet.

6.2 Structures

6.2.1 Shallow spread footings

Shallow spread footings bearing on undisturbed native or engineered fill can be used to support the structures as recommended in section 6.1. Recommended footing depths and allowable bearing pressures are presented in Table 3 below.

Table 3
Allowable Bearing Pressure for Shallow Foundations

Footing Depth Below Finished Grade (ft.)*	Allowable Bearing Pressure (psf)
2.0	3,000
3.0	3,500
4.0 and greater	4,000

***Note**: Footing depth is defined as the depth below the lowest adjacent finished grade elevation within 5-feet of the edge of the footing.

A one-third increase may be applied to the design bearing pressures when considering short duration loads, such as wind and seismic.

Continuous footings should have a minimum width of 12-inches. The minimum widths are recommended for ease of construction, and to provide a margin of safety against a local or punching shear failure of the foundation soils. All footings should be reinforced to reduce potential distress caused by differential foundation movement.

All the footing excavations should be observed by the Geotechnical Engineer prior to placement of reinforcing steel and/or concrete. If subsurface conditions are encountered that are different than indicated by the test borings, revised recommendations may be required.

6.2.1.1 Estimated Settlements

Settlement of footings designed as recommended above are estimated not to exceed 1-inch. Differential settlements between similarly loaded, adjacent footings are expected to be less than ½-inch. Significant moisture increases above those recommended for compaction could result in additional movements. In order to minimize the sensitivity of the structure to differential settlements, footings should be reinforced to allow for a degree of load redistribution should a localized zone of supporting soils become saturated.

6.2.1.2 Resistance to Lateral Loads

Proposed walls/structures that will retain soil must be designed to withstand lateral soil pressures. Cantilevered retaining walls, or unrestrained walls subject to lateral earth pressures, should be designed for an equivalent fluid pressure (EFP) of 34 PCF. Restrained walls should be designed to withstand a residual or long-term at-rest (Ko) earth pressure condition of 53 pounds per cubic foot (PCF).

A passive EFP of 300 PCF may be used for shallow spread footings. A coefficient of friction of 0.40 is recommended for computing lateral resistance between the base of footing and soil in analyzing lateral loads. Vehicular surcharge loads and/or hydrostatic pressure will increase the recommended EFP.

Only cohesionless, free-draining granular materials should be used as backfill, adjacent to earth-retaining structures. We recommend that backfill directly behind the walls be compacted with light, hand-held compactors. Heavy compactors and grading equipment should not be allowed to operate within 3 feet of the walls during backfilling, to avoid developing excessive temporary or long-term lateral soil pressures. Positive gravity drainage of the backfill should be provided.

6.2.2 Retaining Walls

6.2.2.1 Lateral Earth Pressures

If retaining walls are utilized in this project, they should be designed to resist the earth pressure exerted by the retained, compacted backfill plus any additional lateral force that will be applied to the wall due to surface loads placed at or near the top of the wall. The at-rest earth pressure against walls that are restrained at the top and with level backfill may be taken as equivalent to the pressure exerted by a fluid weighing 53 pounds per cubic foot (pcf). Fifty percent of any uniform areal surcharge placed at the top of a restrained wall may be assumed to act as a uniform horizontal pressure over the entire height of the wall.

Retaining walls that are not restrained at the top and with backfill, which is level behind the wall, may be designed for an active earth pressure developed by an equivalent fluid weighing 34 pcf. Thirty percent of any uniform surcharge may be assumed to act as a uniform horizontal pressure over the entire height of the wall.

6.2.2.2 Wall Drainage

The above-recommended values do not include lateral pressures due to hydrostatic forces. Therefore, wall backfill should be free draining and provisions should be made to collect and dispose of excess water that may accumulate behind earth retaining structures.

Wall drainage should be collected by continuous perforated drainpipes, filter fabric, and gravel connected to weep holes. The drainpipe must run parallel to the wall. We recommend drainrock consist of durable stone having 100 percent passing the 1-inch sieve and zero percent passing the No. 4 sieve. Synthetic filter fabric should have an equivalent opening size (EOS), U.S. Standard Sieve, of between 40 and 70, a permeability of at least 0.02 centimeters per second and minimum puncture strength of 50 pounds.

6.2.2.3 Backfill Placement

All backfill should be placed and compacted in accordance with recommendations provided above for engineered fill. Light equipment should be used during backfill compaction to minimize possible overstressing of the wall.

6.2.3 Box Culverts

A total of 13 culverts are anticipated along the project alignment. Based on our understanding of the 30% project plans all culverts will bear on native soils. We anticipate that the scour depth will not exceed the bottom elevation of the culvert. Base on our exploration and the above assumptions, we provide the following design recommendations:

- An allowable bearing pressure of 3,000 pounds per square foot may be used for box culverts bearing at a minimum depth of 48 inches below adjacent grade or greater.
- A passive EFP of 300 PCF may be used for design. A coefficient of friction of 0.40 is recommended for computing lateral resistance between the base and soil in analyzing lateral loads.
- Estimated settlement of the box culvert is estimated to be 1-inch total and 1/2 –inch differential.
- The excavations should be observed by the Geotechnical Engineer prior to placement of reinforcing steel and/or concrete.

Culvert walls which are laterally supported and can be expected to undergo only a slight amount of movement should be designed for an at rest lateral earth pressure of 53 pounds per cubic foot (PCF). Cantilevered retaining walls, or unrestrained walls subject to lateral earth pressures, should be designed for an equivalent fluid pressure (EFP) of 34 PCF. The pressures assume drained soil conditioned behind structure, a horizontal backfill surface, and no surcharge.

6.3 Pavement Areas

6.3.1 Asphalt Pavements

The on-site soils should be suitable as pavement subgrade soils provided all unsuitable debris, rubble, oversized cobbles, etc. are removed. A flexible pavement is recommended for the pavement areas. The recommended pavement sections are based on the assumption that the subgrade soils are prepared in accordance with section 6.1.7 of this report.

The flexible pavement section should consist of Central Plant Mix Asphaltic Concrete Pavement (AC) on compacted Aggregate Base Course (ABC) as recommended in the table below. Flexible pavement should be placed in accordance with MAG Section 321 and local municipality standards.

6.3.2 Roadway Classification

The following roadway classifications were provided by Jacobs Engineering based on consultation with Maricopa County Department of Transportation.

Table 4
Roadway Classification

Pavement Section	Designation
Palm Lane	Principle Arterial (Park and Ride)
Encanto Boulevard	Major Collector Road
Virginia Avenue	Local Residential
Thomas Road	Minor Arterial Road
Indian School Road	Principle Arterial
Minnezona Avenue	Local Residential
Camelback Road	Minor Arterial Road
Colter Street	Local Residential
Jackrabbit Trail	Principle Arterial
O&M Roadways	O&M

6.3.3 Traffic

The following traffic counts were based on average weekday two-way traffic recorded in 2007 obtained from the Maricopa Association of Governments website (http://www.mag.maricopa.gov /pdf/cms.resource/MAG_2007_Traffic-Counts-Map_Final-v421934.pdf).

Table 5a
Traffic Volumes

Pavement Section	Average Weekday Volumes (Two-way)
Thomas Road	1,000
Indian School Road	4,000
Jackrabbit Trail	4,000

Traffic counts for the following roadways were not available at the time of this investigation. Therefore, the following traffic counts were estimated based on similar traffic conditions.

Table 5a
Traffic Volumes

Pavement Section	Average Weekday Volumes (Two-way)
Palm Lane	500
Encanto Boulevard	750
Virginia Avenue	500
Minnezona Avenue	750
Camelback Road	1,000
Colter Street	500

A traffic directional distribution of 50 percent was used to determine the one-way average daily traffic (ADT). A design life of 20 years was used in design. The following assumed traffic distribution was used with the corresponding equivalent factors for design: 91 percent passenger cars (0.0008), 3 percent buses (0.6806), 3 percent panel & pickup trucks (0.0122), and 3 percent three axle Tractor semi trailer (0.8646). A four percent growth was applied to the total calculated equivalent single axial loads (ESALs) for each roadway.

The O&M roadways were designed using a maximum of 250,000 ESALs for a 20-year design life.

6.3.4 Recommended Structural Number

Please refer to Appendix D for additional parameters used in design. Summary of the recommended pavement sections and structural numbers are presented below:

Table 6
Pavement Sections

PAVEMENT AREA	ASPHALT SURFACE THICKNESS (IN)	AGGREGATE BASE COURSE THICKNESS (IN)	STRUCTURAL NUMBER (SN)
Virginia Avenue, Colter Street, Minnezona Avenue	2 ½	6	1.77
Encanto Boulevard,	2 ½	9	2.13
Palm Lane, Thomas Road, Indian School Road, Camelback Road, Jackrabbit Trail	4	10	2.88
	5	7	2.94
O&M Roadways	2	6	1.56

Two options have been provided for the collector and arterial roads above. Our calculations for design of the pavements are based upon our classification of the subsurface soils, the reported or assumed traffic in 18 kips equivalent single axle loads referenced above, the site preparation and grading recommendations provided above. Due to low traffic counts (available traffic data) minimum pavement sections by roadway classification governed design.

Areas subject to sustained, heavy concentrated loads, such as dumpster areas should be paved with PCC. A pavement section of 6 inches of PCC on 4 inches of aggregate base course is recommended in these areas. We should be contacted for additional recommendations if there will be any areas subjected to volumes of traffic heavier than those assumed for this report.

Aggregate Base Course (ABC), Asphalt concrete materials and mix design should conform to the local governing and/or MAG Specifications.

6.3.5 Aggregate Base Course

Aggregate base used in support of concrete or asphalt pavements should conform to the local governing and/or M.A.G. Section 702 Specifications. The plasticity index of the fraction of material passing the No. 40 sieve should not exceed five when tested in accordance with ASTM Test Method D 4318. Coarse aggregate should have a percent of wear, when subjected to the Los Angeles abrasion test (ASTM Test Method C 131), of no greater than 40.

All aggregate base should be placed in lifts not thicker than eight inches and compacted to a minimum of 98 percent of maximum dry density as determined by American Society for Testing and Materials (ASTM) Test Method D 698 or as specified by local specifications. The moisture content during compaction should be maintained within two percent of optimum moisture content.

6.4 Pipe Installation and Trench Backfill

The following sections present geotechnical design, and construction recommendations for the evaluation of soil loads on flexible pipes.

6.4.1 Soil Loads on Buried Flexible Pipes

The pipe loading pressure for flexible pipes such as PVC, HDPE, or welded steel may be determined by calculating the soil overburden pressure, adding the live load pressures and multiplying by the pressure transfer coefficient Cp. The coefficient Cp typically varies from 0.65 to 2.0 depending on the type and degree of compaction of the bedding and initial backfill materials. The value of Cp may be determined from the pipe manufacturers or may be conservatively estimated as Cp = 2.0. For aggregate base or clean washed sand bedding and initial backfill materials compacted as recommended in this report, a Cp value of 0.80 is recommended for design.

6.4.2 Design Values for Buried Flexible Pipes

Flexible pipes typically derive part of their resistance to ring deflection from the initial backfill and trench wall soils. Evaluation of ring deflection of buried pipes under soil and live loads may be determined using the Iowa Formula. The elastic modulus of the soils surrounding the pipe, or E', may be evaluated by knowing the trench width, the pipe diameter, the elastic modulus of the initial backfill (E'b), and the elastic modulus of the native trench wall soils (E'n - also termed Constrained Modulus). Recommendations for pipe design using the Iowa Formula are presented in Table 7.

Table 7 presents recommended E'b values for use in the Iowa Formula for proposed initial backfill materials placed and compacted in accordance with our recommendations. The value of E'b is a lateral modulus of subgrade reaction for the initial backfill material. For E'b values at depths between the intervals presented below, the E'b value between data points may be determined by linear interpolation.

The recommended E'b values presented in Table 7 apply to aggregate base or graded sand bedding and initial backfill material along the sides of the pipe at the recommended level of compaction. These values are applicable for pipe design where the initial backfill width is at least 2 times the pipe diameter (D) on each side of the pipe (trench width of 5D).

Table 7
E'b Values for Design of Buried Flexible Pipes

Soil Type	Depth to Springline	Recommended E'b (psi)
Pipe Bedding and Initial Backfill (aggregate base or graded sand)	5 10 15	1000 1500 1600

Notes: 1. The above design values are based on "Evaluation of the Modulus of Soil Reaction, E', and its Variation With Depth," by Hartley & Duncan, dated June 1982.
2. Based on providing at least 2 pipe diameters of backfill on each side of pipes.

Where the zone of backfill beside the pipe is less than 2D, the E'b values resented above may not be applicable and the constrained soil modulus E'n will affect flexible pipe design. The actual lateral soil modulus at the pipe depth will lie somewhere between E'b and E'n depending on the trench width.

Based on the field and laboratory data obtained along the pipeline alignments, we recommend an E'n value of 2,000 psi for the pipeline parallel to FRS #3 and 3,000 psi for the pipeline under the spillway (AWWA M45, 1996) be used for design of flexible pipes. This value is applicable to the undisturbed native soils encountered at the site. For trench widths less than 5D, the design E' may be calculated by multiplying E'b by the Soil Support Combining Factors (Sc) presented in Table 8, where Bd is the trench width at pipe springline and D is the diameter of the pipe.

$$\text{Design } E' = Sc(E'b)$$

Table 8
Sc Values For Design of Buried Flexible Pipes
(Soil Support Combining Factor)

E'n/E'b	Bd /D 1.5	Bd /D 2.0	Bd /D 2.5	Bd /D 3.0	Bd /D 4.0	Bd /D 5.0
0.1	0.15	0.30	0.60	0.80	0.90	1.00
0.2	0.30	0.45	0.70	0.85	0.92	1.00
0.4	0.50	0.60	0.80	0.90	0.95	1.00
0.6	0.70	0.80	0.90	0.95	1.00	1.00
0.8	0.85	0.90	0.95	0.98	1.00	1.00
1.0	1.00	1.00	1.00	1.00	1.00	1.00
1.5	1.30	1.15	1.10	1.05	1.00	1.00
2.0	1.50	1.30	1.15	1.10	1.05	1.00
3.0	1.75	1.45	1.30	1.20	1.08	1.00
≥5.0	2.00	1.60	1.40	1.25	1.10	1.00
Source: "AWWA M45,", 1996.						

6.4.3 Flexible Pipe Trench Width Recommendations

According to ASTM D 2321, "Standard Practice for Underground Installation of Thermoplastic Pipes for Sewers and other Gravity-Flow Applications", the minimum trench width for flexible pipes should be the greater of 16 inches greater than the pipe diameter or 1.25 times the pipe diameter plus 12 inches. For flexible pipes, the trench width should be kept to a minimum to reduce the soil loading on the pipes. Wider trenches will generally impart higher soil loads on buried flexible pipes. Where granular pipe zone backfill is used, the trench should be wide enough to accommodate compaction equipment and shoring along the sides of the pipe. Care should be taken during installation of the pipe zone backfill around the haunches of the pipe (i.e., from the bottom of the pipe to springline) such that voids are eliminated and the backfill material is firm and unyielding. Lateral restraint against ring deflection for the pipes will be provided by the stiffness of the pipe zone backfill material and/or the trench wall soils.

6.4.4 Flexible Pipe Construction Considerations

Flexible pipes require uniform support from bedding materials especially in haunch areas to prevent overloading. The pipeline designers should evaluate the proximity of adjacent pipelines, excavations, and their related effects on the proposed construction. If proper trench wall support cannot be provided in a portion of the pipe trench, we recommend consideration be given to the use of lean concrete or Controlled Low Strength Material (CLSM) initial backfill around the pipes. In general we recommend lean concrete or CLSM materials designed to meet MAG Specification 728 Controlled Low Strength Material.

6.4.5 Trench Backfill

Materials

Pipe zone backfill (i.e., material beneath and in the immediate vicinity of the pipe) should consist of aggregate base or graded sand with a maximum particle size less than one inch. Trench zone backfill (i.e., material placed between the pipe zone backfill and finished subgrade) may consist of site soil or soil that meets the requirements for import fill provided in Section 6.1.10.

If import material is used for pipe or trench zone backfill, we recommend it consist of well-graded sand, or aggregate base. In general, poorly graded coarse-grained sand and gravel should not be used for pipe or trench zone backfill due to the potential for soil migration into the relatively large void spaces present in this type of material and water seepage along trenches backfilled with coarse-grained sand and/or gravel.

Recommendations provided above for pipe zone backfill are minimum requirements only. More stringent material specifications may be required to fulfill local codes and/or bedding requirements for specific types of pipes. We recommend the project Civil Engineer develop these material specifications based on planned pipe types, bedding conditions, and other factors beyond the scope of this study.

Compaction Criteria

Backfill of trenches should utilize non-expansive (preferably granular) soils, in order to aid compaction and reduce potential differential settlement problems. Backfilling of utility trenches should be in 6 to 8-inch maximum loose lifts, and compacted to a minimum of 90%, and 95% of ASTM D-698 (standard Proctor), in non-structural areas and structurally loaded areas, respectively. Please note that the local governing agency specifications may surpass these trench backfill requirements. Water settling or jetting, flooding, or pudding shall not be utilized.

6.5 Moisture Protection

Positive drainage is a key to the successful performance of any structure. Good surface and subsurface drainage should be established during and after construction to prevent the soils below or adjacent to the structural areas from becoming wet.

Infiltration of water into utility or foundation excavations must be prevented during construction. The drainage design must route all storm and landscape water away from the structural areas in a positive manner. All water should be diverted away from areas where it could penetrate the ground surface near the structures.

6.6 Corrosion Potential

Electrical Resistivity of a soil is a measure of resistance to the flow of electrical current. Corrosion of buried metal is an electrochemical process in which the amount of metal loss due to corrosion is directly proportional to the flow of electrical current (DC) from the metal into the soil. As a soil's resistivity decreases, its corrosivity increases.

A commonly accepted correlation between soil resistivity and corrosivity towards ferrous metals is shown in the following table.

Table 9
Resistivity and Relative Corrosivity

Resistivity (ohm-cm)	Corrosivity Classification
0 to 1,000	severely corrosive
1,000 to 2,000	Corrosive
2,000 to 10,000	Moderately corrosive
Over 10,000	Mildly corrosive

Table 10
pH and Resistivity Test Results

Sample Location	pH	Resistivity (Ohm-cm)
Bulk Sample B-5	7.1	9,650
Bulk Sample B-8	7.2	9,500
Bulk Sample B-12	7.1	8,970
Bulk Sample B-13	7.2	6,985
Bulk Sample B-25	7.1	10,250
Bulk Sample B-27	6.9	7,800
Bulk Sample B-31	6.8	7,750
Bulk Sample B-37	6.7	6,120
Bulk Sample B-42	7.0	11,250
Bulk Sample B-44	7.1	9,540
Bulk Sample B-47	7.3	11,250

Based on the laboratory tests as shown in the preceding table, this soil would be considered "moderately to mildly corrosive". It should be noted that these corrosion conditions are for the soils at submerged moisture conditions. Resistivities at drier moisture contents would be less corrosive than the results of the test.

Estimated life for 16 and 14 gage galvanized CMP, based on Figure 6.7 of the Handbook of Steel Drainage & Highway Construction Products published by American Iron and Steel Institute Fourth Edition, 1993, is tabulated below. Details of the laboratory test results are presented in the Appendix C of this report.

Table 11
Estimated life for 16 and 14 gage galvanized CMP

Sample Location	Design Life (yrs)	
	Gage 16	Gage 14
Bulk Sample B-5	85	136
Bulk Sample B-8	92	148
Bulk Sample B-12	84	135
Bulk Sample B-13	88	140
Bulk Sample B-25	86	138
Bulk Sample B-27	73	117
Bulk Sample B-31	70	112
Bulk Sample B-37	64	102
Bulk Sample B-42	83	132
Bulk Sample B-44	85	136
Bulk Sample B-47	109	174

7 CLOSURE

7.1 Limitations

Our professional services have been performed using that degree and skill ordinarily exercised, under similar circumstances, by reputable Geotechnical Engineers practicing in this or similar localities. No warranty is expressed or implied is made regarding the recommendations and opinions presented in this report.

The recommendations contained in this report are based on our field exploration, laboratory test results, and our understanding of the proposed construction. The subsurface data used in the preparation of this report was obtained from the test borings excavated during the field subsurface exploration. It is anticipated that some variations in the soil conditions will exist on-site. The nature and extent of variations may not be evident until construction occurs. If any conditions are encountered at this site that are different from those described in this report, we should be immediately notified so that we may make any necessary revisions to the recommendations contained in this report. In addition, if the scope of the proposed construction changes from that described in this report, our firm should also be notified.

It is the Client's responsibility to see that all parties to the project including the designer, contractor, subcontractor, etc. are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk.

This report is for the exclusive purpose of providing Geotechnical Engineering and/or testing information and recommendations. The scope of services for this project does not include, either specifically or by implication, any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken. This report has also not addressed the site geology and the possible presence of geologic hazards.

This report may be used only by the Client and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on and off-site), or other factors may change over time, and additional work may be required with the passage of time. Any party, other than the Client, who wishes to use this report, shall notify Alpha of such intended use. Based on the intended use of this report, Alpha may require that additional work be performed and that an updated report be issued.

7.2 Recommended Additional Services

The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be performed during the construction. These tests and observations should be performed by the Geotechnical Engineer's representative and should include, but are not necessarily be limited to the following:

- Observe and document that any existing surficial vegetation and other deleterious materials have been removed from the site as required in site preparation section.
- Approve any material used as engineered fill in structural areas to document that it meets the requirements outlined above before placement.
- Monitor the scarification operations of the exposed subgrade.
- Monitor earthwork operations to document those footings are bearing in soils as recommended above.
- Monitor the backfill procedures.
- Perform field density tests, as needed, to verify compaction compliance. The representative should monitor the progress of compaction and filling operations.
- Keep records of on-site activity and progress.

Observation of footing excavations should be performed prior to placement of reinforcing and concrete to confirm that satisfactory bearing materials are present. Construction testing, including field and laboratory evaluation of fill and backfill materials, concrete and steel should be performed to determine whether applicable project requirements have been met.

8 REFERENCES

Euge, Kenneth M., Schell, Bruce A., and Po Lam, Ignatious, 1992, Development of Seismic Acceleration Contour Maps for Arizona. Arizona Department of Transportation, One Sheet.

Euge, Kenneth M., Schell, Bruce A., and Po Lam, Ignatious, 1992, Map of Horizontal Acceleration at Bedrock for Arizona with 90 Percent Probability of Non-Exceedance. Arizona Department of Transportation, One Sheet.

Hammett, B.A. and Herther, R.L., 1991, Maps Showing Groundwater Conditions in the Phoenix Active Management Area, Maricopa, Pinal, and Yavapai Counties, Arizona. Arizona Department of Water Resources. One Sheet.

Schumann, H. H., 1974, Land Subsidence and Earth Fissures in Alluvial Deposits in the Phoenix Area, Arizona. U.S. Geological Survey. One Sheet.

Schumann, H. H. and Genualdi, Robert B., Land Subsidence and Earth Fissures, and Water-Levl Change in South Arizona. One Sheet.

ADWR; 2004; InSAR Interferometry Data: DifSAR Deformation Data July 10, 1992 to October 30, 2000 (5 cm/full fringe)

AMEC; 2009; Draft Preliminary Ground Subsidence and Earth fissure Evaluation, White Tanks FRS No. 3 Outfall Channel, Maricopa County, Arizona; prepared by AMEC Earth & Environmental, Inc., Tempe, Arizona; AMEC Job No. 0*9-117-01019 for Flood Control District of Maricopa County, FCD Contract No. 2008-C016, Work Assignment 9; July 31, 2009; 11 p.

AMEC; 2004; Preliminary Geotechnical Investigation Report, White Tanks FRS No. 3, Contract FCD 2003C014, Work Assignment 1; prepared by AMEC Earth & Environmental, Inc., Phoenix, Arizona; AMEC Project No. 4-117-001040 for Flood Control District of Maricopa County, FCD Contract No. 2003-C014, Work Assignment 3; June 16, 2004; 11 p. ; 27 p.

AMEC; 2004; Supplemental Appraisal of Earth Fissure Risk, White Tanks FRS No. 3, Contract FCD 2003C014, Work Assignment 1; prepared by AMEC Earth & Environmental, Inc., Phoenix, Arizona; AMEC Project No. 3-117-001076; 27 p.

Arizona Geological Survey (AzGS); 2009; Earth Fissure Map of the Luke Study Area, Maricopa County, Arizona; Scale 1:24,000; Digital Map Series, Earth Fissure Map 8 (DM-EF-8); February 2009.

Bureau of Reclamation (BOR); 1976; Central Arizona Project Geology and Groundwater Resources Report, Maricopa and Pinal Counties, Arizona; Volumes 1 and 2; December 1976.

Conway, B. D.; 2009; InSAR Interferograms and Interferometry Data: DifSAR Deformation Data October 4, 2003 to November 21, 2009; Arizona Department of Water Resources, Deliverable 9, IGA FCD 2005A005, December 3, 2009.

Dames & Moore; 1998; Draft Design Issues Report, White Tanks FRS No. 3, Modifications Design Project for Flood Control District of Maricopa County; Contract No. FCD98-11, PCN 4700430; D & M Project No. 15448-005-022; November 20, 1998.

Field, J.J. and Pearthree, P.A.; 1991; Surficial Geology Around the White Tank Mountains, Central Arizona; Arizona Geological Survey; Open-File Report 91-8, November 1991; 7 p.

Geological Consultants Inc.; 2009: consultant letter from Geological Consultants Inc. to Hoskin Ryan Consultants Inc., November 27, 2009 for Flood Control District of Maricopa County entitled Review of AMEC Report, Draft Preliminary Ground Subsidence and Earth Fissure Evaluation, White Tanks FRS No. 3 Outfall Channel, Maricopa County, Arizona; GCI Project No. 2009-129, HRC PCN 470.04.32, FCD Contract 2009C012; 8 p.

Geological Consultants Inc.; 2008; Seismic Refraction Survey Results, White Tanks FRS No. 3 Remediation Project, October 2008 Additional Phase II Investigation, Maricopa County, Arizona; prepared by Geological Consultants Inc. Phoenix, Arizona, GCI Project No. 2008-162 for URS Corporation & Flood Control District of Maricopa County, FCD Contract 2003C055; November 20, 2008; 5 p.

Geological Consultants Inc.; 2008; Technical Memorandum, Geological and Geologic Hazard Evaluation, White Tanks FRS No. 4; prepared by Geological Consultants Inc. Phoenix, Arizona, GCI Project No. 2004-159 for Gannett Flemming Inc. & Flood Control District of Maricopa County, FCD Contract 2004C019, Work Assignment 6; April 15, 2008; 21 p.

Geological Consultants Inc.; 2006; Foundation Inspection Report, White Tanks No. 3 FRS Remediation Project, Phase I Construction, Maricopa County, Arizona; prepared by Geological Consultants Inc., Phoenix, Arizona; GCI Project No. 2003-162-02 for URS Corporation & Flood Control District of Maricopa County, FCD Contract 2003C055; January 31, 2006; 8 p.

Geological Consultants Inc.; 2004; Subsidence at White Tanks FRS No. 3, Historical and Predictive Subsidence Assessment, prepared by Geological Consultants Inc. Phoenix, Arizona, GCI Project No. 2003-162 for URS Corporation & Flood Control District of Maricopa County, FCD Contract 2003C055; May 17, 2004; 19 p.

Geological Consultants Inc.; 2004; Seismic Refraction Geophysical Survey, Work Assignment No. 2, White Tanks FRS No. 3 Remediation Project; prepared by Geological Consultants Inc. Phoenix, Arizona, GCI Project No. 2003-162 for URS Corporation & Flood Control District of Maricopa County, FCD Contract 2003C055; August 30, 2004; 19 p.

Geological Consultants Inc.; 2002; Geological Input to Structures Assessment Report, McMicken Dam and White Tanks FRS No. 4, Maricopa County, Arizona; prepared by Geological Consultants Inc.

URS Corporation; 2004; 90 Percent Submittal, Draft Design Report, White Tanks FRS No. 3 Remediation Project Phase 1, URS PCN 470.04.30; URS Job No. 23443748; Prepared for Flood Control District of Maricopa County, FCD Contract No. 2003C017; September 13, 2004.

APPENDIX A
SAMPLE LOCATION PLAN

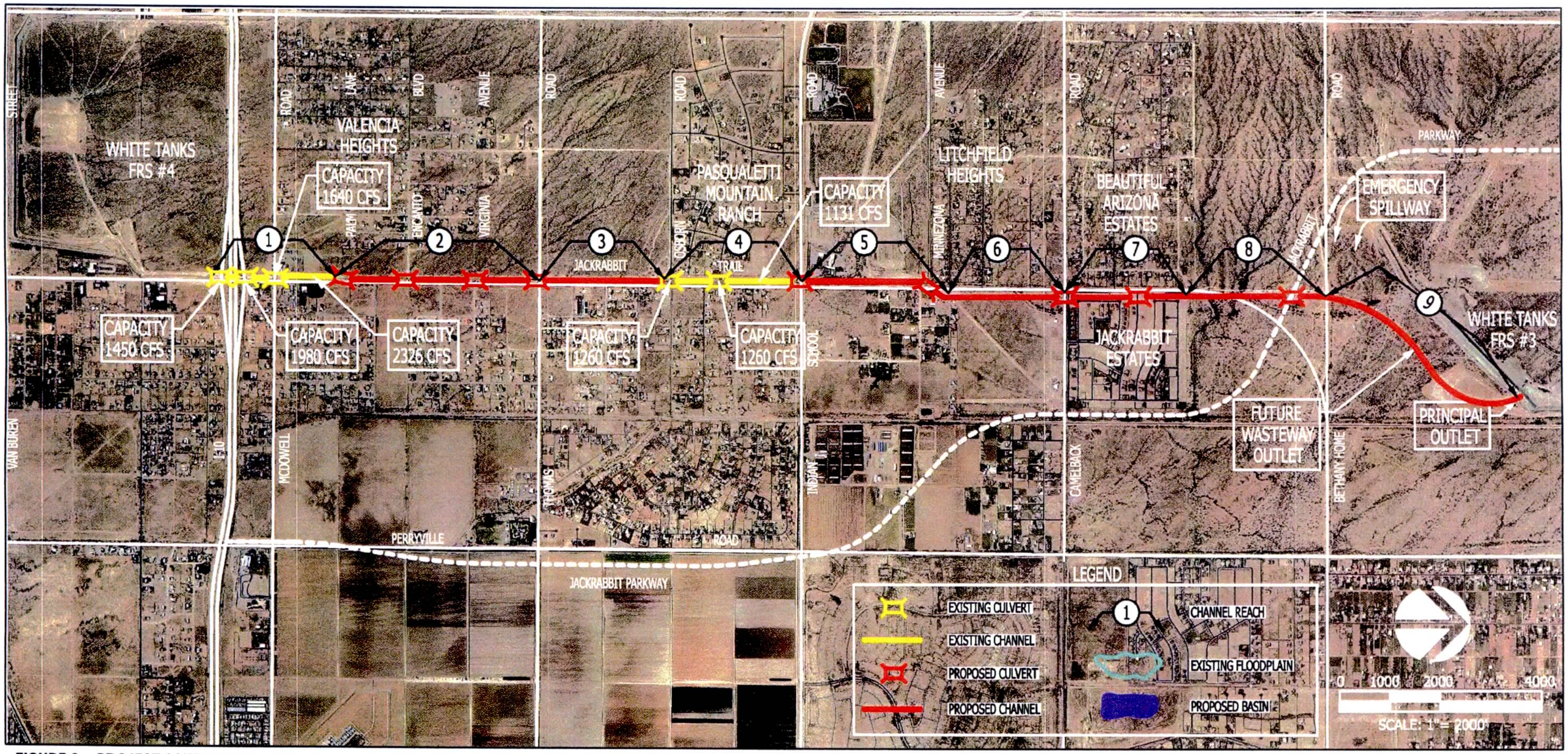
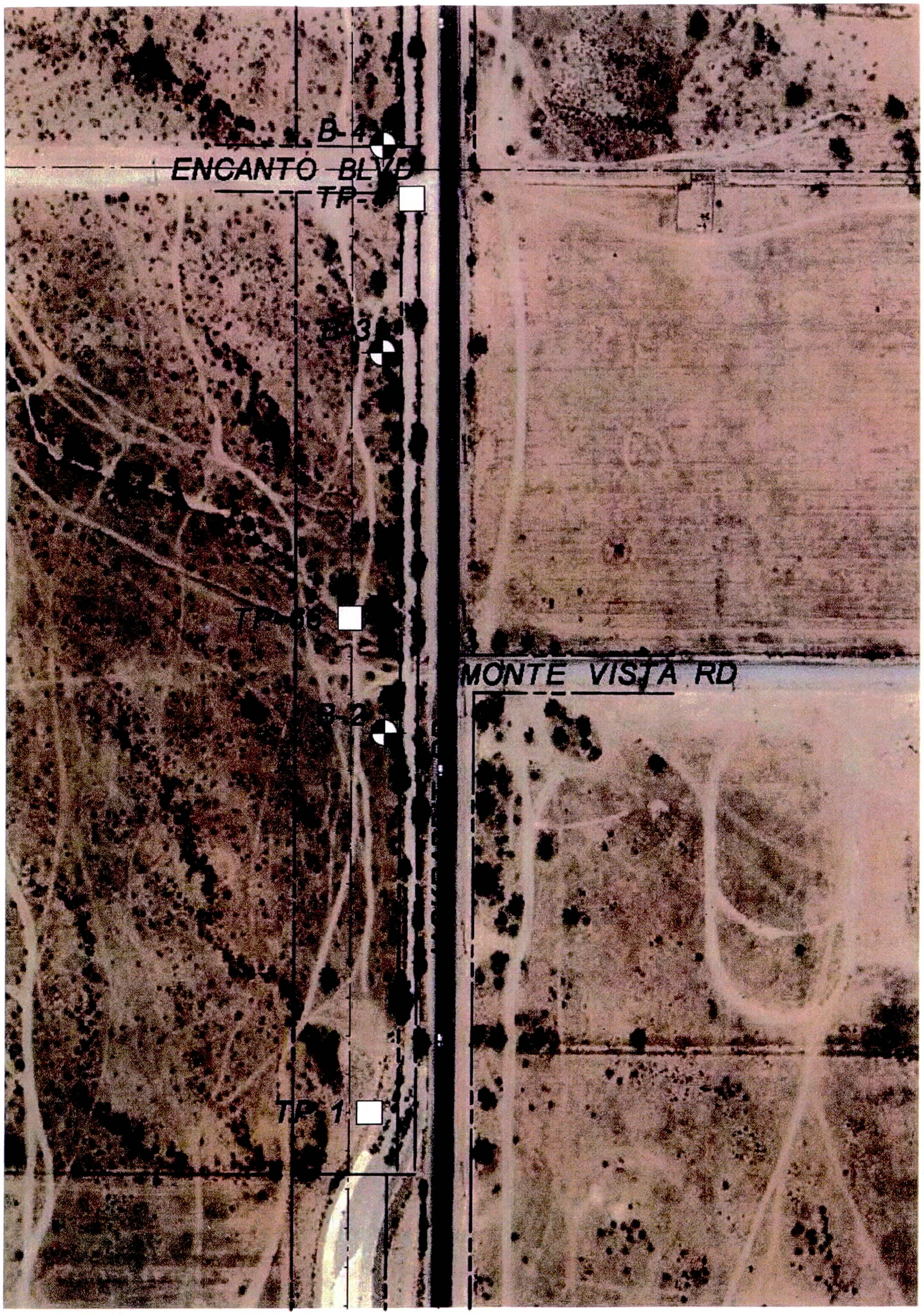
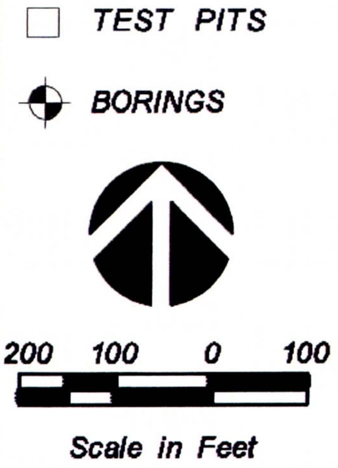


FIGURE 2 – PROJECT SCHEMATIC MAP

Figure 3A





Flood Control District of Maricopa County

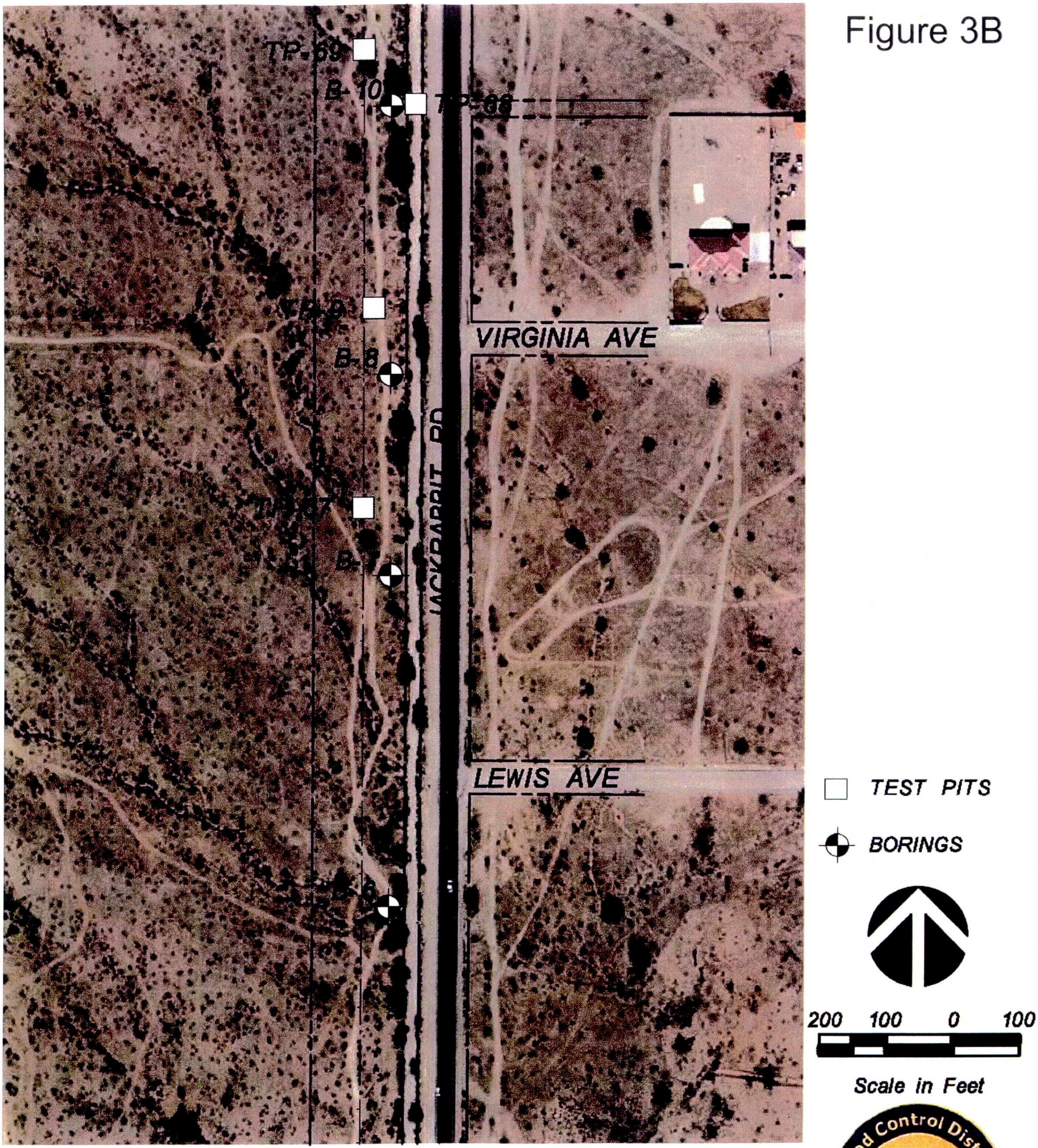
FCD 2009CO12

BORING LOCATIONS

WHITE TANKS FRS NO.3 OUTFALL CHANNEL

Alpha Geotechnical & Materials, Inc. in association with Hoskin • Ryan Consultants

Figure 3B



BORING LOCATIONS

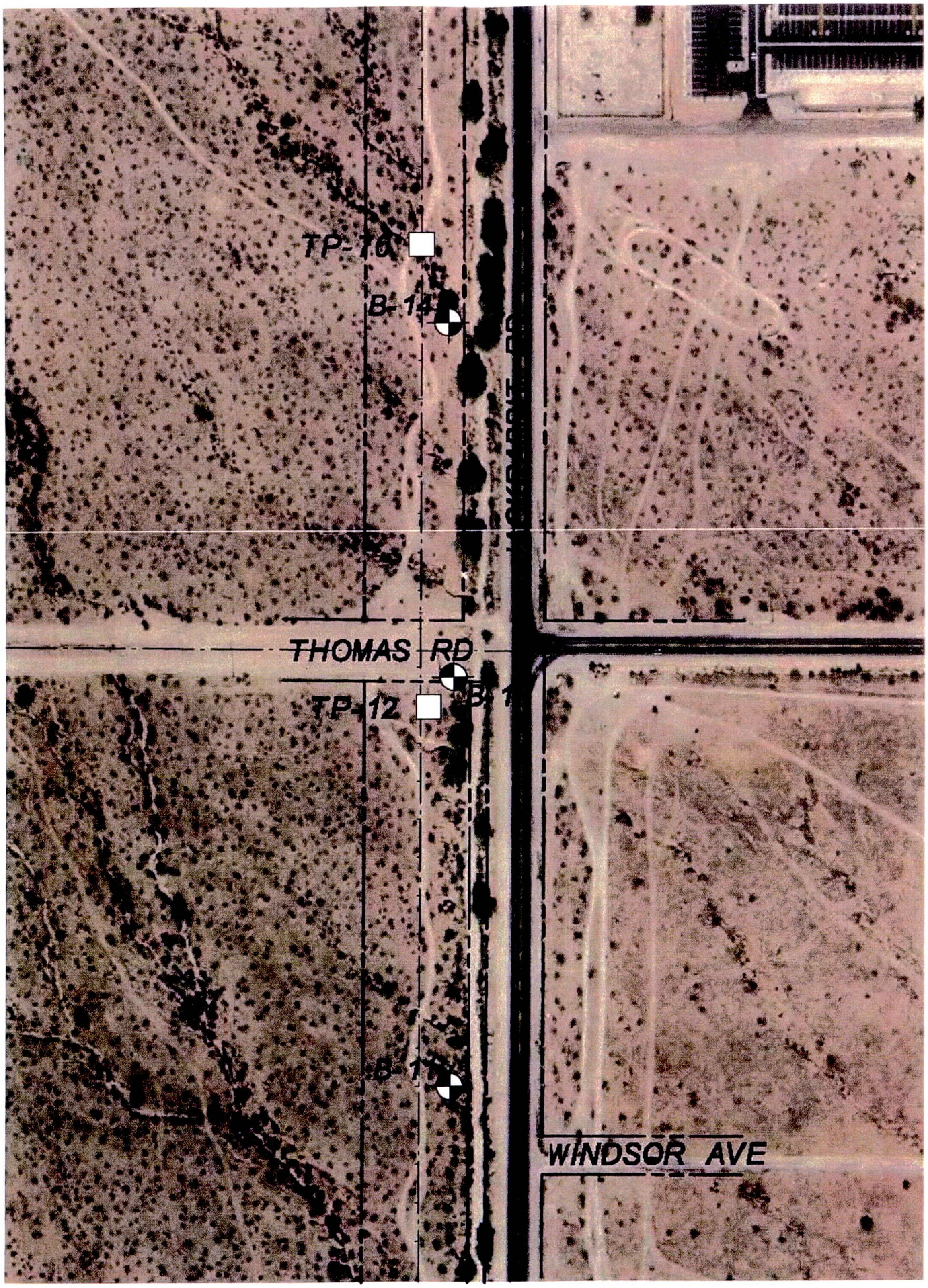
WHITE TANKS FRS NO.3 OUTFALL CHANNEL

Alpha Geotechnical & Materials, Inc. in association with Hoskin • Ryan Consultants creative engineering solutions

Flood Control District of Maricopa County

FCD 2009C012

Figure 3C



TEST PITS

BORINGS

200 100 0 100

Scale in Feet

BORING LOCATIONS

WHITE TANKS FRS NO.3 OUTFALL CHANNEL

Alpha Geotechnical & Materials, Inc. in association with Hoskin • Ryan Consultants creative engineering solutions

Flood Control District of Maricopa County

FCD 2009C012

Figure 3D

TEST PITS

BORINGS

200 100 0 100

Scale in Feet

BORING LOCATIONS

WHITE TANKS FRS NO.3 OUTFALL CHANNEL

Alpha Geotechnical & Materials, Inc. in association with Hoskin • Ryan Consultants creative engineering solutions

Flood Control District of Maricopa County

FCD 2009C012

Figure 3E

TEST PITS

BORINGS

200 100 0 100

Scale in Feet

BORING LOCATIONS

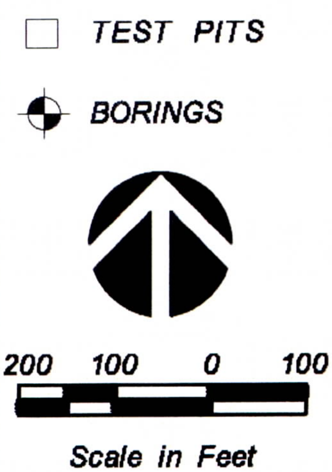
WHITE TANKS FRS NO.3 OUTFALL CHANNEL

Alpha Geotechnical & Materials, Inc. in association with Hoskin • Ryan Consultants *creative engineering solutions*

Flood Control District of Maricopa County

FCD 2009C012

Figure 3F



BORING LOCATIONS

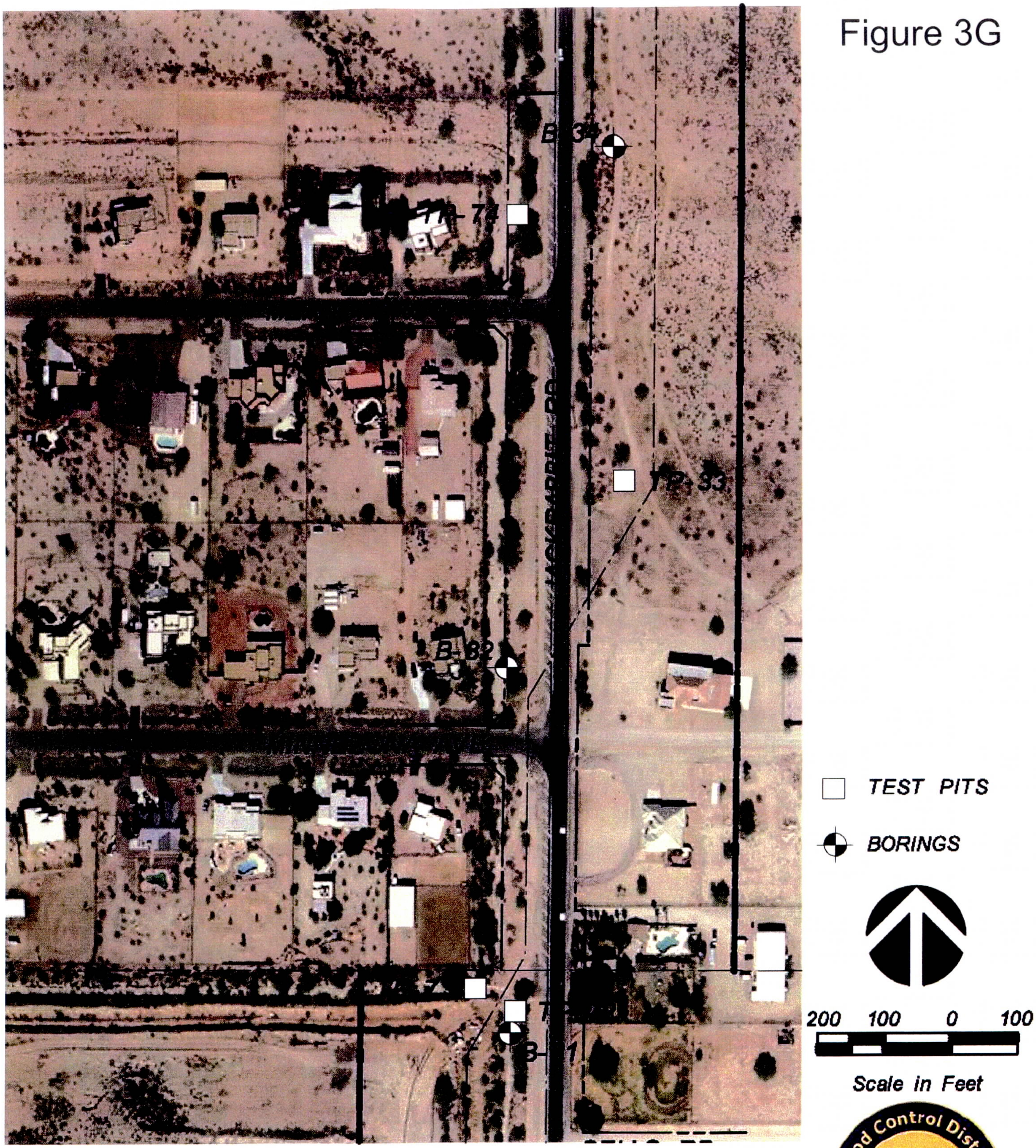
WHITE TANKS FRS NO.3 OUTFALL CHANNEL

Alpha Geotechnical & Materials, Inc. in association with Hoskin • Ryan Consultants *creative engineering solutions*

Flood Control District of Maricopa County

FCD 2009C012

Figure 3G



BORING LOCATIONS

WHITE TANKS FRS NO.3 OUTFALL CHANNEL

Alpha Geotechnical & Materials, Inc. in association with Hoskin • Ryan Consultants *creative engineering solutions*

Flood Control District of Maricopa County

FCD 2009C012

Figure 3H

☐ TEST PITS

BORINGS

200 100 0 100

Scale in Feet

BORING LOCATIONS

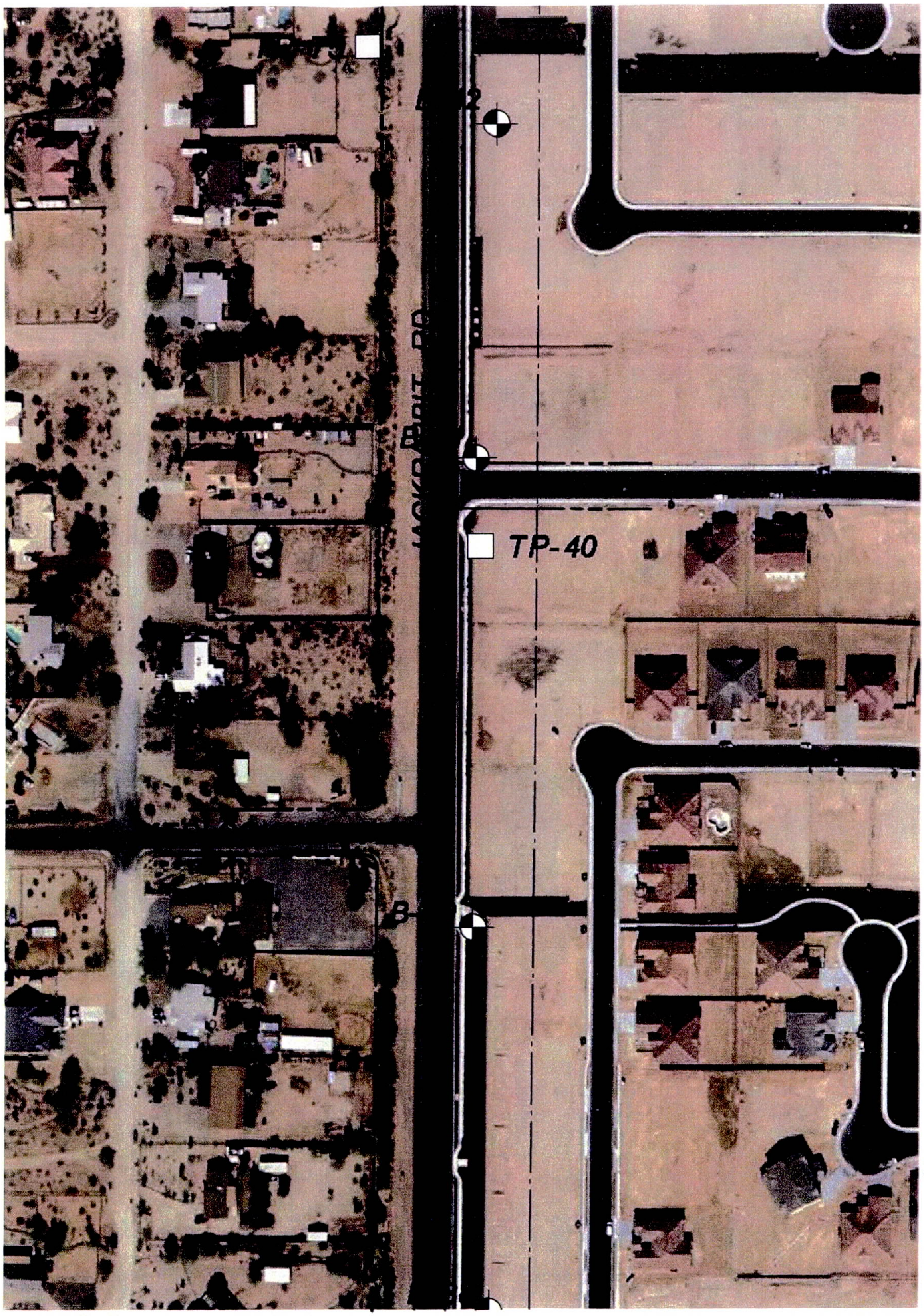
WHITE TANKS FRS NO.3 OUTFALL CHANNEL

Alpha Geotechnical & Materials, Inc. in association with Hoskin • Ryan Consultants *creative engineering solutions*

Flood Control District of Maricopa County

FCD 2009C012

Figure 3I



BORING LOCATIONS

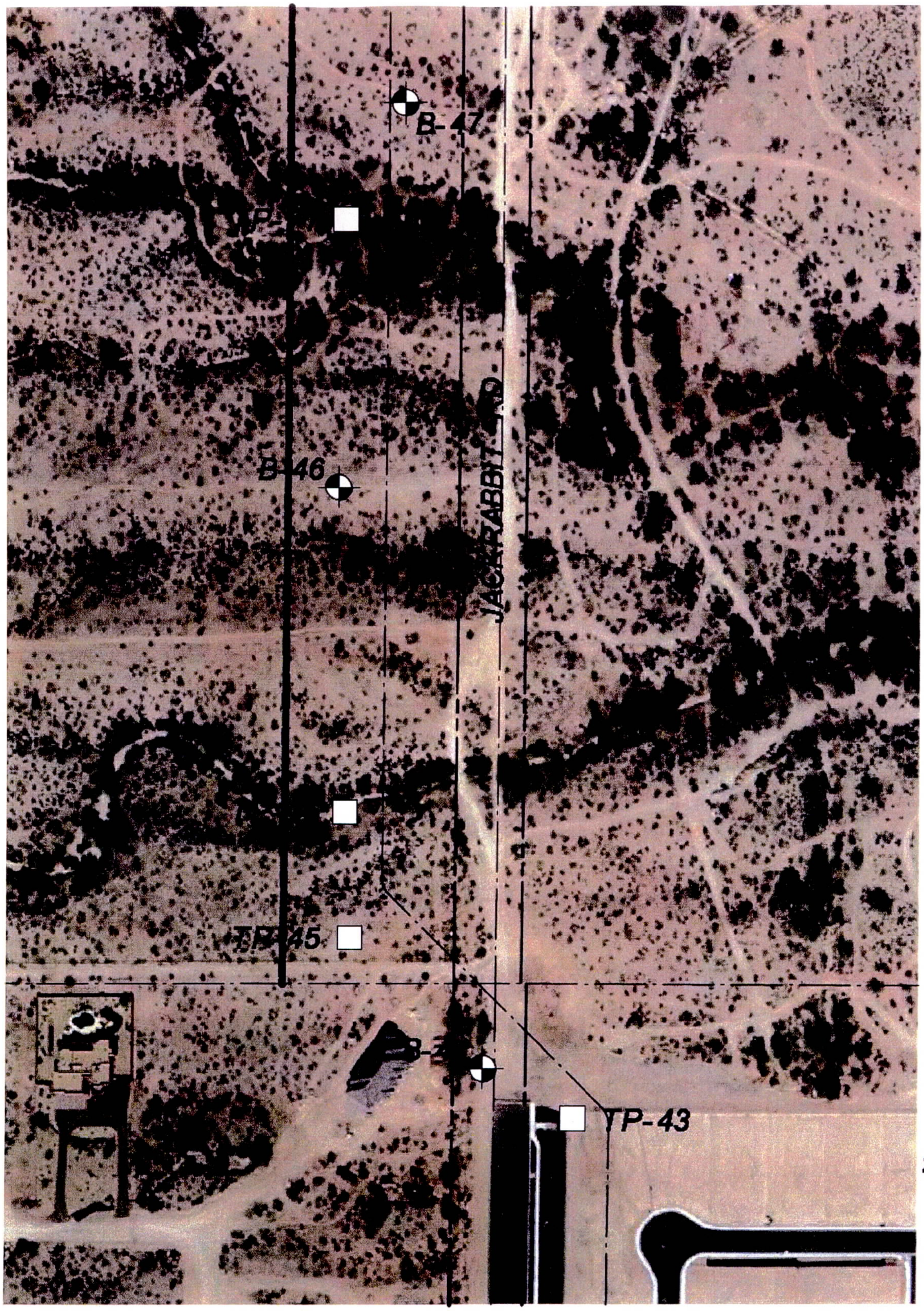
WHITE TANKS FRS NO.3 OUTFALL CHANNEL

Alpha Geotechnical & Materials, Inc. in association with Hoskin • Ryan Consultants creative engineering solutions

Flood Control District of Maricopa County

FCD 2009C012

Figure 3J



TEST PITS

BORINGS

200 100 0 100

Scale in Feet

Flood Control District of Maricopa County

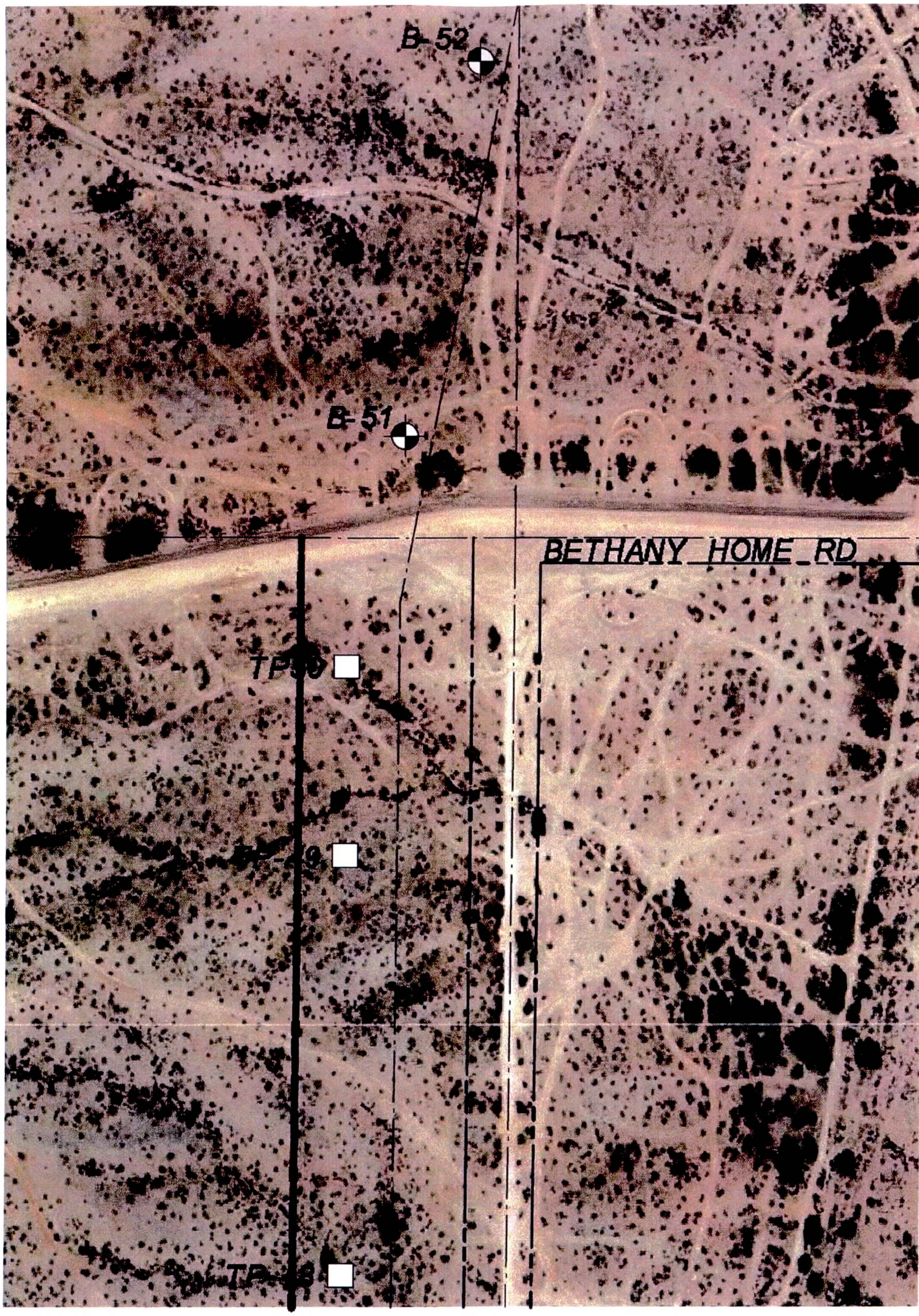
BORING LOCATIONS

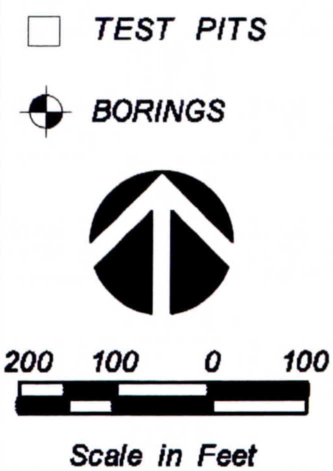
WHITE TANKS FRS NO.3 OUTFALL CHANNEL

Alpha Geotechnical & Materials, Inc. in association with Hoskin • Ryan Consultants creative engineering solutions

FCD 2009C012

Figure 3K





BORING LOCATIONS

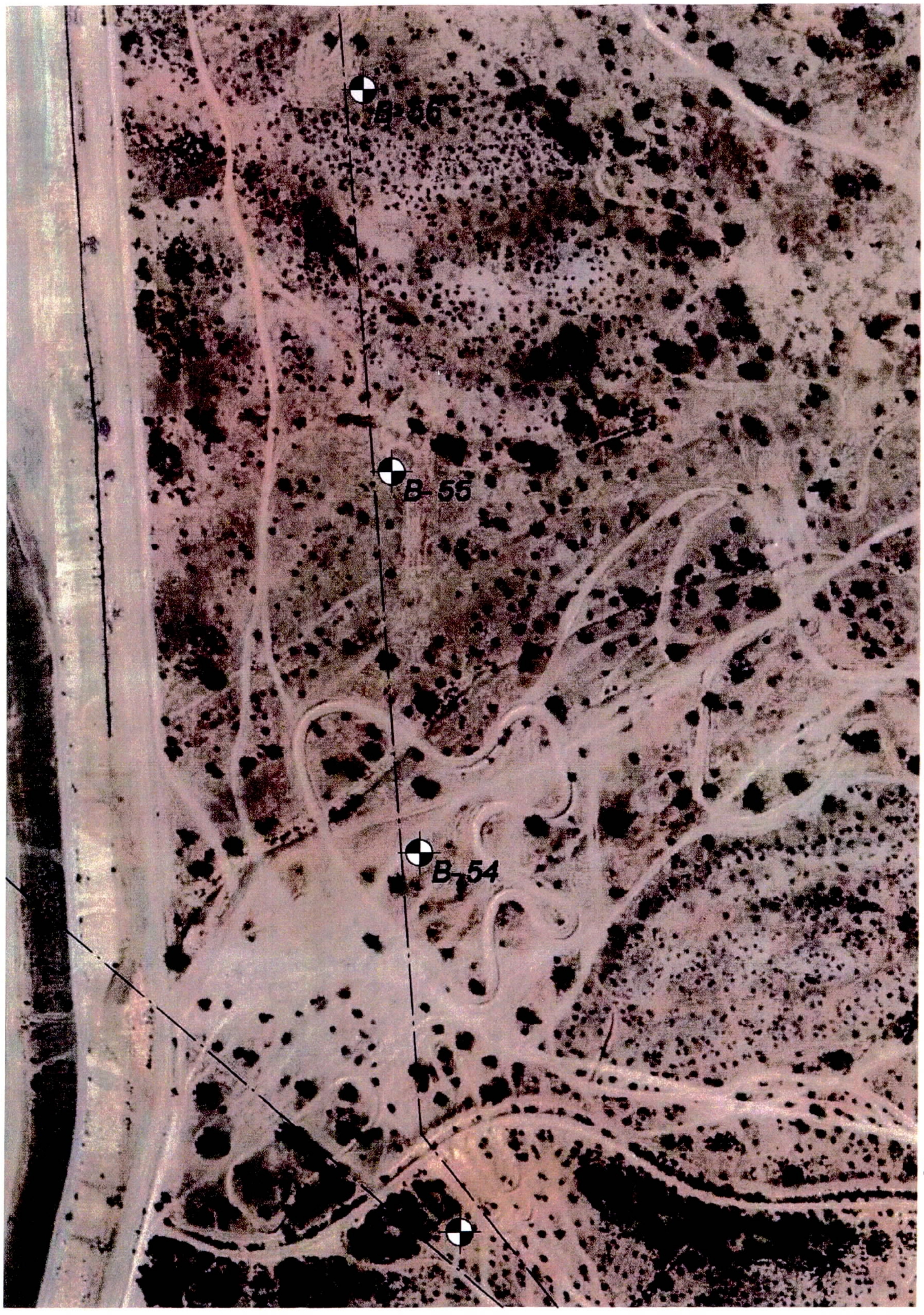
WHITE TANKS FRS NO.3 OUTFALL CHANNEL

Alpha Geotechnical & Materials, Inc. in association with Hoskin • Ryan Consultants creative engineering solutions

Flood Control District of Maricopa County

FCD 2009C012

Figure 3L



TEST PITS

BORINGS

200 100 0 100

Scale in Feet

Flood Control District of Maricopa County

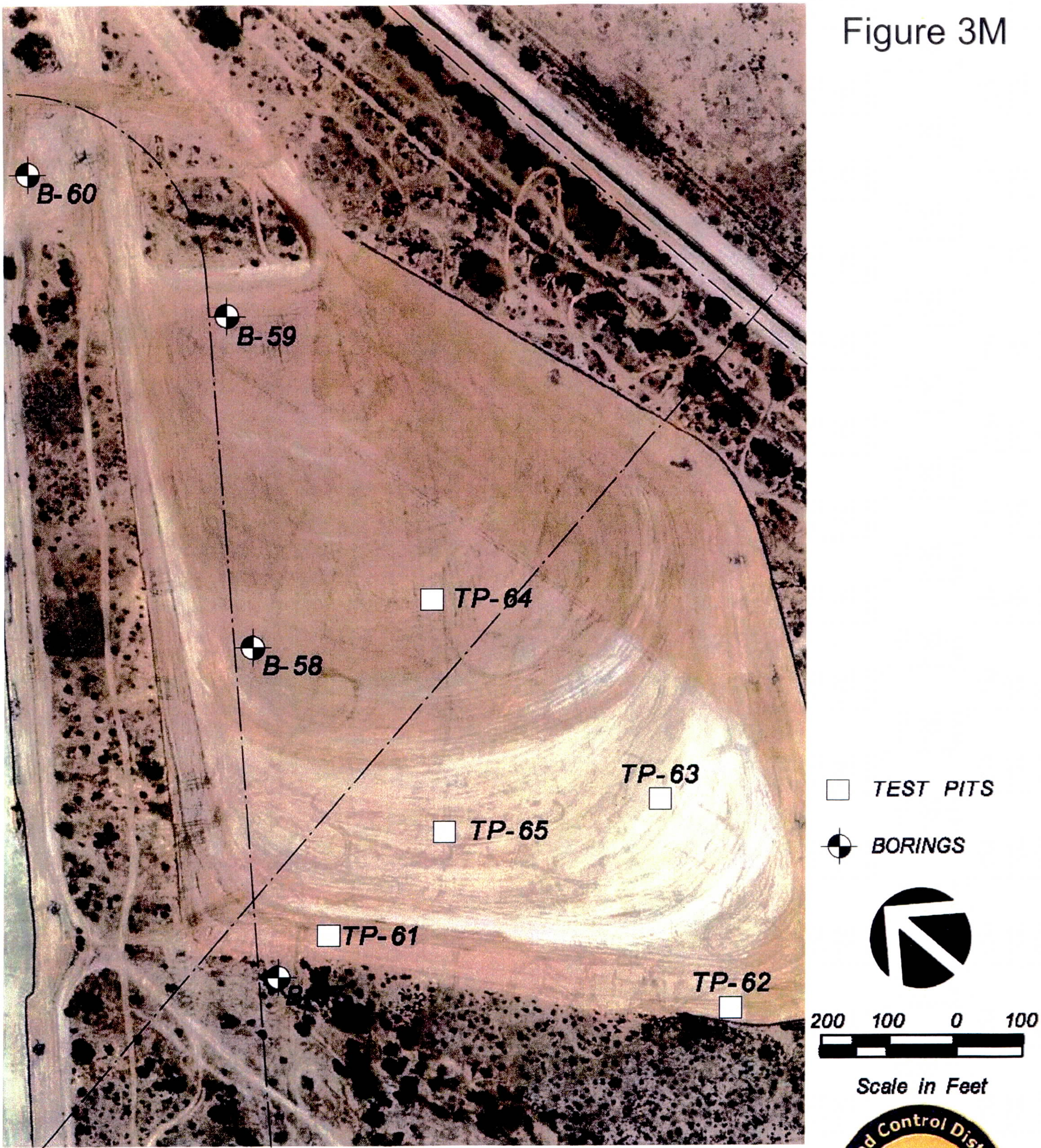
FCD 2009C012

BORING LOCATIONS

WHITE TANKS FRS NO.3 OUTFALL CHANNEL

Alpha Geotechnical & Materials, Inc. in association with Hoskin•Ryan Consultants creative engineering solutions

Figure 3M



BORING LOCATIONS

WHITE TANKS FRS NO.3 OUTFALL CHANNEL

Alpha Geotechnical & Materials, Inc. in association with Hoskin • Ryan Consultants *creative engineering solutions*

Flood Control District of Maricopa County

FCD 2009C012

APPENDIX B
SOIL TEST PIT AND BORING LOGS

APPENDIX B
FIELD INVESTIGATION

TEST LOCATIONS

The subsurface conditions at the site were explored between November 2, 2009, and December 16, 2009 by advancing a total of 77 soil test pits and borings. The soil test pits were advanced using a Case 580 Super Ram backhoe. The soil test borings were advanced using a Dirdrick D-120 and a CME-45 power drill rig. The locations of soil test borings performed for this investigation are shown in appendix A of the report.

Our engineer maintained a log of the excavations; visually classified soils encountered according to the Unified Soil Classification System (USCS) (see USCS Table) and obtained samples of the subsurface materials.

SAMPLING PROCEDURES

Bulk samples were taken from the test pits and borings at selected intervals. Soil samples were packaged and sealed in the field to reduce moisture loss and disturbance, and returned to our laboratory for further testing. After the soil test pits and borings were completed, they were backfilled with the excavated soils.

LIST OF ATTACHMENTS

The following plates are attached and complete this appendix.

Unified Soil Classification System
Logs of Soil Test Pit and Borings

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions			Group Symbols	Typical Names
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		Gravels With Fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		Sands With Fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine-Grained Soils 50% or more passes No. 200 sieve	Silts and Clays Liquid Limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays Liquid Limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat, muck, and other highly organic soils

CONSISTENCY OR RELATIVE DENSITY

CRITERIA

Standard Penetration Test
Density of Granular Soils

Penetration Resistance N (blows/ft)	Relative Density
0-4	Very Loose
5-10	Loose
11-30	Medium Dense
31-50	Dense
>50	Very Dense

Standard Penetration Test
Consistency of Cohesive Soils

Penetration Resistance N (blows/ft)	Consistency	Unconfined Compressive Strength (Tons/ft2)
<2	Very Soft	<0.25
2-4	Soft	0.25-0.50
4-8	Firm	0.50-1.00
8-15	Stiff	1.00-2.00
15-30	Very Stiff	2.00-4.00
>30	Hard	>4.0

3" 3/4" #4 #10 #40 #200 U.S. Standard Sieve

Unified Soil Classification	Cobbles	Gravel		Sand			Silt or Clay
		coarse	fine	coarse	medium	fine	

MOISTURE CONDITIONS

Dry	Absence of moist, dusty, dry to the touch
Slightly Damp	Below optimum moisture content for compaction
Moist	Near optimum moisture content, will moisten the hand
Very Moist	Above optimum moisture content
Wet	Visible free water; below water table

MATERIAL QUANTITY

trace	0 - 5%
few	5 - 10%
little	10 - 25%
some	25 - 45%
mostly	50 - 100%

OTHER SYMBOLS

C	Core Sample
S	SPT Sample
B	Bulk Sample
▾	Groundwater
Qp	Pocket Penetrometer

BASIC LOG FORMAT:
Group name, Group symbol, (grain size), color, moisture, consistency or relative density. Additional comments: odor, presence of roots, mica, gypsum, coarse grained particles, etc.

EXAMPLE:
Brown, loose fine to medium Sand (SP), trace silt, little fine gravel, damp

UNIFIED SOIL CLASSIFICATION SYSTEM

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-1
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	STA. 67+00

Latitude: 33º 28' 8.4" **Longitude:** -112º 28' 44.1"

Remarks: Hand Samples taken at 1'-2' and 3'-5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			0.2	0–1	SW	**SAND** Gray, well graded, subangular, dry, non-plastic, non-cemented.
				1–3	SP-SM	**SAND WITH SILT** Light brown, well graded, subangular, dry to slightly damp, non-plastic, weakly cemented.
H			4.9	3–7	SM	**SILTY SAND** Light brown, well graded, subangular, dry to slightly damp, non-plastic, moderately cemented.
				7		**Bottom of test pit @ 7'; no groundwater encountered.**

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

The stratification lines represent the approximate boundary lines Between soil and rock types; In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/10/09

Back Hoe: Case 580 Super Ram

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-2
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 72+00

Latitude: 33° 28' 12" **Longitude:** -112° 28' 45"

Remarks: Bulk Sample taken from 0'-5', Ring Sample driven from 10'-10.5', and Split Spoon Samples driven from 2'-3.5', 5'-6.5', and 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B			1.6		SM	**SILTY SAND** Light brown, well graded, subrounded, medium dense to very dense, dry, non-plastic.
				1		
S	7-10-10			2		
				3		
				4		
S	8-15-19			5		
				6		
				7		
				8		Note: some gravel.
				9		
R	50/6"	106	4.0	10		
				11		
				12		
				13		
				14		
S	19-23-29			15		
				16		
				17		**Bottom of boring @ 16.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/13/09

Drill Rig: CME 45

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-3
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 77+00

Latitude: 33° 28' 17.1" **Longitude:** -112° 28' 44.9"

Remarks: Bulk Sample taken at 0'-2', Ring Sample driven from 2'-3', and Split Spoon Samples driven from 5'-6.5', 10'-11.5', and 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B			1.7		SM	**SILTY SAND WITH GRAVEL** Light brown, well graded, subrounded, medium dense to dense to medium dense, dry to slightly damp, non-plastic, non to weakly cemented.
				1		
R	11-14	96	5.1	2		
				3		
				4		
S	10-13-14			5		
				6		
				7		
				8		
				9		
S	9-16-23			10		
				11		
				12		
				13		
				14		
S	8-10-11			15	SW	**SAND** Light brown, well graded, subrounded, medium dense, dry, non-plastic, weakly cemented.
				16		
				17		**Bottom of boring @ 16.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/02/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	Log of Test Pit No.	TP-4
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Test Pit Location:	STA. 79+00

Latitude: 33° 28' 18.5" | Longitude: -112° 28' 44.4"

Remarks: Hand Samples taken at 1'-5' and 7'-8'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SP	**SAND** Gray, predominately fine graded, subangular, dry, non-plastic, non-cemented.
H			3.9	1		
				2	SM	**SILTY SAND WITH GRAVEL** Medium brown, well graded, subangular, dry, non-plastic, weakly cemented.
				3		
				4		
				5		
				6	SM	**SILTY SAND** Light brown, well graded, subangular, slightly damp, non-plastic, weakly cemented.
H			6.9	7		
				8		**Bottom of test pit @ 8'; no groundwater encountered.**
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/10/09

Back Hoe: Case 580 Super Ram

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-5
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 79+50

Latitude: 33º 28' 19.1" **Longitude:** -112º 28' 44.6"

Remarks: Bulk Sample taken at 0'-2', Ring Samples driven from 5'-6' and 10'-11', and Split Spoon Samples driven from 2'-3.5', and 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B			1.5		SM	**SILTY SAND** Light brown, well graded, subrounded, medium dense to dense, dry, non-plastic.
				1		
S	8-14-15			2		
				3		
				4		
R	14-24	106	5.6	5		
				6		
				7		
				8		
				9		
R	18-27			10		
				11		
				12		
				13		
				14		
S	9-13-18			15		
				16		
				17		**Bottom of boring @ 16.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/02/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-6
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 84+00

Latitude: 33º 28' 23.2" **Longitude:** -112º 28' 44.8"

Remarks: Split Spoon Samples driven from 2'-3.5', 5'-6.5', and 10'-11.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND** Light brown, well graded, subrounded, medium dense, dry, non-plastic.
				1		
S	6-13-17			2		
				3		
				4		
S	13-9-9			5		
				6		
				7		
				8		
				9		
S	4-9-15			10		
				11		
						Bottom of boring @ 11.5'; no groundwater encountered.
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/02/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-7
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 89+00

Latitude: 33º 28' 29" **Longitude:** -112º 28' 45"

Remarks: Bulk Sample taken from 5'-10', Ring Samples driven from 1'-2', and 5'-5.5', and Split Spoon Samples driven from 2'-3.5', 10'-11.5', and 15'-15.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
R	9-9	105	7.0		SM	**SILTY SAND** Light to medium brown, well graded, subrounded, medium dense to very dense, slightly damp to dry, non-plastic.
				1		
S	6-10-15			2		
				3		
				4		
B/R	50/4"		3.7	5		Note: no recovery.
				6		
				7		
				8		
				9		
S	21-26-34			10		
				11		
				12		
				13	SW	**SAND** Medium brown, predominately fine graded, subangular, very dense, dry, non-plastic.
				14		
S	50/5"			15		
				16		**Bottom of boring @ 15.5'; no groundwater encountered.**
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/13/09

Drill Rig: CME 45

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-8
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 92+00

Latitude: 33° 28' 31" **Longitude:** -112° 28' 45"

Remarks: Bulk Sample taken from 5'-10', Ring Samples driven from 5'-6', and 10'-11', and Split Spoon Samples driven from 2'-3.5', and 15'-15.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND** Light brown, well graded, subrounded, medium dense to very dense, dry, non-plastic.
				1		
S	14-15-15			2		Note: no recovery.
				3		
				4		
B/R	17-37			5		
				6		
				7		
				8		
				9		
R	27-38			10		
				11		
				12		
				13		
				14		
S	50/2"	111	3.1	15		Note: no recovery.
				16		**Bottom of boring @ 15.5'; no groundwater encountered.**
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	11/13/09
Drill Rig:	CME 45

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-9
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	STA. 93+00

Latitude: 33º 28' 31.5" **Longitude:** -112º 28' 44.3"

Remarks: Hand Samples taken at 5'-7' and 9'-10'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				0–1	SP	**SAND** Light brown, predominately course graded, angular to subangular, dry, non-plastic, non-cemented.
				1–4.5	ML	**SANDY SILT** Medium brown, well graded, subangular, dry, low plasticity, non-cemented.
H			4.3	4.5–9	SM	**SILTY SAND** Light brown, well graded, subangular, dry, non-plastic, weakly to moderately cemented.
H			3.8	9–10	ML	**SANDY SILT** Medium brown, well graded, subangular, dry, low plasticity, non to weakly cemented.
				10		**Bottom of test pit @ 10'; no groundwater encountered.**

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/10/09

Back Hoe: Case 580 Super Ram

Alpha Project Number:	09-G-1597	Log of Boring No.	B-10
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	STA. 96+00

Latitude: 33° 28' 36" **Longitude:** -112° 28' 45"

Remarks: Bulk Sample taken from 5'-10', Ring Sample driven from 5'-6', and Split Spoon Samples driven from 2'-3.5', 10'-11.5', and 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND** Light to medium to light brown, well graded, subrounded, loose to dense, dry to slightly damp to dry, non-plastic.
				1		
S	4-5-5			2		
				3		
				4		
B/R	11-20			5		
				6		
				7		
				8		
				9		
S	21-20-24			10		
				11		
				12		
				13		
				14		
S	15-20-27			15		
				16		
				17		**Bottom of boring @ 16.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	11/13/09
Drill Rig:	CME 45

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-11
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 100+00
		Latitude: 33º 28' 39.0"	**Longitude:** -112º 28' 44.8"

Remarks: Split Spoon Samples driven from 2'-3.5', 5'-6.5', 10'-11.5', and 15'-16'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND** Light brown, well graded, subrounded, loose, dry, non-plastic.
				1		
				2		
S	3-4-4					
				3		
				4		
				5		
S	3-3-7					
				6		
				7		
				8		
				9		
				10		
S	6-30-38				GM	**SILTY GRAVEL WITH SAND** Light brown, well graded, subrounded, very dense, dry, non-plastic.
				11		
				12		
				13		
				14		
				15		
S	31-50/2"					Note: no recovery.
				16		**Bottom of boring @ 16'; no groundwater encountered.**
				17		

The stratification lines represent the approximate boundary lines
Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample
BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc. **2504 West Southern Avenue** **Tempe, Arizona 85282**	**Sample Date:**	**11/02/09**
	Drill Rig:	**Dirdrick D-120**

Alpha Project Number:	09-G-1597	Log of Test Pit No.	TP-12
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Test Pit Location:	STA.105+00
		Latitude: 33° 28' 44.4"	Longitude: -112° 28' 44.4"

Remarks: Hand Samples taken at 3'-5', 7'-8', and 9'-10'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				0–1.5	SP	**SAND WITH GRAVEL** Light brown, predominately course graded, subangular, dry, non-plastic, non-cemented.
				1.5–3	SM	**SILTY SAND** Medium brown, well graded, subangular, dry, low plasticity, non-cemented.
H			3.3	3–7	SM	**SILTY SAND WITH GRAVEL** Light brown, well graded, subangular, dry, non-plastic, weakly cemented.
H			4.4	7–10	SM	**SILTY SAND** Medium to light brown, well graded, subangular, dry to slightly damp, non-plastic, weakly to moderately cemented.
H			5.6	9		
				10		**Bottom of test pit @ 10'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	12/10/09
Back Hoe:	Case 580 Super Ram

Alpha Project Number:	09-G-1597	Log of Boring No.	B-13
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	STA. 105+50

Latitude: 33° 28' 44.6" **Longitude:** -112° 28' 45.0"

Remarks: Bulk Sample taken at 0'-2', Ring Sample driven from 10'-11', and Split Spoon Samples driven from 2'-3.5', 5'-6.5', and 15'-16'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B					SM	**SILTY SAND** Light brown, well graded, subrounded, loose to medium dense to very dense, dry, non-plastic.
				1		
				2		
S	3-5-5					
				3		
				4		
				5		
S	5-7-8		0.8			
				6		
				7		
				8		
				9		
				10		
R	19-50/6"					Note: some gravel.
				11		
				12		
				13		
				14		
				15		
S	19-50/6"					
				16		**Bottom of boring @ 16'; no groundwater encountered.**
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	**11/02/09**
Drill Rig:	**Dirdrick D-120**

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-14
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 110+00

Latitude: 33° 28' 49.2" **Longitude:** -112° 28' 45.0"

Remarks: Bulk Sample taken at 0'-2', and Split Spoon Samples driven from 2'-3.5', 5'-6.5', 10'-11.5', and 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B			0.4		SM	**SILTY SAND** Light brown, well graded, subrounded, loose, dry, non-plastic, non-cemented.
				1		
S	3-4-4			2		
				3		
				4		
S	4-5-7			5	SP	**SAND** Light brown to gray, well graded, subrounded, medium dense, dry, non-plastic, weakly cemented. Note: no recovery.
				6		
				7		
				8		
				9		
S	13-17-28			10		
				11		
				12		Note: some gravel.
				13		
				14		
S	16-27-34			15		
				16		
				17		**Bottom of boring @ 16.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/02/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-15
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 115+00

Latitude: 33° 28' 54" **Longitude:** -112° 28' 45"

Remarks: Bulk Sample taken from 0'-5', Ring Samples driven from 2'-3', 10'-10.5', and Split Spoon Samples driven from 5'-6.5', and 15'-15.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B				0	SM	**SILTY SAND** Light to medium brown, well graded, subrounded, medium dense, dry to slightly damp, non-plastic.
				1		
R	13-15			2		
				3		
				4		
S	10-13-14			5	SW	**SAND** Light brown, well graded, subrounded, medium dense to very dense, slightly damp, non-plastic.
				6		
				7		
				8		
				9		
R	50/6"			10		
				11		
				12		
				13		
				14		
S	50/4"			15		Note: no recovery.
				16		**Bottom of boring @ 15.5'; no groundwater encountered.**
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/13/09

Drill Rig: CME 45

Alpha Project Number: 09-G-1597		**Log of Boring No.**	B-16
Project: White Tanks FRS #3 - Outfall Channel		**Client:**	Hoskin Ryan Consultants, Inc.
Project Location: Maricopa County, Arizona		**Boring Location:**	STA. 119+00

Latitude: 33° 28' 59" **Longitude:** -112° 28' 45"

Remarks: Split Spoon Samples driven from 2'-3.5', 5'-6.5', 10'-11.5', and 15'-15.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				0	SW	**SAND** Light brown, well graded, subangular, medium dense, dry, non-plastic.
				1		
S	5-6-6			2		
				3		
				4		
S	7-9-9			5	SM	**SILTY SAND** Medium brown, well graded, subangular, medium dense to dense to very dense, slightly damp, non-plastic.
				6		
				7		
				8		
				9		
S	16-22-19			10		
				11		
				12		
				13		Note: some gravel.
				14		
S	50/6"			15		Note: no recovery.
				16		**Bottom of boring @ 15.5'; no groundwater encountered.**
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	**11/13/09**
Drill Rig:	**CME 45**

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-17
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 123+00

Latitude: 33° 29' 02.3" **Longitude:** -112° 28' 43.8"

Remarks: Split Spoon Samples driven from 2'-3.5', 5'-6.5', 10'-11.5', and 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND** Light brown to gray to medium brown, well graded, subrounded, dense to medium dense, dry, non-plastic.
				1		
				2		
S	12-17-25					
				3		
				4		
				5		
S	6-8-10					Note: some gravel and no recovery.
				6		
				7		
				8	SP	**SAND** Medium brown, predominately fine graded, subrounded, medium dense, slightly damp, non-plastic.
				9		
				10	GM	**SILTY GRAVEL WITH SAND** Medium brown, well graded, subrounded, medium dense, slightly damp, non-plastic.
S	8-11-11		2.7			
				11		
				12		
				13		
				14		
				15		
S	12-14-16					
				16		
				17		**Bottom of boring @ 16.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines
Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample
BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/02/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-18
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 128+00

Latitude: 33° 29' 07.2" **Longitude:** -112° 28' 44.4"

Remarks: Bulk Sample taken at 0'-2', and Split Spoon Samples driven from 2'-3.5', 5'-6.5', 10'-11', and 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				0–2	SM	**SILTY SAND WITH GRAVEL** Medium to light brown, well graded, subangular, medium dense, dry, non-plastic.
S	11-14-10			2–5	SM	**SILTY SAND** Medium brown, well graded, subangular, medium dense, slightly damp, non-plastic.
S	9-14-13		3.0	5	SM	**SILTY SAND WITH GRAVEL** Medium brown, well graded, subangular, medium dense, dry, non-plastic.
S	29-50/2"			10		Note: no recovery.
S	26-34-39			15	GM	**SILTY GRAVEL WITH SAND** Gray, well graded, subangular, very dense, slightly damp, non-plastic.
				17		**Bottom of boring @ 16.5'; no groundwater encountered.**

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	**11/02/09**
Drill Rig:	**Dirdrick D-120**

Alpha Project Number:	09-G-1597	Log of Boring No.	B-23
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	STA. 153+00

Latitude: 33° 29' 31.9" Longitude: -112° 28' 43.9"

Remarks: Bulk Sample taken at 0'-2', Ring Sample driven from 2'-3', and Split Spoon Samples driven from 5'-6.5', and 10'-11.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B			1.4		SM	**SILTY SAND WITH GRAVEL** Medium to light brown, well graded, subrounded, very to medium dense, dry to slightly damp, non-plastic, non-cemented.
				1		
R	16-21			2		
				3		
				4		
S	6-5-12			5		
				6		
				7		
				8		
				9		
S	14-15-17			10		Note: no recovery.
				11		
				12		**Bottom of boring @ 11.5'; no groundwater encountered.**
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	11/02/09
Drill Rig:	Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-24
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	STA. 157+00

Latitude: 33° 29' 36.7" **Longitude:** -112° 28' 44.2"

Remarks: Hand Samples taken at 0'-0.5', 1'-3', and 4'-6'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			1.6	0	GP-GM	**GRAVEL WITH SILT AND SAND** Light brown, well graded, subangular, dry, non-plastic, non-cemented.
H			4.6	1	SM	**SILTY SAND WITH GRAVEL** Medium to light brown, well graded, subangular, dry, low plasticity, weakly to moderately cemented.
H			5.5	4	SM	**SILTY SAND** Medium to light brown, well graded, subangular, slightly damp, non-plastic, weakly to moderately cemented.
				8	GM	**SILTY GRAVEL WITH SAND** Light brown, well graded, subrounded, dry, non-plastic, weakly cemented.
				10		**Bottom of test pit @ 10'; no groundwater encountered.**

Depth scale (feet): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

The stratification lines represent the approximate boundary lines
Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample
BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/10/09

Back Hoe: Case 580 Super Ram

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-25
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 158+50

Latitude: 33° 29' 36.6" **Longitude:** -112° 28' 43.7"

Remarks: Bulk Sample taken at 0'-2', Ring Sample driven from 10'-11', and Split Spoon Samples driven from 5'-6.5', and 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND WITH GRAVEL** Medium brown, well graded, subrounded, medium dense, dry, non-plastic.
				1		
				2		
				3		
				4		
S	5-5-10		1.1	5		
				6		
				7		
				8		
				9		
R	13-15			10		
				11		
				12		
				13		
				14		
S	12-14-14			15		
				16		
				17		**Bottom of boring @ 16.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	**11/02/09**
Drill Rig:	**Dirdrick D-120**

Alpha Project Number:	09-G-1597	Log of Boring No.	B-26
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	STA. 162+00

Latitude: 33° 29' 40.9" | Longitude: -112° 28' 43.9"

Remarks: Split Spoon Samples driven from 2'-3.5', 5'-6.5', and 10'-11.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND** Light to medium brown, well graded, subrounded, medium dense, dry to slightly damp, non-plastic, non to weakly cemented.
				1		
				2		
S	18-18-18					
				3		
				4		
				5		
S	9-7-5					
				6		
				7		
				8		
				9		
				10		
S	5-8-10					
				11		
				12		**Bottom of boring @ 11.5'; no groundwater encountered.**
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/02/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	Log of Boring No.	B-27
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	STA. 167+00

Latitude: 33° 29' 43.3" | Longitude: -112° 28' 43.9"

Remarks: Bulk Sample taken at 0'-2', Ring Sample driven from 5'-6', and Split Spoon Samples driven from 2'-3.5', and 10'-11.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B			2.4	0–9	SM	**SILTY SAND WITH GRAVEL** Light to medium brown, well graded, subrounded, medium dense, dry to slightly damp, non-plastic.
S	15-9-8			2		
R	8-8			5		
				9–11.5	GM	**SILTY GRAVEL WITH SAND** Light brown, well graded, subrounded, medium dense, slightly damp, non-plastic. Note: no recovery.
S	6-11-11			10		
				11.5–17		**Bottom of boring @ 11.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/05/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-28
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 172+00

Latitude: 33º 29' 50.3" **Longitude:** -112º 28' 43.9"

Remarks: Split Spoon Samples driven from 2'-3.5', 5'-6.5', 10'-11.5', and 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND WITH GRAVEL** Medium to light brown, well graded, subrounded, dense, dry to slightly damp to dry, non-plastic, non to weakly cemented.
				1		
				2		
S	4-11-20					
				3		
				4		
				5		
S	7-15-17		4.7			
				6		
				7		
				8		
				9		
				10		
S	6-15-16					
				11		
				12		
				13		
				14		
				15		
S	3-4-5				SP	**SAND** Medium brown, perdominately course graded, subrounded, loose, non-plastic.
				16		
				17		**Bottom of boring @ 16.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/05/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	Log of Boring No.	B-29
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	STA. 177+00

Latitude: 33° 29' 55.2" | Longitude: -112° 28' 43.8"

Remarks: Bulk Sample taken at 5'-10', and Split Spoon Samples driven from 2'-3.5', 5'-6.5', 10'-11.5', and 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND** Medium to light brown, well graded, subrounded, medium dense, dry to slightly damp, non-plastic, non to weakly to moderately cemented.
				1		
S	12-14-13			2		
				3		
				4		
S/B	14-15-18			5		
				6		
				7		
				8		Note: some gravel.
				9		
S	16-18-17			10		
				11		
				12		
				13		
				14		
S	12-31-43			15	SP	**SAND** Medium brown, perdominately course graded, subrounded, loose, non-plastic, moderately cemented.
				16		
				17		**Bottom of boring @ 16.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/05/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-30
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	STA. 182+00

Latitude: 33° 30' 0.5" **Longitude:** -112° 28' 44.2"

Remarks: Hand Samples taken at 1'-4', and 5'-6'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SW	**SAND WITH GRAVEL** Light brown, perdominately fine graded, subangular, dry, non-plastic, non-cemented.
H			7.0	1		
				2	SM	**SILTY SAND** Medium brown, well graded, subangular, slightly damp, non-plastic, non-cemented.
				3		
				4		
				5		
H			9.0		SM	**SILTY SAND WITH GRAVEL** Light brown, well graded, subrounded, slightly damp, non-plastic, weakly to moderately cemented.
				6		
				7		**Bottom of test pit @ 7'; no groundwater encountered.**
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/10/09

Back Hoe: Case 580 Super Ram

Alpha Project Number:	09-G-1597	Log of Boring No.	B-31
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	STA. 184+50

Latitude: 33° 30' 01.5" Longitude: -112° 28' 43.9"

Remarks: Bulk Samples taken at 0'-2', and 10'-15', Ring Samples driven at 2'-3', and 10'-11', and Split Spoon Samples driven from 5'-6.5', and 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B					SM	**SILTY SAND WITH GRAVEL** Light to medium to light brown, well graded, subrounded, medium dense to dense to medium dense, dry, non-plastic, non to weakly cemented.
				1		
				2		
R	7-10					
				3		
				4		
				5		
S	7-9-12					
				6		
				7		
				8		
				9		
				10		
R/B	20-21		2.9			
				11		
				12		
				13		
				14		
				15		
S	10-13-12					
				16		
				17		Bottom of boring @ 16.5'; no groundwater encountered.

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/05/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-32
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 189+50
		Latitude: 33° 30' 07.8"	**Longitude:** -112° 28' 43.8"

Remarks: Ring Sample driven from 5'-6', and Split Spoon Samples driven from 2'-3.5', 10'-11.5', and 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				1	ML	**SANDY SILT** Medium brown, well graded, subrounded, soft to firm, dry to slightly damp, non-plastic, non-cemented.
S	3-3-3		2.7	2		
				3		
				4		
R	8-15	101	6.6	5		
				6		
				7		
				8		
				9		
S	6-7-8			10	SM	**SILTY SAND WITH GRAVEL** Light brown, well graded, subrounded, medium dense, dry, non-plastic, weakly cemented.
				11		
				12		
				13		
				14		
				15		
S	6-8-8			16		
				17		**Bottom of boring @ 16.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	11/09/09
Drill Rig:	Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-33
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	STA. 193+00

Latitude: 33° 30' 10.6" **Longitude:** -112° 28' 41.7"

Remarks: Hand Samples taken at 0'-1', 6'-8', and 9'-10'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			6.5	0-2	ML	**SANDY SILT** Medium brown, perdominately fine graded, subrounded, dry, non-plastic, non-cemented.
				2-6	SM	**SILTY SAND** Medium brown, well graded, subangular, slightly damp, non-plastic, non-cemented.
H			5.0	6-10	SM	**SILTY SAND WITH GRAVEL** Light brown, well graded, subrounded, sllightly damp, non-plastic, weakly cemented.
H			5.4	10-12.5	SM	**SILTY SAND** Light brown, well graded, subrounded, sllightly damp, non-plastic, weakly cemented.
				12.5-17		**Bottom of test pit @ 12.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/10/09

Back Hoe: Case 580 Super Ram

Alpha Project Number:	09-G-1597	Log of Boring No.	B-34
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	STA. 198+00

Latitude: 33° 30' 15.8" **Longitude:** -112° 28' 41.9"

Remarks: Split Spoon Samples driven at 2'-3.5', 5'-6.5', 10'-10.5', and 15'-16'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND** Light to medium brown, well graded, subrounded, medium dense to dense to very dense, dry to slightly damp, non-plastic, non-cemented.
				1		
S	7-14-15			2		
				3		
				4		
S	9-15-16			5		
				6		
				7		
				8		
				9		
S	50/6"			10		Note: no recovery.
				11	GM	**SILTY GRAVEL WITH SAND** Light brown to gray, well graded, subangular, very dense, dry, non-plastic, weakly cemented.
				12		
				13		
				14		
S	34-50/6"			15		
				16		**Bottom of boring @ 16'; no groundwater encountered.**
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/09/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	Log of Boring No.	B-35
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	STA. 203+00

Latitude: 33° 30' 20.4" Longitude: -112° 28' 41.6"

Remarks: Bulk Sample taken from 5'-10'-, Ring Sample driven at 5'-6', and Split Spoon Samples driven at 2'-3.5', and 10'-10.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				0	SM	**SILTY SAND** Light to medium brown, well graded, subrounded, medium dense to dense, dry to slightly damp, non-plastic, non-cemented.
				1		
S	2-5-7		1.7	2		
				3		
				4		
B/R	12-22			5		
				6		Note: some gravel.
				7		
				8		
				9		
S	50/3"			10	GM	**SILTY GRAVEL WITH SAND AND COBBLES** Gray, well graded, subrounded, very dense, dry, non-plastic, weakly cemented.
				11		**Auger refusal on cobbles @ 11'; no groundwater encountered.**
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	11/09/09
Drill Rig:	Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-36
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 208+00

Latitude: 33° 30' 25.3" **Longitude:** -112° 28' 41.1"

Remarks: Bulk Sample taken from 10'-12', and Split Spoon Samples driven at 2'-3.5', 5'-6.5', and 10'-10.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				0–5	SM	**SILTY SAND** Light to medium brown, well graded, subrounded, medium dense, dry to slightly damp, non-plastic, non-cemented.
S	6-7-7			2		
				5–10	ML	**SANDY SILT** Medium brown, well graded, subrounded, moderately firm, dry, non-plastic, non-cemented.
S	4-4-6			5		
S/B	50/4"			10–12	GM	**SILTY GRAVEL WITH SAND AND COBBLES** Light brown, well graded, subrounded, very dense, dry, non-plastic, weakly cemented.
				12		**Auger refusal on cobbles @ 12'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/09/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-37
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 211+50

Latitude: 33° 30' 29.0" **Longitude:** -112° 28' 41.9"

Remarks: Bulk Sample taken from 2'-5', Ring Sample driven at 5'-6', and Split Spoon Samples driven at 2'-3.5', 10'-11.5', and 15'-16'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND WITH GRAVEL** Light to medium to light brown to gray, well graded, subrounded, medium dense to dense to very dense, dry to slightly damp, non-plastic, non to weakly to moderately cemented.
				1		
				2		
S	10-7-4		1.4			
				3		
				4		
				5		
B/R	14-19	107	6.5			
				6		
				7		
				8		Note: some gravel.
				9		
				10		
S	14-20-23					
				11		
				12		
				13		
				14		
				15		
S	28-50/6"					Note: no recovery.
				16		**Bottom of boring @ 16'; no groundwater encountered.**
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	**11/09/09**
Drill Rig:	**Dirdrick D-120**

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-38
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 216+00

Latitude: 33° 30' 33.5" **Longitude:** -112° 28' 41.7"

Remarks: Bulk Sample taken from 5'-8', and Split Spoon Samples driven at 2'-3.5', 5'-6.5', and 10'-10.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				0–5	SM	**SILTY SAND (FILL MATERIAL)** Light to medium brown, well graded, subrounded, very dense, dry to slightly damp, non-plastic, non-cemented.
S	14-27-23		5.4	2		
B/S	3-3-3		3.5	5–9	ML	**SANDY SILT (NATIVE MATERIAL)** Medium brown, well graded, subrounded, soft, dry, non-plastic, non-cemented.
S	50/6"			9–12	GM	**SILTY GRAVEL WITH SAND AND COBBLES** Light brown, well graded, subangular, very dense, dry, non-plastic, non-cemented. Note: no recovery.
				12–17		**Auger refusal on cobbles @ 12'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/09/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	Log of Boring No.	B-39
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	STA. 221+00

Latitude: 33° 30' 38.5" Longitude: -112° 28' 42.0"

Remarks: Bulk Sample taken from 5'-7', and Split Spoon Samples driven at 2'-3.5', 5'-6.5', and 9'-9.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				0–4	SM	**SILTY SAND (FILL MATERIAL)** Light to medium brown, well graded, subrounded, dense, slightly damp to moist, non-plastic.
S	18-23-15			2		
				4–8	SM	**SILTY SAND (NATIVE MATERIAL)** Light brown, well graded, subrounded, loose, dry, non-plastic.
B/S	4-4-3		3.0	5		
				8–9.5	GM	**SILTY GRAVEL WITH SAND AND COBBLES** Light brown, well graded, subangular, very dense, dry, non-plastic.
S	50/2"			9		
						Auger refusal on cobbles @ 9.5'; no groundwater encountered.

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/09/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-40
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	STA. 226+00

Latitude: 33° 30' 43.6" **Longitude:** -112° 28' 42.4"

Remarks: Hand Samples taken at 0'-2' and 12'-13'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			5.2	0–4.5	SM	**SILTY SAND WITH GRAVEL (FILL MATERIAL)** Medium brown, well graded, subangular, slightly damp, non-plastic, non-cemented.
				4.5–9	ML	**SANDY SILT (NATIVE MATERIAL)** Medium brown, well graded, subangular, slightly damp, non-plastic, non-cemented.
H			3.4	9–13	GM	**SILTY GRAVEL WITH SAND** Light brown, well graded, angular, dry, non-plastic, weakly to moderately cemented.
				13–17		**Bottom of test pit @ 13'; no groundwater encountered.**

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/09/09

Back Hoe: Case 580 Super Ram

Alpha Project Number:	09-G-1597	Log of Boring No.	B-41
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	STA. 227+00

Latitude: 33° 30' 44.4" Longitude: -112° 28' 42.0"

Remarks: Ring Samples driven at 5'-6', and 7'-8', and Split Spoon Samples driven at 2'-3.5', and 10'-11.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND (FILL MATERIAL)** Light to medium brown, well graded, subrounded, medium dense, dry to slightly damp to moist, non-plastic, non-cemented.
				1		
S	16-12-6			2		
				3	ML	**SANDY SILT (NATIVE MATERIAL)** Medium brown, well graded, subrounded, firm, slightly damp, non-plastic, non-cemented.
				4		
R	38-50/4.5"		3.3	5	SM	**SILTY SAND** Light brown, well graded, subangular, very dense, dry, non-plastic, non to weakly cemented.
				6		
R	37-25			7		
				8		
				9		
S	29-34-38			10		
				11		Note: some cobbles.
				12		
				13		**Auger refusal on cobbles @ 13'; no groundwater encountered.**
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	11/09/09
Drill Rig:	Dirdrick D-120

Alpha Project Number:	09-G-1597	Log of Boring No.	B-42
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	STA. 231+50

Latitude: 33° 30' 48.8" Longitude: -112° 28' 41.7"

Remarks: Bulk Sample taken from 0'-2', and Split Spoon Samples driven at 2'-3.5', 5'-6.5', 10'-11.5', and 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B			1.7	0–1	SM	**SILTY SAND (FILL MATERIAL)** Light to medium brown, well graded, subrounded, medium dense, dry to slightly damp, non-plastic, non-cemented.
S	8-8-7			2–3		
S	5-5-7			5–6		
				7	SM	**SILTY SAND (NATIVE MATERIAL)** Medium to light brown, well graded, subrounded, very dense, slightly damp, non-plastic, non to weakly cemented.
S	7-24-29		3.5	10–11		
S	29-44-50/4"			15–16		
				17		**Bottom of boring @ 16.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/09/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-43
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	STA. 236+50

Latitude: 33° 30' 53.5" **Longitude:** -112° 28' 41.6"

Remarks: Hand Samples taken at 0'-1', 4'-5', and 9'-10'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			4.1	0–1	SM	**SILTY SAND WITH GRAVEL (FILL MATERIAL)** Medium brown, well graded, subangular, slightly damp, non-plastic, non-cemented.
				1.5–6	SP-SM	**SAND WITH SILT AND GRAVEL (NATIVE MATERIAL)** Light brown, well graded, subangular, slightly damp, non-plastic, weakly cemented.
H			3.2	4–5		
				6–10	GP-GM	**GRAVEL WITH SILT AND SAND** Light brown, well graded, subangular, dry, non-plastic, non-cemented.
H			3.1	9–10		
				10		**Bottom of test pit @ 10'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/09/09

Back Hoe: Case 580 Super Ram

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-44
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 238+00

Latitude: 33° 30' 54.6" **Longitude:** -112° 28' 43.0"

Remarks: Bulk Sample taken from 10'-12', and Split Spoon Samples driven at 2'-3.5', 5'-6.5', 10'-11.5', and 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				1	ML	**SANDY SILT** Light to medium to light brown, well graded, subangular, very firm to firm to hard, dry to slightly damp, non-plastic, non-cemented.
R	11-24	109	5.1	2		
S	7-9-12			3		
				4		
S	15-34-41		4.4	5		
				6		
				7	GM	**SILTY GRAVEL WITH SAND** Light brown to gray, well graded, subangular, very dense, dry, non-plastic, non to weakly cemented.
				8		
				9		
B/S	47-50/5"			10		Note: no recovery.
				11		
				12		**Bottom of boring @ 12'; no groundwater encountered.**
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/09/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-45
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	STA. 240+50

Latitude: 33° 31' 0" **Longitude:** -112° 28' 46.0"

Remarks: Hand Samples taken at 0'-1' and 7'-11'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			4.7	0–6	SM	**SILTY SAND WITH GRAVEL** Reddish to light brown, well graded, subangular, slightly damp, non-plastic, non to weakly to moderately cemented. Note: some cobbles and boulders.
H			3.1	6–11	GP	**GRAVEL WITH SAND** Light brown, predominately course graded, subangular, dry, non-plastic, moderately cemented.
				11–17		**Bottom of test pit @ 11'; no groundwater encountered.**

Depth scale (Feet): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/09/09

Back Hoe: Case 580 Super Ram

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-46
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 246+00

Latitude: 33° 31' 2" **Longitude:** -112° 28' 45.3"

Remarks: Bulk Sample taken from 3'-5', and Split Spoon Samples driven from 2'-3.5', and 5'-6'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND WITH GRAVEL** Medium to light brown, well graded, subangular, very dense, dry, non-plastic, non to weakly to moderately to strongly cemented.
				1		
S	28-39-38			2		
B				3		
				4		
S	32-50/6"			5		
				6		
				7		
				8		**Auger refusal @ 8'; no groundwater encountered.**
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/13/09

Drill Rig: CME 45

Alpha Project Number:	09-G-1597	Log of Boring No.	B-47
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	STA. 251+00

Latitude: 33° 31' 06.7" Longitude: -112° 28' 44.3"

Remarks: Bulk Sample taken from 5'-10', Ring Sample driven at 0'-1', and Split Spoon Samples driven at 2'-3', 5'-6.5', 10'-10.5', and 15'-15.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
R	6-11				SM	**SILTY SAND WITH GRAVEL** Medium to light brown, predominately fine graded, subrounded, medium dense to very dense to dense to very dense, dry, non-plastic, non to weakly cemented.
				1		
S	17-50/4"			2		
				3		
				4		
B/S	26-19-21		1.4	5		
				6		
				7		
				8		
				9		
S	50/6"			10		
				11		
				12		
				13		
				14		
S	50/5"			15		
				16		**Bottom of boring @ 15.5'; no groundwater encountered.**
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	11/16/09
Drill Rig:	Dirdrick D-120

Alpha Project Number:	09-G-1597	Log of Test Pit No.	TP-48
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Test Pit Location:	STA. 256+00
		Latitude: 33° 31' 12.0"	Longitude: -112° 28' 45.3"

Remarks: Hand Sample taken at 0'-1', and 3'-4'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			7.3	0–3	GP-GM	**GRAVEL WITH SILT AND SAND** Medium to light brown, well graded, subangular, slightly damp, non-plastic, non-cemented.
H			0.4	3–4.5	GP	**GRAVEL WITH SAND** Light brown, predominately course graded, angular, dry, non-plastic, weakly to moderately to strongly cemented.
						Note: hydraulic rock hammer (1100 energy class: TB425X) fitted with a 16", 4-tooth bucket used to brake through refusal material.
				5.5–9	GP	**GRAVEL WITH SAND** Light brown, predominately course graded, angular, dry, non-plastic, weakly cemented.
				9–10.5	SC-SM	**SILTY CLAYEY SAND WITH GRAVEL AND COBBLES** Light brown, well graded, subangular, slightly damp, non-plastic, non-cemented.
				10.5		**Bottom of test pit @ 10.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines
Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample
BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	12/09/09
Back Hoe:	Case 580 Super Ram

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-49
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	STA. 261+50

Latitude: 33º 31' 17.3" **Longitude:** -112º 28' 45.3"

Remarks: Hand Sample taken at 0'-3', 5'-6', and 11.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			1.3		SM	**SILTY SAND** Medium brown, well graded, subangular, dry, non-plastic, non to weakly cemented.
				1		
				2		
				3		
				4		
				5		
H			13.6		GP-GM	**GRAVEL WITH SILT, SAND, COBBLES AND BOULDERS** Light brown, predominately course graded, angular, dry, non-plastic, weakly to moderately to strongly cemented.
				6		**Note: backhoe refusal was encountered with a 24", 5-tooth bucket. Bucket swithed to a 16", 4-tooth bucket and pit advanced through refusal material.**
				7		
				8		
				9		
				10		
				11		
					SM	**SILTY SAND WITH GRAVEL** Light brown, well graded, subrounded, dry, non-plastic, moderately cemented.
				12		**Bottom of test pit @ 12'; no groundwater encountered.**
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines
Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample
BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/09/09

Back Hoe: Case 580 Super Ram

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-50
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	STA. 264+00

Latitude: 33° 31' 19.6" **Longitude:** -112° 28' 45.3"

Remarks: Hand Sample taken at 11'-12'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				0–4	ML	**SANDY SILT** Medium brown, well graded, subangular, dry, non-plastic, non-cemented.
				4–9	SM	**SILTY SAND** Light brown, predominately course graded, subangular, dry, non-plastic, weakly cemented.
				9–11	GM	**SILTY GRAVEL WITH SAND** Light brown, well graded, subangular, dry, non-plastic, weakly to moderately cemented.
H			5.6	11–13	SM	**SILTY SAND** Light brown, well graded, subangular, slightly damp, non-plastic, weakly to moderately cemented.
				13		**Bottom of test pit @ 13'; no groundwater encountered.**

Depth scale (feet): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/09/09

Back Hoe: Case 580 Super Ram

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-51
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 267+00

Latitude: 33° 31' 22.8" **Longitude:** -112° 28' 44.5"

Remarks: Ring Samples driven at 2'-3', 5'-6', and 10'-11' and Split Spoon Samples driven at 15'-16' and 20'-21.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND** Light to medium to light brown, predominately fine graded, subrounded, medium dense to dense, dry to slightly damp, non-plastic, non to weakly cemented.
				2		
R	9-10					
				4		
R	17-28					
				6		
				8		
				10		
R	19-27					
				12		
				14		
S	17-50/6"		3.7		SM	**SILTY SAND WITH GRAVEL** Gray, predominately fine graded, subangular, very dense, dry, non-plastic, weakly cemented.
				16		
				18		
				20		
S	18-17-21		1.5		GM	**SILTY GRAVEL WITH SAND** Gray, predominately fine graded, subangular, dense, dry, non-plastic, weakly cemented.
				22		**Bottom of boring @ 21.5'; no groundwater encountered.**
				24		
				26		
				28		
				30		
				32		
				34		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	**11/16/09**
Drill Rig:	**Dirdrick D-120**

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-52
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 272+00

Latitude: 33° 31' 27.4" **Longitude:** -112° 28' 43.6"

Remarks: Bulk Sample taken from 12'-15', Ring Samples driven at 0'-1', 5'-6', 10'-10.5', and Split Spoon Samples driven at 2'-3.5', 15'-16.5', and 20'-21.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
R	6-8	107	8.0		SM	**SILTY SAND** Medium to light to medium brown, predominately fine graded, subrounded, medium dense to loose, slightly damp, non-plastic, non-cemented.
S	4-4-5			2, 4		
R	6-12			6, 8	SW	**SAND** Medium brown, well graded, subrounded, medium dense, slightly damp, non-plastic, non-cemented.
R	50/3"			10	SM	**SILTY SAND WITH GRAVEL** Light brown, predominately fine graded, subangular, dense to very dense, dry, non-plastic, weakly cemented. Note: no recovery.
B			2.4	12, 14		
S	20-21-24			16, 18		
S	26-22-27			20		
				22, 24, 26, 28, 30, 32, 34		**Bottom of boring @ 21.5'; no groundwater encountered**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/16/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-53
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 277+00

Latitude: 33º 31' 32.5" **Longitude:** -112º 28' 42.5"

Remarks: Bulk Sample taken from 0'-5', Ring Samples driven at 2'-3', 5'-6', and 10'-11', and Split Spoon Sample driven at 15'-16.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B					SM	**SILTY SAND** Light brown, poorly graded, subrounded, medium dense to dense, dry to slightly damp, non-plastic, non cemented.
				1		
R	12-15			2		
				3		
				4		
R	12-28			5		
				6		
				7		
				8		
				9		
R	24-26			10	GM	**SILTY GRAVEL WITH SAND** Gray, predominately fine graded, subangular to subrounded, very dense, slightly damp, non-plastic, weakly cemented.
				11		
				12		
				13	SM	**SILTY SAND WITH GRAVEL** Medium brown, predominately fine graded, subrounded, dense, slightly damp, non-plastic, non-cemented.
				14		
S	16-19-19		5.1	15		
				16		
				17		**Bottom of boring @ 16.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	**11/16/09**
Drill Rig:	**Dirdrick D-120**

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-54
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 282+00

Latitude: 33° 31' 36.3" **Longitude:** -112° 28' 39.1"

Remarks: Split Spoon Samples driven at 2'-3.5', 5'-6.5', and 10'-11.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				0–5	ML	**SANDY SILT** Medium brown, predominately fine graded, subrounded, soft, dry, non-non-cemented.
S	2-3-3		2.3	2		
				5–11.5	SM	**SILTY SAND** Medium to light brown, well graded, subrounded to subangular, loose to medium densedry, non-plastic, weakly cemented.
S	3-4-4			5		
S	5-9-10			10		
				11.5		**Bottom of boring @ 11.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines
Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample
BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	11/16/09
Drill Rig:	Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-55
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 287+00

Latitude: 33° 31' 39.7" **Longitude:** -112° 28' 34.9"

Remarks: Ring Sample driven at 2'-3', and Split Spoon Sample driven at 5'-6.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					ML	**SANDY SILT** Medium brown, medium graded, subrounded, firm, dry to slightly damp, non-plastic.
				1		
				2		
R	7-9					
				3		
				4		
				5		
S	6-7-10		3.4		SM	**SILTY SAND** Medium brown, medium graded, subrounded, medium dense, dry to slightly damp, non-plastic.
				6		
						Bottom of boring @ 6.5'; no groundwater encountered.
				7		
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	**11/16/09**
Drill Rig:	**Dirdrick D-120**

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-56
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 292+00

Latitude: 33° 31' 43.3" **Longitude:** -112° 28' 30.7"

Remarks: Ring Sample driven at 2'-3', and Split Spoon Sample driven at 5'-6.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND WITH GRAVEL** Medium to light brown, poorly graded, subrounded, medium dense, dry to slightly damp, non-plastic.
				1		
S	10-11		1.7	2		
				3		
				4		
S	4-8-9			5		
				6		
				7		**Bottom of boring @ 6.5'; no groundwater encountered.**
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/16/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	Log of Boring No.	B-57
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	STA. 297+00

Latitude: 33° 31' 46.7" | Longitude: -112° 28' 26.5"

Remarks: Ring Samples driven at 5'-6', 10'-11', and 20'-21', and Split Spoon Samples driven at 2'-3.5', 15'-16.5', and 25'-26.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND** Medium brown, poorly graded, subrounded, loose to medium dense, dry, non-plastic, non-cemented.
S	2-3-3			2		
R	6-7			4, 6, 8		
					GM	**SILTY GRAVEL WITH SAND** Light brown to gray, poorly graded, subangular, dense, dry, non-plastic, weakly cemented.
R	26-21			10, 12, 14		
S	16-16-20			16, 18		Note: fractured cobbles.
					SM	**SILTY SAND WITH GRAVEL** Medium brown, poorly graded, subangular, medium dense to very dense, slightly damp, non-plastic, non to weakly cemented.
R	16-21	98.0	9.2	20, 22, 24		
S	21-32-39			26		
				28, 30, 32, 34		**Bottom of boring @ 26.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	11/16/09
Drill Rig:	Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-58
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 302+00

Latitude: 33° 31' 50.2" **Longitude:** -112° 28' 22.3"

Remarks: Ring Samples driven at 5'-6', and 10'-11', and Split Spoon Samples driven at 2'-3.5', 15'-16.5', and 20'-21.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND** Light brown, poorly graded, subrounded, dense to medium dense, dry to slightly damp, non-plastic.
S	17-16-15			2		
				4		
R	19-24	112	7.8	6		
				8		
				10		
R	16-20			12		
				14		
S	7-10-13		4.2	16	ML	**SANDY SILT** Medium brown, poorly graded, subrounded, firm to very firm, slightly damp, non-plastic.
				18		
				20		
S	12-18-20					
				22		**Bottom of boring @ 21.5'; no groundwater encountered.**
				24		
				26		
				28		
				30		
				32		
				34		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	**11/16/09**
Drill Rig:	**Dirdrick D-120**

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-59
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 307+00

Latitude: 33° 31' 53.7" **Longitude:** -112° 28' 18.1"

Remarks: Ring Samples driven at 5'-6' and 10-11', and Split Spoon Sample driven at 2'-3.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND** Light to medium brown, poorly graded, subrounded, dense, dry to slightly damp, non-plastic.
				1		
				2		
S	14-16-21					
				3		
				4		
				5		
R	15-23		4.6		ML	**SANDY SILT** Light to medium brown, poorly graded, subrounded, very firm, dry to slightly damp, non-plastic.
				6		
				7		
				8		
				9		
				10		
R	14-22					
				11		**Bottom of boring @ 11'; no groundwater encountered.**
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	**11/16/09**
Drill Rig:	**Dirdrick D-120**

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-60
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	STA. 312+00

Latitude: 33° 30' 58.1" **Longitude:** -112° 28' 17.6"

Remarks: Ring Sample driven at 2'-3', and Split Spoon Sample driven at 5'-6.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				0–1	SM	**SILTY SAND WITH GRAVEL** Light to medium brown, poorly graded, subrounded, medium dense to loose, dry to slightly damp, non-plastic.
R	7-10			2		
				3		
				4		
S	3-4-5		6.7	5	ML	**SILTY SAND** Medium brown, poorly graded, subrounded, moderately firm, slightly damp, non-plastic.
				6		
				7–17		**Bottom of boring @ 6.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/16/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-61
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	See attached sample plan

Latitude: 33° 31' 47.4" **Longitude:** -112° 28' 24.4"

Remarks: Bulk Samples taken at 0'-5', Ring Samples driven at 0'-1', 5'-6', 10'-11', 15'-15.5', 20'-21', 25'-25.5', and 30'-31'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B/R	10-14	113	6.3/4.0		SM	**SILTY SAND WITH GRAVEL (FILL MATERIAL)** Medium to dark brown, well graded, subrounded, medium dense to dense, slightly damp to moist, non-plastic.
				2		
				4		
R	21-20	126	5.6	6		
				8		
R	18-27			10		
				12		
				14	SW	**SAND (FILL MATERIAL)** Medium brown, well graded, subrounded, very dense, dry, non-plastic. Note: no recovery.
R	50/6"			16		
				18		
R	25-28			20		Note: no recovery.
				22		
B				24		
R	50/6"			26	SM	**SILTY SAND (NATIVE MATERIAL)** Medium brown, well graded, subrounded, very dense, slightly damp, non-plastic.
				28		
R	23-50/6"	91	6.8/7.6	30		
				32		**Bottom of boring @ 31'; no groundwater encountered.**
				34		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	11/05/09
Drill Rig:	Dirdrick D-120

Alpha Project Number:	09-G-1597	Log of Boring No.	B-62
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Boring Location:	See attached sample plan

Latitude: 33° 31' 42.2" Longitude: -112° 28' 20.8"

Remarks: Bulk Sample taken at 5'-10', Ring Samples driven at 5'-6', 10'-11', 15'-16', and 20'-21', and Split Spoon Samples driven at 25'-26.5', and 30'-30.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				0–18	ML	**SANDY SILT (FILL MATERIAL)** Medium to dark brown, well graded, subrounded, very firm to firm, slightly damp to moist, non-plastic.
B/R	18-22	121	7.9/7.4	5		
R	10-11	113	6.9	10		
R	9-10	119	8.0	15		
				18–24	ML	**SANDY SILT (NATIVE MATERIAL)** Light brown, well graded, subrounded, firm, slightly damp, low plasticity, non-cemented.
R	8-10	96	3.6	20		
				24–27	SP	**SAND (NATIVE MATERIAL)** Light brown, well graded, subrounded, medium dense, slightly damp, non-plastic, non-cemented.
S	5-5-7			25		
				27–30.5	GM	**SILTY GRAVEL WITH SAND (NATIVE MATERIAL)** Light brown, well graded, subrounded, very dense, dry, non-plastic, non-cemented.
S	50/6"			30		
						Bottom of boring @ 30.5'; no groundwater encountered.

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/05/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-63
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	See attached sample plan

Latitude: 33° 31' 45.0" **Longitude:** -112° 28' 18.8"

Remarks: Ring Samples driven at 5'-6', 10'-11', 15'-16', 20'-21', and 25'-26', and Split Spoon Sample driven at 30'-31.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
				0–19	SM	**SILTY SAND (FILL MATERIAL)** Light to medium brown, well graded, subrounded, dense, dry to slightly damp, non-plastic, non-cemented.
R	15-18	124	6.4	6		
R	13-19			10–11		
R	19-32	119	8.8	15–16		
				19–31.5	ML	**SANDY SILT (NATIVE MATERIAL)** Medium brown, well graded, subrounded, moderately firm to firm to very firm, dry, non-plastic, non to weakly cemented.
R	6-8	93	4.4/2.8	20–21		
R	10-14	96	5.8	25–26		
S	22-18-16			30–31.5		
				32, 34		**Bottom of boring @ 31.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/05/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-64
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	See attached sample plan

Latitude: 33° 31' 49.5" **Longitude:** -112° 28' 18.7"

Remarks: Bulk Sample taken from 0'-5', Ring Samples driven at 0'-5', 5'-6', 10'-11', 15'-16', 20'-21', and 25'-26', and Split Spoon Sample driven at 30'-31.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B/R	8-17		9.3	2, 4	SM	**SILTY SAND (FILL MATERIAL)** Medium brown, well graded, subrounded, medium dense, slightly damp, non-plastic.
R	28-34			6, 8	GM	**SILTY GRAVEL WITH SAND (FILL MATERIAL)** Light brown, well graded, subangular, very dense, dry, non-plastic. Note: no recovery.
R	16-22	107	6.5	10, 12, 14	SM	**SILTY SAND WITH GRAVEL (FILL MATERIAL)** Medium brown, well graded, subrounded, dense, dry, non-plastic.
R	15-26	117	7.2	16, 18		
R	12-23	106	3.3	20, 22, 24	ML	**SANDY SILT (NATIVE MATERIAL)** Medium brown, well graded, subrounded, very firm to hard to firm, slightly damp, non-plastic.
R	32-27	104	4.0	26, 28		
S	12-13-15			30		
				32, 34		**Bottom of boring @ 31.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines
Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample
BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 11/05/09

Drill Rig: Dirdrick D-120

Alpha Project Number:	09-G-1597	**Log of Boring No.**	B-65
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Boring Location:**	See attached sample plan
		Latitude: 33° 31' 47.1"	**Longitude:** -112° 28' 21.7"

Remarks: Bulk Samples taken at 0'-5', 15'-17', and 25'-28', Ring Samples driven at 0'-1', 2'-3', 5'-6', 10'-11', 15'-16', 20'-21', and 25'-26', and Split Spoon Sample driven at 30'-30.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B/R	15-18	116	3.0/4.8		ML	**SANDY SILT (FILL MATERIAL)** Light brown, poorly graded, subrounded, very firm to hard,
R	19-33	111	6.9	2		dry to slightly damp, non-plastic.
				4	SM	**SILTY SAND (FILL MATERIAL)** Light brown, poorly graded, subrounded, medium dense to very
R	10-13			6		dense, dry to slightly damp, non-plastic.
				8		
R	13-19	110	8.5	10		
				12		
				14		
B/R	50/6"		5.4	16		Note: no recovery.
				18	ML	**SANDY SILT (NATIVE MATERIAL)** Medium brown, well graded, subrounded, very firm to firm to hard,
R	15-17	94	7.1	20		slightly damp, non-plastic.
				22		
				24		
B/R	16-20			26		Note: no recovery.
				28		
R	50/6"			30		Note: no recovery.
				32		**Bottom of boring @ 30.5'; no groundwater encountered.**
				34		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	11/16/09
Drill Rig:	Dirdrick D-120

Alpha Project Number:	09-G-1597	Log of Test Pit No.	TP-66
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Test Pit Location:	See attached site plan

Latitude: 33° 28' 12.7" Longitude: -112° 28' 45.1"

Remarks: Hand Sample taken from 0'-1'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			2.5	0–1	SP	**SAND** Light brown to gray, predominately course graded, dry, non-plastic.
				1		**Bottom of test pit @ 1'; no groundwater encountered.**
				2		
				3		
				4		
				5		
				6		
				7		
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/14/09

Sample Type: Shovel

Alpha Project Number:	09-G-1597	Log of Test Pit No.	TP-67
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Test Pit Location:	See attached site plan

Latitude: 33° 28' 28.5" Longitude: -112° 28' 44.9"

Remarks: Hand Sample taken from 0'-1'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			0.9	1	SP-SM	**SAND WITH SILT AND GRAVEL** Light brown to gray, predominately course graded, dry, non-plastic.
						Bottom of test pit @ 1'; no groundwater encountered.
				2		
				3		
				4		
				5		
				6		
				7		
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/14/09

Sample Type: Shovel

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-68
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	See attached site plan

Latitude: 33° 28' 35.2" **Longitude:** -112° 28' 44.4"

Remarks: Hand Sample taken from 0'-1'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			2.7	0–1	SP	**SAND** Light brown to gray, predominately course graded, dry, non-plastic.
				1		**Bottom of test pit @ 1'; no groundwater encountered.**
				2		
				3		
				4		
				5		
				6		
				7		
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	12/14/09
Sample Type:	Shovel

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-69
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	See attached site plan

Latitude: 33° 28' 36.2" **Longitude:** -112° 28' 45.3"

Remarks: Hand Sample taken from 0'-1'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			3.0	0–1	SP-SM	**SAND WITH SILT** Light brown to gray, predominately course graded, dry, non-plastic.
				1		**Bottom of test pit @ 1'; no groundwater encountered.**
				2		
				3		
				4		
				5		
				6		
				7		
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/14/09

Sample Type: Shovel

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-70
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	See attached site plan

Latitude: 33° 28' 50.2" **Longitude:** -112° 28' 45.4"

Remarks: Hand Sample taken from 0'-1'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			3.5	0–1	SP-SM	**SAND WITH SILT** Light brown to gray, predominately course graded, dry, non-plastic.
				1		**Bottom of test pit @ 1'; no groundwater encountered.**

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/14/09

Sample Type: Shovel

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-71
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	See attached site plan

Latitude: 33° 29' 32.1" **Longitude:** -112° 28' 46.2"

Remarks: Hand Sample taken from 0'-1'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			2.7		SP-SM	**SAND WITH SILT WITH GRAVEL** Light brown to gray, predominately course graded, dry, non-plastic.
				1		**Bottom of test pit @ 1'; no groundwater encountered.**
				2		
				3		
				4		
				5		
				6		
				7		
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/14/09

Sample Type: Shovel

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-72
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	See attached site plan

Latitude: 33° 30' 2.8" **Longitude:** -112° 28' 44.3"

Remarks: Hand Sample taken from 0'-1'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			1.7		SP	**SAND WITH GRAVEL** Light brown to gray, predominately course graded, dry, non-plastic.
				1		**Bottom of test pit @ 1'; no groundwater encountered.**
				2		
				3		
				4		
				5		
				6		
				7		
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/14/09

Sample Type: Shovel

Alpha Project Number:	09-G-1597	**Log of Test Pit No.**	TP-73
Project:	White Tanks FRS #3 - Outfall Channel	**Client:**	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	**Test Pit Location:**	See attached site plan

Latitude: 33° 30' 3" **Longitude:** -112° 28' 45"

Remarks: Hand Sample taken from 0'-1'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			1.5		SP	**SAND** Light brown to gray, predominately course graded, dry, non-plastic.
				1		**Bottom of test pit @ 1'; no groundwater encountered.**
				2		
				3		
				4		
				5		
				6		
				7		
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/14/09

Sample Type: Shovel

Alpha Project Number:	09-G-1597	Log of Test Pit No.	TP-74
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Test Pit Location:	See attached site plan

Latitude:	33° 30' 15.6"	Longitude:	-112° 28' 44.5"

Remarks: Hand Sample taken from 0'-1'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			1.7	0–1	SP	**SAND** Light brown to gray, predominately course graded, dry, non-plastic.
				1		**Bottom of test pit @ 1'; no groundwater encountered.**

Depth scale (Feet): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	12/14/09
Sample Type:	Shovel

Alpha Project Number:	09-G-1597	Log of Test Pit No.	TP-75
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Test Pit Location:	See attached site plan

Latitude: 33° 30' 49.8" Longitude: -112° 28' 44.1"

Remarks: Hand Sample taken from 0'-1'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			3.1	1	SP	**SAND** Light brown to gray, predominately course graded, dry, non-plastic.
				2		**Bottom of test pit @ 1'; no groundwater encountered.**
				3		
				4		
				5		
				6		
				7		
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines
Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample
BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date:	12/14/09
Sample Type:	Shovel

Alpha Project Number:	09-G-1597	Log of Test Pit No.	TP-76
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Test Pit Location:	See attached site plan

Latitude: 33° 30' 57.6" Longitude: -112° 28' 46"

Remarks: Hand Sample taken from 0'-1'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			2.9	0–1	GP	**GRAVEL WITH SAND** Light brown to gray, predominately course graded, dry, non-plastic.
				1		**Bottom of test pit @ 1'; no groundwater encountered.**
				2–17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/14/09

Sample Type: Shovel

Alpha Project Number:	09-G-1597	Log of Test Pit No.	TP-77
Project:	White Tanks FRS #3 - Outfall Channel	Client:	Hoskin Ryan Consultants, Inc.
Project Location:	Maricopa County, Arizona	Test Pit Location:	See attached site plan

Latitude: 33° 31 5.5" **Longitude:** -112° 28' 45.8"

Remarks: Hand Sample taken from 0'-1'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
H			2.0		SP	**SAND WITH GRAVEL** Light brown to gray, predominately course graded, dry, non-plastic.
				1		**Bottom of test pit @ 1'; no groundwater encountered.**
				2		
				3		
				4		
				5		
				6		
				7		
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 12/14/09
Sample Type: Shovel

APPENDIX C
LABORATORY TEST

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location:	Maricopa County, Arizona	**Work Order Number:**	1-4
Client:	Hoskin Ryan Consultants, Inc.	**Sample Date:**	11/02/09 to 11/19/09
Sample Source:	See Below	**Material:**	Native

Mechanical Sieve Analysis

Group Sumbol, USCS (ASTM D-2487)

					Silt or Clay	Sand									Gravel									Moisture
						Fine			Medium			Coarse			Fine				Coarse					
Lab Number	**Location & Depth**	**USCS**	**LL**	**PI**	**#200**	**#100**	**#50**	**#40**	**#30**	**#16**	**#10**	**#8**	**#4**	**1/4"**	**3/8"**	**1/2"**	**3/4"**	**1"**	**1 1/4"**	**1 1/2"**	**2"**	**3"**	**%**
	Percent Passing By Weight																						
79	Bulk Sample B-2 @ 0'-5'	SM	NV	NP	37	50	62	69	76	86	92	94	97	100	100	100	100	100	100	100	100	100	1.6
1	Bulk Sample B-3 @ 0'-2'	SM	NV	NP	34	42	51	56	61	68	72	73	74	100	100	100	100	100	100	100	100	100	1.7
2	Bulk Sample B-5 @ 0'-2'	SM	NV	NP	39	53	65	70	75	81	84	85	86	95	99	100	100	100	100	100	100	100	1.5
80	Bulk Sample B-7 @ 5'-10'	SM	NV	NP	33	42	52	58	64	76	83	86	91	94	100	100	100	100	100	100	100	100	3.7
81	Bulk Sample B-8 @ 5'-10'	SM	NV	NP	33	44	58	65	71	80	85	87	90	95	99	100	100	100	100	100	100	100	2.6
82	Bulk Sample B-12 @ 0'-5'	SM	NV	NP	27	37	49	56	62	76	85	87	92	97	100	100	100	100	100	100	100	100	0.7
3	STP B-13 @ 5'-6.5'	SM	NV	NP	26	33	45	52	60	73	82	85	90	100	100	100	100	100	100	100	100	100	0.8
4	Bulk Sample B-14 @ 0'-2'	SM	NV	NP	26	37	49	56	63	78	87	90	94	100	100	100	100	100	100	100	100	100	0.4
5	STP B-17 @ 10'-11.5'	GM	NV	NP	18	24	31	34	38	46	53	55	59	100	100	100	100	100	100	100	100	100	2.7
6	STP B-18 @ 5'-6.5'	SM	NV	NP	34	46	56	60	63	69	73	74	77	100	100	100	100	100	100	100	100	100	3.0
7	Bulk Sample B-23 @ 0'-2'	SM	NV	NP	26	29	40	47	54	66	74	76	83	88	91	95	99	100	100	100	100	100	1.4
8	STP B-25 @ 5'-6.5'	SM	NV	NP	29	38	48	55	62	72	79	81	85	100	100	100	100	100	100	100	100	100	1.1
11	Bulk Sample B-27 @ 0'-2'	SM	NV	NP	30	37	47	53	58	69	77	79	83	94	99	100	100	100	100	100	100	100	2.4
12	STP B-28 @ 5'-6.5'	SM	NV	NP	39	47	54	58	63	71	78	80	85	100	100	100	100	100	100	100	100	100	4.7
13	Bulk Sample B-31 @ 10'-15'	SM	NV	NP	21	27	33	37	42	52	60	63	70	80	87	92	95	99	100	100	100	100	2.9
59	STP B-32 @ 2'-3.5'	ML	NV	NP	54	62	71	76	81	89	94	95	98	100	100	100	100	100	100	100	100	100	2.7
60	STP B-35 @ 2'-3.5'	SM	NV	NP	47	55	63	68	73	81	87	88	93	100	100	100	100	100	100	100	100	100	1.7
61	Bulk Sample B-37 @ 2'-5'	SM	NV	NP	17	22	30	34	39	49	57	60	68	68	73	77	84	89	100	100	100	100	1.4
62	STP B-38 @ 2'-3.5'	SM	NV	NP	48	54	62	67	72	81	88	90	95	100	100	100	100	100	100	100	100	100	5.4
63	Bulk Sample B-38 @ 5'-10'	SM	NV	NP	38	47	56	62	67	78	85	87	92	100	100	100	100	100	100	100	100	100	3.5
64	Bulk Sample B-39 @ 5'-7'	SM	NV	NP	30	40	50	56	61	72	80	82	89	100	100	100	100	100	100	100	100	100	3.0
65	Ring Sample B-41 @ 5'-6'	SM	NV	NP	32	42	53	58	63	75	82	85	93	100	100	100	100	100	100	100	100	100	3.3
66	Bulk Sample B-42 @ 0'-2'	SM	NV	NP	34	42	54	59	66	77	85	87	91	100	100	100	100	100	100	100	100	100	1.7
67	STP B-42 @ 10'-11.5'	SM	NV	NP	42	49	58	63	68	78	84	87	93	100	100	100	100	100	100	100	100	100	3.5
68	STP B-44 @ 5'-6.5'	ML	NV	NP	57	64	71	75	79	86	90	91	94	100	100	100	100	100	100	100	100	100	4.4
83	Bulk Sample B-45 @ 3'-5'	SM	NV	NP	26	33	40	45	51	62	71	74	83	88	95	99	100	100	100	100	100	100	3.4

Reviewed By: AC

Alpha Geotechnical & Materials, Inc.

Project: White Tanks FRS #3 - Outfall Channel
Project Location: Maricopa County, Arizona
Client: Hoskin Ryan Consultants, Inc.
Sample Source: See Below

Project Number: 09-G-1597
Work Order Number: 1-4
Sample Date: 11/02/09 to 11/19/09
Material:

Mechanical Sieve Analysis
Group Sumbol, USCS (ASTM D-2487)

					Silt or	Sand								Gravel									Moisture
					Clay	Fine			Medium			Coarse		Fine				Coarse					
Lab Number	Location & Depth	USCS	LL	PI	#200	#100	#50	#40	#30	#16	#10	#8	#4	1/4"	3/8"	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	3"	%
											Percent Passing By Weight												
100	Bulk Sample B-47 @ 5'-10'	SM	NV	NP	22	28	33	37	40	49	56	58	69	79	86	94	98	100	100	100	100	100	1.4
101	STP B-51 @ 15'-16'	SM	NV	NP	31	38	45	49	54	63	71	74	85	100	100	100	100	100	100	100	100	100	3.7
102	STP B-51 @ 20'-21.5'	GM	NV	NP	23	27	32	35	38	45	50	52	58	100	100	100	100	100	100	100	100	100	1.5
103	Bulk Sample B-52 @ 12'-15'	SM	NV	NP	27	34	43	48	53	64	72	74	83	100	100	100	100	100	100	100	100	100	2.4
104	Bulk Sample B-53 @ 15'-16.5'	SM	NV	NP	31	37	44	49	53	62	68	70	80	100	100	100	100	100	100	100	100	100	5.1
105	Bulk Sample B-54 @ 2'-3.5'	ML	NV	NP	50	66	80	85	89	94	96	97	98	100	100	100	100	100	100	100	100	100	2.3
106	STP B-55 @ 5'-6.5'	SM	NV	NP	38	51	63	69	74	84	91	93	97	100	100	100	100	100	100	100	100	100	3.4
107	Ring Sample B-56 @ 2'-3'	SM	NV	NP	22	29	38	44	50	68	80	83	90	100	100	100	100	100	100	100	100	100	1.7
108	STP B-58 @ 15'-16.5'	ML	NV	NP	67	79	87	91	93	97	99	99	100	100	100	100	100	100	100	100	100	100	4.2
109	Ring Sample B-59 @ 5'-6'	ML	NV	NP	51	61	69	82	86	90	94	94	96	100	100	100	100	100	100	100	100	100	4.6
110	STP B-60 @ 5'-6.5'	ML	NV	NP	56	65	73	77	82	88	92	93	95	100	100	100	100	100	100	100	100	100	6.7
14	Bulk Sample B-61 @ 0'-5'	SM	NV	NP	33	40	47	51	56	67	76	78	84	91	98	100	100	100	100	100	100	100	6.3
15	Ring Sample B-61 @ 30'-31'	SM	NV	NP	34	44	52	58	64	76	85	88	96	100	100	100	100	100	100	100	100	100	7.6
16	Bulk Sample B-62 @ 5'-10'	ML	NV	NP	52	59	66	71	76	86	92	94	96	100	100	100	100	100	100	100	100	100	7.9
17	Ring Sample B-63 @ 20'-21'	ML	NV	NP	65	73	82	87	91	95	97	97	98	100	100	100	100	100	100	100	100	100	2.8
18	Bulk Sample B-64 @ 0'-5'	SM	NV	NP	42	51	59	65	70	80	86	88	91	100	100	100	100	100	100	100	100	100	9.3
111	Ring Sample B-65 @ 0'-1'	ML	NV	NP	50	57	66	71	77	87	94	95	100	100	100	100	100	100	100	100	100	100	3.0
112	Bulk Sample B-65 @ 15'-17'	SM	NV	NP	44	52	60	65	70	80	86	88	91	100	100	100	100	100	100	100	100	100	5.4

Reviewed By: AC

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location:	Maricaopa County, Arizona	**Work Order Number:**	1-4
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	See Below
Material:	Native	**Date Sampled:**	11/2/09 to 11/19/09
Sample Source:	See Below		

Density of Soil in Place by the Drive-Cylinder Method (ASTM D2937)

Lab Number	Boring	Wet Wt. (g)	Moisture Dry Wt. (g)	Moist. Content	# Of Rings	Wet Wt'+ Rings (g)	Wt.of Rings (g)	Dry Density (pcf)
69	Ring Sample B-2 @ 10'-10.5'	101.2	97.3	4.0%	4	709.9	177.4	106.0
19	Ring Sample B-3 @ 2'-3'	107.4	102.2	5.1%	6	995.4	264.2	96.0
20	Ring Sample B-5 @ 10'-11'	113.5	107.5	5.6%	2	362.4	92.0	106.0
70	Ring Sample B-7 @ 0'-1'	103.1	96.4	7.0%	4	718.4	176.9	104.8
71	Ring Sample B-8 @ 15'-15.5'	102.9	99.8	3.1%	4	730.8	175.9	111.4
72	Ring Sample B-12 @ 10'-10.5'	101.7	97.2	4.6%	5	923.3	223.5	110.8
37	Ring Sample B-32 @ 5'-6'	100.5	94.3	6.6%	6	1042.3	266.0	100.5
38	Ring Sample B-37 @ 5'-6'	101.8	95.6	6.5%	5	862.8	176.1	106.8
84	Ring Sample B-52 @ 0'-1'	101.1	93.6	8.0%	4	733.7	177.3	106.6
85	Ring Sample B-57 @ 20'-21'	100.4	91.9	9.2%	4	689.3	170.8	98.2
86	Ring Sample B-58 @ 5'-6'	104.6	97.0	7.8%	5	951.8	220.8	112.3
21	Ring Sample B-61 @ 0'-1'	113.3	108.9	4.0%	5	937.4	226.7	113.1
22	Ring Sample B-61 @ 5'-6'	109.0	103.2	5.6%	5	1023.0	222.0	125.6
23	Ring Sample B-61 @ 25'-26'	110.2	101.3	8.8%	5	999.6	226.5	117.7
24	Ring Sample B-61 @ 30'-31'	147.5	138.1	6.8%	5	804.6	221.0	90.5
25	Ring Sample B-62 @ 5'-6'	104.0	96.8	7.4%	5	1008.4	223.1	121.0
26	Ring Sample B-62 @ 10'-11'	102.2	95.6	6.9%	4	759.8	178.6	112.5
27	Ring Sample B-62 @ 15'-16'	104.3	96.6	8.0%	5	996.1	222.7	118.6
28	Ring Sample B-62 @ 20'-21'	103.0	99.4	3.6%	5	824.7	221.9	96.3
29	Ring Sample B-63 @ 5'-6'	101.7	95.6	6.4%	6	1217.0	257.8	124.4
30	Ring Sample B-63 @ 15'-20'	100.9	92.7	8.8%	5	1004.7	222.6	119.0
31	Ring Sample B-63 @ 20'-21'	112.4	107.7	4.4%	3	483.6	132.6	92.8
32	Ring Sample B-63 @ 25'-26'	110.2	104.2	5.8%	5	828.7	217.1	95.8
33	Ring Sample B-64 @ 10'-11'	105.6	99.2	6.5%	5	914.7	230.0	106.5
34	Ring Sample B-64 @ 15'-16'	101.2	94.4	7.2%	6	1132.3	223.6	117.0
35	Ring Sample B-64 @ 20'-21'	105.8	102.4	3.3%	4	703.9	175.2	105.9
36	Ring Sample B-64 @ 25'-26'	109.1	104.9	4.0%	4	696.4	174.4	103.9
39	Ring Sample B-44 @ 2'-3'	100.1	95.2	5.1%	5	863.3	173.1	108.7
87	Ring Sample B-65 @ 0'-1'	100.8	96.2	4.8%	5	948.9	217.0	115.7
88	Ring Sample B-65 @ 2'-3'	100.8	94.3	6.9%	3	564.4	134.9	110.9
89	Ring Sample B-65 @ 10'-11'	100.8	92.9	8.5%	4	757.8	181.4	110.0
90	Ring Sample B-65 @ 20'-21'	100.0	93.4	7.1%	5	825.0	217.4	94.0

Reviewed by: AC

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location:	Maricopa County, AZ	**Work Order Number:**	6.0
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	See Below
Material:	Native	**Date Sampled:**	11/19/09
Sample Source:	See Below		

Density of Soil in Place by the Drive-Cylinder Method (ASTM D2937)

Lab Number	**Boring**	Wet Wt. (g)	Moisture Dry Wt. (g)	**Moist. Content**	# Of Rings	Wet Wt'+ Rings (g)	Wt.of Rings (g)	**Dry Density (pcf)**
176	**Ring Sample B-15 @ 2'-3'**	101.9	96.1	**6.0%**	5	911.2	243.1	**104.3**
175	**Ring Sample B-23 @ 2'-3'**	102.3	95.6	**7.0%**	5	912.3	245.6	**103.2**

Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS # 3 - Outfall Channel	**Project Number:**	09-G-1597
Location:	Maricopa County, Arizona	**Work Order Number:**	1-4
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	See Below
Material:	See Below	**Date Sampled:**	11/02/09 to 11/19/09
Sample Source:	See Below		

pH & Resistivity (AZ 236)

Lab Number	Sample Source	Material	Resistivity (Ohm-cm)	pH
40	Bulk Sample B-5 @ 0'-2'	Native	9,650	7.1
41	Bulk Sample B-13 @ 0'-2'	Native	6,985	7.2
42	Bulk Sample B-25 @ 0'-2'	Native	10,250	7.1
43	Bulk Sample B-27 @ 0'-2'	Native	7,800	6.9
44	Bulk Sample B-31 @ 10'-15'	Native	7,750	6.8
45	Bulk Sample B-37 @ 2'-5'	Native	6,120	6.7
46	Bulk Sample B-42 @ 0'-2'	Native	11,250	7.0
47	Bulk Sample B-44 @ 10'-12'	Native	9,540	7.1
74	Bulk Sample B-8 @ 5'-10'	Native	9,500	7.2
75	Bulk Sample B-12 @ 0'-5'	Native	8,970	7.1
91	Bulk Sample B-47 @ 5'-10'	Native	11,250	7.3

Reviewed by: AC

ALPHA Geotechnical & Materials, Inc.

Project: White Tanks FRS #3 - Outfall Channel
Project Location: Maricopa County, Arizona
Client: Hoskin Ryan Consultants, Inc.
Material: Native
Sample Source: See Below
Sample Prep: Remolded to 95% of Max. Dry Density, and at 2% below Opt. Moisture

Job Number: 09-G-1597
Work Order Number: 3
Lab Number: See Below
Sample Date: 11/13/09

ONE DIMENSIONAL SWELL OR SETTLEMENT POTENTIAL OF COHESIVE SOILS (ASTM D-4546)

Lab number	Sample description	Initial reading (in)	Final reading (in)	% Swell
76	Bulk Sample B-2 @ 0'-5'		0.002	0.2%
77	Bulk Sample B-7 @ 5'-10'		0.006	0.6%
78	Bulk Sample B-46 @ 3'-5'		0.0032	0.3%

Reviewed by: AC

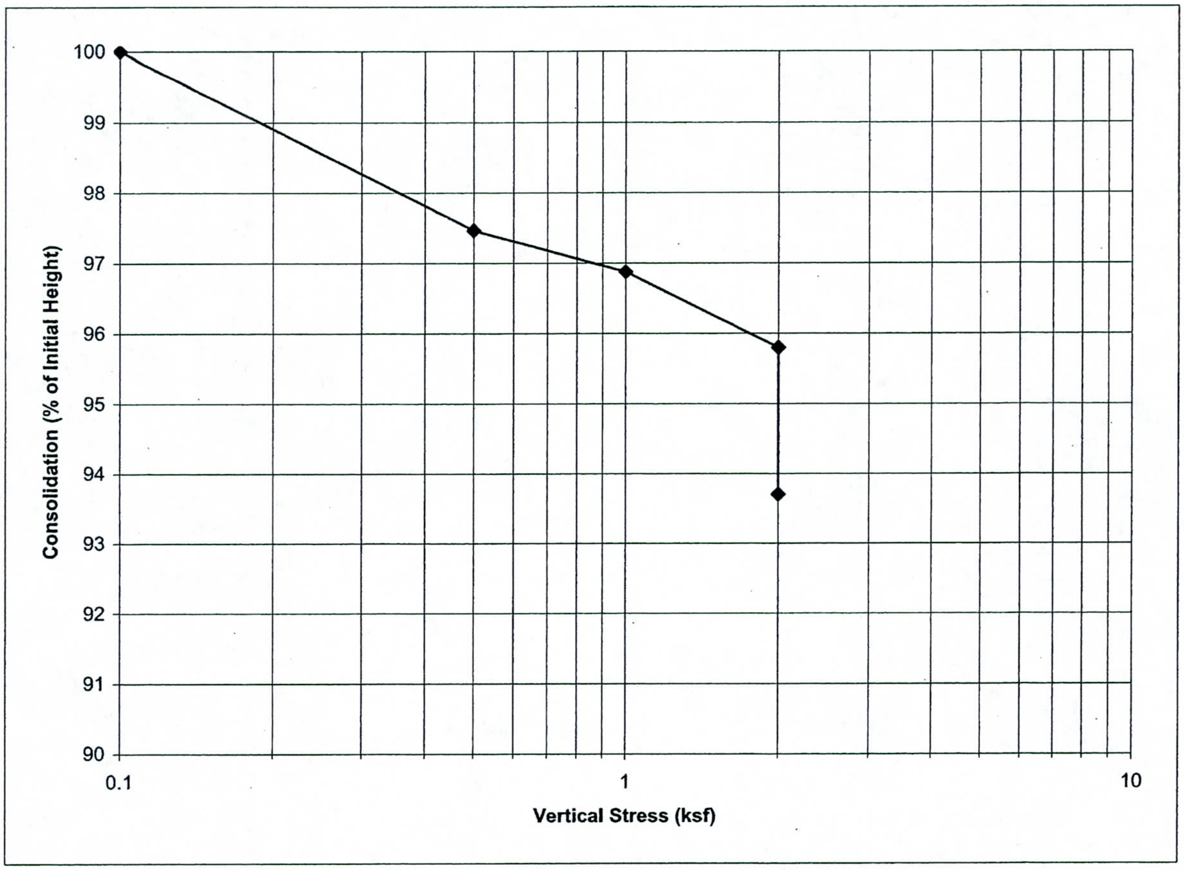
Alpha Geotechnical Materials, Inc.
5216 S. 40th St.
Phoenix, AZ 85040
(602) 453-3265

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	4
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	98
Material:	Native	**Date Sampled:**	11/13/09
Sample Source:	Ring Sample B-60 @ 2'-3'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.31
Initial Moisture Content	5.7%	Final Moisture Content	22.5%
Initial Dry Density(pcf)	96.6	FInal Dry Density(pcf)	103.0
Initial Degree of Saturation	21%	FInal Degree of Saturation	99%
Initial Void Ratio	0.7	Final Void Ratio	0.6
Estimated Specific Gravity	2.65	Saturated at	2 ksf



Reviewed by: AC

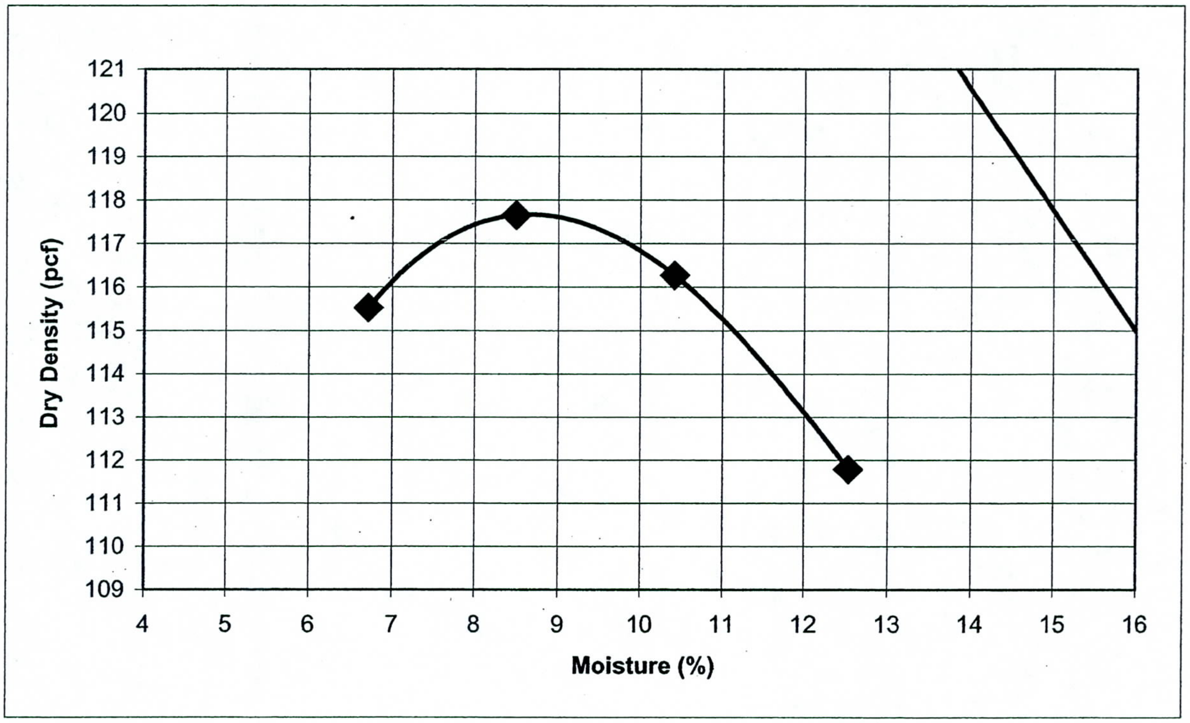
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

ALPHA Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Location:	Maricopa County, Arizona	**Work Order Number:**	1
Material:	Native	**Lab Number:**	55
Sample Source:	Bulk Sample B-61 @ 0'-5'	**Sample Date:**	11/04/09
Proposed Use:	Pads/ Mass Grading	**Sampled by:**	J Floyd

Laboratory Compaction Characteristics of Soils Using
Standard Efforts (12,400ft-lb-ft/cu.ft) (ASTMD698A)

	English (pcf)	Metric (kg/ cu.m.)
Maximum Dry Density:	117.7	1885
Optimum Moisture (%):	8.7	8.7



Notes:
- The Zero Air Void Curve Represents a Specific Gravity of: 2.65 (Assumed).
- This is a Summarized Report of the Referenced Procedures and Does Not Include All Reporting Requirements. Additional Data Can be Provided at Clients Request.

Reviewed by: AC

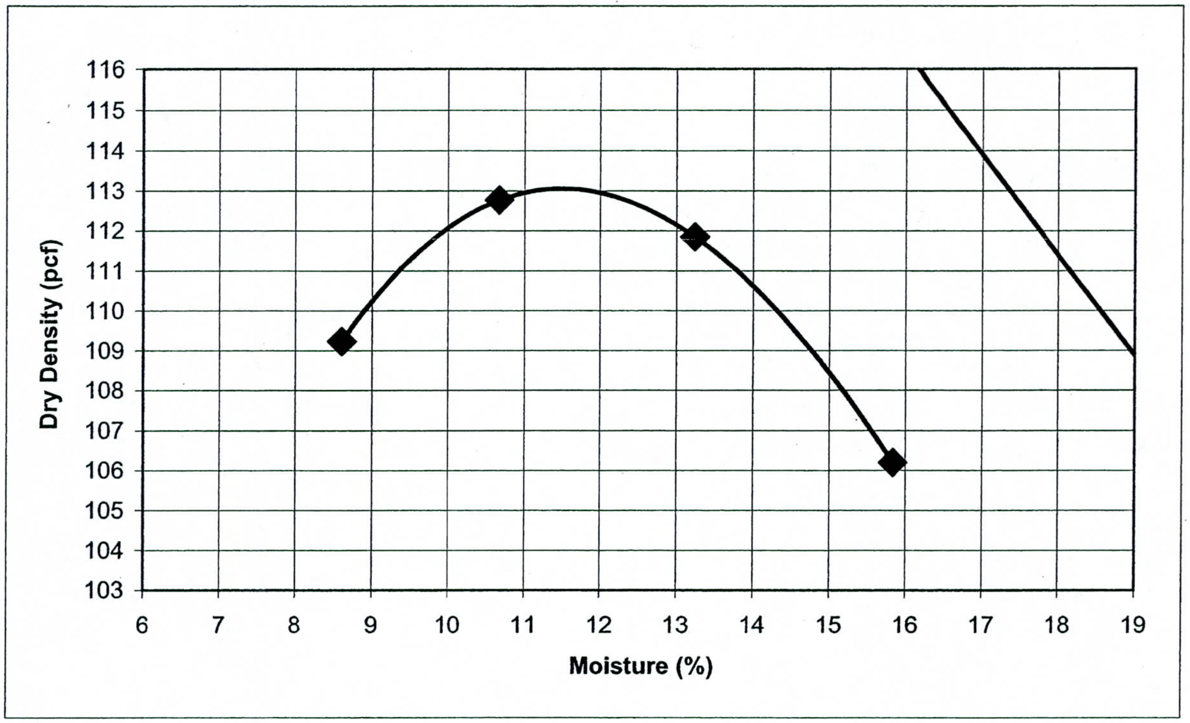
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

ALPHA Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Location:	Maricopa County, Arizona	**Work Order Number:**	1
Material:	Native	**Lab Number:**	56
Sample Source:	Bulk Sample B-62 @ 5'-10'	**Sample Date:**	11/04/09
Proposed Use:	Pads/ Mass Grading	**Sampled by:**	J Floyd

Laboratory Compaction Characteristics of Soils Using
Standard Efforts (12,400ft-lb-ft/cu.ft) (ASTMD698A)

	English (pcf)	Metric (kg/ cu.m.)
Maximum Dry Density:	113.1	1811
Optimum Moisture (%):	11.5	11.5



Notes:
- The Zero Air Void Curve Represents a Specific Gravity of: 2.65 (Assumed).
- This is a Summarized Report of the Referenced Procedures and Does Not Include All Reporting Requirements. Additional Data Can be Provided at Clients Request.

Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

ALPHA Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Location:	Maricopa County, Arizona	**Work Order Number:**	1
Material:	Native	**Lab Number:**	57
Sample Source:	Bulk Sample B-64 @ 0'-5'	**Sample Date:**	11/04/09
Proposed Use:	Pads/ Mass Grading	**Sampled by:**	J Floyd

Laboratory Compaction Characteristics of Soils Using
Standard Efforts (12,400ft-lb-ft/cu.ft) (ASTMD698A)

	English (pcf)	Metric (kg/ cu.m.)
Maximum Dry Density:	119.2	1909
Optimum Moisture (%):	9.3	9.3

Notes:
- The Zero Air Void Curve Represents a Specific Gravity of: 2.65 (Assumed).
- This is a Summarized Report of the Referenced Procedures and Does Not Include All Reporting Requirements. Additional Data Can be Provided at Clients Request.

Reviewed by: AC

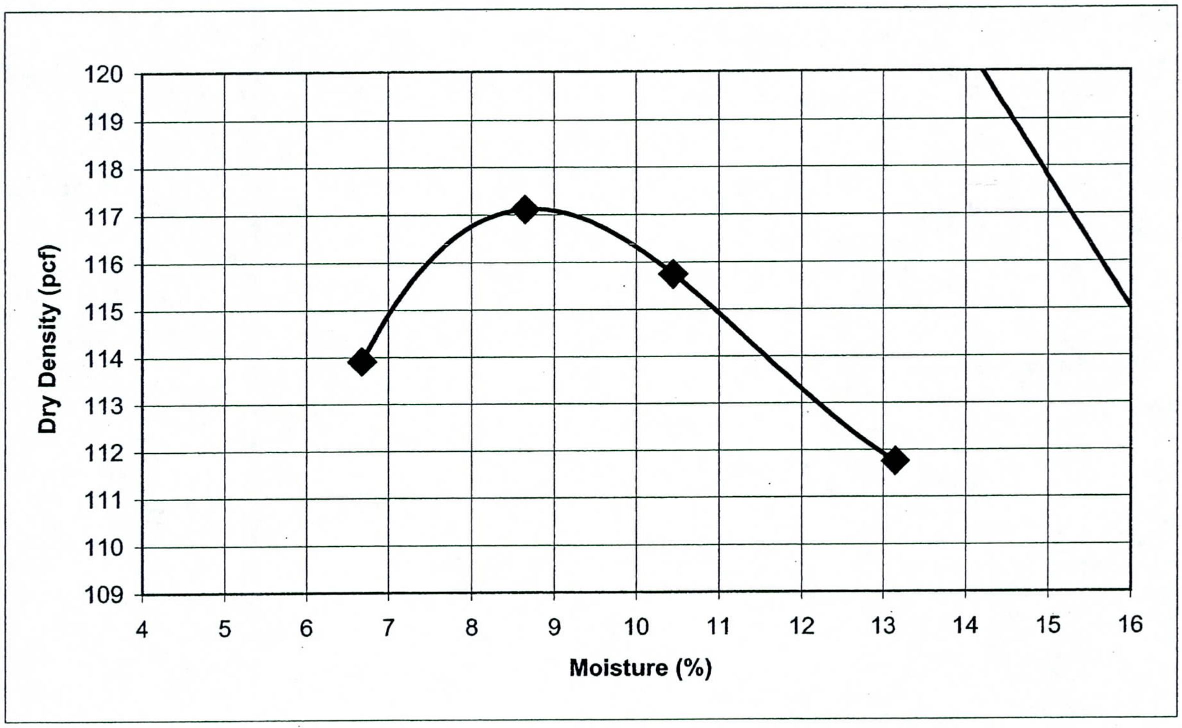
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

ALPHA Geotechnical & Materials, Inc.

Project:	Whaite Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Location:	Maricopa County, Arizona	**Work Order Number:**	4
Material:	Native	**Lab Number:**	99
Sample Source:	Bulk Sample B-65 @ 15'-17'	**Sample Date:**	11/16/09
Proposed Use:	Pads/ Mass Grading	**Sampled by:**	J Floyd

Laboratory Compaction Characteristics of Soils Using
Standard Efforts (12,400ft-lb-ft/cu.ft) (ASTMD698A)

	English (pcf)	Metric (kg/ cu.m.)
Maximum Dry Density:	117.1	1876
Optimum Moisture (%):	8.7	8.7



Notes:
- The Zero Air Void Curve Represents a Specific Gravity of: 2.65 (Assumed).
- This is a Summarized Report of the Referenced Procedures and Does Not Include All Reporting Requirements. Additional Data Can be Provided at Clients Request.

Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location	Maricopa County, Arizona	**Work Order Number:**	2
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	58
Material:	Native	**Date Sampled:**	11/09/09
Sample Source:	Bulk Sample B-38 @ 5'-10'		

Hydrometer Test Report (ASTM D-422)

Weight of Sample Dispersed	75.40	**Specific Gravity of Solids**	2.65
Percent Passing #10 Sieve	84.8%		

Full Sieve Analysis

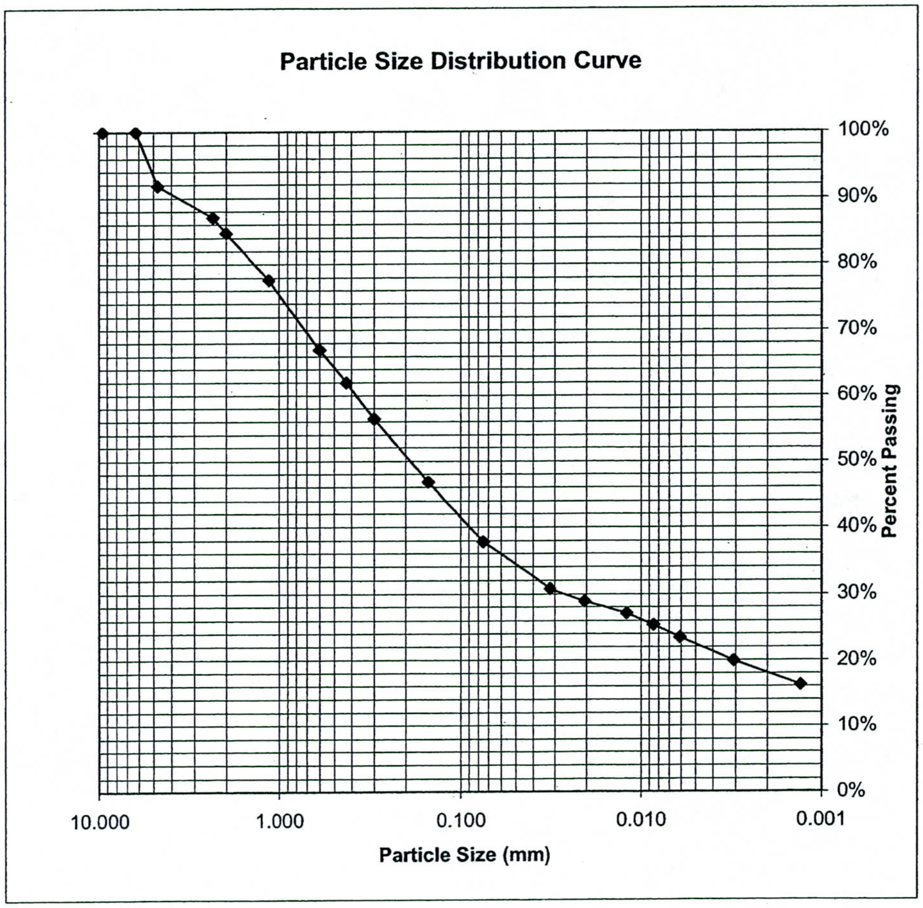
(Mechanical Sieve & Hydrometer)

(% Passing)

# 4		92%
# 8		87%
# 10		85%
# 16		78%
# 30		67%
# 40		62%
# 50		56%
# 100		47%
# 200		37.7%
0.0320	mm	31%
0.0205	mm	29%
0.0120	mm	27%
0.0085	mm	25%
0.0061	mm	23%
0.0031	mm	20%
0.0013	mm	16%
0.0009	mm	14%

Mechanical Sieve Analysis After Hydrometer (% Passing)

#200	#100	#50	#40	#30	#16	#10
38%	47%	56%	62%	67%	78%	85%



Reviewed by: AC

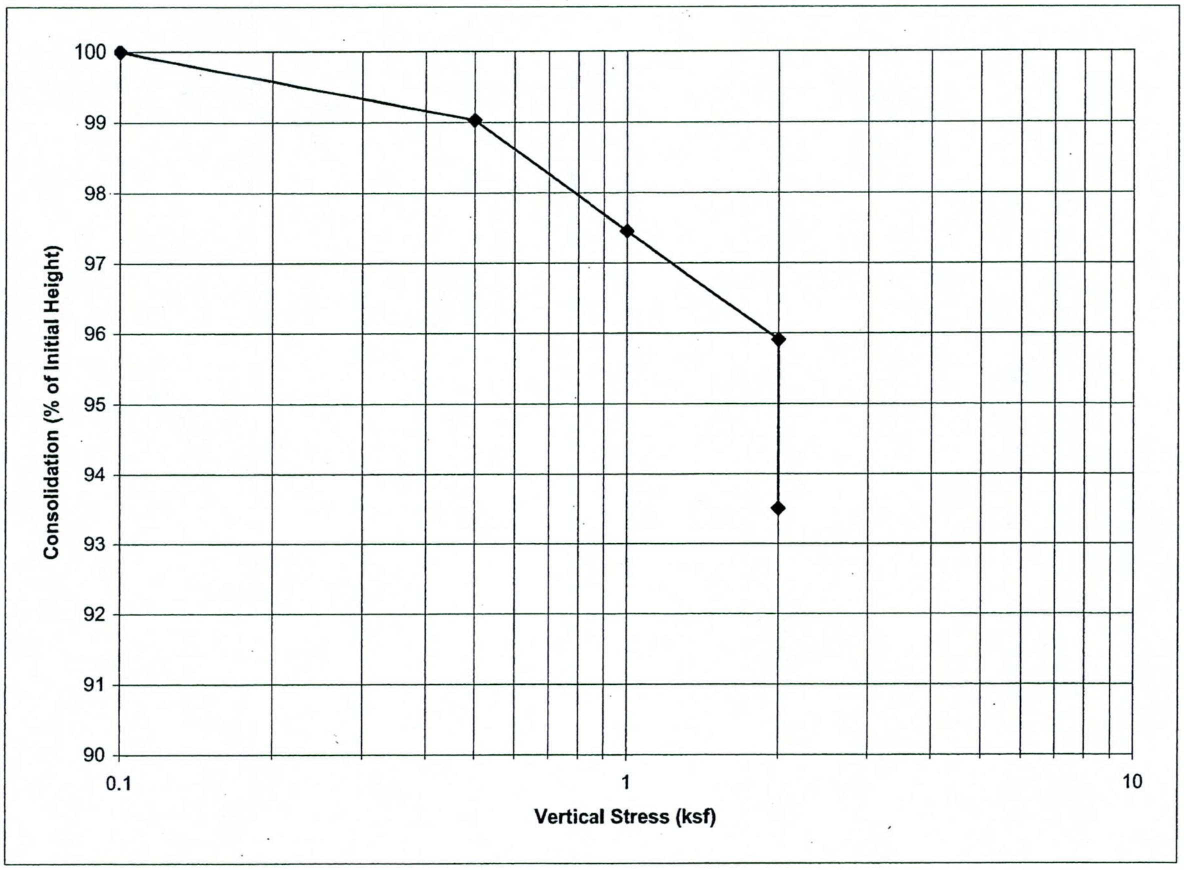
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	1
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	48
Material:	Native	**Date Sampled:**	11/02/09
Sample Source:	Ring Sample B-5 @ 5'-6'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.31
Initial Moisture Content	3.3%	Final Moisture Content	14.0%
Initial Dry Density(pcf)	111.8	FInal Dry Density(pcf)	119.5
Initial Degree of Saturation	18%	FInal Degree of Saturation	97%
Initial Void Ratio	0.5	Final Void Ratio	0.4
Estimated Specific Gravity	2.65	Saturated at	2 ksf



Reviewed by: AC

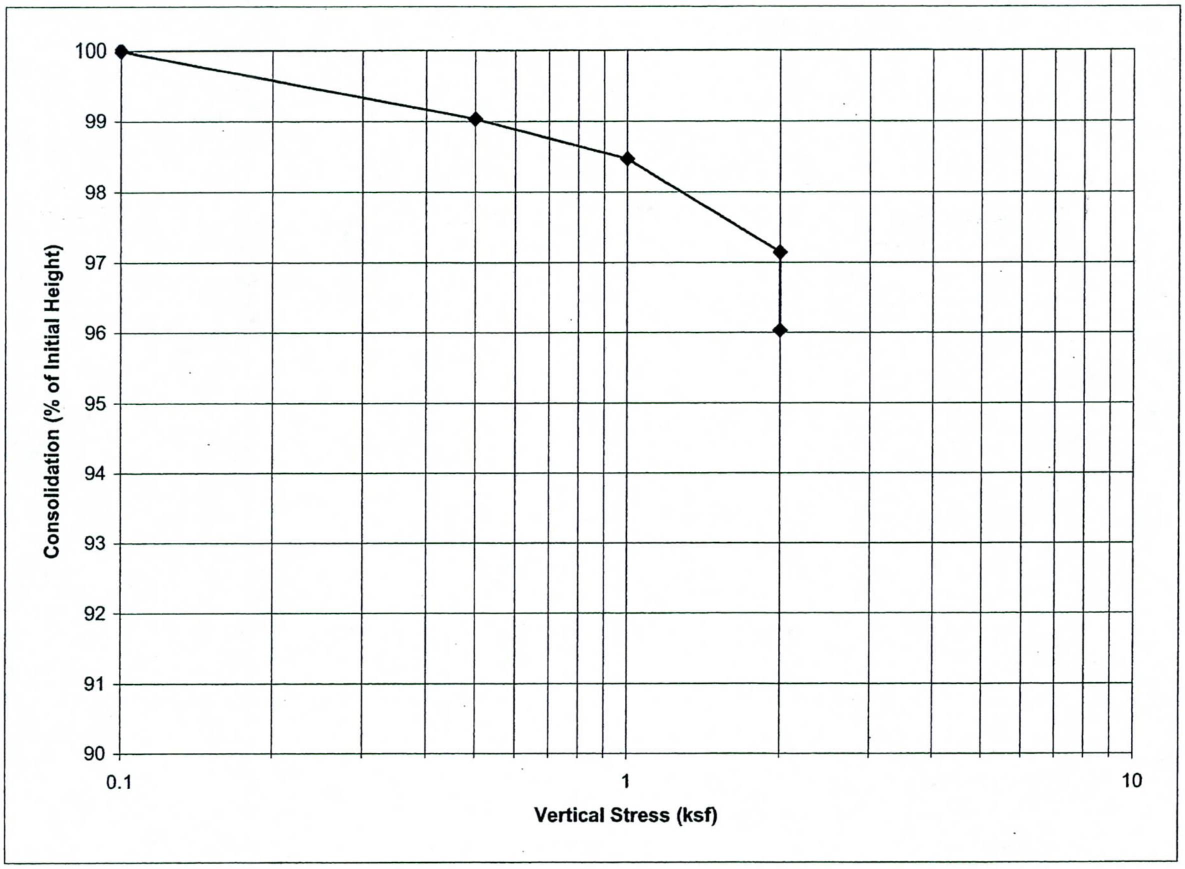
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	3
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	69
Material:	Native	**Date Sampled:**	11/13/09
Sample Source:	Ring Sample B-8 @ 5'-6'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.42
Initial Moisture Content	11.7%	Final Moisture Content	23.6%
Initial Dry Density(pcf)	95.6	FInal Dry Density(pcf)	99.6
Initial Degree of Saturation	42%	FInal Degree of Saturation	95%
Initial Void Ratio	0.7	Final Void Ratio	0.7
Estimated Specific Gravity	2.65	Saturated at	2 ksf



Reviewed by: AC

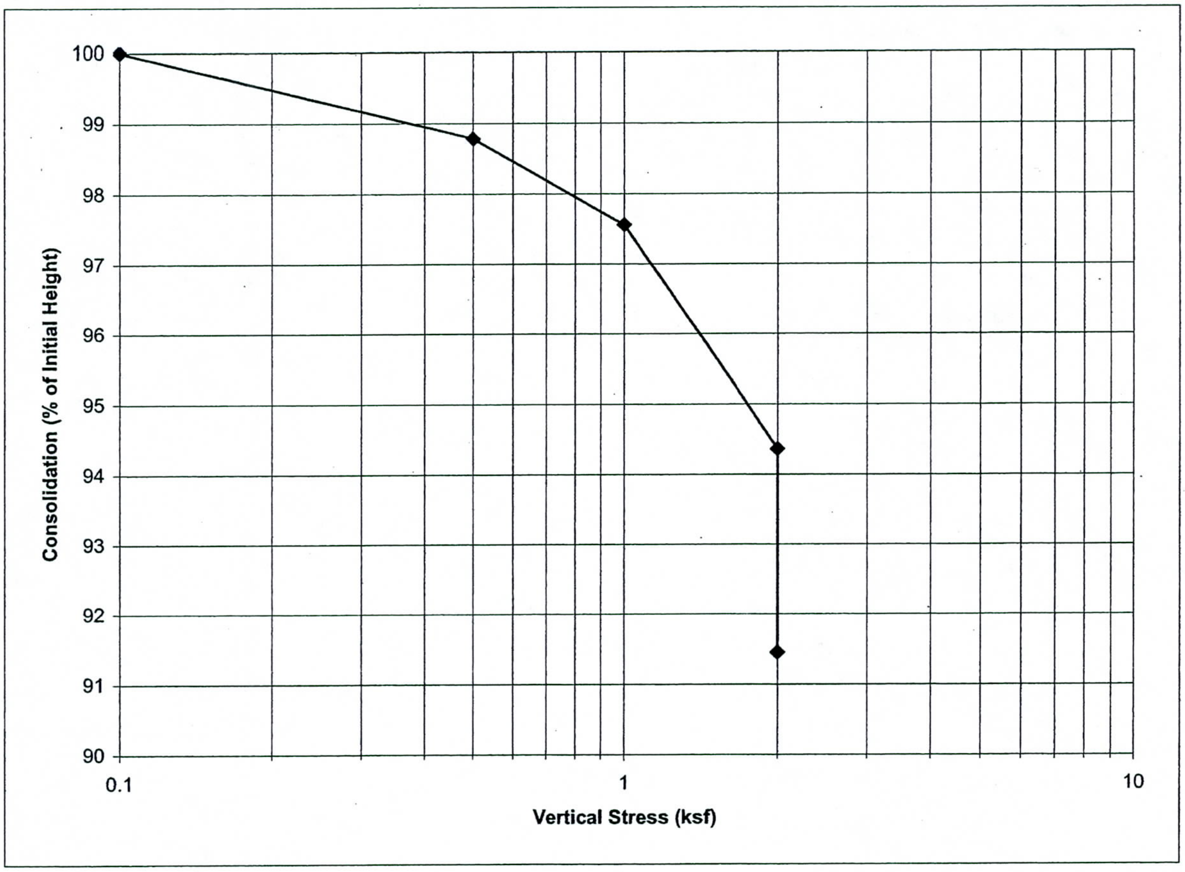
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	1
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	49
Material:	Native	**Date Sampled:**	11/02/09
Sample Source:	Ring Sample B-13 @ 10'-11'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.21
Initial Moisture Content	6.0%	Final Moisture Content	12.7%
Initial Dry Density(pcf)	111.9	FInal Dry Density(pcf)	122.4
Initial Degree of Saturation	33%	FInal Degree of Saturation	96%
Initial Void Ratio	0.5	Final Void Ratio	0.4
Estimated Specific Gravity	2.65	Saturated at	2 ksf



Reviewed by: AC

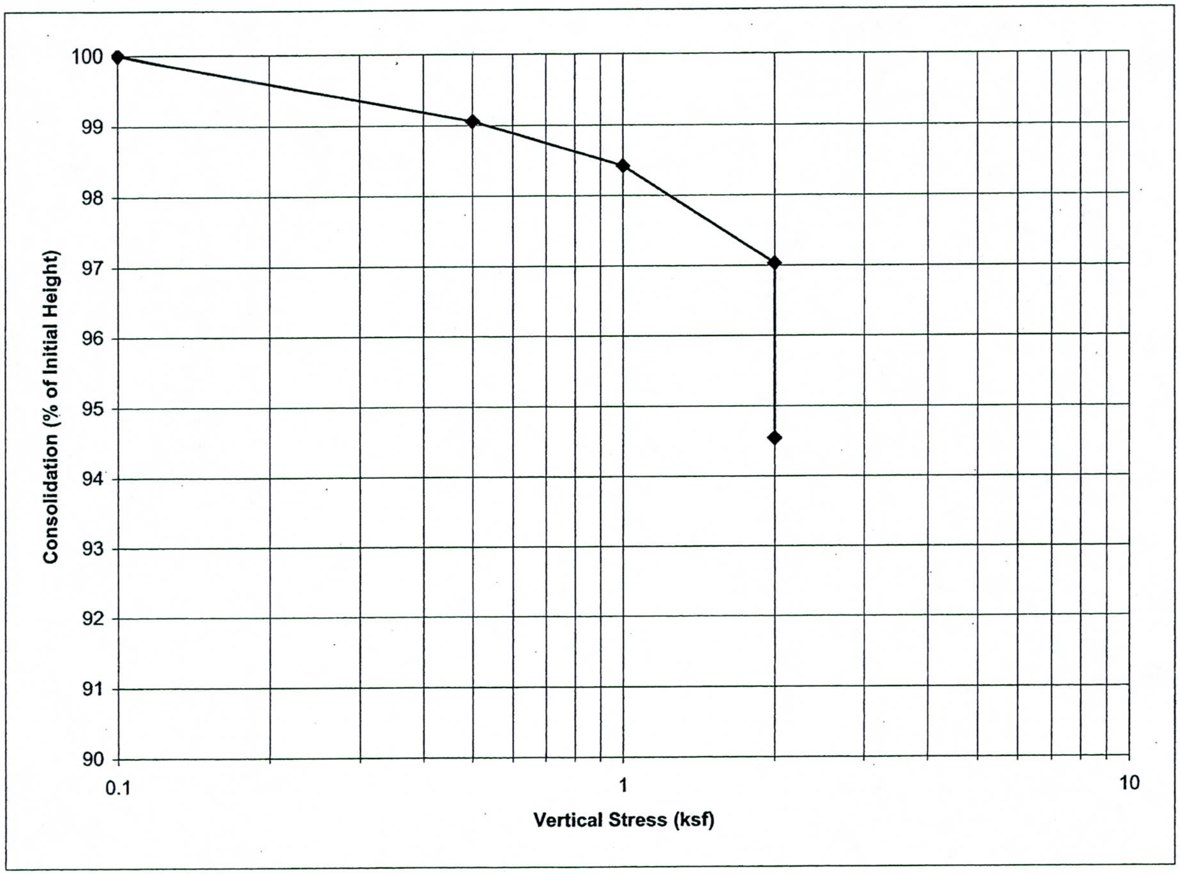
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	1
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	50
Material:	Native	**Date Sampled:**	11/02/09
Sample Source:	Ring Sample B-25 @ 10'-11'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.35
Initial Moisture Content	7.0%	Final Moisture Content	23.5%
Initial Dry Density(pcf)	95.9	FInal Dry Density(pcf)	101.4
Initial Degree of Saturation	26%	FInal Degree of Saturation	99%
Initial Void Ratio	0.7	Final Void Ratio	0.6
Estimated Specific Gravity	2.65	Saturated at	2 ksf



Reviewed by: AC

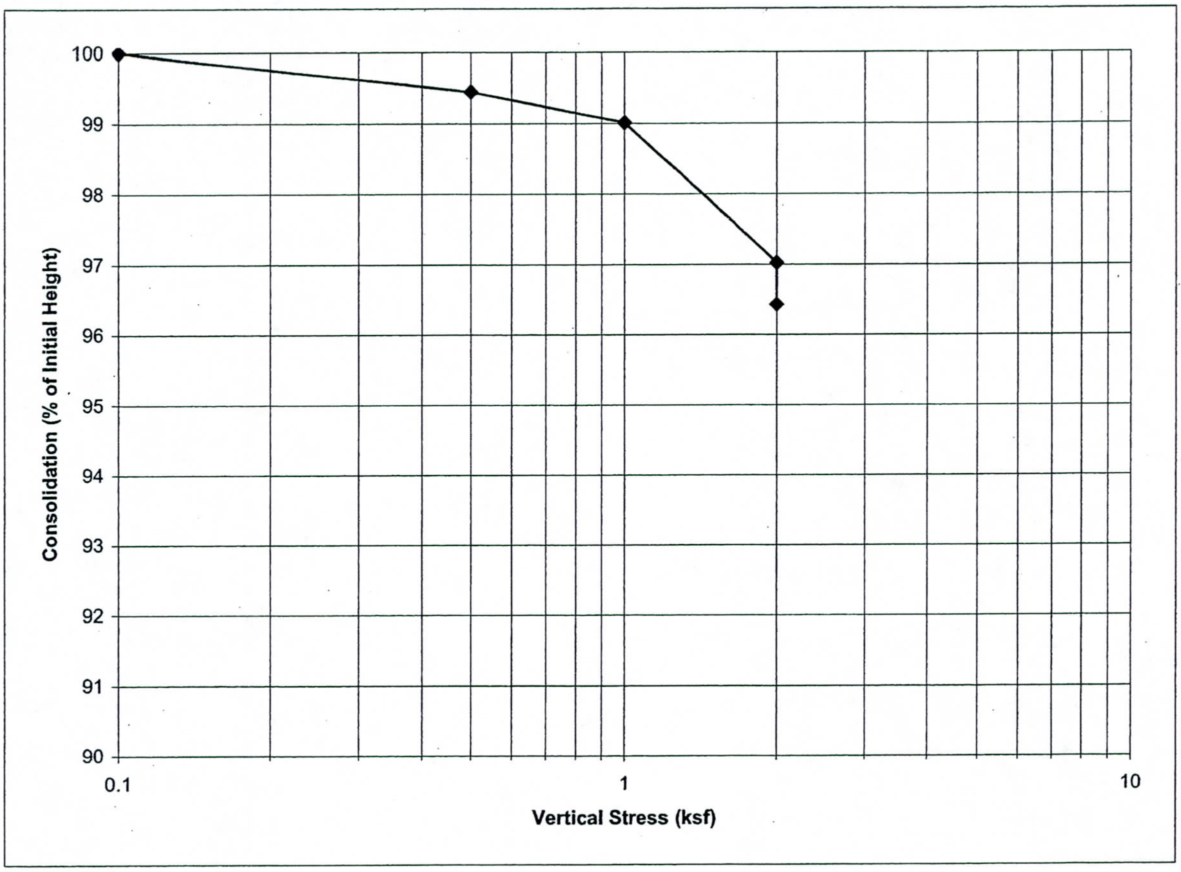
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	1
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	51
Material:	Native	**Date Sampled:**	11/04/09
Sample Source:	Ring Sample B-27 @ 5'-6'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.44
Initial Moisture Content	6.2%	Final Moisture Content	14.9%
Initial Dry Density(pcf)	113.8	FInal Dry Density(pcf)	117.9
Initial Degree of Saturation	36%	FInal Degree of Saturation	98%
Initial Void Ratio	0.5	Final Void Ratio	0.4
Estimated Specific Gravity	2.65	Saturated at	2 ksf



Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project: White Tanks FRS#3 - Outfall Channel
Project Location: Maricopa County, Arizona
Client: Hoskin Ryan Consultants, Inc.
Material: Native

Job Number: 09-G-1597
Work Order Number: 6
Lab Number: See Below
Sample Date: 12/23/09

Total Water Content (ASTM D2216)

Lab Number	Sample Location	Moisture Wet Wt. (g)	Moisture Dry Wt. (g)	Moisture Moist. Content
165	**STP B-2 @ 5'-6'**	308.6	297.3	3.8%
163	**STP B-3 @ 10'-11'**	317.0	309.2	2.5%
154	**STP B-7 @ 10'-11'**	307.7	301.6	2.0%
157	**STP B-10 @ 15'-16'**	301.8	293.6	2.8%
158	**STP B-11 @ 5'-6'**	311.4	308.8	0.8%
156	**STP B-13 @ 2'-3'**	314.1	308.0	2.0%
162	**STP B-14 @ 2'-3.5'**	321.7	319.4	0.7%
161	**STP B-15 @ 5'-6'**	302.3	297.0	1.8%
155	**STP B-16 @ 5'-6'**	310.1	303.9	2.0%
159	**STP B-18 @ 2'-3'**	263.4	261.1	0.9%
160	**STP B-20 @ 10'-11'**	305.0	292.5	4.3%
170	**STP B-25 @ 15'-16'**	301.2	283.3	6.3%
171	**STP B-26 @ 2'-3'**	313.3	305.1	2.7%
169	**STP B-29 @ 15'-16'**	262.0	247.2	6.0%
174	**STP B-32 @ 10'-11'**	314.0	309.7	1.4%
172	**STP B-34 @ 5'-6'**	319.0	307.2	3.8%
164	**STP B-35 @ 10'-11'**	301.2	296.2	1.7%
166	**STP B-36 @ 2'-5'**	305.1	299.0	2.0%
167	**STP B-37 @ 2'-3'**	305.7	300.8	1.6%
168	**STP B-39 @ 2'-3.5'**	318.2	301.0	5.7%
173	**STP B-41 @ 10'-11'**	310.7	304.2	2.1%

Reviewed by: **AC**

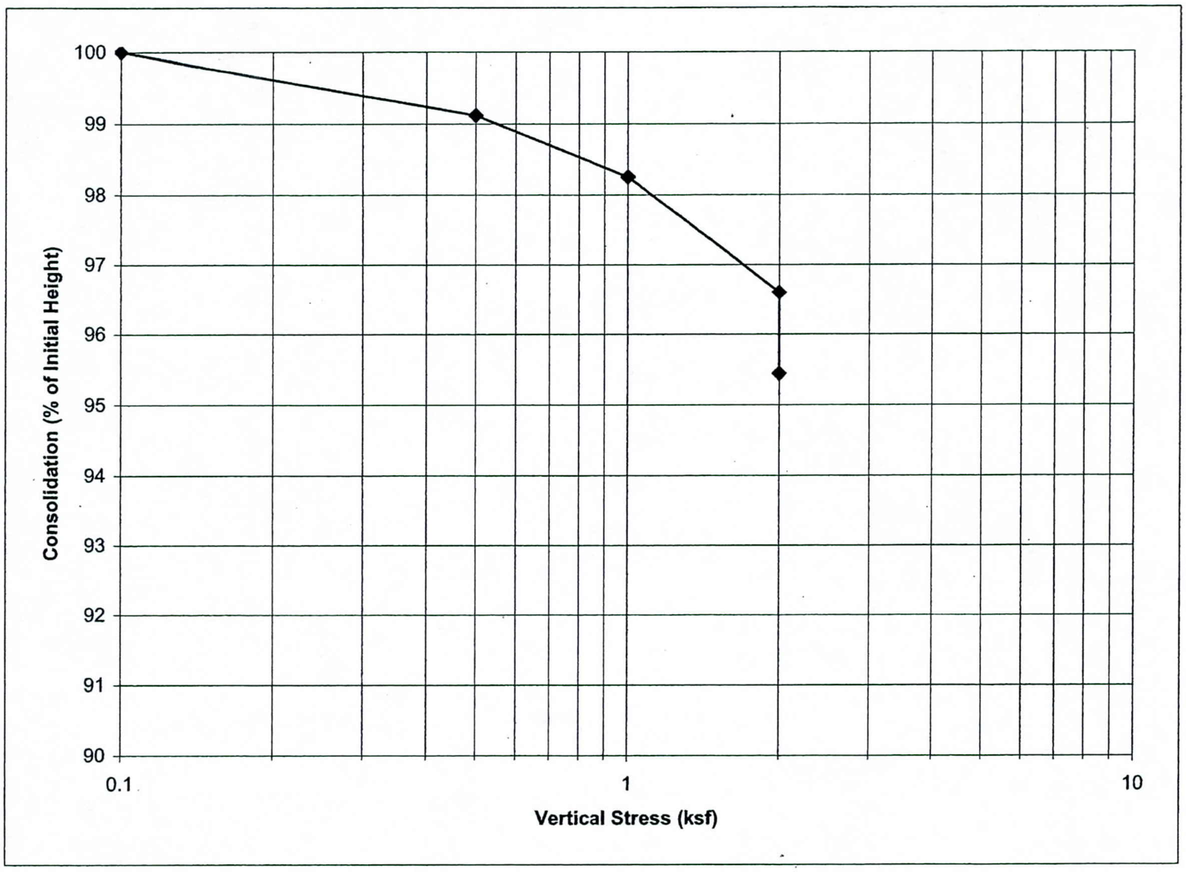
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	1
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	52
Material:	Native	**Date Sampled:**	11/04/09
Sample Source:	Ring Sample B-31 @ 2'-3'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.39
Initial Moisture Content	7.0%	Final Moisture Content	21.8%
Initial Dry Density(pcf)	99.2	FInal Dry Density(pcf)	103.9
Initial Degree of Saturation	28%	FInal Degree of Saturation	98%
Initial Void Ratio	0.7	Final Void Ratio	0.6
Estimated Specific Gravity	2.65	Saturated at	2 ksf



Reviewed by: AC

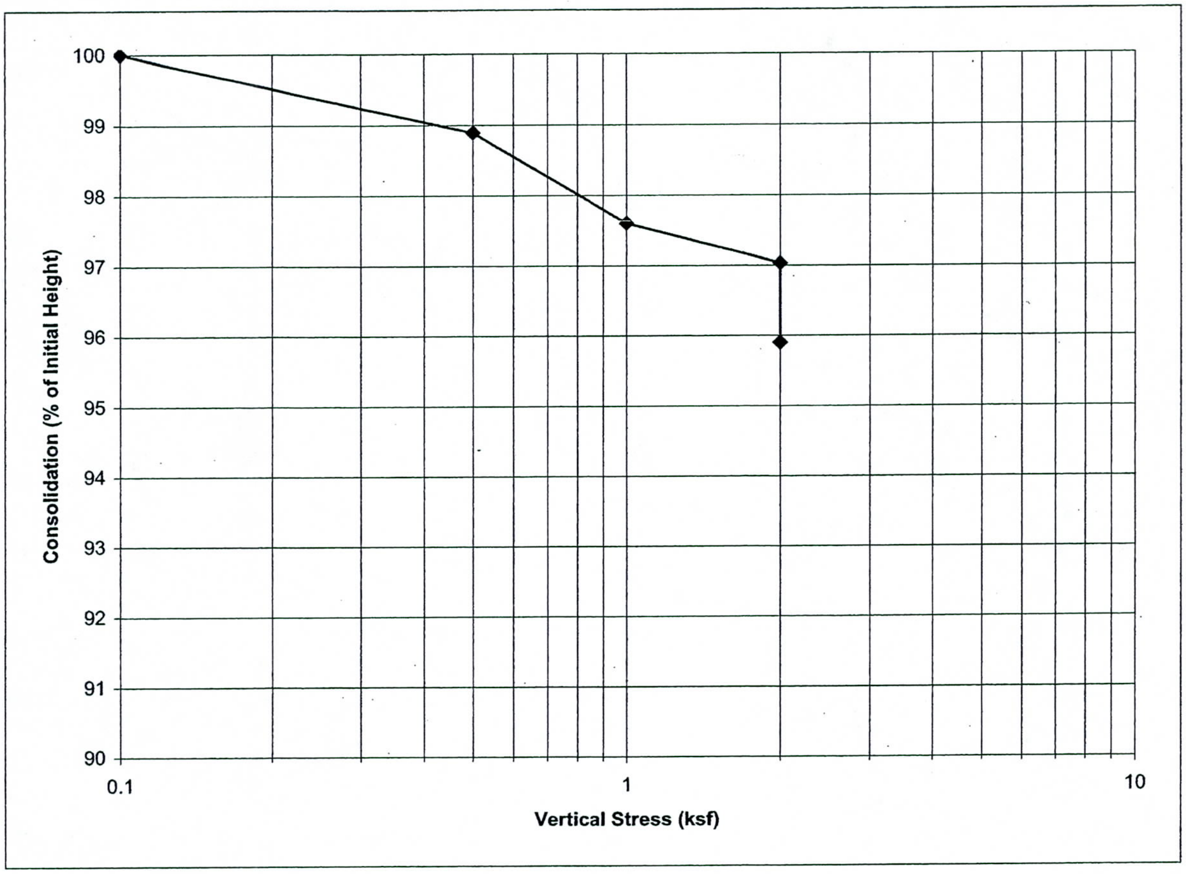
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	1
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	53
Material:	Native	**Date Sampled:**	11/04/09
Sample Source:	Ring Sample B-35 @ 5'-6'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.42
Initial Moisture Content	6.3%	Final Moisture Content	16.3%
Initial Dry Density(pcf)	110.8	FInal Dry Density(pcf)	115.5
Initial Degree of Saturation	34%	FInal Degree of Saturation	100%
Initial Void Ratio	0.5	Final Void Ratio	0.4
Estimated Specific Gravity	2.65	Saturated at	2 ksf



Reviewed by: AC

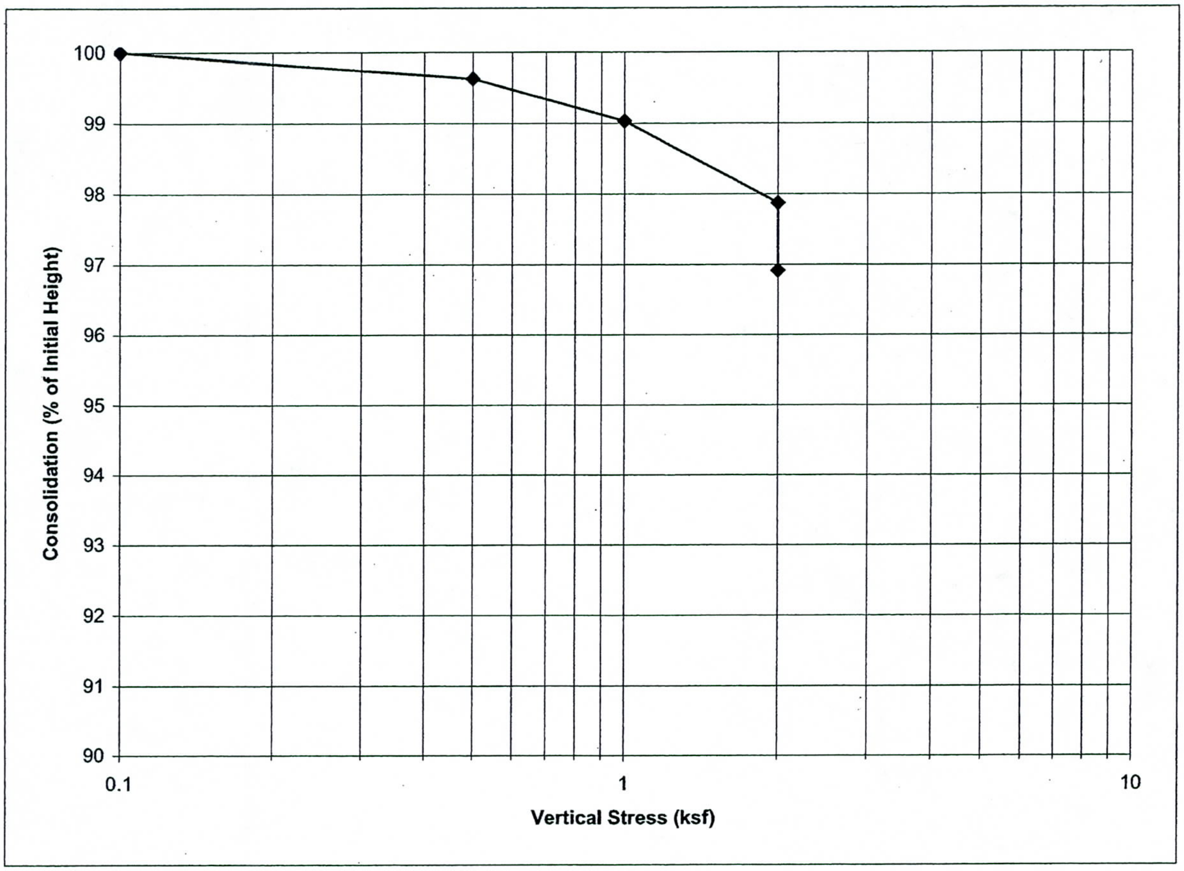
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	1
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	54
Material:	Native	**Date Sampled:**	11/04/09
Sample Source:	Ring Sample B-41 @ 7'-8'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.46
Initial Moisture Content	5.3%	Final Moisture Content	10.5%
Initial Dry Density(pcf)	125.0	FInal Dry Density(pcf)	128.9
Initial Degree of Saturation	43%	FInal Degree of Saturation	98%
Initial Void Ratio	0.3	Final Void Ratio	0.3
Estimated Specific Gravity	2.65	Saturated at	2 ksf



Reviewed by: AC

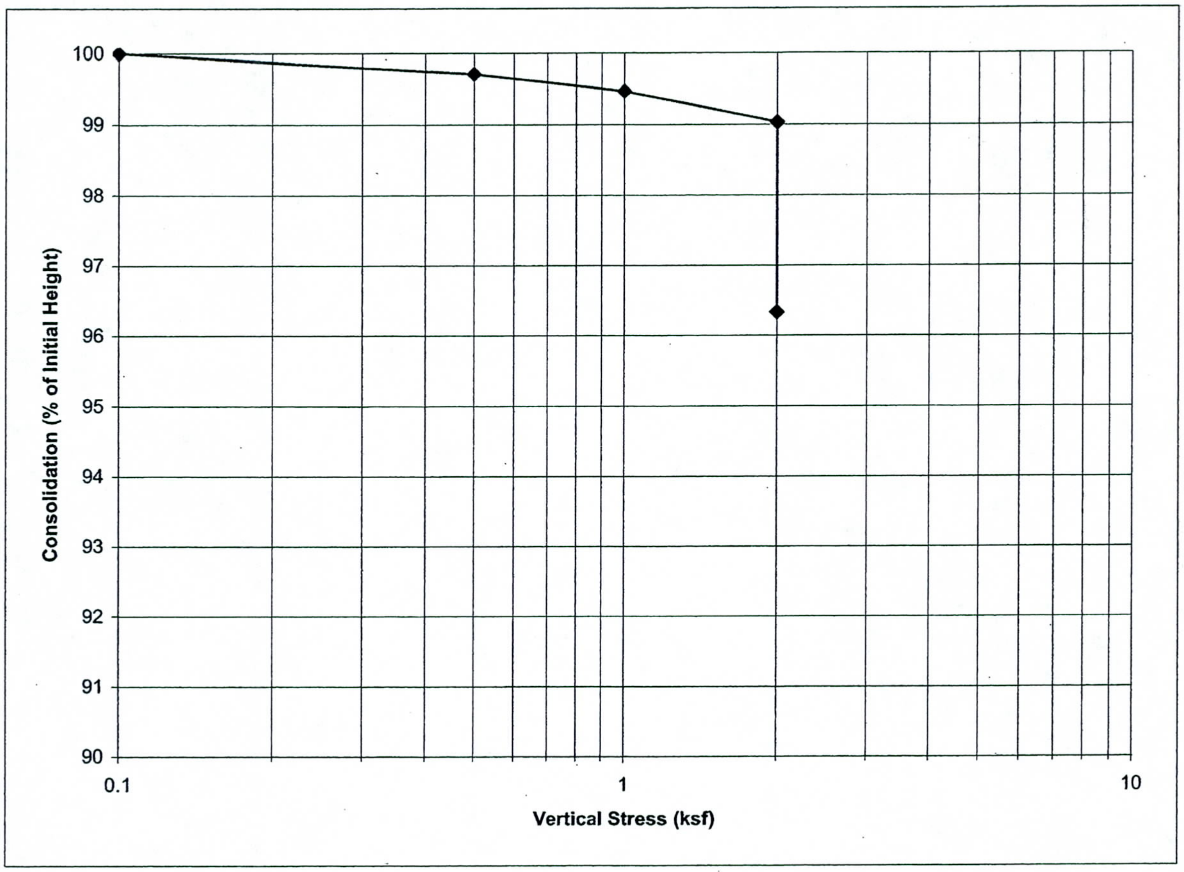
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	4
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	92
Material:	Native	**Date Sampled:**	11/13/09
Sample Source:	Ring Sample B-47 @ 0'-1'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.44
Initial Moisture Content	15.4%	Final Moisture Content	33.0%
Initial Dry Density(pcf)	83.2	FInal Dry Density(pcf)	86.3
Initial Degree of Saturation	41%	FInal Degree of Saturation	96%
Initial Void Ratio	1.0	Final Void Ratio	0.9
Estimated Specific Gravity	2.65	Saturated at	2 ksf



Reviewed by: AC

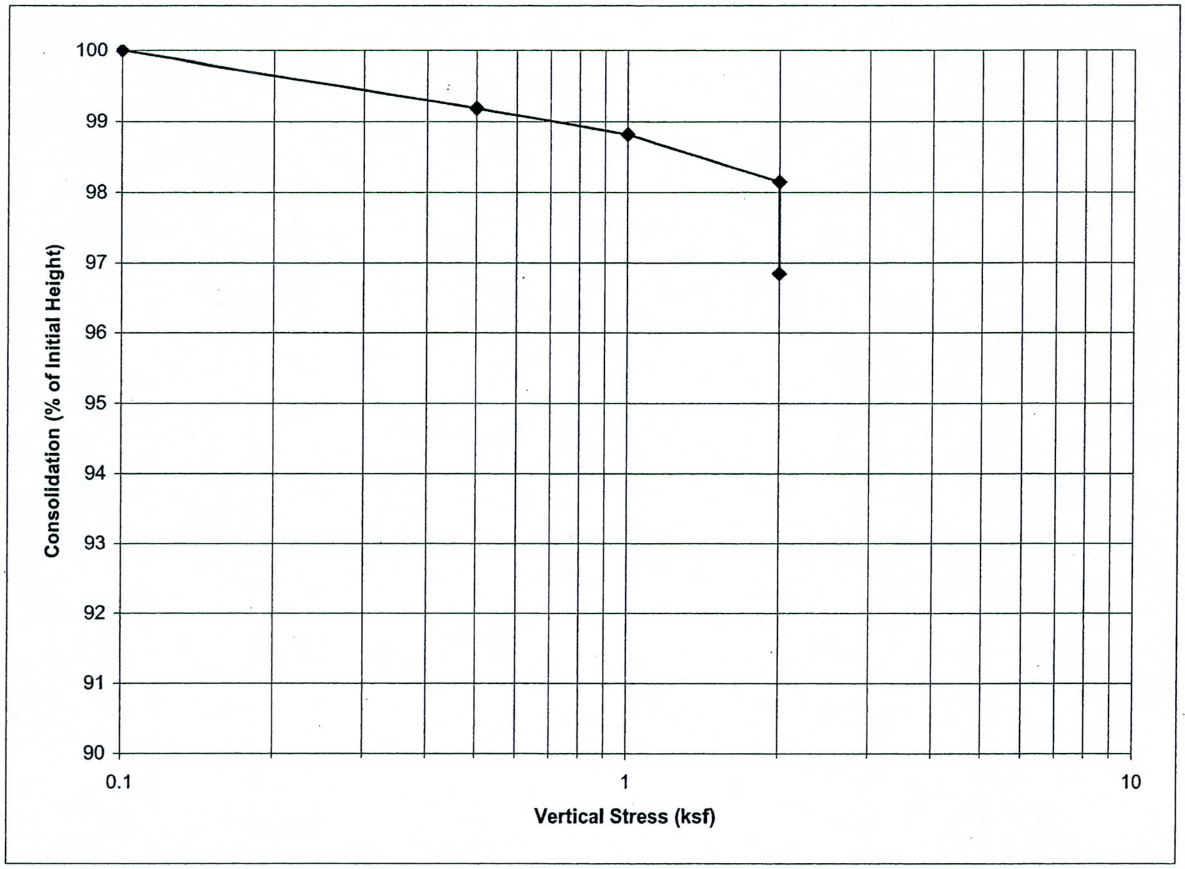
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	4
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	93
Material:	Native	**Date Sampled:**	11/13/09
Sample Source:	Ring Sample B-51 @ 2'-3'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.46
Initial Moisture Content	11.4%	Final Moisture Content	31.9%
Initial Dry Density(pcf)	86.5	FInal Dry Density(pcf)	89.3
Initial Degree of Saturation	33%	FInal Degree of Saturation	99%
Initial Void Ratio	0.9	Final Void Ratio	0.9
Estimated Specific Gravity	2.65	Saturated at	2 ksf



Reviewed by: AC

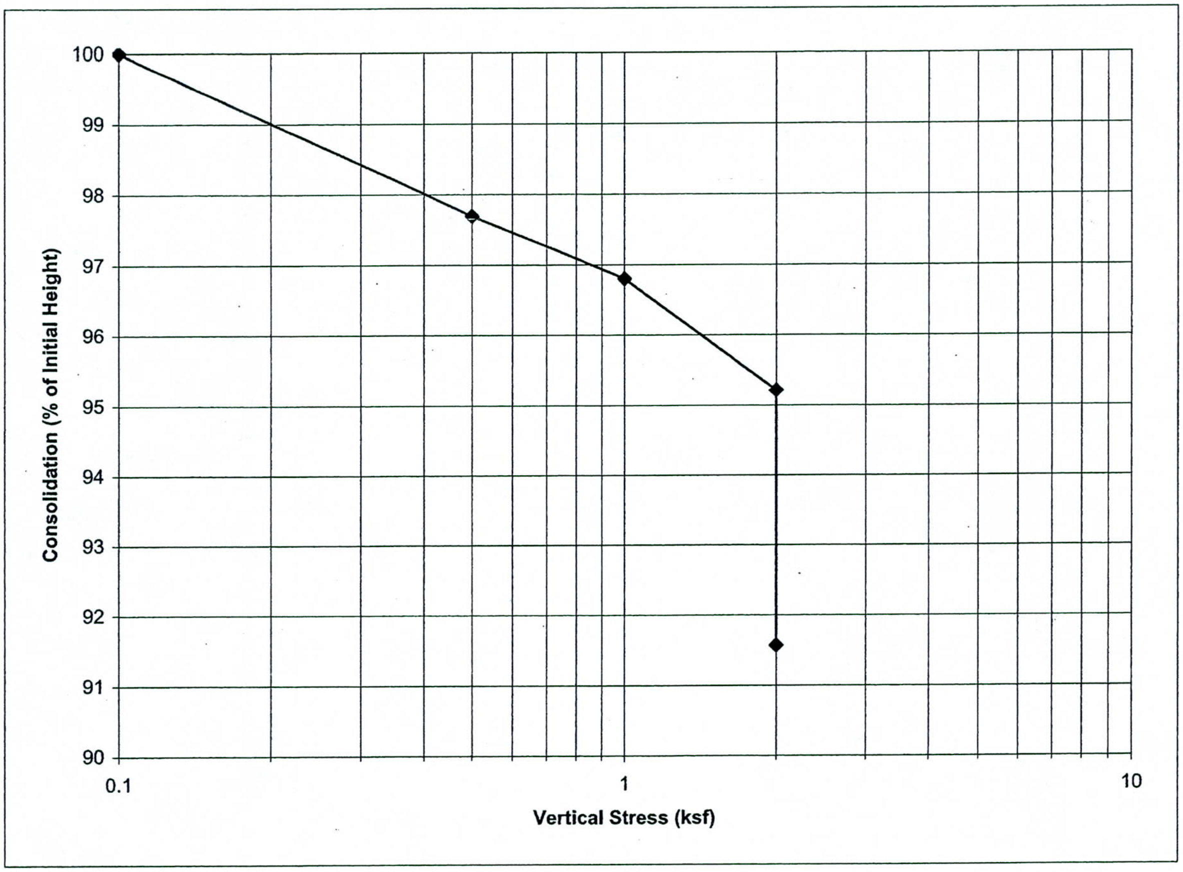
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	4
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	94
Material:	Native	**Date Sampled:**	11/13/09
Sample Source:	Ring Sample B-53 @ 2'-3'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.22
Initial Moisture Content	14.2%	Final Moisture Content	31.2%
Initial Dry Density(pcf)	82.0	FInal Dry Density(pcf)	89.5
Initial Degree of Saturation	37%	FInal Degree of Saturation	97%
Initial Void Ratio	1.0	Final Void Ratio	0.8
Estimated Specific Gravity	2.65	Saturated at	2 ksf



Reviewed by: AC

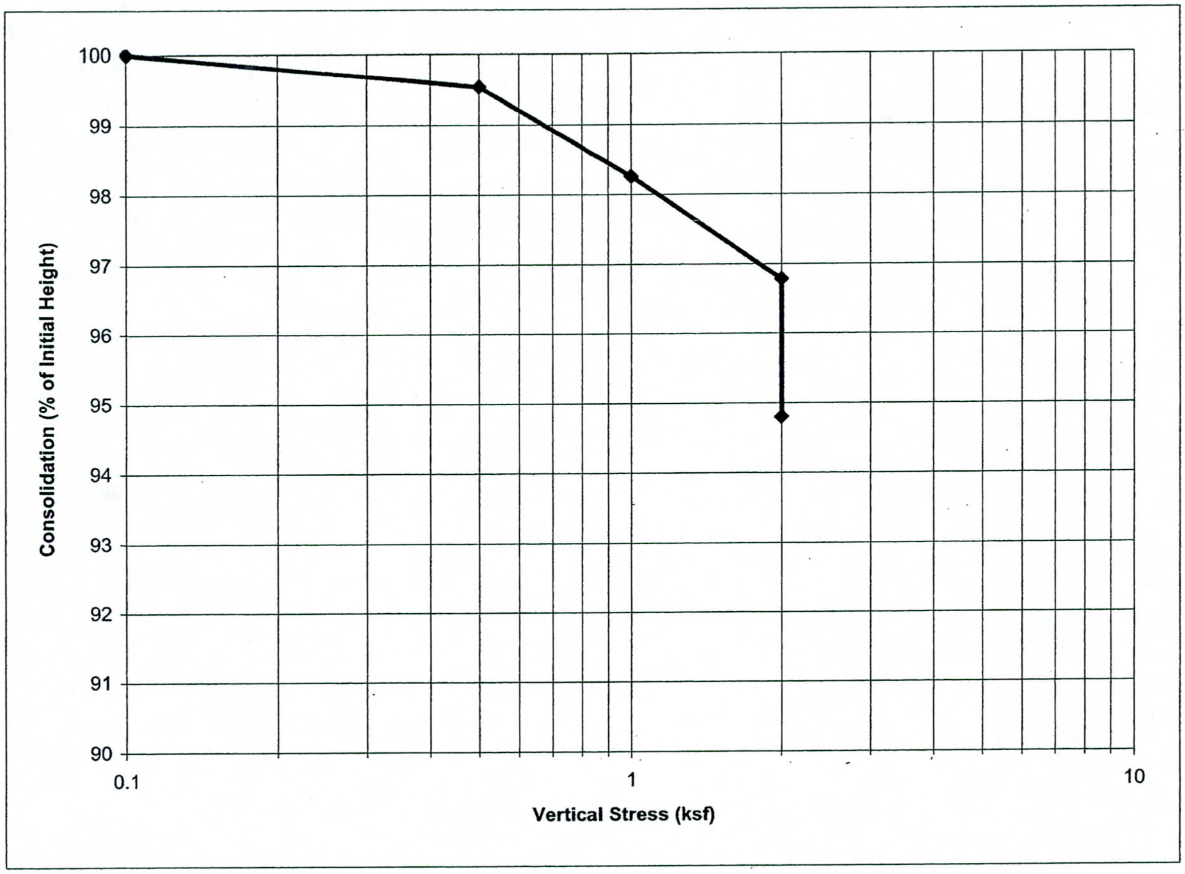
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	4
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	95
Material:	Native	**Date Sampled:**	11/13/09
Sample Source:	Ring Sample B-55 @ 2'-3'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.36
Initial Moisture Content	8.8%	Final Moisture Content	25.1%
Initial Dry Density(pcf)	93.5	FInal Dry Density(pcf)	98.6
Initial Degree of Saturation	30%	FInal Degree of Saturation	98%
Initial Void Ratio	0.8	Final Void Ratio	0.7
Estimated Specific Gravity	2.65	Saturated at	2 ksf



Reviewed by: AC

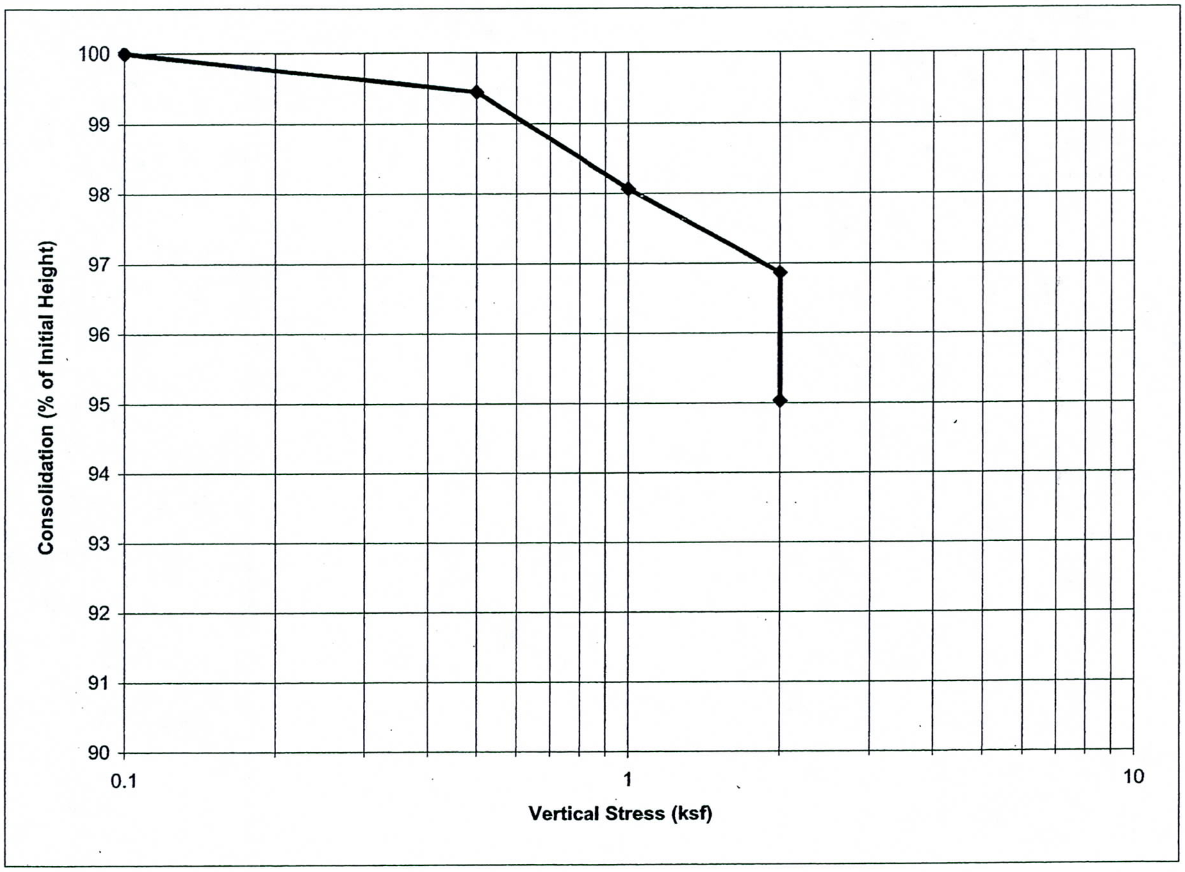
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	4
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	96
Material:	Native	**Date Sampled:**	11/13/09
Sample Source:	Ring Sample B-57 @ 5'-6'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.38
Initial Moisture Content	8.2%	Final Moisture Content	24.7%
Initial Dry Density(pcf)	94.7	FInal Dry Density(pcf)	99.6
Initial Degree of Saturation	29%	FInal Degree of Saturation	99%
Initial Void Ratio	0.7	Final Void Ratio	0.7
Estimated Specific Gravity	2.65	Saturated at	2 ksf



Reviewed by: AC

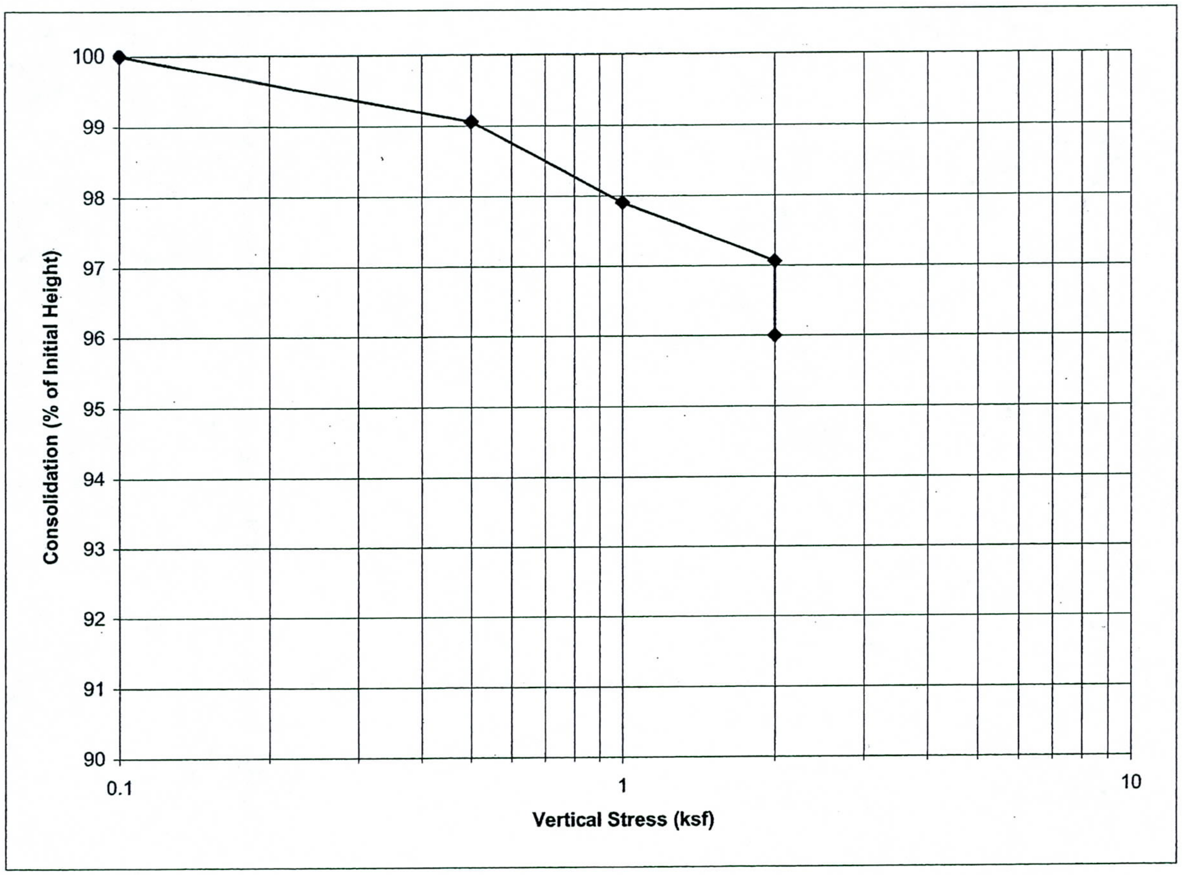
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Loaction:	Maricopa County, Arizona	**Work Order Number:**	4
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	97
Material:	Native	**Date Sampled:**	11/13/09
Sample Source:	Ring Sample B-59 @ 5'-6'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.42
Initial Moisture Content	11.3%	Final Moisture Content	22.2%
Initial Dry Density(pcf)	98.6	FInal Dry Density(pcf)	102.7
Initial Degree of Saturation	44%	FInal Degree of Saturation	97%
Initial Void Ratio	0.7	Final Void Ratio	0.6
Estimated Specific Gravity	2.65	Saturated at	2 ksf



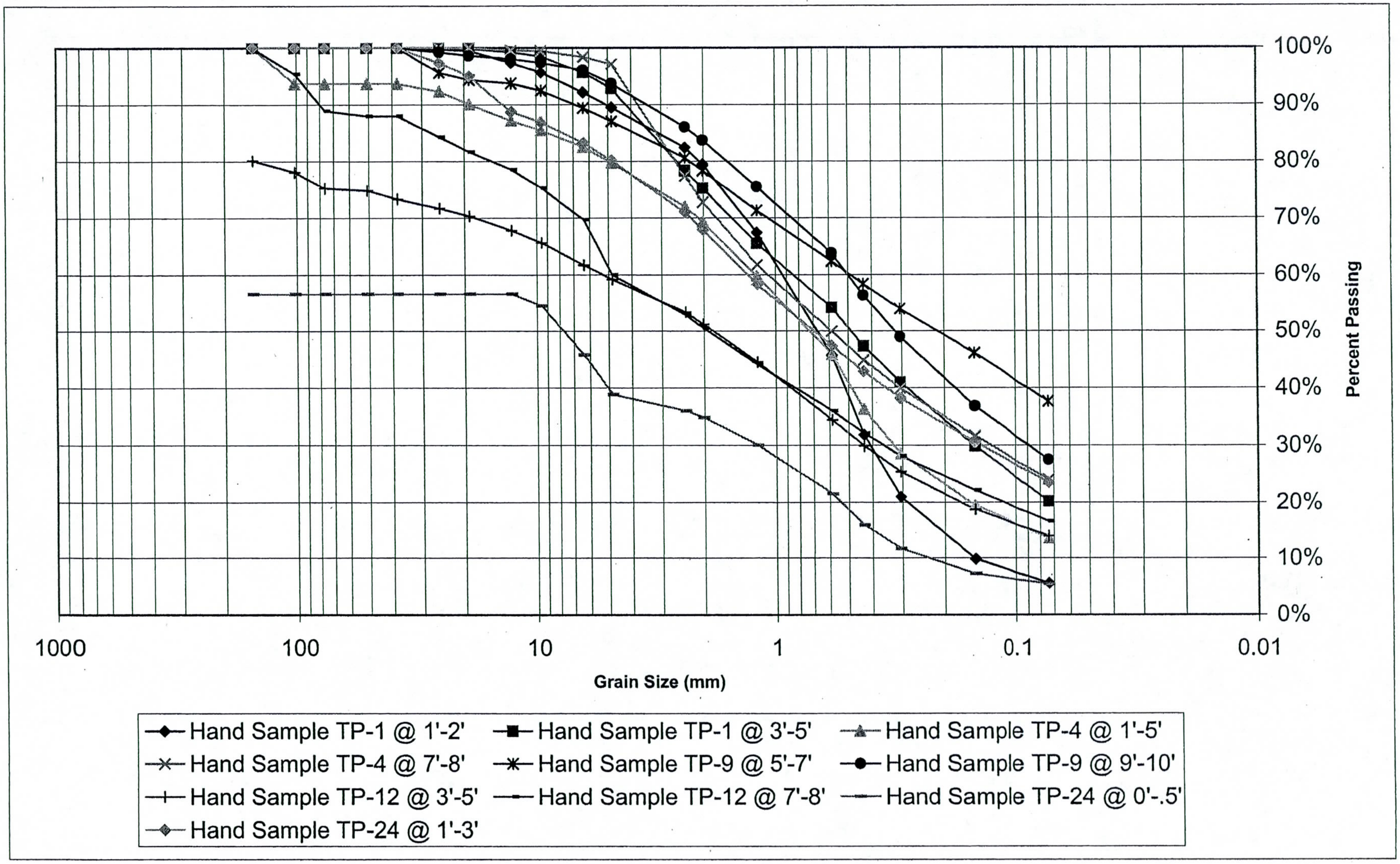
Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location:	Maricopa County, Arizona	**Work Order Number:**	5
Client:	Hoskin Ryan Consultants, Inc.	**Sample Date:**	11/19/09
Sample Source:	See Below	**Material:**	Native

MECHANICAL SIEVE ANALYSIS

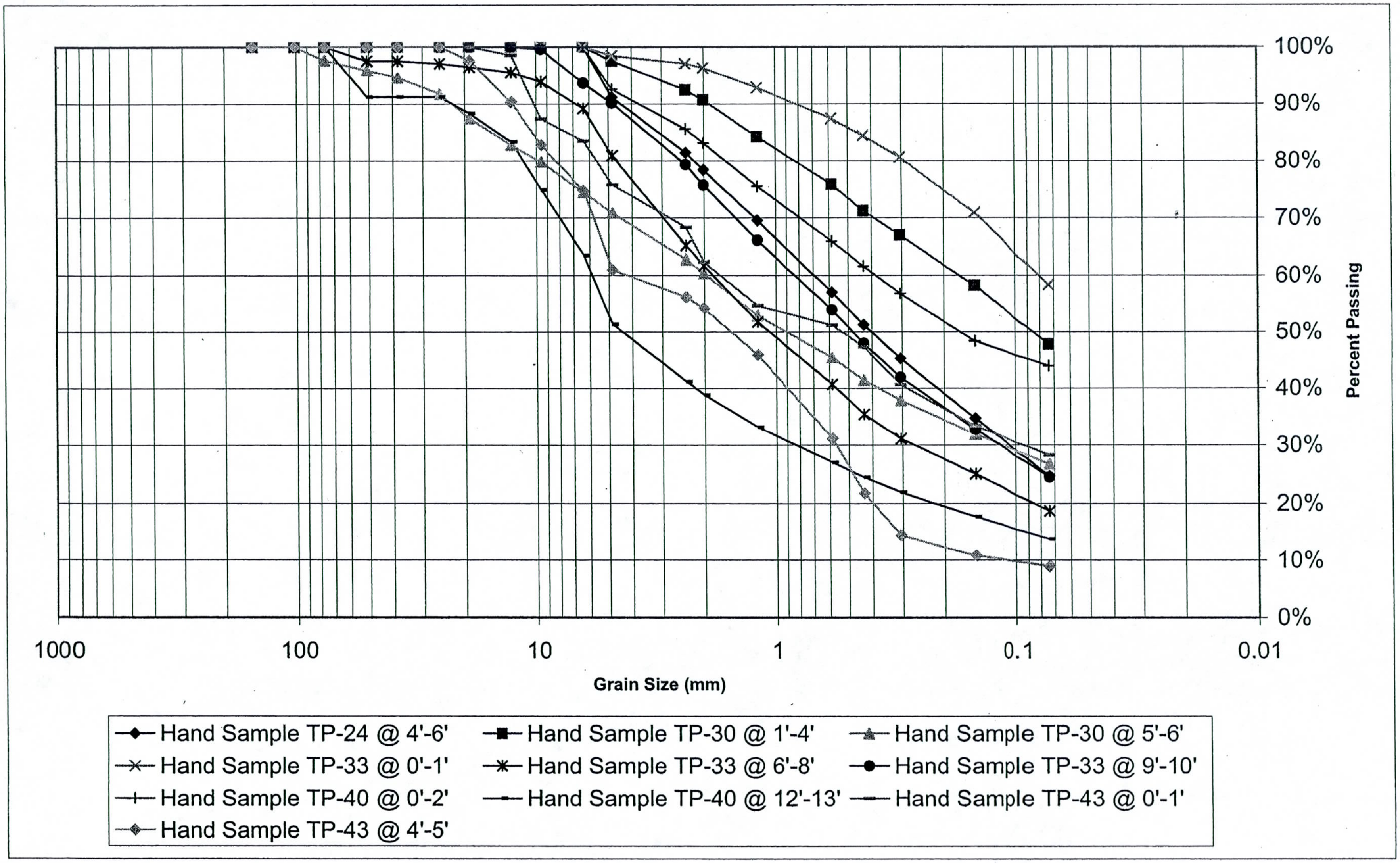


Reviewed By: AC

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location:	Maricopa County, Arizona	**Work Order Number:**	5
Client:	Hoskin Ryan Consultants, Inc.	**Sample Date:**	11/19/09
Sample Source:	See Below	**Material:**	Native

MECHANICAL SIEVE ANALYSIS

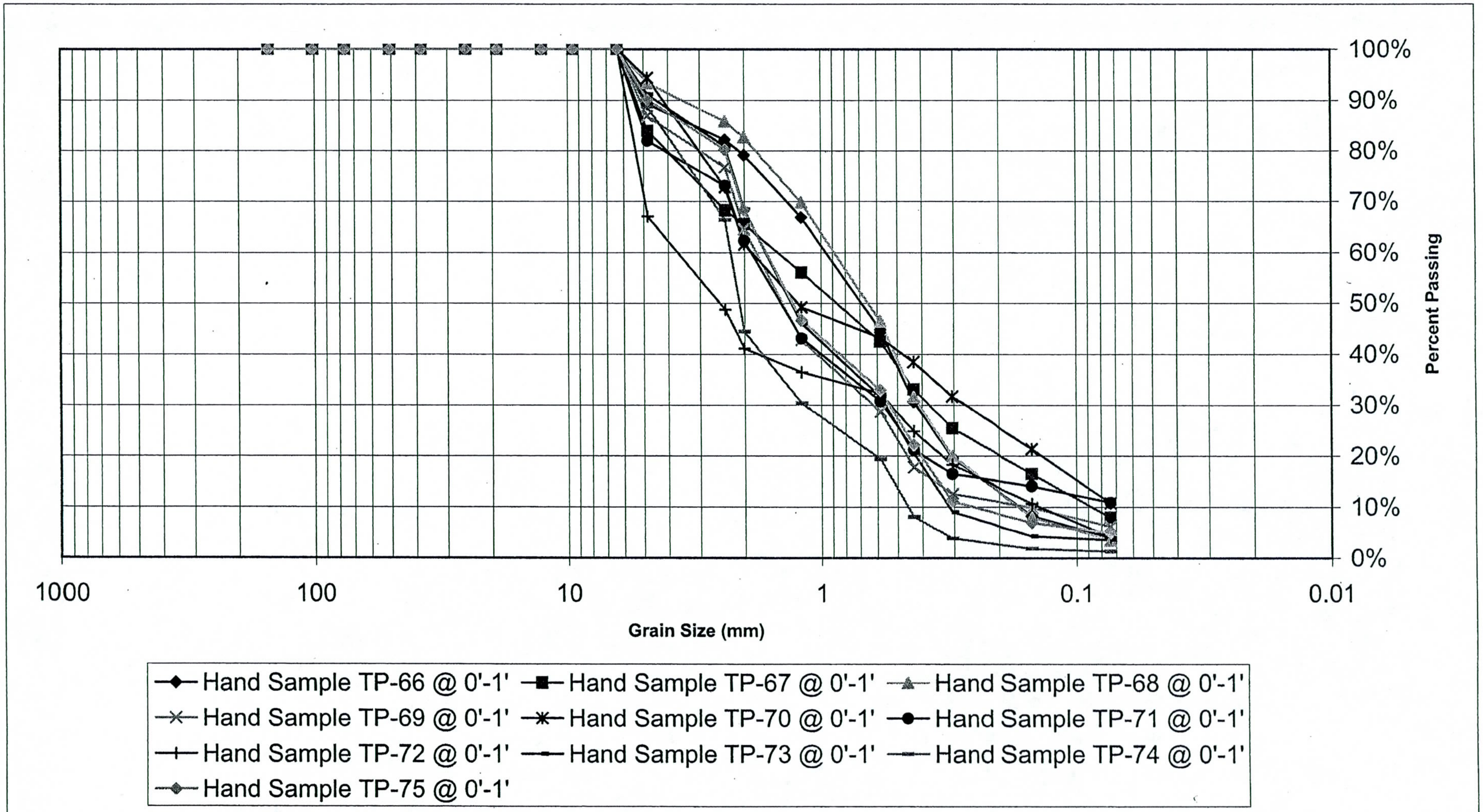


Reviewed By: AC

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location:	Maricopa County, Arizona	**Work Order Number:**	5
Client:	White Tanks FRS #3 - Outfall Channel	**Sample Date:**	12/14/09
Sample Source:	See Below	**Material:**	Native

MECHANICAL SIEVE ANALYSIS

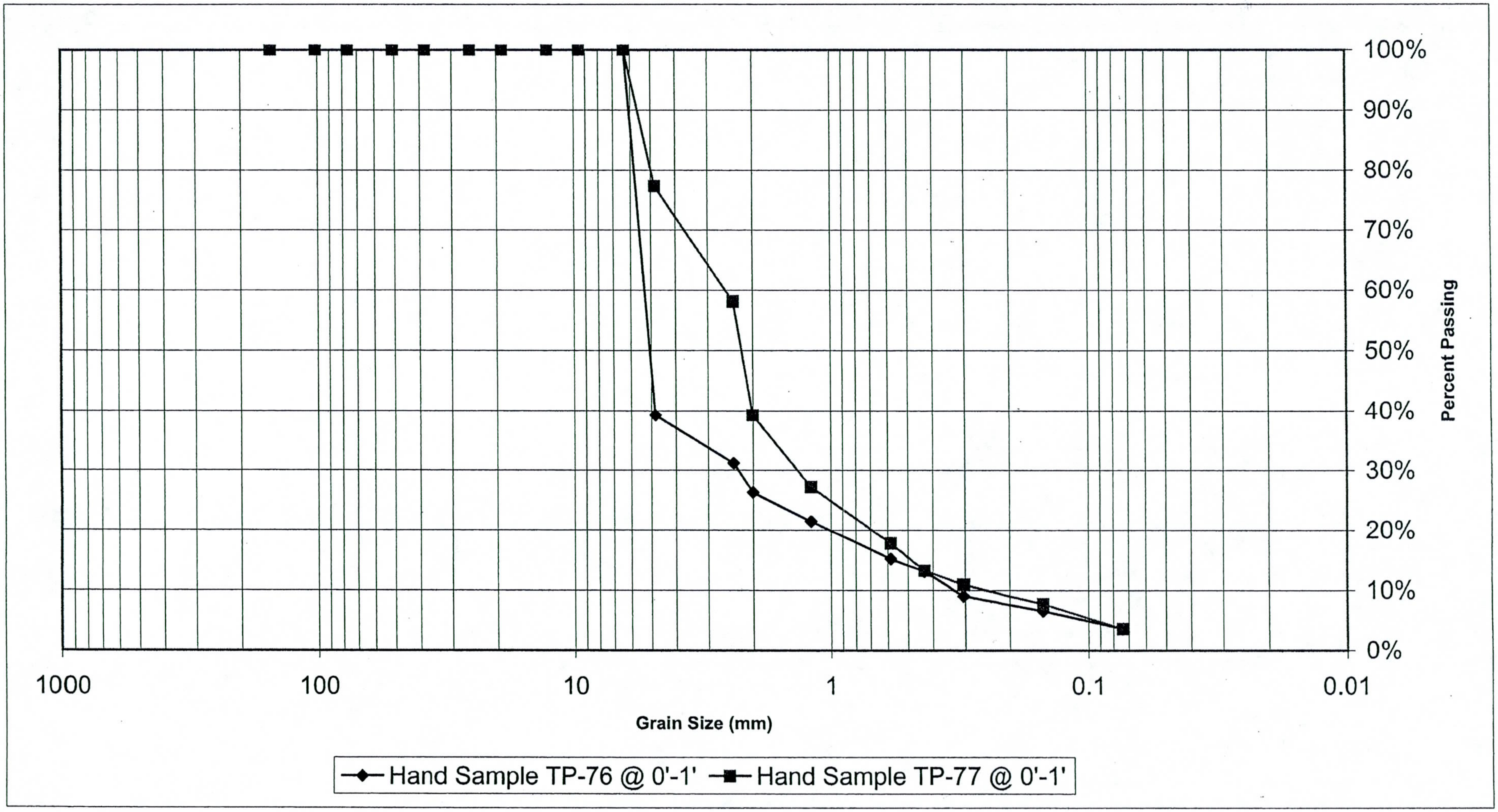


Reviewed By: AC

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location:	Maricopa County, Arizona	**Work Order Number:**	5
Client:	White Tanks FRS #3 - Outfall Channel	**Sample Date:**	12/14/09
Sample Source:	See Below	**Material:**	Native

MECHANICAL SIEVE ANALYSIS



Reviewed By: AC

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location	Maricopa County, Arizona	**Work Order Number:**	6
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	142
Material:	Native	**Date Sampled:**	11/19/09
Sample Source:	Test Pit TP-1 @ 3'-5'		

Hydrometer Test Report (ASTM D-422)

Weight of Sample Dispersed	85.60	**Specific Gravity of Solids**	2.65
Percent Passing #10 Sieve	75.3%		

Full Sieve Analysis

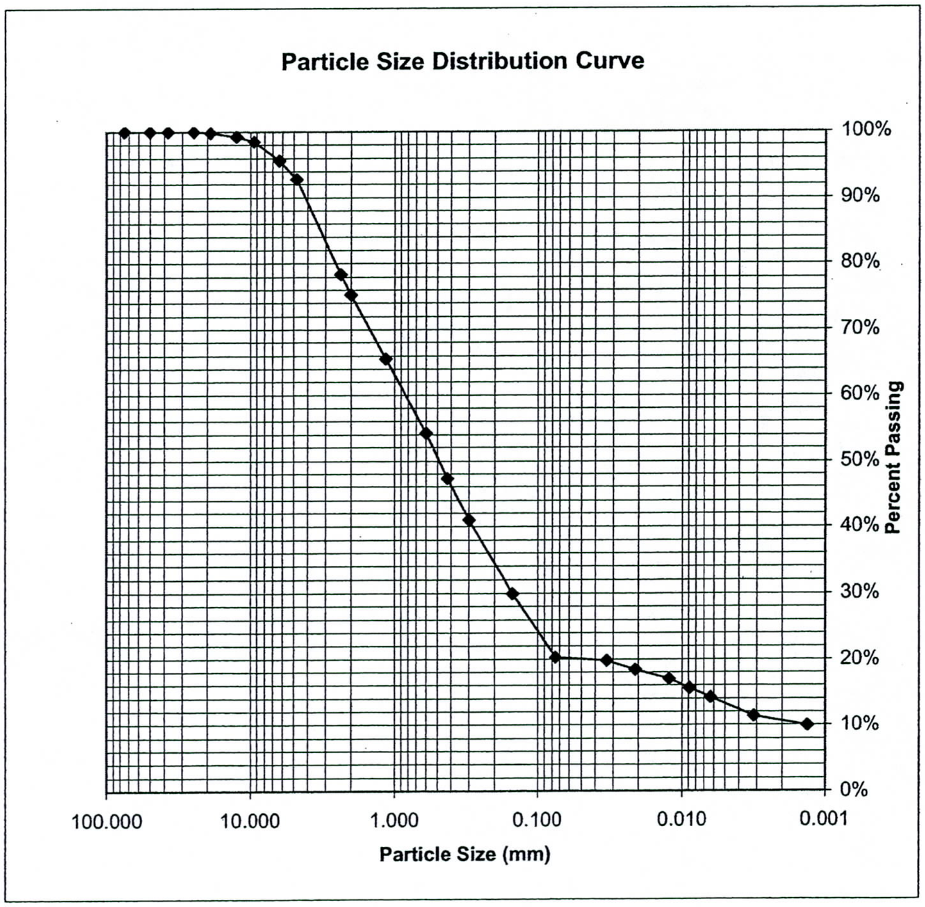
(Mechanical Sieve & Hydrometer)

(% Passing)

# 4		93%
# 8		78%
# 10		75%
# 16		65%
# 30		54%
# 40		47%
# 50		41%
# 100		30%
# 200		20.2%
0.0331	mm	20%
0.0212	mm	18%
0.0123	mm	17%
0.0088	mm	16%
0.0063	mm	14%
0.0031	mm	11%
0.0013	mm	10%
0.0009	mm	8%

Mechanical Sieve Analysis After Hydrometer (% Passing)

#200	#100	#50	#40	#30	#16	#10
20%	30%	41%	47%	54%	66%	75%



Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location	Maricopa County, Arizona	**Work Order Number:**	6
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	143
Material:	Native	**Date Sampled:**	11/19/09
Sample Source:	Test Pit TP-4 @ 1'-5'		

Hydrometer Test Report (ASTM D-422)

Weight of Sample Dispersed	84.50	**Specific Gravity of Solids**	2.65
Percent Passing #10 Sieve	69.3%		

Full Sieve Analysis

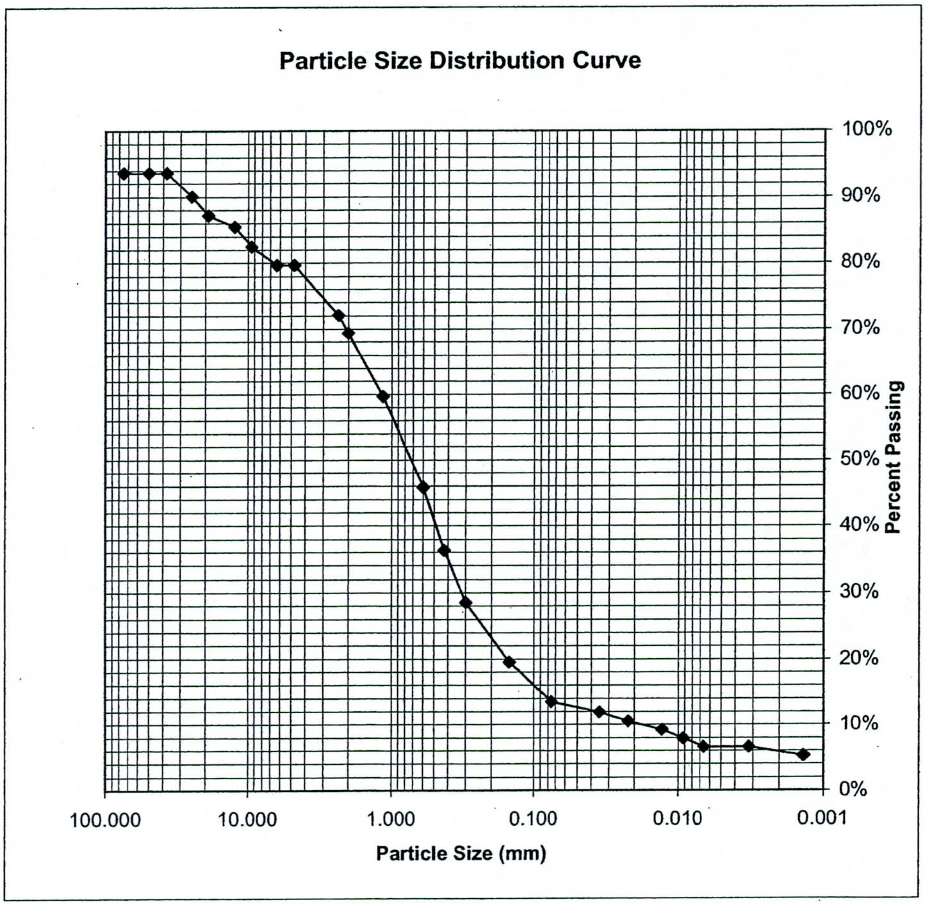
(Mechanical Sieve & Hydrometer)

(% Passing)

# 4		80%
# 8		72%
# 10		69%
# 16		60%
# 30		46%
# 40		36%
# 50		29%
# 100		19%
# 200		13.5%
0.0348	mm	12%
0.0222	mm	11%
0.0129	mm	9%
0.0092	mm	8%
0.0066	mm	7%
0.0032	mm	7%
0.0014	mm	5%
0.0010	mm	4%

Mechanical Sieve Analysis After Hydrometer (% Passing)

#200	#100	#50	#40	#30	#16	#10
14%	20%	29%	36%	46%	60%	69%



Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location	Maricopa County, Arizona	**Work Order Number:**	6
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	144
Material:	Native	**Date Sampled:**	11/19/09
Sample Source:	Test Pit TP-9 @ 5'-7'		

Hydrometer Test Report (ASTM D-422)

Weight of Sample Dispersed	86.50	**Specific Gravity of Solids**	2.65
Percent Passing #10 Sieve	78.3%		

Full Sieve Analysis

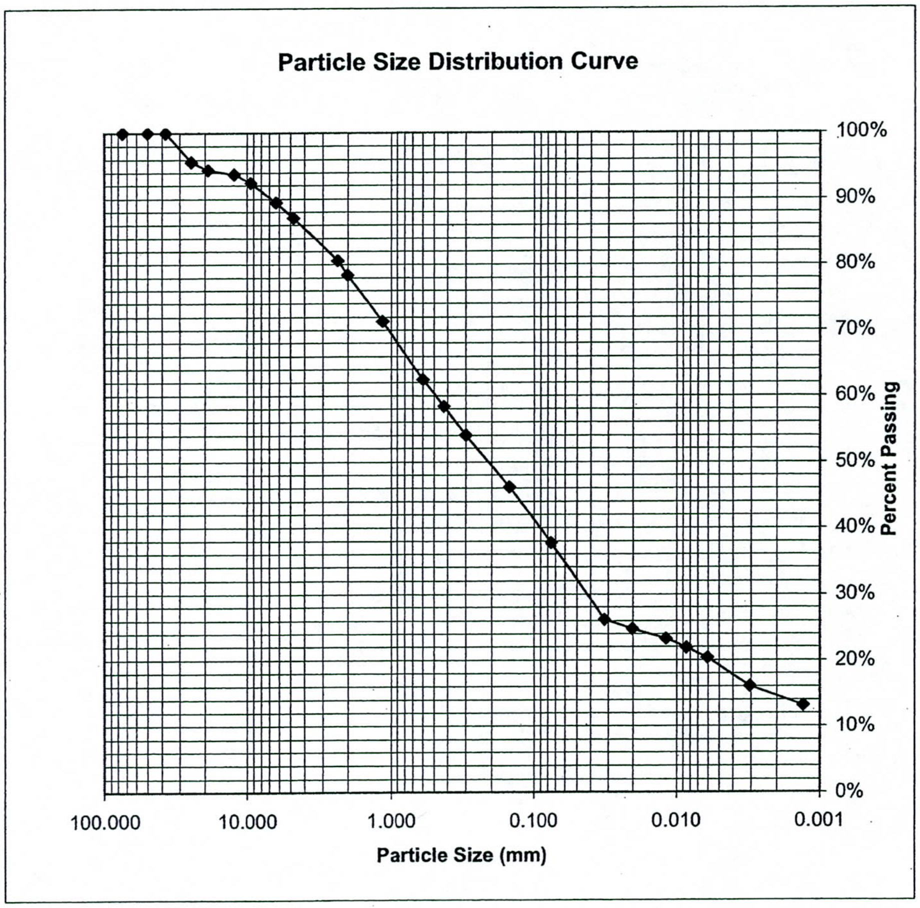
(Mechanical Sieve & Hydrometer)

(% Passing)

# 4		87%
# 8		81%
# 10		78%
# 16		71%
# 30		62%
# 40		58%
# 50		54%
# 100		46%
# 200		37.7%
0.0317	mm	26%
0.0203	mm	25%
0.0118	mm	23%
0.0085	mm	22%
0.0060	mm	20%
0.0031	mm	16%
0.0013	mm	13%
0.0009	mm	12%

Mechanical Sieve Analysis After Hydrometer (% Passing)

#200	#100	#50	#40	#30	#16	#10
38%	46%	54%	58%	62%	71%	78%



Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	Project Number:	09-G-1597
Project Location	Maricopa County, Arizona	Work Order Number:	6
Client:	Hoskin Ryan Consultants, Inc.	Lab Number:	145
Material:	Native	Date Sampled:	11/19/09
Sample Source:	Test Pit TP-12 @ 7'-8'		

Hydrometer Test Report (ASTM D-422)

Weight of Sample Dispersed	87.40	Specific Gravity of Solids	2.65
Percent Passing #10 Sieve	50.5%		

Full Sieve Analysis

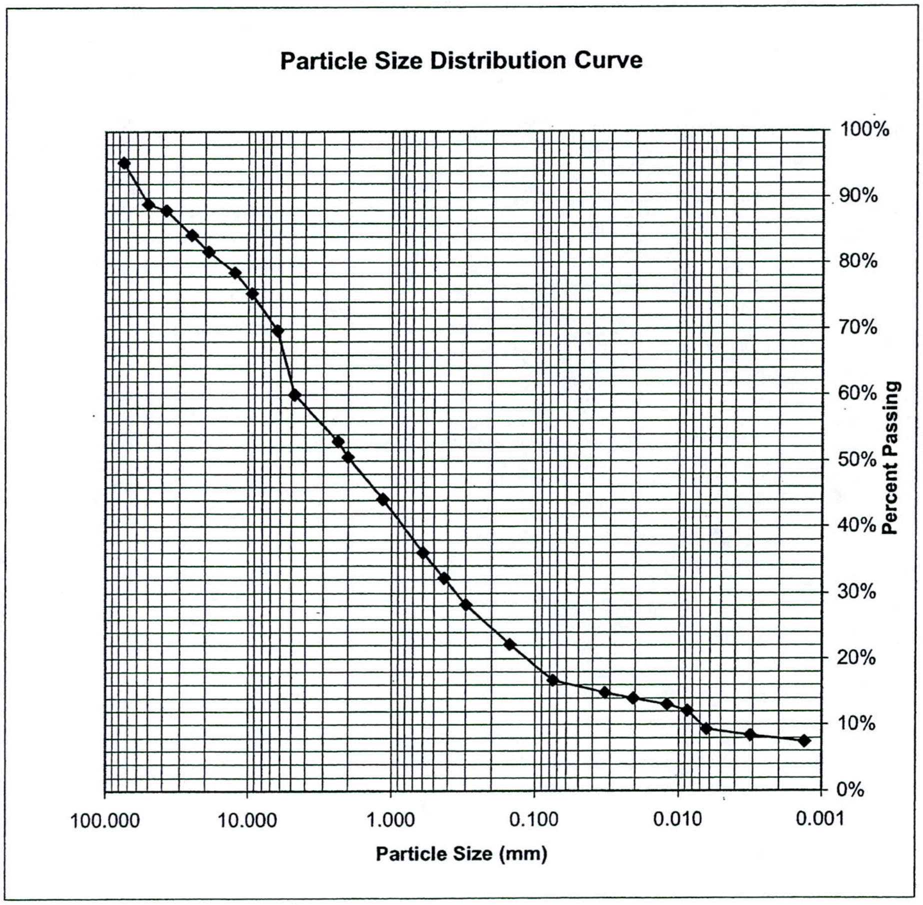
(Mechanical Sieve & Hydrometer)

(% Passing)

# 4		60%
# 8		53%
# 10		51%
# 16		44%
# 30		36%
# 40		32%
# 50		28%
# 100		22%
# 200		16.6%
0.0324	mm	15%
0.0207	mm	14%
0.0121	mm	13%
0.0086	mm	12%
0.0063	mm	9%
0.0031	mm	8%
0.0013	mm	7%
0.0009	mm	6%

Mechanical Sieve Analysis After Hydrometer (% Passing)

#200	#100	#50	#40	#30	#16	#10
17%	22%	28%	32%	36%	44%	51%



Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	Project Number:	09-G-1597
Project Location	Maricopa County, Arizona	Work Order Number:	6
Client:	Hoskin Ryan Consultants, Inc.	Lab Number:	146
Material:	Native	Date Sampled:	11/19/09
Sample Source:	Test Pit TP-24 @ 1'-3'		

Hydrometer Test Report (ASTM D-422)

Weight of Sample Dispersed	90.20	Specific Gravity of Solids	2.65
Percent Passing #10 Sieve	67.9%		

Full Sieve Analysis

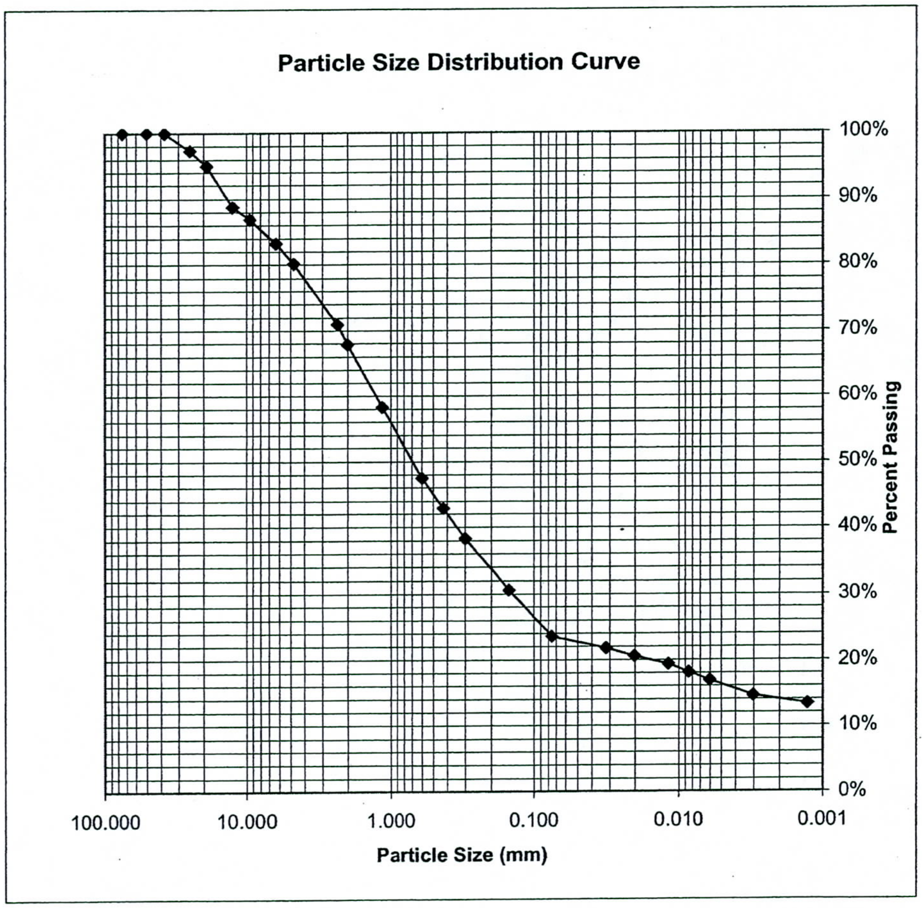
(Mechanical Sieve & Hydrometer)

(% Passing)

# 4		80%
# 8		71%
# 10		68%
# 16		58%
# 30		47%
# 40		43%
# 50		38%
# 100		31%
# 200		23.5%
0.0317	mm	22%
0.0203	mm	21%
0.0118	mm	19%
0.0085	mm	18%
0.0060	mm	17%
0.0030	mm	14%
0.0013	mm	13%
0.0009	mm	11%

Mechanical Sieve Analysis After Hydrometer (% Passing)

#200	#100	#50	#40	#30	#16	#10
24%	31%	38%	43%	47%	58%	68%



Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location	Maricopa County, Arizona	**Work Order Number:**	6
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	147
Material:	Native	**Date Sampled:**	11/19/09
Sample Source:	Test Pit TP-30 @ 1'-4'		

Hydrometer Test Report (ASTM D-422)

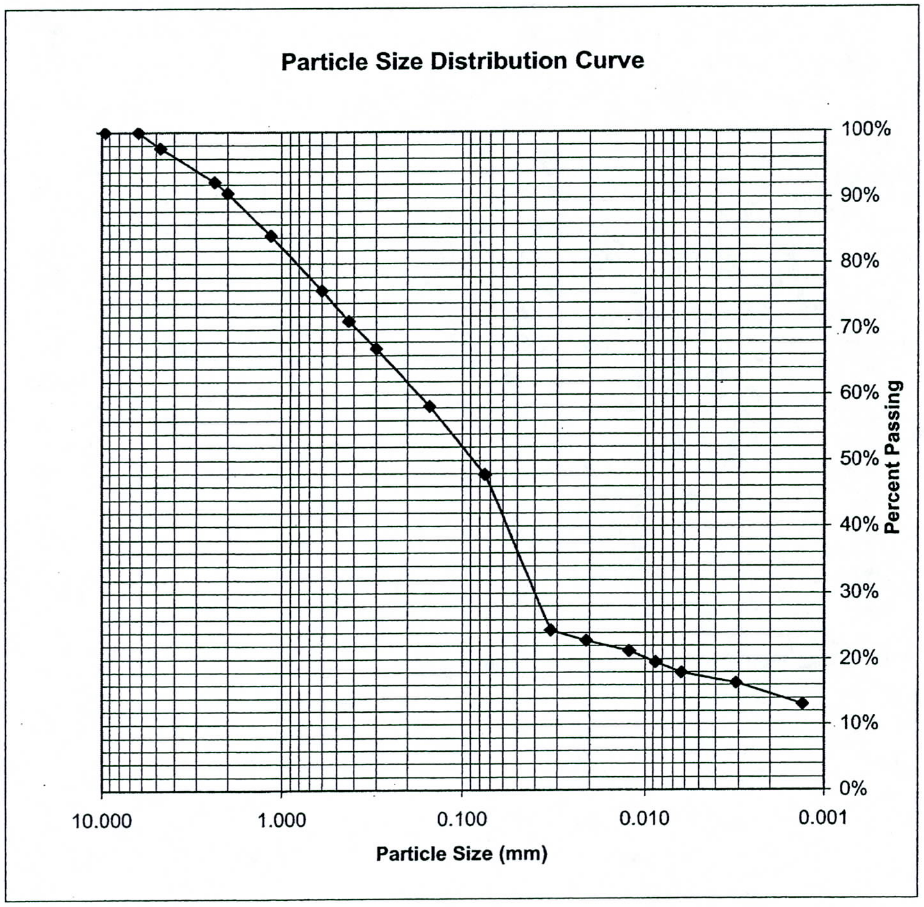
Weight of Sample Dispersed	89.54	**Specific Gravity of Solids**	2.65
Percent Passing #10 Sieve	90.7%		

Full Sieve Analysis
(Mechanical Sieve & Hydrometer)
(% Passing)

# 4		98%
# 8		92%
# 10		91%
# 16		84%
# 30		76%
# 40		71%
# 50		67%
# 100		58%
# 200		47.8%
0.0327	mm	24%
0.0209	mm	23%
0.0122	mm	21%
0.0087	mm	20%
0.0062	mm	18%
0.0031	mm	16%
0.0013	mm	13%
0.0009	mm	10%

Mechanical Sieve Analysis After Hydrometer (% Passing)

#200	#100	#50	#40	#30	#16	#10
48%	58%	67%	71%	76%	84%	91%



Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	Project Number:	09-G-1597
Project Location	Maricopa County, Arizona	Work Order Number:	6
Client:	Hoskin Ryan Consultants, Inc.	Lab Number:	148
Material:	Native	Date Sampled:	11/19/09
Sample Source:	Test Pit TP-33 @ 0'-1'		

Hydrometer Test Report (ASTM D-422)

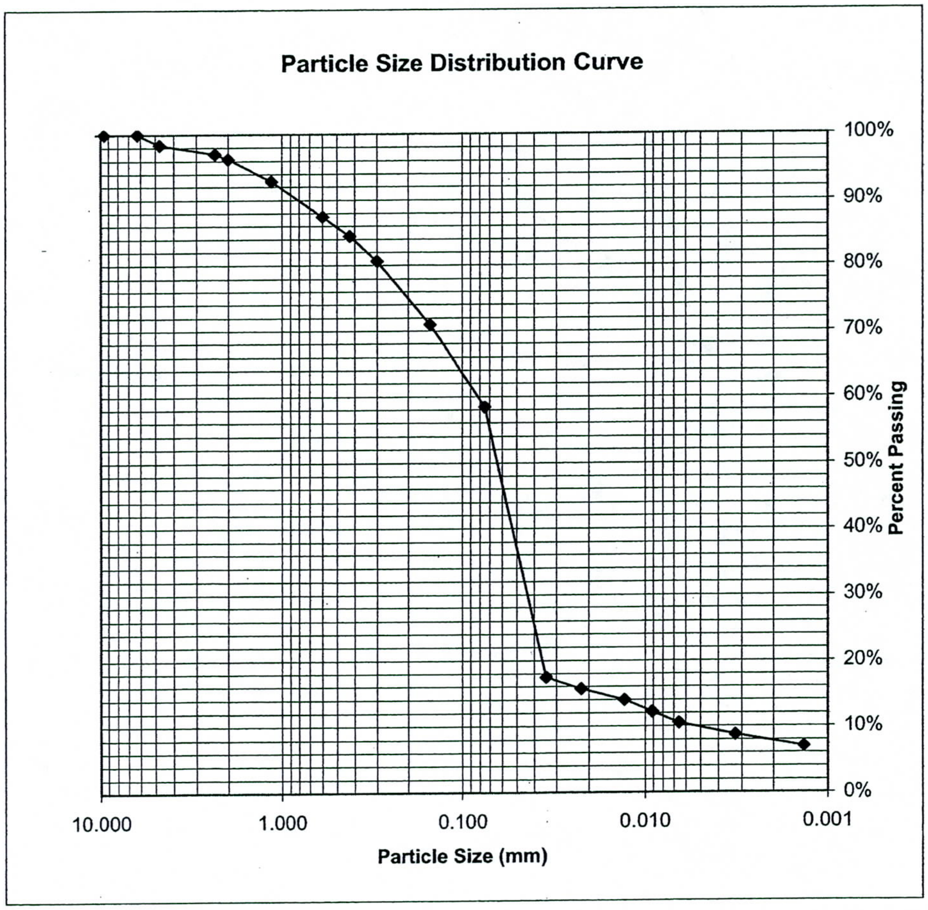
Weight of Sample Dispersed	88.70	Specific Gravity of Solids	2.65
Percent Passing #10 Sieve	96.3%		

Full Sieve Analysis
(Mechanical Sieve & Hydrometer)
(% Passing)

# 4		98%
# 8		97%
# 10		96%
# 16		93%
# 30		87%
# 40		84%
# 50		81%
# 100		71%
# 200		58.4%
0.0345	mm	17%
0.0220	mm	16%
0.0128	mm	14%
0.0092	mm	12%
0.0065	mm	10%
0.0032	mm	9%
0.0014	mm	7%
0.0010	mm	5%

Mechanical Sieve Analysis After Hydrometer (% Passing)

#200	#100	#50	#40	#30	#16	#10
58%	71%	81%	84%	87%	93%	96%



Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location	Maricopa County, Arizona	**Work Order Number:**	6
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	149
Material:	Native	**Date Sampled:**	11/19/09
Sample Source:	Test Pit TP-40 @ 0'-2'		

Hydrometer Test Report (ASTM D-422)

Weight of Sample Dispersed	88.30	**Specific Gravity of Solids**	2.65
Percent Passing #10 Sieve	83.1%		

Full Sieve Analysis

(Mechanical Sieve & Hydrometer)

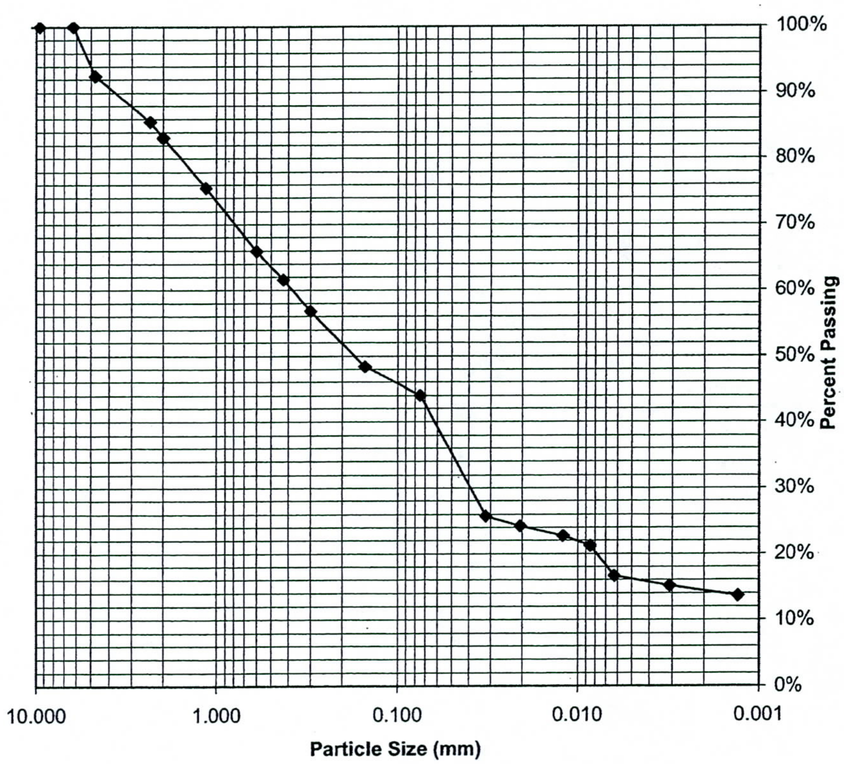
(% Passing)

# 4		93%
# 8		86%
# 10		83%
# 16		76%
# 30		66%
# 40		62%
# 50		57%
# 100		48%
# 200		44.0%
0.0320	mm	26%
0.0205	mm	24%
0.0120	mm	23%
0.0085	mm	21%
0.0062	mm	17%
0.0031	mm	15%
0.0013	mm	14%
0.0009	mm	12%

Mechanical Sieve Analysis After Hydrometer (% Passing)

#200	#100	#50	#40	#30	#16	#10
44%	48%	57%	62%	66%	76%	83%

Particle Size Distribution Curve



Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location	Maricopa County, Arizona	**Work Order Number:**	6
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	150
Material:	Native	**Date Sampled:**	11/19/09
Sample Source:	Test Pit TP-43 @ 0'-1'		

Hydrometer Test Report (ASTM D-422)

Weight of Sample Dispersed	86.50	**Specific Gravity of Solids**	2.65
Percent Passing #10 Sieve	62.3%		

Full Sieve Analysis

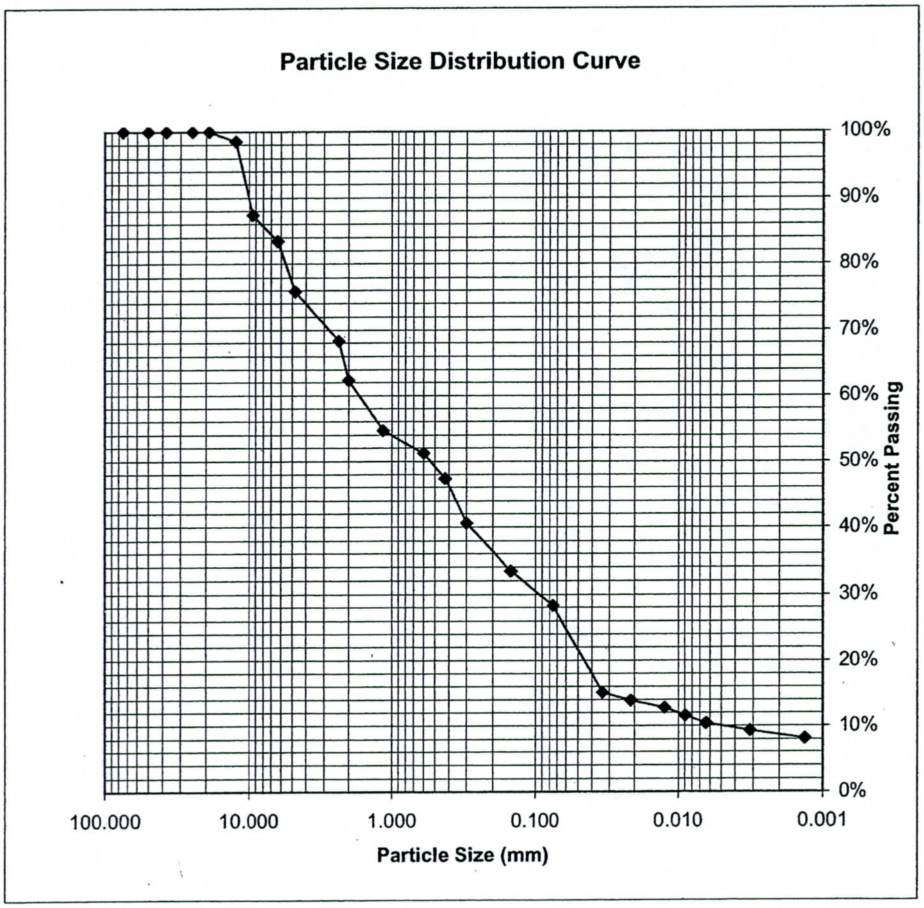
(Mechanical Sieve & Hydrometer)

(% Passing)

# 4		76%
# 8		68%
# 10		62%
# 16		55%
# 30		51%
# 40		47%
# 50		41%
# 100		33%
# 200		28.3%
0.0334	mm	15%
0.0214	mm	14%
0.0125	mm	13%
0.0089	mm	12%
0.0064	mm	10%
0.0031	mm	9%
0.0013	mm	8%
0.0009	mm	7%

Mechanical Sieve Analysis After Hydrometer (% Passing)

#200	#100	#50	#40	#30	#16	#10
28%	33%	41%	47%	51%	55%	62%



Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	Project Number:	09-G-1597
Project Location	Maricopa County, Arizona	Work Order Number:	6
Client:	Hoskin Ryan Consultants, Inc.	Lab Number:	151
Material:	Native	Date Sampled:	11/19/09
Sample Source:	Test Pit TP-45 @ 0'-1'		

Hydrometer Test Report (ASTM D-422)

Weight of Sample Dispersed	86.50	Specific Gravity of Solids	2.65
Percent Passing #10 Sieve	66.2%		

Full Sieve Analysis

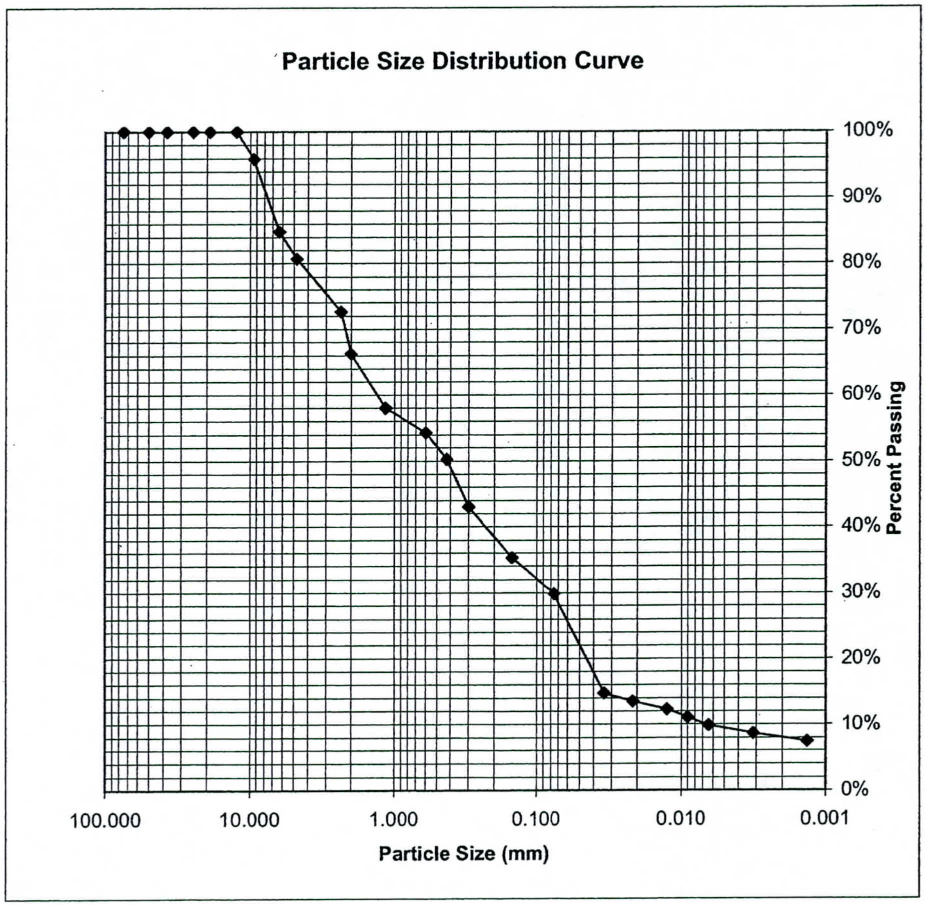
(Mechanical Sieve & Hydrometer)

(% Passing)

# 4		81%
# 8		73%
# 10		66%
# 16		58%
# 30		54%
# 40		50%
# 50		43%
# 100		35%
# 200		29.8%
0.0338	mm	15%
0.0216	mm	14%
0.0126	mm	12%
0.0090	mm	11%
0.0064	mm	10%
0.0032	mm	9%
0.0013	mm	7%
0.0010	mm	6%

Mechanical Sieve Analysis After Hydrometer (% Passing)

#200	#100	#50	#40	#30	#16	#10
30%	35%	43%	50%	54%	58%	66%



Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	Project Number:	09-G-1597
Project Location	Maricopa County, Arizona	Work Order Number:	6
Client:	Hoskin Ryan Consultants, Inc.	Lab Number:	152
Material:	Native	Date Sampled:	11/19/09
Sample Source:	Test Pit TP-48 @ 0'-1'		

Hydrometer Test Report (ASTM D-422)

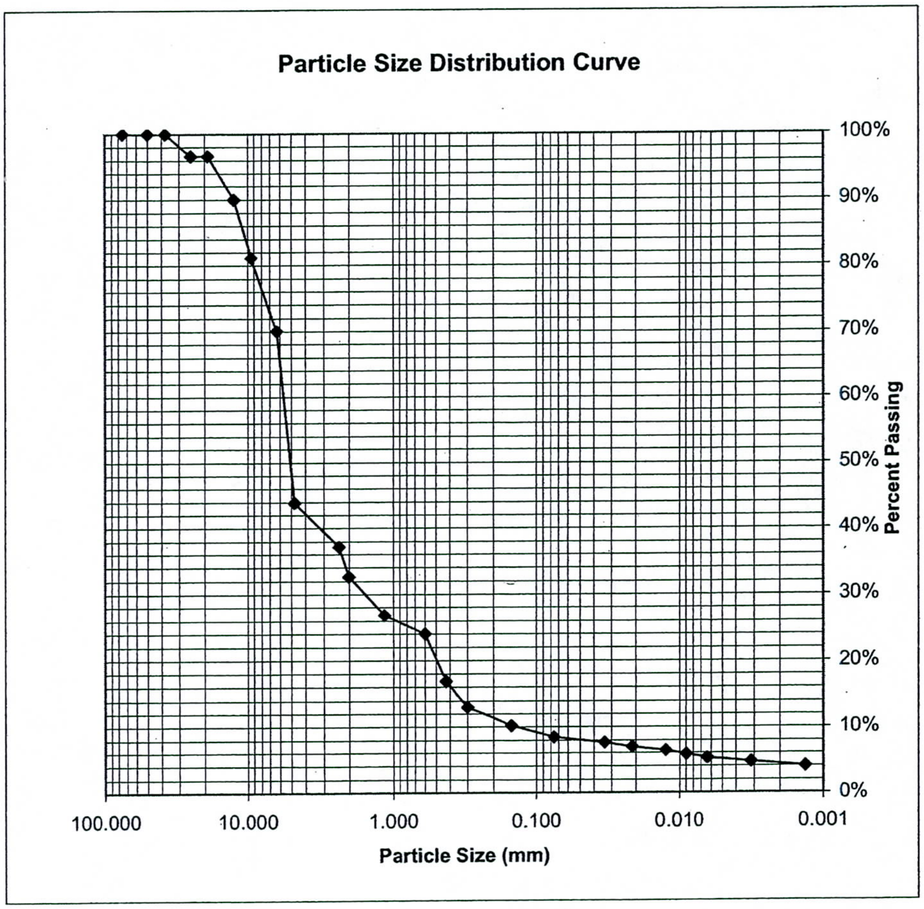
Weight of Sample Dispersed	90.10	Specific Gravity of Solids	2.65
Percent Passing #10 Sieve	32.6%		

Full Sieve Analysis
(Mechanical Sieve & Hydrometer)
(% Passing)

# 4		44%
# 8		37%
# 10		33%
# 16		27%
# 30		24%
# 40		17%
# 50		13%
# 100		10%
# 200		8.5%
0.0334	mm	8%
0.0214	mm	7%
0.0125	mm	6%
0.0089	mm	6%
0.0064	mm	5%
0.0031	mm	5%
0.0013	mm	4%
0.0009	mm	3%

Mechanical Sieve Analysis After Hydrometer (% Passing)

#200	#100	#50	#40	#30	#16	#10
8%	10%	13%	17%	24%	27%	33%



Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	White Tanks FRS #3 - Outfall Channel	**Project Number:**	09-G-1597
Project Location	Maricopa County, Arizona	**Work Order Number:**	6
Client:	Hoskin Ryan Consultants, Inc.	**Lab Number:**	153
Material:	Native	**Date Sampled:**	11/19/09
Sample Source:	Test Pit TP-49 @ 0'-3'		

Hydrometer Test Report (ASTM D-422)

Weight of Sample Dispersed	100.70	**Specific Gravity of Solids**	2.65
Percent Passing #10 Sieve	73.7%		

Full Sieve Analysis

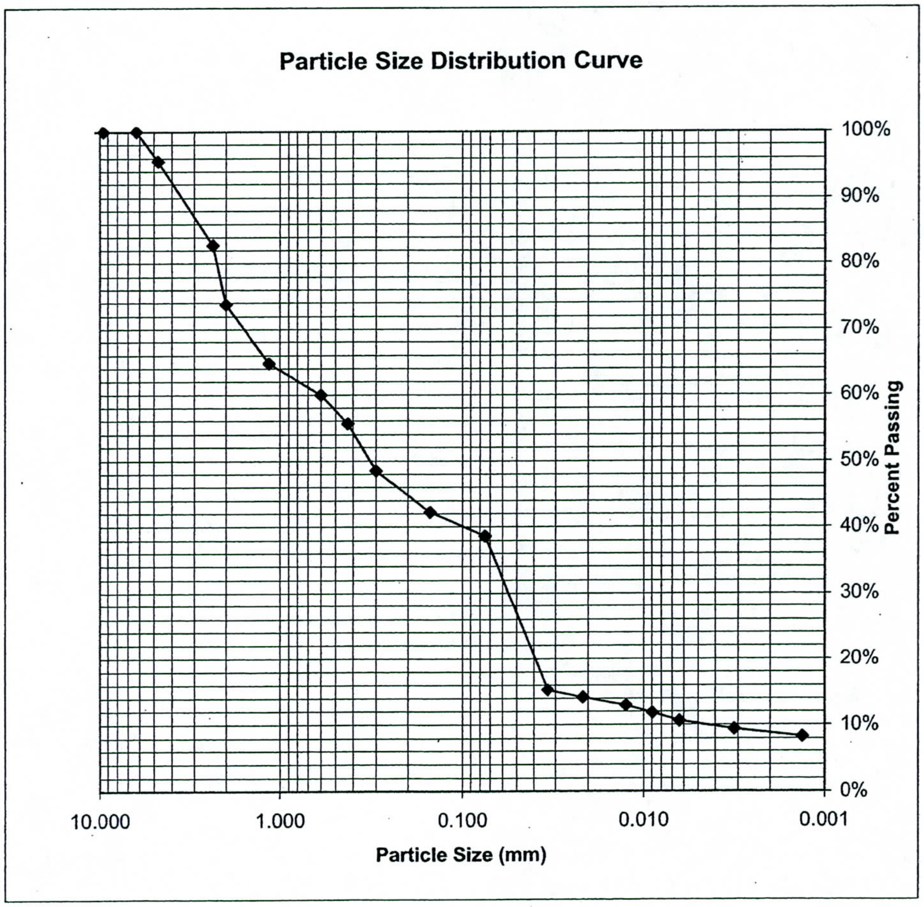
(Mechanical Sieve & Hydrometer)

(% Passing)

# 4		95%
# 8		83%
# 10		74%
# 16		65%
# 30		60%
# 40		56%
# 50		48%
# 100		42%
# 200		38.6%
0.0334	mm	15%
0.0214	mm	14%
0.0125	mm	13%
0.0089	mm	12%
0.0064	mm	11%
0.0031	mm	9%
0.0013	mm	8%
0.0010	mm	6%

Mechanical Sieve Analysis After Hydrometer (% Passing)

#200	#100	#50	#40	#30	#16	#10
39%	42%	49%	56%	60%	65%	74%



Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Victoria Normandin, LLC
Email: vicn@cox.net
Voice: 602-799-7248

Date: 12/23/09
Report: 901211-01 through -10
Information provided by the laboratory: The material will be for landscaping around a levee near 195th Avenue south of the White Tanks. B62 and 64 are from a stockpile. The remaining samples are in-situ.

Soil nutrient levels vary greatly in the areas sampled.
pH ranges from 8.1 to 8.8. Where pH is >8.3, 10 lbs Sulfur/1000 sq.ft can be tilled into the surface soil. Sulfur also assists in leaching high sodium. Four areas contain very high levels of sodium, > 300 ppm, and high pH levels. After adding sulfur to lower pH, these areas should be leached by applying large amounts of water to move sodium below the root zone. Soil stockpiled, B-62 and B-64, add .45 lbs S/cubic yd.

EC or soluble salt is low to moderate ranging from .2 to 2.0 dS/m. Sodium, sulfate-S and nitrate-N are very soluble and contribute to the EC reading. In the process of leaching sodium, nitrate-N and sulfate-S will also leach.

Nitrate-N is high in two areas, B-16 and B-23, and no N is needed preplant.
Nitrate-N is moderate in two areas, B-34 and B-43. Nitrogen fertilization during the cool season will depend upon the plant species. A small amount of nitrogen can be added until warm weather returns.
Nitrate-N is low in many areas. 2 lb N/1000 sq.ft can be applied before planting. Stockpile soil add .08 lb N/cubic yd.
Phosphorus is low in all areas. Till 2 lb P/1000 sq.ft into the soil. Stockpile soil add .08 lb P/cubic yd.

Potassium is low to moderate. Add 1 lb K/1000 sq.ft where K is <100 ppm.

The Ca: Mg ratio is wide, > 20:1, in half of the samples. Mg deficiencies could occur in some plants.

Micronutrients, Fe, Zn, Mn, Cu and B are predominately low. Fe deficiencies become visible in landscape plants typically in late summer. Zinc deficiencies may affect flowering plants. Using an N or N-P blended fertilizer containing micronutrients is recommended.

Due to the low levels of phosphorus, potassium, magnesium, and micronutrients, mixing good quality compost or composted manure into the surface soil may be advantageous @ 250lbs/1000 sq.ft.
Thank you,

Victoria Normandin

Vicki Normandin

Note: Interpretations of the soil and water results are based on the data provided by Motzz Laboratory.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials

Project:	09-G-1597
Sampler:	
Date Received:	12/21/2009
Date Reported:	12/22/2009
PO Number:	09-G-1597
Crop:	Landscape
Growth Stage:	

Lab Number: 901211-01
Sample ID: B-7 5'
Description: White Tanks FRS #3 - Outfall Channel

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.8	SU	Very High
Electrical Conductivity, EC	1:1	0.56	dS/m	Medium
Calcium, Ca	NH4OAc (pH 8.5)	3,600	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	160	ppm	High
Sodium, Na	NH4OAc (pH 8.5)	370	ppm	Very High
Potassium, K	NH4OAc (pH 8.5)	110	ppm	Medium
Zinc, Zn	DTPA	<0.01	ppm	Low
Iron, Fe	DTPA	4.3	ppm	Medium
Manganese, Mn	DTPA	1.3	ppm	Low
Copper, Cu	DTPA	0.36	ppm	Medium
Nickel, Ni	DTPA	0.012	ppm	
Nitrate-N, NO3-N	Cd Reduction	1.4	ppm	Low
Phosphate-P, PO4-P	Olsen	3.3	ppm	Low
Sulfate-S, SO4-S	Hot Water	37	ppm	High
Boron, B	Hot Water	0.59	ppm	Medium
Free Lime, FL	Acid Test	High		
ESP	Calculated	7.6	%	
CEC	Calculated	21.2	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/22/2009

PO Number: 09-G-1597

Lab Number: 901211-02
Sample ID: B-16 10'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.3	SU	High
Electrical Conductivity, EC	1:1	1.2	dS/m	Medium
Calcium, Ca	NH4OAc (pH 8.5)	3,600	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	170	ppm	High
Sodium, Na	NH4OAc (pH 8.5)	190	ppm	Medium
Potassium, K	NH4OAc (pH 8.5)	59	ppm	Low
Zinc, Zn	DTPA	<0.01	ppm	Low
Iron, Fe	DTPA	2.9	ppm	Medium
Manganese, Mn	DTPA	0.57	ppm	Low
Copper, Cu	DTPA	0.17	ppm	Low
Nickel, Ni	DTPA	0.0090	ppm	
Nitrate-N, NO3-N	Cd Reduction	93	ppm	Very High
Phosphate-P, PO4-P	Olsen	2.1	ppm	Low
Sulfate-S, SO4-S	Hot Water	46	ppm	High
Boron, B	Hot Water	0.62	ppm	Medium
Free Lime, FL	Acid Test	High		
ESP	Calculated	4.1	%	
CEC	Calculated	20.4	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/22/2009

PO Number: 09-G-1597

Lab Number: 901211-03
Sample ID: B-23 5'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.1	SU	High
Electrical Conductivity, EC	1:1	0.52	dS/m	Medium
Calcium, Ca	NH4OAc (pH 8.5)	3,900	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	180	ppm	High
Sodium, Na	NH4OAc (pH 8.5)	120	ppm	Medium
Potassium, K	NH4OAc (pH 8.5)	110	ppm	Medium
Zinc, Zn	DTPA	0.078	ppm	Low
Iron, Fe	DTPA	2.6	ppm	Medium
Manganese, Mn	DTPA	1.1	ppm	Low
Copper, Cu	DTPA	0.39	ppm	Medium
Nickel, Ni	DTPA	0.042	ppm	
Nitrate-N, NO3-N	Cd Reduction	36	ppm	High
Phosphate-P, PO4-P	Olsen	1.9	ppm	Low
Sulfate-S, SO4-S	Hot Water	19	ppm	High
Boron, B	Hot Water	0.20	ppm	Low
Free Lime, FL	Acid Test	High		
ESP	Calculated	2.4	%	
CEC	Calculated	21.8	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/22/2009

PO Number: 09-G-1597

Lab Number: 901211-04
Sample ID: B-25 5'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.4	SU	Very High
Electrical Conductivity, EC	1:1	0.39	dS/m	Low
Calcium, Ca	NH4OAc (pH 8.5)	3,800	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	110	ppm	Medium
Sodium, Na	NH4OAc (pH 8.5)	55	ppm	Medium
Potassium, K	NH4OAc (pH 8.5)	79	ppm	Low
Zinc, Zn	DTPA	<0.01	ppm	Low
Iron, Fe	DTPA	3.0	ppm	Medium
Manganese, Mn	DTPA	1.7	ppm	Low
Copper, Cu	DTPA	0.38	ppm	Medium
Nickel, Ni	DTPA	0.026	ppm	
Nitrate-N, NO3-N	Cd Reduction	9.4	ppm	Low
Phosphate-P, PO4-P	Olsen	4.3	ppm	Low
Sulfate-S, SO4-S	Hot Water	43	ppm	High
Boron, B	Hot Water	0.23	ppm	Low
Free Lime, FL	Acid Test	High		
ESP	Calculated	1.2	%	
CEC	Calculated	20.4	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/22/2009

PO Number: 09-G-1597

Lab Number: 901211-05
Sample ID: B-34 5'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.2	SU	High
Electrical Conductivity, EC	1:1	0.63	dS/m	Medium
Calcium, Ca	NH4OAc (pH 8.5)	3,100	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	140	ppm	High
Sodium, Na	NH4OAc (pH 8.5)	150	ppm	Medium
Potassium, K	NH4OAc (pH 8.5)	130	ppm	Medium
Zinc, Zn	DTPA	<0.01	ppm	Low
Iron, Fe	DTPA	3.4	ppm	Medium
Manganese, Mn	DTPA	1.5	ppm	Low
Copper, Cu	DTPA	0.40	ppm	Medium
Nickel, Ni	DTPA	0.031	ppm	
Nitrate-N, NO3-N	Cd Reduction	27	ppm	High
Phosphate-P, PO4-P	Olsen	0.92	ppm	Low
Sulfate-S, SO4-S	Hot Water	46	ppm	High
Boron, B	Hot Water	0.65	ppm	Medium
Free Lime, FL	Acid Test	High		
ESP	Calculated	3.7	%	
CEC	Calculated	17.7	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/22/2009

PO Number: 09-G-1597

Lab Number: 901211-06
Sample ID: B-43 4'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.5	SU	Very High
Electrical Conductivity, EC	1:1	2.0	dS/m	Medium
Calcium, Ca	NH4OAc (pH 8.5)	3,300	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	200	ppm	High
Sodium, Na	NH4OAc (pH 8.5)	490	ppm	Very High
Potassium, K	NH4OAc (pH 8.5)	50	ppm	Low
Zinc, Zn	DTPA	<0.01	ppm	Low
Iron, Fe	DTPA	1.8	ppm	Low
Manganese, Mn	DTPA	0.37	ppm	Low
Copper, Cu	DTPA	0.12	ppm	Low
Nickel, Ni	DTPA	0.010	ppm	
Nitrate-N, NO3-N	Cd Reduction	19	ppm	Medium
Phosphate-P, PO4-P	Olsen	1	ppm	Low
Sulfate-S, SO4-S	Hot Water	360	ppm	Very High
Boron, B	Hot Water	1.1	ppm	Medium
Free Lime, FL	Acid Test	High		
ESP	Calculated	10.4	%	
CEC	Calculated	20.4	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

sheet says 4' bag says 5'

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/22/2009

PO Number: 09-G-1597

Lab Number: 901211-07
Sample ID: B-48 10'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.4	SU	Very High
Electrical Conductivity, EC	1:1	0.21	dS/m	Low
Calcium, Ca	NH4OAc (pH 8.5)	1,900	ppm	High
Magnesium, Mg	NH4OAc (pH 8.5)	130	ppm	Medium
Sodium, Na	NH4OAc (pH 8.5)	68	ppm	Medium
Potassium, K	NH4OAc (pH 8.5)	140	ppm	Medium
Zinc, Zn	DTPA	0.076	ppm	Low
Iron, Fe	DTPA	2.8	ppm	Medium
Manganese, Mn	DTPA	1.8	ppm	Low
Copper, Cu	DTPA	0.63	ppm	High
Nickel, Ni	DTPA	0.043	ppm	
Nitrate-N, NO3-N	Cd Reduction	0.63	ppm	Low
Phosphate-P, PO4-P	Olsen	3.5	ppm	Low
Sulfate-S, SO4-S	Hot Water	5.9	ppm	Medium
Boron, B	Hot Water	0.21	ppm	Low
Free Lime, FL	Acid Test	High		
ESP	Calculated	2.6	%	
CEC	Calculated	11.2	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials

Project:	09-G-1597
Sampler:	
Date Received:	12/21/2009
Date Reported:	12/22/2009
PO Number:	09-G-1597
Crop:	Landscape
Growth Stage:	

Lab Number: 901211-08
Sample ID: B-57 10'
Description: White Tanks FRS #3 - Outfall Channel

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.6	SU	Very High
Electrical Conductivity, EC	1:1	0.22	dS/m	Low
Calcium, Ca	NH4OAc (pH 8.5)	4,100	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	150	ppm	High
Sodium, Na	NH4OAc (pH 8.5)	78	ppm	Medium
Potassium, K	NH4OAc (pH 8.5)	100	ppm	Medium
Zinc, Zn	DTPA	0.048	ppm	Low
Iron, Fe	DTPA	4.4	ppm	Medium
Manganese, Mn	DTPA	0.44	ppm	Low
Copper, Cu	DTPA	0.37	ppm	Medium
Nickel, Ni	DTPA	0.0100	ppm	
Nitrate-N, NO3-N	Cd Reduction	<1.0	ppm	Low
Phosphate-P, PO4-P	Olsen	0.42	ppm	Low
Sulfate-S, SO4-S	Hot Water	2.7	ppm	Low
Boron, B	Hot Water	0.22	ppm	Low
Free Lime, FL	Acid Test	High		
ESP	Calculated	1.5	%	
CEC	Calculated	22.3	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/22/2009

PO Number: 09-G-1597

Lab Number: 901211-09
Sample ID: B-62 10'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.6	SU	Very High
Electrical Conductivity, EC	1:1	0.61	dS/m	Medium
Calcium, Ca	NH4OAc (pH 8.5)	3,900	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	300	ppm	Very High
Sodium, Na	NH4OAc (pH 8.5)	340	ppm	Very High
Potassium, K	NH4OAc (pH 8.5)	140	ppm	Medium
Zinc, Zn	DTPA	0.64	ppm	Medium
Iron, Fe	DTPA	5.4	ppm	Medium
Manganese, Mn	DTPA	1.5	ppm	Low
Copper, Cu	DTPA	0.39	ppm	Medium
Nickel, Ni	DTPA	0.040	ppm	
Nitrate-N, NO3-N	Cd Reduction	0.63	ppm	Low
Phosphate-P, PO4-P	Olsen	1.3	ppm	Low
Sulfate-S, SO4-S	Hot Water	31	ppm	High
Boron, B	Hot Water	0.35	ppm	Medium
Free Lime, FL	Acid Test	High		
ESP	Calculated	6.2	%	
CEC	Calculated	23.8	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/22/2009

PO Number: 09-G-1597

Lab Number: 901211-10
Sample ID: B-64 10'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.7	SU	Very High
Electrical Conductivity, EC	1:1	0.68	dS/m	Medium
Calcium, Ca	NH4OAc (pH 8.5)	3,100	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	210	ppm	High
Sodium, Na	NH4OAc (pH 8.5)	300	ppm	High
Potassium, K	NH4OAc (pH 8.5)	120	ppm	Medium
Zinc, Zn	DTPA	0.021	ppm	Low
Iron, Fe	DTPA	3.9	ppm	Medium
Manganese, Mn	DTPA	1.4	ppm	Low
Copper, Cu	DTPA	0.38	ppm	Medium
Nickel, Ni	DTPA	0.025	ppm	
Nitrate-N, NO3-N	Cd Reduction	0.62	ppm	Low
Phosphate-P, PO4-P	Olsen	1.4	ppm	Low
Sulfate-S, SO4-S	Hot Water	45	ppm	High
Boron, B	Hot Water	0.37	ppm	Medium
Free Lime, FL	Acid Test	High		
ESP	Calculated	6.9	%	
CEC	Calculated	18.9	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials
Jamie Floyd
2504 W. Southern Ave
Tempe, AZ 85282

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/24/2009

PO Number: 09-G-1597

Lab Number: 901211-01
Sample ID: B-7 5'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.8	SU	Very High
Electrical Conductivity, EC	1:1	0.56	dS/m	Medium
Calcium, Ca	NH4OAc (pH 8.5)	3,600	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	160	ppm	High
Sodium, Na	NH4OAc (pH 8.5)	370	ppm	Very High
Potassium, K	NH4OAc (pH 8.5)	110	ppm	Medium
Zinc, Zn	DTPA	<0.01	ppm	Low
Iron, Fe	DTPA	4.3	ppm	Medium
Manganese, Mn	DTPA	1.3	ppm	Low
Copper, Cu	DTPA	0.36	ppm	Medium
Nickel, Ni	DTPA	0.012	ppm	
Nitrate-N, NO3-N	Cd Reduction	1.4	ppm	Low
Phosphate-P, PO4-P	Olsen	3.3	ppm	Low
Sulfate-S, SO4-S	Hot Water	37	ppm	High
Boron, B	Hot Water	0.59	ppm	Medium
Free Lime, FL	Acid Test	High		
ESP	Calculated	7.6	%	
CEC	Calculated	21.2	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials
Jamie Floyd
2504 W. Southern Ave
Tempe, AZ 85282

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/24/2009

PO Number: 09-G-1597

Lab Number: 901211-02
Sample ID: B-16 10'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.3	SU	High
Electrical Conductivity, EC	1:1	1.2	dS/m	Medium
Calcium, Ca	NH4OAc (pH 8.5)	3,600	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	170	ppm	High
Sodium, Na	NH4OAc (pH 8.5)	190	ppm	Medium
Potassium, K	NH4OAc (pH 8.5)	59	ppm	Low
Zinc, Zn	DTPA	<0.01	ppm	Low
Iron, Fe	DTPA	2.9	ppm	Medium
Manganese, Mn	DTPA	0.57	ppm	Low
Copper, Cu	DTPA	0.17	ppm	Low
Nickel, Ni	DTPA	0.0090	ppm	
Nitrate-N, NO3-N	Cd Reduction	93	ppm	Very High
Phosphate-P, PO4-P	Olsen	2.1	ppm	Low
Sulfate-S, SO4-S	Hot Water	46	ppm	High
Boron, B	Hot Water	0.62	ppm	Medium
Free Lime, FL	Acid Test	High		
ESP	Calculated	4.1	%	
CEC	Calculated	20.4	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials		Project:	09-G-1597
Jamie Floyd		Sampler:	
2504 W. Southern Ave		Date Received:	12/21/2009
Tempe, AZ 85282		Date Reported:	12/24/2009
		PO Number:	09-G-1597
Lab Number:	901211-03	Crop:	Landscape
Sample ID:	B-23 5'	Growth Stage:	
Description:	White Tanks FRS #3 - Outfall Channel		

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.1	SU	High
Electrical Conductivity, EC	1:1	0.52	dS/m	Medium
Calcium, Ca	NH4OAc (pH 8.5)	3,900	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	180	ppm	High
Sodium, Na	NH4OAc (pH 8.5)	120	ppm	Medium
Potassium, K	NH4OAc (pH 8.5)	110	ppm	Medium
Zinc, Zn	DTPA	0.078	ppm	Low
Iron, Fe	DTPA	2.6	ppm	Medium
Manganese, Mn	DTPA	1.1	ppm	Low
Copper, Cu	DTPA	0.39	ppm	Medium
Nickel, Ni	DTPA	0.042	ppm	
Nitrate-N, NO3-N	Cd Reduction	36	ppm	High
Phosphate-P, PO4-P	Olsen	1.9	ppm	Low
Sulfate-S, SO4-S	Hot Water	19	ppm	High
Boron, B	Hot Water	0.20	ppm	Low
Free Lime, FL	Acid Test	High		
ESP	Calculated	2.4	%	
CEC	Calculated	21.8	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials
Jamie Floyd
2504 W. Southern Ave
Tempe, AZ 85282

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/24/2009

PO Number: 09-G-1597

Lab Number: 901211-04
Sample ID: B-25 5'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.4	SU	Very High
Electrical Conductivity, EC	1:1	0.39	dS/m	Low
Calcium, Ca	NH4OAc (pH 8.5)	3,800	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	110	ppm	Medium
Sodium, Na	NH4OAc (pH 8.5)	55	ppm	Medium
Potassium, K	NH4OAc (pH 8.5)	79	ppm	Low
Zinc, Zn	DTPA	<0.01	ppm	Low
Iron, Fe	DTPA	3.0	ppm	Medium
Manganese, Mn	DTPA	1.7	ppm	Low
Copper, Cu	DTPA	0.38	ppm	Medium
Nickel, Ni	DTPA	0.026	ppm	
Nitrate-N, NO3-N	Cd Reduction	9.4	ppm	Low
Phosphate-P, PO4-P	Olsen	4.3	ppm	Low
Sulfate-S, SO4-S	Hot Water	43	ppm	High
Boron, B	Hot Water	0.23	ppm	Low
Free Lime, FL	Acid Test	High		
ESP	Calculated	1.2	%	
CEC	Calculated	20.4	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials		Project:	09-G-1597
Jamie Floyd		Sampler:	
2504 W. Southern Ave		Date Received:	12/21/2009
Tempe, AZ 85282		Date Reported:	12/24/2009
		PO Number:	09-G-1597
Lab Number:	901211-05	Crop:	Landscape
Sample ID:	B-34 5'	Growth Stage:	
Description:	White Tanks FRS #3 - Outfall Channel		

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.2	SU	High
Electrical Conductivity, EC	1:1	0.63	dS/m	Medium
Calcium, Ca	NH4OAc (pH 8.5)	3,100	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	140	ppm	High
Sodium, Na	NH4OAc (pH 8.5)	150	ppm	Medium
Potassium, K	NH4OAc (pH 8.5)	130	ppm	Medium
Zinc, Zn	DTPA	<0.01	ppm	Low
Iron, Fe	DTPA	3.4	ppm	Medium
Manganese, Mn	DTPA	1.5	ppm	Low
Copper, Cu	DTPA	0.40	ppm	Medium
Nickel, Ni	DTPA	0.031	ppm	
Nitrate-N, NO3-N	Cd Reduction	27	ppm	High
Phosphate-P, PO4-P	Olsen	0.92	ppm	Low
Sulfate-S, SO4-S	Hot Water	46	ppm	High
Boron, B	Hot Water	0.65	ppm	Medium
Free Lime, FL	Acid Test	High		
ESP	Calculated	3.7	%	
CEC	Calculated	17.7	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials
Jamie Floyd
2504 W. Southern Ave
Tempe, AZ 85282

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/24/2009
PO Number: 09-G-1597

Lab Number: 901211-06
Sample ID: B-43 4'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.5	SU	Very High
Electrical Conductivity, EC	1:1	2.0	dS/m	Medium
Calcium, Ca	NH4OAc (pH 8.5)	3,300	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	200	ppm	High
Sodium, Na	NH4OAc (pH 8.5)	490	ppm	Very High
Potassium, K	NH4OAc (pH 8.5)	50	ppm	Low
Zinc, Zn	DTPA	<0.01	ppm	Low
Iron, Fe	DTPA	1.8	ppm	Low
Manganese, Mn	DTPA	0.37	ppm	Low
Copper, Cu	DTPA	0.12	ppm	Low
Nickel, Ni	DTPA	0.010	ppm	
Nitrate-N, NO3-N	Cd Reduction	19	ppm	Medium
Phosphate-P, PO4-P	Olsen	1	ppm	Low
Sulfate-S, SO4-S	Hot Water	360	ppm	Very High
Boron, B	Hot Water	1.1	ppm	Medium
Free Lime, FL	Acid Test	High		
ESP	Calculated	10.4	%	
CEC	Calculated	20.4	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

sheet says 4' bag says 5'

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials
Jamie Floyd
2504 W. Southern Ave
Tempe, AZ 85282

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/24/2009

PO Number: 09-G-1597

Lab Number: 901211-07
Sample ID: B-48 10'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.4	SU	Very High
Electrical Conductivity, EC	1:1	0.21	dS/m	Low
Calcium, Ca	NH4OAc (pH 8.5)	1,900	ppm	High
Magnesium, Mg	NH4OAc (pH 8.5)	130	ppm	Medium
Sodium, Na	NH4OAc (pH 8.5)	68	ppm	Medium
Potassium, K	NH4OAc (pH 8.5)	140	ppm	Medium
Zinc, Zn	DTPA	0.076	ppm	Low
Iron, Fe	DTPA	2.8	ppm	Medium
Manganese, Mn	DTPA	1.8	ppm	Low
Copper, Cu	DTPA	0.63	ppm	High
Nickel, Ni	DTPA	0.043	ppm	
Nitrate-N, NO3-N	Cd Reduction	0.63	ppm	Low
Phosphate-P, PO4-P	Olsen	3.5	ppm	Low
Sulfate-S, SO4-S	Hot Water	5.9	ppm	Medium
Boron, B	Hot Water	0.21	ppm	Low
Free Lime, FL	Acid Test	High		
ESP	Calculated	2.6	%	
CEC	Calculated	11.2	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials
Jamie Floyd
2504 W. Southern Ave
Tempe, AZ 85282

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/24/2009

PO Number: 09-G-1597

Lab Number: 901211-08
Sample ID: B-57 10'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.6	SU	Very High
Electrical Conductivity, EC	1:1	0.22	dS/m	Low
Calcium, Ca	NH4OAc (pH 8.5)	4,100	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	150	ppm	High
Sodium, Na	NH4OAc (pH 8.5)	78	ppm	Medium
Potassium, K	NH4OAc (pH 8.5)	100	ppm	Medium
Zinc, Zn	DTPA	0.048	ppm	Low
Iron, Fe	DTPA	4.4	ppm	Medium
Manganese, Mn	DTPA	0.44	ppm	Low
Copper, Cu	DTPA	0.37	ppm	Medium
Nickel, Ni	DTPA	0.0100	ppm	
Nitrate-N, NO3-N	Cd Reduction	<1.0	ppm	Low
Phosphate-P, PO4-P	Olsen	0.42	ppm	Low
Sulfate-S, SO4-S	Hot Water	2.7	ppm	Low
Boron, B	Hot Water	0.22	ppm	Low
Free Lime, FL	Acid Test	High		
ESP	Calculated	1.5	%	
CEC	Calculated	22.3	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials		Project:	09-G-1597
Jamie Floyd		Sampler:	
2504 W. Southern Ave		Date Received:	12/21/2009
Tempe, AZ 85282		Date Reported:	12/24/2009
		PO Number:	09-G-1597
Lab Number:	901211-09	Crop:	Landscape
Sample ID:	B-62 10'	Growth Stage:	
Description:	White Tanks FRS #3 - Outfall Channel		

Soil Complete Test

Test	Method	Result	Units	Levels
pH	1:1	8.6	SU	Very High
Electrical Conductivity, EC	1:1	0.61	dS/m	Medium
Calcium, Ca	NH4OAc (pH 8.5)	3,900	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	300	ppm	Very High
Sodium, Na	NH4OAc (pH 8.5)	340	ppm	Very High
Potassium, K	NH4OAc (pH 8.5)	140	ppm	Medium
Zinc, Zn	DTPA	0.64	ppm	Medium
Iron, Fe	DTPA	5.4	ppm	Medium
Manganese, Mn	DTPA	1.5	ppm	Low
Copper, Cu	DTPA	0.39	ppm	Medium
Nickel, Ni	DTPA	0.040	ppm	
Nitrate-N, NO3-N	Cd Reduction	0.63	ppm	Low
Phosphate-P, PO4-P	Olsen	1.3	ppm	Low
Sulfate-S, SO4-S	Hot Water	31	ppm	High
Boron, B	Hot Water	0.35	ppm	Medium
Free Lime, FL	Acid Test	High		
ESP	Calculated	6.2	%	
CEC	Calculated	23.8	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials
Jamie Floyd
2504 W. Southern Ave
Tempe, AZ 85282

Project: 09-G-1597
Sampler:
Date Received: 12/21/2009
Date Reported: 12/24/2009

PO Number: 09-G-1597

Lab Number: 901211-10
Sample ID: B-64 10'
Description: White Tanks FRS #3 - Outfall Channel

Crop: Landscape
Growth Stage:

Soil Complete Test

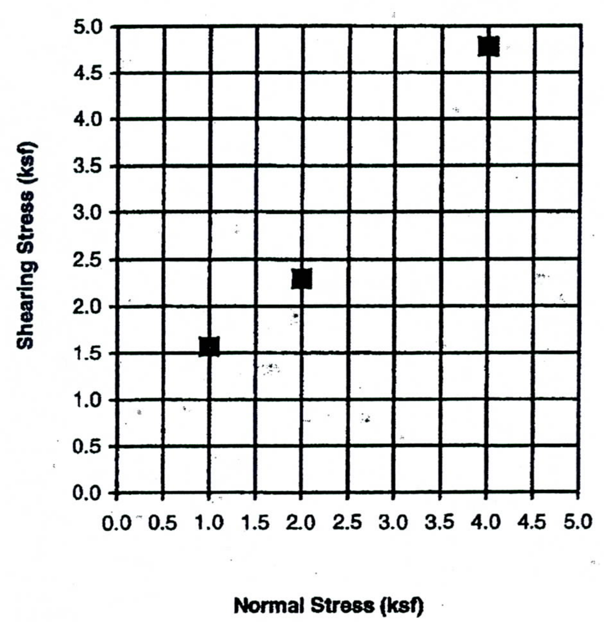
Test	Method	Result	Units	Levels
pH	1:1	8.7	SU	Very High
Electrical Conductivity, EC	1:1	0.68	dS/m	Medium
Calcium, Ca	NH4OAc (pH 8.5)	3,100	ppm	Very High
Magnesium, Mg	NH4OAc (pH 8.5)	210	ppm	High
Sodium, Na	NH4OAc (pH 8.5)	300	ppm	High
Potassium, K	NH4OAc (pH 8.5)	120	ppm	Medium
Zinc, Zn	DTPA	0.021	ppm	Low
Iron, Fe	DTPA	3.9	ppm	Medium
Manganese, Mn	DTPA	1.4	ppm	Low
Copper, Cu	DTPA	0.38	ppm	Medium
Nickel, Ni	DTPA	0.025	ppm	
Nitrate-N, NO3-N	Cd Reduction	0.62	ppm	Low
Phosphate-P, PO4-P	Olsen	1.4	ppm	Low
Sulfate-S, SO4-S	Hot Water	45	ppm	High
Boron, B	Hot Water	0.37	ppm	Medium
Free Lime, FL	Acid Test	High		
ESP	Calculated	6.9	%	
CEC	Calculated	18.9	meq/100g	

Levels are generalized and apply to most cropping environments.
Low means a high probability that applying nutrient will elicit a growth response.
Medium means a moderate probability of plant growth from application.
High means little or no response expected from application of this nutrient.
Very High means adding the nutrient may reduce growth or cause imbalance.

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	279
SAMPLE SOURCE:	B-61 @ 10.0-11.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu		
	Innundated for 10 minutes prior to shear		

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)

Initial thickness of specimen (in.):	1.00		
Initial diameter of specimen (in.):	2.42		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.016		
Direct shear point:	1	2	3
Dry mass of specimen (g):	115.0	119.0	122.2
Initial Moisture Content:	8.8%	8.8%	8.3%
Initial Wet Density (lb per cu.ft):	103.6	107.2	109.6
Initial Dry Density (lb per cu.ft):	95.3	98.6	101.2
Final Moisture Content:	25.9%	23.6%	22.1%
Final Wet Density (lb per cu.ft):	119.9	121.8	123.6
Final Dry Density (lb per cu.ft):	95.2	98.5	101.2
Normal Stress (ksf):	1.0	2.0	4.0
Maximum Shearing Stress (kips per sq. ft):	1.57	2.30	4.78
Vertical Deformation @ Max Shear (in):	0.030	0.025	0.039
Horizontal Deformation @ Max Shear (in):	0.230	0.242	0.478



AASHTO R18

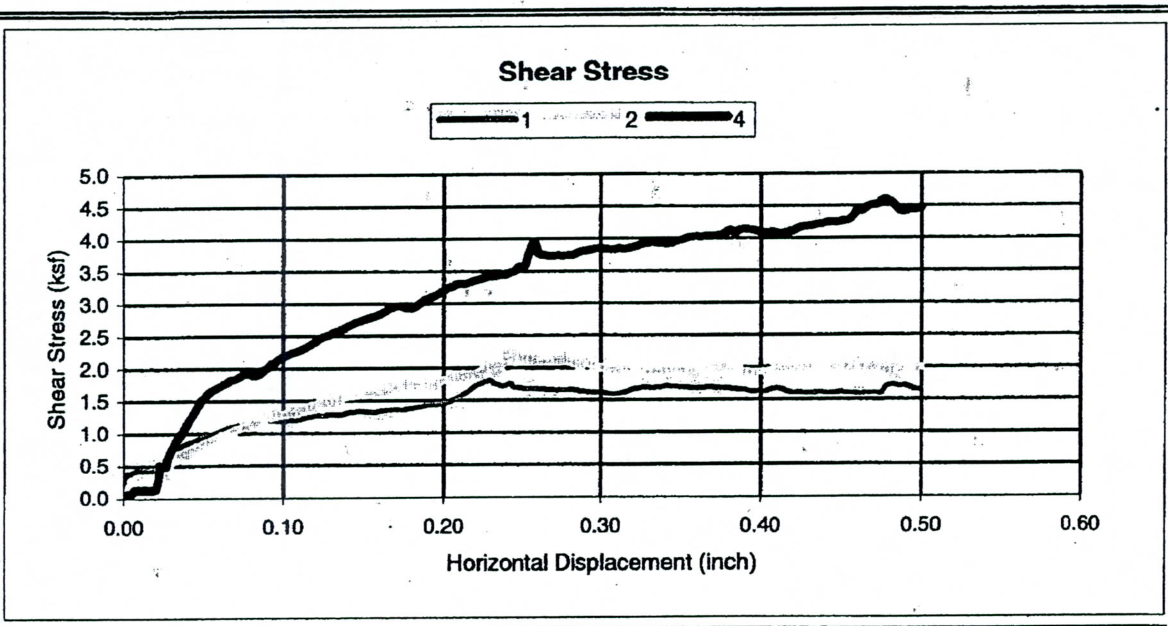
REVIEWED BY ____________________

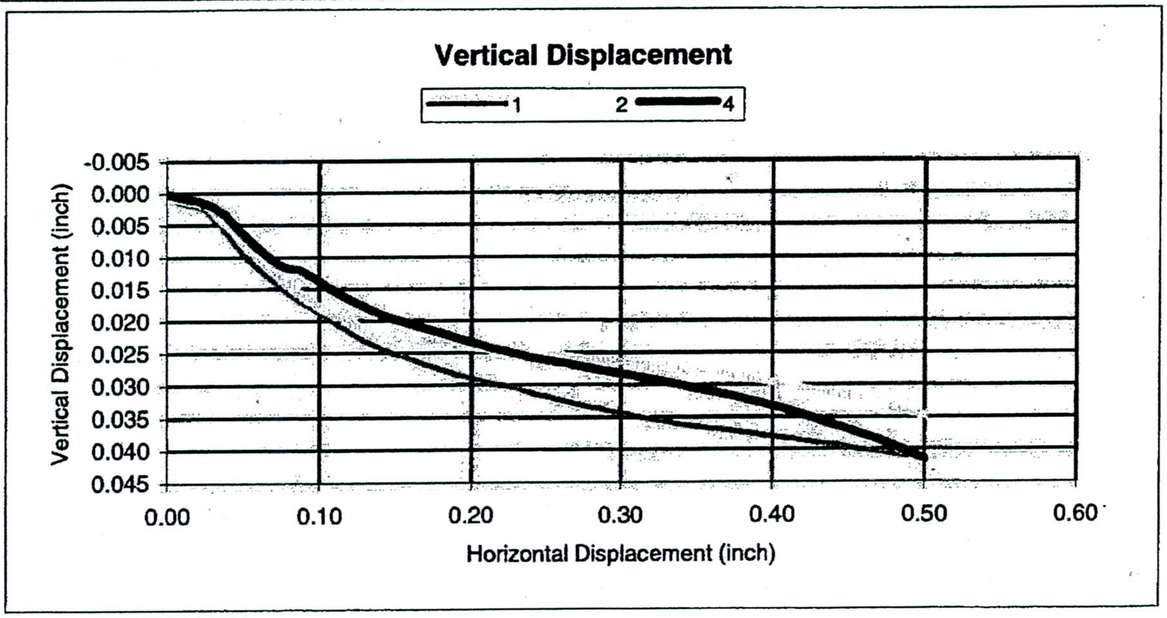
amec

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	279
SAMPLE SOURCE:	B-61 @ 10.0-11.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu		
	Innundated for 10 minutes prior to shear		

NORMAL LOADS (ksf): 1 2 4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)





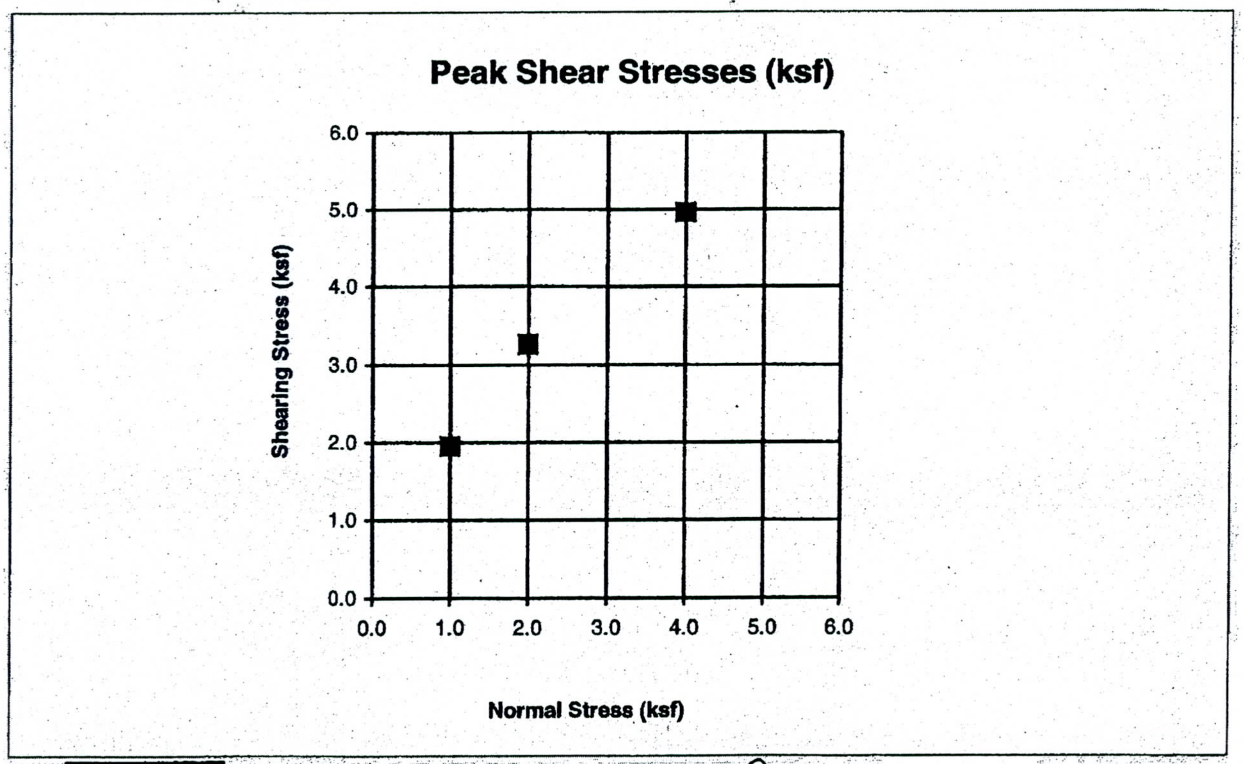
AAP AASHTO R18

amec

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	280
SAMPLE SOURCE:	B-63 @ 10.0-11.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu		
	Innundated for 10 minutes prior to shear		

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)

Initial thickness of specimen (in.):	1.00		
Initial diameter of specimen (in.):	2.42		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.016		
Direct shear point:	1	2	3
Dry mass of specimen (g):	128.9	120.2	110.9
Initial Moisture Content:	9.8%	10.1%	10.3%
Initial Wet Density (lb per cu.ft):	117.2	109.6	101.3
Initial Dry Density (lb per cu.ft):	106.8	99.6	91.8
Final Moisture Content:	21.0%	24.6%	23.8%
Final Wet Density (lb per cu.ft):	129.2	124.0	113.7
Final Dry Density (lb per cu.ft):	106.7	99.5	91.8
Normal Stress (ksf):	1.0	2.0	4.0
Maximum Shearing Stress (kips per sq. ft):	1.96	3.26	4.97
Vertical Deformation @ Max Shear (in):	0.040	0.041	0.038
Horizontal Deformation @ Max Shear (in):	0.245	0.500	0.500



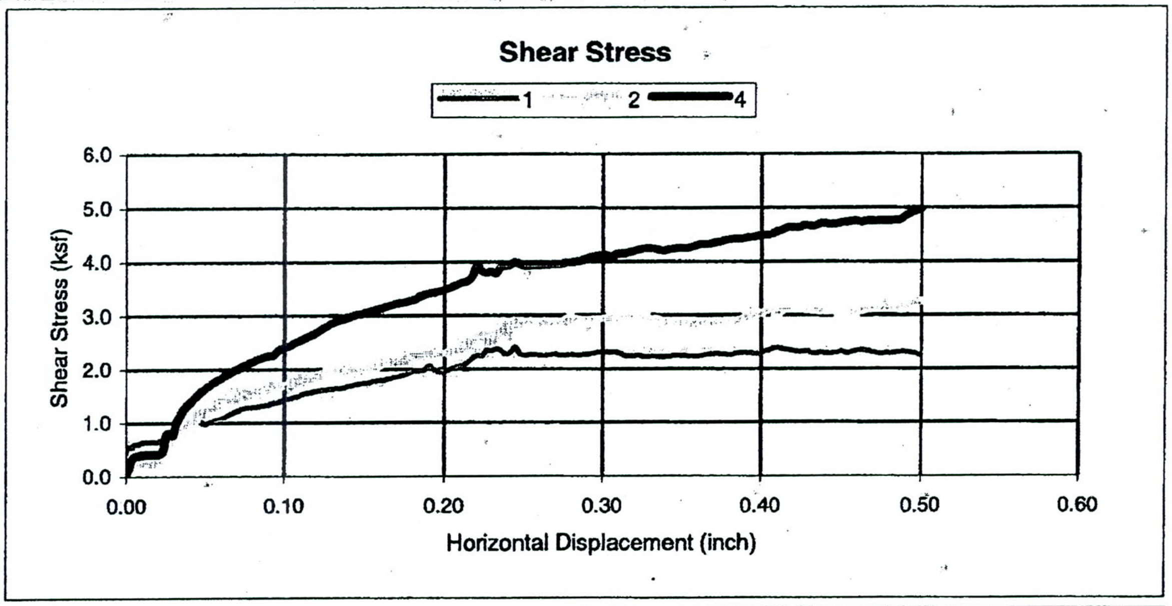
AAP AASHTO R18

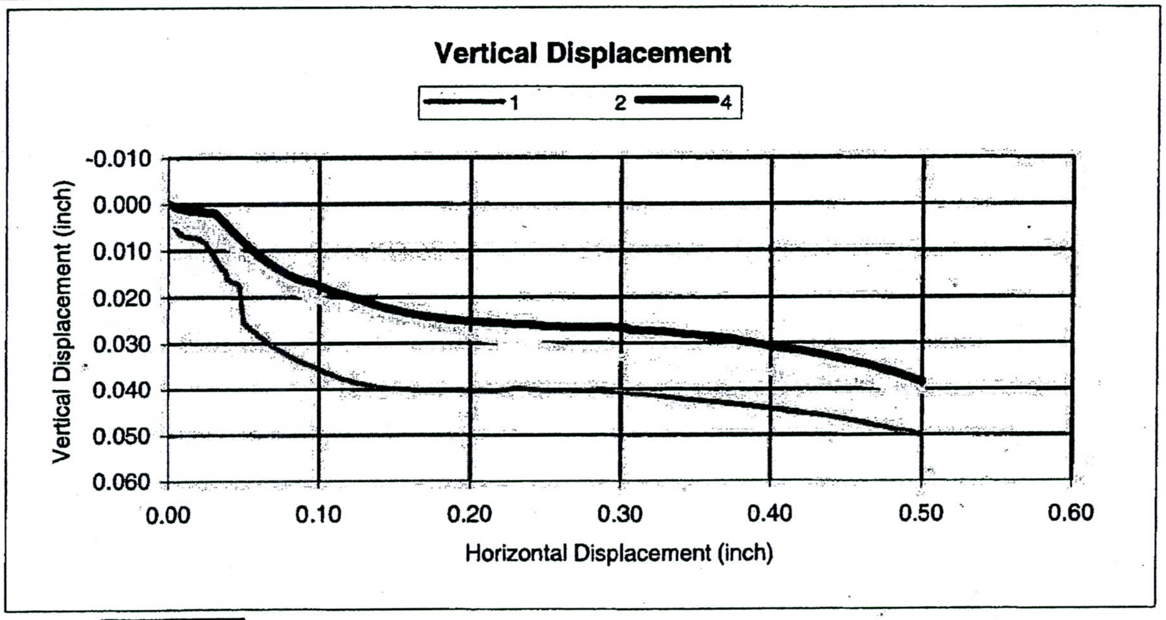
REVIEWED BY

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	280
SAMPLE SOURCE:	B-63 @ 10.0-11.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu Innundated for 10 minutes prior to shear		

NORMAL LOADS (ksf): 1 2 4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)





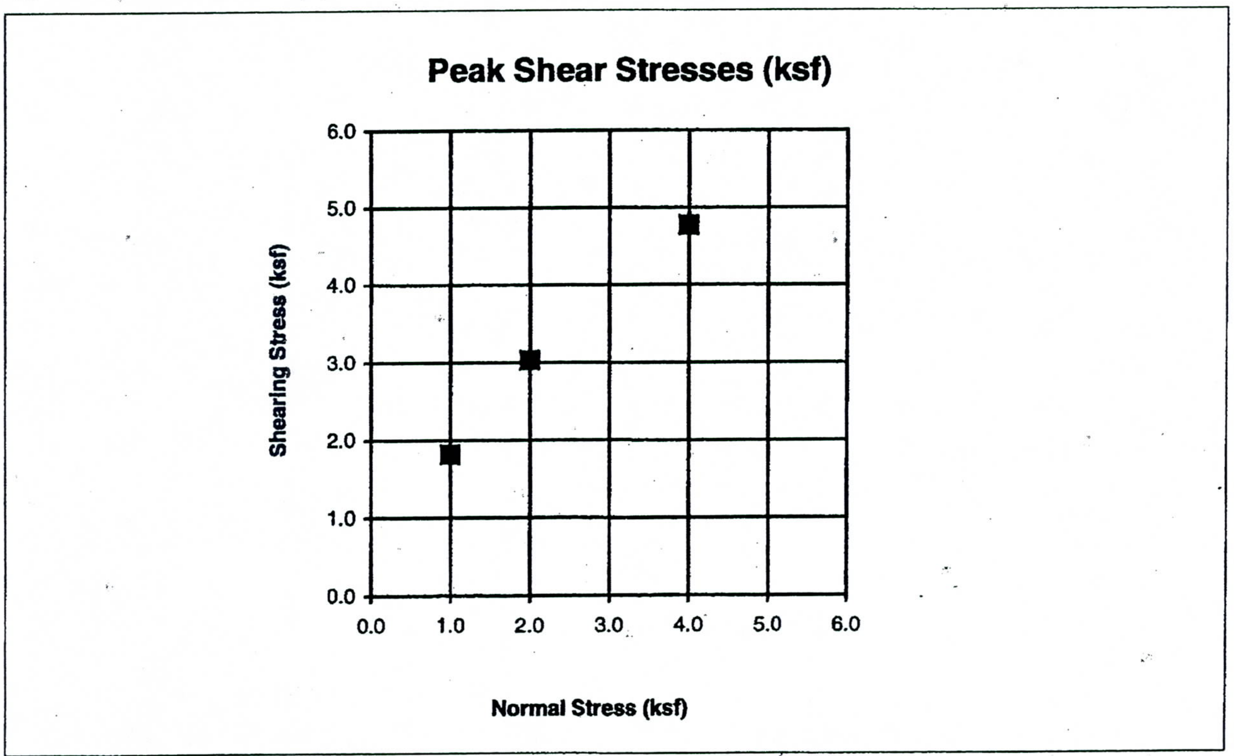
AASHTO R18

amec

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	281
SAMPLE SOURCE:	B-64 @ 0.0-1.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu Innundated for 10 minutes prior to shear		

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)

Initial thickness of specimen (in.):	1.00		
Initial diameter of specimen (in.):	2.42		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.016		
Direct shear point:	1	2	3
Dry mass of specimen (g):	127.6	118.8	113.7
Initial Moisture Content:	4.1%	5.9%	5.4%
Initial Wet Density (lb per cu.ft):	110.0	104.1	99.2
Initial Dry Density (lb per cu.ft):	105.7	98.4	94.2
Final Moisture Content:	18.1%	21.0%	21.9%
Final Wet Density (lb per cu.ft):	124.8	118.9	114.8
Final Dry Density (lb per cu.ft):	105.7	98.3	94.1
Normal Stress (ksf):	1.0	2.0	4.0
Maximum Shearing Stress (kips per sq. ft):	1.82	3.04	4.78
Vertical Deformation @ Max Shear (in):	0.051	0.056	0.067
Horizontal Deformation @ Max Shear (in):	0.472	0.469	0.393



AAP AASHTO R-18

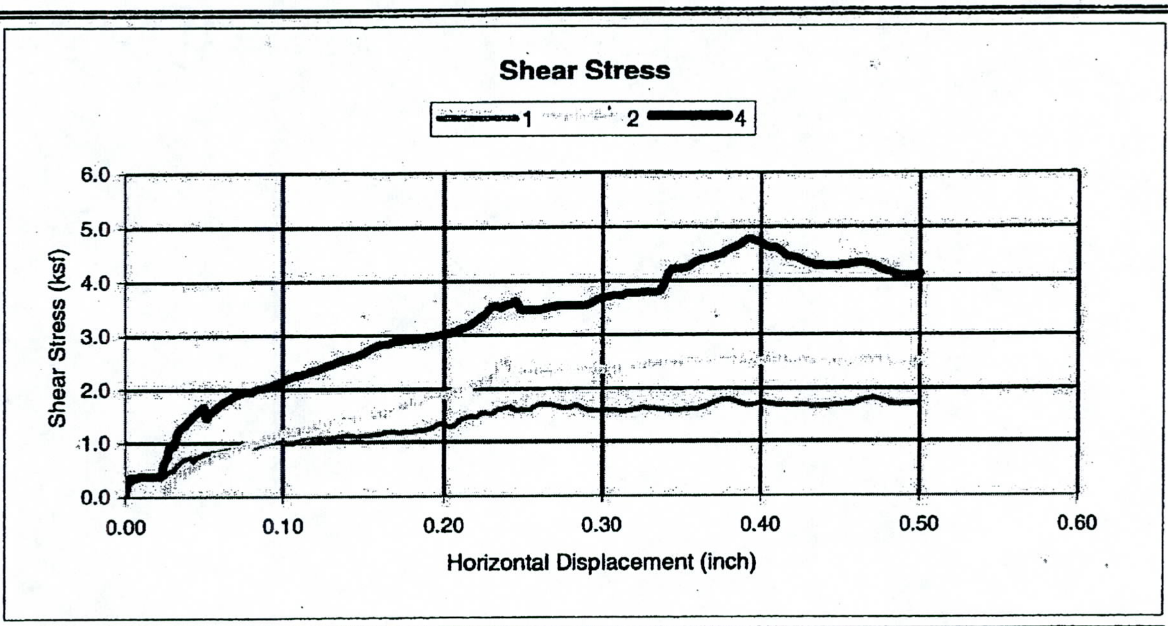
REVIEWED BY

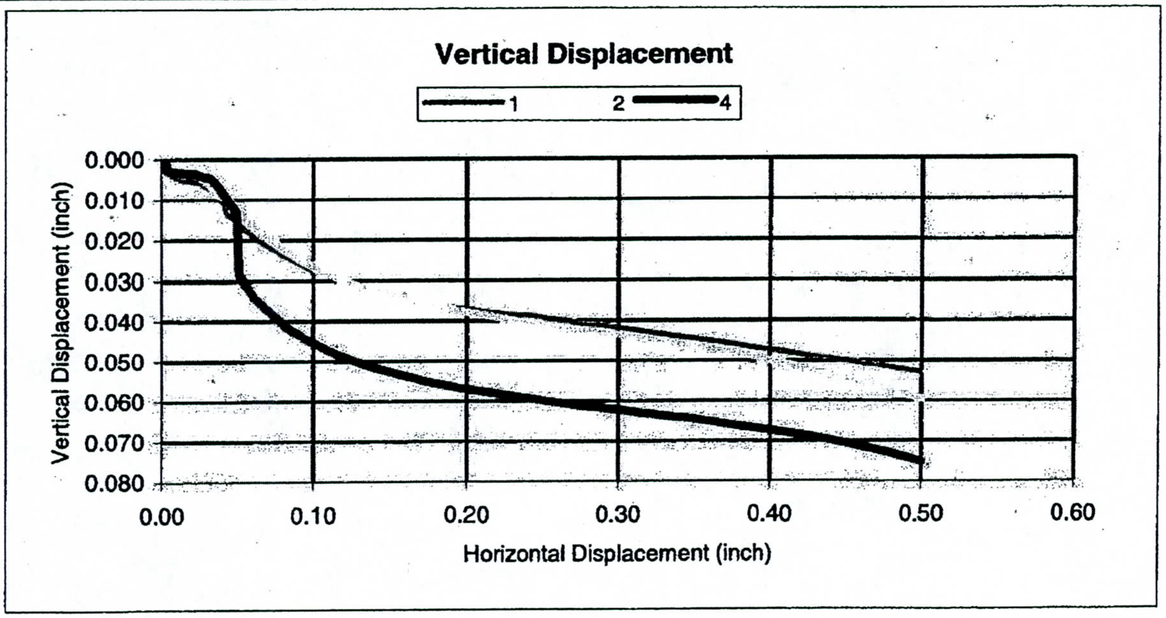
amec

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	281
SAMPLE SOURCE:	B-64 @ 0.0-1.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu		
	Innundated for 10 minutes prior to shear		

NORMAL LOADS (ksf): 1 2 4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)





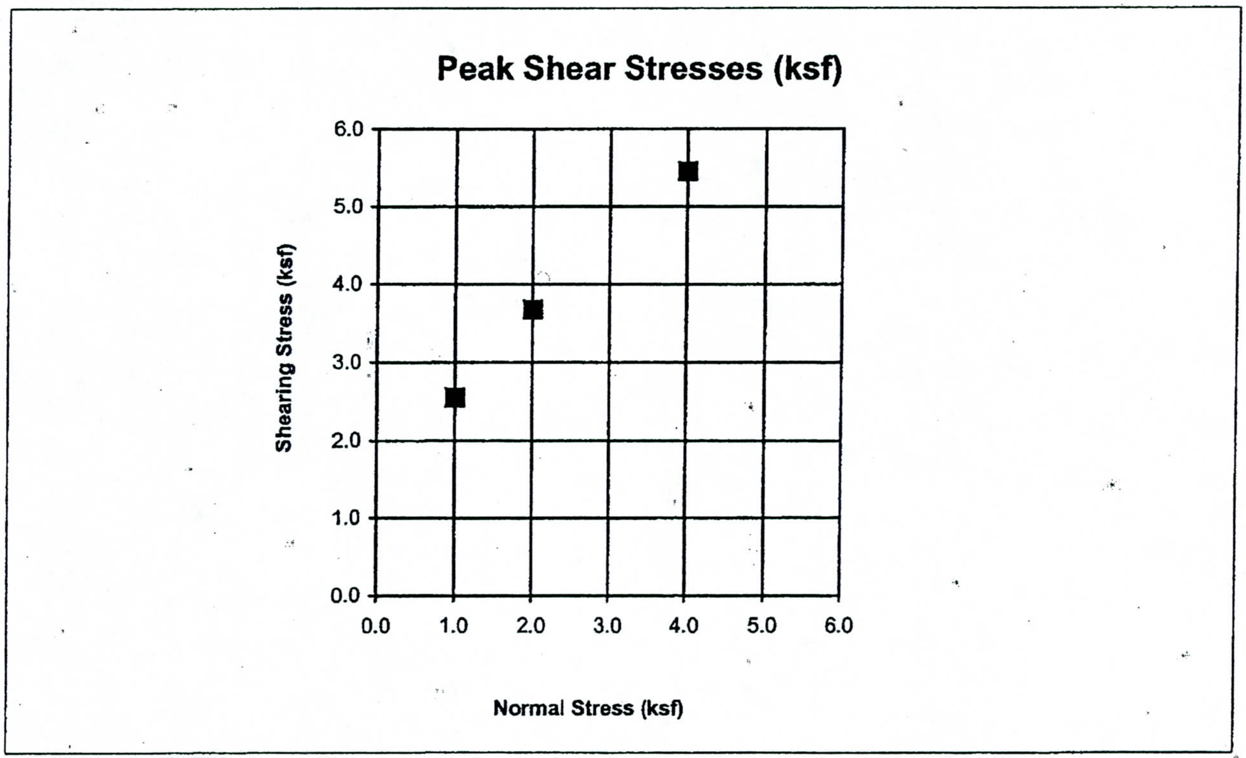
AAP AASHTO R18

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	282
SAMPLE SOURCE:	B-65 @ 5.0-6.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu		
	Innundated for 10 minutes prior to shear		

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)

Initial thickness of specimen (in.): 1.00
Initial diameter of specimen (in.): 2.42
Shearing device used: DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment
Rate of deformation (in/min): 0.016

Direct shear point:	1	2	3
Dry mass of specimen (g):	130.6	122.9	117.5
Initial Moisture Content:	6.7%	7.0%	6.8%
Initial Wet Density (lb per cu.ft):	115.3	108.9	103.8
Initial Dry Density (lb per cu.ft):	108.2	101.8	97.3
Final Moisture Content:	20.0%	21.9%	21.9%
Final Wet Density (lb per cu.ft):	129.7	124.1	118.6
Final Dry Density (lb per cu.ft):	108.1	101.8	97.3
Normal Stress (ksf):	1.0	2.0	4.0
Maximum Shearing Stress (kips per sq. ft):	2.55	3.68	5.45
Vertical Deformation @ Max Shear (in):	0.036	0.050	0.047
Horizontal Deformation @ Max Shear (in):	0.236	0.500	0.500



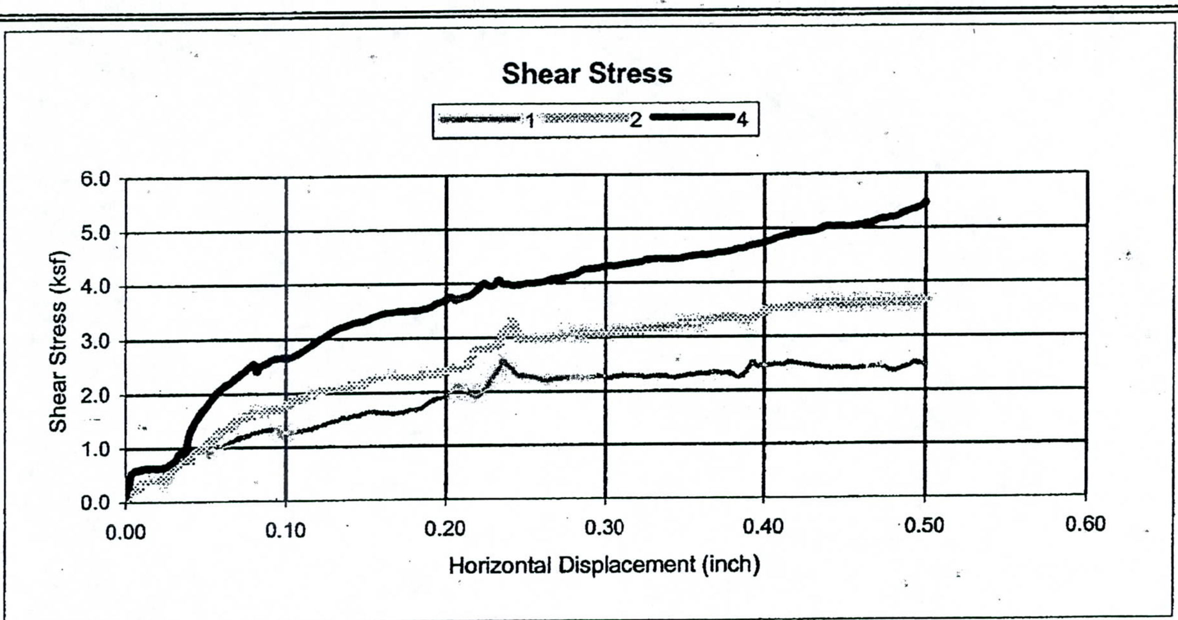
REVIEWED BY ____

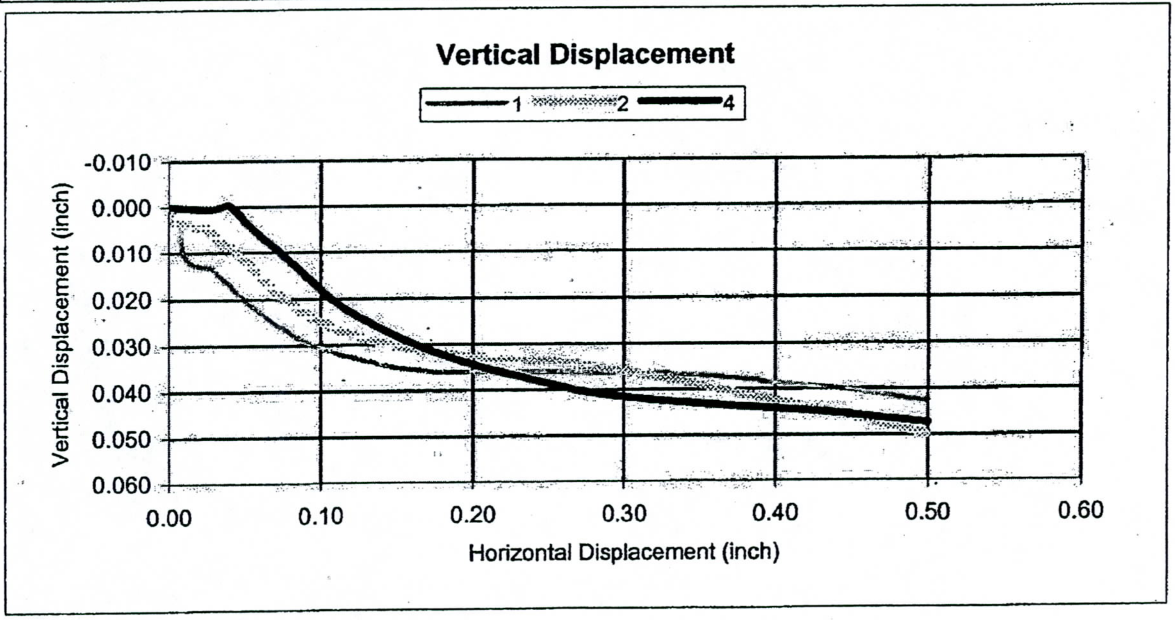
PROJECT: White Tanks FRS #3 - Outfall Channel
LOCATION: Phoenix, Arizona
MATERIAL: Soil
SAMPLE SOURCE: B-65 @ 5.0-6.0'
SAMPLE PREPARATION: Insitu
Innundated for 10 minutes prior to shear

JOB NO: 3-119-000186
WORK ORDER NO: 211
LAB NO: 282
DATE ASSIGNED: 12/21/2009

NORMAL LOADS (ksf): 1 2 4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)



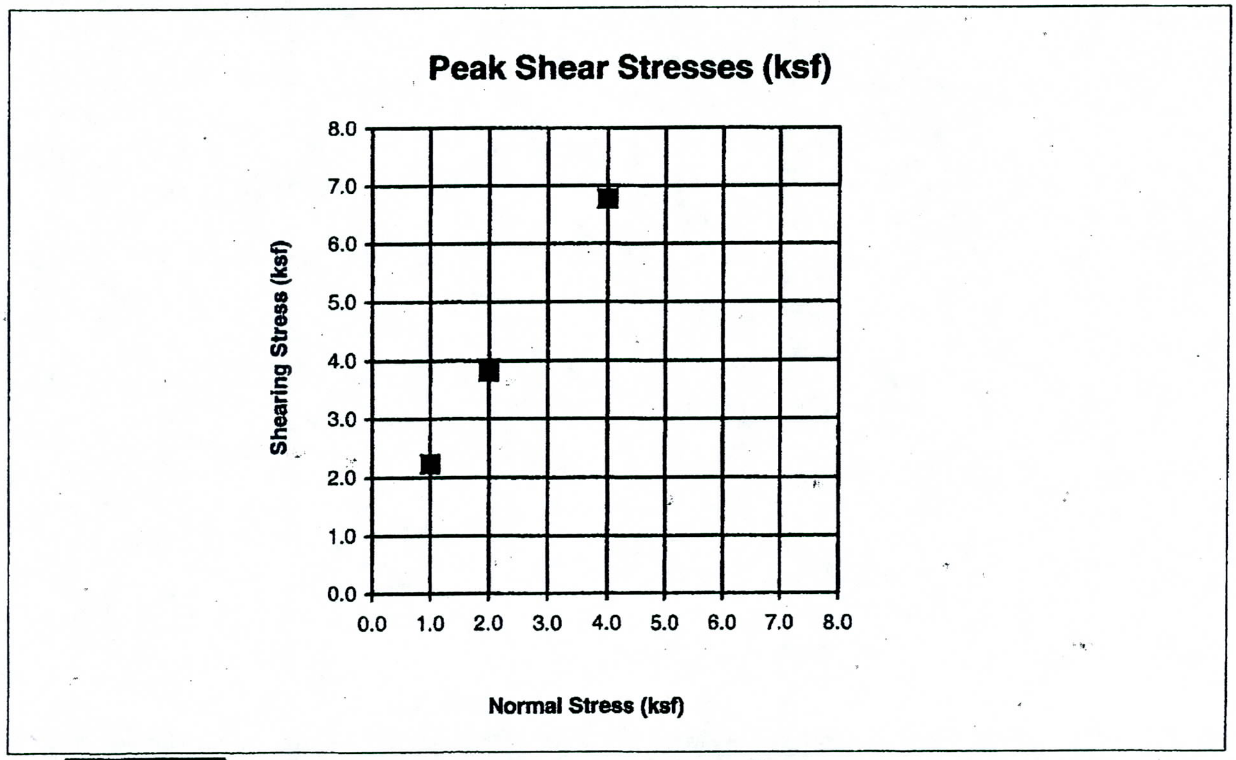


amec

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	284
SAMPLE SOURCE:	B-58 @ 10.0-11.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu Innundated for 10 minutes prior to shear		

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)

Initial thickness of specimen (in.):	1.00		
Initial diameter of specimen (in.):	2.42		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.016		
Direct shear point:	1	2	3
Dry mass of specimen (g):	136.6	149.7	143.6
Initial Moisture Content:	10.5%	11.1%	10.6%
Initial Wet Density (lb per cu.ft):	124.9	137.7	131.5
Initial Dry Density (lb per cu.ft):	113.1	124.0	118.9
Final Moisture Content:	19.0%	15.1%	19.4%
Final Wet Density (lb per cu.ft):	134.6	142.7	141.9
Final Dry Density (lb per cu.ft):	113.1	124.0	118.9
Normal Stress (ksf):	1.0	2.0	4.0
Maximum Shearing Stress (kips per sq. ft):	2.24	3.82	6.78
Vertical Deformation @ Max Shear (in):	0.051	0.003	0.020
Horizontal Deformation @ Max Shear (in):	0.493	0.148	0.500



AAP AASHTO R18

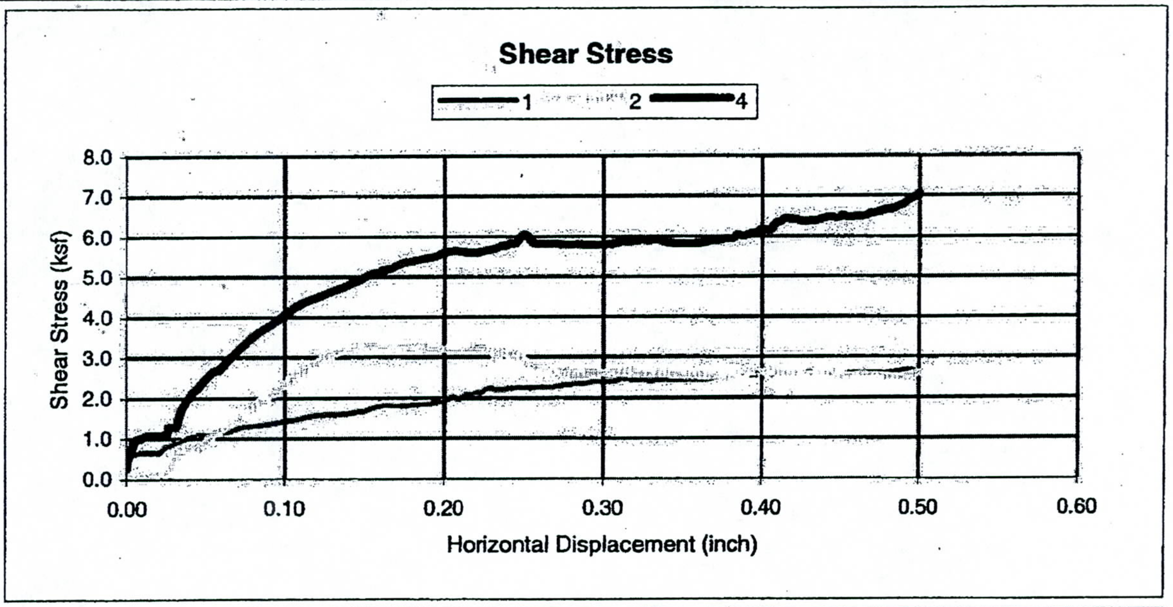
REVIEWED BY

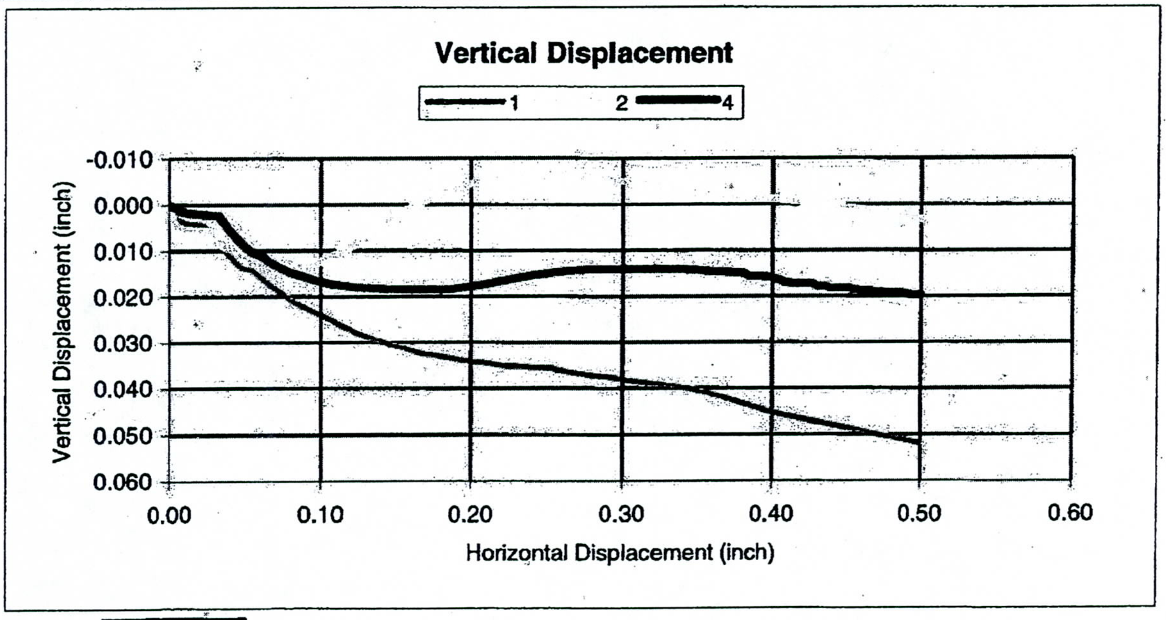
amec

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	284
SAMPLE SOURCE:	B-58 @ 10.0-11.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu		
	Innundated for 10 minutes prior to shear		

NORMAL LOADS (ksf): 1 2 4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)





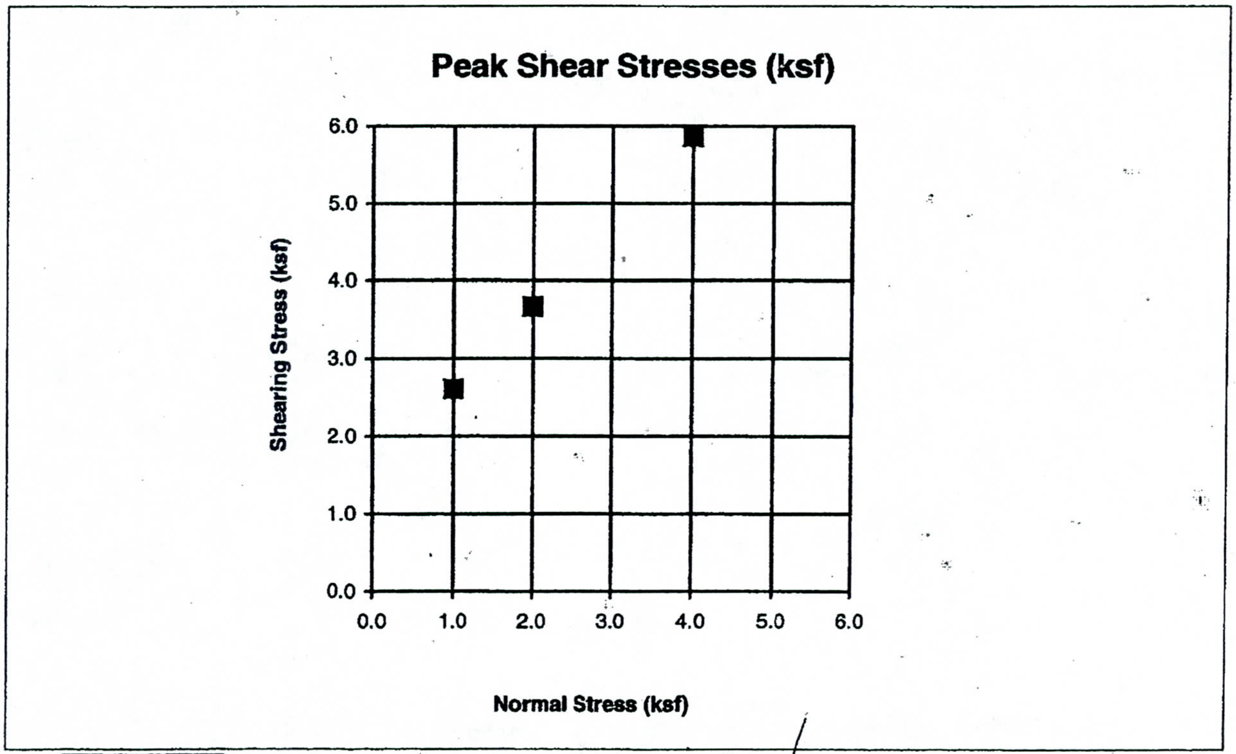
AAP AASHTO R18

amec

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	285
SAMPLE SOURCE:	B-52 @ 5.0-6.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu Innundated for 10 minutes prior to shear		

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)

Initial thickness of specimen (in.):	1.00		
Initial diameter of specimen (in.):	2.42		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.016		
Direct shear point:	1	2	3
Dry mass of specimen (g):	131.7	131.0	128.1
Initial Moisture Content:	1.3%	1.3%	1.4%
Initial Wet Density (lb per cu.ft):	110.4	109.8	107.5
Initial Dry Density (lb per cu.ft):	109.1	108.5	106.1
Final Moisture Content:	15.8%	17.3%	16.3%
Final Wet Density (lb per cu.ft):	126.3	127.2	123.3
Final Dry Density (lb per cu.ft):	109.0	108.4	106.0
Normal Stress (ksf):	1.0	2.0	4.0
Maximum Shearing Stress (kips per sq. ft):	2.62	3.67	5.87
Vertical Deformation @ Max Shear (in):	0.043	0.043	0.041
Horizontal Deformation @ Max Shear (in):	0.487	0.499	0.490



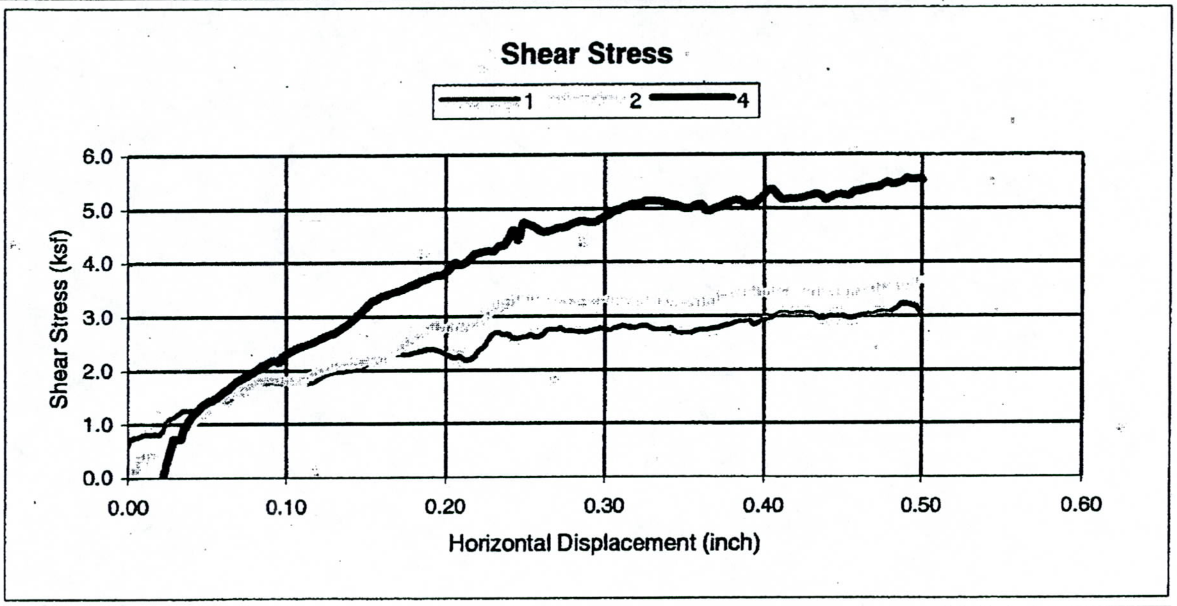
AAP AASHTO R18

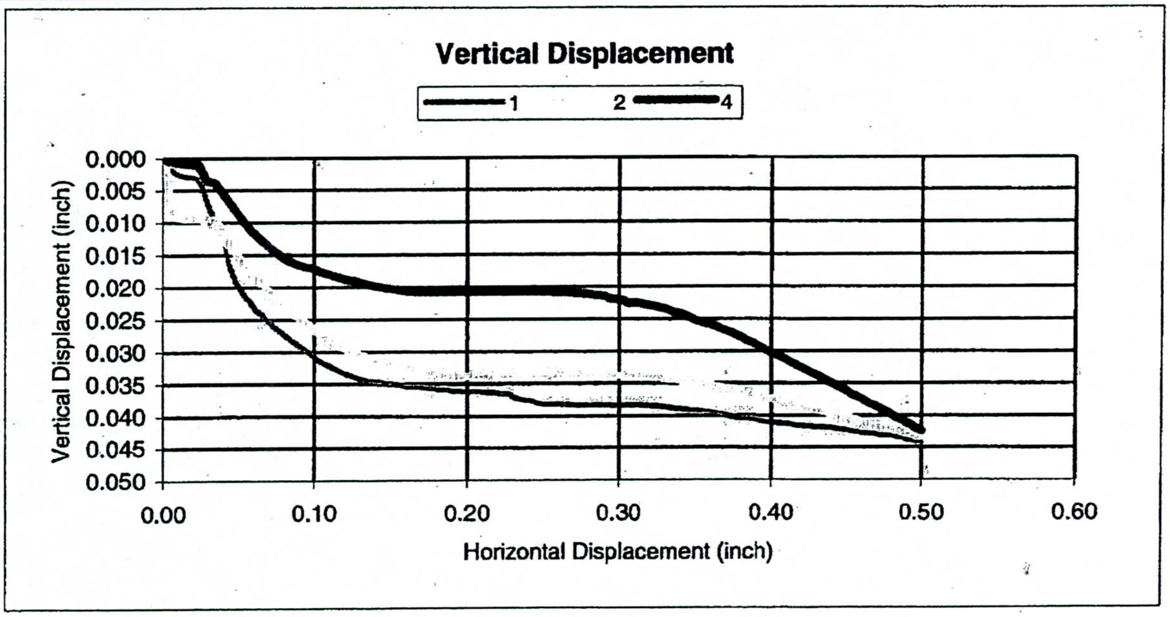
REVIEWED BY ______________

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	285
SAMPLE SOURCE:	B-52 @ 5.0-6.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu Innundated for 10 minutes prior to shear		

NORMAL LOADS (ksf): 1 2 4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)

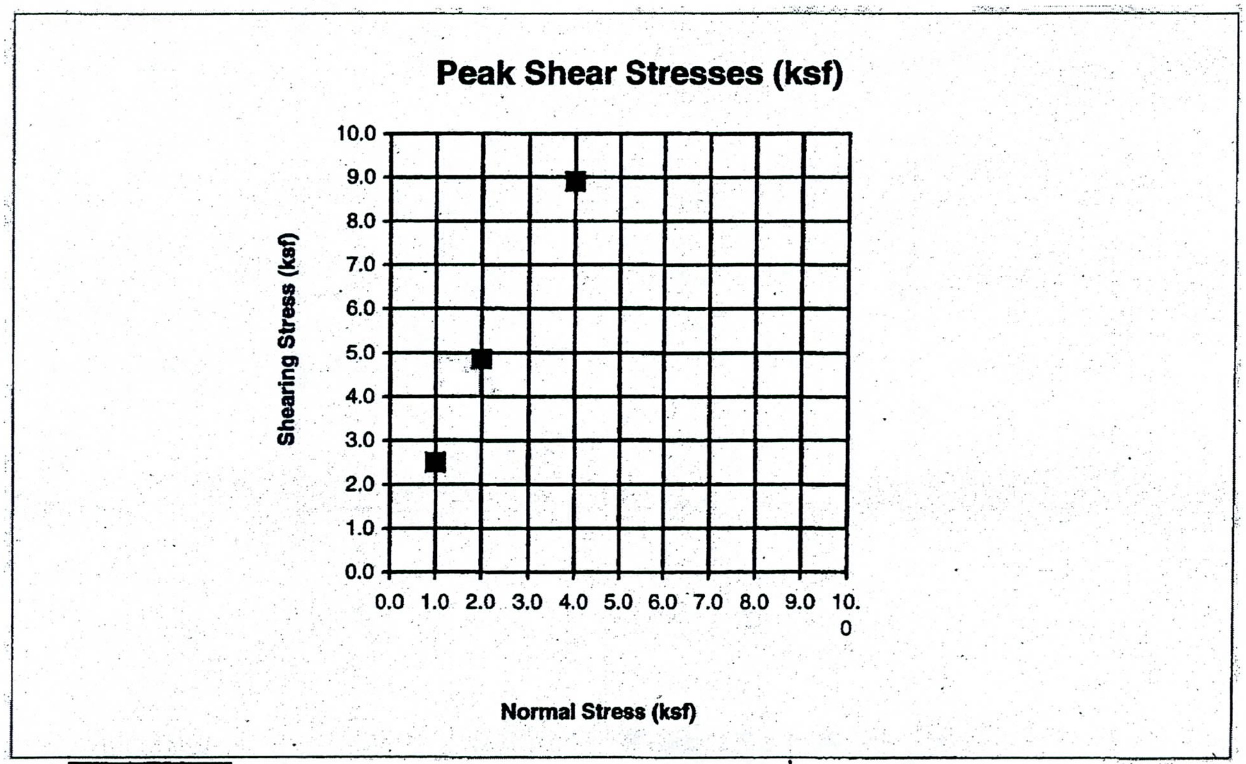




PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	286
SAMPLE SOURCE:	B-53 @ 10.0-11.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu Innundated for 10 minutes prior to shear		

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)

Initial thickness of specimen (in.):	1.00		
Initial diameter of specimen (in.):	2.42		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.016		
Direct shear point:	1	2	3
Dry mass of specimen (g):	142.4	130.6	139.5
Initial Moisture Content:	1.9%	1.9%	1.5%
Initial Wet Density (lb per cu.ft):	120.2	110.1	117.2
Initial Dry Density (lb per cu.ft):	118.0	108.1	115.5
Final Moisture Content:	15.2%	17.9%	14.9%
Final Wet Density (lb per cu.ft):	135.9	127.4	132.7
Final Dry Density (lb per cu.ft):	117.9	108.1	115.5
Normal Stress (ksf):	1.0	2.0	4.0
Maximum Shearing Stress (kips per sq. ft):	2.51	4.87	8.91
Vertical Deformation @ Max Shear (in):	0.030	0.038	0.051
Horizontal Deformation @ Max Shear (in):	0.363	0.454	0.490



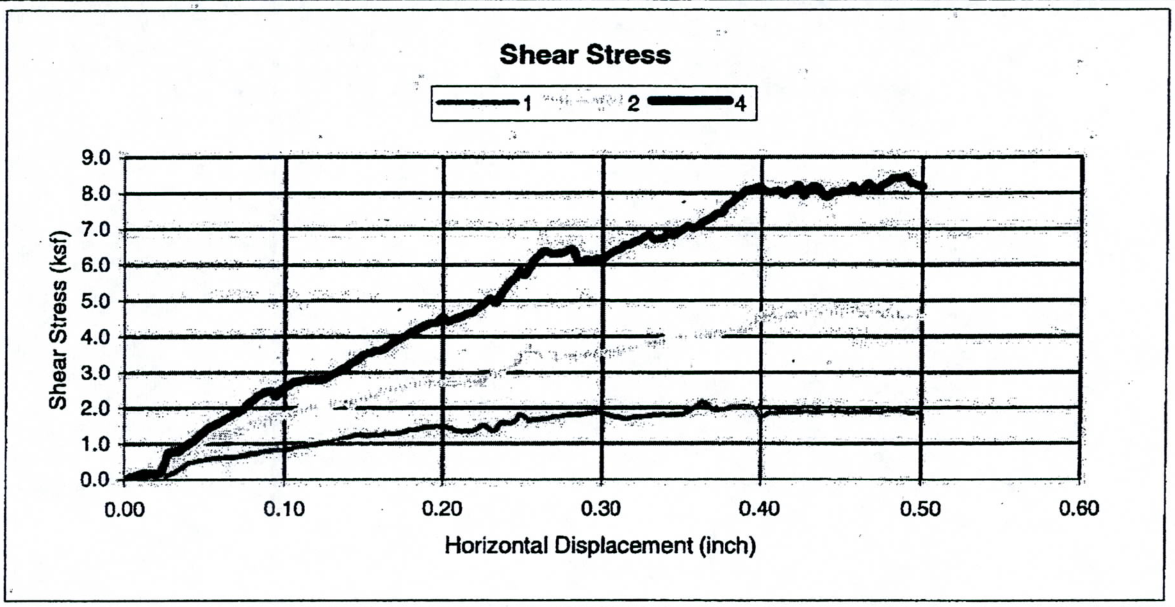
AAP AASHTO R18

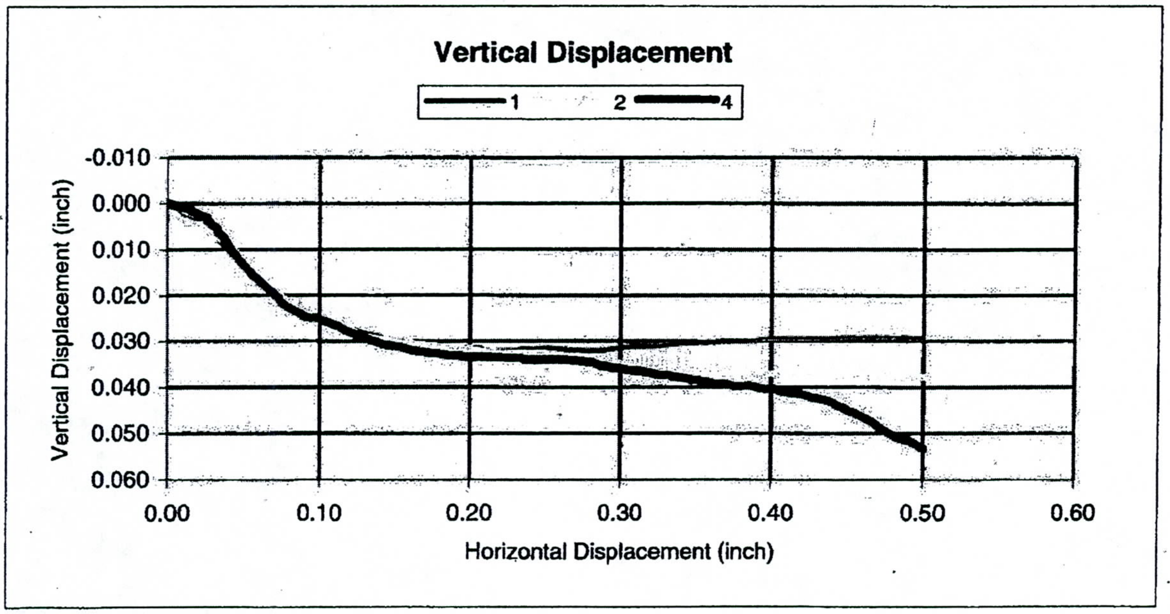
REVIEWED BY

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	286
SAMPLE SOURCE:	B-53 @ 10.0-11.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu Innundated for 10 minutes prior to shear		

NORMAL LOADS (ksf): 1 2 4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)





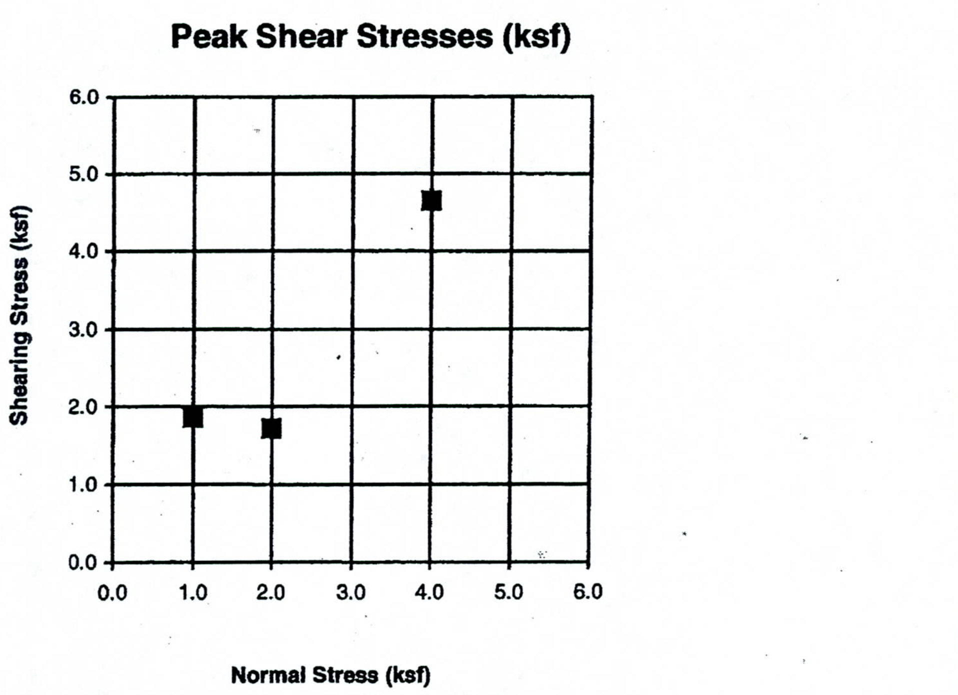
AASHTO R18

amec

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	287
SAMPLE SOURCE:	B-51 @ 10.0-11.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu		
	Innundated for 10 minutes prior to shear		

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)

Initial thickness of specimen (in.):	1.00		
Initial diameter of specimen (in.):	2.42		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.016		
Direct shear point:	1	2	3
Dry mass of specimen (g):	122.0	114.3	113.7
Initial Moisture Content:	5.8%	10.7%	7.1%
Initial Wet Density (lb per cu.ft):	106.9	104.7	100.9
Initial Dry Density (lb per cu.ft):	101.1	94.6	94.2
Final Moisture Content:	24.4%	26.0%	24.3%
Final Wet Density (lb per cu.ft):	125.6	119.2	117.1
Final Dry Density (lb per cu.ft):	101.0	94.6	94.2
Normal Stress (ksf):	1.0	2.0	4.0
Maximum Shearing Stress (kips per sq. ft):	1.87	1.73	4.65
Vertical Deformation @ Max Shear (in):	0.043	0.023	0.059
Horizontal Deformation @ Max Shear (in):	0.233	0.227	0.500



AASHTO R18

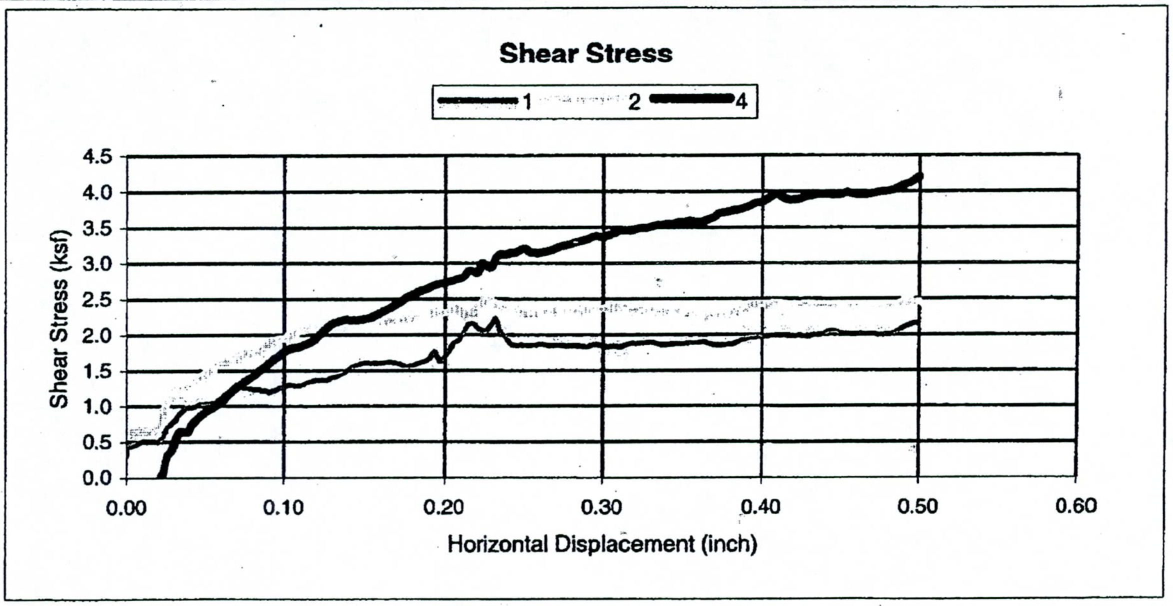
REVIEWED BY ____________

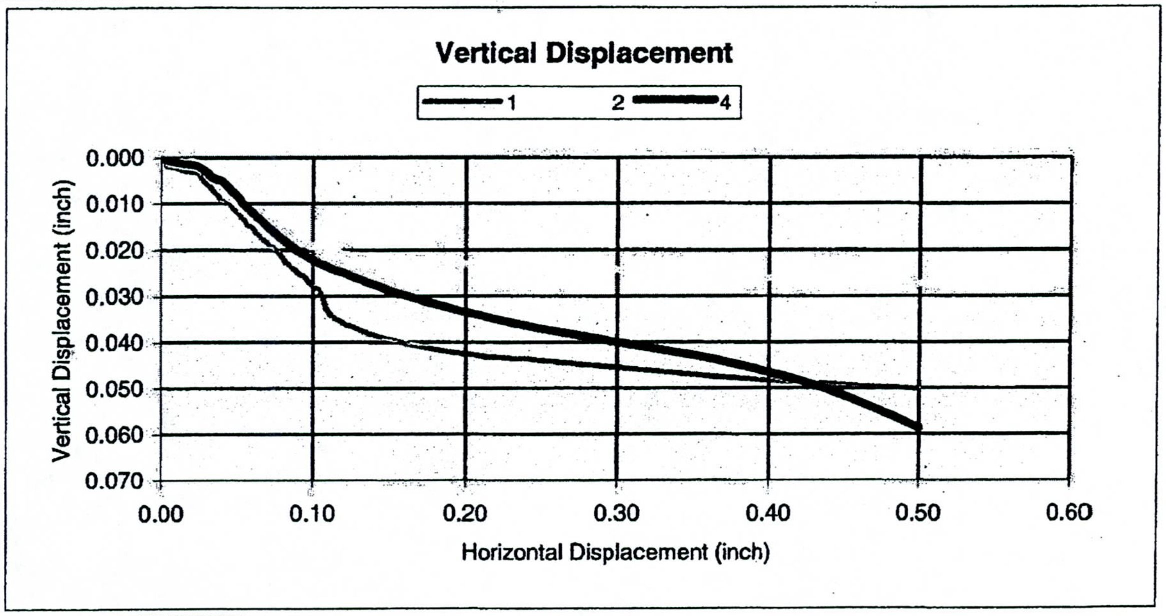
amec

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	287
SAMPLE SOURCE:	B-51 @ 10.0-11.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu		
	Innundated for 10 minutes prior to shear		

NORMAL LOADS (ksf): 1 2 4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)





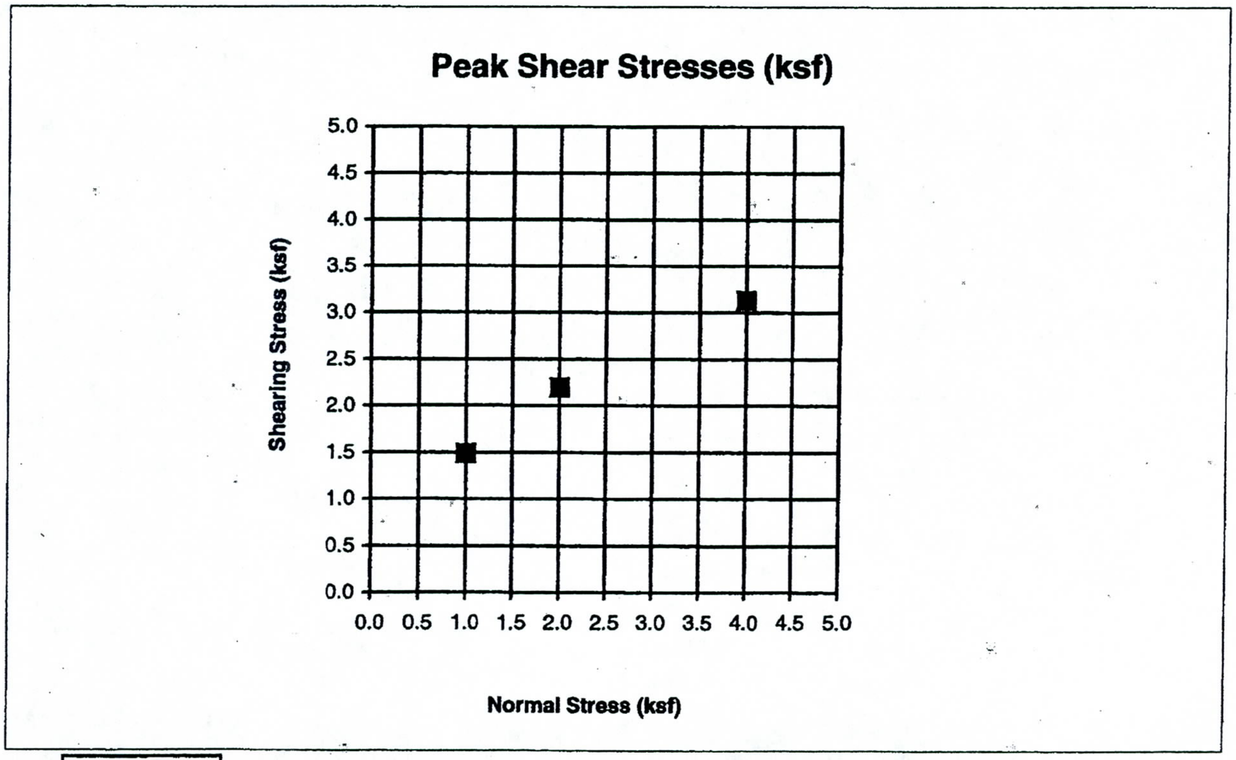
AAP AASHTO R18

amec

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	288
SAMPLE SOURCE:	B-51 @ 5.0-6.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu Innundated for 10 minutes prior to shear		

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)

Initial thickness of specimen (in.):	1.00		
Initial diameter of specimen (in.):	2.42		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.016		
Direct shear point:	1	2	3
Dry mass of specimen (g):	123.7	122.2	115.5
Initial Moisture Content:	4.1%	4.5%	3.4%
Initial Wet Density (lb per cu.ft):	106.6	105.6	98.8
Initial Dry Density (lb per cu.ft):	102.5	101.2	95.7
Final Moisture Content:	23.7%	20.5%	20.9%
Final Wet Density (lb per cu.ft):	126.7	121.9	115.6
Final Dry Density (lb per cu.ft):	102.4	101.1	95.6
Normal Stress (ksf):	1.0	2.0	4.0
Maximum Shearing Stress (kips per sq. ft):	1.49	2.20	3.14
Vertical Deformation @ Max Shear (in):	0.032	0.050	0.018
Horizontal Deformation @ Max Shear (in):	0.242	0.445	0.493



AAP AASHTO R18

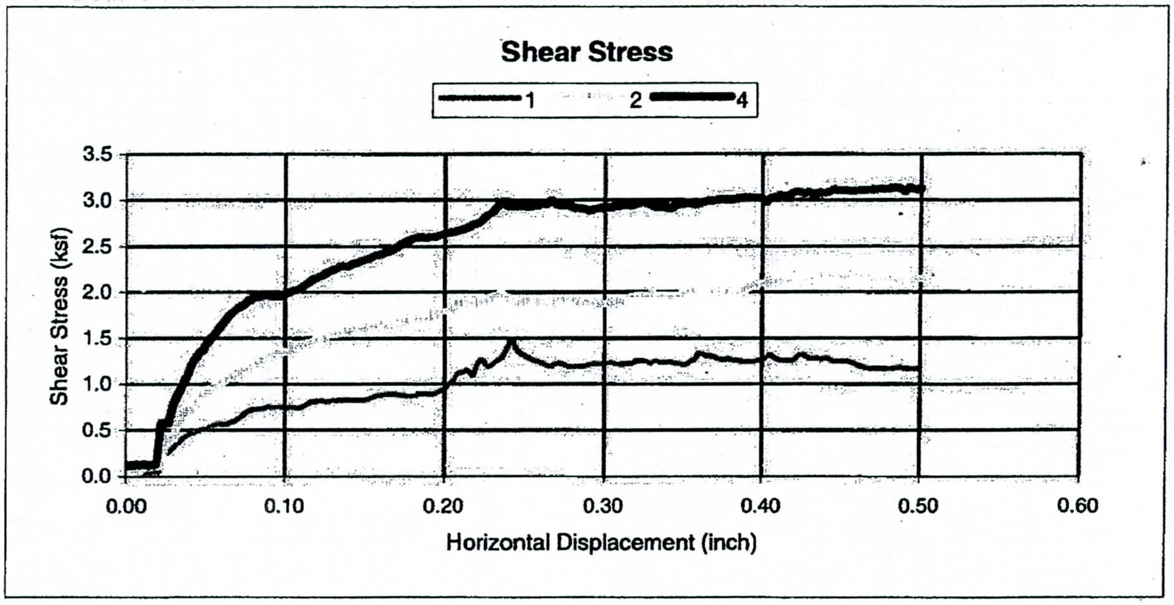
REVIEWED BY

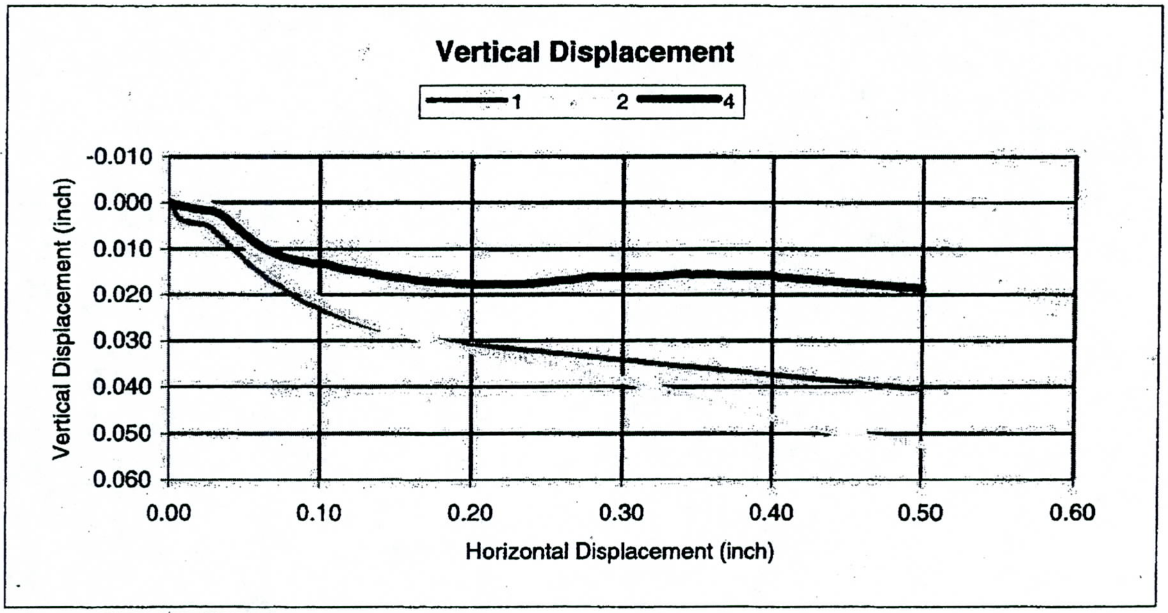
amec

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	288
SAMPLE SOURCE:	B-51 @ 5.0-6.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu		
	Innundated for 10 minutes prior to shear		

NORMAL LOADS (ksf): 1 2 4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)



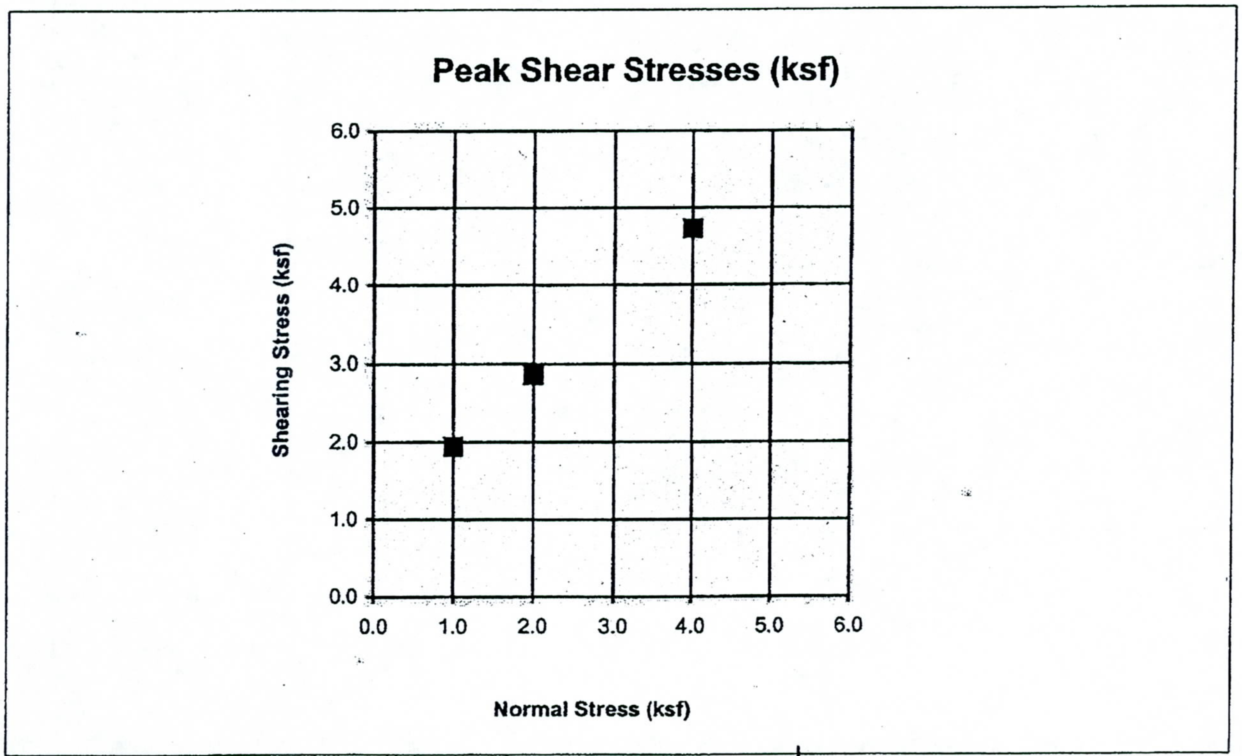


AAP AASHTO R18

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	289
SAMPLE SOURCE:	B-53 @ 5.0-6.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu Innundated for 10 minutes prior to shear		

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)

Initial thickness of specimen (in.):	1.00		
Initial diameter of specimen (in.):	2.42		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.016		
Direct shear point:	1	2	3
Dry mass of specimen (g):	109.1	105.1	106.0
Initial Moisture Content:	5.2%	6.4%	7.3%
Initial Wet Density (lb per cu.ft):	94.9	92.6	94.1
Initial Dry Density (lb per cu.ft):	90.3	87.1	87.8
Final Moisture Content:	30.1%	28.0%	27.5%
Final Wet Density (lb per cu.ft):	117.4	111.4	111.8
Final Dry Density (lb per cu.ft):	90.3	87.0	87.8
Normal Stress (ksf):	1.0	2.0	4.0
Maximum Shearing Stress (kips per sq. ft):	1.94	2.86	4.72
Vertical Deformation @ Max Shear (in):	0.071	0.071	0.073
Horizontal Deformation @ Max Shear (in):	0.463	0.496	0.499



AAP AASHTO R18

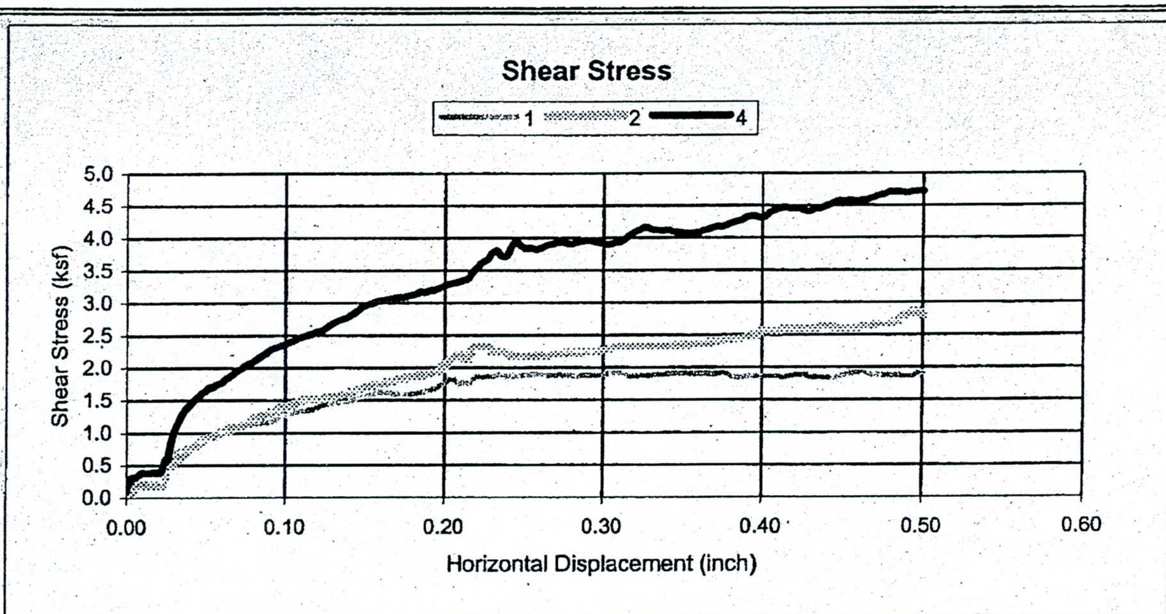
REVIEWED BY ____________

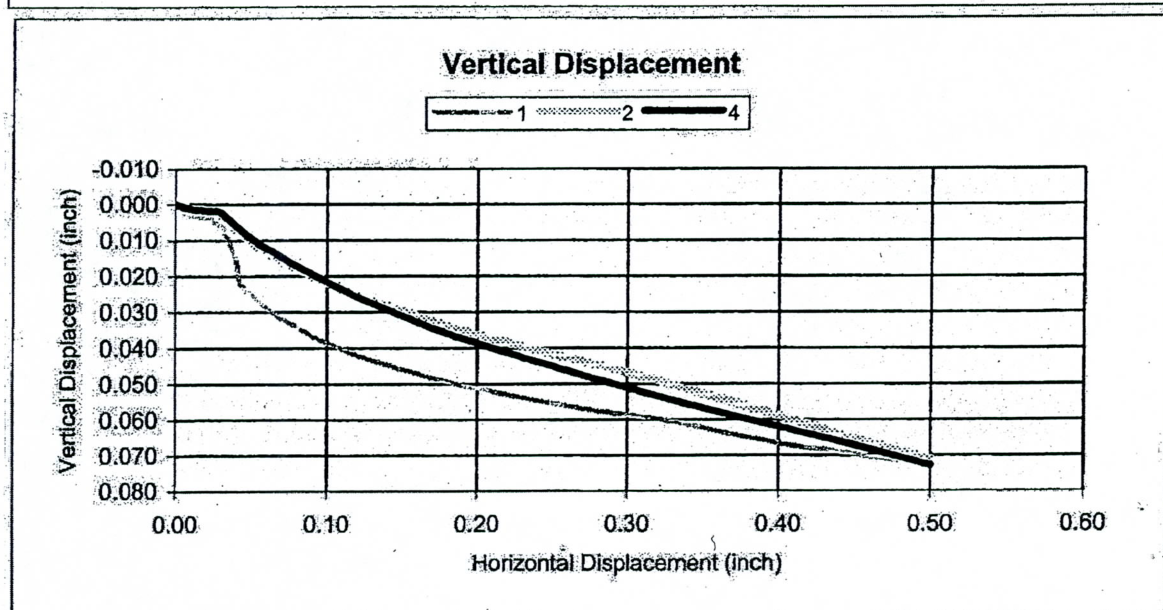
amec

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	289
SAMPLE SOURCE:	B-53 @ 5.0-6.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu		
	Innundated for 10 minutes prior to shear		

NORMAL LOADS (ksf): 1 2 4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)





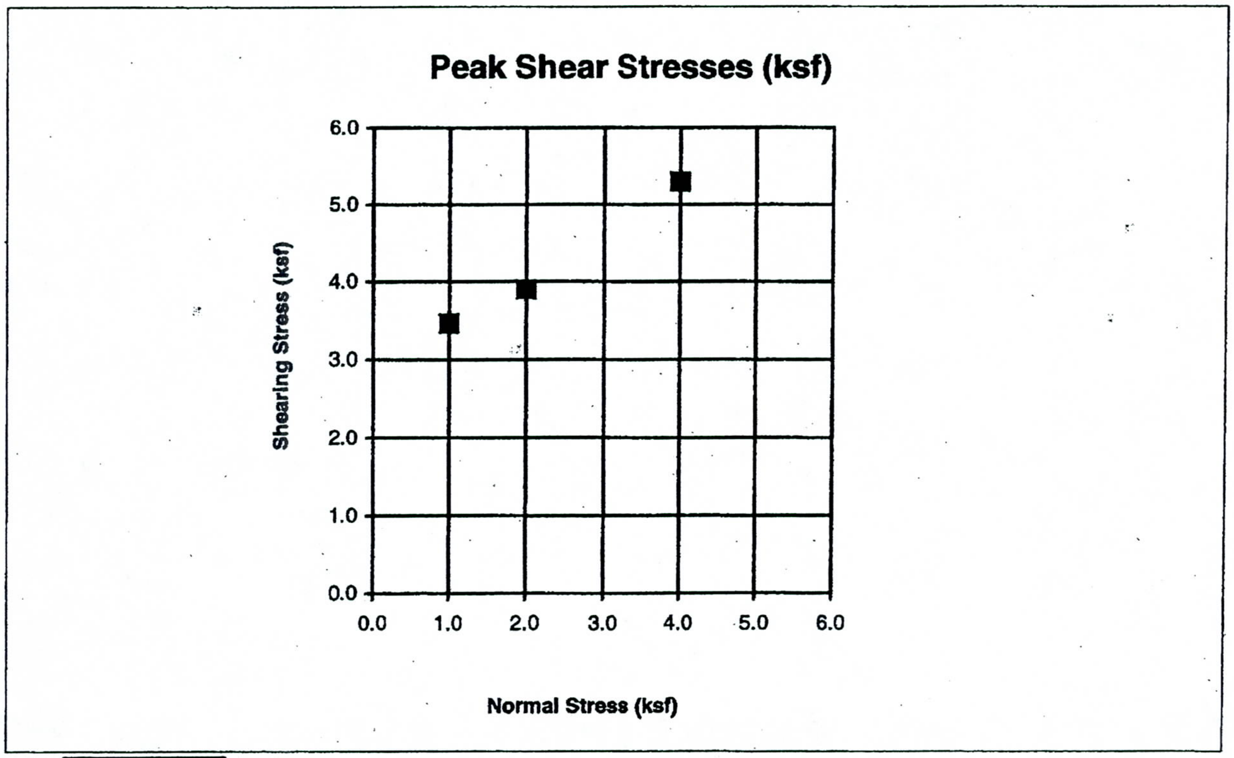
AAP AASHTO R18

amec

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	290
SAMPLE SOURCE:	B-59 @ 10.0-11.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu Innundated for 10 minutes prior to shear		

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)

Initial thickness of specimen (in.):	1.00		
Initial diameter of specimen (in.):	2.42		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.016		
Direct shear point:	1	2	3
Dry mass of specimen (g):	117.0	114.1	120.3
Initial Moisture Content:	5.9%	8.1%	6.7%
Initial Wet Density (lb per cu.ft):	102.6	102.1	106.2
Initial Dry Density (lb per cu.ft):	96.9	94.5	99.6
Final Moisture Content:	25.0%	27.1%	22.3%
Final Wet Density (lb per cu.ft):	121.1	120.0	121.8
Final Dry Density (lb per cu.ft):	96.9	94.5	99.6
Normal Stress (ksf):	1.0	2.0	4.0
Maximum Shearing Stress (kips per sq. ft):	3.47	3.91	5.30
Vertical Deformation @ Max Shear (in):	0.047	0.055	0.041
Horizontal Deformation @ Max Shear (in):	0.341	0.384	0.496



AAP AASHTO R18

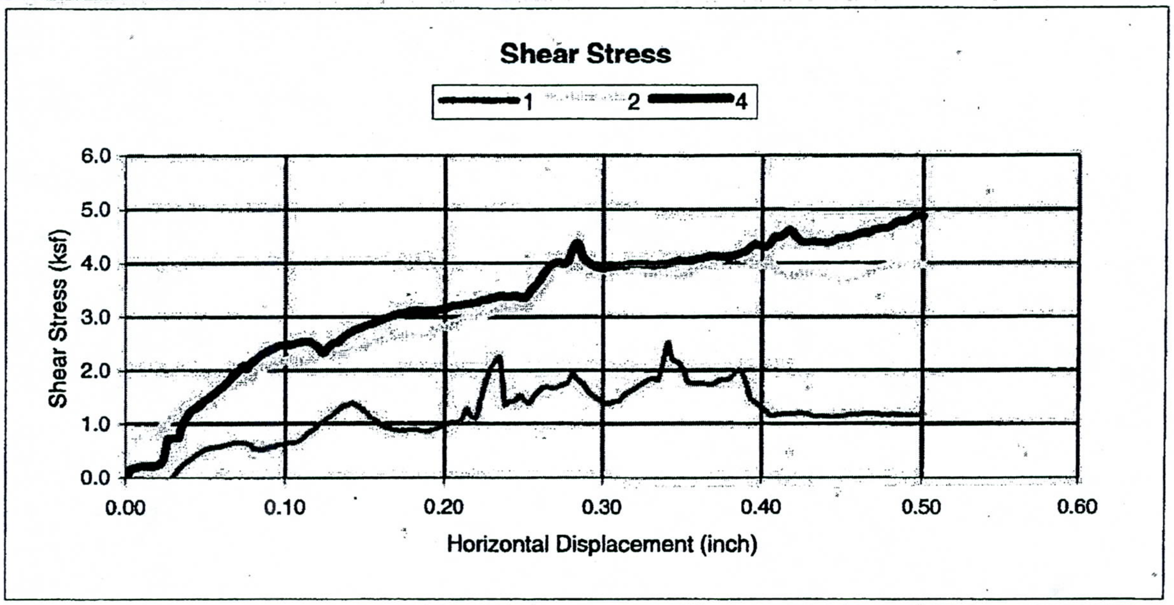
REVIEWED BY

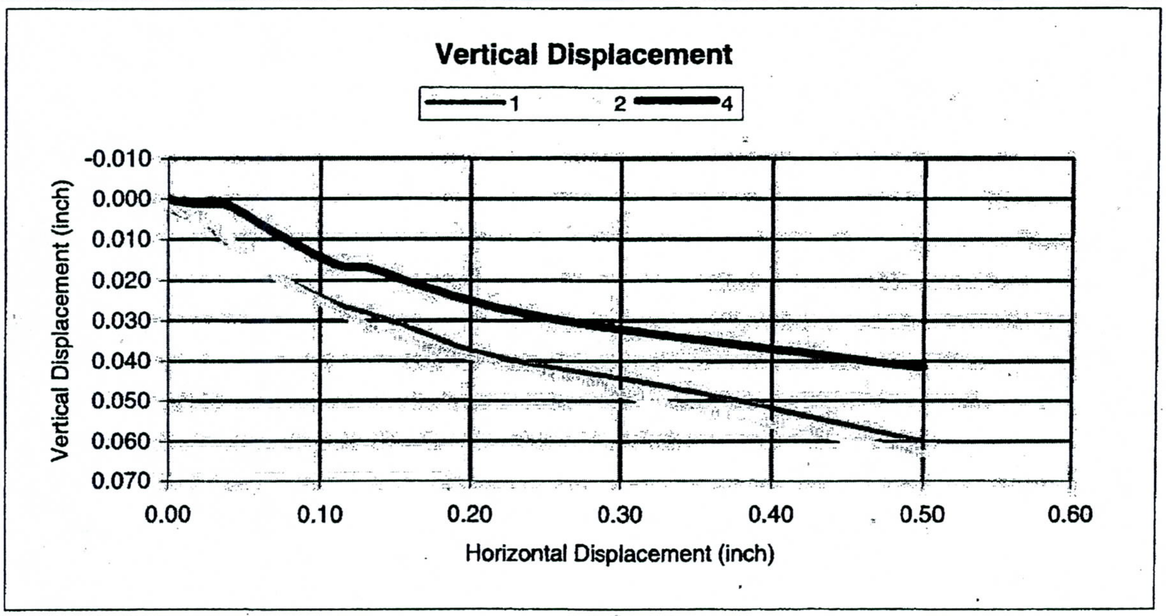
amec

PROJECT:	White Tanks FRS #3 - Outfall Channel	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**WORK ORDER NO:**	211
MATERIAL:	Soil	**LAB NO:**	290
SAMPLE SOURCE:	B-59 @ 10.0-11.0'	**DATE ASSIGNED:**	12/21/2009
SAMPLE PREPARATION:	Insitu		
	Innundated for 10 minutes prior to shear		

NORMAL LOADS (ksf): 1 2 4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)





AASHTO R18

APPENDIX D
PAVEMENT DESIGN

Flexible Pavement Design (AASHTO)

Project Name:	White Tank FRS NO. 3 Outfall Channel
Project Number:	09-G-1597
Client:	Hoskin Ryan Consultants, Inc.
Location:	Buckeye, Arizona
Design Section:	Palm Lane
Engineer:	J Floyd
Date:	1/29/2010

Flexible Pavement Structural Design:

	Resilient Modulus (psi)	26,000
	SubgradeType	N/A
	Subgrade Thickness (inches)	-
	Subbase Type	AB
	Subbase Thickness (inches)	10.0
	Asphaltic Concrete Thickness (inches)	4.0
*	Structural Number (Required)	1.38
*	Structural Number (Section)	2.88
	Performance (years)	20.0
	Allowable 18-kip ESAL Repetition	129,894

Design Parameters:

Standard Normal Deviate		-0.841
Combined Standard error		0.45
Design Serviceability Loss		2.2
Desired Level of Reliability (percent)		80.0
Asphaltic Concrete Layer Coefficient		0.42
Subbase Layer Coefficient	AB	0.12
Subgrade Layer Coefficient	N/A	0.11

Flexible Pavement Design (AASHTO)

Project Name:	White Tank FRS NO. 3 Outfall Channel
Project Number:	09-G-1597
Client:	Hoskin Ryan Consultants, Inc.
Location:	Buckeye, Arizona
Design Section:	Minnezona Avenue
Engineer:	J Floyd
Date:	1/29/2010

Flexible Pavement Structural Design:

	Resilient Modulus (psi)	26,000
	SubgradeType	N/A
	Subgrade Thickness (inches)	-
	Subbase Type	AB
	Subbase Thickness (inches)	6.0
	Asphaltic Concrete Thickness (inches)	2.5
*	Structural Number (Required)	1.61
*	Structural Number (Section)	1.77
	Performance (years)	20.0
	Allowable 18-kip ESAL Repetition	194,842

Design Parameters:

Standard Normal Deviate		-1.282
Combined Standard error		0.45
Design Serviceability Loss		2.1
Desired Level of Reliability (percent)		90.0
Asphaltic Concrete Layer Coefficient		0.42
Subbase Layer Coefficient	AB	0.12
Subgrade Layer Coefficient	N/A	0.11

Flexible Pavement Design (AASHTO)

Project Name:	White Tank FRS NO. 3 Outfall Channel
Project Number:	09-G-1597
Client:	Hoskin Ryan Consultants, Inc.
Location:	Buckeye, Arizona
Design Section:	Encanto Boulevard
Engineer:	J Floyd
Date:	1/29/2010

Flexible Pavement Structural Design:

	Resilient Modulus (psi)	26,000
	SubgradeType	N/A
	Subgrade Thickness (inches)	-
	Subbase Type	AB
	Subbase Thickness (inches)	9.0
	Asphaltic Concrete Thickness (inches)	2.5
*	Structural Number (Required)	1.61
*	Structural Number (Section)	2.13
	Performance (years)	20.0
	Allowable 18-kip ESAL Repetition	194,842

Design Parameters:

Standard Normal Deviate		-1.282
Combined Standard error		0.45
Design Serviceability Loss		2.1
Desired Level of Reliability (percent)		90.0
Asphaltic Concrete Layer Coefficient		0.42
Subbase Layer Coefficient	AB	0.12
Subgrade Layer Coefficient	N/A	0.11

Flexible Pavement Design (AASHTO)

Project Name:	White Tank FRS NO. 3 Outfall Channel
Project Number:	09-G-1597
Client:	Hoskin Ryan Consultants, Inc.
Location:	Maricopa County, Arizona
Design Section:	Colter Street
Engineer:	J Floyd
Date:	1/29/2010

Flexible Pavement Structural Design:

	Resilient Modulus (psi)	26,000
	SubgradeType	N/A
	Subgrade Thickness (inches)	-
	Subbase Type	AB
	Subbase Thickness (inches)	6.0
	Asphaltic Concrete Thickness (inches)	2.5
*	Structural Number (Required)	1.38
*	Structural Number (Section)	1.77
	Performance (years)	20.0
	Allowable 18-kip ESAL Repetition	129,894

Design Parameters:

Standard Normal Deviate		-0.841
Combined Standard error		0.45
Design Serviceability Loss		2.2
Desired Level of Reliability (percent)		80.0
Asphaltic Concrete Layer Coefficient		0.42
Subbase Layer Coefficient	AB	0.12
Subgrade Layer Coefficient	N/A	0.11

Flexible Pavement Design (AASHTO)

Project Name:	White Tank FRS NO. 3 Outfall Channel
Project Number:	09-G-1597
Client:	Hoskin Ryan Consultants, Inc.
Location:	Buckeye, Arizona
Design Section:	Virginia Avenue
Engineer:	J Floyd
Date:	1/29/2010

Flexible Pavement Structural Design:

	Resilient Modulus (psi)	26,000
	SubgradeType	N/A
	Subgrade Thickness (inches)	-
	Subbase Type	AB
	Subbase Thickness (inches)	6.0
	Asphaltic Concrete Thickness (inches)	2.5
*	Structural Number (Required)	1.38
*	Structural Number (Section)	1.77
	Performance (years)	20.0
	Allowable 18-kip ESAL Repetition	129,894

Design Parameters:

Standard Normal Deviate		-0.841
Combined Standard error		0.45
Design Serviceability Loss		2.2
Desired Level of Reliability (percent)		80.0
Asphaltic Concrete Layer Coefficient		0.42
Subbase Layer Coefficient	AB	0.12
Subgrade Layer Coefficient	N/A	0.11

Flexible Pavement Design (AASHTO)

Project Name:	White Tank FRS NO. 3 Outfall Channel
Project Number:	09-G-1597
Client:	Hoskin Ryan Consultants, Inc.
Location:	Maricopa County, Arizona
Design Section:	Camelback Road
Engineer:	J Floyd
Date:	1/29/2010

Flexible Pavement Structural Design:

	Resilient Modulus (psi)	26,000
	SubgradeType	N/A
	Subgrade Thickness (inches)	-
	Subbase Type	AB
	Subbase Thickness (inches)	10.0
	Asphaltic Concrete Thickness (inches)	4.0
*	Structural Number (Required)	1.81
*	Structural Number (Section)	2.88
	Performance (years)	20.0
	Allowable 18-kip ESAL Repetition	259,789

Design Parameters:

Standard Normal Deviate		-1.645
Combined Standard error		0.45
Design Serviceability Loss		2.0
Desired Level of Reliability (percent)		95.0
Asphaltic Concrete Layer Coefficient		0.42
Subbase Layer Coefficient	AB	0.12
Subgrade Layer Coefficient	N/A	0.11

Flexible Pavement Design (AASHTO)

Project Name:	White Tank FRS NO. 3 Outfall Channel
Project Number:	09-G-1597
Client:	Hoskin Ryan Consultants, Inc.
Location:	Buckeye, Arizona
Design Section:	Indian School Road
Engineer:	J Floyd
Date:	1/29/2010

Flexible Pavement Structural Design:

	Resilient Modulus (psi)	26,000
	SubgradeType	N/A
	Subgrade Thickness (inches)	-
	Subbase Type	AB
	Subbase Thickness (inches)	10.0
	Asphaltic Concrete Thickness (inches)	4.0
*	Structural Number (Required)	2.28
*	Structural Number (Section)	2.88
	Performance (years)	20.0
	Allowable 18-kip ESAL Repetition	1,039,155

Design Parameters:

Standard Normal Deviate		-1.645
Combined Standard error		0.45
Design Serviceability Loss		2.0
Desired Level of Reliability (percent)		95.0
Asphaltic Concrete Layer Coefficient		0.42
Subbase Layer Coefficient	AB	0.12
Subgrade Layer Coefficient	N/A	0.11

Flexible Pavement Design (AASHTO)

Project Name:	White Tank FRS NO. 3 Outfall Channel
Project Number:	09-G-1597
Client:	Hoskin Ryan Consultants, Inc.
Location:	Buckeye, Arizona
Design Section:	Thomas Road
Engineer:	J Floyd
Date:	1/29/2010

Flexible Pavement Structural Design:

	Resilient Modulus (psi)	26,000
	SubgradeType	N/A
	Subgrade Thickness (inches)	-
	Subbase Type	AB
	Subbase Thickness (inches)	10.0
	Asphaltic Concrete Thickness (inches)	4.0
*	Structural Number (Required)	2.04
*	Structural Number (Section)	2.88
	Performance (years)	20.0
	Allowable 18-kip ESAL Repetition	259,789

Design Parameters:

Standard Normal Deviate		-1.645
Combined Standard error		0.45
Design Serviceability Loss		2.0
Desired Level of Reliability (percent)		95.0
Asphaltic Concrete Layer Coefficient		0.42
Subbase Layer Coefficient	AB	0.12
Subgrade Layer Coefficient	N/A	0.11

Flexible Pavement Design (AASHTO)

Project Name:	White Tank FRS NO. 3 Outfall Channel
Project Number:	09-G-1597
Client:	Hoskin Ryan Consultants, Inc.
Location:	Maricopa County, Arizona
Design Section:	Jackrabbit Trail
Engineer:	J Floyd
Date:	1/29/2010

Flexible Pavement Structural Design:

	Resilient Modulus (psi)	26,000
	SubgradeType	N/A
	Subgrade Thickness (inches)	-
	Subbase Type	AB
	Subbase Thickness (inches)	10.0
	Asphaltic Concrete Thickness (inches)	4.0
*	Structural Number (Required)	2.28
*	Structural Number (Section)	2.88
	Performance (years)	20.0
	Allowable 18-kip ESAL Repetition	1,039,155

Design Parameters:

Standard Normal Deviate		-1.645
Combined Standard error		0.45
Design Serviceability Loss		2.0
Desired Level of Reliability (percent)		95.0
Asphaltic Concrete Layer Coefficient		0.42
Subbase Layer Coefficient	AB	0.12
Subgrade Layer Coefficient	N/A	0.11

Flexible Pavement Design (AASHTO)

Project Name:	White Tank FRS NO. 3 Outfall Channel
Project Number:	09-G-1597
Client:	Hoskin Ryan Consultants, Inc.
Location:	Maricopa County, Arizona
Design Section:	O&M Roadways
Engineer:	A Ortega
Date:	7/27/2010

Flexible Pavement Structural Design:

	Resilient Modulus (psi)	26,000
	SubgradeType	N/A
	Subgrade Thickness (inches)	-
	Subbase Type	AB
	Subbase Thickness (inches)	6.0
	Asphaltic Concrete Thickness (inches)	2.0
*	Structural Number (Required)	1.56
*	Structural Number (Section)	1.56
	Performance (years)	20.0
	Allowable 18-kip ESAL Repetition	250,000

Design Parameters:

Standard Normal Deviate		-0.841
Combined Standard error		0.45
Design Serviceability Loss		2.0
Desired Level of Reliability (percent)		80.0
Asphaltic Concrete Layer Coefficient		0.42
Subbase Layer Coefficient	AB	0.12
Subgrade Layer Coefficient	N/A	0.11

APPENDIX E
GEOLOGICAL MEMORANDUM
GEOLOGICAL CONSULTANTS, INC.

Memorandum

Revised: January 26, 2010

REGISTERED GEOLOGIST CERTIFICATE NO. 10338 KENNETH M. EUGE Date Signed 1/26/10 ARIZONA, U.S.A. EXP. 09-30-2011

To: Mr. Paul W. R. Hoskin, P.E.
Hoskin Ryan Consultants Inc.

From: Ken Euge, R.G.

Subject: Geological Memorandum:
White Tanks FRS No. 3 Outfall Channel Final Design
FCD Contract No. 2009C012
Geological Consultants Project No. 2009-129

According to the scope of work for the White Tanks FRS No. 3, Outfall Channel Final Design, Geological Consultants Inc. is submitting herewith this Geological Memorandum to satisfy related section of Item 8.0 of the project Scope of Work.

1.0 Introduction

Geological Consultants, Inc., and Alpha Geotechnical and Materials, Inc., in association with Hoskin-Ryan Consultants, Inc., have been contracted by the Flood Control District of Maricopa County (District) to prepare a Geotechnical Report for the White Tanks FRS No. 3 (FRS#3) Outfall Channel project. The District is in the process of performing rehabilitation to FRS#3, including a new principal outlet that discharges adjacent to the Beardsley Canal. The project provides a channel along the Jackrabbit Trail corridor, to convey the principal outlet flows from FRS#3 to FRS#4 (Figure 1 (Figure 4, Geotechnical Report)). The outfall channel will extend south from the principal outlet at FRS#3 to

2333 West Northern Avenue, Ste 1A, Phoenix, Arizona 85021 | phone 602.864.1888 | fax 602.864.1899 | www.geologicalconsultants.com

the existing FRS#4 inlet channel north of McDowell Road, and lie within the Town of Buckeye and unincorporated Maricopa County.

Geological support for the geotechnical investigation for the White Tanks FRS No. 3 Outfall Channel final design identified in the project slope of work included the following tasks:

- Review of existing geological information available from previous studies in the area and recent InSAR data provided by the District from ADWR.
- Review of AMEC (2009) land subsidence and earth fissure evaluation report. Provide recommendations for further analysis, for earth fissure risk zone and land subsidence mitigation, and monitoring.
- Meet with ADWR Staff regarding possible dam safety issues and outfall channel design at the White Tanks FRS No. 3 emergency spillway.
- Provide engineering geology support and oversight for the geotechnical investigation conducted by Alpha Geotechnical.
- Provide design recommendations for the outfall channel design through the identified earth fissure risk zone and for the emergency spillway crossing.
- Prepare this geological memorandum to document the data findings, define historic land subsidence trends and deduce from the data future potential land subsidence that may impact the White Tanks FRS No. 3 structure.

2.0 Review of AMEC (2009) Report

Geological Consultants Inc. (GCI) has completed its review of the subject AMEC report as required in the Project Scope of Work (Task 8.2.4). Based on our review of the results and findings of the AMEC assessment and our professional experience obtained from ground subsidence and earth fissure evaluations at and in the vicinity of FRS #3 and FRS #4, we are including our comments, opinions and recommendations for additional analyses that we believe are necessary to thoroughly assess ground subsidence and earth conditions in the project area. A copy of the report review memorandum is provided in Appendix A. A copy of the AMEC report (2009) is included as part of the Appendices in the Geotechnical Investigation Report prepared by Alpha Geotechnical (2009).

3.0 ADWR Coordination

The White Tanks FRS No. 3 outfall channel alignment through a portion of Reach 9 will traverse the White Tanks FRS No. 3 emergency spillway. Because of the potential dam safety related issues associated with the penetration of the emergency spillway Item 8.2.5 of the project scope of work requires meetings and discussions with the ADWR Dam Safety Division and the NRCS to address potential dam safety issues and the outfall channel design through the emergency spillway.

A meeting was held with ADWR Dam Safety and the NRCS on November 9, 2009. During the meeting, an informative general overview of the outfall channel project was provided for the ADWR and the NRCS that included operation characteristics of the spillway structure, flow rates, Emergency Action Plan and the proposed 30-percent design plan that incorporates a concrete box culver (CBC) system for the crossing. Alternatives to the CBC were addressed including HDPE pipe, reinforced concrete pipe, and steel pipe along with spillway channel erosion protection up and down stream from the channel penetration.

ADWR and NRCS concerns raised during the meeting were summarized in the meeting notes prepared by Hoskin Ryan and are provided herein:

- The ADWR will only have safety concerns if the design impacts the operation or the dam structure.
- An issue as regarding the potential for the outflow channel to block flow from the Principal Spillway Outlet. This issue may be resolved if a hydraulic analysis of the design connection and flow demonstrates there are no impacts.
- If the outfall channel design does not affect the dam hydraulics, only an informational memo would need to be submitted to the ADWR.
- The NRCS believes the Sites model with the culvert crossing should be run to determine the scour effects of the Outfall Channel crossing.
- If deemed necessary, the 60-percent design with the VA alternative should be presented to the NRCS.
- The ADWR has a minimum review time from of six months (four months for administrative review and two months for technical review).
- The NRCS and ADWR review can be performed concurrently.

Suggested alternatives for the earth fissure risk zone and Emergency Spillway crossings based on the results of the land subsidence and earth fissure evaluations are provided in section 7.0 of this Memorandum.

4.0 Engineering Geology Support & Oversight

Geological Consultants Inc. (GCI) provided engineering geology support and oversight for portions of the geotechnical investigation program implemented by Alpha Geotechnical. GCI worked closely with Alpha to review their comprehensive investigative program, and to suggest modifications to their proposed exploration program. Oversight was provided during the excavation and soil sampling of backhoe test pits at selected location along the proposed Outfall Channel Alignment. Information relative to the determination of the relative erosion potential of the soils encountered in the excavation including the soil layer stratification, relative cementation, sorting, and gradation, and the dry unconfined compressive strength of the soil were noted.

The information gathered during the geotechnical field investigation and from the review of the available geological, hydrogeological, geodetic, and geotechnical data were used to prepare the remaining sections of this memorandum and to address the other land subsidence and earth fissure issues outlined in the project scope of work.

5.0 Geology

5.1 Geological Setting

Numerous geological and geotechnical investigations have been conducted in the vicinity of the FRS #3 Outfall Channel. Reports documenting these investigations, conducted by agencies including the District, Arizona Geological Survey (AzGS), Arizona Department of Water Resources, U.S. Geological Survey, National Resources Conservation Service, US Army Corps of Engineers, and by private consultants, provide descriptions of the surface geological and soils conditions present along the Outfall Channel alignment. For additional discussions of the regional geology and the West Salt River Basin stratigraphy, readers are referred to recent reports by AMEC (2004, and 2009), AzGS (2009), and Geological Consultants Inc. (GCI) (2002, 2004, 2008, and 2009)

5.1.2 Regional Geology

The FRS #3 Outfall Channel is located approximately 1.5 miles east to about 2.2 miles southeast of the eastern flanks of the White Tank Mountains. The Outfall Channel begins at the FRS #3 principal spillway outlet and parallels the Jackrabbit Trail alignment throughout most of its length, terminating downstream at the FRS #4 inlet. The FRS #3 Outfall Channel is located within the Sonoran Desert section of the Basin and Range Physiographic Province. This portion of the Basin and Range is characterized by northwest, north, and northeast trending mountains that rise abruptly to form broad, elongated, deep, sediment-filled valleys produced by block faulting and folding during past episodes of mountain and basin bounding fault movements (Cooley, 1977).

The White Tank Mountains are composed predominately of old, Pre-Cambrian age (570 million years ago (mya)) metamorphic and granitic crystalline bedrock, intruded by younger dikes. A portion of the White Tank metamorphic core complex, the oldest rock units, are high-grade Proterozoic (2,000 million year ago (mya)) metamorphic rocks that include gabbros (iron-rich granitic rocks) and local ultramafic (dark colored) rocks. Two Proterozoic plutons, a tonalite to the south and a granodiorite-granite to the north, intruded into the older unit as a series of sills parallel to foliation in the metamorphic rocks (Reynolds, 2002). The bedrock is locally overlain by Tertiary age (66 mya to 1.6 mya) volcanic rock and Quaternary age (younger than 1.6 mya) alluvium. The basin fill within the valley composed of both fine and coarse grained alluvial sediments commonly makes up the principle groundwater aquifer of the region.

5.1.3 General Basin Stratigraphy

The basin stratigraphy beneath the FRS #3 Outlet Channel alignment is typical of the stratigraphy found in the portion of the West Salt River Valley that parallels the margin of the White Tank Mountains pediment. Three distinct alluvial units underlie the study area: a lower, middle, and an upper alluvial unit. Granitic and metamorphic bedrock underlies the lower alluvial unit. The exact thickness of these units under the study area is unknown. However, gravity surveys in the area are used to calculate the approximate depth to bedrock that is estimated to range from about 600 feet below the ground surface at FRS #3 to about 1,200 feet below the ground surface near FRS #4.

- Upper Alluvial Unit: Gravel, and sand with lesser amounts of silt and clay. Mostly unconsolidated with locally moderate to strong cementation near mountain fronts and major stream courses (SGC, 1998; Alpha, 2009). Along the Outfall Channel alignment, the thickness of this unit is estimated to range from about 300 to 400 feet (GCI, 2004 & 2008).

- Middle Alluvial Unit: Silt, and clay with thin interbeds of silty sand and gravel. Mostly weakly consolidated, but moderately to well-cemented. Grades to fine grained mudstone and evaporite deposits in the central part of the basin near Luke Air Force Base (Schumann, 1995). Although the estimated thickness of the Middle Alluvial Unit (MAU) is estimated to be about approximately 600 feet thick near the center of the West Salt River Valley (BOR, 1976; Schumann, 1995), the MAU probably pinches out to the west near the White Tank Mountains and therefore it may not underlie the Outfall Channel alignment.

- Lower Alluvial Unit: Silt, gravel, and conglomerate. The lower and older part of this unit is moderately to well-consolidated. Toward the margins of the West Salt River Valley basin within the project area, this unit is very coarse grained and relatively thin whereas. Near the center of the basin, east of the project area, the basing fill sediments grade to fine-grained sand, silt, and clay (BOR, 1976), mudstone, and evaporite deposits (Schumann, 1995) and the unit could reach a thickness of more than 1,000 feet. A relatively thin coarser-grained section of the Lower Alluvial Unit, ranging from less than 100 feet to possibly 200 feet thick, may underlie the Outfall Channel alignment. It is not expected that the Outfall Channel excavation would encounter this unit.

5.1.4 Outfall Channel Alignment Geology

The FRS #3 Outfall Channel parallels the Jackrabbit Trail alignment from FRS #3 to FRS #4 near the eastern margin of the White Tank Mountains. The Outfall Channel traverses older, Pleistocene age (10 ka to 300 ka) alluvial fan terrace deposits that are coarse grained and locally dissected. Along this route, the detritus, resulting from the erosion from the White Tank Mountains, was deposited to form a series of coalesced alluvial fans on the mountain pediment that sloped toward the basin center. The older, dissected alluvial fan deposits are commingled with accumulations of younger, Holocene age (less than 3 ka to 10 ka) alluvial fan deposits and stream channel alluvium (Field & Pearthree, 1991). Brief geologic descriptions, supplemented with information gathered during the field investigation conducted for this project, are provided in the following sections. Table 1 summarizes the distribution of the geomorphic surfaces and the associated alluvial deposits traversed by the the Outfall Channel (Figure 1 (Figure 4, Geotechnical Report)). The approximate limit, or locations, where the contacts (or boundaries) of the various geologic units are keyed to the Outfall Channel (30-percent design) control line stationing (HRC, 2009).

Table 1a

Surficial Distribution of Geologic Units Along Outfall Channel Alignment
White Tanks FRS No. 3 Outfall Channel

Outfall Channel Station		Reach	Geologic Symbol	Geologic Name	Age (ka=1,000 years ago)
From	To				
Beginning of Project					
63+21	66+80	1	QY	Undifferentiated Alluvial Fan	Holocene (0-10)
66+80	72+00	2	QM12	Alluvial Fan (Distal)	Middle to Late Pleistocene (10-300)
72+00	74+95	2	QY1	Alluvial Fan & Terraces	Late to Early Holocene (1-10)
74+95	84+00	2	QM1b	Alluvial Fans	Middle to Late Pleistocene (150-300)
84+00	127+45	2 / 3	QY1	Alluvial Fan & Terraces	Late to Early Holocene (1-10)
Thomas Road Alignment					
127+45	141+90	3 / 4	QY2	Alluvial Fan, Low Terraces, & Active Stream Channels	Recent to Late Holocene (<3)
141+90	146+70	4	QM2	Alluvial Fans	Latest to Late Pleistocene (10-150)
146+70	159+45	4	QM1b	Alluvial Fans	Middle to Late Pleistocene (150-300)
Indian School Road Alignment					
159+45	185+45	5	QY	Undifferentiated Alluvial Fan	Holocene (0-10)
185+45	212+40	6	QM2	Alluvial Fans	Latest to Late Pleistocene (10-150)

Note: Geologic symbol, geologic name, and age from Field and Pearthree (1991).

Table 1b

Surficial Distribution of Geologic Units Along Outfall Channel Alignment
White Tanks FRS No. 3 Outfall Channel

Outfall Channel Station		Reach	Geologic Symbol	Geologic Name	Age (ka=1,000 years ago)
From	To				
Camelback Road Alignment					
212+40	216+45	7	QY	Undifferentiated Alluvial Fan	Holocene (0-10)
216+45	242+65	8	QM1b	Alluvial Fans	Middle to Late Pleistocene (150-300)
242+65	244+15		QY	Undifferentiated Alluvial Fan	Holocene (0-10)
244+15	249+35		QM1b	Alluvial Fans	Middle to Late Pleistocene (150-300)
249+35	250+95		QY	Undifferentiated Alluvial Fan	Holocene (0-10)
250+95	263+65		QM1b	Alluvial Fans	Middle to Late Pleistocene (150-300)
Bethany Home Road Alignment					
263+65	266+70	8	QY	Undifferentiated Alluvial Fan	Holocene (0-10)
266+70	277+70	9	QM1b	Alluvial Fan	Middle to Late Pleistocene (150-300)
277+70	285+95		QY	Undifferentiated Alluvial Fan	Holocene (0-10)
285+95	295+95		QM1b	Alluvial Fan	Middle to Late Pleistocene (150-300)
295+95	2299+70		QY	Undifferentiated Alluvial Fan	Holocene (0-10)
289+90	313+00		Fill/QM1b	Fill/Alluvial Fan	Recent/Middle to Late Pleistocene (150-300)
End of Project - White Tanks FRS No. 3 Principal Spillway Outlet					

Note: Geologic symbol, geologic name, and age from Field and Pearthree (1991).

Based on our interpretation of the surface geological mapping data, aerial photographs, and test pit explorations along the Outfall Channel alignment, we expect the majority of the Outfall Channel invert to be founded in the moderate to well-cemented Late or Middle Pleistocene age (10 to 300 ka) alluvial fan deposits. Along the southern portions of the alignment between McDowell Road and Indian School Road, geologically Recent age to Late Holocene age (0 to 10 ka) could be encountered at the Outfall Channel invert grade.

5.1.4.1 Alluvial Fans, Low Terraces, and Active Stream Channels (QY2; Holocene, <3ka)

Recent alluvial fan deposits are composed of fine silts and sands near the distal portions of the fan. Active stream channels grade toward the southeast and dissect the fan surfaces in response to infrequent flow events. Stream channel deposits consist of erosional detritus composed of loose to dense, unconsolidated, and poorly sorted silt, sand, and gravel. This geologic unit is susceptible to erosion when subjected to sustained flow.

5.1.4.2 Alluvial Fans and Terraces (QY1; Late to Early Holocene, 1 to 10 ka)

These deposits are composed of moderately dense to dense, coarse grained, poorly sorted mixtures of silt, sand, and gravel with angular to subangular granitic and metamorphic rock fragments. A poorly developed, pebble to granule desert pavement may be present. As these deposits approach the distal ends of the fans, they typically consist of finer grained silt and sand. Where soil profiles are well developed, the underlying deposits are slightly calcareous resulting from accumulations of Stage I to II caliche. This unit is expected to be slightly susceptible to erosion.

5.1.4.3 Undifferentiated Alluvial Fan Deposits (QY; Recent to Early Holocene, 0 to 10 ka)

This geologic unit designation is used for areas that include extensively commingled QY1 and QY2 units. This designation also includes areas where the geologic units have been be disturbed by agricultural activity and urban development but are also believed to the Holocene age. Refer to report Section 2.3.1 and 2.3.2 for a description of this designated geologic unit.

5.1.4.4 Alluvial Fans (QM2; Latest to Late Pleistocene, 10 to 150 ka)

The alluvial fan deposits are mapped at three intervals along the Outfall Channel alignment, one near the intersection of Jackrabbit Road and Clarendon Avenue and at two others locations along Jackrabbit Road between Indian School Road and Camelback Road. Where undisturbed, a gravel to cobble desert pavement is poorly to moderately developed. The deposits consist of a poorly sorted, angular to subangular admixtures of silt, sand, and gravel with localized layered accumulations of cobble- to boulder-size granitic and metamorphic rock fragments. The surface soils of this unit are commonly dark brown to brown but below the surface, where the unit is slightly to moderately cemented with caliche, the formation is very light orange brown. This unit is dense to very dense and slightly to moderately indurated due to the caliche cementation. Where exposed in test pits, the unit exhibits poorly to moderately stratified layers of silty sandy gravel and silty gravelly sand with some layers containing a high (greater that 50 percent) cobble to boulder-size rock fragments. Estimated unconfined compressive dry strength of the finer grained constituents of this unit, measure with a pocket penetrometer, is greater than 4.5 tons per square foot. Based on the observed Stage II caliche cementation, the interlocking character of the angular to subangular coarse fraction, and the very high dry strength, we would expect soils in this alluvial fan unit to be very slightly to non-erosive and moderately difficult to excavate.

5.1.4.5 Alluvial Fans (QM1b; Middle to Late Pleistocene, 150 to 300 ka)

The older alluvial fan deposits are mapped at a couple of locations along the Outfall Channel alignment, one near the intersection of Jackrabbit Road and Encanto Boulevard and along Jackrabbit Road between Clarendon Avenue and Camelback Road. Unit QM1b is also extensively mapped along the Outfall Channel alignment north of Camelback Road to the north side of the FRS #3 emergency spillway. Where undisturbed, a well-preserved gravel to cobble desert pavement has formed on the elevated, locally dissected fan surfaces separated by shallow, incised stream channels. The deposits also consist of a poorly sorted, angular to subangular admixture of silt, sand, and gravel with localized layered accumulations of cobble- to boulder-size granitic and metamorphic rock fragments. The surface soils of this unit are commonly dark brown to brown but below the surface, where the unit is cemented with caliche, the formation is a mottled very light orange brown to cream color whereas the excavated soil appears whitish in color. This unit is dense to very dense and moderately indurated due to the caliche cementation. Where exposed in test pits, the unit also exhibits poorly to moderately stratified layers of silty sandy gravel and silty gravelly sand with some layers containing a high percentage (greater that 50 percent) of cobble to boulder-size rock fragments. Estimated unconfined compressive dry strength of the finer grained constituents of this unit, measure with a pocket penetrometer, is greater than 4.5 tons per square foot. The wet strength of cemented soils was determined by saturating two samples for a 12-day period, a cemented sandy gravel/gravelly sand and cemented silty sand. The samples were obtained from a test pit TP-48 at the depth approximating the outfall channel invert elevation in Reach 9. At the end of the test period, the unconfined compressive strengths measured with a pocket penetrometer were 4.5 tons per square foot in the cemented sandy gravel/gravelly sand sample obtained at a depth of about 8 feet below existing grade and 3.7 tons per square foot in the cemented silty sand obtained at a depth of about 10 feet below existing grade. Based on the observed Stage II to III caliche cementation, the interlocking character of the angular to subangular coarse fraction, and the very high dry and wet strengths, we would expect soils in this alluvial fan unit to be non-erosive and difficult to excavate.

5.1.4.6 Distal Alluvial Fans (QM12; Late to Middle Pleistocene, 10 to 300 ka)

This undifferentiated alluvial fan unit is mapped in one area of the Outfall Channel alignment along Jackrabbit Road between Palm Lane and Monte Vista Road. This map unit designation is used to identify areas believed to be underlain by geologic units M1b and M2 that have been disturbed by agricultural activity or urban development. Refer to report Sections 2.3.4 and 2.3.5 for the description of the units that may be encountered where this unit is mapped. In the agriculturally disturbed area, the competency of the upper few feet of the soil structure has been destroyed by tillage and as a result, this near-surface zone could be susceptible to erosion.

6.2 Subsidence and Earth Fissures

6.2.1 Land Subsidence

Land subsidence due to the excessive removal of groundwater from the West Salt River Valley sub-basin aquifer is well documented in the vicinity of the FRS #3 Outfall Channel (GCI, 2002, 2004, 2008; AMEC, 2004, 2009: Schumann, 1974, 1995; Schumann & Genualdi, 1986; Dames & Moore, 1998; and others). With the development of groundwater resources for agricultural purposes beginning in the early 1920s and with increased agricultural activity and urban development following World War II, significant declines of regional groundwater levels of 100 to 200 feet have resulted in the consolidation of compressible basin fill sediments along with the subsequent lowering of the ground surface (land subsidence). About 17 feet of land subsidence has taken place in the Luke Air Force Base area, almost 4 feet at FRS #3, and about one to 1.5 feet near FRS #4. In the late 1970s and early 1980s the downward trend in water levels abated due to increased recharge to the aquifer and to the greater availability of surface water. As a result, the water level conditions today are essentially static or slightly increasing.

Level line survey data from the National Geodetic Survey (NGS) provided some of the earliest indication of land subsidence in the project area. Level survey data obtained in 1948 was compared with surveys conducted in 1967. Almost two feet of subsidence was documented along the Beardsley Canal alignment in the vicinity of FRS #3. Total land subsidence documented from 1948 though 2004 using NGS data adjusted by the District from their surveys at FRS #3 ranged from about 2.5 feet to

3.7 feet. To the best or our knowledge there have been no level line surveys in the area (personal communication (NGS, 2008)) other than the survey data prepared by the District in 2004. In early 1990s, a remote radar survey technique became available that can measure changes in land surface elevations using low orbit satellite platforms. The technique is referred to as repeat pass Synthetic Aperture Radar Interferometry, or InSAR.

6.2.1.1 InSAR Data

Interferometric Synthetic Aperture Radar (InSAR) is a remote sensing technique that uses radar satellite images. A radar satellite shoots constant beams of radar waves toward earth and records them after they bounce back off the Earth's surface. The intensity of the wave bounced back to the satellite indicates how much of the wave has been absorbed and how much has reflected back to the satellite. The phase of the wave indicates the time necessary for the radar wave to hit the ground and return to the satellite. The intensity information is used to characterize the material the wave bounced off. The phase information is used to determine any changes that have occurred over time. A phase reading taken at the same point over time should be identical. If there is a difference in readings from successive radar passes over time this is an indication that a change has taken place. By using both the intensity and phase data, differential ground movement can be located and measured.

InSAR data can depict vertical land movement (potentially subsidence) at locations where the land would have otherwise remained undisturbed for the period of time during which the data was collected. This technology does not provide useful data in areas where the land surface changes on a somewhat regular basis (i.e. agricultural lands, rivers, etc.). In these areas, the data decorrelates and is unreadable.

InSAR imaging is available from the Arizona Department of Water Resources (Conway, 2009) that documents the land surface deformation as measured by differential interferometric synthetic aperture radar (DifSAR) that includes the FRS #3 Outfall Channel alignment area for the period of 1992 through 2000 (ADWR, 2004) and from 2003 through 2009 (Conway, 2009). To evaluate the near-term historic land subsidence along the Outfall Channel alignment, we examined and plotted DifSAR data set obtained along a satellite track closest to the Jackrabbit Trail alignment which parallels from Outfall Channel Reach 1 through a portion of Reach 9 (Figure 2 (Figure 5, Geotechnical Report)) including the FRS #3 emergency spillway. We also examined and plotted the DifSAR data set along satellite track that parallels the Beardsley Canal alignment including the area near the FRS #3 principal spillway outlet structure.

Interpretation of the DifSAR data indicates that land subsidence, albeit at a very low rate, continues in the project area. Interpretation of the 1992 through 2000 Beardsley Canal alignment DifSAR data set indicates that land subsidence ranging from about 0.16 feet (at a rate of about 0.02 feet per year) took place near the FRS #3 principal spillway outlet. The Jackrabbit Trail DifSAR data set indicates about 0.15 feet of subsidence occurred in the FRS #3 emergency spillway area and about 0.17 feet of subsidence occurred near the Missouri

Avenue alignment. About 0.025 feet was recorded at the Camelback Road intersection with the Outfall Channel and about 0.02 feet south of Indian School Road near its intersection with Clarendon Avenue. Examination of the 2003 through 2009 DifSAR data suggests similar subsidence trends but the total subsidence is nil to about 10 percent of the 1992 to 2000 measured subsidence (Figure 2 (Figure 5, Geotechnical Report)).

Figure 2 (Figure 5, Geotechnical Report) can be used to identify areas along the Outfall Channel alignment that could potentially experience a grade changed due to differential land subsidence taking place over time. For example, at the northern terminus of the Outfall Channel, using the latest (2003-2009) DifSAR subsidence data assuming a 50-year life of the facility, approximately 0.2 feet of subsidence (down-dropping to north) might take place. Using the 1992 to 2000 InSAR data, approximately one foot of land subsidence could take place. For the purpose of assessing potential outfall channel grade reversal due to land subsidence over the 50-year useful life of the facility, it is our opinion, the year 1992 to year 2000 historic land subsidence determined from the InSAR/DifSAR data should be used to estimate future potential land subsidence. Our reasons for using these data include considerations of ongoing residual land subsidence, continued development and related groundwater demand from the basin aquifer, and the application of nominal conservatism to accommodate unforeseen circumstances that could exacerbate land subsidence in the West Salt River Valley during the useful life of the FRS #3 outfall channel. Considering the very low design flow line gradient of the Outfall Channel invert that ranges from 0.001 feet/foot to 0.005 feet/foot and if the estimated year 1992 to year 2000 rate of land subsidence continues at the same rate, or at an increased rate, throughout the useful life of the facility, the differential land subsidence could cause a reversal of the channel invert grade.

6.2.2 Earth fissures

Earth fissures form in response to settlement or subsidence caused by the natural or human-induced removal of solid, liquid, or gas material from near-surface ore bodies, aquifers, or reservoirs. In the West Salt River Valley, earth fissures occur in unconsolidated sediments, typically near the margins of the alluvium-filled basin, in response to the removal of groundwater from the basin aquifer.

Earth fissures are initiated deep beneath the land surface once the tensile stresses, caused by the consolidation of the basin fill sediments induced by groundwater removal, exceed the strength of the soil. Tensile stresses, induced by the resulting land subsidence continue to increase until the ground breaks to form the earth fissure. The fissures then propagate upwards to intersect the ground surface. Although the initial earth fissure rupture may only have an aperture of one to two inches at depth, at the surface the fissure crack can grow in width and length creating fissure gullies that are one foot to more than 10 feet deep and from a few feet to as much as 40 feet wide when subjected to erosion caused by overland surface runoff. During their formation, the earth fissures can extend initially from a length of a few feet to reach a few thousand feet along the length of their surface expression. The earth fissure with the greatest reported length of more than nine mile is located near the west-central margin of the Picacho Basin near Eloy, Arizona. These features are easily recognized on aerial photographs and in the field unless the ground surface has been modified by agricultural activity or urban development.

Numerous earth fissures have been mapped in the West Salt River Valley. In February 2009, the Arizona Geological Survey published the Luke Study Area earth fissure map compiling the known and suspect earth fissures in the West Salt River Valley (AzGS, 2009). Also, several earth fissure investigations have been conducted in the project area by GCI (2002, 2004, 2008) and AMEC (2004, 2009). These investigations include detailed analysis and interpretation of aerial photographs, field geological reconnaissance to investigate identified suspect features, and, where deemed necessary, surface and subsurface explorations of selected suspect features that appear to have the greatest likelihood of being earth fissures. Also, as part of the design investigation conducted for the remediation of FRS #3 (GCI; 2004, 2004, & 2005; AMEC; 2004) and FRS #4 (GCI, 2008), geophysical seismic survey were conducted to assist in the selection of geotechnical design parameters for the site. The seismograms generated during these surveys were carefully examined to identify any anomalies that could be related to earth fissures. During the construction at FRS #3 earth fissure risk zone mitigation measure, additional seismic refraction surveys were conducted by AMEC and a detailed geological examination of the cutoff excavation was conducted by GCI to determine if any earth fissures existed (GCI, 2006). No earth fissure were identified within the FRS #3 earth fissure risk zone cutoff excavation during the construction inspections.

Based on the results of the previous investigations, no earth fissures are identified at or in the vicinity of the FRS #3 Outfall Channel alignment, FRS #3, or FRS #4 as of the date of this report. The closest earth fissures to the Outfall Channel alignment are located about three miles to the north near the south end of McMicken Dam, about three miles to the northeast near the intersection of Northern Avenue and Cotton Lane, and about six miles to the east near Luke Air Force Base (AzGS, 2009).

6.2.2.1 Earth Fissure Risk

No earth fissures are identified along the FRS #3 Outfall Channel alignment. The relative earth fissure risk is believed to be low except for Reach 8 and 9 (Figure 2 (Figure 5, Geotechnical Report)) (AMEC, 2009). During the site investigations conducted at FRS #3, an "earth fissure risk zone" was identified by AMEC (2009), which parallels a portion of Reach 9. No surface expressions of suspect fissures within the "zone" were observed by AMEC (2009) or by GCI during the geotechnical field investigation conducted for this outfall channel design project. Because of the documented history of differential land subsidence of almost four feet in the FRS #3 area and because InSAR data indicates residual land subsidence is continuing in the area at a low rate, a commensurate low risk potential exists for the build-up of tensile stresses in the vicinity that could cause an earth fissure to form. Therefore, this potential level of risk should be factored into the design and operation of the outfall channel. If the present trend of locally static to slightly rising water table condition is reversed and if groundwater withdrawal accelerates in the future, lowering of the water table within the West Salt River Valley, tensile stresses would increase at a more rapid rate to exacerbate future potential earth fissure development. Because of the apparent low level of earth fissure risk along FRS #3 Outfall Channel, "soft" mitigation measures, such as land subsidence and earth fissure monitoring should be considered by the District.

7.0 Recommendations

7.1 Land Subsidence and Earth Fissures

Based upon our current understanding land subsidence conditions within the West Salt River Valley and the associated level of earth fissure risk along the FRS #3 Outfall Channel, the following preliminary recommendations are provided to mitigate earth fissure risk. For conservatism we have used the 1992 to 2000 DifSAR data set to identify area where alignment grade modification should be considered to mitigate future potential land subsidence.

We are aware that the 30-percent design (HRI, 2009) proposed using an unlined open channel from the FRS #3 outlet works to the intersection with the FRS #3 emergency spillway in Reach 9. The Pre-Design Report recommends an alternative to the initially proposed unlined channel. The alternative includes two 72-inch diameter HDPE Pipes from the Principal Outlet, across the White Tanks FRS #3 Emergency Spillway, and across Bethany Home Road to Reach 8. Both of these alternatives, unlined channel or HDPE pipe drains, are acceptable an acceptable alternatives to accommodate future potential land subsidence using an appropriate invert grade modifications to accommodate one foot of future potential land subsidence during the 50-year operational life and the implementation of a land subsidence monitoring program. However, in our opinion, to monitor for future potential earth fissures within the identified earth fissure risk zone, the open channel alternative provides the District with opportunity for the direct visual observation and detection of future earth fissures that may form and intersect the outfall channel. The early detection should permit a rapid response for the implementation of repairs needed to maintain the integrity of the outfall channel system. If the HDPE pipeline alternative is used and an earth fissure intersects the pipeline alignment, it is conceivable that earth fissure could cause a loss of pipe support and possible failure before the earth fissure breach is expressed at the ground surface resulting in a slower emergency response to the problem.

In our opinion, an outfall channel system should be constructed that employs the best opportunities to monitor for earth fissure formation, and to provide a rapid, focused response for the implementation of repairs.

- For the aforementioned reasons, if future potential land subsidence is considered to have the greater impact on the outfall channel operation and maintenance, we would recommend using the HDPE piping system from the Principal Spillway Outlet to the Emergency Spillway. However, if future potential earth fissure formation is considered to have the greater impact, we recommend the construction an earthen channel from the Principal Spillway Outlet to the Emergency Spillway. Either the concrete box structure system or the duel HDPE pipeline system is acceptable for traversing the FRS #3 emergency spillway. One or a combination of alignment modifications, grade changes, or drop structures should be implemented to accommodate a minimum of one foot of future potential land subsidence at the FRS #3 principal outlet.

- Our evaluation of the recent land subsidence using InSAR also identified other area of the Outfall Channel alignment where future potential land subsidence could occur. We also recommend one or a combination of an alignment modification, grade changes, or drop structures to accommodate a minimum of one-foot near the Colter Street intersection and 0.2 feet at Camelback Road and at Clarendon Avenue intersections.

- The future potential land subsidence-induce Outfall Channel invert grade change locations were identified and quantified based on our preliminary analysis of the DifSAR data sets. We recommend a detailed analysis of the available DifSAR data sets to define the critical locations of land subsidence "hinge points" and where Outfall Channel modifications should be considered to accommodate the future potential land subsidence.

- The utilization of the excavation made along the outfall channel alignment for unlined earthen channel sections or pipelines and the excavation through the emergency spillway for the concrete box culvert or duel HDPE pipeline that traverse the identified earth fissure risk zone in Reach 8 and Reach 9 provides an excellent opportunity to directly examine the exposed soil strata and determine if any earth fissures are present. We recommend that an experience engineering geologist visually examine and log the excavations made along the Outfall Channel alignment. If an earth fissure is identified, a hardened sections of the Outfall Channel can be quickly designed to mitigate and avoid the potential breach.

- We recommend that a land subsidence and earth fissure monitoring program be developed for FRS #3 Outfall Channel. This program could consist of the installation of a series of permanent survey monuments and back-up replacement monuments along the entire Outfall channel alignment beginning at McDowell Road and every one-half mile thereafter and at the FRS #3 principal outlet headwall structure. Additional monuments, as needed, should be established at the inlet, midpoint, and outlet of the concrete box structure at the emergency spillway crossing. Each of these monuments should be designed per National Geodetic Survey (NGS) standards and set for monitoring of both horizontal and vertical movement. Following the initial baseline survey of all the monuments tied to an existing NGS or MCDOT benchmark established at a stable rock location, the primary monuments should be monitored on an annual basis. The monitoring schedule may be adjusted following the acquisition and evaluation of a sufficient number of readings. We recommend that the Outfall Channel alignment subsidence monitoring program be integrated into the subsidence monitoring programs that are implemented or planned for the FRS #3 and the FRS #4 structures.

In addition to the direct survey of established monuments, groundwater monitoring should be conducted using the water level data from wells in the project area that are included in the public GWSI data base maintained by ADWR. Additionally, InSAR data analysis and interpretation are key monitoring elements that should be integrated into the monitoring program.

In addition to InSAR data, ADWR has another product available that could be used for land subsidence monitoring. This product is formed by using a Coherent Target Monitoring (CTM) routine. This monitoring technique can be used over smaller portions of the InSAR frame and it identifies coherent targets on the ground that consistently reflects the radar signal during each satellite pass. Utilization of this tool may provide deformation results in an area that was previously masked. The sites of interest that could be used for CTM along the Outfall Channel alignment could be street/culvert intersections or other structure expected to be fixed throughout a long time period. We recommend the District pursue discussion with the ADWR for the possible application of the CTM technique to the FRS #3 Outfall Channel and other District sites located in subsidence prone area.

7.2 Emergency Spillway Crossing

- The emergency spillway crossing should be constructed in a manner to satisfy the Arizona Department of Water Resources, Dam Safety (ADWR) and the National Resources Conservation Service (NRCS) dam safety and spillway design criteria.

- Because of potential for spillway erosion during a discharge when the spillway flow intersects the concrete box culvert (CBC), earth fills should not be used for the construction process. The expected moderately to well-cemented character of the soils along the proposed alignment through the emergency spillway should provide relatively stable temporary cut slopes to permit the installation of and HDPE piping system or concrete box culvert to be cast-in-place. An alternative to the cast-in-place CBC could be the utilization of precast concrete box elements integrally tied together and supported in a manner to resist differential settlement and using high-strength concrete slurry to backfill the open space between the cut slope and the box culvert exterior.

- Upstream erosion protection should be provided from the upstream edge of the box culvert. This upstream erosion protection should include coarse, angular stone riprap that is large enough to resist the peak spillway flows. It may be possible to use smaller size stone but in may be necessary to grout the small stone in-place for create a grouted riprap blanket. The design width of the riprap apron and its thickness must be determined using a riprap design program acceptable to both the ADWR and the NRCS.

- If the dual HDPE pipeline alternative is used for the Emergency Spillway Crossing, appropriately graded structural earth fill should be used to backfill the excavation to an elevation of three feet below the Emergency Spillway grade. An appropriately designed soil cement using site soils should be mixed in-place and compacted to form a soil cement cap 18 inches thick on top of the pipeline earth backfill.

Erosion protection for the pipeline excavation, backfill, and spillway channel should be provided for the pipeline area from the top of the soil cement cap to the Emergency Spillway grade and upstream from the upstream edge of the pipeline excavation. As stated previously, this upstream erosion protection should include coarse, angular stone riprap that is large enough to resist the peak spillway flows. It may be possible to use smaller size stone but in may be necessary to use the smaller stones in a grouted riprap blanket. The design width of the riprap apron and its thickness must be determined using a riprap design program acceptable to both the ADWR and the NRCS.

8.0 General Conditions

The geological, land subsidence and earth fissure observations, findings, conclusions, and recommendations presented in this memorandum report for the assessment related to the White Tanks No. 3 FRS Outfall Channel Final Design and the interpretations made relied on information gathered from a variety of sources including FCDMC, ADWR, USGS, NGS, URS, AMEC and published documents in Geological Consultants Inc. library. These sources are believed to be reliable and appropriate for the evaluation of land subsidence and earth fissures and for application reasonable recommendations to mitigate future potential land subsidence and earth fissures that could possible impact the FRS #3 Outfall Channel.

It must be recognized that subsurface geologic, soils, and hydrogeological conditions may vary from place to place, over time, and from those found at locations where measurements or surveys were made by others to provide data used the investigator. No warranty or representation, either expressed or implied, is or should be construed regarding geological, soil, or hydrogeological conditions at locations other than those described in this report. Verification of the subsurface conditions, survey data, and other data provided by the various sources was beyond the scope of this investigation. The land subsidence predictions presented in this report used the best information and data available at the time of this evaluation. Although there may be uncertainties in the predicted subsidence estimates, the interpretations made and the assumptions used to render opinion regarding predicted land subsidence are believed to be reasonable.

The services provided by Geological Consultants Inc. were performed in accordance with generally accepted geological principles and standard practices used by members of the geological profession in this locale at the time of this study.

9.0 Bibliography

ADWR; 2004; InSAR Interferometry Data: DifSAR Deformation Data July 10, 1992 to October 30, 2000 (5 cm/full fringe)

AMEC; 2009; Draft Preliminary Ground Subsidence and Earth fissure Evaluation, White Tanks FRS No. 3 Outfall Channel, Maricopa County, Arizona; prepared by AMEC Earth & Environmental, Inc., Tempe, Arizona; AMEC Job No. 0*9-117-01019 for Flood Control District of Maricopa County, FCD Contract No. 2008-C016, Work Assignment 9; July 31, 2009; 11 p.

AMEC; 2004; Preliminary Geotechnical Investigation Report, White Tanks FRS No. 3, Contract FCD 2003C014, Work Assignment 1; prepared by AMEC Earth & Environmental, Inc., Phoenix, Arizona; AMEC Project No. 4-117-001040 for Flood Control District of Maricopa County, FCD Contract No. 2003-C014, Work Assignment 3; June 16, 2004; 11 p. ; 27 p.

AMEC; 2004; Supplemental Appraisal of Earth Fissure Risk, White Tanks FRS No. 3, Contract FCD 2003C014, Work Assignment 1; prepared by AMEC Earth & Environmental, Inc., Phoenix, Arizona; AMEC Project No. 3-117-001076; 27 p.

Arizona Geological Survey (AzGS); 2009; Earth Fissure Map of the Luke Study Area, Maricopa County, Arizona; Scale 1:24,000; Digital Map Series, Earth Fissure Map 8 (DM-EF-8); February 2009.

Bureau of Reclamation (BOR); 1976; Central Arizona Project Geology and Groundwater Resources Report, Maricopa and Pinal Counties, Arizona; Volumes 1 and 2; December 1976.

Conway, B. D.; 2009; InSAR Interferograms and Interferometry Data: DifSAR Deformation Data October 4, 2003 to November 21, 2009; Arizona Department of Water Resources, Deliverable 9, IGA FCD 2005A005, December 3, 2009.

Dames & Moore; 1998; Draft Design Issues Report, White Tanks FRS No. 3, Modifications Design Project for Flood Control District of Maricopa County; Contract No. FCD98-11, PCN 4700430; D & M Project No. 15448-005-022; November 20, 1998.

Field, J.J. and Pearthree, P.A.; 1991; Surficial Geology Around the White Tank Mountains, Central Arizona; Arizona Geological Survey; Open-File Report 91-8, November 1991; 7 p.

Geological Consultants Inc.; 2009: consultant letter from Geological Consultants Inc. to Hoskin Ryan Consultants Inc., November 27, 2009 for Flood Control District of Maricopa County entitled *Review of AMEC Report, Draft Preliminary Ground Subsidence and Earth Fissure Evaluation, White Tanks FRS No. 3 Outfall Channel, Maricopa County, Arizona*; GCI Project No. 2009-129, HRC PCN 470.04.32, FCD Contract 2009C012; 8 p.

Geological Consultants Inc.; 2008; Seismic Refraction Survey Results, White Tanks FRS No. 3 Remediation Project, October 2008 Additional Phase II Investigation, Maricopa County, Arizona; prepared by Geological Consultants Inc. Phoenix, Arizona, GCI Project No. 2008-162 for URS Corporation & Flood Control District of Maricopa County, FCD Contract 2003C055; November 20, 2008; 5 p.

Geological Consultants Inc.; 2008; Technical Memorandum, Geological and Geologic Hazard Evaluation, White Tanks FRS No. 4; prepared by Geological Consultants Inc. Phoenix, Arizona, GCI Project No. 2004-159 for Gannett Flemming Inc. & Flood Control District of Maricopa County, FCD Contract 2004C019, Work Assignment 6; April 15, 2008; 21 p.

Geological Consultants Inc.; 2006; Foundation Inspection Report, White Tanks No. 3 FRS Remediation Project, Phase I Construction, Maricopa County, Arizona; prepared by Geological Consultants Inc., Phoenix, Arizona; GCI Project No. 2003-162-02 for URS Corporation & Flood Control District of Maricopa County, FCD Contract 2003C055; January 31, 2006; 8 p.

Geological Consultants Inc.; 2004; Subsidence at White Tanks FRS No. 3, Historical and Predictive Subsidence Assessment, prepared by Geological Consultants Inc. Phoenix, Arizona, GCI Project No. 2003-162 for URS Corporation & Flood Control District of Maricopa County, FCD Contract 2003C055; May 17, 2004; 19 p.

Geological Consultants Inc.; 2004; Seismic Refraction Geophysical Survey, Work Assignment No. 2, White Tanks FRS No. 3 Remediation Project; prepared by Geological Consultants Inc. Phoenix, Arizona, GCI Project No. 2003-162 for URS Corporation & Flood Control District of Maricopa County, FCD Contract 2003C055; August 30, 2004; 19 p.

Geological Consultants Inc.; 2002; Geological Input to Structures Assessment Report, McMicken Dam and White Tanks FRS No. 4, Maricopa County, Arizona; prepared by Geological Consultants Inc. Phoenix, Arizona, GCI Project No. 2001-125 for URS Corporation & Flood Control District of Maricopa County, FCD Contract 2001C012; August 30, 2002; 32 p.

Hoskin-Ryan Consultants Inc (HRI), 2009; 30% Plans for the Construction of White Tanks FRS No. 3 Outfall Channel, PCN 470.04.32, FCD Contract No. 2007C016 (4); July 1, 2009; 55 sheets.

National Geodetic Survey (NGS); 2003; NGS Level Line Survey Data Files: Level Line L12530 (December 17, 1947 to April 23, 1948), L21029 (February 8, 1967 to April 21, 1967), and L24555/2 (December 15, 1980 to March 26, 1981).

Schumann, H.H. and O'Day, C.M.; 1995; Investigation of Hydrogeology, Land Subsidence, and Earth Fissures, Luke Air Force Base, Arizona; U.S. Geological Survey, Administrative Report, prepared in cooperation with U.S. Air Force.

Schumann, H.H. and Genualdi, R.B.; 1986; Land Subsidence, Earth Fissures, and Water-Level Change in Southern Arizona; Arizona Bureau of Geology and Mineral Technology; Open-File Report 86-14.

Schumann, H.H.; 1974; Land Subsidence and Earth Fissures in Alluvial Deposits in the Phoenix Area, Arizona; U.S. Geological Survey; Map I-845-H.

Southwest Ground-water Consultants (SGC); 1998; consultants report entitled Luke Salt Body in Vicinity of Dreaming Summit Development, Maricopa County, Arizona; 10 p.

URS Corporation; 2005; Geotechnical Data Report, White Tanks FRS No. 3 Remediation Project, URS PCN 470.04.30; URS Job No. 23443748; Prepared for Flood Control District of Maricopa County, FCD Contract No. 2003C055; March 2005.

URS Corporation; 2005; Supplemental Design and Geotechnical/Geophysical Investigation Report, White Tanks FRS No. 3 Remediation Project, Phase 1, URS PCN 470.04.30; URS Job No. 23443748; Prepared for Flood Control District of Maricopa County, FCD Contract No. 2003C055; March 2005.

URS Corporation; 2004; 90 Percent Submittal, Draft Design Report, White Tanks FRS No. 3 Remediation Project Phase 1, URS PCN 470.04.30; URS Job No. 23443748; Prepared for Flood Control District of Maricopa County, FCD Contract No. 2003C017; September 13, 2004.

APPENDIX A

Consultant letter from Geological Consultants Inc. to Hoskin Ryan Consultants Inc.

Review of AMEC Report, Draft Preliminary Ground Subsidence and Earth Fissure Evaluation, White Tanks FRS No. 3 Outfall Channel, Maricopa County, Arizona

November 27, 2009

GCI Project No. 2009-129, HRC PCN 470.04.32, FCD Contract 2009C012.

KENNETH M. EUGE, R.G.

REGISTERED GEOLOGIST CERTIFICATE NO. 10338 KENNETH M. EUGE Date Signed 11/27/09 ARIZONA, U.S.A. EXP. 09-30-2011

November 27, 2009

Hoskin Ryan Consultants Inc.
201 W. Indian School Road
Phoenix, AZ 85013-3203

Attention: Mr. Paul W. R. Hoskin, P.E.
Project Principal

Subject: Review of AMEC Report: *Draft Preliminary Ground Subsidence 7 Earth Fissure Evaluation, White Tanks FRS No. 3 Outfall Channel, Maricopa County, Arizona* (July 31, 2009).
GCI Project No. 2009-129
HRC PCN 470.04.32
FCD Contract No. 2009C012

Dear Mr. Hoskin:

The subject AMEC report was contracted by the Flood Control District of Maricopa County (District) to provide a preliminary ground subsidence and earth fissure evaluation for the proposed White Tanks FRS No. 3 outlet channel beginning at the White Tanks FRS No.3 (WT #3) principal spillway outlet and ending downstream at the inlet to White Tanks FRS No. 4 (WT #4). The evaluation relied on an appraisal of available technical data, the interpretation of selected remote sensing data, available aerial photography, and limited ground reconnaissance of the Project area. The goal of the AMEC evaluation was to assess the potential impacts of earth fissuring and ground subsidence on the design and operation of the outlet channel.

Geological Consultants Inc. (GCI) has completed its review of the subject AMEC report as required in the Project Scope of Work (Task 8.2.4). Based on our review of the results and findings of the AMEC assessment and our professional experience obtained from ground subsidence and earth fissure evaluations at and in the vicinity of WT #3 and WT #4, we are including our comments, opinions and recommendations for additional analyses that we believe are necessary to thoroughly assess ground subsidence and earth conditions in the project area.

The review-order of the comments, opinions, and recommendation we are providing herein parallel the general format of the AMEC report that includes the following items:

- Investigative approach
- Geological setting
- Hydrogeological conditions
- Discussion
- Conclusions and recommendations.

2333 West Northern Avenue, Ste 1A, Phoenix, Arizona 85021 | phone 602.864.1888 | fax 602.864.1899 | www.geologicalconsultants.com

Investigative Approach

AMEC's investigative approach for this ground subsidence and earth fissure evaluation is generally consistent with the current methodology used by practicing, experienced, and registered geologists and engineering working on similar projects in Arizona and other ground subsidence and earth fissure prone areas.

Review of Existing Data: The draft report states that several data sources, including "relevant District reports," were reviewed; however, reports related to the WT #3 dam modifications and remediation design project, including the site-specific geotechnical investigations, prepared by URS Corporation were not addressed in the AMEC draft report. Also, a report prepared by GCI (a subconsultant to URS) that discusses historical subsidence in the WT #3 area was not included in the review. The draft report also states that the information has been compiled, digitized, and presented in tabular or graphic formats. However, no tables or graphical presentations are provided relative to the time history and magnitude of ground subsidence that has taken place in the project area.

Comment 1: *We recommend a more thorough search, and assessment, of the available data base be conducted and that the compilation of findings be made in such a manner to permit an independent evaluation of the data as it relates to ground subsidence and earth fissure impacts in the project area as well as the subsurface conditions that could impact the selection of a suitable design alternative for the outfall channel within the WT #3 earth fissure risk zone. We also recommend that tables and graphics be included in the final report to document the time history, magnitude, and rates of ground subsidence that has occurred along and in the immediate vicinity of the proposed WT #3 outfall channel alignment.*

Synthetic Aperture Radar Interferometry (InSAR): Interferograms derived from different satellite platforms for the periods from 1996 to 2008 were compiled and analyzed by AMEC. The elevation changes between two orbital observations relied on the interpretation of the color cycles depicted on the interferograms. Data from an older interferogram (1992 to 2000) (GCI, 2004) was not included in the AMEC's InSAR evaluation.

Comment 2: *We recommend the older InSAR interferograms be included in the data evaluation. Also, graphical presentation DiffSAR data that parallels the proposed outfall channel alignment, similar to the DiffSAR elevation profile presented in the WT #3 historical subsidence assessment (GCI, 2004), be included, and updated, to assist with the identification of historical subsidence trends and target areas along the outfall channel alignment where differential elevation changes of the channel invert grade could occur over time.*

High Resolution Aerial Photography: High resolution, color aerial photography is an excellent tool for the photo-interpretation of linear or curvilinear surface features that could represent earth fissure features. Several lineaments possibly representing earth fissures were identified on the aerial photographs included in their draft report. We performed a cursory examination of the aerial photography provided in the draft report. As a result of that examination we identified several additional lineaments or "suspect" linear and curvilinear features.

Comment 3: *We recommend the high resolution aerial photographs be reexamined and reinterpreted to identify and characterize all suspect features.*

Ground Reconnaissance: AMEC indicated in the draft report that "all lineaments with the study area with the potential to impact proposed facilities were observed on the ground." However, based on our examination and interpretation of the aerial photographs provided in the AMEC draft report, we identified several additional lineaments within the study area that in our opinion warrant a field inspection. However, based on the results of the photo-interpretations made by AMEC of the features they identified and well as the suspect features ground reconnaissance conducted by GCI in the project area related to WT #3, WT #4, and others nearby sites, it is likely that the additional lineaments that we identified on the aerial photographs will ultimately prove to be unrelated to earth fissures.

Comment 4: *We recommend the additional "suspect" features identified from the reinterpretation of the high resolution aerial photographs be field checked.*

Geological Setting

The description of the geological setting, including the Geologic Overview, Regional Alluvial Stratigraphy, and Surficial Geology adequately present the general geology and surface soil conditions along the proposed WT #3 outfall channel alignment.

Specific stratigraphic relationships of the Holocene and Pleistocene geologic/soil units along the proposed outfall channel alignment, particularly in Reach 8 and 9 where a potential earth fissure risk zone has been identified by AMEC, have not been characterized. The subsurface position of the Holocene/Pleistocene boundary, in our opinion, is critical for the design of proposed earth fissure risk zone mitigation alternatives that may be proposed along the outfall channel alignment.

Comment 5: *We recommend a stratigraphic profile, similar to the stratigraphic soil profile constructed for the design of the WT #3 cutoff wall, be constructed that clearly depicts the Holocene/Pleistocene boundary along the proposed outfall channel alignment.*

Hydrogeological Conditions

A very general description of the hydrogeological conditions and the historical water level elevation changes of the West Salt River Valley (WSRV) is provided in the AMEC draft report. Detailed data is limited to a well location map with a few ADWR hydrographs (AMEC (2009), Figure 4). Some of the hydrographs provided in Figure 2 depict relative short time-histories. We realize that detailed ADWR groundwater data can be very sparse. However, there are a few wells in the WT #3/WT #4 area that have record dating back to the 1940s (GCI, 2004; URS, 2004).

Commetn 6: *We recommend the discussion of the hydrogeological conditions be expanded to include ADWR well data that can provide a better time-history of water level elevation changes and trends from wells within one mile of the proposed outfall channel alignment. Groundwater level contour maps should be included.*

Discussion

Subsidence and Earth Fissure History of the Study Area: The AMEC draft report briefly describes the amount of ground subsidence that has taken place at WT #3 using District data that was included in their 2004 reports and in a report by Schumann (1992). The magnitude of ground subsidence in the WT #4 area is based on information provided in GCI (2008) and AMEC (2009) reports.

Additional information documenting the ground subsidence history in the WT 3# area and along the Beardsley Canal is available in a subsidence assessment report prepared by GCI (2004) as part of the WT #3 design studies for dam modifications.

Comment 7: See Comment 1

The AMEC report states that the available historic NGS level data along the Beardsley Canal south of Bethany Home Road is of limited usefulness. We concur with that statement because of the few readings that are available in the NGS data base. However, AMEC implies that the NGS data north of Bethany Home Road, which includes Reach 9 of the outfall channel, is better quality.

Comment 8: In our opinion the historic NGS data available for the Project area has value and is useful, particularly the in the WT #3 area. We recommend tabular time-history summaries and graphical presentations of these data be provided in the final AMEC report.

AMEC states that there are no documented earth fissures within the Project area. Considering the results of GCI's subsidence investigations in the project area and the earth fissure field reconnaissance conducted as part of those investigations, we concur with AMEC's statement. AMEC also states "The earth fissure risk zone present at White Tanks FRS No. 3. . . . has an elevated risk for formation of earth fissures in the future." No discussion or narrative is provided in the report that describes or summarizes the basis or rational for the "earth fissure risk zone."

Comment 9: We recommend that the final report include a discussion or narrative describes or summarizes the basis or rational for the "earth fissure risk zone".

Several InSAR images were evaluated by AMEC for the Project area between 1996 and 2008. Other earlier images are available back to 1992. DiffSAR data, which is also available for various time periods, was not discussed in the draft report.

Comment 10: See Comment 2

Lineament Analysis: This section of the report summarizes the results of the lineament analysis and stats that "No features suspected of being earth fissures were identified during this investigation." As we stated previously, our interpretation of the high resolution aerial photographs provided in the AMEC report revealed several additional "suspect" linear features that in our opinion warrant field examination.

Comment 11: See Comment 3

Subsidence and Earth Fissure Risk Zones: A statement is made by AMEC that differential subsidence has taken place along the proposed outfall channel alignment exists and in the future ongoing differential subsidence could pose a risk the outfall channel operations. This risk, which appears to be greatest along Reach 8 and 9, consist of potential subsidence-induced gradient increase, or reversal, changes along the alignment that could result in channel erosion where gradient increases, sediment deposition where gradients decrease to reduce flow velocity, and ultimately a flow reversal. We concur with AMEC statement regarding potential for differential ground subsidence to occur along the proposed outfall channel alignment.

Comment 12: Considering the fact that ground subsidence-induce channel gradient and flow reversal have occurred in the West Salt River Valley (Dysart Drain near Luke Air Force Base), additional details should be provided in the report to better characterize the potential extent and portion of the outfall channel alignment that could be subjected to the risks of differential ground subsidence.

Although an earth fissure mitigation decision matric is provided in the AMEC report, the delineation of specific earth fissure risk zones was not performed. One of the reasons given for not providing the delineation was ". . . the potential for the misinterpretation of the earth fissure risk zones by landowners along the Project alignment." If potential misunderstanding could result from the specific delineation of earth fissure risk zones, we find it difficult to understand why each reach of the Project was assigned to an earth fissure risk zone.

Comment 13: Considering the fact that the District is a landowner and controls the easements along the outfall channel right-of way, in our opinion specific earth fissure risk zones should be delineated along the alignment.

The earth fissure risk zones included in the decision matrix, defined as Zones 1, 2, 3, and 4, are described in the AMEC report. Key factors in determining if an area is in one of these zones is the presence, absence, or proximity of known, documented earth fissures and evidence that an area has experienced, is experiencing, or is expected to experience measurable amounts of ground strain.

Comment 14: In our opinion, additional discussion should be provided to define the basis for the statement made that an area has experience measurable strain (Zone 1) and the presence and definition of "elevated" ground strain (Zone 2). The "indications" that the strain experienced in an area is low (Zone 3) should be described. It is obvious that for the Zone 1 definition that the critical strain threshold has been exceeded where known earth fissures are present. It would seem to be appropriate to include a discussion of the strain thresholds for each of the zone.

Conclusion and Recommendations

We agree with the conclusions and recommendations provided in the AMEC draft report regarding:

- Monitoring of groundwater trends in key wells in the Project area.
- Directly monitoring subsidence trends using periodic surveys along the outfall channel alignment and the periodic analysis of InSAR data.

Comment 15: We recommend DiffSAR data also be included in the periodic analysis.

- Permanent survey monument installations at one-half mile centers along the outfall channel alignment and level, or GPS, surveys of these monuments at an established monitoring frequency that should be adjusted to subsidence trends documented from the surveys.
- Incorporation of design elements into the outfall channel design to accommodate future potential ground subsidence.

Comment 16: Considering the long-term operation and performance of the outfall channel would be degraded due to ongoing ground subsidence, we suggest "worst case scenarios" considerations be given to the selection of ground subsidence mitigation design alternatives.

- Special design considerations are warranted for the outfall channel reaches potentially impacted by future potential earth fissures.

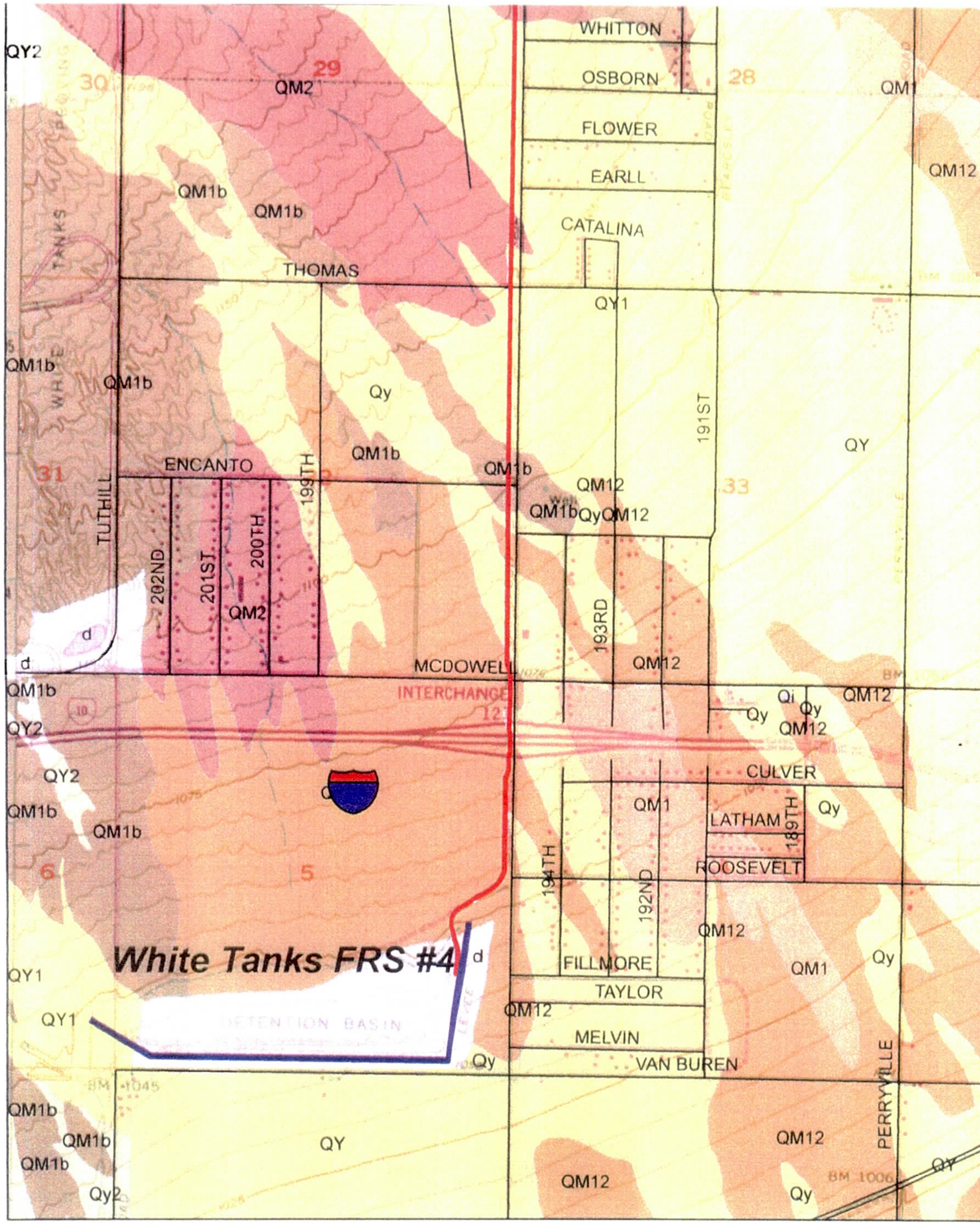
Comment 17: The special design(s) for the outfall channel earth fissure risk zone crossing should be commensurate with the level of earth fissure risk defined along the White Tanks FRS No. 3 outfall channel.

Thank you for the opportunity to provide this review for you and the District. We look forward to responding to your questions concerning our review.

Very truly yours,
GEOLOGICAL CONSULTANTS INC.

Kenneth M. Euge, R.G.
Principal Geologist.

APPENDIX F
GEOLOGIC MAP



X/K/T Bedrock: granitic & metamorphic rock units, undifferentiated

d Disturbed ground due to human activity.

N

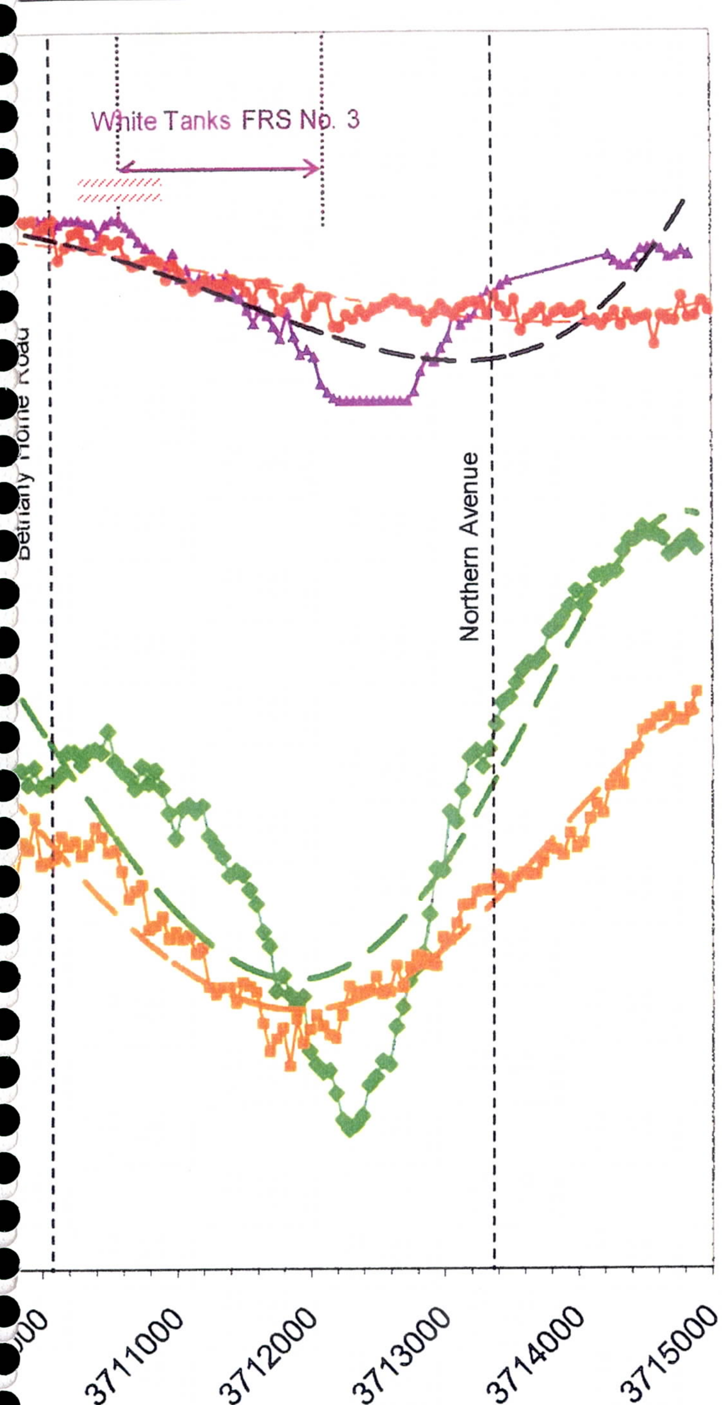
1:26,210
Scale: 1 inch = 2,000 feet

Note: Geologic map modified from Field & Pearthree (1991).

Geological / GeotechnicalEvaluation
WT #3 Outfall Channel
Geologic Map
Figure 4

GEOLOGICAL CONSULTANTS INC.
2333 West Northern Ave, Suite 1A
Phoenix, AZ 85021
phone 602-864-1888
fax 602-864-1899

APPENDIX G
HISTORICAL LAND SUBSIDENCE



EXPLANATION:

Jackrabbit Road Alignment

Differential InSAR data point: 2003-2009

5th Order polynomial trend line

Differential InSAR data point: 1992-2000

5th Order polynomial trend line

Beardsley Canal Alignment

Differential InSAR data point: 2003-2009

5th Order polynomial trend line

Differential InSAR data point:1992-2000

5th Order polynomial trend line

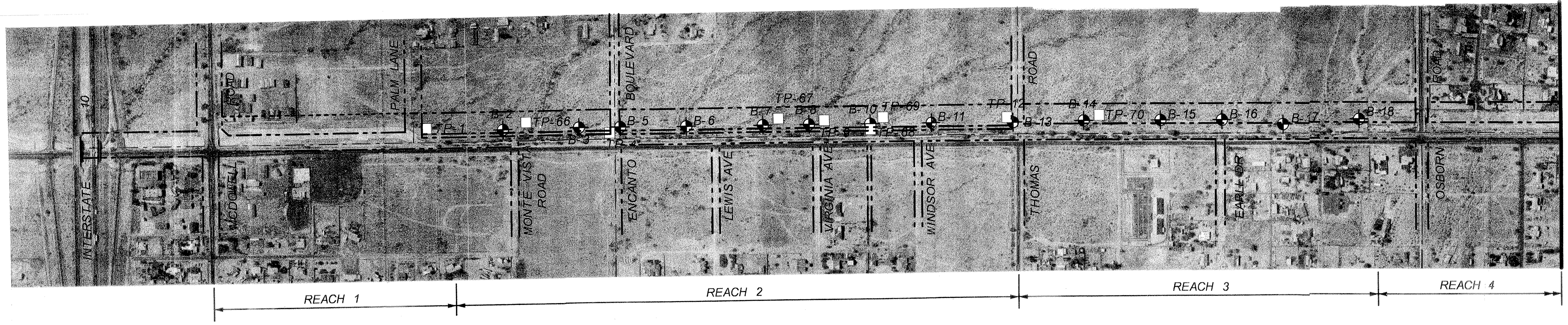
Portions of Jackrabbit Road & Beardsley Canal alignments with decorrelated InSAR data or data indicating positive change in ground surface elevation; 1992-2000 data set.

Portions of Outfall Channel alignments possibly subject to grade changes due to future potential ground subsidence.

ANAL ALIGNMENT

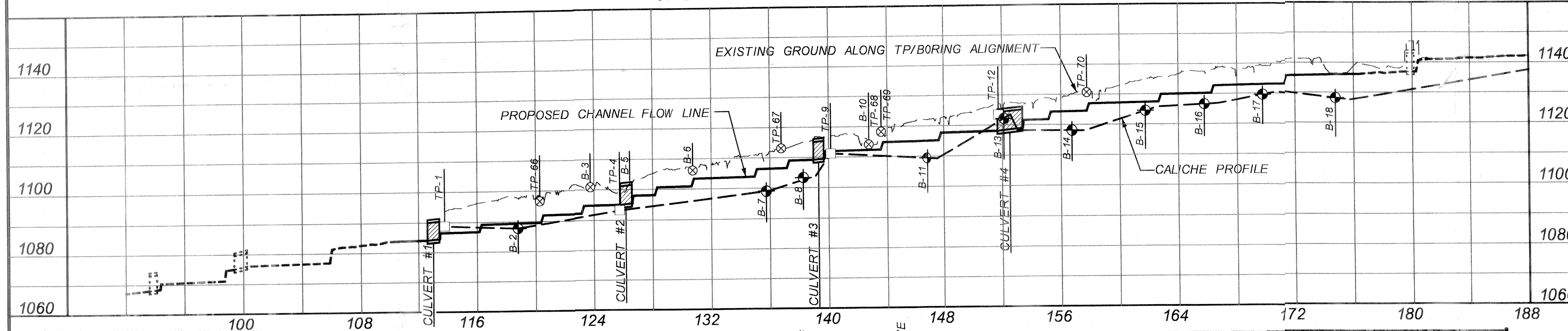
FCD 2009C012

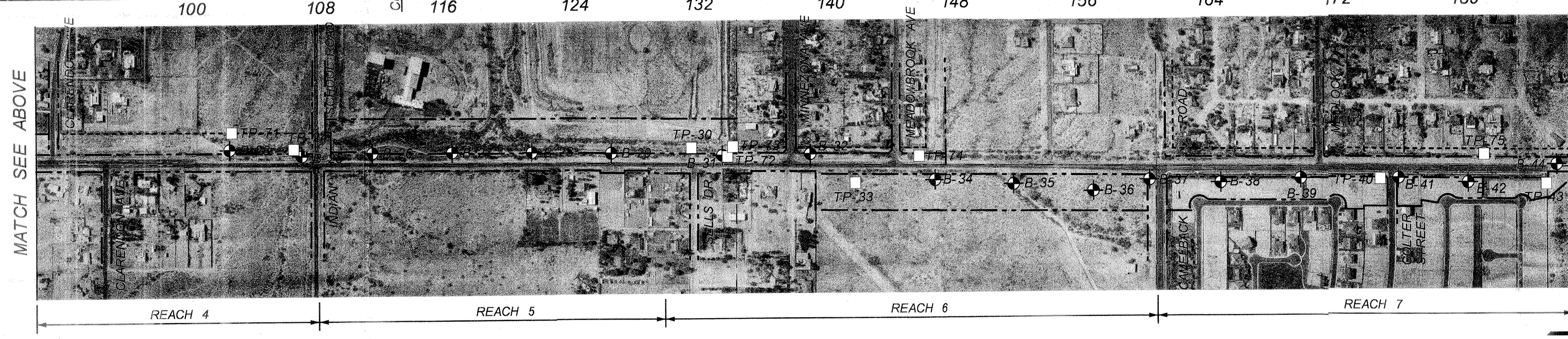
APPENDIX H
GEOLOGICAL PLAN PROFILE



200 0 200 400
Scale: 1"=400' Horiz.
Scale: 1"=20' Vert.

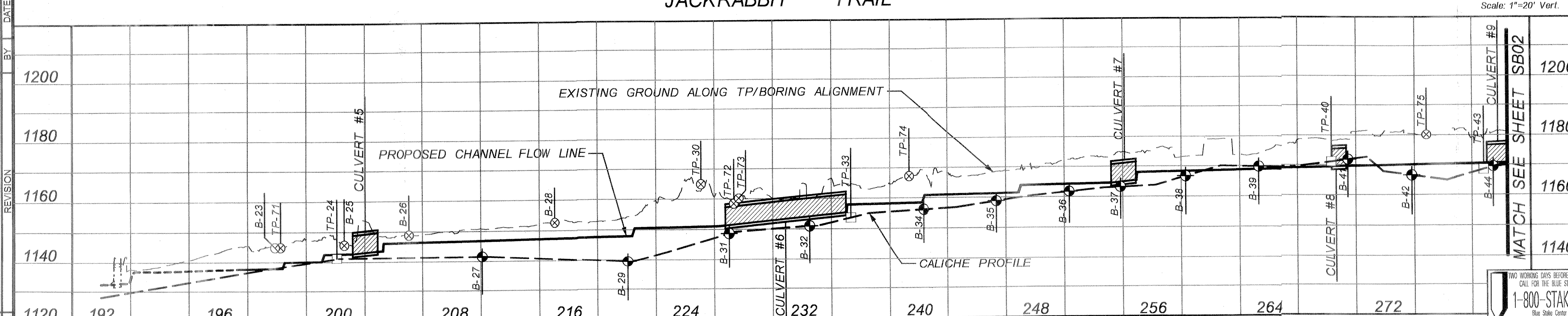
JACKRABBIT TRAIL





200 0 200 400
Scale: 1"=400' Horiz.
Scale: 1"=20' Vert.

JACKRABBIT TRAIL



REVISION | NO. 1 2 3 | BY | DATE

TWO WORKING DAYS BEFORE YOU DIG CALL FOR THE BLUE STAKES
1-800-STAKE-IT

G:\Projects\2009\09-077 WTO3 Final\03 - 90% Design\- SOILS BORINGS.dgn
8/4/2010

LEGEND

- EXISTING GROUND
- CALICHE PROFILE INTERPRETATION BASED ON BORINGS AMD
- BORING LOCATIONS
- TRENCH PIT LOCATIONS
- B-1 BORING NO.
- TP-1 TRENCH PIT NO.
- BORINGS WITH LIMITED DRILL HOLE LOG DATA THAT DO NOT PERMIT INTERPRETATION OF THE CALICHE BOUNDARY CONDITIONS OR BORING AND TEST PITS THAT WERE NOT USED TO INTERPRET BOUNDARY
- PROPOSED CHANNEL FLOW LINE
- EXISTING CHANNEL PROFILE
- CONCRETE BOX CULVERT
- STORM DRAIN PIPE

NOTES:

CALICHE BOUNDARY IS APPROXIMATE AND MAY NOT ACCURATELY DEPICT INSITU CONDITIONS BETWEEN DRILL HOLE AND TEST PIT LOCATIONS. BOUNDARY TRANSITIONS MAY BE ABRUPT, GRADUAL, OR PINCH OUT BETWEEN DRILL HOLE AND TEST PIT LOCATIONS.

FOR DETAILED INFORMATION ON BORINGS & TEST PITS SEE GEOTECHNICAL REPORT PREPARED BY ALPHA.

DATED ____________

GEOLOGICAL CONSULTANTS INC.

Alpha Geotechnical & Materials, Inc.

Hoskin • Ryan Consultants
creative engineering solutions
6245 N. 24th Parkway, Suite 100, Phoenix, Arizona 85016
Office: (602) 252-8384 Fax: (602) 252-8385 www.hoskinryan.com

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY ENGINEERING DIVISION

WHITE TANKS FRS NO. 3 OUTFALL CHANNEL FCD 2009C012

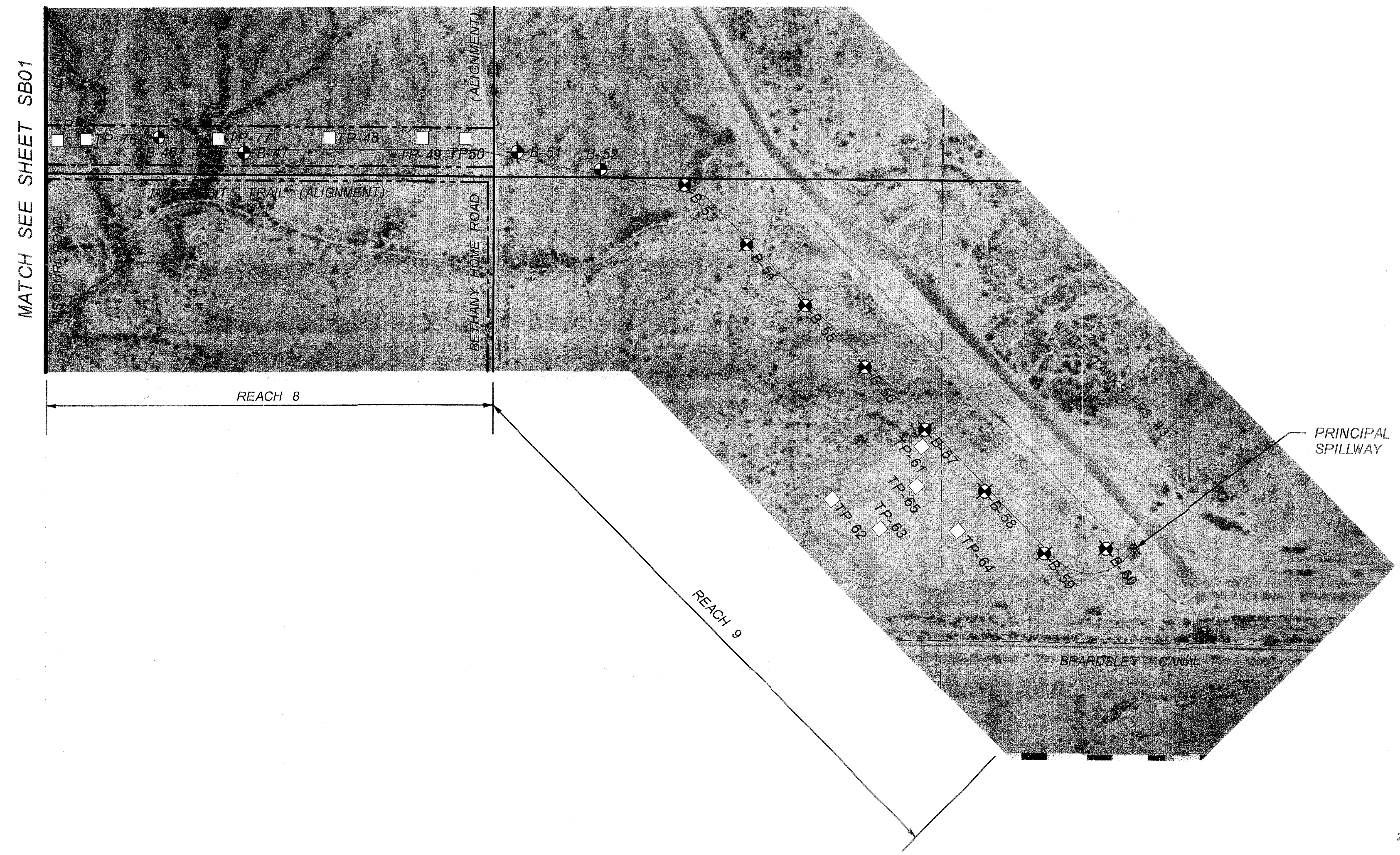
60% SUBMITTAL

	BY	DATE
DESIGNED		
DRAWN		
CHECKED		

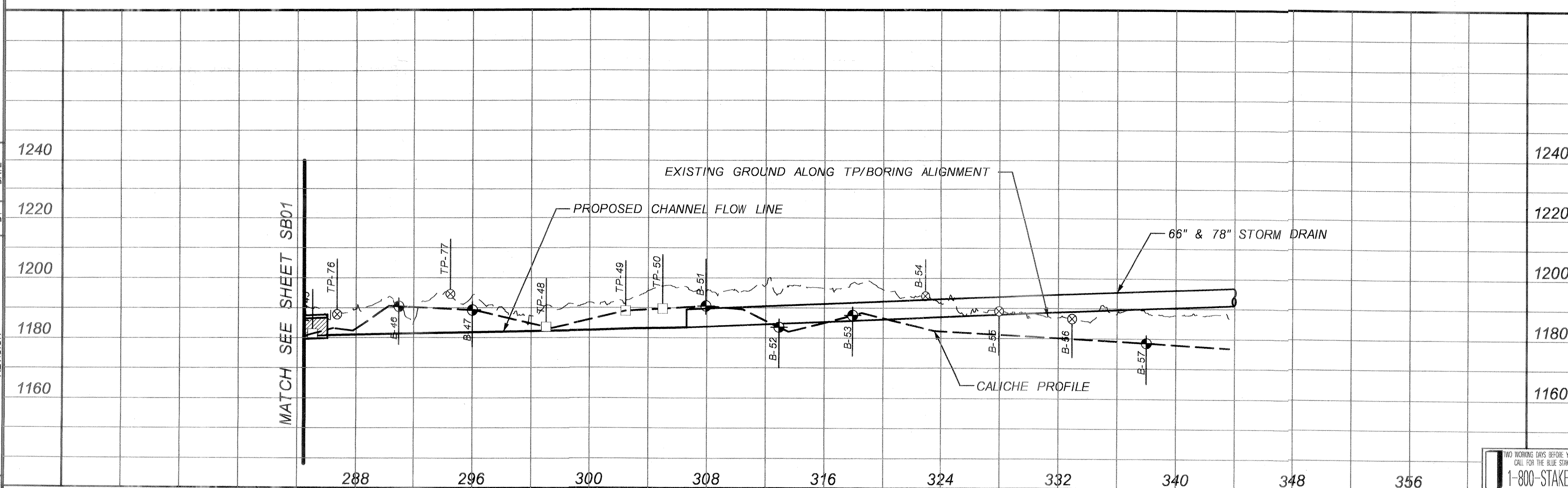
GEOLOGICAL PLAN AND PROFILE

DRAWING NO. SB01 | SHEET 1 OF 2

GENERAL | QUANTITIES | DETAILS | CIVIL CONSTRUCTION | STRUCTURES | LANDSCAPE | CROSS SECTIONS | SOIL BORINGS



JACKRABBIT TRAIL



NO.	REVISION	BY	DATE
1			
2			
3			

G:\Projects\09\09-077 W103 Final\03 - 90% Design\E-SOILS BORINGS.dgn
8/4/2010

LEGEND

- EXISTING GROUND
- CALICHE PROFILE INTERPRETATION BASED ON BORINGS AMD
- BORING LOCATIONS
- TRENCH PIT LOCATIONS
- B-1 BORING NO.
- TP-1 TRENCH PIT NO.
- ⊗ BORINGS WITH LIMITED DRILL HOLE LOG DATA THAT DO NOT PERMIT INTERPRETATION OF THE CALICHE BOUNDARY CONDITIONS OR BORING AND TEST PITS THAT WERE NOT USED TO INTERPRET BOUNDARY
- PROPOSED CHANNEL FLOW LINE
- EXISTING CHANNEL PROFILE
- CONCRETE BOX CULVERT
- STORM DRAIN PIPE

NOTES:

CALICHE BOUNDARY IS APPROXIMATE AND MAY NOT ACCURATELY DEPICT INSITU CONDITIONS BETWEEN DRILL HOLE AND TEST PIT LOCATIONS. BOUNDARY TRANSITIONS MAY BE ABRUPT, GRADUAL, OR PINCH OUT BETWEEN DRILL HOLE AND TEST PIT LOCATIONS.

FOR DETAILED INFORMATION ON BORINGS & TEST PITS SEE GEOTECHNICAL REPORT PREPARED BY ALPHA.

DATED ____________

GEOLOGICAL CONSULTANTS INC.

Alpha Geotechnical & Materials, Inc.

Hoskin • Ryan Consultants
creative engineering solutions
6245 N. 24th Parkway, Suite 100, Phoenix, Arizona 85016
Office: (602) 252-8384 Fax: (602) 252-8385 www.hoskinryan.com

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY ENGINEERING DIVISION

WHITE TANKS FRS NO. 3
OUTFALL CHANNEL
FCD 2009C012

60% SUBMITTAL

	BY	DATE
DESIGNED		
DRAWN		
CHECKED		

GEOLOGICAL PLAN AND PROFILE

DRAWING NO. | SHEET 2 OF 2

TWO WORKING DAYS BEFORE YOU DIG CALL FOR THE BLUE STAKES 1-800-STAKE-IT Blue Stake Center 1-800-782-5348

GENERAL | QUANTITIES | DETAILS | CIVIL CONSTRUCTION | STRUCTURES | LANDSCAPE | CROSS SECTIONS | SOIL BORINGS