Geotechnical Engineering Report

Sabino Canyon Road Extension

Mullins Landfill Bridge

Tucson, Arizona

February 25, 2014

Terracon Project No. 63125005

Prepared for:

PSOMAS

Tucson, Arizona

Prepared by:

Terracon Consultants, Inc.

Tucson, Arizona

February 25, 2014

Terracon

PSOMAS
800 East Wetmore Road
Suite 110
Tucson, Arizona 85719

Attn: Kevin Thornton, P.E.
Ph: (520) 690-7866

RE: Geotechnical Engineering Report
Sabino Canyon Road Extension
Mullins Landfill Bridge
Tucson, Arizona
Terracon Project No. 63125005

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. These services were performed in general accordance with our proposal number P63100454, dated December 1, 2010. The results of our engineering analyses, including the results of the subsurface engineering exploration and foundation design analyses recommendations for construction of foundations for the Mullins Landfill Bridge are attached.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

REGISTERED PROFESSIONAL ENGINEER (Civil) CERTIFICATE NO. 25003 SCOTT D NEELY Date Signed 2-25-14 ARIZONA U.S.A. Expires 9/30/2015

Scott D. Neely, P.E.
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Brent M. Borchers, P.E.
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Copies to: Addressee (1 via email, 1 via mail)

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EXHIBIT NO.

Appendix S – Mullins Landfill Bridge – South Abutment – Drilled Shaft Axial Load Analyses Results

GEOTECHNICAL ENGINEERING REPORT
SABINO CANYON ROAD EXTENSION
MULLINS LANDFILL BRIDGE CROSSING
TUCSON, ARIZONA

Terracon Project No. 63125005
February 25, 2014

1.0 INTRODUCTION

This report presents the final results of our geotechnical engineering services performed for the bridge crossing the Mullins Landfill in Tucson, Arizona. This is part of the Sabino Canyon Road Extension Project. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- seismic considerations
- foundation recommendations
- groundwater conditions
- lateral earth pressures

Our geotechnical engineering scope of work for this portion of the project included the advancement of an additional 15 test borings to depths of approximately 100 feet below existing site grades. This report and our analyses includes the data from one boring performed for our previous Project No. 63105043, Boring No. B-2, which was drilled to an approximate depth of 61½ feet below existing site grade.

Logs of the borings along with a Site Plan and Boring Locations Diagram (Exhibit A-1), are included in Appendix A of this report. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included in Appendix B of this report. Descriptions of the field exploration and laboratory testing are included in their respective appendices.

2.0 PROJECT INFORMATION

2.1 Project Description

ITEM	DESCRIPTION
Site layout	Refer to the Site Plan and Boring Location diagram (Exhibit A-1 in Appendix A) for the general location of the project and specific location of the borings. The Northern Portion of the bridge consists of that portion of bridge extending from Boring Nos. B-101 to B-110. The Southern Portion of the bridge consists of that portion of bridge extending from Boring Nos. B-111 to B-115.

<table>
<tr><th>ITEM</th><th>DESCRIPTION</th></tr>
<tr><td>Structures / Type of construction</td><td>Major elements of the Mullins Landfill Bridge will include:
16 Spans
The bridge deck will be founded on grade, but supported on deep foundations and bridge piers. Therefore the abutments do not have below grade walls.
The deep foundations will consist of either drilled shafts or driven piles.
There will be a closure slab between the south abutment of the Mullins Landfill Bridge and the eastern abutment of the Pantano Wash Bridge.</td></tr>
<tr><td>Structural Loads</td><td>We understand that the project will be designed and constructed in accordance with City of Tucson/Pima County Standard Specifications for Public Improvements and in conformance with AASHTO LRFD design specifications. The following table summarizes the loads for each structure.
<table>
<tr><th>Foundation Element</th><th>Factored Design Load (kips)</th></tr>
<tr><td>North Abutment</td><td>2,675</td></tr>
<tr><td>Pier #1</td><td>2,945</td></tr>
<tr><td>Piers #2 thru #13</td><td>3,530</td></tr>
<tr><td>Pier #14</td><td>2,824</td></tr>
<tr><td>Pier #15</td><td>1,412</td></tr>
<tr><td>South Abutment</td><td>2,880</td></tr>
</table></td></tr>
<tr><td>Drilled Shaft Strength Limit 1 Structure Axial Loads</td><td>
<table>
<tr><th>Foundation Element</th><th>Factored Design Load (kips)</th><th>Downdrag* Load due to Landfill (kips)</th><th>Total Load (kips)</th></tr>
<tr><td>North Abutment</td><td>535</td><td>122</td><td>657.4</td></tr>
<tr><td>Pier #1</td><td>589</td><td>170</td><td>759.0</td></tr>
<tr><td>Pier #2</td><td rowspan="14">706</td><td>163</td><td>868.6</td></tr>
<tr><td>Pier #3</td><td>179</td><td>884.9</td></tr>
<tr><td>Pier #4</td><td>184</td><td>890.4</td></tr>
<tr><td>Pier #5</td><td>203</td><td>909.0</td></tr>
<tr><td>Pier #6</td><td>155</td><td>861.5</td></tr>
<tr><td>Pier #7</td><td>203</td><td>909.0</td></tr>
<tr><td>Pier #8</td><td>207</td><td>913.2</td></tr>
<tr><td>Pier #9</td><td>132</td><td>837.5</td></tr>
<tr><td>Pier #10</td><td>124</td><td>829.8</td></tr>
<tr><td>Pier #11</td><td>169</td><td>875.4</td></tr>
<tr><td>Pier #12</td><td>225</td><td>930.6</td></tr>
<tr><td>Pier #13</td><td>241</td><td>947.1</td></tr>
<tr><td>Pier #14</td><td>217</td><td>922.8</td></tr>
<tr><td>Pier #15</td><td>217</td><td>922.8</td></tr>
<tr><td>South Abutment</td><td>576</td><td>217</td><td>792.8</td></tr>
</table>
*Downdrag load is factored and for a 4 foot diameter drilled shaft.</td></tr>
</table>

2.2 Site Location and Description

ITEM	DESCRIPTION
Project Location	The southern end of the proposed alignment of Sabino Canyon Road as it crosses the Mullins Landfill in Tucson, Arizona.
Existing site features	The major site feature for this bridge is the Mullins Landfill. The Mullins Landfill was formally created in 1967 and operated as a municipal solid waste disposal site. The landfill has been closed since 1987. A methane extraction system is currently in operation withdrawing gas from the landfill. During our drilling operations, not much waste material was brought to the surface on the flights of the auger. The native soils beneath the landfill were not brought to the surface on the auger flights during drilling. Our experience would indicate the landfill materials and the underlying native soils were pushed into the sidewalls of the landfill while drilling. Large obstacles to drilling were not encountered during our field exploration.
Existing topography	The topography across Mullins Landfill varies slightly between the north and south ends of the proposed bridge. The ground surface elevation of the north and south ends are 2,532 feet and 2,536 feet MSL, respectively.

3.0 SUBSURFACE CONDITIONS

3.1 Site Geology

The project area is located in the Basin and Range physiographic province ([1]Cooley, 1967) of the North American Cordillera ([2]Stern, et al, 1979) of the southwestern United States. The southern portion of the Basin and Range province is situated along the southwestern flank of the Colorado Plateau and is bounded by the Sierra Nevada Mountains to the west. Formed during middle and late Tertiary time (100 to 15 m.y. ago), the Basin and Range province is dominated by fault controlled topography. The topography consists of mountain ranges and relatively flat alluviated valleys. These mountain ranges and valleys have evolved from generally complex movements and associated erosional and depositional processes. Structurally, the site lies within the Santa Cruz River Basin. Drainage flows to the Santa Cruz River during late Tertiary time, coupled with structural activity discussed above, are generally responsible for the present day topography within the basin.

[1]Cooley, M.E., 1967, ***Arizona Highway Geologic Map***, Arizona Geological Society.

[2]Stern, C.W., et al, 1979, ***Geological Evolution of North America***, John Wiley & Sons, Santa Barbara, California.

Typically, the ranges in this area are of small areal extent, but protrude significantly above adjacent wide alluviated plains and valleys. The basin rims are formed by the mountain ranges which consist of sedimentary, igneous and metamorphic materials which have been subjected to recurrent faulting and tilting and in some places, volcanic and intrusive events. As a result of erosion, the valleys have experienced partial infilling with sedimentary material which has been deposited as alluvial fans. Occasionally, the valleys may become interlocking as a result of coalescing alluvial fans which are referred to as bajadas.

Surficial geologic conditions mapped at the site ([3]Wilson, et al, 1960) consist of alluvium of Quaternary age (10,000 to 1 m.y. ago). The alluvial materials have been described as deposits consisting of sand, silt and gravel. Locally, the alluvium can include clay deposits commonly referred to as playas. Playas are typically formed in shallow temporary lake beds on the valley floor.

3.2 Typical Subsurface Profile

Specific conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs included in Appendix A of this report.

Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Northern Portion of Bridge (Boring Locations B-101 thru 110, B-2 from Project No. 63105043)

Description	Approximate Depth to Bottom of Stratum (feet)	Material Encountered	Consistency/Density
Stratum 1	2 to 12	Landfill cap –Silty Sand	Medium Dense
Stratum 2	26 to 32	Municipal Solid Waste (MSW) Landfill Material	--
Stratum 3	61½ to 100	Silty sand with varying amounts of gravel and cobbles	Dense to Very Dense

[3]Wilson, E.D., Moore, R.T., and O'Haire, R.T., 1960, ***Geologic Map of Pima and Santa Cruz Counties, Arizona***, Arizona Bureau of Mines, University of Arizona.

Southern Portion of Bridge (Boring Locations B-111 thru 115)

Description	Approximate Depth to Bottom of Stratum (feet)	Material Encountered	Consistency/Density
Stratum 1	2 to 12	Landfill cap –Silty Sand	Medium Dense
Stratum 2	35 to 42	Municipal Solid Waste (MSW) Landfill Material	--
Stratum 3	10 to 101½	Silty sand with varying amounts of gravel and cobbles	Dense to Very Dense

3.3 Field and Laboratory Test Data

The results of the laboratory testing are shown in graphical and tabular form in Appendix B. A brief summary of the laboratory test results is provided in this section. Direct shear results obtained from the Pantano Wash bridge borings were also used in our analyses to provide the recommendations contained in this report.

Landfill materials encountered during drilling of the borings consisted of primarily of clothes, plastic and newspaper. The waste material was not brought to the surface on the flights of the auger during drilling. The native soils beneath the landfill were also not brought to the surface on the auger flights. Our experience would indicate the landfill materials and the underlying native soils were pushed into the sidewalls of the landfill while drilling. Large obstacles to drilling were not encountered during our field exploration.

The site soils are typically non-plastic.

The dry unit weight and water content was measured on three samples. The unit weight was 110, 115 and 120 pcf with the moisture contents of 3, 9 and 4 percent, respectively.

The peak angle of internal friction of the site soils at the Pantano Wash bridge location varied from 31 to 39 degrees with cohesion value varying from 0 to 640 psf. The angle of internal friction at maximum displacement varied from 27 to 37 degrees with the cohesion varying from 0 to 380 psf.

3.4 Groundwater

Groundwater was not observed in any test boring at the time of field exploration. These observations represent groundwater conditions at the time of the field exploration and may not be indicative of other times, or at other locations. Groundwater conditions can change with varying seasonal and weather conditions, and other factors.

Based on information obtained from the Arizona Wells' database website (http://www.sahra.arizona.edu/wells), the depth to groundwater was measured in 2005 to be approximately 300 feet below the ground surface (approximate elevation of 2230 feet above mean sea level) at an United States Geological Survey (USGS) monitored well site located less than one-eighth mile east of the site.

3.5 Seismic Considerations

Terracon researched available literature and maps relating to seismic activity in the vicinity of the site in Pima County, Arizona ([4]Arizona Geological Survey, Spring 2000 - Volume 30, No. 1). Historical earthquake activity in the State of Arizona dates to about 1776, but records are sparse prior to the late 1800s. Based on this review, earthquake hazard levels are categorized as being low in the vicinity of the site and in this general region of south-central Arizona. This categorization is based upon historical earthquake activity, number of potentially active faults, and the estimated slip rates for those faults.

Based on information contained in the literature, we believe that the potential of seismic activity and the potential of significant damage to structures resulting from seismic activity in the vicinity of the site to be unlikely.

Based on the geotechnical exploration, the subsurface soil type can be classified as dense to very dense soils with average blow counts ranging between 15 and 100 blows per foot. The seismic site is classified as Site Class D as per Table 3.10.3.1-1 of the AASHTO LRFD Bridge Design Manual ([5]AASHTO, 2010).

The following table presents the seismic site classification and site coefficients based on the AASHTO LRFD Bridge Design Manual

Description	Value
Site Class	D
Site Latitude	32.241322°
Site Longitude	-110.841865°
PGA	0.07[1]
S_s	0.28

[4] Arizona Geological Survey, ***Earthquake Hazard in Arizona***, Volume 30, No. 1, Spring 2000

[5] American Association of State Highway and Transportation Officials, ***AASHTO LRFD Bridge Design Specifications,*** 5th Edition, 2010

Description	Value
S_1	0.08
F_{pga}	1.6
F_a	1.6
F_v	2.4

Notes:
[1]AASHTO's recommended PGA maps have a return period of 1000 years, which corresponds to a 7% probability of exceedance in 75 years.

The Design Response Spectrum for the bridge structures should be constructed based on the information presented in the table above and the procedure outlined in Section 3.10.4.1 of the AASHTO LRFD Bridge Design Manual.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Geotechnical engineering recommendations for foundation design and construction and other earth connected phases of the project are outlined below. The recommendations contained in this report are based upon the results of the test borings performed by Terracon, field and laboratory testing, engineering analyses, and our current understanding of the proposed project.

The following deep foundation types were considered in support of the bridge abutments and piers:

- Drilled shafts
- Driven Piles
  - H-Piles
  - Open End Steel Pipe Piles

Prior to development of load capacity charts for the open end pipe piles, a preliminary drivability analyses was performed using the GRL WEAP program. Based on these analyses, an open end pipe pile is not recommended on this project due to the relatively shallow depth to which the piles could be driven below the landfill. Sufficient penetration into the underlying silty sand soils to produce sufficient lateral and axial capacity is considered difficult and problematic. And based on input from the City of Tucson, the use of H-Piles or any other type of driven pile is not considered a desirable alternative. Therefore, only recommendations for drilled shafts are included in this report.

4.2 Drilled Shaft Foundations

4.2.1 Drilled Shaft Design Methodology and Analyses

The engineering analyses for development of the tables and graphs related to drilled shafts in this report have been based on the AASHTO LRFD Bridge Design Manual ([6]AASHTO, 2012). The above reference was supplemented by the two Geotechnical Design Policies dated December 1, 2010, prepared by the [7],[8]ADOT Geotechnical Design Section and titled, "Load Resistance Factor Design (LRFD); Development of Drilled Shaft Axial Resistance Charts for Use by Bridge Engineers", and "Load Resistance Factor Design (LRFD); Design of Drilled Shafts in Gravel and Gravelly Soils Exhibiting Drained Behavior".

The AASHTO design approach for drilled shaft foundation systems incorporates the beta (β) method for cohesionless (sand and gravel soils). The drained shear strength in the AASHTO design procedure for cohesionless soils is based on the results of the standard penetration testing and the resulting N_{60} values determined in each of the test borings.

Based on the ADOT Geotechnical Design Policy for drilled shafts in gravel or gravelly soils, drained soil behavior is applicable for the analyses and the cohesionless soils must be further differentiated into sand, gravelly or gravel classifications (based on the gravel percentage of the coarse grained fraction of the material) for determination of appropriate beta (β) values to determine side resistance and to determine the appropriate load transfer curves for the computation of drilled shaft settlements. The field and laboratory testing indicates that the cohesionless soil layers at this site are classified as sands with varying gravel contents. Based on the gravel percentages obtained from the testing, the sand classification was considered appropriate for all soils and was used to estimate the 'β' values and for selection of the appropriate load transfer curves.

The engineering analyses considered both redundancy and no redundancy for the drilled shafts. For drilled shafts considered to be non-redundant the base and side resistance factors for compression used in our analyses were 0.40 and 0.44, respectively. For drilled shafts considered

[6] American Association of State Highway and Transportation Officials, ***AASHTO LRFD Bridge Design Specifications,*** 6th Edition, 2012.

[7]Arizona Department of Transportation Geotechnical Design Section, ***Load Resistance Factor Design (LRFD), Development of Drilled Shaft Axial Resistance Charts for use by Bridge Engineers***, Geotechnical Design Policy DS-1, December 1, 2010.

[8]Arizona Department of Transportation Geotechnical Design Section, ***Load Resistance Factor Design (LRFD), Design of Drilled Shafts in Gravel and Gravelly Soils Exhibiting Drained Behavior***, Geotechnical Design Policy DS-2, December 1, 2010

to be redundant the base and side resistance factors for compression used in our analyses were 0.50 and 0.55, respectively.

There will be downdrag loads for the entire bridge due to the long term compression of the landfill materials with time ([9]Leonard & Floom). According to ([10]Watts and Charles,1990), the landfill will continue to compress at an estimated 2 percent of the fill thickness per log cycle of time. The landfill is expected to settle approximately 2% of 360 inches (30 feet x 12) between year 10 and 100, or about 7.2 inches within this period of time. The landfill is approximately 27 years old, and therefore, there is an estimated 5.8 inches of additional settlement anticipated between the present time (2013) and the year 2085.

The downdrag load due to the landfill cap material and the municipal solid waste (MSW) has been calculated based on a negative skin friction method following the governing equation below:

$$Q_s = \Pi B \sum_{i-1}^{n} Y_i Z_i \Delta Z_i \text{Tan}\phi_i K_{oi} \text{ (for cohesionless materials)}$$

In which:

Q_s	=	ultimate shaft side resistance
B	=	shaft diameter
Y_i	=	effective unit weight (pcf) of ith layer
Z_i	=	depth from ground surface to midpoint of ith layer
ΔZ_i	=	thickness of ith layer
ϕ_i	=	friction angle of ith layer with concrete
K_{oi}	=	ratio of horizontal stress to vertical stress of ith layer

The parameters for the MSW material were obtained from ([11]Pelkey, 1989). The following table summarizes the parameters used in our analyses.

Material Type	Unit Weight (pcf)	Friction Angle (°)	K_o
Landfill Soil Cover – Silty Sand	120	32	0.7
Municipal Solid Waste	70	30	0.37

[9]Leonard, M.L., and Floom, K.J. ***Estimating Method and Use of Landfill Settlement.***

[10]Watts, K.S. and J.A. Charles. (December, 1990). ***Settlement of Recently Placed Domestic Refuse Landfill.*** Proceedings of the Institution of Civil Engineers, Part 1: Design and Construction, Vol. 88, pgs. 971-993.

[11]Pelkey, S.G. (1989). ***Geotechnical Properties of Municipal Solid Waste.*** A thesis submitted in partial fulfillment of the requirement for the Degree of Masters of Science in Engineering, University of New Brunswick.

Based on these parameters the following table summarizes the downdrag loads for a proposed drilled shaft diameter of four feet for all foundations:

Foundation Element	Landfill Cover (ft)	Thickness of MSW (ft)	Drilled Shaft Diameter (ft)	Downdrag Load (kips)	Downdrag Load Factor	Factored Downdrag Load (kips)
North Abutment	8	18	4	97.9	1.25	122.4
Pier #1	9	22	4	136.0	1.25	170.0
Pier #2	8	23	4	130.1	1.25	162.6
Pier #3	9	23	4	143.1	1.25	178.9
Pier #4	12	18	4	147.5	1.25	184.4
Pier #5	12	20	4	162.4	1.25	203.0
Pier #6	7	24	4	124.4	1.25	155.5
Pier #7	12	20	4	162.4	1.25	203.0
Pier #8	12½	19½	4	165.8	1.25	207.2
Pier #9	2	30	4	105.2	1.25	131.5
Pier #10	2	29	4	99.0	1.25	123.8
Pier #11	4	31	4	135.5	1.25	169.4
Pier #12	5	35	4	179.7	1.25	224.6
Pier #13	7	33	4	192.9	1.25	241.1
Pier #14	4	26	4	173.4	1.25	216.8
Piers #15 & South Abutment	4	26	4	173.4	1.25	216.8

These factored downdrag loads for the specified shaft diameter of four feet were added to the structural loads that were provided for our analysis of the drilled shafts for the northern or southern portions of the bridge as applicable.

Based on the subsurface exploration, laboratory test results, and the foregoing discussion, the following design subsurface profiles were used in the drilled shaft analyses for the Mullins Landfill Bridge. The pertinent engineering properties are summarized in the following table.

Summary of Subsurface Profiles for Drilled Shaft Analyses							
Foundation Element	**Boring No.**	**Top of Layer (ft)**	**Bottom of Layer (ft)**	**Soil Type[1]**	**Unit Weight (pcf)**	**Std. Penetration N_{60} (blows/ft)**	**Notes**
North Abutment	101	0	8	SM	120	0	Downdrag[2]
		8	26	MSW	70	0	Downdrag[2]
		26	37	SM	125	75*	
		37	62	SM	125	65	
		62	100	SM	130	75*	
Pier #1	102	0	9	SM	120	0	Downdrag[2]
		9	31	MSW	70	0	Downdrag[2]
		31	37	SM	125	75*	
		37	42	SM	125	59	
		42	47	SM	125	41	
		47	52	SM	125	64	
		52	100	SM	130	75*	
Pier #2	103	0	8	SM	120	0	Downdrag[2]
		8	31	MSW	70	0	Downdrag[2]
		31	37	SM	125	75*	
		37	42	SM	125	25	
		42	52	SM	125	51	
		52	100	SM	130	75*	
Pier #3	104	0	9	SM	120	0	Downdrag[2]
		9	32	MSW	70	0	Downdrag[2]
		32	37	SM	125	61	
		37	57	SM	125	51	
		57	100	SM	130	75*	
Pier #4	105	0	12	SM	120	0	Downdrag[2]
		12	30	MSW	70	0	Downdrag[2]
		30	37	SM	125	55	
		37	47	SM	125	30	
		47	100	SM	130	75*	
Pier #5	106	0	12	SM	120	0	Downdrag[2]
		12	32	MSW	70	0	Downdrag[2]
		32	100	SM	130	75*	

Summary of Subsurface Profiles for Drilled Shaft Analyses							
Foundation Element	**Boring No.**	**Top of Layer (ft)**	**Bottom of Layer (ft)**	**Soil Type[1]**	**Unit Weight (pcf)**	**Std. Penetration N_{60} (blows/ft)**	**Notes**
Pier #6	107	0	7	SM	120	0	Downdrag[2]
		7	31	MSW	70	0	Downdrag[2]
		31	42	SM	125	40	
		42	47	SM	125	55	
		47	100	SM	130	75*	
Pier #7	108	0	12	SM	120	0	Downdrag[2]
		12	32	MSW	70	0	Downdrag[2]
		32	42	SM	125	41	
		42	52	SM	125	59	
		52	100	SM	130	75*	
Pier #8	B-2	0	12½	SM	120	0	Downdrag[2]
		12½	32	MSW	70	0	Downdrag[2]
		32	37	SM	125	35	
		37	52	SM	125	75*	
		52	57	SM	125	49	
		57	100	SM	125	75*	
Pier #9	109	0	2	SM	120	0	Downdrag[2]
		2	32	MSW	70	0	Downdrag[2]
		32	42	SM	125	40	
		42	67	SM	125	65	
		67	100	SM	130	75*	
Pier #10	110	0	2	SM	120	0	Downdrag[2]
		2	31	MSW	70	0	Downdrag[2]
		31	42	SM	125	13	
		42	52	SM	125	67	
		52	62	SM	125	75*	
		62	67	SM	125	65	
		67	100	SM	130	75*	
Pier #11	111	0	4	SM	120	0	Downdrag[2]
		4	35	MSW	70	0	Downdrag[2]

Summary of Subsurface Profiles for Drilled Shaft Analyses							
Foundation Element	**Boring No.**	**Top of Layer (ft)**	**Bottom of Layer (ft)**	**Soil Type[1]**	**Unit Weight (pcf)**	**Std. Penetration N_{60} (blows/ft)**	**Notes**
		35	42	SM	125	13	
		42	47	SM	125	36	
		47	57	SM	125	55	
		57	100	SM	130	75*	
Pier #12	112	0	5	SM	120	0	Downdrag[2]
		5	40	MSW	70	0	Downdrag[2]
		40	52	SM	125	37	
		52	100	SM	130	75*	
Pier #13	113	0	7	SM	120	0	Downdrag[2]
		7	40	MSW	70	0	Downdrag[2]
		40	47	SM	125	48	
		47	100	SM	130	75*	
Pier #14	114	0	4	SM	120	0	Downdrag[2]
		4	40	MSW	70	0	Downdrag[2]
		40	52	SM	125	67	
		52	100	SM	130	75*	
Pier #15 and South Abutment	115	0	4	SM	120	0	Downdrag[2]
		4	40	MSW	70	0	Downdrag[2]
		40	47	SM	125	40	
		47	52	SM	130	56	
		52	100	SM	130	75*	

Note: Height of drilled shaft above existing grade is zero feet for all shafts.
Note*: N_{60} = 75 used for this stratum based on maximum end bearing criteria outlined in AASHTO.

4.2.2 Design Shaft Recommendations

Results of LRFD calculations for drilled shaft foundations for each foundation substructure element of the proposed bridge are presented in Appendices C through S. Calculations were performed considering both redundancy of the drilled shafts, and non-redundancy. The results of the both analyses are summarized in the following two tables:

Summary Table Using Resistance Factors Considering Redundancy								
Foundation Element	**Factored Load per Shaft (kips)**	**Shaft Diameter (ft)**	**Length of Shaft (ft)**	**Ground Surface Elevation (ft)**	**Top of Drilled Shaft Elevation (ft.)**	**Design Tip Elevation (ft)**	**Strength Limit Resistance (kips)**	**Estimated Settlement at Strength Limit**
North Abutment	657.4[a]	4	44	2532	2532	2488	660	< 0.25 inches
Pier #1	759.0[a]	4	54	2532	2532	2478	777	< 0.25 inches
Pier #2	868.6[a]	4	60	2532	2532	2472	892	< 0.25 inches
Pier #3	884.9[a]	4	62	2533	2533	2471	891	< 0.25 inches
Pier #4	890.4[a]	4	60	2533	2533	2473	918	< 0.25 inches
Pier #5	909.0[a]	4	62	2533	2533	2471	922	< 0.25 inches
Pier #6	861.5[a]	4	60	2534	2534	2474	881	< 0.25 inches
Pier #7	909.0[a]	4	62	2534	2534	2472	915	< 0.25 inches
Pier #8	913.2[a]	4	62	2534	2534	2472	914	< 0.25 inches
Pier #9	837.5[a]	4	62	2534	2534	2472	855	< 0.25 inches
Pier #10	829.8[a]	4	62	2535	2535	2473	833	< 0.25 inches
Pier #11	875.4[a]	4	66	2534	2534	2468	887	< 0.25 inches
Pier #12	930.6[a]	4	76	2535	2535	2459	961	< 0.25 inches
Pier #13	947.1[a]	4	76	2536	2536	2460	975	< 0.25 inches
Pier #14	922.8[a]	4	74	2536	2536	2462	928	< 0.25 inches
Pier #15	922.8[a]	4	74	2536	2536	2462	928	< 0.25 inches
South Abutment	792.8[a]	4	68	2536	2536	2468	826	< 0.25 inches

[a] **Note:**
[a] The factored load includes the factored downdrag load.

Summary Table Using Resistance Factors Considering No Redundancy								
Foundation Element	**Factored Load per Shaft (kips)**	**Shaft Diameter (ft)**	**Length of Shaft (ft)**	**Ground Surface Elevation (ft)**	**Top of Drilled Shaft Elevation (ft.)**	**Design Tip Elevation (ft)**	**Strength Limit Resistance (kips)**	**Estimated Settlement at Strength Limit**
North Abutment	657.4[a]	4	54	2532	2532	2478	682	< 0.25 inches
Pier #1	759.0[a]	4	64	2532	2532	2468	776	< 0.25 inches
Pier #2	868.6[a]	4	70	2532	2532	2462	868	< 0.25 inches
Pier #3	884.9[a]	4	74	2533	2533	2459	893	< 0.25 inches
Pier #4	890.4[a]	4	70	2533	2533	2463	894	< 0.25 inches
Pier #5	909.0[a]	4	74	2533	2533	2459	926	< 0.25 inches
Pier #6	861.5[a]	4	72	2534	2534	2462	888	< 0.25 inches
Pier #7	909.0[a]	4	74	2534	2534	2460	917	< 0.25 inches
Pier #8	913.2[a]	4	74	2534	2534	2460	915	< 0.25 inches
Pier #9	837.5[a]	4	74	2534	2534	2460	855	< 0.25 inches
Pier #10	829.8[a]	4	72	2535	2535	2463	861	< 0.25 inches
Pier #11	875.4[a]	4	78	2534	2534	2456	880	< 0.25 inches
Pier #12	930.6[a]	4	90	2535	2535	2445	947	< 0.25 inches
Pier #13	947.1[a]	4	90	2536	2536	2446	961	< 0.25 inches
Pier #14	922.8[a]	4	90	2536	2536	2446	947	< 0.25 inches
Pier #15	922.8[a]	4	90	2536	2536	2446	947	< 0.25 inches
South Abutment	792.8[a]	4	78	2536	2536	2458	795	< 0.25 inches

[a] **Note:**
[a] The factored load includes the factored downdrag load.

The following are limitations or conditions assumed or used in development of the resistances presented on the calculations and load resistance charts:

- The effects of redundancy should be addressed by the bridge engineer and the appropriate drilled shaft tip elevation chosen.
- The normalized load-displacement curves used to develop the Service Limit State charts are contained in the [8,9]ADOT Geotechnical Design Policies (DS-1 and DS-2) dated December 1, 2010 for sand, gravelly and gravel soils.
- A "rigid" shaft was assumed without elastic shortening for simplicity of calculations.
- Based on the AASHTO LRFD Bridge Design Manual, 2012, Section 10.8.3.6.3, the reduction factor (η) for center-to-center spacing of drilled shafts less than 4 shaft diameters is calculated as follows:
  - η = 0.65 for a center-to-center spacing of 2.5 shaft diameters.
  - η = 1.0 for a center-to-center spacing of 4.0 shaft diameters.

  For center-to-center spacings between 2.5 and 4.0 shaft diameters, linearly interpolated values should be used.

The results of the analyses are presented in Appendices C through S arranged by substructure. The sheets in each of the Appendices are organized in the following order:

- Design Shaft-Load Settlement Curve considering redundancy for a specific shaft diameter at a specific depth
- Design Shaft-Load Settlement Curve considering no redundancy for a specific shaft diameter at a specific depth
- Input parameters used to develop the graphs considering redundancy
- Input parameters used to develop the graphs considering no redundancy
- Nominal End Bearing Resistance and Skin Friction Factors
- Strength Limit State Shaft Resistance Table
- Strength Limit State Shaft Resistance Graph - Compression

4.2.3 Drilled Shaft Construction Considerations

The landfill materials will likely be less homogeneous than the native soils beneath the landfill. The potential for unusual drilling conditions including voids, large objects and potential caving of the MSW into the drill hole, could be encountered during drilling of the shafts. Though large objects and voids were not encountered during our field exploration, the potential to encounter such conditions is significantly higher due to the greater number of drilled shafts and much higher volumes of excavated material that will occur during foundation construction.

Based on the potential drilling issues associated with the landfill materials outlined above, we anticipate the drilling conditions could be difficult for installation of drilled shafts. Therefore, we recommend a test shaft be constructed at the site for observation by potential drilled shaft installation companies to provide a better understanding of the installation issues that may be encountered during construction of the foundations. In addition, we recommend integrity testing consisting of crosshole sonic logging be performed to determine the shaft integrity of each drilled shaft on the project.

If voids are encountered during drilling, a permanent casing will be needed to complete the drilled shaft. If voids are not encountered, then temporary casing will likely be required during drilled shaft excavation to prevent caving in the granular soils or caving in the MSW materials. Temporary casing should also be used whenever shafts are installed adjacent to existing structures or improvements to reduce potential ground loss and movement due to drilled shaft excavation. Shaft concrete should be placed immediately after completion of drilling and cleaning. Due to potential sloughing, raveling and compression of MSW materials, foundation concrete quantities are anticipated to exceed calculated geometric volumes.

If temporary casing is used for drilled shaft construction, it should be withdrawn in a slow continuous manner maintaining a sufficient head of concrete above the bottom of the casing at all times to prevent infiltration of MSW into the hole or the creation of voids in shaft concrete. Shaft concrete should have a relatively high fluidity when placed in cased shaft holes or through a tremie. Shaft concrete with slump in the range of 6 to 8 inches is recommended. All drilled shaft construction techniques should be in accordance with Section 609 of the Arizona Department of Transportation (ADOT) Standard Specifications.

Free-fall concrete placement in drilled shafts will only be acceptable if provisions are taken to avoid striking the concrete on the sides of the hole or reinforcing steel. The use of a bottom-dump hopper, or an elephant's trunk discharging near the bottom of the hole where concrete segregation will be minimized, is recommended.

4.3 Lateral Loading Design Criteria

Based on Section 10.8.3.8 and 10.7.3.12 of AASHTO 2012 the nominal horizontal resistance of drilled shafts, shaft groups and driven piles should be based on modeling P-y curves for the soils at the site. Recommended geotechnical parameters for lateral load analysis of drilled shaft or driven pile foundations have been developed for use in the computer program L-PILE that utilizes P-y curve analyses and are presented by structure in the following tables.

Mullins Landfill Bridge						
Foundation Element	**Top Depth (ft)**	**Bottom Depth (ft)**	**Soil Type (P-y curve model)**	**Unit Weight (pcf)**	**Friction Angle**	**Subgrade Reaction k_s (pci)**
Northern Portion of Bridge	0	4	Sand (Reese)	120	32	25
	4	32	Sand (Reese)	70	30	15
	32	37	Sand (Reese)	125	38	225
	37	47	Sand (Reese)	125	34	120
	47	100	Sand (Reese)	125	36	170
Southern Portion of Bridge	0	4	Sand (Reese)	120	32	25
	4	42	Sand (Reese)	70	30	15
	42	48	Sand (Reese)	125	34	120
	48	73	Sand (Reese)	125	36	170
	73	100	Sand (Reese)	125	40	225

Based on Section 10.7.3.12 of AASHTO 2012, the P-y curves need to be modeled to account for group effects when used in the design, utilizing P-multipliers included in Table 10.7.2.4-1 as outlined below:

Shaft/Pile Center to Center Spacing (in the direction of loading)	**P-Multipliers**		
	Row 1	**Row 2**	**Row 3 and Higher**
3B	0.8	0.4	0.35
5B	1.0	0.85	0.7

Other provisions outlined in Section 10.7.2.4 of AASHTO 2012 should be applied in the lateral load analyses of drilled shaft or driven pile foundations. In accordance with Table 10.5.5.2.3-1 a resistance factor of 1.0 may be applied to the geotechnical resistance values determined in accordance with the values outlined above.

Based on the memorandum from [12]ADOT Geotechnical Design Section and titled, "Load Resistance Factor Design (LRFD); Analysis of Drilled Shafts Subjected to Lateral Loads", a y-modification factor (y_m) should be used within potentially collapse-susceptible soil layers. Collapse-susceptible soils were not encountered within the limits of this project. Thus, no modification of the y value will be required or was used for the lateral capacity analyses.

[12]Arizona Department of Transportation Geotechnical Design Section, ***Load Resistance Factor Design (LRFD), Analysis of Drilled Shafts Subjected to Lateral Loads based on Load and Resistance Factor (LRFD) Design Methodology***, Geotechnical Design Policy DS-3, December 1, 2010

4.4 Corrosion Potential

Results of soluble sulfate testing on the native soils indicate that ASTM Type I/II Portland cement is suitable for all concrete on and below grade. Foundation concrete should be designed for low sulfate exposure in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

The amount of soluble chloride in the native soils based on our laboratory testing is below the detection limit of the equipment used in the analyses. This would indicate the potential for corrosion based on exposure to chlorides is relatively small.

It is unknown at this time what the composition or quantity (if any) of leachate being created by the Mullins landfill. We recommend a study be performed to determine the composition and quantity of leachate being created by the landfill, so a corrosion potential analyses can be performed by a corrosion engineer. In any event, the driven piles should have some level of corrosion protection or some amount of sacrificial steel.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

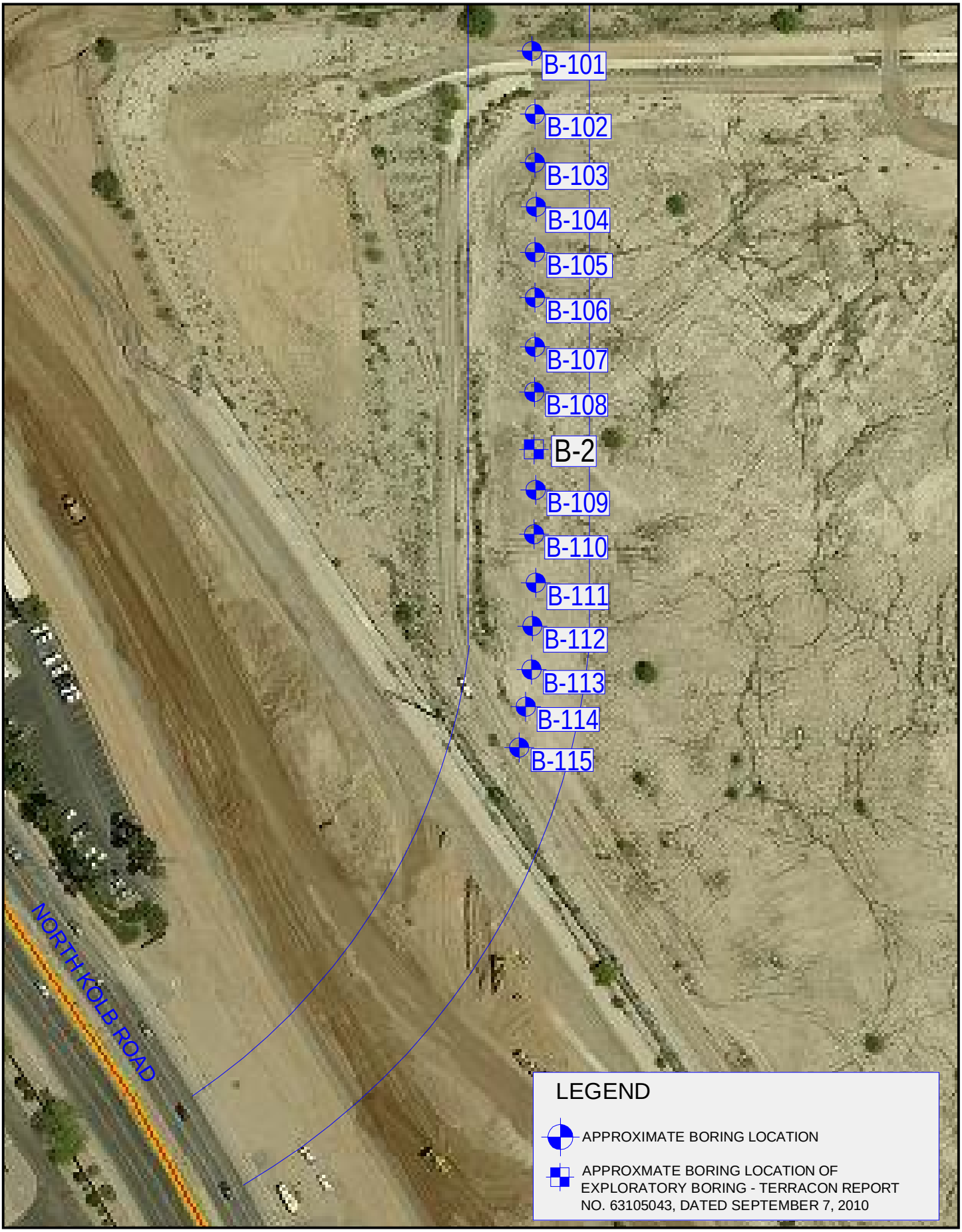
The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site

safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A

FIELD EXPLORATION



Project Mngr:	BMB
Drawn By:	JCW
Checked By:	BMB
Approved By:	BMB

Project No.	63125005
Scale:	NA
File No.	63125005
Date:	06/2013

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SITE PLAN & BORING LOCATIONS DIAGRAM

PSOMAS

SABINO-KOLB EXTENSION

MULLINS LANDFILL BRIDGE

TUCSON ARIZONA

EXHIBIT

A-1

Field Exploration Description

A total of 16 test borings were drilled at the site on three separate mobilizations to the site. The borings were drilled to depths ranging from approximately 100 to 101½ feet below the ground surface at the approximate locations shown on the attached Site Plan and Boring Locations diagram, Exhibit A-1. The dates the test borings were drilled and their locations are as follows:

Boring Nos.	Location	Drill Dates of 1st Mobilization	Drill Dates of 2nd Mobilization	Depths (feet)
B-101	North Abutment	3-2-12	4-17-13	100½
B-102	Pier #1	3-1-12	4-18-13	101½
B-103	Pier #2	3-1-12	4-19-13	100½
B-104	Pier #3	2-27-12	4-22-13	100½
B-105	Pier #4	2-27-12	4-23-13	101
B-106	Pier #5	2-27-12	4-25-13	100½
B-107	Pier #6	2-28-12	4-26-13	100½
B-108	Pier #7	2-28-12	4-29-13	100½
B-2	Pier #8	6-3-10	4-30-13	101½
B-109	Pier #9	2-28-12	4-30-13	100½
B-110	Pier #10	2-29-12	5-2-13	100½
B-111	Pier #11	2-29-12	5-7-13	100½
B-112	Pier #12	2-29-12	5-7-13	100½
B-113	Pier #13	3-1-12	5-8-13	101
B-114	Pier #14	3-1-12	5-9-13	101
B-115	Pier #15 and South Abutment	3-1-12	5-10-13	100½

The test borings were advanced with a truck-mounted CME-75 drill rig utilizing 4¼-inch inside diameter hollow-stem augers. The borings were located in the field by using the proposed site plan, an aerial photograph of the site, and measuring from existing property lines. The accuracy of boring locations should only be assumed to the level implied by the method used.

Continuous lithologic logs of each boring were recorded by the field geologist during the drilling operations. At selected intervals, samples of the subsurface materials were taken by driving split-spoon or ring-barrel samplers. Bulk samples of subsurface materials were also obtained.

An automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count (N) value by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

Groundwater conditions were evaluated in each boring at the time of site exploration.

Methane monitoring was performed while drilling landfill locations using a Landtech GA90 monitor. Methane levels remained below 0.2% methane/volume of air during exploration.

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-3/8" I.D., 2" O.D., unless otherwise noted	HS:	Hollow Stem Auger
MC:	Modified California Sampler – 2.5" O.D., unless otherwise noted	DC:	Dynamic Cone
RS:	Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted	HA:	Hand Auger
BS:	Bulk Sample or Auger Sample	GS:	Grab Sample
Hammer Blows:	Number of Blows to advance the 9" O.D. steel casing one foot with the diesel hammer at "full" throttle.	WB:	Wash Boring or Mud Rotary

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value". For 3" O.D. ring samplers (RS) the penetration value is reported as the number of blows required to advance the sampler 12 inches using a 140-pound hammer falling 30 inches, reported as "blows per foot," and is not considered equivalent to the "Standard Penetration" or "N-value".

WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WS:	While Sampling
WCI:	Wet Cave in	WD:	While Drilling
DCI:	Dry Cave in	BCR:	Before Casing Removal
AB:	After Boring	ACR:	After Casing Removal

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined and/or described on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	<2	Very Soft
500 – 1,000	2-3	Soft
1,001 – 2,000	4-6	Medium Stiff
2,001 – 4,000	7-12	Stiff
4,001 – 8,000	13-26	Very Stiff
8,000+	26+	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	Ring Sampler (RS) Blows/Ft.	Relative Density
0 – 3	0-6	Very Loose
4 – 9	7-17	Loose
10 – 29	18-55	Medium Dense
30 – 49	56-95	Dense
50+	96+	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75 mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 – 12
Modifiers	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0-3
Low	4-15
Medium	16-25
High	25+

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]					Soil Classification	
					Group Symbol	Group Name[B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]		GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]		GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH		GM	Silty gravel[F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]		SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]		SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH		SM	Silty sand[G,H,I]
			Fines Classify as CL or CH		SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]		CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]		ML	Silt[K,L,M]
		organic	Liquid limit - oven dried	< 0.75	OL	Organic clay[K,L,M,N]
			Liquid limit - not dried			Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line		CH	Fat clay[K,L,M]
			PI lots below "A" line		MH	Elastic Silt[K,L,M]
		organic	Liquid limit - oven dried	< 0.75	OH	Organic clay[K,L,M,P]
			Liquid limit - not dried			Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

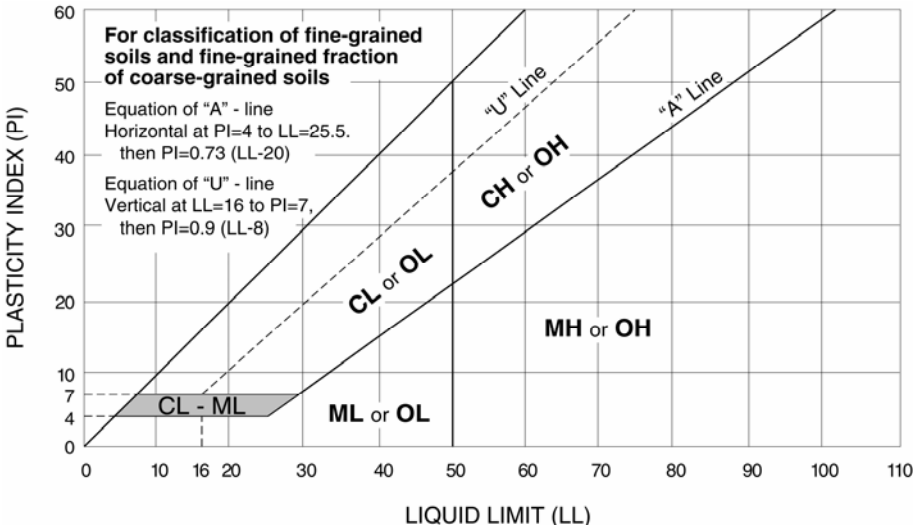
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Terracon

Form 111—6/98

Exhibit A-5

LOG OF BORING NO. B-101

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; light brown, dense to very dense, slightly damp, non-plastic.	36	SM		RS	50/5"					
		38									
		40	SM		RS	78/10"					
		42									
		44									
		46	SM		SS	74			0	0	29
		48									
		50	SM		RS	83/10"					
		52									
		54									
		56	SM		SS	52					
		58									
		60	SM		SS	45					
		62									
		64									
		66	SM		SS	77					
		68									
		70									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			3-2-12
BORING COMPLETED			4-17-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-101

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; light brown, dense to very dense, slightly damp, non-plastic.		SM	X	SS	90/11"					
		72									
		74									
			SM	X	SS	50/4"					
		76									
		78									
		80	SM	X	SS	84					
		82									
		84									
			SM	X	SS	67					
		86									
		88									
		90	SM	X	SS	75					
		92									
		94									
			SM	X	SS	50/3"					
		96									
		98									
	100.5 2431.5	100	SM	X	SS	50/3"					
	Bottom of BORING.										

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			3-2-12
BORING COMPLETED			4-17-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-102

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	Approx. Surface Elev.: 2532 ft										
	FILL - LANDFILL CAP, CLAYEY SAND; brown, slightly damp, medium plasticity.	2	SC		BS						
		4									
		6									
		8									
	9 2523										
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF PAPER, CLOTH, PLASTIC AND A RUBBER SOLE.	10									
		12									
		14									
		16									
		18									
		20									
		22									
		24									
		26									
		28									
	31 2501	30									
	SILTY SAND; light brown, very dense, slightly damp, non-plastic.	32									
		34									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			4-18-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-102

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; light brown, very dense, slightly damp, non-plastic.	36	SM		RS	90/9"					
		38									
		40	SM		RS	80/11"					
		42									
		44									
		46	SM		SS	31					
		48									
		50	SM		RS	88/11"					
		52									
		54									
		56	SM		SS	63					
		58									
		60	SM		SS	57					
		62									
		64									
		66	SM		SS	68					
		68									
		70									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			4-18-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-102

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; light brown, very dense, slightly damp, non-plastic.		SM	X	SS	92/10"					
		72									
		74									
			SM	X	SS	83/11"					
		76									
		78									
		80	SM	X	SS	50/5"					
		82									
		84									
			SM	X	SS	50/5"					
		86									
		88									
		90	SM	X	SS	50/5"					
		92									
		94									
			SM	X	SS	50/5"					
		96									
		98									
		100									
			SM	X	SS	87/11"					
	101.5 2430.5										
	Bottom of BORING.										

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			4-18-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-103

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	Approx. Surface Elev.: 2532 ft										
	FILL - LANDFILL CAP, SILTY SAND; light brown, slightly damp, non-plastic.	2	SM		BS				0	0	24
	8 2524	4									
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF NEWSPAPER, CLOTHES, PLASTIC AND METAL.	6									
		8									
		10									
		12									
		14									
		16									
		18									
		20									
		22									
		24									
		26									
		28									
		30									
	31 2501	32									
	SILTY SAND; light brown, very dense, slightly damp, non-plastic. cobble layer at 32 feet.	34									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			4-19-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 6/10/13

LOG OF BORING NO. B-103

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; light brown, very dense, slightly damp, non-plastic.	36	SM		RS	50/4"					
		38									
		40	SM	X	SS	19					
		42									
		44									
		46	SM		RS	74					
		48									
		50	SM		RS	74/11"					
		52									
		54									
		56	SM	X	SS	77					
		58									
		60	SM	X	SS	56					
		62									
		64									
		66	SM	X	SS	66					
		68									
		70									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			4-19-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 6/10/13

LOG OF BORING NO. B-103

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; light brown, very dense, slightly damp, non-plastic.		SM	X	SS	89/8"					
		72									
		74									
			SM	X	SS	50/5"					
		76									
		78									
		80	SM	X	SS	50/5"					
		82									
		84									
			SM	X	SS	93/9"					
		86									
		88									
		90	SM	X	SS	50/3"					
		92									
		94									
			SM	X	SS	50/5"					
		96									
		98									
	100.5 2431.5	100	SM	X	SS	50/5"					
	Bottom of BORING.										

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			4-19-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 6/10/13

LOG OF BORING NO. B-104

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge, Tucson, Arizona**

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	Approx. Surface Elev.: 2533 ft										
	FILL - LANDFILL CAP, SILTY SAND; light brown, slightly damp, non-plastic.	2	SM		BS						
		4									
		6									
		8									
	9 2524										
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF PAPER, CLOTH, PLASTIC, SCRAP METAL.	10									
		12									
		14									
		16									
		18									
		20									
		22									
		24									
		26									
		28									
	32 2501	30	SM		RS	74/9"					
	SILTY SAND WITH GRAVEL; light brown, dense to very dense, slightly damp, non-plastic.	32									
		34									
	Continued Next Page										

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED	2-27-12		
BORING COMPLETED	4-22-13		
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 6/10/13

LOG OF BORING NO. B-104

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	cobble layer between 33 and 35 feet.	36	SM		RS	69/9"					
	SILTY SAND WITH GRAVEL; light brown, dense to very dense, slightly damp, non-plastic.	38									
		40	SM		RS	78					
		42									
		44									
		46	SM		SS	34					
		48									
		50	SM		SS	38					
		52									
		54									
		56	SM		SS	43					
		58									
		60	SM		SS	57					
		62									
		64									
		66	SM		SS	50/5"					
		68									
		70									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			2-27-12
BORING COMPLETED			4-22-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 6/10/13

LOG OF BORING NO. B-104

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND WITH GRAVEL; light brown, dense to very dense, slightly damp, non-plastic.		SM	X	SS	85					
		72									
		74									
			SM	X	SS	50/4"					
		76									
		78									
		80	SM	X	SS	50/5"					
		82									
		84									
			SM	X	SS	90					
		86									
		88									
		90	SM	X	SS	50/4"					
		92									
		94									
			SM	X	SS	50/5"					
		96									
		98									
	100.5 2432.5	100	SM	X	SS	50/2"					
	Bottom of BORING.										

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED	2-27-12		
BORING COMPLETED	4-22-13		
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 6/10/13

LOG OF BORING NO. B-105

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	Approx. Surface Elev.: 2533 ft										
	FILL - LANDFILL CAP, SILTY SAND; light brown, slightly damp, non-plastic.	2	SM		BS						
		4									
		6									
		8									
		10									
	12 2521	12									
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF NEWSPAPER, CLOTHES, PLASTIC AND METAL.	14									
		16									
		18									
		20									
		22									
		24									
		26									
		28									
	30 2503	30									
	SILTY SAND WITH GRAVEL; light brown, medium dense to very dense, slightly damp, non-plastic, occassional cobble layers.	32									
		34									
	Continued Next Page										

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			2-27-12
BORING COMPLETED			4-23-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-105

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND WITH GRAVEL; light brown, medium dense to very dense, slightly damp, non-plastic, occassional cobble layers.	36	SM		RS	76/11"					
		38									
		40	SM		RS	50					
		42									
		44									
		46	SM		SS	21					
		48									
		50	SM		RS	50/5"					
		52									
		54									
		56	SM		SS	63					
		58									
		60	SM		SS	50/5"					
		62									
		64									
		66	SM		SS	78					
		68									
		70									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			2-27-12
BORING COMPLETED			4-23-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-105

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND WITH GRAVEL; light brown, medium dense to very dense, slightly damp, non-plastic, occassional cobble layers.		SM	X	SS	78/10"					
		72									
		74									
			SM	X	SS	92/10"					
		76									
		78									
		80	SM	X	SS	92/10"					
		82									
		84									
			SM	X	SS	96/9"					
		86									
		88									
		90	SM	X	SS	50/3"					
		92									
		94									
		96	SM	X	SS	50/5"					
		98									
	101 2432	100	SM	X	SS	50/3"					
	Bottom of BORING.										

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED	2-27-12		
BORING COMPLETED	4-23-13		
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-106

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	Approx. Surface Elev.: 2533 ft										
	FILL - LANDFILL CAP, CLAYEY SAND; brown, slightly damp, medium plasticity.	2	SC		BS						
		4									
		6									
		8									
		10									
	12 2521	12									
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF PAPER SCRAP, CLOTHES, PLASTIC, RUBBER AND METAL SCRAP.	14									
		16									
		18									
		20									
		22									
		24									
		26									
		28									
		30									
	32 2501	32									
	SILTY SAND; light brown, very dense, slightly damp, non-plastic.	34									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED	2-27-12		
BORING COMPLETED	4-25-13		
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-106

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; light brown, very dense, slightly damp, non-plastic.	36	SM		RS	86/9"					
		38									
		40	SM		SS	91					
		42									
		44									
		46	SM		SS	75			0	0	33
		48									
		50	SM		RS	50/5"					
		52									
		54									
		56	SM		SS	77					
		58									
	60 2473	60									
	SILTY SAND WITH GRAVEL; light brown, very dense, slightly damp, non-plastic.	60	SM		SS	50/4"					
		62									
		64									
	65 2468										
	SILTY SAND; trace gravel, light brown, very dense, slightly damp, non-plastic.	66	SM		SS	72					
		68									
	Continued Next Page	70									

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			2-27-12
BORING COMPLETED			4-25-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-106

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; trace gravel, light brown, very dense, slightly damp, non-plastic.		SM	X	SS	74					
		72									
		74									
			SM	X	SS	50/4"					
		76									
		78									
		80	SM	X	SS	50/3"					
		82									
	85 2448	84									
	CLAYEY SAND; trace gravel, brown, very dense, slightly damp, low to medium plasticity.	86	SM	X	SS	50/3"					
		88									
		90	SM	X	SS	50/5"					
		92									
	95 2438	94									
	SILTY SAND WITH GRAVEL; light brown, very dense, slightly damp, non-plastic.		SM	X	SS	50/5"					
		96									
		98									
	100.5 2432.5	100	SM	X	SS	50/4"					
	Bottom of BORING.										

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED	2-27-12		
BORING COMPLETED	4-25-13		
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-107

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	Approx. Surface Elev.: 2534 ft										
	FILL - LANDFILL CAP, CLAYEY SAND; brown, slightly damp, medium plasticity.	2	SC		BS						
		4									
	7 2527	6									
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF PAPER SCRAP, CLOTHES AND PLASTIC.	8									
		10									
		12									
		14									
		16									
		18									
		20									
		22									
		24									
		26									
		28									
	31 2503	30									
	SILTY SAND WITH GRAVEL; light brown, very dense, slightly damp, non-plastic. cobble layer at 32 feet.	32									
		34									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED	2-28-12		
BORING COMPLETED	4-26-13		
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 6/10/13

LOG OF BORING NO. B-107

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	SILTY SAND WITH GRAVEL; light brown, very dense, slightly damp, non-plastic.	36									
		38									
		40	SM		RS	61	4	120			
		42									
		44									
		46	SM		RS	76/11"					
		48									
		50	SM		RS	83/9"					
		52									
		54									
		56	SM		SS	50/5"					
		58									
		60	SM		SS	83/11"					
		62									
		64									
		66	SM		SS	72					
		68									
		70									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			2-28-12
BORING COMPLETED			4-26-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 6/10/13

LOG OF BORING NO. B-107

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND WITH GRAVEL; light brown, very dense, slightly damp, non-plastic.		SM	X	SS	80					
		72									
		74									
			SM	X	SS	78					
		76									
		78									
			SM	X	SS	50/5"					
		80									
		82									
		84									
			SC	X	SS	50/5"					
		86									
		88									
		90									
			SC	X	SS	50/5"					
		92									
		94									
			SM	X	SS	50/5"					
		96									
		98									
		100									
			SM	X	SS	50/5"					
	100.5 2433.5 **Bottom of BORING.**										

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED			2-28-12
BORING COMPLETED			4-26-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 6/10/13

LOG OF BORING NO. B-108

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	Approx. Surface Elev.: 2534 ft										
	FILL - LANDFILL CAP, SILTY SAND; light brown, slightly damp, non-plastic.	2	SM		BS						
		4									
		6									
		8									
		10									
	12 2522	12									
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF NEWSPAPER, CLOTHES, PLASTIC SCRAP AND RUBBER TUBING.	14									
		16									
		18									
		20									
		22									
		24									
		26									
		28									
		30									
	32 2502	32									
	SILTY SAND; light brown, very dense, slightly damp, non-plastic, occasional cobbles.	34									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED	2-28-12		
BORING COMPLETED	4-29-13		
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-108

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	SILTY SAND; light brown, very dense, slightly damp, non-plastic, occasional cobbles.	36									
		38									
		40	SM		RS	62					
		42									
		44									
		46	SM		RS	78/11"					
		48									
		50	SM		RS	85/11"					
		52									
		54									
		56	SM		SS	50/5"					
		58									
		60	SM		SS	75					
		62									
		64									
		66	SM		SS	84					
		68									
		70									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			2-28-12
BORING COMPLETED			4-29-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-108

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; light brown, very dense, slightly damp, non-plastic, occasional cobbles.		SM		SS	50/5"					
	75 2459	72									
		74									
	SILTY SAND WITH GRAVEL; brown, very dense, slightly damp, non-plastic.	76	SM		SS	50/5"					
		78									
		80	SM		SS	50/5"					
		82									
		84									
		86	SM		SS	50/4"					
		88									
		90	SM		SS	94/10"					
		92									
		94									
		96	SM		SS	50/5"					
		98									
	100.5 2433.5	100	SM		SS	50/5"					
	Bottom of BORING.										

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED	2-28-12		
BORING COMPLETED	4-29-13		
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-109

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	Approx. Surface Elev.: 2534 ft										
	FILL - LANDFILL CAP, SILTY SAND; light brown, slightly damp, non-plastic.	0	SM		BS						
	2 2532	2									
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF CLOTH AND PLASTIC.	4									
		6									
		8									
		10									
		12									
		14									
		16									
		18									
		20									
		22									
		24									
		26									
		28									
		30									
	32 2502	32									
	SILTY SAND; light brown, very dense, slightly damp, non-plastic, occasional cobbles.	34									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED	2-28-12		
BORING COMPLETED	4-30-13		
RIG	CME-75	FOREMAN	NJE
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-109

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge, Tucson, Arizona**

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; light brown, very dense, slightly damp, non-plastic, occasional cobbles.	36									
		38									
		40	SM		RS	60					
		42									
		44									
		46	SM		RS	77/9"					
		48									
		50	SM		RS	50/5"					
		52									
	55 2479	54									
	POORLY GRADED SAND WITH SILT; light brown, dense, slightly damp, non-plastic.	56	SP-SM		SS	50					
		58									
		60	SP-SM		SS	47					
		62									
	65 2469	64									
	SILTY SAND; trace gravel, brown, dense to very dense, slightly damp, non-plastic.	66	SM		SS	47					
		68									
	Continued Next Page	70									

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			2-28-12
BORING COMPLETED			4-30-13
RIG	CME-75	FOREMAN	NJE
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-109

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; trace gravel, brown, dense to very dense, slightly damp, non-plastic.		SM	X	SS	69					
		72									
		74									
		76	SM	X	SS	91					
		78									
		80	SM	X	SS	50/5"					
		82									
		84									
		86	SM	X	SS	50/4"					
		88									
		90	SM	X	SS	50/5"					
		92									
		94									
		96	SM	X	SS	50/5"					
		98									
	100.5 2433.5	100	SM	X	SS	50/5"					
	Bottom of BORING.										

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED	2-28-12		
BORING COMPLETED	4-30-13		
RIG	CME-75	FOREMAN	NJE
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-110

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	Approx. Surface Elev.: 2535 ft										
	FILL - LANDFILL CAP, SILTY SAND; light brown, slightly damp, non-plastic.	2	SM		BS						
	2533										
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF PAPER, CLOTH, RUBBER, SCRAP METAL AND PLASTIC.	2									
		4									
		6									
		8									
		10									
		12									
		14									
		16									
		18									
		20									
		22									
		24									
		26									
		28									
		30									
	31										
	2504										
	SILTY SAND; light brown, medium dense to very dense, slightly damp, non-plastic.	32									
		34									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED	2-29-12		
BORING COMPLETED	5-2-13		
RIG	CME-75	FOREMAN	NJE
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-110

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge, Tucson, Arizona**

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; light brown, medium dense to very dense, slightly damp, non-plastic.	36	SM		RS	17					
		38									
		40	SM		RS	21	3	110			
		42									
		44									
		46	SM		SS	77			0	0	28
		48									
		50	SM		RS	50/6"					
		52									
		54									
	55 2480										
	POORLY GRADED SAND WITH SILT; light brown, very dense, slightly damp, non-plastic.	56	SP-SM		SS	80/10"					
		58									
	60 2475	60									
	SILTY SAND; light brown, dense to very dense, slightly damp, non-plastic.	62	SM		SS	50/5"					
		64									
		66	SM		SS	49					
		68									
		70									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			2-29-12
BORING COMPLETED			5-2-13
RIG	CME-75	FOREMAN	NJE
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-110

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; light brown, dense to very dense, slightly damp, non-plastic.		SM	X	SS	87					
		72									
		74									
			SM	X	SS	44					
		76									
		78									
		80	SM	X	SS	92/11"					
		82									
		84									
			SM	X	SS	50/5"					
		86									
		88									
		90	SM	X	SS	88/11"					
		92									
		94									
			SM	X	SS	78/11"					
		96									
		98									
	100.5 2434.5	100	SM	X	SS	50/5"					
	Bottom of BORING.										

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED			2-29-12
BORING COMPLETED			5-2-13
RIG	CME-75	FOREMAN	NJE
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-111

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	Approx. Surface Elev.: 2534 ft										
	FILL - LANDFILL CAP, CLAYEY SAND; brown, slightly damp, medium plasticity.	2	SC		BS						
	4 2530	4									
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF PAPER, CLOTH, PLASTIC SCRAP AND POLYETHYLENE TARP.	6									
		8									
		10									
		12									
		14									
		16									
		18									
		20									
		22									
		24									
		26									
		28									
		30									
		32									
		34									
	35 2499										

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			2-29-12
BORING COMPLETED			5-7-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-111

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge, Tucson, Arizona**

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; light brown, dense to very dense, slightly damp, non-plastic, occasional cobbles.	36									
		38									
		40									
		42									
		44									
		46									
		48									
		50	SM		RS	80					
		52									
		54									
		56	SM		RS	~~50/6"~~					
	58 2476		SM		SS	38					
	SILTY SAND WITH GRAVEL; brown, very dense, slightly damp, non-plastic.	58									
		60	SM		SS	50/4"					
		62									
		64									
		66	SM		SS	83					
		68									
		70									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			2-29-12
BORING COMPLETED			5-7-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-111

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND WITH GRAVEL; brown, very dense, slightly damp, non-plastic.		SM	X	SS	50/4"					
		72									
		74									
		76	SM	X	SS	88					
		78									
		80	SM	X	SS	50/5"					
		82									
		84									
		86	SM	X	SS	50/5"					
		88									
		90	SM	X	SS	50/4"					
		92									
		94									
		96	SM	X	SS	50/4"					
		98									
	100.5 2433.5	100	SM	X	SS	50/3"					
	Bottom of BORING.										

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED	2-29-12		
BORING COMPLETED	5-7-13		
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-112

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	Approx. Surface Elev.: 2535 ft										
	FILL - LANDFILL CAP, CLAYEY SAND; brown, slightly damp, medium plasticity.	2	SC		BS						
	5 2530	4									
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF PAPER, METAL WIRE, STRING, RUBBER BASKETBALL, CLOTH AND PLASTIC SCRAP.	6									
		8									
		10									
		12									
		14									
		16									
		18									
		20									
		22									
		24									
		26									
		28									
		30									
		32									
		34									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			2-29-12
BORING COMPLETED			5-7-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-112

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF PAPER, METAL WIRE, STRING, RUBBER BASKETBALL, CLOTH AND PLASTIC SCRAP. 40 2495	36									
		38									
		40									
	SILTY SAND; light brown, medium dense to very dense, damp, non-plastic, occasional cobbles.	42									
		44									
		46	SM		RS	53					
		48									
		50	SM		RS	59	9	115			
		52									
	58 2477	54									
	SILTY SAND WITH GRAVEL; light brown, very dense, slightly damp, non-plastic.	56	SM		SS	71					
		58									
		60	SM		SS	50/5"					
		62									
		64									
		66	SM		SS	79					
		68									
		70									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			2-29-12
BORING COMPLETED			5-7-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-112

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND WITH GRAVEL; light brown, very dense, slightly damp, non-plastic.		SM	X	SS	50/5"					
		72									
		74									
			SM	X	SS	97					
		76									
		78									
			SM	X	SS	82					
		80									
		82									
		84									
			SM	X	SS	50/5"					
		86									
		88									
		90									
			SM	X	SS	50/5"					
		92									
		94									
			SM	X	SS	50/5"					
		96									
		98									
		100									
			SM	X	SS	50/5"					
	100.5 2434.5										
	Bottom of BORING.										

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			2-29-12
BORING COMPLETED			5-7-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-113

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	Approx. Surface Elev.: 2536 ft										
	FILL - LANDFILL CAP, CLAYEY SAND; brown, slightly damp, medium plasticity.	2	SC		BS						
		4									
	7 2529	6									
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF PAPER, CLOTH AND PLASTIC.	8									
		10									
		12									
		14									
		16									
		18									
		20									
		22									
		24									
		26									
		28									
		30									
		32									
		34									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			5-8-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-113

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge, Tucson, Arizona**

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF PAPER, CLOTH AND PLASTIC.	36									
		38									
	40 2496	40									
	SILTY SAND; light brown, very dense, slightly damp, non-plastic.	42									
		44									
		46	SM		RS	66/11"					
		48									
	50.5 2485.5	50	SM		RS	50/5"					
	SILTY SAND; trace gravel, brown, very dense, slightly damp, non-plastic.	52									
		54									
		56	SM		SS	81					
		58									
		60	SM		SS	88					
		62									
		64									
		66	SM		SS	50/5"					
		68									
		70									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			5-8-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-113

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; trace gravel, brown, very dense, slightly damp, non-plastic.		SM	X	SS	75					
		72									
		74									
	75 2461										
	SILTY SAND WITH GRAVEL; brown, very dense, slightly damp, non-plastic.	76	SM	X	SS	68					
		78									
		80	SM	X	SS	78					
		82									
		84									
		86	SM	X	SS	83					
		88									
		90	SM	X	SS	50/5"					
		92									
		94									
		96	SM	X	SS	50/5"					
		98									
		100									
	101 2435		SM	X	SS	50/4"					
	Bottom of BORING.										

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			5-8-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-114

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	Approx. Surface Elev.: 2536 ft										
	FILL - LANDFILL CAP, SILTY SAND; light brown, slightly damp, non-plastic.	2	SM		BS						
	4 2532	4									
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF PAPER, CLOTH AND PLASTIC SCRAP.	6									
		8									
		10									
		12									
		14									
		16									
		18									
		20									
		22									
		24									
		26									
		28									
		30									
		32									
		34									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			5-9-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-114

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge, Tucson, Arizona**

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF PAPER, CLOTH AND PLASTIC SCRAP.	36									
		38									
	40 2496	40									
	SILTY SAND; light brown, very dense, slightly damp, non-plastic.	42									
		44									
		46	SM		RS	50/5"					
		48									
		50	SM		RS	50/6"					
		52									
		54									
		56	SM	X	SS	82					
		58									
		60	SM	X	SS	89/11"					
		62									
		64									
		66	SM	X	SS	50/5"					
		68									
	70 2466	70									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			5-9-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-114

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND WITH GRAVEL; brown, very dense, slightly damp, non-plastic.		SM	X	SS	88					
		72									
		74									
			SM	X	SS	50/5"					
		76									
		78									
		80	SM	X	SS	89/11"					
		82									
		84									
			SM	X	SS	50/5"					
		86									
		88									
		90	SM	X	SS	50/4"					
		92									
		94									
			SM	X	SS	50/3"					
		96									
		98									
		100									
	101 2435		SM	X	SS	50/5"					
	Bottom of BORING.										

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			5-9-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-115

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	Approx. Surface Elev.: 2536 ft										
	FILL - LANDFILL CAP, SILTY SAND; light brown, slightly damp, non-plastic.	2	SM		BS						
	4 2532	4									
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF PAPER SCRAP, CLOTH, METAL AND PLASTIC.	6									
		8									
		10									
		12									
		14									
		16									
		18									
		20									
		22									
		24									
		26									
		28									
		30									
		32									
		34									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			5-10-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-115

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF PAPER SCRAP, CLOTH, METAL AND PLASTIC.	36									
		38									
	40 2496	40									
	SILTY SAND; light brown, dense to very dense, slightly damp, non-plastic.	42									
		44									
		46	SM		RS	60					
		48									
		50	SM		RS	85					
		52									
		54									
		56	SM		SS	82/11"					
		58									
		60	SM		SS	92/11"					
		62									
	65 2471	64									
	SILTY SAND WITH GRAVEL; brown to light brown, very dense, slightly damp, non-plastic.	66	SM		SS	92/11"					
		68									
	Continued Next Page	70									

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

WATER LEVEL OBSERVATIONS, ft			
WL	▽ None WD	▼	
WL	▼	▼	
WL	Backfilled Upon Completion		

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			5-10-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-115

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND WITH GRAVEL; brown to light brown, very dense, slightly damp, non-plastic.		SM	X	SS	50/5"					
		72									
		74									
			SM	X	SS	50/5"					
		76									
		78									
		80	SM	X	SS	77					
		82									
		84									
			SM	X	SS	90/10"					
		86									
		88									
		90	SM	X	SS	74/11"					
		92									
		94									
			SM	X	SS	50/4"					
		96									
		98									
	100.5 2435.5	100	SM	X	SS	50/5"					
	Bottom of BORING.										

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽ None WD	▼
WL	▼	▼
WL	Backfilled Upon Completion	

Terracon

BORING STARTED			3-1-12
BORING COMPLETED			5-10-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-2

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge, Tucson, Arizona**

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	Approx. Surface Elev.: 2534 ft										
	FILL - LANDFILL CAP, CLAYEY SAND; brown, slightly damp, medium plasticity.	2	SC		BS						
		4									
		6									
		8									
		10									
	12.5 2521.5	12									
	LANDFILL DEBRIS CONSISTING OF SOIL AND MUNICIPAL WASTE WITH VISIBLE PIECES OF NEWSPAPER, CLOTHES, PLASTIC, METAL SHARDS, METAL PIPE.	14			BS						
		16									
		18									
		20									
		22									
		24									
		26									
		28									
		30			RS	35					
	32 2502	32									
	SILTY SAND WITH GRAVEL; light brown, dense to very dense, slightly damp, non-plastic.	34									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽	▼
WL	▼	▼
WL		

Terracon

BORING STARTED	6-3-10		
BORING COMPLETED	4-30-13		
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-2

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS -#200
	SILTY SAND WITH GRAVEL; light brown, dense to very dense, slightly damp, non-plastic.	36	SM		RS	51					
		38									
		40	SM		SS	62/12"					
		42									
		44									
		46	SM		RS	50/2"					
	48 2486	48									
	SILTY SAND; trace gravel, light brown, very dense, slightly damp, non-plastic.	50	SM		RS	80/8"					
		52									
		54									
		56	SM		RS	74					
		58									
		60	SM		SS	60					
		62									
		64									
		66	SM		SS	53					
		68									
		70									

Continued Next Page

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽	▼
WL	▼	▽
WL		

Terracon

BORING STARTED	6-3-10		
BORING COMPLETED	4-30-13		
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

LOG OF BORING NO. B-2

CLIENT **PSOMAS**

SITE **Mullins Landfill Bridge**
Tucson, Arizona

PROJECT **Sabino-Kolb Extention**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE PENETRATION TEST RESULTS (BLOWS/FT.)	TESTS WATER CONTENT, %	TESTS DRY DENSITY pcf	TESTS LIQUID LIMIT	TESTS PLASTICITY INDEX	TESTS #200
	SILTY SAND; trace gravel, light brown, very dense, slightly damp, non-plastic.	72									
		74									
		76	SM	X	SS	56					
		78									
		80	SM	X	SS	88/10"					
		82									
		84									
		86	SM	X	SS	80/10"					
		88									
	90 2444	90									
	POORLY GRADED SAND WITH SILT; light brown, very dense, slightly damp, non-plastic.	92	SP-SM	X	SS	57					
	95 2439	94									
	SILTY SAND WITH GRAVEL; light brown, very dense, slightly damp, non-plastic.	96	SM	X	SS	50/5"					
	100 2434	98									
	POORLY GRADED SAND WITH SILT; light brown, very dense, slightly damp, non-plastic.	100	SP-SM	X	SS	99/9"					
	101.5 2432.5 **Bottom of BORING.**										

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

WATER LEVEL OBSERVATIONS, ft		
WL	▽	▼
WL	▼	▽
WL		

Terracon

BORING STARTED			6-3-10
BORING COMPLETED			4-30-13
RIG	CME-75	FOREMAN	LDB
APPROVED	OBL	JOB #	63125005

BOREHOLE 2008 63125005.GPJ TERR2000.GDT 5/13/13

APPENDIX B

LABORATORY TESTING

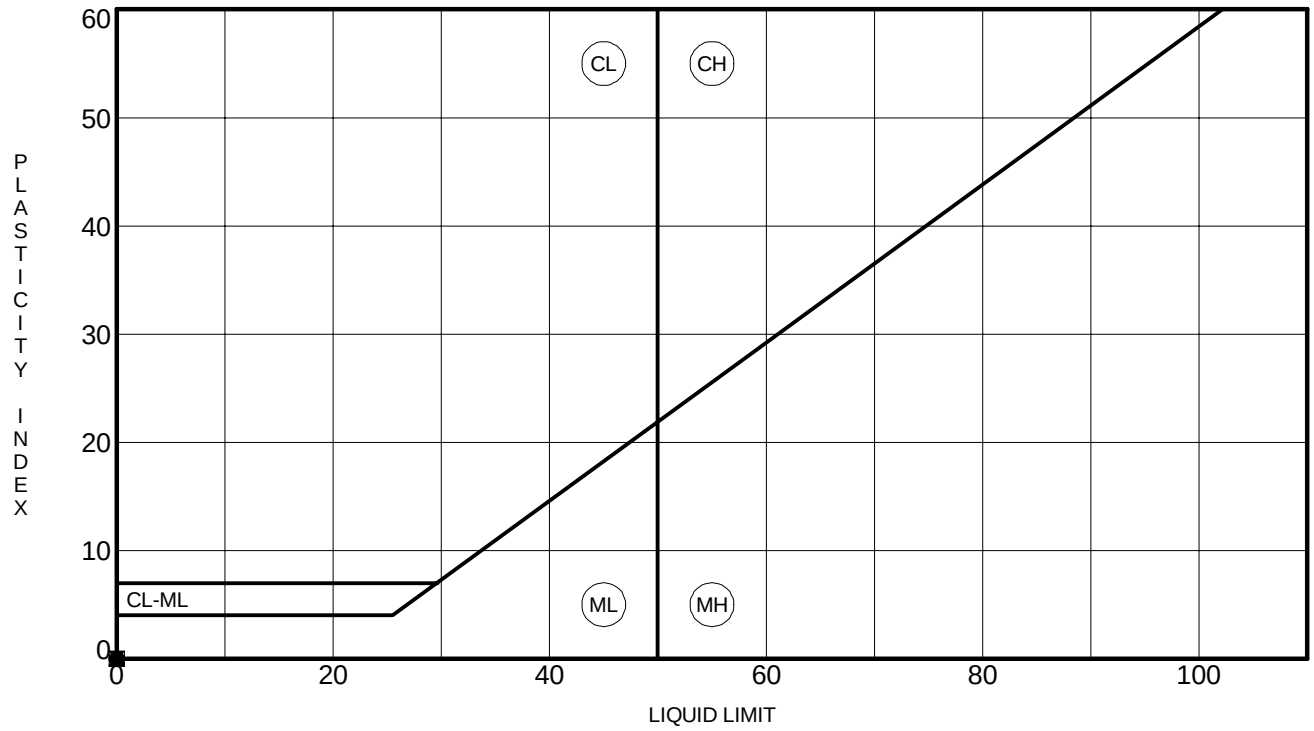
Laboratory Testing

Samples retrieved during the field exploration were taken to the laboratory for further observation by the project geotechnical engineer and were classified in accordance with the Unified Soil Classification System (USCS) described in Appendix A. At that time, the field descriptions were confirmed or modified as necessary and an applicable laboratory testing program was formulated to determine engineering properties of the subsurface materials.

Laboratory tests were conducted on selected soil samples and the test results are presented in this appendix. The laboratory test results were used for the geotechnical engineering analyses, and the development of foundation and earthwork recommendations. Laboratory tests were performed in general accordance with the applicable ASTM, local or other accepted standards.

Selected soil samples obtained from the site were tested for the following engineering properties:

- Direct Shear
- Sieve Analysis
- Atterberg Limits
- In-situ Water Content
- In-situ Dry Density



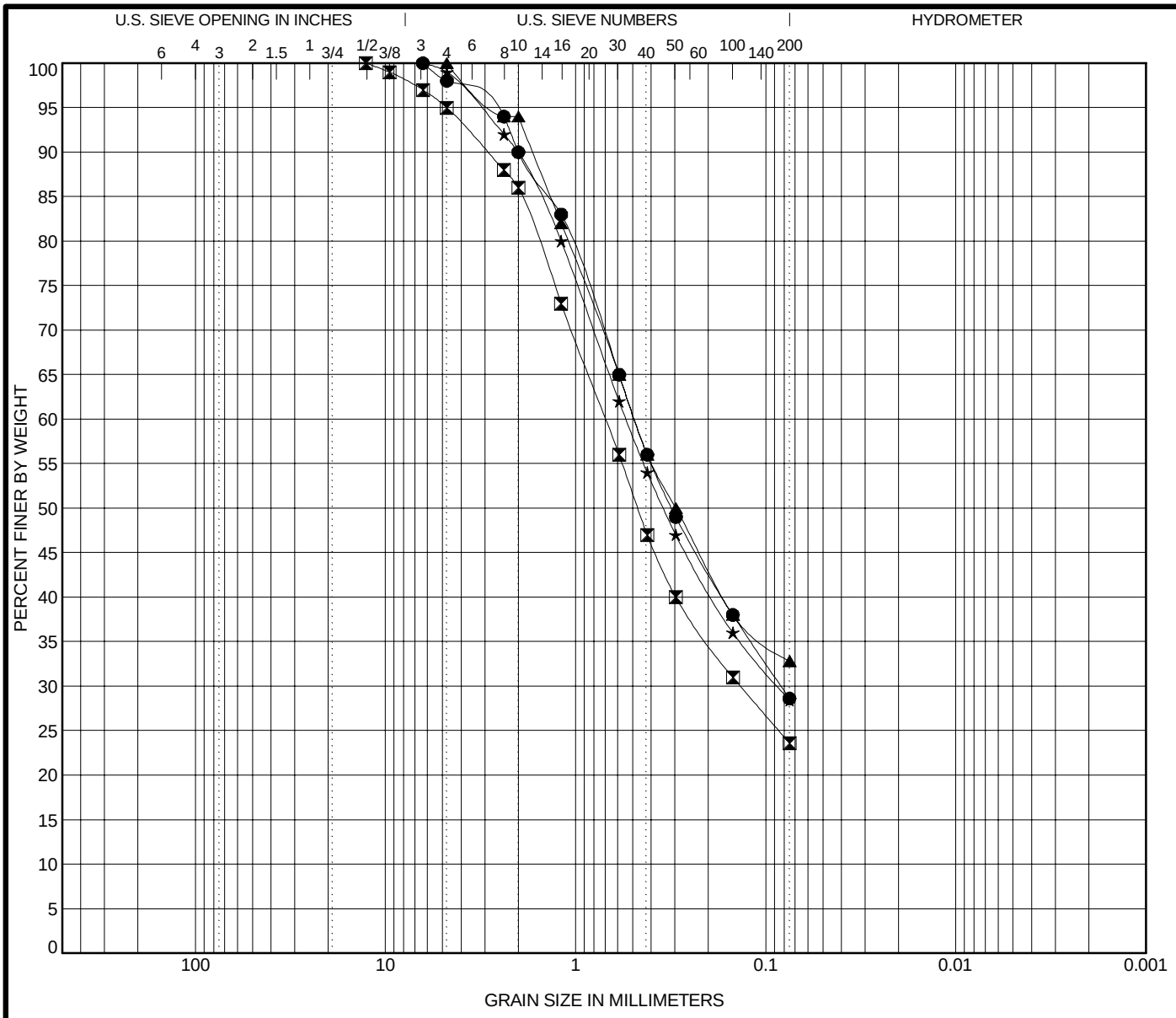
	Specimen Identification		LL	PL	PI	%-#200	Soil Description
●	**B-101**	**45.0ft**	**NP**	**NP**	**NP**	**29**	**SILTY SAND(SM)**
⧓	**B-103**	**0.0ft**	**NP**	**NP**	**NP**	**24**	**SILTY SAND(SM)**
▲	**B-106**	**45.0ft**	**NP**	**NP**	**NP**	**33**	**SILTY SAND(SM)**
★	**B-110**	**45.0ft**	**NP**	**NP**	**NP**	**28**	**SILTY SAND(SM)**

Terracon

ATTERBERG LIMITS RESULTS

Project: Sabino-Kolb Extention
Site: Mullins Landfill Bridge Tucson, Arizona
Job #: 63125005
Date: 1-16-13

TC ATTERBERG_LIMITS 63125005.GPJ TERRACON.GDT 1/16/13



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		USCS Soil Classification	LL	PL	PI	Cc	Cu
●	**B-101**	**45.0 ft**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		
⊠	**B-103**	**0.0 ft**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		
▲	**B-106**	**45.0 ft**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		
★	**B-110**	**45.0 ft**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-101**	**45.0 ft**	**6.35**	**0.488**	**0.083**		**2**	**69**	**29**	
⊠	**B-103**	**0.0 ft**	**12.7**	**0.696**	**0.136**		**5**	**71**	**24**	
▲	**B-106**	**45.0 ft**	**4.75**	**0.488**			**0**	**67**	**33**	
★	**B-110**	**45.0 ft**	**6.35**	**0.542**	**0.087**		**1**	**71**	**28**	

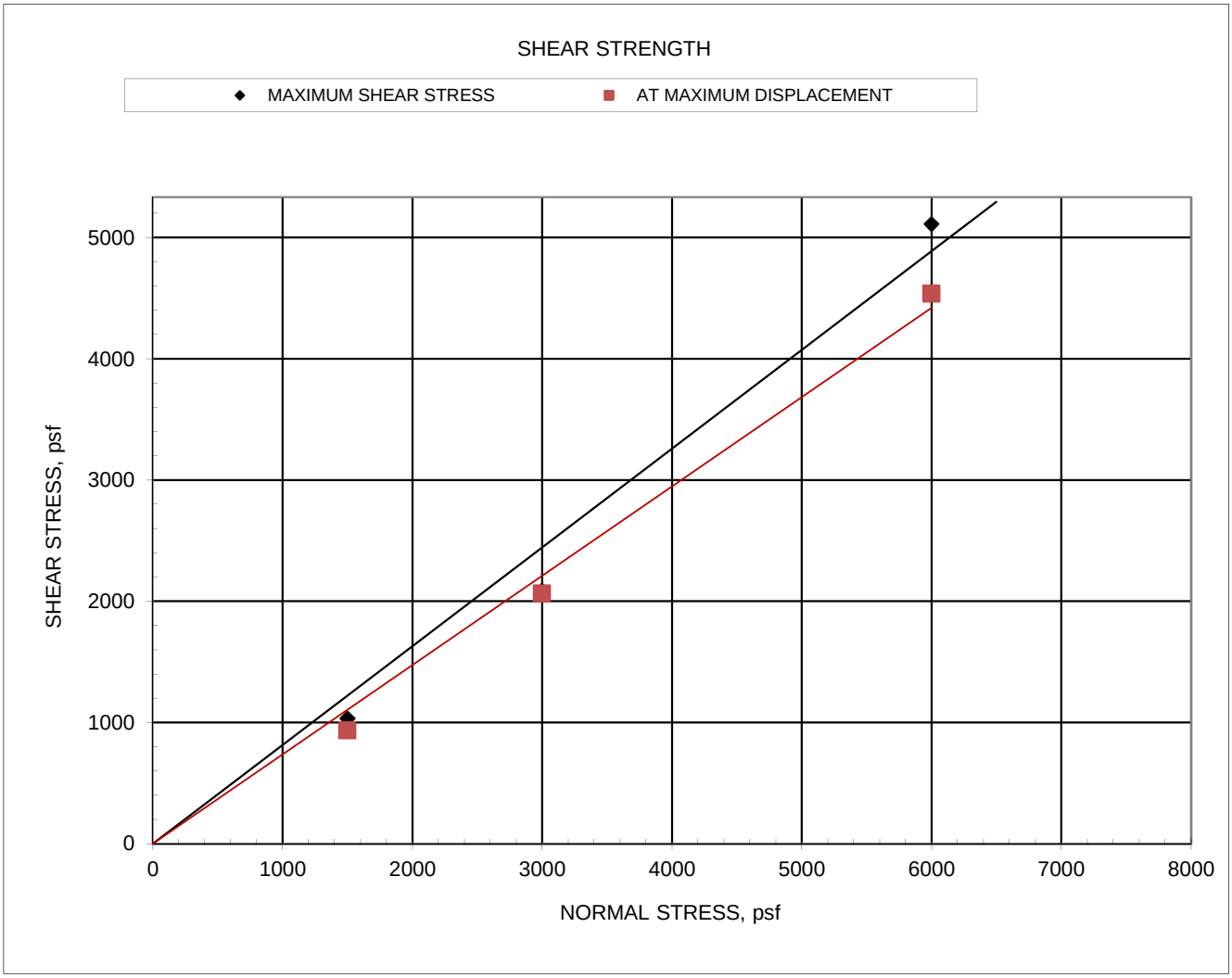
Terracon

GRAIN SIZE DISTRIBUTION

Project: Sabino-Kolb Extention
Site: Mullins Landfill Bridge Tucson, Arizona
Job #: 63125005
Date: 1-16-13

TC GRAIN SIZE MULTI 63125005.GPJ TERRACON.GDT 1/16/13

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS
ASTM D3080



		FRICTION ANGLE	COHESION	NORMAL	NORMAL	NORMAL
AT MAXIMUM SHEAR STRESS		**39.2 deg**	**0 psf**	STRESS, psf	STRESS, psf	STRESS, psf
AT MAXIMUM DISPLACEMENT		**37.1 deg**	**0 psf**	1500	3000	6000
INITIAL AREA, in2	4.584	INITIAL MOISTURE, %		1.9	1.9	1.9
INITIAL LENGTH, in	1.000	INITIAL DRY DENSITY, pcf		107.4	109.8	112.1
SPECIFIC GRAVITY	2.68	INITIAL SATURATION, %		9	10	10
SG ASSUMED	X	INITIAL VOID RATIO		0.56	0.52	0.49
SG TESTED		FINAL MOISTURE, %		14.7	13.8	12.5
LIQUID LIMIT	NP	FINAL SATURATION, %		75	78	76
PLASTIC LIMIT	NV	FINAL VOID RATIO		0.53	0.47	0.44
PLASTICITY INDEX	NP	MAXIMUM SHEAR STRESS, psf		1032	2088	5112
		DISPLACEMENT AT MAXIMUM SHEAR, in		0.141	0.351	0.226
		SHEAR STRESS AT MAX DISPLACEMENT, psf		936	2064	4536
		MAXIMUM DISPLAEMENT, in		0.401	0.401	0.401
SAMPLE TYPE	UNDISTURBED	RATE OF LOADING, in/min		0.0100	0.0100	0.0100
DESCRIPTION	SILTY SAND(SM)					

PROJECT NAME: Sabino Canyon Road

LOCATION: Pantano Wash Bridge

JOB NO.: 63125005

DATE: 3/22/2012

BORING NO. B-5

SAMPLE NO. @

DEPTH, feet 40 TO 41

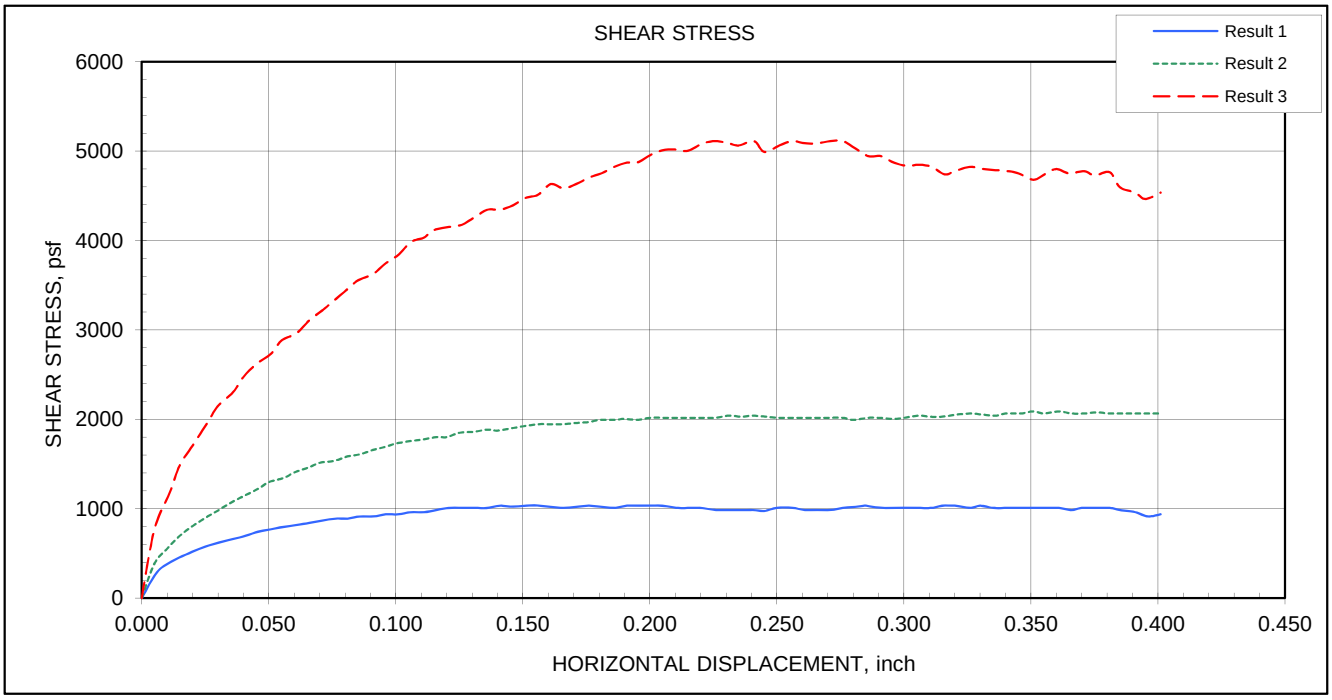
N:\Projects TEMPORARY Folder\GEOTECH\Tucson (63)\63125005.Psomas.Pantano Wash Bridge\[63125005 B-5 @ 40 .xlsm]

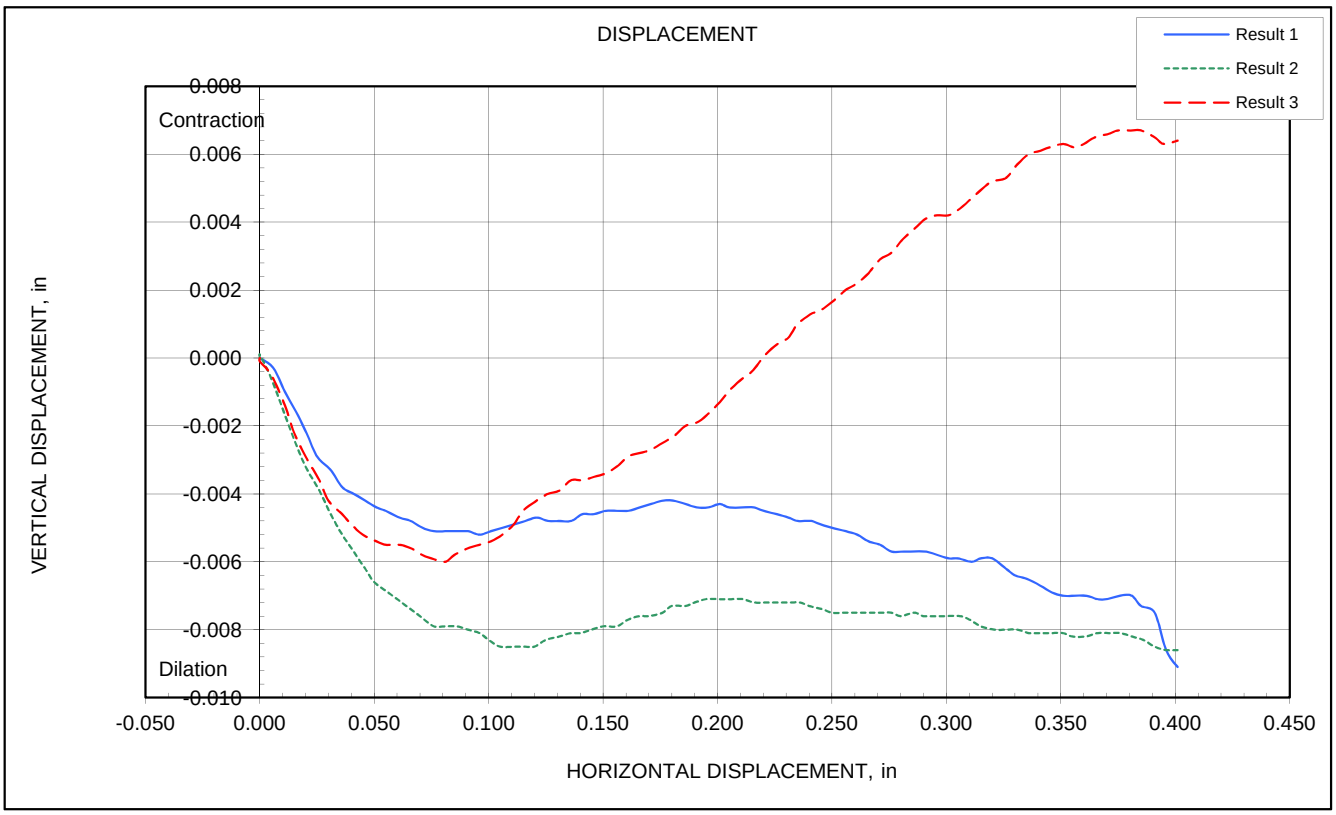
Terracon

Exhibit B-4

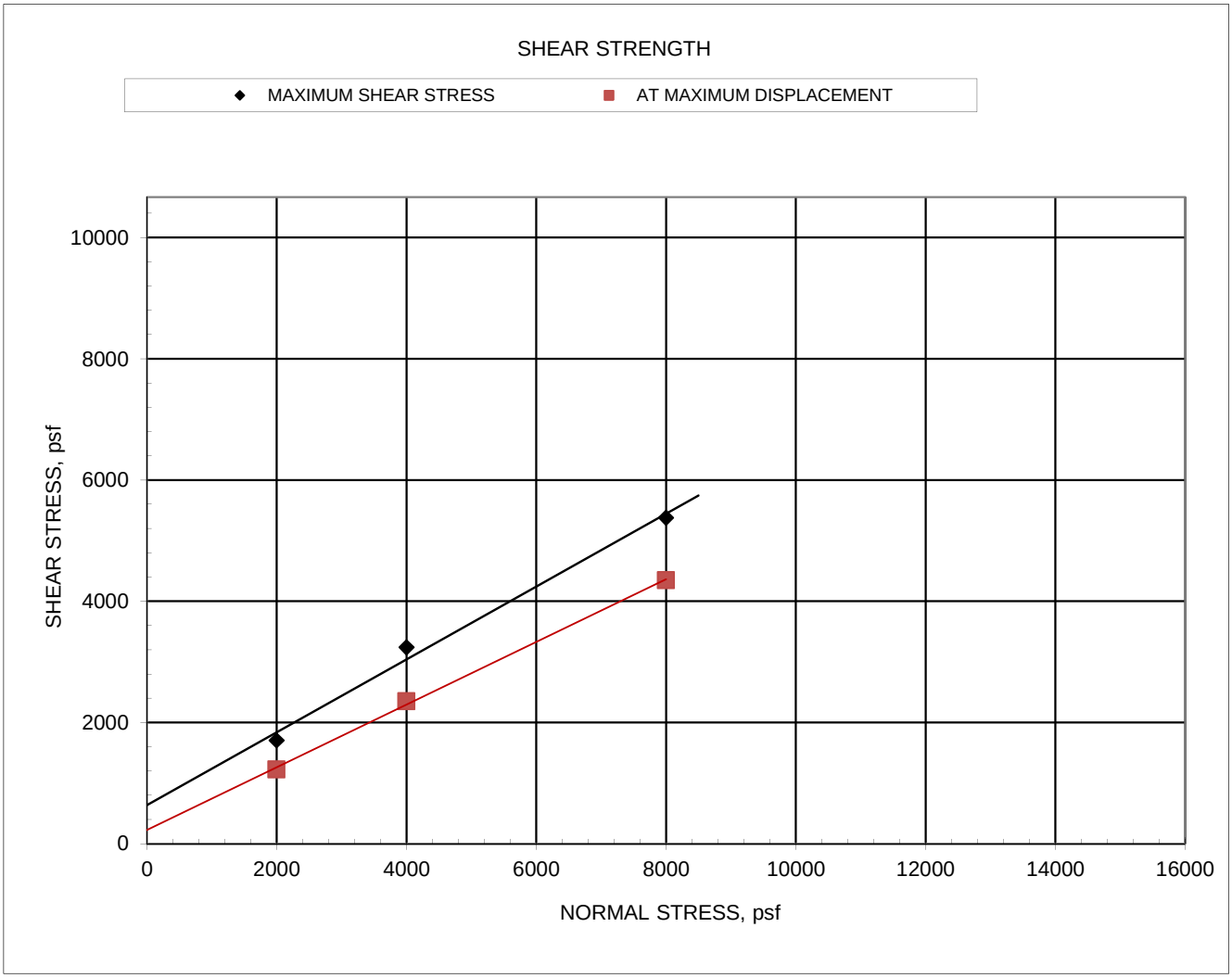
Sabino Canyon Road
Pantano Wash Bridge
63125005
3/22/2012

BORING NO.	B-5
SAMPLE NO.	@
DEPTH, feet	40 TO 41





DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS
ASTM D3080



		FRICTION ANGLE	COHESION	NORMAL	NORMAL	NORMAL
AT MAXIMUM SHEAR STRESS		**31.0 deg**	**636 psf**	STRESS, psf	STRESS, psf	STRESS, psf
AT MAXIMUM DISPLACEMENT		**27.3 deg**	**228 psf**	2000	4000	8000
INITIAL AREA, in2	4.584	INITIAL MOISTURE, %		8.0	8.0	8.0
INITIAL LENGTH, in	1.000	INITIAL DRY DENSITY, pcf		111.5	111.2	108.7
SPECIFIC GRAVITY	2.68	INITIAL SATURATION, %		43	43	40
SG ASSUMED	X	INITIAL VOID RATIO		0.50	0.50	0.54
SG TESTED		FINAL MOISTURE, %		19.4	18.5	19.3
LIQUID LIMIT		FINAL SATURATION, %		108	104	103
PLASTIC LIMIT		FINAL VOID RATIO		0.48	0.48	0.50
PLASTICITY INDEX		MAXIMUM SHEAR STRESS, psf		1704	3240	5376
		DISPLACEMENT AT MAXIMUM SHEAR, in		0.101	0.126	0.156
		SHEAR STRESS AT MAX DISPLACEMENT, psf		1224	2352	4344
		MAXIMUM DISPLAEMENT, in		0.400	0.401	0.401
SAMPLE TYPE	UNDISTURBED	RATE OF LOADING, in/min		0.0100	0.0100	0.0100
DESCRIPTION	SILTY SAND(SM)					

PROJECT NAME: Sabino Canyon Road

LOCATION: Pantano Wash Bridge

JOB NO.: 63125005

DATE: 3/22/2012

BORING NO. B-18

SAMPLE NO. @

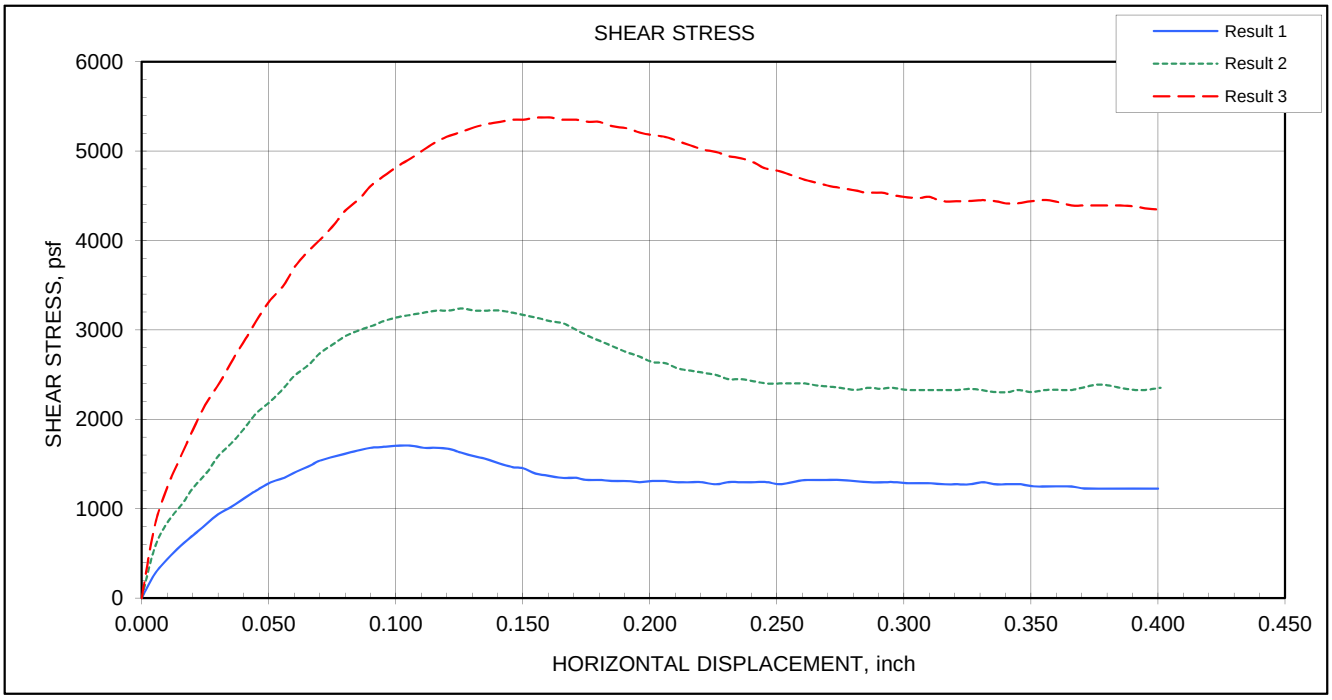
DEPTH, feet 55 TO 56

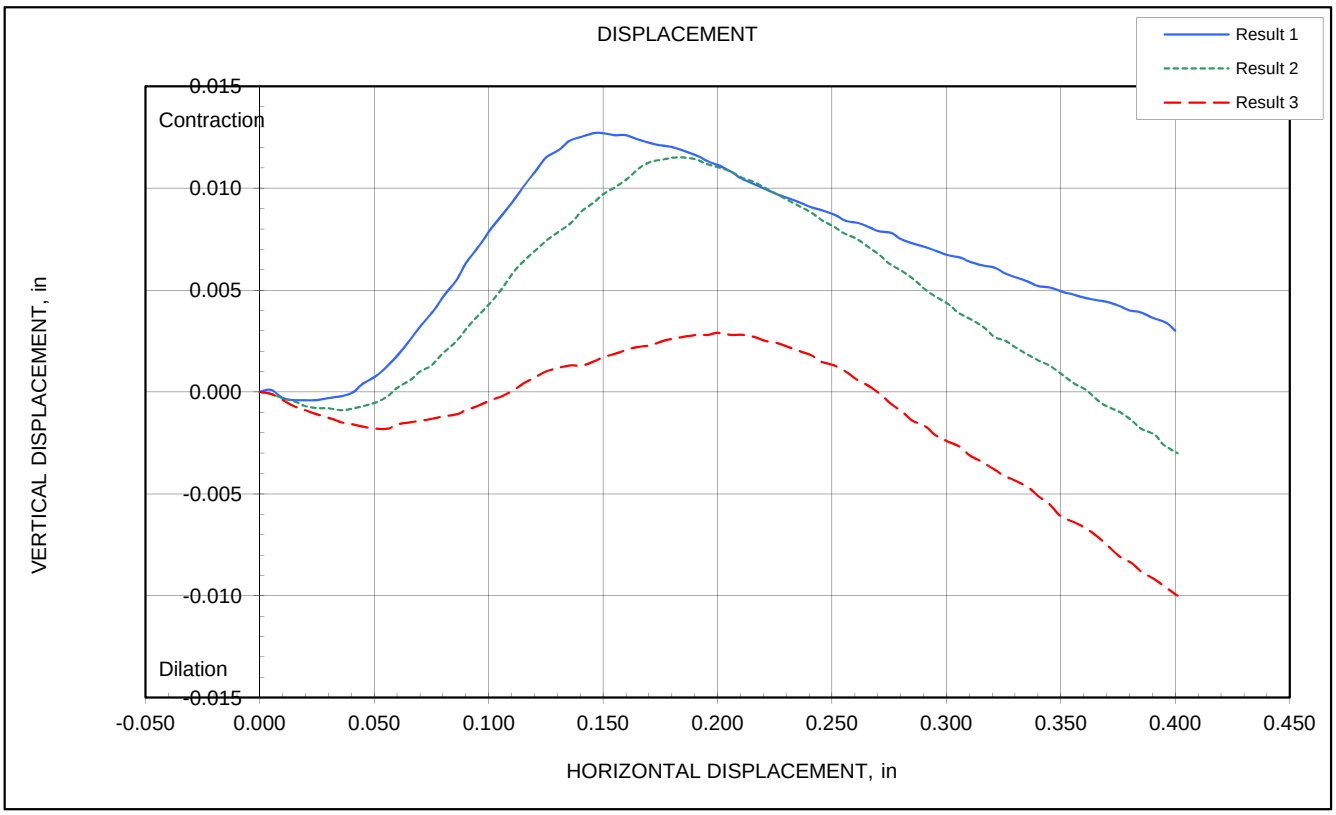
N:\Projects TEMPORARY Folder\GEOTECH\Tucson (63)\63125005.Psomas.Pantano Wash Bridge\[63125005 B-18 @ 55 .xls

Terracon

Sabino Canyon Road
Pantano Wash Bridge
63125005
3/22/2012

BORING NO.	B-18
SAMPLE NO.	@
DEPTH, feet	55 TO 56





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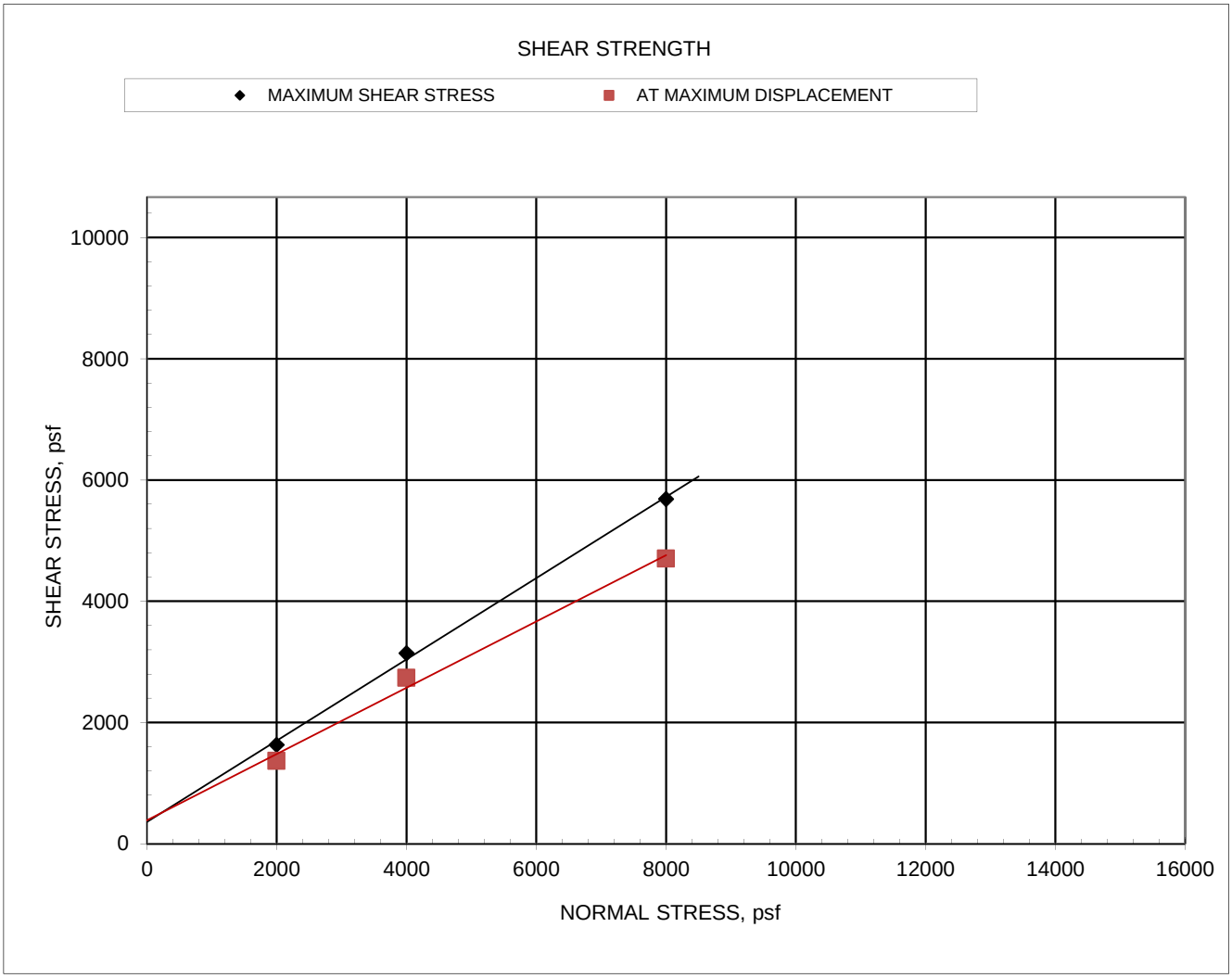
Terracon

Exhibit B-7

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS
ASTM D3080



		FRICTION ANGLE	COHESION	NORMAL	NORMAL	NORMAL
AT MAXIMUM SHEAR STRESS		**33.8 deg**	**360 psf**	STRESS, psf	STRESS, psf	STRESS, psf
AT MAXIMUM DISPLACEMENT		**28.7 deg**	**384 psf**	2000	4000	8000
INITIAL AREA, in2	4.584	INITIAL MOISTURE, %		7.2	7.2	7.2
INITIAL LENGTH, in	1.000	INITIAL DRY DENSITY, pcf		108.8	106.3	108.1
SPECIFIC GRAVITY	2.68	INITIAL SATURATION, %		36	34	35
SG ASSUMED	X	INITIAL VOID RATIO		0.54	0.57	0.55
SG TESTED		FINAL MOISTURE, %		18.5	18.7	19.5
LIQUID LIMIT		FINAL SATURATION, %		97	92	102
PLASTIC LIMIT		FINAL VOID RATIO		0.51	0.54	0.51
PLASTICITY INDEX		MAXIMUM SHEAR STRESS, psf		1632	3144	5688
		DISPLACEMENT AT MAXIMUM SHEAR, in		0.116	0.141	0.156
		SHEAR STRESS AT MAX DISPLACEMENT, psf		1368	2736	4704
		MAXIMUM DISPLAEMENT, in		0.401	0.401	0.401
SAMPLE TYPE	UNDISTURBED	RATE OF LOADING, in/min		0.0100	0.0100	0.0100
DESCRIPTION	SILTY SAND(SM)					

PROJECT NAME: Sabino Canyon Road

LOCATION: Pantano Wash Bridge

JOB NO.: 63125005

DATE: 3/22/2012

BORING NO. B-19

SAMPLE NO. @

DEPTH, feet 65 TO 66

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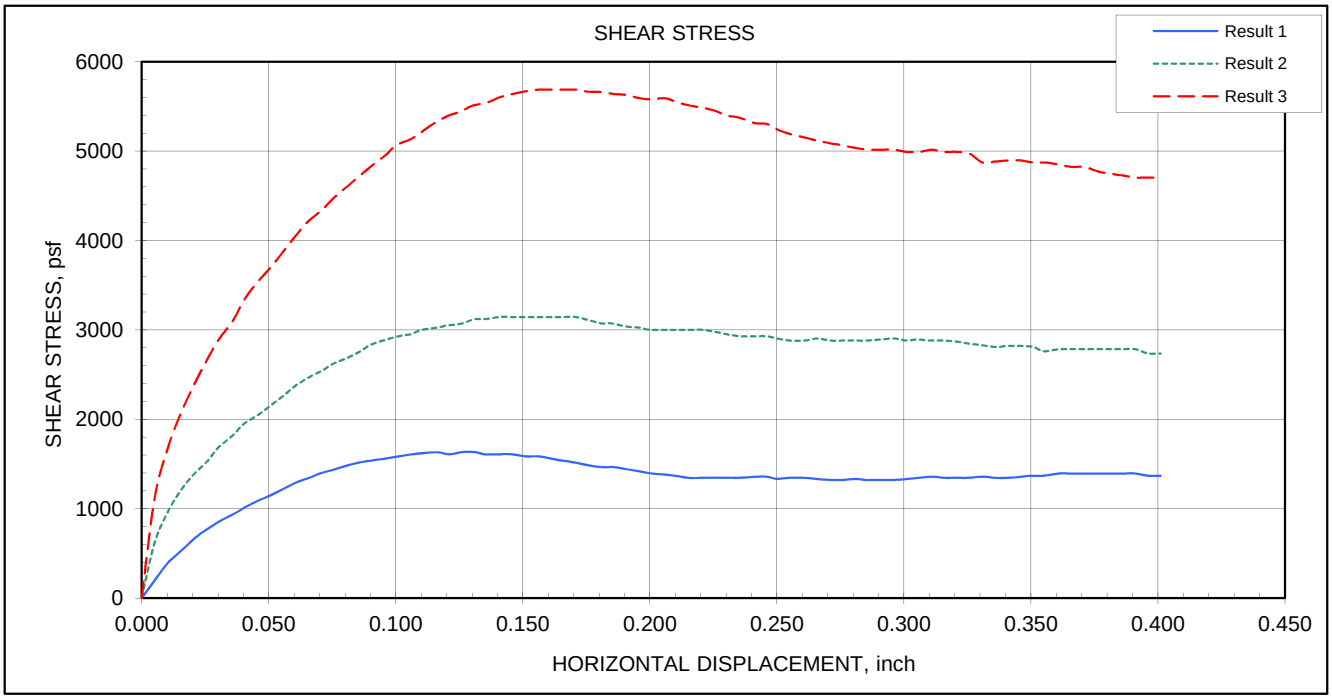
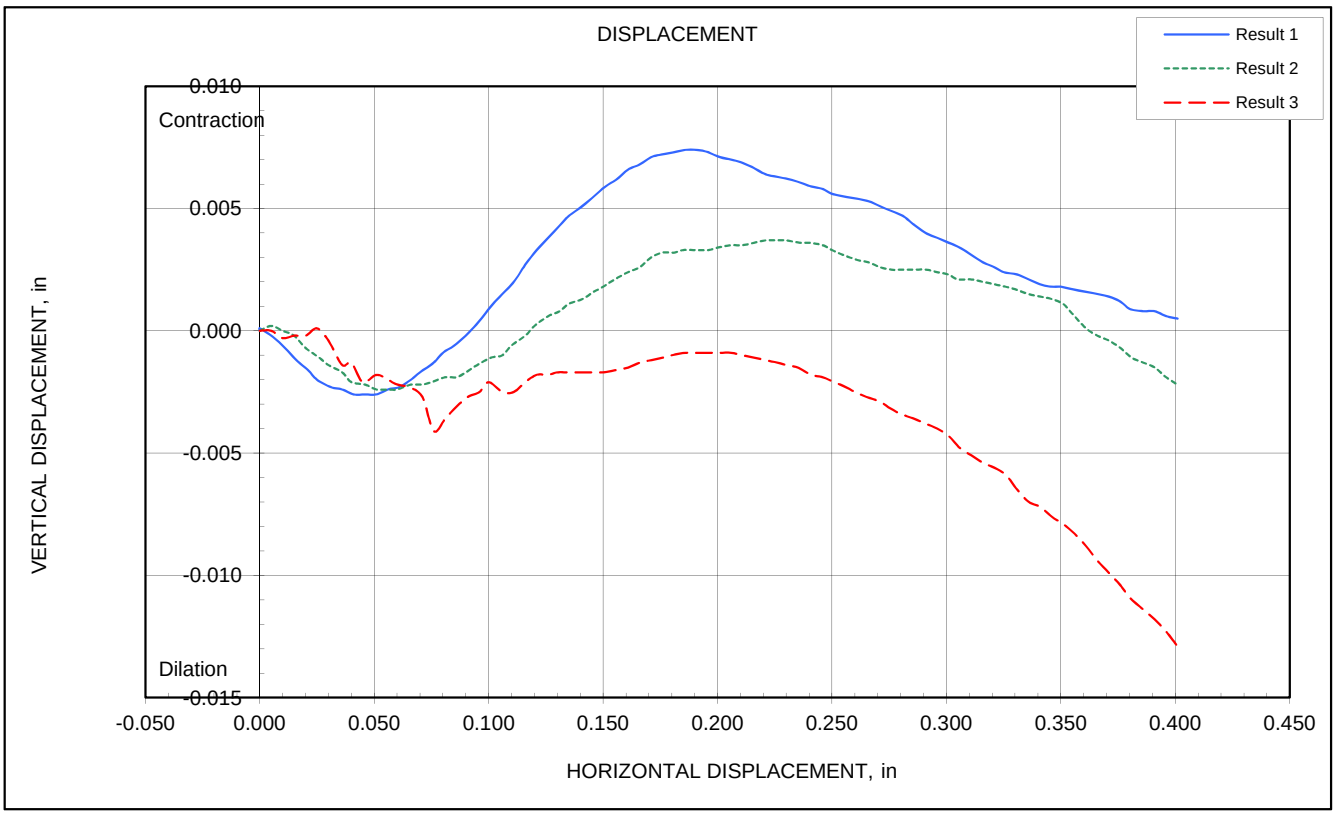
Terracon

Sabino Canyon Road
Pantano Wash Bridge
63125005
3/22/2012

BORING NO.	B-19
SAMPLE NO.	@
DEPTH, feet	65 TO 66





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Terracon

Exhibit B-9

Borehole No.	Depth (ft.)	USCS Soil Class.	In-Situ Properties		Classification				Expansion Testing					Corrosivity			Remarks
			Dry Density (pcf)	Water Content (%)	Passing #200 Sieve (%)	Atterberg Limits			Dry Density (pcf)	Water Content (%)	Surcharge (psf)	Expansion (%)	Expansion Index EI_{50}	pH	Resistivity (ohm-cm)	Sulfates (ppm)	
						LL	PL	PI									
B-101	45	SM			29	NP	NP	NP									
B-103	0	SM			24	NP	NP	NP									
B-106	45	SM			33	NP	NP	NP									
B-107	0	SC														0	2
B-107	40	SM	120	4													1, 2
B-110	40	SM	110	3													1, 2
B-110	45	SM			28	NP	NP	NP									
B-112	50	SM	115	9													1, 2

REMARKS

1. Dry Density and/or moisture determined from one or more rings of a multi-ring sample.
2. Visual Classification.
3. Submerged to approximate saturation.
4. Expansion Index in accordance with ASTM D4829-95.
5. Air-Dried Sample

Terracon

SUMMARY OF LABORATORY RESULTS

Project: Sabino-Kolb Extention
Site: Mullins Landfill Bridge Tucson, Arizona
Job #: 63125005
Date: 1-16-13

SOIL PROPERTIES 63125005.GPJ TERR2000.GDT 1/16/13

APPENDIX C

Mullins Landfill Bridge

North Abutment

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	North Abut

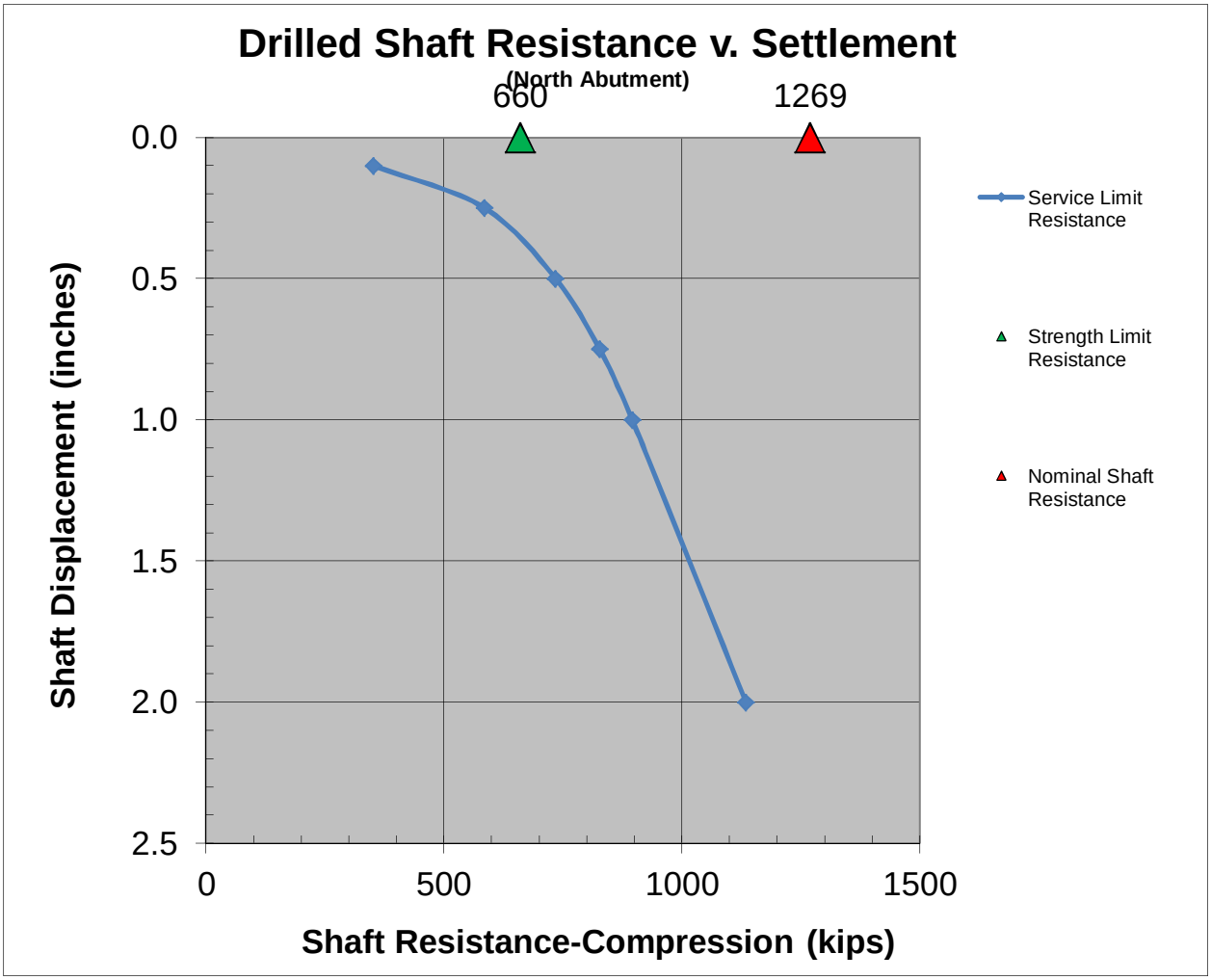
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	44	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	351.8
2	0.25	585.4
3	0.50	734.4
4	0.75	827.1
5	1.00	895.7
6	2.00	1134.5

Strength Limit Resistance Kips	Nominal Resistance Kips
660	1269



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	North Abut

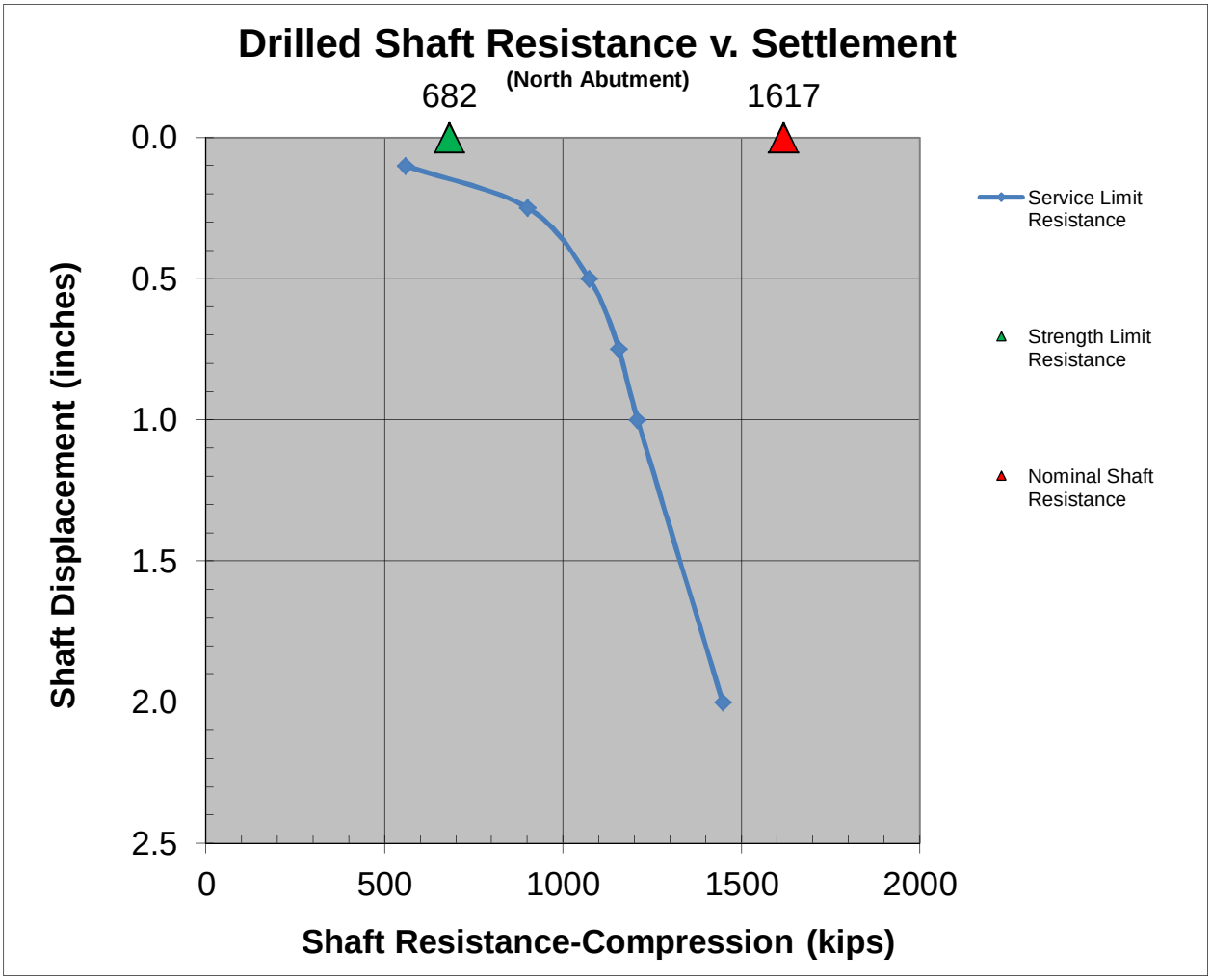
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	54	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	558.1
2	0.25	901.5
3	0.50	1073.0
4	0.75	1156.8
5	1.00	1209.1
6	2.00	1447.9

Strength Limit Resistance Kips	Nominal Resistance Kips
682	1617



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	North Abut

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	60	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	44	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2532.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	8	26	37	62	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	75	65	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	8.0	18.0	11.0	25.0	38.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted for Redundant Design**				
Side Resistance-Compression	0.55	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	North Abut

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	60	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	54	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2532.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	8	26	37	62	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	75	65	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	8.0	18.0	11.0	25.0	38.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted Without Redundant Design**				
Side Resistance-Compression	0.44	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

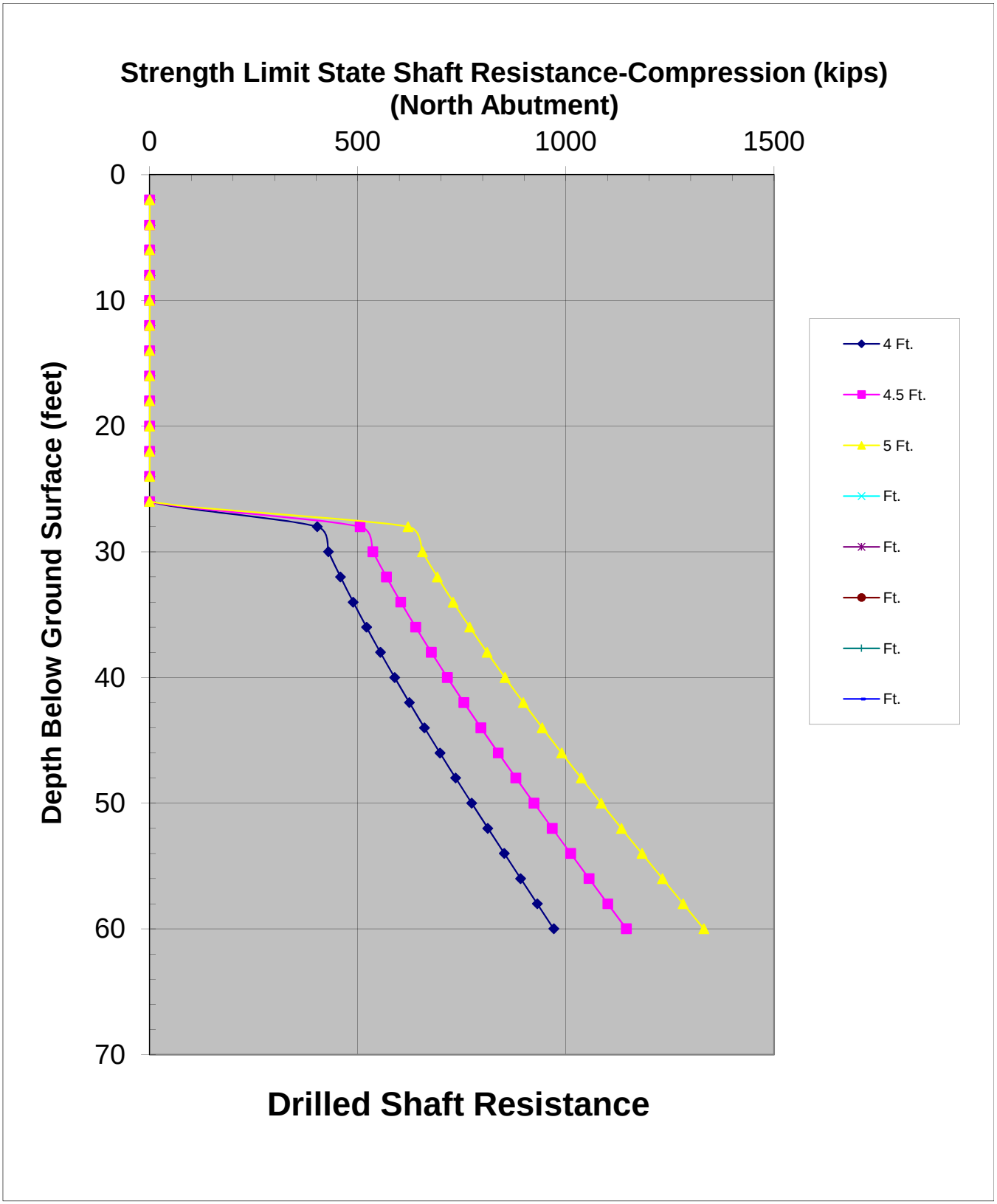
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2530.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2528.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2526.00	6.0	0.0		120.0	600.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2524.00	8.0	0.0		120.0	840.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2522.00	10.0	0.0		70.0	1030.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2520.00	12.0	0.0		70.0	1170.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2518.00	14.0	0.0		70.0	1310.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2516.00	16.0	0.0		70.0	1450.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2514.00	18.0	0.0		70.0	1590.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2512.00	20.0	0.0		70.0	1730.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2510.00	22.0	0.0		70.0	1870.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2508.00	24.0	0.0		70.0	2010.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2506.00	26.0	0.0		70.0	2150.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2504.00	28.0	75.0		125.0	2345.0	0.79		1.84	0.55	0.45	0.50	60.0	60.0	60.0					
2502.00	30.0	75.0		125.0	2595.0	0.76		1.97	0.55	0.45	0.50	60.0	60.0	60.0					
2500.00	32.0	75.0		125.0	2845.0	0.74		2.09	0.55	0.45	0.50	60.0	60.0	60.0					
2498.00	34.0	75.0		125.0	3095.0	0.71		2.21	0.55	0.45	0.50	60.0	60.0	60.0					
2496.00	36.0	75.0		125.0	3345.0	0.69		2.31	0.55	0.45	0.50	60.0	60.0	60.0					
2494.00	38.0	65.0		125.0	3595.0	0.67		2.40	0.55	0.45	0.50	60.0	60.0	60.0					
2492.00	40.0	65.0		125.0	3845.0	0.65		2.48	0.55	0.45	0.50	60.0	60.0	60.0					
2490.00	42.0	65.0		125.0	4095.0	0.63		2.56	0.55	0.45	0.50	60.0	60.0	60.0					
2488.00	44.0	65.0		125.0	4345.0	0.60		2.63	0.55	0.45	0.50	60.0	60.0	60.0					
2486.00	46.0	65.0		125.0	4595.0	0.58		2.69	0.55	0.45	0.50	60.0	60.0	60.0					
2484.00	48.0	65.0		125.0	4845.0	0.56		2.74	0.55	0.45	0.50	60.0	60.0	60.0					
2482.00	50.0	65.0		125.0	5095.0	0.55		2.78	0.55	0.45	0.50	60.0	60.0	60.0					
2480.00	52.0	65.0		125.0	5345.0	0.53		2.81	0.55	0.45	0.50	60.0	60.0	60.0					
2478.00	54.0	65.0		125.0	5595.0	0.51		2.84	0.55	0.45	0.50	60.0	60.0	60.0					
2476.00	56.0	65.0		125.0	5845.0	0.49		2.86	0.55	0.45	0.50	60.0	60.0	60.0					
2474.00	58.0	65.0		125.0	6095.0	0.47		2.88	0.55	0.45	0.50	60.0	60.0	60.0					
2472.00	60.0	65.0		125.0	6345.0	0.45		2.88	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2530.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2528.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2526.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2524.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2522.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2520.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2518.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2516.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2514.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2512.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2510.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2508.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2506.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2504.00	28.0	377.00	25.47	402.47	477.15	28.65	505.80	589.07	31.83	620.90																	
2502.00	30.0	377.00	52.75	429.75	477.15	59.34	536.49	589.07	65.94	655.01																	
2500.00	32.0	377.00	81.71	458.71	477.15	91.92	569.07	589.07	102.14	691.20																	
2498.00	34.0	377.00	112.21	489.21	477.15	126.23	603.38	589.07	140.26	729.33																	
2496.00	36.0	377.00	144.11	521.12	477.15	162.13	639.27	589.07	180.14	769.21																	
2494.00	38.0	377.00	177.30	554.30	477.15	199.46	676.61	589.07	221.62	810.69																	
2492.00	40.0	377.00	211.64	588.65	477.15	238.10	715.24	589.07	264.55	853.62																	
2490.00	42.0	377.00	247.03	624.03	477.15	277.91	755.05	589.07	308.79	897.85																	
2488.00	44.0	377.00	283.34	660.34	477.15	318.75	795.90	589.07	354.17	943.24																	
2486.00	46.0	377.00	320.46	697.46	477.15	360.51	837.66	589.07	400.57	989.64																	
2484.00	48.0	377.00	358.28	735.28	477.15	403.06	880.21	589.07	447.85	1036.92																	
2482.00	50.0	377.00	396.69	773.69	477.15	446.28	923.42	589.07	495.86	1084.93																	
2480.00	52.0	377.00	435.59	812.60	477.15	490.04	967.19	589.07	544.49	1133.56																	
2478.00	54.0	377.00	474.88	851.88	477.15	534.24	1011.38	589.07	593.60	1182.67																	
2476.00	56.0	377.00	514.45	891.45	477.15	578.76	1055.90	589.07	643.06	1232.13																	
2474.00	58.0	377.00	554.21	931.21	477.15	623.48	1100.63	589.07	692.76	1281.83																	
2472.00	60.0	377.00	594.05	971.06	477.15	668.31	1145.46	589.07	742.57	1331.63																	


Strength Limit State Shaft Resistance-Compression (kips)
(North Abutment)
0
500
1000
1500
0
10
20
30
40
50
60
70
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX D

Mullins Landfill Bridge

Pier #1

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #1

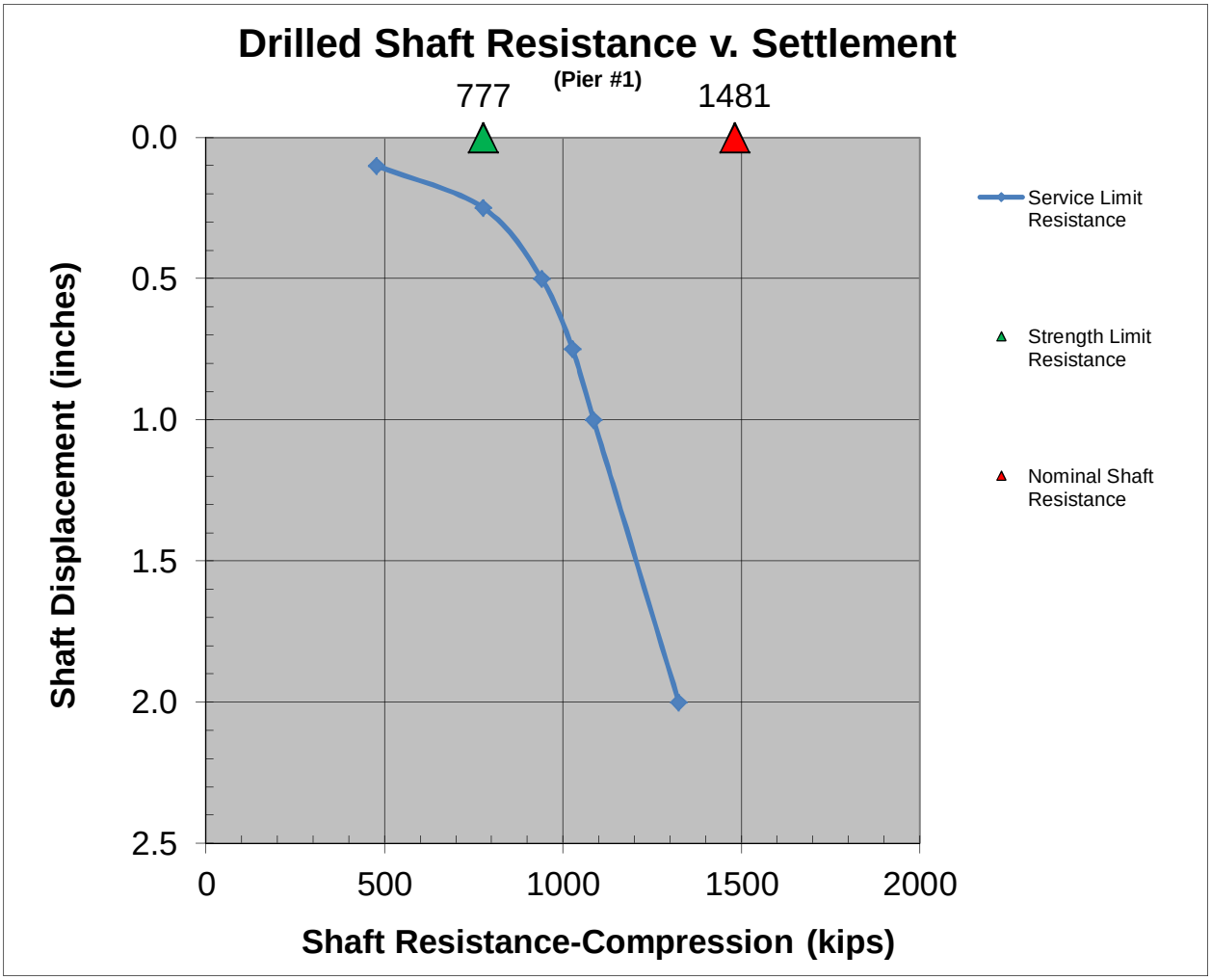
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	54	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	477.1
2	0.25	777.3
3	0.50	940.0
4	0.75	1027.2
5	1.00	1086.0
6	2.00	1324.8

Strength Limit Resistance Kips	Nominal Resistance Kips
777	1481



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #1

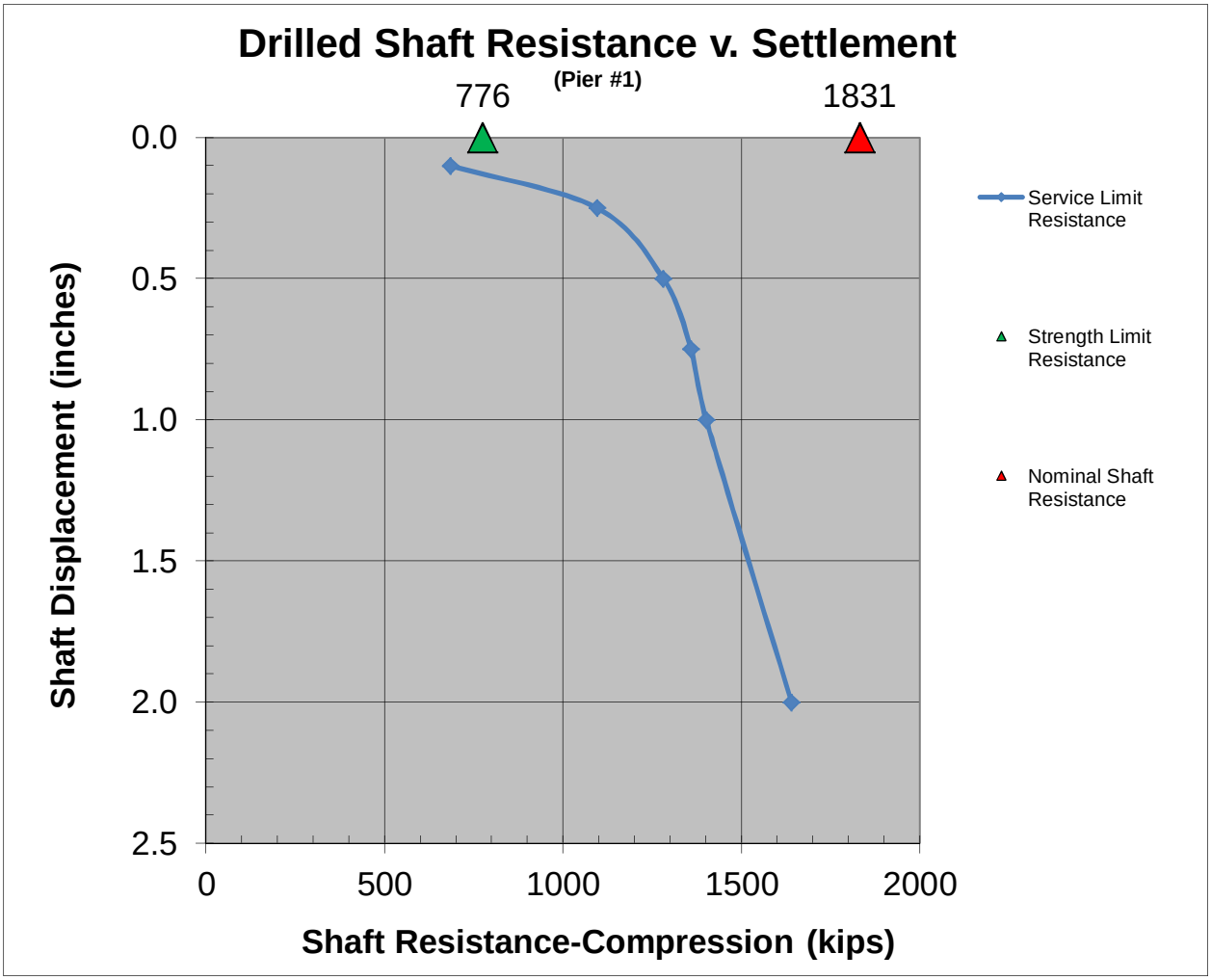
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	64	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	684.8
2	0.25	1095.7
3	0.50	1281.1
4	0.75	1359.3
5	1.00	1401.7
6	2.00	1640.5

Strength Limit Resistance Kips	Nominal Resistance Kips
776	1831



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #1

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	70	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	54	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	7	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2532.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5	6	7
Depth from Ground Surface	9	31	37	42	47	52	100
Unit Weight of Layer (γ) pcf	120	70	125	125	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	75	59	41	64	75
Cohesion "**c**" of Layer (ksf)							
Thickness of layer (ft)	9.0	22.0	6.0	5.0	5.0	5.0	48.0
Soil Type	Sand	Sand	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted for Redundant Design**

Side Resistance-Compression	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #1

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	70	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	64	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	7	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2532.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5	6	7
Depth from Ground Surface	9	31	37	42	47	52	100
Unit Weight of Layer (γ) pcf	120	70	125	125	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	75	59	41	64	75
Cohesion "**c**" of Layer (ksf)							
Thickness of layer (ft)	9.0	22.0	6.0	5.0	5.0	5.0	48.0
Soil Type	Sand	Sand	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted Without Redundant Design**

Side Resistance-Compression	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

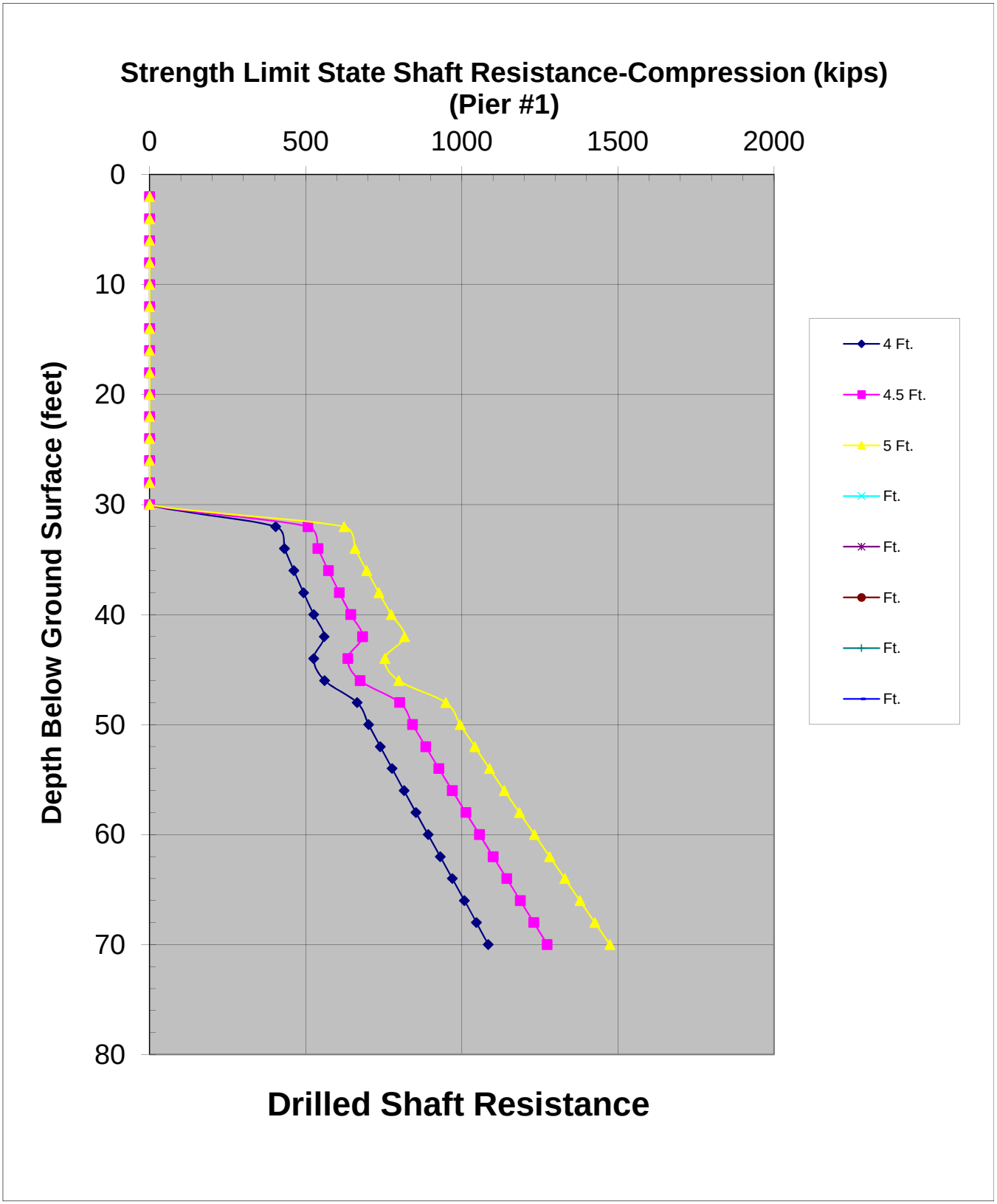
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2530.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2528.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2526.00	6.0	0.0		120.0	600.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2524.00	8.0	0.0		120.0	840.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2522.00	10.0	0.0		70.0	1030.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2520.00	12.0	0.0		70.0	1170.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2518.00	14.0	0.0		70.0	1310.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2516.00	16.0	0.0		70.0	1450.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2514.00	18.0	0.0		70.0	1590.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2512.00	20.0	0.0		70.0	1730.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2510.00	22.0	0.0		70.0	1870.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2508.00	24.0	0.0		70.0	2010.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2506.00	26.0	0.0		70.0	2150.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2504.00	28.0	0.0		70.0	2290.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2502.00	30.0	0.0		70.0	2430.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2500.00	32.0	75.0		125.0	2625.0	0.74		1.93	0.55	0.45	0.50	60.0	60.0	60.0					
2498.00	34.0	75.0		125.0	2875.0	0.71		2.05	0.55	0.45	0.50	60.0	60.0	60.0					
2496.00	36.0	75.0		125.0	3125.0	0.69		2.16	0.55	0.45	0.50	60.0	60.0	60.0					
2494.00	38.0	59.0		125.0	3375.0	0.67		2.25	0.55	0.45	0.50	60.0	60.0	60.0					
2492.00	40.0	59.0		125.0	3625.0	0.65		2.34	0.55	0.45	0.50	60.0	60.0	60.0					
2490.00	42.0	59.0		125.0	3875.0	0.63		2.42	0.55	0.45	0.50	60.0	60.0	60.0					
2488.00	44.0	41.0		125.0	4125.0	0.60		2.49	0.55	0.45	0.50	49.2	49.2	49.2					
2486.00	46.0	41.0		125.0	4375.0	0.58		2.56	0.55	0.45	0.50	49.2	49.2	49.2					
2484.00	48.0	64.0		125.0	4625.0	0.56		2.61	0.55	0.45	0.50	60.0	60.0	60.0					
2482.00	50.0	64.0		125.0	4875.0	0.55		2.66	0.55	0.45	0.50	60.0	60.0	60.0					
2480.00	52.0	64.0		125.0	5125.0	0.53		2.70	0.55	0.45	0.50	60.0	60.0	60.0					
2478.00	54.0	75.0		130.0	5380.0	0.51		2.73	0.55	0.45	0.50	60.0	60.0	60.0					
2476.00	56.0	75.0		130.0	5640.0	0.49		2.76	0.55	0.45	0.50	60.0	60.0	60.0					
2474.00	58.0	75.0		130.0	5900.0	0.47		2.78	0.55	0.45	0.50	60.0	60.0	60.0					
2472.00	60.0	75.0		130.0	6160.0	0.45		2.80	0.55	0.45	0.50	60.0	60.0	60.0					
2470.00	62.0	75.0		130.0	6420.0	0.44		2.81	0.55	0.45	0.50	60.0	60.0	60.0					
2468.00	64.0	75.0		130.0	6680.0	0.42		2.81	0.55	0.45	0.50	60.0	60.0	60.0					
2466.00	66.0	75.0		130.0	6940.0	0.40		2.80	0.55	0.45	0.50	60.0	60.0	60.0					
2464.00	68.0	75.0		130.0	7200.0	0.39		2.78	0.55	0.45	0.50	60.0	60.0	60.0					
2462.00	70.0	75.0		130.0	7460.0	0.37		2.76	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2530.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2528.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2526.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2524.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2522.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2520.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2518.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2516.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2514.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2512.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2510.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2508.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2506.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2504.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2502.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2500.00	32.0	377.00	26.72	403.72	477.15	30.06	507.20	589.07	33.40	622.47																	
2498.00	34.0	377.00	55.05	432.05	477.15	61.93	539.07	589.07	68.81	657.88																	
2496.00	36.0	377.00	84.85	461.86	477.15	95.46	572.61	589.07	106.07	695.14																	
2494.00	38.0	377.00	116.01	493.01	477.15	130.51	607.66	589.07	145.01	734.08																	
2492.00	40.0	377.00	148.39	525.40	477.15	166.94	644.09	589.07	185.49	774.56																	
2490.00	42.0	377.00	181.88	558.88	477.15	204.61	681.76	589.07	227.34	816.41																	
2488.00	44.0	309.14	216.35	525.49	391.26	243.39	634.65	483.04	270.43	753.47																	
2486.00	46.0	309.14	251.69	560.83	391.26	283.15	674.41	483.04	314.61	797.65																	
2484.00	48.0	377.00	287.79	664.79	477.15	323.76	800.91	589.07	359.74	948.81																	
2482.00	50.0	377.00	324.55	701.55	477.15	365.11	842.26	589.07	405.68	994.75																	
2480.00	52.0	377.00	361.85	738.85	477.15	407.08	884.22	589.07	452.31	1041.38																	
2478.00	54.0	377.00	399.62	776.63	477.15	449.58	926.72	589.07	499.53	1088.60																	
2476.00	56.0	377.00	437.81	814.81	477.15	492.53	969.68	589.07	547.26	1136.33																	
2474.00	58.0	377.00	476.29	853.29	477.15	535.83	1012.97	589.07	595.36	1184.43																	
2472.00	60.0	377.00	514.98	891.98	477.15	579.35	1056.49	589.07	643.72	1232.79																	
2470.00	62.0	377.00	553.76	930.76	477.15	622.98	1100.12	589.07	692.20	1281.27																	
2468.00	64.0	377.00	592.54	969.55	477.15	666.61	1143.75	589.07	740.68	1329.75																	
2466.00	66.0	377.00	631.23	1008.23	477.15	710.13	1187.28	589.07	789.03	1378.10																	
2464.00	68.0	377.00	669.72	1046.73	477.15	753.44	1230.58	589.07	837.15	1426.22																	
2462.00	70.0	377.00	707.93	1084.93	477.15	796.42	1273.57	589.07	884.91	1473.98																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #1)
0
500
1000
1500
2000
0
10
20
30
40
50
60
70
80
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX E

Mullins Landfill Bridge

Pier #2

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #2

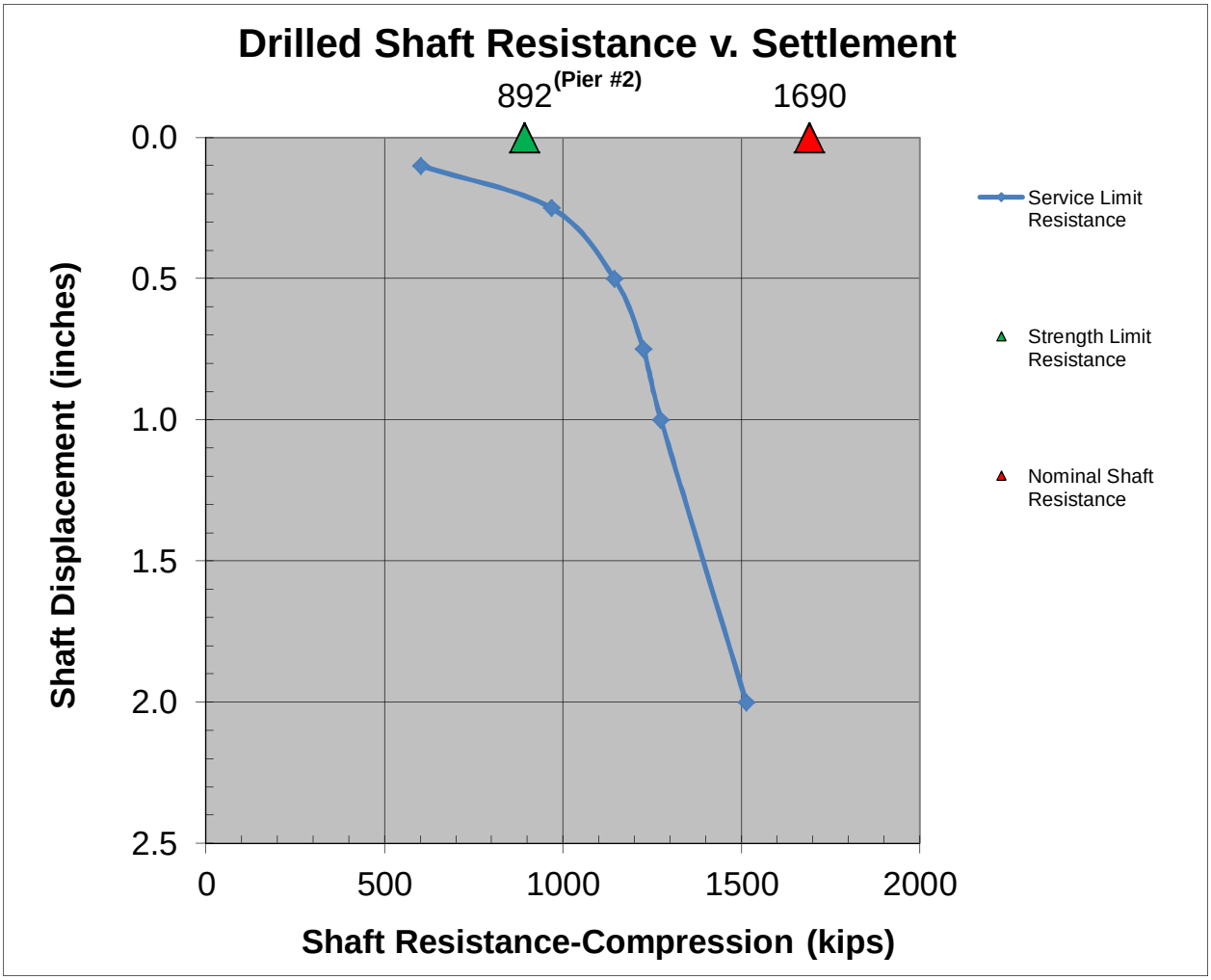
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	60	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	601.3
2	0.25	967.7
3	0.50	1143.9
4	0.75	1225.8
5	1.00	1274.7
6	2.00	1513.5

Strength Limit Resistance Kips	Nominal Resistance Kips
892	1690



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #2

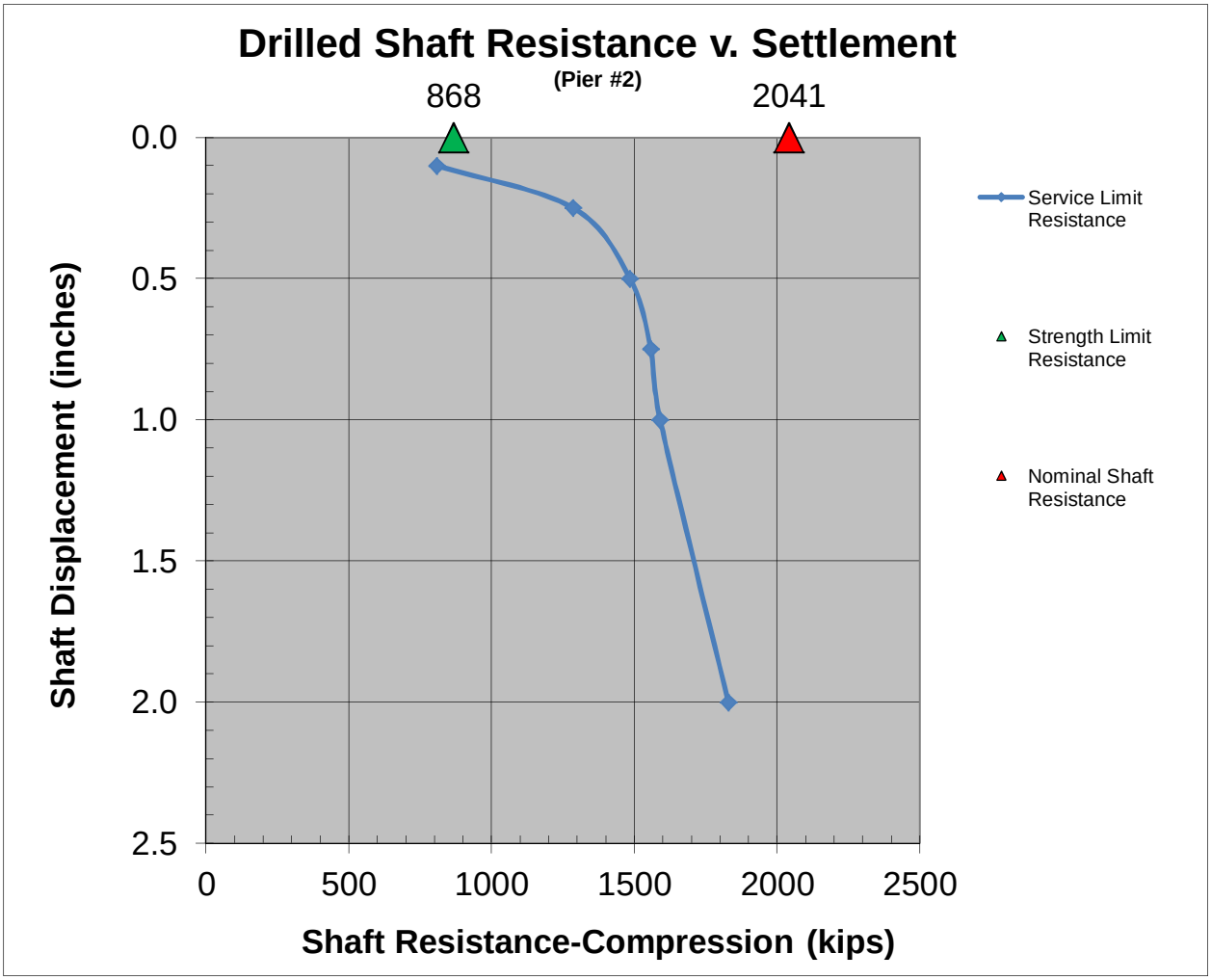
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	70	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	809.1
2	0.25	1286.1
3	0.50	1485.1
4	0.75	1557.9
5	1.00	1590.5
6	2.00	1829.3

Strength Limit Resistance Kips	Nominal Resistance Kips
868	2041



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #2

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	60	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	6	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2532.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5	6
Depth from Ground Surface	8	31	37	42	52	100
Unit Weight of Layer (γ) pcf	120	70	125	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	75	25	51	75
Cohesion "**c**" of Layer (ksf)						
Thickness of layer (ft)	8.0	23.0	6.0	5.0	10.0	48.0
Soil Type	Sand	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted for Redundant Design**

Side Resistance-Compression	0.55	0.55	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #2

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	70	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	6	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2532.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5	6
Depth from Ground Surface	8	31	37	42	52	100
Unit Weight of Layer (γ) pcf	120	70	125	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	75	25	51	75
Cohesion "**c**" of Layer (ksf)						
Thickness of layer (ft)	8.0	23.0	6.0	5.0	10.0	48.0
Soil Type	Sand	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted Without Redundant Design**

Side Resistance-Compression	0.44	0.44	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

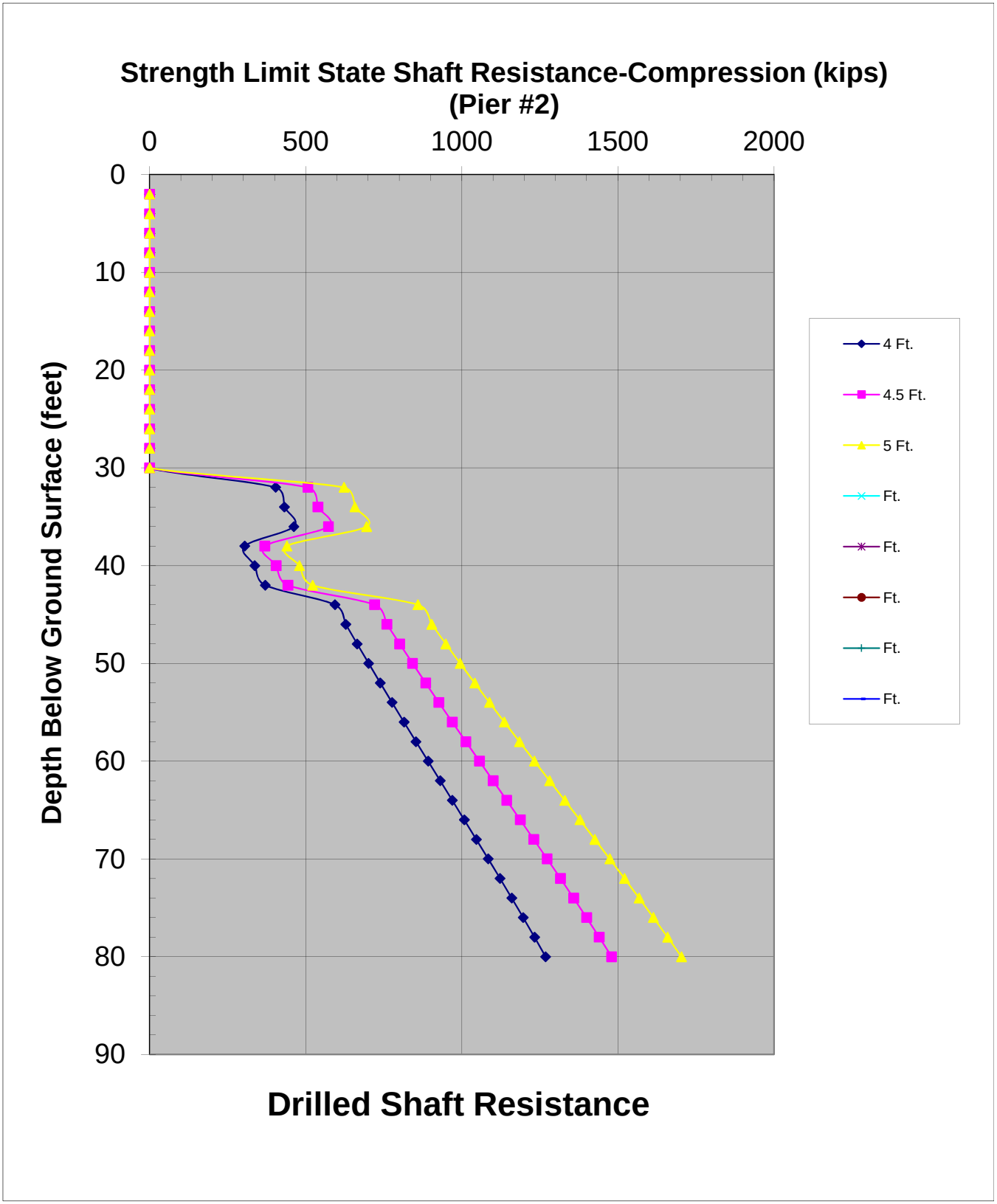
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2530.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2528.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2526.00	6.0	0.0		120.0	600.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2524.00	8.0	0.0		120.0	840.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2522.00	10.0	0.0		70.0	1030.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2520.00	12.0	0.0		70.0	1170.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2518.00	14.0	0.0		70.0	1310.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2516.00	16.0	0.0		70.0	1450.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2514.00	18.0	0.0		70.0	1590.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2512.00	20.0	0.0		70.0	1730.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2510.00	22.0	0.0		70.0	1870.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2508.00	24.0	0.0		70.0	2010.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2506.00	26.0	0.0		70.0	2150.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2504.00	28.0	0.0		70.0	2290.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2502.00	30.0	0.0		70.0	2430.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2500.00	32.0	75.0		125.0	2625.0	0.74		1.93	0.55	0.45	0.50	60.0	60.0	60.0					
2498.00	34.0	75.0		125.0	2875.0	0.71		2.05	0.55	0.45	0.50	60.0	60.0	60.0					
2496.00	36.0	75.0		125.0	3125.0	0.69		2.16	0.55	0.45	0.50	60.0	60.0	60.0					
2494.00	38.0	25.0		125.0	3375.0	0.67		2.25	0.55	0.45	0.50	30.0	30.0	30.0					
2492.00	40.0	25.0		125.0	3625.0	0.65		2.34	0.55	0.45	0.50	30.0	30.0	30.0					
2490.00	42.0	25.0		125.0	3875.0	0.63		2.42	0.55	0.45	0.50	30.0	30.0	30.0					
2488.00	44.0	51.0		125.0	4125.0	0.60		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2486.00	46.0	51.0		125.0	4375.0	0.58		2.56	0.55	0.45	0.50	60.0	60.0	60.0					
2484.00	48.0	51.0		125.0	4625.0	0.56		2.61	0.55	0.45	0.50	60.0	60.0	60.0					
2482.00	50.0	51.0		125.0	4875.0	0.55		2.66	0.55	0.45	0.50	60.0	60.0	60.0					
2480.00	52.0	51.0		125.0	5125.0	0.53		2.70	0.55	0.45	0.50	60.0	60.0	60.0					
2478.00	54.0	75.0		130.0	5380.0	0.51		2.73	0.55	0.45	0.50	60.0	60.0	60.0					
2476.00	56.0	75.0		130.0	5640.0	0.49		2.76	0.55	0.45	0.50	60.0	60.0	60.0					
2474.00	58.0	75.0		130.0	5900.0	0.47		2.78	0.55	0.45	0.50	60.0	60.0	60.0					
2472.00	60.0	75.0		130.0	6160.0	0.45		2.80	0.55	0.45	0.50	60.0	60.0	60.0					
2470.00	62.0	75.0		130.0	6420.0	0.44		2.81	0.55	0.45	0.50	60.0	60.0	60.0					
2468.00	64.0	75.0		130.0	6680.0	0.42		2.81	0.55	0.45	0.50	60.0	60.0	60.0					
2466.00	66.0	75.0		130.0	6940.0	0.40		2.80	0.55	0.45	0.50	60.0	60.0	60.0					
2464.00	68.0	75.0		130.0	7200.0	0.39		2.78	0.55	0.45	0.50	60.0	60.0	60.0					
2462.00	70.0	75.0		130.0	7460.0	0.37		2.76	0.55	0.45	0.50	60.0	60.0	60.0					
2460.00	72.0	75.0		130.0	7720.0	0.35		2.74	0.55	0.45	0.50	60.0	60.0	60.0					
2458.00	74.0	75.0		130.0	7980.0	0.34		2.70	0.55	0.45	0.50	60.0	60.0	60.0					
2456.00	76.0	75.0		130.0	8240.0	0.32		2.66	0.55	0.45	0.50	60.0	60.0	60.0					
2454.00	78.0	75.0		130.0	8500.0	0.31		2.62	0.55	0.45	0.50	60.0	60.0	60.0					
2452.00	80.0	75.0		130.0	8760.0	0.29		2.56	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2530.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2528.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2526.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2524.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2522.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2520.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2518.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2516.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2514.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2512.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2510.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2508.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2506.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2504.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2502.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2500.00	32.0	377.00	26.72	403.72	477.15	30.06	507.20	589.07	33.40	622.47																	
2498.00	34.0	377.00	55.05	432.05	477.15	61.93	539.07	589.07	68.81	657.88																	
2496.00	36.0	377.00	84.85	461.86	477.15	95.46	572.61	589.07	106.07	695.14																	
2494.00	38.0	188.50	116.01	304.51	238.57	130.51	369.09	294.53	145.01	439.55																	
2492.00	40.0	188.50	148.39	336.89	238.57	166.94	405.51	294.53	185.49	480.02																	
2490.00	42.0	188.50	181.88	370.38	238.57	204.61	443.18	294.53	227.34	521.88																	
2488.00	44.0	377.00	216.35	593.35	477.15	243.39	720.53	589.07	270.43	859.50																	
2486.00	46.0	377.00	251.69	628.69	477.15	283.15	760.29	589.07	314.61	903.68																	
2484.00	48.0	377.00	287.79	664.79	477.15	323.76	800.91	589.07	359.74	948.81																	
2482.00	50.0	377.00	324.55	701.55	477.15	365.11	842.26	589.07	405.68	994.75																	
2480.00	52.0	377.00	361.85	738.85	477.15	407.08	884.22	589.07	452.31	1041.38																	
2478.00	54.0	377.00	399.62	776.63	477.15	449.58	926.72	589.07	499.53	1088.60																	
2476.00	56.0	377.00	437.81	814.81	477.15	492.53	969.68	589.07	547.26	1136.33																	
2474.00	58.0	377.00	476.29	853.29	477.15	535.83	1012.97	589.07	595.36	1184.43																	
2472.00	60.0	377.00	514.98	891.98	477.15	579.35	1056.49	589.07	643.72	1232.79																	
2470.00	62.0	377.00	553.76	930.76	477.15	622.98	1100.12	589.07	692.20	1281.27																	
2468.00	64.0	377.00	592.54	969.55	477.15	666.61	1143.75	589.07	740.68	1329.75																	
2466.00	66.0	377.00	631.23	1008.23	477.15	710.13	1187.28	589.07	789.03	1378.10																	
2464.00	68.0	377.00	669.72	1046.73	477.15	753.44	1230.58	589.07	837.15	1426.22																	
2462.00	70.0	377.00	707.93	1084.93	477.15	796.42	1273.57	589.07	884.91	1473.98																	
2460.00	72.0	377.00	745.76	1122.76	477.15	838.98	1316.13	589.07	932.20	1521.27																	
2458.00	74.0	377.00	783.12	1160.12	477.15	881.01	1358.16	589.07	978.90	1567.97																	
2456.00	76.0	377.00	819.92	1196.93	477.15	922.41	1399.56	589.07	1024.90	1613.97																	
2454.00	78.0	377.00	856.08	1233.08	477.15	963.09	1440.23	589.07	1070.10	1659.17																	
2452.00	80.0	377.00	891.50	1268.51	477.15	1002.94	1480.09	589.07	1114.38	1703.45																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #2)
0
500
1000
1500
2000
0
10
20
30
40
50
60
70
80
90
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX F

Mullins Landfill Bridge

Pier #3

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #3

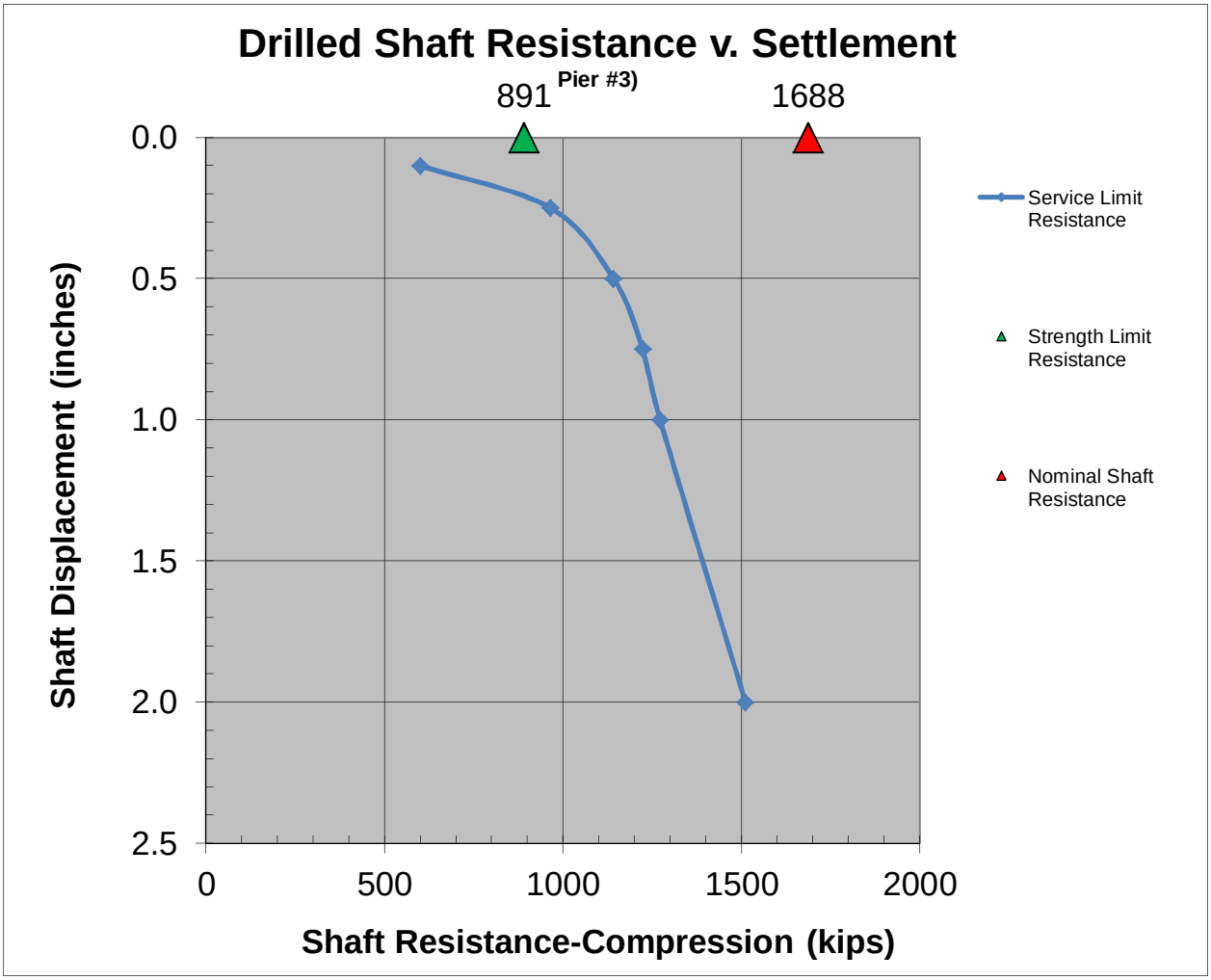
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	62	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	599.7
2	0.25	965.4
3	0.50	1141.4
4	0.75	1223.4
5	1.00	1272.4
6	2.00	1511.2

Strength Limit Resistance Kips	Nominal Resistance Kips
891	1688



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #3

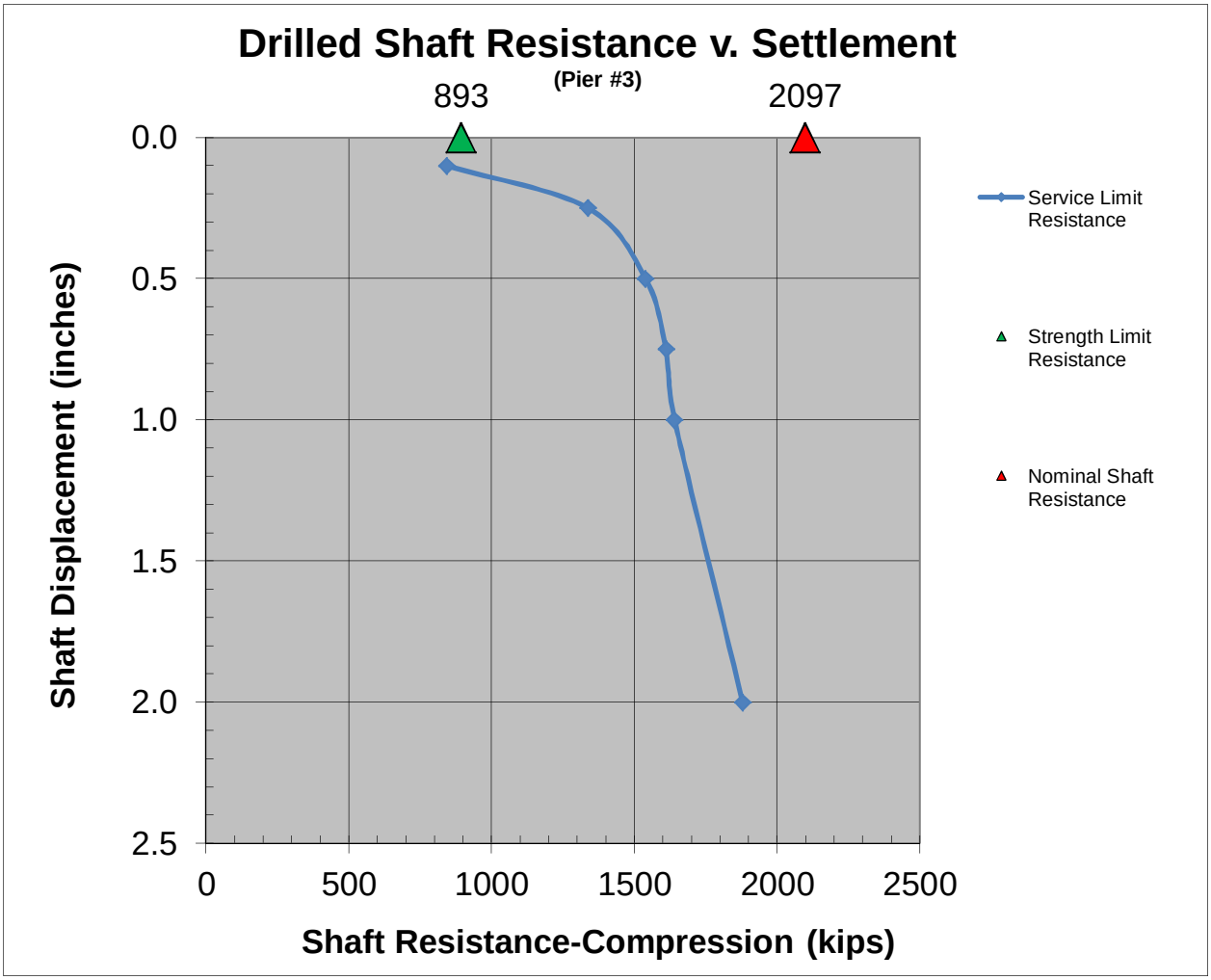
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	74	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	842.4
2	0.25	1337.1
3	0.50	1539.7
4	0.75	1611.1
5	1.00	1641.1
6	2.00	1879.8

Strength Limit Resistance Kips	Nominal Resistance Kips
893	2097



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #3

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	62	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2533.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	9	32	37	57	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	61	51	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	9.0	23.0	5.0	20.0	43.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted for Redundant Design**				
Side Resistance-Compression	0.55	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #3

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	74	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2533.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	9	32	37	57	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	61	51	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	9.0	23.0	5.0	20.0	43.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted Without Redundant Design**				
Side Resistance-Compression	0.44	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

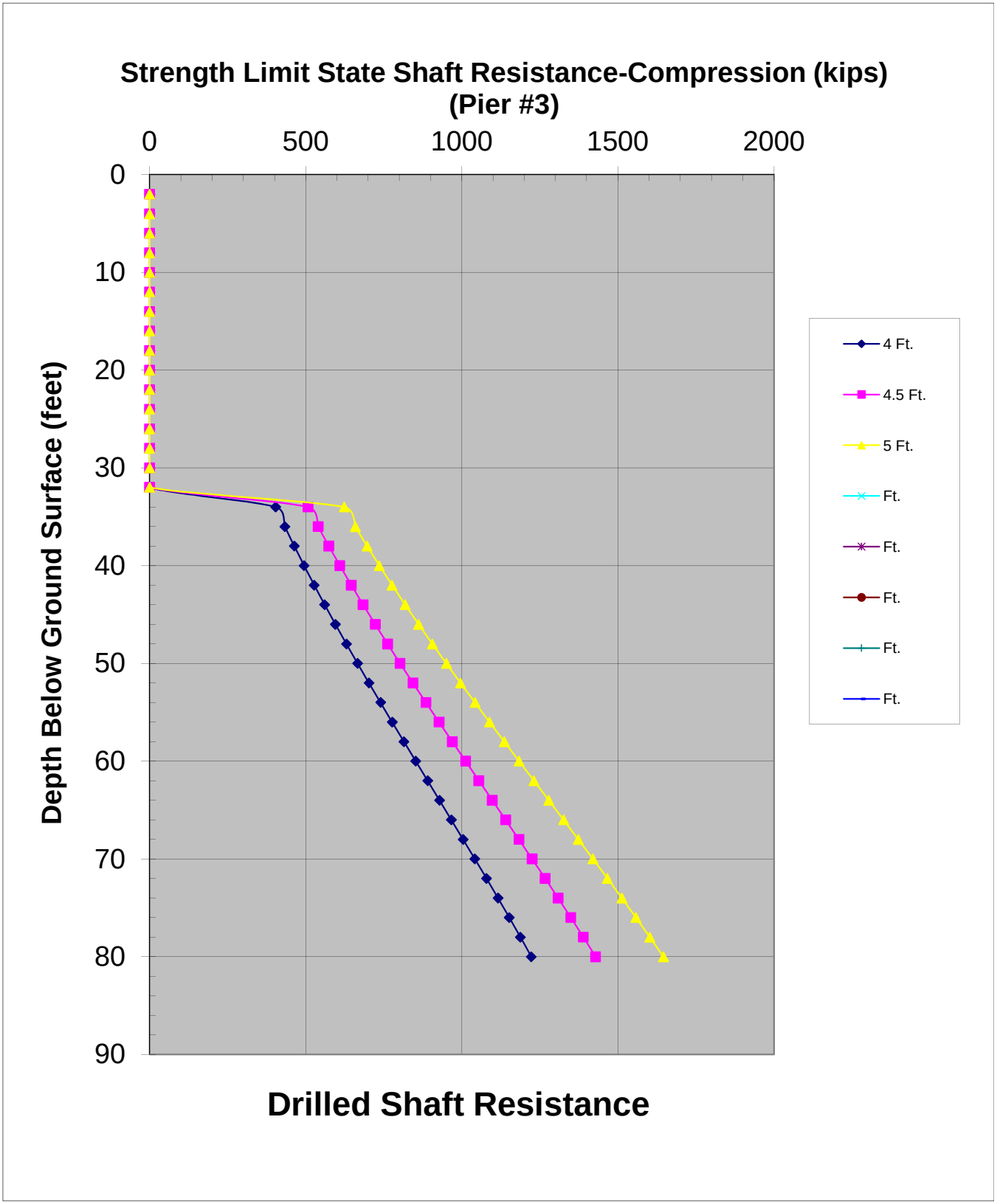
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2531.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2529.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2527.00	6.0	0.0		120.0	600.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2525.00	8.0	0.0		120.0	840.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2523.00	10.0	0.0		70.0	1030.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2521.00	12.0	0.0		70.0	1170.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2519.00	14.0	0.0		70.0	1310.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2517.00	16.0	0.0		70.0	1450.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2515.00	18.0	0.0		70.0	1590.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2513.00	20.0	0.0		70.0	1730.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2511.00	22.0	0.0		70.0	1870.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2509.00	24.0	0.0		70.0	2010.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2507.00	26.0	0.0		70.0	2150.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2505.00	28.0	0.0		70.0	2290.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2503.00	30.0	0.0		70.0	2430.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2501.00	32.0	0.0		70.0	2570.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2499.00	34.0	61.0		125.0	2765.0	0.71		1.97	0.55	0.45	0.50	60.0	60.0	60.0					
2497.00	36.0	61.0		125.0	3015.0	0.69		2.08	0.55	0.45	0.50	60.0	60.0	60.0					
2495.00	38.0	51.0		125.0	3265.0	0.67		2.18	0.55	0.45	0.50	60.0	60.0	60.0					
2493.00	40.0	51.0		125.0	3515.0	0.65		2.27	0.55	0.45	0.50	60.0	60.0	60.0					
2491.00	42.0	51.0		125.0	3765.0	0.63		2.35	0.55	0.45	0.50	60.0	60.0	60.0					
2489.00	44.0	51.0		125.0	4015.0	0.60		2.43	0.55	0.45	0.50	60.0	60.0	60.0					
2487.00	46.0	51.0		125.0	4265.0	0.58		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2485.00	48.0	51.0		125.0	4515.0	0.56		2.55	0.55	0.45	0.50	60.0	60.0	60.0					
2483.00	50.0	51.0		125.0	4765.0	0.55		2.60	0.55	0.45	0.50	60.0	60.0	60.0					
2481.00	52.0	51.0		125.0	5015.0	0.53		2.64	0.55	0.45	0.50	60.0	60.0	60.0					
2479.00	54.0	51.0		125.0	5265.0	0.51		2.67	0.55	0.45	0.50	60.0	60.0	60.0					
2477.00	56.0	51.0		125.0	5515.0	0.49		2.70	0.55	0.45	0.50	60.0	60.0	60.0					
2475.00	58.0	75.0		130.0	5770.0	0.47		2.72	0.55	0.45	0.50	60.0	60.0	60.0					
2473.00	60.0	75.0		130.0	6030.0	0.45		2.74	0.55	0.45	0.50	60.0	60.0	60.0					
2471.00	62.0	75.0		130.0	6290.0	0.44		2.75	0.55	0.45	0.50	60.0	60.0	60.0					
2469.00	64.0	75.0		130.0	6550.0	0.42		2.75	0.55	0.45	0.50	60.0	60.0	60.0					
2467.00	66.0	75.0		130.0	6810.0	0.40		2.75	0.55	0.45	0.50	60.0	60.0	60.0					
2465.00	68.0	75.0		130.0	7070.0	0.39		2.73	0.55	0.45	0.50	60.0	60.0	60.0					
2463.00	70.0	75.0		130.0	7330.0	0.37		2.72	0.55	0.45	0.50	60.0	60.0	60.0					
2461.00	72.0	75.0		130.0	7590.0	0.35		2.69	0.55	0.45	0.50	60.0	60.0	60.0					
2459.00	74.0	75.0		130.0	7850.0	0.34		2.66	0.55	0.45	0.50	60.0	60.0	60.0					
2457.00	76.0	75.0		130.0	8110.0	0.32		2.62	0.55	0.45	0.50	60.0	60.0	60.0					
2455.00	78.0	75.0		130.0	8370.0	0.31		2.58	0.55	0.45	0.50	60.0	60.0	60.0					
2453.00	80.0	75.0		130.0	8630.0	0.29		2.52	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2531.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2529.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2527.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2525.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2523.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2521.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2519.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2517.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2515.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2513.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2511.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2509.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2507.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2505.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2503.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2501.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2499.00	34.0	377.00	27.25	404.25	477.15	30.65	507.80	589.07	34.06	623.13																	
2497.00	36.0	377.00	56.00	433.01	477.15	63.00	540.15	589.07	70.00	659.07																	
2495.00	38.0	377.00	86.14	463.15	477.15	96.91	574.06	589.07	107.68	696.75																	
2493.00	40.0	377.00	117.54	494.55	477.15	132.23	609.38	589.07	146.93	736.00																	
2491.00	42.0	377.00	150.07	527.08	477.15	168.83	645.98	589.07	187.59	776.66																	
2489.00	44.0	377.00	183.63	560.63	477.15	206.58	683.73	589.07	229.53	818.60																	
2487.00	46.0	377.00	218.08	595.08	477.15	245.34	722.49	589.07	272.60	861.67																	
2485.00	48.0	377.00	253.32	630.33	477.15	284.99	762.14	589.07	316.65	905.72																	
2483.00	50.0	377.00	289.25	666.25	477.15	325.41	802.55	589.07	361.56	950.63																	
2481.00	52.0	377.00	325.75	702.75	477.15	366.47	843.61	589.07	407.19	996.25																	
2479.00	54.0	377.00	362.72	739.72	477.15	408.06	885.20	589.07	453.40	1042.47																	
2477.00	56.0	377.00	400.06	777.06	477.15	450.06	927.21	589.07	500.07	1089.14																	
2475.00	58.0	377.00	437.69	814.70	477.15	492.40	969.55	589.07	547.12	1136.18																	
2473.00	60.0	377.00	475.56	852.56	477.15	535.01	1012.15	589.07	594.45	1183.52																	
2471.00	62.0	377.00	513.56	890.56	477.15	577.75	1054.90	589.07	641.95	1231.02																	
2469.00	64.0	377.00	551.59	928.59	477.15	620.53	1097.68	589.07	689.48	1278.55																	
2467.00	66.0	377.00	589.55	966.55	477.15	663.24	1140.39	589.07	736.94	1326.00																	
2465.00	68.0	377.00	627.35	1004.35	477.15	705.77	1182.91	589.07	784.18	1373.25																	
2463.00	70.0	377.00	664.89	1041.89	477.15	748.00	1225.15	589.07	831.11	1420.18																	
2461.00	72.0	377.00	702.08	1079.09	477.15	789.84	1266.99	589.07	877.60	1466.67																	
2459.00	74.0	377.00	738.83	1115.84	477.15	831.19	1308.33	589.07	923.54	1512.61																	
2457.00	76.0	377.00	775.06	1152.06	477.15	871.94	1349.08	589.07	968.82	1557.89																	
2455.00	78.0	377.00	810.66	1187.66	477.15	911.99	1389.14	589.07	1013.32	1602.39																	
2453.00	80.0	377.00	845.56	1222.56	477.15	951.25	1428.40	589.07	1056.95	1646.01																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #3)
0
500
1000
1500
2000
0
10
20
30
40
50
60
70
80
90
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX G

Mullins Landfill Bridge

Pier #4

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #4

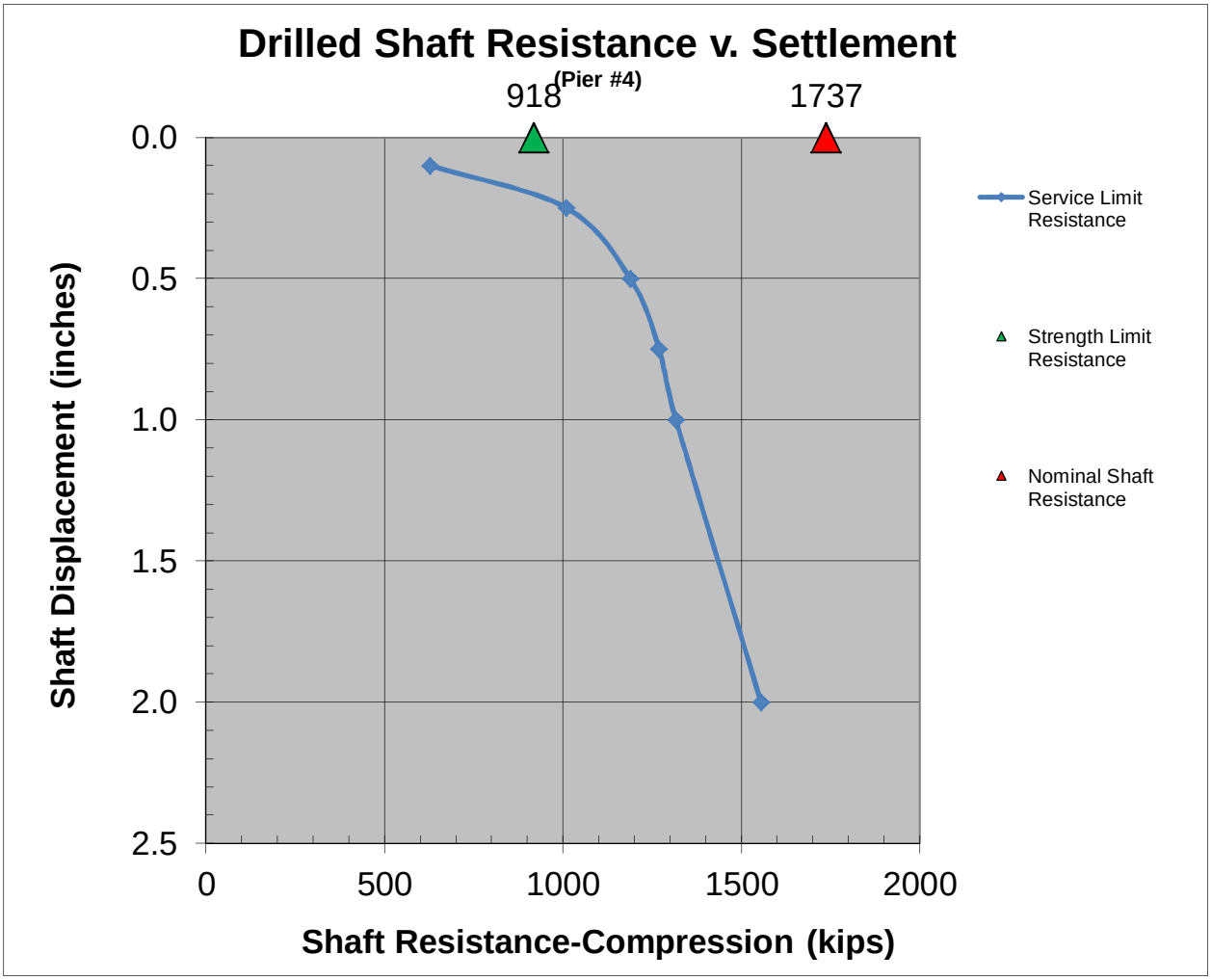
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	60	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	628.8
2	0.25	1009.8
3	0.50	1189.1
4	0.75	1269.7
5	1.00	1316.5
6	2.00	1555.3

Strength Limit Resistance Kips	Nominal Resistance Kips
918	1737



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #4

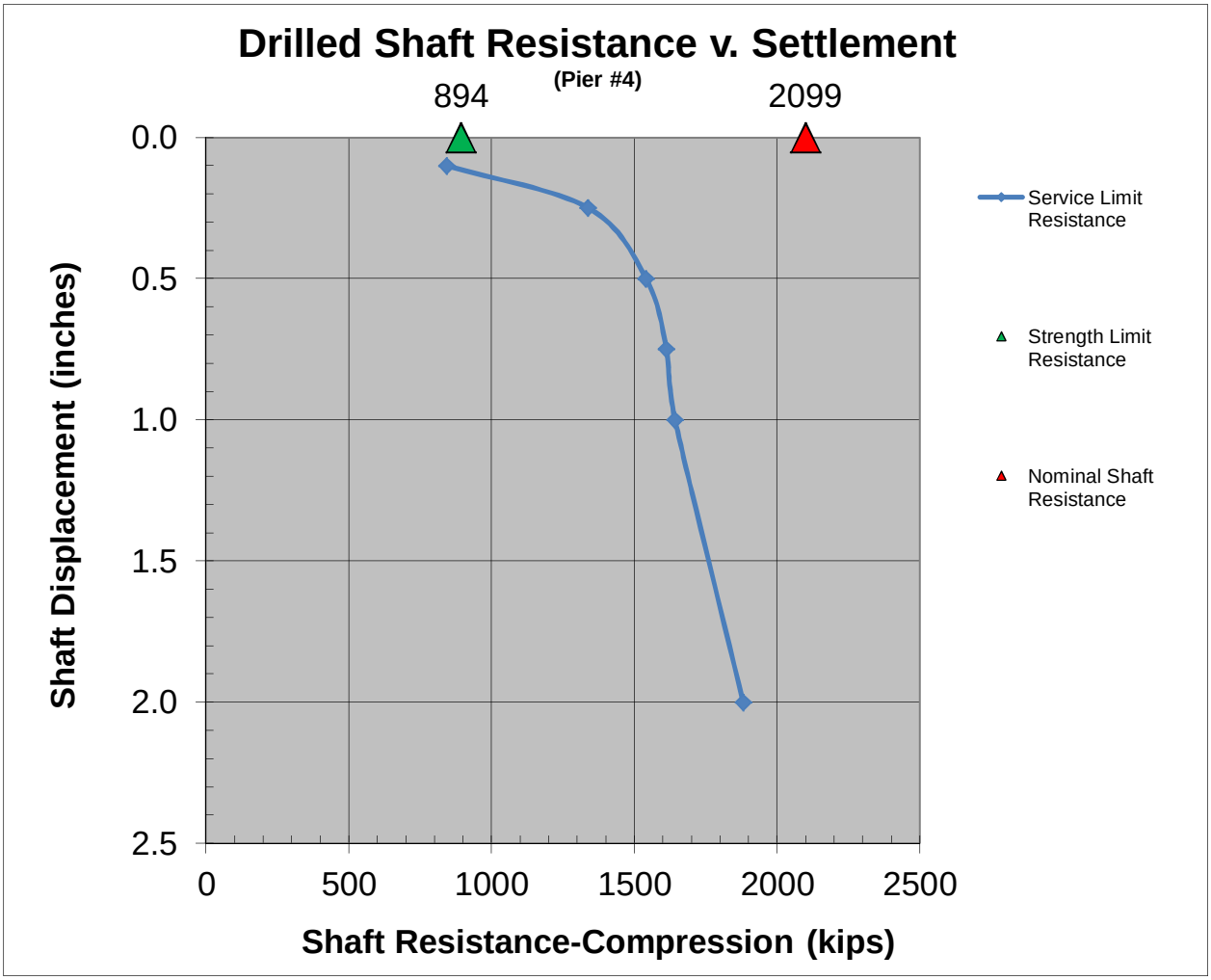
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	70	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	843.5
2	0.25	1338.9
3	0.50	1541.6
4	0.75	1612.9
5	1.00	1642.8
6	2.00	1881.6

Strength Limit Resistance Kips	Nominal Resistance Kips
894	2099



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #4

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	76	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	60	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2533.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	12	30	37	47	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	55	30	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	12.0	18.0	7.0	10.0	53.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted for Redundant Design**				
Side Resistance-Compression	0.55	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #4

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	76	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	70	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2533.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	12	30	37	47	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	55	30	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	12.0	18.0	7.0	10.0	53.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted Without Redundant Design**				
Side Resistance-Compression	0.44	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

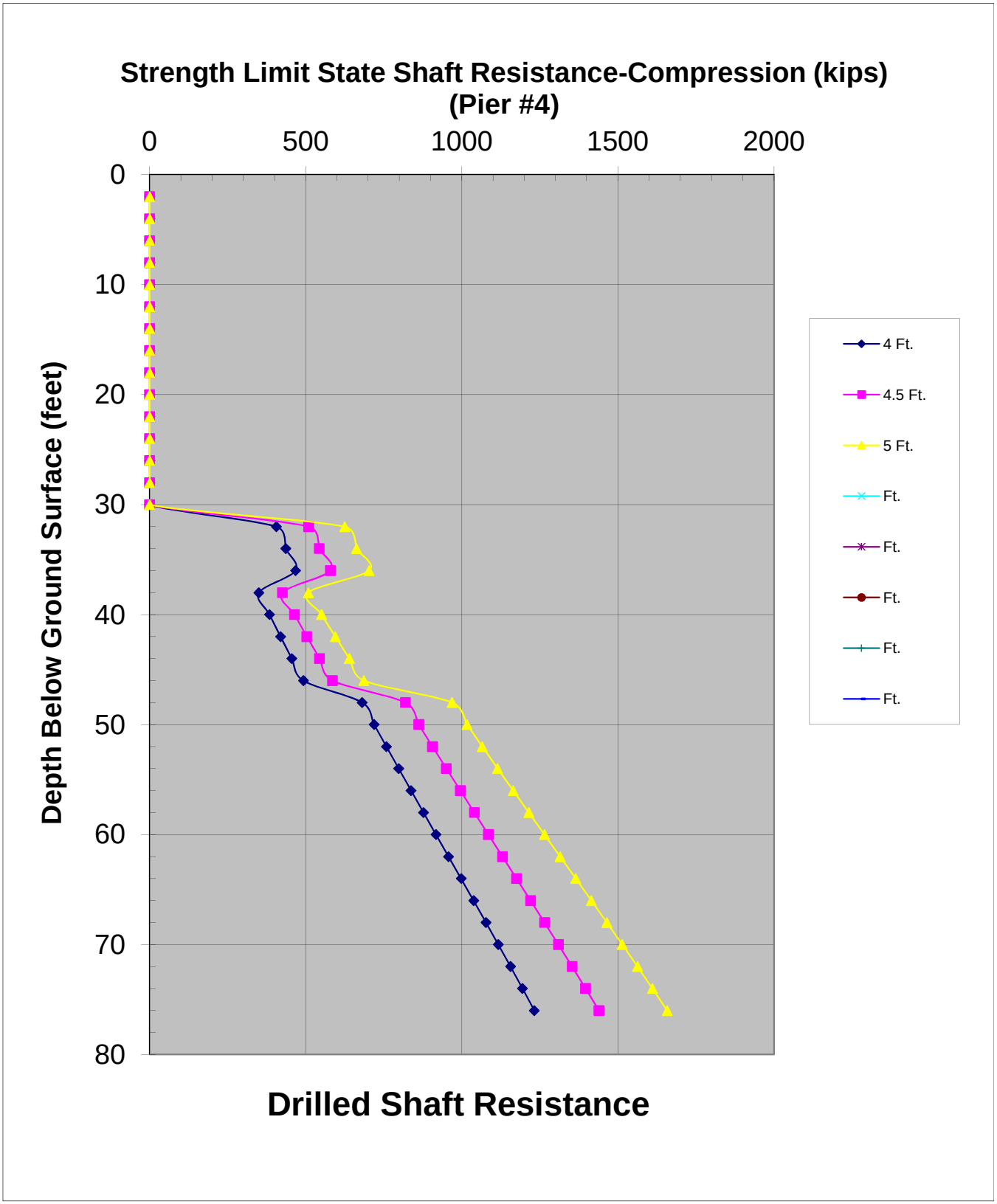
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2531.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2529.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2527.00	6.0	0.0		120.0	600.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2525.00	8.0	0.0		120.0	840.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2523.00	10.0	0.0		120.0	1080.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2521.00	12.0	0.0		120.0	1320.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2519.00	14.0	0.0		70.0	1510.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2517.00	16.0	0.0		70.0	1650.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2515.00	18.0	0.0		70.0	1790.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2513.00	20.0	0.0		70.0	1930.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2511.00	22.0	0.0		70.0	2070.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2509.00	24.0	0.0		70.0	2210.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2507.00	26.0	0.0		70.0	2350.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2505.00	28.0	0.0		70.0	2490.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2503.00	30.0	0.0		70.0	2630.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2501.00	32.0	55.0		125.0	2825.0	0.74		2.08	0.55	0.45	0.50	60.0	60.0	60.0					
2499.00	34.0	55.0		125.0	3075.0	0.71		2.19	0.55	0.45	0.50	60.0	60.0	60.0					
2497.00	36.0	55.0		125.0	3325.0	0.69		2.29	0.55	0.45	0.50	60.0	60.0	60.0					
2495.00	38.0	30.0		125.0	3575.0	0.67		2.39	0.55	0.45	0.50	36.0	36.0	36.0					
2493.00	40.0	30.0		125.0	3825.0	0.65		2.47	0.55	0.45	0.50	36.0	36.0	36.0					
2491.00	42.0	30.0		125.0	4075.0	0.63		2.55	0.55	0.45	0.50	36.0	36.0	36.0					
2489.00	44.0	30.0		125.0	4325.0	0.60		2.61	0.55	0.45	0.50	36.0	36.0	36.0					
2487.00	46.0	30.0		125.0	4575.0	0.58		2.67	0.55	0.45	0.50	36.0	36.0	36.0					
2485.00	48.0	75.0		130.0	4830.0	0.56		2.73	0.55	0.45	0.50	60.0	60.0	60.0					
2483.00	50.0	75.0		130.0	5090.0	0.55		2.78	0.55	0.45	0.50	60.0	60.0	60.0					
2481.00	52.0	75.0		130.0	5350.0	0.53		2.82	0.55	0.45	0.50	60.0	60.0	60.0					
2479.00	54.0	75.0		130.0	5610.0	0.51		2.85	0.55	0.45	0.50	60.0	60.0	60.0					
2477.00	56.0	75.0		130.0	5870.0	0.49		2.87	0.55	0.45	0.50	60.0	60.0	60.0					
2475.00	58.0	75.0		130.0	6130.0	0.47		2.89	0.55	0.45	0.50	60.0	60.0	60.0					
2473.00	60.0	75.0		130.0	6390.0	0.45		2.90	0.55	0.45	0.50	60.0	60.0	60.0					
2471.00	62.0	75.0		130.0	6650.0	0.44		2.91	0.55	0.45	0.50	60.0	60.0	60.0					
2469.00	64.0	75.0		130.0	6910.0	0.42		2.90	0.55	0.45	0.50	60.0	60.0	60.0					
2467.00	66.0	75.0		130.0	7170.0	0.40		2.89	0.55	0.45	0.50	60.0	60.0	60.0					
2465.00	68.0	75.0		130.0	7430.0	0.39		2.87	0.55	0.45	0.50	60.0	60.0	60.0					
2463.00	70.0	75.0		130.0	7690.0	0.37		2.85	0.55	0.45	0.50	60.0	60.0	60.0					
2461.00	72.0	75.0		130.0	7950.0	0.35		2.82	0.55	0.45	0.50	60.0	60.0	60.0					
2459.00	74.0	75.0		130.0	8210.0	0.34		2.78	0.55	0.45	0.50	60.0	60.0	60.0					
2457.00	76.0	75.0		130.0	8470.0	0.32		2.74	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2531.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2529.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2527.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2525.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2523.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2521.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2519.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2517.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2515.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2513.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2511.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2509.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2507.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2505.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2503.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2501.00	32.0	377.00	28.75	405.76	477.15	32.35	509.49	589.07	35.94	625.01																	
2499.00	34.0	377.00	59.05	436.06	477.15	66.44	543.58	589.07	73.82	662.89																	
2497.00	36.0	377.00	90.77	467.77	477.15	102.12	579.26	589.07	113.46	702.53																	
2495.00	38.0	226.20	123.77	349.97	286.29	139.24	425.53	353.44	154.71	508.16																	
2493.00	40.0	226.20	157.94	384.14	286.29	177.68	463.97	353.44	197.42	550.86																	
2491.00	42.0	226.20	193.15	419.35	286.29	217.29	503.58	353.44	241.44	594.88																	
2489.00	44.0	226.20	229.29	455.49	286.29	257.95	544.24	353.44	286.62	640.06																	
2487.00	46.0	226.20	266.25	492.45	286.29	299.53	585.82	353.44	332.81	686.25																	
2485.00	48.0	377.00	303.95	680.96	477.15	341.95	819.09	589.07	379.94	969.01																	
2483.00	50.0	377.00	342.33	719.33	477.15	385.12	862.27	589.07	427.91	1016.98																	
2481.00	52.0	377.00	381.27	758.27	477.15	428.92	906.07	589.07	476.58	1065.65																	
2479.00	54.0	377.00	420.66	797.66	477.15	473.24	950.39	589.07	525.82	1114.89																	
2477.00	56.0	377.00	460.40	837.40	477.15	517.95	995.09	589.07	575.50	1164.57																	
2475.00	58.0	377.00	500.38	877.39	477.15	562.93	1040.08	589.07	625.48	1214.55																	
2473.00	60.0	377.00	540.51	917.52	477.15	608.08	1085.22	589.07	675.64	1264.71																	
2471.00	62.0	377.00	580.69	957.69	477.15	653.27	1130.42	589.07	725.86	1314.93																	
2469.00	64.0	377.00	620.80	997.81	477.15	698.40	1175.55	589.07	776.00	1365.07																	
2467.00	66.0	377.00	660.77	1037.78	477.15	743.37	1220.51	589.07	825.97	1415.03																	
2465.00	68.0	377.00	700.50	1077.50	477.15	788.06	1265.20	589.07	875.62	1464.69																	
2463.00	70.0	377.00	739.88	1116.89	477.15	832.37	1309.51	589.07	924.85	1513.92																	
2461.00	72.0	377.00	778.84	1155.84	477.15	876.19	1353.34	589.07	973.55	1562.62																	
2459.00	74.0	377.00	817.28	1194.28	477.15	919.44	1396.58	589.07	1021.60	1610.66																	
2457.00	76.0	377.00	855.11	1232.11	477.15	961.99	1439.14	589.07	1068.88	1657.95																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #4)
0
500
1000
1500
2000
0
10
20
30
40
50
60
70
80
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX H

Mullins Landfill Bridge

Pier #5

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #5

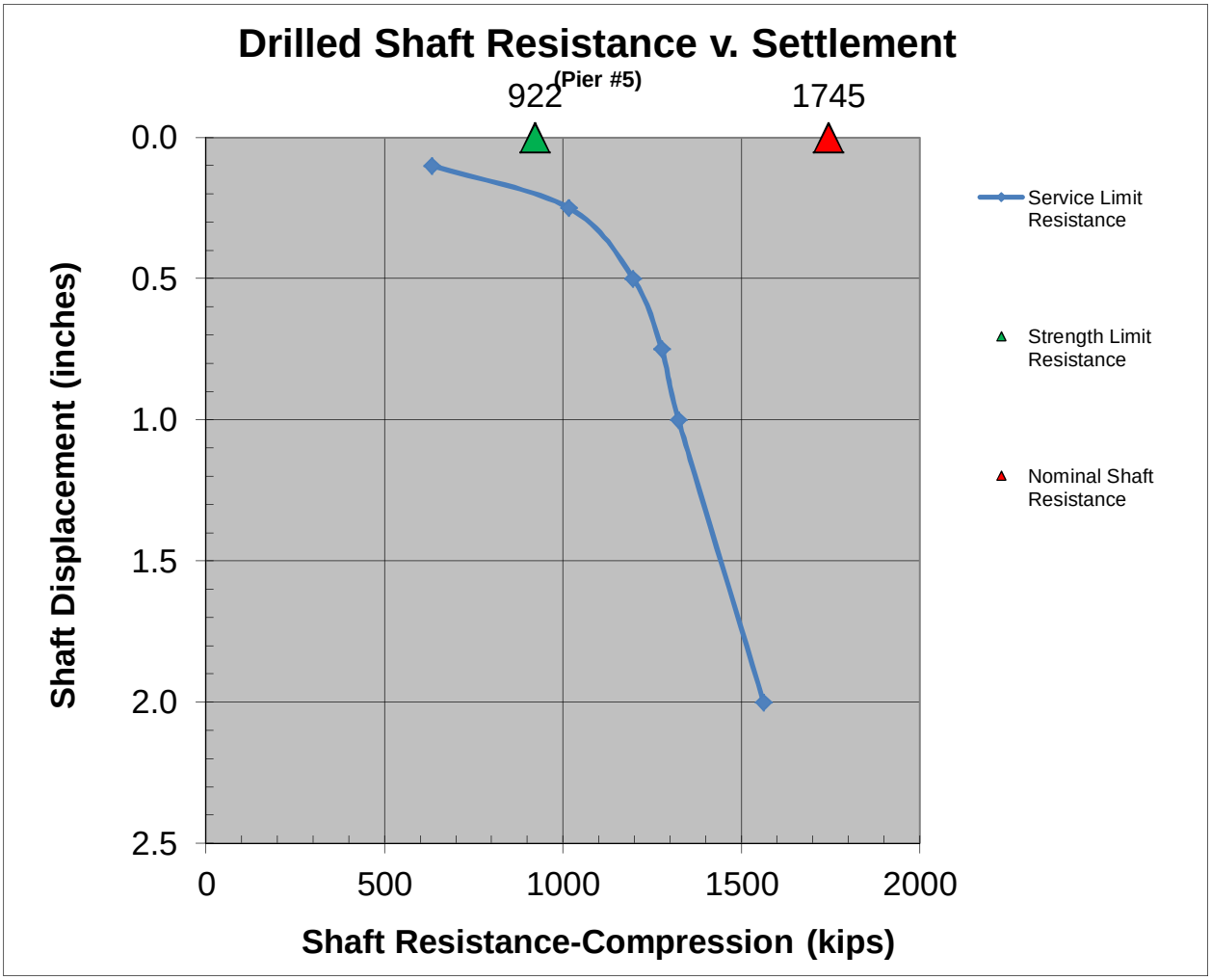
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	62	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	633.5
2	0.25	1017.1
3	0.50	1196.9
4	0.75	1277.4
5	1.00	1323.8
6	2.00	1562.6

Strength Limit Resistance Kips	Nominal Resistance Kips
922	1745



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #5

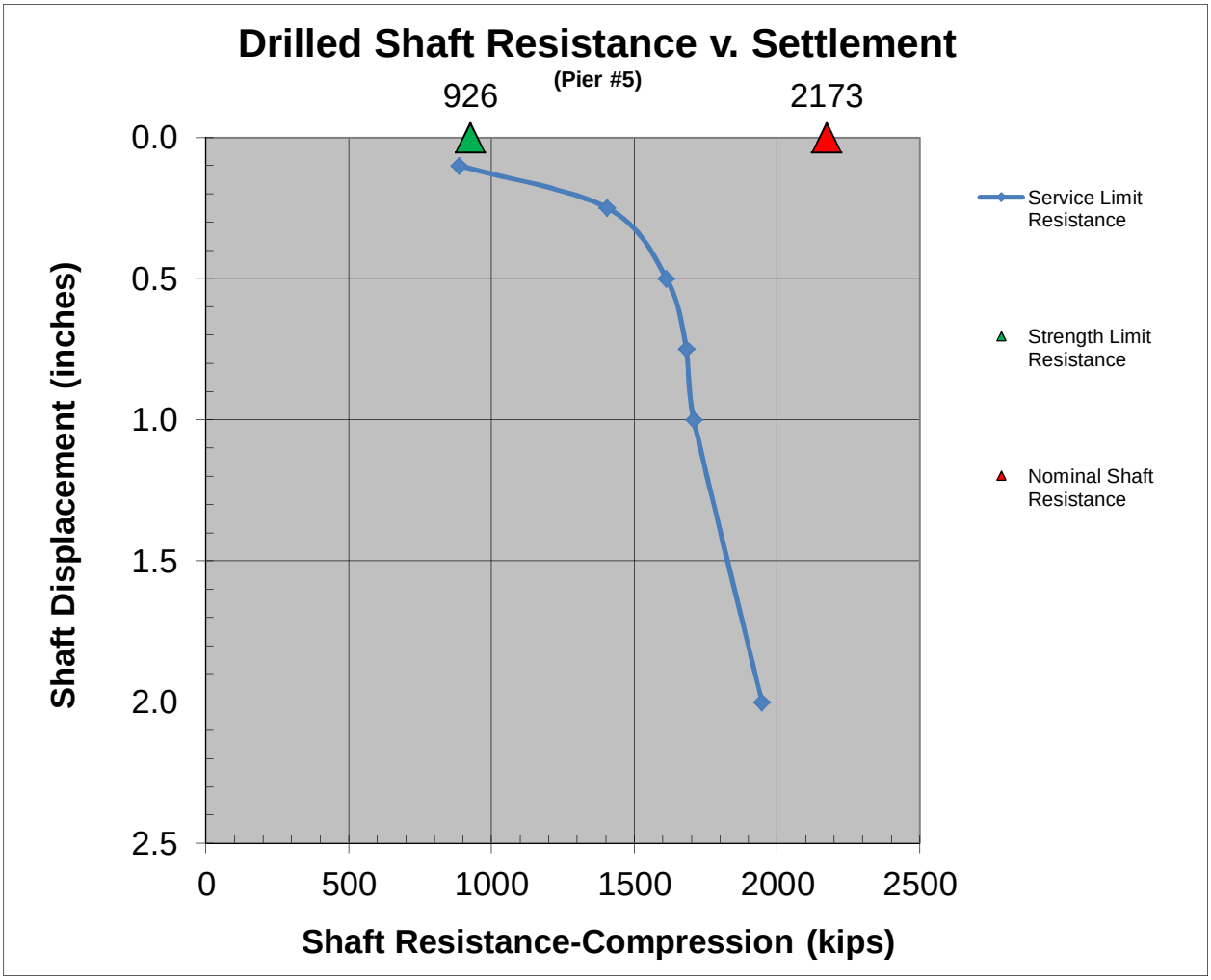
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	74	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	887.0
2	0.25	1405.5
3	0.50	1613.0
4	0.75	1682.4
5	1.00	1708.9
6	2.00	1947.7

Strength Limit Resistance Kips	Nominal Resistance Kips
926	2173



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #5

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	62	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	3	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2533.0	ft.

Soil Layer Properties

Layer Number	1	2	3
Depth from Ground Surface	12	32	100
Unit Weight of Layer (γ) pcf	120	70	130
Penetration Resistance "N_{60}" Blows/ft	0	0	75
Cohesion "**c**" of Layer (ksf)			
Thickness of layer (ft)	12.0	20.0	68.0
Soil Type	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted for Redundant Design**		
Side Resistance-Compression	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #5

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	74	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	3	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2533.0	ft.

Soil Layer Properties

Layer Number	1	2	3
Depth from Ground Surface	12	32	100
Unit Weight of Layer (γ) pcf	120	70	130
Penetration Resistance "N_{60}" Blows/ft	0	0	75
Cohesion "**c**" of Layer (ksf)			
Thickness of layer (ft)	12.0	20.0	68.0
Soil Type	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted Without Redundant Design**

Side Resistance-Compression	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

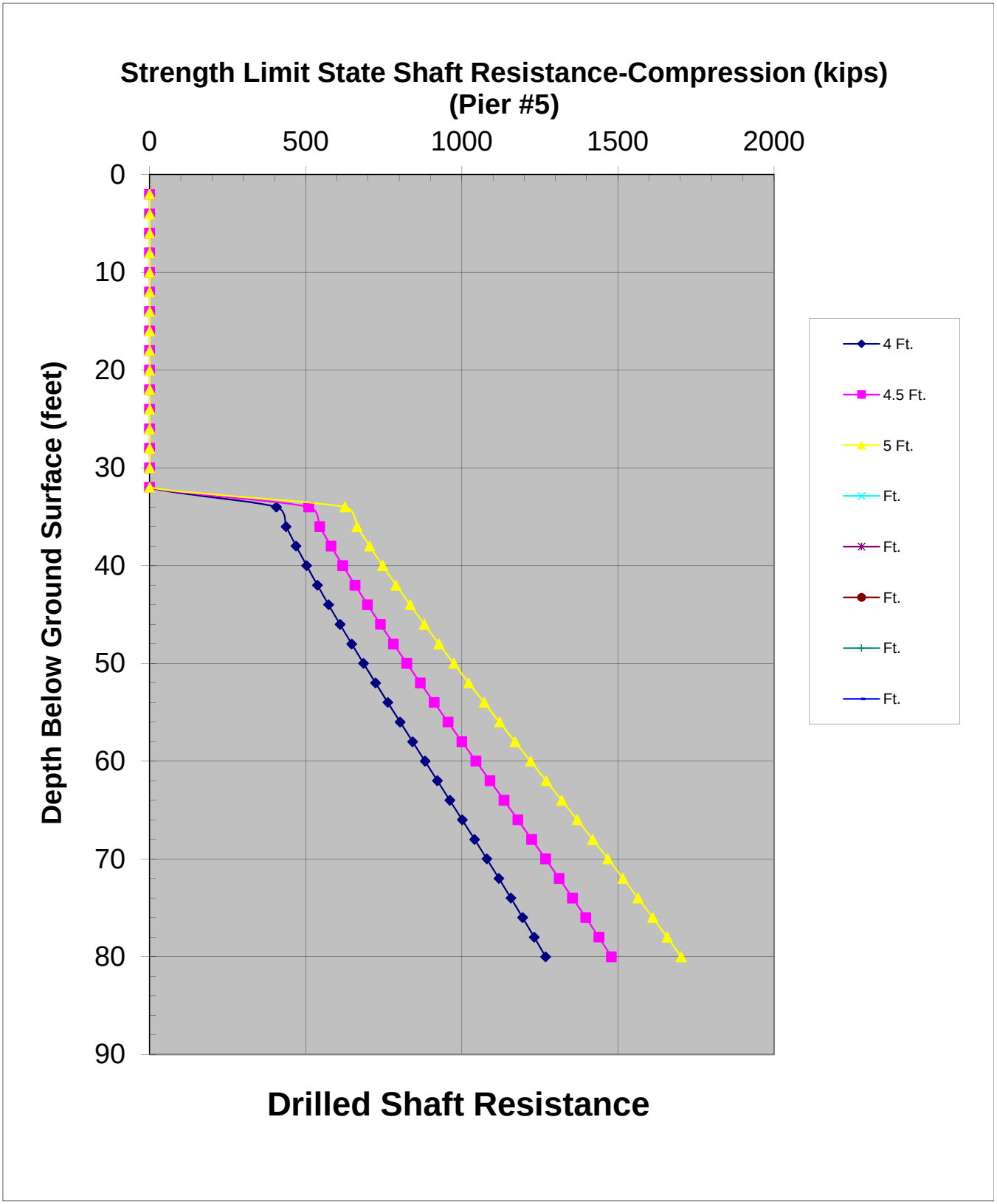
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2531.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2529.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2527.00	6.0	0.0		120.0	600.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2525.00	8.0	0.0		120.0	840.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2523.00	10.0	0.0		120.0	1080.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2521.00	12.0	0.0		120.0	1320.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2519.00	14.0	0.0		70.0	1510.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2517.00	16.0	0.0		70.0	1650.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2515.00	18.0	0.0		70.0	1790.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2513.00	20.0	0.0		70.0	1930.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2511.00	22.0	0.0		70.0	2070.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2509.00	24.0	0.0		70.0	2210.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2507.00	26.0	0.0		70.0	2350.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2505.00	28.0	0.0		70.0	2490.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2503.00	30.0	0.0		70.0	2630.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2501.00	32.0	0.0		70.0	2770.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2499.00	34.0	75.0		130.0	2970.0	0.71		2.12	0.55	0.45	0.50	60.0	60.0	60.0					
2497.00	36.0	75.0		130.0	3230.0	0.69		2.23	0.55	0.45	0.50	60.0	60.0	60.0					
2495.00	38.0	75.0		130.0	3490.0	0.67		2.33	0.55	0.45	0.50	60.0	60.0	60.0					
2493.00	40.0	75.0		130.0	3750.0	0.65		2.42	0.55	0.45	0.50	60.0	60.0	60.0					
2491.00	42.0	75.0		130.0	4010.0	0.63		2.51	0.55	0.45	0.50	60.0	60.0	60.0					
2489.00	44.0	75.0		130.0	4270.0	0.60		2.58	0.55	0.45	0.50	60.0	60.0	60.0					
2487.00	46.0	75.0		130.0	4530.0	0.58		2.65	0.55	0.45	0.50	60.0	60.0	60.0					
2485.00	48.0	75.0		130.0	4790.0	0.56		2.70	0.55	0.45	0.50	60.0	60.0	60.0					
2483.00	50.0	75.0		130.0	5050.0	0.55		2.75	0.55	0.45	0.50	60.0	60.0	60.0					
2481.00	52.0	75.0		130.0	5310.0	0.53		2.80	0.55	0.45	0.50	60.0	60.0	60.0					
2479.00	54.0	75.0		130.0	5570.0	0.51		2.83	0.55	0.45	0.50	60.0	60.0	60.0					
2477.00	56.0	75.0		130.0	5830.0	0.49		2.86	0.55	0.45	0.50	60.0	60.0	60.0					
2475.00	58.0	75.0		130.0	6090.0	0.47		2.87	0.55	0.45	0.50	60.0	60.0	60.0					
2473.00	60.0	75.0		130.0	6350.0	0.45		2.88	0.55	0.45	0.50	60.0	60.0	60.0					
2471.00	62.0	75.0		130.0	6610.0	0.44		2.89	0.55	0.45	0.50	60.0	60.0	60.0					
2469.00	64.0	75.0		130.0	6870.0	0.42		2.89	0.55	0.45	0.50	60.0	60.0	60.0					
2467.00	66.0	75.0		130.0	7130.0	0.40		2.88	0.55	0.45	0.50	60.0	60.0	60.0					
2465.00	68.0	75.0		130.0	7390.0	0.39		2.86	0.55	0.45	0.50	60.0	60.0	60.0					
2463.00	70.0	75.0		130.0	7650.0	0.37		2.83	0.55	0.45	0.50	60.0	60.0	60.0					
2461.00	72.0	75.0		130.0	7910.0	0.35		2.80	0.55	0.45	0.50	60.0	60.0	60.0					
2459.00	74.0	75.0		130.0	8170.0	0.34		2.77	0.55	0.45	0.50	60.0	60.0	60.0					
2457.00	76.0	75.0		130.0	8430.0	0.32		2.72	0.55	0.45	0.50	60.0	60.0	60.0					
2455.00	78.0	75.0		130.0	8690.0	0.31		2.67	0.55	0.45	0.50	60.0	60.0	60.0					
2453.00	80.0	75.0		130.0	8950.0	0.29		2.62	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2531.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2529.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2527.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2525.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2523.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2521.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2519.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2517.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2515.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2513.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2511.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2509.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2507.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2505.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2503.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2501.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2499.00	34.0	377.00	29.27	406.27	477.15	32.92	510.07	589.07	36.58	625.65																	
2497.00	36.0	377.00	60.07	437.08	477.15	67.58	544.73	589.07	75.09	664.16																	
2495.00	38.0	377.00	92.29	469.30	477.15	103.83	580.97	589.07	115.36	704.43																	
2493.00	40.0	377.00	125.79	502.79	477.15	141.51	618.66	589.07	157.24	746.30																	
2491.00	42.0	377.00	160.44	537.44	477.15	180.49	657.64	589.07	200.55	789.62																	
2489.00	44.0	377.00	196.12	573.12	477.15	220.64	697.78	589.07	245.15	834.22																	
2487.00	46.0	377.00	232.72	609.72	477.15	261.80	738.95	589.07	290.89	879.96																	
2485.00	48.0	377.00	270.11	647.11	477.15	303.87	781.02	589.07	337.63	926.70																	
2483.00	50.0	377.00	308.18	685.18	477.15	346.70	823.85	589.07	385.23	974.29																	
2481.00	52.0	377.00	346.83	723.83	477.15	390.18	867.33	589.07	433.53	1022.60																	
2479.00	54.0	377.00	385.94	762.94	477.15	434.18	911.33	589.07	482.42	1071.49																	
2477.00	56.0	377.00	425.41	802.41	477.15	478.58	955.73	589.07	531.76	1120.83																	
2475.00	58.0	377.00	465.13	842.14	477.15	523.27	1000.42	589.07	581.41	1170.48																	
2473.00	60.0	377.00	505.01	882.01	477.15	568.14	1045.28	589.07	631.26	1220.33																	
2471.00	62.0	377.00	544.94	921.94	477.15	613.06	1090.20	589.07	681.18	1270.24																	
2469.00	64.0	377.00	584.83	961.83	477.15	657.93	1135.08	589.07	731.03	1320.10																	
2467.00	66.0	377.00	624.57	1001.58	477.15	702.64	1179.79	589.07	780.71	1369.78																	
2465.00	68.0	377.00	664.08	1041.09	477.15	747.09	1224.24	589.07	830.10	1419.17																	
2463.00	70.0	377.00	703.26	1080.27	477.15	791.17	1268.32	589.07	879.08	1468.15																	
2461.00	72.0	377.00	742.02	1119.03	477.15	834.78	1311.92	589.07	927.53	1516.60																	
2459.00	74.0	377.00	780.27	1157.28	477.15	877.81	1354.95	589.07	975.34	1564.41																	
2457.00	76.0	377.00	817.93	1194.93	477.15	920.17	1397.31	589.07	1022.41	1611.48																	
2455.00	78.0	377.00	854.89	1231.89	477.15	961.75	1438.90	589.07	1068.61	1657.68																	
2453.00	80.0	377.00	891.08	1268.08	477.15	1002.47	1479.61	589.07	1113.85	1702.92																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #5)
0
500
1000
1500
2000
0
10
20
30
40
50
60
70
80
90
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX I

Mullins Landfill Bridge

Pier #6

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #6

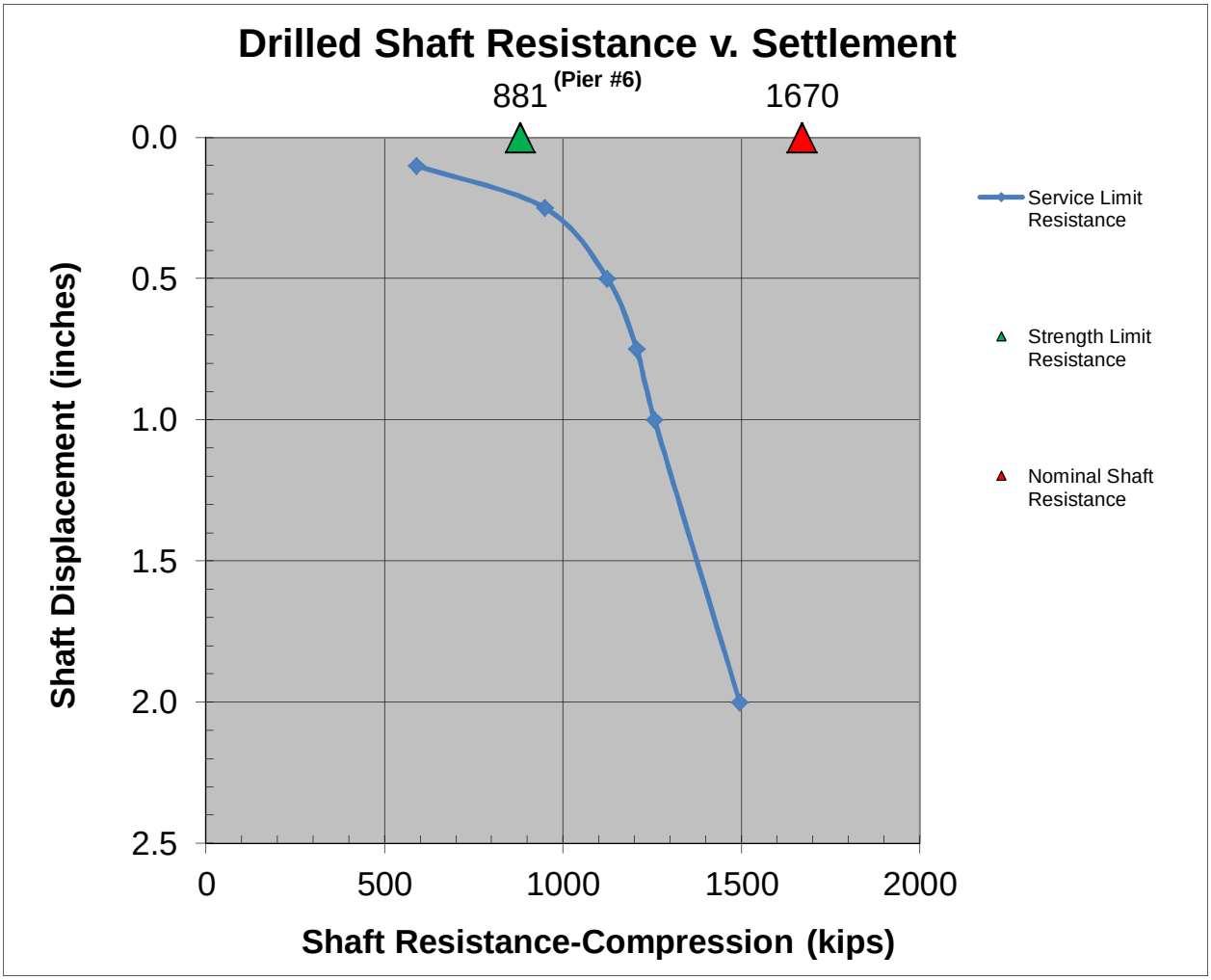
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	60	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	589.4
2	0.25	949.4
3	0.50	1124.4
4	0.75	1206.7
5	1.00	1256.6
6	2.00	1495.4

Strength Limit Resistance Kips	Nominal Resistance Kips
881	1670



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #6

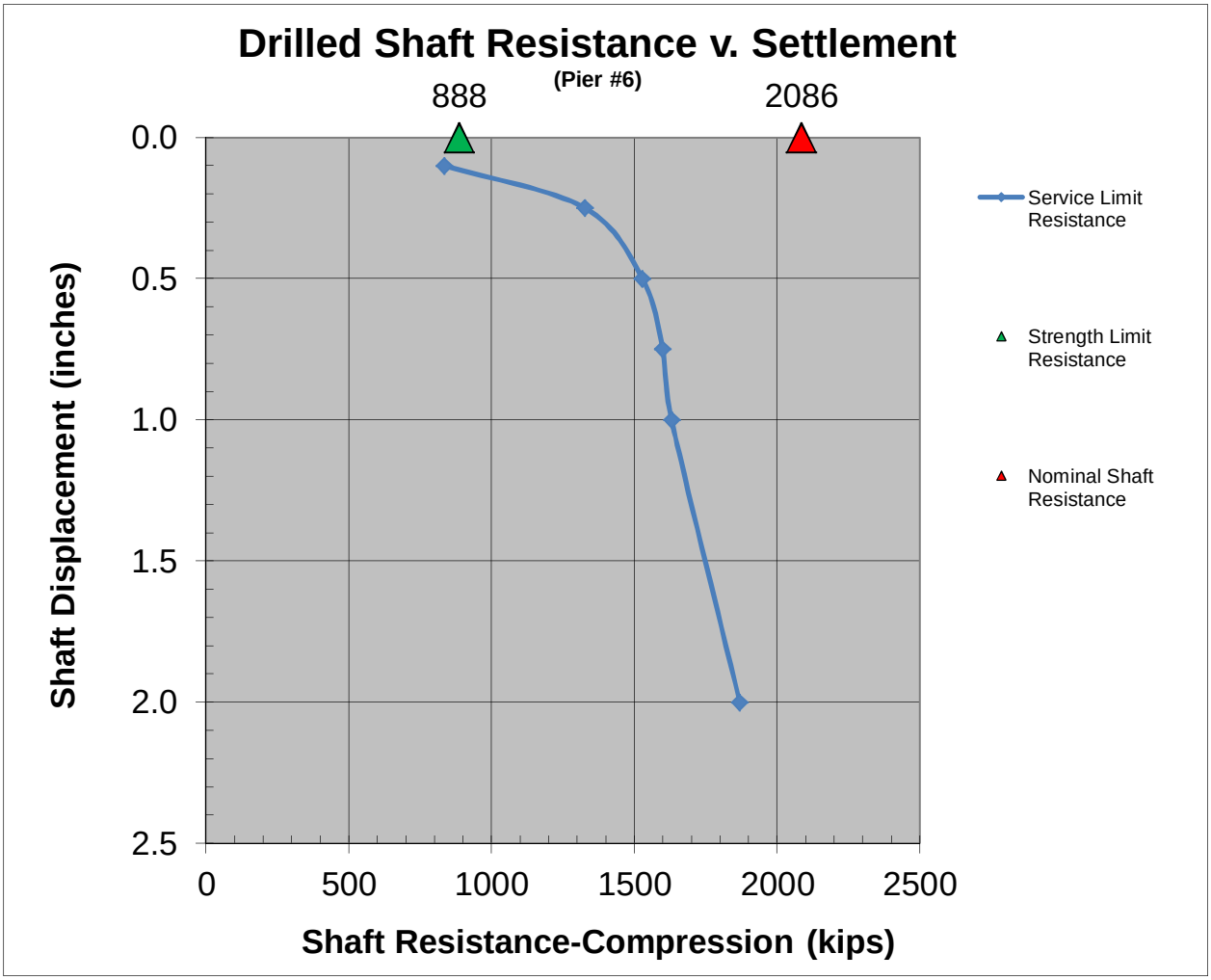
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	72	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	835.4
2	0.25	1326.5
3	0.50	1528.3
4	0.75	1600.0
5	1.00	1630.5
6	2.00	1869.3

Strength Limit Resistance Kips	Nominal Resistance Kips
888	2086



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #6

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	60	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2534.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	7	31	42	47	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	40	55	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	7.0	24.0	11.0	5.0	53.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted for Redundant Design**				
Side Resistance-Compression	0.55	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #6

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	72	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2534.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	7	31	42	47	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	40	55	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	7.0	24.0	11.0	5.0	53.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted Without Redundant Design**

Side Resistance-Compression	0.44	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

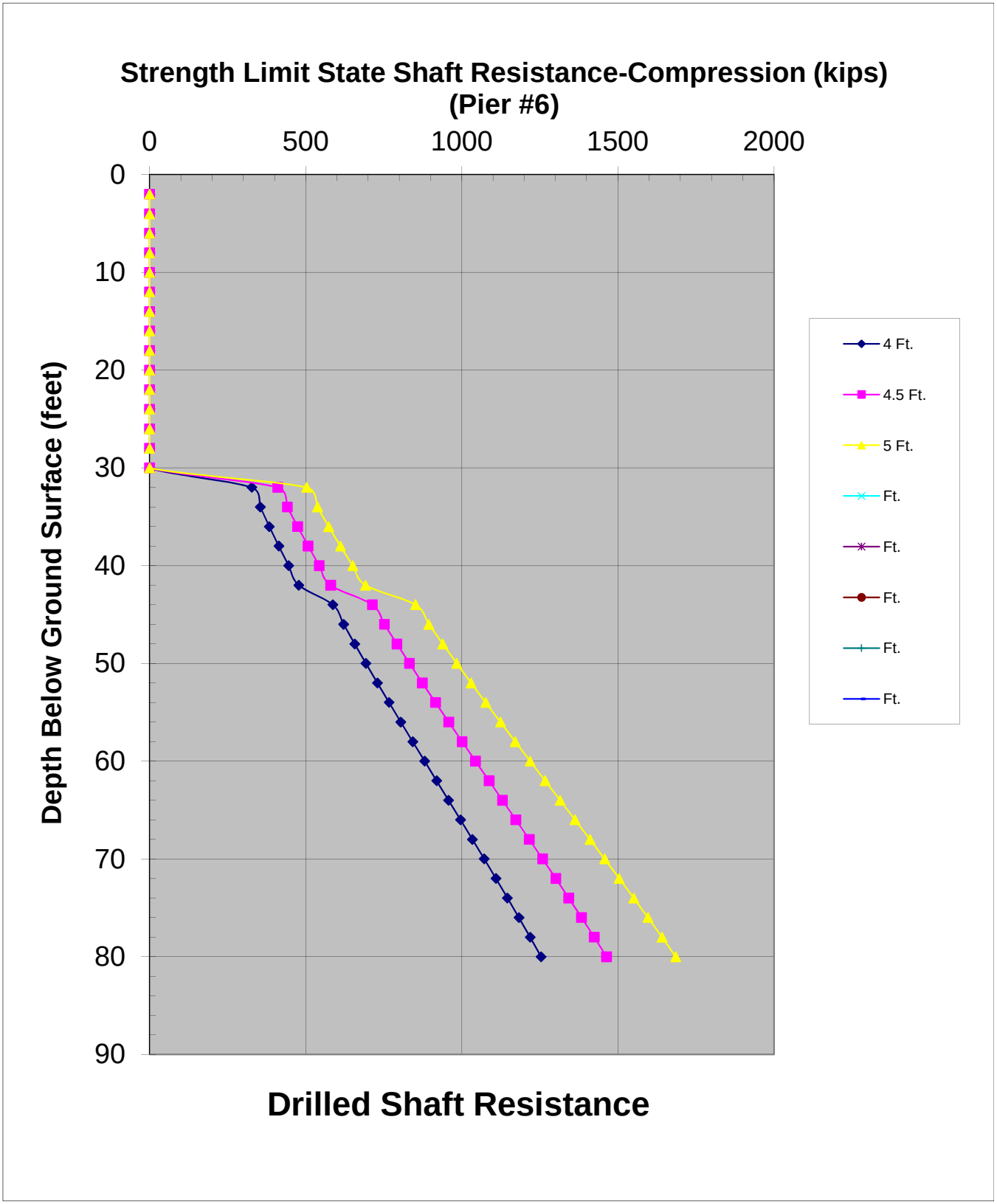
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2532.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2530.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2528.00	6.0	0.0		120.0	600.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2526.00	8.0	0.0		70.0	790.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2524.00	10.0	0.0		70.0	930.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2522.00	12.0	0.0		70.0	1070.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2520.00	14.0	0.0		70.0	1210.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2518.00	16.0	0.0		70.0	1350.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2516.00	18.0	0.0		70.0	1490.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2514.00	20.0	0.0		70.0	1630.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2512.00	22.0	0.0		70.0	1770.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2510.00	24.0	0.0		70.0	1910.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2508.00	26.0	0.0		70.0	2050.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2506.00	28.0	0.0		70.0	2190.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2504.00	30.0	0.0		70.0	2330.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2502.00	32.0	40.0		125.0	2525.0	0.74		1.86	0.55	0.45	0.50	48.0	48.0	48.0					
2500.00	34.0	40.0		125.0	2775.0	0.71		1.98	0.55	0.45	0.50	48.0	48.0	48.0					
2498.00	36.0	40.0		125.0	3025.0	0.69		2.09	0.55	0.45	0.50	48.0	48.0	48.0					
2496.00	38.0	40.0		125.0	3275.0	0.67		2.19	0.55	0.45	0.50	48.0	48.0	48.0					
2494.00	40.0	40.0		125.0	3525.0	0.65		2.28	0.55	0.45	0.50	48.0	48.0	48.0					
2492.00	42.0	40.0		125.0	3775.0	0.63		2.36	0.55	0.45	0.50	48.0	48.0	48.0					
2490.00	44.0	55.0		125.0	4025.0	0.60		2.43	0.55	0.45	0.50	60.0	60.0	60.0					
2488.00	46.0	55.0		125.0	4275.0	0.58		2.50	0.55	0.45	0.50	60.0	60.0	60.0					
2486.00	48.0	75.0		130.0	4530.0	0.56		2.56	0.55	0.45	0.50	60.0	60.0	60.0					
2484.00	50.0	75.0		130.0	4790.0	0.55		2.61	0.55	0.45	0.50	60.0	60.0	60.0					
2482.00	52.0	75.0		130.0	5050.0	0.53		2.66	0.55	0.45	0.50	60.0	60.0	60.0					
2480.00	54.0	75.0		130.0	5310.0	0.51		2.70	0.55	0.45	0.50	60.0	60.0	60.0					
2478.00	56.0	75.0		130.0	5570.0	0.49		2.73	0.55	0.45	0.50	60.0	60.0	60.0					
2476.00	58.0	75.0		130.0	5830.0	0.47		2.75	0.55	0.45	0.50	60.0	60.0	60.0					
2474.00	60.0	75.0		130.0	6090.0	0.45		2.77	0.55	0.45	0.50	60.0	60.0	60.0					
2472.00	62.0	75.0		130.0	6350.0	0.44		2.78	0.55	0.45	0.50	60.0	60.0	60.0					
2470.00	64.0	75.0		130.0	6610.0	0.42		2.78	0.55	0.45	0.50	60.0	60.0	60.0					
2468.00	66.0	75.0		130.0	6870.0	0.40		2.77	0.55	0.45	0.50	60.0	60.0	60.0					
2466.00	68.0	75.0		130.0	7130.0	0.39		2.76	0.55	0.45	0.50	60.0	60.0	60.0					
2464.00	70.0	75.0		130.0	7390.0	0.37		2.74	0.55	0.45	0.50	60.0	60.0	60.0					
2462.00	72.0	75.0		130.0	7650.0	0.35		2.71	0.55	0.45	0.50	60.0	60.0	60.0					
2460.00	74.0	75.0		130.0	7910.0	0.34		2.68	0.55	0.45	0.50	60.0	60.0	60.0					
2458.00	76.0	75.0		130.0	8170.0	0.32		2.64	0.55	0.45	0.50	60.0	60.0	60.0					
2456.00	78.0	75.0		130.0	8430.0	0.31		2.59	0.55	0.45	0.50	60.0	60.0	60.0					
2454.00	80.0	75.0		130.0	8690.0	0.29		2.54	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2532.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2530.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2528.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2526.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2524.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2522.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2520.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2518.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2516.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2514.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2512.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2510.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2508.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2506.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2504.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2502.00	32.0	301.60	25.70	327.30	381.72	28.91	410.63	471.26	32.13	503.38																	
2500.00	34.0	301.60	53.04	354.65	381.72	59.68	441.39	471.26	66.31	537.56																	
2498.00	36.0	301.60	81.90	383.50	381.72	92.14	473.85	471.26	102.37	573.63																	
2496.00	38.0	301.60	112.13	413.73	381.72	126.15	507.86	471.26	140.16	611.42																	
2494.00	40.0	301.60	143.62	445.22	381.72	161.57	543.29	471.26	179.52	650.78																	
2492.00	42.0	301.60	176.24	477.84	381.72	198.27	579.98	471.26	220.30	691.55																	
2490.00	44.0	377.00	209.87	586.88	477.15	236.11	713.25	589.07	262.34	851.41																	
2488.00	46.0	377.00	244.41	621.41	477.15	274.96	752.10	589.07	305.51	894.58																	
2486.00	48.0	377.00	279.77	656.77	477.15	314.74	791.88	589.07	349.71	938.78																	
2484.00	50.0	377.00	315.88	692.89	477.15	355.37	832.51	589.07	394.85	983.92																	
2482.00	52.0	377.00	352.64	729.64	477.15	396.72	873.86	589.07	440.80	1029.86																	
2480.00	54.0	377.00	389.92	766.93	477.15	438.66	915.81	589.07	487.40	1076.47																	
2478.00	56.0	377.00	427.63	804.64	477.15	481.08	958.23	589.07	534.54	1123.61																	
2476.00	58.0	377.00	465.66	842.66	477.15	523.87	1001.01	589.07	582.07	1171.14																	
2474.00	60.0	377.00	503.90	880.91	477.15	566.89	1044.04	589.07	629.88	1218.95																	
2472.00	62.0	377.00	542.26	919.27	477.15	610.05	1087.19	589.07	677.83	1266.90																	
2470.00	64.0	377.00	580.64	957.65	477.15	653.22	1130.37	589.07	725.80	1314.87																	
2468.00	66.0	377.00	618.94	995.94	477.15	696.30	1173.45	589.07	773.67	1362.74																	
2466.00	68.0	377.00	657.06	1034.06	477.15	739.19	1216.33	589.07	821.32	1410.39																	
2464.00	70.0	377.00	694.91	1071.91	477.15	781.77	1258.92	589.07	868.63	1457.70																	
2462.00	72.0	377.00	732.39	1109.40	477.15	823.94	1301.09	589.07	915.49	1504.56																	
2460.00	74.0	377.00	769.43	1146.43	477.15	865.61	1342.75	589.07	961.78	1550.85																	
2458.00	76.0	377.00	805.92	1182.92	477.15	906.66	1383.80	589.07	1007.40	1596.46																	
2456.00	78.0	377.00	841.77	1218.78	477.15	947.00	1424.14	589.07	1052.22	1641.29																	
2454.00	80.0	377.00	876.91	1253.92	477.15	986.53	1463.67	589.07	1096.14	1685.21																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #6)
0
500
1000
1500
2000
0
10
20
30
40
50
60
70
80
90
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX J

Mullins Landfill Bridge

Pier #7

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #7

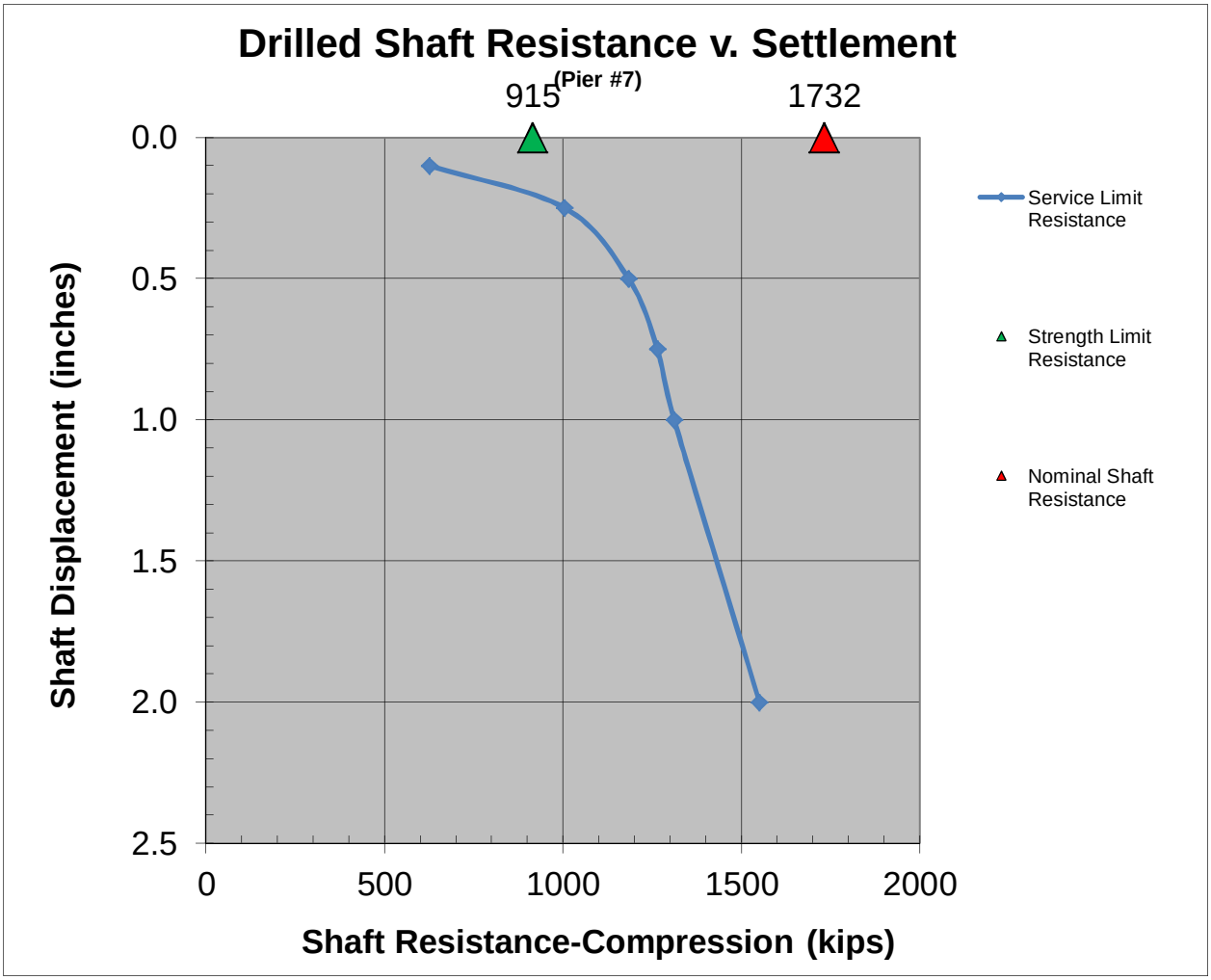
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	62	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	625.7
2	0.25	1005.1
3	0.50	1184.0
4	0.75	1264.8
5	1.00	1311.9
6	2.00	1550.6

Strength Limit Resistance Kips	Nominal Resistance Kips
915	1732



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #7

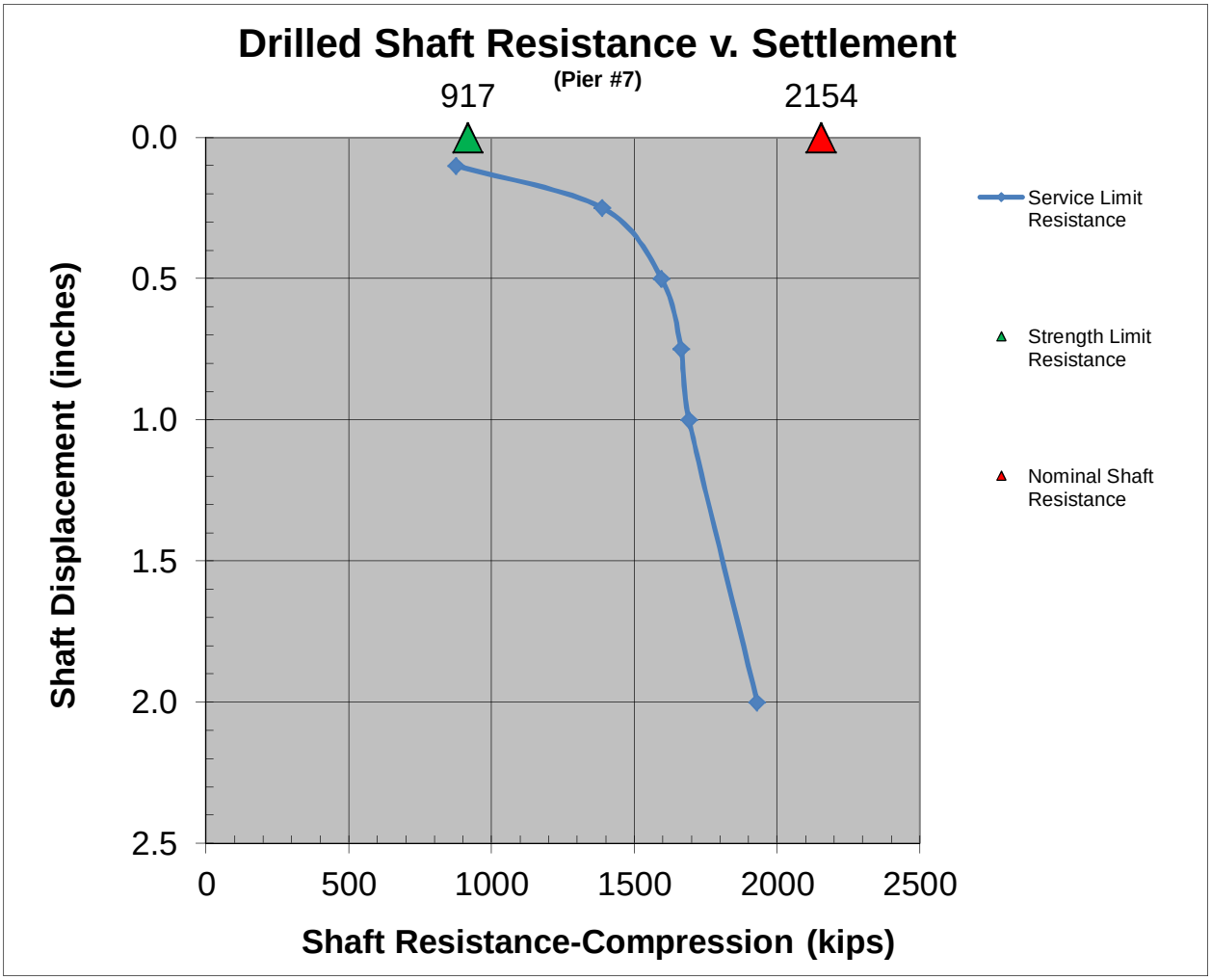
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	74	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	875.7
2	0.25	1388.3
3	0.50	1594.5
4	0.75	1664.5
5	1.00	1691.8
6	2.00	1930.6

Strength Limit Resistance Kips	Nominal Resistance Kips
917	2154



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #7

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	62	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2534.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	12	32	42	52	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	41	59	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	12.0	20.0	10.0	10.0	48.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted for Redundant Design**				
Side Resistance-Compression	0.55	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #7

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	74	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2534.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	12	32	42	52	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	41	59	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	12.0	20.0	10.0	10.0	48.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted Without Redundant Design**

Side Resistance-Compression	0.44	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

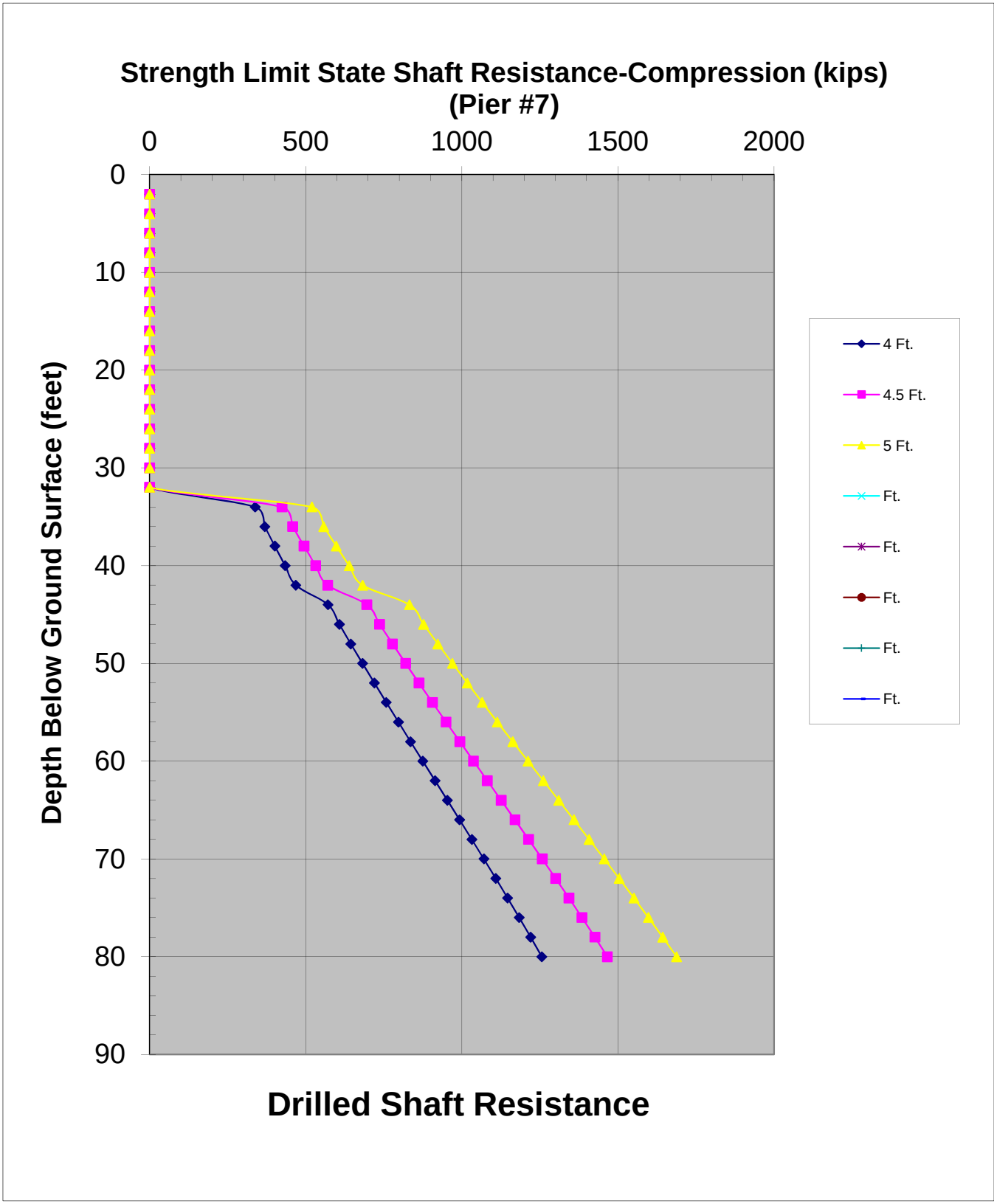
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2532.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2530.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2528.00	6.0	0.0		120.0	600.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2526.00	8.0	0.0		120.0	840.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2524.00	10.0	0.0		120.0	1080.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2522.00	12.0	0.0		120.0	1320.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2520.00	14.0	0.0		70.0	1510.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2518.00	16.0	0.0		70.0	1650.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2516.00	18.0	0.0		70.0	1790.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2514.00	20.0	0.0		70.0	1930.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2512.00	22.0	0.0		70.0	2070.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2510.00	24.0	0.0		70.0	2210.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2508.00	26.0	0.0		70.0	2350.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2506.00	28.0	0.0		70.0	2490.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2504.00	30.0	0.0		70.0	2630.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2502.00	32.0	0.0		70.0	2770.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2500.00	34.0	41.0		125.0	2965.0	0.71		2.11	0.55	0.45	0.50	49.2	49.2	49.2					
2498.00	36.0	41.0		125.0	3215.0	0.69		2.22	0.55	0.45	0.50	49.2	49.2	49.2					
2496.00	38.0	41.0		125.0	3465.0	0.67		2.31	0.55	0.45	0.50	49.2	49.2	49.2					
2494.00	40.0	41.0		125.0	3715.0	0.65		2.40	0.55	0.45	0.50	49.2	49.2	49.2					
2492.00	42.0	41.0		125.0	3965.0	0.63		2.48	0.55	0.45	0.50	49.2	49.2	49.2					
2490.00	44.0	59.0		125.0	4215.0	0.60		2.55	0.55	0.45	0.50	60.0	60.0	60.0					
2488.00	46.0	59.0		125.0	4465.0	0.58		2.61	0.55	0.45	0.50	60.0	60.0	60.0					
2486.00	48.0	59.0		125.0	4715.0	0.56		2.66	0.55	0.45	0.50	60.0	60.0	60.0					
2484.00	50.0	59.0		125.0	4965.0	0.55		2.71	0.55	0.45	0.50	60.0	60.0	60.0					
2482.00	52.0	59.0		125.0	5215.0	0.53		2.75	0.55	0.45	0.50	60.0	60.0	60.0					
2480.00	54.0	75.0		130.0	5470.0	0.51		2.78	0.55	0.45	0.50	60.0	60.0	60.0					
2478.00	56.0	75.0		130.0	5730.0	0.49		2.81	0.55	0.45	0.50	60.0	60.0	60.0					
2476.00	58.0	75.0		130.0	5990.0	0.47		2.83	0.55	0.45	0.50	60.0	60.0	60.0					
2474.00	60.0	75.0		130.0	6250.0	0.45		2.84	0.55	0.45	0.50	60.0	60.0	60.0					
2472.00	62.0	75.0		130.0	6510.0	0.44		2.84	0.55	0.45	0.50	60.0	60.0	60.0					
2470.00	64.0	75.0		130.0	6770.0	0.42		2.84	0.55	0.45	0.50	60.0	60.0	60.0					
2468.00	66.0	75.0		130.0	7030.0	0.40		2.83	0.55	0.45	0.50	60.0	60.0	60.0					
2466.00	68.0	75.0		130.0	7290.0	0.39		2.82	0.55	0.45	0.50	60.0	60.0	60.0					
2464.00	70.0	75.0		130.0	7550.0	0.37		2.80	0.55	0.45	0.50	60.0	60.0	60.0					
2462.00	72.0	75.0		130.0	7810.0	0.35		2.77	0.55	0.45	0.50	60.0	60.0	60.0					
2460.00	74.0	75.0		130.0	8070.0	0.34		2.73	0.55	0.45	0.50	60.0	60.0	60.0					
2458.00	76.0	75.0		130.0	8330.0	0.32		2.69	0.55	0.45	0.50	60.0	60.0	60.0					
2456.00	78.0	75.0		130.0	8590.0	0.31		2.64	0.55	0.45	0.50	60.0	60.0	60.0					
2454.00	80.0	75.0		130.0	8850.0	0.29		2.59	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2532.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2530.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2528.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2526.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2524.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2522.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2520.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2518.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2516.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2514.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2512.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2510.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2508.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2506.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2504.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2502.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2500.00	34.0	309.14	29.22	338.36	391.26	32.87	424.13	483.04	36.52	519.56																	
2498.00	36.0	309.14	59.88	369.02	391.26	67.37	458.63	483.04	74.85	557.89																	
2496.00	38.0	309.14	91.87	401.01	391.26	103.35	494.61	483.04	114.84	597.87																	
2494.00	40.0	309.14	125.05	434.20	391.26	140.68	531.94	483.04	156.32	639.35																	
2492.00	42.0	309.14	159.31	468.46	391.26	179.23	570.49	483.04	199.14	682.18																	
2490.00	44.0	377.00	194.54	571.54	477.15	218.85	696.00	589.07	243.17	832.24																	
2488.00	46.0	377.00	230.61	607.61	477.15	259.43	736.58	589.07	288.26	877.33																	
2486.00	48.0	377.00	267.41	644.42	477.15	300.84	777.98	589.07	334.26	923.33																	
2484.00	50.0	377.00	304.84	681.85	477.15	342.95	820.10	589.07	381.06	970.12																	
2482.00	52.0	377.00	342.80	719.80	477.15	385.65	862.80	589.07	428.50	1017.57																	
2480.00	54.0	377.00	381.21	758.21	477.15	428.86	906.01	589.07	476.51	1065.58																	
2478.00	56.0	377.00	420.00	797.01	477.15	472.50	949.65	589.07	525.00	1114.07																	
2476.00	58.0	377.00	459.07	836.08	477.15	516.46	993.60	589.07	573.84	1162.91																	
2474.00	60.0	377.00	498.32	875.33	477.15	560.61	1037.76	589.07	622.90	1211.97																	
2472.00	62.0	377.00	537.65	914.65	477.15	604.86	1082.00	589.07	672.06	1261.13																	
2470.00	64.0	377.00	576.96	953.96	477.15	649.07	1126.22	589.07	721.19	1310.26																	
2468.00	66.0	377.00	616.14	993.15	477.15	693.16	1170.31	589.07	770.18	1359.25																	
2466.00	68.0	377.00	655.12	1032.12	477.15	737.01	1214.15	589.07	818.90	1407.97																	
2464.00	70.0	377.00	693.79	1070.79	477.15	780.51	1257.66	589.07	867.23	1456.30																	
2462.00	72.0	377.00	732.06	1109.06	477.15	823.57	1300.71	589.07	915.07	1504.14																	
2460.00	74.0	377.00	769.84	1146.84	477.15	866.07	1343.22	589.07	962.30	1551.37																	
2458.00	76.0	377.00	807.05	1184.05	477.15	907.93	1385.07	589.07	1008.81	1597.88																	
2456.00	78.0	377.00	843.58	1220.59	477.15	949.03	1426.18	589.07	1054.48	1643.55																	
2454.00	80.0	377.00	879.37	1256.37	477.15	989.29	1466.44	589.07	1099.21	1688.28																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #7)
0
500
1000
1500
2000
0
10
20
30
40
50
60
70
80
90
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX K

Mullins Landfill Bridge

Pier #8

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #8

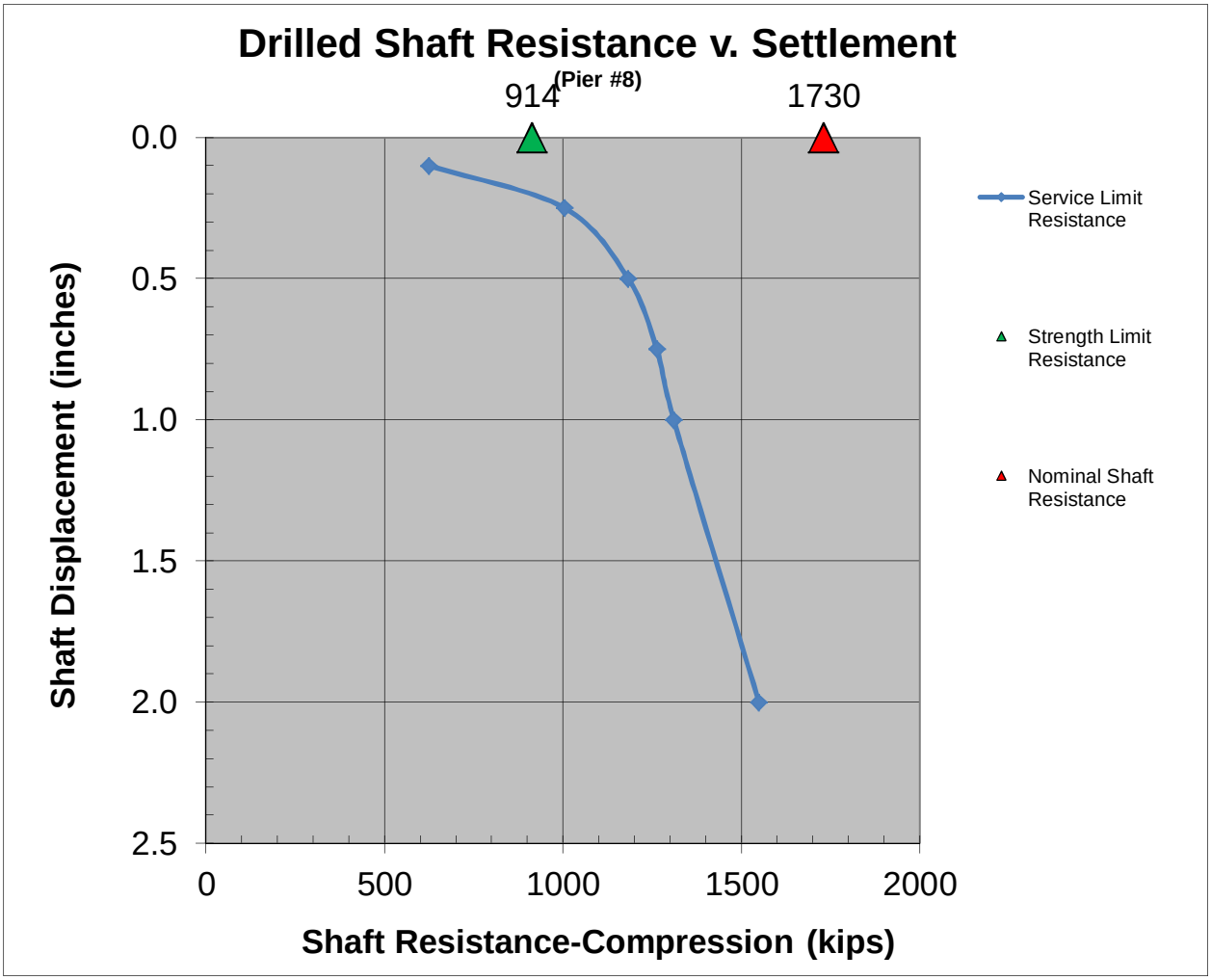
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	62	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	624.8
2	0.25	1003.8
3	0.50	1182.6
4	0.75	1263.5
5	1.00	1310.6
6	2.00	1549.3

Strength Limit Resistance Kips	Nominal Resistance Kips
914	1730



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #8

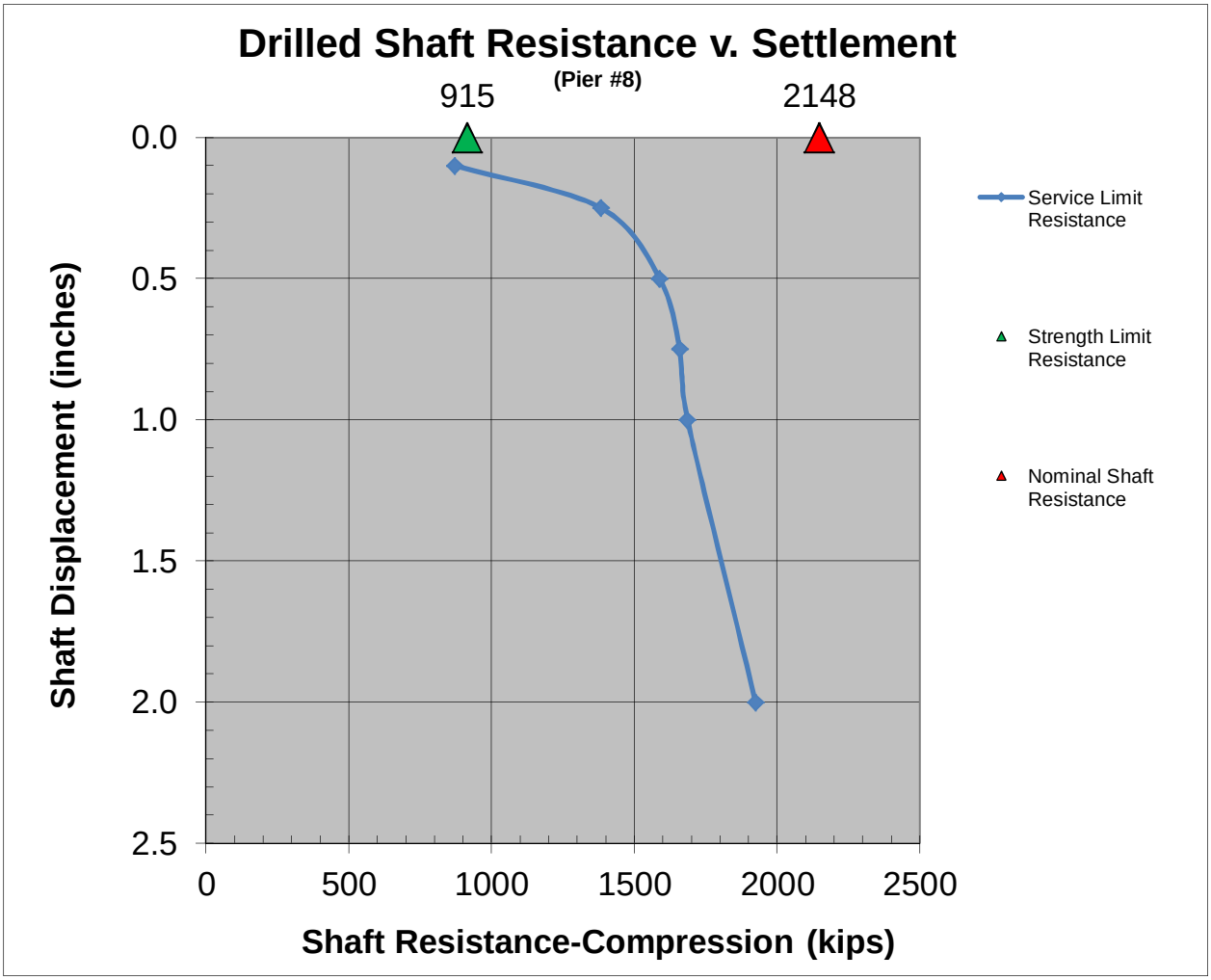
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	74	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	872.2
2	0.25	1382.9
3	0.50	1588.8
4	0.75	1658.8
5	1.00	1686.5
6	2.00	1925.2

Strength Limit Resistance Kips	Nominal Resistance Kips
915	2148



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #8

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	62	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	6	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2534.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5	6
Depth from Ground Surface	12.5	32	37	52	57	100
Unit Weight of Layer (γ) pcf	120	70	125	125	125	125
Penetration Resistance "N_{60}" Blows/ft	0	0	35	75	49	75
Cohesion "**c**" of Layer (ksf)						
Thickness of layer (ft)	12.5	19.5	5.0	15.0	5.0	43.0
Soil Type	Sand	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted for Redundant Design**					
Side Resistance-Compression	0.55	0.55	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #8

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	74	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	6	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2534.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5	6
Depth from Ground Surface	12.5	32	37	52	57	100
Unit Weight of Layer (γ) pcf	120	70	125	125	125	125
Penetration Resistance "N_{60}" Blows/ft	0	0	35	75	49	75
Cohesion "**c**" of Layer (ksf)						
Thickness of layer (ft)	12.5	19.5	5.0	15.0	5.0	43.0
Soil Type	Sand	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted Without Redundant Design**					
Side Resistance-Compression	0.44	0.44	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

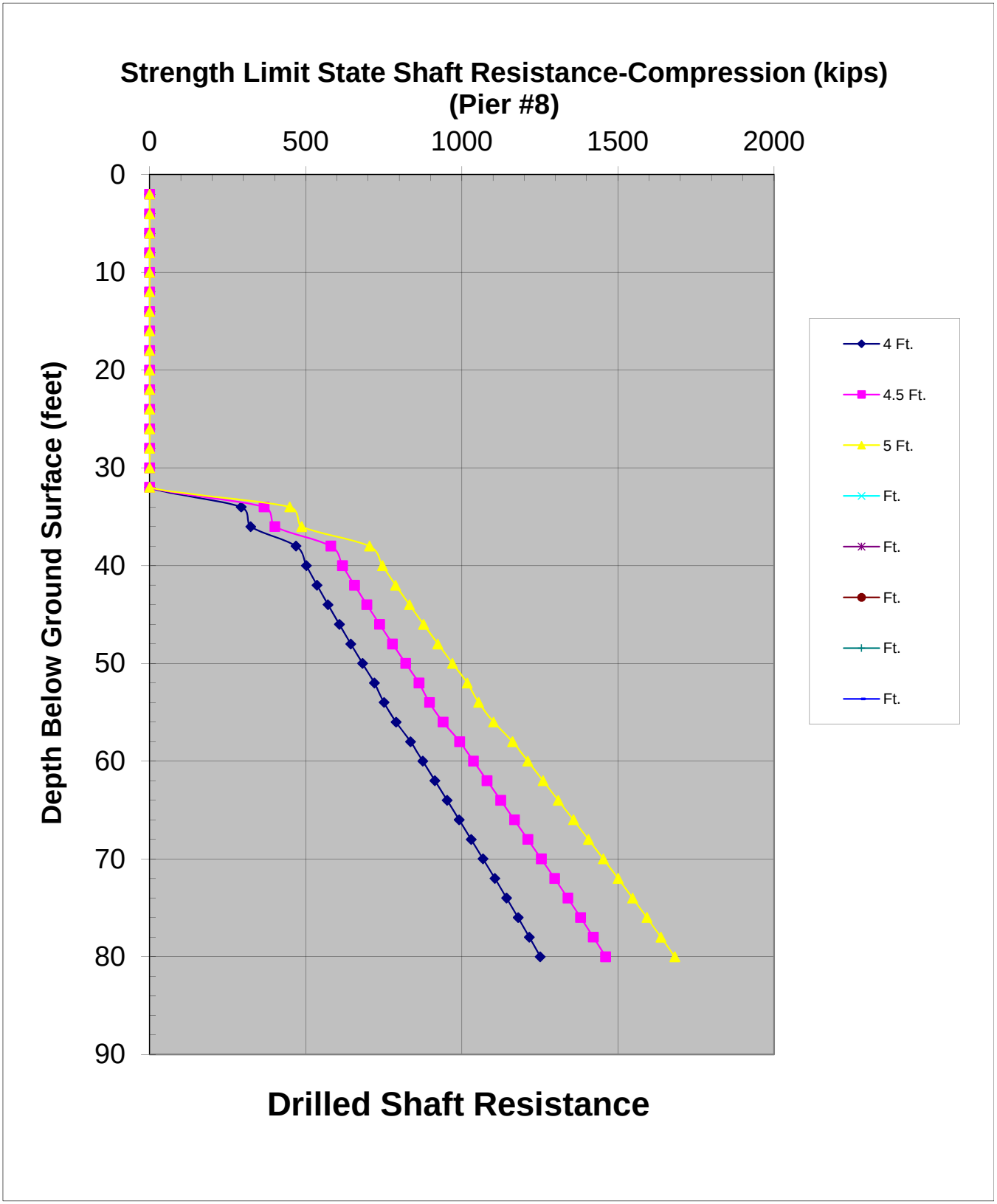
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2532.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2530.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2528.00	6.0	0.0		120.0	600.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2526.00	8.0	0.0		120.0	840.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2524.00	10.0	0.0		120.0	1080.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2522.00	12.0	0.0		120.0	1320.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2520.00	14.0	0.0		70.0	1510.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2518.00	16.0	0.0		70.0	1650.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2516.00	18.0	0.0		70.0	1790.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2514.00	20.0	0.0		70.0	1930.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2512.00	22.0	0.0		70.0	2070.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2510.00	24.0	0.0		70.0	2210.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2508.00	26.0	0.0		70.0	2350.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2506.00	28.0	0.0		70.0	2490.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2504.00	30.0	0.0		70.0	2630.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2502.00	32.0	0.0		70.0	2770.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2500.00	34.0	35.0		125.0	2965.0	0.71		2.11	0.55	0.45	0.50	42.0	42.0	42.0					
2498.00	36.0	35.0		125.0	3215.0	0.69		2.22	0.55	0.45	0.50	42.0	42.0	42.0					
2496.00	38.0	75.0		125.0	3465.0	0.67		2.31	0.55	0.45	0.50	60.0	60.0	60.0					
2494.00	40.0	75.0		125.0	3715.0	0.65		2.40	0.55	0.45	0.50	60.0	60.0	60.0					
2492.00	42.0	75.0		125.0	3965.0	0.63		2.48	0.55	0.45	0.50	60.0	60.0	60.0					
2490.00	44.0	75.0		125.0	4215.0	0.60		2.55	0.55	0.45	0.50	60.0	60.0	60.0					
2488.00	46.0	75.0		125.0	4465.0	0.58		2.61	0.55	0.45	0.50	60.0	60.0	60.0					
2486.00	48.0	75.0		125.0	4715.0	0.56		2.66	0.55	0.45	0.50	60.0	60.0	60.0					
2484.00	50.0	75.0		125.0	4965.0	0.55		2.71	0.55	0.45	0.50	60.0	60.0	60.0					
2482.00	52.0	75.0		125.0	5215.0	0.53		2.75	0.55	0.45	0.50	60.0	60.0	60.0					
2480.00	54.0	49.0		125.0	5465.0	0.51		2.78	0.55	0.45	0.50	58.8	58.8	58.8					
2478.00	56.0	49.0		125.0	5715.0	0.49		2.80	0.55	0.45	0.50	58.8	58.8	58.8					
2476.00	58.0	75.0		125.0	5965.0	0.47		2.81	0.55	0.45	0.50	60.0	60.0	60.0					
2474.00	60.0	75.0		125.0	6215.0	0.45		2.82	0.55	0.45	0.50	60.0	60.0	60.0					
2472.00	62.0	75.0		125.0	6465.0	0.44		2.83	0.55	0.45	0.50	60.0	60.0	60.0					
2470.00	64.0	75.0		125.0	6715.0	0.42		2.82	0.55	0.45	0.50	60.0	60.0	60.0					
2468.00	66.0	75.0		125.0	6965.0	0.40		2.81	0.55	0.45	0.50	60.0	60.0	60.0					
2466.00	68.0	75.0		125.0	7215.0	0.39		2.79	0.55	0.45	0.50	60.0	60.0	60.0					
2464.00	70.0	75.0		125.0	7465.0	0.37		2.77	0.55	0.45	0.50	60.0	60.0	60.0					
2462.00	72.0	75.0		125.0	7715.0	0.35		2.73	0.55	0.45	0.50	60.0	60.0	60.0					
2460.00	74.0	75.0		125.0	7965.0	0.34		2.70	0.55	0.45	0.50	60.0	60.0	60.0					
2458.00	76.0	75.0		125.0	8215.0	0.32		2.65	0.55	0.45	0.50	60.0	60.0	60.0					
2456.00	78.0	75.0		125.0	8465.0	0.31		2.60	0.55	0.45	0.50	60.0	60.0	60.0					
2454.00	80.0	75.0		125.0	8715.0	0.29		2.55	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2532.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2530.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2528.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2526.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2524.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2522.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2520.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2518.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2516.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2514.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2512.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2510.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2508.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2506.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2504.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2502.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2500.00	34.0	263.90	29.22	293.12	334.00	32.87	366.87	412.35	36.52	448.87																	
2498.00	36.0	263.90	59.88	323.78	334.00	67.37	401.37	412.35	74.85	487.20																	
2496.00	38.0	377.00	91.87	468.87	477.15	103.35	580.50	589.07	114.84	703.90																	
2494.00	40.0	377.00	125.05	502.06	477.15	140.68	617.83	589.07	156.32	745.38																	
2492.00	42.0	377.00	159.31	536.32	477.15	179.23	656.37	589.07	199.14	788.21																	
2490.00	44.0	377.00	194.54	571.54	477.15	218.85	696.00	589.07	243.17	832.24																	
2488.00	46.0	377.00	230.61	607.61	477.15	259.43	736.58	589.07	288.26	877.33																	
2486.00	48.0	377.00	267.41	644.42	477.15	300.84	777.98	589.07	334.26	923.33																	
2484.00	50.0	377.00	304.84	681.85	477.15	342.95	820.10	589.07	381.06	970.12																	
2482.00	52.0	377.00	342.80	719.80	477.15	385.65	862.80	589.07	428.50	1017.57																	
2480.00	54.0	369.46	381.17	750.64	467.60	428.82	896.42	577.29	476.47	1053.75																	
2478.00	56.0	369.46	419.86	789.33	467.60	472.35	939.95	577.29	524.83	1102.12																	
2476.00	58.0	377.00	458.77	835.78	477.15	516.12	993.27	589.07	573.47	1162.54																	
2474.00	60.0	377.00	497.80	874.81	477.15	560.03	1037.17	589.07	622.25	1211.32																	
2472.00	62.0	377.00	536.86	913.86	477.15	603.97	1081.11	589.07	671.07	1260.14																	
2470.00	64.0	377.00	575.84	952.85	477.15	647.83	1124.97	589.07	719.81	1308.87																	
2468.00	66.0	377.00	614.67	991.67	477.15	691.50	1168.65	589.07	768.34	1357.41																	
2466.00	68.0	377.00	653.24	1030.25	477.15	734.90	1212.05	589.07	816.56	1405.62																	
2464.00	70.0	377.00	691.48	1068.48	477.15	777.91	1255.06	589.07	864.35	1453.42																	
2462.00	72.0	377.00	729.28	1106.29	477.15	820.44	1297.59	589.07	911.60	1500.67																	
2460.00	74.0	377.00	766.57	1143.58	477.15	862.40	1339.54	589.07	958.22	1547.29																	
2458.00	76.0	377.00	803.27	1180.27	477.15	903.67	1380.82	589.07	1004.08	1593.15																	
2456.00	78.0	377.00	839.27	1216.28	477.15	944.18	1421.33	589.07	1049.09	1638.16																	
2454.00	80.0	377.00	874.51	1251.52	477.15	983.83	1460.97	589.07	1093.14	1682.21																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #8)
0
500
1000
1500
2000
0
10
20
30
40
50
60
70
80
90
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX L

Mullins Landfill Bridge

Pier #9

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #9

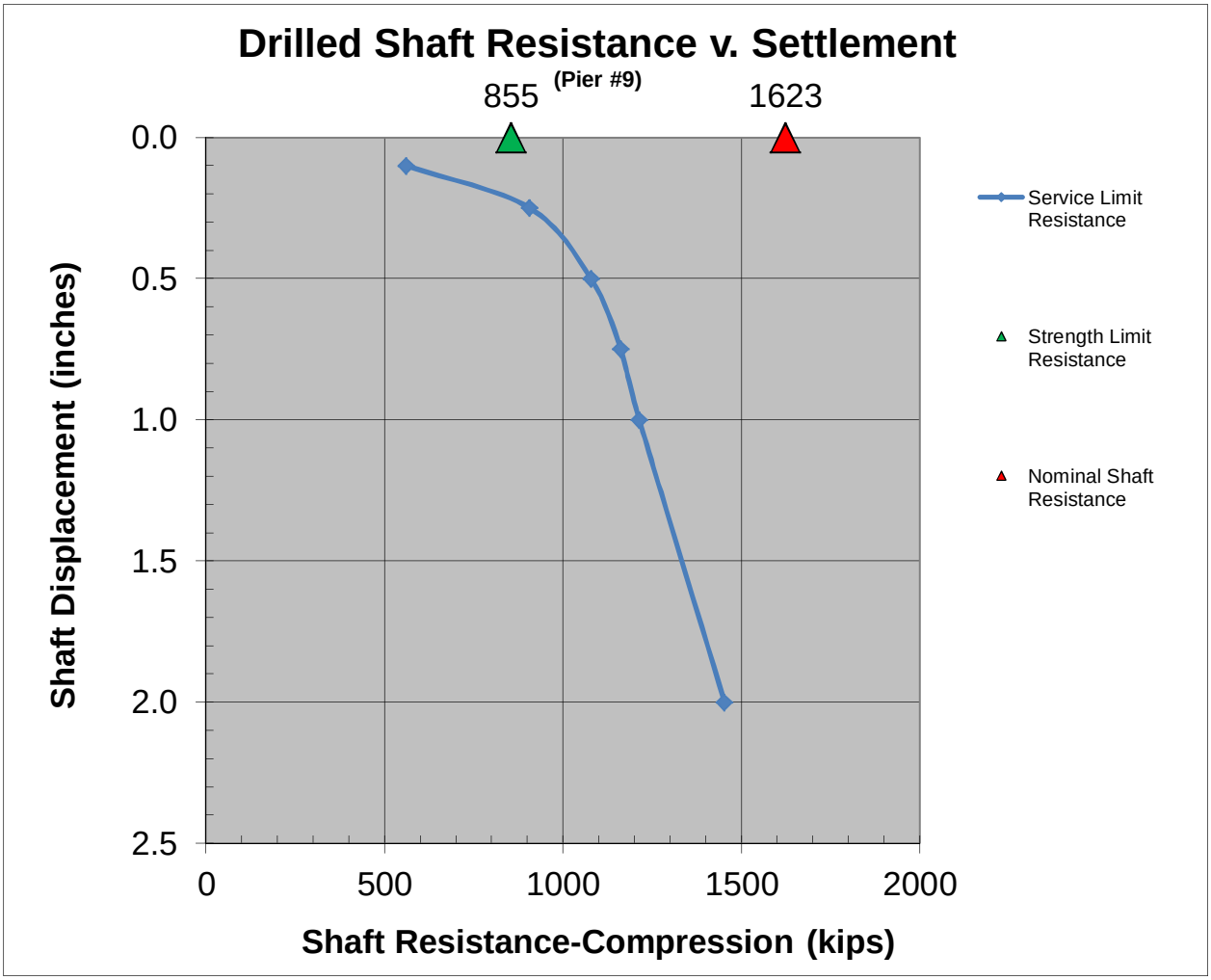
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	62	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	561.4
2	0.25	906.5
3	0.50	1078.4
4	0.75	1162.0
5	1.00	1214.1
6	2.00	1452.9

Strength Limit Resistance Kips	Nominal Resistance Kips
855	1623



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #9

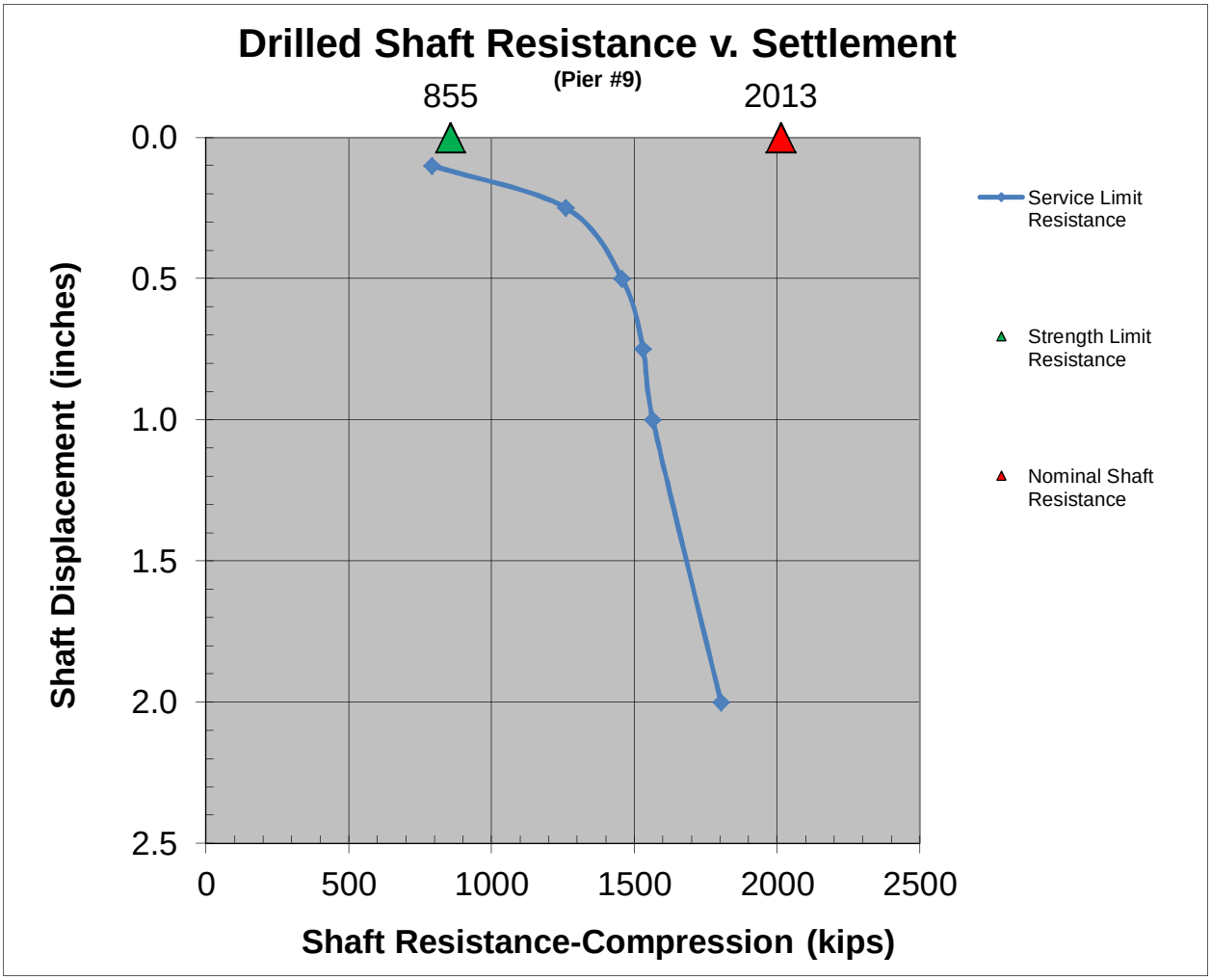
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	74	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	792.2
2	0.25	1260.3
3	0.50	1457.4
4	0.75	1531.0
5	1.00	1564.9
6	2.00	1803.7

Strength Limit Resistance Kips	Nominal Resistance Kips
855	2013



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #9

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	62	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2534.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	2	32	42	67	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	40	65	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	2.0	30.0	10.0	25.0	33.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted for Redundant Design**				
Side Resistance-Compression	0.55	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #9

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	74	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2534.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	2	32	42	67	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	40	65	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	2.0	30.0	10.0	25.0	33.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted Without Redundant Design**				
Side Resistance-Compression	0.44	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

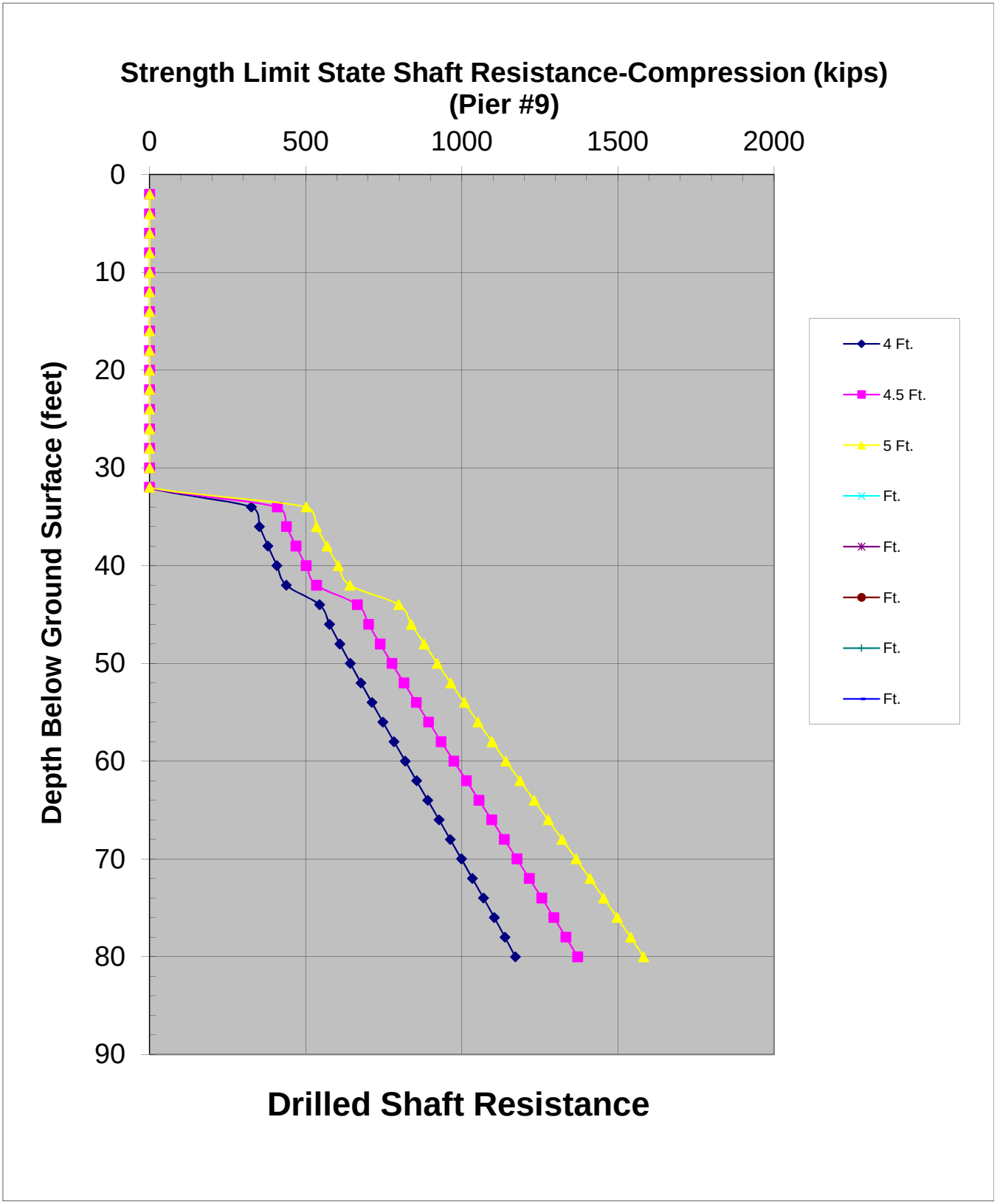
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2532.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2530.00	4.0	0.0		70.0	310.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2528.00	6.0	0.0		70.0	450.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2526.00	8.0	0.0		70.0	590.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2524.00	10.0	0.0		70.0	730.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2522.00	12.0	0.0		70.0	870.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2520.00	14.0	0.0		70.0	1010.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2518.00	16.0	0.0		70.0	1150.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2516.00	18.0	0.0		70.0	1290.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2514.00	20.0	0.0		70.0	1430.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2512.00	22.0	0.0		70.0	1570.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2510.00	24.0	0.0		70.0	1710.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2508.00	26.0	0.0		70.0	1850.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2506.00	28.0	0.0		70.0	1990.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2504.00	30.0	0.0		70.0	2130.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2502.00	32.0	0.0		70.0	2270.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2500.00	34.0	40.0		125.0	2465.0	0.71		1.76	0.55	0.45	0.50	48.0	48.0	48.0					
2498.00	36.0	40.0		125.0	2715.0	0.69		1.87	0.55	0.45	0.50	48.0	48.0	48.0					
2496.00	38.0	40.0		125.0	2965.0	0.67		1.98	0.55	0.45	0.50	48.0	48.0	48.0					
2494.00	40.0	40.0		125.0	3215.0	0.65		2.08	0.55	0.45	0.50	48.0	48.0	48.0					
2492.00	42.0	40.0		125.0	3465.0	0.63		2.17	0.55	0.45	0.50	48.0	48.0	48.0					
2490.00	44.0	65.0		125.0	3715.0	0.60		2.25	0.55	0.45	0.50	60.0	60.0	60.0					
2488.00	46.0	65.0		125.0	3965.0	0.58		2.32	0.55	0.45	0.50	60.0	60.0	60.0					
2486.00	48.0	65.0		125.0	4215.0	0.56		2.38	0.55	0.45	0.50	60.0	60.0	60.0					
2484.00	50.0	65.0		125.0	4465.0	0.55		2.44	0.55	0.45	0.50	60.0	60.0	60.0					
2482.00	52.0	65.0		125.0	4715.0	0.53		2.48	0.55	0.45	0.50	60.0	60.0	60.0					
2480.00	54.0	65.0		125.0	4965.0	0.51		2.52	0.55	0.45	0.50	60.0	60.0	60.0					
2478.00	56.0	65.0		125.0	5215.0	0.49		2.55	0.55	0.45	0.50	60.0	60.0	60.0					
2476.00	58.0	65.0		125.0	5465.0	0.47		2.58	0.55	0.45	0.50	60.0	60.0	60.0					
2474.00	60.0	65.0		125.0	5715.0	0.45		2.60	0.55	0.45	0.50	60.0	60.0	60.0					
2472.00	62.0	65.0		125.0	5965.0	0.44		2.61	0.55	0.45	0.50	60.0	60.0	60.0					
2470.00	64.0	65.0		125.0	6215.0	0.42		2.61	0.55	0.45	0.50	60.0	60.0	60.0					
2468.00	66.0	65.0		125.0	6465.0	0.40		2.61	0.55	0.45	0.50	60.0	60.0	60.0					
2466.00	68.0	75.0		130.0	6720.0	0.39		2.60	0.55	0.45	0.50	60.0	60.0	60.0					
2464.00	70.0	75.0		130.0	6980.0	0.37		2.59	0.55	0.45	0.50	60.0	60.0	60.0					
2462.00	72.0	75.0		130.0	7240.0	0.35		2.57	0.55	0.45	0.50	60.0	60.0	60.0					
2460.00	74.0	75.0		130.0	7500.0	0.34		2.54	0.55	0.45	0.50	60.0	60.0	60.0					
2458.00	76.0	75.0		130.0	7760.0	0.32		2.51	0.55	0.45	0.50	60.0	60.0	60.0					
2456.00	78.0	75.0		130.0	8020.0	0.31		2.47	0.55	0.45	0.50	60.0	60.0	60.0					
2454.00	80.0	75.0		130.0	8280.0	0.29		2.42	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2532.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2530.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2528.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2526.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2524.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2522.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2520.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2518.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2516.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2514.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2512.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2510.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2508.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2506.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2504.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2502.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2500.00	34.0	301.60	24.29	325.89	381.72	27.33	409.04	471.26	30.36	501.62																	
2498.00	36.0	301.60	50.19	351.79	381.72	56.46	438.18	471.26	62.73	533.99																	
2496.00	38.0	301.60	77.56	379.16	381.72	87.25	468.97	471.26	96.95	568.20																	
2494.00	40.0	301.60	106.27	407.88	381.72	119.56	501.28	471.26	132.84	604.10																	
2492.00	42.0	301.60	136.22	437.82	381.72	153.24	534.96	471.26	170.27	641.52																	
2490.00	44.0	377.00	167.26	544.26	477.15	188.17	665.31	589.07	209.08	798.14																	
2488.00	46.0	377.00	199.29	576.29	477.15	224.20	701.35	589.07	249.11	838.18																	
2486.00	48.0	377.00	232.19	609.20	477.15	261.22	738.36	589.07	290.24	879.31																	
2484.00	50.0	377.00	265.86	642.86	477.15	299.09	776.23	589.07	332.32	921.39																	
2482.00	52.0	377.00	300.17	677.18	477.15	337.69	814.84	589.07	375.22	964.28																	
2480.00	54.0	377.00	335.04	712.04	477.15	376.91	854.06	589.07	418.79	1007.86																	
2478.00	56.0	377.00	370.34	747.35	477.15	416.63	893.78	589.07	462.93	1052.00																	
2476.00	58.0	377.00	405.99	782.99	477.15	456.74	933.88	589.07	507.49	1096.55																	
2474.00	60.0	377.00	441.88	818.88	477.15	497.11	974.26	589.07	552.35	1141.42																	
2472.00	62.0	377.00	477.91	854.92	477.15	537.65	1014.80	589.07	597.39	1186.46																	
2470.00	64.0	377.00	514.00	891.00	477.15	578.25	1055.39	589.07	642.50	1231.56																	
2468.00	66.0	377.00	550.03	927.04	477.15	618.79	1095.93	589.07	687.54	1276.61																	
2466.00	68.0	377.00	585.96	962.97	477.15	659.21	1136.35	589.07	732.45	1321.52																	
2464.00	70.0	377.00	621.71	998.72	477.15	699.43	1176.57	589.07	777.14	1366.21																	
2462.00	72.0	377.00	657.19	1034.19	477.15	739.34	1216.48	589.07	821.49	1410.56																	
2460.00	74.0	377.00	692.30	1069.31	477.15	778.84	1255.99	589.07	865.38	1454.45																	
2458.00	76.0	377.00	726.96	1103.97	477.15	817.83	1294.98	589.07	908.70	1497.77																	
2456.00	78.0	377.00	761.08	1138.08	477.15	856.21	1333.36	589.07	951.35	1540.41																	
2454.00	80.0	377.00	794.56	1171.56	477.15	893.88	1371.02	589.07	993.20	1582.27																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #9)
0
500
1000
1500
2000
0
10
20
30
40
50
60
70
80
90
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX M

Mullins Landfill Bridge

Pier #10

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #10

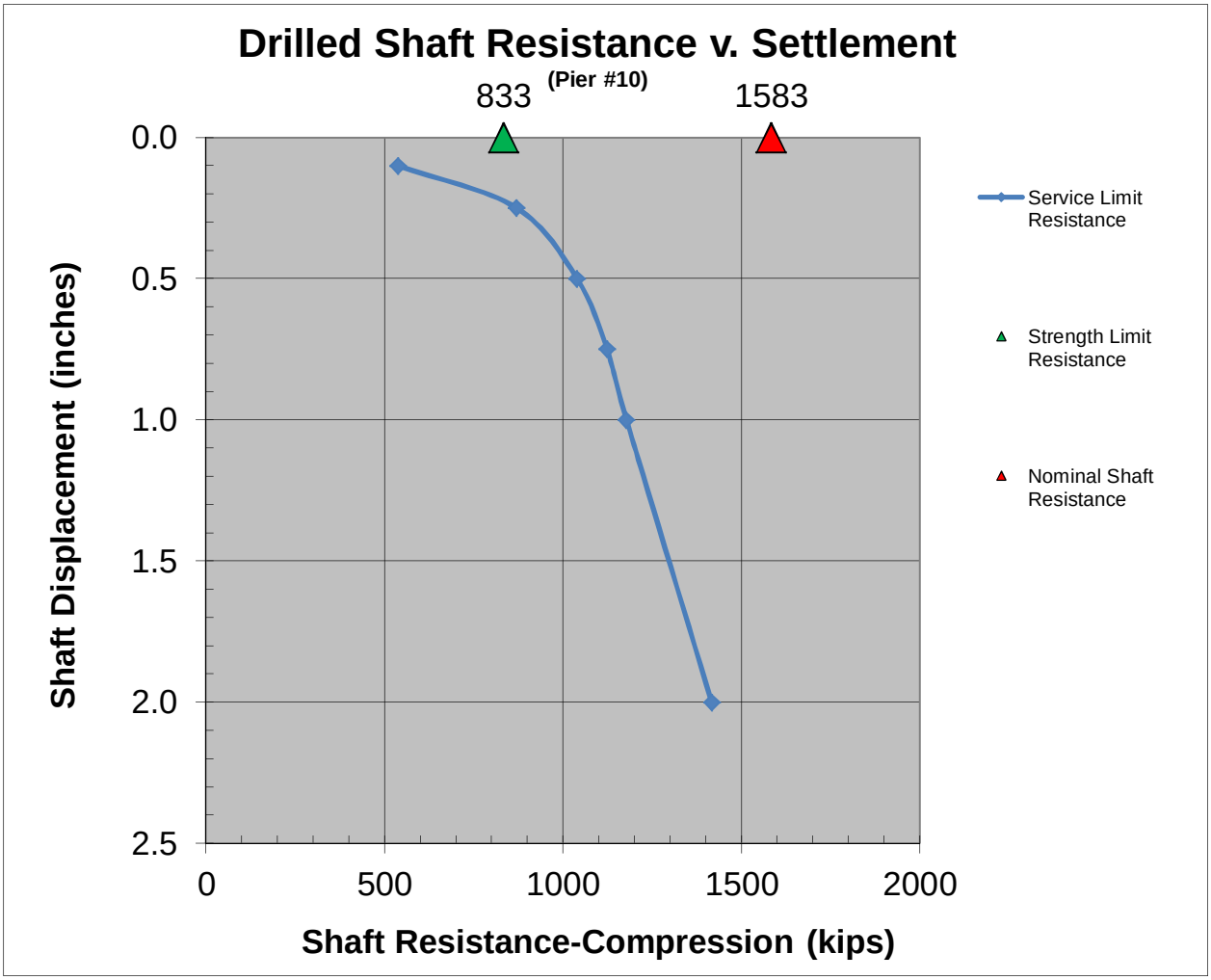
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	60	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	537.6
2	0.25	870.1
3	0.50	1039.4
4	0.75	1124.0
5	1.00	1178.0
6	2.00	1416.8

Strength Limit Resistance Kips	Nominal Resistance Kips
833	1583



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #10

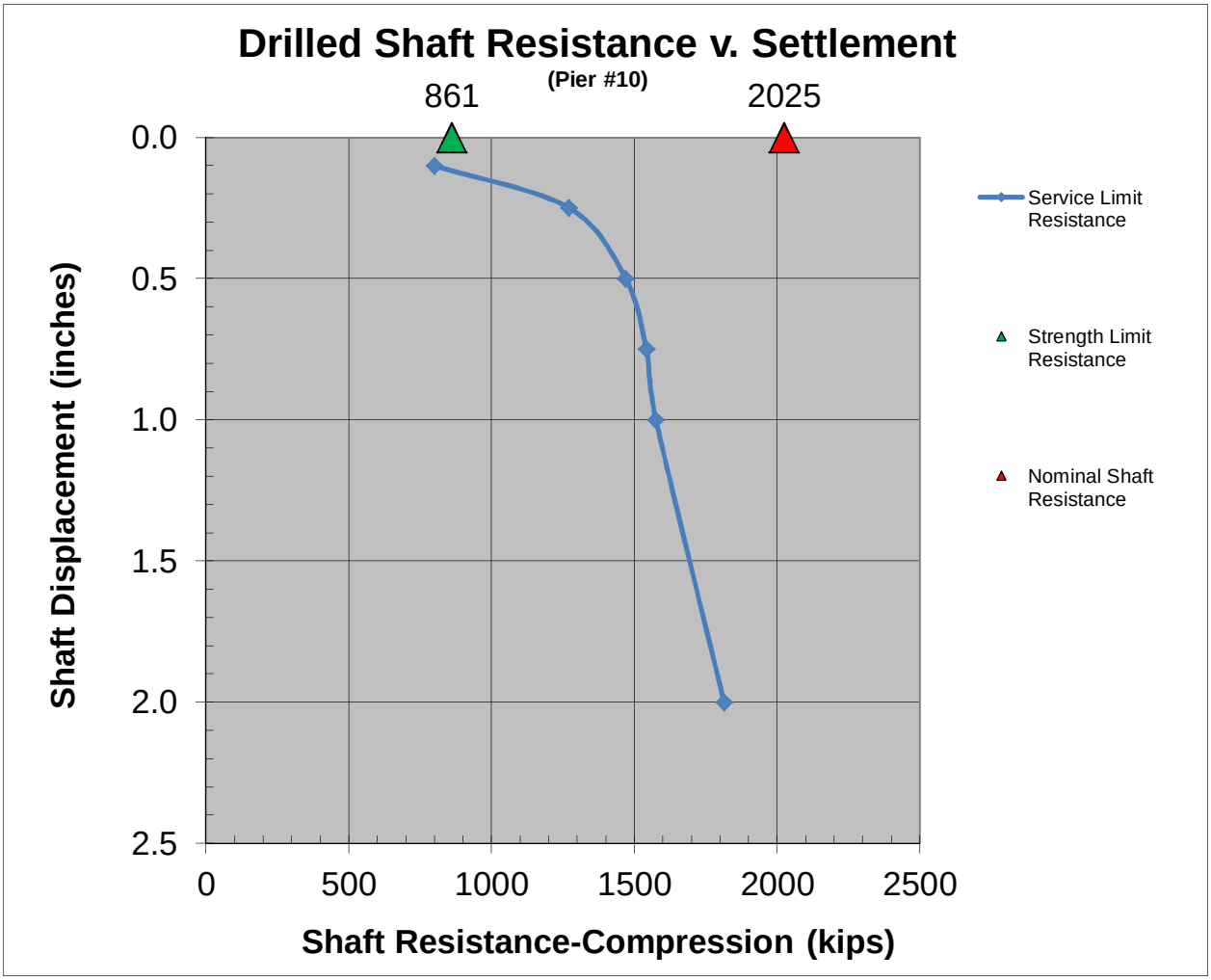
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	72	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	799.4
2	0.25	1271.4
3	0.50	1469.2
4	0.75	1542.5
5	1.00	1575.8
6	2.00	1814.6

Strength Limit Resistance Kips	Nominal Resistance Kips
861	2025



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #10

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	60	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	7	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2535.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5	6	7
Depth from Ground Surface	2	31	42	52	62	67	100
Unit Weight of Layer (γ) pcf	120	70	125	125	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	13	67	75	65	75
Cohesion "**c**" of Layer (ksf)							
Thickness of layer (ft)	2.0	29.0	11.0	10.0	10.0	5.0	33.0
Soil Type	Sand	Sand	Sand	Sand	Sand		

Strength Resistance Factors — **Analyses Conducted for Redundant Design**

Side Resistance-Compression	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #10

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	72	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	7	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2535.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5	6	7
Depth from Ground Surface	2	31	42	52	62	67	100
Unit Weight of Layer (γ) pcf	120	70	125	125	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	13	67	75	65	75
Cohesion "**c**" of Layer (ksf)							
Thickness of layer (ft)	2.0	29.0	11.0	10.0	10.0	5.0	33.0
Soil Type	Sand	Sand	Sand	Sand	Sand		

Strength Resistance Factors — **Analyses Conducted Without Redundant Design**

Side Resistance-Compression	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

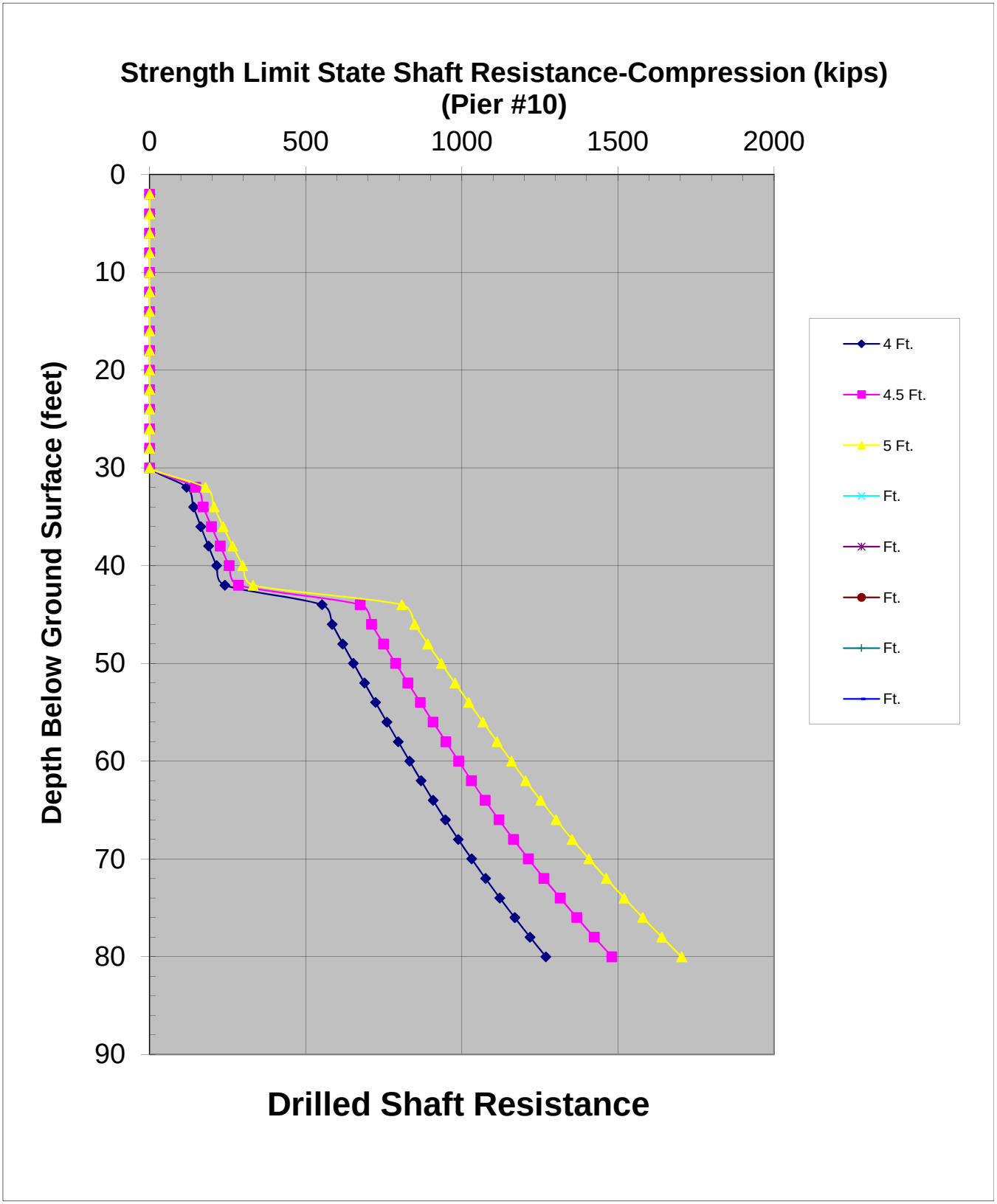
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2533.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2531.00	4.0	0.0		70.0	310.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2529.00	6.0	0.0		70.0	450.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2527.00	8.0	0.0		70.0	590.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2525.00	10.0	0.0		70.0	730.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2523.00	12.0	0.0		70.0	870.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2521.00	14.0	0.0		70.0	1010.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2519.00	16.0	0.0		70.0	1150.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2517.00	18.0	0.0		70.0	1290.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2515.00	20.0	0.0		70.0	1430.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2513.00	22.0	0.0		70.0	1570.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2511.00	24.0	0.0		70.0	1710.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2509.00	26.0	0.0		70.0	1850.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2507.00	28.0	0.0		70.0	1990.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2505.00	30.0	0.0		70.0	2130.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2503.00	32.0	13.0		125.0	2325.0	0.64		1.48	0.55	0.45	0.50	15.6	15.6	15.6					
2501.00	34.0	13.0		125.0	2575.0	0.62		1.59	0.55	0.45	0.50	15.6	15.6	15.6					
2499.00	36.0	13.0		125.0	2825.0	0.60		1.69	0.55	0.45	0.50	15.6	15.6	15.6					
2497.00	38.0	13.0		125.0	3075.0	0.58		1.78	0.55	0.45	0.50	15.6	15.6	15.6					
2495.00	40.0	13.0		125.0	3325.0	0.56		1.86	0.55	0.45	0.50	15.6	15.6	15.6					
2493.00	42.0	13.0		125.0	3575.0	0.54		1.94	0.55	0.45	0.50	15.6	15.6	15.6					
2491.00	44.0	67.0		125.0	3825.0	0.60		2.31	0.55	0.45	0.50	60.0	60.0	60.0					
2489.00	46.0	67.0		125.0	4075.0	0.58		2.38	0.55	0.45	0.50	60.0	60.0	60.0					
2487.00	48.0	67.0		125.0	4325.0	0.56		2.44	0.55	0.45	0.50	60.0	60.0	60.0					
2485.00	50.0	67.0		125.0	4575.0	0.55		2.50	0.55	0.45	0.50	60.0	60.0	60.0					
2483.00	52.0	67.0		125.0	4825.0	0.53		2.54	0.55	0.45	0.50	60.0	60.0	60.0					
2481.00	54.0	75.0		125.0	5075.0	0.51		2.58	0.55	0.45	0.50	60.0	60.0	60.0					
2479.00	56.0	75.0		125.0	5325.0	0.49		2.61	0.55	0.45	0.50	60.0	60.0	60.0					
2477.00	58.0	75.0		125.0	5575.0	0.47		2.63	0.55	0.45	0.50	60.0	60.0	60.0					
2475.00	60.0	75.0		125.0	5825.0	0.45		2.65	0.55	0.45	0.50	60.0	60.0	60.0					
2473.00	62.0	75.0		125.0	6075.0	0.44		2.65	0.55	0.45	0.50	60.0	60.0	60.0					
2471.00	64.0	65.0		125.0	6325.0	0.44		2.76	0.55	0.45	0.50	60.0	60.0	60.0					
2469.00	66.0	65.0		125.0	6575.0	0.44		2.87	0.55	0.45	0.50	60.0	60.0	60.0					
2467.00	68.0	75.0		130.0	6830.0	0.44		2.98	0.55	0.45	0.50	60.0	60.0	60.0					
2465.00	70.0	75.0		130.0	7090.0	0.44		3.10	0.55	0.45	0.50	60.0	60.0	60.0					
2463.00	72.0	75.0		130.0	7350.0	0.44		3.21	0.55	0.45	0.50	60.0	60.0	60.0					
2461.00	74.0	75.0		130.0	7610.0	0.44		3.33	0.55	0.45	0.50	60.0	60.0	60.0					
2459.00	76.0	75.0		130.0	7870.0	0.44		3.44	0.55	0.45	0.50	60.0	60.0	60.0					
2457.00	78.0	75.0		130.0	8130.0	0.44		3.55	0.55	0.45	0.50	60.0	60.0	60.0					
2455.00	80.0	75.0		130.0	8390.0	0.44		3.67	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2533.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2531.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2529.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2527.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2525.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2523.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2521.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2519.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2517.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2515.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2513.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2511.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2509.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2507.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2505.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2503.00	32.0	98.02	20.51	118.53	124.06	23.07	147.13	153.16	25.64	178.80																	
2501.00	34.0	98.02	42.50	140.52	124.06	47.81	171.87	153.16	53.12	206.28																	
2499.00	36.0	98.02	65.85	163.87	124.06	74.08	198.14	153.16	82.32	235.47																	
2497.00	38.0	98.02	90.45	188.48	124.06	101.76	225.82	153.16	113.07	266.23																	
2495.00	40.0	98.02	116.19	214.22	124.06	130.72	254.78	153.16	145.24	298.40																	
2493.00	42.0	98.02	142.97	240.99	124.06	160.84	284.90	153.16	178.71	331.87																	
2491.00	44.0	377.00	174.93	551.94	477.15	196.80	673.94	589.07	218.66	807.73																	
2489.00	46.0	377.00	207.85	584.85	477.15	233.83	710.98	589.07	259.81	848.88																	
2487.00	48.0	377.00	241.61	618.61	477.15	271.81	748.96	589.07	302.01	891.08																	
2485.00	50.0	377.00	276.10	653.11	477.15	310.62	787.76	589.07	345.13	934.20																	
2483.00	52.0	377.00	311.22	688.22	477.15	350.12	827.27	589.07	389.03	978.09																	
2481.00	54.0	377.00	346.86	723.86	477.15	390.21	867.36	589.07	433.57	1022.64																	
2479.00	56.0	377.00	382.91	759.91	477.15	430.77	907.92	589.07	478.63	1067.70																	
2477.00	58.0	377.00	419.27	796.28	477.15	471.68	948.83	589.07	524.09	1113.16																	
2475.00	60.0	377.00	455.85	832.86	477.15	512.83	989.98	589.07	569.82	1158.88																	
2473.00	62.0	377.00	492.55	869.56	477.15	554.12	1031.27	589.07	615.69	1204.76																	
2471.00	64.0	377.00	530.76	907.76	477.15	597.11	1074.25	589.07	663.45	1252.52																	
2469.00	66.0	377.00	570.48	947.48	477.15	641.79	1118.94	589.07	713.10	1302.17																	
2467.00	68.0	377.00	611.74	988.74	477.15	688.21	1165.35	589.07	764.67	1353.74																	
2465.00	70.0	377.00	654.57	1031.57	477.15	736.39	1213.54	589.07	818.21	1407.28																	
2463.00	72.0	377.00	698.97	1075.98	477.15	786.34	1263.49	589.07	873.71	1462.78																	
2461.00	74.0	377.00	744.94	1121.95	477.15	838.06	1315.21	589.07	931.18	1520.25																	
2459.00	76.0	377.00	792.49	1169.49	477.15	891.55	1368.69	589.07	990.61	1579.68																	
2457.00	78.0	377.00	841.60	1218.60	477.15	946.80	1423.94	589.07	1052.00	1641.07																	
2455.00	80.0	377.00	892.28	1269.29	477.15	1003.82	1480.96	589.07	1115.35	1704.42																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #10)
0
500
1000
1500
2000
0
10
20
30
40
50
60
70
80
90
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX N

Mullins Landfill Bridge

Pier #11

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #11

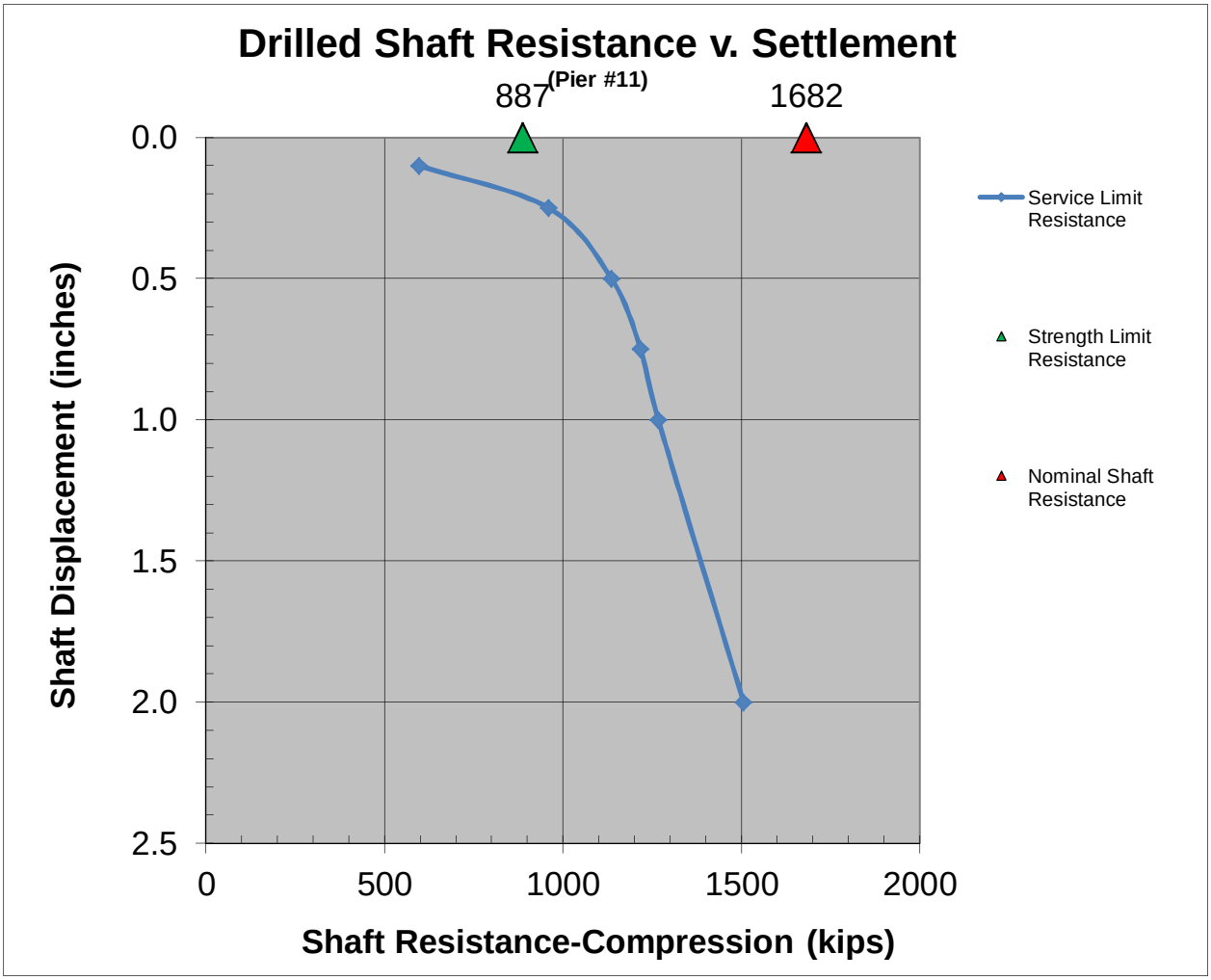
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	66	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	596.4
2	0.25	960.2
3	0.50	1135.8
4	0.75	1217.9
5	1.00	1267.3
6	2.00	1506.1

Strength Limit Resistance Kips	Nominal Resistance Kips
887	1682



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #11

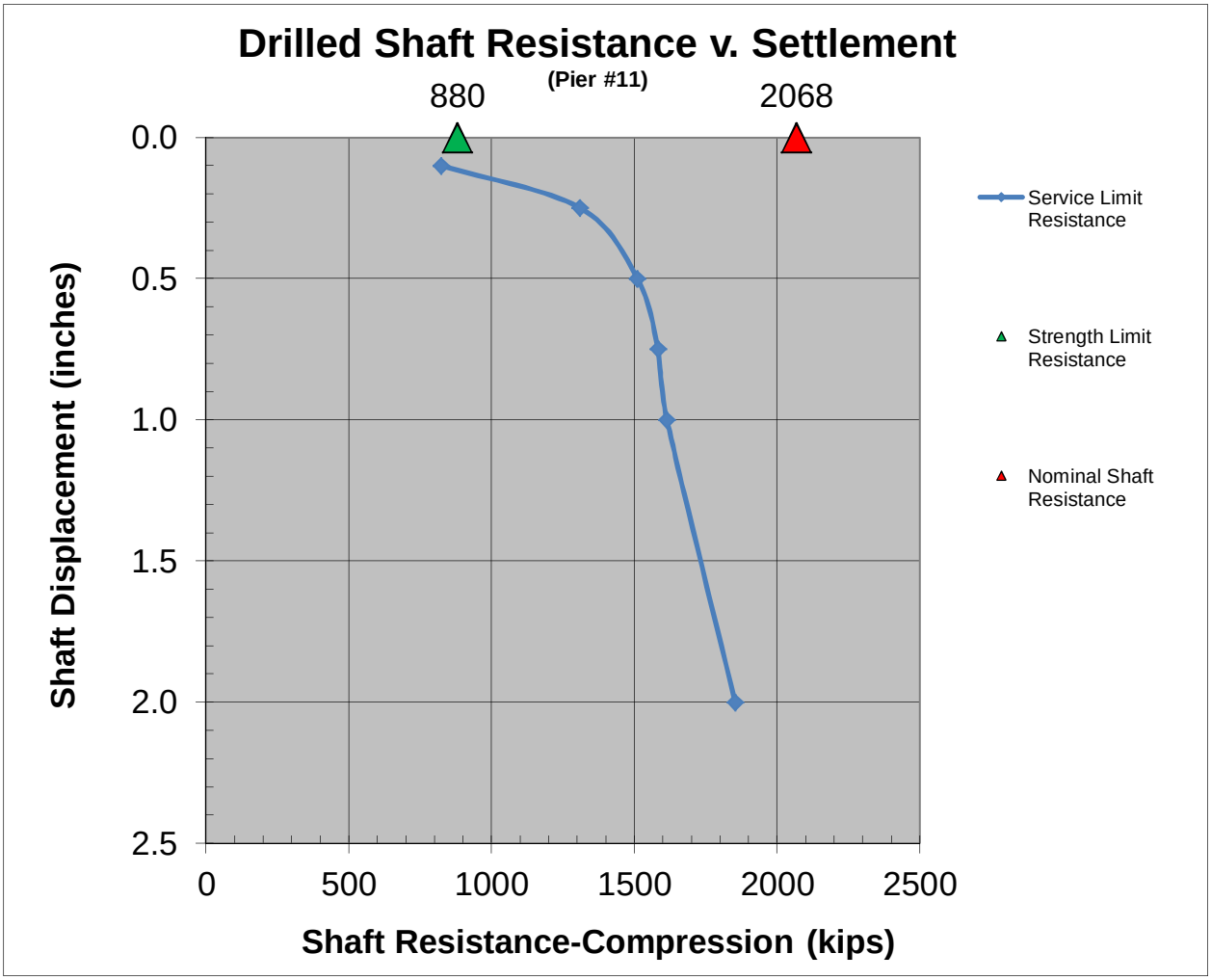
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	78	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	824.9
2	0.25	1310.3
3	0.50	1511.0
4	0.75	1583.1
5	1.00	1614.5
6	2.00	1853.3

Strength Limit Resistance Kips	Nominal Resistance Kips
880	2068



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #11

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	66	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	6	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2534.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5	6
Depth from Ground Surface	4	35	42	47	57	100
Unit Weight of Layer (γ) pcf	120	70	125	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	13	36	55	75
Cohesion "**c**" of Layer (ksf)						
Thickness of layer (ft)	4.0	31.0	7.0	5.0	10.0	43.0
Soil Type	Sand	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted for Redundant Design**

Side Resistance-Compression	0.55	0.55	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #11

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	80	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	78	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	6	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2534.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5	6
Depth from Ground Surface	4	35	42	47	57	100
Unit Weight of Layer (γ) pcf	120	70	125	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	13	36	55	75
Cohesion "**c**" of Layer (ksf)						
Thickness of layer (ft)	4.0	31.0	7.0	5.0	10.0	43.0
Soil Type	Sand	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted Without Redundant Design**

Side Resistance-Compression	0.44	0.44	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

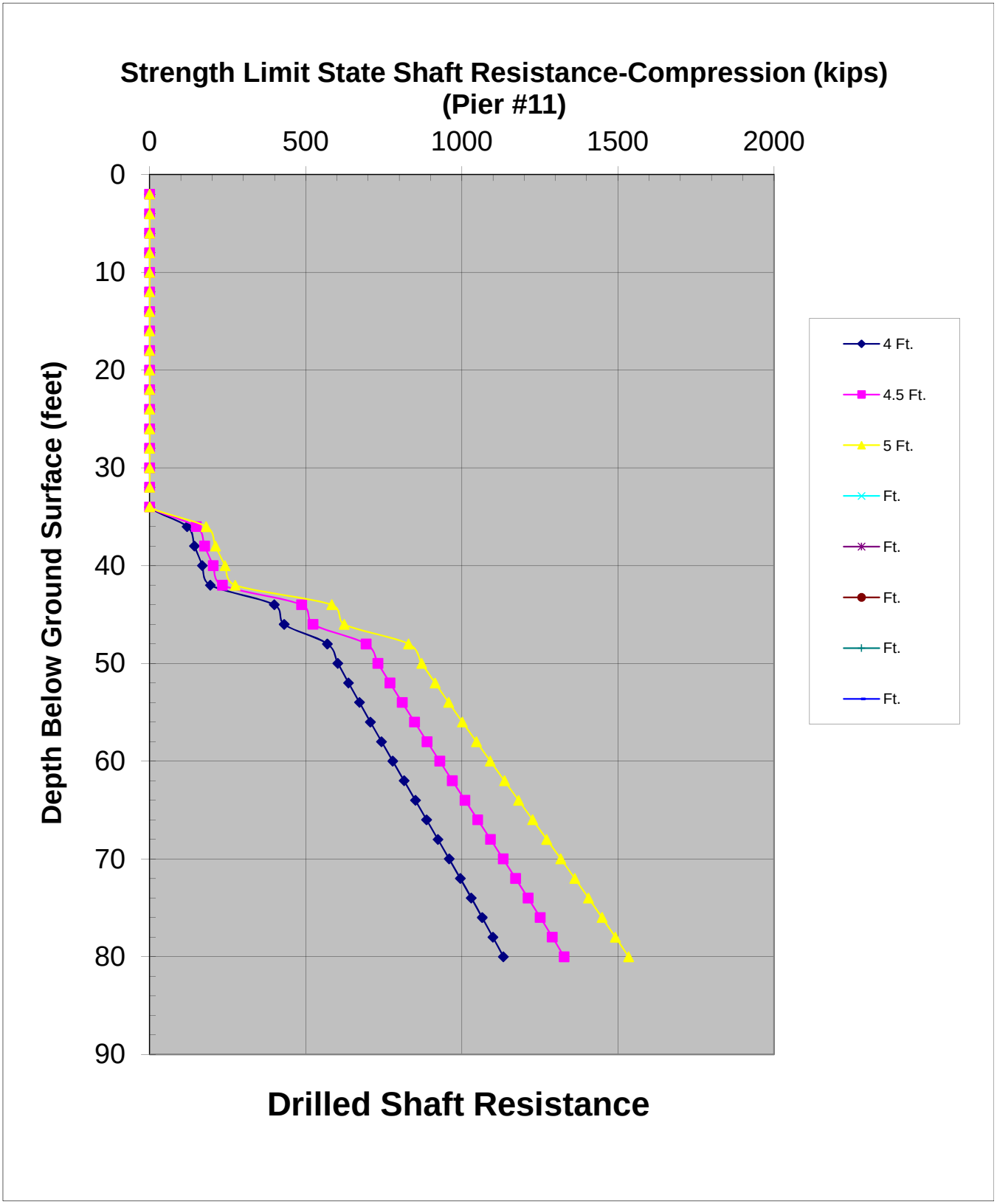
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2532.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2530.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2528.00	6.0	0.0		70.0	550.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2526.00	8.0	0.0		70.0	690.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2524.00	10.0	0.0		70.0	830.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2522.00	12.0	0.0		70.0	970.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2520.00	14.0	0.0		70.0	1110.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2518.00	16.0	0.0		70.0	1250.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2516.00	18.0	0.0		70.0	1390.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2514.00	20.0	0.0		70.0	1530.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2512.00	22.0	0.0		70.0	1670.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2510.00	24.0	0.0		70.0	1810.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2508.00	26.0	0.0		70.0	1950.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2506.00	28.0	0.0		70.0	2090.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2504.00	30.0	0.0		70.0	2230.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2502.00	32.0	0.0		70.0	2370.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2500.00	34.0	0.0		70.0	2510.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2498.00	36.0	13.0		125.0	2705.0	0.60		1.62	0.55	0.45	0.50	15.6	15.6	15.6					
2496.00	38.0	13.0		125.0	2955.0	0.58		1.71	0.55	0.45	0.50	15.6	15.6	15.6					
2494.00	40.0	13.0		125.0	3205.0	0.56		1.79	0.55	0.45	0.50	15.6	15.6	15.6					
2492.00	42.0	13.0		125.0	3455.0	0.54		1.87	0.55	0.45	0.50	15.6	15.6	15.6					
2490.00	44.0	36.0		125.0	3705.0	0.60		2.24	0.55	0.45	0.50	43.2	43.2	43.2					
2488.00	46.0	36.0		125.0	3955.0	0.58		2.31	0.55	0.45	0.50	43.2	43.2	43.2					
2486.00	48.0	55.0		125.0	4205.0	0.56		2.37	0.55	0.45	0.50	60.0	60.0	60.0					
2484.00	50.0	55.0		125.0	4455.0	0.55		2.43	0.55	0.45	0.50	60.0	60.0	60.0					
2482.00	52.0	55.0		125.0	4705.0	0.53		2.48	0.55	0.45	0.50	60.0	60.0	60.0					
2480.00	54.0	55.0		125.0	4955.0	0.51		2.52	0.55	0.45	0.50	60.0	60.0	60.0					
2478.00	56.0	55.0		125.0	5205.0	0.49		2.55	0.55	0.45	0.50	60.0	60.0	60.0					
2476.00	58.0	75.0		130.0	5460.0	0.47		2.58	0.55	0.45	0.50	60.0	60.0	60.0					
2474.00	60.0	75.0		130.0	5720.0	0.45		2.60	0.55	0.45	0.50	60.0	60.0	60.0					
2472.00	62.0	75.0		130.0	5980.0	0.44		2.61	0.55	0.45	0.50	60.0	60.0	60.0					
2470.00	64.0	75.0		130.0	6240.0	0.42		2.62	0.55	0.45	0.50	60.0	60.0	60.0					
2468.00	66.0	75.0		130.0	6500.0	0.40		2.62	0.55	0.45	0.50	60.0	60.0	60.0					
2466.00	68.0	75.0		130.0	6760.0	0.39		2.61	0.55	0.45	0.50	60.0	60.0	60.0					
2464.00	70.0	75.0		130.0	7020.0	0.37		2.60	0.55	0.45	0.50	60.0	60.0	60.0					
2462.00	72.0	75.0		130.0	7280.0	0.35		2.58	0.55	0.45	0.50	60.0	60.0	60.0					
2460.00	74.0	75.0		130.0	7540.0	0.34		2.55	0.55	0.45	0.50	60.0	60.0	60.0					
2458.00	76.0	75.0		130.0	7800.0	0.32		2.52	0.55	0.45	0.50	60.0	60.0	60.0					
2456.00	78.0	75.0		130.0	8060.0	0.31		2.48	0.55	0.45	0.50	60.0	60.0	60.0					
2454.00	80.0	75.0		130.0	8320.0	0.29		2.43	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2532.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2530.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2528.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2526.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2524.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2522.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2520.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2518.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2516.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2514.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2512.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2510.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2508.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2506.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2504.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2502.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2500.00	34.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2498.00	36.0	98.02	22.36	120.38	124.06	25.16	149.21	153.16	27.95	181.11																	
2496.00	38.0	98.02	46.00	144.02	124.06	51.75	175.81	153.16	57.50	210.66																	
2494.00	40.0	98.02	70.81	168.83	124.06	79.67	203.72	153.16	88.52	241.68																	
2492.00	42.0	98.02	96.69	194.71	124.06	108.77	232.83	153.16	120.86	274.02																	
2490.00	44.0	271.44	127.65	399.09	343.54	143.60	487.15	424.13	159.56	583.69																	
2488.00	46.0	271.44	159.60	431.04	343.54	179.55	523.09	424.13	199.50	623.63																	
2486.00	48.0	377.00	192.42	569.43	477.15	216.48	693.62	589.07	240.53	829.60																	
2484.00	50.0	377.00	226.01	603.01	477.15	254.26	731.41	589.07	282.51	871.58																	
2482.00	52.0	377.00	260.25	637.26	477.15	292.79	769.93	589.07	325.32	914.39																	
2480.00	54.0	377.00	295.05	672.05	477.15	331.93	809.07	589.07	368.81	957.88																	
2478.00	56.0	377.00	330.28	707.29	477.15	371.57	848.72	589.07	412.86	1001.92																	
2476.00	58.0	377.00	365.90	742.90	477.15	411.64	888.78	589.07	457.37	1046.44																	
2474.00	60.0	377.00	401.82	778.83	477.15	452.05	929.19	589.07	502.28	1091.35																	
2472.00	62.0	377.00	437.95	814.95	477.15	492.69	969.84	589.07	547.43	1136.50																	
2470.00	64.0	377.00	474.17	851.18	477.15	533.45	1010.59	589.07	592.72	1181.79																	
2468.00	66.0	377.00	510.41	887.41	477.15	574.21	1051.35	589.07	638.01	1227.08																	
2466.00	68.0	377.00	546.55	923.55	477.15	614.87	1092.01	589.07	683.19	1272.26																	
2464.00	70.0	377.00	582.50	959.51	477.15	655.32	1132.46	589.07	728.13	1317.20																	
2462.00	72.0	377.00	618.18	995.18	477.15	695.45	1172.60	589.07	772.72	1361.79																	
2460.00	74.0	377.00	653.48	1030.48	477.15	735.16	1212.31	589.07	816.85	1405.92																	
2458.00	76.0	377.00	688.32	1065.32	477.15	774.36	1251.50	589.07	860.40	1449.46																	
2456.00	78.0	377.00	722.60	1099.60	477.15	812.93	1290.07	589.07	903.25	1492.32																	
2454.00	80.0	377.00	756.24	1133.25	477.15	850.77	1327.92	589.07	945.31	1534.37																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #11)
0
500
1000
1500
2000
0
10
20
30
40
50
60
70
80
90
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX O

Mullins Landfill Bridge

Pier #12

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #12

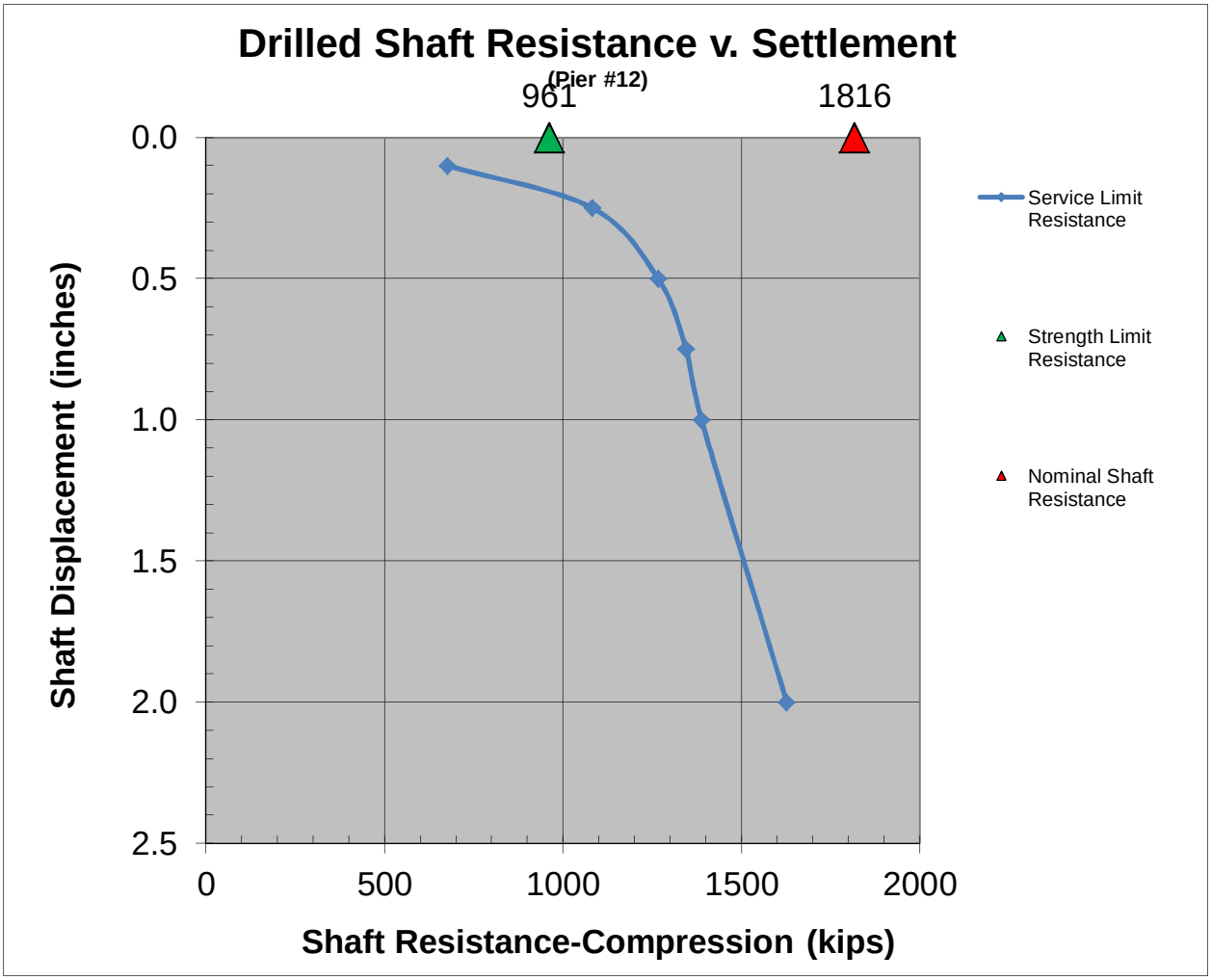
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	76	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	676.0
2	0.25	1082.2
3	0.50	1266.6
4	0.75	1345.2
5	1.00	1388.3
6	2.00	1627.1

Strength Limit Resistance Kips	Nominal Resistance Kips
961	1816



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #12

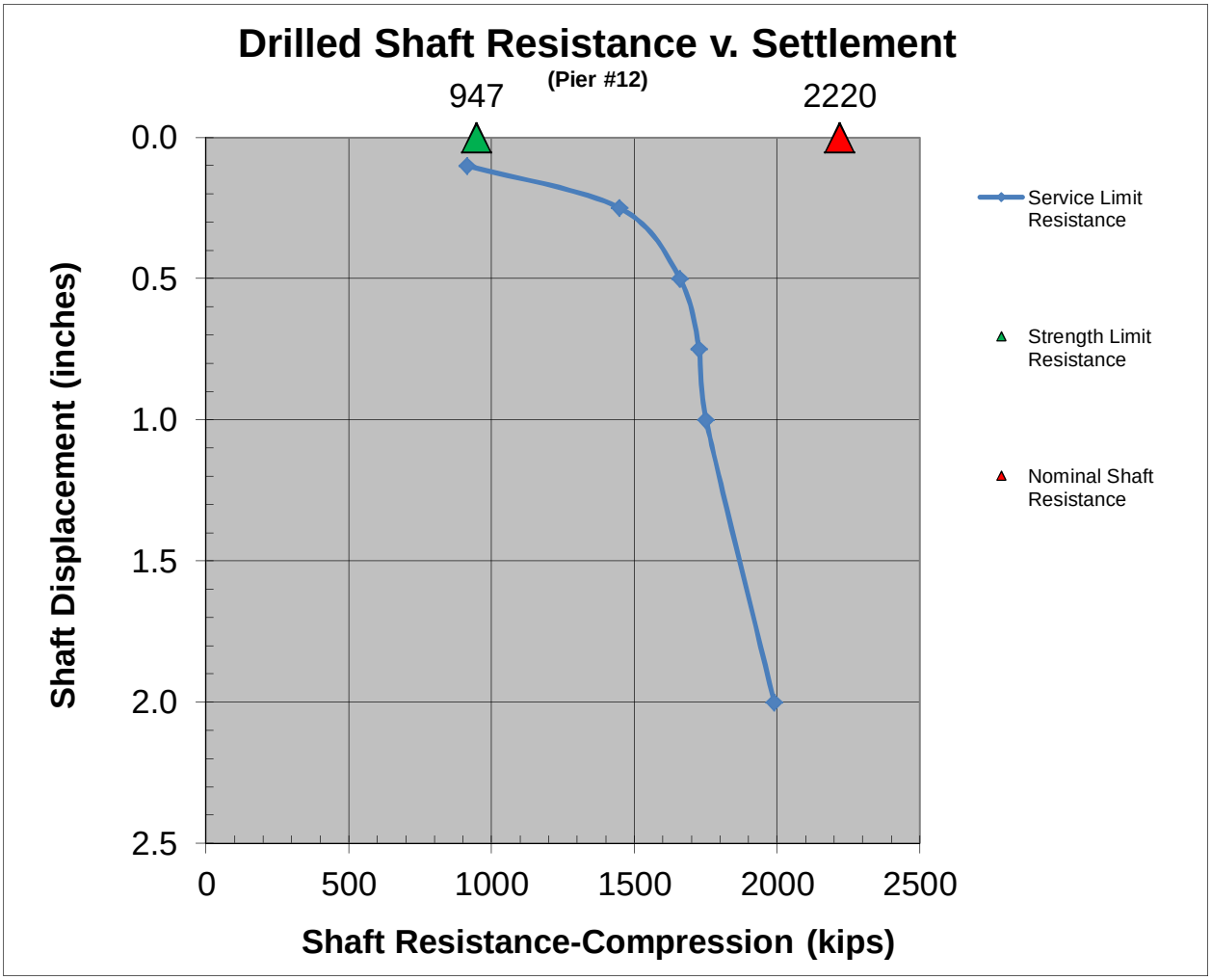
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	90	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	914.9
2	0.25	1448.4
3	0.50	1658.9
4	0.75	1727.1
5	1.00	1751.4
6	2.00	1990.2

Strength Limit Resistance Kips	Nominal Resistance Kips
947	2220



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #12

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	90	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	76	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	4	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2535.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4
Depth from Ground Surface	5	40	52	100
Unit Weight of Layer (γ) pcf	120	70	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	37	75
Cohesion "**c**" of Layer (ksf)				
Thickness of layer (ft)	5.0	35.0	12.0	48.0
Soil Type	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted for Redundant Design**

Side Resistance-Compression	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #12

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	90	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	90	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	4	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2535.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4
Depth from Ground Surface	5	40	52	100
Unit Weight of Layer (γ) pcf	120	70	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	37	75
Cohesion "**c**" of Layer (ksf)				
Thickness of layer (ft)	5.0	35.0	12.0	48.0
Soil Type	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted Without Redundant Design**

Side Resistance-Compression	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

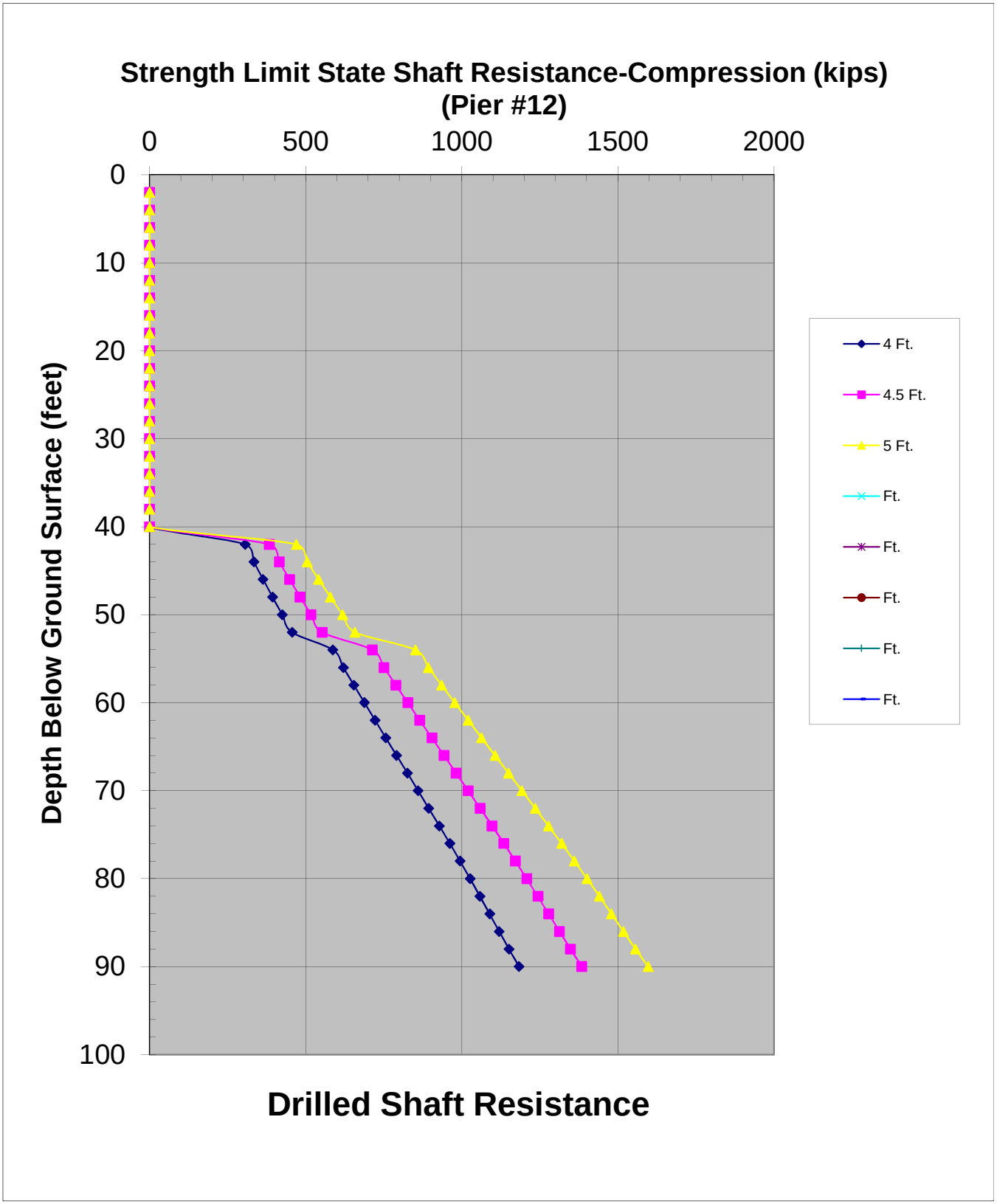
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2533.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2531.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2529.00	6.0	0.0		70.0	550.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2527.00	8.0	0.0		70.0	690.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2525.00	10.0	0.0		70.0	830.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2523.00	12.0	0.0		70.0	970.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2521.00	14.0	0.0		70.0	1110.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2519.00	16.0	0.0		70.0	1250.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2517.00	18.0	0.0		70.0	1390.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2515.00	20.0	0.0		70.0	1530.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2513.00	22.0	0.0		70.0	1670.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2511.00	24.0	0.0		70.0	1810.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2509.00	26.0	0.0		70.0	1950.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2507.00	28.0	0.0		70.0	2090.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2505.00	30.0	0.0		70.0	2230.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2503.00	32.0	0.0		70.0	2370.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2501.00	34.0	0.0		70.0	2510.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2499.00	36.0	0.0		70.0	2650.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2497.00	38.0	0.0		70.0	2790.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2495.00	40.0	0.0		70.0	2930.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2493.00	42.0	37.0		125.0	3125.0	0.63		1.95	0.55	0.45	0.50	44.4	44.4	44.4					
2491.00	44.0	37.0		125.0	3375.0	0.60		2.04	0.55	0.45	0.50	44.4	44.4	44.4					
2489.00	46.0	37.0		125.0	3625.0	0.58		2.12	0.55	0.45	0.50	44.4	44.4	44.4					
2487.00	48.0	37.0		125.0	3875.0	0.56		2.19	0.55	0.45	0.50	44.4	44.4	44.4					
2485.00	50.0	37.0		125.0	4125.0	0.55		2.25	0.55	0.45	0.50	44.4	44.4	44.4					
2483.00	52.0	37.0		125.0	4375.0	0.53		2.30	0.55	0.45	0.50	44.4	44.4	44.4					
2481.00	54.0	75.0		130.0	4630.0	0.51		2.35	0.55	0.45	0.50	60.0	60.0	60.0					
2479.00	56.0	75.0		130.0	4890.0	0.49		2.39	0.55	0.45	0.50	60.0	60.0	60.0					
2477.00	58.0	75.0		130.0	5150.0	0.47		2.43	0.55	0.45	0.50	60.0	60.0	60.0					
2475.00	60.0	75.0		130.0	5410.0	0.45		2.46	0.55	0.45	0.50	60.0	60.0	60.0					
2473.00	62.0	75.0		130.0	5670.0	0.44		2.48	0.55	0.45	0.50	60.0	60.0	60.0					
2471.00	64.0	75.0		130.0	5930.0	0.42		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2469.00	66.0	75.0		130.0	6190.0	0.40		2.50	0.55	0.45	0.50	60.0	60.0	60.0					
2467.00	68.0	75.0		130.0	6450.0	0.39		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2465.00	70.0	75.0		130.0	6710.0	0.37		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2463.00	72.0	75.0		130.0	6970.0	0.35		2.47	0.55	0.45	0.50	60.0	60.0	60.0					
2461.00	74.0	75.0		130.0	7230.0	0.34		2.45	0.55	0.45	0.50	60.0	60.0	60.0					
2459.00	76.0	75.0		130.0	7490.0	0.32		2.42	0.55	0.45	0.50	60.0	60.0	60.0					
2457.00	78.0	75.0		130.0	7750.0	0.31		2.38	0.55	0.45	0.50	60.0	60.0	60.0					
2455.00	80.0	75.0		130.0	8010.0	0.29		2.34	0.55	0.45	0.50	60.0	60.0	60.0					
2453.00	82.0	75.0		130.0	8270.0	0.28		2.30	0.55	0.45	0.50	60.0	60.0	60.0					
2451.00	84.0	75.0		130.0	8530.0	0.26		2.24	0.55	0.45	0.50	60.0	60.0	60.0					
2449.00	86.0	75.0		130.0	8790.0	0.25		2.20	0.55	0.45	0.50	60.0	60.0	60.0					
2447.00	88.0	75.0		130.0	9050.0	0.25		2.26	0.55	0.45	0.50	60.0	60.0	60.0					
2445.00	90.0	75.0		130.0	9310.0	0.25		2.33	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2533.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2531.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2529.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2527.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2525.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2523.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2521.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2519.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2517.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2515.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2513.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2511.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2509.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2507.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2505.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2503.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2501.00	34.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2499.00	36.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2497.00	38.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2495.00	40.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2493.00	42.0	278.98	27.00	305.99	353.09	30.38	383.47	435.91	33.75	469.67																	
2491.00	44.0	278.98	55.21	334.19	353.09	62.11	415.19	435.91	69.01	504.92																	
2489.00	46.0	278.98	84.49	363.47	353.09	95.05	448.14	435.91	105.61	541.52																	
2487.00	48.0	278.98	114.74	393.72	353.09	129.08	482.17	435.91	143.42	579.33																	
2485.00	50.0	278.98	145.84	424.82	353.09	164.07	517.16	435.91	182.30	618.21																	
2483.00	52.0	278.98	177.68	456.66	353.09	199.89	552.98	435.91	222.10	658.01																	
2481.00	54.0	377.00	210.19	587.19	477.15	236.46	713.61	589.07	262.74	851.81																	
2479.00	56.0	377.00	243.30	620.30	477.15	273.71	750.85	589.07	304.12	893.19																	
2477.00	58.0	377.00	276.89	653.89	477.15	311.50	788.65	589.07	346.11	935.18																	
2475.00	60.0	377.00	310.86	687.87	477.15	349.72	826.87	589.07	388.58	977.65																	
2473.00	62.0	377.00	345.12	722.12	477.15	388.26	865.40	589.07	431.39	1020.46																	
2471.00	64.0	377.00	379.54	756.55	477.15	426.99	904.13	589.07	474.43	1063.50																	
2469.00	66.0	377.00	414.05	791.05	477.15	465.81	942.95	589.07	517.56	1106.63																	
2467.00	68.0	377.00	448.53	825.54	477.15	504.60	981.75	589.07	560.67	1149.74																	
2465.00	70.0	377.00	482.90	859.91	477.15	543.26	1020.41	589.07	603.63	1192.70																	
2463.00	72.0	377.00	517.06	894.06	477.15	581.69	1058.83	589.07	646.32	1235.39																	
2461.00	74.0	377.00	550.91	927.91	477.15	619.77	1096.91	589.07	688.63	1277.70																	
2459.00	76.0	377.00	584.36	961.36	477.15	657.40	1134.55	589.07	730.45	1319.52																	
2457.00	78.0	377.00	617.32	994.33	477.15	694.49	1171.64	589.07	771.65	1360.72																	
2455.00	80.0	377.00	649.71	1026.72	477.15	730.93	1208.07	589.07	812.14	1401.21																	
2453.00	82.0	377.00	681.44	1058.44	477.15	766.62	1243.77	589.07	851.80	1440.87																	
2451.00	84.0	377.00	712.42	1089.42	477.15	801.47	1278.61	589.07	890.52	1479.59																	
2449.00	86.0	377.00	742.79	1119.80	477.15	835.64	1312.79	589.07	928.49	1517.56																	
2447.00	88.0	377.00	774.07	1151.07	477.15	870.83	1347.97	589.07	967.59	1556.66																	
2445.00	90.0	377.00	806.24	1183.25	477.15	907.02	1384.17	589.07	1007.80	1596.87																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #12)
0
500
1000
1500
2000
0
10
20
30
40
50
60
70
80
90
100
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX P

Mullins Landfill Bridge

Pier #13

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #13

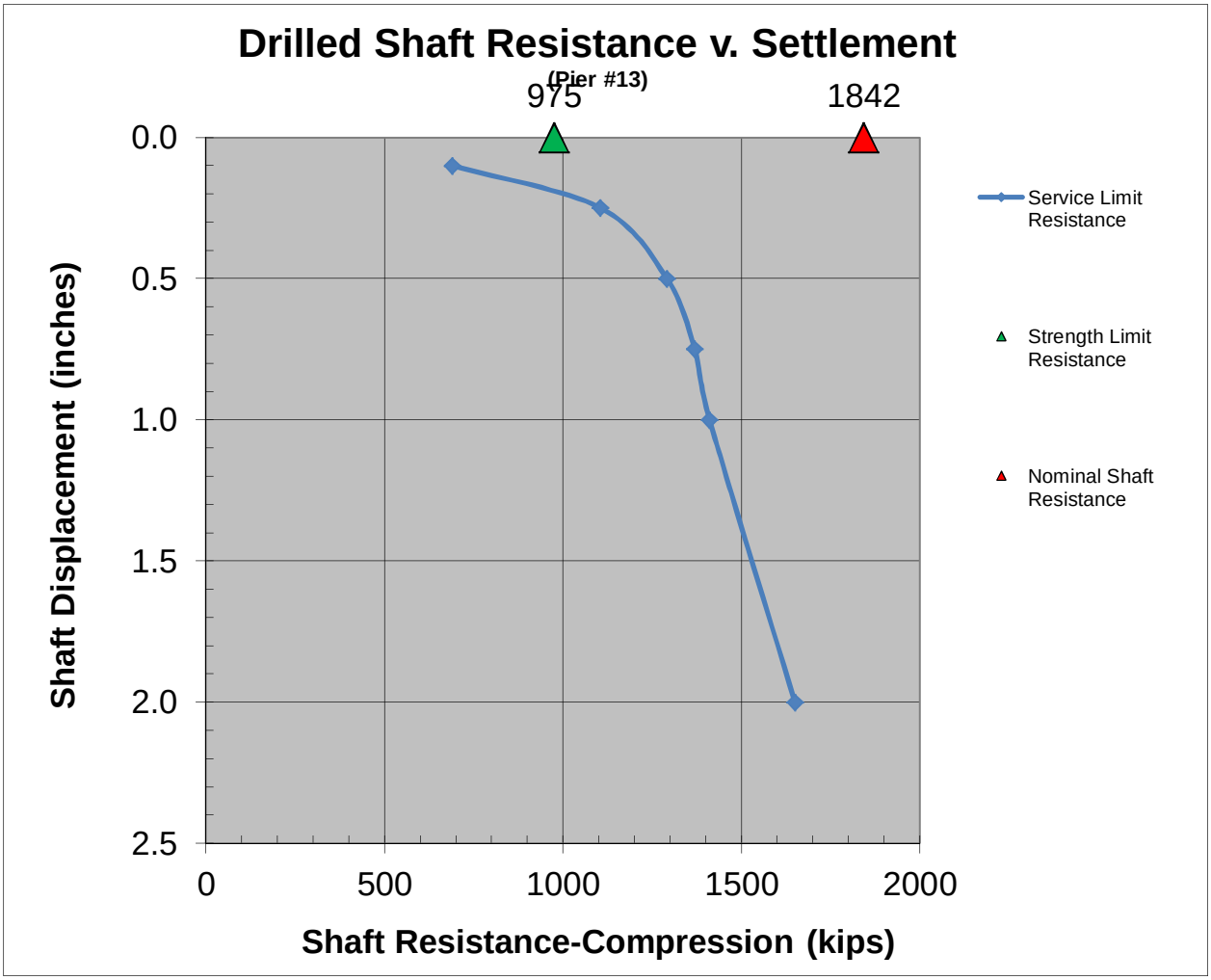
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	76	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	691.1
2	0.25	1105.3
3	0.50	1291.4
4	0.75	1369.3
5	1.00	1411.2
6	2.00	1650.0

Strength Limit Resistance Kips	Nominal Resistance Kips
975	1842



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #13

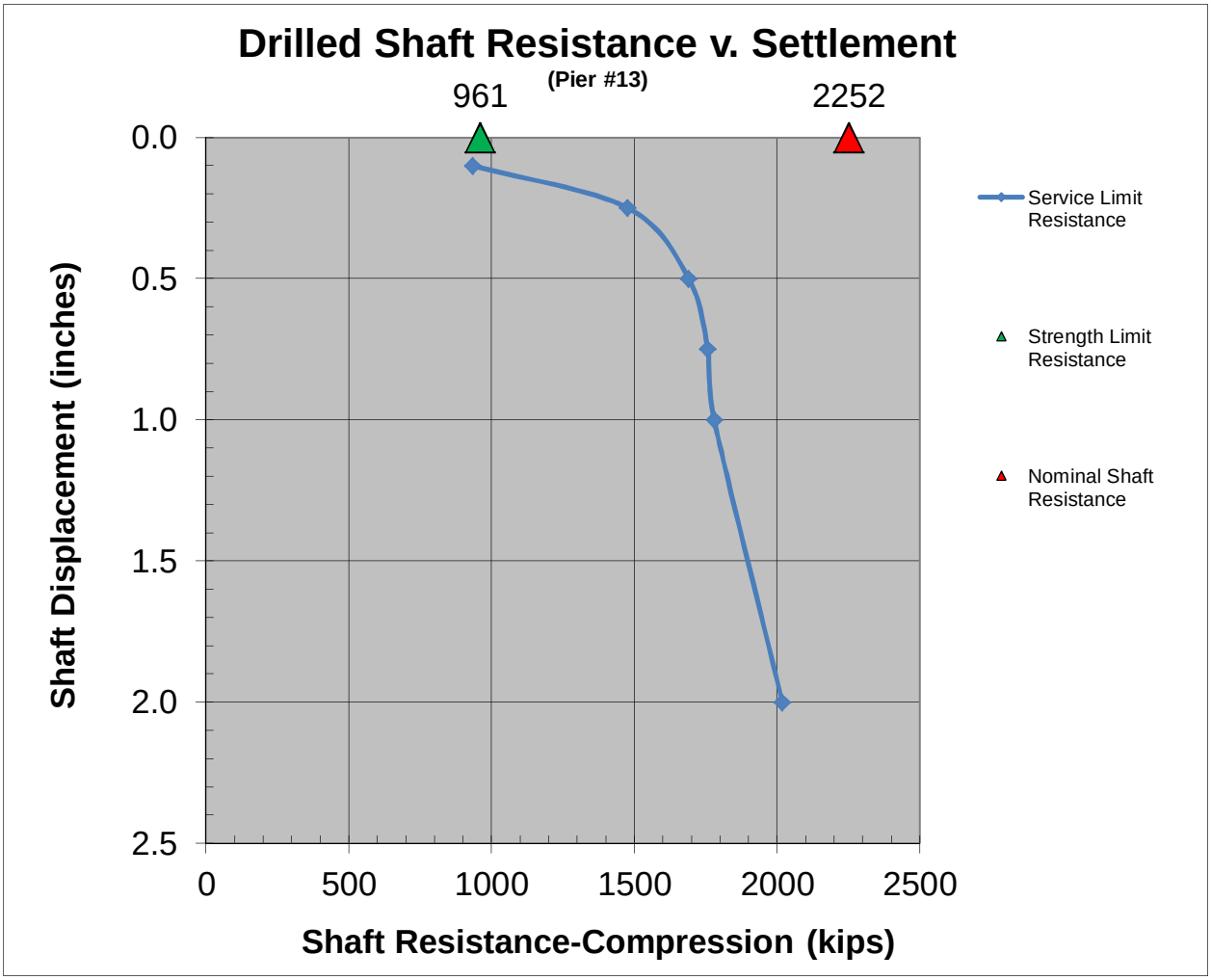
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	90	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	933.7
2	0.25	1477.1
3	0.50	1689.7
4	0.75	1757.1
5	1.00	1779.9
6	2.00	2018.6

Strength Limit Resistance Kips	Nominal Resistance Kips
961	2252



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #13

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	100	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	76	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	4	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2536.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4
Depth from Ground Surface	7	40	47	100
Unit Weight of Layer (γ) pcf	120	70	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	48	75
Cohesion "**c**" of Layer (ksf)				
Thickness of layer (ft)	7.0	33.0	7.0	53.0
Soil Type	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted for Redundant Design**			
Side Resistance-Compression	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #13

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	100	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	90	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	4	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2536.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4
Depth from Ground Surface	7	40	47	100
Unit Weight of Layer (γ) pcf	120	70	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	48	75
Cohesion "**c**" of Layer (ksf)				
Thickness of layer (ft)	7.0	33.0	7.0	53.0
Soil Type	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted Without Redundant Design**

Side Resistance-Compression	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

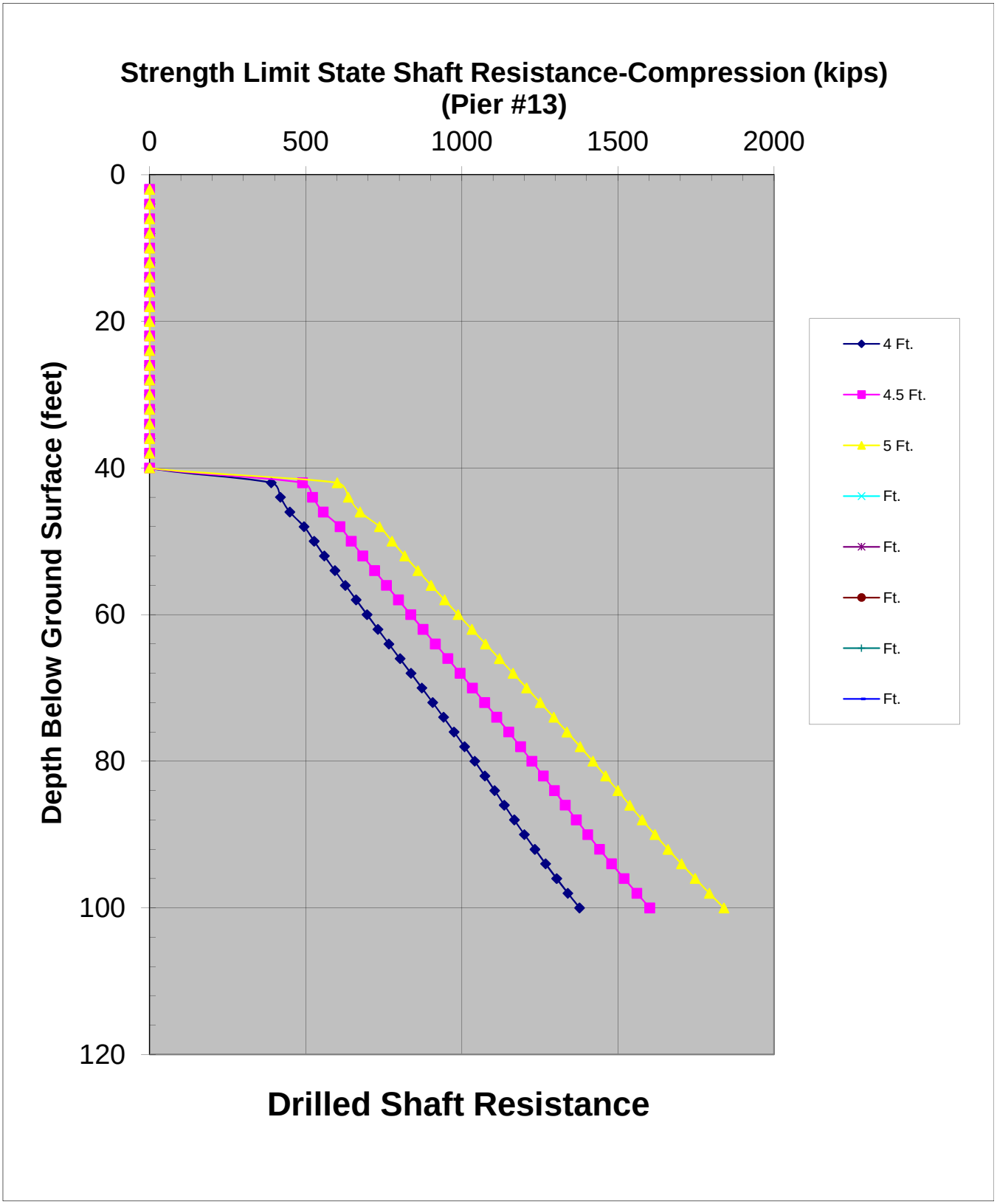
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2534.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2532.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2530.00	6.0	0.0		120.0	600.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2528.00	8.0	0.0		70.0	790.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2526.00	10.0	0.0		70.0	930.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2524.00	12.0	0.0		70.0	1070.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2522.00	14.0	0.0		70.0	1210.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2520.00	16.0	0.0		70.0	1350.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2518.00	18.0	0.0		70.0	1490.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2516.00	20.0	0.0		70.0	1630.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2514.00	22.0	0.0		70.0	1770.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2512.00	24.0	0.0		70.0	1910.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2510.00	26.0	0.0		70.0	2050.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2508.00	28.0	0.0		70.0	2190.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2506.00	30.0	0.0		70.0	2330.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2504.00	32.0	0.0		70.0	2470.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2502.00	34.0	0.0		70.0	2610.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2500.00	36.0	0.0		70.0	2750.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2498.00	38.0	0.0		70.0	2890.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2496.00	40.0	0.0		70.0	3030.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2494.00	42.0	48.0		125.0	3225.0	0.63		2.02	0.55	0.45	0.50	57.6	57.6	57.6					
2492.00	44.0	48.0		125.0	3475.0	0.60		2.10	0.55	0.45	0.50	57.6	57.6	57.6					
2490.00	46.0	48.0		125.0	3725.0	0.58		2.18	0.55	0.45	0.50	57.6	57.6	57.6					
2488.00	48.0	75.0		130.0	3980.0	0.56		2.25	0.55	0.45	0.50	60.0	60.0	60.0					
2486.00	50.0	75.0		130.0	4240.0	0.55		2.31	0.55	0.45	0.50	60.0	60.0	60.0					
2484.00	52.0	75.0		130.0	4500.0	0.53		2.37	0.55	0.45	0.50	60.0	60.0	60.0					
2482.00	54.0	75.0		130.0	4760.0	0.51		2.42	0.55	0.45	0.50	60.0	60.0	60.0					
2480.00	56.0	75.0		130.0	5020.0	0.49		2.46	0.55	0.45	0.50	60.0	60.0	60.0					
2478.00	58.0	75.0		130.0	5280.0	0.47		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2476.00	60.0	75.0		130.0	5540.0	0.45		2.52	0.55	0.45	0.50	60.0	60.0	60.0					
2474.00	62.0	75.0		130.0	5800.0	0.44		2.53	0.55	0.45	0.50	60.0	60.0	60.0					
2472.00	64.0	75.0		130.0	6060.0	0.42		2.55	0.55	0.45	0.50	60.0	60.0	60.0					
2470.00	66.0	75.0		130.0	6320.0	0.40		2.55	0.55	0.45	0.50	60.0	60.0	60.0					
2468.00	68.0	75.0		130.0	6580.0	0.39		2.54	0.55	0.45	0.50	60.0	60.0	60.0					
2466.00	70.0	75.0		130.0	6840.0	0.37		2.53	0.55	0.45	0.50	60.0	60.0	60.0					
2464.00	72.0	75.0		130.0	7100.0	0.35		2.52	0.55	0.45	0.50	60.0	60.0	60.0					
2462.00	74.0	75.0		130.0	7360.0	0.34		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2460.00	76.0	75.0		130.0	7620.0	0.32		2.46	0.55	0.45	0.50	60.0	60.0	60.0					
2458.00	78.0	75.0		130.0	7880.0	0.31		2.42	0.55	0.45	0.50	60.0	60.0	60.0					
2456.00	80.0	75.0		130.0	8140.0	0.29		2.38	0.55	0.45	0.50	60.0	60.0	60.0					
2454.00	82.0	75.0		130.0	8400.0	0.28		2.33	0.55	0.45	0.50	60.0	60.0	60.0					
2452.00	84.0	75.0		130.0	8660.0	0.26		2.28	0.55	0.45	0.50	60.0	60.0	60.0					
2450.00	86.0	75.0		130.0	8920.0	0.25		2.23	0.55	0.45	0.50	60.0	60.0	60.0					
2448.00	88.0	75.0		130.0	9180.0	0.25		2.30	0.55	0.45	0.50	60.0	60.0	60.0					
2446.00	90.0	75.0		130.0	9440.0	0.25		2.36	0.55	0.45	0.50	60.0	60.0	60.0					
2444.00	92.0	75.0		130.0	9700.0	0.25		2.43	0.55	0.45	0.50	60.0	60.0	60.0					
2442.00	94.0	75.0		130.0	9960.0	0.25		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2440.00	96.0	75.0		130.0	10220.0	0.25		2.56	0.55	0.45	0.50	60.0	60.0	60.0					
2438.00	98.0	75.0		130.0	10480.0	0.25		2.62	0.55	0.45	0.50	60.0	60.0	60.0					
2436.00	100.0	75.0		130.0	10740.0	0.25		2.69	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2534.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2532.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2530.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2528.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2526.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2524.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2522.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2520.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2518.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2516.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2514.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2512.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2510.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2508.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2506.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2504.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2502.00	34.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2500.00	36.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2498.00	38.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2496.00	40.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2494.00	42.0	361.92	27.87	389.79	458.06	31.35	489.41	565.51	34.83	600.34																	
2492.00	44.0	361.92	56.91	418.83	458.06	64.02	522.08	565.51	71.13	636.64																	
2490.00	46.0	361.92	87.00	448.92	458.06	97.87	555.93	565.51	108.75	674.25																	
2488.00	48.0	377.00	118.07	495.07	477.15	132.82	609.97	589.07	147.58	736.65																	
2486.00	50.0	377.00	150.03	527.04	477.15	168.79	645.93	589.07	187.54	776.61																	
2484.00	52.0	377.00	182.78	559.79	477.15	205.63	682.78	589.07	228.48	817.55																	
2482.00	54.0	377.00	216.21	593.21	477.15	243.23	720.38	589.07	270.26	859.33																	
2480.00	56.0	377.00	250.19	627.20	477.15	281.47	758.61	589.07	312.74	901.81																	
2478.00	58.0	377.00	284.63	661.64	477.15	320.21	797.36	589.07	355.79	944.86																	
2476.00	60.0	377.00	319.42	696.43	477.15	359.35	836.50	589.07	399.28	988.35																	
2474.00	62.0	377.00	354.46	731.47	477.15	398.77	875.92	589.07	443.08	1032.15																	
2472.00	64.0	377.00	389.65	766.65	477.15	438.35	915.50	589.07	487.06	1076.13																	
2470.00	66.0	377.00	424.88	801.88	477.15	477.99	955.13	589.07	531.10	1120.16																	
2468.00	68.0	377.00	460.06	837.06	477.15	517.56	994.71	589.07	575.07	1164.14																	
2466.00	70.0	377.00	495.09	872.09	477.15	556.97	1034.12	589.07	618.86	1207.93																	
2464.00	72.0	377.00	529.88	906.88	477.15	596.11	1073.26	589.07	662.35	1251.42																	
2462.00	74.0	377.00	564.34	941.34	477.15	634.88	1112.03	589.07	705.42	1294.49																	
2460.00	76.0	377.00	598.37	975.38	477.15	673.17	1150.31	589.07	747.96	1337.03																	
2458.00	78.0	377.00	631.89	1008.89	477.15	710.88	1188.02	589.07	789.86	1378.93																	
2456.00	80.0	377.00	664.81	1041.81	477.15	747.91	1225.05	589.07	831.01	1420.08																	
2454.00	82.0	377.00	697.03	1074.04	477.15	784.16	1261.31	589.07	871.29	1460.36																	
2452.00	84.0	377.00	728.48	1105.48	477.15	819.54	1296.69	589.07	910.60	1499.67																	
2450.00	86.0	377.00	759.31	1136.31	477.15	854.22	1331.37	589.07	949.13	1538.20																	
2448.00	88.0	377.00	791.03	1168.03	477.15	889.91	1367.06	589.07	988.79	1577.86																	
2446.00	90.0	377.00	823.65	1200.66	477.15	926.61	1403.76	589.07	1029.57	1618.64																	
2444.00	92.0	377.00	857.18	1234.18	477.15	964.32	1441.47	589.07	1071.47	1660.54																	
2442.00	94.0	377.00	891.60	1268.60	477.15	1003.05	1480.19	589.07	1114.50	1703.56																	
2440.00	96.0	377.00	926.92	1303.92	477.15	1042.78	1519.93	589.07	1158.64	1747.71																	
2438.00	98.0	377.00	963.13	1340.14	477.15	1083.52	1560.67	589.07	1203.92	1792.99																	
2436.00	100.0	377.00	1000.25	1377.25	477.15	1125.28	1602.43	589.07	1250.31	1839.38																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #13)
0
500
1000
1500
2000
0
20
40
60
80
100
120
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX Q

Mullins Landfill Bridge

Pier #14

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #14

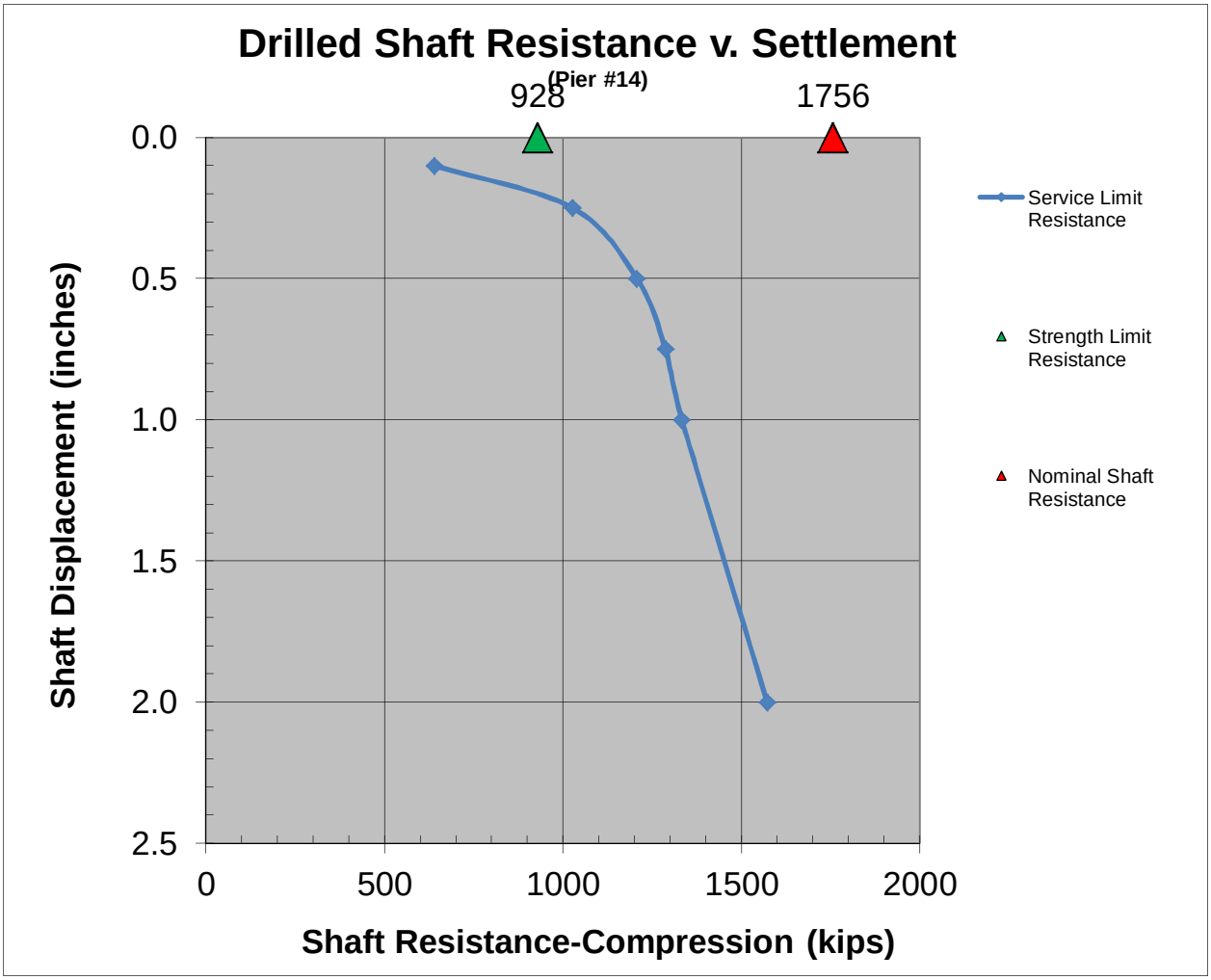
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	74	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	640.0
2	0.25	1027.0
3	0.50	1207.4
4	0.75	1287.6
5	1.00	1333.5
6	2.00	1572.3

Strength Limit Resistance Kips	Nominal Resistance Kips
928	1756



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #14

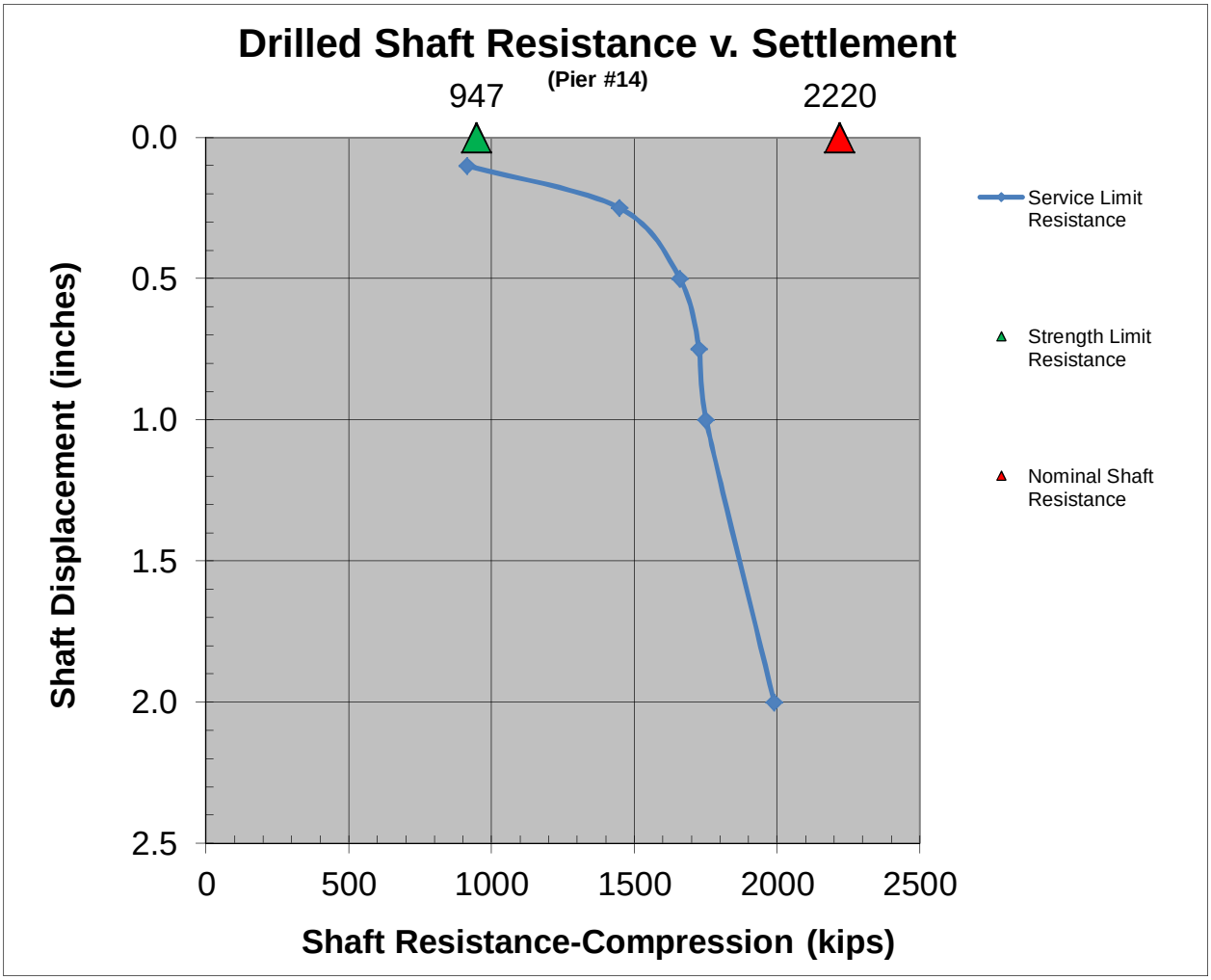
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	90	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	914.9
2	0.25	1448.4
3	0.50	1658.9
4	0.75	1727.1
5	1.00	1751.4
6	2.00	1990.2

Strength Limit Resistance Kips	Nominal Resistance Kips
947	2220



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #14

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	100	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	74	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	4	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2536.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4
Depth from Ground Surface	4	40	52	100
Unit Weight of Layer (γ) pcf	120	70	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	67	75
Cohesion "**c**" of Layer (ksf)				
Thickness of layer (ft)	4.0	36.0	12.0	48.0
Soil Type	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted for Redundant Design**			
Side Resistance-Compression	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #14

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	100	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	90	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	4	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2536.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4
Depth from Ground Surface	4	40	52	100
Unit Weight of Layer (γ) pcf	120	70	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	67	75
Cohesion "**c**" of Layer (ksf)				
Thickness of layer (ft)	4.0	36.0	12.0	48.0
Soil Type	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted Without Redundant Design**

Side Resistance-Compression	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

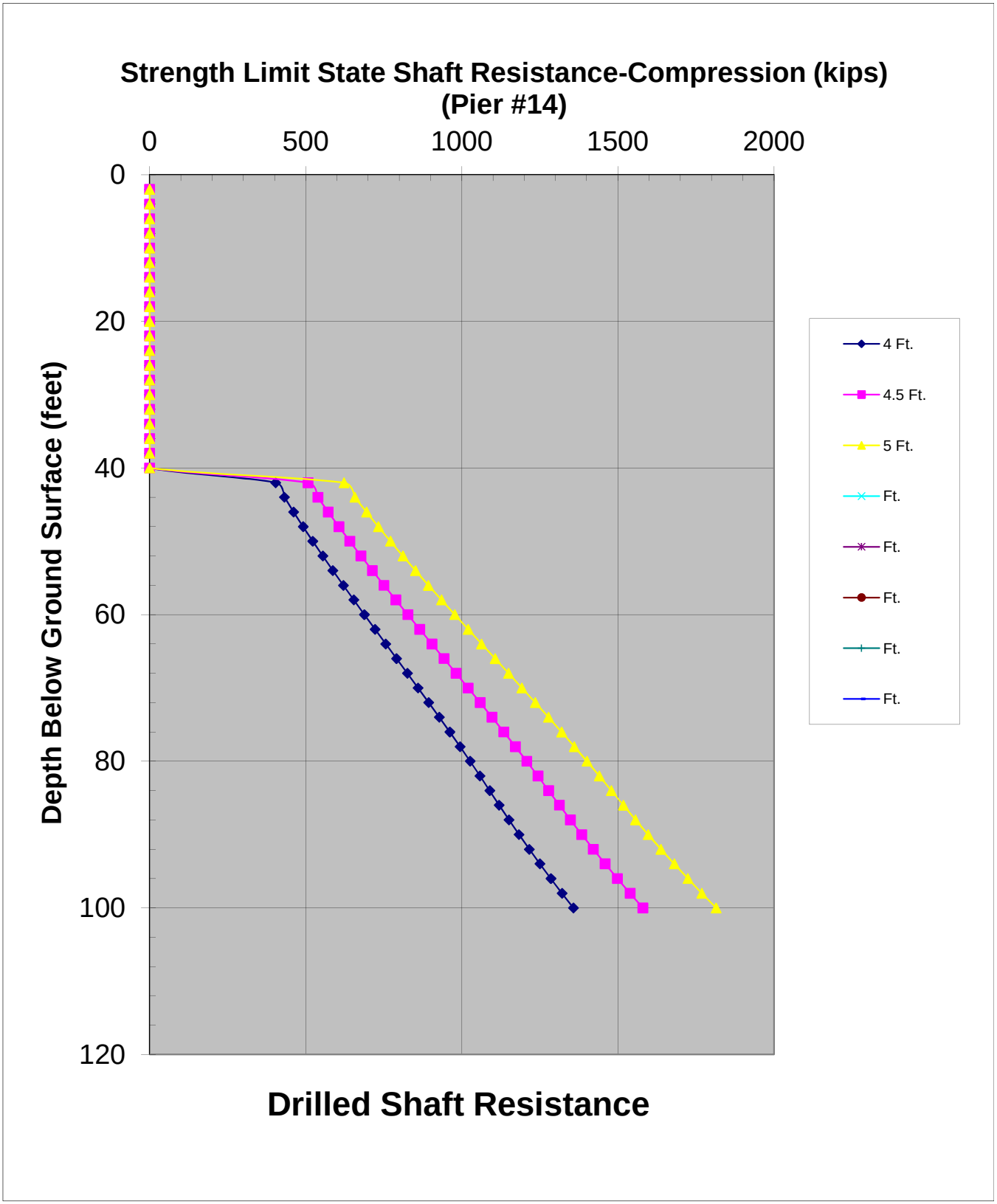
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2534.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2532.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2530.00	6.0	0.0		70.0	550.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2528.00	8.0	0.0		70.0	690.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2526.00	10.0	0.0		70.0	830.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2524.00	12.0	0.0		70.0	970.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2522.00	14.0	0.0		70.0	1110.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2520.00	16.0	0.0		70.0	1250.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2518.00	18.0	0.0		70.0	1390.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2516.00	20.0	0.0		70.0	1530.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2514.00	22.0	0.0		70.0	1670.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2512.00	24.0	0.0		70.0	1810.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2510.00	26.0	0.0		70.0	1950.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2508.00	28.0	0.0		70.0	2090.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2506.00	30.0	0.0		70.0	2230.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2504.00	32.0	0.0		70.0	2370.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2502.00	34.0	0.0		70.0	2510.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2500.00	36.0	0.0		70.0	2650.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2498.00	38.0	0.0		70.0	2790.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2496.00	40.0	0.0		70.0	2930.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2494.00	42.0	67.0		125.0	3125.0	0.63		1.95	0.55	0.45	0.50	60.0	60.0	60.0					
2492.00	44.0	67.0		125.0	3375.0	0.60		2.04	0.55	0.45	0.50	60.0	60.0	60.0					
2490.00	46.0	67.0		125.0	3625.0	0.58		2.12	0.55	0.45	0.50	60.0	60.0	60.0					
2488.00	48.0	67.0		125.0	3875.0	0.56		2.19	0.55	0.45	0.50	60.0	60.0	60.0					
2486.00	50.0	67.0		125.0	4125.0	0.55		2.25	0.55	0.45	0.50	60.0	60.0	60.0					
2484.00	52.0	67.0		125.0	4375.0	0.53		2.30	0.55	0.45	0.50	60.0	60.0	60.0					
2482.00	54.0	75.0		130.0	4630.0	0.51		2.35	0.55	0.45	0.50	60.0	60.0	60.0					
2480.00	56.0	75.0		130.0	4890.0	0.49		2.39	0.55	0.45	0.50	60.0	60.0	60.0					
2478.00	58.0	75.0		130.0	5150.0	0.47		2.43	0.55	0.45	0.50	60.0	60.0	60.0					
2476.00	60.0	75.0		130.0	5410.0	0.45		2.46	0.55	0.45	0.50	60.0	60.0	60.0					
2474.00	62.0	75.0		130.0	5670.0	0.44		2.48	0.55	0.45	0.50	60.0	60.0	60.0					
2472.00	64.0	75.0		130.0	5930.0	0.42		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2470.00	66.0	75.0		130.0	6190.0	0.40		2.50	0.55	0.45	0.50	60.0	60.0	60.0					
2468.00	68.0	75.0		130.0	6450.0	0.39		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2466.00	70.0	75.0		130.0	6710.0	0.37		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2464.00	72.0	75.0		130.0	6970.0	0.35		2.47	0.55	0.45	0.50	60.0	60.0	60.0					
2462.00	74.0	75.0		130.0	7230.0	0.34		2.45	0.55	0.45	0.50	60.0	60.0	60.0					
2460.00	76.0	75.0		130.0	7490.0	0.32		2.42	0.55	0.45	0.50	60.0	60.0	60.0					
2458.00	78.0	75.0		130.0	7750.0	0.31		2.38	0.55	0.45	0.50	60.0	60.0	60.0					
2456.00	80.0	75.0		130.0	8010.0	0.29		2.34	0.55	0.45	0.50	60.0	60.0	60.0					
2454.00	82.0	75.0		130.0	8270.0	0.28		2.30	0.55	0.45	0.50	60.0	60.0	60.0					
2452.00	84.0	75.0		130.0	8530.0	0.26		2.24	0.55	0.45	0.50	60.0	60.0	60.0					
2450.00	86.0	75.0		130.0	8790.0	0.25		2.20	0.55	0.45	0.50	60.0	60.0	60.0					
2448.00	88.0	75.0		130.0	9050.0	0.25		2.26	0.55	0.45	0.50	60.0	60.0	60.0					
2446.00	90.0	75.0		130.0	9310.0	0.25		2.33	0.55	0.45	0.50	60.0	60.0	60.0					
2444.00	92.0	75.0		130.0	9570.0	0.25		2.39	0.55	0.45	0.50	60.0	60.0	60.0					
2442.00	94.0	75.0		130.0	9830.0	0.25		2.46	0.55	0.45	0.50	60.0	60.0	60.0					
2440.00	96.0	75.0		130.0	10090.0	0.25		2.52	0.55	0.45	0.50	60.0	60.0	60.0					
2438.00	98.0	75.0		130.0	10350.0	0.25		2.59	0.55	0.45	0.50	60.0	60.0	60.0					
2436.00	100.0	75.0		130.0	10610.0	0.25		2.65	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2534.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2532.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2530.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2528.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2526.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2524.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2522.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2520.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2518.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2516.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2514.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2512.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2510.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2508.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2506.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2504.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2502.00	34.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2500.00	36.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2498.00	38.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2496.00	40.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2494.00	42.0	377.00	27.00	404.01	477.15	30.38	507.52	589.07	33.75	622.82																	
2492.00	44.0	377.00	55.21	432.21	477.15	62.11	539.25	589.07	69.01	658.08																	
2490.00	46.0	377.00	84.49	461.49	477.15	95.05	572.20	589.07	105.61	694.68																	
2488.00	48.0	377.00	114.74	491.74	477.15	129.08	606.23	589.07	143.42	732.49																	
2486.00	50.0	377.00	145.84	522.84	477.15	164.07	641.21	589.07	182.30	771.37																	
2484.00	52.0	377.00	177.68	554.68	477.15	199.89	677.04	589.07	222.10	811.17																	
2482.00	54.0	377.00	210.19	587.19	477.15	236.46	713.61	589.07	262.74	851.81																	
2480.00	56.0	377.00	243.30	620.30	477.15	273.71	750.85	589.07	304.12	893.19																	
2478.00	58.0	377.00	276.89	653.89	477.15	311.50	788.65	589.07	346.11	935.18																	
2476.00	60.0	377.00	310.86	687.87	477.15	349.72	826.87	589.07	388.58	977.65																	
2474.00	62.0	377.00	345.12	722.12	477.15	388.26	865.40	589.07	431.39	1020.46																	
2472.00	64.0	377.00	379.54	756.55	477.15	426.99	904.13	589.07	474.43	1063.50																	
2470.00	66.0	377.00	414.05	791.05	477.15	465.81	942.95	589.07	517.56	1106.63																	
2468.00	68.0	377.00	448.53	825.54	477.15	504.60	981.75	589.07	560.67	1149.74																	
2466.00	70.0	377.00	482.90	859.91	477.15	543.26	1020.41	589.07	603.63	1192.70																	
2464.00	72.0	377.00	517.06	894.06	477.15	581.69	1058.83	589.07	646.32	1235.39																	
2462.00	74.0	377.00	550.91	927.91	477.15	619.77	1096.91	589.07	688.63	1277.70																	
2460.00	76.0	377.00	584.36	961.36	477.15	657.40	1134.55	589.07	730.45	1319.52																	
2458.00	78.0	377.00	617.32	994.33	477.15	694.49	1171.64	589.07	771.65	1360.72																	
2456.00	80.0	377.00	649.71	1026.72	477.15	730.93	1208.07	589.07	812.14	1401.21																	
2454.00	82.0	377.00	681.44	1058.44	477.15	766.62	1243.77	589.07	851.80	1440.87																	
2452.00	84.0	377.00	712.42	1089.42	477.15	801.47	1278.61	589.07	890.52	1479.59																	
2450.00	86.0	377.00	742.79	1119.80	477.15	835.64	1312.79	589.07	928.49	1517.56																	
2448.00	88.0	377.00	774.07	1151.07	477.15	870.83	1347.97	589.07	967.59	1556.66																	
2446.00	90.0	377.00	806.24	1183.25	477.15	907.02	1384.17	589.07	1007.80	1596.87																	
2444.00	92.0	377.00	839.32	1216.32	477.15	944.23	1421.38	589.07	1049.15	1638.21																	
2442.00	94.0	377.00	873.29	1250.29	477.15	982.45	1459.59	589.07	1091.61	1680.68																	
2440.00	96.0	377.00	908.16	1285.16	477.15	1021.68	1498.82	589.07	1135.20	1724.27																	
2438.00	98.0	377.00	943.93	1320.93	477.15	1061.92	1539.06	589.07	1179.91	1768.98																	
2436.00	100.0	377.00	980.59	1357.60	477.15	1103.17	1580.31	589.07	1225.74	1814.81																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #14)
0
500
1000
1500
2000
0
20
40
60
80
100
120
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX R

Mullins Landfill Bridge

Pier #15

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #15

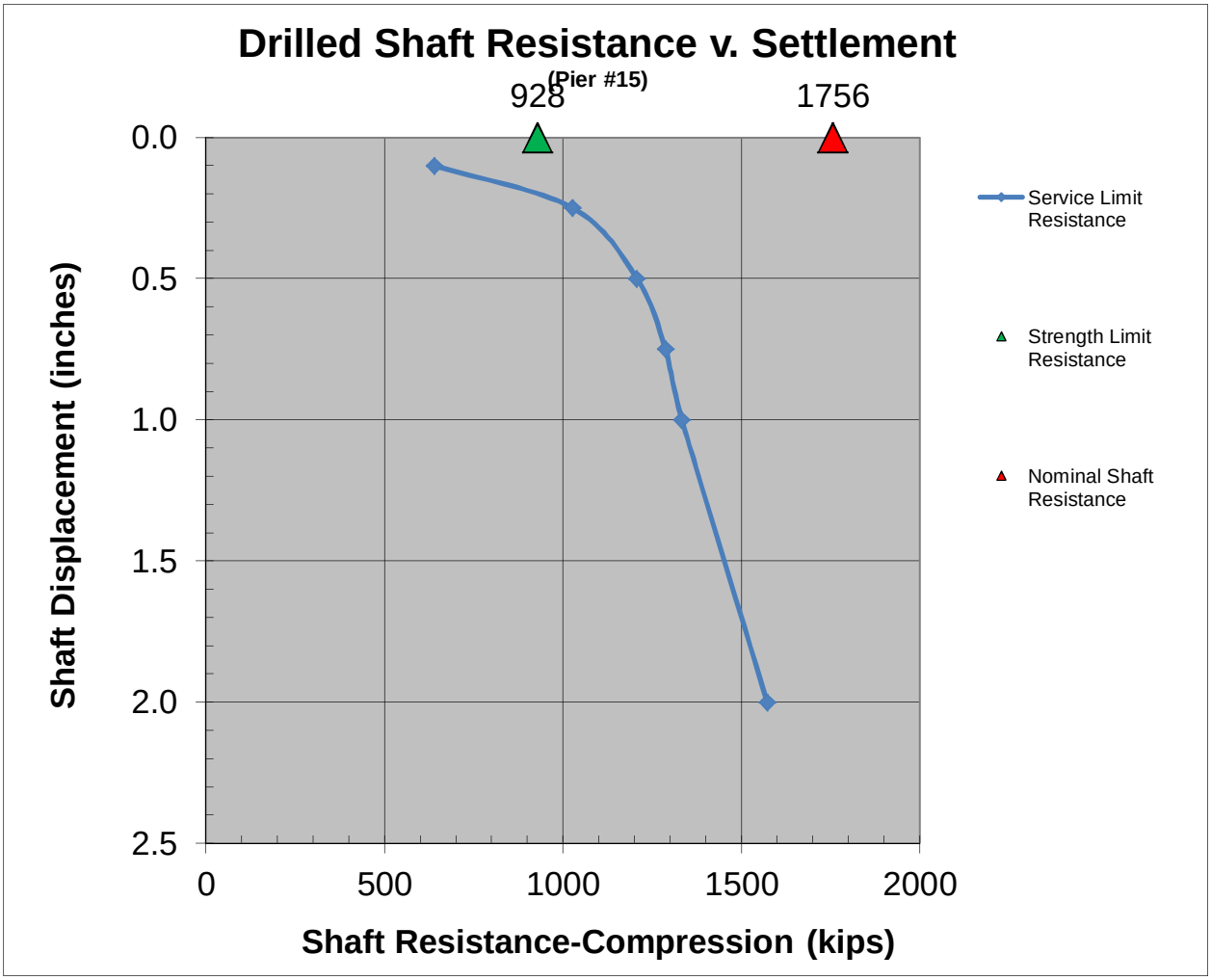
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	74	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	640.0
2	0.25	1027.0
3	0.50	1207.4
4	0.75	1287.6
5	1.00	1333.5
6	2.00	1572.3

Strength Limit Resistance Kips	Nominal Resistance Kips
928	1756



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	Pier #15

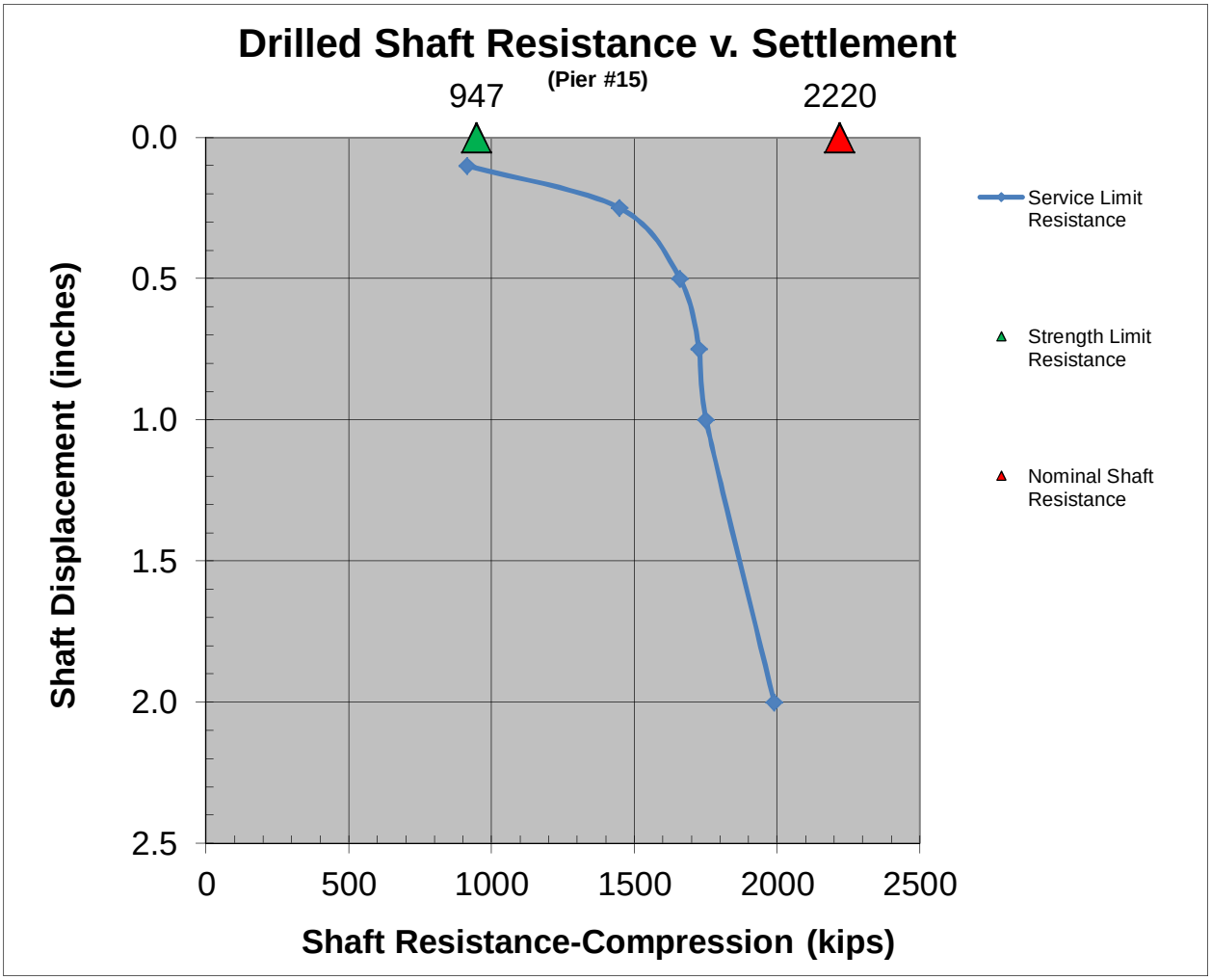
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	90	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	914.9
2	0.25	1448.4
3	0.50	1658.9
4	0.75	1727.1
5	1.00	1751.4
6	2.00	1990.2

Strength Limit Resistance Kips	Nominal Resistance Kips
947	2220



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #15

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	100	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	74	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2536.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	4	40	47	52	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	40	56	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	4.0	36.0	7.0	5.0	48.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted for Redundant Design**

Side Resistance-Compression	0.55	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	Pier #15

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	100	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	90	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2536.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	4	40	47	52	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	40	56	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	4.0	36.0	7.0	5.0	48.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors	**Analyses Conducted Without Redundant Design**				
Side Resistance-Compression	0.44	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

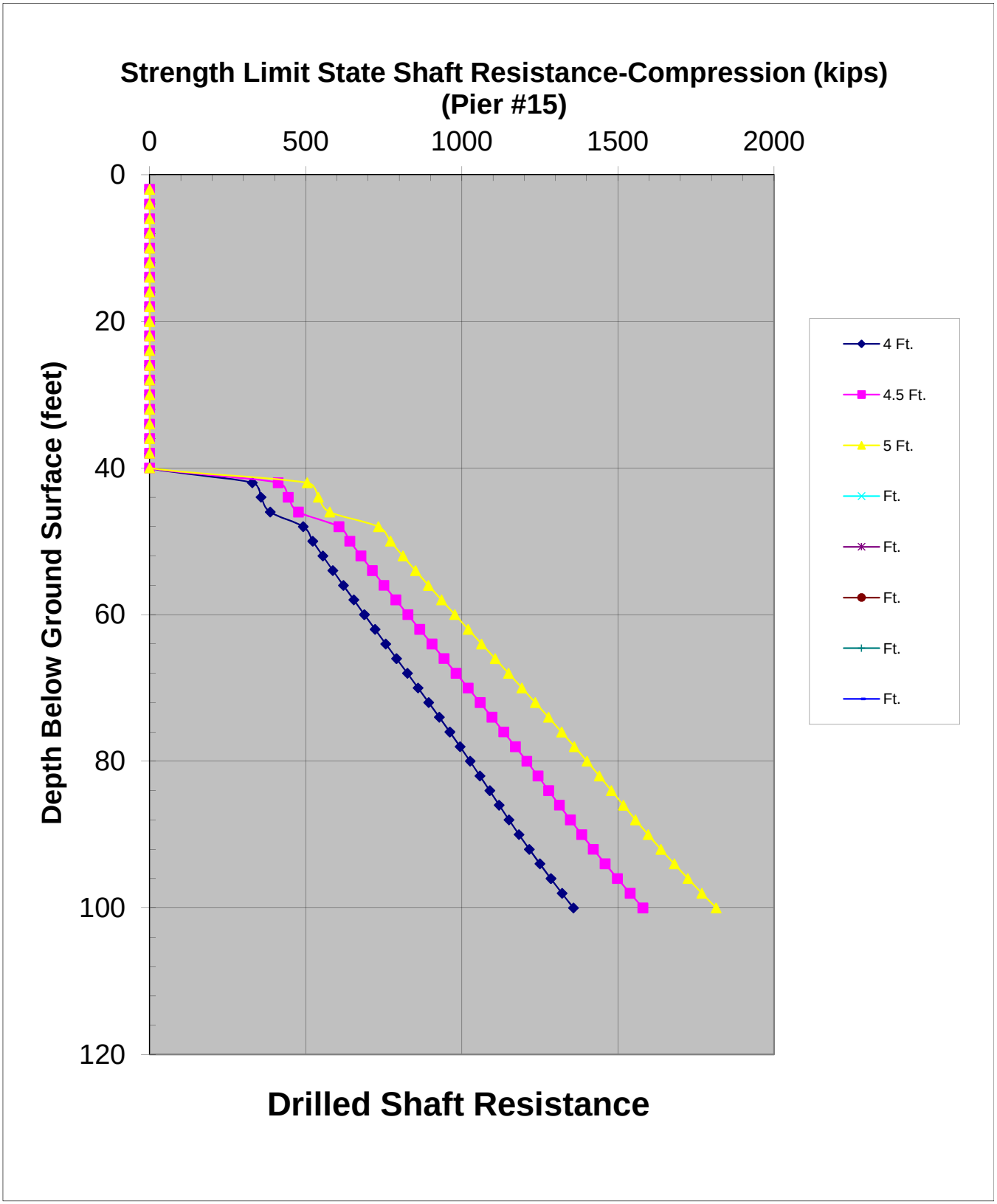
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2534.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2532.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2530.00	6.0	0.0		70.0	550.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2528.00	8.0	0.0		70.0	690.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2526.00	10.0	0.0		70.0	830.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2524.00	12.0	0.0		70.0	970.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2522.00	14.0	0.0		70.0	1110.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2520.00	16.0	0.0		70.0	1250.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2518.00	18.0	0.0		70.0	1390.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2516.00	20.0	0.0		70.0	1530.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2514.00	22.0	0.0		70.0	1670.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2512.00	24.0	0.0		70.0	1810.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2510.00	26.0	0.0		70.0	1950.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2508.00	28.0	0.0		70.0	2090.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2506.00	30.0	0.0		70.0	2230.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2504.00	32.0	0.0		70.0	2370.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2502.00	34.0	0.0		70.0	2510.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2500.00	36.0	0.0		70.0	2650.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2498.00	38.0	0.0		70.0	2790.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2496.00	40.0	0.0		70.0	2930.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2494.00	42.0	40.0		125.0	3125.0	0.63		1.95	0.55	0.45	0.50	48.0	48.0	48.0					
2492.00	44.0	40.0		125.0	3375.0	0.60		2.04	0.55	0.45	0.50	48.0	48.0	48.0					
2490.00	46.0	40.0		125.0	3625.0	0.58		2.12	0.55	0.45	0.50	48.0	48.0	48.0					
2488.00	48.0	56.0		125.0	3875.0	0.56		2.19	0.55	0.45	0.50	60.0	60.0	60.0					
2486.00	50.0	56.0		125.0	4125.0	0.55		2.25	0.55	0.45	0.50	60.0	60.0	60.0					
2484.00	52.0	56.0		125.0	4375.0	0.53		2.30	0.55	0.45	0.50	60.0	60.0	60.0					
2482.00	54.0	75.0		130.0	4630.0	0.51		2.35	0.55	0.45	0.50	60.0	60.0	60.0					
2480.00	56.0	75.0		130.0	4890.0	0.49		2.39	0.55	0.45	0.50	60.0	60.0	60.0					
2478.00	58.0	75.0		130.0	5150.0	0.47		2.43	0.55	0.45	0.50	60.0	60.0	60.0					
2476.00	60.0	75.0		130.0	5410.0	0.45		2.46	0.55	0.45	0.50	60.0	60.0	60.0					
2474.00	62.0	75.0		130.0	5670.0	0.44		2.48	0.55	0.45	0.50	60.0	60.0	60.0					
2472.00	64.0	75.0		130.0	5930.0	0.42		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2470.00	66.0	75.0		130.0	6190.0	0.40		2.50	0.55	0.45	0.50	60.0	60.0	60.0					
2468.00	68.0	75.0		130.0	6450.0	0.39		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2466.00	70.0	75.0		130.0	6710.0	0.37		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2464.00	72.0	75.0		130.0	6970.0	0.35		2.47	0.55	0.45	0.50	60.0	60.0	60.0					
2462.00	74.0	75.0		130.0	7230.0	0.34		2.45	0.55	0.45	0.50	60.0	60.0	60.0					
2460.00	76.0	75.0		130.0	7490.0	0.32		2.42	0.55	0.45	0.50	60.0	60.0	60.0					
2458.00	78.0	75.0		130.0	7750.0	0.31		2.38	0.55	0.45	0.50	60.0	60.0	60.0					
2456.00	80.0	75.0		130.0	8010.0	0.29		2.34	0.55	0.45	0.50	60.0	60.0	60.0					
2454.00	82.0	75.0		130.0	8270.0	0.28		2.30	0.55	0.45	0.50	60.0	60.0	60.0					
2452.00	84.0	75.0		130.0	8530.0	0.26		2.24	0.55	0.45	0.50	60.0	60.0	60.0					
2450.00	86.0	75.0		130.0	8790.0	0.25		2.20	0.55	0.45	0.50	60.0	60.0	60.0					
2448.00	88.0	75.0		130.0	9050.0	0.25		2.26	0.55	0.45	0.50	60.0	60.0	60.0					
2446.00	90.0	75.0		130.0	9310.0	0.25		2.33	0.55	0.45	0.50	60.0	60.0	60.0					
2444.00	92.0	75.0		130.0	9570.0	0.25		2.39	0.55	0.45	0.50	60.0	60.0	60.0					
2442.00	94.0	75.0		130.0	9830.0	0.25		2.46	0.55	0.45	0.50	60.0	60.0	60.0					
2440.00	96.0	75.0		130.0	10090.0	0.25		2.52	0.55	0.45	0.50	60.0	60.0	60.0					
2438.00	98.0	75.0		130.0	10350.0	0.25		2.59	0.55	0.45	0.50	60.0	60.0	60.0					
2436.00	100.0	75.0		130.0	10610.0	0.25		2.65	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2534.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2532.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2530.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2528.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2526.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2524.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2522.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2520.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2518.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2516.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2514.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2512.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2510.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2508.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2506.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2504.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2502.00	34.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2500.00	36.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2498.00	38.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2496.00	40.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2494.00	42.0	301.60	27.00	328.61	381.72	30.38	412.10	471.26	33.75	505.01																	
2492.00	44.0	301.60	55.21	356.81	381.72	62.11	443.82	471.26	69.01	540.26																	
2490.00	46.0	301.60	84.49	386.09	381.72	95.05	476.77	471.26	105.61	576.87																	
2488.00	48.0	377.00	114.74	491.74	477.15	129.08	606.23	589.07	143.42	732.49																	
2486.00	50.0	377.00	145.84	522.84	477.15	164.07	641.21	589.07	182.30	771.37																	
2484.00	52.0	377.00	177.68	554.68	477.15	199.89	677.04	589.07	222.10	811.17																	
2482.00	54.0	377.00	210.19	587.19	477.15	236.46	713.61	589.07	262.74	851.81																	
2480.00	56.0	377.00	243.30	620.30	477.15	273.71	750.85	589.07	304.12	893.19																	
2478.00	58.0	377.00	276.89	653.89	477.15	311.50	788.65	589.07	346.11	935.18																	
2476.00	60.0	377.00	310.86	687.87	477.15	349.72	826.87	589.07	388.58	977.65																	
2474.00	62.0	377.00	345.12	722.12	477.15	388.26	865.40	589.07	431.39	1020.46																	
2472.00	64.0	377.00	379.54	756.55	477.15	426.99	904.13	589.07	474.43	1063.50																	
2470.00	66.0	377.00	414.05	791.05	477.15	465.81	942.95	589.07	517.56	1106.63																	
2468.00	68.0	377.00	448.53	825.54	477.15	504.60	981.75	589.07	560.67	1149.74																	
2466.00	70.0	377.00	482.90	859.91	477.15	543.26	1020.41	589.07	603.63	1192.70																	
2464.00	72.0	377.00	517.06	894.06	477.15	581.69	1058.83	589.07	646.32	1235.39																	
2462.00	74.0	377.00	550.91	927.91	477.15	619.77	1096.91	589.07	688.63	1277.70																	
2460.00	76.0	377.00	584.36	961.36	477.15	657.40	1134.55	589.07	730.45	1319.52																	
2458.00	78.0	377.00	617.32	994.33	477.15	694.49	1171.64	589.07	771.65	1360.72																	
2456.00	80.0	377.00	649.71	1026.72	477.15	730.93	1208.07	589.07	812.14	1401.21																	
2454.00	82.0	377.00	681.44	1058.44	477.15	766.62	1243.77	589.07	851.80	1440.87																	
2452.00	84.0	377.00	712.42	1089.42	477.15	801.47	1278.61	589.07	890.52	1479.59																	
2450.00	86.0	377.00	742.79	1119.80	477.15	835.64	1312.79	589.07	928.49	1517.56																	
2448.00	88.0	377.00	774.07	1151.07	477.15	870.83	1347.97	589.07	967.59	1556.66																	
2446.00	90.0	377.00	806.24	1183.25	477.15	907.02	1384.17	589.07	1007.80	1596.87																	
2444.00	92.0	377.00	839.32	1216.32	477.15	944.23	1421.38	589.07	1049.15	1638.21																	
2442.00	94.0	377.00	873.29	1250.29	477.15	982.45	1459.59	589.07	1091.61	1680.68																	
2440.00	96.0	377.00	908.16	1285.16	477.15	1021.68	1498.82	589.07	1135.20	1724.27																	
2438.00	98.0	377.00	943.93	1320.93	477.15	1061.92	1539.06	589.07	1179.91	1768.98																	
2436.00	100.0	377.00	980.59	1357.60	477.15	1103.17	1580.31	589.07	1225.74	1814.81																	


Strength Limit State Shaft Resistance-Compression (kips)
(Pier #15)
0
500
1000
1500
2000
0
20
40
60
80
100
120
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.

APPENDIX S

Mullins Landfill Bridge

South Abutment

Drilled Shaft Axial Load Analyses Results

Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	South Abut

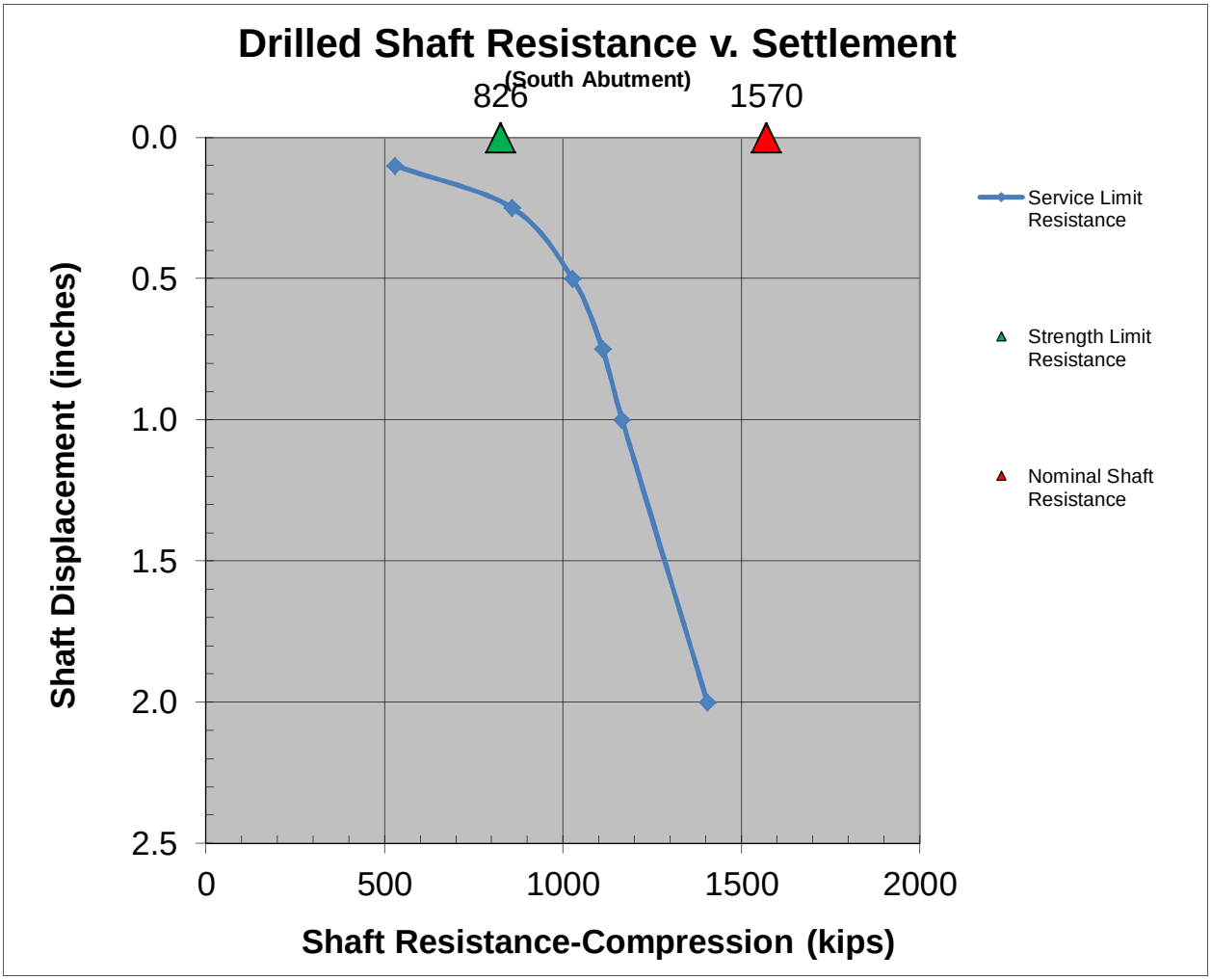
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	68	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	529.7
2	0.25	858.0
3	0.50	1026.5
4	0.75	1111.4
5	1.00	1166.0
6	2.00	1404.8

Strength Limit Resistance Kips	Nominal Resistance Kips
826	1570



Drilled Shaft Resistance Analysis

Design Shaft-Displacement/Resistance Curve

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	0
Foundation Element	South Abut

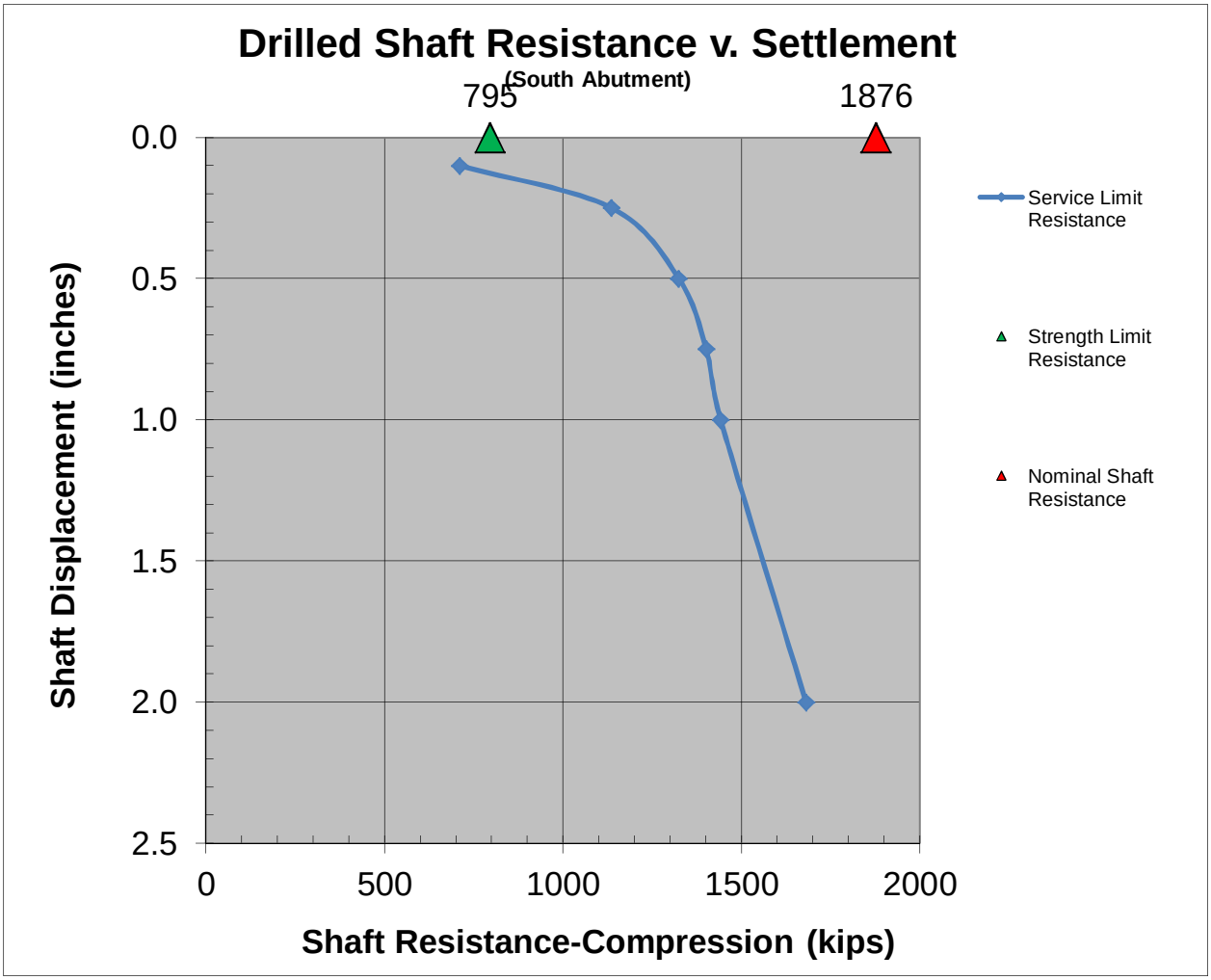
Foundation Design Criteria

Design Shaft Diameter	4.0	ft.
Design Shaft Depth	78	ft.

Service Limit Displacements & Resistances

	δ (in)	Kips
1	0.10	711.5
2	0.25	1136.6
3	0.50	1324.9
4	0.75	1401.9
5	1.00	1442.2
6	2.00	1681.0

Strength Limit Resistance Kips	Nominal Resistance Kips
795	1876



Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	South Abut

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	90	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	Yes	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	68	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2536.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	4	40	47	52	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	40	56	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	4.0	36.0	7.0	5.0	48.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted for Redundant Design**

Side Resistance-Compression	0.55	0.55	0.55	0.55	0.55
Side Resistance-Uplift	0.45	0.45	0.45	0.45	0.45
Base Resistance-Compression	0.50	0.50	0.50	0.50	0.50

Drilled Shaft LRFD Analysis

Drilled Shaft Foundation Analysis is based on procedures outlined in AASHTO (2010) & FHWA NHI-09

- Analysis applies to cohesive and cohesionless soils (phi=0 and c=0)
- Drilled shaft service state loads based on the Load Transfer curves outlined in AASHTO 2010
- The analyses follow the ADOT Geotechnical Design Policys DS-1 and DS-2 dated December 1, 2010

PROJECT

Project Name:	Sabino Road over Mullins Landfill Bridge
Project Location:	Tucson, Arizona
Project Number:	63125005

Stucture Data

Structure Designation	
Foundation Element	South Abut

Foundation Data

Shaft Diameters

Maximum Diameter	5.0	ft.
Minimum Diameter	4.0	ft.
Increment for Diameter	0.5	ft.
Maximum Shaft Tip Depth	90	ft.

Service Limit Displacements

	δ (in)
1	0.10
2	0.25
3	0.50
4	0.75
5	1.00
6	2.00

Foundation Design Criteria

Design for Redundancy	No	
Design Shaft Diameter	4.0	ft.
Design Shaft Depth	78	ft.

Show Service Limit Output for Case: 2

Subsurface Data

Initial Information

Number of Soil Layers	5	
Depth to Groundwater	300	ft.
Ground Surface Elevation	2536.0	ft.

Soil Layer Properties

Layer Number	1	2	3	4	5
Depth from Ground Surface	4	40	47	52	100
Unit Weight of Layer (γ) pcf	120	70	125	125	130
Penetration Resistance "N_{60}" Blows/ft	0	0	40	56	75
Cohesion "**c**" of Layer (ksf)					
Thickness of layer (ft)	4.0	36.0	7.0	5.0	48.0
Soil Type	Sand	Sand	Sand	Sand	Sand

Strength Resistance Factors — **Analyses Conducted Without Redundant Design**

Side Resistance-Compression	0.44	0.44	0.44	0.44	0.44
Side Resistance-Uplift	0.36	0.36	0.36	0.36	0.36
Base Resistance-Compression	0.40	0.40	0.40	0.40	0.40

Drilled Shaft Resistance Analyses

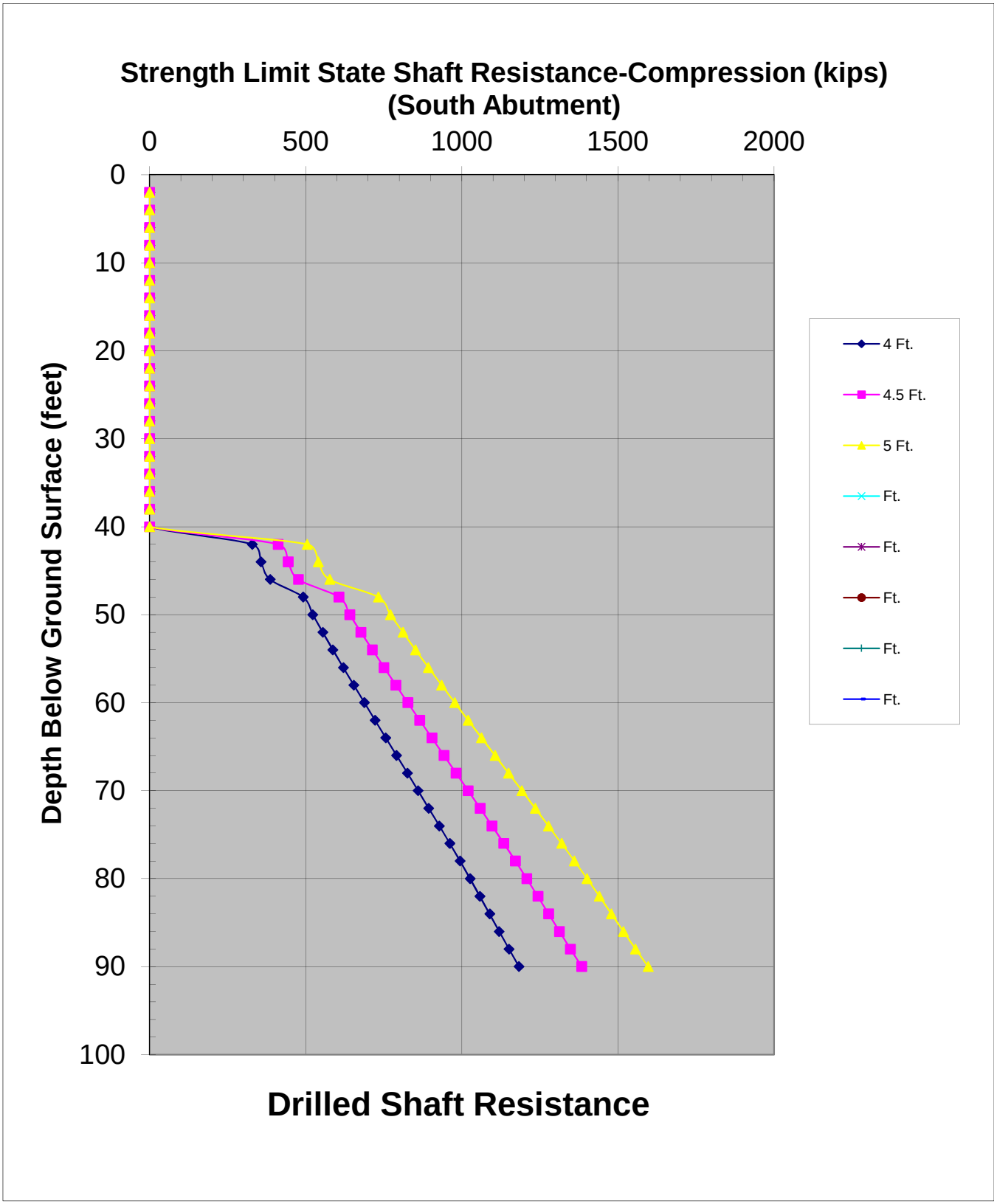
Nominal End Bearing Resistance and Skin Friction Factors

Elevation feet	Depth of Shaft feet	Penetration Resistance N	Cohesion c (ksf)	Soil Unit Weight γ' (pcf)	Effective Stress σ'_z (psf)	β	α	Unit Skin Friction Load (ksf)	Side Resistance Factor Compression	Side Resistance Factor Uplift	Base Resistance Factor	Ultimate End Bearing Pressure (ksf) Shaft Diameter (ft) 4	4.5	5					
2534.00	2.0	0.0		120.0	120.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2532.00	4.0	0.0		120.0	360.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2530.00	6.0	0.0		70.0	550.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2528.00	8.0	0.0		70.0	690.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2526.00	10.0	0.0		70.0	830.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2524.00	12.0	0.0		70.0	970.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2522.00	14.0	0.0		70.0	1110.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2520.00	16.0	0.0		70.0	1250.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2518.00	18.0	0.0		70.0	1390.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2516.00	20.0	0.0		70.0	1530.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2514.00	22.0	0.0		70.0	1670.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2512.00	24.0	0.0		70.0	1810.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2510.00	26.0	0.0		70.0	1950.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2508.00	28.0	0.0		70.0	2090.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2506.00	30.0	0.0		70.0	2230.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2504.00	32.0	0.0		70.0	2370.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2502.00	34.0	0.0		70.0	2510.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2500.00	36.0	0.0		70.0	2650.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2498.00	38.0	0.0		70.0	2790.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2496.00	40.0	0.0		70.0	2930.0	0.00		0.00	0.55	0.45	0.50	0.0	0.0	0.0					
2494.00	42.0	40.0		125.0	3125.0	0.63		1.95	0.55	0.45	0.50	48.0	48.0	48.0					
2492.00	44.0	40.0		125.0	3375.0	0.60		2.04	0.55	0.45	0.50	48.0	48.0	48.0					
2490.00	46.0	40.0		125.0	3625.0	0.58		2.12	0.55	0.45	0.50	48.0	48.0	48.0					
2488.00	48.0	56.0		125.0	3875.0	0.56		2.19	0.55	0.45	0.50	60.0	60.0	60.0					
2486.00	50.0	56.0		125.0	4125.0	0.55		2.25	0.55	0.45	0.50	60.0	60.0	60.0					
2484.00	52.0	56.0		125.0	4375.0	0.53		2.30	0.55	0.45	0.50	60.0	60.0	60.0					
2482.00	54.0	75.0		130.0	4630.0	0.51		2.35	0.55	0.45	0.50	60.0	60.0	60.0					
2480.00	56.0	75.0		130.0	4890.0	0.49		2.39	0.55	0.45	0.50	60.0	60.0	60.0					
2478.00	58.0	75.0		130.0	5150.0	0.47		2.43	0.55	0.45	0.50	60.0	60.0	60.0					
2476.00	60.0	75.0		130.0	5410.0	0.45		2.46	0.55	0.45	0.50	60.0	60.0	60.0					
2474.00	62.0	75.0		130.0	5670.0	0.44		2.48	0.55	0.45	0.50	60.0	60.0	60.0					
2472.00	64.0	75.0		130.0	5930.0	0.42		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2470.00	66.0	75.0		130.0	6190.0	0.40		2.50	0.55	0.45	0.50	60.0	60.0	60.0					
2468.00	68.0	75.0		130.0	6450.0	0.39		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2466.00	70.0	75.0		130.0	6710.0	0.37		2.49	0.55	0.45	0.50	60.0	60.0	60.0					
2464.00	72.0	75.0		130.0	6970.0	0.35		2.47	0.55	0.45	0.50	60.0	60.0	60.0					
2462.00	74.0	75.0		130.0	7230.0	0.34		2.45	0.55	0.45	0.50	60.0	60.0	60.0					
2460.00	76.0	75.0		130.0	7490.0	0.32		2.42	0.55	0.45	0.50	60.0	60.0	60.0					
2458.00	78.0	75.0		130.0	7750.0	0.31		2.38	0.55	0.45	0.50	60.0	60.0	60.0					
2456.00	80.0	75.0		130.0	8010.0	0.29		2.34	0.55	0.45	0.50	60.0	60.0	60.0					
2454.00	82.0	75.0		130.0	8270.0	0.28		2.30	0.55	0.45	0.50	60.0	60.0	60.0					
2452.00	84.0	75.0		130.0	8530.0	0.26		2.24	0.55	0.45	0.50	60.0	60.0	60.0					
2450.00	86.0	75.0		130.0	8790.0	0.25		2.20	0.55	0.45	0.50	60.0	60.0	60.0					
2448.00	88.0	75.0		130.0	9050.0	0.25		2.26	0.55	0.45	0.50	60.0	60.0	60.0					
2446.00	90.0	75.0		130.0	9310.0	0.25		2.33	0.55	0.45	0.50	60.0	60.0	60.0					

Drilled Shaft Resistance Analyses

Strength Limit State Shaft Resistances

		Diameter=	4	Ft.	Diameter=	4.5	Ft.	Diameter=	5	Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.	Diameter=		Ft.
Elevation feet	Depth of Shaft feet	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips	End Bearing kips	Skin Capacity kips	Total Capacity kips
2534.00	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2532.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2530.00	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2528.00	8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2526.00	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2524.00	12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2522.00	14.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2520.00	16.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2518.00	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2516.00	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2514.00	22.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2512.00	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2510.00	26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2508.00	28.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2506.00	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2504.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2502.00	34.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2500.00	36.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2498.00	38.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2496.00	40.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00																	
2494.00	42.0	301.60	27.00	328.61	381.72	30.38	412.10	471.26	33.75	505.01																	
2492.00	44.0	301.60	55.21	356.81	381.72	62.11	443.82	471.26	69.01	540.26																	
2490.00	46.0	301.60	84.49	386.09	381.72	95.05	476.77	471.26	105.61	576.87																	
2488.00	48.0	377.00	114.74	491.74	477.15	129.08	606.23	589.07	143.42	732.49																	
2486.00	50.0	377.00	145.84	522.84	477.15	164.07	641.21	589.07	182.30	771.37																	
2484.00	52.0	377.00	177.68	554.68	477.15	199.89	677.04	589.07	222.10	811.17																	
2482.00	54.0	377.00	210.19	587.19	477.15	236.46	713.61	589.07	262.74	851.81																	
2480.00	56.0	377.00	243.30	620.30	477.15	273.71	750.85	589.07	304.12	893.19																	
2478.00	58.0	377.00	276.89	653.89	477.15	311.50	788.65	589.07	346.11	935.18																	
2476.00	60.0	377.00	310.86	687.87	477.15	349.72	826.87	589.07	388.58	977.65																	
2474.00	62.0	377.00	345.12	722.12	477.15	388.26	865.40	589.07	431.39	1020.46																	
2472.00	64.0	377.00	379.54	756.55	477.15	426.99	904.13	589.07	474.43	1063.50																	
2470.00	66.0	377.00	414.05	791.05	477.15	465.81	942.95	589.07	517.56	1106.63																	
2468.00	68.0	377.00	448.53	825.54	477.15	504.60	981.75	589.07	560.67	1149.74																	
2466.00	70.0	377.00	482.90	859.91	477.15	543.26	1020.41	589.07	603.63	1192.70																	
2464.00	72.0	377.00	517.06	894.06	477.15	581.69	1058.83	589.07	646.32	1235.39																	
2462.00	74.0	377.00	550.91	927.91	477.15	619.77	1096.91	589.07	688.63	1277.70																	
2460.00	76.0	377.00	584.36	961.36	477.15	657.40	1134.55	589.07	730.45	1319.52																	
2458.00	78.0	377.00	617.32	994.33	477.15	694.49	1171.64	589.07	771.65	1360.72																	
2456.00	80.0	377.00	649.71	1026.72	477.15	730.93	1208.07	589.07	812.14	1401.21																	
2454.00	82.0	377.00	681.44	1058.44	477.15	766.62	1243.77	589.07	851.80	1440.87																	
2452.00	84.0	377.00	712.42	1089.42	477.15	801.47	1278.61	589.07	890.52	1479.59																	
2450.00	86.0	377.00	742.79	1119.80	477.15	835.64	1312.79	589.07	928.49	1517.56																	
2448.00	88.0	377.00	774.07	1151.07	477.15	870.83	1347.97	589.07	967.59	1556.66																	
2446.00	90.0	377.00	806.24	1183.25	477.15	907.02	1384.17	589.07	1007.80	1596.87																	


Strength Limit State Shaft Resistance-Compression (kips)
(South Abutment)
0
500
1000
1500
2000
0
10
20
30
40
50
60
70
80
90
100
Depth Below Ground Surface (feet)
Drilled Shaft Resistance
4 Ft.
4.5 Ft.
5 Ft.
Ft.
Ft.
Ft.
Ft.
Ft.