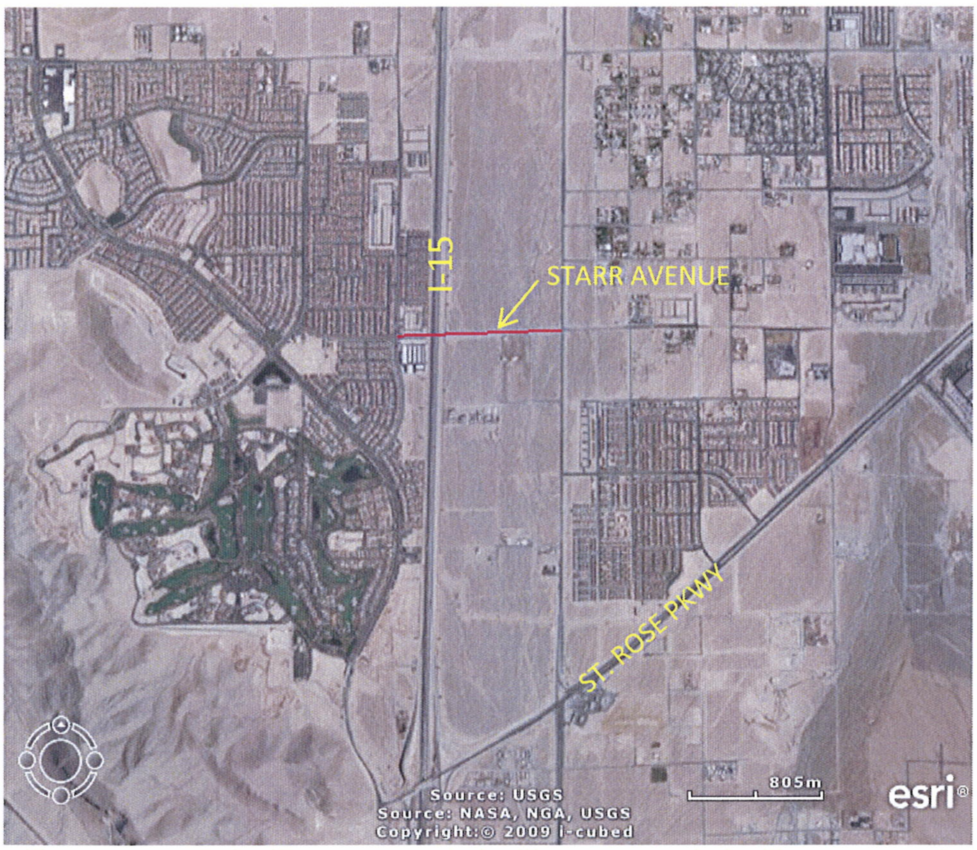
GEOTECHNICAL REPORT

INTERSTATE 15
STARR AVENUE INTERCHANGE
HENDERSON, CLARK COUNTY, NEVADA

June 2016



NEVADA DOT
GEOTECHNICAL ENGINEERING

STATE OF NEVADA

DEPARTMENT OF TRANSPORTATION

MATERIALS DIVISION

GEOTECHNICAL SECTION

GEOTECHNICAL REPORT

INTERSTATE 15 / STARR AVENUE INTERCHANGE

HENDERSON, CLARK COUNTY, NEVADA

JUNE 2016

EA #73687

Prepared by NDOT Geotechnical Section

Reviewed by ____________________

Ronald A. Siegel, P.E.

Principal Geotechnical Engineer

Approved by ____________________

Darin Tedford, P.E.

Chief Materials Engineer

TABLE OF CONTENTS

1.0 INTRODUCTION

This report presents the results of our geotechnical investigation for the proposed Starr Avenue Interchange on Interstate 15 (I-15) in Henderson, Clark County, Nevada. The Starr Avenue alignment is located on the section line between Section 32, Township 22 North and Section 5, Township 23 North, Range 61 East, MDM. The project location is shown in Figure 1. The current plan consists of extending Starr Avenue from Dean Martin Drive in the west over I-15 to Las Vegas Boulevard in the east. Starr Avenue will eventually accommodate seven lanes.

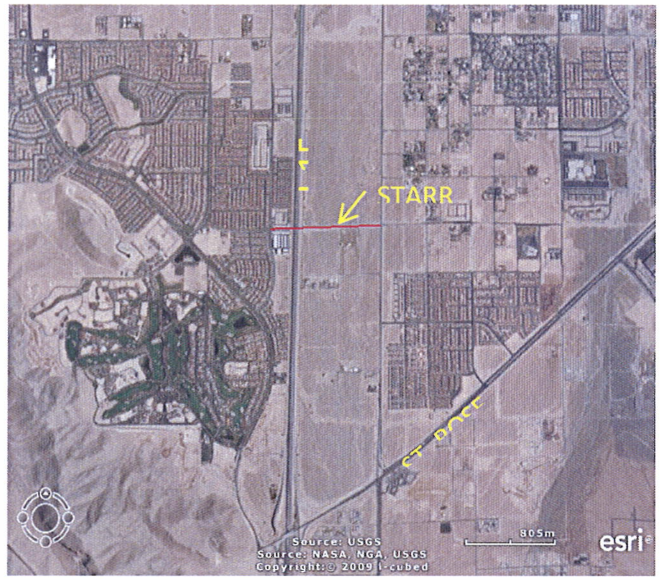


FIGURE 1 – PROJECT LOCATION[3]

2.0 SCOPE OF WORK

The purpose of this geotechnical investigation was to determine general subsurface soil and ground water conditions in the project area to provide recommendations for design and construction as related to these conditions. The scope of work performed by the Geotechnical Section included the following:

- Subsurface field exploration;
- Geophysical surveys;
- Laboratory testing;
- Engineering analysis;
- Review of published maps and reports;
- Review of preliminary design information provided by the Roadway and Structures Divisions of the Nevada Department of Transportation (NDOT).

3.0 PROJECT SITE

Starr Avenue is currently paved west of the NDOT I-15 right-of-way and is generally devoid of vegetation within the I-15 right-of-way. Some grading has occurred along the Starr Avenue alignment east of the I-15 right-of-way with scattered vegetation consisting of grasses and small shrubs.

FIGURE 2 – SITE CONDITIONS[3]

The topography along the project area generally slopes north. The I-15 alignment at the proposed interchange has a slope gradient of less than two percent. Site drainage across the project area is generally conveyed via sheet flow and several shallow natural drainage channels.

The western portion of the Starr Avenue alignment is located in a residential neighborhood with housing to the north and a storage facility to the south. The area east of the I-15 right-of-way is mostly vacant with one developed property located south of the alignment about 575 feet west of the intersection of Las Vegas Boulevard and Starr Avenue. Several structures are located on this parcel as shown in Figure 2 – Site Conditions.

4.0 FIELD EXPLORATION

Field exploration consisted of drilling one boring and conducting seismic refraction and refraction microtremor (ReMi) geophysical surveys. Boring and geophysical survey locations, shown on the Location Map included in Appendix A, were obtained using resource grade Global Positioning System (GPS) equipment. The locations should be considered accurate only to the degree implied by this method.

4.1 Drilling

Boring SIC-1 was drilled to a depth of 105 feet below the existing ground surface within the median of I-15 near the centerline of the Starr Avenue alignment. The boring was drilled using a Diedrich D120 auger type drill rig (Unit #1082) equipped with an automatic hammer utilizing Hollow Stem Continuous Flight Auger (HSA) methods. Our engineer logged the subsurface soil and groundwater conditions encountered during the field investigation and classified soils according to the Unified Soil Classification System (USCS). The boring log, a brief key to the boring log and the USCS are included in Appendix B.

Soil samples were obtained using a Standard Penetration Sampler driven 18 inches (unless otherwise noted) into the bottom of the boring using a 30-inch drop of a 140-pound hammer (Standard Penetration Test – SPT). The number of blows to drive the sampler the final 12 inches of an 18-inch penetration into undisturbed soil provides an N-value (presented as 'Blow Count' on the boring log). The N-value is an indication of the apparent density/consistency of the *in situ* soils. Blow counts presented on the boring log have not been corrected for energy, sampler type, rod length, hammer type, etc. The energy transfer from the automatic hammer into the drill rig string was calibrated at 87.5% for Unit #1802 (SPT Calibration done by Gregg Drilling and Testing, Inc., June 18, 2009). Bulk samples were also obtained by collecting auger cuttings between certain depths during drilling operations.

Soil samples were returned to NDOT laboratories and tested as described under the Laboratory Testing section of this report. The maximum particle size recovered using the SPT sampler is approximately 1⅜ inches. Therefore, the boring log may not adequately represent the actual quantity or presence of coarse gravel, cobbles or boulders.

4.2 Geophysical Surveys

Four seismic refraction and ReMi geophysical surveys were conducted along the proposed interchange alignment and are presented in Appendix D labeled 'West', 'Middle', 'East 2', and 'East 3'. The West survey line was placed parallel and west of I-15. The Middle line was placed parallel to I-15 in the centerline of the I-15 median. East 2 and East 3 were placed east of I-15 with East 2 parallel to I-15 and East 3 situated transverse to the centerline of East 2 (refer to Location Map, Appendix A).

Both the seismic refraction and ReMi survey data was obtained using cables with 12 geophones spaced 20 feet apart with the exception of East 3. East 3 was conducted using 12 geophones placed 8 feet apart. The data was analyzed by an Optim Software and Data Solutions representative using the most current SeisOpt software.

5.0 LABORATORY TESTING

Laboratory data is presented in Appendix C of this report and includes a summary of test results and graphical reports. The laboratory testing program for selected samples consisted of Natural Moisture Contents (Nev. T-104), Particle Size Gradations (Nev. T-206), Atterberg Limits (Nev. T-210, T-211 and T-212), and Resistance Value (R-Value, Nev. T-115).

6.0 GEOLOGY

Site geology consists of quaternary alluvium (Q_{al}) as shown in Figure 3 – Geologic Map. Quaternary alluvium is described as *unconsolidated clay, silt, and sand deposited on old flood plains of streams; coarse gravelly deposits spread by sporadic sheetfloods on wide slopes bordering high ranges.*[4]

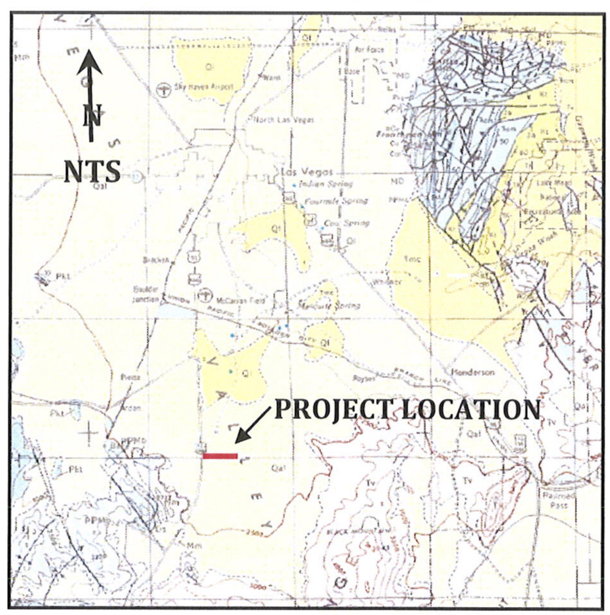


FIGURE 3 – GEOLOGIC MAP[4]

7.0 GEOLOGIC HAZARDS

7.1 Faulting and Fissures

A review of published earthquake and fault data indicates that no faults or fissures cross the project alignment. A series of Quaternary faults and two fissure areas are located approximately 5 miles northeast of the project site trending a generally northwest to southeast.[1,2,5]

7.2 Liquefaction

Liquefaction is a loss of soil shear strength that can occur during a seismic event as cyclic shear stresses cause excessive pore water pressure between the soil grains. This phenomenon is generally limited to unconsolidated, clean to silty sand (up to 35 percent non-plastic fines) lying below the ground water table. The higher the ground acceleration and the longer that shaking caused by a seismic event occurs, the more likely liquefaction will take place. Severe liquefaction can result in catastrophic settlements of large civil structures.

The site is underlain by dense granular soils; therefore, only localized amplification of ground motion would be expected during an earthquake. Liquefaction potential, in our opinion, is negligible.

8.0 SOIL AND GROUNDWATER CONDITIONS

Based on the subsurface investigation, site soils generally consist of very dense silty sand with gravel to poorly graded sand with silt/clay and silty gravel with interbeds of poorly graded sand and sandy silt with gravel. A one-foot thick caliche layer was encountered at 51½ feet. Cementation was observed throughout the subsurface profile to varying degrees. Soils are generally slightly moist to moist. Ground water was not encountered during the subsurface exploration and is expected to lie at a depth that will not affect construction.

9.0 DISCUSSION AND RECOMMENDATIONS

9.1 Site Preparation and Earthwork

All excavation and site preparation shall be performed in accordance with NDOT Standard Specifications for Road and Bridge Construction.

9.2 Trenching and Excavation

For excavations less than 20 feet deep, site soils are considered Type B for temporary excavation purposes with an allowed OSHA maximum allowable slope of 1H:1V. Cemented soils may cause difficulties during excavation and trenching activities, however, blasting will likely not be required.

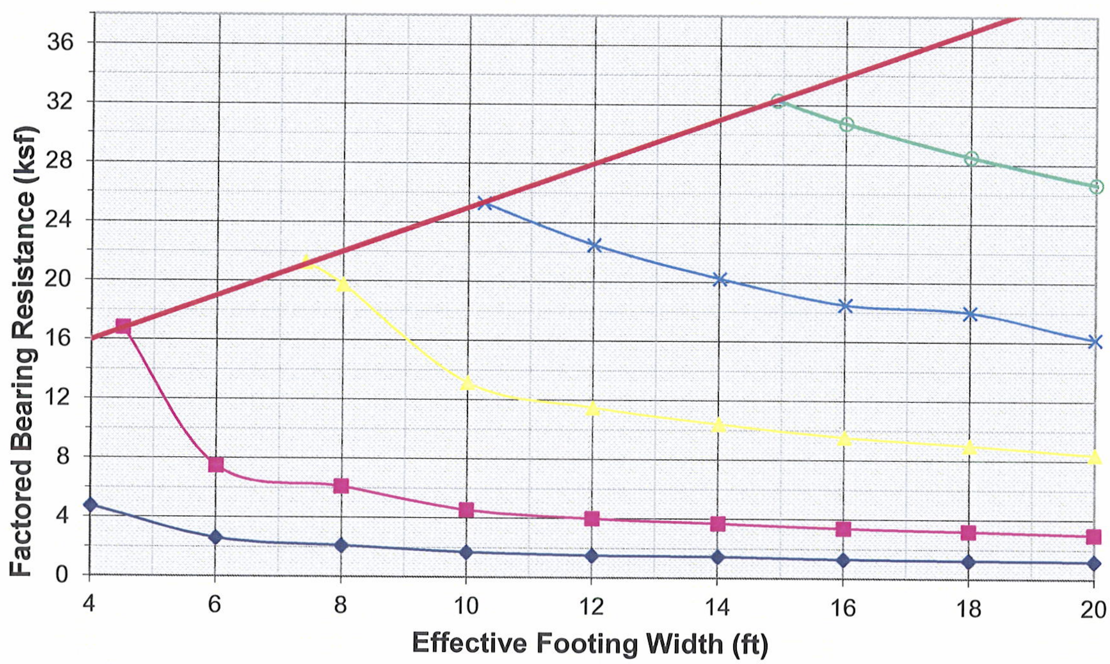
9.3 Seismic Design Parameters

Seismic Design parameters are based on the results of the geophysical surveys and field exploration. The average 1-dimensional shear wave velocity profiles for the upper 100 feet of the soil profile are presented in Appendix D. The average shear wave velocities at the project site ranged from 2,067 feet per second (ft/s) to 2,431 ft/s; therefore, the soil profile is considered Site Class C (Table 3.10.3.1-1 of AASHTO LRFD Bridge Design Specifications, 2010).

The Peak Ground Acceleration for Clark County is 0.15g with a Short-Period Acceleration Coefficient (S_s) of 0.40 and a Long-Period Spectral Acceleration Coefficient (S_1) of 0.15(NDOT Bridge Manual).

9.4 Foundation Design

Based on the results of the field exploration and laboratory testing, native soils can provide support for shallow spread footings for bridge and wall structures. Foundation grade soils shall be prepared in accordance with NDOT standards and specifications. Figures 4 and 5 provide strength limit state factored bearing resistance values and service limit state settlement values for pier and embankment foundations, respectively. These values are based on gross bearing resistance with an embedment depth of five feet for pier structures and zero embedment for foundations in embankment material.



LEGEND

- s = 0.25"
- s = 0.50"
- s = 1.00"
- s = 1.50"
- s = 2.00"
- Factored Bearing Resistance at Strength Limit State

NOTES

1. Factored Bearing Resistance at Strength Limit State, q_r (ϕ_b = 0.45)
2. Settlement, s, at Service Limit State
3. Factored Bearing Resistance values are based on nominal gross bearing resistance

FIGURE 4 – PIER FOUNDATIONS
SETTLEMENT AND FACTORED BEARING RESISTANCE

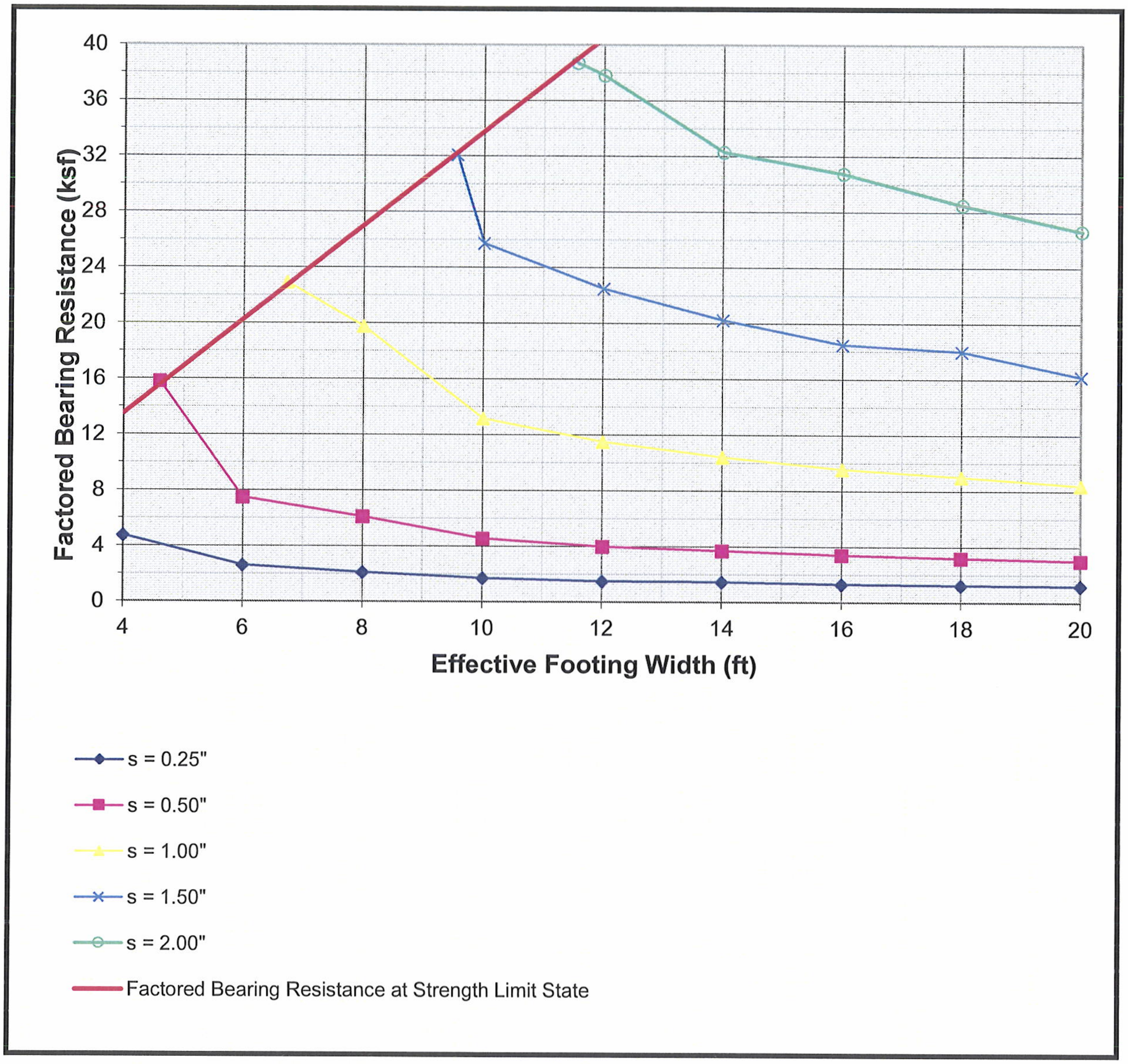


FIGURE 5 – EMBANKMENT FOUNDATIONS
SETTLEMENT AND FACTORED BEARING RESISTANCE

Lateral loads, such as wind or seismic, may be resisted by passive soil pressure and friction on the bottom of the footing. A friction factor of 0.40 may be utilized for sliding resistance at the base of the spread footing. Design value for passive equivalent fluid pressures is 300 pounds per square foot (psf) per foot of depth. Both the passive pressure and sliding resistance can be assumed to act concurrently. In designing for passive pressure, the soil above the footing should not be included unless confined by a concrete slab, or pavement. The base of all excavations should be dry and free of loose materials at the time of concrete placement. Loose, soft, wet, frozen or disturbed soils encountered at foundation subgrade should be removed to expose suitable soils and the resulting excavation shall be backfilled with compacted granular fill.

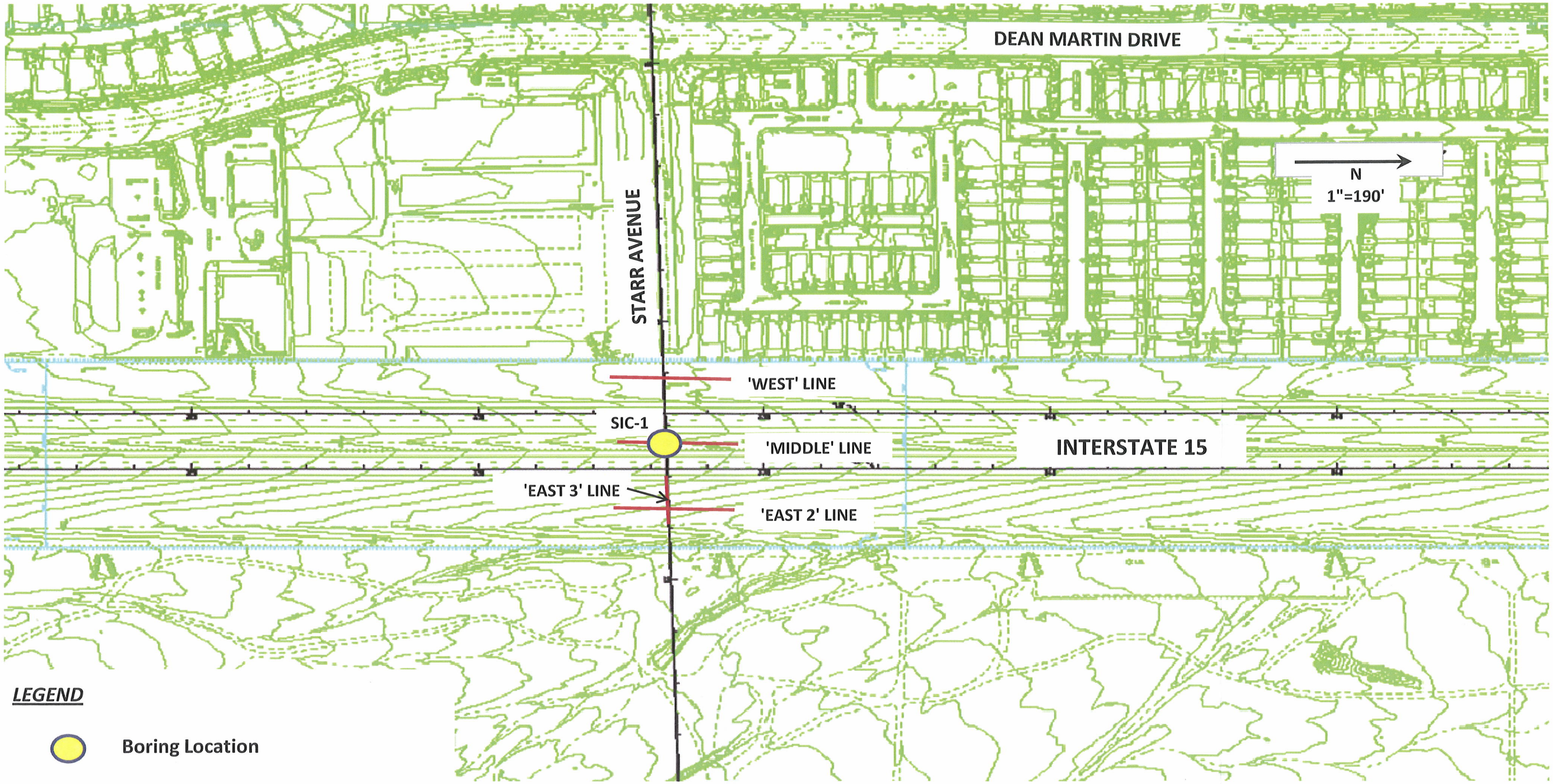
9.5 Settlement

Total settlement of an individual foundation will vary depending on the plan dimensions of the foundation and the actual load supported. Settlement of all foundations is expected to occur rapidly and should be essentially complete shortly after initial application of the loads due to the very dense granular soils present at the site.

10.0 REFERENCES

1. Bell, J.W. and Price, G.G., 1993, *Subsidence in Las Vegas Valley, 1980-1991, Final Project Report*, Nevada Bureau of Mines and Geology, Open-File Report 93-4.
2. dePolo, C.M., and Bell, J.W., 2000, *Map of Faults and Earth Fissures in the Las Vegas Area*, Nevada Bureau of Mines and Geology, prepared in cooperation with Las Vegas Valley Water District: Plate 1.
3. ESRI, Arc GIS Explorer, *Aerial Photograph,* United States Geological Society (USGS), NASA, NGA, 2008.
4. Longwell, C. R. Pampeyan, E. H., Bowyer, Ben, and Roberts, R. J., 1965, *Geology and Mineral Deposits of Clark County*, Nevada, Nevada Bureau of Mines and Geology, Bulletin 52,.
5. United States Geological Survey (USGS), 2011b, *Quaternary Faults and Folds Database of the United States*: http://earthquakes.usgs.gov/qfaults.

APPENDIX A



LEGEND

Boring Location

ReMi/Refraction Survey Line

NEVADA DOT
GEOTECHNICAL ENGINEERING

Henderson, Clark County, Nevada
EA#: 73687
DATE: October 2011

LOCATION MAP
BORINGS AND GEOPHYSICAL SURVEYS

INTERSTATE 15
STARR AVENUE INTERCHANGE

APPENDIX B

KEY TO EXPLORATION LOGS

PARTICLE SIZE LIMITS								
CLAY	SILT	SAND			GRAVEL		COBBLES	BOULDERS
		FINE	MEDIUM	COARSE	FINE	COARSE		

.002 mm #200 #40 #10 #4 ¾ inch 3 inch 12 inch

USCS GROUP	TYPICAL SOIL DESCRIPTION
GW	Well graded gravels, gravel-sand mixtures, little or no fines
GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
GC	Clayey gravels, poorly graded gravel-sand-clay mixtures
SW	Well graded sands, gravelly sands, little or no fines
SP	Poorly graded sands, gravelly sands, little or no fines
SM	Silty sands, poorly graded sand-silt mixtures
SC	Clayey sands, poorly graded sand-clay mixtures
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
OL	Organic silts and organic silt-clays of low plasticity
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
CH	Inorganic clays of high plasticity, fat clays
OH	Organic clays of medium to high plasticity
PT	Peat and other highly organic soils

MOISTURE CONDITION CRITERIA

Description	Criteria
Dry	Absence of moisture, dusty, dry to touch.
Moist	Damp, no visible free water.
Wet	Visible free water, usually below groundwater table.
▽ ▼	Groundwater Elevation Symbols

SOIL CEMENTATION CRITERIA

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Won't break or crumble w/finger pressure

STANDARD PENETRATION CLASSIFICATION*			
GRANULAR SOIL		CLAYEY SOIL	
BLOWS/FT	DENSITY	BLOWS/FT	CONSISTENCY
0 - 4	VERY LOOSE	0 - 1	VERY SOFT
5 – 10	LOOSE	2 - 4	SOFT
11 - 30	MEDIUM DENSE	5 - 8	MEDIUM STIFF
31 - 50	DENSE	9 - 15	STIFF
OVER 50	VERY DENSE	16 - 30	VERY STIFF
		31 - 60	HARD
		OVER 60	VERY HARD

*Standard Penetration Test (N) 140 lb hammer 30 inch free fall on 2 inch O.D. x 1.4 inch I.D. sampler.

Field Blow counts on California Modified Sampler (N_{CMS}) can be converted to $N_{SPT\ field}$ by:

$(N_{CMS\ field})(0.62) = N_{SPT\ field}$

Blow counts from Automatic Hammer can be converted to Standard SPT N_{60} by:

Rig #1627: $(N_{SPT\ field})(1.2) = N_{60}$

Rig #1082: $(N_{SPT\ field})(1.45) = N_{60}$

TEST ABBREVIATIONS

CD	CONSOLIDATED DRAINED
CH	CHEMICAL (CORROSIVENESS)
CM	COMPACTION
CU	CONSOLIDATED UNDRAINED
D	DISPERSIVE SOILS
DS	DIRECT SHEAR
E	EXPANSIVE SOIL
G	SPECIFIC GRAVITY
H	HYDROMETER
HC	HYDRO-COLLAPSE
K	PERMEABILITY
OC	ORGANIC CONTENT
C	CONSOLIDATION
PI	PLASTICITY INDEX
RQD	ROCK QUALITY DESIGNATION
RV	R-VALUE
S	SIEVE ANALYSIS
SL	SHRINKAGE LIMIT
U	UNCONFINED COMPRESSION
UU	UNCONSOLIDATED UNDRAINED
UW	UNIT WEIGHT
W	MOISTURE CONTENT

SOIL COLOR DESIGNATIONS ARE FROM THE MUNSELL SOIL/ROCK COLOR CHARTS.

EXAMPLE: (7.5 YR 5/3) BROWN

SAMPLER NOTATION

CMS	CALIF. MODIFIED SAMPLER[1]
CPT	CONE PENETRATION TEST
CS	CONTINUOUS SAMPLER[2]
PB	PITCHER BARREL
RC	ROCK CORE[3]
SH	SHELBY TUBE[4]
SPT	STANDARD PENETRATION TEST
TP	TEST PIT

1- I.D.= 2.421 inch
2- I.D.=3.228 inch with tube; 3.50 inch w/o tube
3- NXB I.D.= 1.875 inch
4- I.D.= 2.875 inch

Revised August 2010

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE	10/6/10	STATION	333+34 "LS"
END DATE	10/7/10	OFFSET	53' RT
JOB DESCRIPTION	I-15 STARR INTERCHANGE	ENGINEER	MLB
LOCATION	CLARK COUNTY	EQUIPMENT	DRILL RIG #1801
BORING	SIC-1	OPERATOR	D. FORD
E.A. #	73687	DRILLING METHOD	HSA
GROUND ELEV.	2361' (ft)	BACKFILLED	Yes DATE 10/07/10
HAMMER DROP SYSTEM	AUTO		

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
	N.E.	0.0

ELEV. (ft)	DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 6 inch Increments	BLOW COUNT Last 1 foot	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	0.00	A	AUGER					GM	**SILTY GRAVEL WITH SAND** dry, light brown, with subrounded gravel. NOTE: Cobbles encountered at 2 to 2 1/2 feet with an approximate maximum 4-inch nominal diameter.	No free water encountered.
5	5.00								5.00	
	5.10 – 6.60	B2	SPT	17 39 50	89	0		SM	**SILTY SAND WITH GRAVEL** dry to moist, tan to light orange brown, mostly medium to coarse sand with subangular gravel.	
	7.50	B1	AUGER							
	7.50 – 8.83	C	SPT	28 39 50/4"	50/4"	100				
10	10.00 – 10.17	D	SPT	50/2"	50/2"	0				
	12.50 – 12.75	E	SPT	50/3"	50/3"	100			High SPT blow counts are due to presence of strong cementation.	
15	15.00 – 15.30	F	SPT	50/3.75"	50/3.75"	90				
20	20.00 – 20.10	G	SPT	50/1"	50/1"	0			20.00	
		H	BULK						**POORLY GRADED SAND WITH CLAY AND GRAVEL** moist, tan to light orange brown, mostly medium to course sand with subangular to angular gravel and low plastic fines	
25	25.00 – 25.38	I	SPT	50/4.5"	50/4.5"	100			High SPT blow counts are due to presence of strong cementation.	
	30.00									

EXPLORATION LOG

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

START DATE	10/6/10	STATION	333+34 "LS"
END DATE	10/7/10	OFFSET	53' RT
JOB DESCRIPTION	I-15 STARR INTERCHANGE	ENGINEER	MLB
LOCATION	CLARK COUNTY	EQUIPMENT	DRILL RIG #1801
BORING	SIC-1	OPERATOR	D. FORD
E.A. #	73687	DRILLING METHOD	HSA
GROUND ELEV.	2361' (ft)	BACKFILLED	Yes
HAMMER DROP SYSTEM	AUTO	DATE	10/07/10

GROUNDWATER LEVEL

DATE	DEPTH ft	ELEV. ft
	N.E.	0.0

ELEV. (ft)	DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 6 inch Increments	BLOW COUNT Last 1 foot	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	30.17	J	SPT	50/2"	50/2"	100				
	35 35.00 35.42	K	SPT	50/5"	50/5"	100				
	40 40.00 40.30	L	SPT	50/3.5"	50/3.5"	29		SP SC		
	45 45.00 45.21	M	SPT	50/2.5"	50/2.5"	100				
	50 50.00 50.33	N	SPT	50/4"	50/4"	100			NOTE: HARD CALICHE LAYER AT 51' TO 52.5'	
	55 55.00 55.08	O	SPT	50/<1"	50/<1"	75				
	60.00								60.00	

EXPLORATION LOG

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

START DATE	10/6/10	STATION	333+34 "LS"
END DATE	10/7/10	OFFSET	53' RT
JOB DESCRIPTION	I-15 STARR INTERCHANGE	ENGINEER	MLB
LOCATION	CLARK COUNTY	EQUIPMENT	DRILL RIG #1801
BORING	SIC-1	OPERATOR	D. FORD
E.A. #	73687	DRILLING METHOD	HSA
GROUND ELEV.	2361' (ft)	BACKFILLED	Yes
HAMMER DROP SYSTEM	AUTO	DATE	10/07/10

GROUNDWATER LEVEL

DATE	DEPTH ft	ELEV. ft
	N.E.	0.0

ELEV. (ft)	DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 6 inch Increments	BLOW COUNT Last 1 foot	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	60.25	P	SPT	50/3"	50/3"	100			**INTERBEDDED POORLY GRADED SAND WITH CLAY AND GRAVEL AND SANDY SILT WITH GRAVEL** dry, tan, some fine to medium sand, fine subangular to angular gravel.	
	65									
	70.00 / 70.25	Q	SPT	50/3"	50/3"	100				
	75									
	80.00 / 80.31	R	SPT	50/3.75"	50/3.75"	100				
								MH		
	85									
	90.00									

NEVADA DEPARTMENT OF TRANSPORTATION GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE 10/6/10
END DATE 10/7/10
JOB DESCRIPTION I-15 STARR INTERCHANGE
LOCATION CLARK COUNTY
BORING SIC-1
E.A. # 73687
GROUND ELEV. 2361' (ft)
HAMMER DROP SYSTEM AUTO

GROUNDWATER LEVEL		
DATE	DEPTH ft	ELEV. ft
	N.E.	0.0

STATION 333+34 "LS"
OFFSET 53' RT
ENGINEER MLB
EQUIPMENT DRILL RIG #1801
OPERATOR D. FORD
DRILLING METHOD HSA
BACKFILLED Yes DATE 10/07/10

ELEV. (ft)	DEPTH (ft)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 6 inch Increments	BLOW COUNT Last 1 foot	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	90.17	S	SPT	50/2"	50/2"	100				
	95									
	100.00 / 100.17	T	SPT	50/2"	50/2"	100				
	105								105.00 Bottom of boring at 105 feet.	
	110									
	115									

APPENDIX C

SUMMARY OF RESULTS
N.D.O.T. GEOTECHNICAL SECTION

EA/Cont # 73687 **Job Description** I-15 Starr Interchange

Boring No. SIC - 1 **Elevation (ft)** 2361' **Station** 333+34, 53' RT **Date** 10/7/2010

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMPLER TYPE	N BLOWS per ft.	SOIL GROUP	W%	DRY UW pcf	% PASS #200	LL %	PL %	PI %	STRENGTH TEST: TEST TYPE	Peak: Φ deg.	Peak: C psi	Residual: Φ deg.	Residual: C psi	COMMENTS
A	0.0 - 5.0	Auger		GM			15.5	28	25	3						RV = 80
B1	5.0 - 10.0	Auger		SC-SM	3.4		13.6	25	20	5						
B2	5.1-6.6	SPT	89	SM												
C	7.5 - 9.0	SPT	50/4"	SM	6.6		19.3	38	27	11						
D	10.0-10.17	SPT	R		4.8		15.6									
E	12.5-12.75	SPT	R		4.8		15.6									
F	15.0-15.3	SPT	R		2.0		24.3									
H	20.0-25.0	Auger	R	SP-SC	2.9		10.7	38	24	14						

SAMPLE 'D' AND 'E' COMBINED

CMS = California Modified Sampler 2.42" ID
SPT = Standard Penetration 1.38" ID
CS = Continuous Sample 3.23" ID
RC = Rock Core
PB = Pitcher Barrel
CSS = Calif. Split Spoon 2.42" ID
CPT = Cone Penetration Test
TP = Test Pit
P = Pushed, not driven
R = Refusal
Sh = Shelby Tube 2.87" ID

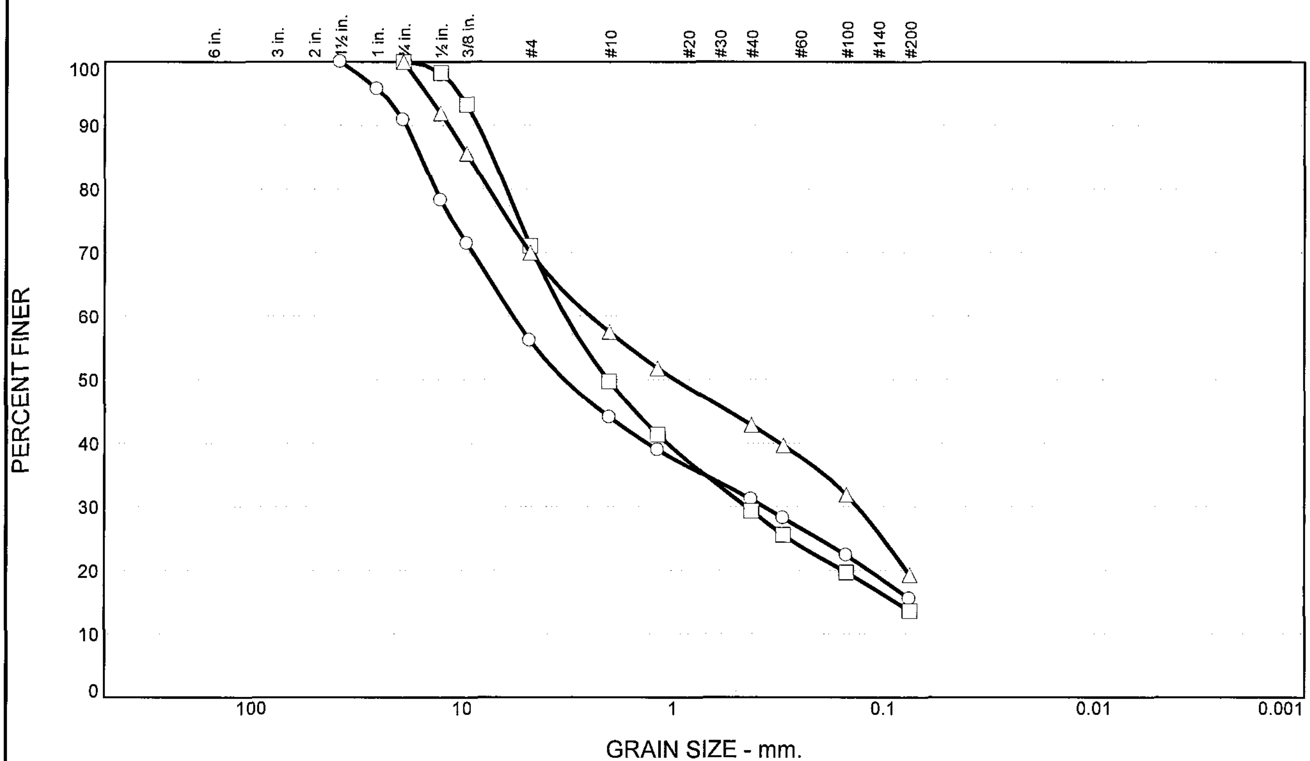
U = Unconfined Compressive
UU = Unconsolidated Undrained
CD = Consolidated Drained
CU = Consolidated Undrained
DS = Direct Shear
Φ = Friction
C = Cohesion
N = No. of blows per ft., sampler

N = Field SPT N = $(N_{css})(0.62)$

H = Hydrometer
S = Sieve
G = Specific Gravity
PI = Plasticity Index
LL = Liquid Limit
PL = Plastic Limit
NP = Non-Plastic
OC = Consolidation
Ch = Chemical
RV = R - Value
MD = Moisture Density

CM = Compaction
E = Swell/Pressure on Expansive Soils
SL = Shrinkage Limit
UW= Unit Weight
W = Moisture Content
K = Permeability
O = Organic Content
D = Dispersive
RQD = Rock Quality Designation
X = X-Ray Defraction
HCpot = Hydro-Collapse Potential

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT / % CLAY	USCS	AASHTO	PL	LL
○	0.0	43.9	40.6	15.5	GM	A-1-b	25	28
□	0.0	29.0	57.4	13.6	SC-SM	A-1-a	20	25
△	0.0	30.0	50.7	19.3	SM	A-2-6(0)	27	38

SIEVE inches size	PERCENT FINER ○	□	△
1.5"	100.0		
1"	95.7		
3/4"	90.9	100.0	100.0
1/2"	78.3	98.2	91.9
3/8"	71.4	93.3	85.6
	GRAIN SIZE		
D_{60}	5.7374	3.2299	2.4714
D_{30}	0.3707	0.4493	0.1328
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	56.1	71.0	70.0
#10	44.1	49.7	57.5
#16	39.0	41.4	51.8
#40	31.1	29.4	42.9
#50	28.2	25.6	39.6
#100	22.4	19.7	31.9
#200	15.5	13.6	19.3

Material Description
○ silty gravel with sand
□ silty, clayey sand with gravel
△ silty sand with gravel

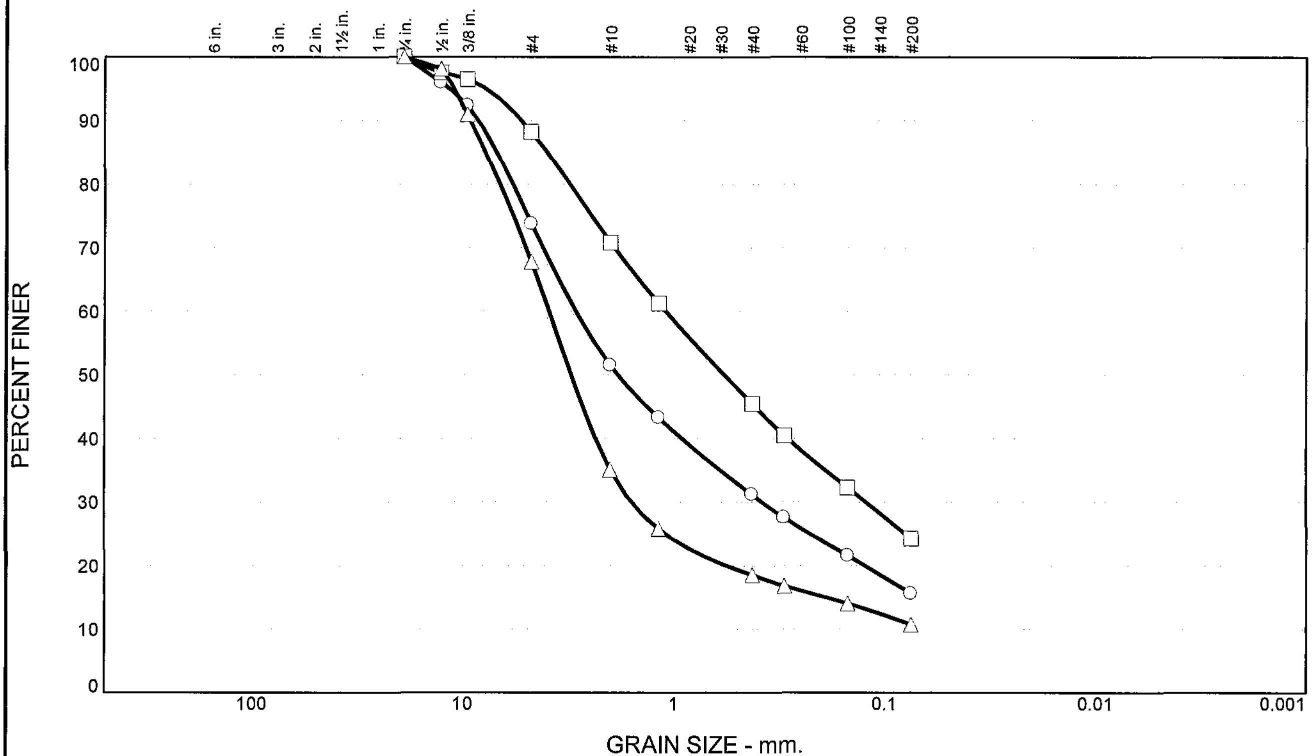
REMARKS:
○
□
△

○ Source of Sample: SIC-1 Depth: 0.0 - 5.0' Sample Number: A
□ Source of Sample: SIC-1 Depth: 5.0 - 10.0' Sample Number: B
△ Source of Sample: SIC-1 Depth: 7.5 - 9.0' Sample Number: C

NEVADA DEPARTMENT OF TRANSPORTATION

Client: M. Boutilier
Project: I-15 Starr Interchange
Project No.: EA 73687 Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	26.2	58.2	15.6					
□	0.0	11.8	63.9	24.3					
△	0.0	32.2	57.1	10.7		SP-SC	A-2-6(0)	24	38

SIEVE inches size	PERCENT FINER ○	□	△
3/4"	100.0	100.0	100.0
1/2"	96.0	97.6	98.1
3/8"	92.4	96.5	91.0
	GRAIN SIZE		
D_{60}	2.9148	1.0961	3.9124
D_{30}	0.3809	0.1226	1.5886
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	73.8	88.2	67.8
#10	51.5	70.8	35.1
#16	43.3	61.2	25.8
#40	31.2	45.5	18.5
#50	27.6	40.5	16.8
#100	21.6	32.3	14.1
#200	15.6	24.3	10.7

Material Description
○
□
△ poorly graded sand with clay and gravel

REMARKS:
○
□
△

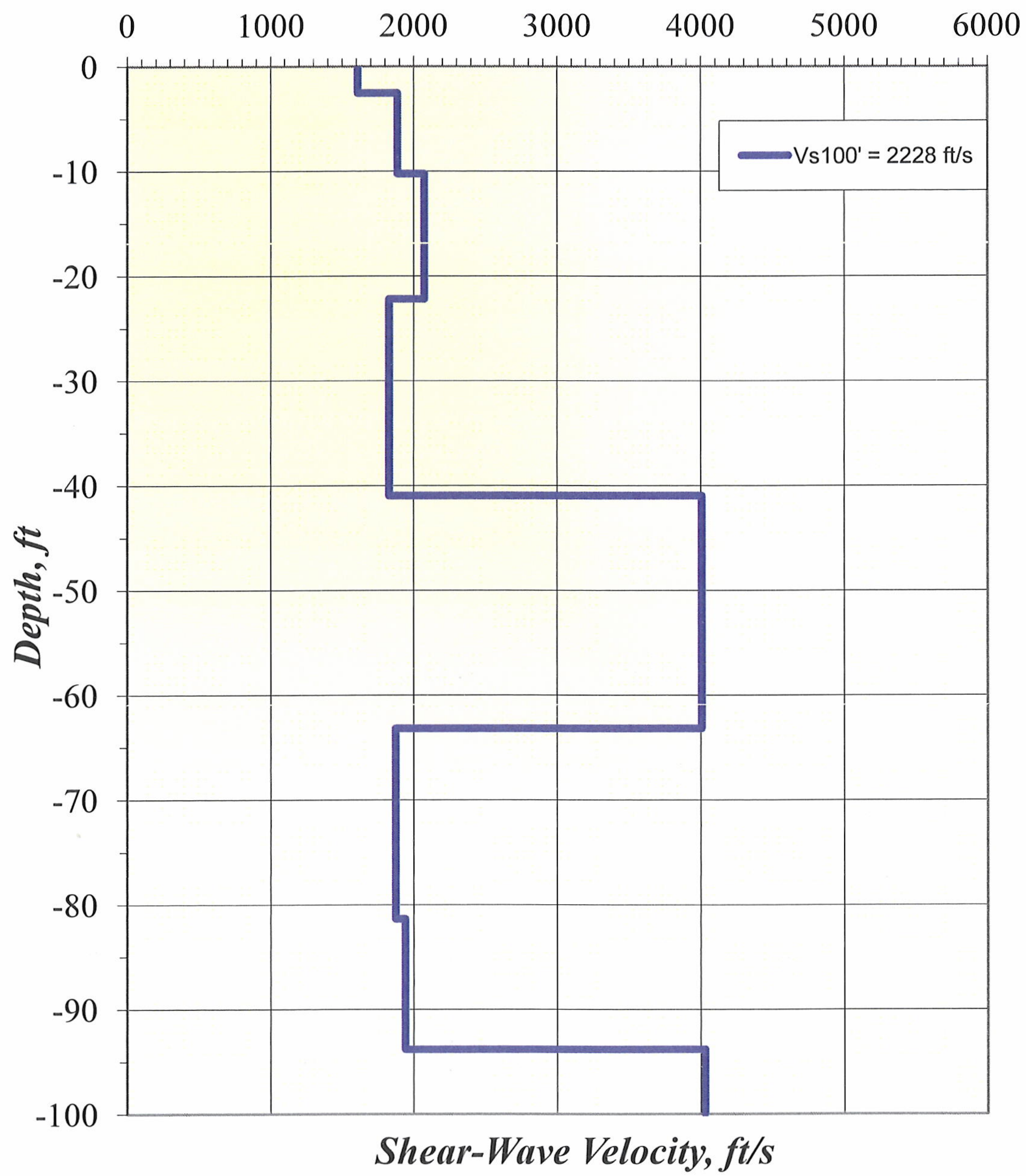
○ Source of Sample: SIC-1 Depth: 12.5 - 14.0' Sample Number: E
□ Source of Sample: SIC-1 Depth: 15.0 - 16.5' Sample Number: F
△ Source of Sample: SIC-1 Depth: 20.0 - 25.0' Sample Number: H

NEVADA DEPARTMENT OF TRANSPORTATION

Client: M. Boutilier
Project: I-15 Starr Interchange
Project No.: EA 73687 Figure

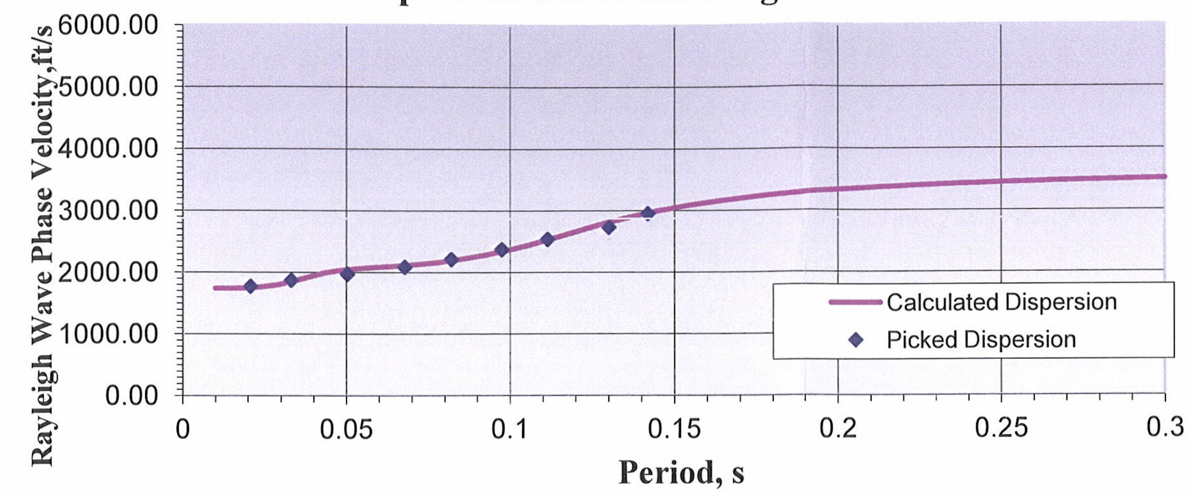
APPENDIX D

West: Vs Model

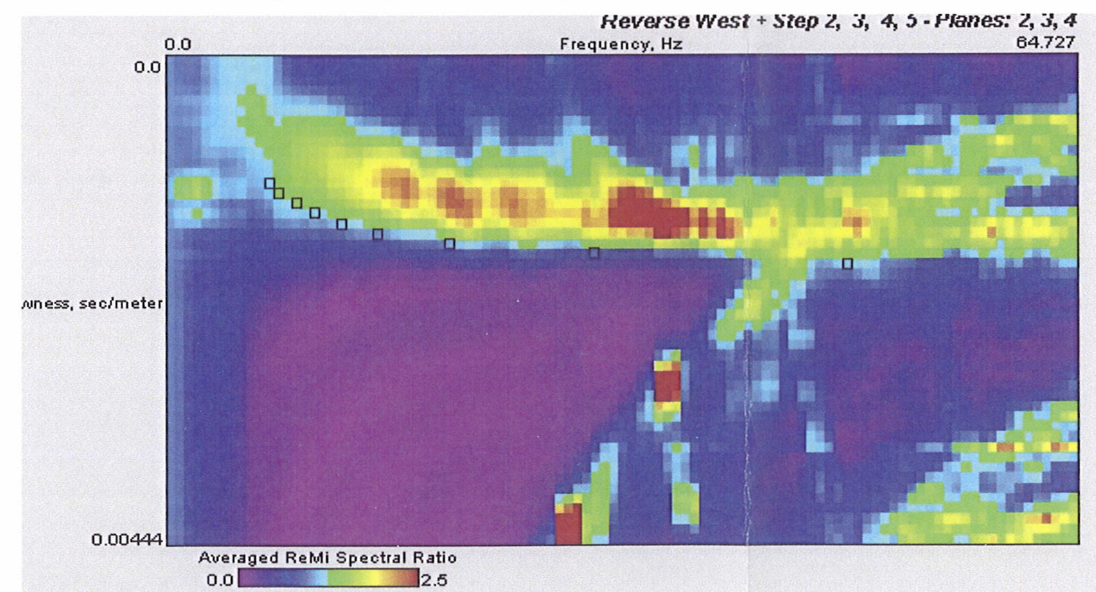


West: Supportive Illustration

Dispersion Curve Showing Picks and Fit

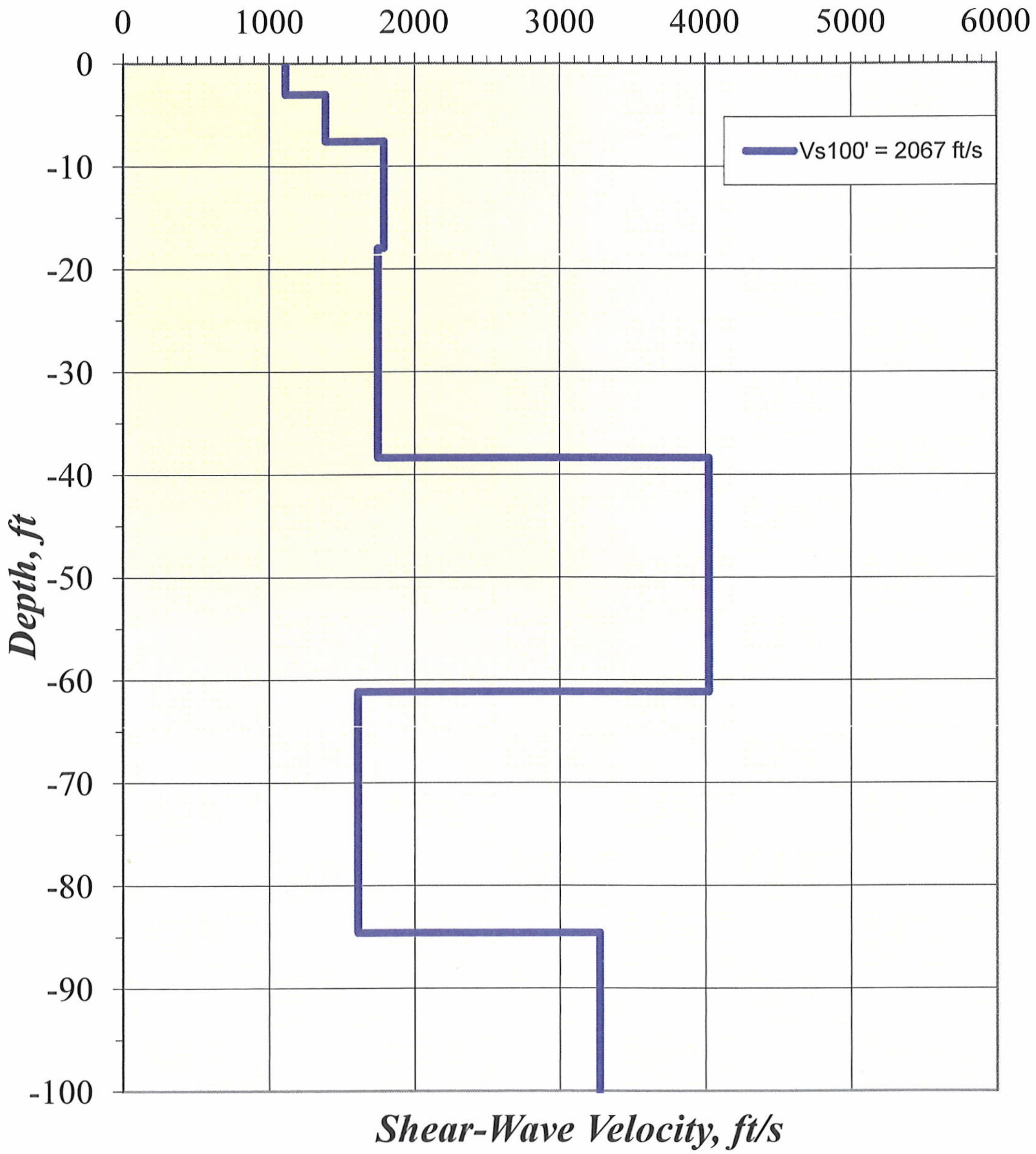


p-f Image with Dispersion Modeling Picks



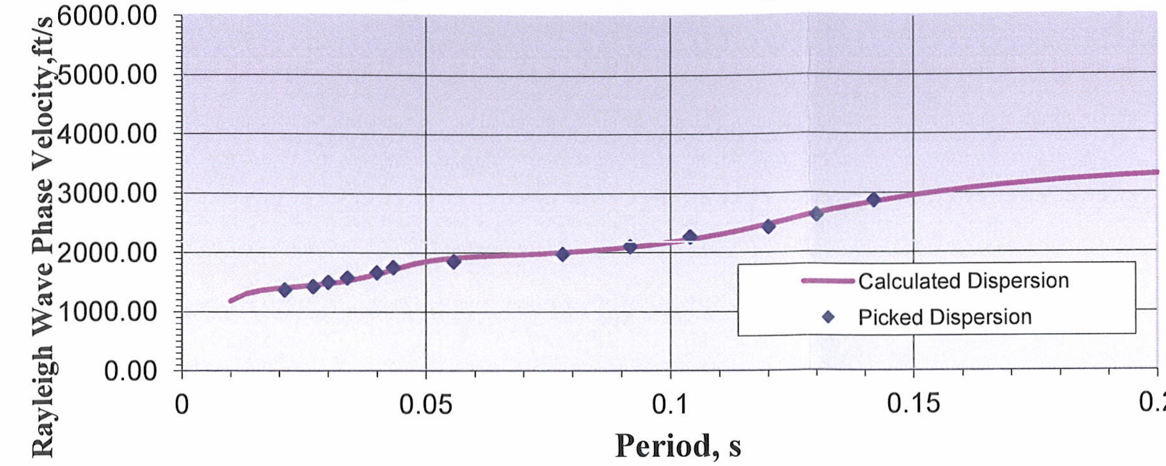
NEVADA DOT GEOTECHNICAL ENGINEERING	Henderson, Clark County, Nevada EA#: 73687 DATE: October 2011		WEST REMI LINE REMI RESULTS INTERSTATE 15 STARR AVENUE INTERCHANGE

Middle: Vs Model

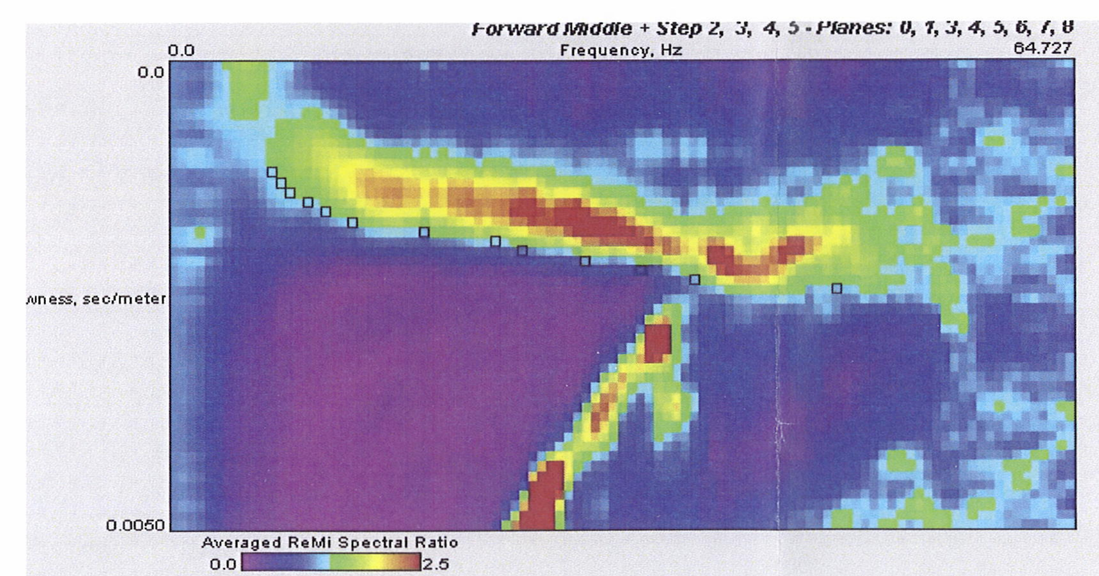


Middle: Supportive Illustration

Dispersion Curve Showing Picks and Fit

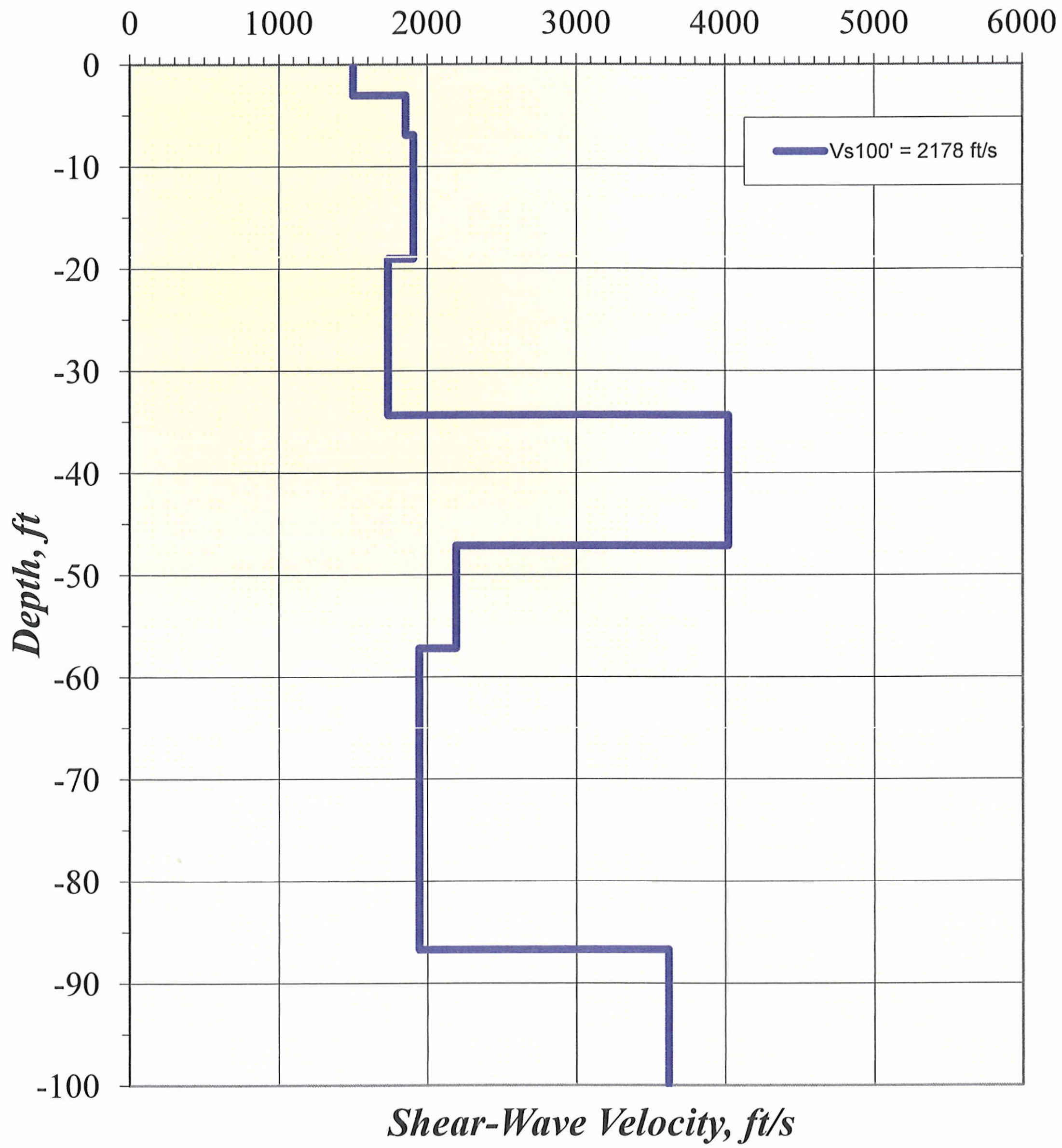


p-f Image with Dispersion Modeling Picks

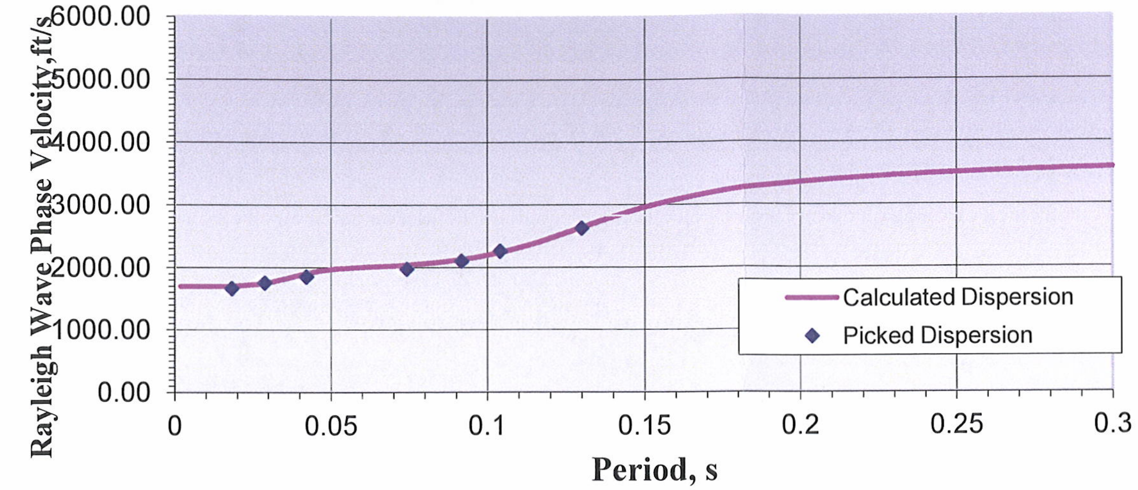


NEVADA DOT GEOTECHNICAL ENGINEERING	Henderson, Clark County, Nevada EA#: 73687 DATE: October 2011		MIDDLE REMI LINE REMI RESULTS INTERSTATE 15 STARR AVENUE INTERCHANGE

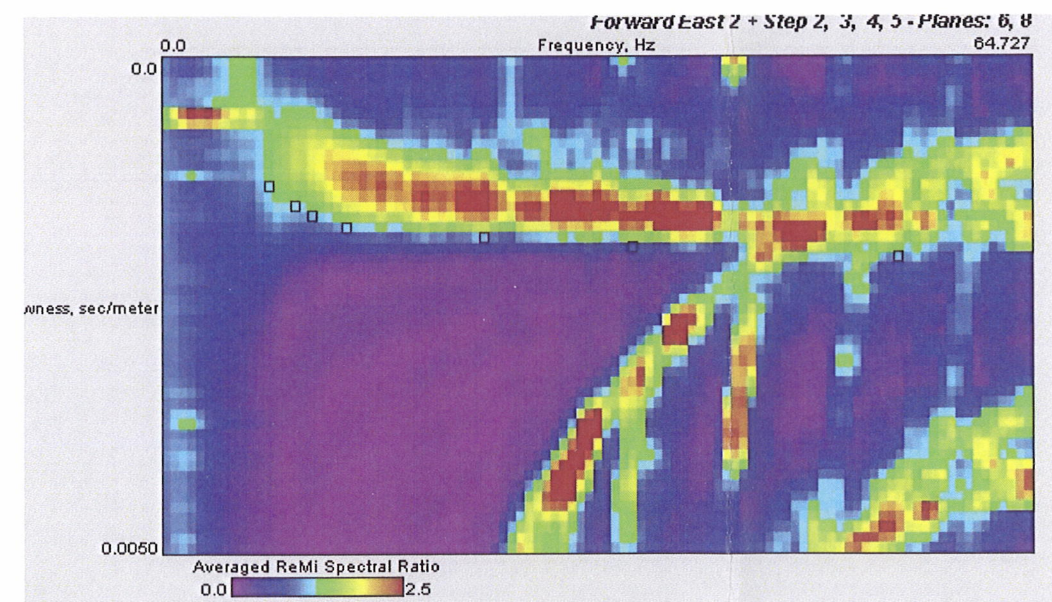
East 2: Vs Model



East 2: Supportive Illustration
Dispersion Curve Showing Picks and Fit

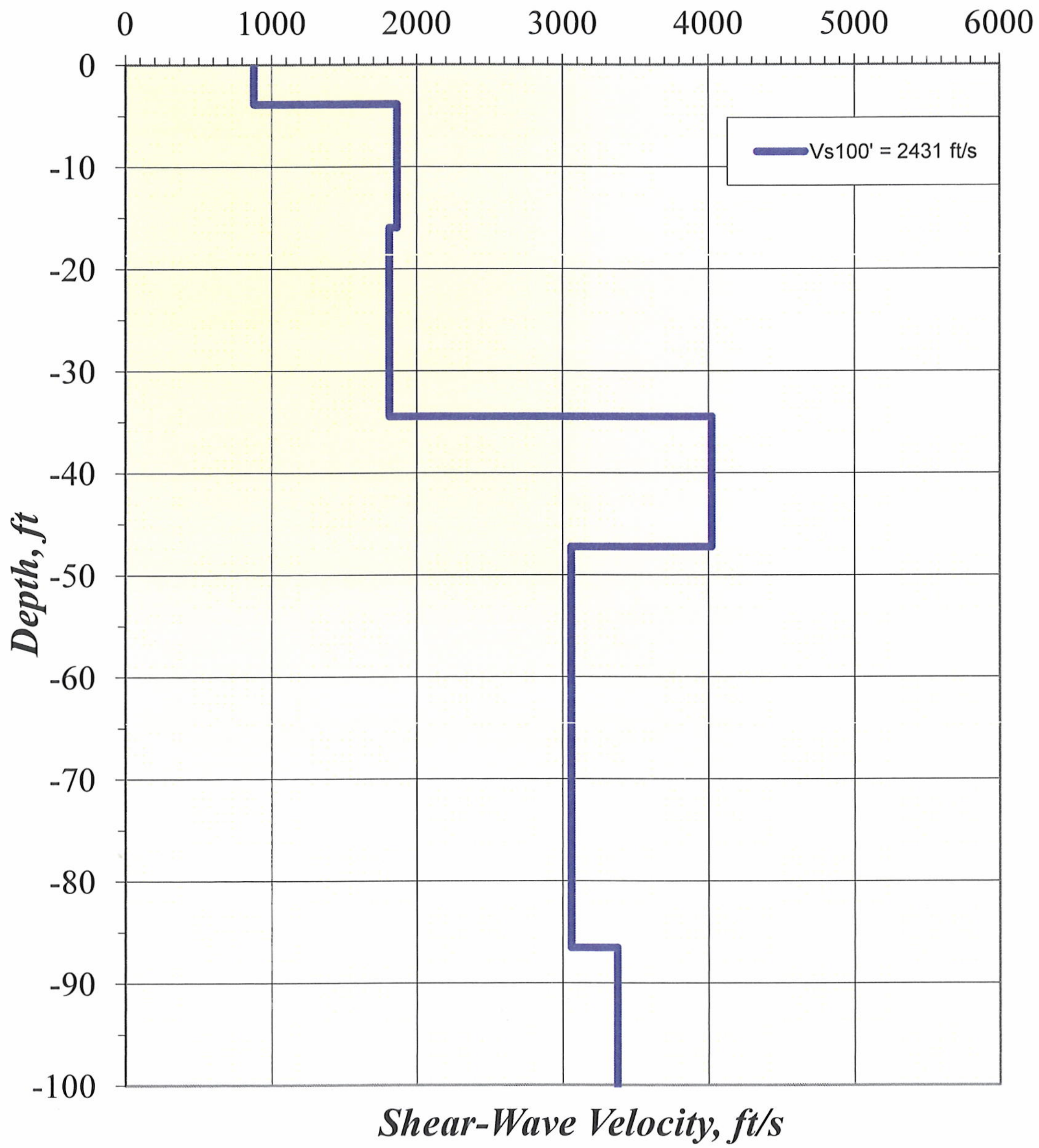


p-f Image with Dispersion Modeling Picks

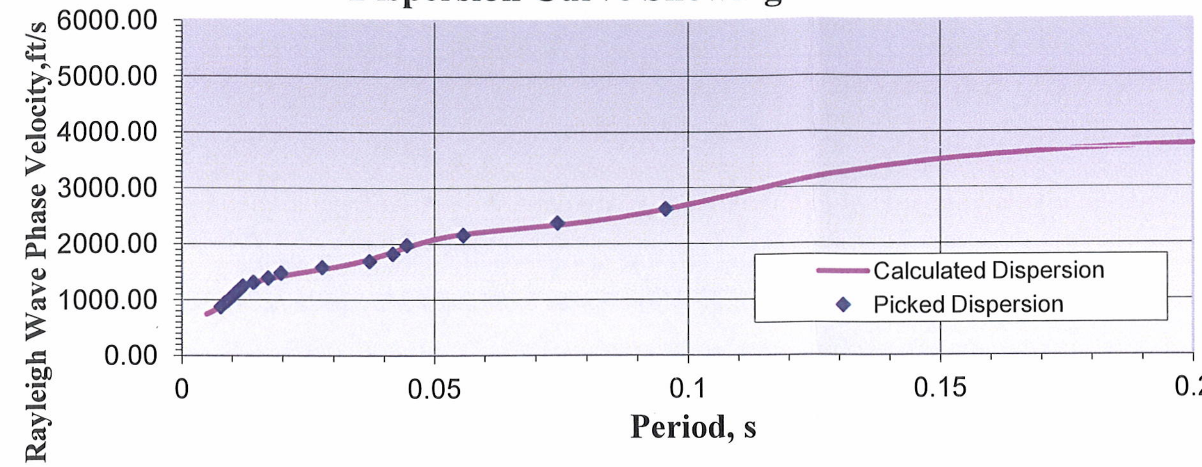


NEVADA DOT GEOTECHNICAL ENGINEERING	Henderson, Clark County, Nevada EA#: 73687 DATE: October 2011		EAST 2 REMI LINE REMI RESULTS INTERSTATE 15 STARR AVENUE INTERCHANGE

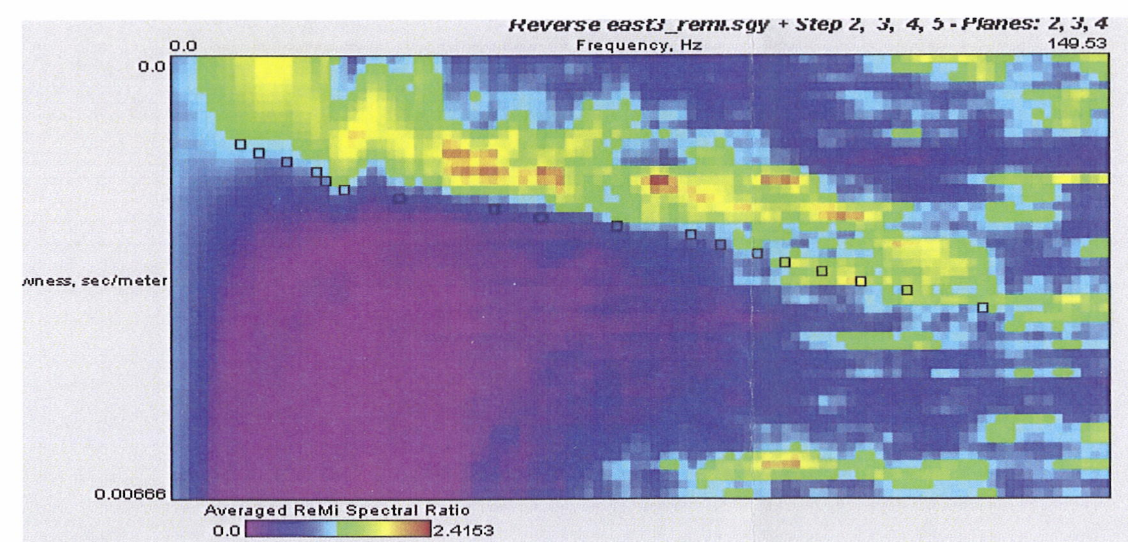
East 3: Vs Model



East 3: Supportive Illustration
Dispersion Curve Showing Picks and Fit

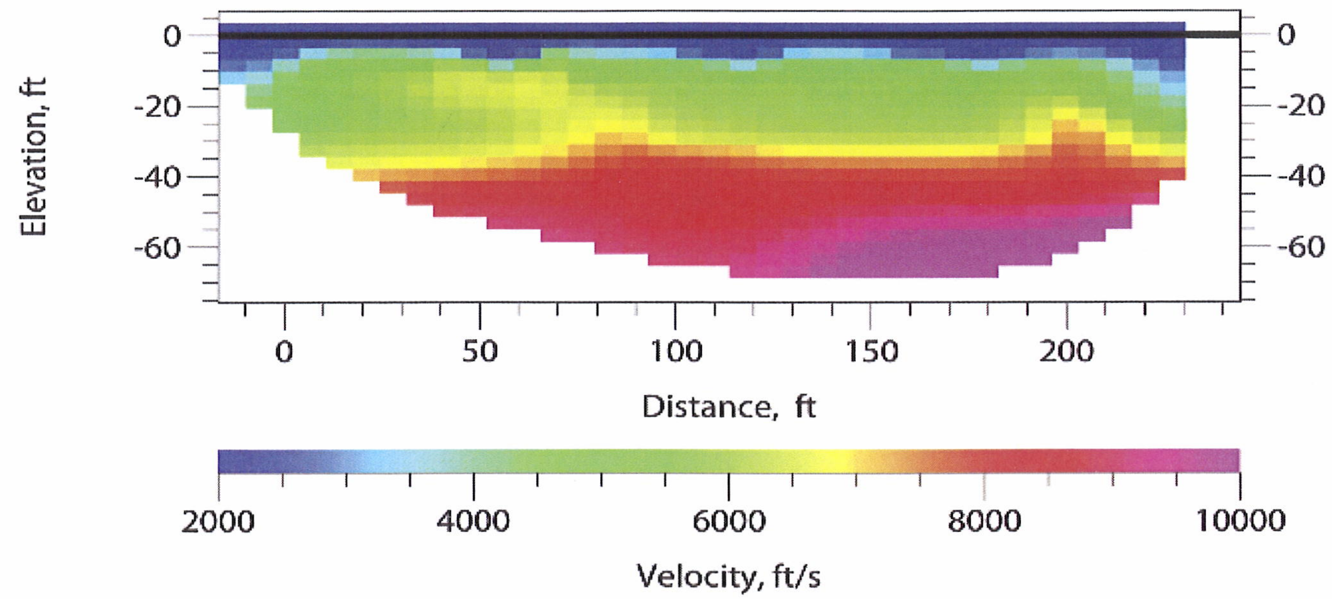


p-f Image with Dispersion Modeling Picks

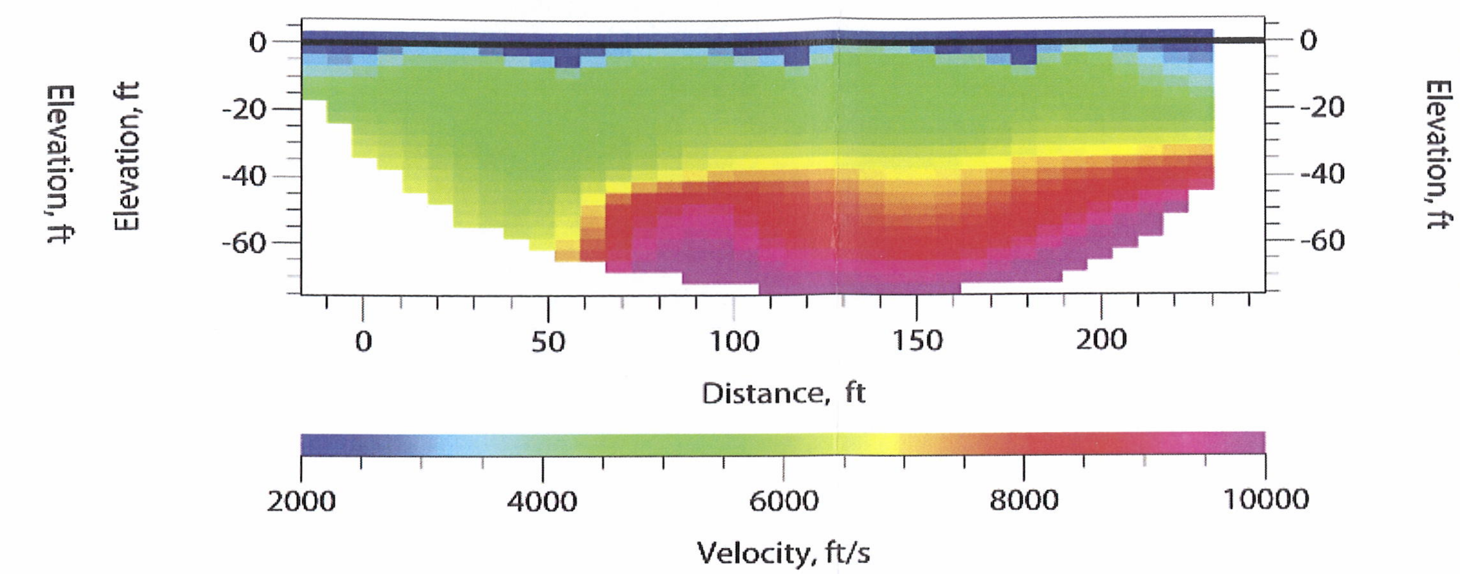


NEVADA DOT GEOTECHNICAL ENGINEERING	*Henderson, Clark County, Nevada* *EA#: 73687* *DATE: October 2011*		*EAST 3 REMI LINE* *REMI RESULTS* INTERSTATE 15 STARR AVENUE INTERCHANGE

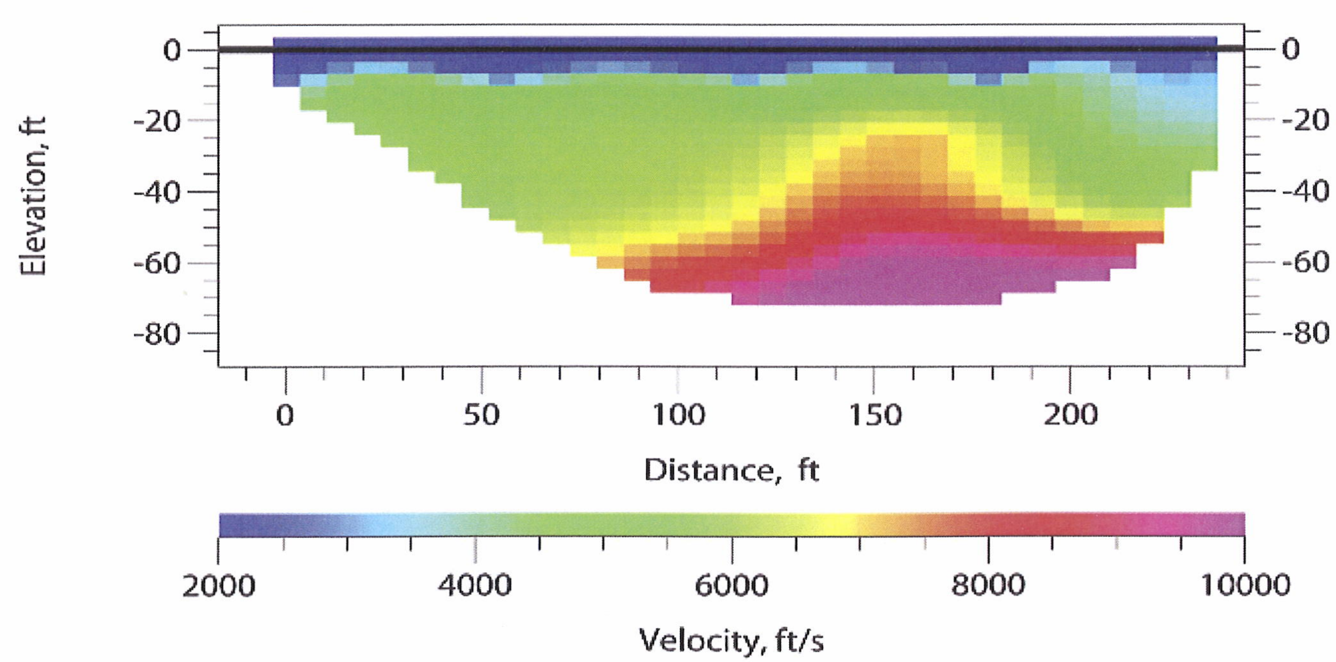
West



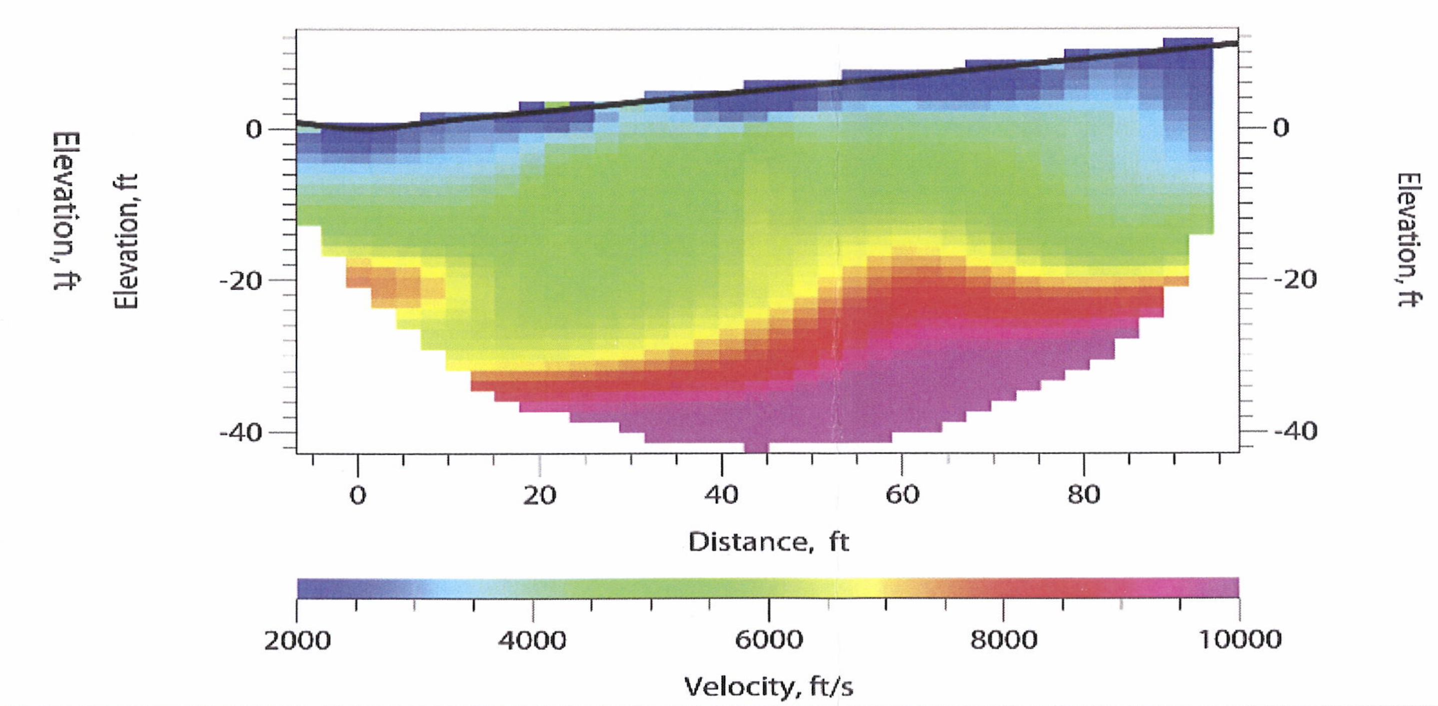
East 2



Middle



East 3



NEVADA DOT
GEOTECHNICAL ENGINEERING

Henderson, Clark County, Nevada
EA#: 73687
DATE: October 2011

REFRACTION RESULTS

INTERSTATE 15
STARR AVENUE INTERCHANGE