GEOTECHNICAL REPORT

I-15/SR 160 BLUE DIAMOND INTERCHANGE

LAS VEGAS
CLARK COUNTY, NEVADA

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GEOTECHNICAL SECTION
MATERIALS DIVISION

DEPARTMENT OF TRANSPORTATION

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I-15/SR 160 BLUE DIAMOND INTERCHANGE

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CLARK COUNTY, NEVADA

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I. INTRODUCTION

General

A geotechnical investigation has been conducted for the proposed new I-15 & SR-160 (Blue Diamond) Interchange in Las Vegas, Nevada. This interchange will be located about 140 meters south of the existing Arden Interchange.

Purpose and Scope of Study

The purpose of this geotechnical investigation was to determine the subsurface soil conditions of the site, to provide geotechnical design criteria, and to provide construction recommendations for the proposed interchange. The scope of this investigation included site reconnaissance, subsurface exploration, soil sampling, laboratory testing, analysis of field and laboratory data, research of available geologic literature pertaining to the site, and report preparation. This report provides information, conclusion, and recommendations for:

* The encountered site subsurface soils conditions
* Physical and geotechnical properties of the soils
* Potential geotechnical risks to the structures
* Foundation type and design criteria
* Settlement analysis of the structure
* Lateral earth pressures on earth retaining walls
* Drainage systems for the earth retaining walls
* Seismic response spectra
* A general evaluation of MSE walls based on external stability
* Earthwork
* Construction Concerns

Geotechnical Exploration

During April and May of 2000, the Geotechnical Section of the Materials Division of NDOT conducted a subsurface investigation at the proposed structure site. The subsurface soil conditions were explored by drilling five borings to a maximum depth of 27.3 meters (89.5 feet). The approximate locations of the borings are shown in Appendix A. Drilling was performed using wet rotary wash drilling technique. Logs of the subsurface conditions, as encountered during the field investigation, were recorded by a geotechnical engineer. Logs of the boring are shown in Appendix B. Drive samples were obtained using a Standard Penetration Testing (SPT-ASTM D1586) sampler and a 63.5 millimeters (2.5 inch) internal diameter California Modified Sampler (CMS) equipped with brass liners (ASTM D3550). Both samplers were advanced using a 63.5-kilogram (140-lb) mass falling free from a height of 760 millimeters (30 inches). Sampler driving resistance (N-value), expressed as blows per 0.3 meters (one foot) of penetration, is presented on the boring logs at the respective sampling depth. The N-values is an indication of the apparent density of coarse-grained soils and the consistency of fine-grained soils. The blow counts presented on the boring logs have not been corrected for sampler type, overburden pressure, hammer type, rod length, etc. The correction factors are provided on the Key to Boring Log sheet, Appendix B.

Representative soil samples and N-values were obtained. Selected soil samples were tested at the NDOT headquarters' laboratory facilities.

Recommendations contained in this report are based on the information obtained from our field explorations, laboratory tests, and observations of our Project Engineer. The nature and extent of variations may not be evident until the construction takes place. If conditions are encountered during construction, which differs from those described in this report, or if the scope of construction is altered significantly, the Geotechnical Section must be notified in order that a review of our recommendations can be provided.

This report was prepared in accordance with accepted standards of geotechnical practice.

Laboratory Testing

Laboratory testing program for selected samples consisted of:

- Natural Moisture Contents (AASHTO T-265)
- Particle Size Gradations (AASHTO T-88 and ASTM D1140)
- Atterberg Limits (AASHTO T-89 AND T-90)
- Unit Weight (ASTM D2937)
- Specific gravity (ASTM D854)
- Hydro-Collapse Potential (ASTM D5333)
- Direct Shear (AASHTO T-236)
- Electro-Chemical analyses (AASHTO T-288 for determining soil resistivity, T-289 for determining soil pH, T-290 for determining water-soluble sulfate in soil, T-291 for determining water-soluble chloride in soil)

Individual laboratory test results can be found in Appendix C of this report.

Project Description

NDOT in cooperation with the FHWA and Clark County is planning to improve Blue Diamond Highway (SR-160) from Las Vegas Boulevard to Rainbow Boulevard. The site location of the project is shown in Appendix A.

The proposed improvements to State Route (SR) 160 consists of realigning the roadway from Las Vegas Boulevard to Industrial Road and widening the existing roadway to six travel lanes (three in each direction) along the present alignment from Industrial Road to Rainbow Boulevard. The proposed improvement includes constructing a new interchange at I-15, an eastbound SR160 to northbound I-15 fly-over ramp, and construction of a grade separation at the Union Pacific Railroad Crossing.

The proposed improvements to I-15 are to construct a Collector Distributor Road parallel to I-15 from approximately one-half mile south of the new I-15/Blue Diamond Road structure and north to the I-215 interchange. In addition, improvements will include the removal of the existing Warm Springs structure and the construction of a new grade separation at the same location to allow for additional lane widths needed for the Collector Distributor Roads.

The purpose of this project is to:

* Provide sufficient roadway capacity to accommodate the current traffic volume by improving roadway geometric.
* Provide sufficient roadway capacity to accommodate anticipated volume increase over the next twenty years by improving roadway geometric.
* Provide for alternative transportation modes (bicycles and pedestrians).
* Create a logical and efficient connection to the regional roadway network.

Presently, Arden Interchange (I-675) located approximately 140 meters (460 feet) to the north of the proposed structure conveys the traffic between SR-160 and I-15.

This report addresses the geotechnical issues related only to the proposed SR-160/I-15 interchange. The Union Pacific Railroad Crossing and Warm Springs geotechnical issues will be addressed in separate reports.

Site Description

The subject site is located in Section 17, T. 22 S., R.61 E., M.D.B. & M. The approximate elevation of the original ground along the proposed alignment is 686 meters (2250 feet) above Mean Sea Level (MSL). The region consists of a gentle gradient (less than 5%) dipping towards the East.

II. DISCUSSION

Local Geology

The primary geologic reference for this area is the geologic map prepared by Jonathan C. Matti and Fred W. Bachhuber, 1985 of Nevada Bureau of Mines and Geology[1]. According to this map, a Quaternary age formation of intermittently alluvium deposits underlies the site. Carbonate clasts (limestone) are the predominant rock type.

Local Faults

Geological mapping of the site shows no mapped faults within the Quaternary aged alluvial deposit at the proposed site. There are several mapped faults located within three kilometers (two miles) northeast and northwest of the site.

Ground Motion

The estimation of the bedrock acceleration generated by earthquake at the site is based on NEHRP Map that was prepared by the U.S. Geological Survey, 1988. This is the map of Horizontal Acceleration (expressed as percent of gravity) in Rock with 90 percent probability of not being exceeded in 50 years. The site is located in an area defined by the NEHRP Map as having a horizontal acceleration coefficient in rock of 0.075g. However, it is NDOT policy to use a horizontal acceleration coefficient of 0.15g in this region.

Subsurface Conditions Encountered

The following section presents a generalized description of the soil types encountered during our field investigation. The boring logs should be reviewed for more detail description.

During the field investigation, relatively uniform conditions were encountered along the alignment such as:

At the center pier location, the first 2.5 meters (8 feet) of soil is loose to medium dense silty sand with occasional gravel. The soil below this layer is very dense silty sand and very hard clayey sand with gravel and moderate cementation.

At the east abutment, the top 1meter (3 feet) of soil is loose to medium dense silty sand. The soil below this layer is dense to very dense silty sand and clayey sand with gravel and moderate cementation.

At the west abutment, the first 2.0 meters (6 ft) of soil is loose to medium dense silty sand. The soil below this layer is dense to very dense silty sand and clayey sand with gravel and moderate cementation.

Along the proposed I-15 Southbound On-ramp (southwest of the proposed structure) and I-15 Northbound Off-ramp (southeast corner of the proposed structure) locations, the upper 1meter (3 ft.) of soil is loose to medium dense silty sand. The soil below this layer is dense to very dense silty sand and clayey sand with gravel and moderate cementation.

The presence of moderate cementation in the soil is indicative of water-soluble cementing material such as calcium carbonate, which was detected from its intense reaction with dilute hydrochloric acid (HCL). Calcium carbonate deposition is the result of a drop in the groundwater table in that region within the last few decades. The near surface soil layers [upper 3 meters (10 feet)] were identified as moderately hydro-collapsible and have a potential to undergo a decrease in its volume of up to 2% upon increase in its moisture content. The soils moisture content was low throughout the depths explored.

Groundwater

Groundwater was not encountered in any of the exploratory boreholes made on the site. The Las Vegas SW Quadrangle Ground Water Map[2] shows that the depth to the regional groundwater during March of 1979 was deeper than 150 feet below the ground surface. Therefore, groundwater should have no adverse effect on design, construction, and performance of the proposed structures.

Soil Corrosive Potential

Electro-Chemical analyses were performed on the subsurface soil samples to determine the concentration of corrosive chloride and sulfate salts. Soil pH values that represent the hydrogen concentration in the soil (referred to as the intensity factor), and soil resistivity which is an indirect measurement of the soluble salt content in the soil, were also measured. Results of these analyses are provided in Appendix C.

III. EVALUATIONS AND RECOMMENDATIONS

Spread Footing Foundation

Based on the results of field investigation and laboratory testing, the site is suitable for construction of the proposed interchange and roadway ramps. Spread footing foundation (continuous or rectangular shape) may be used to support the proposed bridge pier(s) and abutments. The bridge pier(s) should be placed a minimum of 2.0 meters (6.5 feet) below the existing ground to reduce the collapse potential of the soil. The abutment footings can be placed below the existing ground, similar to the pier footing(s), or within the compacted embankment fill. The retaining walls for the proposed on-ramp and off-ramp may be supported on spread footings if the footings are placed a minimum of one meter (3 feet) below the existing ground.

Allowable Static Bearing Capacity of Spread Footings

The following table provides estimates of the static bearing capacities. These capacities are for uniform vertical pressures or a vertical point loads applied to the center of the footings. These capacities include factors of safety of 3.0.

Footing Location	Minimum Footing Width m (ft)	Allowable Soil Bearing Capacity kPa (tons / sq. ft)		Minimum Embedment Depth m (ft)
Center Pier	1.5 (5)	300 (3)		2 (6.5)
West Abutments	2.5 (8)	200 (2) footing placed in embankment	300 (3) footing placed in native soil	2 (6.5)
East Abutments	2.5 (8)	200 (2) footing placed in embankment	300 (3) footing placed in native soil	2 (6.5)

Conventional earth retaining walls bearing on undisturbed native soil can be designed for a maximum allowable bearing capacity of 200 kilo-Pascals [200 kPa (2 tons/ft^2)].

Settlement Under Static Loading

An estimated total settlement of less than 25 millimeters (1 inch), and a differential settlement of less than 13 millimeters (0.5 inches) is expected by applying the above allowable soil pressures at the specified depths. Most of the expected settlement will take place during construction.

Sliding Resistance of Footings

In calculating the sliding resistance of the pier footing, the unit adhesion and the frictional resistance of the base of the footing to sliding is multiplied by the area of the base to determine the sliding resistance. Since the footings are formed with cast-in-place concrete on cohesionless soil, the sliding resistance is purely frictional. It is recommended that the interface friction coefficients (tan-δ) be calculated by reducing the soil internal friction angles by 30% such as:

Interface friction coefficient of native soil and pier footing (tan δ) = (1-0.3)(tan 35°) = 0.5

Interface friction coefficient of embankment soil and abutment footing (tan δ) = (1-0.3)(tan 32°) = 0.4.

Passive static resistant force in front of the footing (P_P) should be neglected in the top two feet unless confined by concrete slab-on-grade or pavement.

Failure by sliding shall be considered by comparing the lateral force on the footing (P) to the maximum resisting force (P_{max}):

$$\mathbf{P_{max} = (P_v + W) \tan \delta + P_P (L)}$$

P_v = net applied static vertical force on the footing

Static passive earth pressure coefficient (K_P) = 6.87

W = weight of the footing

Passive static resistant force (P_P) = 1/2 γ D^2 K_P

$P_P = (1/2)(19\ kN/m^3)\ (D^2)\ (6.87) = 65\ D^2$, kN/m

D = embedment depth of the footing

L = length of the footing perpendicular to the direction of sliding.

The location of P_p is assumed to be at 1/3D above the base of the footing.

The maximum passive resisting force (P_{max}) should be reduced by a factor of 1.5 (factor of safety = 1.5), (AASHTO 4.4.7.1.1.3-7) in order to limit the movements.

Seismic Bearing Capacity of Spread Footings

In addition to the static vertical load, it is necessary to consider lateral and overturning moment from the design level earthquake.

After selecting the footing dimensions and performing the seismic response computations to estimate the peak dynamic vertical and horizontal loads on top of the footings by the structural engineer, then the seismic bearing capacities of the footings can be analyzed through the "pseudo-static analysis" method. The allowable static soil bearing pressure, as provided in the above table, can also be increased by 1/3 for seismic loading.

Seismic Sliding Resistance of Footings

The sliding stability of the pier footing(s) subject to seismic loading requires consideration of the sliding resistance on the base of the footing and seismic active and passive pressure, using "pseudo-static analysis" method. Sliding resistance may be based upon the dead load on the footing, as this is the average normal load acting on the footing during an earthquake:

$$\mathbf{P_{max} = [(P_v + W) \tan \delta + P_{PE} (L)] - [(0.5\ K_h W) + (P_{AE} . L)]}$$

$K_h W$ = the inertia force on the footing

K_h = is the coefficient of horizontal acceleration addressed on page 14

$P_{PE} = 1/2\ \gamma\ D^2\ K_{PE}$

$K_{PE} = 5.68$

γ = soil unit weight = 19 kN/m^3 (121 pcf).

P_{AE} = resultant active earth pressure on the wall due to the combined static and earthquake pressures

$(P_{AE}) = 1/2\ \gamma\ D^2\ K_{AE}$

K_{AE} = Seismic Active Pressure Coefficient = 0.39.

The location of P_{PE} and P_{AE} act at the mid-height of the footing.

Factor of safety of 1.1 is recommended be applied to the maximum resisting force (P_{max}).

Seismic sliding resistance of the abutment footings are addressed in the retaining walls section of this report (page 12)

Seismic-Induced Settlement

Seismic-induced settlement of the pier footing on native soils will be negligible due to soil high blow counts (N-values) of greater than 50 (indicative of very dense soil) below the recommended footing depth.

Seismic-induced settlement of the abutment footings on the embankment soils is estimated to be less than 6 millimeters (0.25 inches).

ABUTMENTS AND RETAINING WALLS

(1) ABUTMENT AND CANTILEVER RETAINING WALLS

This section provides recommendations for estimating static and seismic earth pressures on the bridge abutment and cantilever retaining walls:

STATIC EARTH PRESSURE

(A) Free Standing Abutment (seat-type) and Cantilever Retaining Walls

Basic design parameters are:

* Wall Height = H
* Footing Width = B
* Embedment Depth = D
* Backfill Soil Moist Unit Weight (γ) = 20.41 kN/m^3 (130 pcf)
* Angle of Internal Friction of Structural Backfill = 34 degrees
* Interface friction angle between soil and concrete = 1/2 (34) = 17 degrees
* Live surcharge due to traffic on abutment and retaining wall = 12 kN/m^2 (250 psf)
* Static active earth pressure coefficient (K_A) = 0.26, computed by using Coulomb procedure
* Static active earth resultant force (P_A) on the wall is determined by Coulomb procedure
  $P_A = 1/2\ \gamma\ H^2\ K_A$
* The location of this force (P_A) is assumed to be at 1/3H above the base of the wall (H is the total height of the wall)
* The resistance due to passive earth pressure (P_P) in front of the wall shall be neglected, unless the wall extends well below the depth of frost penetration (more than 2 feet).
  $P_P = 1/2\ \gamma\ D^2\ K_P$, where static passive earth pressure coefficient (K_P) = 6.87

* A minimum factor of safety of 1.5 must be applied to the ultimate resistance of the soil (P_P) in order to limit movements (AASHTO 4.4.7.1.1.3-7)

(B) **Monolithic Abutment Walls** (integral or end-diaphragm abutments)

This type of abutment is cast monolithically with the superstructure and may be directly supported on spread footings.

In monolithic abutments, the maximum pressure distribution behind the wall be taken as the static pressure distribution arising from gravity loads (at-rest earth pressure distribution, $\mathbf{F_0}$):

$$\mathbf{F_0 = \frac{1}{2} K_0 \gamma H^2}$$

K_0 (at-rest coefficient) = 1- sin Φ = 0.44

SEISMIC EARTH PRESSURE

General Basic Design Parameters are:

* Acceleration Coefficient (A) = 0.15g (NDOT policy for Las Vegas areas)
* Soil Profile = Type II (AASHTO Seismic Design-3.5)
* Site Coefficient (S) = 1.2 (AASHTO Seismic Design-3.5.1)
* Response Modification Factor (R) = Variable (AASHTO Seismic Design- Table 3.7)
* Vertical acceleration coefficient = 0 [AASHTO 6.4.3(A)]
* Poisson's ratio for granular backfill material (μ) = 0.35
* Young Modulus for granular backfill material (E_s):

  E_s= [(20) (N-value), ksf, $N_{ave.}$ = 20 (estimated)] = 19166 kPa ($\approx$ 2777 psi)
* Shear Modulus for granular backfill material (G) = E_s / 2(1+ μ) = 7100 kPa ($\approx$1028 psi)

(A) Free-Standing Abutment (seat-type) and Cantilever Retaining Walls

For free-standing abutments or retaining walls which may displace horizontally without significant restraint, the pseudo-static Mononobe-Okabe (M-O) method of analysis is recommended for computing lateral active soil pressure during seismic loading. A seismic coefficient equal to one-half the acceleration coefficient ($K_h = 0.5$ A) is recommended [AASHTO 6.4.3(A)]. The effect of vertical acceleration may be omitted. The walls should be proportioned to slide rather than tilt, and provisions should be made to accommodate small seismically induced horizontal abutment displacements when minimal damage is desired. Wall displacements of up to 254A (mm) may be expected. Geotechnical design parameters for these types of walls are:

* Seismic Active Pressure Coefficient, $K_{AE} = 0.39$
* The resultant active earth pressure on the wall due to the combined static and earthquake pressures (P_{AE}) is: $P_{AE} = 1/2\ \gamma\ H^2\ K_{AE}$
* The location of the resultant active earth pressure (P_{AE}) is assumed to be at 0.5H above the bottom of the wall
* If the abutment wall is being pushed into the backfill, the passive force (P_{PE}) $= 1/2\ \gamma\ H^2\ K_{PE}$, $K_{PE} = 5.68$

(B) Monolithic Abutment Walls

For monolithic abutments where the abutment forms an integral part of the bridge superstructure, the maximum earth pressure acting on the abutment may be assumed to be equal to the maximum longitudinal earthquake force transferred from the superstructure to the abutment. To minimize abutment damage, the abutment should be designed to resist the passive pressure capable of being mobilized by the abutment backfill, which should be greater than the maximum estimated longitudinal earthquake force transferred to the abutment. It may be assumed that the lateral active earth pressure during seismic loading is less than the superstructure earthquake load (AASHTO 6.4.3(B)).

In monolithic abutments, the total earth pressure on the abutment during an earthquake (**F**) is a sum of the static pressure distribution arising from gravity loads, at-rest earth pressure distribution, ($\mathbf{F_0}$) and the pressure arising from forces of lateral translation ($\mathbf{F_1}$) and rotation ($\mathbf{F_2}$) of the wall:

$$\mathbf{F = F_0 + F_1 + F_2 < P_{PE}}$$

$\mathbf{P_{PE}}$ = ultimate abutment soil resistance if the abutment wall is being pushed into the backfill (provision must be made for adequate passive resistance to avoid excessive relative displacements).

When longitudinal seismic forces are resisted by piers or columns, it is necessary to estimate abutment stiffness in the longitudinal direction in order to compute the proportion of earthquake load transferred to the abutment. If the stiffness of the monolithic abutment walls is incorporated into a dynamic model of a bridge system, the following equations (Lam and Martin - elasticity theory) can be used to calculate stiffness coefficient for the abutment walls. The abutment wall stiffness is intended for bridge analysis when the wall is displaced into the backfill by longitudinal inertia loading from the superstructure:

$K_s = 0.425\ E_s\ B$ = translational stiffness (Mpa .m)

$K_\theta = 0.072\ E_s\ B\ H^2$ = rotational stiffness (Mpa .m^3)

The location of the resultant force due to abutment wall translation may be applied at 0.6H from the base of the wall while the resultant force from wall rotation acts at approximately 0.37H from the base of the wall.

In making estimates of monolithic abutment stiffness and associated longitudinal displacements during transfer of peak earthquake forces from the structure, it is recommended that abutments be proportioned to restrict displacements to 90 millimeters (0.3 ft.) or less in order to minimize damage.

The following two methods (FHWA Method and CALTRANS Method) are recommended to calculate the total earth pressure (F) on a monolithic abutment wall during an earthquake:

(1) FHWA (Elasticity) Method

F (total earth pressure) **=** $\mathbf{F_0 + F_1 + F_2 < P_{PE}}$ (ultimate abutment soil resistance)

$F_0 = ½ K_0 \gamma H^2$

$K_0 = 1 - \sin \Phi = 0.44$

F_1 (Resultant forces due to wall translation) $= 0.425 E_s \delta_1$, applied at 0.37 H

F_2 (Resultant forces due to wall rotation) $= 0.12 E_s \delta_2$, applied at 0.6 H

δ_1 = displacement due to lateral translation of the wall

δ_2 = displacement due to rotational displacement of the wall = θ H, where θ is rotational angle

δ_1 and δ_2 are determined by seismic analysis.

P_{PE} = total passive resistance capacity of the abutment backfill is only mobilized if the abutment wall is being pushed into the backfill = $1/2 \gamma H^2 K_{PE}$, and $K_{PE} = 5.68$

(2) CALTRANS (Empirical) Method

F (total earth pressure) **=** $\mathbf{F_0 + F_1 + F_2 < P_{PE}}$ = ultimate abutment soil resistance

$P_{PE} <$ (7.7 ksf) (H) (B)

F_1 = longitudinal force = (200 k/in) x (abutment width)

F_2 = transverse force = (200 k/in) x (abutment wall height)

P_{PE} is the maximum soil resistance capacity and needs to be less than (7.7 ksf) (H) (B).

Dimensions and External Stability

(Abutments and Cantilever Retaining Walls)

Walls shall be dimensioned to ensure stability against possible failure modes, such as bearing capacity failure, sliding failure, overturning failure, and overall stability failure, by satisfying the following minimum factors of safety (FS) criteria (AASHTO 5.5.5 and 5.2.2.3):

	FACTORS OF SAFETY (FS) AGAINST FAILURE	
	Under Static Loads	Under Static + Seismic Loads
Bearing Capacity	FS = 3.0	FS = 2.25
Sliding	FS = 1.5	FS = 1.1
Overturning	FS = 2.0	FS = 1.5
Overall Stability (abutments supported on a slope)	FS = 1.3 (FS = 1.5)	FS = 1.1

Additional sliding stability can be derived from the use of a key beneath the retaining wall base. If the base key is chosen, an embedment depth of 0.3 meters (1 ft.) into the native soil and a width of 0.6 meters (2 ft.) are recommended.

(2) MECHANICALLY STABILIZED EARTH (MSE) WALLS

If retaining walls are chosen for the construction of the proposed I-15 Southbound On-ramp (southwest of the proposed structure) and I-15 Northbound Off-ramp (southeast corner of the proposed structure), mechanically stabilized earth (MSE) walls with metallic reinforcement strips are recommended.

Back-To-Back MSE walls with double-faced walls are considered for the above locations. These walls are actually two separate walls with parallel facings. In this case, the overall base width is large enough so that each wall behaves and can be designed independently.

Sizing for External Stability

Based on the results of preliminary analysis (AASHTO 5.8.2 and 5.8.9.1), the minimum reinforcement length of 0.80 times the wall height is sufficient for each wall up to 6 meters (20 feet) in height. MSE walls can be designed to resist sliding, using a coefficient of friction of 0.60.

MSE walls bearing on undisturbed native soil can be designed for a maximum allowable bearing capacity of 200 kilo-Pascals [200 kPa (2 tons/ft^2)].

Internal Stability

Internal stability computation including maximum reinforcement loads should be calculated using the Simplified Coherent Gravity method (AASHTO 5.8.4.).

Embedment Depth

The minimum embedment depths for walls from adjoining finish grade to top of the leveling pads should not be less than 0.91 meters (3.0 feet).

SEISMIC RESPONSE SPECTRA

Graphs of Uniform Building Code (UBC) Design Response Spectra using UBC seismic zone map, USGS Spectral Accelerations using USGS local seismic hazard map, and AASHTO Design Response Spectra for soil profile Type II are provided on the following page. The AASHTO Response Spectrum is recommended for the design.

Backfill and Compaction Requirements for Walls

Granular backfill gradations and compaction requirements should conform to Section 207 of the NDOT Standard Specifications for Road and Bridge Construction. Compaction of backfill material within the vicinity of the wall by heavy equipment may result in development of lateral pressures greater than the design condition. Therefore, no heavy static or vibratory compaction equipment is allowed within a distance of one-half of the wall height behind the wall during construction, unless the walls are designed structurally for this additional lateral loading.

Drainage System

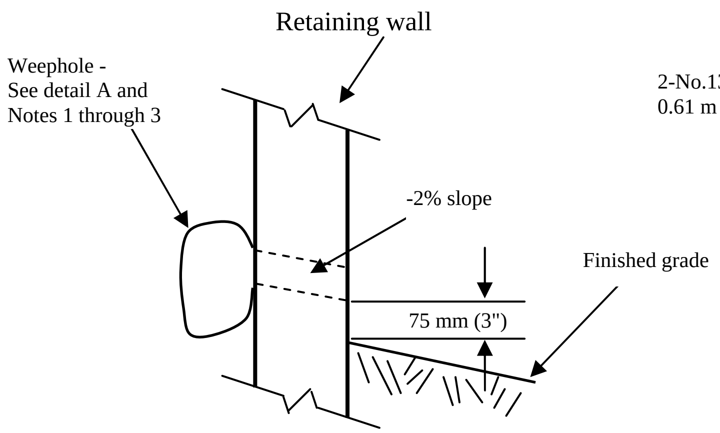
Providing drainage systems for cantilever retaining walls and abutment walls to prevent the accumulation of surface runoff behind the walls, and subsequent hydrostatic pressure buildup is recommended.

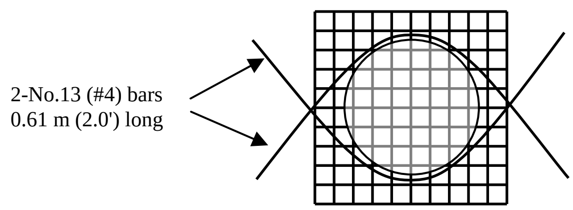
Drainage can be accomplished by providing weepholes behind the walls with outlets at or near the base of the walls. Weepholes should be at least 4 inches in diameter and shall be placed through the walls at a maximum horizontal spacing of 4.6 meter (15 ft.). Place a minimum of 0.06 cubic meters (2 cubic feet) of free-draining material (such as NDOT drain backfill type 1 or type 2) encapsulated in geotextile at each weep hole (AASHTO 7.5.2).

An impervious surface layer should cover the backfill and a gutter should be provided for collecting runoff at the top of the wall.

Weephole details are shown on the following page:

WEEPHOLE DETAIL





DETAIL A

NOTES:

1. 100 mm (4") diameter drains with horizontal and vertical spacing of 4.5 m (15') ± center to center. The bottom row must be located 75 mm (3") above finished grade.

2. 150 mm (6") square aluminum or galvanized steel wire mesh hardware cloth with a minimum wire diameter of 0.75 mm (0.03").

3. $0.06 m^3$ ($2 ft^3$) of NDOT Type 1 or 2 Drain Backfill, encapsulated in a geotextile , securely tied. The geotextile must:
   a) have an AOS no greater than U.S. Sieve No. 40
   b) have a permittivity of at least 0.5 sec^{-1}

Earthwork

Where borrow material is necessary, materials should meet the requirements listed for "Select Borrow" in section 203 of NDOT Standard Specifications, which requires a minimum R-value of 45 and 100% of the material passing the 75 millimeter (3 inches) sieve size.

Stability Analysis of Bridge Approach Embankments

The stability analyses of the sloped highway embankments were performed using the XSTABL™ computer program, employing Limit Equilibrium-Modified Bishop's Method. The analysis performs a search procedure to locate the critical failure surface. A minimum factor of safety of 1.5 is used as acceptable criteria for the static load case. A minimum factor of safety of 1.13 (75% of the factor of safety under static condition) is used as acceptable criteria for the seismic case. The horizontal acceleration used in the seismic stability analyses was based on 50% of the peak ground acceleration (0.15g) or 0.075g. A traffic surcharge load of 12 kPa (250 psf) was included in each analysis. The results of these analyses are provided in Appendix D of this report.

The analyses indicate that the factors of safety, under both static and seismic loading condition, for the proposed bridge approach embankments (estimated maximum height of 10 meters) constructed on 1:2 (vertical: horizontal) exceed the minimum specified. The estimated factors of safety are provided in the following table:

FACTORS OF SAFETY AGAINST SLOPE FAILURE

Soil Type	Soil Properties	Static Loading	Static + Seismic Loading
Embankment Soil	γ = 18.8 kN/m^3 = 120 pcf φ = 34° C = 5 kPa = (105 psf)	1.85	1.57
Native Soil	γ = 18.8 kN/m^3 = (120 pcf) φ = 39° C = 38 kPa = (800 psf)		

Bridge Approach Embankment Settlement

The approach embankment settlement consists of two components, internal settlement within the embankment fill and the external settlement of the native soil under the embankment fill. Internal settlement of the embankment fill is a controlled settlement issue and can be considered negligible since the embankment fill will be compacted properly. The external settlements of the native soils were estimated based on using an embankment height of 10 meters (30 feet) with end and side slopes constructed on 1:2 (vertical: horizontal). The procedure for approach embankment pressure distribution is based on FHWA (Publication No. FHWA HI-88-009, 993). Since the groundwater was not encountered within the zone of influence of the loading, the native soils are anticipated to be almost immediate, occurring mostly during the construction of the approach abutments.

The following table presents the total estimated settlements at the top of the slope (center line of the embankment), at the mid-height of the slope, and at the toe of the slope:

Embankment Location	**Estimated Total settlement (mm)**
Top of the End-Slope	50 (2 inches)
Mid-height of the End –Slope	30 (1.2 inches)
Toe of the End-Slope	20 (0.8 inches)

IV. CONSTRUCTION CONCERNS

Excavation Difficulties

The soils encountered at the site exhibit moderate to strong cementation in some areas, however, they were easily drilled during the subsurface investigation.

Temporary construction excavations in the cemented material may stand at steep angles. However, un-shored construction excavations in the moderately cemented soils should be sloped not steeper than 1:1 (vertical: horizontal). Some raveling of the cut slopes should be expected. Moisture conditioning of the cut slopes will reduce raveling.

All excavations should be complied with OSHA requirements.

REFERENCES

1) Jonathan C. Matti and Fred W. Bachhuber, Las Vegas SW Quadrangle-Geology Map, Nevada Bureau of Mines and Geology, 1985.

2) Katzer, Harril, Berggren, and Plume, Las Vegas SW Quadrangle-Groundwater Map, Nevada Bureau of Mines and Geology, 1985.

3) FHWA, Soils and Foundations Workshop Manual, U.S. Department of Transportation, Washington D.C., 1982.

4) AASHTO, Standard Specifications for Highway Bridges, AASHTO, Washington D.C., 1996.

5) FHWA-NHI, Seismic Design of Highway Bridges-Map of Horizontal Acceleration, Federal Highway Administration Publication No. FHWA-HI-91-019, Washington D.C., 1988.

6) Wyman et al., Geology of Las Vegas, Bulletin of the Association of Engineering Geologists, March 1993, Volume XXX, Number 1.

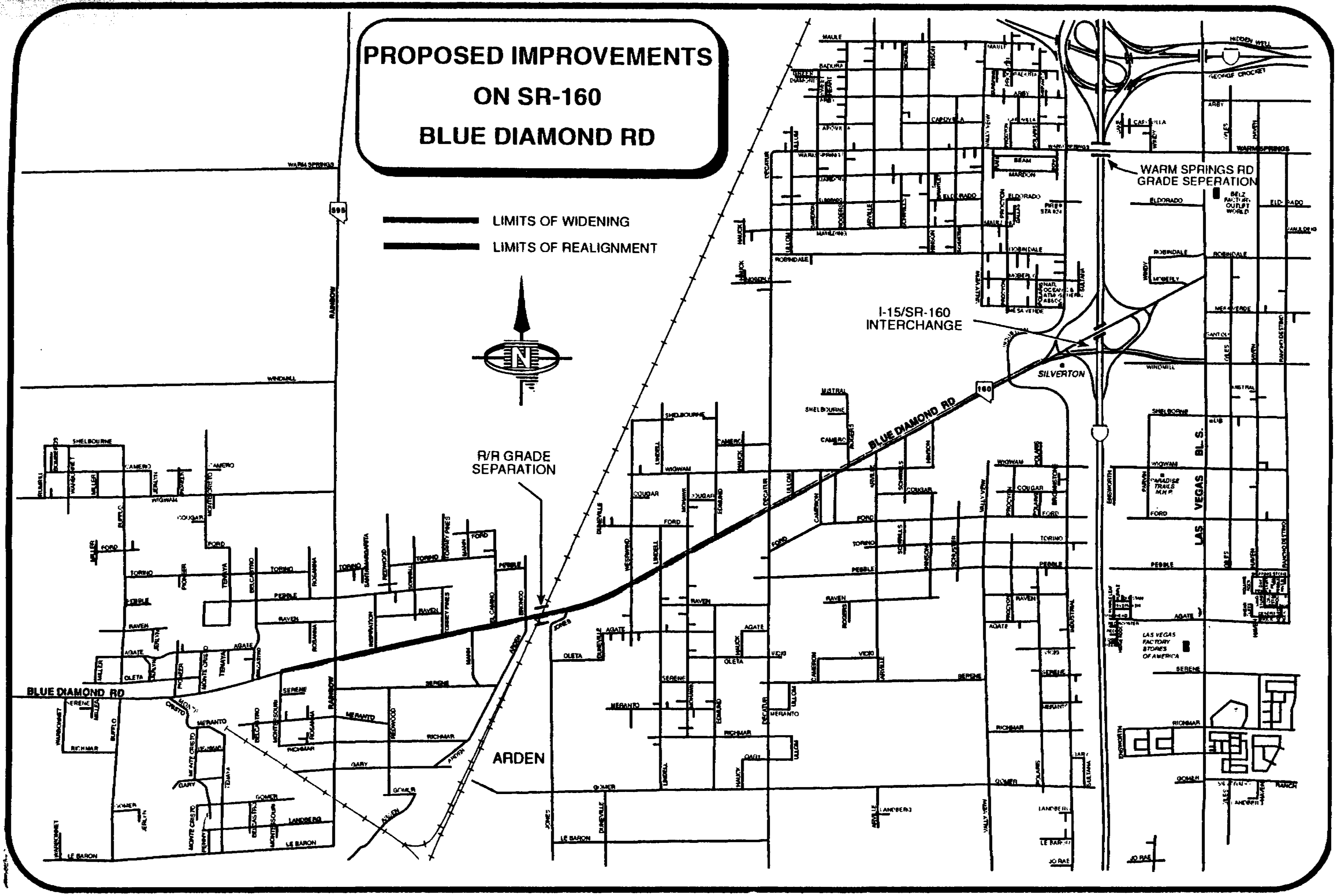
7) FHWA, Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines, Federal Highway Administration Publication No. FHWA-SA-96-071, August 1997.

8) FHWA, Geotechnical Earthquake Engineering, Federal Highway Administration Publication No. FHWA HI-99-012, August 1998.

APPENDIX A

* BRIDGE GENERAL VICINITY MAP
* BRIDGE PROFILE
* REGIONAL GEOLOGY MAP

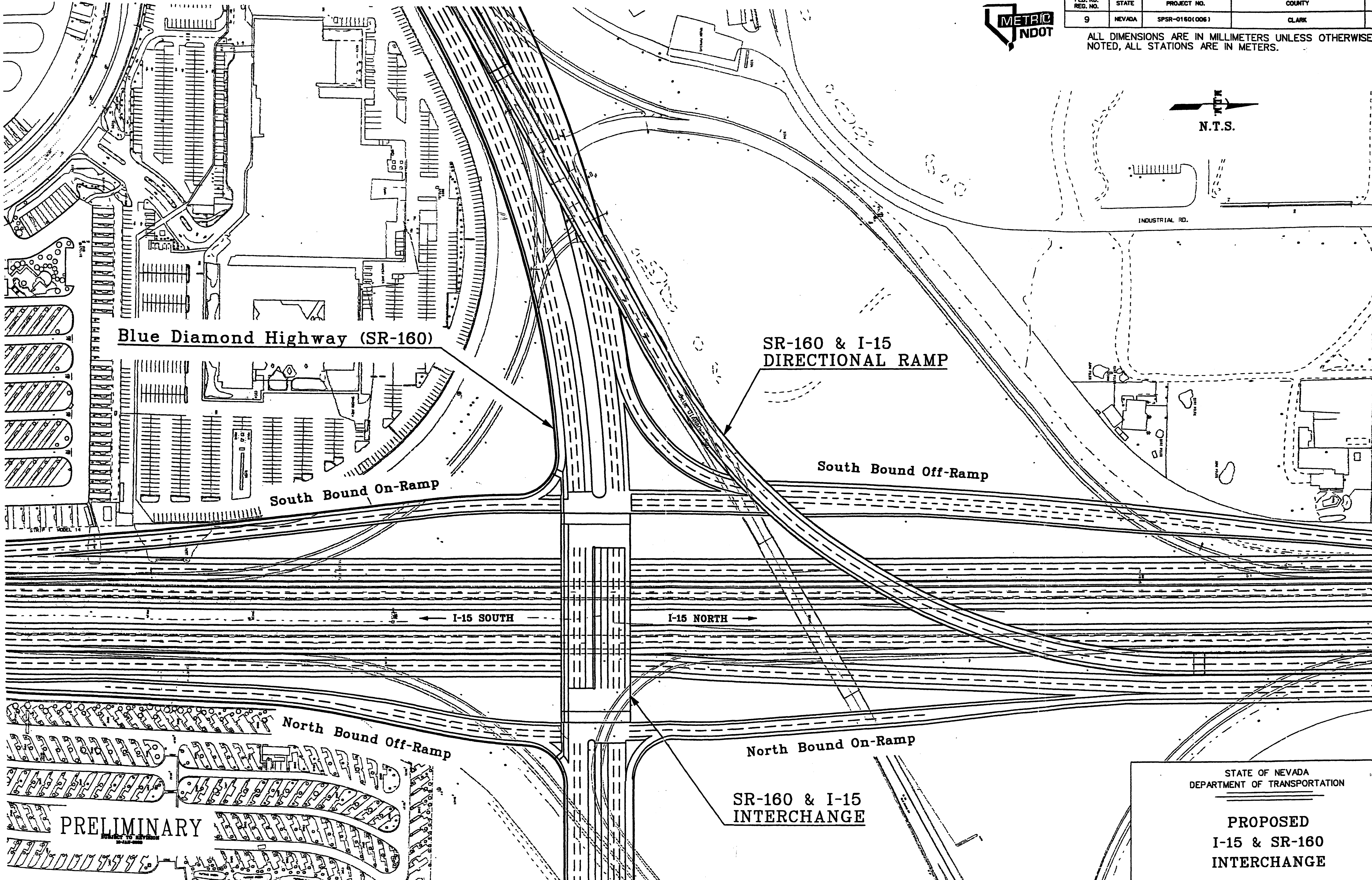
PROPOSED IMPROVEMENTS ON SR-160 BLUE DIAMOND RD



FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	SPSR-0160(006)	CLARK	

METRIC NDOT

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED, ALL STATIONS ARE IN METERS.

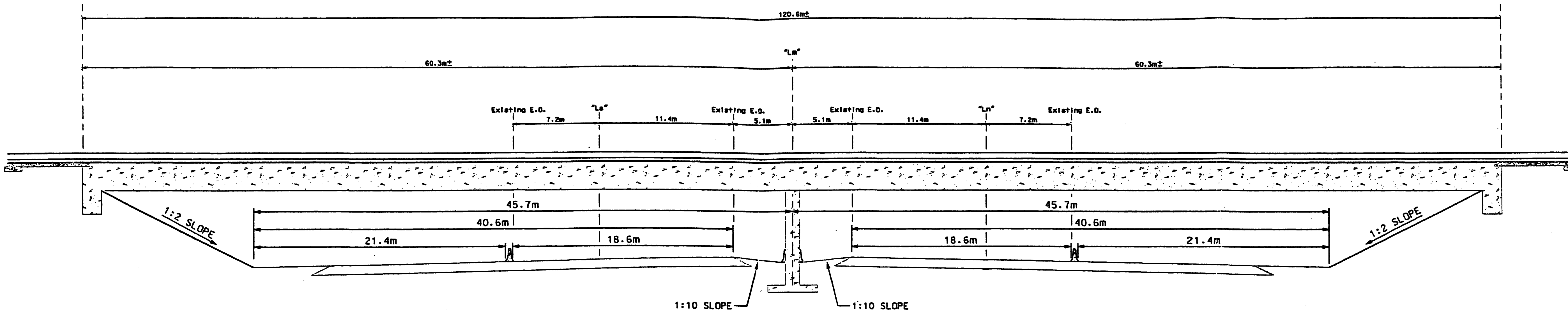


STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

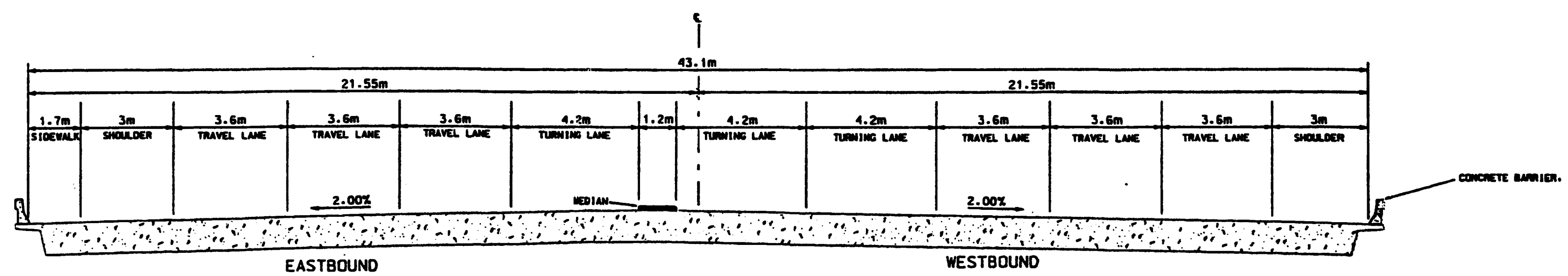
PROPOSED
I-15 & SR-160
INTERCHANGE

FED. RD. REG. NO.	STATE	PROJECT NO.	COUNTY	SHEET NO.
9	NEVADA	SPSR-0160(006)	CLARK	

METRIC NDOT

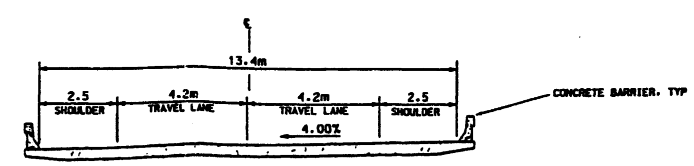


SR-160 OVERPASS



SR-160 OVERPASS TYPICAL SECTION

Deck Area = 5198sqm ±



SR-160 DIRECTIONAL RAMP
(EAST TO NORTHBOUND)

DECK AREA = 8710sqm ±

PRELIMINARY
SUBJECT TO REVISION
10-JAN-2000

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

PROPOSED
I-15 & SR-160
INTERCHANGE

Terry Katzer, James R. Harrill, Gregg Berggren, and Russell W. Plume, 1985

Water Resources Division
U.S. Geological Survey
Carson City, Nevada

Lithologic units from Matti and Bachhuber (1982) Preliminary geologic map of Las Vegas SW quadrangle, Nevada Bureau of Mines and Geology, Open-file Map 82-5; and modified from Bingler (1977) Geologic map, Las Vegas SE quadrangle, Nevada Bureau of Mines and Geology Map 3Ag; and from Plume (1984) Ground-water conditions in Las Vegas Valley, Clark County, Nevada—Part I, hydrogeologic framework, U.S. Geological Survey Open-file Report 84-130.

LITHOLOGIC UNITS

Alluvial and fanglomerate deposits. Associated interbedded alluvial deposits consisting of fine to coarse sand and pebble to cobble gravel as mapped by Matti and Bachhuber (1982). Lithologies similar to the surficial units mapped by Bingler (1977) and described by Plume (1984). Deposits also include a minor amount of small boulders.

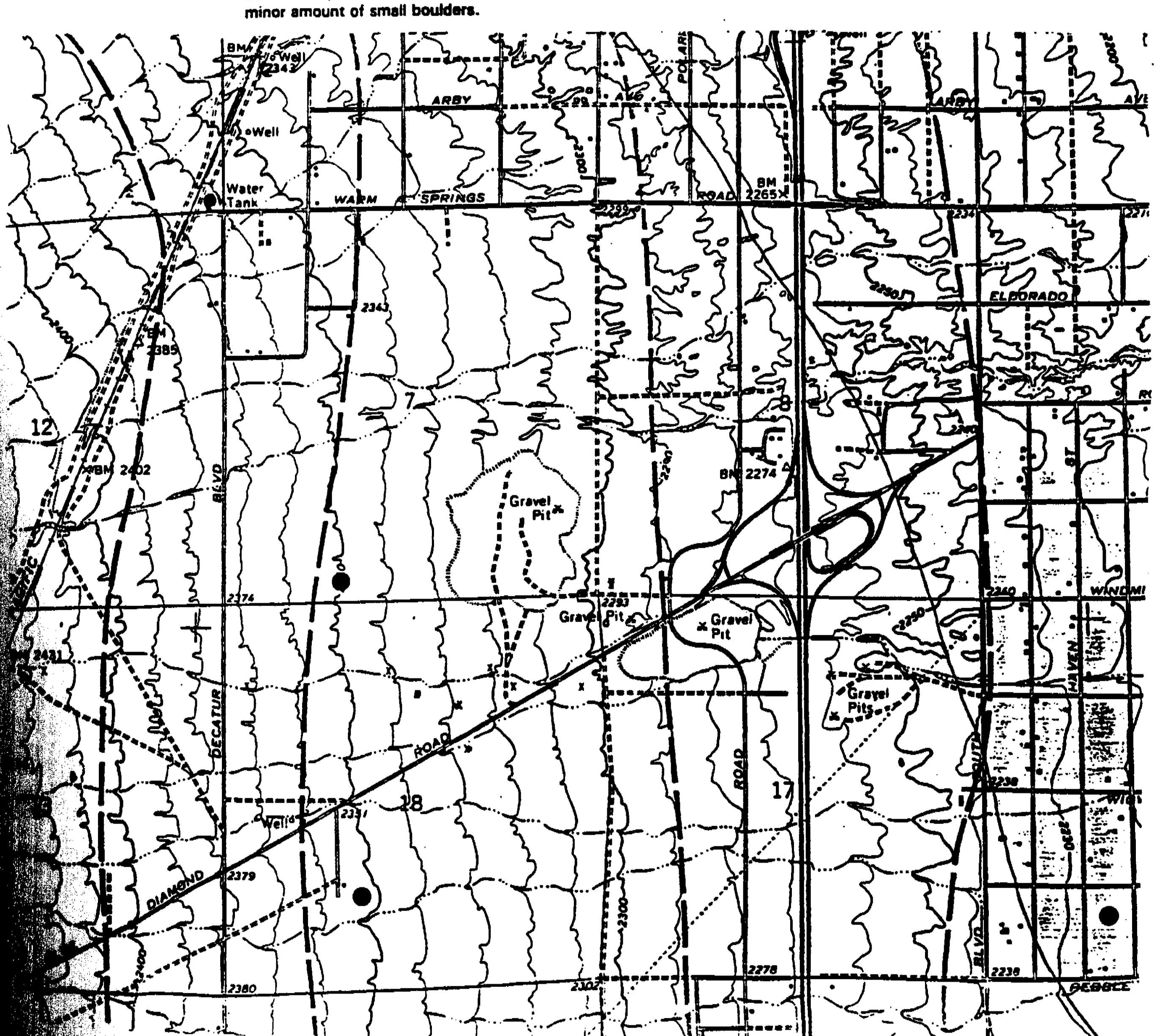
Scale 1:24,000

CONTOUR INTERVAL 10 FEET

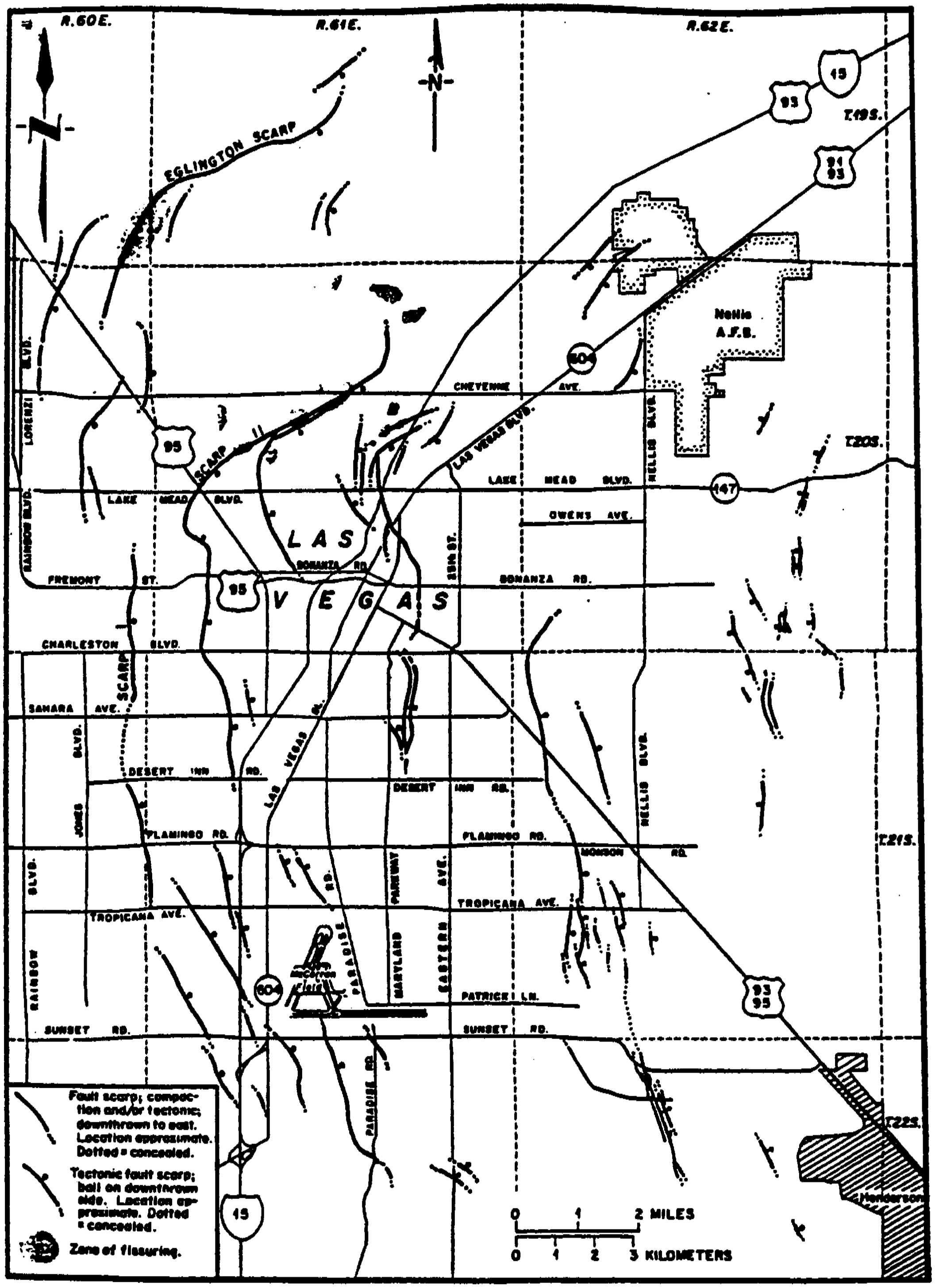
0 0.5 1 kilometer

0 0.5 1 mile

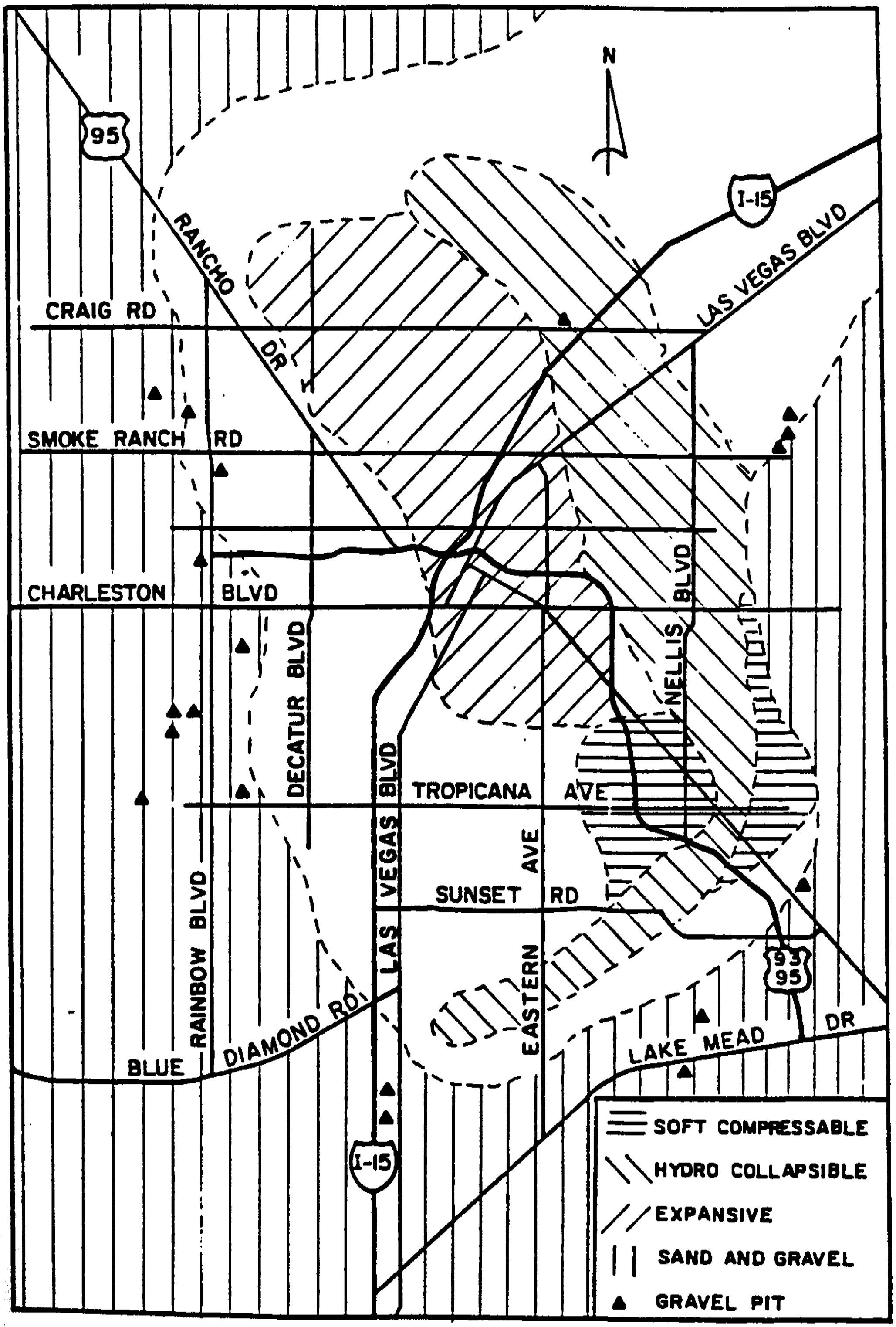
0 1000 2000 3000 4000 5000 feet



GENERAL GEOLOGY



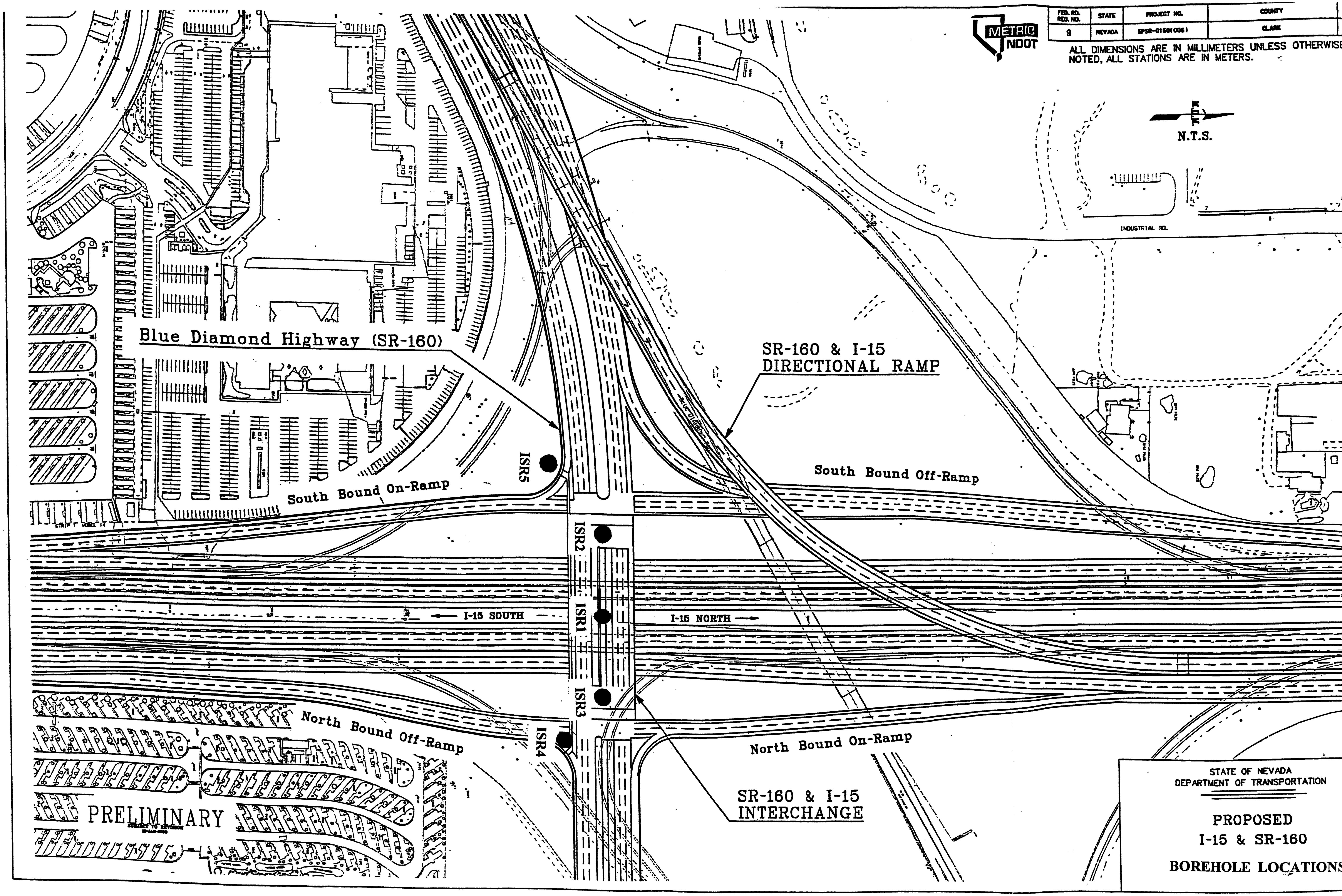
Main fault scarps and fissures in the Las Vegas Valley (from Bell, 1981). Approximate locations of the main faults are indicated. Many minor faults, and smaller, or gently sloping connecting scarps are not shown.



Soil types and gravel pits of the Las Vegas Valley

APPENDIX B

* BOREHOLE LOCATIONS
* KEY TO BORING LOGS
* BORING LOGS



STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

PROPOSED
I-15 & SR-160
BOREHOLE LOCATIONS

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE	04/10/00	STATION	"B" 33+71.09
END DATE	04/19/00	OFFSET	Median
JOB DESCRIPTION	I-15 at SR 160 Interchange - Las Vegas	ENGINEER	ABBAS
LOCATION	I-15 & SR 160, median	EQUIPMENT	Mobile B-57
BORING	ISR1	OPERATOR	Orlando
E.A. #	72495	DRILLING METHOD	Wet
GROUND ELEV.	691.47 (m)	BACKFILLED	Yes DATE 04/19/00
HAMMER DROP SYSTEM	Automatic/Safety		

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	10.06–10.52	M	SPT	20 35 39	74	100	W, Ch			
680.5	11									
	11.58–12.04	N	SPT	43 55 57	112	100	W, S, LL, PL, PI	SC	CLAYEY SAND WITH GRAVEL - Very hard to hard, moist.	Catcher was used in sampler.
679.5	12								(12.5 m to 13.1 m relatively soft drilling)	
678.5	13									
	13.11–13.56	O	SPT	23 25 31	56	100	W, S, LL, PL, PI		CLAYEY SAND WITH NO GRAVEL - Low plasticity (Avg. pocket pen = 192 KPa).	
677.5	14									
	14.63–14.78	P	CMS	30/152 mm		100	W, UW		partially cemented with moderate cementation, trace of gravel.	
676.5	15									
675.5	16								16.15	
	16.15–16.61	Q	SPT	12 18 51	69	100	W, LL, PL, PI		REDDISH BROWN CLAYEY SAND - Plastic, moist, some gravel, hard.	
									16.76	
674.5	17									
	17.68–17.83	R	SPT	120/152 mm		100	W, Ch			
673.5	18									
672.5	19									3450 KPa down pressure.
	19.20–19.30	S	SPT	100/102 mm		67	W, S	SM	SILTY SAND - Moist, very dense, light green.	89 mm diameter hole

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE 04/10/00
END DATE 04/19/00
JOB DESCRIPTION I-15 at SR 160 Interchange - Las Vegas
LOCATION I-15 & SR 160, median
BORING ISR1
E.A. # 72495
GROUND ELEV. Approx. 691.0 m
HAMMER DROP SYSTEM Safety

STATION "Bm" 33+71.09
OFFSET Median
ENGINEER Abbas
EQUIPMENT Mobile B80
OPERATOR Orlando
DRILLING METHOD Wet
BACKFILLED Yes DATE 04/19/00

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	20.73–20.84	T	SPT	100/114 mm		75		SM	SILTY SAND WITH GRAVEL - Very dense.	
670.5	21									
669.5	22								22.25	
	22.25–25.30	U	CORE						REDDISH BROWN SANDY LEAN CLAY - No core recovery, strong cementation, moist.	
668.5	23									
667.5	24									
666.5	25									
	25.30–25.76	V	SPT	15 30 49	79	100	W, S, LL, PL, PI		REDDISH BROWN SANDY LEAN CLAY - Very hard, partially cemented, moist, recovery 100%.	Pocket Pen Avg. = 240 KPa
665.5	26								Coarse sand in the cuttings (25.6 m to 26.5 m).	
	26.82–27.28	W	SPT	30 43 40	83	100	W, S, LL, PL, PI	CL	REDDISH BROWN CLAYEY SAND - Very hard, with occasional coarse sand/fine gravel. 27.28	
664.5	27									B.O.H. at 27.28 m. No Groundwater was encountered.
663.5	28									
662.5	29									

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE 05/09/00
END DATE 05/11/00
JOB DESCRIPTION I-15 at SR 160 Interchange - Las Vegas
LOCATION I-15 & SR-160, West Abutment
BORING ISR2
E.A. # 72495
GROUND ELEV. 691.41 (m)
HAMMER DROP SYSTEM Safety

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

STATION "Bm" 33+71.09
OFFSET West Abutment
ENGINEER Abbas
EQUIPMENT Mobile B80
OPERATOR Orlando
DRILLING METHOD Wet
BACKFILLED Yes DATE 5/11/00

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
									BROWN SILTY SAND - Bare ground.	88.9 mm diameter hole.
690.4	0.91 – 1.37	A	SPT	5 5 5	10	100	Ch		BROWN SILTY SAND - Loose to medium dense, dry	
	1.37 – 1.83	B	SPT	5 9 8	17	100	S, LL, PL, PI			
689.4	1.83 – 2.29	C	SPT	5 8 11	19	100	S, LL, PL, PI	SM	CLAYEY SAND WITH GRAVEL.	
	2.29 – 2.74	D	SPT	8 11 15	26	100	G		2.74	
688.4	2.74 – 3.20	E	SPT	21 41 65	106	100	S	GM	SILTY GRAVEL WITH SAND - Very dense, dry. 3.20	
	3.20 – 3.66	F	SPT	36 50 50/25 mm		100	S, Ch		POORLY GRADED SAND WITH SILT & GRAVEL.	
687.4	3.66 – 3.96									
	3.96 – 4.42	G	SPT	14 28 45	73	100	S, LL, PL, PI		REDDISH BROWN SILTY CLAYEY SAND - Moist, hard.	Pocket Pen = 96 KPa.
	4.42 – 4.88	H	SPT	22 35 53	88	100	S		SILTY SAND WITH GRAVEL.	
686.4	4.88 – 5.18	I	SPT	75 115/152 mm		100	S			
	5.18 – 5.33									
	5.33 – 5.79	J	SPT	23 33 78	111	100	S, LL, PL, PI	SC SM		
685.4	6									
684.4	7.01								7.01	
	7.01 – 7.47	K	SPT	55 80 120	200	100	S		SILTY GRAVELS WITH SAND - Very dense.	
683.4	8									
	8.53 – 8.62	L	SPT	100/89 mm		58		GM		
682.4	9									

NV_DOT ISR2.GPJ NV_DOT.GDT 12/13/00

NEVADA DEPARTMENT OF TRANSPORTATION

GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE	05/09/00	STATION	"Bm" 33+71.09
END DATE	05/11/00	OFFSET	West Abutment
JOB DESCRIPTION	I-15 at SR 160 Interchange - Las Vegas	ENGINEER	Abbas
LOCATION	I-15 & SR-160, West Abutment	EQUIPMENT	Mobile B80
BORING	ISR2	OPERATOR	Orlando
E.A. #	72495	DRILLING METHOD	Wet
GROUND ELEV.	691.41 (m)	BACKFILLED	Yes DATE 5/11/00
HAMMER DROP SYSTEM	Safety		

GROUNDWATER LEVEL

DATE	DEPTH m	ELEV. m

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	10.06–10.52	M	SPT	40 45 90	135	100	S, LL, PL, PI			
									10.67 REDDISH BROWN SILTY SAND WITH GRAVEL - Very dense.	
680.4	11									
	11.58–12.04	N	SPT	56 54 68	122	100	S			
679.4	12									
678.4	13								Sand and fine gravel are in the matrix of very hard silt, moist.	
	13.11–13.19	O	SPT			58				
677.4	14									
	14.63–14.90	P	SPT	53 100/114 mm		88	S			
676.4	15									
675.4	16									
	16.15–16.41	Q	SPT	100/108 mm		71				
674.4	17							SM		
	17.68–17.79	R	SPT	120/114 mm		75				
673.4	18									
672.4	19									
	19.20–19.31	S	SPT	100/108 mm		71	S, LL, PL, PI			

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE	05/09/00	STATION	"Bm" 33+71.09
END DATE	05/11/00	OFFSET	West Abutment
JOB DESCRIPTION	I-15 at SR 160 Interchange - Las Vegas	ENGINEER	Abbas
LOCATION	I-15 & SR-160, West Abutment	EQUIPMENT	Mobile B80
BORING	ISR2	OPERATOR	Orlando
E.A. #	72495	DRILLING METHOD	Wet
GROUND ELEV.	691.41 (m)	BACKFILLED	Yes DATE 5/11/00
HAMMER DROP SYSTEM	Safety		

GROUNDWATER LEVEL

DATE	DEPTH m	ELEV. m

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	20.73 / 20.80	T	SPT	100/70 mm		46				
670.4	21									
669.4	22									
	22.25 / 22.52	U	SPT	50 100/114 mm		88	S, LL, PL, PI	CL	22.25 REDDISH BROWN LEAN CLAY WITH SAND - Very hard. 22.86	
668.4	23									
667.4	23.77 / 24 / 24.21	V	SPT	22 32 140/133 mm		96	S, LL, PL, PI	SC SM	REDDISH BROWN SILTY CLAYEY SAND WITH GRAVEL - Highly cemented sand in the last 133 mm in the SPT shoe. 24.16	B.O.H. at 24.16 m. No Groundwater was encountered.
666.4	25								Note: Presence of weak to moderate soil cementation generated high N-SPT with Partial Sampler Penetration. This cementation is indicative of water-soluble cementing materials such as calcium carbonate. Calcium carbonate was detected from the intensity of the soil reaction with dilute HCl. Soils with 50<N60<100 is called Intermediate Geomaterials (Transitional between soils and rock).	
665.4	26									
664.4	27									
663.4	28									
662.4	29									

NEVADA DEPARTMENT OF TRANSPORTATION

GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE	05/15/00	STATION	"Bm" 33+71.09
END DATE	05/18/00	OFFSET	East Abutment
JOB DESCRIPTION	I-15 at SR 160 Interchange - Las Vegas	ENGINEER	Abbas
LOCATION	I-15 & SR-160, East Abutment	EQUIPMENT	Mobile B80
BORING	ISR3	OPERATOR	Orlando
E.A. #	72495	DRILLING METHOD	Wet
GROUND ELEV.	690.65 (m)	BACKFILLED	Yes DATE 5/18/00
HAMMER DROP SYSTEM	Safety		

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	0.91									Stroke = 0.9 m
689.6	1 1.37	A	SPT	13 14 22	36	100	W, S, LL, PL, PI		REDDISH BROWN SILTY SAND - Dense and moist.	Catcher was used in the SPT Sampler.
	1.83	B	SPT	15 19 19	38	100	Ch, G			
688.6	2 2.29	C	SPT	14 17 35	52	100	S			
	2.44									
	2.90	D	SPT	20 56 67	123	100	W, S			
687.6	3 3.26	E	SPT	18 37 65/64 mm		81	W, S		REDDISH BROWN SILTY SAND WITH GRAVEL - Dense, moist at 3.20 m.	
	3.66									
	3.99	F	SPT	13 93		72	W, S		POORLY GRADED SAND WITH GRAVEL.	
686.6	4 4.11			50/25 mm						
	4.23	G	SPT	100/114 mm		75				
	4.57									
	4.85	H	SPT	69 100/127 mm		92	W, S, Ch	SM		
685.6	5 5.03								5.03	
	5.49	I	SPT	18 37 32	69	100	W, S, LL, PL, PI, Ch			
	5.94	J	SPT	18 40 37	77	100	W, S, LL, PL, PI		REDDISH BROWN SILTY CLAYEY SAND - Moist with moderate cementation, sandy gravel interbedded, low plasticity.	
684.6	6									
683.6	7 7.01									
	7.14	K	SPT	100/127 mm		83	Ch	SC SM		
682.6	8									
	8.53									
	8.99	L	SPT	58 60 45	105	100	W, S, LL, PL, PI			
681.6	9								9.14	

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE 05/15/00
END DATE 05/18/00
JOB DESCRIPTION I-15 at SR 160 Interchange - Las Vegas
LOCATION I-15 & SR-160, East Abutment
BORING ISR3
E.A. # 72495
GROUND ELEV. 690.65 (m)
HAMMER DROP SYSTEM Safety

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

STATION "Bm" 33+71.09
OFFSET East Abutment
ENGINEER Abbas
EQUIPMENT Mobile B80
OPERATOR Orlando
DRILLING METHOD Wet
BACKFILLED Yes DATE 5/18/00

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	10.06–10.52	M	SPT	13 21 37	58	100	W, S, LL, PL, PI		VERY LIGHT GREY SILTY SAND WITH GRAVEL - Moist, moderately cemented (fizzing reaction with HCl).	
679.6	11									
	11.58–12.04	N	SPT	31 33 32	65	100	W, S		LIGHT BROWN SILTY SAND WITH FINE GRAVEL.	
678.6	12									
677.6	13									
	13.11–13.48	O	SPT	25 24 100/70 mm		82	W, S			
676.6	14									
	14.63–14.94	P	SPT	72 110/152 mm		100	W, S		SILTY SAND WITH GRAVEL - Trace of gypsum/salt (reacts with HCl).	
675.6	15									
674.6	16									
	16.15–16.61	Q	SPT	20 23 52	75	100	W, S, Ch			
673.6	17									
	17.68–18.14	R	SPT	57 43 117	160	100	W, S	SM	(Fizzing reaction with HCl)	
672.6	18									
	18.29								REDDISH BROWN SANDY FAT CLAY - Strong cementation, very hard, moist, trace of sand/gravel.	
671.6	19									
	19.20–19.66	S	SPT	80 73 115	188	100	W, S	CH	Reactive to HCl (fizzing).	Sand catcher was used through the entire hole.

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE 05/15/00
END DATE 05/18/00
JOB DESCRIPTION I-15 at SR 160 Interchange - Las Vegas
LOCATION I-15 & SR-160, East Abutment
BORING ISR3
E.A. # 72495
GROUND ELEV. 690.65 (m)
HAMMER DROP SYSTEM Safety

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

STATION "Bm" 33+71.09
OFFSET East Abutment
ENGINEER Abbas
EQUIPMENT Mobile B80
OPERATOR Orlando
DRILLING METHOD Wet
BACKFILLED Yes DATE 5/18/00

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	20.73								20.57	
669.6	21 / 21.18	T	SPT	24 52 100	152	100	W, S, LL, PL, PI	CL	REDDISH BROWN CLAYEY SAND - Very hard, reactive to HCl, Pocket Pen (Avg. = 240 KPa).	
668.6	22 / 22.25									
	22.71	U	SPT	30 22 27	49	100	W, S, LL, PL, PI		REDDISH BROWN SANDY LEAN CLAY - Hard, moist plastic, reative to HCl, Pocket Pen = 192 KPa.	
667.6	23									
	23.77									
666.6	24 / 24.23	V	SPT	11 14 13	27	100	W, S, LL, PL, PI		24.23	
									Note: Presence of weak to moderate soil cementation generated high N-SPT with Partial Sampler Penetration. This cementation is indicative of water-soluble cementing materials such as calcium carbonate. Calcium carbonate was detected from the intensity of the soil reaction with dilute HCl. Soils with 50<N60<100 is called Intermediate Geomaterials (Transitional between soils and rock).	B.O.H. at 24.23 m. No Groundwater was encountered.
665.6	25									
664.6	26									
663.6	27									
662.6	28									
661.6	29									

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE	05/23/00	STATION	"Bm" 33+71.09
END DATE	05/23/00	OFFSET	Southeast Corner
JOB DESCRIPTION	I-15 AND SR 160 Blue Diamond Interchange	ENGINEER	Abbas
LOCATION	I-15 & SR 160, Las Vegas, Southeast Corner	EQUIPMENT	Mobile B80
BORING	ISR4	OPERATOR	Orlando
E.A. #	72495	DRILLING METHOD	Wet
GROUND ELEV.	Approx. 691.0 m	BACKFILLED	Yes DATE 5/23/00
HAMMER DROP SYSTEM	Safety		

GROUNDWATER LEVEL		
DATE	DEPTH m	ELEV. m

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	0.91									Stroke = 0.91 m. Hole diameter = 88.9 mm.
690.0	1 / 1.37	A	CMS	20 27 25	52	100	W, UW, S		LIGHT REDDISH-BROWN SILTY CLAYEY SAND - Hard and dry.	
	1.83	B	SPT	13 23 24	47	100	W, S, LL, PL, PI, Ch	SC SM		
689.0	2 / 2.29	C	CMS	20 26 38	64	100	W, UW, S, LL, PL, PI		2.44	
	2.74	D	SPT	28 46 61	107	100	W, S		POORLY GRADED GRAVEL WITH SILT AND SAND - Strong reaction with HCl, light reddish brown.	
688.0	3 / 3.05	E	CMS	52 125/152 mm		100	W, UW, S			
	3.35	F	SPT	36 100/152 mm		100	W, S	GP GM		
	3.96								3.96	
687.0	4 / 4.42	G	SPT	12 60 106	166	100	W, S, LL, PL, PI		REDDISH BROWN SANDY LEAN CLAY - Hard.	The entire subsurface soils have a strong reaction with HCl; indicative of calcium carbonate.
	4.57									
686.0	5 / 5.03	H	SPT	14 23 17	40	100	W, S, LL, PL, PI	CL		
	5.18									
	5.64	I	SPT	15 24 25	49	100	W, Ch		5.79	Soils have weak to moderate cementation.
685.0	6 / 6.10									
	6.55	J	SPT	27 32 38	70	100	W, S, LL, PL, PI		REDDISH BROWN CLAYEY SAND - Very hard, moist, partially cemented, moderate cementation, moist.	
684.0	7 / 7.01									Soils are moist.
	7.47	K	CMS	90 88 60	148	100	W, UW, S, LL, PL, PI, HC			
	7.92	L	SPT	25 52 75	127	100	W	SC		
683.0	8									
	8.53									
682.0	8.99 / 9	M	CMS	73 105 95	200	100	W, UW, S			
	9.45	N	SPT	38 34 34	68	100	W, S, LL, PL, PI, G		9.45	B.O.H. at 9.45 m. No groundwater was encountered.

EXPLORATION LOG

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

START DATE	05/24/00	STATION	"Bm" 33+71.09
END DATE	05/25/00	OFFSET	Southwest Corner
JOB DESCRIPTION	I-15 at SR 160 Blue Diamond Interchange	ENGINEER	Abbas
LOCATION	I-15 & SR 160, Las Vegas, Southwest Corner	EQUIPMENT	Mobile B80
BORING	ISR5	OPERATOR	Orlando
E.A. #	72495	DRILLING METHOD	Wet
GROUND ELEV.	Approx. 691.5 m	BACKFILLED	Yes DATE 5/25/00
HAMMER DROP SYSTEM	Safety		

GROUNDWATER LEVEL

DATE	DEPTH m	ELEV. m

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
										Stroke = 0.91 m
690.4	0.91 – 1 – 1.37	A	CMS	7 11 25	36	100	W, UW, S, DS, F, C, G	SM	LIGHT BROWN SILTY SAND - Dense, dry.	
	1.37 – 1.83	B	SPT	14 17 26	43	100	W, S, Ch	SM		
689.4	1.83 – 2 – 2.29	C	CMS	30 37 35	72	100	W, UW, S, Ch	GW	1.98 SANDY GRAVEL - Very dense, dry. 2.29	
	2.29 – 2.74	D	SPT	20 34 37	71	100	W, S, Ch	SM	From depth 1.8 m to 3.7 m, the average gravel content is about 40%.	
688.4	3 – 3.20							SM		
	3.20 – 3.66	E	CMS	55 109 105	214	100	W, UW, S	SM		
687.4	3.66 – 4 – 4.11	F	SPT	21 55 62	117	10	W, S, LL, PL, PI	SM	REDDISH BROWN SILTY SAND - Very hard, moist.	
	4.11 – 4.57	G	CMS	53 81 61	142	100	W, UW, S, DS, F, C	SM		
686.4	4.57 – 5 – 5.03	H	SPT	40 62 57	119	100	W, S, Ch	SM		
	5.03 – 5.32	I	CMS	64 200/140 mm		96	W, UW, S	SM	5.33	
	5.32 – 5.64							CL	VERY LIGHT GRAY SANDY CLAY - Very hard, dry.	
685.4	5.64 – 5.94 – 6	J	SPT	72 130/152 mm		100	W, S, LL, PL, PI	CL		
								CL	6.71	
684.4	7.01 – 7 – 7.12	K	SPT	30/108 mm		71		GM		4137 KPa down pressure.
683.4	8							GM	GRAYISH ORANGE PINK SILTY GRAVEL WITH SAND - Very dense.	
	8.53 – 8.61	L	SPT	100/76 mm		50		GM		
682.4	9 – 9.14							GM		
	9.14 – 9.60	M	SPT	8 11 8	19	100	W, S	GM	9.60	2068 KPa down pressure.

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING

EXPLORATION LOG

START DATE	05/24/00	STATION	"Bm" 33+71.09
END DATE	05/25/00	OFFSET	Southwest Corner
JOB DESCRIPTION	I-15 at SR 160 Blue Diamond Interchange	ENGINEER	Abbas
LOCATION	I-15 & SR 160, Las Vegas, Southwest Corner	EQUIPMENT	Mobile B80
BORING	ISR5	OPERATOR	Orlando
E.A. #	72495	DRILLING METHOD	Wet
GROUND ELEV.	Approx. 691.5 m	BACKFILLED	Yes DATE 5/25/00
HAMMER DROP SYSTEM	Safety		

GROUNDWATER LEVEL

DATE	DEPTH m	ELEV. m

ELEV. (m)	DEPTH (m)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT 150 mm Increments	BLOW COUNT Last 300 mm	Percent Recov'd	LAB TESTS	USCS Group	MATERIAL DESCRIPTION	REMARKS
	10.06 – 10.52	N	SPT	1 13 14	27	100	W, S, LL, PL, PI	SM	VERY LIGHT GRAY SILTY SAND WITH GRAVEL - Medium dense, moist.	
	10.67 – 11.13	O	CMS	14 20 51	71	100	W, UW, S, LL, PL, PI		10.97	
680.4	11									
	11.13 – 11.58	P	SPT	33 61 97	158	100	W, S, Ch	GM	SILTY GRAVEL WITH SAND 11.58	B.O.H. at 11.58 m. No groundwater was encountered.
679.4	12									
678.4	13									
677.4	14									
676.4	15									
675.4	16									
674.4	17									
673.4	18									
672.4	19									

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

EA/Cont # 72495 **Job Description** I-15 @ SR 160 Interchange - Las Vegas

Boring No. ISR1 **Elevation (ft)** 691.5 **Station** "B" 110+60 (center of bridge)

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMP-LER 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	0.61 -	SPT	14	SC-SM	14.5		39.7	20	14	6						
A1	- 1.07	SPT	14	SM			27.0									
B	1.07 - 1.52	SPT	22	SM	11.2		24.3									
C	1.52 - 1.98	SPT	30	SM	9.5		24.9									
D	1.98 - 2.44	SPT	25	SM	10.9		32.8	17	NP	NP						
E	2.44 - 2.90	CMS	R	GW	1.1		3.2									
F	3.05 - 3.51	SPT	71	SP-SM	7.7	17.7	10.1				DS	35.6	0.369			DS
G	3.51 - 3.96	SPT	R		9.1											Ch
H	3.96 - 4.42	SPT	R	SM	9.2		12.3									
I	4.42 - 4.88	SPT	R	SC-SM	6.3		26.5	57	29	28						Ch
J	4.88 - 5.33	SPT	R	SM	12.0	18.5	16.3				DS	39.1	0.244			DS

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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
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UW= Unit Weight
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RQD = Rock Quality Designation
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HCpot = Hydro-Collapse Potential

*** = Average of subsamples**

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

EA/Cont # 72495 **Job Description** I-15 @ SR 160 Interchange - Las Vegas

Boring No. ISR1 **Elevation (ft)** 691.5 **Station** "B" 110+60 (center of bridge)

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
K	7.01 - 7.16	SPT	R	SM	19.2		33.4									
L	8.53 - 8.99	SPT			18.5											
M	10.06 - 10.52	SPT	74		15.2											Ch
N	11.58 - 12.04	SPT	112	SC	16.6		28.5	65	62	33						
O	13.11 - 13.56	SPT	56	SC	13.3		47.2	34	19	15						
P	14.63 - 14.78	CMS	R		15.1	18.6										
Q	16.15 - 16.46	SPT			20.0			67	30	37						
R	17.68 - 17.83	SPT	R		12.5											Ch
S	19.20 - 19.29	SPT	R	SM	19.4		43.5									
T	20.73 - 20.82	SPT	R													
U	25.30 - 25.60	coring														

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

EA/Cont # 72495 **Job Description** I-15 @ SR 160 Interchange - Las Vegas

Boring No. ISR1 **Elevation (ft)** 691.5 **Station** "B" 110+60 (center of bridge)

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMP-LER TYPE	N BLOWS per ft.	SOIL GROUP	W%	DRY UW pcf	% PASS #200	LL %	PL %	PI %	STRENGTH TEST TEST TYPE	Φ deg. Peak	C psi Peak	Φ deg. Residual	C psi Residual	COMMENTS
V	25.60 - 25.76	SPT	79	CL	16.0		57.2	38	18	20						
W	26.82 - 27.28	SPT	83	SC	17.3		49.2	49.2	20	12						

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

EA/Cont # 72495 **Job Description** I-15 @ SR 160 Interchange - Las Vegas

Boring No. ISR2 **Elevation (ft)** 691.4 **Station** West Abutment, "B" 110+60, 60m Lt.

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	0.91 - 1.37	SPT	10													Ch
B	1.37 - 1.83	SPT	17	SM			43.4	18	15	3						
C	1.83 - 2.29	SPT	19	SC			42.2	22	12	10						
D	2.29 - 2.74	SPT	26													G=2.634
E	2.74 - 3.20	SPT	106	GM			12.2									
F1	3.20 - 3.50	SPT	50/.15M	SP-SM			11.1									
F2	3.50 - 3.66	SPT	25/.15M													Ch
G	3.96 - 4.42	SPT	73	SC-SM			41.9	23	17	6						
H	4.42 - 4.88	SPT	88	SM			15.6									
I	4.88 - 5.33	SPT	R	SW-SM			8.1									
J	5.33 - 5.79	SPT	111	SC-SM			25.8	22	18	4						

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

EA/Cont # 72495 **Job Description** I-15 @ SR 160 Interchange - Las Vegas

Boring No. ISR2 **Elevation (ft)** 691.4 **Station** West Abutment, "B" 110+60, 60m Lt.

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
K	7.01 - 7.47	SPT	200	GM			16.4									
L	8.53 - 9.00	SPT	R													
M	10.06 - 10.51	SPT	135	GM			22.2	67	33	34						
N	11.58 - 12.04	SPT	122	SM			18.4									
O	13.10 - 13.56	SPT	R													
P	14.63 - 15.09	SPT	R	SM			27.8									
Q	16.15 - 16.61	SPT	R													
R	17.68 - 18.13	SPT	R													
S	19.20 - 19.70	SPT	R	SM			23.5	74	13	61						
T	20.73 - 20.80	SPT	R													
U	22.25 - 22.55	SPT	R	CL			77.4	38	18	20						
V	23.77 - 24.33	SPT	R	SC-SM			22.6	24	18	6						

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N = No. of blows per ft., sampler
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SUMMARY OF RESULTS
N.D.O.T. GEOTECHNICAL SECTION

EA/Cont # 72495 **Job Description** I-15 @ SR 160 Interchange - Las Vegas

Boring No. ISR3 **Elevation (ft)** 690.7 **Station** East Abutment, "B" 110+60, 60m Lt.

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMP-LER 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	0.91 - 1.37	SPT	36	SM	10.3		32.3	17	16	1						
B	1.37 - 1.83	SPT	38													Ch, G = 2.667
C1	1.83 - 2.13	SPT		SM			28.9									
C2	2.13 - 2.29	SPT														
D	2.44 - 2.90	SPT	123	SM	8.2		25.0									
E	2.90 - 3.35	SPT	R	SM	10.3		14.0									
F	3.35 - 3.66	SPT	R	SP	8.8		4.6									
G	3.66 - 4.11	SPT	R													
H	4.57 - 5.03	SPT	R	SM	15.8		35.6									Ch
I	5.03 - 5.49	SPT	69	SC	13.6		47.1	25	13	12						Ch
J	5.49 - 5.94	SPT	77	SC	12.7		33.2	24	17	7						

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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
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PL = Plastic Limit
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Ch = Chemical
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K = Permeability
O = Organic Content
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X = X-Ray Defraction
HCpot = Hydro-Collapse Potential

*** = Average of subsamples**

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

EA/Cont # 72495 **Job Description** I-15 @ SR 160 Interchange - Las Vegas

Boring No. ISR3 **Elevation (ft)** 690.7 **Station** East Abutment, "B" 110+60, 60m Lt.

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMP-LER 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
K	7.01 - 7.31	SPT	R													Ch
L	8.53 - 8.99	SPT	105	SC	16.0		29.3	51	26	25						
M	10.05 - 10.52	SPT	58	SM	26.3		46.3	96	43	53						
N	11.58 - 12.04	SPT	65	SM	15.5		17.7									
O	13.10 - 13.56	SPT	R	SM	19.6		27.5									
P	14.63 - 14.94	SPT	R	SM	11.6		12.1									
Q	16.15 - 16.61	SPT		SM	13.5		14.9									Ch
R	17.68 - 18.13	SPT		SM	9.1		14.1									
S	19.20 - 19.66	SPT	188	CH	19.5		55.3	74	13	61						
T	20.73 - 21.18	SPT	152	SC	13.1		39.8	41	19	22						
U	22.25 - 22.71	SPT	49	CL	16.8		65.2	34	16	18						
V	23.77 - 24.33	SPT	27	CL	16.5		41.7	34	17	17						

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SPT = Standard Penetration 1.38" ID
CS = Continuous Sample 3.23" ID
RC = Rock Core
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U = Unconfined Compressive
UU = Unconsolidated Undrained
CD = Consolidated Drained
CU = Consolidated Undrained
DS = Direct Shear
Φ = Fri 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
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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

*** = Average of subsamples**

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

EA/Cont # 72495 **Job Description** I-15 @ SR 160 Interchange - Las Vegas

Boring No. ISR4 **Elevation (ft)** 691.0 **Station** S.E. Retaining Wall, "B" 110+30, 100m

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMP-LER 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
A1	0.91 - 1.22	CMS	52	SM	4.0	18.6	34.7									
A2	1.22 - 1.37	CMS		ML	5.4	17.6	57.1									
B	1.37 - 1.83	SPT	47	SC-SM	9.5		34.8	17	13	4						Ch
C1	1.83 - 2.13	CMS	64	CL	7.8	16.5	65.2	24	14	10						
C2	2.13 - 2.29	CMS		SC-SM	3.3		43.3	19	15	4						
D1	2.29 - 2.44	SPT		GP-GM	6.0		6.7									
D2	2.44 - 2.74	SPT	107	SM	7.6		31.8									
E	2.74 - 3.05	CMS	R	GP-GM	6.6	21.00	7.7									
F	3.05 - 3.35	SPT	R	GW-GM	6.7		7.6									
G	3.96 - 4.42	SPT	166	CL	14.4		54.1	46	24	22						
H1	4.57 - 4.72	SPT		CL	16.5		77.8	43	19	24						

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
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RQD = Rock Quality Designation
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HCpot = Hydro-Collapse Potential

*** = Average of subsamples**

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

EA/Cont # 72495 **Job Description** I-15 @ SR 160 Interchange - Las Vegas

Boring No. ISR4 **Elevation (ft)** 691.0 **Station** S.E. Retaining Wall, "B" 110+30, 100m

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMP-LER TYPE	N BLOWS per ft.	SOIL GROUP	W%	DRY UW pcf	% PASS #200	LL %	PL %	PI %	STRENGTH TEST					COMMENTS
											TEST TYPE	Φ deg.	C psi	Φ deg.	C psi	
												Peak		Residual		
H2	16.0 - 16.5	SPT	40	40	CL	15.8		73.7	29	15	14					
I1	17.0 -	SPT	49	49		12.5										
I2	-18.5	SPT				10.4										Ch
J	20.0 - 21.5	SPT	70	70	SC	7.8		42.1	24	15	9					
K1	23.5 - 24.0	CMS			SC	8.7	18.00	48.0	36	21	15					
K2	24.0 - 24.5	CMS	148	148	SC	6.1	17.1	45.9	39	22	17					HC
L	24.5 - 26.0	SPT	127	127		14.9										
M1	28.5 - 29.0	CMS			SC	10.0	17.9	32.9	55	28	27					
M2	29.5 - 30.0	CMS	200	200	SC	10.5	17.5	36.6	71	30	41					
N	29.5 - 31.0	SPT	68	68	SC	13.4		21.9	37	22	15					G=2.703

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
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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
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O = Organic Content
D = Dispersive
RQD = Rock Quality Designation
X = X-Ray Defraction
HCpot = Hydro-Collapse Potential

*** = Average of subsamples**

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

EA/Cont # 72495 **Job Description** I-15 @ SR 160 Interchange - Las Vegas

Boring No. ISR5 **Elevation (ft)** **Station**

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMP-LER 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
A1	1.07 - 1.22			SM	1.8	16.4	24.9									
A2	1.22 - 1.37			SM	3.4	17.6	42.5				DS	40.8	0.322			G=2.61, DS (recomp sample)
B	1.37 - 1.83			SM	7.4		23.5									Ch
C1	1.98 - 2.13				5.6	21.4										Ch
C2	2.13 - 2.29			GW	1.1	22.5	4.3									
D	2.29 - 2.74			SP-SM	4.0		8.0									Ch
E1	3.35 - 3.50			SW-SM	4.2	21.2	5.9									
E2	3.50 - 3.66			SW-SM	0.4	22.1	5.3									
F	3.66 - 4.11			SC-SM	5.0		33.6	25	19	6						
G1	4.27 - 4.42			SM	3.7	19.4	22.5				DS	39.1	0.402			DS (recomp sample)
G2	4.42 - 4.57															

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

*** = Average of subsamples**

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

EA/Cont # 72495 **Job Description** I-15 @ SR 160 Interchange - Las Vegas

Boring No. ISR5 **Elevation (ft)** **Station**

SAMPLE NO.	SAMPLE DEPTH (ft)	SAMP-LER 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
H	4.57 - 5.03			SM	4.7		13.2									Ch
I	5.18 - 5.33			SP-SM	2.7	21.3	11.7									
J	5.33 - 5.64			CL	7.4		55.9	27	14	13						
K	7.01 - 7.11															
L	8.53 - 8.61															
M	9.60 - 10.06			GM	1.5		15.7									
N	10.06 - 10.51			SM	7.6		41.4	85	47	38						
O1	10.80 - 10.97			SC	17.1	17.1	33.0	57	34	33						
O2	10.97 - 11.12															
P	11.12 - 11.58			GM	7.4		15.9									Ch

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
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DS = Direct Shear
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N = No. of blows per ft., sampler
N = Field SPT N = $(N_{css})(0.62)$

H = Hydrometer
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D = Dispersive
RQD = Rock Quality Designation
X = X-Ray Defraction
HCpot = Hydro-Collapse Potential

*** = Average of subsamples**

NEVADA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL SECTION

CHEMICAL ANALYSIS

E.A. No. 72495

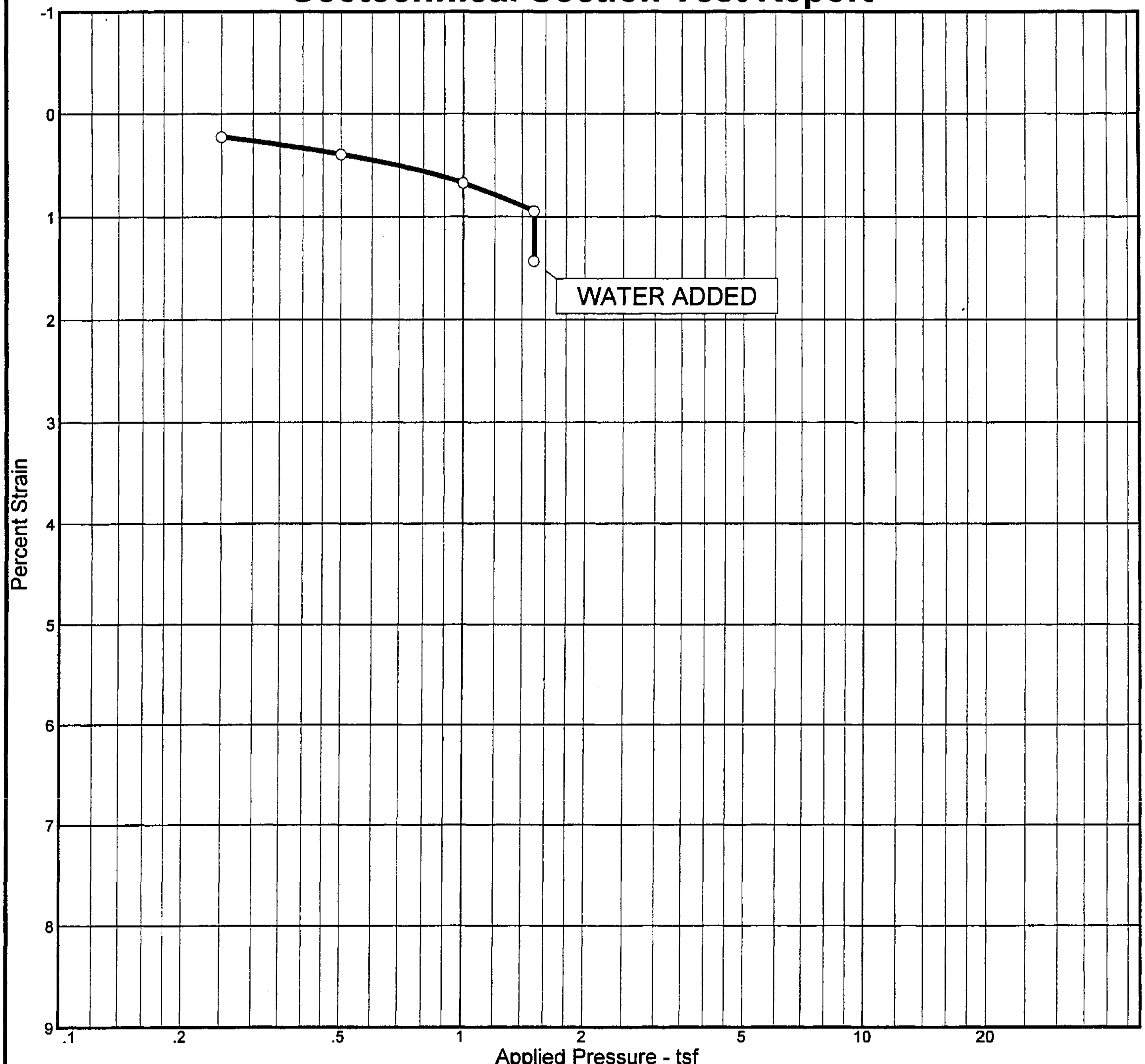
PROJECT I - 15 @ SR 160 Interchange

BORING # ISR

Sample No.	Chlorides	Sulfates	Ph	Resistivity
1-g	310	900	8.0	923
1-l	110	1,000	8.2	1,965
1-m	60	300	8.2	3,509
1-r	*	*	8.3	3,906
2-a	50	1,000	7.9	517
2-f2	440	900	7.9	683
3-b	1,100	5,000	7.9	202
3-h	60	800	8.0	1,385
3-I	80	800	8.0	1,486
3-k	*	*	7.9	1,669
3-q	50	500	7.9	3,413
4-b	590	1,000	7.8	514
4-i2	70	1,000	7.8	2,114
5-b	290	1,000	8.5	636
5-c1	140	700	8.5	1,739
5-d	130	850	8.4	1,560
5-h	150	900	7.7	1,835
5-p	90	1,000	8.6	2,667

* Insufficient amount of material to complete test.

Geotechnical Section Test Report



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Swell Press. (tsf)	Clpse. %	e_o
Sat.	Moist.											
											0.5	

MATERIAL DESCRIPTION	USCS	AASHTO
Hydro Collapse		

Project No. FL-14-00 **Client:** Abbas Bafghi

Project: Blue Diamond, Las Vegas

Location: ISR4-K2c collapse

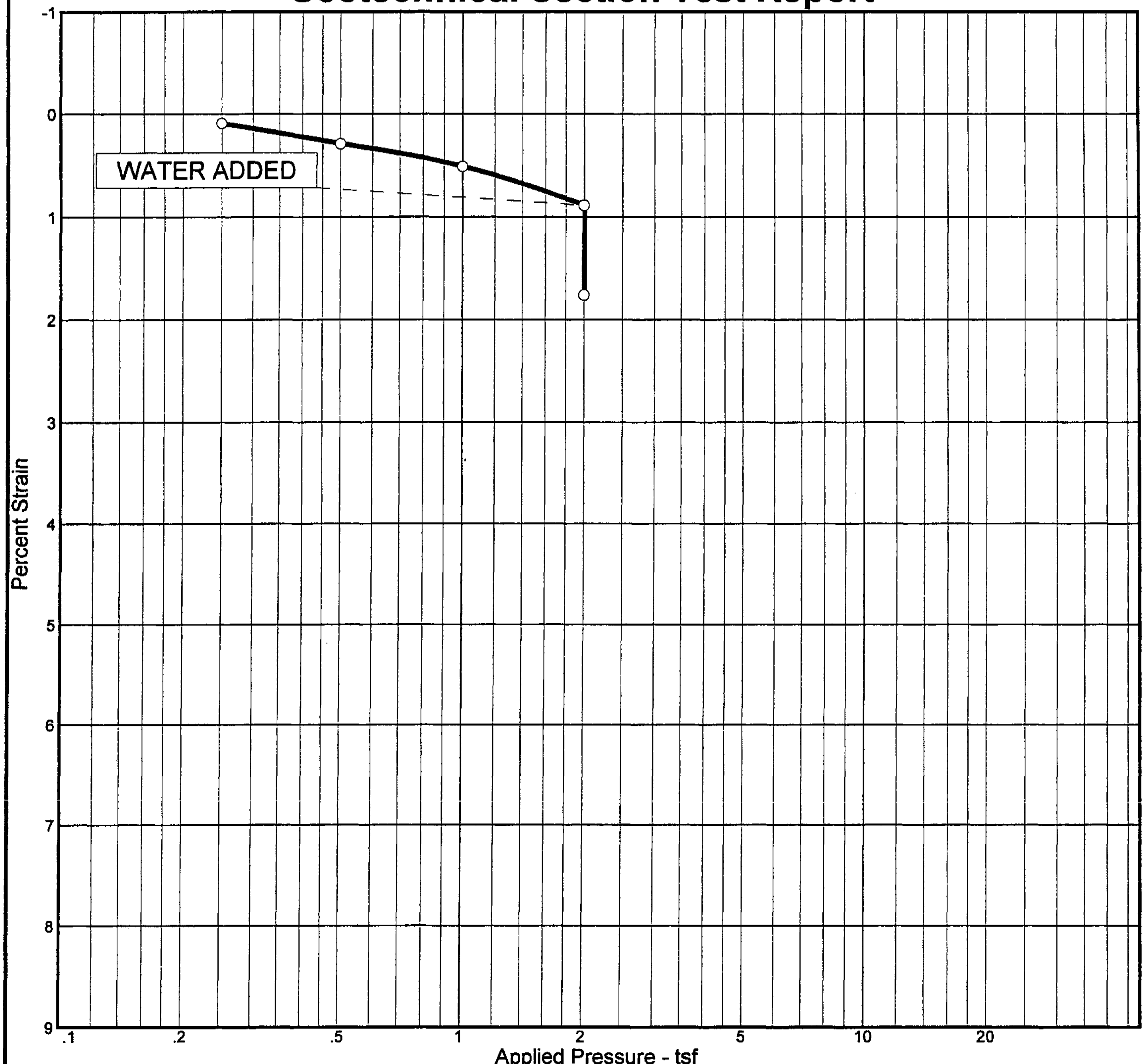
Remarks:
Sample ISR4-K2c

Geotechnical Section Test Report

NEVADA DEPARTMENT OF TRANSPORTATION

Plate

Geotechnical Section Test Report



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Swell Press. (tsf)	Clpse. %	e_o
Sat.	Moist.											
											0.9	

MATERIAL DESCRIPTION	USCS	AASHTO
Hydro Collapse		

Project No. FL-14-00 **Client:** Abbas Bafghi

Project: Blue Diamond, Las Vegas

Location: ISR4-K2d collapse

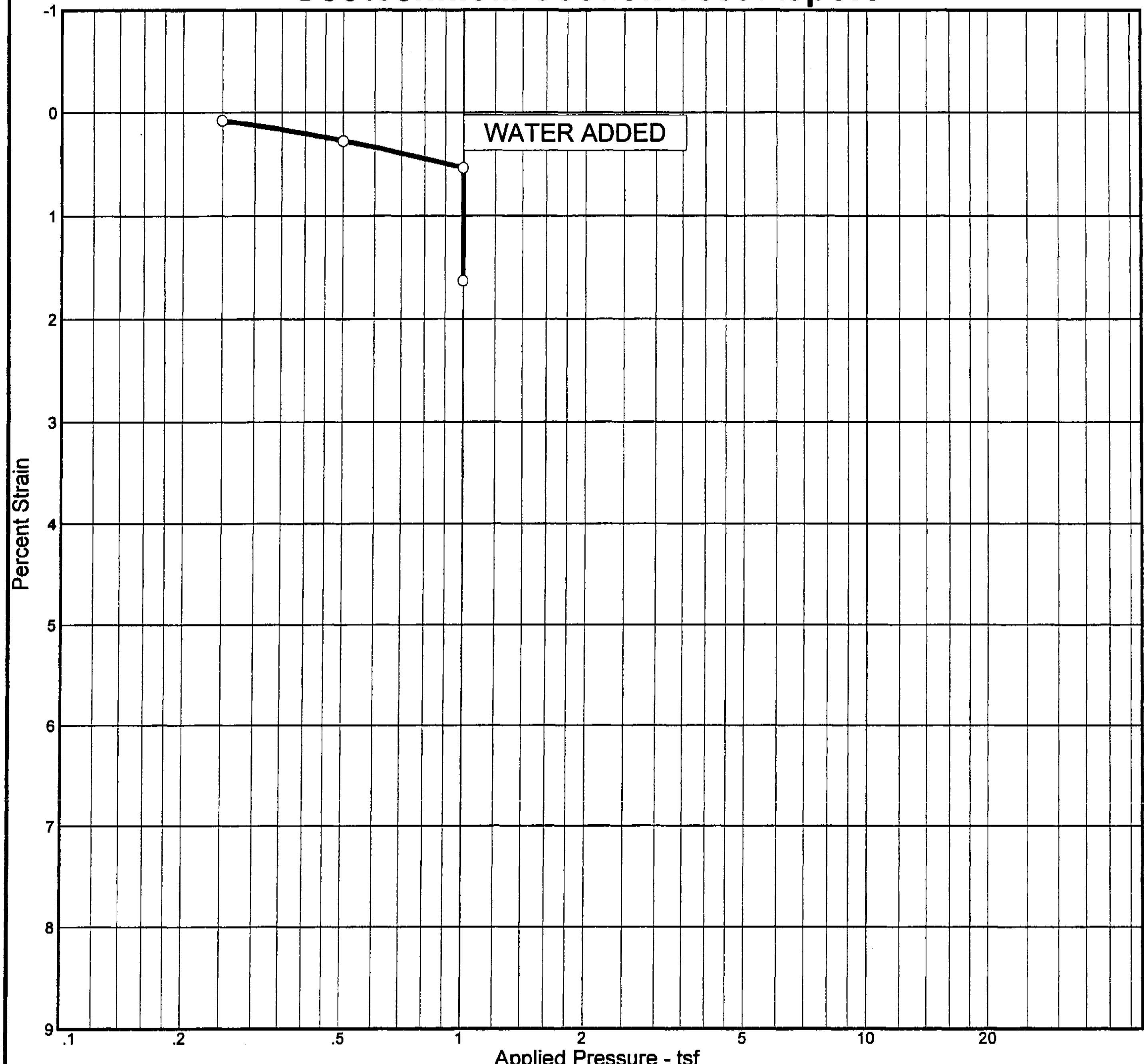
Remarks:
Sample ISR4-K2d

Geotechnical Section Test Report

NEVADA DEPARTMENT OF TRANSPORTATION

Plate

Geotechnical Section Test Report



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Swell Press. (tsf)	Clpse. %	e_o
Sat.	Moist.											
											1.1	

MATERIAL DESCRIPTION	USCS	AASHTO
Hydro Collapse		

Project No. FL-14-00 **Client:** Abbas Bafghi

Project: Blue Diamond, Las Vegas

Location: ISR4-C1c collapse

Remarks:

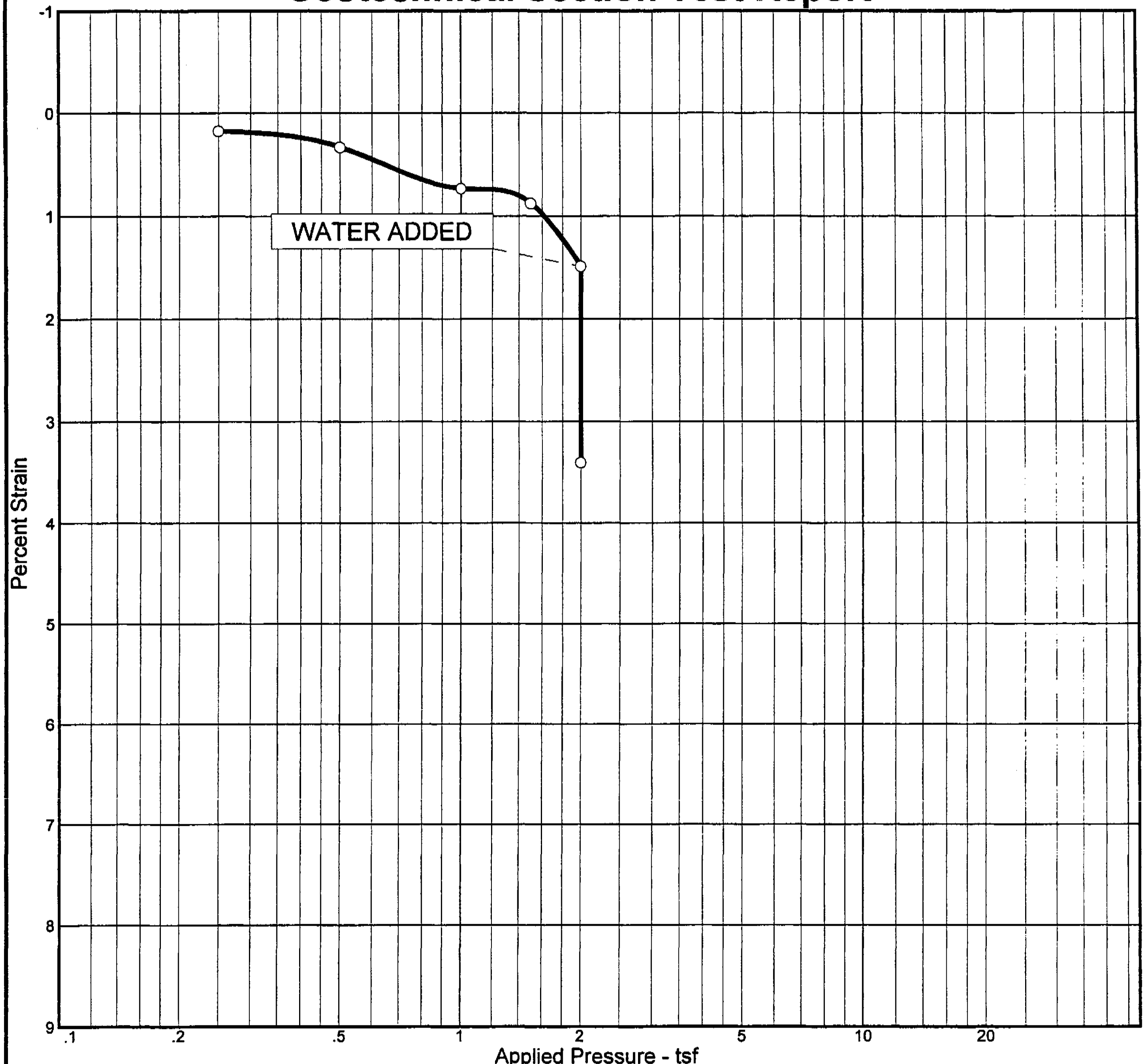
Sample ISR4-C1c

Geotechnical Section Test Report

NEVADA DEPARTMENT OF TRANSPORTATION

Plate

Geotechnical Section Test Report



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Swell Press. (tsf)	Clpse. %	e_o
Sat.	Moist.											
											1.9	

MATERIAL DESCRIPTION	USCS	AASHTO
Hydro Collapse		

Project No. FL-14-00 **Client:** Abbas Bafghi

Project: Blue Diamond, Las Vegas

Location: ISR4-K2b collapse

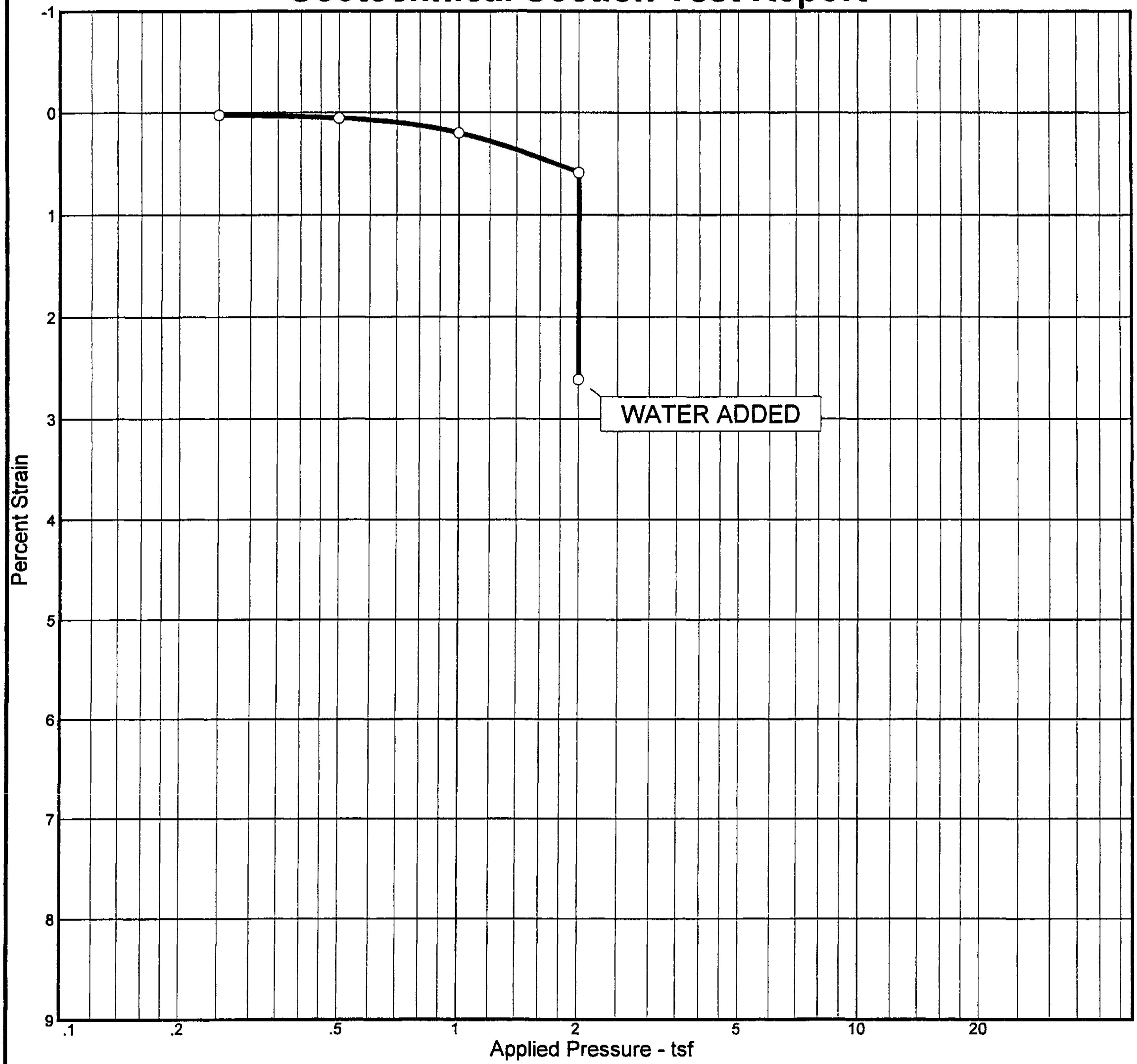
Remarks:
Sample ISR4-K2b

Geotechnical Section Test Report

NEVADA DEPARTMENT OF TRANSPORTATION

Plate

Geotechnical Section Test Report



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Swell Press. (tsf)	Clpse. %	e_o
Sat.	Moist.											
											2.0	

MATERIAL DESCRIPTION	USCS	AASHTO
Hydro Collapse		

Project No. FL-14-00 **Client:** Abbas Bafghi

Project: Blue Diamond, Las Vegas

Location: ISR4-C1a collapse

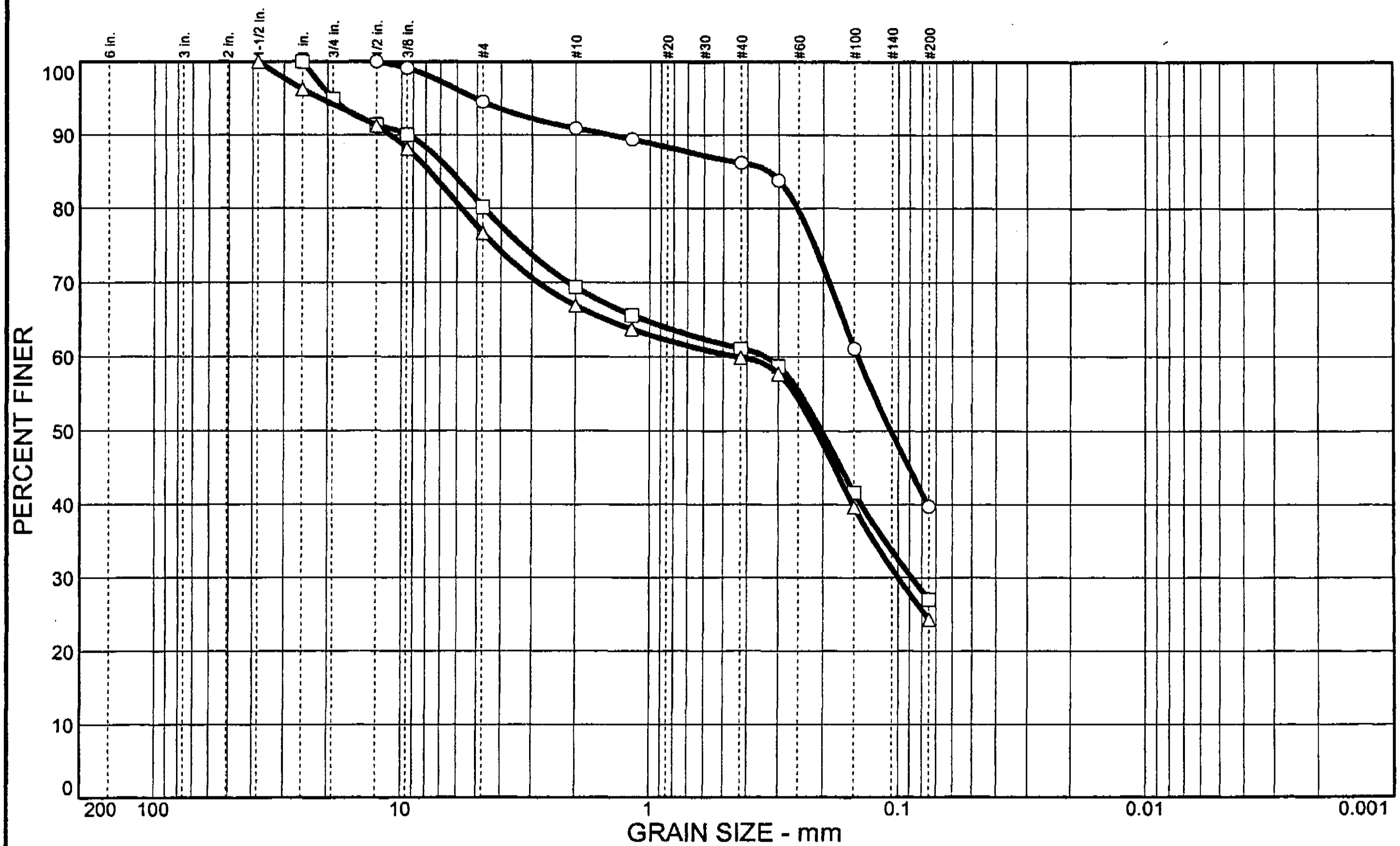
Remarks:
Sample ISR4-C1a

Geotechnical Section Test Report

NEVADA DEPARTMENT OF TRANSPORTATION

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		5.5	54.8			SC-SM		20	6
□		19.8	53.2			SM			
△		23.3	52.4			SM			

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □	PERCENT FINER △
1-1/2"			100.0
1"		100.0	96.2
3/4"		94.9	
1/2"	100.0	91.4	91.2
3/8"	99.1	90.0	88.1
GRAIN SIZE			
D_{60}	0.146	0.340	0.441
D_{30}		0.0881	0.100
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	PERCENT FINER □	PERCENT FINER △
#4	94.5	80.2	76.7
#10	90.9	69.4	66.9
#16	89.4	65.6	63.7
#40	86.2	61.1	59.9
#50	83.8	58.7	57.7
#100	61.1	41.6	39.6
#200	39.7	27.0	24.3

SOIL DESCRIPTION

○ Silty, clayey sand

□ Silty sand with gravel

△ Silty sand with gravel

REMARKS:

○

□

△

○ Location: Boring ISR1, sample: A

□ Location: Boring ISR1, sample: A1

△ Location: Boring ISR1, sample: B

NEVADA DEPARTMENT OF TRANSPORTATION

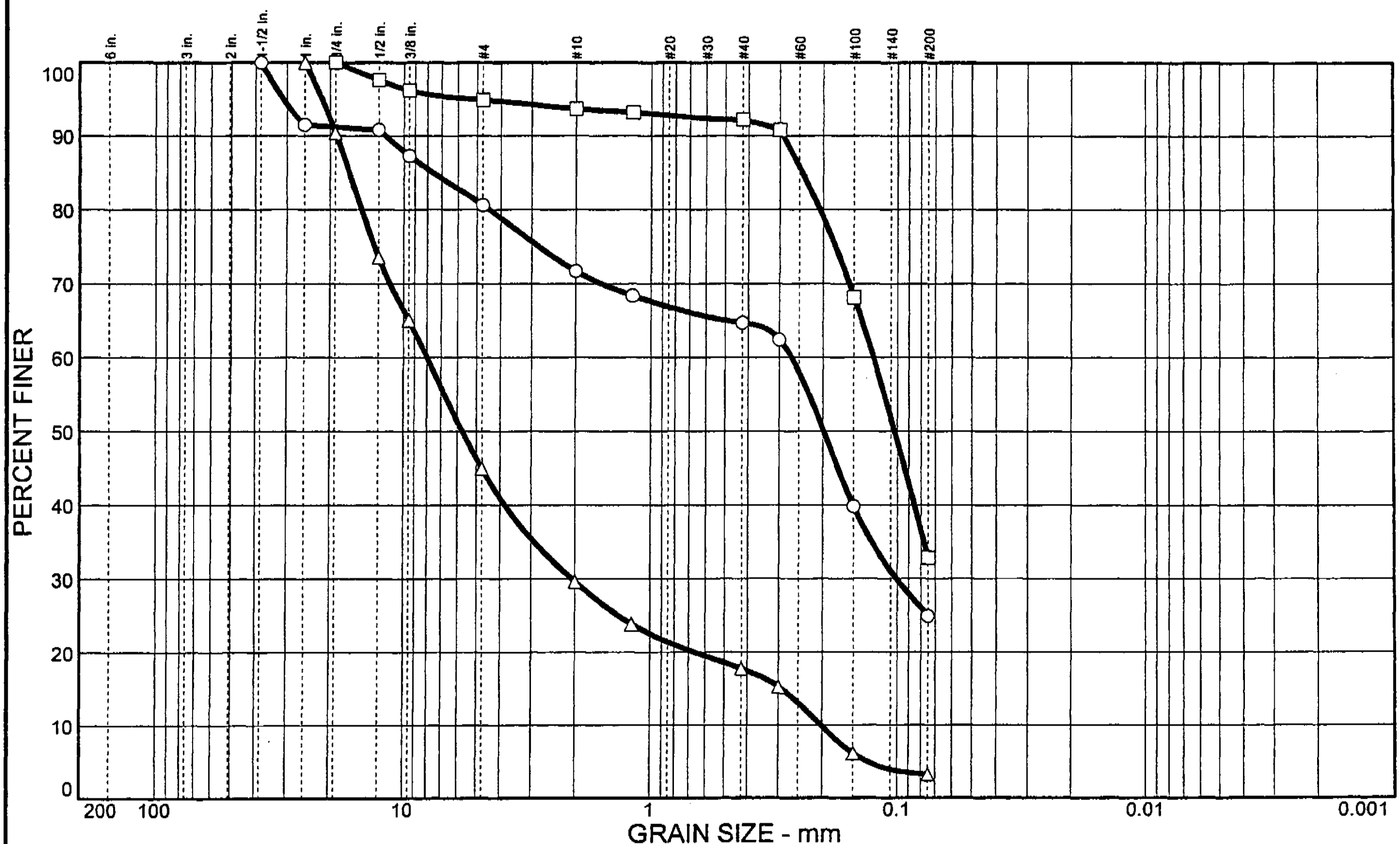
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		19.4	55.7			SM			
□		5.1	62.1			SM		17	np
△		55.1	41.7			GW			

SIEVE inches size	PERCENT FINER ○	□	△
1-1/2"	100.0		
1"	91.5		100.0
3/4"		100.0	90.4
1/2"	90.8	97.6	73.6
3/8"	87.3	96.2	65.1
	GRAIN SIZE		
D_{60}	0.268	0.125	7.99
D_{30}	0.101		2.06
D_{10}			0.203
	COEFFICIENTS		
C_c			2.62
C_u			39.34

SIEVE number size	PERCENT FINER ○	□	△
#4	80.6	94.9	44.9
#10	71.7	93.7	29.6
#16	68.4	93.2	23.8
#40	64.7	92.2	17.7
#50	62.4	90.8	15.2
#100	39.8	68.2	6.1
#200	24.9	32.8	3.2

SOIL DESCRIPTION

○ Silty sand with gravel

□ Silty sand

△ Well-graded gravel with sand

REMARKS:

○

□

△

○ Location: Boring ISR1, sample: C

□ Location: Boring ISR1, sample:D

△ Location: Boring ISR1, sample: E

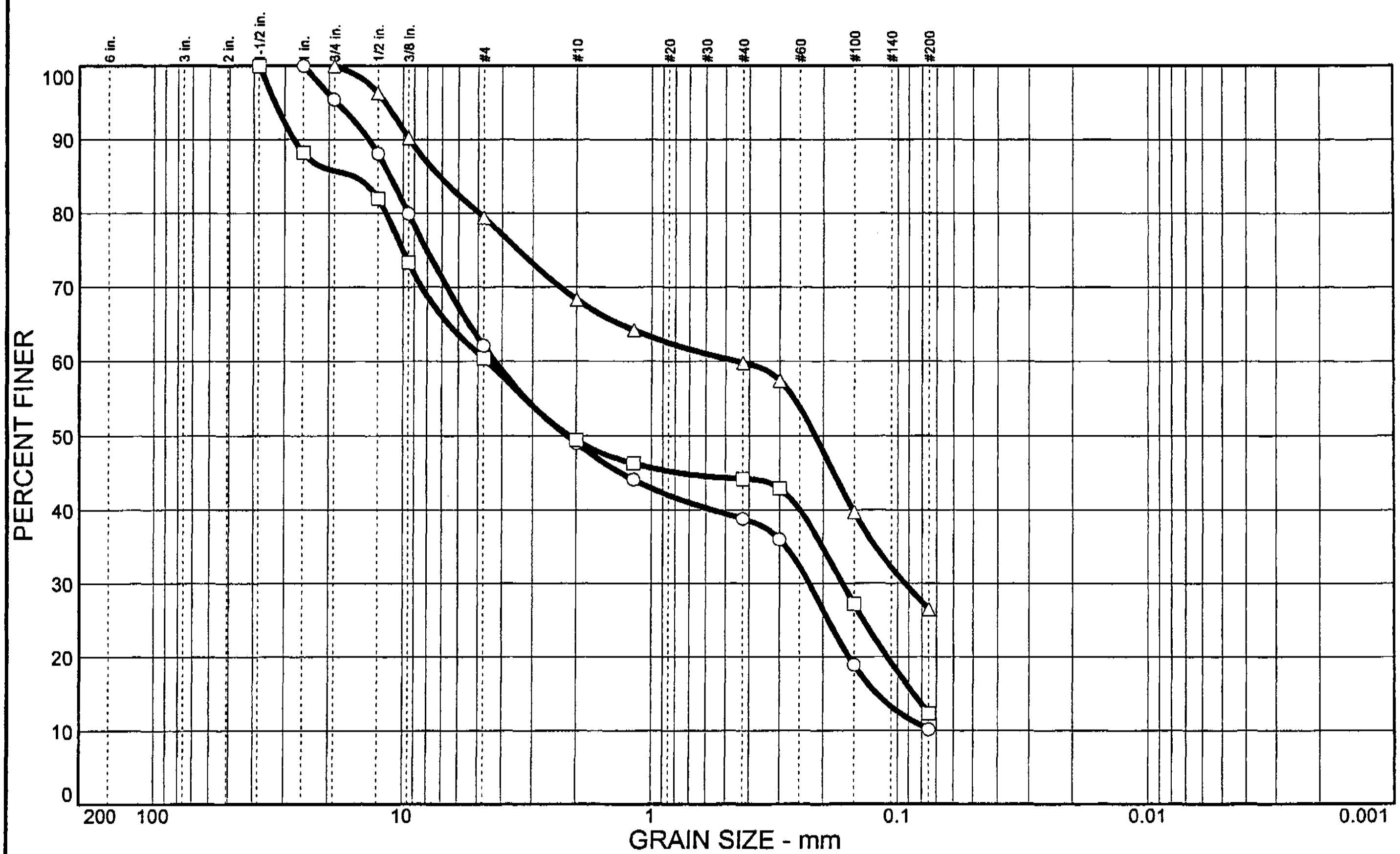
NEVADA DEPARTMENT OF TRANSPORTATION

Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1 Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		37.9	52.0			SP-SM			
□		39.6	48.1			SM			
△		20.6	52.9			SC		57	28

SIEVE inches size	PERCENT FINER ○	□	△
1-1/2"		100.0	
1"	100.0	88.2	
3/4"	95.4		100.0
1/2"	88.1	82.0	96.3
3/8"	79.9	73.3	90.2
	GRAIN SIZE		
D_{60}	4.27	4.61	0.452
D_{30}	0.228	0.167	0.0934
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	62.1	60.4	79.4
#10	49.0	49.4	68.3
#16	44.1	46.3	64.2
#40	38.8	44.2	59.8
#50	36.0	42.9	57.4
#100	18.9	27.2	39.7
#200	10.1	12.3	26.5

SOIL DESCRIPTION

○ Poorly graded sand with silt and gravel

□ Silty sand with gravel

△ Clayey sand with gravel

REMARKS:

○

□

△

○ Location: Boring ISR1, sample: F

□ Location: Boring ISR1, sample: H

△ Location: Boring ISR1, sample: I

NEVADA DEPARTMENT OF TRANSPORTATION

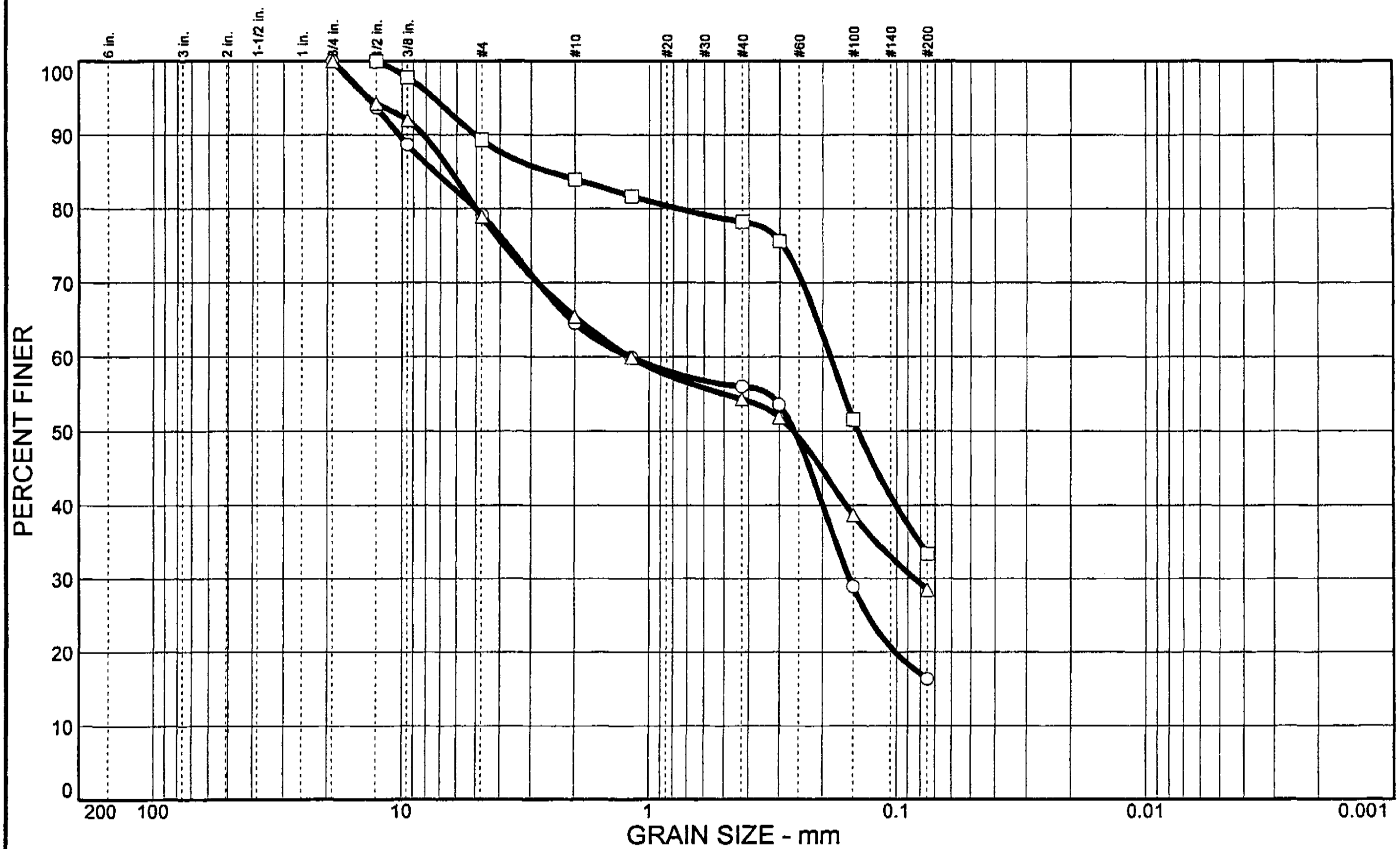
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		20.9	62.8			SM			
□		10.7	55.9			SM			
△		21.1	50.4			SC		65	33

SIEVE inches size	PERCENT FINER ○	□	△
3/4"	100.0		100.0
1/2"	93.7	100.0	94.3
3/8"	88.7	97.8	92.0
GRAIN SIZE			
D_{60}	1.20	0.186	1.19
D_{30}	0.155		0.0846
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	79.1	89.3	78.9
#10	64.5	84.0	65.4
#16	59.9	81.7	59.9
#40	56.0	78.2	54.3
#50	53.6	75.6	51.9
#100	28.9	51.6	38.7
#200	16.3	33.4	28.5

SOIL DESCRIPTION

○ Silty sand with gravel

□ Silty sand

△ Clayey sand with gravel

REMARKS:

○

□

△

○ Location: Boring ISR1, sample: J

□ Location: Boring ISR1, sample: K

△ Location: Boring ISR1, sample: N

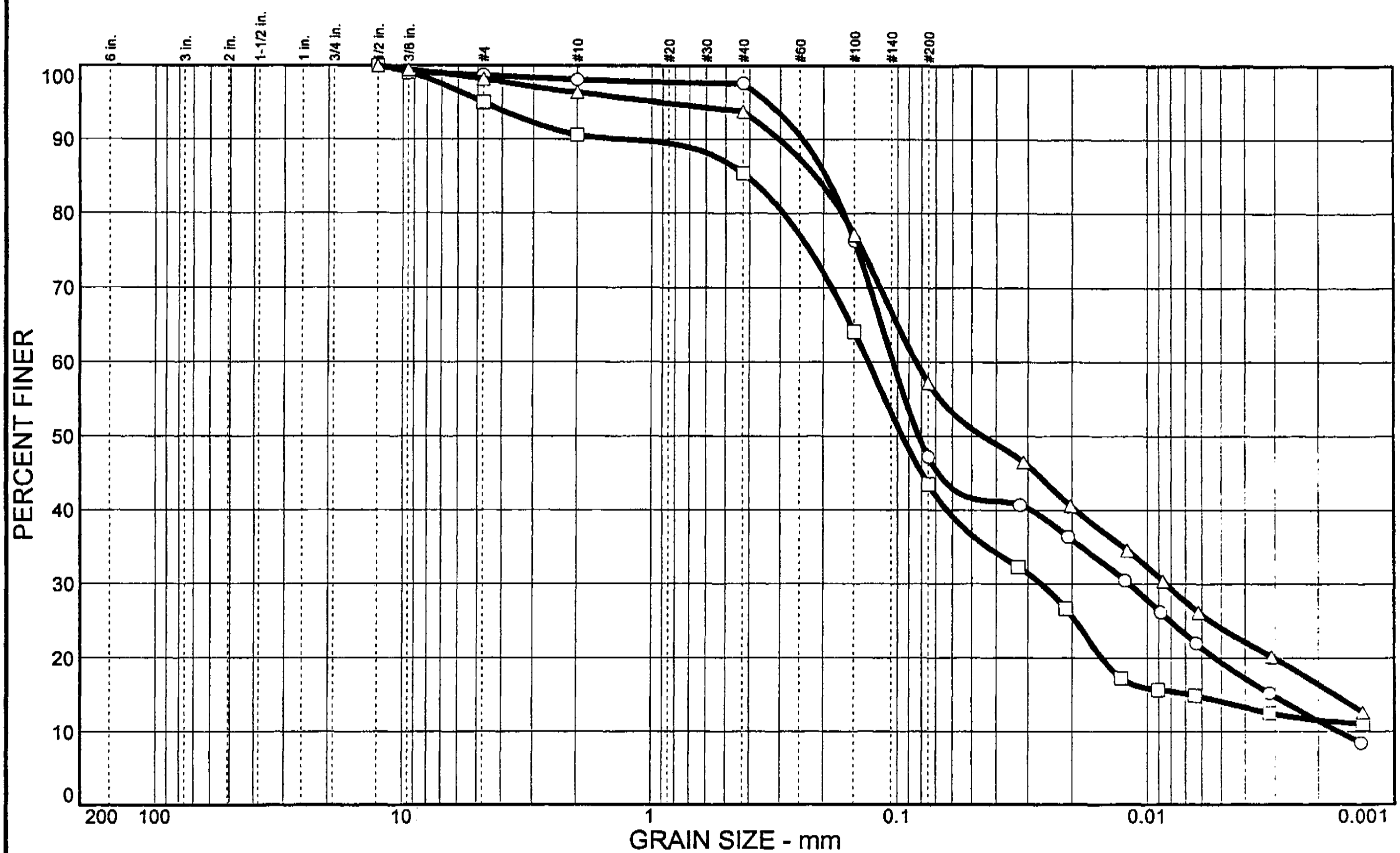
NEVADA DEPARTMENT OF TRANSPORTATION

Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1 Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		1.3	51.5	35.8	11.4	SC		34	15
□		5.0	51.5	32.0	11.5	SM			
△		1.8	41.0	40.8	16.4	CL		38	20

SIEVE inches size	PERCENT FINER ○	□	△
1/2"	100.0	100.0	100.0
3/8"	99.3	99.1	99.5
GRAIN SIZE			
D_{60}	0.104	0.131	0.0841
D_{30}	0.0118	0.0265	0.0084
D_{10}	0.0017		
COEFFICIENTS			
C_c	0.80		
C_u	62.60		

SIEVE number size	PERCENT FINER ○	□	△
#4	98.7	95.0	98.2
#10	98.1	90.6	96.4
#40	97.6	85.4	93.8
#100	76.3	64.1	77.1
#200	47.2	43.5	57.2

SOIL DESCRIPTION

○ Clayey sand

□ Silty sand

△ Sandy lean clay

REMARKS:

○

□

△

○ Location: Boring ISR1, sample: O

□ Location: Boring ISR1, sample: S

△ Location: Boring ISR1, sample: V1

NEVADA DEPARTMENT OF TRANSPORTATION

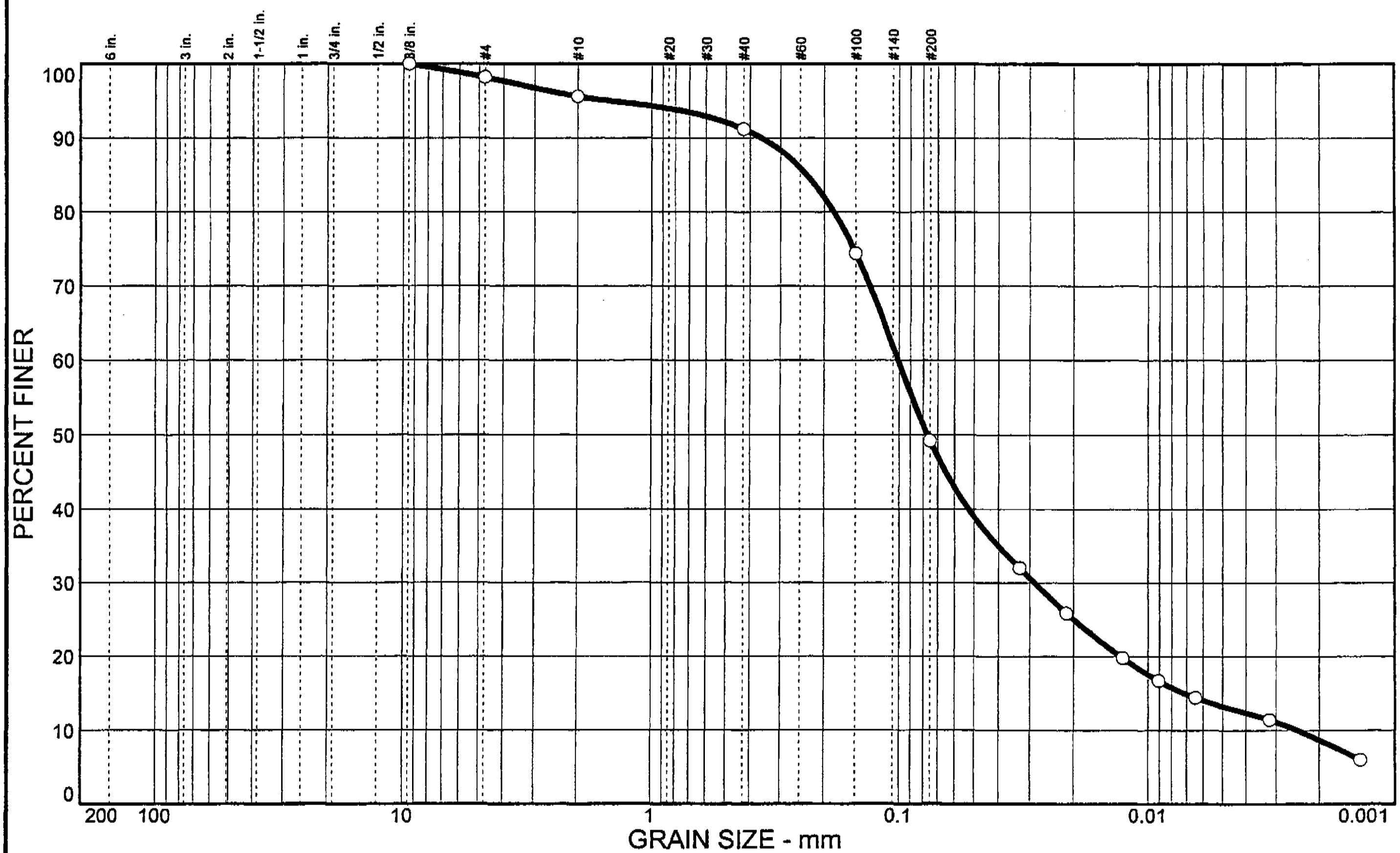
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		1.8	49.0	40.5	8.7	SC		32	12

SIEVE inches size	PERCENT FINER ○		
3/8"	100.0		
	GRAIN SIZE		
D_{60}	0.101		
D_{30}	0.0287		
D_{10}	0.0025		
	COEFFICIENTS		
C_C	3.31		
C_U	41.01		

SIEVE number size	PERCENT FINER ○		
#4	98.2		
#10	95.6		
#40	91.2		
#100	74.4		
#200	49.2		

SOIL DESCRIPTION

○ Clayey sand

REMARKS:

○

○ Location: Boring ISR1, sample, W

NEVADA DEPARTMENT OF TRANSPORTATION

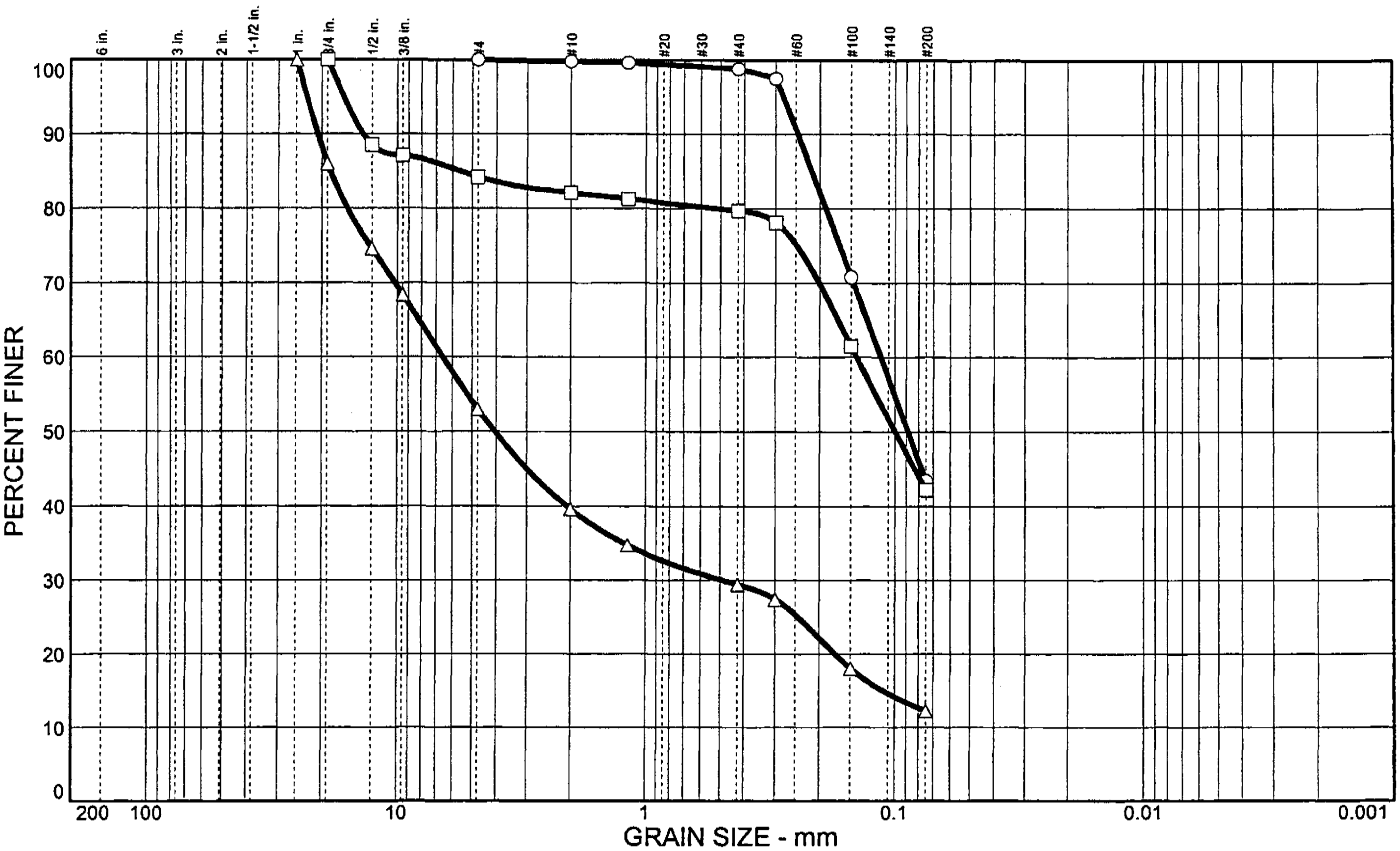
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○			56.6			SM		18	3
□		15.8	42.0			SC		22	10
△		47.0	40.8			GM			

SIEVE inches size	PERCENT FINER ○	□	△
1"			100.0
3/4"		100.0	86.0
1/2"		88.5	74.6
3/8"		87.1	68.4
	GRAIN SIZE		
D_{60}	0.114	0.142	6.57
D_{30}			0.492
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	100.0	84.2	53.0
#10	99.8	82.1	39.6
#16	99.6	81.3	34.7
#40	98.8	79.7	29.4
#50	97.5	78.1	27.4
#100	70.8	61.5	18.0
#200	43.4	42.2	12.2

SOIL DESCRIPTION

○ Silty sand

□ Clayey sand with gravel

△ Silty gravel with sand

REMARKS:

○

□

△

○ Location: Boring ISR2, sample: B

□ Location: Boring ISR2, sample: C

△ Location: Boring ISR2, sample: E

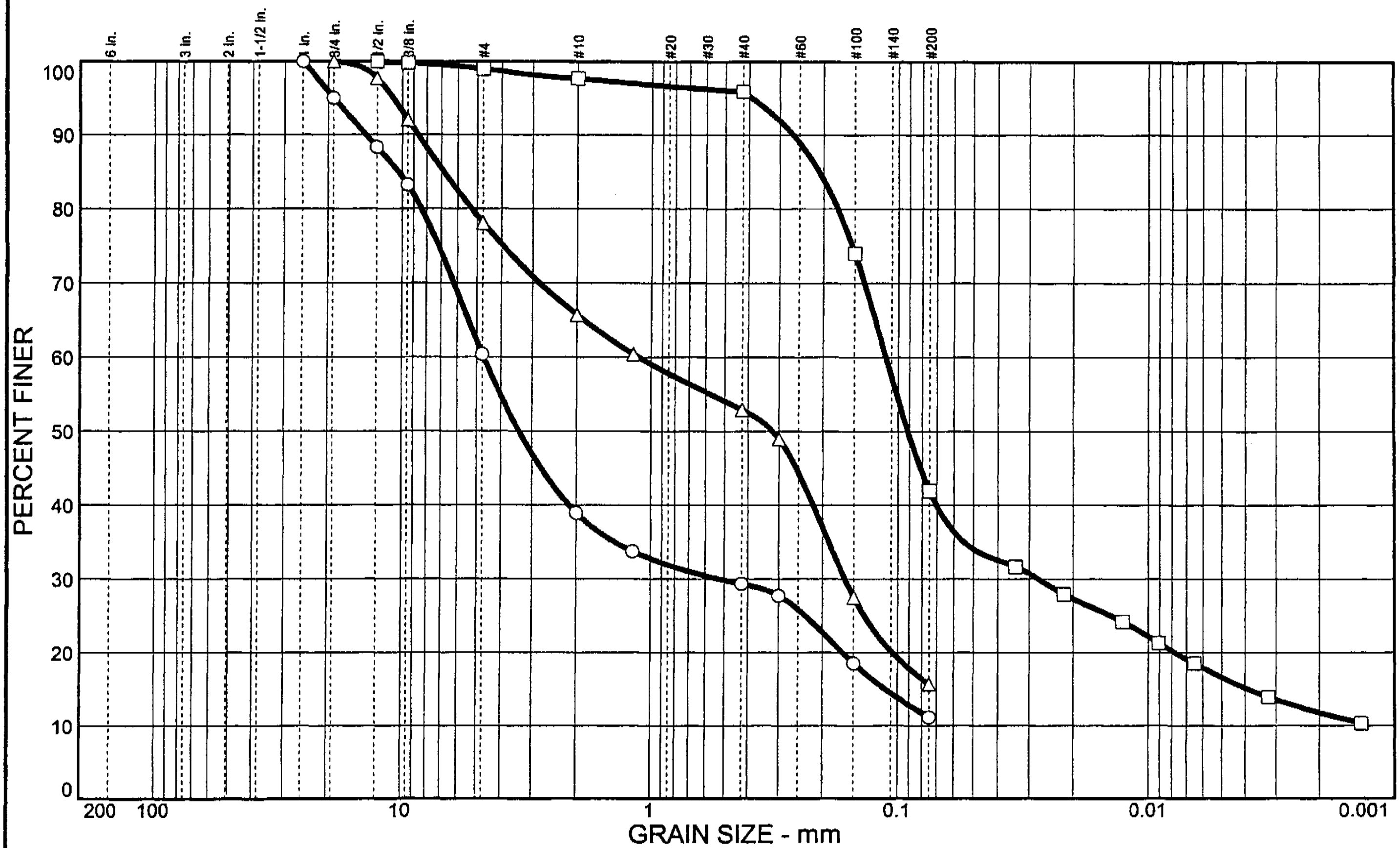
NEVADA DEPARTMENT OF TRANSPORTATION

Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1 Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		39.6	49.3			SP-SM			
□		1.0	57.1	30.2	11.7	SC-SM		23	6
△		21.9	62.5			SM			

SIEVE inches size	PERCENT FINER ○	□	△
1"	100.0		
3/4"	95.0		100.0
1/2"	88.3	100.0	97.7
3/8"	83.2	99.8	92.0
GRAIN SIZE			
D_{60}	4.69	0.112	1.13
D_{30}	0.532	0.0277	0.163
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	60.4	99.0	78.1
#10	38.9	97.7	65.7
#16	33.7		60.4
#40	29.3	95.9	52.9
#50	27.7		48.9
#100	18.5	74.0	27.5
#200	11.1	41.9	15.6

SOIL DESCRIPTION

○ Poorly graded sand with silt and gravel

□ Silty, clayey sand

△ Silty sand with gravel

REMARKS:

○

□

△

○ Location: Boring ISR2, sample: F1

□ Location: Boring ISR2, sample: G

△ Location: Boring ISR2, sample: H

NEVADA DEPARTMENT OF TRANSPORTATION

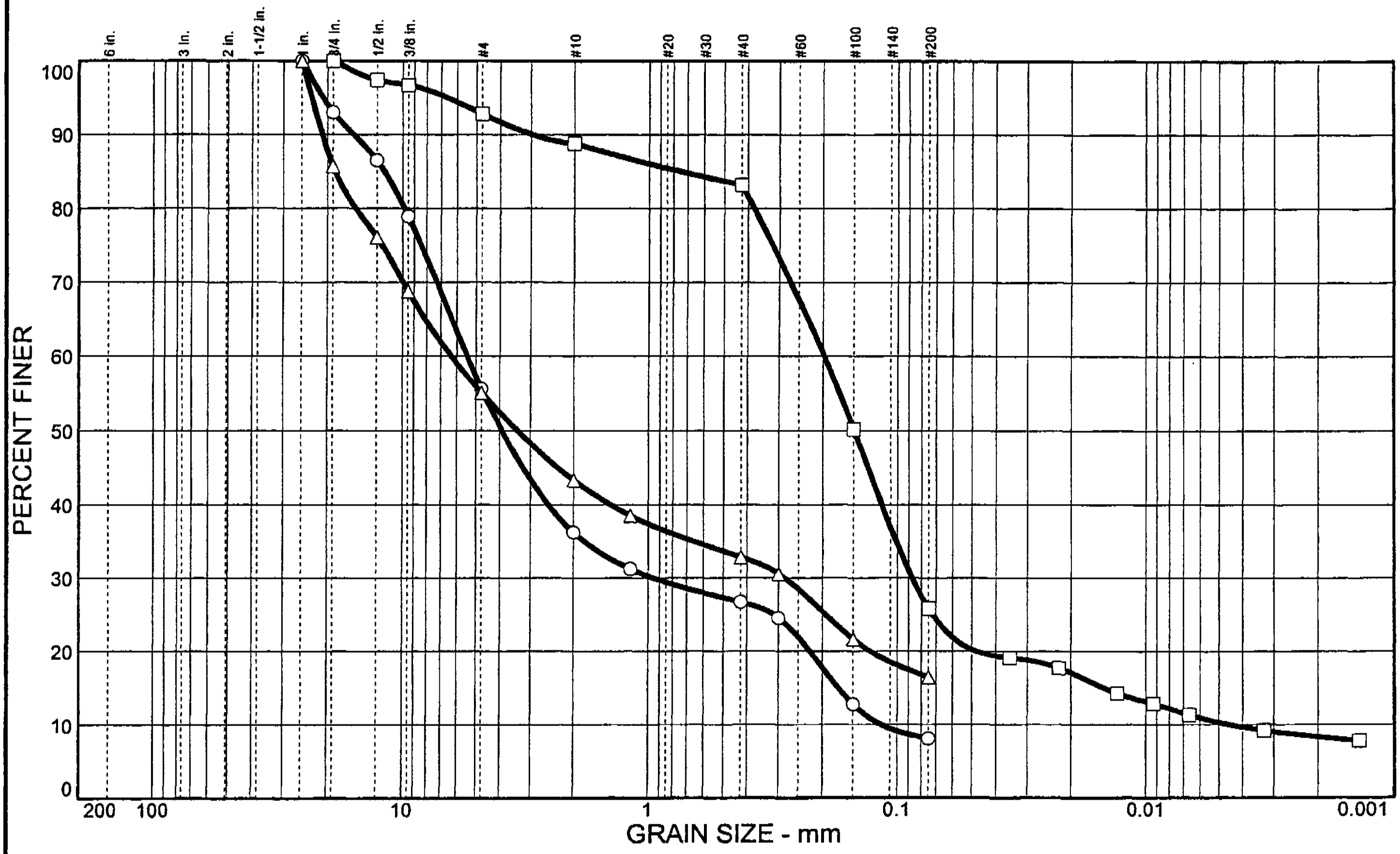
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		44.4	47.5			SW-SM			
□		7.2	67.0	17.5	8.3	SC-SM		22	4
△		44.9	38.7			GM			

SIEVE inches size	PERCENT FINER ○	□	△
1"	100.0		100.0
3/4"	93.0	100.0	85.7
1/2"	86.5	97.4	76.1
3/8"	78.9	96.7	68.8
	GRAIN SIZE		
D_{60}	5.44	0.198	6.34
D_{30}	0.961	0.0873	0.285
D_{10}	0.116	0.0046	
	COEFFICIENTS		
C_c	1.46	8.45	
C_u	46.87	43.27	

SIEVE number size	PERCENT FINER ○	□	△
#4	55.6	92.8	55.1
#10	36.2	88.8	43.3
#16	31.2		38.5
#40	26.7	83.2	32.8
#50	24.5		30.5
#100	12.7	50.2	21.6
#200	8.1	25.8	16.4

SOIL DESCRIPTION

○ Well-graded sand with silt and gravel

□ Silty, clayey sand

△ Silty gravel with sand

REMARKS:

○

□

△

○ Location: Boring ISR2, sample: I

□ Location: Boring ISR2, sample: J

△ Location: Boring ISR2, sample: K

NEVADA DEPARTMENT OF TRANSPORTATION

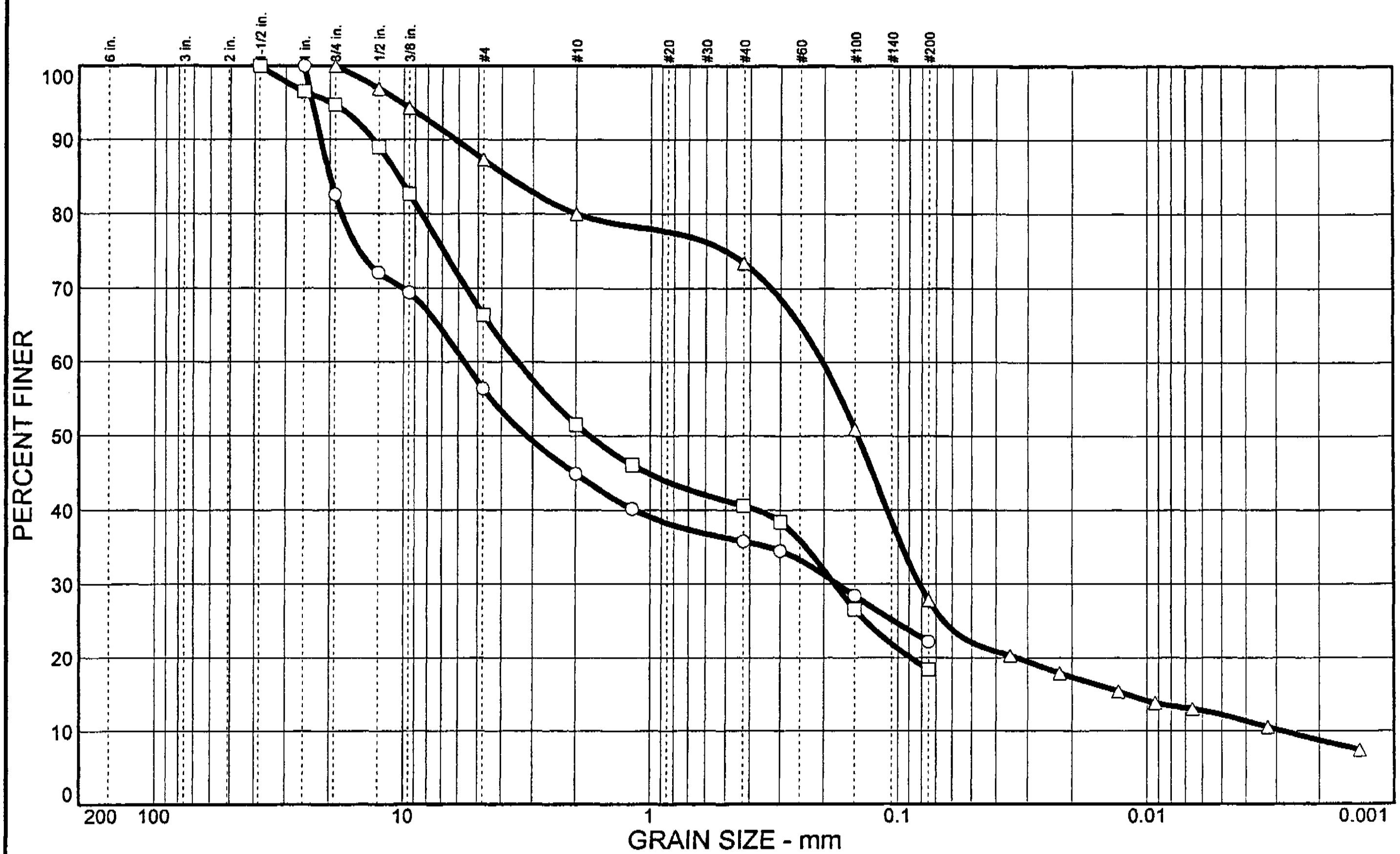
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		43.6	34.2			GM		67	34
□		33.6	48.0			SM			
△		12.7	59.5	19.1	8.7	SM			

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □	PERCENT FINER △
1-1/2"		100.0	
1"	100.0	96.5	
3/4"	82.6	94.7	100.0
1/2"	72.1	89.0	96.9
3/8"	69.4	82.7	94.3

GRAIN SIZE	○	□	△
D_{60}	5.67	3.44	0.203
D_{30}	0.176	0.181	0.0817
D_{10}			0.0029

COEFFICIENTS	○	□	△
C_c			11.48
C_u			70.94

SIEVE number size	PERCENT FINER ○	PERCENT FINER □	PERCENT FINER △
#4	56.4	66.4	87.3
#10	44.9	51.6	80.0
#16	40.2	46.1	
#40	35.8	40.6	73.4
#50	34.5	38.4	
#100	28.4	26.6	50.9
#200	22.2	18.4	27.8

SOIL DESCRIPTION

○ Silty gravel with sand

□ Silty sand with gravel

△ Silty sand

REMARKS:

○

□

△

○ Location: Boring ISR2, sample: M

□ Location: Boring ISR2, sample: N

△ Location: Boring ISR2, sample: P

NEVADA DEPARTMENT OF TRANSPORTATION

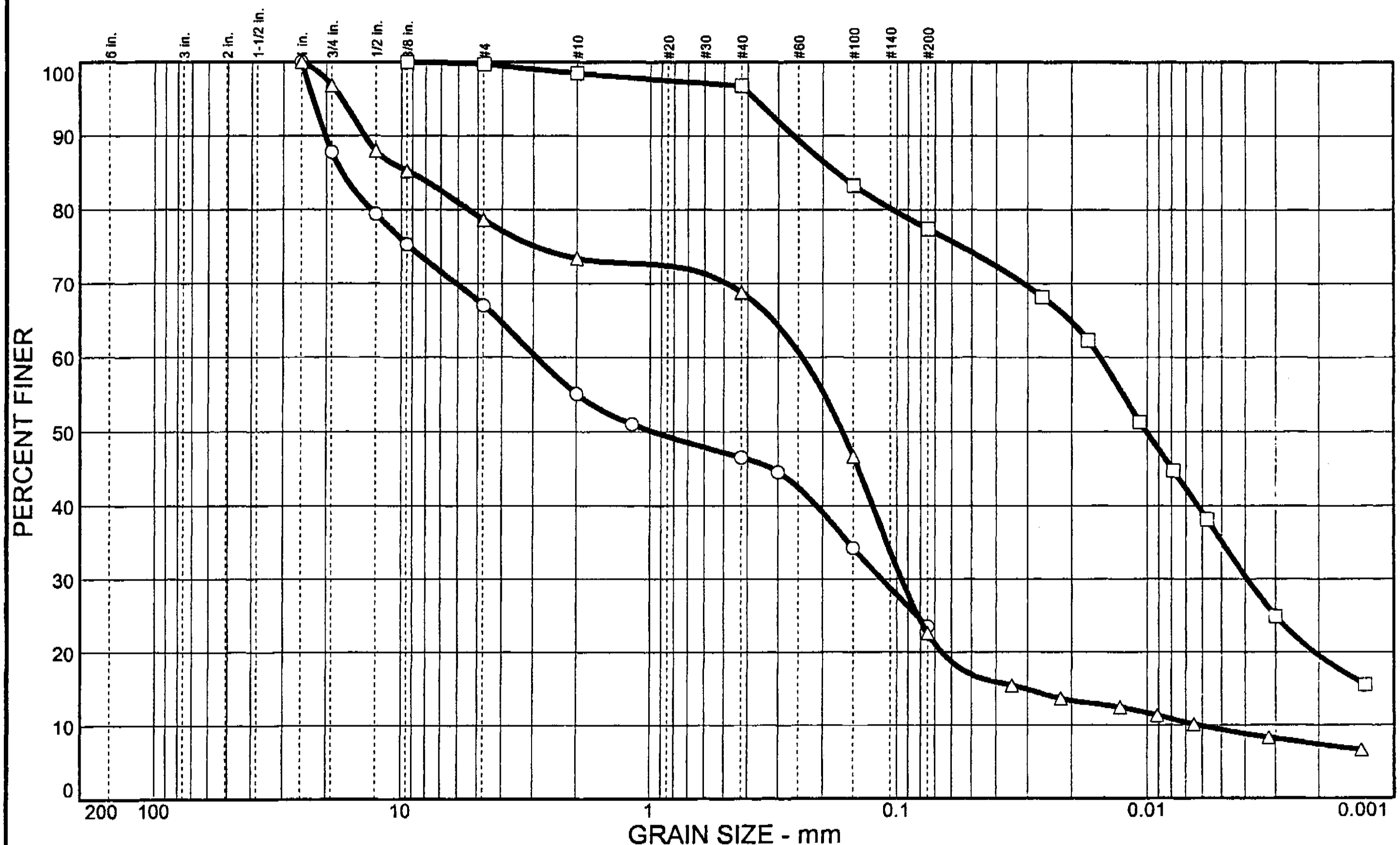
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		33.0	43.5			SM			
□		0.3	22.3	57.9	19.5	CL		38	20
△		21.4	56.0	15.3	7.3	SC-SM		24	6

SIEVE inches size	PERCENT FINER ○	□	△
1"	100.0		100.0
3/4"	87.8		96.8
1/2"	79.4		88.0
3/8"	75.3	100.0	85.3
	GRAIN SIZE		
D_{60}	2.92	0.0155	0.242
D_{30}	0.116	0.0039	0.0959
D_{10}			0.0063
	COEFFICIENTS		
C_c			6.04
C_u			38.42

SIEVE number size	PERCENT FINER ○	□	△
#4	67.0	99.7	78.6
#10	55.1	98.5	73.4
#16	51.0		
#40	46.5	96.8	68.8
#50	44.5		
#100	34.2	83.3	46.6
#200	23.5	77.4	22.6

SOIL DESCRIPTION

○ Silty sand with gravel

□ Lean clay with sand

△ Silty, clayey sand with gravel

REMARKS:

○

□

△

○ Location: Boring ISR2, sample: S

□ Location: Boring ISR2, sample: U

△ Location: Boring ISR2, sample: V

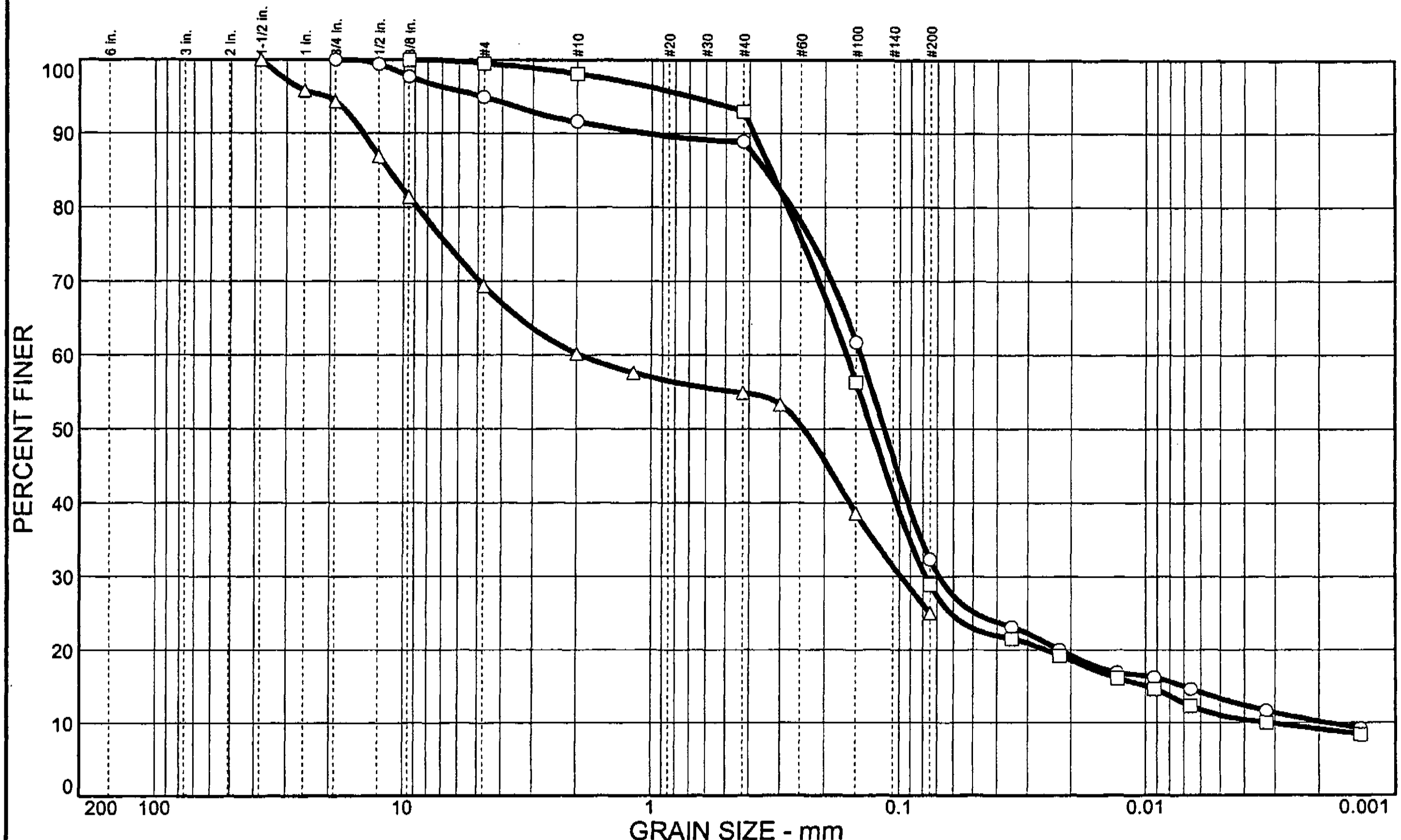
NEVADA DEPARTMENT OF TRANSPORTATION

Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1 Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		5.1	62.6	22.2	10.1	SM		17	1
□		0.5	70.6	19.8	9.1	SM			
△		30.6	44.4			SM			

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □	PERCENT FINER △
1-1/2"			100.0
1"			95.8
3/4"	100.0		94.3
1/2"	99.4		86.9
3/8"	97.7	100.0	81.4
	GRAIN SIZE		
D_{60}	0.144	0.164	1.94
D_{30}	0.0688	0.0781	0.0990
D_{10}	0.0019	0.0033	
	COEFFICIENTS		
C_c	17.43	11.42	
C_u	76.32	50.31	

SIEVE number size	PERCENT FINER ○	PERCENT FINER □	PERCENT FINER △
#4	94.9	99.5	69.4
#10	91.6	98.1	60.2
#16			57.6
#40	88.9	93.0	54.9
#50			53.3
#100	61.7	56.3	38.6
#200	32.3	28.9	25.0

SOIL DESCRIPTION

○ Silty sand

□ Silty sand

△ Silty sand with gravel

REMARKS:

○

□

△

○ Location: Boring ISR3, sample: A

□ Location: Boring ISR3, sample: C1

△ Location: Boring ISR3, sample: D

NEVADA DEPARTMENT OF TRANSPORTATION

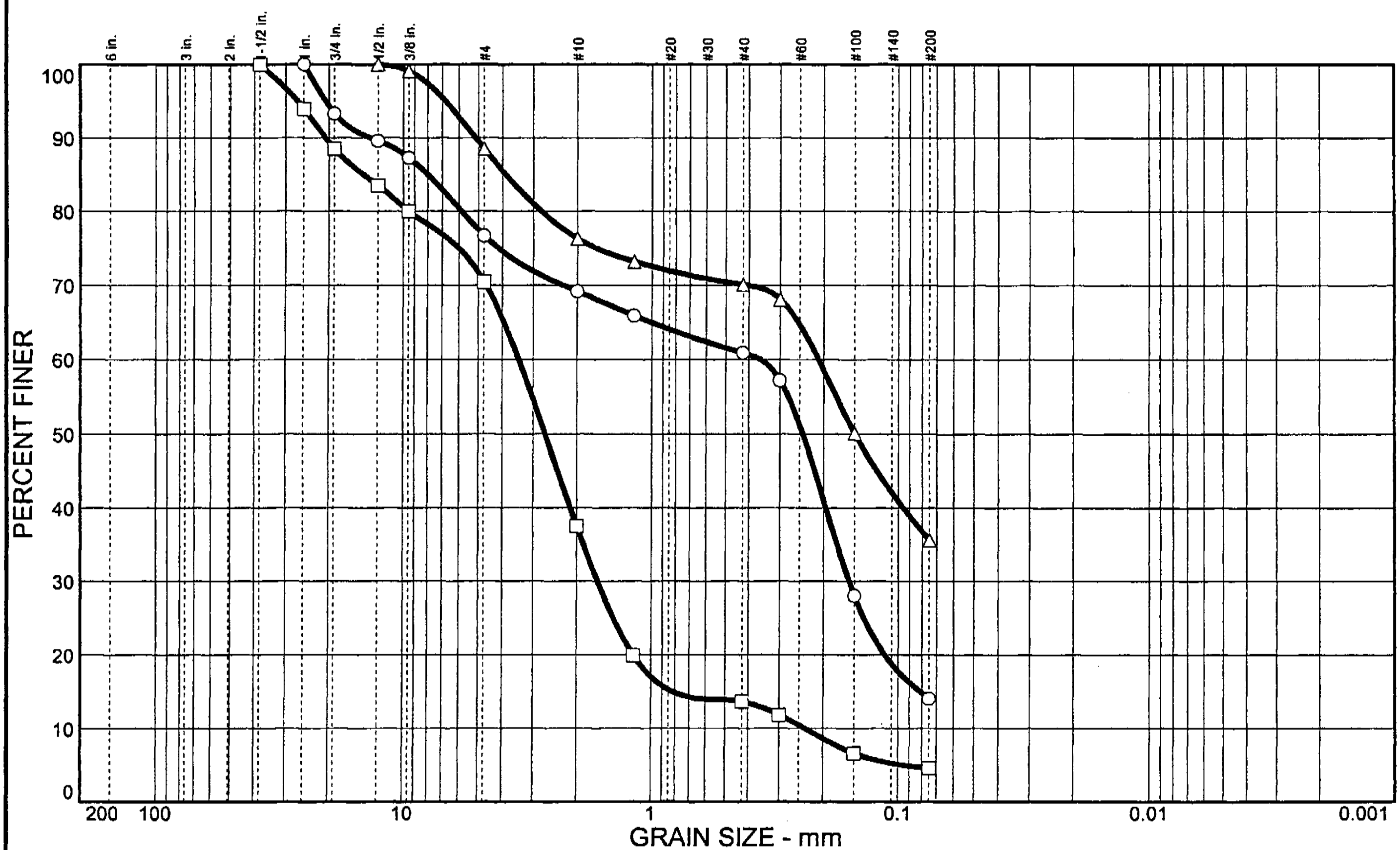
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		23.3	62.7			SM			
□		29.5	65.9			SP			
△		11.5	52.9			SM			

SIEVE inches size	PERCENT FINER ○	□	△
1-1/2"		100.0	
1"	100.0	93.9	
3/4"	93.3	88.5	
1/2"	89.6	83.5	100.0
3/8"	87.3	80.0	99.1
	GRAIN SIZE		
D_{60}	0.360	3.43	0.210
D_{30}	0.158	1.65	
D_{10}		0.238	
	COEFFICIENTS		
C_c		3.35	
C_u		14.42	

SIEVE number size	PERCENT FINER ○	□	△
#4	76.7	70.5	88.5
#10	69.2	37.5	76.3
#16	65.9	19.9	73.2
#40	60.9	13.6	70.1
#50	57.2	11.8	68.1
#100	28.0	6.6	50.1
#200	14.0	4.6	35.6

SOIL DESCRIPTION

○ Silty sand with gravel

□ Poorly graded sand with gravel

△ Silty sand

REMARKS:

○

□

△

○ Location: Boring ISR3, sample: E

□ Location: Boring ISR3, sample: F

△ Location: Boring ISR3, sample: H

NEVADA DEPARTMENT OF TRANSPORTATION

Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report

	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		0.8	52.1			SC		25	12
□		0.5	66.3	19.6	13.6	SC-SM		24	7
△		28.3	42.4			SC		51	25

SIEVE inches size	PERCENT FINER ○	□	△
1"			100.0
3/4"			95.2
1/2"			86.6
3/8"	100.0	100.0	81.4
GRAIN SIZE			
D_{60}	0.135	0.158	0.998
D_{30}		0.0632	0.0793
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	99.2	99.5	71.7
#10	92.9	97.7	64.3
#16	89.0		60.9
#40	82.9	93.7	56.8
#50	79.8		54.9
#100	62.7	57.9	40.1
#200	47.1	33.2	29.3

SOIL DESCRIPTION

○ Clayey sand

□ Silty, clayey sand

△ Clayey sand with gravel

REMARKS:

○

□

△

○ Location: Boring ISR3, sample: I

□ Location: Boring ISR3, sample: J

△ Location: Boring ISR3, sample: L

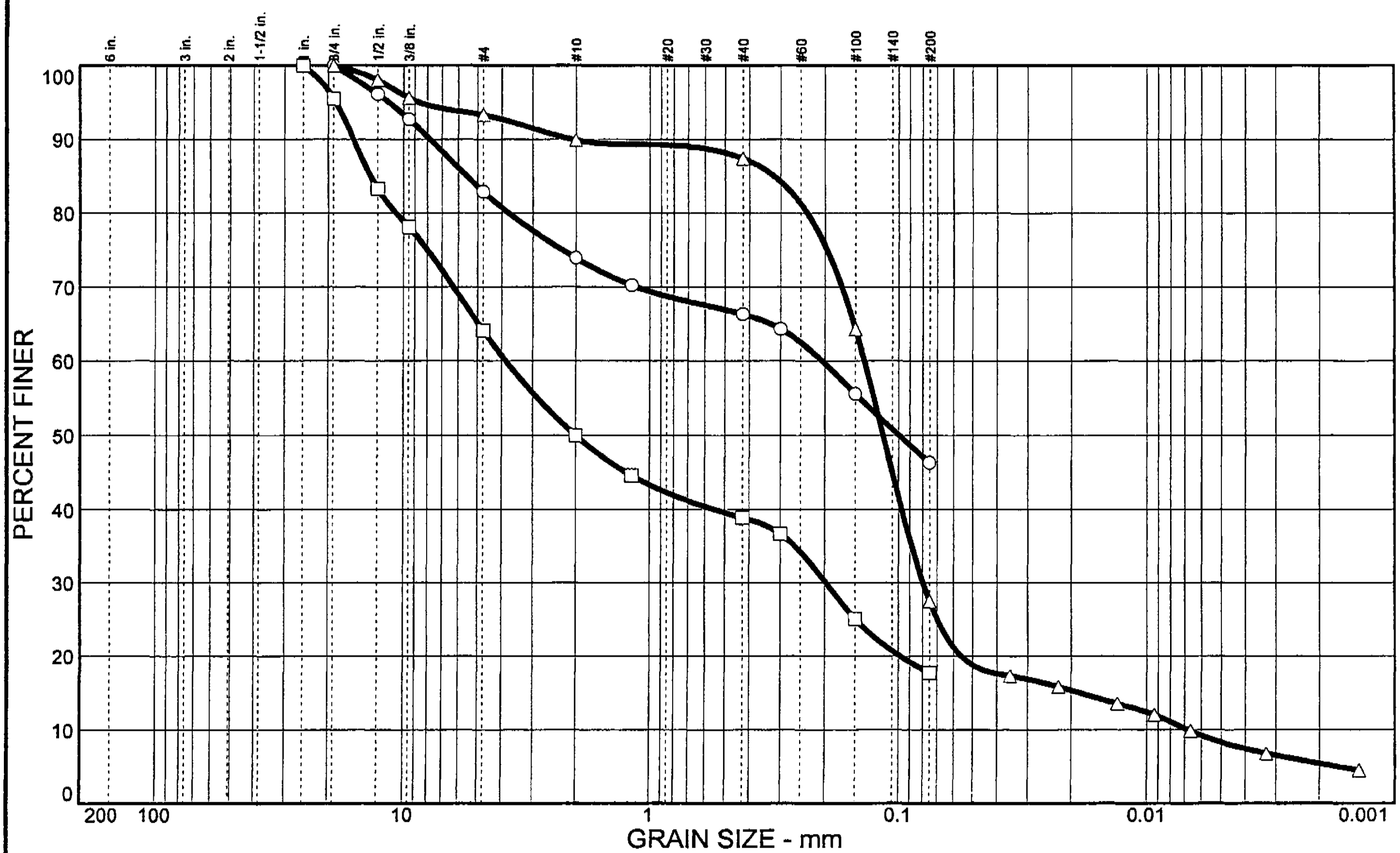
NEVADA DEPARTMENT OF TRANSPORTATION

Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1 Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		17.1	36.6			SM		96	53
□		35.9	46.4			SM			
△		6.7	65.8	22.1	5.4	SM			

SIEVE inches size	PERCENT FINER ○	□	△
1"		100.0	
3/4"	100.0	95.5	100.0
1/2"	96.1	83.3	98.0
3/8"	92.7	78.1	95.6
GRAIN SIZE			
D_{60}	0.205	3.84	0.138
D_{30}		0.197	0.0797
D_{10}			0.0068
COEFFICIENTS			
C_c			6.73
C_u			20.14

SIEVE number size	PERCENT FINER ○	□	△
#4	82.9	64.1	93.3
#10	73.9	50.0	89.9
#16	70.2	44.6	
#40	66.3	38.9	87.4
#50	64.3	36.7	
#100	55.6	25.1	64.3
#200	46.3	17.7	27.5

SOIL DESCRIPTION
○ Silty sand with gravel
□ Silty sand with gravel
△ Silty sand

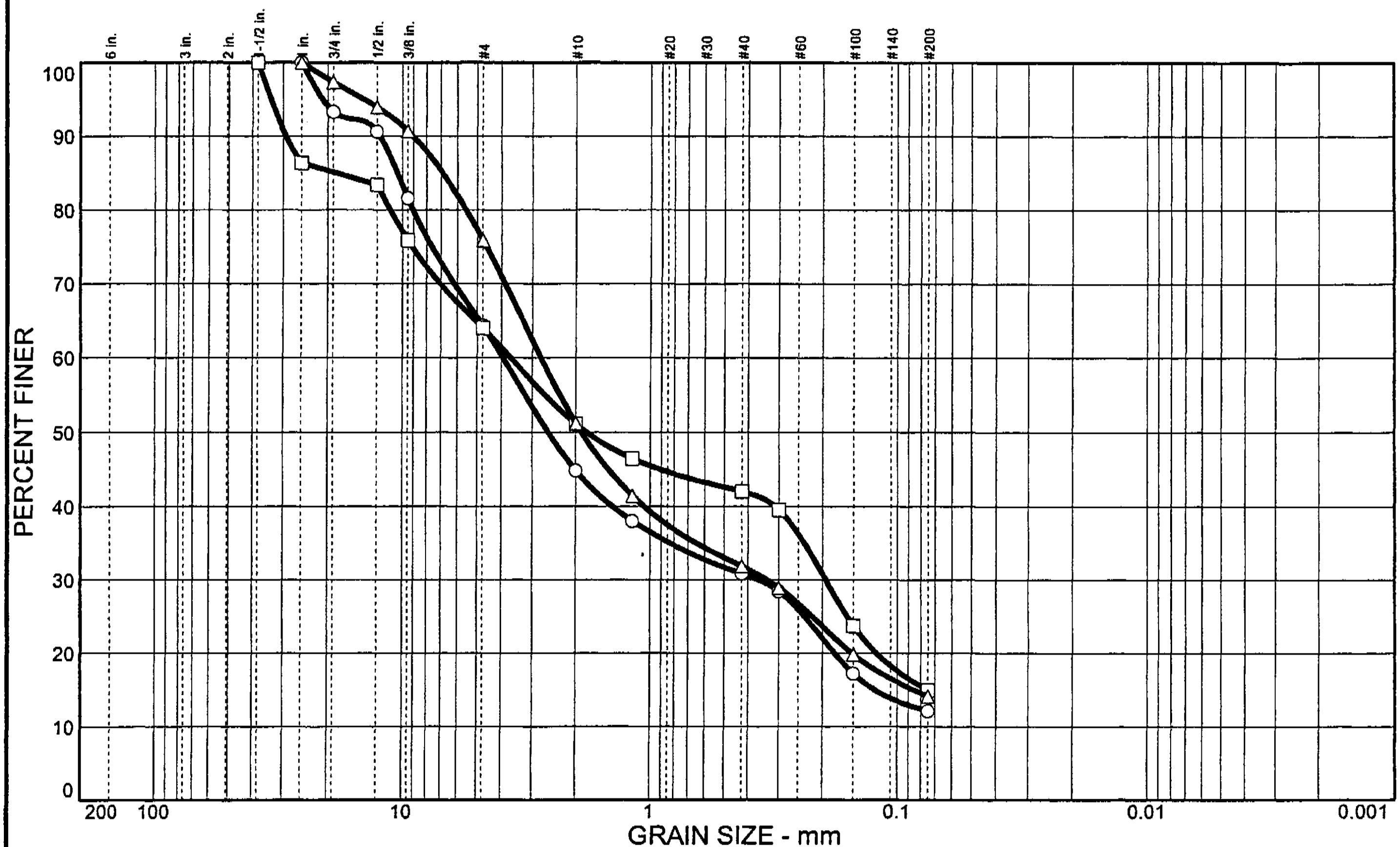
REMARKS:
○
□
△

○ Location: Boring ISR3, sample: M
□ Location: Boring ISR3, sample: N
△ Location: Boring ISR3, sample: O

NEVADA DEPARTMENT OF TRANSPORTATION

Client:
Project: SR160 @ I-15 Interchange
Project No.: 72495-1 Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		35.7	52.2			SM			
□		36.0	49.1			SM			
△		24.1	61.8			SM			

SIEVE inches size	PERCENT FINER ○	□	△
1-1/2"		100.0	
1"	100.0	86.4	100.0
3/4"	93.3		97.3
1/2"	90.6	83.4	93.9
3/8"	81.6	75.9	90.7
	GRAIN SIZE		
D_{60}	3.95	3.68	2.77
D_{30}	0.365	0.195	0.337
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	64.3	64.0	75.9
#10	44.8	51.1	51.2
#16	38.0	46.4	41.4
#40	30.8	42.0	31.8
#50	28.4	39.5	28.9
#100	17.2	23.7	19.8
#200	12.1	14.9	14.1

SOIL DESCRIPTION

○ Silty sand with gravel

□ Silty sand with gravel

△ Silty sand with gravel

REMARKS:

○

□

△

○ Location: Boring ISR3, sample: P

□ Location: Boring ISR3, sample: Q

△ Location: Boring ISR3, sample: R

NEVADA DEPARTMENT OF TRANSPORTATION

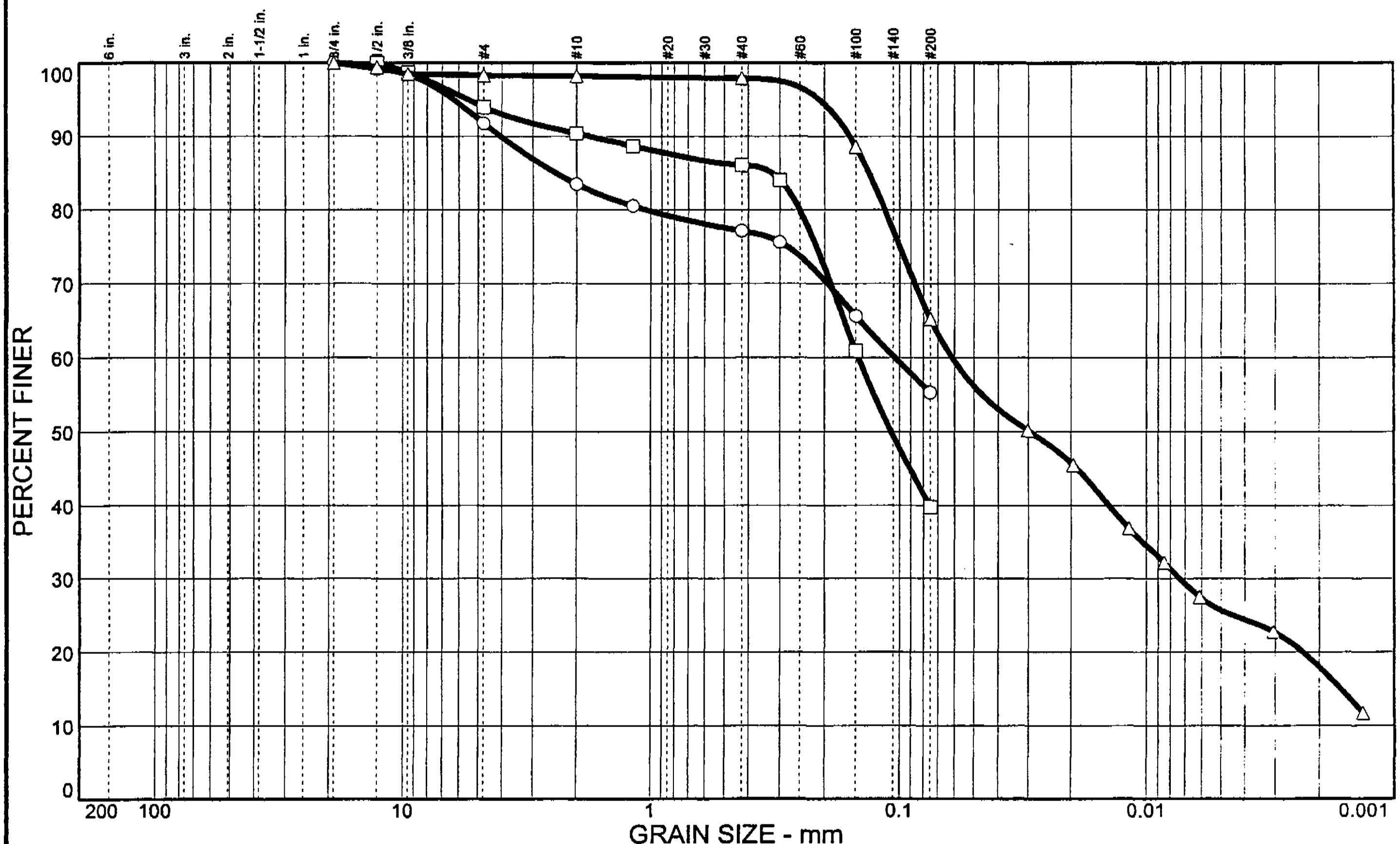
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		8.2	36.5			CH		74	61
□		6.0	54.2			SC		41	22
△		1.7	33.1	47.2	18.0	CL		34	18

SIEVE inches size	PERCENT FINER ○	□	△
3/4"	100.0		100.0
1/2"	99.2	100.0	99.4
3/8"	98.4	98.7	98.5
	GRAIN SIZE		
D_{60}	0.104	0.146	0.0613
D_{30}			0.0073
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	91.8	94.0	98.3
#10	83.5	90.4	98.2
#16	80.5	88.7	
#40	77.1	86.1	97.9
#50	75.6	84.1	
#100	65.6	60.9	88.6
#200	55.3	39.8	65.2

SOIL DESCRIPTION

○ Sandy fat clay

□ Clayey sand

△ Sandy lean clay

REMARKS:

○

□

△

○ Location: Boring ISR3, sample: S

□ Location: Boring ISR3, sample: T

△ Location: Boring ISR3, sample: U

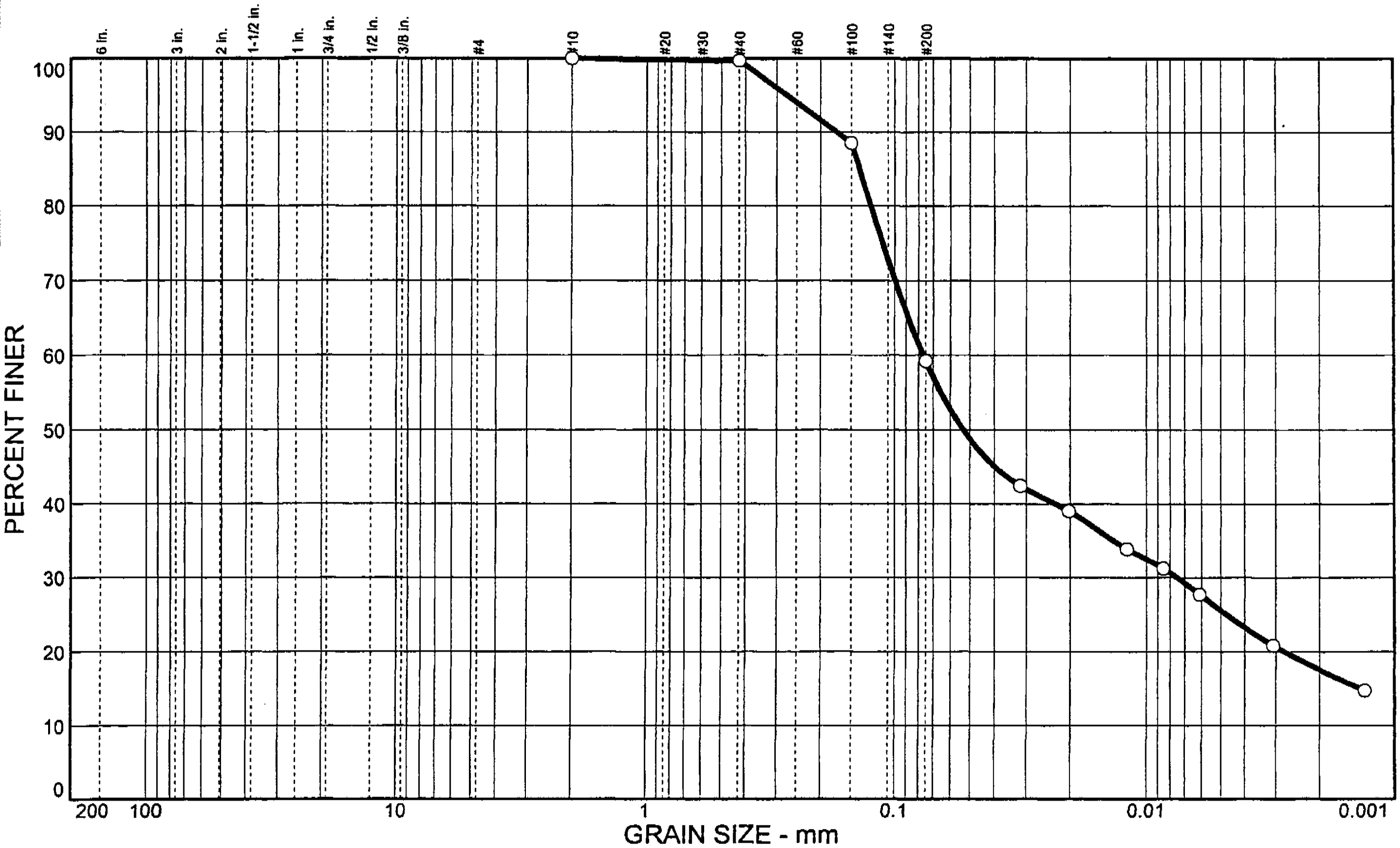
NEVADA DEPARTMENT OF TRANSPORTATION

Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1 Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○			40.8	41.7	17.5	CL		34	17

SIEVE inches size	PERCENT FINER ○		
	GRAIN SIZE		
D_{60}	0.0768		
D_{30}	0.0075		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#10	100.0		
#40	99.7		
#100	88.5		
#200	59.2		

SOIL DESCRIPTION

○ Sandy lean clay

REMARKS:

○

○ Location: Boring ISR3, sample: V

NEVADA DEPARTMENT OF TRANSPORTATION

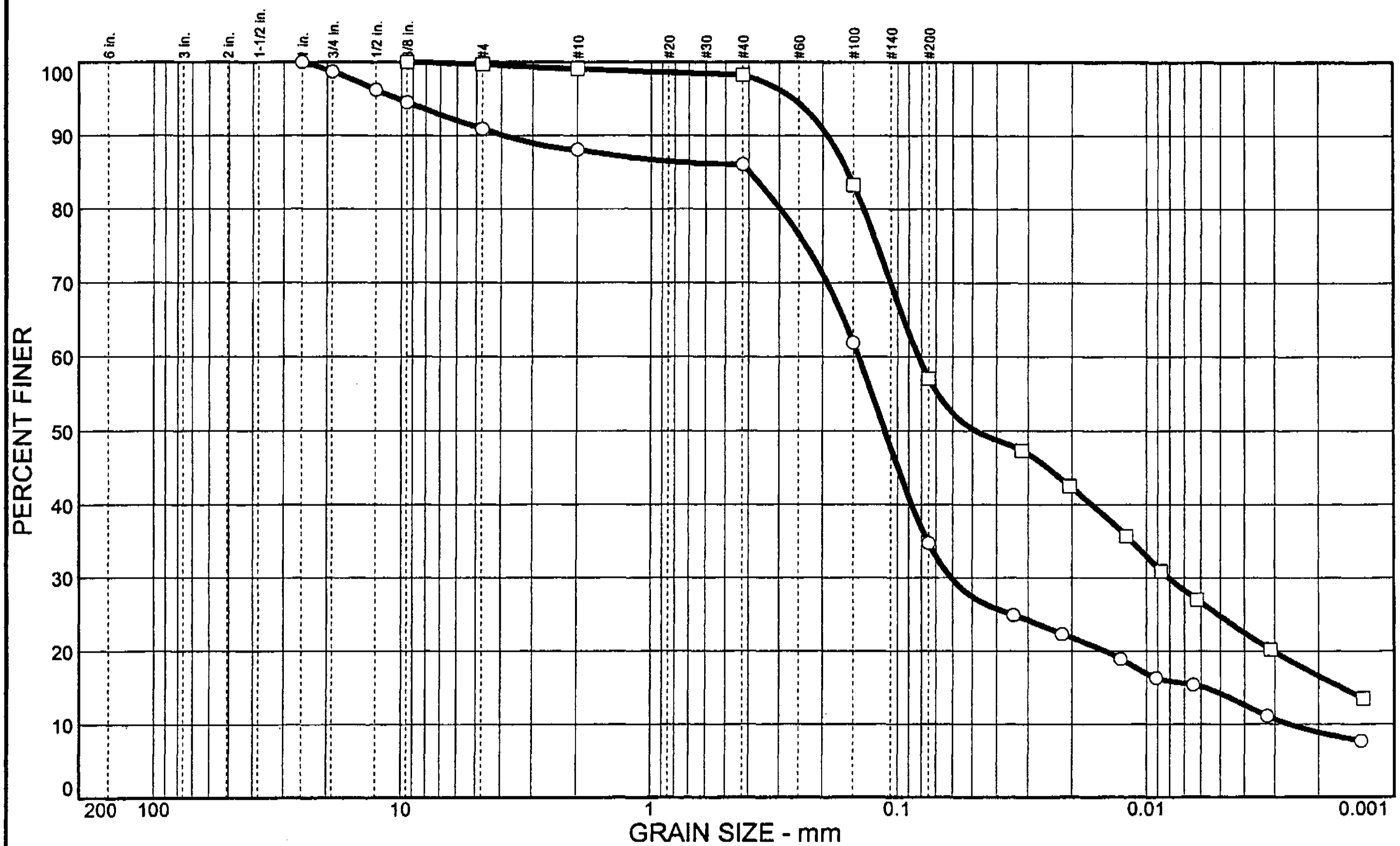
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		9.1	56.2	25.9	8.8	SM			
□		0.3	42.6	40.6	16.5	ML			

SIEVE inches size	PERCENT FINER ○	□	
1"	100.0		
3/4"	98.7		
1/2"	96.2		
3/8"	94.5	100.0	
	GRAIN SIZE		
D_{60}	0.143	0.0823	
D_{30}	0.0610	0.0081	
D_{10}	0.0026		
	COEFFICIENTS		
C_c	9.87		
C_u	53.94		

SIEVE number size	PERCENT FINER ○	□	
#4	90.9	99.7	
#10	88.1	99.1	
#40	86.1	98.3	
#100	61.9	83.3	
#200	34.7	57.1	

SOIL DESCRIPTION

○ Silty sand

□ Sandy silt

REMARKS:

○

□

○ Location: Boring ISR4, sample: A1

□ Location: Boring ISR4, sample: A2

NEVADA DEPARTMENT OF TRANSPORTATION

Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report

	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		6.1	59.1	22.7	12.1	SC-SM		17	4
□		0.3	34.5	41.1	24.1	CL		24	10
△		5.4	51.3	30.9	12.4	SC-SM		19	4

SIEVE inches size	PERCENT FINER ○	□	△
3/4"	100.0		100.0
1/2"	98.6		95.7
3/8"	97.6	100.0	94.9

	GRAIN SIZE ○	□	△
D_{60}	0.157	0.0523	0.109
D_{30}	0.0563	0.0033	0.0202
D_{10}			

	COEFFICIENTS ○	□	△
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	93.9	99.7	94.6
#10	90.7	98.7	93.4
#40	86.5	97.8	92.5
#100	58.4	85.0	74.8
#200	34.8	65.2	43.3

SOIL DESCRIPTION

○ Silty, clayey sand

□ Sandy lean clay

△ Silty, clayey sand

REMARKS:

○

□

△

○ Location: Boring ISR4, sample: B

□ Location: Boring ISR4, sample: C1

△ Location: Boring ISR4, sample: C2

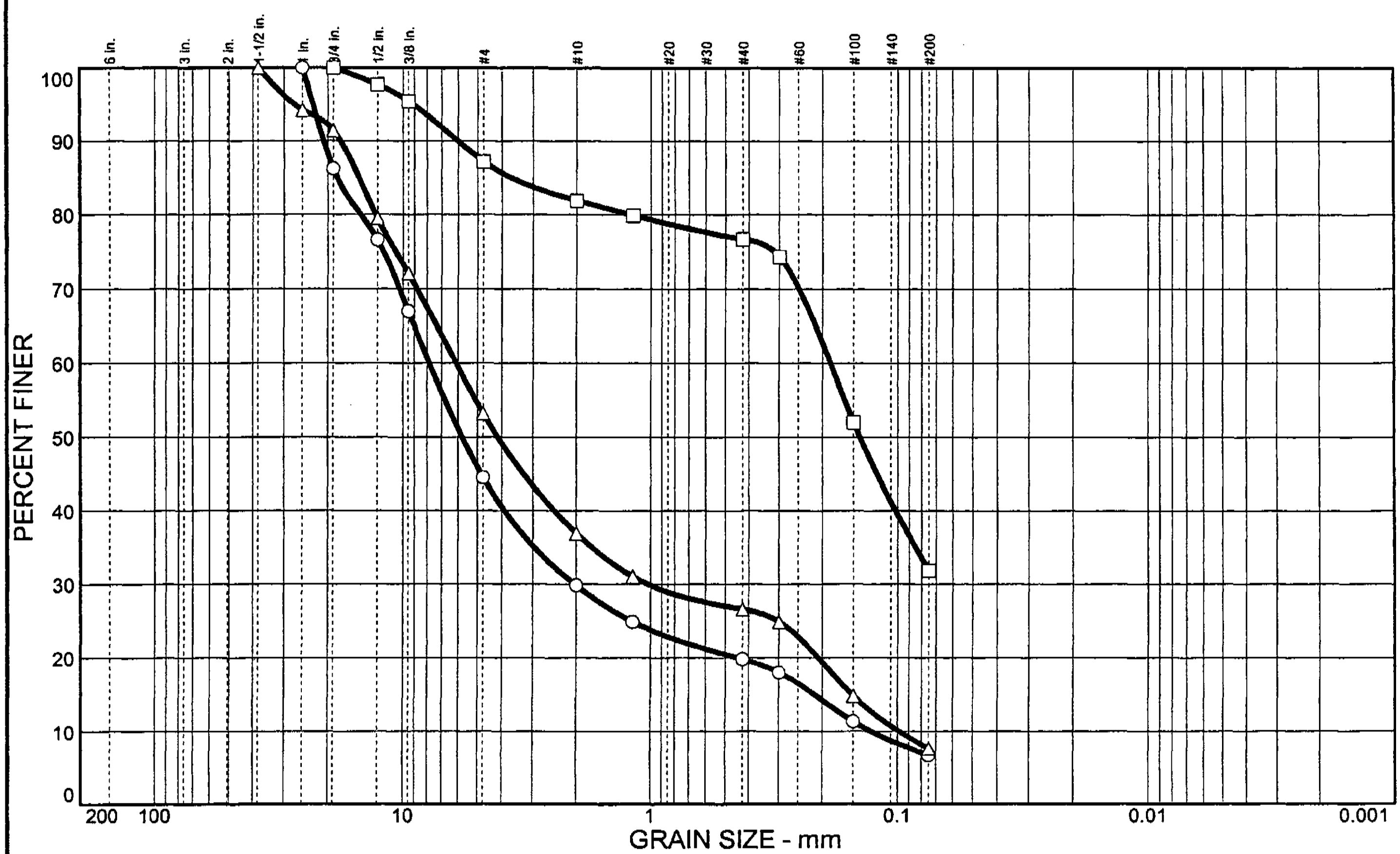
NEVADA DEPARTMENT OF TRANSPORTATION

Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1 Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		55.5	37.8			GP-GM			
□		12.8	55.4			SM			
△		46.8	45.6			GW-GM			

SIEVE inches size	PERCENT FINER ○	□	△
1-1/2"			100.0
1"	100.0		94.2
3/4"	86.2	100.0	91.4
1/2"	76.6	97.7	79.5
3/8"	67.0	95.4	72.1
	GRAIN SIZE		
D_{60}	7.84	0.186	6.12
D_{30}	2.04		1.03
D_{10}	0.128		0.0988
	COEFFICIENTS		
C_c	4.12		1.76
C_u	61.10		61.90

SIEVE number size	PERCENT FINER ○	□	△
#4	44.5	87.2	53.2
#10	29.8	81.9	36.9
#16	24.9	79.9	31.0
#40	19.8	76.7	26.6
#50	18.0	74.3	24.9
#100	11.3	52.0	14.8
#200	6.7	31.8	7.6

SOIL DESCRIPTION

○

□

△

REMARKS:

○

□

△

○ Location: Boring ISR4, sample: D1

□ Location: Boring ISR4, sample: D2

△ Location: Boring ISR4, sample: F

NEVADA DEPARTMENT OF TRANSPORTATION

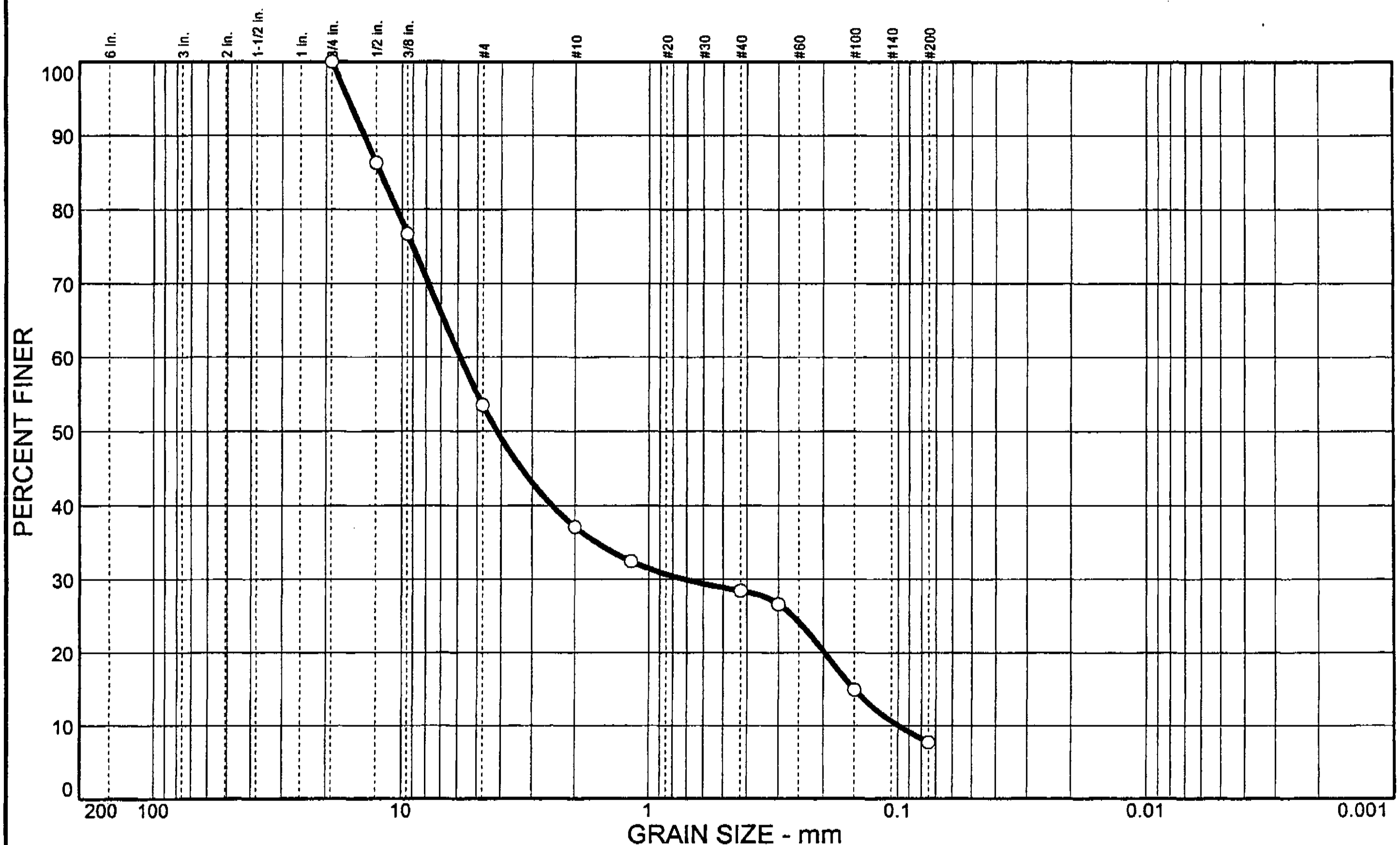
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		46.5	45.8			GP-GM			

SIEVE inches size	PERCENT FINER ○		
3/4"	100.0		
1/2"	86.3		
3/8"	76.7		

	GRAIN SIZE		
D_{60}	5.87		
D_{30}	0.725		
D_{10}	0.0998		

	COEFFICIENTS		
C_c	0.90		
C_u	58.77		

SIEVE number size	PERCENT FINER ○		
#4	53.5		
#10	37.1		
#16	32.4		
#40	28.4		
#50	26.6		
#100	14.9		
#200	7.7		

SOIL DESCRIPTION

○ Poorly graded gravel with silt and sand

REMARKS:

○

○ Location: Boring ISR4, sample: E

NEVADA DEPARTMENT OF TRANSPORTATION

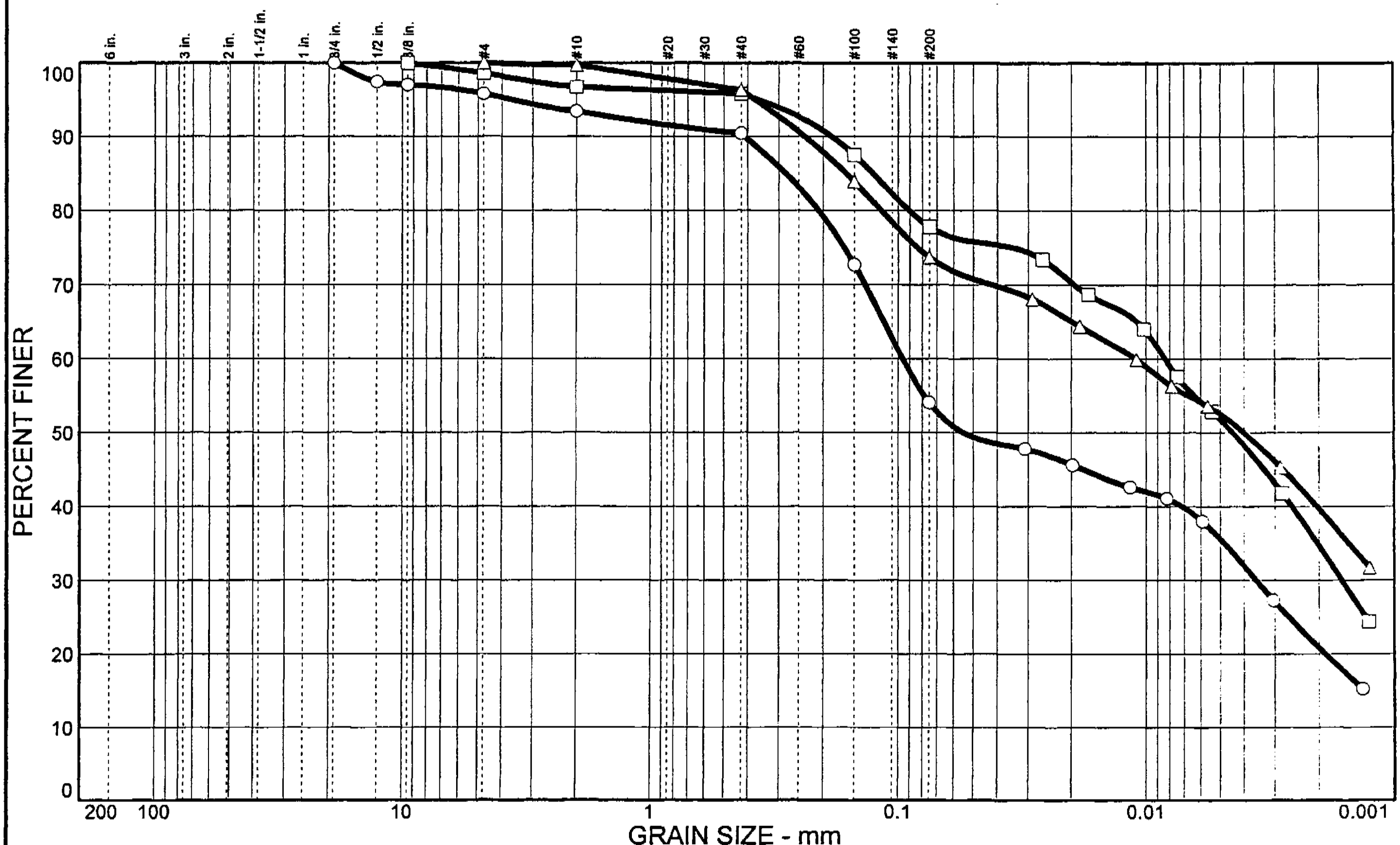
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		4.2	41.7	33.3	20.8	CL		46	22
□		1.4	20.8	43.1	34.7	CL		43	24
△			26.3	34.0	39.7	CL		29	14

SIEVE inches size	PERCENT FINER ○	□	△
3/4"	100.0		
1/2"	97.4		
3/8"	97.0	100.0	
GRAIN SIZE			
D_{60}	0.0960	0.0084	0.0110
D_{30}	0.0036	0.0016	
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	95.8	98.6	100.0
#10	93.4	96.7	99.7
#40	90.4	95.8	96.3
#100	72.7	87.5	83.9
#200	54.1	77.8	73.7

SOIL DESCRIPTION

○ Sandy lean clay

□ Lean clay with sand

△ Lean clay with sand

REMARKS:

○

□

△

○ Location: Boring ISR4, sample: G

□ Location: Boring ISR4, sample: H1

△ Location: Boring ISR4, sample: H2

NEVADA DEPARTMENT OF TRANSPORTATION

Client:

Project: SR160 @ I-15 Interchange

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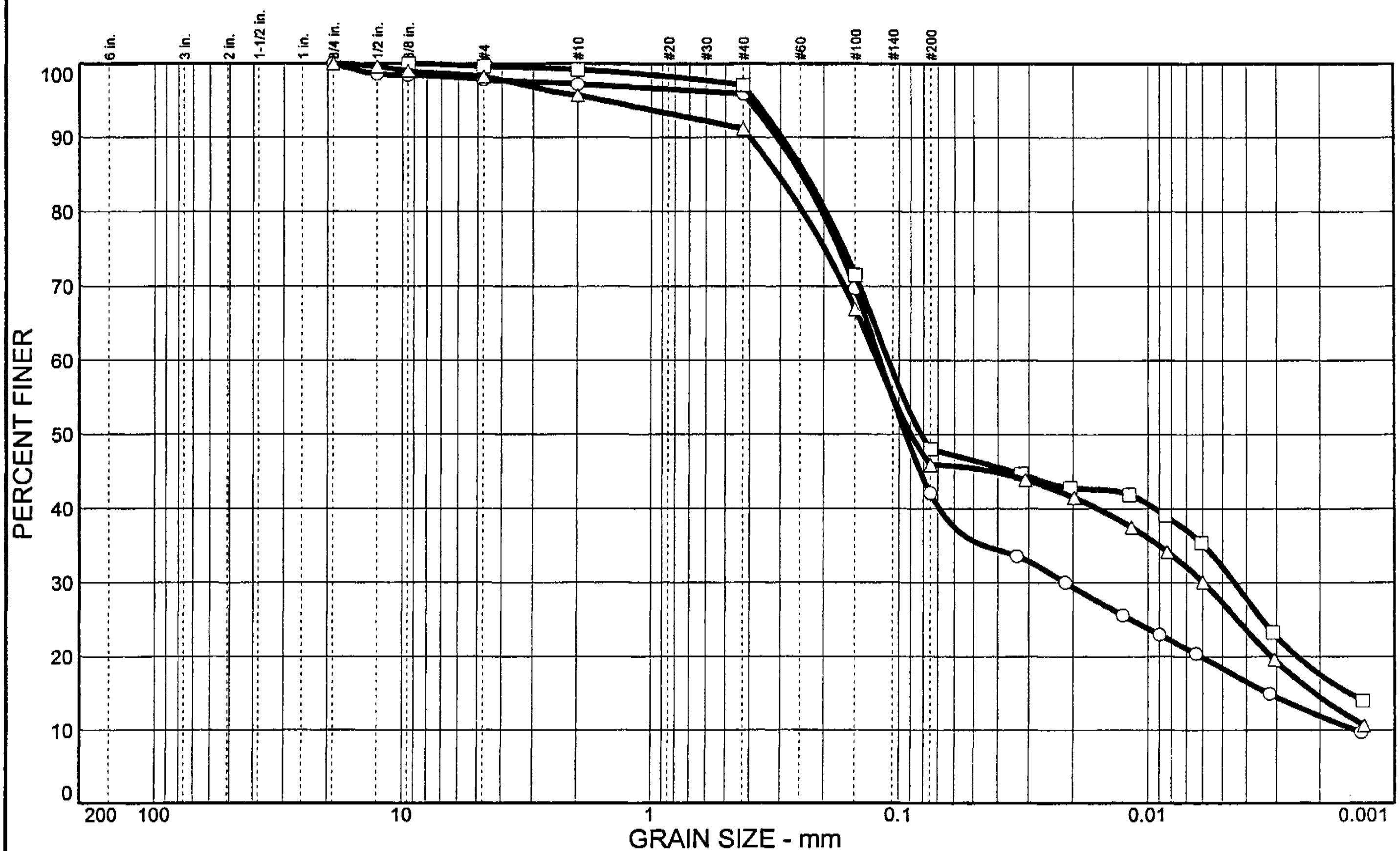
Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		2.2	55.7	30.2	11.9	SC		24	9
□		0.4	51.6	30.4	17.6	SC		36	15
△		1.8	52.3	31.4	14.5	SC		39	17

SIEVE inches size	PERCENT FINER ○	□	△
3/4"	100.0		100.0
1/2"	98.6		99.6
3/8"	98.4	100.0	99.0
	GRAIN SIZE		
D_{60}	0.119	0.111	0.122
D_{30}	0.0215	0.0045	0.0060
D_{10}	0.0014		
	COEFFICIENTS		
C_c	2.70		
C_u	83.07		

SIEVE number size	PERCENT FINER ○	□	△
#4	97.8	99.6	98.2
#10	97.2	99.2	95.7
#40	95.9	97.1	91.2
#100	69.7	71.5	66.9
#200	42.1	48.0	45.9

SOIL DESCRIPTION

○ Clayey sand

□ Clayey sand

△ Clayey sand

REMARKS:

○

□

△

○ Location: Boring ISR4, sample: J

□ Location: Boring ISR4, sample: K1

△ Location: Boring ISR4, sample: K2

NEVADA DEPARTMENT OF TRANSPORTATION

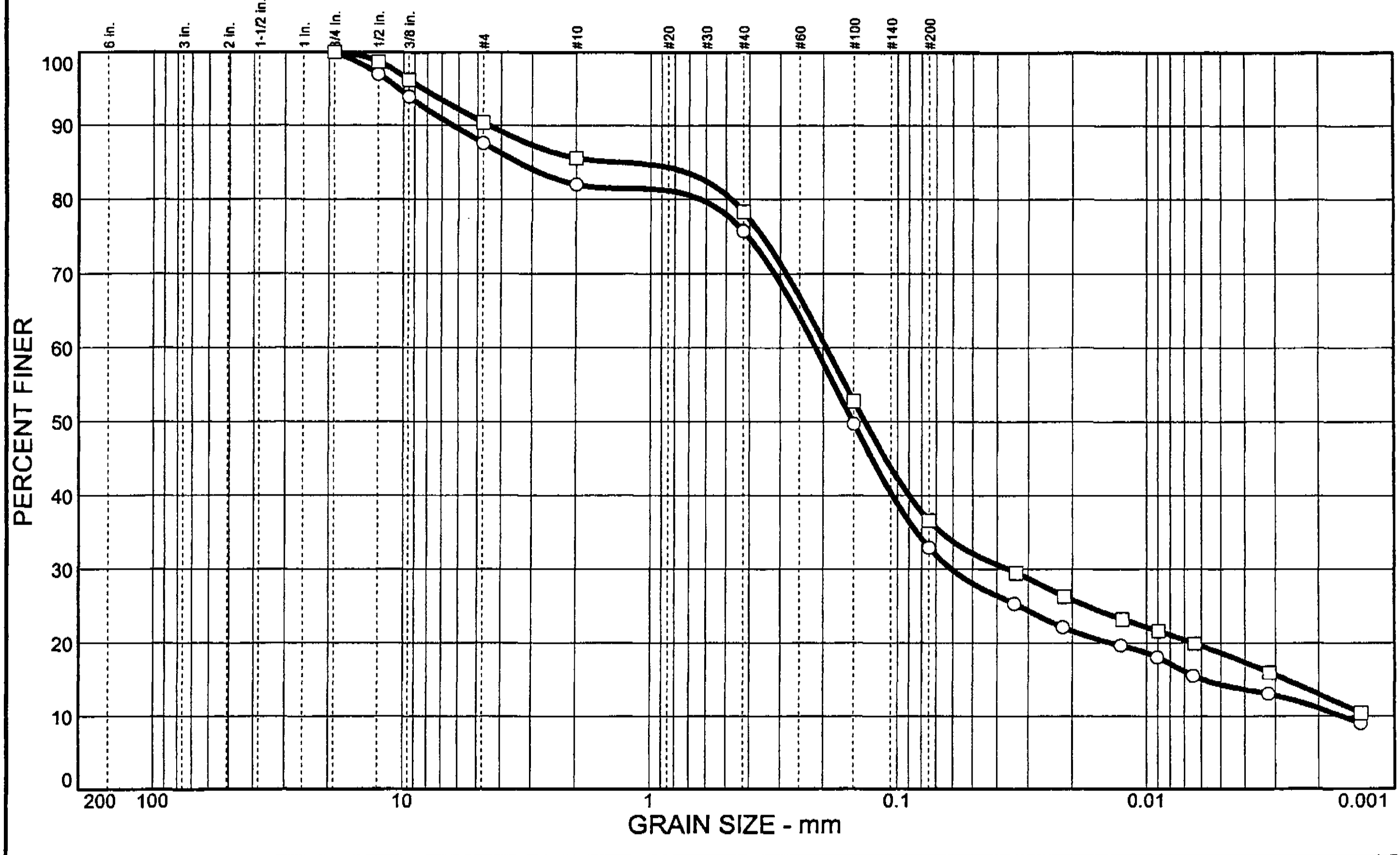
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		12.4	54.7	21.8	11.1	SC		55	27
□		9.6	53.8	23.6	13.0	SC		71	41

SIEVE inches size	PERCENT FINER ○	PERCENT FINER □	
3/4"	100.0	100.0	
1/2"	97.0	98.7	
3/8"	93.9	96.2	
	GRAIN SIZE		
D_{60}	0.215	0.194	
D_{30}	0.0610	0.0363	
D_{10}	0.0016		
	COEFFICIENTS		
C_c	10.64		
C_u	132.03		

SIEVE number size	PERCENT FINER ○	PERCENT FINER □	
#4	87.6	90.4	
#10	82.0	85.6	
#40	75.7	78.3	
#100	49.7	52.8	
#200	32.9	36.6	

SOIL DESCRIPTION

○ Clayey sand

□ Clayey sand

REMARKS:

○

□

○ Location: Boring ISR4, sample: M1

□ Location: Boring ISR4, sample: M2

NEVADA DEPARTMENT OF TRANSPORTATION

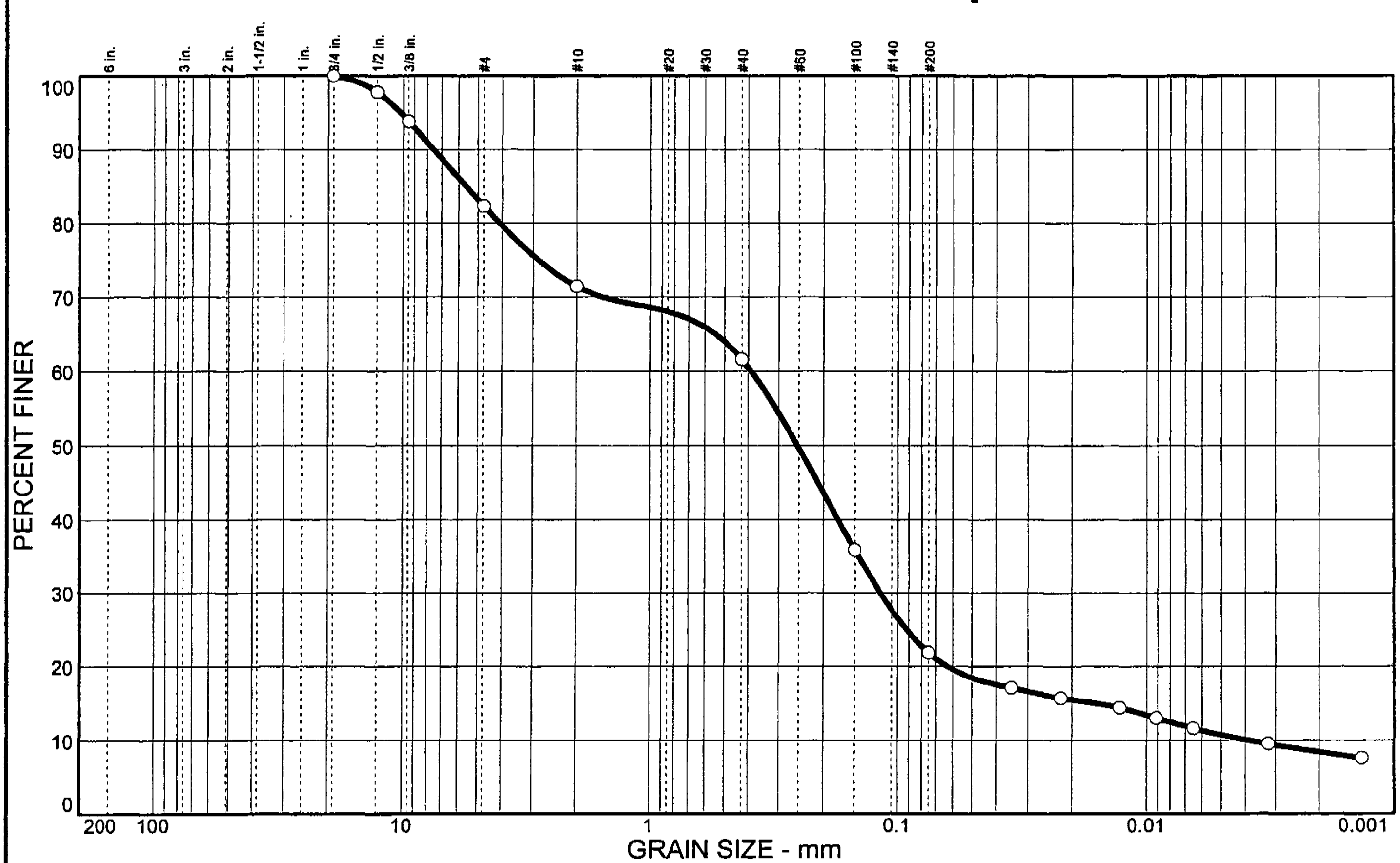
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		17.7	60.4	13.5	8.4	SC		37	15

SIEVE inches size	PERCENT FINER ○		
3/4"	100.0		
1/2"	97.8		
3/8"	93.8		
	GRAIN SIZE		
D_{60}	0.389		
D_{30}	0.118		
D_{10}	0.0039		
	COEFFICIENTS		
C_c	9.09		
C_u	99.43		

SIEVE number size	PERCENT FINER ○		
#4	82.3		
#10	71.4		
#40	61.6		
#100	35.9		
#200	21.9		

SOIL DESCRIPTION

○ Clayey sand with gravel

REMARKS:

○

○ Location: Boring ISR4, sample: N

NEVADA DEPARTMENT OF TRANSPORTATION

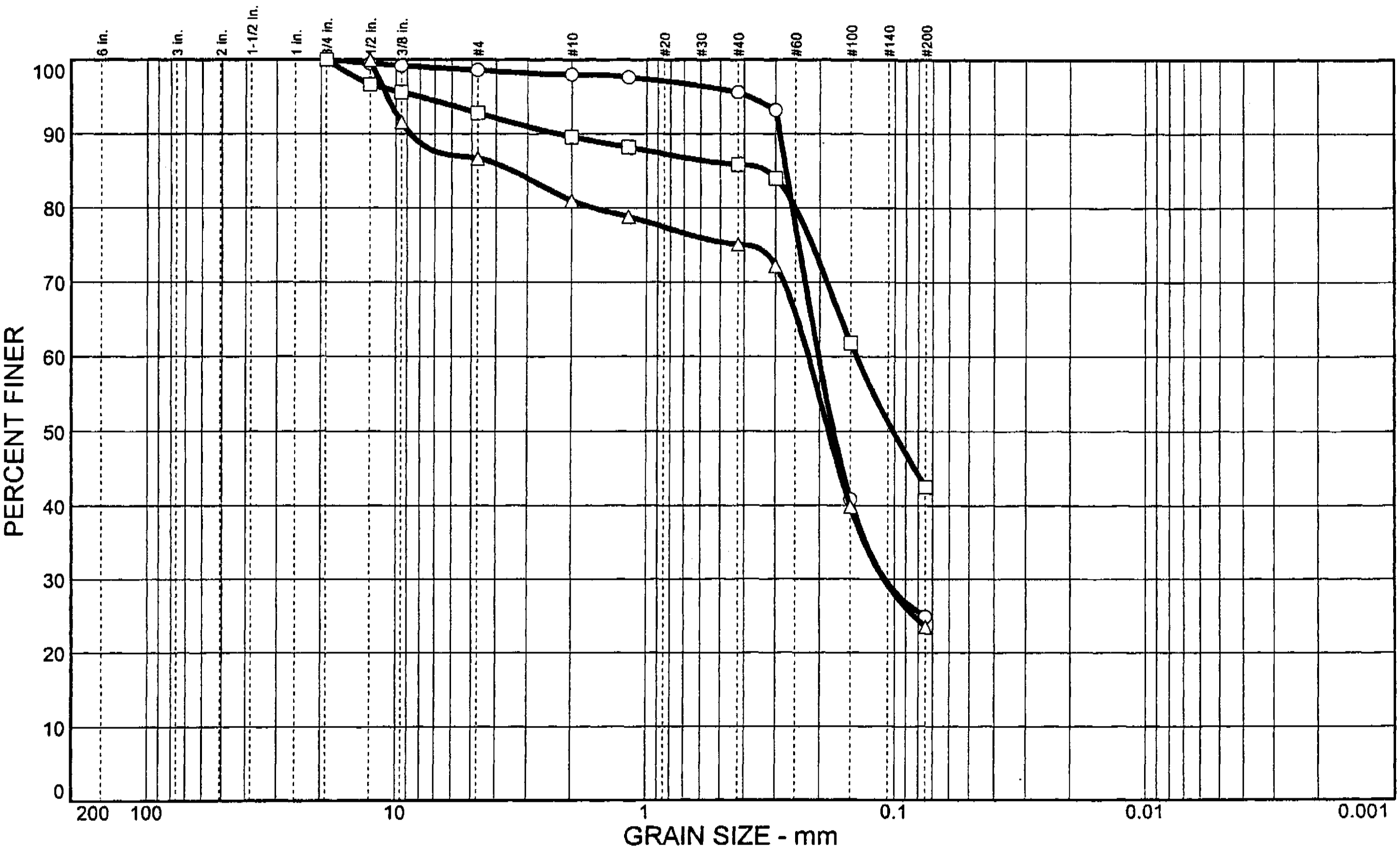
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		1.4	73.7			SM			
□		7.2	50.3			SM			
△		13.3	63.2			SM			

SIEVE inches size	PERCENT FINER ○	□	△
3/4"	100.0	100.0	
1/2"	99.5	96.7	100.0
3/8"	99.2	95.6	91.6
	GRAIN SIZE		
D_{60}	0.202	0.142	0.222
D_{30}	0.109		0.111
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	98.6	92.8	86.7
#10	98.0	89.6	81.0
#16	97.6	88.2	78.8
#40	95.6	85.9	75.1
#50	93.2	84.0	72.2
#100	40.8	61.8	39.8
#200	24.9	42.5	23.5

SOIL DESCRIPTION

○ Silty sand

□ Silty sand

△ Silty sand

REMARKS:

○

□

△

○ Location: Boring ISR5, sample: A1

□ Location: Boring ISR5, sample: A2

△ Location: Boring ISR5, sample: B

NEVADA DEPARTMENT OF TRANSPORTATION

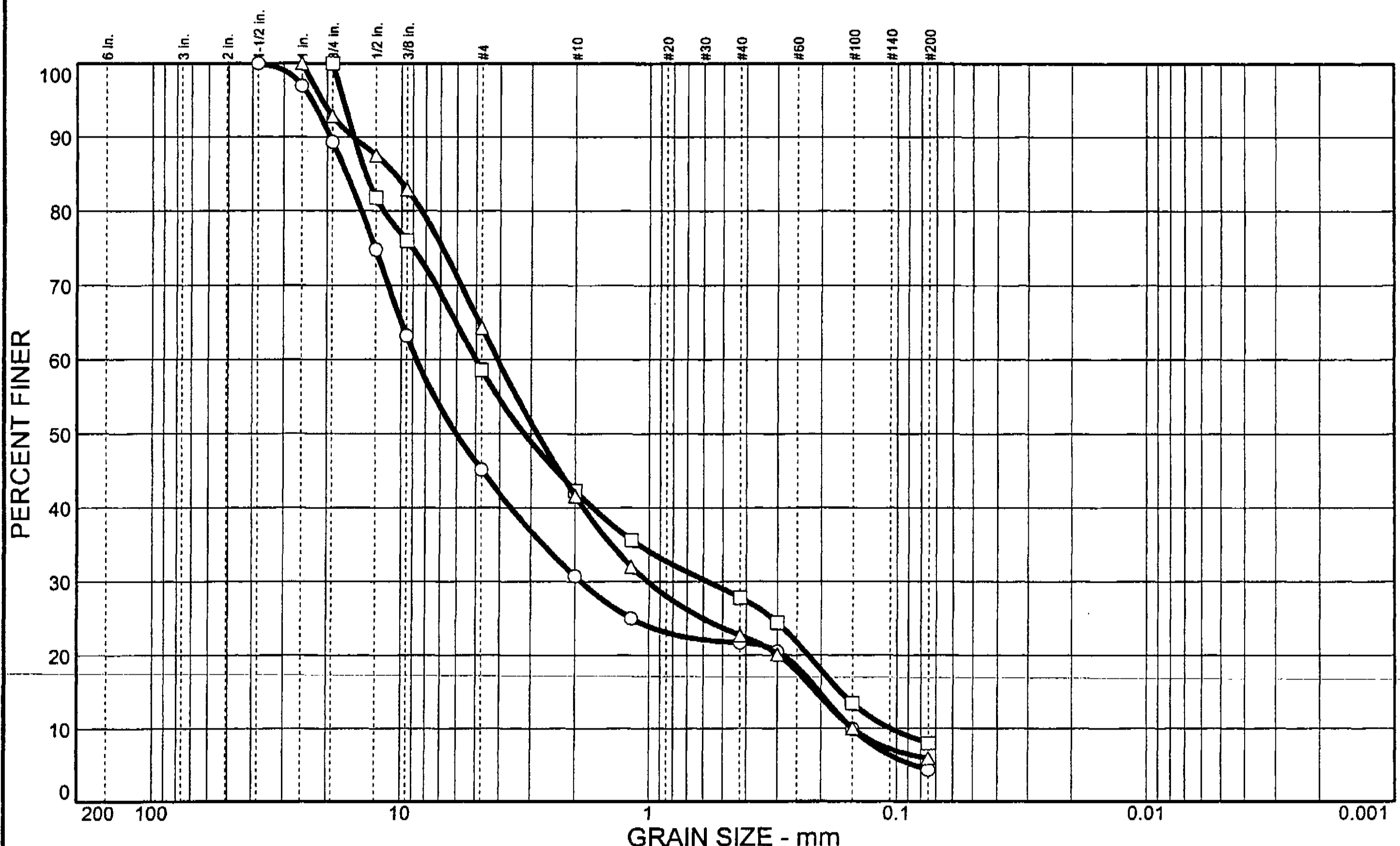
Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		54.9	40.8			GW			
□		41.4	50.6			SP-SM			
△		35.7	58.4			SW-SM			

SIEVE inches size	PERCENT FINER ○	□	△
1-1/2"	100.0		
1"	96.9		100.0
3/4"	89.3	100.0	92.8
1/2"	74.8	81.8	87.5
3/8"	63.2	76.0	82.9
GRAIN SIZE			
D_{60}	8.70	5.02	4.10
D_{30}	1.90	0.580	1.02
D_{10}	0.151	0.106	0.150
COEFFICIENTS			
C_c	2.74	0.63	1.68
C_u	57.57	47.25	27.30

SIEVE number size	PERCENT FINER ○	□	△
#4	45.1	58.6	64.3
#10	30.7	42.3	41.6
#16	25.0	35.6	32.0
#40	21.7	27.8	22.7
#50	20.5	24.4	20.1
#100	9.9	13.4	10.0
#200	4.3	8.0	5.9

SOIL DESCRIPTION
○ Well-graded gravel with sand
□ Poorly graded sand with silt and gravel
△ Well-graded sand with silt and gravel

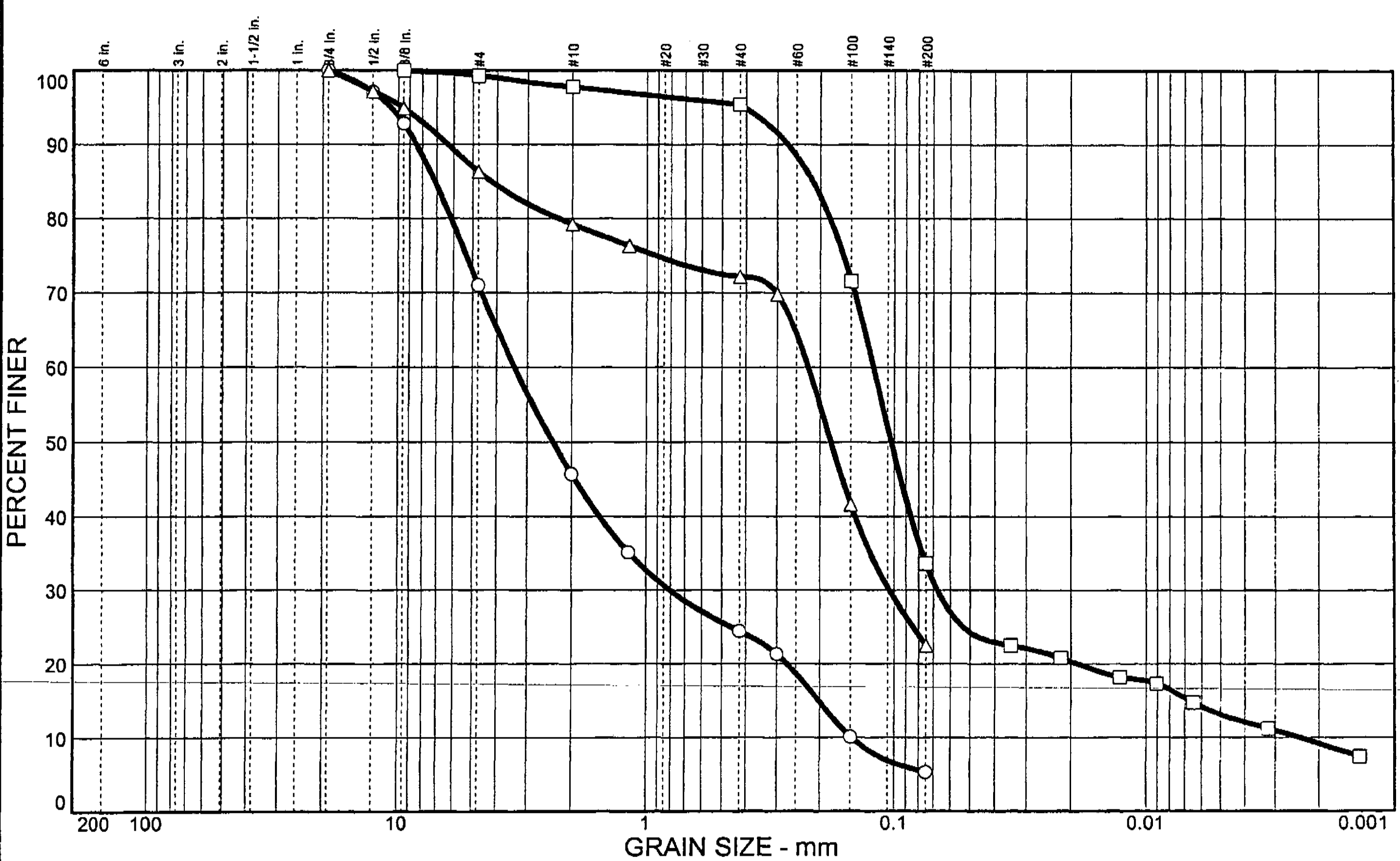
REMARKS:
○
□
△

○ Location: Boring ISR5, sample: C2
□ Location: Boring ISR5, sample: D
△ Location: Boring ISR5, sample: E1

NEVADA DEPARTMENT OF TRANSPORTATION

Client:
Project: SR160 @ I-15 Interchange
Project No.: 72495-1
Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		29.0	65.7			SW-SM			
□		0.7	65.7	24.4	9.2	SC-SM		25	6
△		13.7	63.8			SM			

SIEVE inches size	PERCENT FINER ○	□	△
3/4"	100.0		100.0
1/2"	97.1		97.2
3/8"	92.8	100.0	94.9
	GRAIN SIZE		
D_{60}	3.39	0.122	0.224
D_{30}	0.808	0.0677	0.105
D_{10}	0.149	0.0024	
	COEFFICIENTS		
C_c	1.29	15.63	
C_u	22.74	50.46	

SIEVE number size	PERCENT FINER ○	□	△
#4	71.0	99.3	86.3
#10	45.7	97.8	79.2
#16	35.1		76.3
#40	24.4	95.4	72.2
#50	21.3		69.8
#100	10.1	71.6	41.6
#200	5.3	33.6	22.5

SOIL DESCRIPTION

○ Well-graded sand with silt and gravel

□ Silty, clayey sand

△ Silty sand

REMARKS:

○

□

△

○ Location: ISR5, sample: E2

□ Location: Boring ISR5, sample: F

△ Location: Boring ISR5, sample: G1

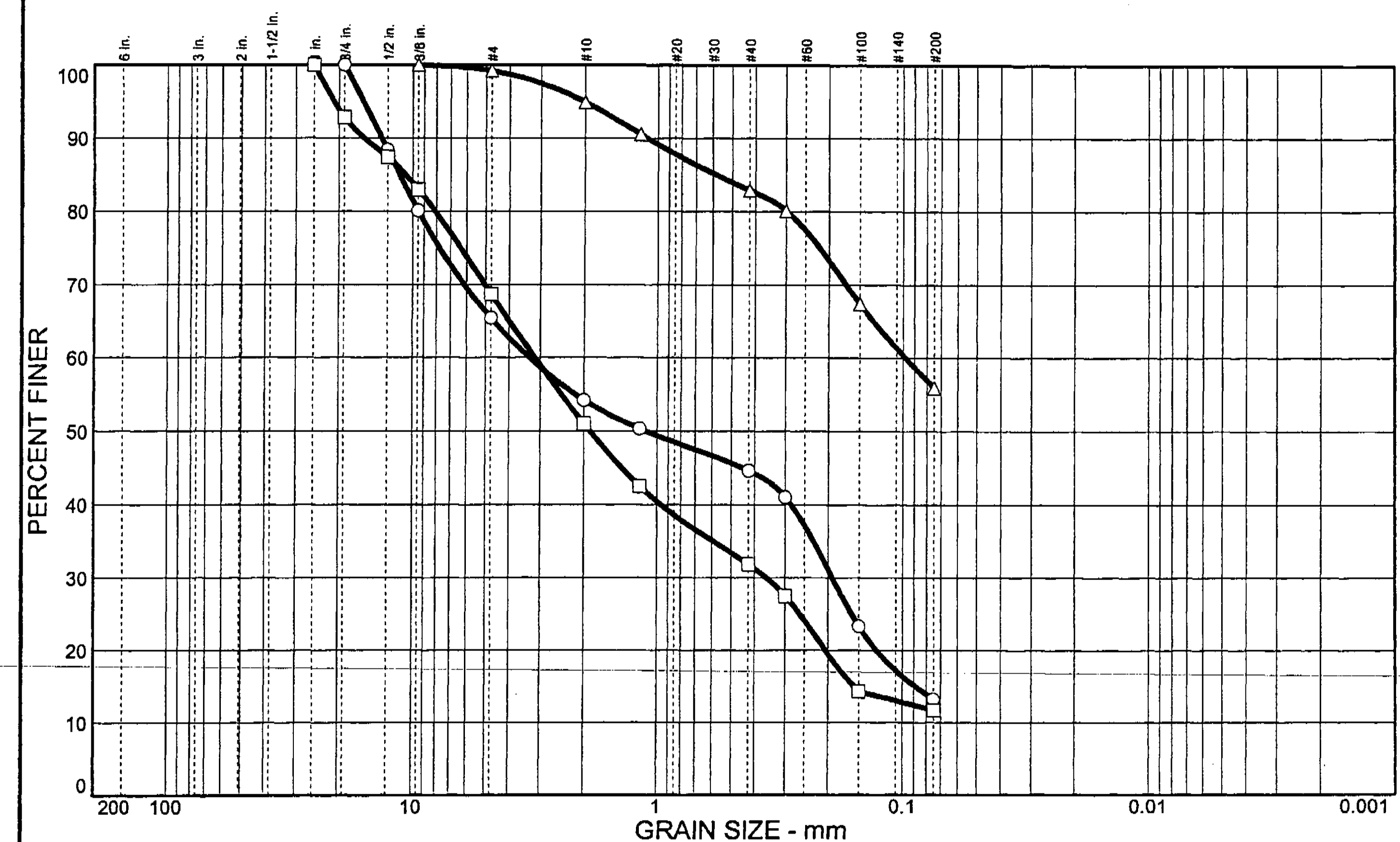
NEVADA DEPARTMENT OF TRANSPORTATION

Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1 Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		34.6	52.2			SM			
□		31.3	57.0			SP-SM			
△		0.8	43.3			CL		27	13

SIEVE inches size	PERCENT FINER ○	□	△
1"		100.0	
3/4"	100.0	92.8	
1/2"	88.4	87.4	
3/8"	80.1	83.0	100.0
	GRAIN SIZE		
D_{60}	3.32	3.16	0.0979
D_{30}	0.193	0.359	
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	65.4	68.7	99.2
#10	54.2	51.0	94.9
#16	50.3	42.5	90.5
#40	44.6	31.8	82.9
#50	41.0	27.5	80.1
#100	23.3	14.3	67.4
#200	13.2	11.7	55.9

SOIL DESCRIPTION

○ Silty sand with gravel

□ Poorly graded sand with silt and gravel

△ Sandy lean clay

REMARKS:

○

□

△

○ Location: Boring ISR5, sample: H

□ Location: Boring ISR5, sample: I

△ Location: BOring ISR5, sample: J

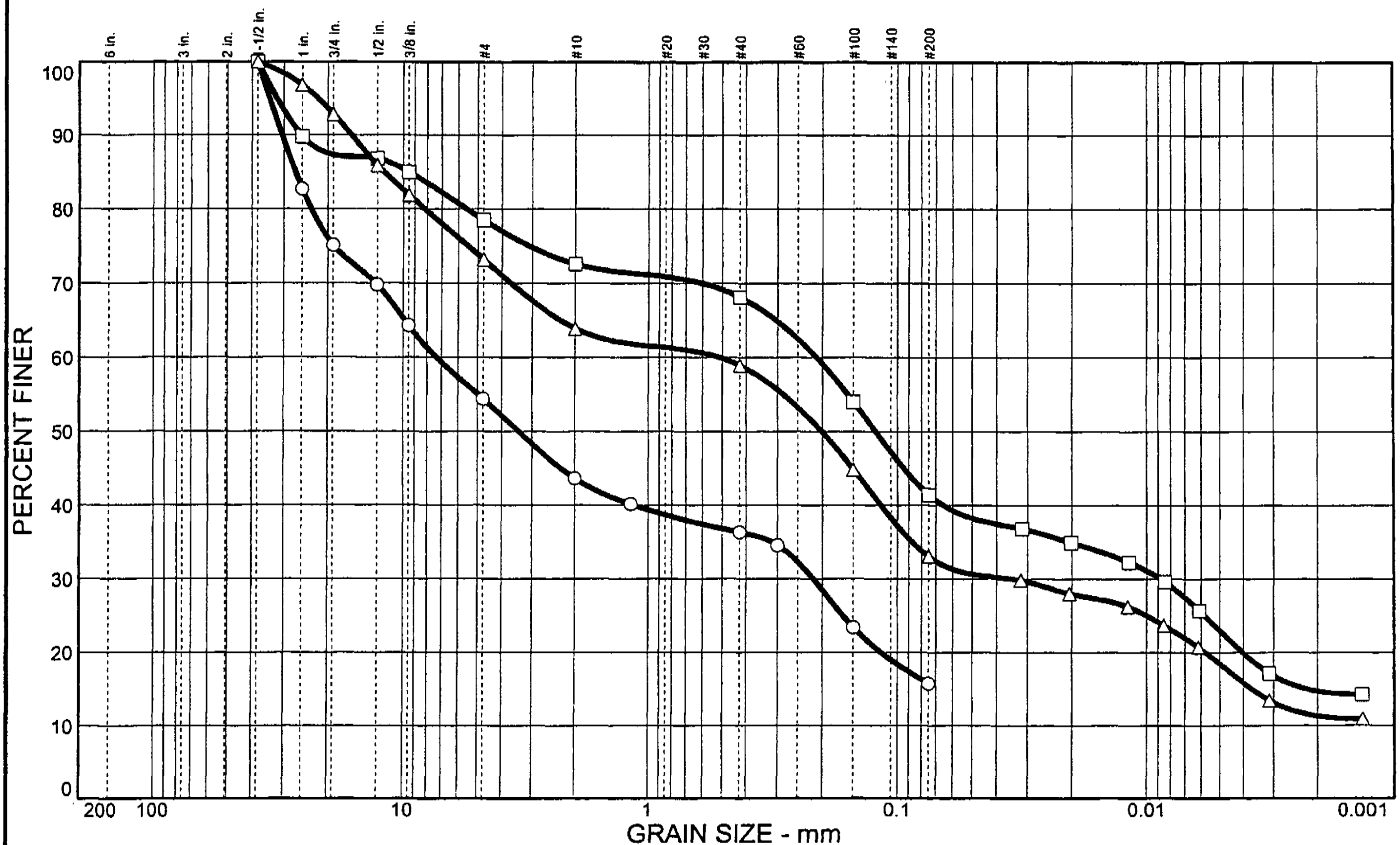
NEVADA DEPARTMENT OF TRANSPORTATION

Client:

Project: SR160 @ I-15 Interchange

Project No.: 72495-1 Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		45.6	38.7			GM			
□		21.5	37.1	26.7	14.7	SM		85	38
△		26.8	40.2	21.7	11.3	SM		57	23

SIEVE inches size	PERCENT FINER ○	□	△
1-1/2"	100.0	100.0	100.0
1"	82.7	89.8	96.8
3/4"	75.1		92.8
1/2"	69.8	86.8	85.9
3/8"	64.3	85.0	81.9
	GRAIN SIZE		
D_{60}	7.34	0.212	0.513
D_{30}	0.218	0.0088	0.0347
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	54.4	78.5	73.2
#10	43.6	72.6	63.9
#16	40.1		
#40	36.3	68.1	58.9
#50	34.5		
#100	23.4	54.0	44.8
#200	15.7	41.4	33.0

SOIL DESCRIPTION

○ Silty gravel with sand

□ Silty sand with gravel

△ Silty sand with gravel

REMARKS:

○

□

△

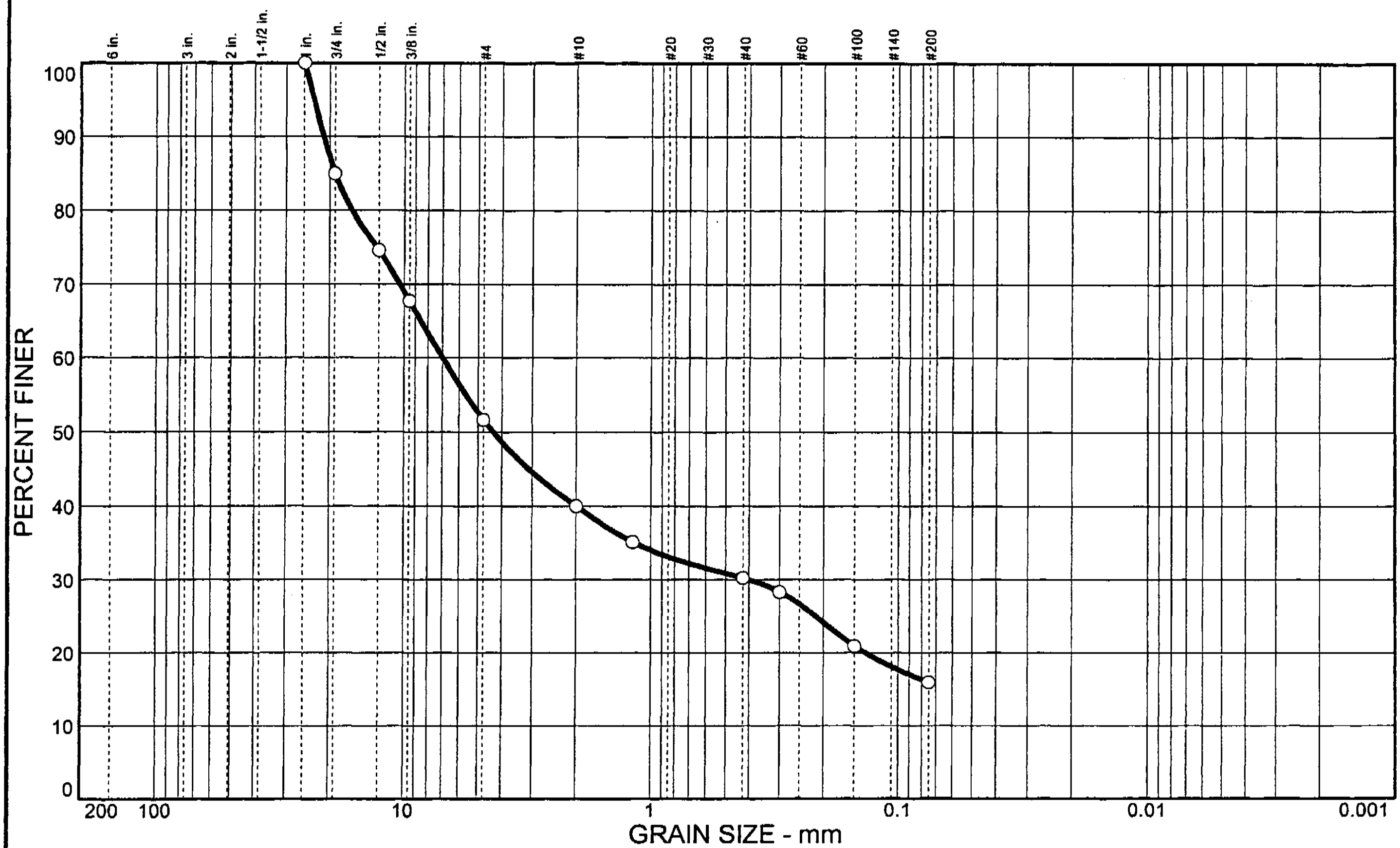
○ Location: Boring ISR5, sample: M

□ Location: Boring ISR5, sample: N

△ Location: Boring ISR5, sample: O1

NEVADA DEPARTMENT OF TRANSPORTATION	Client: Project: SR160 @ I-15 Interchange Project No.: 72495-1 Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	LL	PI
○		48.4	35.7			GM			

SIEVE inches size	PERCENT FINER ○		
1"	100.0		
3/4"	85.0		
1/2"	74.6		
3/8"	67.7		
	GRAIN SIZE		
D_{60}	6.99		
D_{30}	0.405		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	51.6		
#10	40.0		
#16	35.1		
#40	30.2		
#50	28.3		
#100	20.9		
#200	15.9		

SOIL DESCRIPTION

○ Silty gravel with sand

REMARKS:

○

○ Location: Boring ISR5, sample: P

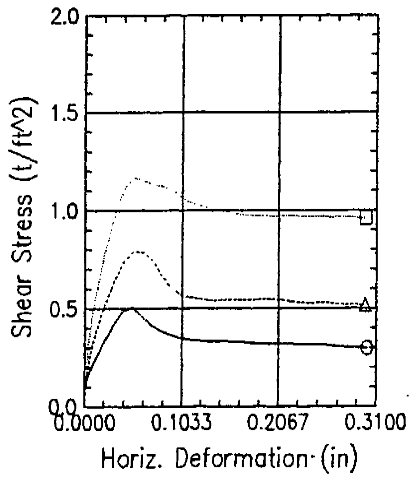
NEVADA DEPARTMENT OF TRANSPORTATION

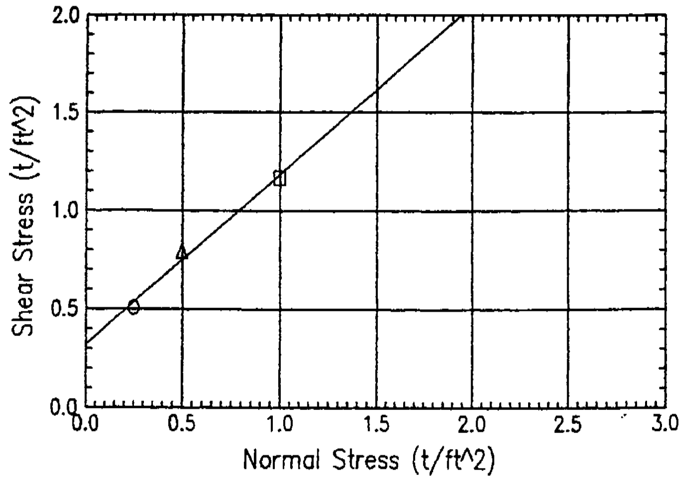
Client:

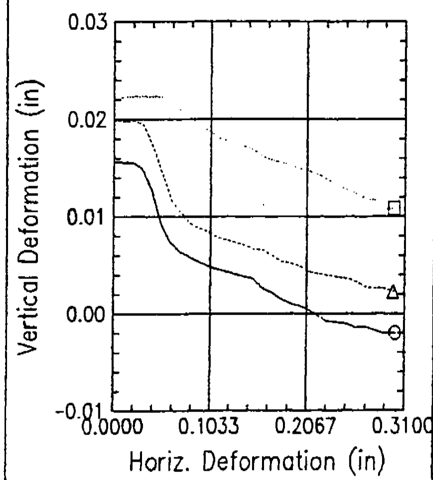
Project: SR160 @ I-15 Interchange

Project No.: 72495-1

Plate







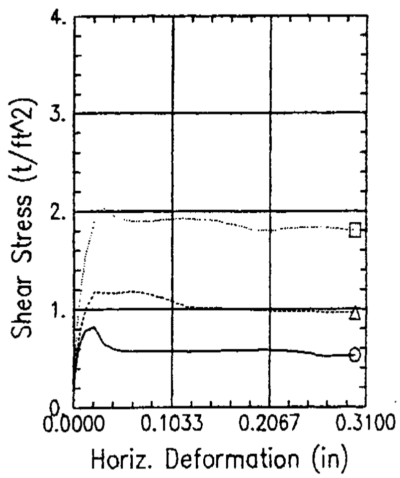
Strength Parameters

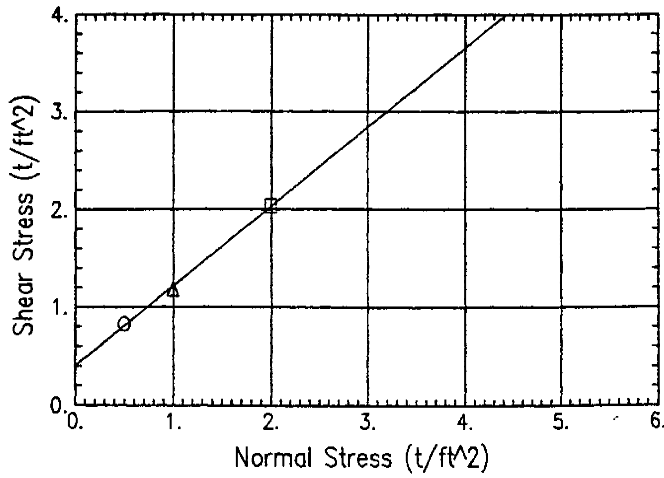
c = 0.322

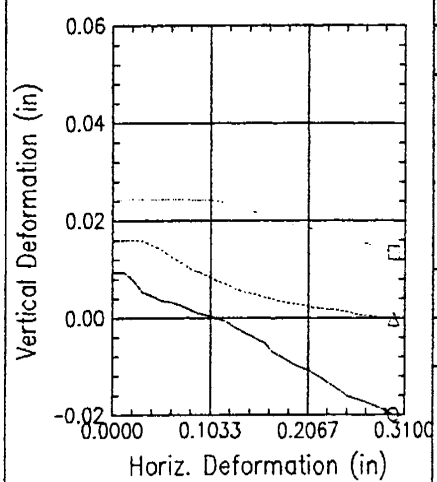
ϕ = 40.8

Graph Symbol			O	Δ	□	
Test No.			a	b	c	
Initial	Water content (%)	w_o	0.00	0.00	0.00	
	Void ratio	e_o	0.00	0.00	0.00	
	Saturation (%)	S_o	0.00	0.00	0.00	
	Dry density (lb/ft^3)	γ_d	0.00	0.00	0.00	
Void ratio after consolidation		e_c	0.00	0.00	0.00	
Time for 50 percent consolidation		t_{50}				
Final	Water content (%)	w_f	0.00	0.00	0.00	
	Void Ratio	e_f	0.00	0.00	0.00	
	Saturation (%)	S_f	0.00	0.00	0.00	
Normal stress (t/ft^2)		σ	0.25	0.50	1.00	
Maximum shear stress (t/ft^2)		τ_{max}	0.51	0.79	1.17	
Actual time to failure (min)		t_f	21	20	22	
Rate of strain						
Ultimate shear stress (t/ft^2)		τ_{ult}	0.30	0.52	0.96	

Type of Specimen	CMS				
Description	Silty Sand				
LL 0.0	PL 0.0	PI 0.0		G_s 0	
Remarks	Sample Re-Compacted using -#4 sieve material	Project	I-15 @ SR160 Interchange		
		Area	6.16 (in^2)	Boring No.	ISR 5
		Depth		Sample No.	A2
		Elevation		Date	10/18/00
		DIRECT SHEAR TEST REPORT			







Strength Parameters

c = 0.402

ϕ = 39.1

Graph Symbol			○	△	□	
Test No.			a	b	c	
Initial	Water content (%)	w_o	0.00	0.00	0.00	
	Void ratio	e_o	0.00	0.00	0.00	
	Saturation (%)	S_o	0.00	0.00	0.00	
	Dry density (lb/ft^3)	γ_d	0.00	0.00	0.00	
Void ratio after consolidation		e_c	0.00	0.00	0.00	
Time for 50 percent consolidation		t_{50}				
Final	Water content (%)	w_f	0.00	0.00	0.00	
	Void Ratio	e_f	0.00	0.00	0.00	
	Saturation (%)	S_f	0.00	0.00	0.00	
Normal stress (t/ft^2)		σ	0.50	1.00	2.00	
Maximum shear stress (t/ft^2)		τ_{max}	0.83	1.18	2.04	
Actual time to failure (min)		t_f	11	12	18	
Rate of strain						
Ultimate shear stress (t/ft^2)		τ_{ult}	0.53	0.97	1.80	

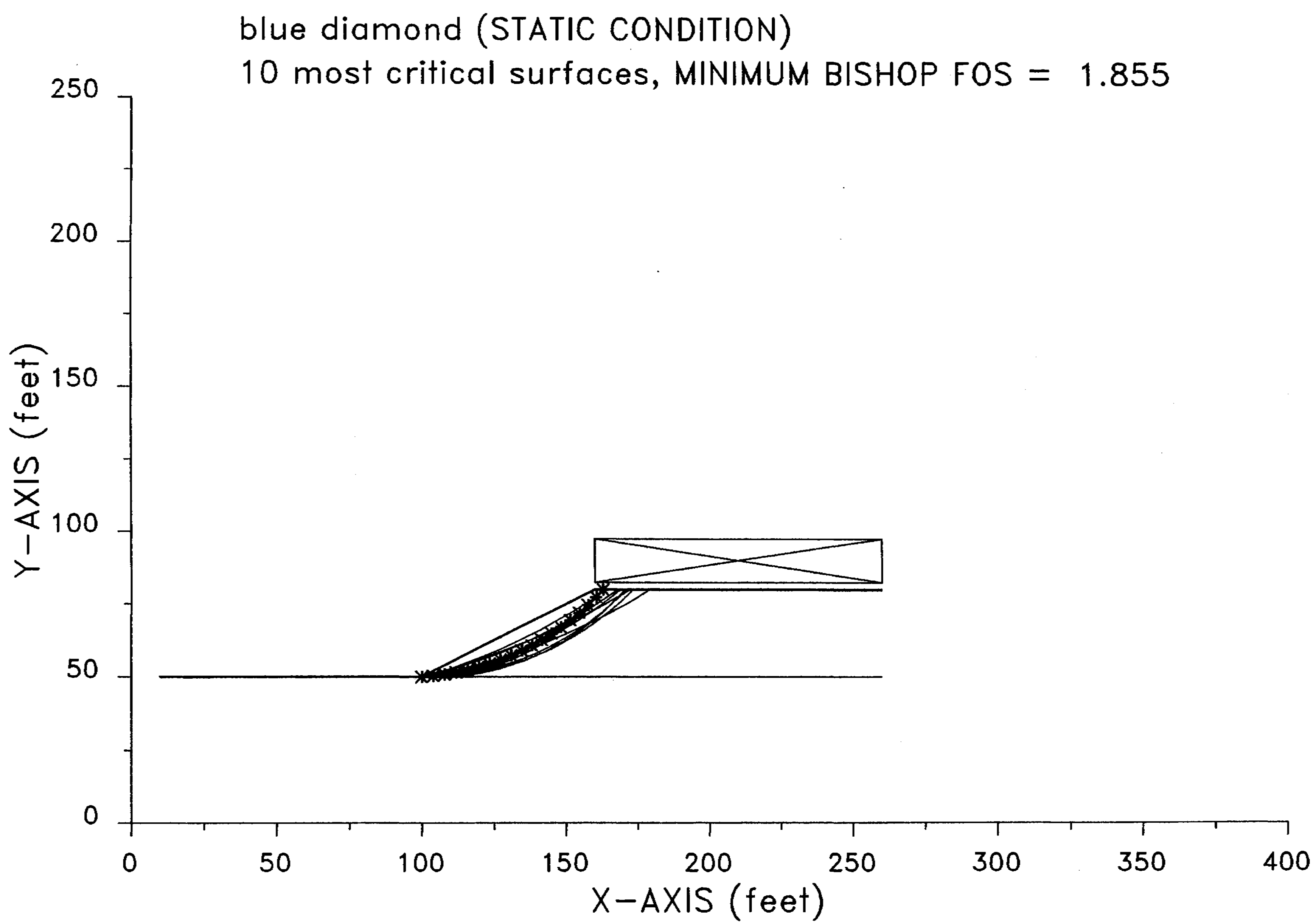
Type of Specimen	CMS				
Description	Sand				
LL 0.0	PL 0.0	PI 0.0		G_s 0	
Remarks	Sample Re-Compacted using -#4 sieve material	Project	I-15 @ SR160 Interchange		
		Area	6.16 (in^2)	Boring No.	ISR 5
		Depth		Sample No.	G1
		Elevation		Date	10/17/00

DIRECT SHEAR TEST REPORT

APPENDIX D

* STABILITY ANALYSIS OF BRIDGE APPROACH EMBANKMENTS

BLUE 7-18-** 8:30



blue diamond (STATIC CONDITION)
10 most critical surfaces, MINIMUM BISHOP FOS = 1.855
250
200
150
100
50
0
Y-AXIS (feet)
0
50
100
150
200
250
300
350
400
X-AXIS (feet)

BLUE2 7-18-** 8:27

blue diamond (EQ)

10 most critical surfaces, MINIMUM BISHOP FOS = 1.575