RockSol
Consulting Group, Inc.

May 29, 2013

Parsons
1776 Lincoln Street, Suite 600
Denver, Colorado 80203

Attention: Mr. Delbreath D. Walker, P.E.

Subject: Preliminary Pavement Design Report, I-70 Havana Bridge Replacement – Preliminary Engineering and Procurement, CDOT Project No. FBR 0704-230 (19339), City and County of Denver, Colorado, RockSol Project Number 304.01

Dear Mr. Walker:

RockSol Consulting Group, Inc. (RockSol) has performed a soil investigation for the *Interim Construction Design* phase of the I-70 Havana Bridge Replacement Project. RockSol has prepared a Soil Investigation Report, under separate cover, that presents information on the subsurface soil, groundwater, and bedrock conditions obtained from soil borings performed within the project limits.

This Preliminary Pavement Design Report also presents a brief discussion of the subsurface conditions encountered, a summary of the lab testing performed on recovered soil and bedrock samples, and pavement design recommendations to assist with preliminary design of pavements for the subject project.

Surface and groundwater hydrology, hydraulic engineering, and environmental studies including contaminant characterization were not included in RockSol's scope of work. RockSol understands that additional geotechnical investigations will be performed at a later time for the ultimate build out design phase of the I-70/Havana Interchange.

Project Description

Project descriptions are based on information and preliminary plan sheets provided by Parsons titled *I-70 East Environmental Impact Statement, I-70 over Havana Street Interim Construction*, Sheets 1 through 5, dated 10/24/2012 and modified 11/8/2012.

The Colorado Department of Transportation (CDOT) is procuring a *Design-Build* contract for a project to replace the I-70 Bridge over Havana Street (Havana) and the Union Pacific Railroad (UPRR) right-of-way (ROW). The existing I-70 bridge structure (Structure No. E-17-JP) over Havana is located in the City and County of Denver (CCD), Colorado (See Figure 1, Site Vicinity Map). Havana is located between Peoria Street and Central Park Boulevard at approximate I-70 Mile Marker 280.6.

The new I-70 Bridge over Havana Street is proposed as a four span structure with approximate span lengths of 70 feet, 95 feet, 95 feet, and 30 feet and will be a multi-lane bridge approximately 210 feet in width. Proposed interim construction at the I-70 over Havana crossing will also include raising the I-70 pavement grade elevation approximately 5 feet at the bridge location and raising the I-70 pavement grade 2 feet to 7 feet to the east and west of Havana and raising the on and off ramp connections to I-70 pavement grade elevations approximately 2 feet to 5 feet. Total reconstruction of the I-70 pavement for the interim design is planned to extend approximately 1,700 feet west and approximately 1,400 feet east of the bridge structure over Havana. Based on information provided, no improvements or modifications are planned for Havana for the interim construction phase of the project. Between

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Havana and I-225, CDOT is also planning to mill 2 inches of flexible pavement and replace with 2 inches of hot mix asphalt (HMA). RockSol understands that CDOT has performed a study to develop recommendations for the mill and fill project.

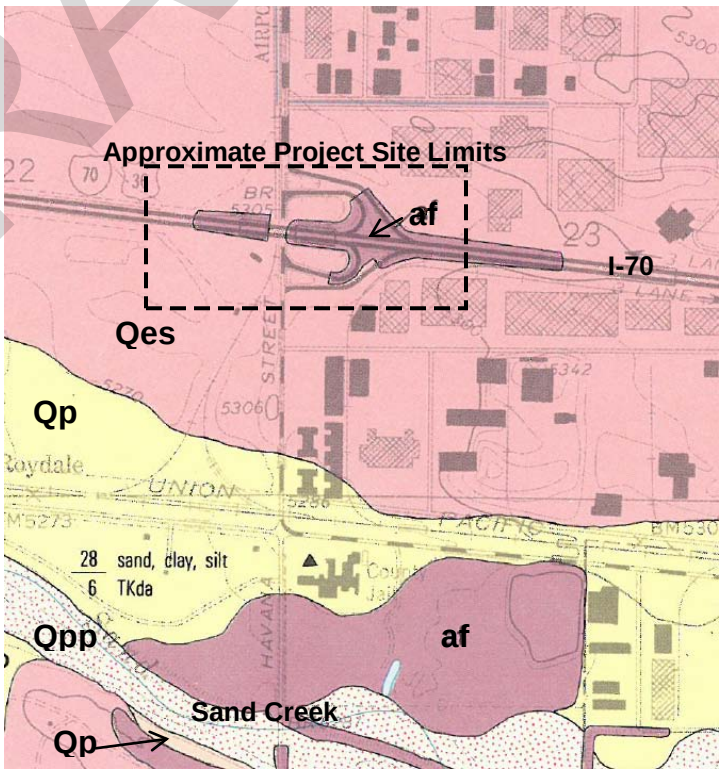
Project Site Conditions

The existing I-70 bridge over Havana is a five span structure consisting of continuous welded girder center spans supported by four sets of nine-concrete column piers. The existing bridge carries five lanes of traffic in each direction over Havana and is approximately 145 feet in width. The existing I-70 approach embankments (fill placement) are approximately 25 feet to 28 feet in height at the bridge abutments. Concrete slope paving (approximate 2H:1V slope) is present at each abutment with embankments side slopes of approximately 3H:1V to 4H:1V. The Havana on and off ramp connections to I-70 are located on the east side of Havana. The UPRR railroad tracks are located to the west of Havana and at a lower elevation grade.

In the project area, I-70 pavement consists of HMA, however, RockSol understands that portions of the original concrete pavement for I-70 are likely still in place and are overlayed with HMA.

A mix of commercial and industrial development borders the project area and includes a CDOT maintenance facility located near the southwest corner of the interchange. Topography at the site generally consists of flat to mild slopes with a general trend of decreasing elevation to the south and west.

Geologic Conditions



The project site is located approximately one-half mile north of the northern limits of the geologic floodplain of Sand Creek, which is located approximately one mile to the south and two miles to the west. Based on the 1983 USGS *Geologic Map of the Sable Quadrangle, Adams and Denver Counties* by Robert M. Lindvall (see image on right, modified by RockSol), the site is underlain by Eolian (windblown) Sand (Qes) and Artificial Fill (af). Lindvall describes the Eolian Sand as consisting of fine sand, sandy silt and clay with a low resistance to erosion on steep slopes, severely susceptible to wind erosion where vegetation is not present, and very permeable, generally allowing for good surface drainage. The artificial fill mapped at the interchange location is associated with the I-70 and Havana interchange approach embankments. Post-Piney and Piney Creek Alluvium (Qpp and Qp) and Slocum Alluvium soil deposits are mapped to the south of the I-70 and Havana interchange and generally consist of sands, gravels, silts, clays, and minor amounts of cobbles and boulders deposited by existing and

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historic stream flows. Bedrock units are not mapped within the interchange area. However, based on information presented in the USGS geologic map and information obtained in the RockSol boreholes drilled for this investigation; the native soils are underlain by sedimentary bedrock of the Denver Formation, which consists of claystone, sandstone, siltstone, and conglomerate.

Subsurface Investigation

RockSol drilled 24 boreholes to evaluate the subsurface conditions for the interim construction portion of the I-70 Havana Bridge Replacement project in March 2013. The borehole locations are identified as BR-1 through BR-6, RW-1 through RW-10 and PV-1 through PV-8, as shown on Figures 2A and 2B, Borehole Location Plans. Boreholes BR-1 through BR-6 were drilled at the approximate location of the proposed bridge structure, Boreholes RW-1 through RW-10 were drilled to assist with retaining wall foundation recommendations, and Boreholes PV-1 through PV-8 were drilled to assist with pavement thickness recommendations. The boreholes were located by field survey provided by the project surveyor (HCL Engineering and Surveying). Horizontal and vertical locations were then provided to RockSol for inclusion on the Borehole Location Plan and on the borehole logs.

Truck mounted CME-45 and CME-55 drill rigs were used for drilling and sampling. The boreholes were advanced using 4-inch and 6-inch outside diameter solid stem augers and 8 inch outside diameter hollow stem augers to maximum depths ranging from approximately 10 feet to 90 feet below existing grades. The boreholes were logged in the field by a representative of RockSol with the depth to groundwater noted at the time of drilling. At Borehole RW-8, a monitoring well was installed for the project environmental team (Pinyon Environmental) and used by RockSol to measure the groundwater level subsequent to drilling operations. Except at Borehole RW-8, the boreholes were backfilled at the completion of drilling and groundwater level checks. Boreholes drilled within existing pavement were patched with concrete and/or asphalt patch mixes.

Subsurface materials were sampled using modified California barrel and standard split spoon samplers. The modified California barrel sampler has an outside diameter of approximately 2.5 inches and an inside diameter of 2 inches. The standard split spoon sampler used had an outside diameter of 2 inches and an inside diameter of 1⅜-inches. Brass tube liners are used with the modified California barrel sampler to retain samples for density, swell, and unconfined compressive strength testing. Sample retaining liners are not used with the standard split spoon sampler.

Penetration Tests were performed at selected intervals using both a standard rope-cathead lift system and an automatic lift system. Both hammer lift systems used a hammer weighing 140 pounds and falling 30 inches. The standard split spoon sampling method is the Standard Penetration Test (SPT) described by ASTM Method D-1586. Penetration Tests were performed using the modified California barrel sampler with a standard hammer weighing 140 pounds falling 30 inches per ASTM D3550.The modified California Barrel sampling method is similar to the SPT test with the difference being the sampler dimensions and the number of 6-inch intervals driven with the hammer. Correlation of blow counts obtained from a modified California sampler to blow counts obtained from a standard split spoon sampler is not available. However, it is RockSol's experience that blow counts obtained with the modified California sampler tend to be slightly greater than a standard split spoon sampler. Penetration resistance values (blow counts) were recorded for each sampling event. Blow counts, when properly evaluated, indicate the relative density or consistency of the soils. Depths at which the samples

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were taken, the type of sampler used, and the blow counts that were obtained are shown on the Boring Logs for each borehole.

Subsurface Conditions

Flexible pavement (asphalt) was encountered at the surface at fourteen borehole locations. Where flexible roadway pavement was encountered on I-70, the thickness generally ranged from 13 inches to 16 inches for mainline I-70 and 9 inches to 14 inches for the I-70 entrance and exit ramps for Havana.Measured thickness of the existing asphalt pavement ranged from 2 inches at the raised center median of Havana to 17 inches in Havana. At Borehole RW-1, approximately 6 inches of flexible asphalt was noted overlying 11 inches of rigid pavement. Aggregate base course material was not noted below the pavement sections.

Table 1 – Existing Pavement Thicknesses

Borehole	Location (FR = Frontage Road)	HMA Thickness (Inches)	PCCP Thickness (Inches) (Note 1)	Total Pavement Thickness (Inches)
BR-2	Center Median Havana	2	NE	2
BR-5	Havana Turn Lane to I-70	17	NE	17
BR-6	EB I-70 Lane 4, E of Havana	16	NE	16
PV-1	WB I-70 Lane 1, W of Havana	16	NE	16
PV-2	EB I-70 Shoulder, W of Havana	13	NE	13
PV-3	WB I-70 Lane 1, W of Havana	16	NE	16
PV-4	WB I-70 Lane 1, E of Havana	16	NE	16
PV-5	EB I-70 Lane 1, E of Havana	11.5	NE	11.5
PV-6	WB I-70 On-Ramp Lane 2	12	NE	12
PV-8	EB I-70 Off-Ramp Lane 2	13	NE	13
RW-1	WB I-70 Shoulder, W of Havana	6	11	17
RW-2	EB I-70 Shoulder, W of Havana	16	NE	16
RW-3	WB I-70 Lane 1, W of Havana	16	NE	16
RW-4	WB I-70 On-Ramp Shoulder	9	NE	9

Note 1: NE = Not Encountered

A summary of the pavement thickness measured from recovered cores is presented in Appendix A, Pavement Core Log Summary. Included in the core logs are photographs of the recovered core sections and RockSol's general assessment of the condition of each core.

Topsoil was encountered at the ground surface at nine borehole locations. The topsoil encountered was lightly organic silty to clayey sand which supported a sparse covering of grasses and weeds. A topsoil thickness of approximately 3 inches to 6 inches was estimated based on field observations.

Beneath the pavement and topsoil, subsurface conditions encountered generally consisted of fill material to approximate depths ranging from 2 feet to 28 feet below existing grades and appears to be associated with the roadway embankment for I-70 over Havana and the interchange entrance and exit ramps. The fill material generally consisted of medium dense to very dense silty sand with sandy clay and gravel in parts, stiff to very stiff sandy clay with silty to clayey sand in parts, medium dense to dense clayey sand with sandy clay in parts, and loose to medium dense silty to clayey sand. Based on laboratory test results, the upper 5 feet of embankment fill material predominantly classified as A-2-4(0) silty sand soils. A-1-b, A-2-6, and A-6 soils were also encountered in the upper 5 feet of the embankment fill materials. Where

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tested, AASHTO soil classifications of the upper 5 feet of embankment soil are indicated on the Borehole Location Plans, Sheets 2A and 2B.

Native soils encountered included loose to very dense silty sand with clay and gravel in parts, stiff to hard sandy clay with silty to clayey sand in parts, medium dense to dense clayey sand with sandy clay in parts, and loose to medium dense silty to clayey sand.

Sedimentary bedrock was encountered beneath the native soils in Boreholes BR-1 through BR-6 at elevations ranging from 5,211 feet to 5,230 feet (approximate depths ranging from 49 feet to 84 feet below existing grades) during drilling operations. The bedrock generally consisted of claystone. Bedrock was not noted to the maximum depths drilled (approximately 10 feet) at Boreholes PV-1 through PV-8. Bedrock was also not encountered in Boreholes RW-1 through RW-10.

Groundwater was encountered in 16 boreholes at elevations ranging from 5,251 feet to 5,265 feet (approximate depths ranging from 20 feet to 49 feet below existing grades) during drilling operations. Groundwater was also measured at an approximate depth of 23.2 feet in the monitoring well installed at Borehole RW-8 subsequent to drilling operations. Groundwater was not encountered to the maximum depths drilled (approximately 10 feet below existing grades) at Boreholes PV-1 through PV-8.

A summary of the bedrock and groundwater elevations encountered is presented in Table 2. The approximate groundwater and bedrock elevations are based on the depth to groundwater and bedrock noted during drilling and sampling operations (except at Borehole RW-8), and the ground surface elevations provided by the project surveyor.

Based on the groundwater elevations presented in Table 2, there appears to be a decreasing gradient to the northwest. Based on the bedrock elevations presented in Table 2, the bedrock surface elevation appears to be decreasing in the northwest direction.

Table 2 – Approximate Groundwater and Bedrock Elevations

Borehole	Ground Elevation (feet)	Groundwater Elevation (feet)	Bedrock Elevation (feet)
BR-1	5,275.0	5,251	5,211
BR-2	5,287.6	5,258	5,220
BR-3	5,282.9	5,260	5,226
BR-4	5,279.1	5,258	5,230
BR-5	5,287.7	5,255	5,227
BR-6	5,308.0	5,259	5,224
RW-1	5,300.6	5,254	NE
RW-2	5,302.4	5,255	NE
RW-3	5,305.3	5,259	NE
RW-4	5,307.9	5,261	NE
RW-5	5,281.8	5,262	NE
RW-6	5,291.6	5,264.6	NE
RW-7	5,290.4	5,261.5	NE
RW-8	5,287.9	5,265	NE
RW-9	5,293.4	5265.4	NE
RW-10	5,287.5	5,264.5	NE

Note: NE indicates not encountered.

Individual logs are included in Appendix B. A summary of laboratory test results is presented in Appendix C.

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Expansive Soil Discussion

Swell potential in the subgrade soils obtained within the upper 5 feet below existing grades ranged from -0.5 percent (consolidation) to 0.4 percent (swell), when tested with a 200 pound per square foot (psf) surcharge. Swell potential in the subgrade soils obtained at a greater than 5 feet below existing grades ranged from -3.2 percent (consolidation) to 2.2 percent (swell), when tested with a 200-psf to 1,000-psf surcharge.

Based on the swell test data, the subgrade soils appear to possess a low swell potential and low consolidation potential. Special earthwork requirements for mitigation of expansive soils are not anticipated for this project.

Cement Type Discussion

Cementitious material requirements for concrete in contact with site soils or groundwater are based on the percentage of water soluble sulfate in either soil or groundwater that will be in contact with concrete constructed for this project. Mix design requirements for concrete exposed to water soluble sulfates in soils or water is considered by CDOT as shown in Table 3 and in the Standard Specifications for Road and Bridge Construction, dated 2011 (CDOT Table 601-2).

Table 3
Requirements to Protect Against Damage to Concrete by Sulfate Attack from External Sources of Sulfate

Severity of sulfate exposure	Water-soluble sulfate (SO_4), in dry soil, percent	Sulfate (SO_4), in water, ppm	Water Cementitious Ratio, maximum	Cementitious Material Requirements
Class 0	0.00 to 0.10	0 to 150	0.45	Class 0
Class 1	0.11 to 0.20	151 to 1,500	0.45	Class 1
Class 2	0.21 to 2.0	1,500 to 10,000	0.45	Class 2
Class 3	2.01 or greater	10,001 or greater	0.40	Class 3

The concentration of water soluble sulfates measured in 40 soil samples obtained from RockSol's exploratory boreholes was less than 0.1 percent by weight. One sample obtained at Borehole RW-6 indicated a water soluble sulfate concentration of 0.27 percent by weight. Water soluble sulfate was also measured in a groundwater sample obtained from Borehole RW-8 and indicated a concentration of 71.8 parts per million (ppm). Based on the results of the water soluble sulfate testing, Exposure Class 0 is considered appropriate for concrete in contact with subgrade materials for the interim construction phase of the project. Additional testing is recommended for future phases of the ultimate design.

Subgrade Support Discussion

R-Value tests were performed on samples of A-4 soil (Borehole PV-1), A-2-4 soil (Borehole PV-5), A-6 soil (Borehole PV-6), and on A-2-6 soil (Borehole PV-7) with R-Value results ranging from 14 to 63. A summary of the R-Value tests is shown in Table 4. All samples tested were obtained within the upper 5 feet of the existing ground surface.

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Table 4
Subgrade Soil R-Value Test Summary

Borehole	AASHTO Classification	R-Value
PV-1	A-4 (0)	18
PV-5	A-2-4 (0)	63
PV-6	A-6 (2)	15
PV-7	A-2-6(2)	14

Based on the results of the R-Value testing and subgrade soil classification testing, RockSol considers the existing subgrade soils in the project area to generally possess an R-Value of at least 15 for preliminary design purposes.

Two proctor tests (AASHTO T180) were performed on bulk samples of subgrade soils obtained within the upper five feet of existing grades from Boreholes BR-3 and BR-6. The samples classified as A-2-4 (0) and A-1-b (0) soils with maximum dry densities (MDD) of 130.5 pounds per cubic foot (pcf) and 126.2 pcf with optimum moisture contents (OMC) of 8.0 percent and 7.5 percent.

Pavement Thickness Recommendations

Traffic volumes (average daily traffic) for I-70 within the project limits and the ramps to and from Havana were provided to RockSol by Parsons. The average daily traffic for mainline I-70 was taken from the Draft Environmental Impact Study for the subject project and included 2012 (current) data. Forecast data for the year 2030 was taken from the CDOT OTIS system. Percent trucks accounted for approximately 8.5 percent of the traffic volume with single unit trucks approximately 4 percent and combination trucks approximately 4.5 percent. A summary of the traffic data provided is included in Appendix D.

Design life ESAL's are based on a project completion year of 2015. A design life of twenty years was used for flexible pavement on mainline I-70. A design life of thirty years was used for rigid pavement on mainline I-70. For the ramps to and from Havana, design life values of 5, 10, and 20 years were considered. The various design life values for the ramps were considered as the ramps will be reconstructed in the ultimate build-out phase, but the year that will be completed is not finalized. ESAL calculation sheets for the various roadways are included in Appendix D.

Pavement thicknesses were calculated using the AASHTOWare DARWin Pavement Design and Analysis System, Version 3.1 for flexible pavement and the NCHRP rigid pavement design supplemental spreadsheet software, based on the 1998 AASHTO Supplemental Guide for rigid pavement. Structural coefficients of 0.15 and 0.44 were used for CDOT Class 6 aggregate base course and hot mix asphalt, respectively, when developing flexible pavement thickness recommendations. Elastic modulus values of 25,000 psi and 3,400,000 psi were used for CDOT Class 6 aggregate base course and portland cement concrete, respectively, when developing rigid pavement thickness recommendations. A Reliability Level of 95 percent was used for the subject roadway.

All pavement thicknesses presented are to be placed on top of 6 inches of Colorado Department of Transportation (CDOT) Class 6 Aggregate Base Course (ABC) since the design life ESAL values are greater than 500,000.

New pavement for mainline I-70 and the interim condition ramps will be constructed on new embankment. RockSol recommends that the top two feet of embankment beneath pavement consist of material with an R-Value of at least 20, exhibit less than 1 percent swell when tested with a 200 psf surcharge, and meet stability requirements of Colorado Procedure CP-L 3102.

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Preliminary pavement thickness recommendations for mainline I-70 and ramps are presented in Table 5:

Table 5 – Preliminary Pavement Thickness Recommendations (Note 1)

Street	Pavement Type	Design Life (years)	Design Lane 18k ESALs	Recommended Pavement Thickness, inches
				Subgrade R-Value = 20
I-70 Mainline West of Havana	Flexible	20	26,600,000	13.0
	Rigid	30	62,300,000	13.5
I-70 Mainline East of Havana	Flexible	20	27,800,000	13.0
	Rigid	30	65,700,000	13.5
EB I-70 Off Ramp to Havana	Flexible	5	1,300,000	8.0
	Flexible	10	2,900,000	9.0
	Flexible	20	5,750,000	10.0
EB I-70 On Ramp from Havana	Flexible	5	850,000	7.5
	Flexible	10	1,800,000	8.5
	Flexible	20	3,600,000	9.5
WB I-70 Off Ramp to Havana	Flexible	5	950,000	7.5
	Flexible	10	2,000,000	8.5
	Flexible	20	4,200,000	9.5
WB I-70 On Ramp from Havana	Flexible	5	1,500,000	8.0
	Flexible	10	3,100,000	9.0
	Flexible	20	6,350,000	10.5

Note 1) Pavement sections placed on 6 inches of CDOT Class 6 ABC.

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The recommended flexible pavement thickness values presented in Table 1 are rounded up to the nearest ½-inch, per CDOT methodology. Recommended pavement thickness values for rigid pavement shown in Table 1 include a ¼-inch thickness added to the calculated thickness and then rounded up to the nearest ½-inch, per CDOT methodology. Pavement thickness calculation sheets from DARWin (flexible pavement) and the 1998 AASHTO Supplement (rigid pavement) are included in Appendix E.

All flexible pavements will be Hot Mix Asphalt (HMA) using CDOT approved mix designs. RockSol recommends using Grade SX or SMA mix for the surface layer and Grade S mix for the lower (intermediate and base) layers. A gyratory design revolution (Ndes) of 100 is recommended. Performance Grade Binder of PG 76-28 is recommended for the surface layer

(Grade SX or SMA mix). Performance Grade Binder of PG 64-22 is recommended for the intermediate and base layers (Grade S mix).

Pavement lifts (from surface to bottom) of 3 inches of SX (or SMA) mix for the surface layer, 3.25 inches and 3.25 inches of S mix for the intermediate layers, and 3.5 inches of S mix for the base layer are suggested for the 13 inch section on I-70.

The contractor may choose alternative layer thicknesses to those shown above, however, the layer thicknesses must conform to the minimum and maximum layer thicknesses presented in Table 3.7 of the 2013 CDOT Pavement Design Manual, or the Manual designated at the time of bidding.

Subgrade Preparation (New Pavement)

For all new pavement areas, proof rolling with pneumatic tire equipment shall be performed using a minimum axle load of 18 kips per axle after specified subgrade compaction has been obtained. Areas found to be weak and those areas which exhibit soft spots, non-uniform deflection or excessive deflection as determined by the project engineer shall be ripped, scarified, wetted or dried if necessary, and re-compacted to the requirements for density and moisture. Complete coverage of the proof roller will be required.

All pavement subgrade preparation, pavement materials, and pavement construction shall conform to CDOT Standard Specifications for Road and Bridge Construction (2011). At a minimum, subgrade moisture conditioning and compaction should meet the compaction specifications outlined in Table 6.

Table 6 –Compaction Specifications

AASHTO Classification	Minimum Relative Compaction (Percentage of MDD), %	Moisture Content (Deviation from OMC)
A-1, A-2-4, A-2-5, A-3,	95% of AASHTO T99	-2 to +2
A-2-6, A-2-7, A-4, A-5 A-6 and A-7	95% of AASHTO T99	0 to +3

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Limitations

This geotechnical field investigation and laboratory results were conducted in general accordance with the scope of work. The testing was performed to provide preliminary design level information. Additional testing is suggested for final design. The geotechnical practices are similar to that used in the Colorado Front Range area with similar soil conditions and our understanding of the proposed work. This report has been prepared by RockSol for use by Parsons for the I-70 Havana Bridge Replacement – Preliminary Engineering and Procurement project. RockSol understands that additional boreholes and geotechnical evaluation will be performed for the final design phase. The information presented is based on our exploratory boreholes and does not take into account variations in the subsurface conditions that may exist between boreholes. Additional investigation is required to address such variation. RockSol is not responsible for liability associated with interpretation of subsurface data by others.

Prepared by RockSol Consulting Group, Inc.:

Jacob Biller, E.I.
Staff Engineer

Donald G. Hunt, P.E.
Senior Geotechnical Engineer

Attachments:

Figure 1 - Site Vicinity Map
Figure 2 - Borehole Location Plan

Appendix A – Pavement Core Log Summary
Appendix B – Legend and Individual Borehole Logs
Appendix C – Laboratory Test Results
Appendix D – Traffic Loading and ESAL Calculation Summary Sheets
Appendix E – Flexible and Rigid Pavement Calculation Sheets

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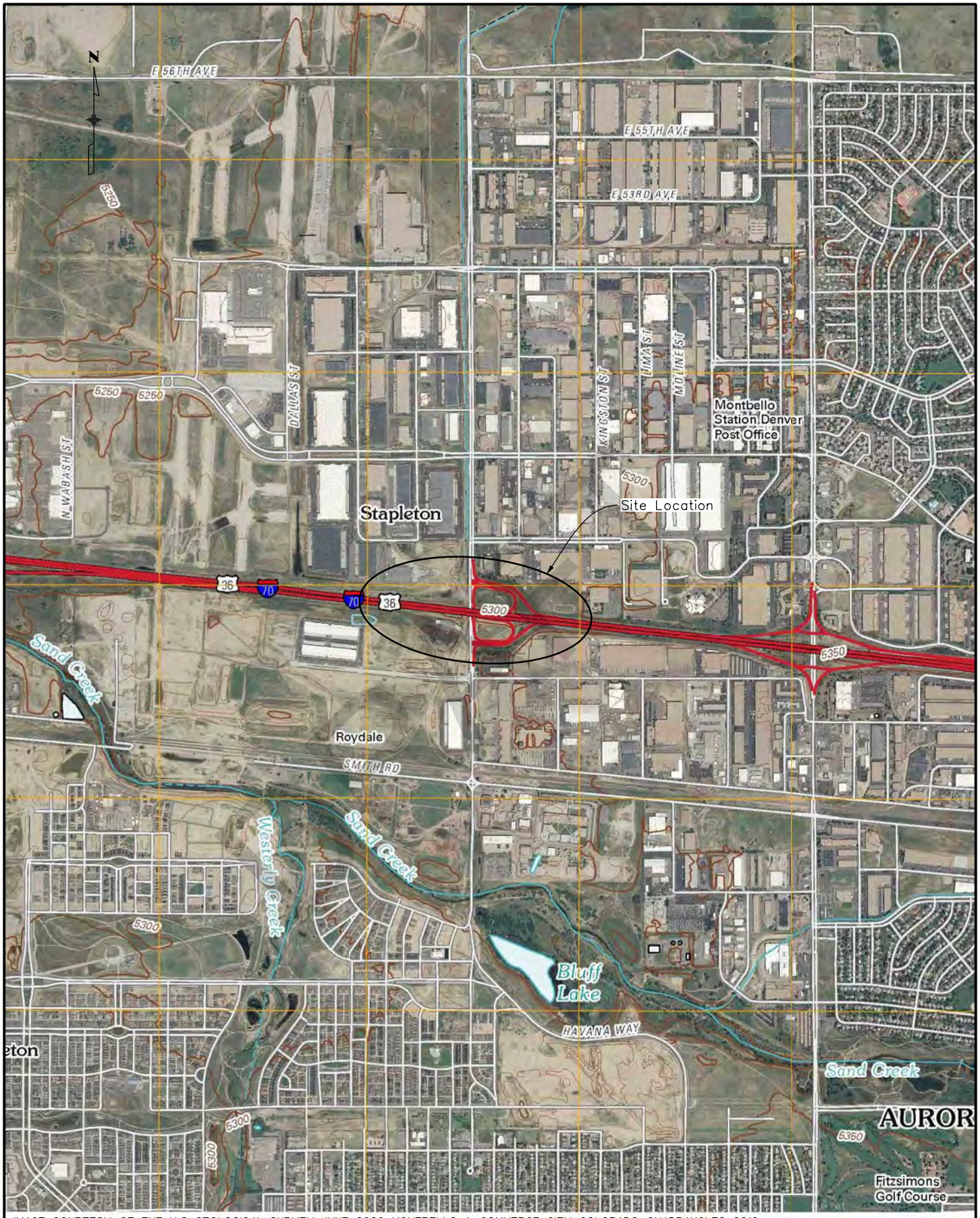

IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY, JUNE 2009, MONTBELLO & COMMERCE CITY, COLORADO QUADRANGLES, 2010

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		13599 (CN)
		Figure 1

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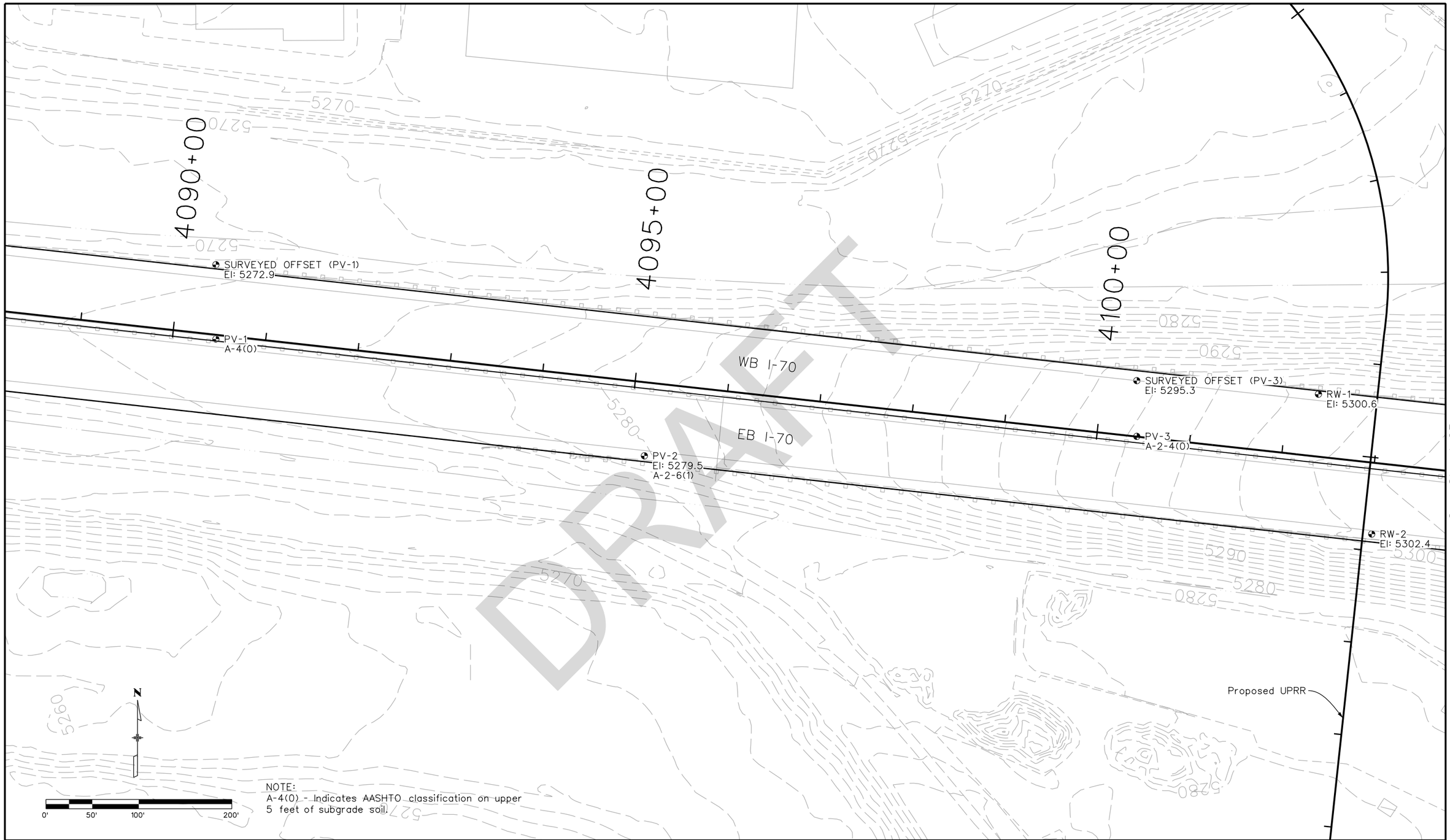

Print Date: 5/28/2013			
File Name: 19339 F2A BoreLocation.dgn			
Horiz. Scale: 1:100	Vert. Scale: As Noted		
Unit Information	Unit Leader Initials		
RockSol Consulting Group, Inc.	6510 W 91st Ave, Ste 130 Westminster, CO 80031	Ph: 303-962-9300 Fax: 303-962-9350	

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Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation

DOT DEPARTMENT OF TRANSPORTATION

2000 S. Holly St.
Denver, CO 80222
Phone: 303-512-4272 FAX: 303-757-9886

Region 1 DK

As Constructed
No Revisions:
Revised:
Void:

I-70 OVER HAVANA STREET
DESIGN BUILD
BOREHOLE LOCATION PLAN

Designer:	D. Hunt	Structure Numbers	
Detailer:	D. Knight		
Sheet Subset:		Subset Sheets:	of

Project No./Code
FBR 0704-230
19339 (CN)
Figure Number 2A

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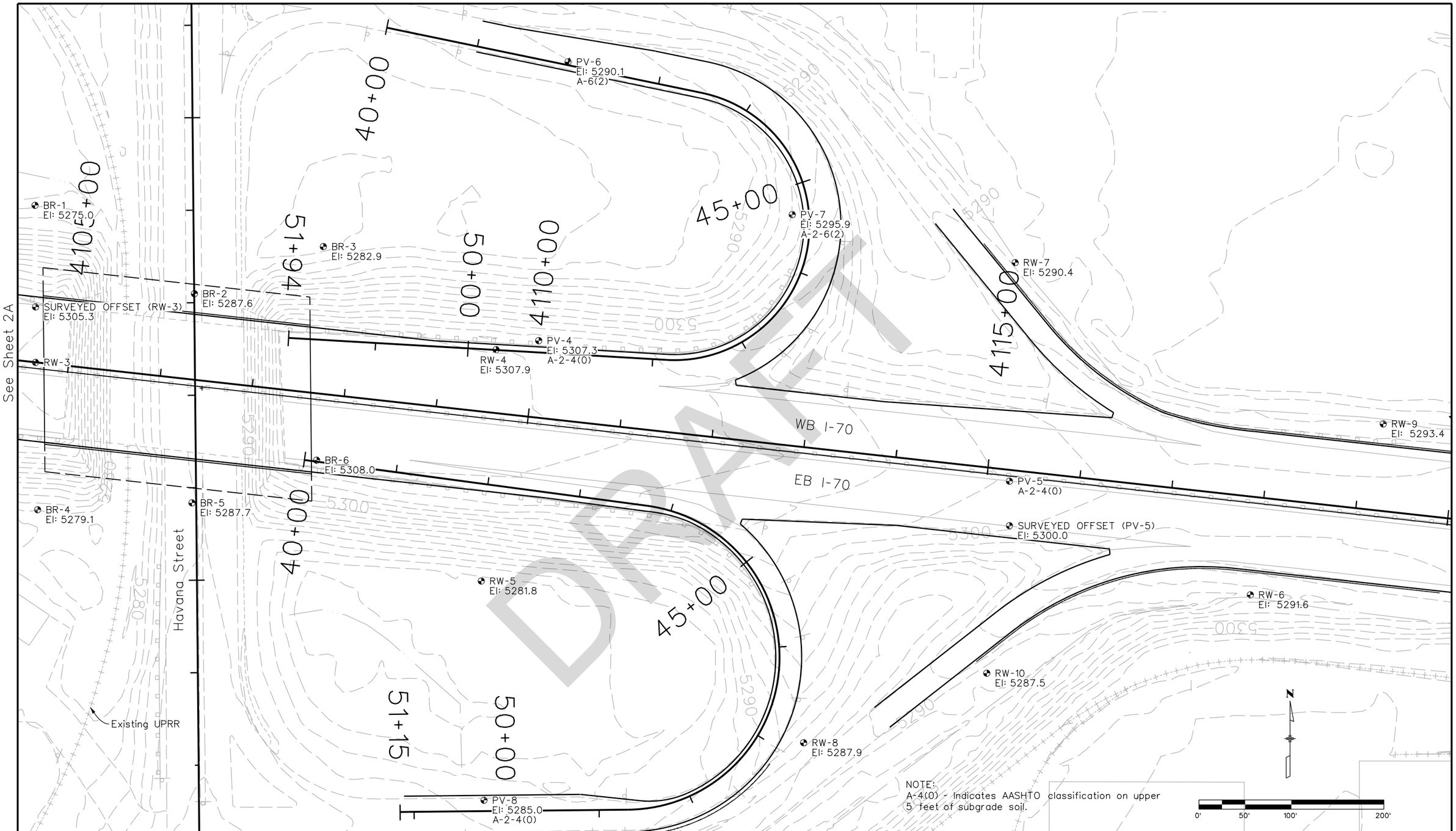

NOTE:
A-4(0) - Indicates AASHTO classification on upper 5 feet of subgrade soil.

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Print Date: 5/29/2013
File Name: 19339 F2B BoreLocation.dgn
Horiz. Scale: 1:100 Vert. Scale: As Noted
Unit Information Unit Leader Initials

RockSol Consulting Group, Inc.
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Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation
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Region 1 DK

As Constructed
No Revisions:
Revised:
Void:

I-70 OVER HAVANA STREET
DESIGN BUILD
BOREHOLE LOCATION PLAN

Designer: D. Hunt
Detailer: D. Knight
Structure Numbers
Sheet Subset:
Subset Sheets: of

Project No./Code
FBR 0704-230
19339 (CN)
Figure Number 2B

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APPENDIX A

PAVEMENT CORE LOG SUMMARY

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BR-5, SB Havana Turn lane to East Bound I-70 On Ramp, 45 feet south of I-70 Bridge

Pavement Thickness: 17 inches
Number of Identifiable HMA Layers:

1. Upper 6.5 inches, layers unidentifiable, upper core layers were chipped out by coring company during coring to facilitate core removal.
2. 2.5 inches
3. 4.0 inches
4. 4.0 inches

Depth of Concrete Pavement: None Encountered
Condition of Asphalt: Good
Condition of Concrete: N/A
Comments: Minimal raveling and loss of fines

BR-6, EB I-70 Lane 5, 35 feet east of I-70 Bridge

Pavement Thickness: 16 inches
Number of Identifiable HMA Layers:

1. Upper 6.0 inches, layers unidentifiable, upper core layers were chipped out by coring company during coring to facilitate core removal.
2. 2.0 inches
3. 4.75 inches
4. 3.25 inches

Depth of Concrete Pavement: None Encountered
Condition of Asphalt: Good
Condition of Concrete: N/A
Comments: Minimal raveling and loss of fines

DRAFT

PV-1, WB I-70 Lane 1, 1500 feet west of I-70 Bridge

Core Length: 16 inches
Number of Identifiable HMA Layers:

1. 2.25 inches
2. 4.75 inches
3. 2.25 inches
4. 6.75 inches (Layer delineation not clear)

Depth of Concrete Pavement: None Encountered
Condition of Asphalt: Good to Fair
Condition of Concrete: N/A
Comments: No major raveling or loss of fines, debonding between layers 2 and 3

PV-2, EB I-70 Shoulder, 1000 feet west of I-70 Bridge

Core Length: 13 inches
Number of Identifiable HMA Layers:

1. 2.25 inches
2. 2.0 inches
3. 3.0 inches
4. 3.0 inches
5. 3.0 inches

Depth of Concrete Pavement: None Encountered
Condition of Asphalt: Good
Condition of Concrete: N/A
Comments: No major loss of fines or raveling

DRAFT

PV-3, WB I-70 Lane 1, 450 feet west of I-70 Bridge	
	Pavement Thickness: 16 inches Recovered Core Length: 15.75 inches Number of Identifiable HMA Layers: 1. 2.5 inches 2. 1.75 inches 3. 2.0 inches 4. 1.0 inches 5. 2.0 inches 6. 2.5 inches 7. 4.0 inches Depth of Concrete Pavement: None Encountered Condition of Asphalt: Fair Condition of Concrete: N/A Comments: Minor loss of fines noted, minor raveling at debonding between layer 2 and 3

PV-4, WB I-70 Lane 1, 275 feet east of I-70 Bridge	
	Core Length: 16 inches Number of Identifiable HMA Layers: 1. 2.25 inches 2. 1.75 inches 3. 2.75 inches 4. 2.5 inches 5. 2.75 inches 6. 1.75 inches 7. 2.25 inches Depth of Concrete Pavement: None Encountered Condition of Asphalt: Fair Condition of Concrete: N/A Comments: Minor loss of fines and raveling at debonding between layers 2 and 3

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PV-5, EB I-70 Lane 1, 775 feet east of I-70

Core Length: 11.5 inches
Number of Identifiable HMA Layers:

1. 2.5 inches
2. 2.25 inches
3. 2.25 inches
4. 1.75 inches
5. 2.75 inches

Depth of Concrete Pavement: None Encountered
Condition of Asphalt: Good
Condition of Concrete: N/A
Comments: minor loss of fines in layers 3 and 4 no visible signs of raveling

PV-6, WB I-70 On-Ramp, 360 feet from intersection with Havana

Pavement Thickness: 12 inches
Recovered Core Length: 11 inches
Number of Identifiable HMA Layers:

1. 1.75 inches
2. 1.25 inches
3. 3.0 inches
4. 2.25 inches
5. 2.75 inches

Depth of Concrete Pavement: None Encountered
Condition of Asphalt: Good
Condition of Concrete: N/A
Comments: No visible loss of fines or raveling

DRAFT

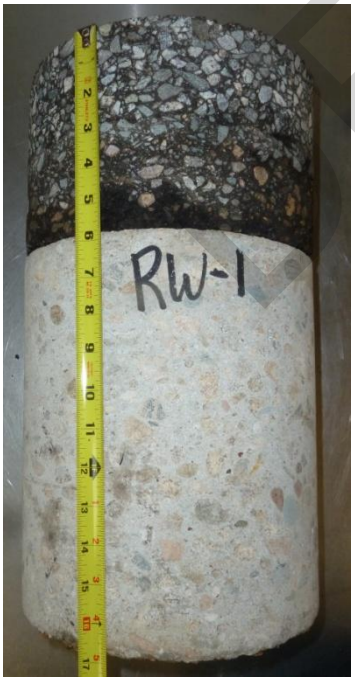
PV-8, WB I-70 Off-Ramp, 270 feet from intersection with Havana

Core Length: 13 inches
Number of Identifiable HMA Layers:

1. 2.5 inches
2. 2.0 inches
3. 3.0 inches
4. 3.0 inches
5. 2.5 inches

Depth of Concrete Pavement: None Encountered
Condition of Asphalt: Good
Condition of Concrete: N/A
Comments: No visible loss of fines or raveling

RW-1, WB I-70 Shoulder, 240 feet west of I-70 Bridge



Depth of Asphalt Overlay: 6 inches
Number of Identifiable HMA Layers:

1. 2.5 inches
2. 2.0 inches
3. 1.5 inches

Depth of Concrete Pavement: 11 inches
Condition of Asphalt Overlay: Good
Condition of Concrete: Good
Comments: No loss of fines or raveling noted, debonding result of core removal

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RW-2, EB Shoulder, 200 feet west of I-70 Bridge

Pavement Thickness: 16 inches
Recovered Core Length: 14 inches
Number of Identifiable HMA Layers:

1. 2.5 inches
2. 2.0 inches
3. 3.75 inches
4. 2.75 inches
5. 3.0 inches

Depth of Concrete Pavement: None Encountered
Condition of Asphalt: Good
Condition of Concrete: N/A
Comments: No visible signs of raveling or loss of fines

RW-3, WB I-70 lane 1, 20 feet west of I-70 Bridge

Pavement Thickness: 16 inches
Recovered Core Length: 13.5 inches
Number of Identifiable HMA Layers:

1. 2.25 inches
2. 3.0 inches
3. 3.0 inches
4. 2.25 inches
5. 3.0 inches

Depth of Concrete Pavement: None Encountered
Condition of Asphalt: Good to Fair
Condition of Concrete: N/A
Comments: No visible loss of fines, slight raveling at bottom.

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RW-4, WB I-70 Lane 5, 210 feet east of I-70 Bridge

Core Length: 9 Inches

Number of Identifiable HMA Layers:

1. 2.5 inches
2. 2.5 inches
3. 2 inches
4. 2 inches

Depth of Concrete Pavement: None Encountered

Condition of Asphalt: Good

Condition of Concrete: N/A

Comments: No visible signs of raveling or loss of fines

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APPENDIX B

LEGEND
AND
INDIVIDUAL BOREHOLE LOGS

B-1 through B-6, RW-1 through RW-10, and PV-1 through PV-8

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LEGEND

CLIENT Parsons

PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01

PROJECT LOCATION Havana and I-70/Denver, CO

LITHOLOGY

- Asphalt Pavement
- Concrete
- Fill - CLAY
- Fill - SAND
- Fill - SAND
- Native - TOPSOIL
- Native - SAND, silty
- Native - SAND, clayey
- Native - CLAY, sandy
- Bedrock - CLAYSTONE
- Bedrock - SANDSTONE
- Bedrock - SILTSTONE

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SAMPLE TYPE

MODIFIED CALIFORNIA SAMPLER
2.5" O.D. AND 2" I.D.
WITH BRASS LINERS INCLUDED

SPLIT SPOON SAMPLER
2" O.D. AND 1 3/8" I.D.
NO LINERS

15/12 Indicates 15 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 12 inches.

50/11 Indicates 50 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 11 inches.

5,5,5 Indicates 5 blows, 5 blows, 5 blows of a 140 pound hammer falling 30 inches was required to drive the sampler 18 inches.

GROUND WATER LEVEL NOTED AT THE TIME OF DRILLING

BORING : BR-1

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/8/13 **COMPLETED** 3/8/13
GROUND ELEVATION 5275.0 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454685.8 **EAST** 679028.2
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8"
BORING LOCATION: Northwest quadrant of, I-70 and Havana
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer
WATER DEPTH 24.0 ft on 3/8/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5275	0		(Topsoil) SAND, silty, very moist, light brown, loose										
			(Native) SAND, silty, moist, light brown, medium dense										
5270	5			MC	23/12			106.1	10.0				
5265	10			MC	18/12			105.1	13.2	NP	NP	NP	28.4
5260	15			MC	14/12			98.9	26.3				
			(Native) CLAY, sandy, very moist, light brown, stiff										
5255	20			MC	13/12	-0.1	0.02	103.8	22.8	51	18	33	54.7
			(Native) SAND, silty, trace gravel, wet, light brown, medium dense										
5250	25			MC	21/12			114.9	18.2				
5245	30		(Native) CLAY, sandy, very moist to wet, light brown, very stiff	MC	24/12	1.9	0.01	93.8	30.6	74	25	49	93.3
			(Native) SAND, silty, clayey in parts, wet, light brown, loose to dense										
5240	35			SS	7/15/20				23.1				

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CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
			(Native) SAND, silty, clayey in parts, wet, light brown, loose to dense *(continued)*										
5235	40												
				SS	13/15/17				17.5	NP	NP	NP	10.0
5230	45												
				SS	2/3/5				23.9				
5225	50												
				SS	8/9/10				24.4	29	16	13	32.0
5220	55												
				SS	7/8/10				27.2				
5215	60												
				SS	18/20/25				17.7				
5210	65		(Bedrock) CLAYSTONE, slightly moist, light olive grey to grey, very hard	SS	50/6		0.01		44.9	95	22	73	86.1
5205	70			MC	50/6			93.0	30.0				
5200	75			MC	50/3			99.8	24.9				
5195	80			MC	50/4			98.9	26.1				
			Bottom of hole at 80.3 feet.										

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BORING : BR-2

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/1/13 **COMPLETED** 3/1/13
GROUND ELEVATION 5287.6 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454590.2 **EAST** 6790200.6
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8"
BORING LOCATION: Center median on Havana, north of I-70
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer
WATER DEPTH 30.0 ft on 3/1/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5288	0		Asphalt Pavement, approximately 2"										
			(Fill) SAND, moist, light brown, medium dense										
			(Native) SAND, silty with trace clay, moist, brown, medium dense										
5283	5			MC	14/12			118.1	13.3	NP	NP	NP	26.8
			(Native) SAND, clayey, grading to sandy CLAY in parts, moist, light brown to brown, medium dense										
5278	10			MC	12/12			116.1	14.2	29	14	15	52.3
5273	15			MC	16/12			107.5	14.1				
			(Native) CLAY, sandy, grading to clayey SAND in parts, moist to wet, light brown, stiff to hard										
5268	20			MC	20/12		0.00	106.1	18.8	31	15	16	45.6
5263	25			MC	20/12			104.3	22.0				
5258	30		▼	MC	15/12			118.4	17.1				
5253	35			SS	6/7/8		0.00		28.1	63	15	48	75.1

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RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5248	40		(Native) CLAY, sandy, grading to clayey SAND in parts, moist to wet, light brown, stiff to hard *(continued)*										
				SS	6/14/17				22.3				
5243	45		(Native) SAND, silty with clay in parts, wet, light brown, medium dense to dense										
				SS	9/12/17				15.9				
5238	50												
				SS	9/18/10				17.2				
5233	55												
				SS	10/13/18				20.8				
5228	60												
				SS	11/11/11				20.9				
5223	65												
				MC	38/12				26.7				33.9
5218	70		(Bedrock) SANDSTONE, clayey, moist, light brown, very hard										
				SS	50/5				28.9				
5213	75												
				MC	50/2		0.00		23.0				40.3
5208	80		(Bedrock) SILTSTONE, with sand, moist, light grey, very hard										
				SS	50/6				38.1	79	39	40	80.0
			Bottom of hole at 80.5 feet.										

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BORING : BR-3

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 2/22/13 **COMPLETED** 2/22/13
GROUND ELEVATION 5282.9 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454641.2 **EAST** 679339.9
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8"
BORING LOCATION: Northeast quadrant of I-70 and Havana
LOGGED BY H. Ochoa
GROUND WATER LEVELS:
NOTES Manual Hammer
WATER DEPTH 23.0 ft on 2/22/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5283	0		(Topsoil) SAND, silty, wet, brown, loose, approximately 6"				0.08			NP	NP	NP	23.2
			(Fill) SAND, silty, moist, brown, medium dense										
			(Native) SAND, silty clayey in parts, moist, reddish brown, medium dense to dense										
5278	5			MC	15/12			121.8	11.7				
5273	10			MC	23/12			103.5	2.2				
5268	15			MC	19/12			112.5	15.4				
5263	20			MC	32/12			111.0	19.1	27	20	7	26.0
5258	25			MC	20/12			100.6	27.0				
5253	30		(Native) CLAY, sandy, very moist to wet, brown to reddish brown, stiff to very stiff	SS	5/6/7				30.1	72	21	51	88.1
5248	35			SS	7/9/11		0.04		24.1				
5243	40		(Native) SAND, with silt to silty, very moist to wet, brown, medium dense to dense										

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RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5243	40		(Native) SAND, with silt to silty, very moist to wet, brown, medium dense to dense *(continued)*	SS	12/20/27				14.6	NP	NP	NP	8.1
5238	45			MC	20/12								
			(Native) CLAY, sandy, very moist to wet, brown, very stiff										
5233	50			SS	7/11/16				25.7	34	18	16	43.8
5228	55			SS	7/10/11				27.1				
			(Bedrock) CLAYSTONE, with sand in parts, moist, brown to grey, very hard										
5223	60			MC	50/5			89.3	32.9	69	31	38	66.4
5218	65			MC	50/6			97.0	29.5				
5213	70			MC	50/3		0.00	98.6	25.9				
5208	75			MC	50/3			95.2	27.6				
			Bottom of hole at 75.3 feet.										

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BORING : BR-4

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 2/21/13 **COMPLETED** 2/21/13
GROUND ELEVATION 5279.1 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454356.7 **EAST** 679031.0
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8"
BORING LOCATION: Southwest quadrant of I-70 and Havana
LOGGED BY H. Ochoa
GROUND WATER LEVELS:
NOTES Manual Hammer/Bottom of Embankment
WATER DEPTH 21.0 ft on 2/21/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5279	0		(Topsoil) SAND, silty, with weeds at ground surface										
			(Fill) SAND, silty with clay, slightly moist, light brown, dense										
5274	5			MC	36/12			122.1	5.2	22	16	6	47.5
			(Native) SAND, silty with trace clay, slightly moist, light brown, medium dense										
5269	10			MC	24/12			103.5	6.3	NP	NP	NP	34.4
			(Native) SAND, clayey, moist, brown, medium dense										
5264	15			MC	16/12			107.8	18.7				
			(Native) CLAY, sandy, moist, brown, very stiff										
5259	20			MC	17/12			108.4	21.3	32	15	17	56.1
5254	25		(Native) SAND, silty with trace clay, wet, brown, medium dense	MC	16/12		0.01	103.3	22.6				
5249	30			MC	25/12			110.4	20.1	28	23	5	31.7
5244	35												

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RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5244	35		(Native) SAND, silty with trace clay, wet, brown, medium dense *(continued)*	SS	7/12/21				20.7	NP	NP	NP	27.1
5239	40			SS	14/14/14				16.3				
			(Native) CLAY, sandy, very moist to wet, brown, very stiff										
5234	45			SS	10/11/15				25.8				50.3
5229	50		(Bedrock) SANDSTONE (weathered), clayey, very moist to wet, brown, hard	SS	11/20/26				35.2				
5224	55		(Bedrock) SANDSTONE, silty to clayey, slightly moist to very moist, brown, very hard	MC	50/6			96.4	28.2	57	30	27	48.9
5219	60		(Bedrock) CLAYSTONE, sandy in parts, SILTSTONE in parts, slightly moist to very moist, gray, very hard	MC	50/8			117.7	27.6	57	26	31	97.2
5214	65			MC	50/6		0.00	94.7	27.1				
5209	70			MC	50/5			89.3	32.6				
			Bottom of hole at 70.5 feet.										

DRAFT

BORING : BR-5

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 2/28/13 **COMPLETED** 2/28/13
GROUND ELEVATION 5287.7 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454364.1 **EAST** 679197.9
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8"
BORING LOCATION: South bound Havana, East bound turn lane, south of I-70
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer
WATER DEPTH 33.0 ft on 2/28/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5288	0		Asphalt Pavement, approximately 17"										
			(Fill) SAND, slightly silty to silty approximately 12"										
			(Native) SAND, silty, clayey in parts, moist, light brown, dense										
5283	5			MC	40/12			119.1	9.1	NP	NP	NP	21.8
5278	10		(Native) SAND, clayey, moist, brown, medium dense	MC	12/12		0.00	121.0	11.6				
5273	15		(Native) CLAY, sandy, moist, brown to reddish brown, stiff to very stiff	SS	7/7/9				18.6	49	13	36	55.7
5268	20		(Native) CLAY, sandy, moist, brown, very stiff	MC	18/12			109.0	18.0				
5263	25		(Native) CLAY, sandy, moist, brown, stiff	MC	9/12			98.2	26.0	44	16	28	55.7
5258	30		(Native) SAND, silty, clayey in parts, very moist to wet, reddish brown, medium dense	MC	13/12			106.5	18.9				
5253	35			SS	4/8/6				19.2				
5248	40												

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RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5248	40		(Native) SAND, silty, clayey in parts, very moist to wet, reddish brown, medium dense *(continued)*	SS	4/6/8				24.7	30	14	16	40.6
5243	45			SS	11/19/30				17.1				
5238	50			SS	9/11/11				17.9				
5233	55			SS	5/1/3				26.1				
5228	60			SS	50/5				33.3				
			(Bedrock) CLAYSTONE, sandy in parts, moist, brown, very hard										
5223	65			MC	50/6			95.1	28.6	58	29	29	58.8
			(Bedrock) CLAYSTONE, moist, grey, very hard										
5218	70			SS	50/2				27.5				
5213	75			MC	50/1				28.7				
			Bottom of hole at 75.1 feet.										

DRAFT

BORING : BR-6

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/5/13 **COMPLETED** 3/5/13
GROUND ELEVATION 5308.0 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454410.3 **EAST** 679332.6
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8"
BORING LOCATION: EB I-70, lane 4, 75' east of Havana
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer/Bridge Borehole
WATER DEPTH 49.0 ft on 3/5/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5308	0		Asphalt Pavement, approximately 16"										
			(Fill) SAND, silty, moist, light brown, medium dense to dense I-70 Embankment				0.01			NP	NP	NP	14.0
5303	5			MC	31/12			117.9	7.2				
5298	10			MC	32/12	-0.4		114.6	9.0				
5293	15		(Fill) SAND, silty, moist, light brown, dense to very dense I-70 Embankment	MC	47/12			112.9	10.7				
5288	20			MC	66/12			115.7	6.6				
5283	25			MC	68/12	-0.1		121.3	9.8				
5278	30		(Native) SAND, silty, moist, light brown, medium dense to very dense to very dense	MC	15/12			112.7	6.6				
5273	35												

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RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5273	35		(Native) SAND, silty, moist, light brown, medium dense to very dense to very dense *(continued)*	MC	37/12			112.2	4.4	NP	NP	NP	12.6
5268	40			MC	35/12	-0.5		109.0	13.2				
			(Native) SAND, silty, clayey in parts, moist to wet, light brown, medium dense to dense										
5263	45			MC	25/12		0.01	111.3	21.0				
5258	50			MC	39/12		0.02	115.8	16.0				
			(Native) SAND, silty, trace gravel, wet, light brown, medium dense to dense										
5253	55			MC	21/12			101.3	22.2	NP	NP	NP	26.0
5248	60			MC	41/12			126.0	14.1				
5243	65			SS	13/20/30				18.6				
			(Native) CLAY, sandy, silt in parts, moist to very moist, light brown, stiff to hard										
5238	70			SS	6/8/14		0.00		27.1	44	19	25	62.3
5233	75												

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RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5233	75		(Native) CLAY, sandy, silt in parts, moist to very moist, light brown, stiff to hard *(continued)*	MC	22/12			96.6	27.8				
5228	80			MC	37/12			85.1	36.8	62	28	34	54.1
5223	85		(Bedrock) CLAYSTONE, sandy, grading to clayey SANDSTONE in parts, moist, light brown, very hard	MC	50/6			91.8	31.7	65	32	33	45.2
5218	90			MC	50/4			96.7	28.3				

Bottom of hole at 90.3 feet.

DRAFT

BORING : PV-1

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/6/13 **COMPLETED** 3/6/13
GROUND ELEVATION 5274.5 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454747.3 **EAST** 677619.2
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 6"
BORING LOCATION: Lane 1 WB I-70, 1,600 feet west of Havana
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer/Estimated Elevation
WATER DEPTH None Encountered on 3/6/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5275	0		Asphalt Pavement, approximately 16"				0.00			22	14	8	41.8
			(Native) SAND, clayey, sandy CLAY in parts, moist, light brown to grey, medium dense	MC	20/12	-0.2		120.7	12.7				66.3
5270	5			MC	18/12			116.8	12.7				29.8
5265	10			MC	23/12			123.3	12.3				42.9
			Bottom of hole at 10.0 feet.										

DRAFT

BORING : PV-2

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/5/13 **COMPLETED** 3/5/13
GROUND ELEVATION 5279.5 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454541.7 **EAST** 678080.2
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: EB I-70 shoulder, 1,100 feet west of Havana
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer
WATER DEPTH None Encountered on 3/5/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5280	0		Asphalt Pavement, approximately 13"										
			(Fill) SAND, silty to clayey, very moist, brown, medium dense				0.00			29	15	14	31.1
			I-70 Embankment	MC	29/12			123.1	13.9				
5275	5		(Fill) CLAY, sandy to very sandy, moist, brown, very stiff	MC	23/12	-0.1		112.8	17.4				
			(Native) SAND, silty to clayey, moist, light brown, medium dense										
5270	10			MC	14/12			118.6	7.9				
			Bottom of hole at 10.0 feet.										

DRAFT

BORING : PV-3

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/6/13 **COMPLETED** 3/6/13
GROUND ELEVATION 5296.0 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454622.6 **EAST** 678610.0
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 6"
BORING LOCATION: Lane 1 WB I-70, 600 feet west of Havana
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer/Estimated Elevation
WATER DEPTH None Encountered on 3/6/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5296	0		Asphalt Pavement, approximately 16"										
			(Fill) SAND, silty, trace clay in parts, moist, light brown, dense to very dense				0.00			NP	NP	NP	16.1
				MC	48/12	-0.1		115.9	7.2				
			I-70 Embankment										
5291	5			MC	39/12			124.5	8.6				
5286	10			MC	72/12			127.6	10.5				
			Bottom of hole at 10.0 feet.										

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BORING : PV-4

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/6/13 **COMPLETED** 3/6/13
GROUND ELEVATION 5307.3 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454539.5 **EAST** 679572.7
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 6"
BORING LOCATION: Lane 1 WB I-70, 350 feet east of Havana
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer
WATER DEPTH None Encountered on 3/6/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5307	0		Asphalt Pavement, approximately 16"										
			(Fill) SAND, silty, moist to very moist, light brown, medium dense to dense				0.01			NP	NP	NP	20.1
				MC	31/12			110.4	8.9				15.0
			I-70 Embankment										
5302	5			MC	27/12			112.6	10.2				18.4
5297	10			MC	50/12			112.7	7.5				10.2
			Bottom of hole at 10.0 feet.										

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BORING : PV-5

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/14/13 **COMPLETED** 3/14/13
GROUND ELEVATION 5302.0 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454339.5 **EAST** 680081.5
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 6"
BORING LOCATION: EB I-70 lane 1, 800 feet E. of Havana
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer/Estimated Elevation
WATER DEPTH None Encountered on 3/14/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5302	0		Asphalt Pavement, approximately 11.5"										
			(Fill) SAND, silty, moist, light brown, dense				0.03			NP	NP	NP	15.5
			I-70 Embankment	MC	49/12			113.0	6.3				
5297	5			MC	51/12			114.7	5.7				
			(Native) SAND, silty to clayey, moist, brown, medium dense										
5292	10			MC	18/12				9.5				
			Bottom of hole at 10.0 feet.										

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BORING : PV-6

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/13/13 **COMPLETED** 3/13/13
GROUND ELEVATION 5290.1 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454840.9 **EAST** 679604.4
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 6"
BORING LOCATION: WB I-70 on-ramp, lane 2
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer.Approx. 400' E of Havana
WATER DEPTH None Encountered on 3/13/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5290	0		Asphalt Pavement, approximately 12"				0.01			30	16	14	39.8
			(Fill) SAND, clayey, moist, dark brown and grey, medium dense	MC	21/12	0.2		120.2	13.1				
5285	5		(Native) SAND, silty, clayey in parts, moist, light brown, medium dense	MC	20/12			116.0	10.9				
5280	10			MC	24/12			122.3	6.6				
			Bottom of hole at 10.0 feet.										

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BORING : PV-7

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 2/19/13 **COMPLETED** 2/19/13
GROUND ELEVATION 5295.9 ft
DRILLING CONTRACTOR Old Dirt Drilling
NORTH 454675.7 **EAST** 679846.7
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: Off shoulder on WB I-70 on-ramp
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Automatic Hammer
WATER DEPTH None Encountered on 2/19/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5296	0		(Topsoil) SAND, silty, slightly moist, brown, loose, approximately 3"				0.01			35	13	22	30.5
			(Fill) SAND, clayey with gravel, moist, brown to black, medium dense	MC	16/12	0.4		123.0	12.1	37	15	22	34.6
5291	5		(Fill) SAND, silty, trace clay, moist, brown, dense	MC	36/12			123.5	9.2				
			Ramp Embankment										
5286	10		(Native) SAND, silty, moist, light brown, loose	MC	6/12			103.4	5.6				

Bottom of hole at 10.0 feet.

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BORING : PV-8

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/14/13 **COMPLETED** 3/14/13
GROUND ELEVATION 5285.0 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454042.7 **EAST** 679513.5
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 6"
BORING LOCATION: EB I-70 off ramp to Havana, lane 2
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer/turn lane to NB Havana
WATER DEPTH None Encountered on 3/14/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5285	0		Asphalt Pavement, approximately 13"										
			(Native) SAND, silty, moist, light brown, dense to very dense				0.06			NP	NP	NP	21.9
				MC	56/12			120.3	8.5				
5280	5		(Native) SAND, clayey, moist, light brown, medium dense to dense	MC	33/12	-0.1		123.4	10.6				
			(Native) SAND, silty, moist, light brown, medium dense										
5275	10			MC	11/12			111.9	4.8				
			Bottom of hole at 10.0 feet.										

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BORING : RW-1

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/13/13 **COMPLETED** 3/13/13
GROUND ELEVATION 5300.6 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454608.0 **EAST** 678805.4
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8"
BORING LOCATION: WB I-70 shoulder, 300' west of bridge
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer
WATER DEPTH 47.0 ft on 3/13/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5301	0		Asphalt Pavement, approximately 6"										
			Concrete Pavement, approximately 11"										
			(Fill) SAND, silty with clay in parts, slightly moist to moist, light brown, dense to very dense										
5296	5		I-70 Embankment Fill										
				MC	39/12			122.9	12.0	NP	NP	NP	17.6
5291	10												
				MC	54/12		0.01	127.9	10.8				
5286	15												
				MC	77/12			124.9	9.6	NP	NP	NP	20.6
5281	20												
				MC	70/12			119.4	6.9				
			(Native) CLAY, sandy, moist, brown, very stiff										
5276	25												
				MC	22/12	-0.4	0.00	122.3	13.0	26	13	13	51.0
			(Native) SAND, silty, slightly moist to moist, light brown, medium dense										
5271	30												
			(Native) CLAY, sandy, moist, brown, stiff to very stiff	MC	19/12			119.2	19.4				
			(Native) SAND, silty, slightly moist to moist, light brown, dense										
5266	35												

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RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5266	35		(Native) SAND, silty, slightly moist to moist, light brown, dense *(continued)*	MC	39/12			108.8	4.9				
			(Native) CLAY, sandy, silty sand in parts, very moist, light brown, stiff to very stiff										
5261	40			MC	19/12			102.2	24.0	50	17	33	56.0
5256	45			MC	14/12	-0.4		95.1	29.3				
5251	50			MC	19/12			106.0	21.9				
			Bottom of hole at 51.0 feet.										

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BORING : RW-2

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/14/13 **COMPLETED** 3/14/13
GROUND ELEVATION 5302.4 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454457.6 **EAST** 678862.7
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8"
BORING LOCATION: EB I-70 shoulder, 20' W. of bridge
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer
WATER DEPTH 47.0 ft on 3/14/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5302	0		Asphalt Pavement, approximately 16"										
			(Fill) SAND, silty to clayey, slightly moist to moist, light brown to grey brown, grey, medium dense to very dense I-70 Embankment Fill										
5297	5			MC	34/12		0.04	119.6	6.5				
5292	10			MC	26/12			122.9	7.1	25	15	10	22.0
5287	15			MC	32/12				14.1				
5282	20			MC	58/12								
5277	25			MC	49/12		0.04	124.1	11.5	NP	NP	NP	26.9
5272	30		(Native) CLAY, sandy, moist, brown, very stiff	MC	24/12	0.7		120.1	14.0				
5267	35		(Native) SAND, silty, moist, light brown, medium dense										

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BORING : RW-2

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5267	35												
			(Native) CLAY, sandy to very sandy, moist to very moist, brown, very stiff	MC	32/12			108.0	18.5				
5262	40												
				MC	19/12			102.4	22.7	34	16	18	59.2
5257	45												
				MC	20/12	-0.1		106.6	21.5				
			(Native) SAND, silty to clayey, very moist to wet, brown, medium dense										
5252	50												
				MC	13/12			109.6	20.4				
			Bottom of hole at 51.0 feet.										

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BORING : RW-3

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/6/13 **COMPLETED** 3/6/13
GROUND ELEVATION 5306.5 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454576.0 **EAST** 679028.8
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8"
BORING LOCATION: Lane 1 WB I-70, 150' west of Havana
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer/Estimated Elevation
WATER DEPTH 48.0 ft on 3/6/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5307	0		Asphalt Pavement, approximately 16"										
			(Fill) SAND, silty, moist, light brown, medium dense to dense I-70 Embankment Fill										
5302	5			MC	25/12			129.1	7.6				
5297	10			MC	33/12			119.9	9.9	NP	NP	NP	31.0
5292	15			MC	31/12			116.3	10.8				
5287	20			SS	12/18/22		0.00		8.7				
5282	25		(Native) SAND, silty, clayey in parts, moist to very moist, light brown, dense to medium dense	MC	74/12			119.4	8.6				
5277	30			MC	16/12			119.9	9.6	NP	NP	NP	29.9
5272	35												

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RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5272	35		(Native) SAND, silty, clayey in parts, moist to very moist, light brown, dense to medium dense *(continued)*	MC	16/12		0.00	111.4	5.3				
5267	40		(Native) CLAY, sandy, very moist, light brown, very stiff	SS	7/9/14				20.7	42	17	25	59.2
5262	45		(Native) SAND, clayey, moist, light brown, dense	MC	44/12			116.1	9.9				19.5
5257	50		(Native) SAND, silty, moist to wet, light brown, dense	MC	47/12			117.9	15.3	NP	NP	NP	14.3
5252	55		(Native) SAND, clayey, very moist to wet, light brown, medium dense	MC	14/12		0.01	102.3	21.1				
5247	60		(Native) SAND, silty, moist to wet, light brown, dense	SS	5/15/20				16.0				

Bottom of hole at 61.5 feet.

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BORING : RW-4

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/13/13 **COMPLETED** 3/13/13
GROUND ELEVATION 5307.9 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454529.7 **EAST** 679526.6
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8"
BORING LOCATION: WB I-70 on-ramp shoulder, east side of Havana
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer
WATER DEPTH 47.0 ft on 3/13/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5308	0		Asphalt Pavement, approximately 9"										
			(Fill) SAND, silty, moist, light brown to brown, dense to very dense				0.00			NP	NP	NP	11.5
			I-70 Embankment Fill										
5303	5												
				MC	38/12		0.01	118.7	9.3	NP	NP	NP	16.1
5298	10												
				MC	46/12			119.9	8.6				
5293	15												
				MC	51/12			120.6	7.1	NP	NP	NP	15.6
5288	20												
			No Sample Recovery	MC	56/12								
			(Native) SAND, clayey to silty, moist, brown, medium dense										
5283	25												
				MC	27/12		0.01	116.7	6.3	NP	NP	NP	18.0
			(Native) CLAY, with sand to sandy, clayey sand in parts, moist to very moist, brown, stiff to very stiff										
5278	30												
				MC	15/12	-0.2		120.6	12.9				
5273	35												

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RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5273	35		(Native) CLAY, with sand to sandy, clayey sand in parts, moist to very moist, brown, stiff to very stiff *(continued)*	MC	29/12			111.3	19.2	52	19	33	57.4
5268	40			MC	20/12	-3.2		110.8	18.2				
5263	45			MC	21/12			117.3	18.7	47	14	33	49.0
5258	50		(Native) SAND, silty to clayey, very moist to wet, light light brown, medium dense	MC	19/12			110.7	21.4				

Bottom of hole at 51.0 feet.

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BORING : RW-5

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/4/13 **COMPLETED** 3/4/13
GROUND ELEVATION 5281.8 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454279.6 **EAST** 679510.6
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8"
BORING LOCATION: SE quadrant of I-70 and Havana
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer/Bottom of embankment
WATER DEPTH 20.0 ft on 3/4/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5282	0		(Native) SAND, silty to clayey, moist, light brown, loose to medium dense										
5277	5			MC	7/12		0.00	92.8	5.8				
5272	10			MC	22/12			114.2	14.7	33	15	18	48.2
5267	15		(Native) CLAY, with sand to very sandy, moist, light brown, very stiff	MC	15/12	-0.3		98.7	24.4	54	19	35	61.6
5262	20		(Native) SAND, silty, wet, light brown, medium dense	MC	13/12			100.6	22.4				
5257	25			SS	6/12/14				19.4	NP	NP	NP	6.0
5252	30			SS	8/9/10				26.8				
5247	35		(Native) SAND, silty, wet, light brown, dense										

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RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5247	35		(Native) SAND, silty, wet, light brown, dense *(continued)*	SS	7/17/29				21.1	NP	NP	NP	3.1
5242	40			SS	13/17/26				18.6				
			Bottom of hole at 41.5 feet.										

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BORING : RW-6

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 2/19/13 **COMPLETED** 2/19/13
GROUND ELEVATION 5297.0 ft
DRILLING CONTRACTOR Old Dirt Drilling
NORTH **EAST**
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: EB I-70 off shoulder, east of EB I-70 on-ramp
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Automatic Hammer
WATER DEPTH 27.0 ft on 2/19/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5297	0		(Topsoil) CLAY, sandy, moist, brown, stiff, approximately 6"				0.27			21	18	3	26.0
			(Native) SAND, silty, trace clay, moist, light brown, loose										
5292	5			MC	7/12			110.6	7.8				
			(Native) SAND, silty with gravel and clay in parts, moist, light brown, medium dense										
5287	10			MC	23/12			113.2	2.4	NP	NP	NP	7.4
5282	15			MC	19/12	-2.0		116.1	9.0				
			(Native) CLAY, sandy, moist, light brown, stiff to very stiff										
5277	20			MC	17/12	0.0		114.9	16.3				
5272	25			MC	13/12			108.6	20.5				
			(Native) SAND, silty with clay lenses in parts, very moist to wet, light brown, medium dense										
5267	30			SS	5/8/10				22.5				
			Bottom of hole at 30.5 feet.										

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BORING : RW-7

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 2/19/13 **COMPLETED** 2/19/13
GROUND ELEVATION 5290.4 ft
DRILLING CONTRACTOR Old Dirt Drilling
NORTH 454623.8 **EAST** 680087.6
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: Off shoulder on I-70 WB off-ramp to Havana
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Automatic Hammer/Approximately 150' N. of I-70
WATER DEPTH 28.5 ft on 2/19/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5290	0		(Topsoil) SAND, silty, moist, brown, loose, approximately 3"				0.01			NP	NP	NP	21.3
			(Native) SAND, silty, moist, light brown, loose										
5285	5			MC	6/12	-0.5		106.6	6.9				
5280	10			MC	3/12	-0.3		104.3	5.2				
			(Native) CLAY, sandy with clayey SAND in parts, very moist to moist, light brown, stiff to very stiff										
5275	15			MC	17/12	0.1		102.0	23.4	49	17	32	67.2
5270	20			MC	17/12			111.1	18.8				
5265	25			SS	6/6/8				21.5	34	16	18	49.9
			(Native) SAND, silty, very moist wet, light brown, medium dense										
5260	30			MC	19/12			115.6	18.1				
			Bottom of hole at 30.0 feet.										

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BORING : RW-8

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 3/4/13 **COMPLETED** 3/4/13
GROUND ELEVATION 5287.9 ft
DRILLING CONTRACTOR Dakota Drilling
NORTH 454104.8 **EAST** 679859.0
DRILLING METHOD Hollow Stem Auger **HOLE SIZE** 8"
BORING LOCATION: Off shoulder, EB I-70 off ramp to Havana
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Manual Hammer/Monitoring Well Installed for Pinyon
WATER DEPTH 23.2 ft on 3/15/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5288	0		(Topsoil) SAND, silty, moist, light brown, loose, approximately 3"				0.06			NP	NP	NP	17.0
			(Fill) SAND, silty, moist, light brown, dense	MC	32/12			119.4	13.1				
5283	5		(Native) CLAY, sandy to very sandy, moist, light brown, stiff	MC	13/12	2.2		115.3	15.2				
5278	10		(Native) SAND, silty to clayey, moist to very moist, light brown, medium dense	MC	15/12			110.5	8.8				
5273	15			MC	18/12			109.9	8.4				
5268	20			MC	13/12			102.4	22.1				
5263	25		(Native) SAND, silty, very moist to wet, light brown, medium dense Ground Water Sample: Chloride=128.9 ppm pH=6.9 WSS=71.8 ppm CR Level=1	SS	5/7/9				24.0	NP	NP	NP	9.9
5258	30			SS	7/14/15				18.4				

Bottom of hole at 31.5 feet.

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BORING : RW-9

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 2/19/13 **COMPLETED** 2/19/13
GROUND ELEVATION 5295.0 ft
DRILLING CONTRACTOR Old Dirt Drilling
NORTH **EAST**
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: WB I-70, off shoulder, east of WB off-ramp
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Automatic Hammer
WATER DEPTH 28.0 ft on 2/19/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5295	0		(Topsoil) SAND, silty, slightly moist, light brown, loose, approximately 3"				0.01			19	18	1	32.5
			(Native) SAND, silty with trace gravel, moist, light brown, loose										
5290	5			MC	6/12	-0.4		104.9	7.1				
5285	10			MC	8/12			110.9	5.3	NP	NP	NP	12.9
			(Native) CLAY, sandy to very sandy with gravel in parts, moist, brown, stiff to very stiff										
5280	15			MC	16/12			104.1	21.1	45	19	26	67.1
5275	20			MC	26/12			117.5	14.8				
5270	25			MC	17/12			112.7	17.4				
			(Native) SAND, clayey, very moist to wet, light brown, medium dense										
5265	30			SS	5/6/6				22.2				
			Bottom of hole at 30.5 feet.										

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BORING : RW-10

RockSol Consulting Group, Inc.

CLIENT Parsons
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering
PROJECT NUMBER 304.01
PROJECT LOCATION Havana and I-70/Denver, CO
DATE STARTED 2/19/13 **COMPLETED** 2/19/13
GROUND ELEVATION 5287.9 ft
DRILLING CONTRACTOR Old Dirt Drilling
NORTH 454180.0 **EAST** 680057.0
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4"
BORING LOCATION: Off shoulder, I-70 EB on-ramp, approx. 800 feet E. of Havar
LOGGED BY J. Biller
GROUND WATER LEVELS:
NOTES Automatic Hammer/Approx 150 ft. S. of I-70
WATER DEPTH 23.5 ft on 2/19/13

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
5288	0		(Topsoil) SAND, silty, slightly moist, light brown, loose, approximately 3"				0.01			18	15	3	25.8
			(Native) SAND, silty, clayey in parts, moist, light brown, loose										
5283	5			MC	6/12	0.0		113.7	14.6				
5278	10			MC	9/12		0.00	125.2	3.7	NP	NP	NP	10.8
			(Native) CLAY, sandy to very sandy, moist, light brown, very stiff										
5273	15			MC	23/12	0.0		107.3	19.2				
			(Native) SAND, clayey, silty in parts, moist, light brown, medium dense										
5268	20			MC	19/12	-0.2		116.5	13.2	38	16	22	27.7
5263	25		(Native) SAND, silty, clayey in parts, moist to wet, light brown, medium dense	SS	4/5/6				19.4				
5258	30			SS	4/5/5				20.4				
5253	35			SS	4/7/8				25.2				
			Bottom of hole at 35.5 feet.										

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APPENDIX C

LABORATORY TEST RESULTS

RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT Parsons

PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01

PROJECT LOCATION Havana and I-70/Denver, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
BR-1	5								10.0	106.1								
BR-1	10	NP	NP	NP		28	SM	A-2-4 (0)	13.2	105.1								
BR-1	15								26.3	98.9								
BR-1	20	51	18	33	-0.1	55	CH	A-7-6 (14)	22.8	103.8		0.02						
BR-1	25								18.2	114.9								
BR-1	30	74	25	49	1.9	93	CH	A-7-6 (52)	30.6	93.8		0.01						
BR-1	35								23.1									
BR-1	40	NP	NP	NP		10		A-3 (0)	17.5									
BR-1	45								23.9									
BR-1	50	29	16	13		32	SC	A-2-6 (1)	24.4									
BR-1	55								27.2									
BR-1	60								17.7									
BR-1	65	95	22	73		86	CH	A-7-6 (69)	44.9			0.01						
BR-1	70								30.0	93.0								
BR-1	75								24.9	99.8								
BR-1	80								26.1	98.9								
BR-2	5	NP	NP	NP		27	SM	A-2-4 (0)	13.3	118.1								
BR-2	10	29	14	15		52	CL	A-6 (4)	14.2	116.1								
BR-2	15								14.1	107.5								
BR-2	20	31	15	16		46	SC	A-6 (4)	18.8	106.1		0.00						
BR-2	25								22.0	104.3								
BR-2	30								17.1	118.4								
BR-2	35	63	15	48		75	CH	A-7-6 (35)	28.1			0.00						
BR-2	40								22.3									
BR-2	45								15.9									
BR-2	50								17.2									
BR-2	55								20.8									
BR-2	60								20.9									
BR-2	65					34			26.7									
BR-2	70								28.9									

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RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT Parsons

PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01

PROJECT LOCATION Havana and I-70/Denver, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
BR-2	75					40			23.0			0.00						
BR-2	80	79	39	40		80	MH	A-7-5 (37)	38.1									
BR-3	0-5	NP	NP	NP		23	SM	A-2-4 (0)				0.08	1350 Ohm-cm @ 15.7%	7.3		130.5	8.0	M
BR-3	5								11.7	121.8								
BR-3	10								2.2	103.5								
BR-3	15								15.4	112.5								
BR-3	20	27	20	7		26	SC-SM	A-2-4 (0)	19.1	111.0								
BR-3	25								27.0	100.6								
BR-3	30	72	21	51		88	CH	A-7-6 (49)	30.1									
BR-3	35								24.1			0.04						
BR-3	40	NP	NP	NP		8	SP-SM	A-1-b (0)	14.6									
BR-3	50	34	18	16		44	SC	A-6 (3)	25.7									
BR-3	55								27.1									
BR-3	60	69	31	38		66	CH	A-7-5 (25)	32.9	89.3								
BR-3	65								29.5	97.0	68.8							
BR-3	70								25.9	98.6		0.00						
BR-3	75								27.6	95.2								
BR-4	5	22	16	6		48	SC-SM	A-4 (0)	5.2	122.1								
BR-4	10	NP	NP	NP		34	SM	A-2-4 (0)	6.3	103.5								
BR-4	15								18.7	107.8								
BR-4	20	32	15	17		56	CL	A-6 (6)	21.3	108.4								
BR-4	25								22.6	103.3		0.01						
BR-4	30	28	23	5		32	SM	A-2-4 (0)	20.1	110.4								
BR-4	35	NP	NP	NP		27	SM	A-2-4 (0)	20.7									
BR-4	40								16.3									
BR-4	45					50			25.8									
BR-4	50								35.2									
BR-4	55	57	30	27		49	SM	A-7-5 (10)	28.2	96.4								
BR-4	60	57	26	31		97	CH	A-7-6 (35)	27.6	117.7								
BR-4	65								27.1	94.7		0.00						

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RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT Parsons

PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01

PROJECT LOCATION Havana and I-70/Denver, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
BR-4	70								32.6	89.3								
BR-5	5	NP	NP	NP		22	SM	A-2-4 (0)	9.1	119.1								
BR-5	10								11.6	121.0		0.00						
BR-5	15	49	13	36		56	CL	A-7-6 (16)	18.6									
BR-5	20								18.0	109.0								
BR-5	25	44	16	28		56	CL	A-7-6 (12)	26.0	98.2								
BR-5	30								18.9	106.5								
BR-5	35								19.2									
BR-5	40	30	14	16		41	SC	A-6 (2)	24.7									
BR-5	45								17.1									
BR-5	50								17.9									
BR-5	55								26.1									
BR-5	60								33.3									
BR-5	65	58	29	29		59	CH	A-7-6 (15)	28.6	95.1								
BR-5	70								27.5									
BR-5	75								28.7									
BR-6	1.25-10	NP	NP	NP		14	SM	A-1-b (0)				0.01	860 OHm-cm @ 13.9%	6.8		126.2	7.5	M
BR-6	5								7.2	117.9								
BR-6	10				-0.4				9.0	114.6								
BR-6	15								10.7	112.9								
BR-6	20								6.6	115.7								
BR-6	25				-0.1				9.8	121.3								
BR-6	30								6.6	112.7								
BR-6	35	NP	NP	NP		13	SM	A-1-b (0)	4.4	112.2								
BR-6	40				-0.5				13.2	109.0								
BR-6	45								21.0	111.3		0.01						
BR-6	50								16.0	115.8		0.02						
BR-6	55	NP	NP	NP		26	SM	A-2-4 (0)	22.2	101.3								
BR-6	60								14.1	126.0								
BR-6	65								18.6									

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RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT Parsons

PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01

PROJECT LOCATION Havana and I-70/Denver, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
BR-6	70	44	19	25		62	CL	A-7-6 (13)	27.1			0.00						
BR-6	75								27.8	96.6								
BR-6	80	62	28	34		54	CH	A-7-6 (15)	36.8	85.1								
BR-6	85	65	32	33		45	SC	A-7-5 (10)	31.7	91.8								
BR-6	90								28.3	96.7								
PV-1	1.25-5	22	14	8		42	SC	A-4 (0)				0.00	570 Ohm-cm @ 19.1%	7.3				
PV-1	2				-0.2	66			12.7	120.7								
PV-1	4					30			12.7	116.8								
PV-1	9					43			12.3	123.3								
PV-2	1.1-5	29	15	14		31	SC	A-2-6 (1)				0.00	575 Ohm-cm @ 16.7%	8.0				
PV-2	2								13.9	123.1								
PV-2	4				-0.1				17.4	112.8								
PV-2	9								7.9	118.6								
PV-3	1.25-5	NP	NP	NP		16	SM	A-2-4 (0)				0.00	800 @ 13.5%	7.3				
PV-3	2				-0.1				7.2	115.9								
PV-3	4								8.6	124.5								
PV-3	9								10.5	127.6								
PV-4	1.25-5	NP	NP	NP		20	SM	A-2-4 (0)				0.01	1100 Ohm-cm @ 15.90%	7.9				
PV-4	2					15			8.9	110.4								
PV-4	4					18			10.2	112.6								
PV-4	9					10			7.5	112.7								
PV-5	1-5	NP	NP	NP		15	SM	A-2-4 (0)				0.03	1200 Ohm-cm @ 14.5%	7.6	0.02			
PV-5	2								6.3	113.0								
PV-5	4								5.7	114.7								
PV-5	5																	
PV-5	9								9.5									
PV-6	1-5	30	16	14		40	SC	A-6 (2)				0.01		6.8	0.02			
PV-6	2				0.2				13.1	120.2								
PV-6	4								10.9	116.0								
PV-6	9								6.6	122.3								

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RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT Parsons

PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01

PROJECT LOCATION Havana and I-70/Denver, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
PV-7	0-5	35	13	22		30	SC	A-2-6 (2)				0.01	395 Ohm-cm @ 18.3%	7.3	0.11			
PV-7	2	37	15	22	0.4	35	SC	A-2-6 (2)	12.1	123.0								
PV-7	4								9.2	123.5								
PV-7	9								5.6	103.4								
PV-8	1-5	NP	NP	NP		22	SM	A-2-4 (0)				0.06	450 Ohm-cm @ 17.0%	7.4	0.05			
PV-8	2								8.5	120.3								
PV-8	4				-0.1				10.6	123.4								
PV-8	9								4.8	111.9								
RW-1	5	NP	NP	NP		18	SM	A-2-4 (0)	12.0	122.9								
RW-1	10								10.8	127.9		0.01						
RW-1	15	NP	NP	NP		21	SM	A-2-4 (0)	9.6	124.9								
RW-1	20								6.9	119.4								
RW-1	25	26	13	13	-0.4	51	CL	A-6 (3)	13.0	122.3		0.00						
RW-1	30								19.4	119.2								
RW-1	35								4.9	108.8								
RW-1	40	50	17	33		56	CH	A-7-6 (15)	24.0	102.2								
RW-1	45				-0.4				29.3	95.1								
RW-1	50								21.9	106.0								
RW-2	5								6.5	119.6		0.04						
RW-2	10	25	15	10		22	SC	A-2-4 (0)	7.1	122.9								
RW-2	15								14.1									
RW-2	25	NP	NP	NP		27	SM	A-2-4 (0)	11.5	124.1		0.04						
RW-2	30				0.7				14.0	120.1								
RW-2	35								18.5	108.0								
RW-2	40	34	16	18		59	CL	A-6 (8)	22.7	102.4								
RW-2	45				-0.1				21.5	106.6								
RW-2	50								20.4	109.6								
RW-3	5								7.6	129.1								
RW-3	10	NP	NP	NP		31	SM	A-2-4 (0)	9.9	119.9								
RW-3	15								10.8	116.3								

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RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT Parsons

PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01

PROJECT LOCATION Havana and I-70/Denver, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
RW-3	20								8.7			0.00						
RW-3	25								8.6	119.4								
RW-3	30	NP	NP	NP		30	SM	A-2-4 (0)	9.6	119.9								
RW-3	35								5.3	111.4		0.00						
RW-3	40	42	17	25		59	CL	A-7-6 (12)	20.7									
RW-3	45					19			9.9	116.1								
RW-3	50	NP	NP	NP		14	SM	A-1-b (0)	15.3	117.9								
RW-3	55								21.1	102.3		0.01						
RW-3	60								16.0									
RW-4	0.75-10	NP	NP	NP		11	SW-SM	A-1-b (0)				0.00	700 Ohm-cm @ 13.2%	7.1	0.05			
RW-4	5	NP	NP	NP		16	SM	A-2-4 (0)	9.3	118.7		0.01						
RW-4	10								8.6	119.9								
RW-4	15	NP	NP	NP		16	SM	A-2-4 (0)	7.1	120.6								
RW-4	25	NP	NP	NP		18	SM	A-2-4 (0)	6.3	116.7		0.01						
RW-4	30				-0.2				12.9	120.6								
RW-4	35	52	19	33		57	CH	A-7-6 (15)	19.2	111.3								
RW-4	40				-3.2				18.2	110.8								
RW-4	45	47	14	33		49	SC	A-7-6 (11)	18.7	117.3								
RW-4	50								21.4	110.7								
RW-5	5								5.8	92.8		0.00						
RW-5	10	33	15	18		48	SC	A-6 (5)	14.7	114.2								
RW-5	15	54	19	35	-0.3	62	CH	A-7-6 (19)	24.4	98.7								
RW-5	20								22.4	100.6								
RW-5	25	NP	NP	NP		6		A-3 (0)	19.4									
RW-5	30								26.8									
RW-5	35	NP	NP	NP		3		A-3 (0)	21.1									
RW-5	40								18.6									
RW-6	0-5	21	18	3		26	SM	A-2-4 (0)				0.27	350 Ohm-cm @ 18.6%	7.3	0.03			
RW-6	4								7.8	110.6								
RW-6	9	NP	NP	NP		7	SW-SM	A-1-b (0)	2.4	113.2								

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RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT Parsons

PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01

PROJECT LOCATION Havana and I-70/Denver, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
RW-6	14				-2.0				9.0	116.1								
RW-6	19				0.0				16.3	114.9								
RW-6	24								20.5	108.6								
RW-6	29								22.5									
RW-7	0-5	NP	NP	NP		21	SM	A-2-4 (0)				0.01	2000 Ohm-cm @ 18.50%	8.0	0.01			
RW-7	4				-0.5				6.9	106.6								
RW-7	9				-0.3				5.2	104.3								
RW-7	14	49	17	32	0.1	67	CL	A-7-6 (19)	23.4	102.0								
RW-7	19								18.8	111.1								
RW-7	24	34	16	18		50	SC	A-6 (5)	21.5									
RW-7	29								18.1	115.6								
RW-8	0-5	NP	NP	NP		17	SM	A-2-4 (0)				0.06	450 Ohm-cm @ 17.7%	8.0				
RW-8	2								13.1	119.4								
RW-8	5				2.2				15.2	115.3								
RW-8	10								8.8	110.5								
RW-8	15								8.4	109.9								
RW-8	20								22.1	102.4								
RW-8	25	NP	NP	NP		10	SP-SM	A-3 (0)	24.0									
RW-8	30								18.4									
RW-9	0-5	19	18	1		32	SM	A-2-4 (0)				0.01	1250 Ohm-cm @ 17.9%	7.0	0.02			
RW-9	4				-0.4				7.1	104.9								
RW-9	9	NP	NP	NP		13	SM	A-2-4 (0)	5.3	110.9								
RW-9	14	45	19	26		67	CL	A-7-6 (16)	21.1	104.1								
RW-9	19								14.8	117.5								
RW-9	24								17.4	112.7								
RW-9	29								22.2									
RW-10	0-5	18	15	3		26	SM	A-2-4 (0)				0.01	2000 Ohm-cm @ 16.2%	6.9	0.01			
RW-10	4				0.0				14.6	113.7								
RW-10	9	NP	NP	NP		11		A-2-4 (0)	3.7	125.2		0.00		7.5				
RW-10	14				0.0				19.2	107.3								

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RockSol Consulting Group, Inc.

SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT Parsons

PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01

PROJECT LOCATION Havana and I-70/Denver, CO

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Swell Potential (%)	%<#200 Sieve	Classification		Water Content (%)	Dry Density (pcf)	Unconfined Compressive Strength (psi)	Sulfate (%)	Resistivity (ohm-cm)	pH	Chlorides (%)	Proctor S=Standard M=Modified		
							USCS	AASHTO								MDD	OMC	S/M
RW-10	14.1																	
RW-10	19	38	16	22	-0.2	28	SC	A-2-6 (2)	13.2	116.5								
RW-10	24								19.4									
RW-10	29								20.4									
RW-10	34								25.2									

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ATTERBERG LIMITS RESULTS
AASHTO T89 Method A/T90

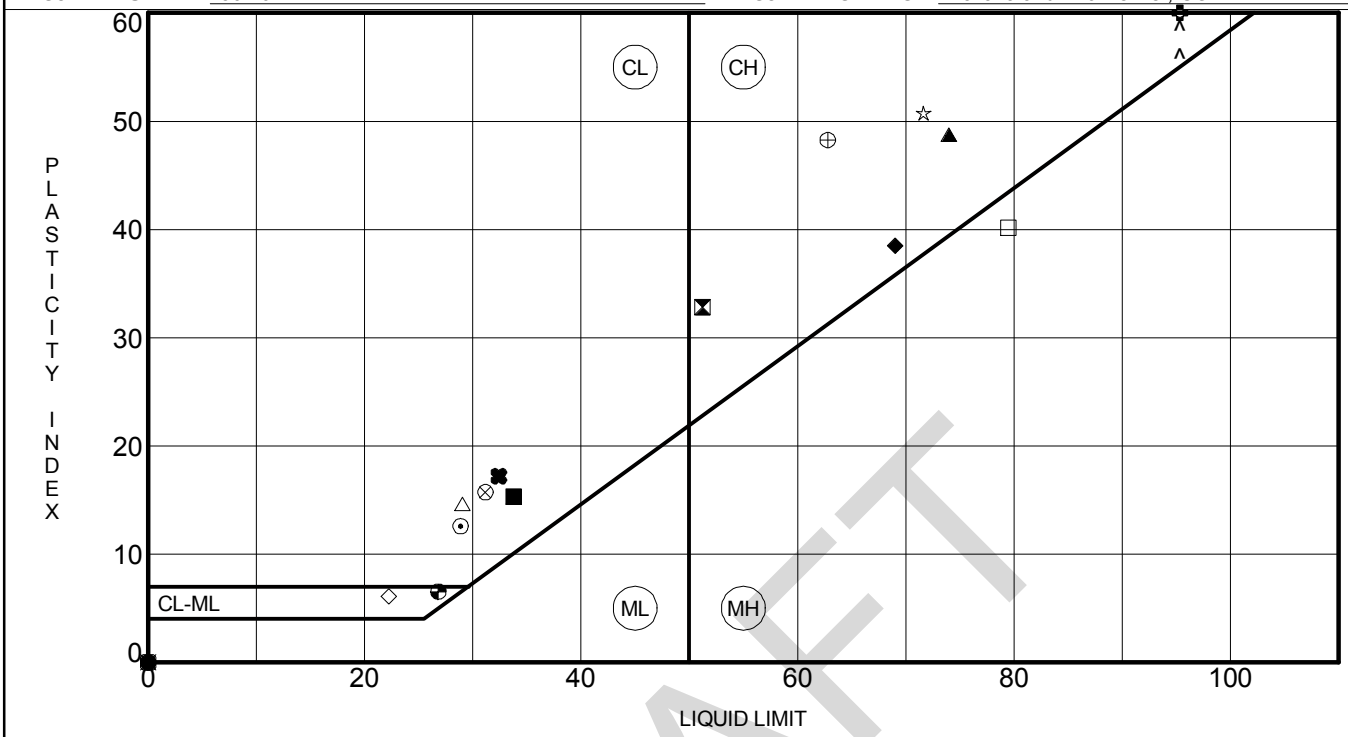
RockSol Consulting Group, Inc.

CLIENT Parsons

PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01

PROJECT LOCATION Havana and I-70/Denver, CO



	Specimen Identification		LL	PL	PI	Fines	Classification
●	BR-1	10	NP	NP	NP	28.4	SILTY SAND (SM)
⧗	BR-1	20	51	18	33	54.7	SANDY FAT CLAY (CH)
▲	BR-1	30	74	25	49	93.3	SILTY SAND (SM)
★	BR-1	40	NP	NP	NP	10.0	SILTY SAND (SM)
⊙	BR-1	50	29	16	13	32.0	CLAYEY SAND (SC)
✿	BR-1	65	95	22	73	86.1	(Bedrock) CLAYSTONE (CH)
○	BR-2	5	NP	NP	NP	26.8	SILTY SAND (SM)
△	BR-2	10	29	14	15	52.3	SANDY LEAN CLAY (CL)
⊗	BR-2	20	31	15	16	45.6	CLAYEY SAND (SC)
⊕	BR-2	35	63	15	48	75.1	FAT CLAY with SAND (CH)
□	BR-2	80	79	39	40	80.0	(Bedrock) SILTSTONE (MH)
⚉	BR-3	0-5.0	NP	NP	NP	23.2	SILTY SAND (SM)
◕	BR-3	20	27	20	7	26.0	SILTY, CLAYEY SAND (SC-SM)
☆	BR-3	30	72	21	51	88.1	FAT CLAY (CH)
⚇	BR-3	40	NP	NP	NP	8.1	POORLY GRADED SAND with SILT (SP-SM)
■	BR-3	50	34	18	16	43.8	CLAYEY SAND (SC)
◆	BR-3	60	69	31	38	66.4	(Bedrock) CLAYSTONE, sandy
◇	BR-4	5	22	16	6	47.5	SILTY, CLAYEY SAND (SC-SM)
×	BR-4	10	NP	NP	NP	34.4	SILTY SAND (SM)
✖	BR-4	20	32	15	17	56.1	SANDY LEAN CLAY (CL)

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ATTERBERG LIMITS RESULTS
AASHTO T89 Method A/T90

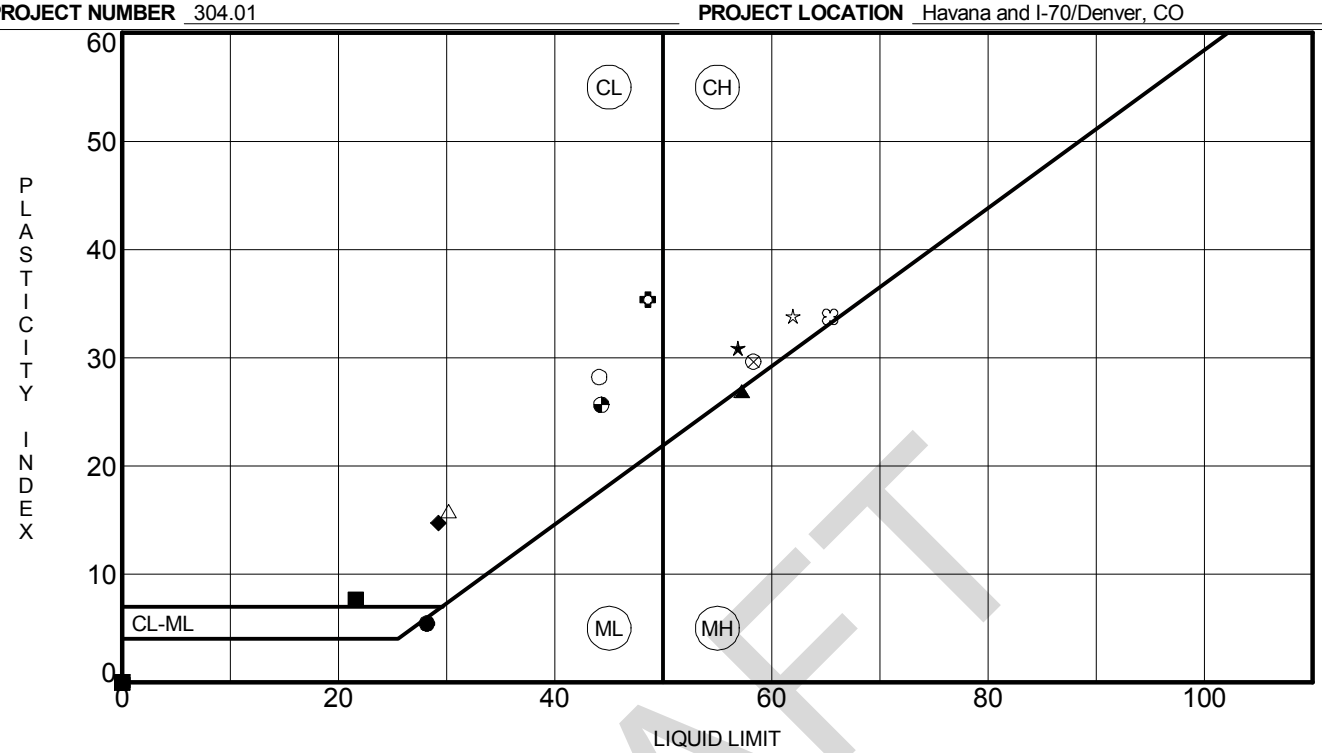
RockSol Consulting Group, Inc.

CLIENT Parsons

PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01

PROJECT LOCATION Havana and I-70/Denver, CO



	Specimen Identification		LL	PL	PI	Fines	Classification
●	BR-4	30	28	23	5	31.7	SILTY SAND (SM)
⊠	BR-4	35	NP	NP	NP	27.1	SILTY SAND (SM)
▲	BR-4	55	57	30	27	48.9	SILTY SAND (SM)
★	BR-4	60	57	26	31	97.2	(Bedrock) CLAYSTONE (CH)
⊙	BR-5	5	NP	NP	NP	21.8	SILTY SAND (SM)
✿	BR-5	15	49	13	36	55.7	SANDY LEAN CLAY (CL)
○	BR-5	25	44	16	28	55.7	SANDY LEAN CLAY (CL)
△	BR-5	40	30	14	16	40.6	CLAYEY SAND (SC)
⊗	BR-5	65	58	29	29	58.8	(Bedrock) CLAYSTONE, sandy (CH)
⊕	BR-6	1-10.0	NP	NP	NP	14.0	SILTY SAND (SM)
□	BR-6	35	NP	NP	NP	12.6	SILTY SAND (SM)
❀	BR-6	55	NP	NP	NP	26.0	SILTY SAND (SM)
◕	BR-6	70	44	19	25	62.3	SANDY LEAN CLAY (CL)
☆	BR-6	80	62	28	34	54.1	SANDY FAT CLAY (CH)
❂	BR-6	85	65	32	33	45.2	(Bedrock) SANDSTONE, clayey (SC)
■	PV-1	1-5.0	22	14	8	41.8	CLAYEY SAND (SC)
◆	PV-2	1-5.0	29	15	14	31.1	CLAYEY SAND (SC)
◇	PV-3	1-5.0	NP	NP	NP	16.1	SILTY SAND (SM)
×	PV-4	1-5.0	NP	NP	NP	20.1	SILTY SAND (SM)
✖	PV-5	1-5.0	NP	NP	NP	15.5	SILTY SAND (SM)

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ATTERBERG LIMITS RESULTS
AASHTO T89 Method A/T90

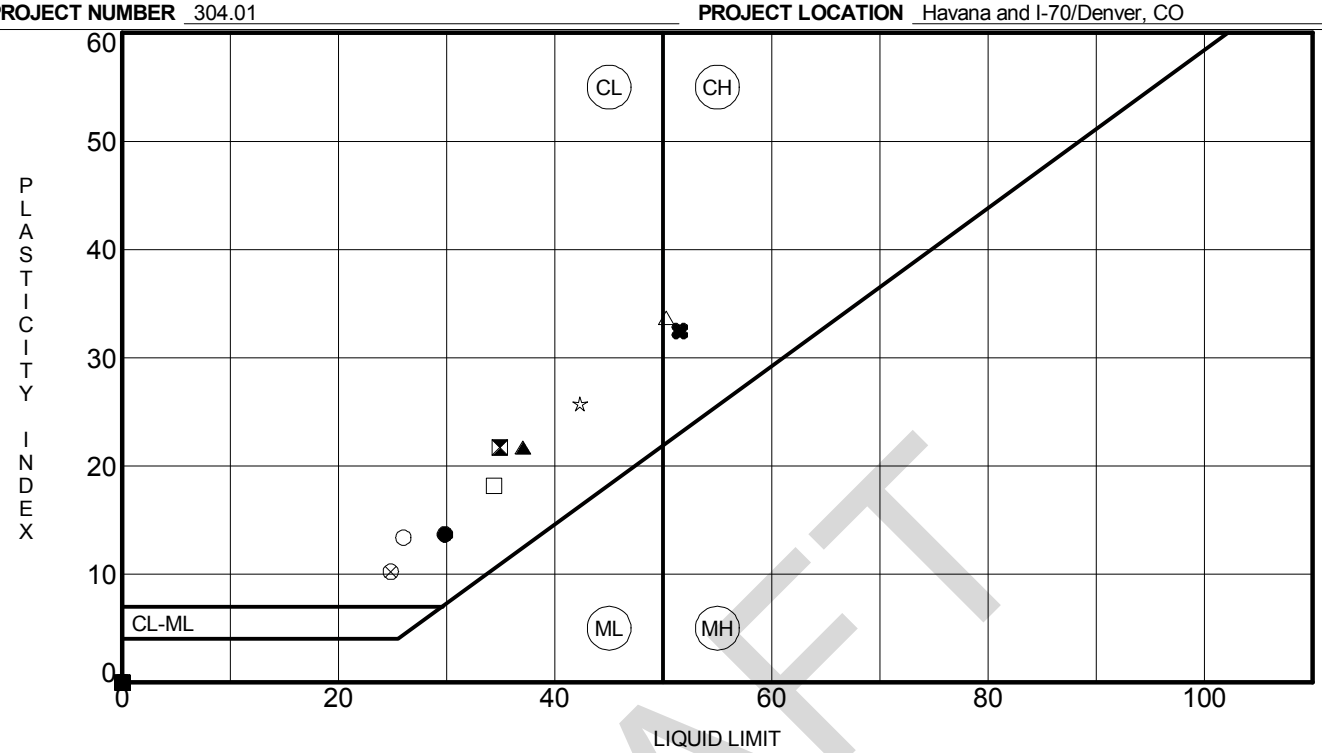
RockSol Consulting Group, Inc.

CLIENT Parsons

PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01

PROJECT LOCATION Havana and I-70/Denver, CO



	Specimen Identification		LL	PL	PI	Fines	Classification
●	PV-6	1-5.0	30	16	14	39.8	CLAYEY SAND (SC)
⧗	PV-7	0-5.0	35	13	22	30.5	CLAYEY SAND (SC)
▲	PV-7	2	37	15	22	34.6	(Fill) CLAYEY SAND (SC)
★	PV-8	1-5.0	NP	NP	NP	21.9	SILTY SAND (SM)
⊙	RW-1	5	NP	NP	NP	17.6	SILTY SAND (SM)
✿	RW-1	15	NP	NP	NP	20.6	SILTY SAND (SM)
○	RW-1	25	26	13	13	51.0	SANDY LEAN CLAY (CL)
△	RW-1	40	50	17	33	56.0	SANDY FAT CLAY (CH)
⊗	RW-2	10	25	15	10	22.0	CLAYEY SAND (SC)
⊕	RW-2	25	NP	NP	NP	26.9	SILTY SAND (SM)
□	RW-2	40	34	16	18	59.2	SANDY LEAN CLAY (CL)
⚉	RW-3	10	NP	NP	NP	31.0	SILTY SAND (SM)
◕	RW-3	30	NP	NP	NP	29.9	SILTY SAND (SM)
☆	RW-3	40	42	17	25	59.2	SANDY LEAN CLAY (CL)
⚇	RW-3	50	NP	NP	NP	14.3	SILTY SAND (SM)
■	RW-4	1-10.0	NP	NP	NP	11.5	WELL-GRADED SAND with SILT and GRAVEL (SW-SM)
◆	RW-4	5	NP	NP	NP	16.1	SILTY SAND (SM)
◇	RW-4	15	NP	NP	NP	15.6	SILTY SAND (SM)
×	RW-4	25	NP	NP	NP	18.0	SILTY SAND (SM)
✖	RW-4	35	52	19	33	57.4	SANDY FAT CLAY (CH)

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ATTERBERG LIMITS RESULTS
AASHTO T89 Method A/T90

RockSol Consulting Group, Inc.

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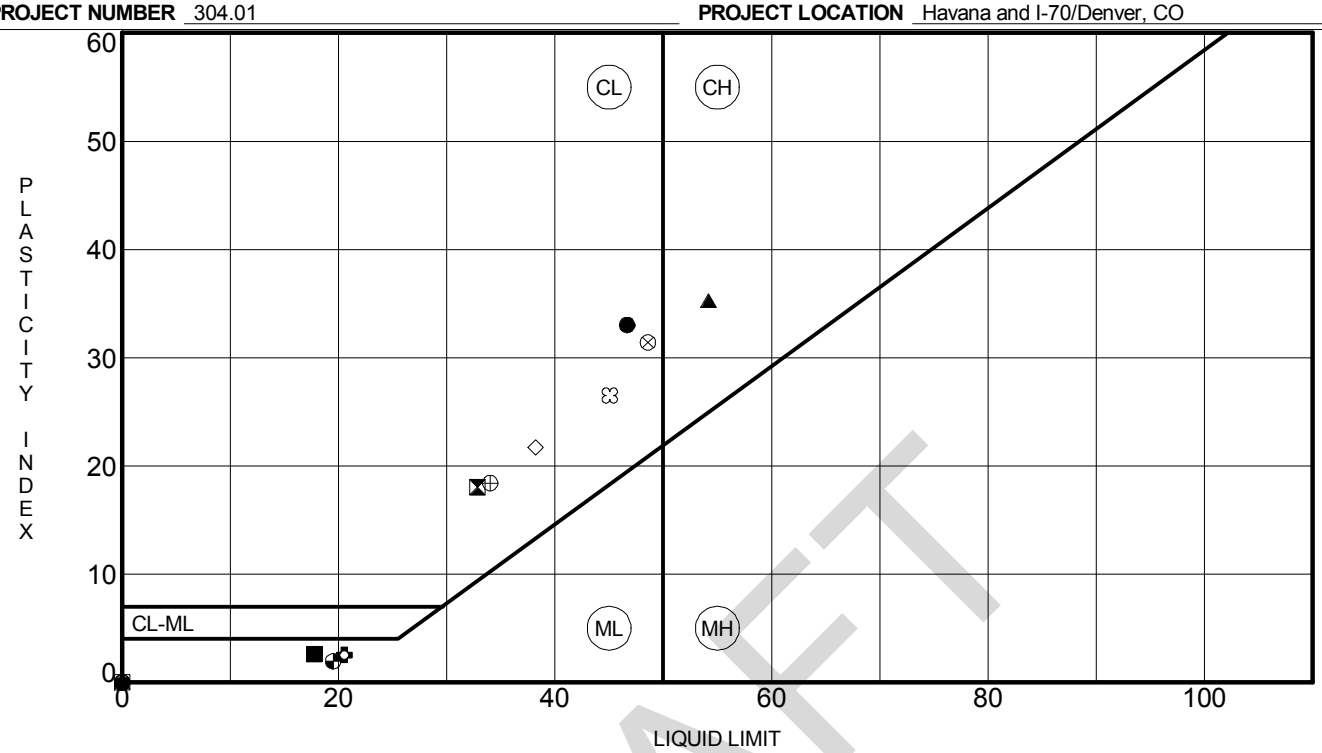
PROJECT NAME I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01

PROJECT LOCATION Havana and I-70/Denver, CO



	Specimen Identification		LL	PL	PI	Fines	Classification
●	RW-4	45	47	14	33	49.0	CLAYEY SAND (SC)
⊠	RW-5	10	33	15	18	48.2	CLAYEY SAND (SC)
▲	RW-5	15	54	19	35	61.6	SANDY FAT CLAY (CH)
★	RW-5	25	NP	NP	NP	6.0	SAND
⊙	RW-5	35	NP	NP	NP	3.1	SAND
✿	RW-6	0-5.0	21	18	3	26.0	SILTY SAND (SM)
○	RW-6	9	NP	NP	NP	7.4	WELL-GRADED SAND with SILT (SW-SM)
△	RW-7	0-5.0	NP	NP	NP	21.3	SILTY SAND (SM)
⊗	RW-7	14	49	17	32	67.2	SANDY LEAN CLAY (CL)
⊕	RW-7	24	34	16	18	49.9	CLAYEY SAND (SC)
□	RW-8	0-5.0	NP	NP	NP	17.0	SILTY SAND (SM)
⊛	RW-8	25	NP	NP	NP	9.9	POORLY GRADED SAND with SILT (SP-SM)
◕	RW-9	0-5.0	19	18	1	32.5	SILTY SAND (SM)
☆	RW-9	9	NP	NP	NP	12.9	SILTY SAND (SM)
⌘	RW-9	14	45	19	26	67.1	SANDY LEAN CLAY (CL)
■	RW-10	0-5.0	18	15	3	25.8	SILTY SAND (SM)
◆	RW-10	9	NP	NP	NP	10.8	SAND with silt (SM)
◇	RW-10	19	38	16	22	27.7	CLAYEY SAND (SC)

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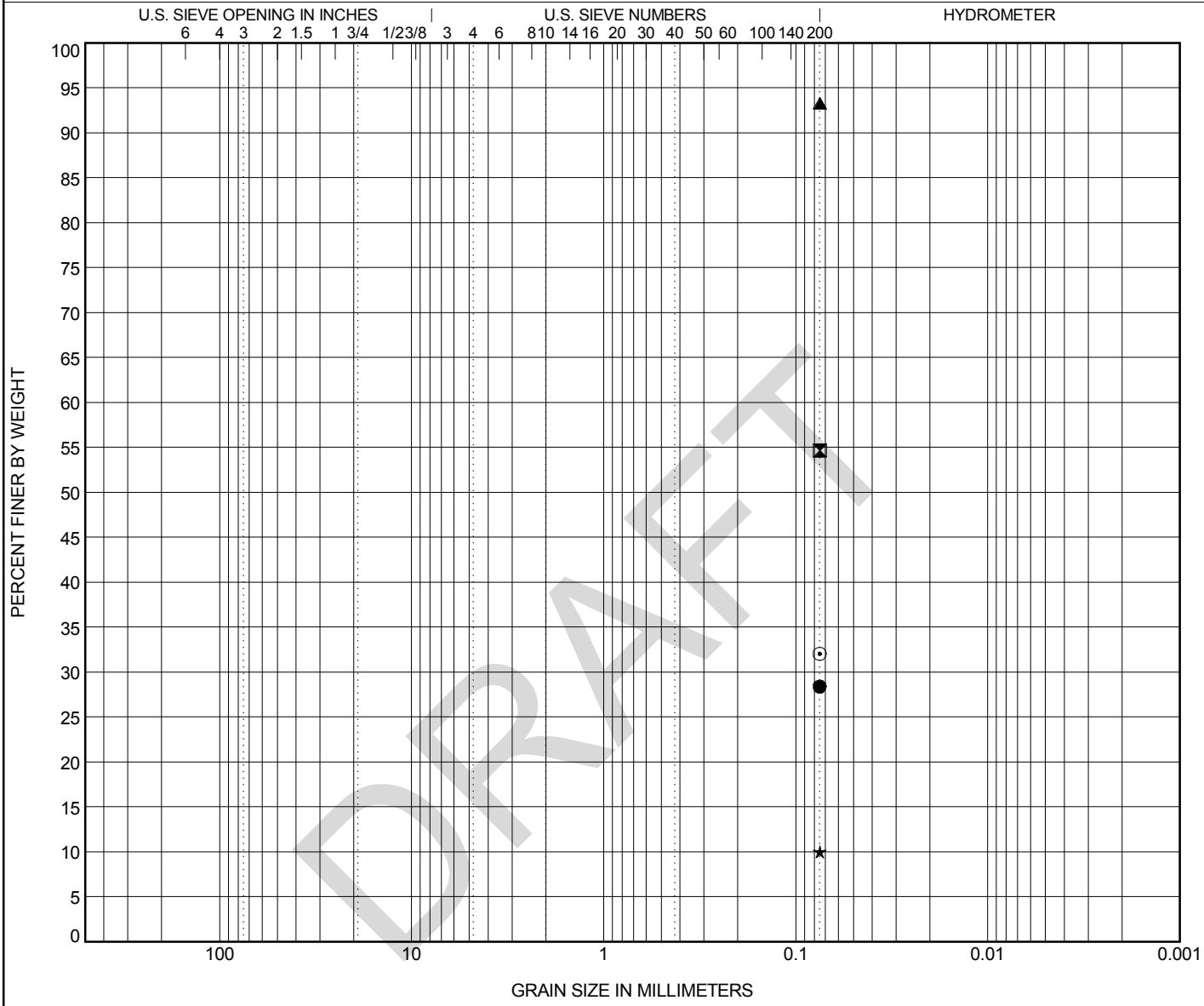
GRAIN SIZE DISTRIBUTION

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	BR-1	10	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		
⧗	BR-1	20	**SANDY FAT CLAY (CH)**	**51**	**18**	**33**		
▲	BR-1	30	**SILTY SAND (SM)**	**74**	**25**	**49**		
★	BR-1	40	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		
⊙	BR-1	50	**CLAYEY SAND (SC)**	**29**	**16**	**13**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BR-1	10	**0.075**						**28.4**	
⧗	BR-1	20	**0.075**						**54.7**	
▲	BR-1	30	**0.075**						**93.3**	
★	BR-1	40	**0.075**			**0.075**			**10.0**	
⊙	BR-1	50	**0.075**						**32.0**	

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GRAIN SIZE DISTRIBUTION

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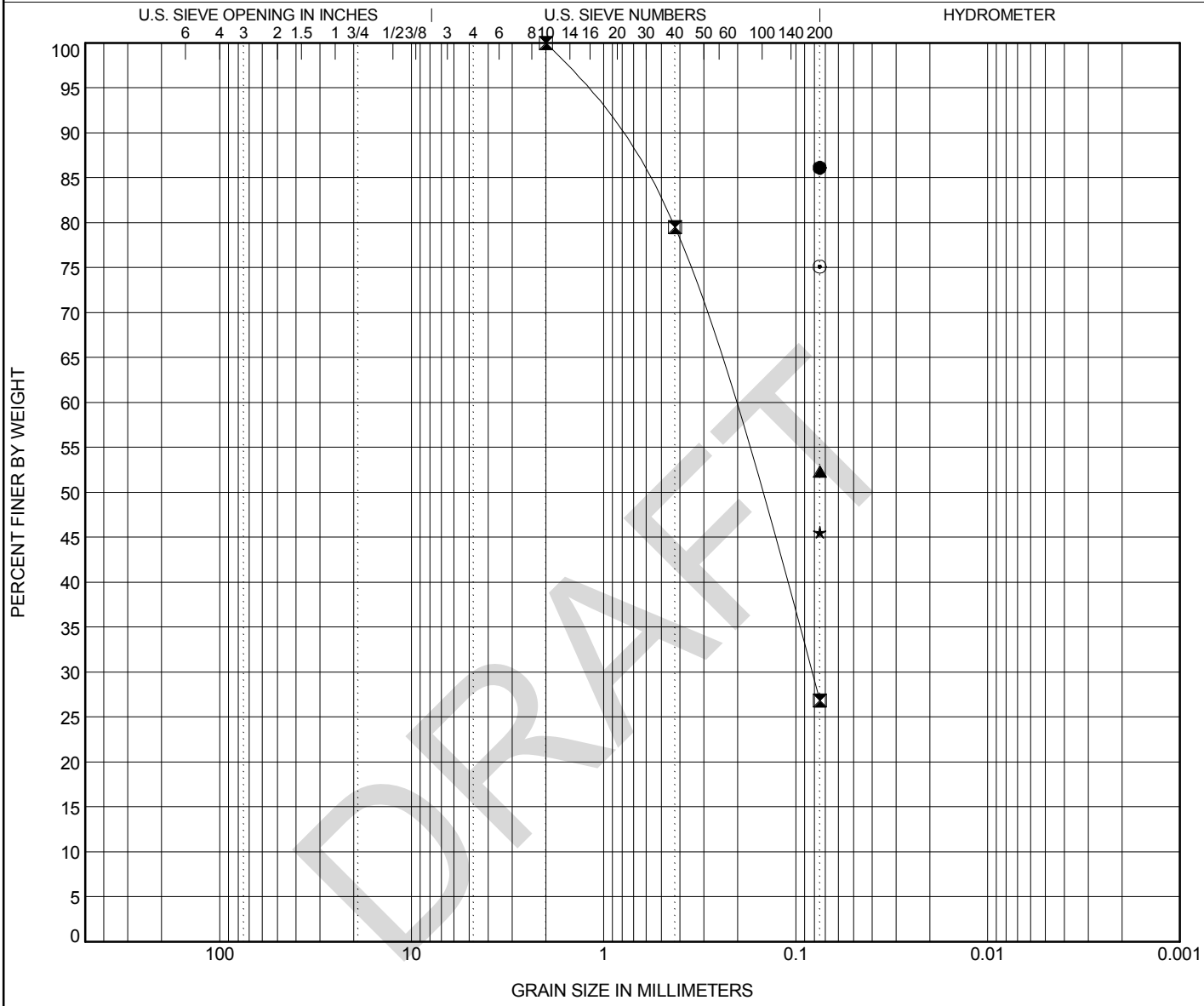
PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**BR-1**	**65**	**(Bedrock) CLAYSTONE (CH)**	**95**	**22**	**73**		
⧗	**BR-2**	**5**	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		
▲	**BR-2**	**10**	**SANDY LEAN CLAY (CL)**	**29**	**14**	**15**		
★	**BR-2**	**20**	**CLAYEY SAND (SC)**	**31**	**15**	**16**		
⊙	**BR-2**	**35**	**FAT CLAY with SAND (CH)**	**63**	**15**	**48**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BR-1**	**65**	**0.075**						**86.1**	
⧗	**BR-2**	**5**	**2**	**0.224**	**0.083**		**0.0**	**73.2**	**26.8**	
▲	**BR-2**	**10**	**0.075**						**52.3**	
★	**BR-2**	**20**	**0.075**						**45.6**	
⊙	**BR-2**	**35**	**0.075**						**75.1**	

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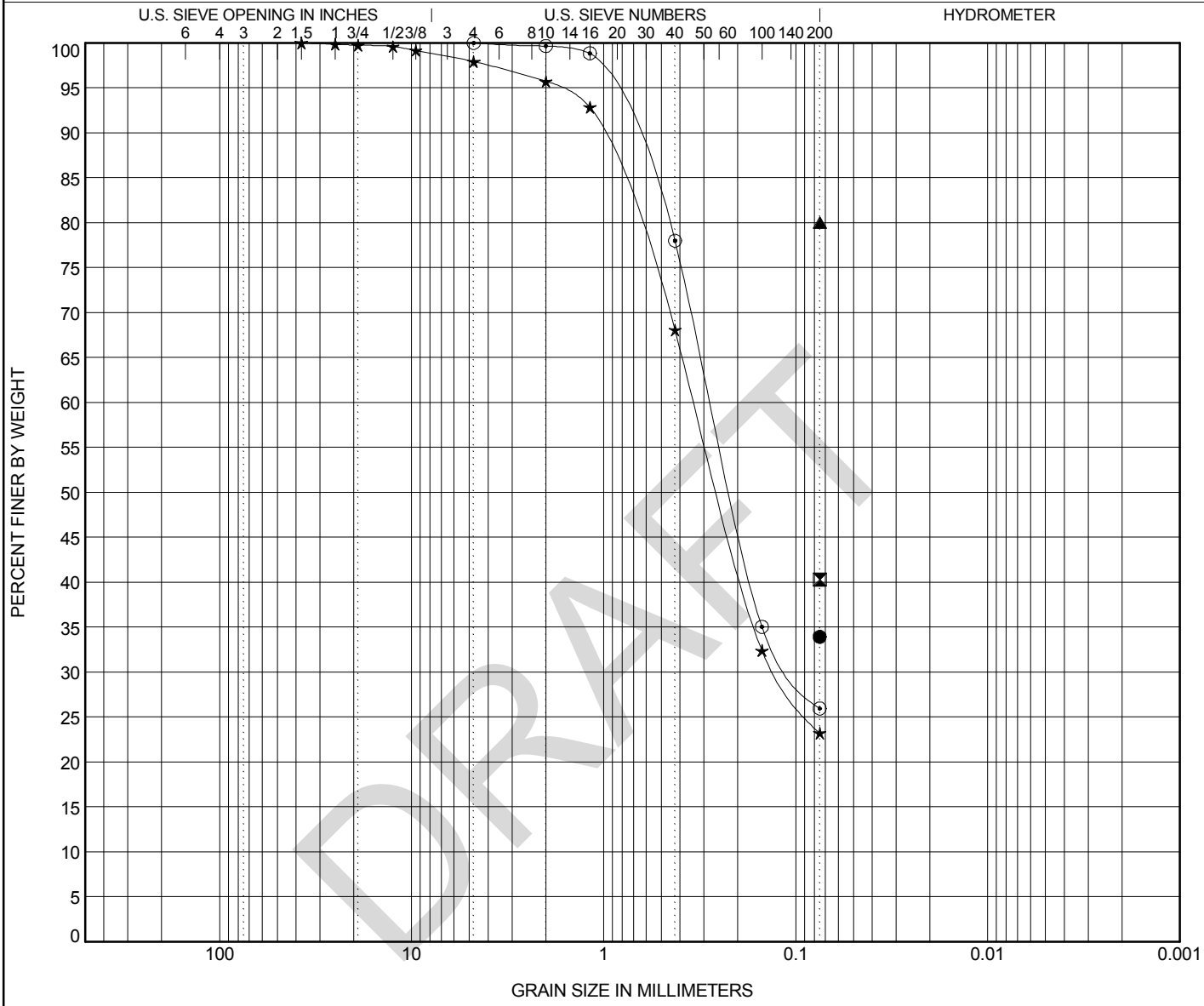
PROJECT NUMBER 304.01

PROJECT LOCATION Havana and I-70/Denver, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**BR-2**	**65**	**SILTY SAND (SM)**					
⧗	**BR-2**	**75**	**(Bedrock) SANDSTONE, clayey (SC)**					
▲	**BR-2**	**80**	**(Bedrock) SILTSTONE (MH)**	**79**	**39**	**40**		
★	**BR-3**	**0-5.0**	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		
⊙	**BR-3**	**20**	**SILTY, CLAYEY SAND (SC-SM)**	**27**	**20**	**7**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BR-2**	**65**	**0.075**						**33.9**	
⧗	**BR-2**	**75**	**0.075**						**40.3**	
▲	**BR-2**	**80**	**0.075**						**80.0**	
★	**BR-3**	**0-5.0**	**37.5**	**0.336**	**0.125**		**2.1**	**74.7**	**23.2**	
⊙	**BR-3**	**20**	**4.75**	**0.275**	**0.102**		**0.0**	**74.0**	**26.0**	

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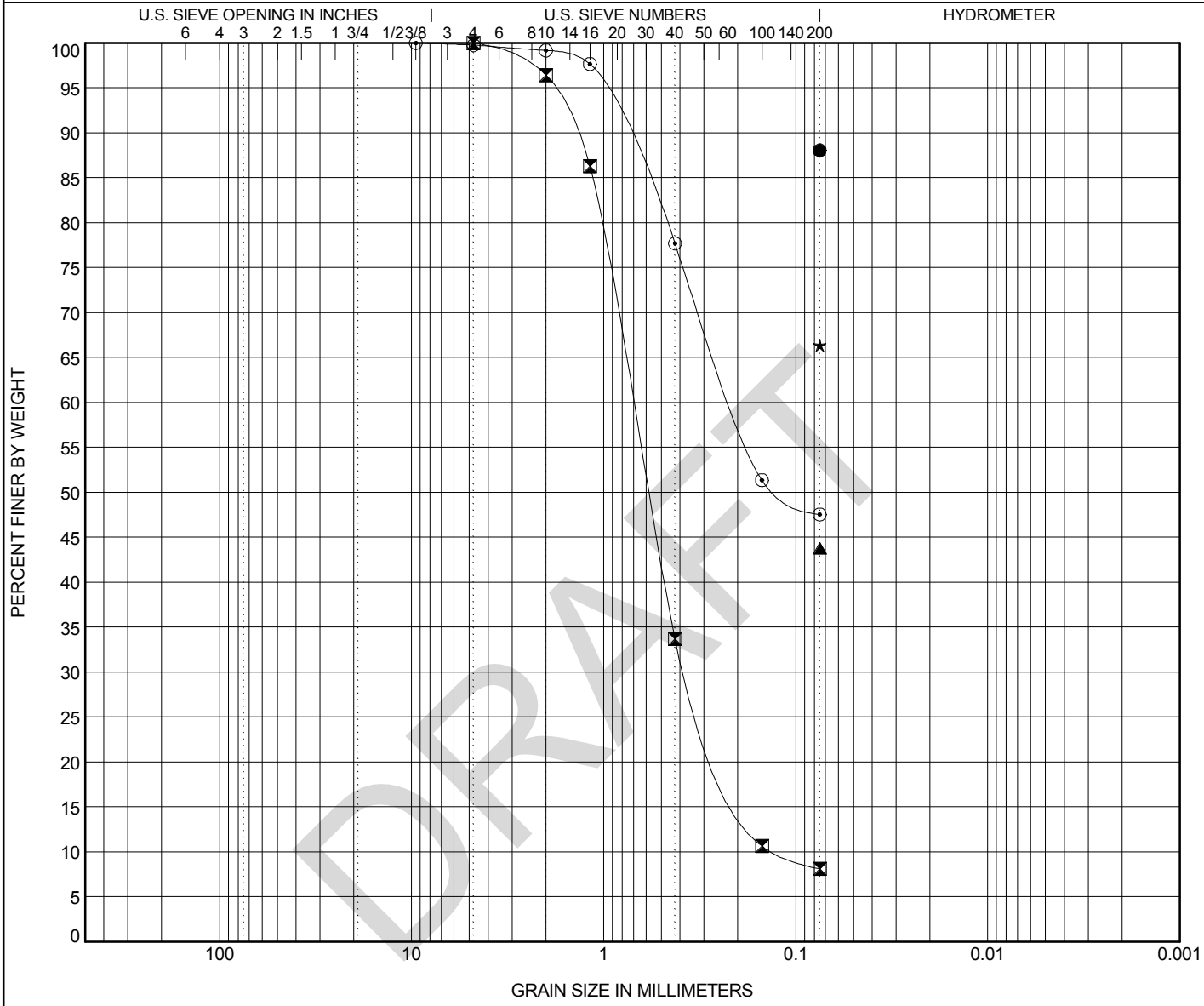

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**BR-3**	**30**	**FAT CLAY (CH)**	**72**	**21**	**51**		
⧗	**BR-3**	**40**	**POORLY GRADED SAND with SILT (SP-SM)**	**NP**	**NP**	**NP**	**1.45**	**5.62**
▲	**BR-3**	**50**	**CLAYEY SAND (SC)**	**34**	**18**	**16**		
★	**BR-3**	**60**	**(Bedrock) CLAYSTONE, sandy**	**69**	**31**	**38**		
⊙	**BR-4**	**5**	**SILTY, CLAYEY SAND (SC-SM)**	**22**	**16**	**6**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BR-3**	**30**	**0.075**						**88.1**	
⧗	**BR-3**	**40**	**4.75**	**0.708**	**0.36**	**0.126**	**0.0**	**91.9**	**8.1**	
▲	**BR-3**	**50**	**0.075**						**43.8**	
★	**BR-3**	**60**	**0.075**						**66.4**	
⊙	**BR-4**	**5**	**9.5**	**0.211**			**0.2**	**52.2**	**47.5**	

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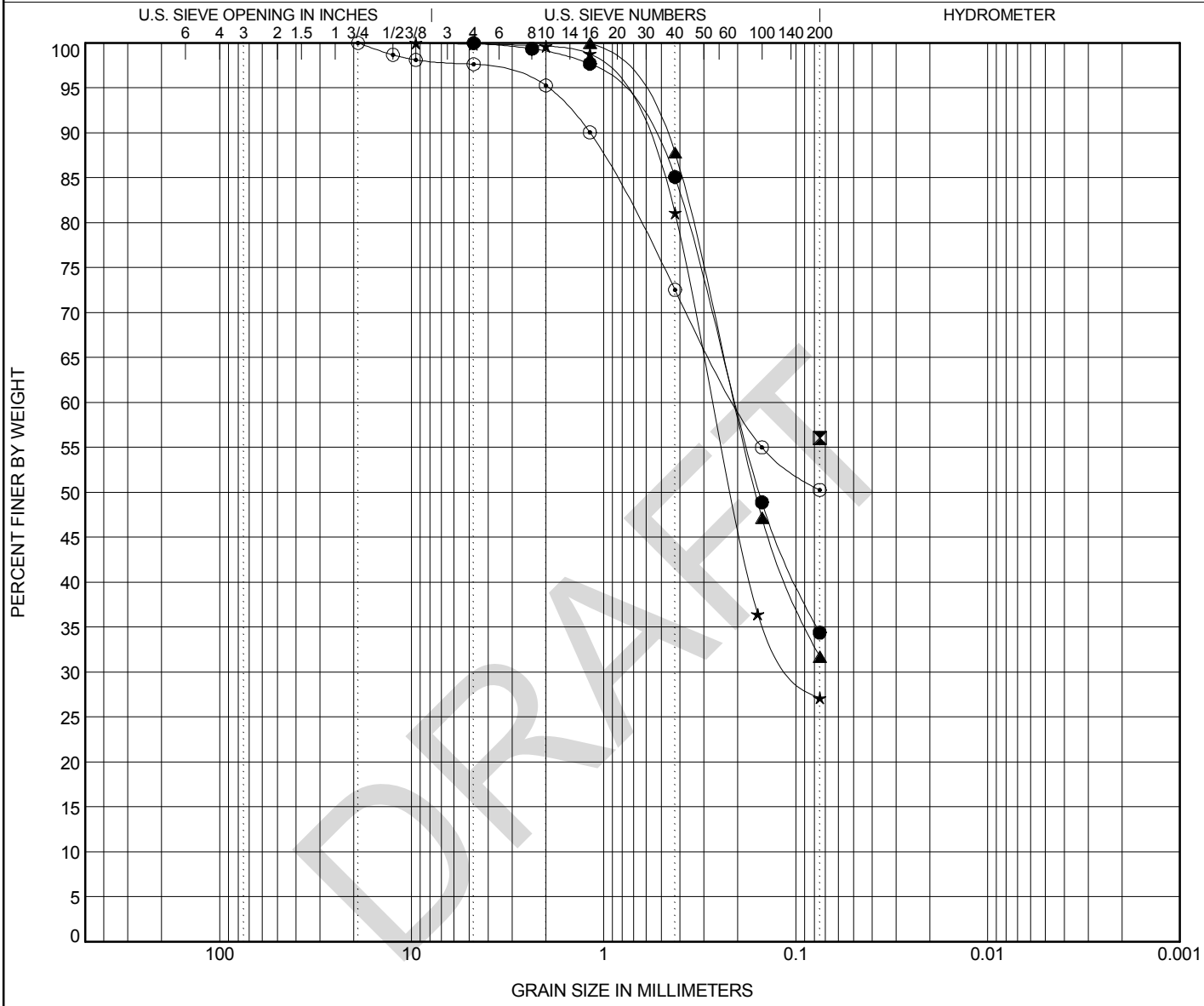

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	BR-4	10	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		
⧗	BR-4	20	**SANDY LEAN CLAY (CL)**	**32**	**15**	**17**		
▲	BR-4	30	**SILTY SAND (SM)**	**28**	**23**	**5**		
★	BR-4	35	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		
⊙	BR-4	45	**SANDY CLAY (CL)**					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BR-4	10	**4.75**	**0.206**			**0.0**	**65.6**	**34.4**	
⧗	BR-4	20	**0.075**						**56.1**	
▲	BR-4	30	**1.18**	**0.208**			**0.0**	**68.3**	**31.7**	
★	BR-4	35	**9.5**	**0.266**	**0.094**		**0.1**	**72.7**	**27.1**	
⊙	BR-4	45	**19**	**0.202**			**2.4**	**47.4**	**50.3**	

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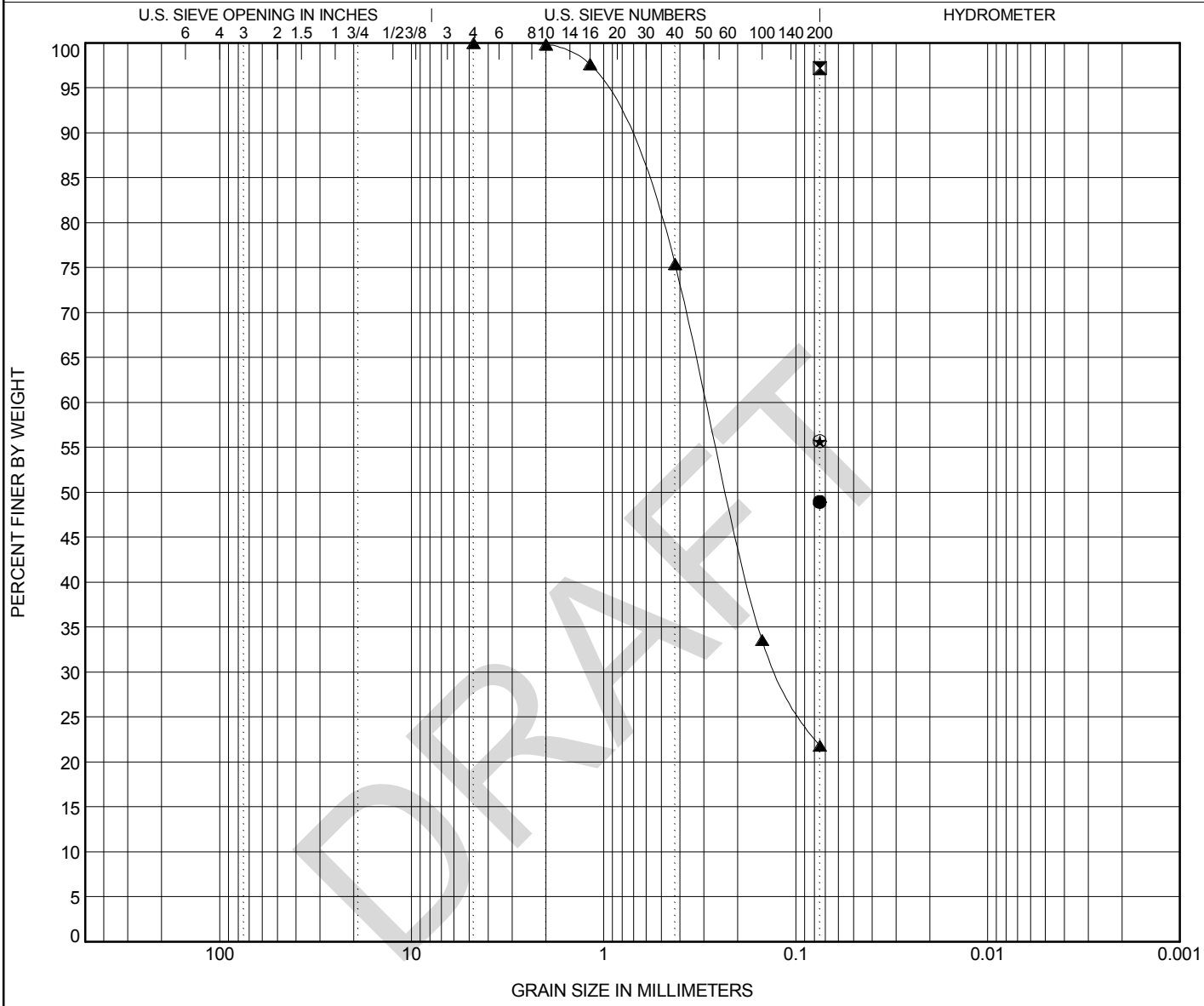

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	BR-4	55	**SILTY SAND (SM)**	57	30	27		
⧗	BR-4	60	**(Bedrock) CLAYSTONE (CH)**	57	26	31		
▲	BR-5	5	**SILTY SAND (SM)**	NP	NP	NP		
★	BR-5	15	**SANDY LEAN CLAY (CL)**	49	13	36		
⊙	BR-5	25	**SANDY LEAN CLAY (CL)**	44	16	28		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BR-4	55	0.075						48.9	
⧗	BR-4	60	0.075						97.2	
▲	BR-5	5	4.75	0.289	0.121		0.0	78.2	21.8	
★	BR-5	15	0.075						55.7	
⊙	BR-5	25	0.075						55.7	

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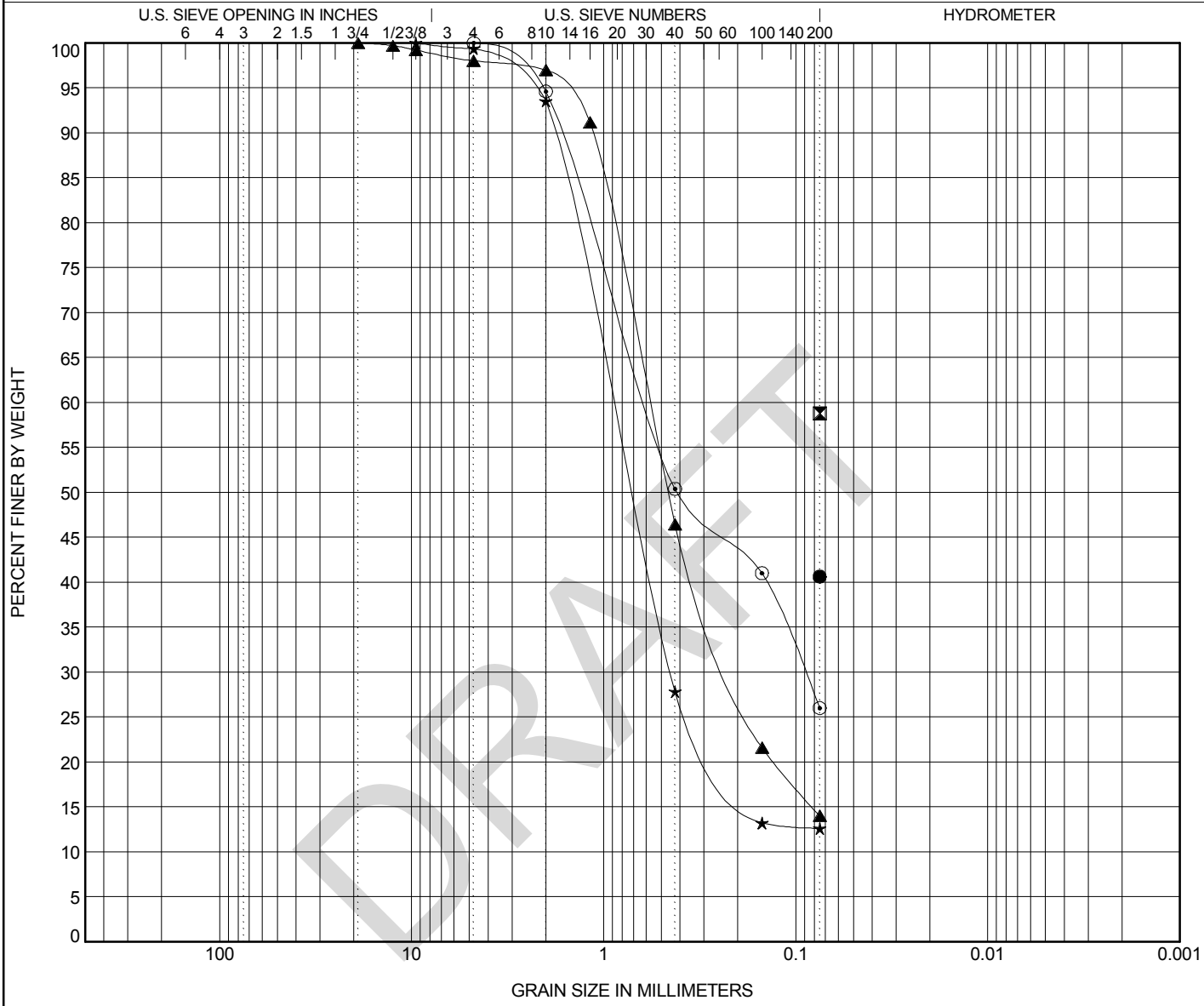

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	BR-5	40	**CLAYEY SAND (SC)**	**30**	**14**	**16**		
⧗	BR-5	65	**(Bedrock) CLAYSTONE, sandy (CH)**	**58**	**29**	**29**		
▲	BR-6	1-10.0	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		
★	BR-6	35	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		
⊙	BR-6	55	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BR-5	40	**0.075**						**40.6**	
⧗	BR-5	65	**0.075**						**58.8**	
▲	BR-6	1-10.0	**19**	**0.579**	**0.213**		**2.0**	**84.0**	**14.0**	
★	BR-6	35	**9.5**	**0.907**	**0.447**		**0.6**	**86.8**	**12.6**	
⊙	BR-6	55	**4.75**	**0.595**	**0.09**		**0.0**	**74.0**	**26.0**	

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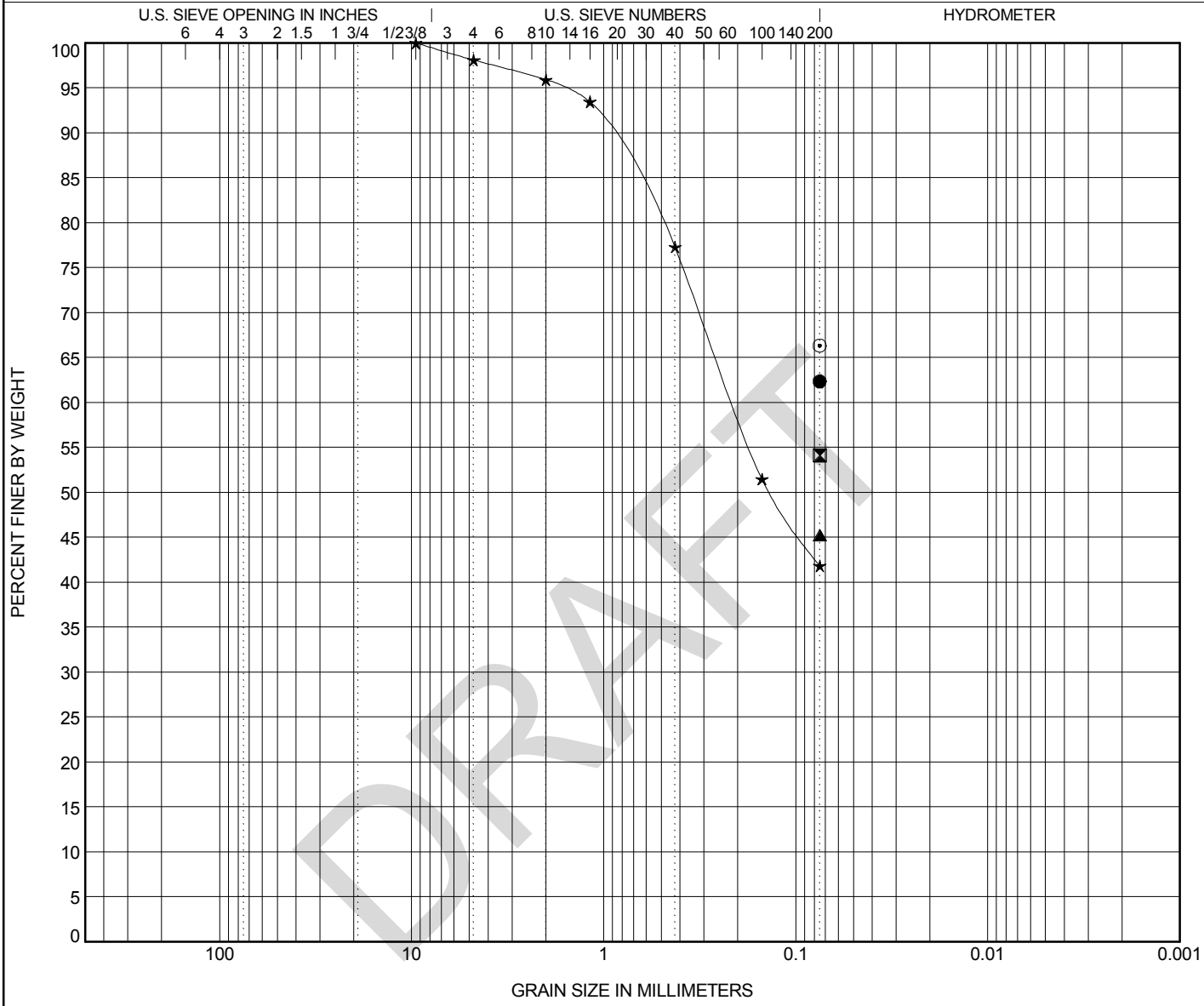

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**BR-6**	**70**	**SANDY LEAN CLAY (CL)**	**44**	**19**	**25**		
⧗	**BR-6**	**80**	**SANDY FAT CLAY (CH)**	**62**	**28**	**34**		
▲	**BR-6**	**85**	**(Bedrock) SANDSTONE, clayey (SC)**	**65**	**32**	**33**		
★	**PV-1**	**1-5.0**	**CLAYEY SAND (SC)**	**22**	**14**	**8**		
⊙	**PV-1**	**2**	**SAND, clayey**					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BR-6**	**70**	**0.075**						**62.3**	
⧗	**BR-6**	**80**	**0.075**						**54.1**	
▲	**BR-6**	**85**	**0.075**						**45.2**	
★	**PV-1**	**1-5.0**	**9.5**	**0.212**			**1.9**	**56.3**	**41.8**	
⊙	**PV-1**	**2**	**0.075**						**66.3**	

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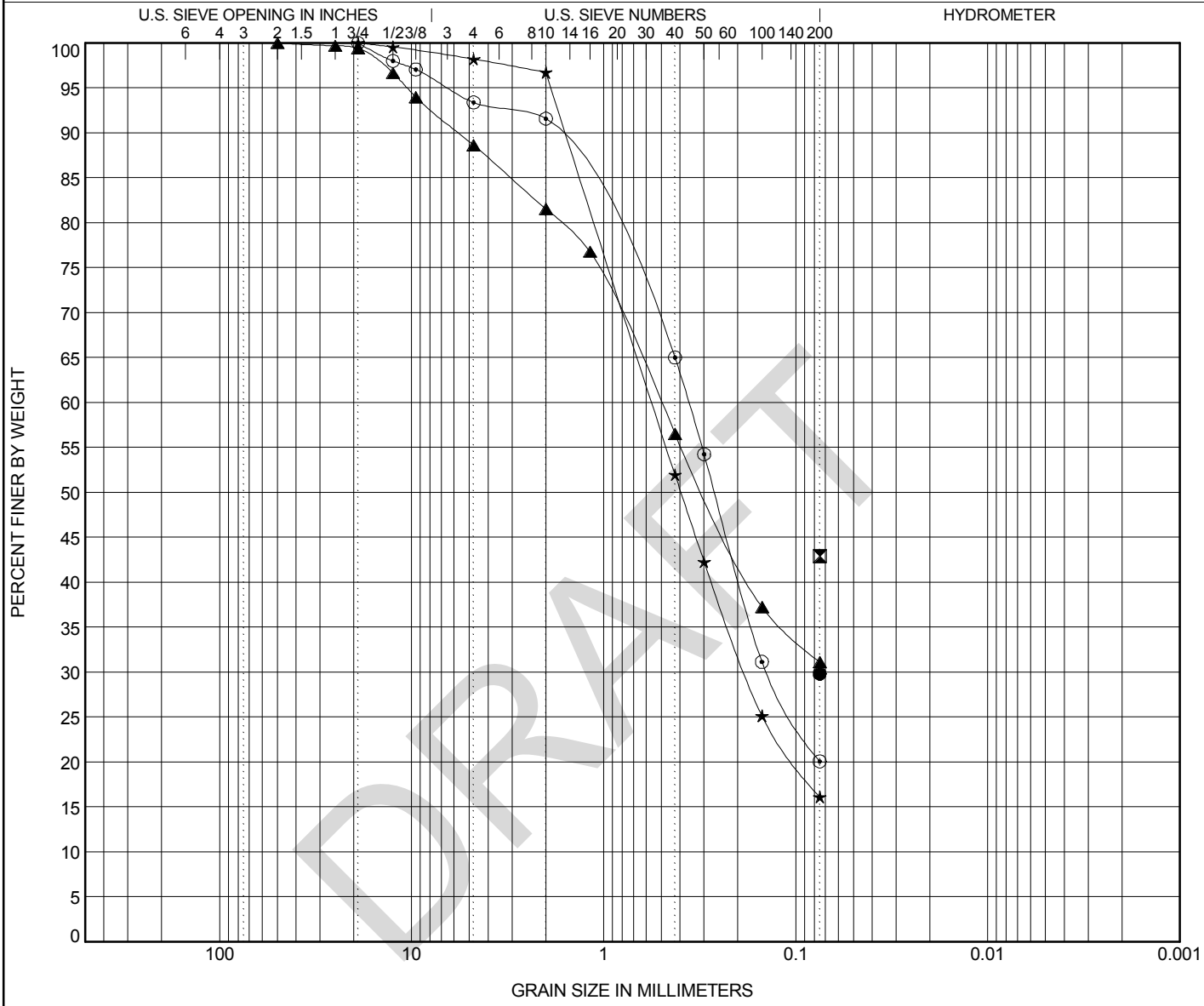

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**PV-1**	**4**	**(Fill) SAND, silty**					
⧗	**PV-1**	**9**	**CLAYEY SAND (SC)**					
▲	**PV-2**	**1-5.0**	**CLAYEY SAND (SC)**	**29**	**15**	**14**		
★	**PV-3**	**1-5.0**	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		
⊙	**PV-4**	**1-5.0**	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**PV-1**	**4**	**0.075**						**29.8**	
⧗	**PV-1**	**9**	**0.075**						**42.9**	
▲	**PV-2**	**1-5.0**	**50**	**0.506**			**11.4**	**57.5**	**31.1**	
★	**PV-3**	**1-5.0**	**19**	**0.561**	**0.183**		**1.8**	**82.1**	**16.1**	
⊙	**PV-4**	**1-5.0**	**19**	**0.361**	**0.14**		**6.6**	**73.3**	**20.1**	

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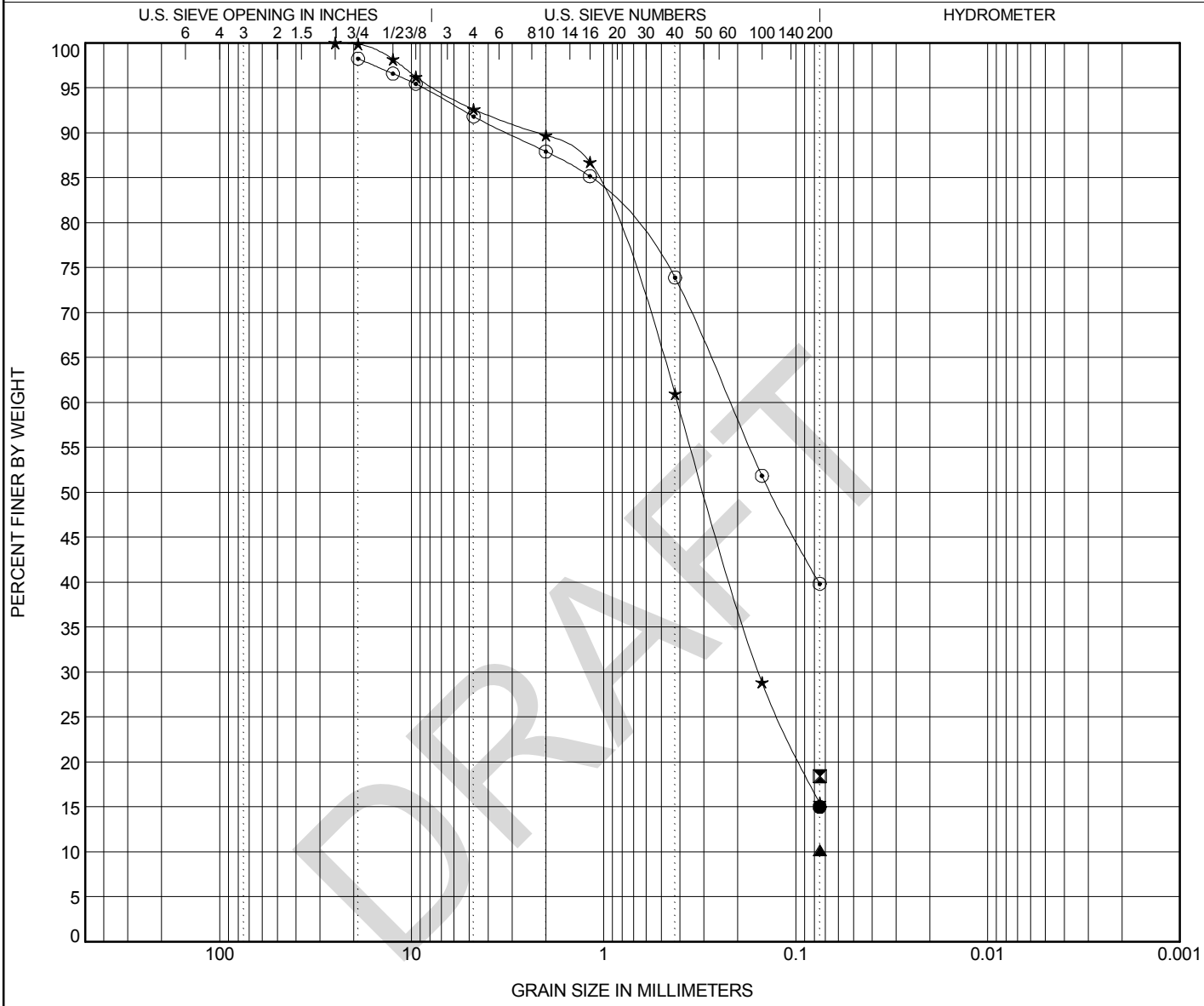

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	PV-4	2	**SILTY SAND (SM)**					
⧗	PV-4	4	**SILTY SAND (SM)**					
▲	PV-4	9	**SILTY SAND (SM)**					
★	PV-5	1-5.0	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		
⊙	PV-6	1-5.0	**CLAYEY SAND (SC)**	**30**	**16**	**14**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	PV-4	2	**0.075**						**15.0**	
⧗	PV-4	4	**0.075**						**18.4**	
▲	PV-4	9	**0.075**						**10.2**	
★	PV-5	1-5.0	**25**	**0.412**	**0.156**		**7.4**	**77.2**	**15.5**	
⊙	PV-6	1-5.0	**19**	**0.22**			**6.4**	**52.0**	**39.8**	

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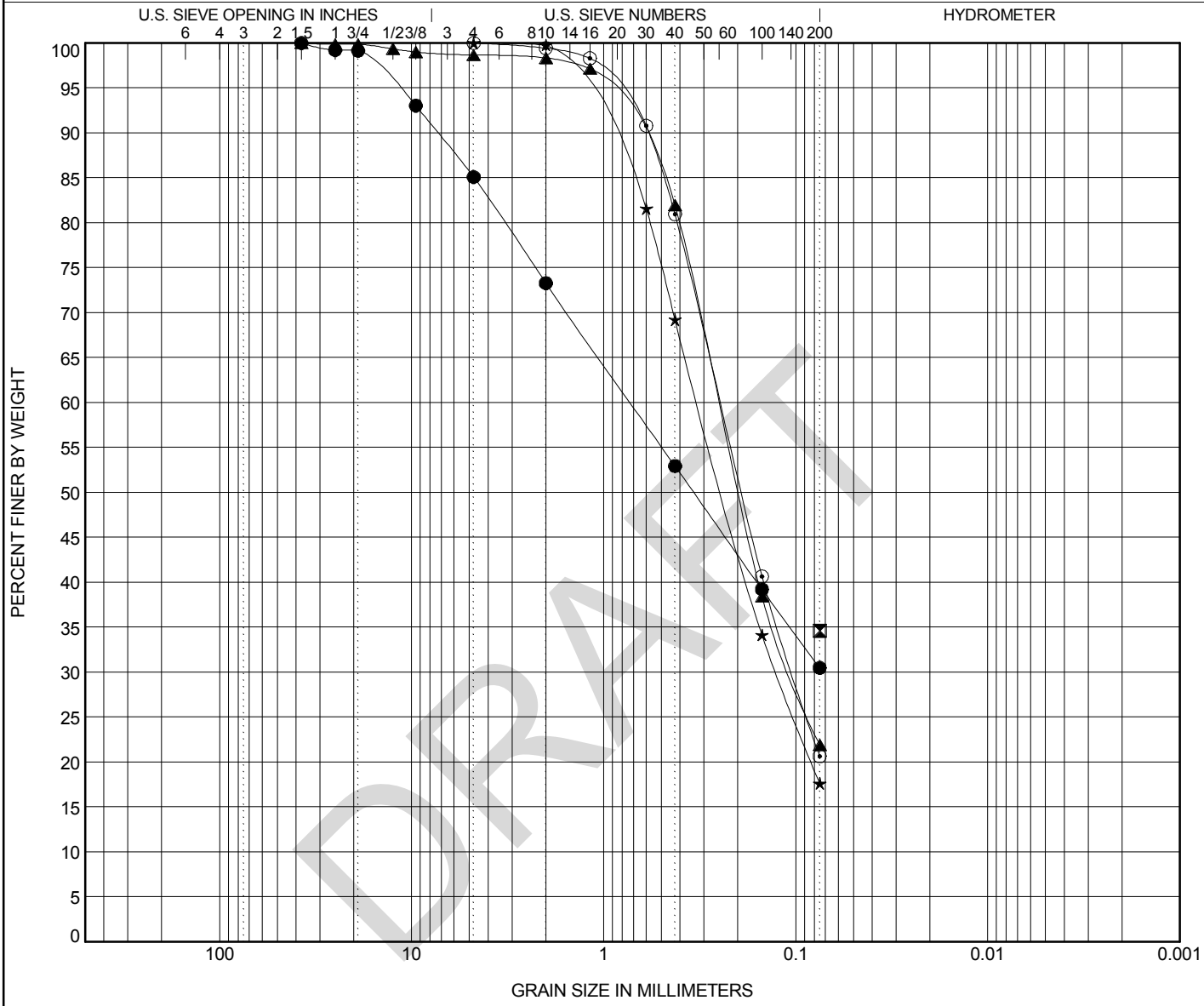

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**PV-7**	**0-5.0**	**CLAYEY SAND (SC)**	**35**	**13**	**22**		
⧗	**PV-7**	**2**	**(Fill) CLAYEY SAND (SC)**	**37**	**15**	**22**		
▲	**PV-8**	**1-5.0**	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		
★	**RW-1**	**5**	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		
⊙	**RW-1**	**15**	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**PV-7**	**0-5.0**	**37.5**	**0.728**			**14.9**	**54.6**	**30.5**	
⧗	**PV-7**	**2**	**0.075**						**34.6**	
▲	**PV-8**	**1-5.0**	**37.5**	**0.251**	**0.105**		**1.3**	**76.8**	**21.9**	
★	**RW-1**	**5**	**4.75**	**0.323**	**0.126**		**0.0**	**82.4**	**17.6**	
⊙	**RW-1**	**15**	**4.75**	**0.247**	**0.104**		**0.0**	**79.4**	**20.6**	

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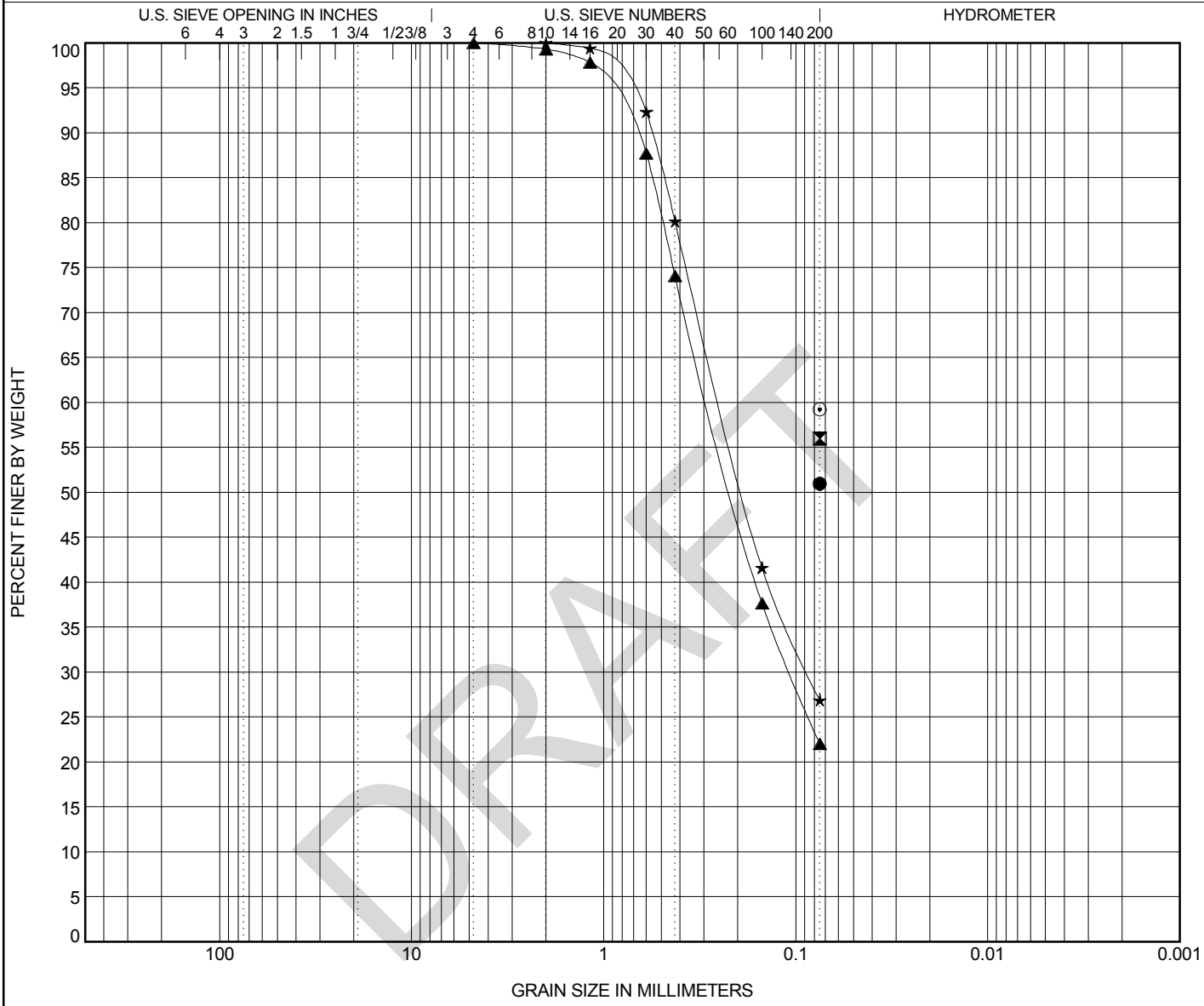

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	RW-1	25	SANDY LEAN CLAY (CL)	26	13	13		
⧗	RW-1	40	SANDY FAT CLAY (CH)	50	17	33		
▲	RW-2	10	CLAYEY SAND (SC)	25	15	10		
★	RW-2	25	SILTY SAND (SM)	NP	NP	NP		
⊙	RW-2	40	SANDY LEAN CLAY (CL)	34	16	18		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	RW-1	25	0.075						51.0	
⧗	RW-1	40	0.075						56.0	
▲	RW-2	10	4.75	0.284	0.107		0.0	78.0	22.0	
★	RW-2	25	2	0.246	0.087		0.0	73.1	26.9	
⊙	RW-2	40	0.075						59.2	

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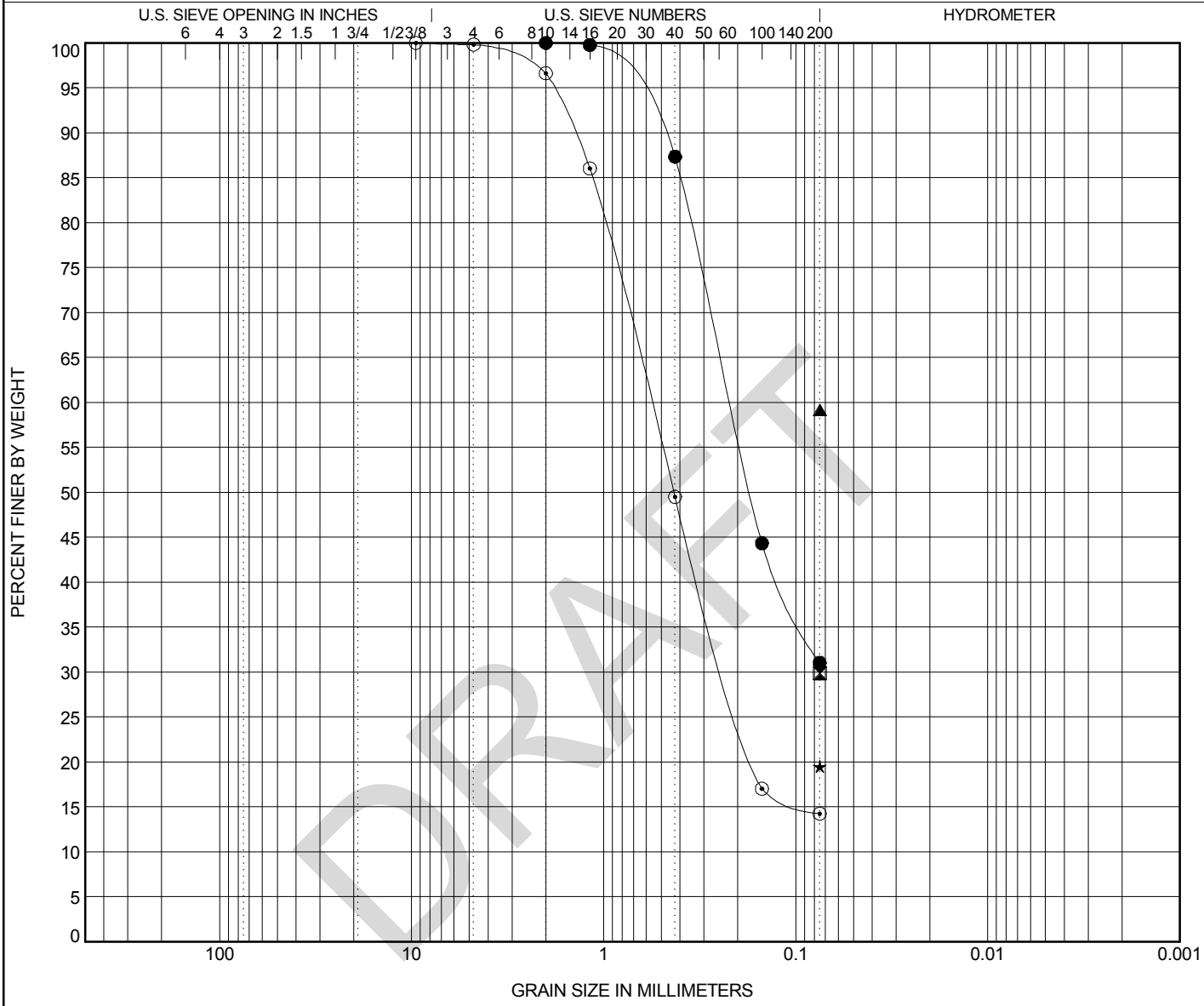

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	RW-3	10	SILTY SAND (SM)	NP	NP	NP		
⧗	RW-3	30	SILTY SAND (SM)	NP	NP	NP		
▲	RW-3	40	SANDY LEAN CLAY (CL)	42	17	25		
★	RW-3	45	CLAYEY SAND (SC)					
⊙	RW-3	50	SILTY SAND (SM)	NP	NP	NP		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	RW-3	10	2	0.219			0.0	69.0	31.0	
⧗	RW-3	30	0.075						29.9	
▲	RW-3	40	0.075						59.2	
★	RW-3	45	0.075						19.5	
⊙	RW-3	50	9.5	0.57	0.227		0.2	85.6	14.3	

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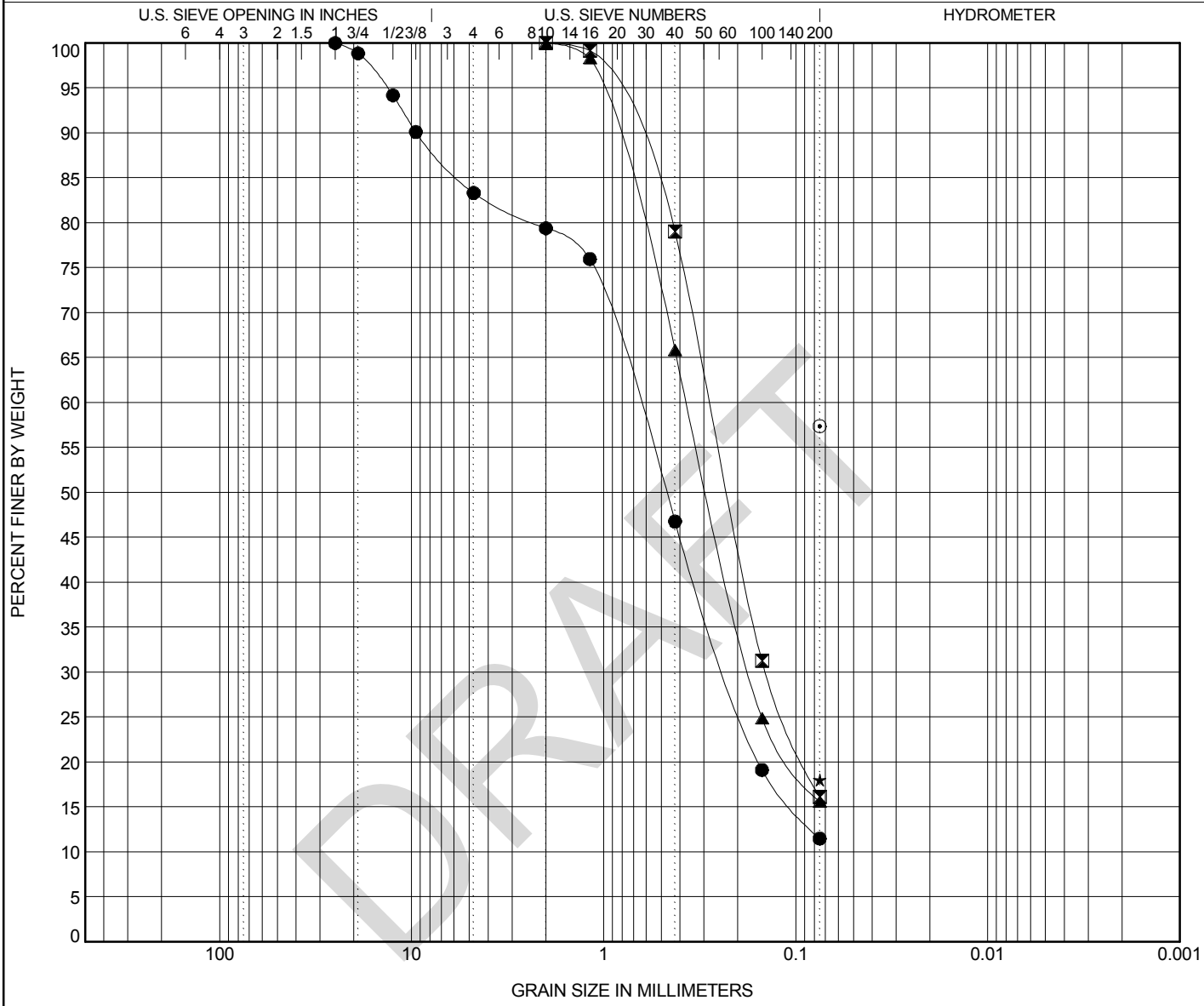
Telephone: 303-962-9300

GRAIN SIZE DISTRIBUTION

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	RW-4	1-10.0	WELL-GRADED SAND with SILT and GRAVEL (SW-SM)	NP	NP	NP	1.15	10.30
⧗	RW-4	5	SILTY SAND (SM)	NP	NP	NP		
▲	RW-4	15	SILTY SAND (SM)	NP	NP	NP		
★	RW-4	25	SILTY SAND (SM)	NP	NP	NP		
⊙	RW-4	35	SANDY FAT CLAY (CH)	52	19	33		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	RW-4	1-10.0	25	0.675	0.226		16.7	71.8	11.5	
⧗	RW-4	5	2	0.281	0.142		0.0	83.9	16.1	
▲	RW-4	15	2	0.366	0.171		0.0	84.4	15.6	
★	RW-4	25	0.075						18.0	
⊙	RW-4	35	0.075						57.4	

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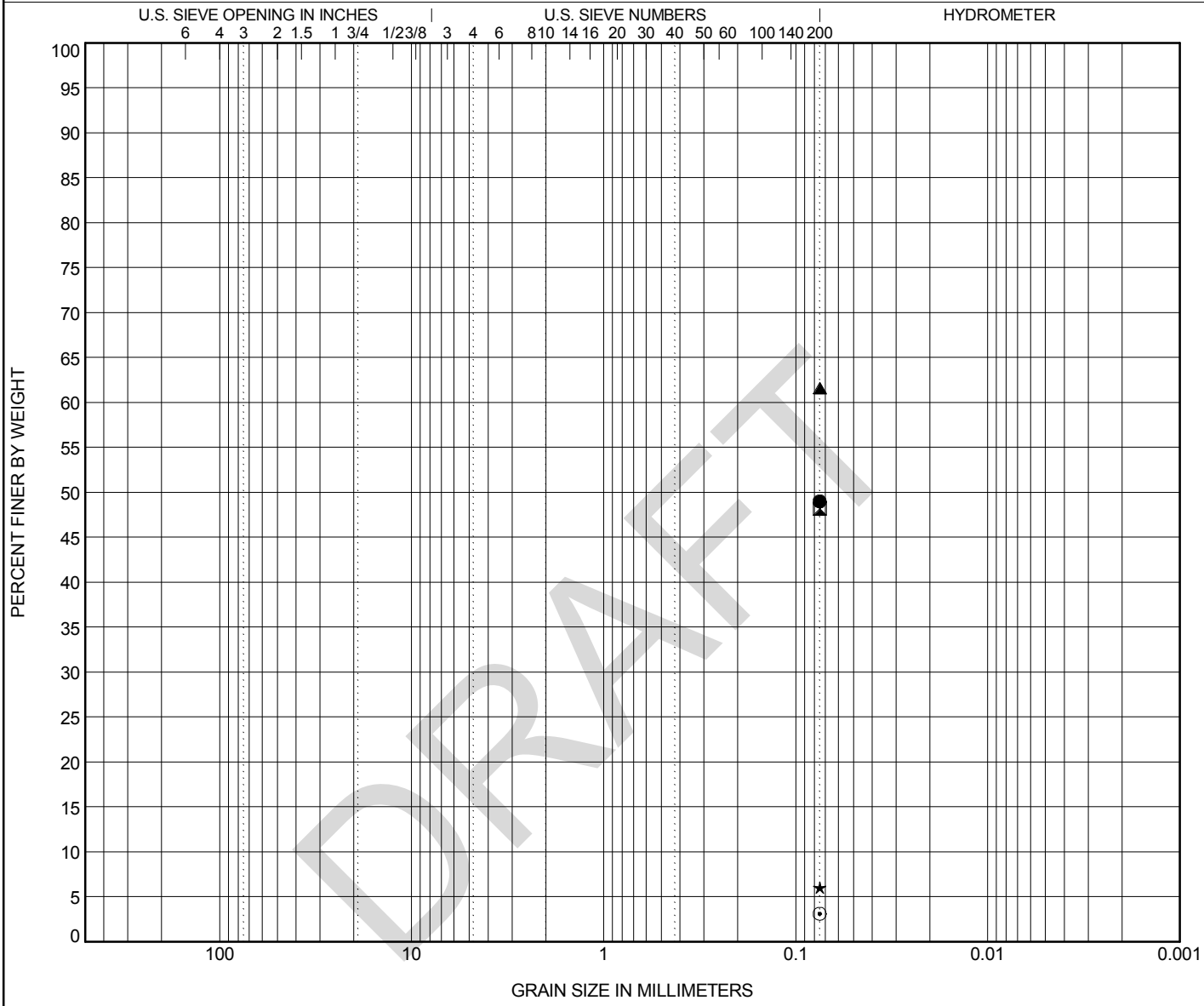
PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**RW-4**	**45**	**CLAYEY SAND (SC)**	**47**	**14**	**33**		
⧗	**RW-5**	**10**	**CLAYEY SAND (SC)**	**33**	**15**	**18**		
▲	**RW-5**	**15**	**SANDY FAT CLAY (CH)**	**54**	**19**	**35**		
★	**RW-5**	**25**	**SAND**	**NP**	**NP**	**NP**		
⊙	**RW-5**	**35**	**SAND**	**NP**	**NP**	**NP**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**RW-4**	**45**	**0.075**						**49.0**	
⧗	**RW-5**	**10**	**0.075**						**48.2**	
▲	**RW-5**	**15**	**0.075**						**61.6**	
★	**RW-5**	**25**	**0.075**						**6.0**	
⊙	**RW-5**	**35**	**0.075**						**3.1**	

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GRAIN SIZE DISTRIBUTION

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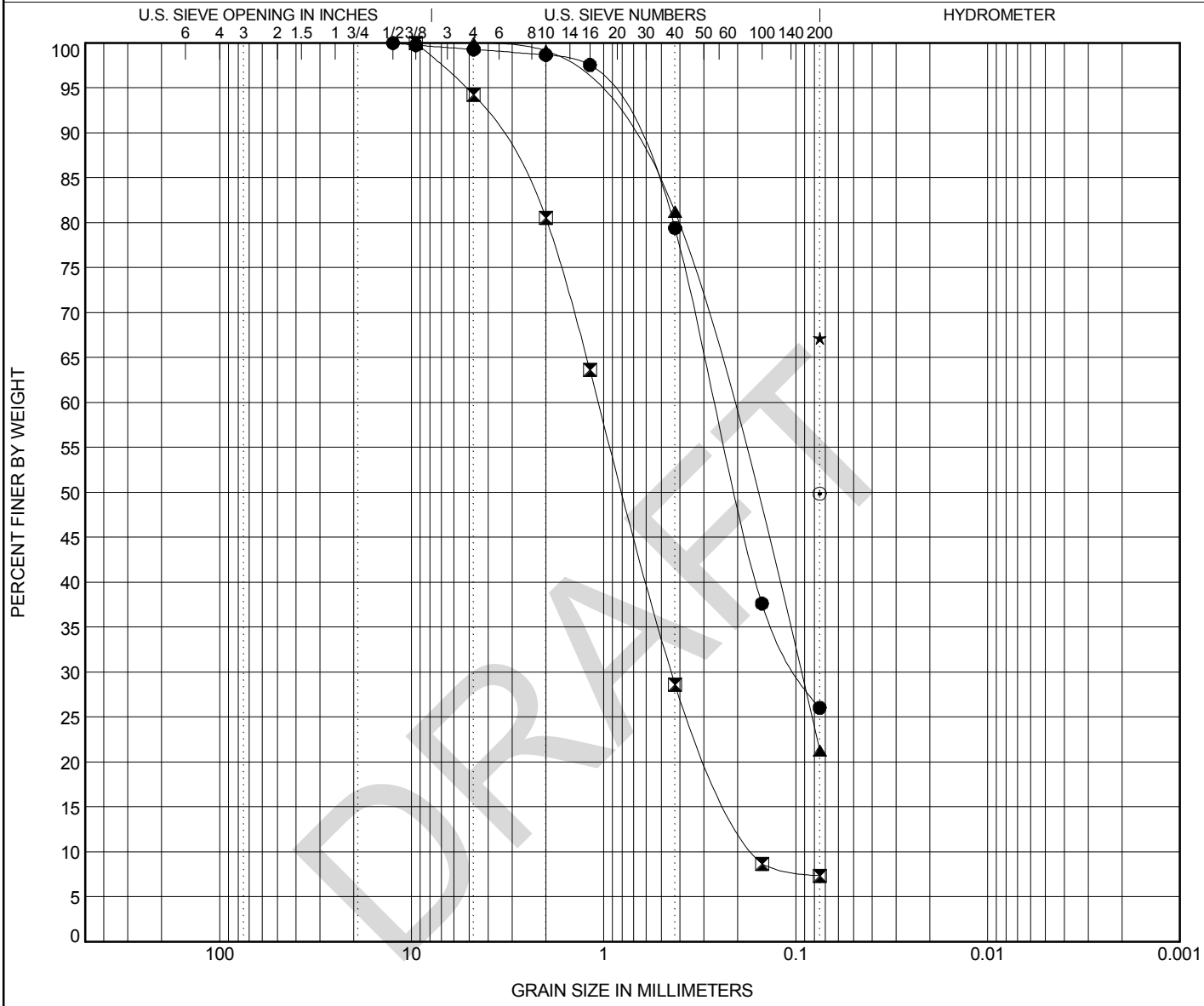
PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	RW-6	0-5.0	SILTY SAND (SM)	21	18	3		
⧗	RW-6	9	WELL-GRADED SAND with SILT (SW-SM)	NP	NP	NP	1.15	6.60
▲	RW-7	0-5.0	SILTY SAND (SM)	NP	NP	NP		
★	RW-7	14	SANDY LEAN CLAY (CL)	49	17	32		
⊙	RW-7	24	CLAYEY SAND (SC)	34	16	18		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	RW-6	0-5.0	12.5	0.262	0.095		0.7	73.2	26.0	
⧗	RW-6	9	9.5	1.062	0.442	0.161	5.7	86.9	7.4	
▲	RW-7	0-5.0	4.75	0.23	0.097		0.0	78.7	21.3	
★	RW-7	14	0.075						67.2	
⊙	RW-7	24	0.075						49.9	

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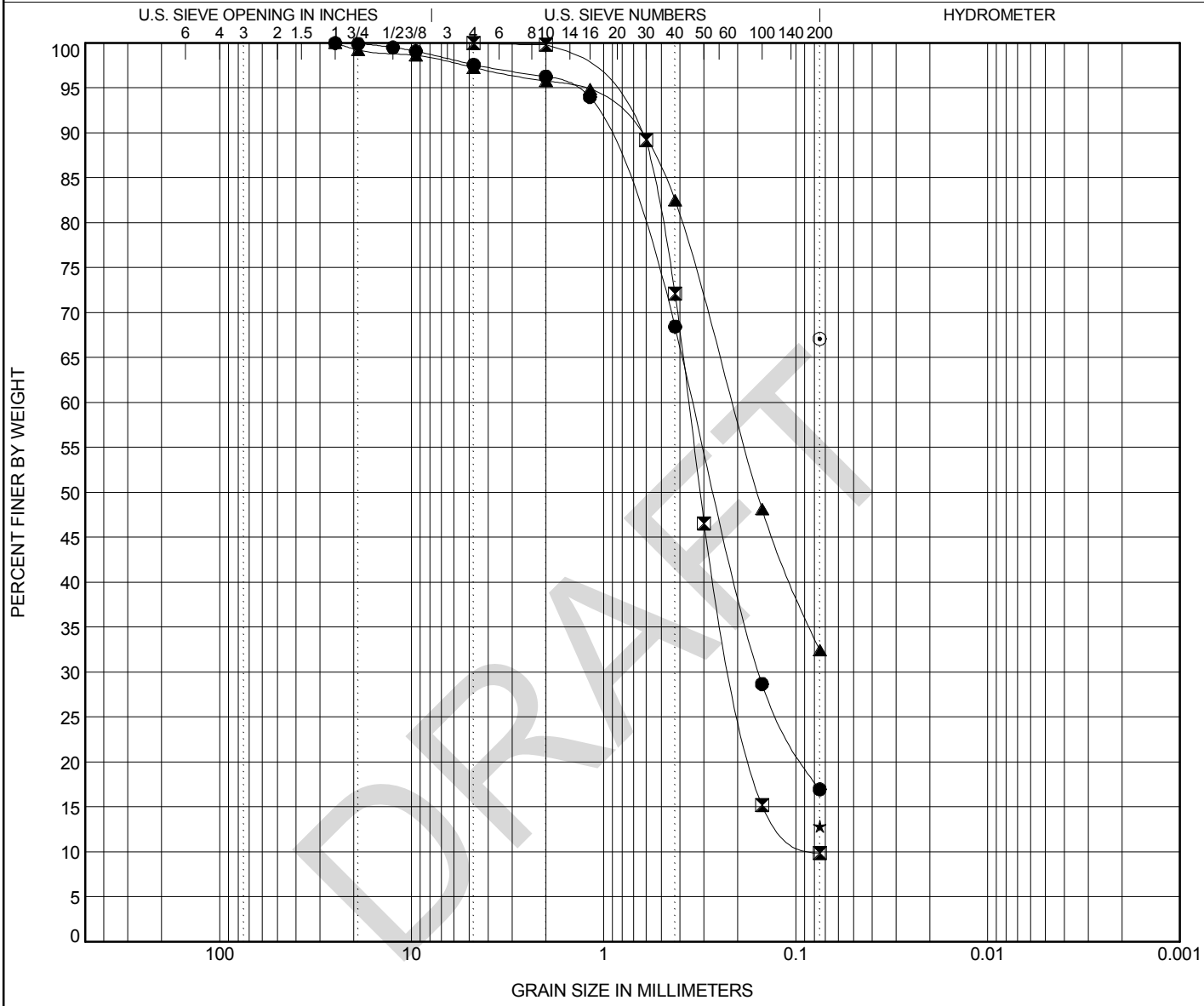
PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**RW-8**	**0-5.0**	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		
⧗	**RW-8**	**25**	**POORLY GRADED SAND with SILT (SP-SM)**	**NP**	**NP**	**NP**	**1.57**	**4.71**
▲	**RW-9**	**0-5.0**	**SILTY SAND (SM)**	**19**	**18**	**1**		
★	**RW-9**	**9**	**SILTY SAND (SM)**	**NP**	**NP**	**NP**		
⊙	**RW-9**	**14**	**SANDY LEAN CLAY (CL)**	**45**	**19**	**26**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**RW-8**	**0-5.0**	**25**	**0.341**	**0.155**		**2.4**	**80.6**	**17.0**	
⧗	**RW-8**	**25**	**4.75**	**0.36**	**0.208**	**0.076**	**0.0**	**90.1**	**9.9**	
▲	**RW-9**	**0-5.0**	**25**	**0.215**			**2.7**	**64.8**	**32.5**	
★	**RW-9**	**9**	**0.075**						**12.9**	
⊙	**RW-9**	**14**	**0.075**						**67.1**	

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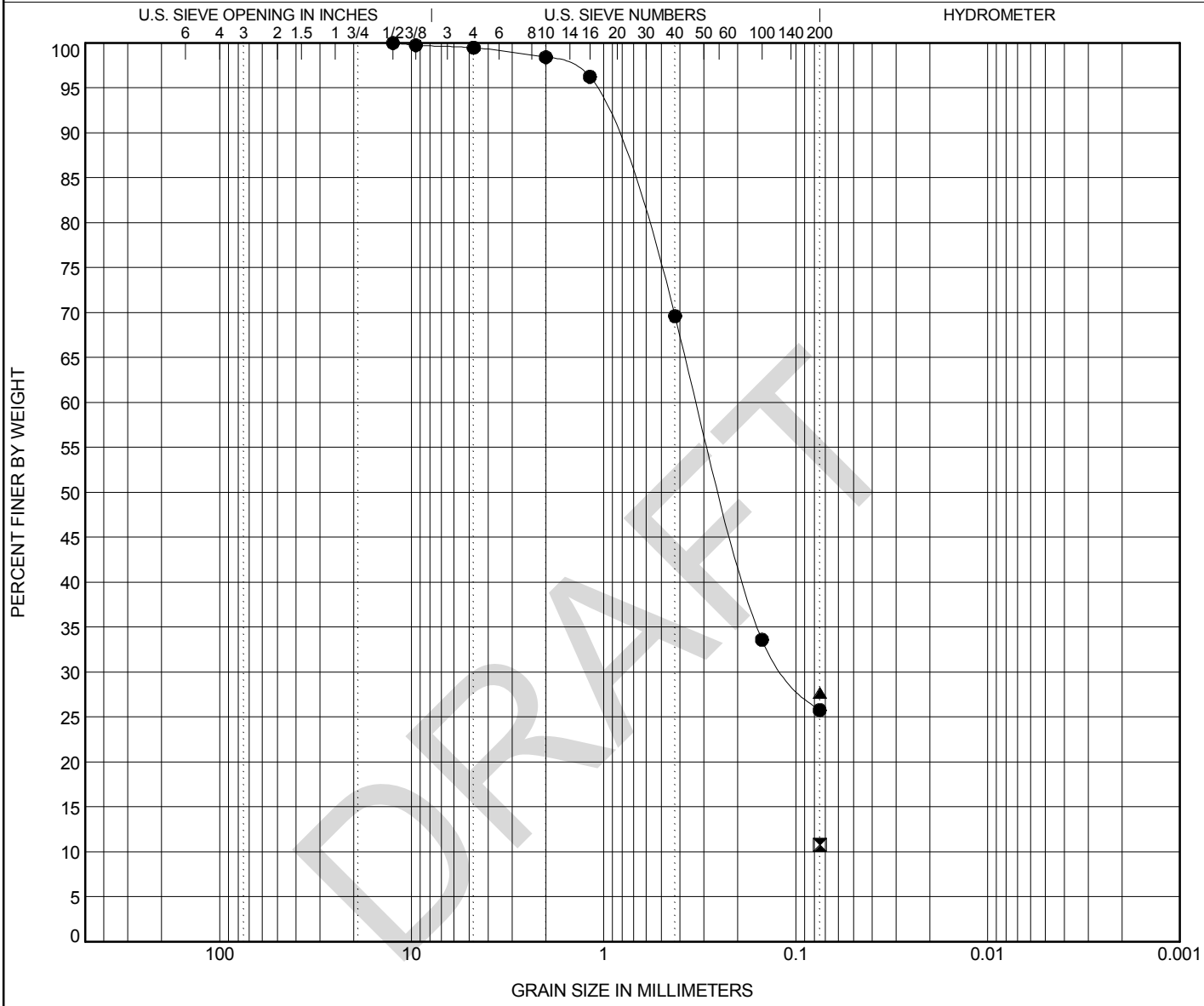

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**RW-10**	**0-5.0**	**SILTY SAND (SM)**	**18**	**15**	**3**		
⧗	**RW-10**	**9**	**SAND with silt (SM)**	**NP**	**NP**	**NP**		
▲	**RW-10**	**19**	**CLAYEY SAND (SC)**	**38**	**16**	**22**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**RW-10**	**0-5.0**	**12.5**	**0.322**	**0.109**		**0.5**	**73.7**	**25.8**	
⧗	**RW-10**	**9**	**0.075**						**10.8**	
▲	**RW-10**	**19**	**0.075**						**27.7**	

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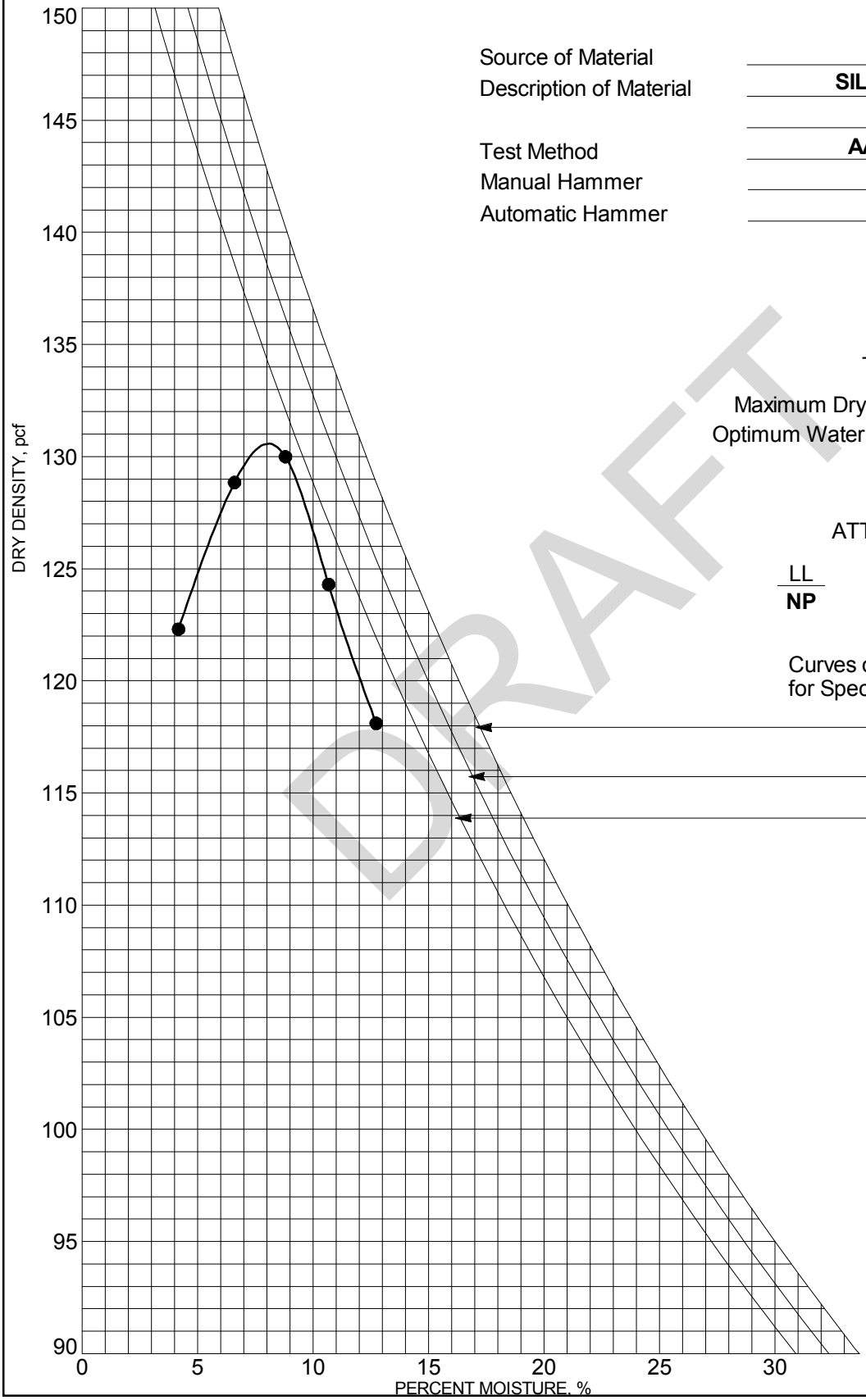

Source of Material	**BR-3 0-5'**
Description of Material	**SILTY SAND (SM)**
	A-2-4(0)
Test Method	**AASHTO T180**
Manual Hammer	X
Automatic Hammer	

TEST RESULTS

Maximum Dry Density	**130.5**	**PCF**
Optimum Water Content	**8.0**	**%**

ATTERBERG LIMITS

LL	PL	PI
NP	**NP**	**NP**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60

DRAFT

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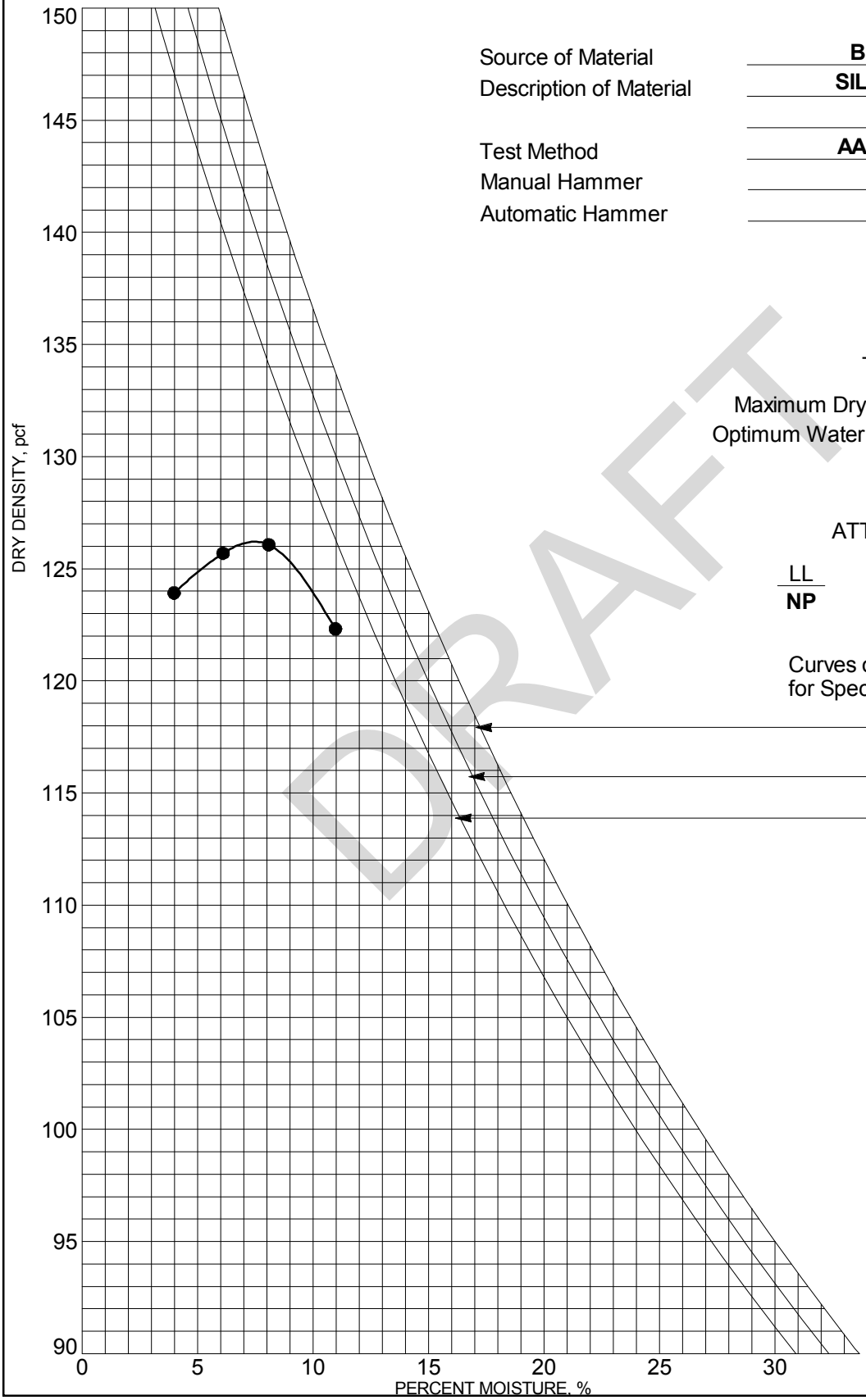
PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



Source of Material	**BR-6 1.25'-10'**
Description of Material	**SILTY SAND (SM)**
	A-1-b(0)
Test Method	**AASHTO T180 A**
Manual Hammer	X
Automatic Hammer	

TEST RESULTS

Maximum Dry Density	**126.2**	**PCF**
Optimum Water Content	**7.5**	**%**

ATTERBERG LIMITS

LL	PL	PI
NP	**NP**	**NP**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60

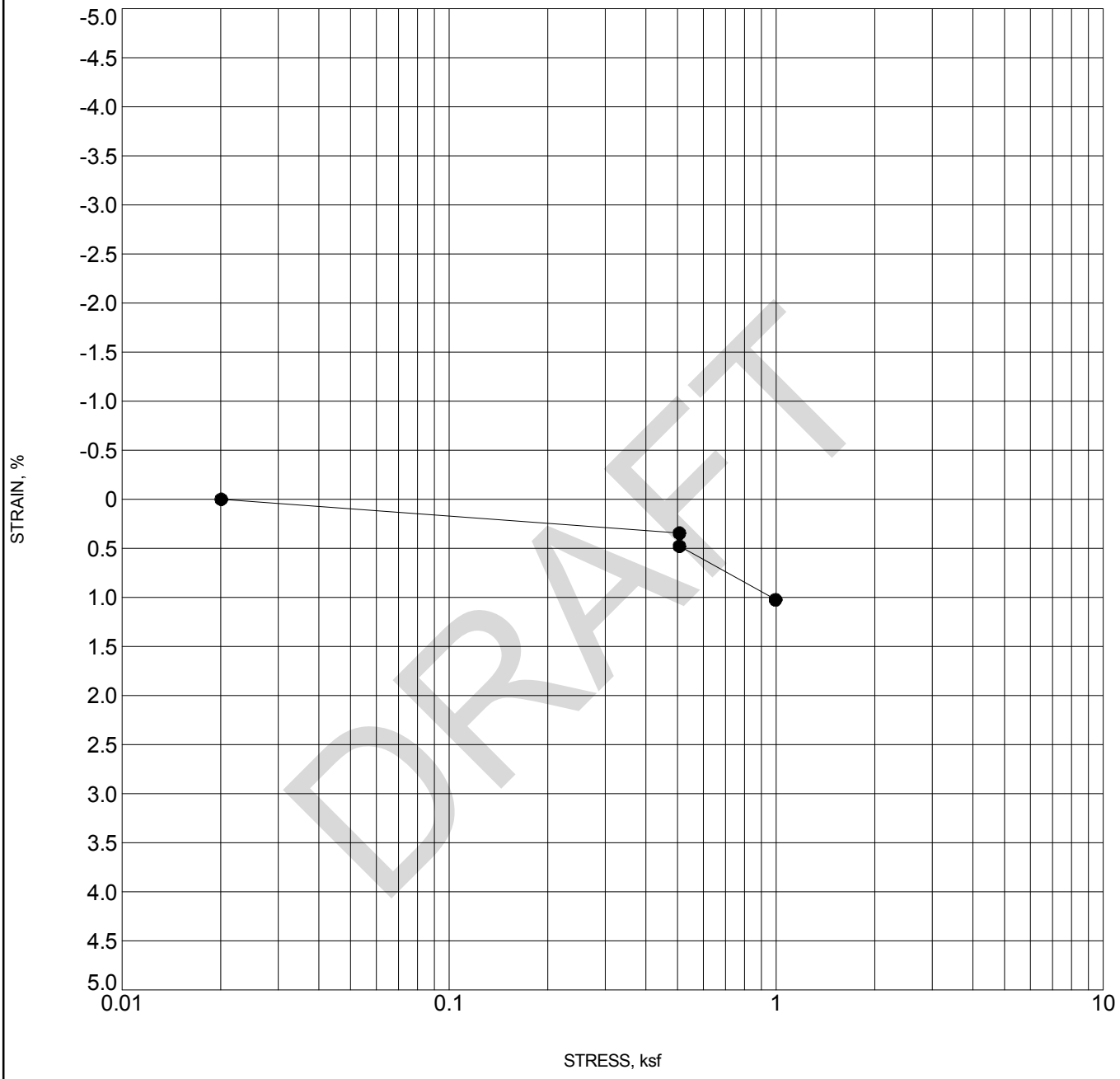
DRAFT

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



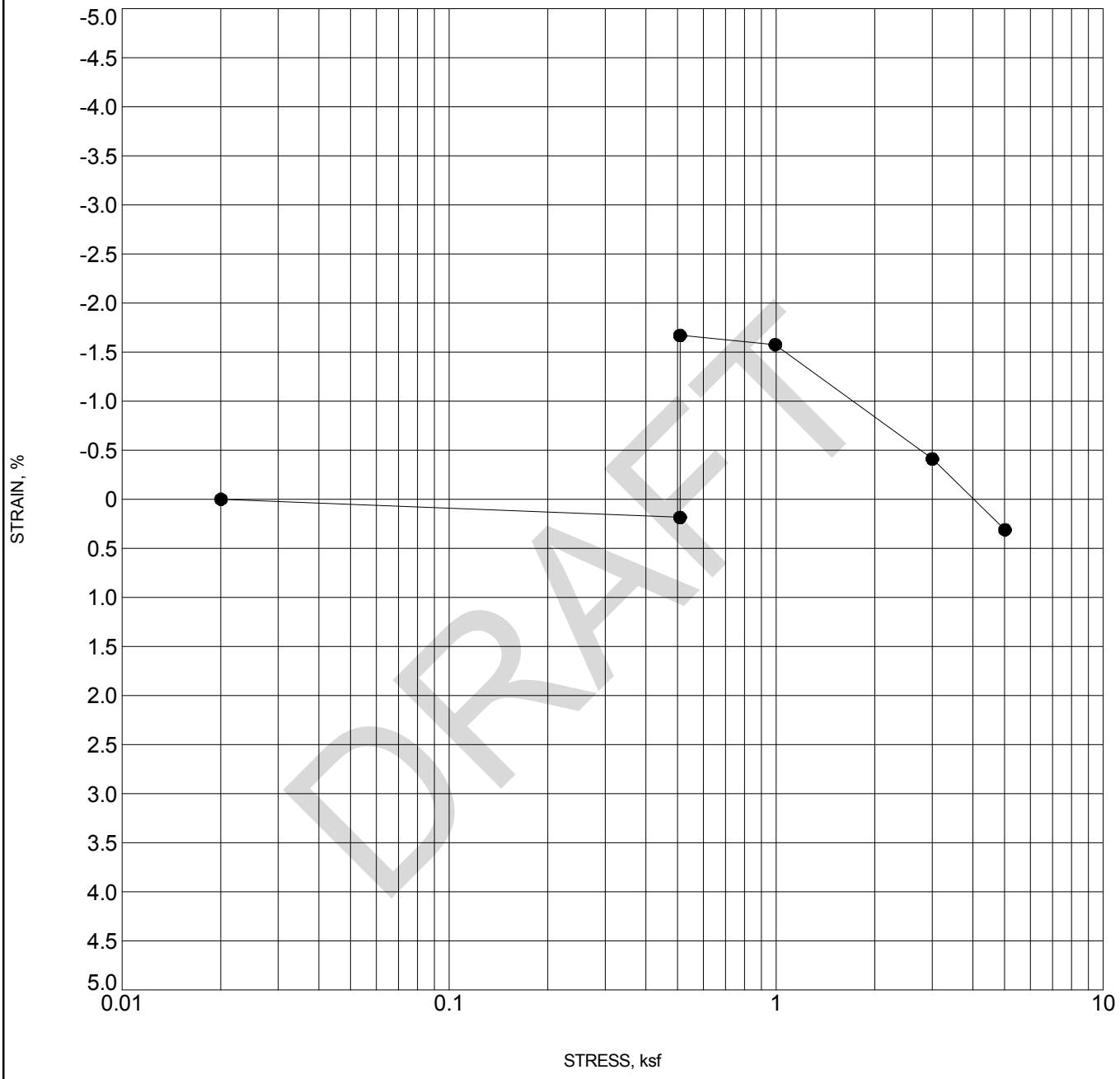
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-1 20**	**SANDY FAT CLAY (CH)**	**-0.1**	**103.8**	**22.8**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-1**	**30**	**SILTY SAND (SM)**	**1.9**	**93.8**	**30.6**

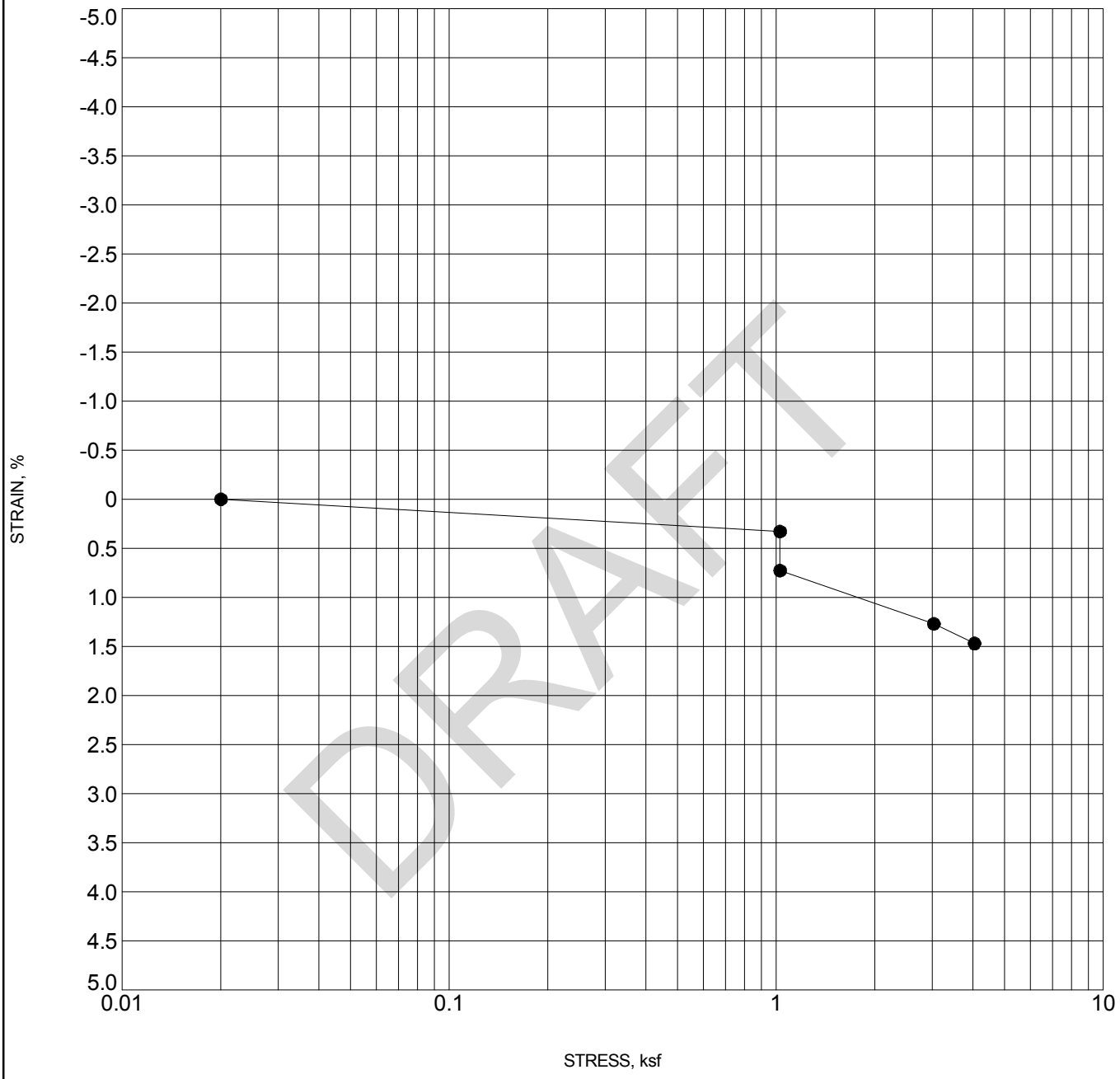
SWELL - STANDARD 304.01 I-70 OVER HAVANA.GPJ ROCKSOL TEMPLATE.GDT 4/18/13

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-6**	**10**	**(Fill) SAND, silty**	**-0.4**	**114.6**	**9.0**

SWELL - CONSOLIDATION TEST

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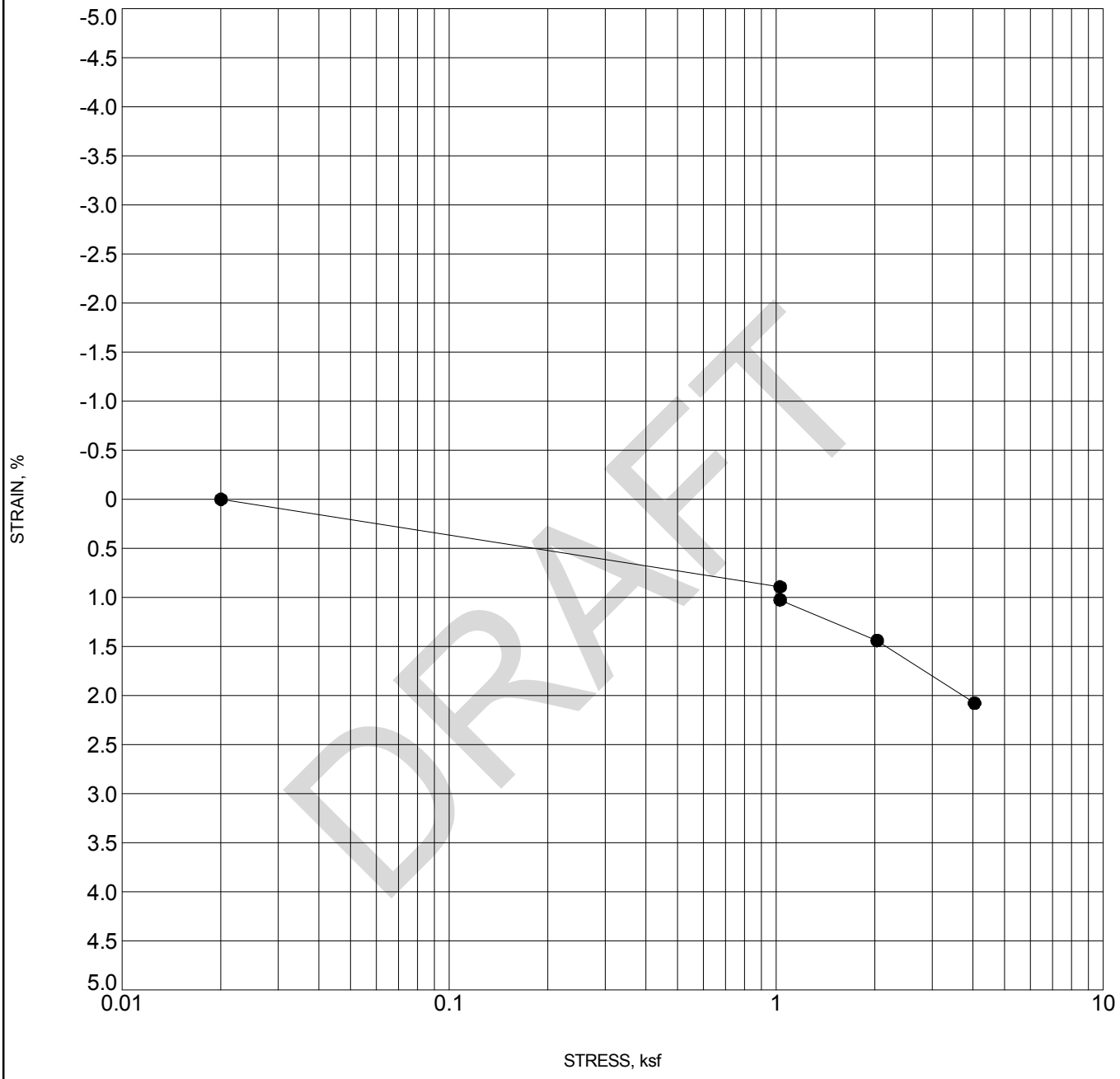

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-6**	**25**	**(Fill) SAND, silty**	**-0.1**	**121.3**	**9.8**

SWELL - CONSOLIDATION TEST

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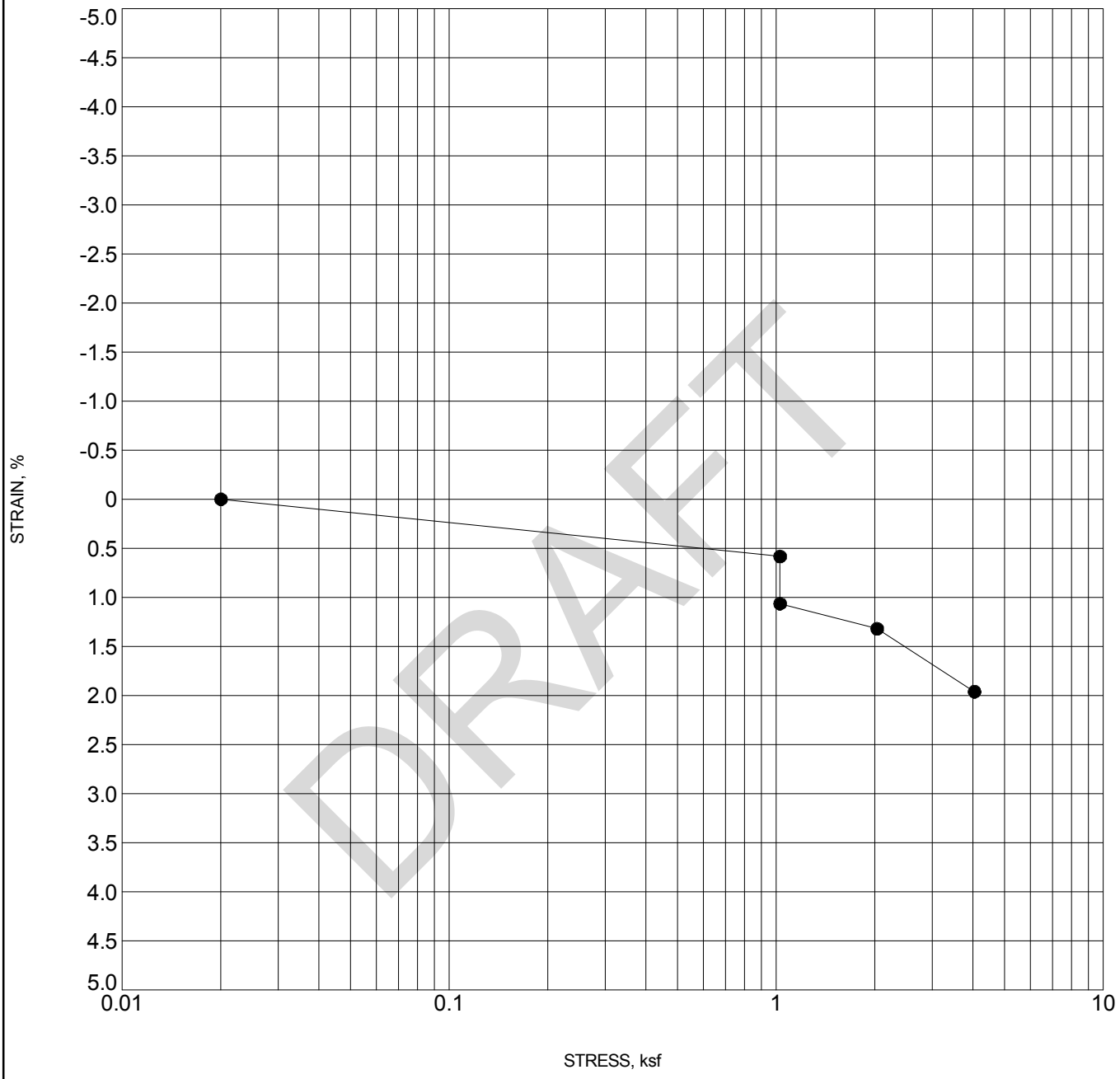

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-6**	**40**	**SAND, silty**	**-0.5**	**109.0**	**13.2**

SWELL - CONSOLIDATION TEST

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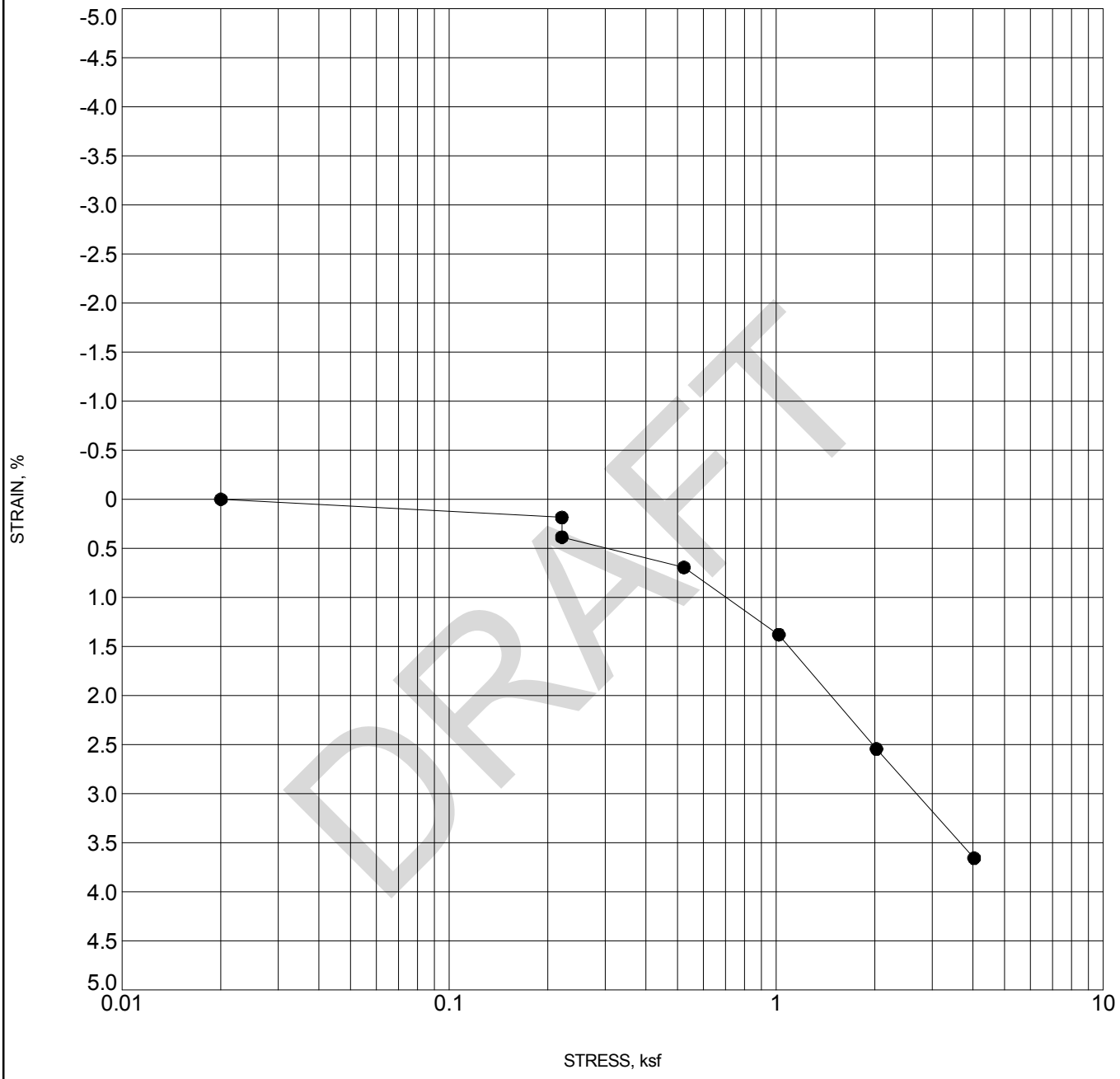

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **PV-1 2**	**SAND, clayey**	**-0.2**	**120.7**	**12.7**

SWELL - CONSOLIDATION TEST

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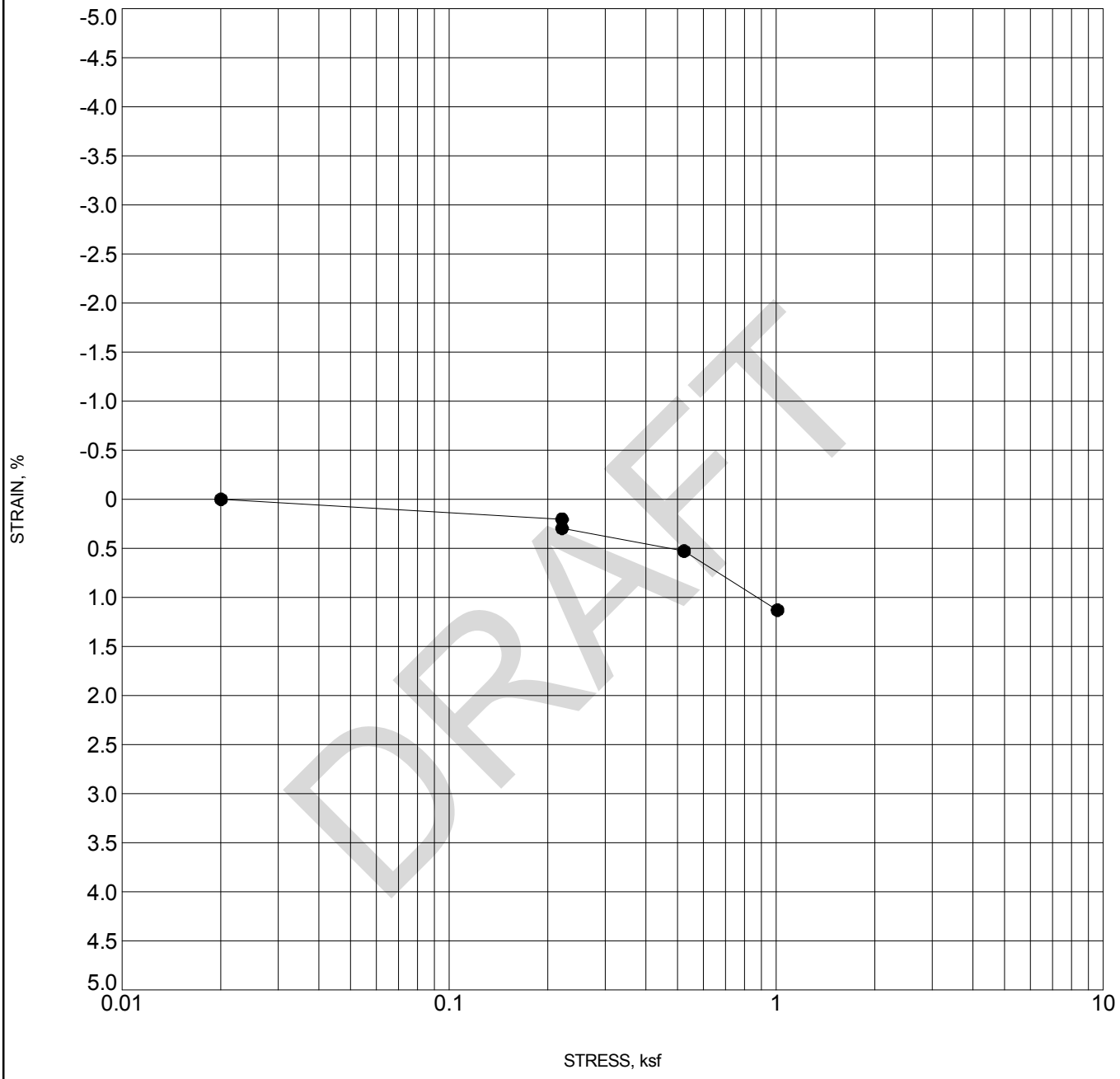

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **PV-2 4**	**(FIII) CLAY, sandy**	**-0.1**	**112.8**	**17.4**

SWELL - CONSOLIDATION TEST

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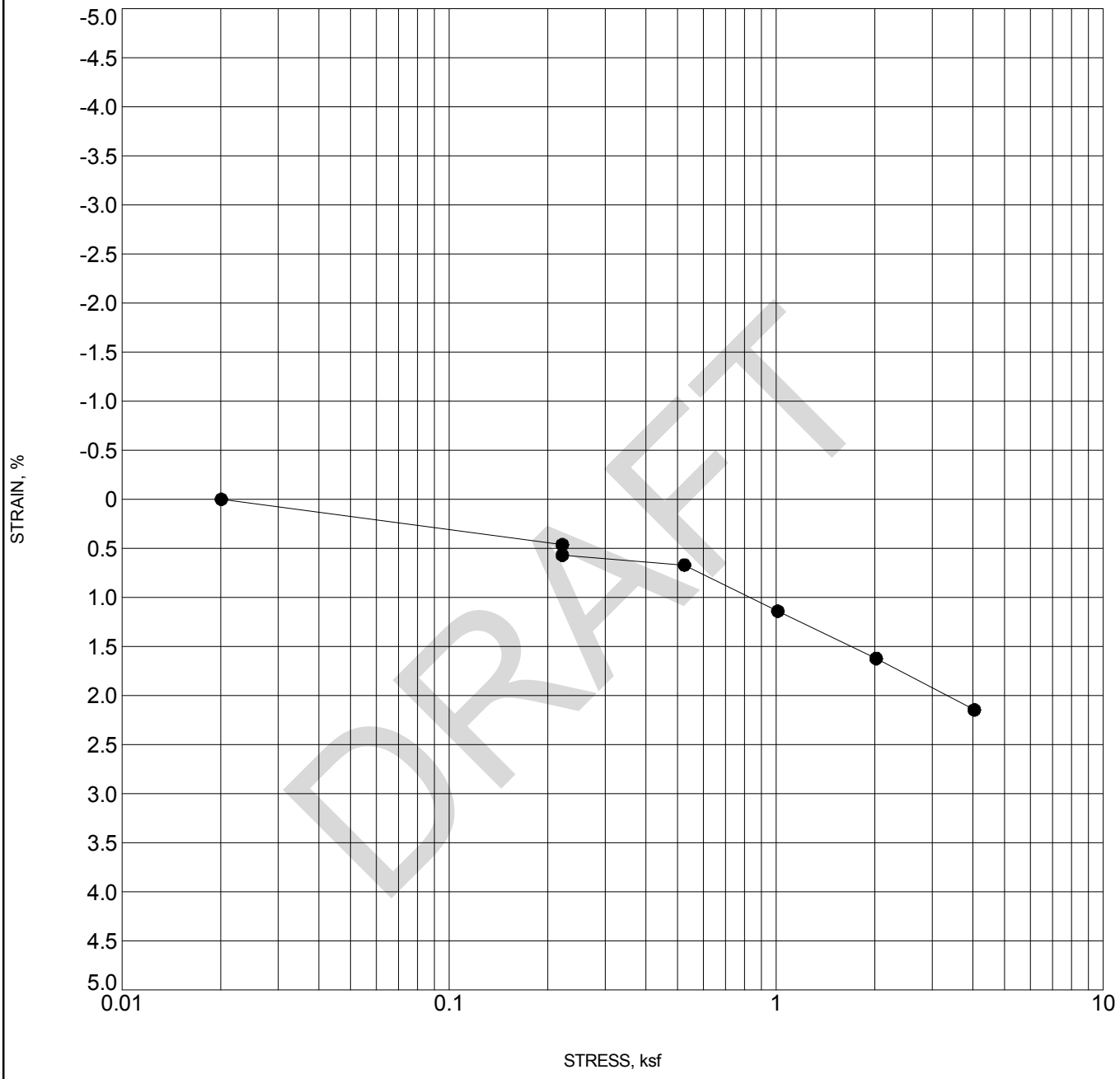

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **PV-3 2**	**(Fill) SAND, silty**	**-0.1**	**115.9**	**7.2**

SWELL - CONSOLIDATION TEST

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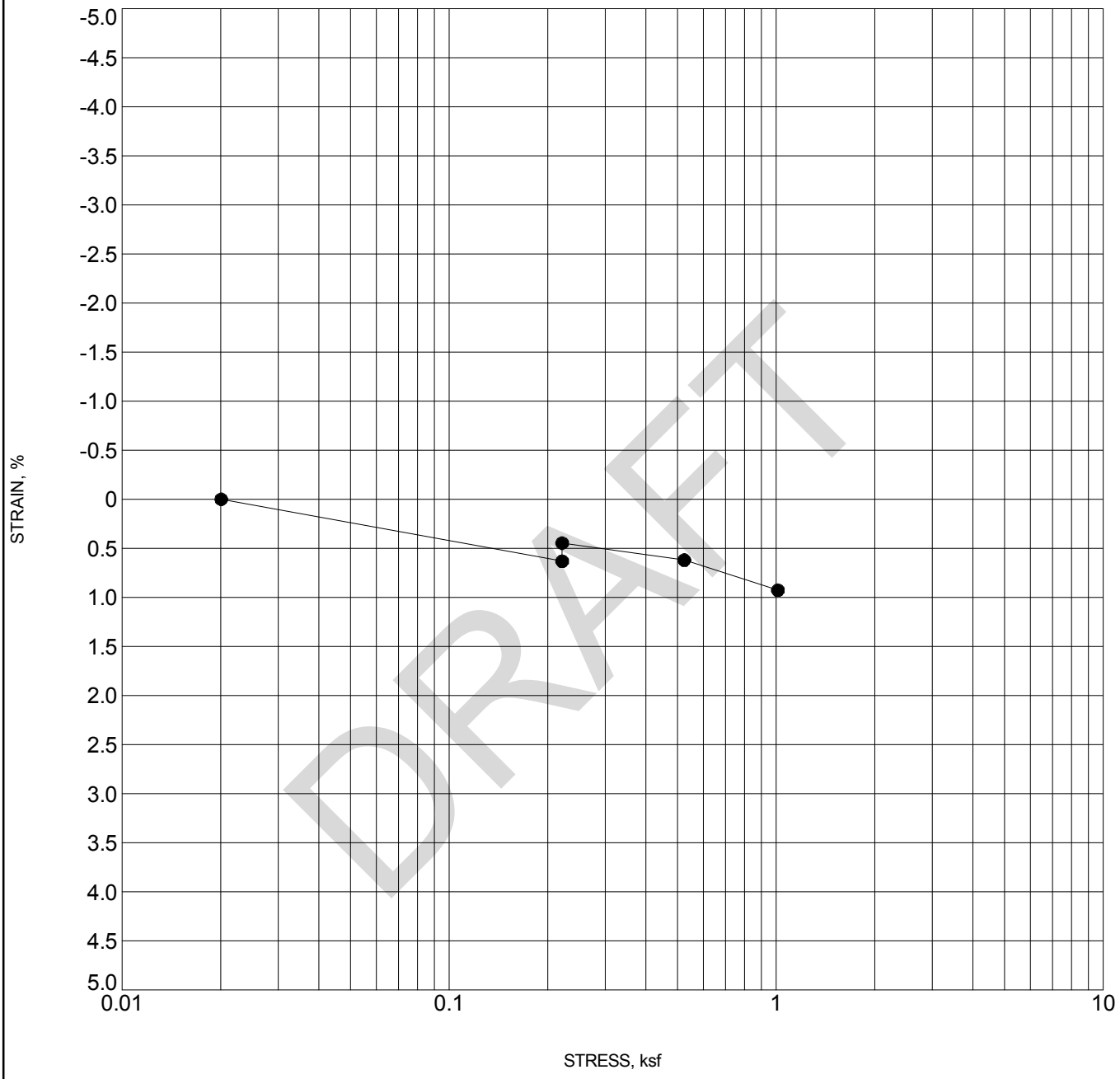

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **PV-6 2**	**(Fill) SAND, clayey**	**0.2**	**120.2**	**13.1**

SWELL - CONSOLIDATION TEST

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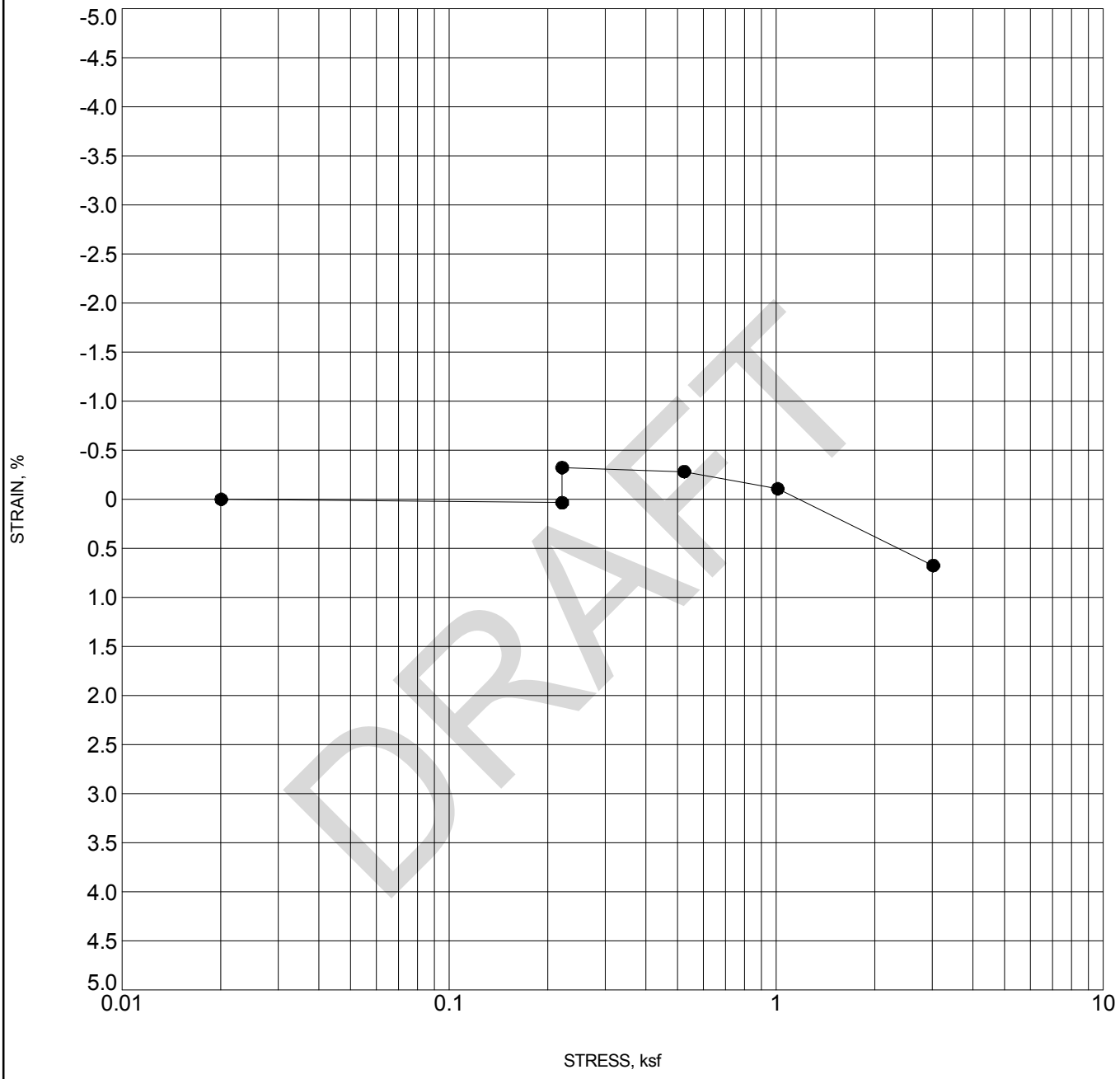
CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **PV-7 2**	**(Fill) CLAYEY SAND (SC)**	**0.4**	**123.0**	**12.1**

SWELL - CONSOLIDATION TEST

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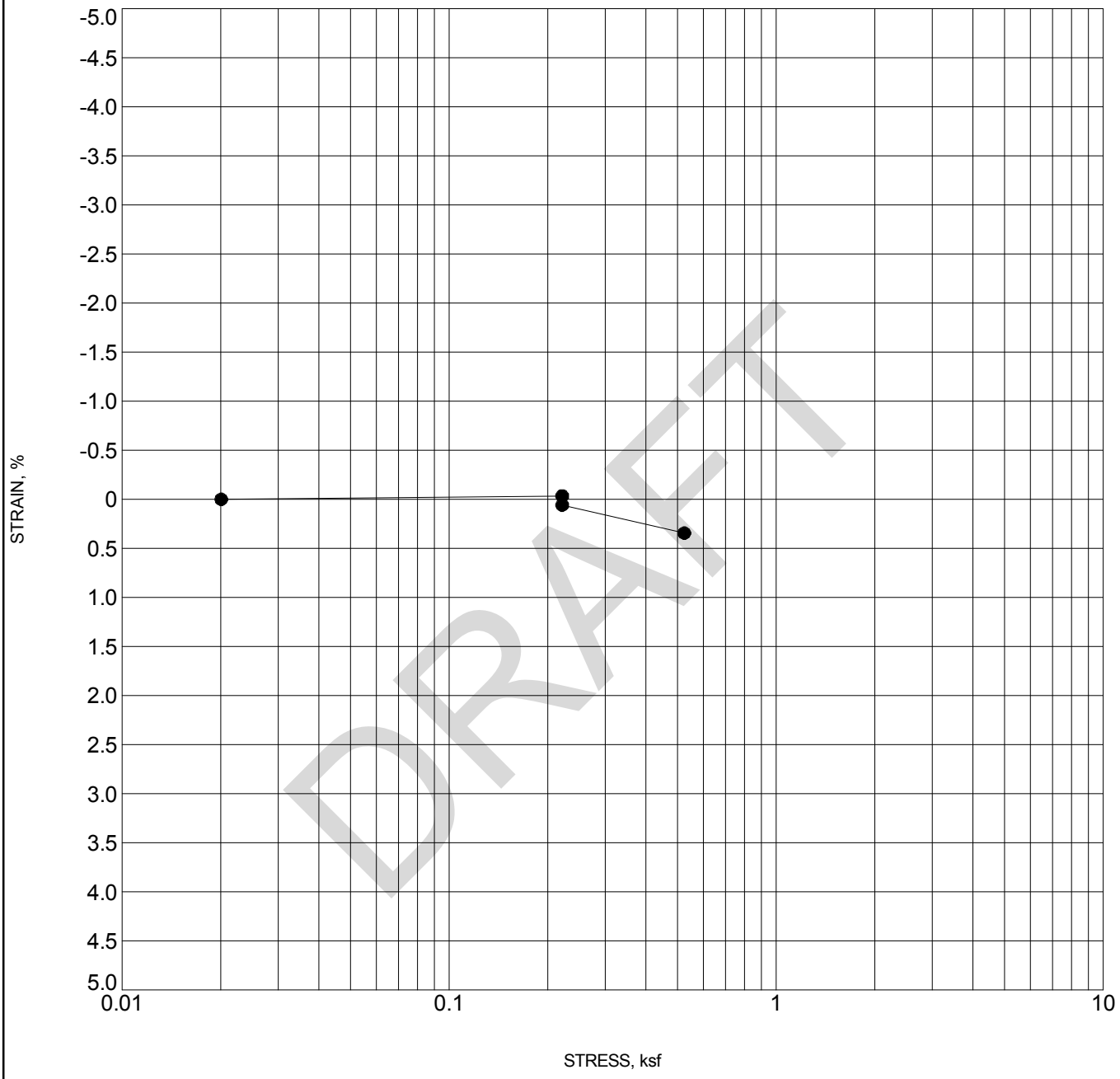
PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **PV-8 4**	**SAND, clayey**	**-0.1**	**123.4**	**10.6**

SWELL - CONSOLIDATION TEST

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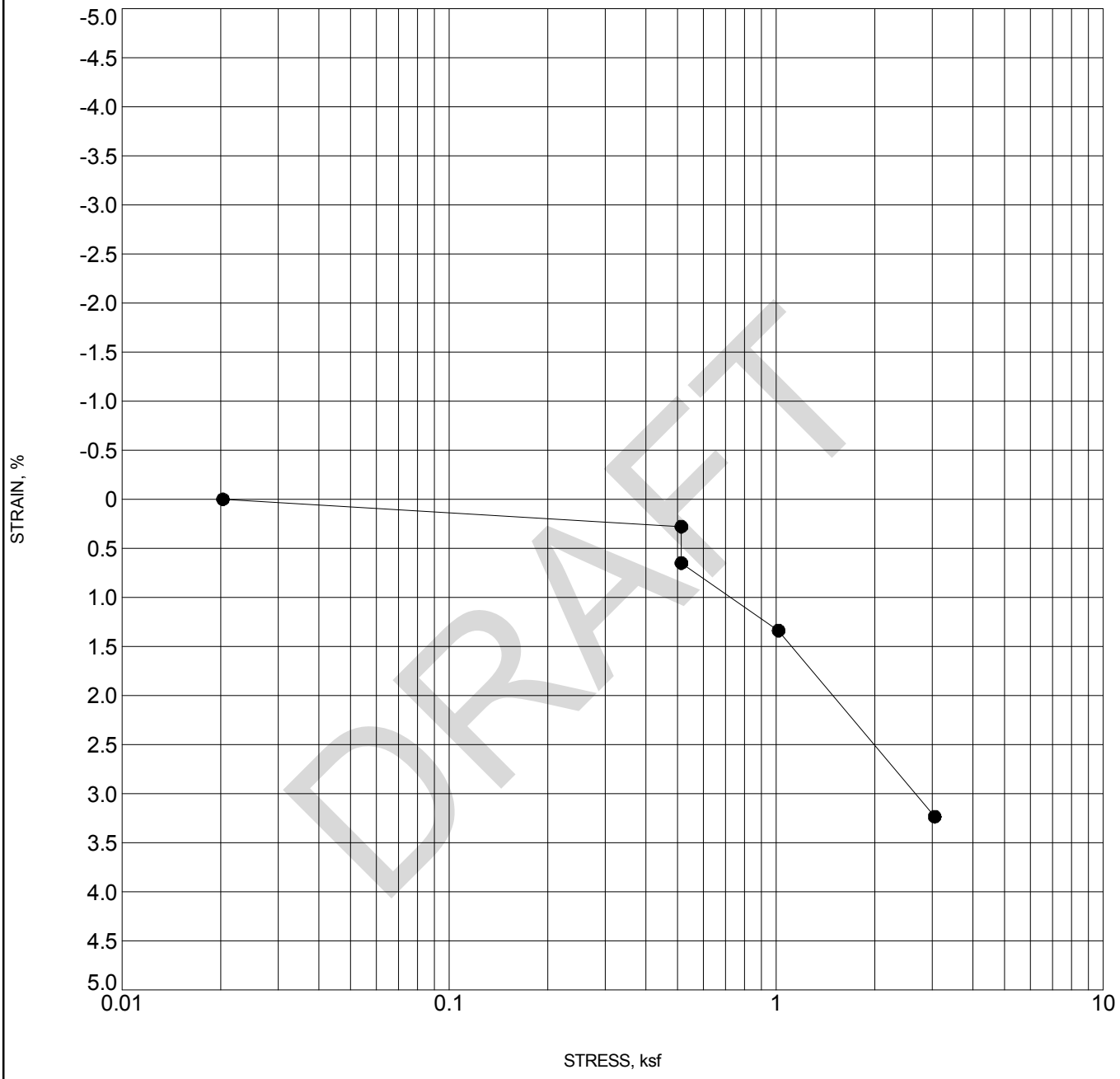

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-1**	**25**	**SANDY LEAN CLAY (CL)**	**-0.4**	**122.3**	**13.0**

SWELL - CONSOLIDATION TEST

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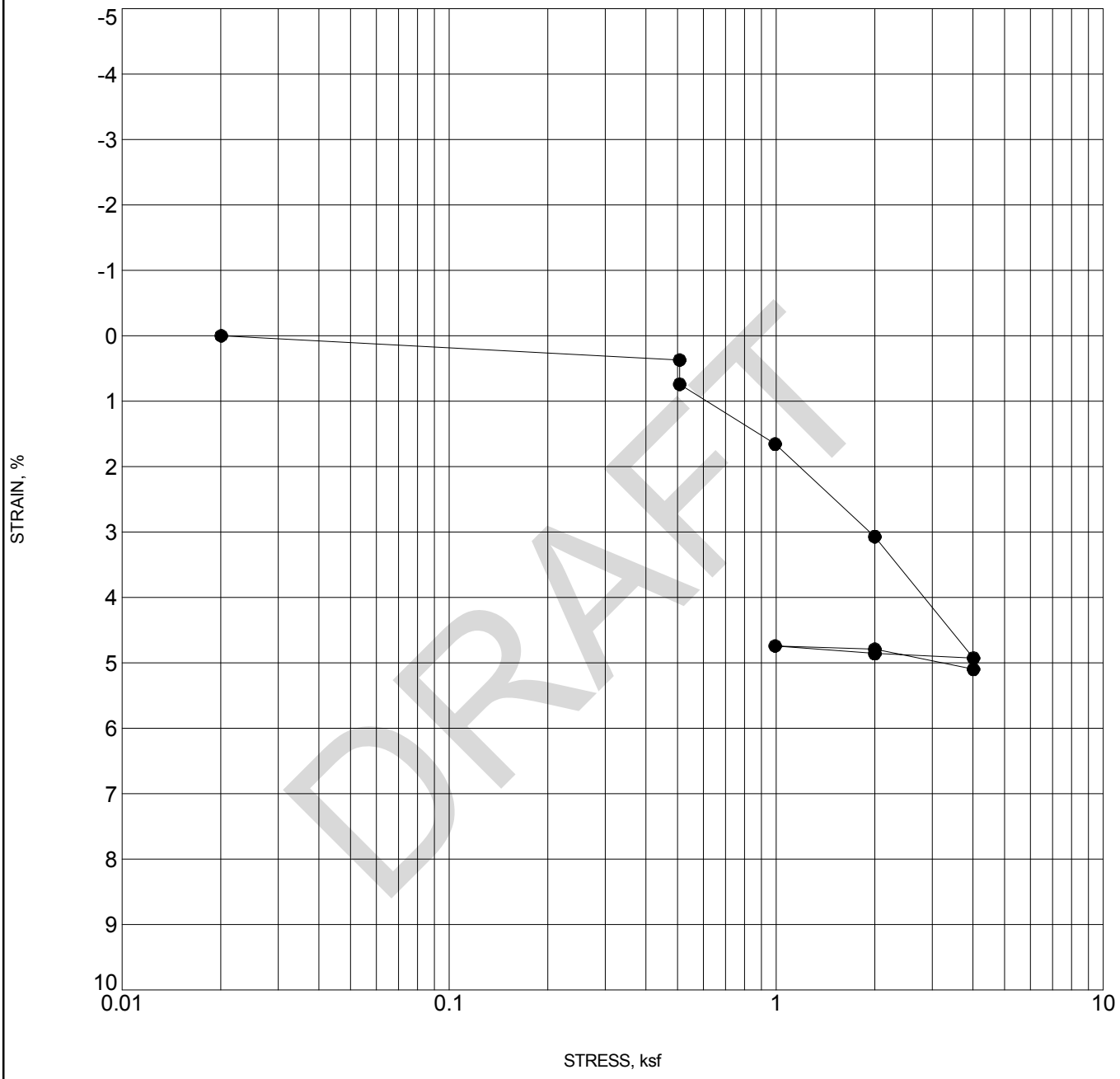

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-1** **45**	**CLAY, sandy**	**-0.4**	**95.1**	**29.3**

SWELL - CONSOLIDATION TEST

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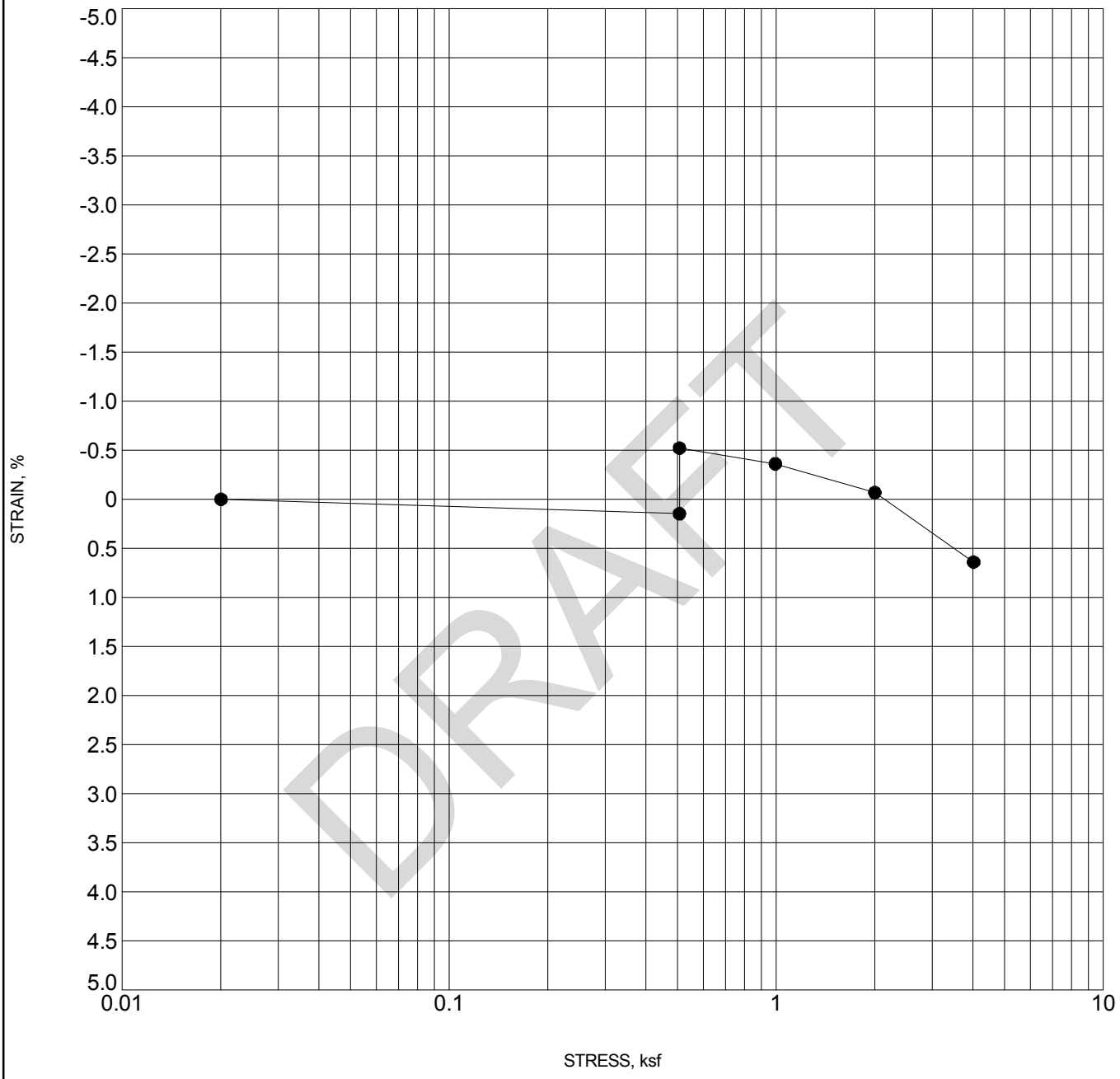


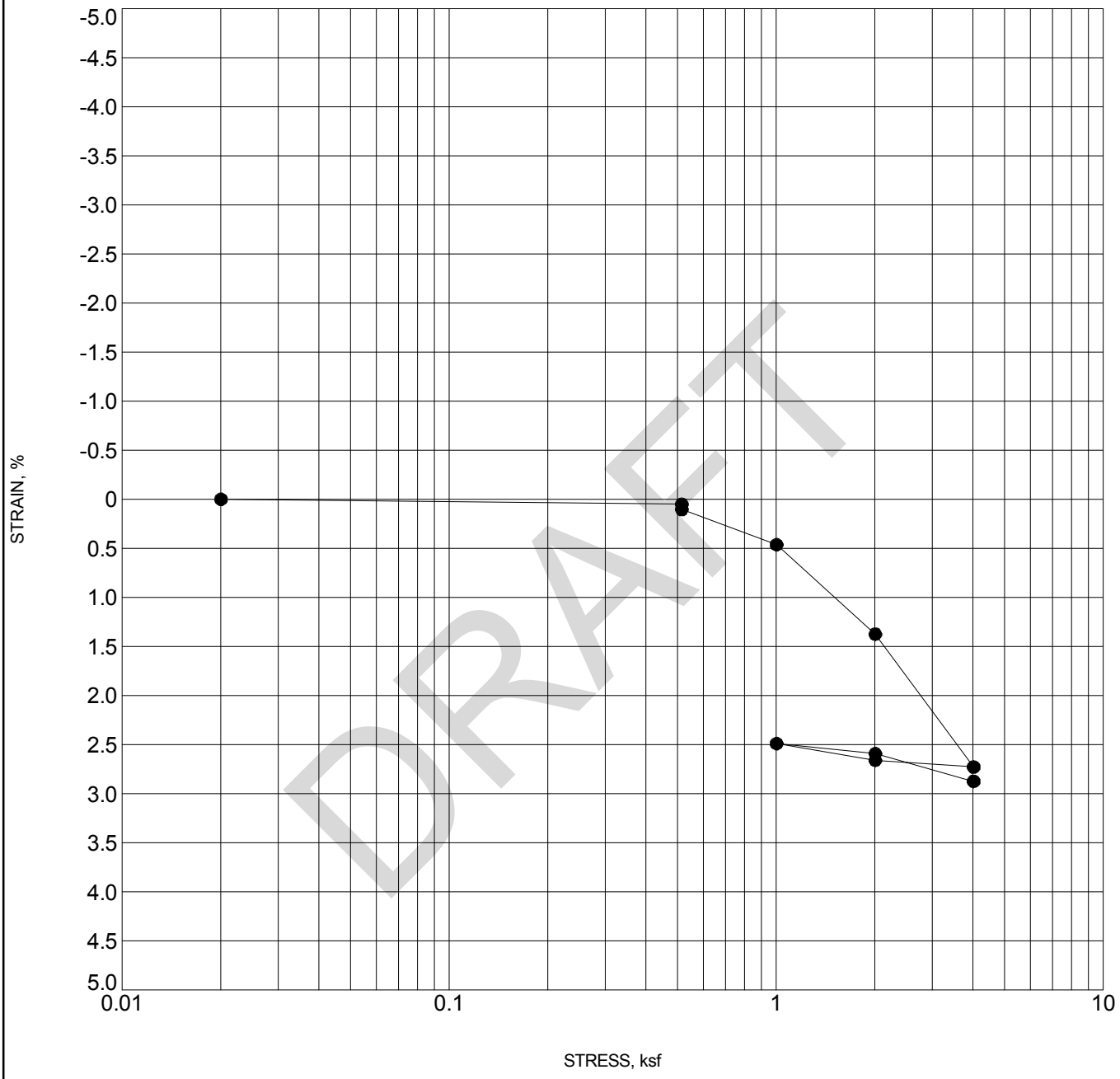
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-2**	**30**	**CLAY, silty**	**0.7**	**120.1**	**14.0**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



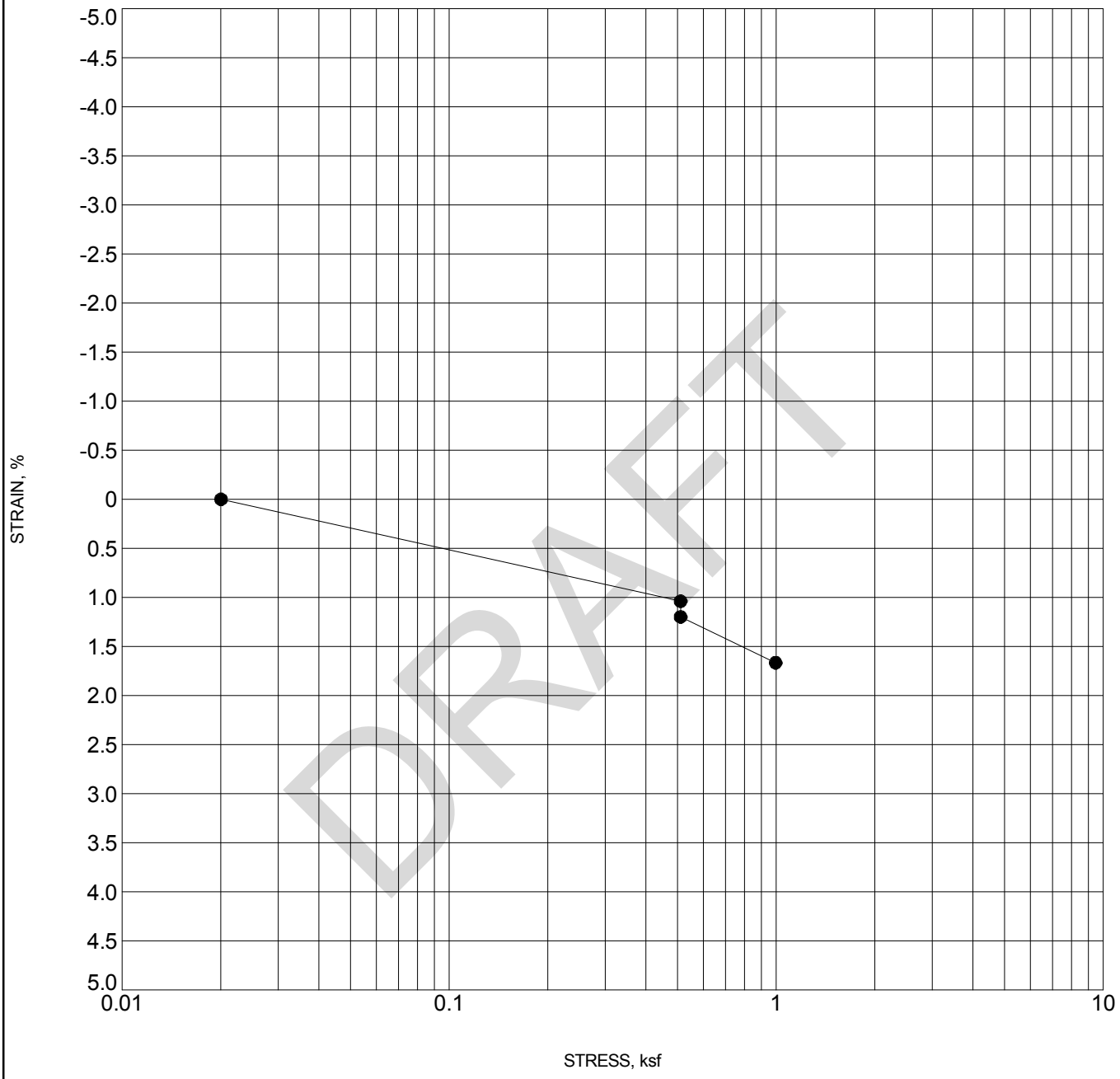
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-2**	**45**	**CLAY, sandy**	**-0.1**	**106.6**	**21.5**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



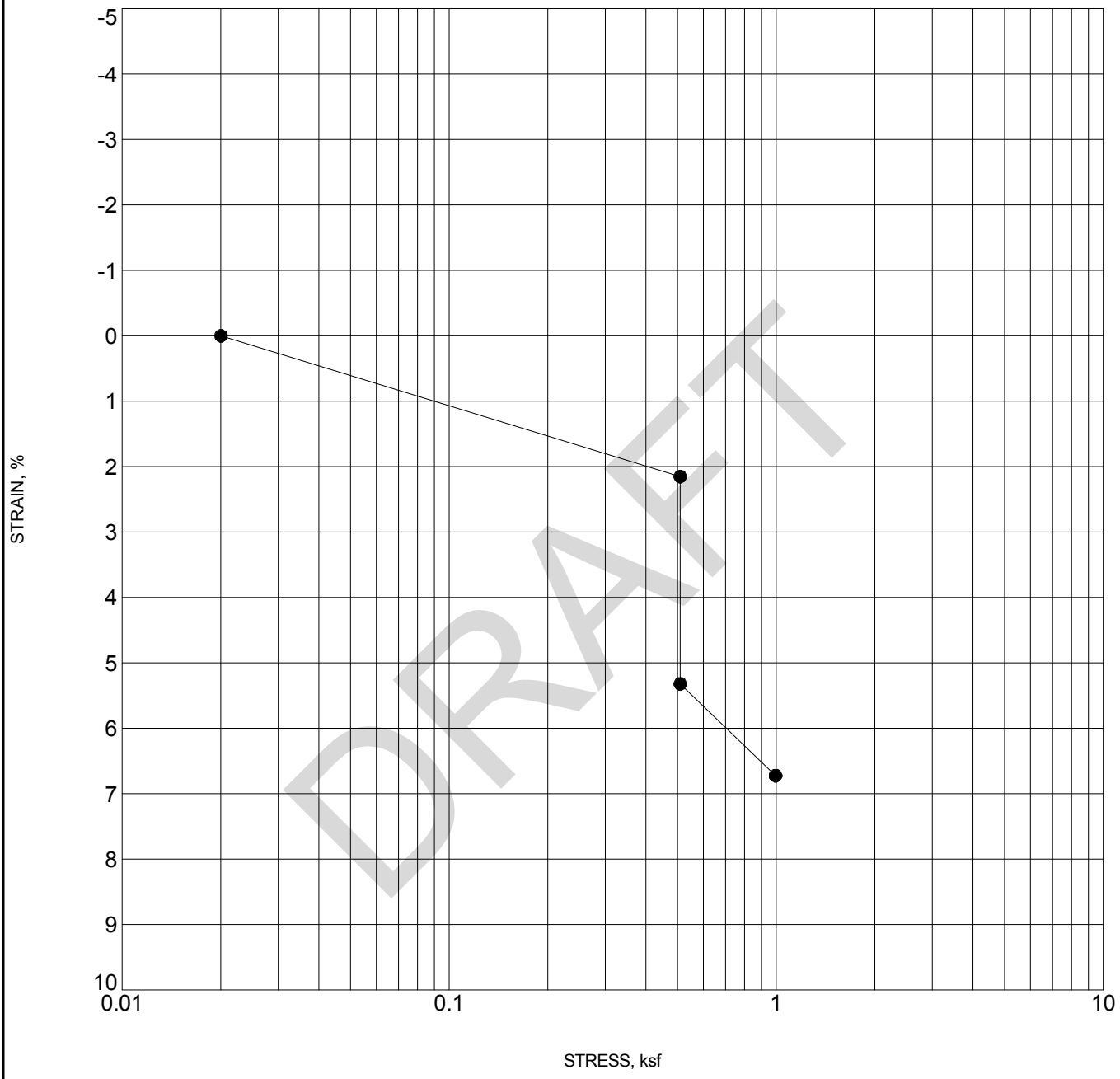
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-4**	**30**	**CLAY, very sandy**	**-0.2**	**120.6**	**12.9**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



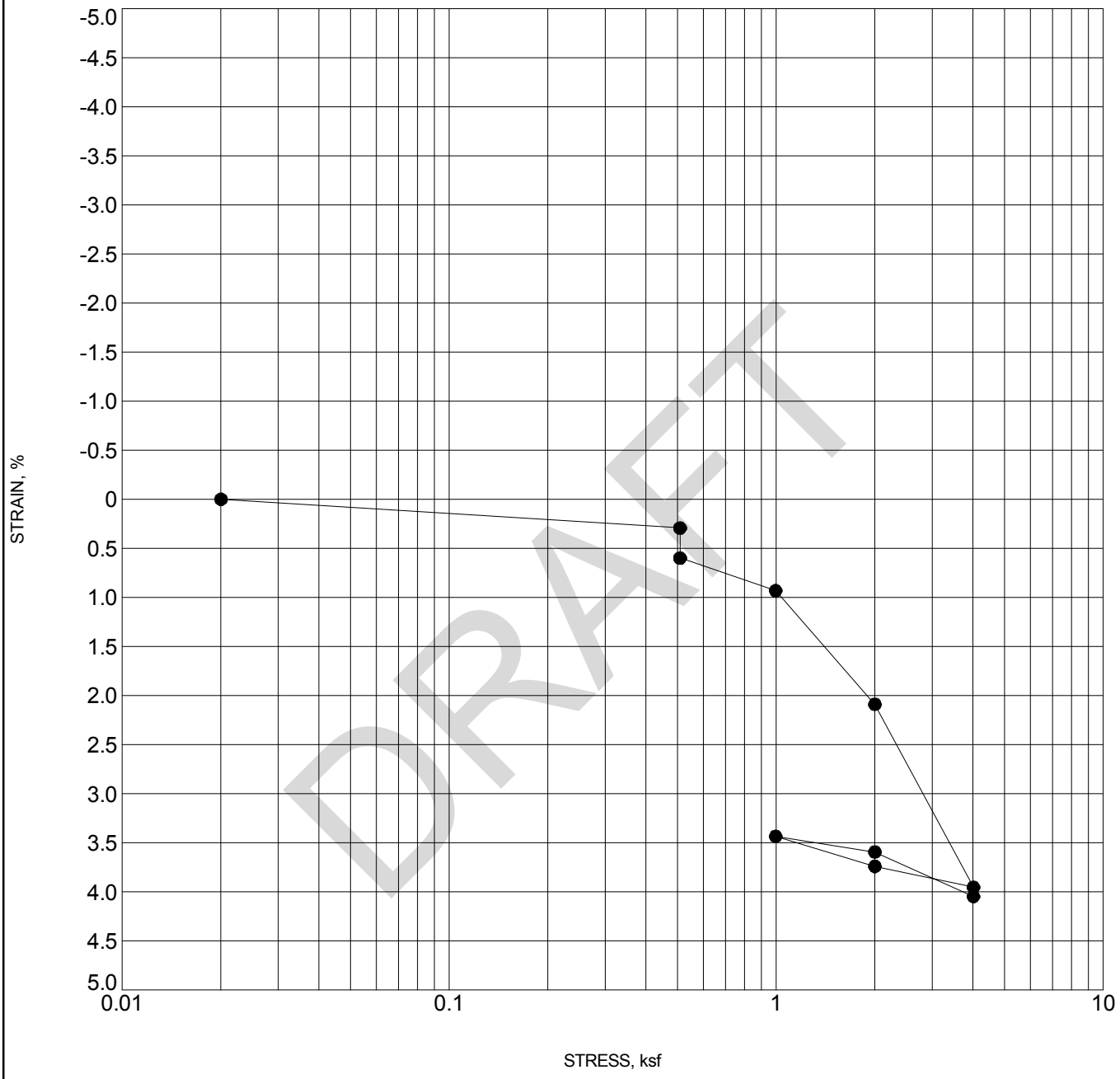
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-4**	**40**	**CLAY, sandy**	**-3.2**	**110.8**	**18.2**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



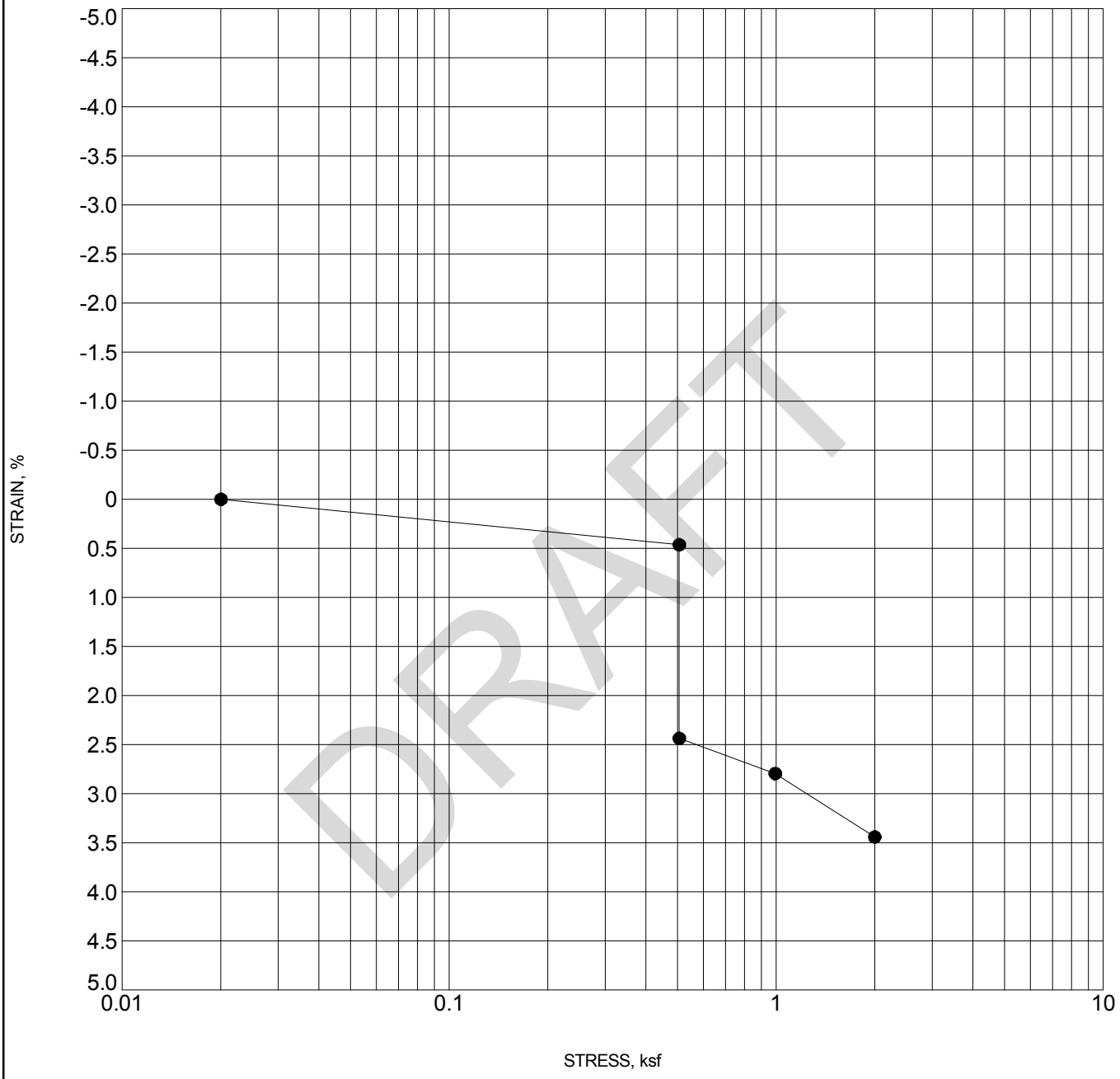
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-5 15**	**SANDY FAT CLAY (CH)**	**-0.3**	**98.7**	**24.4**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



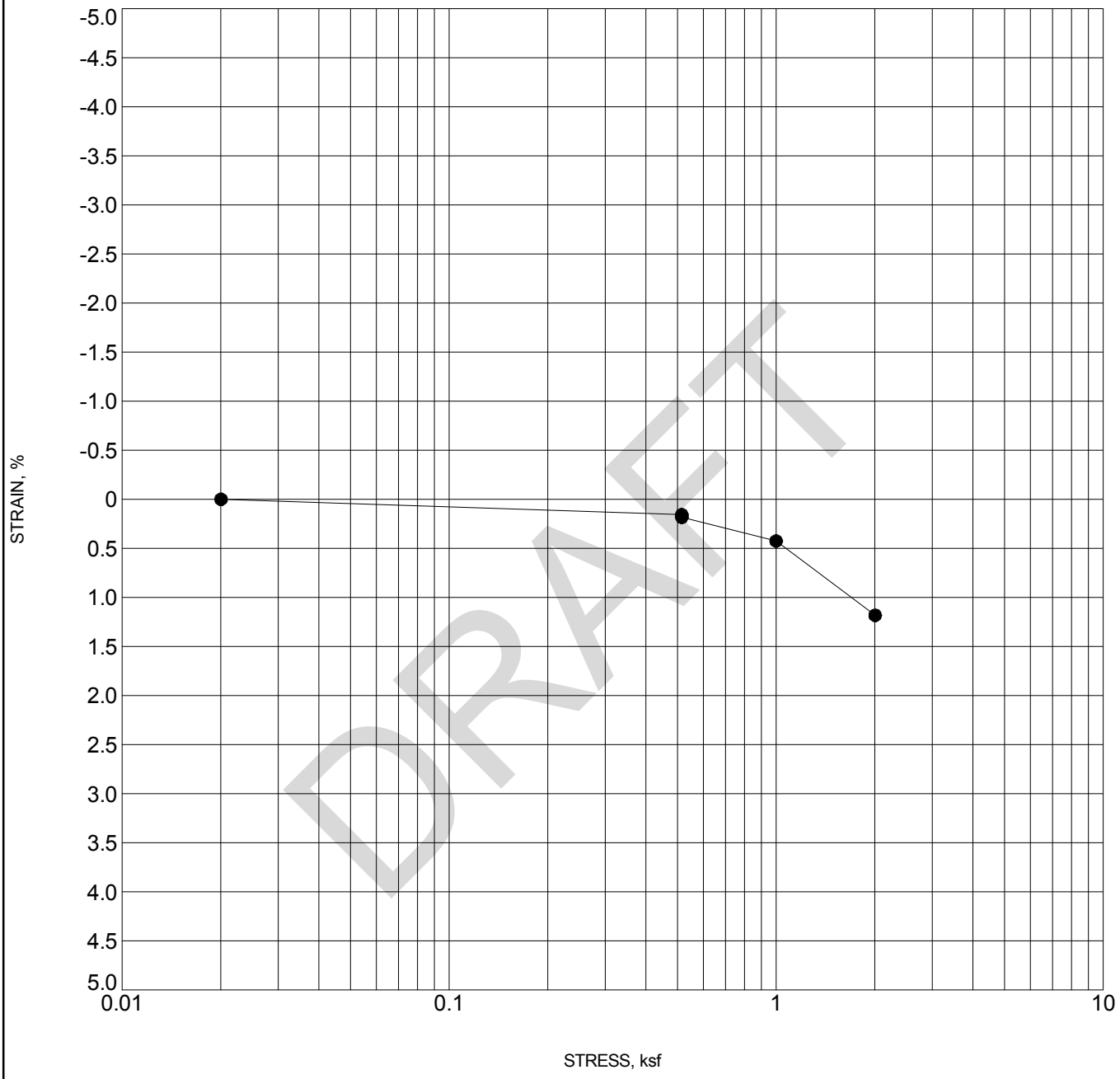
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-6**	**14**	**SAND, silty**	**-2.0**	**116.1**	**9.0**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



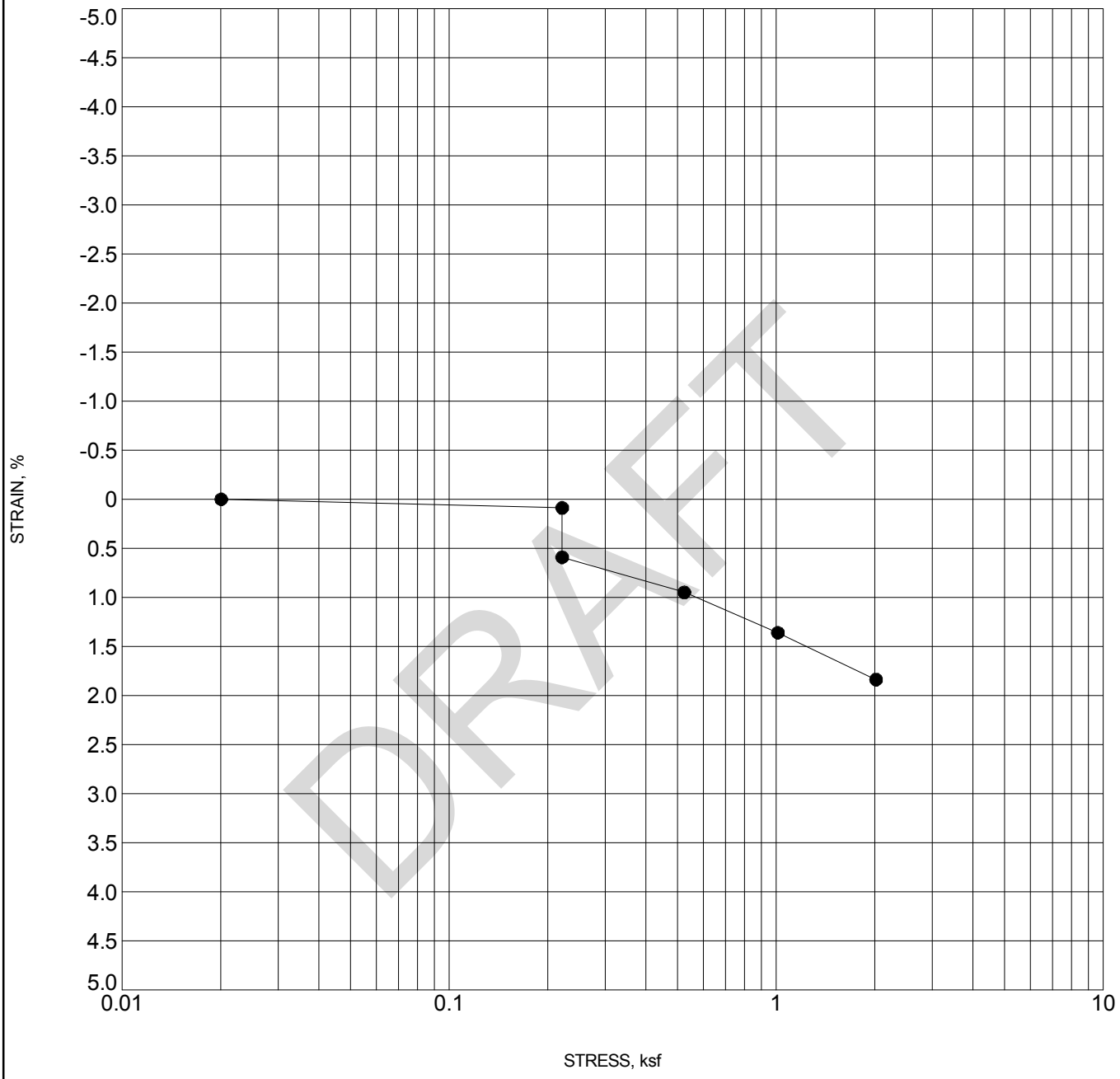
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-6**	**19**	**CLAY, sandy**	**0.0**	**114.9**	**16.3**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



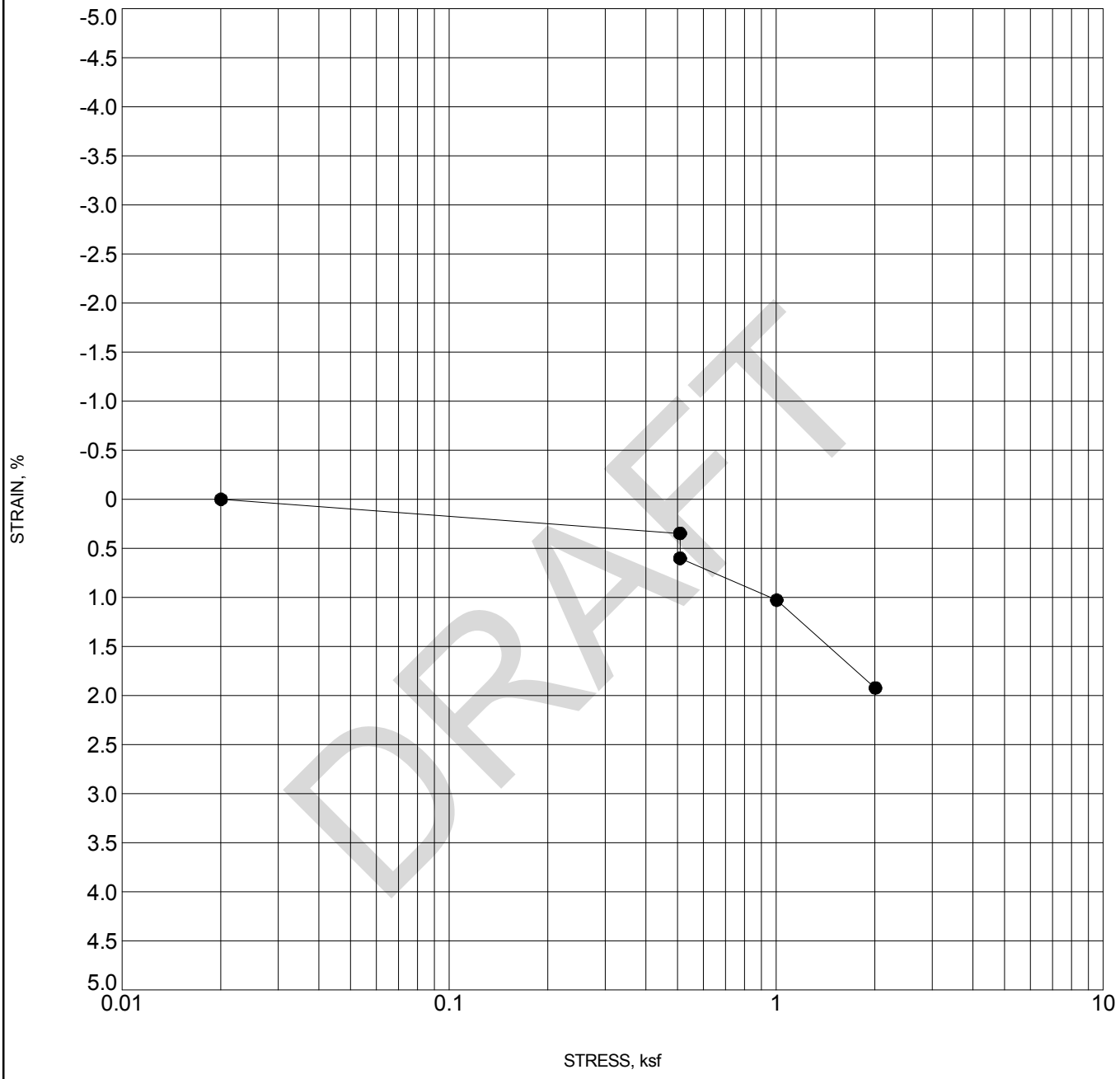
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-7 4**	**SAND, silty**	**-0.5**	**106.6**	**6.9**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



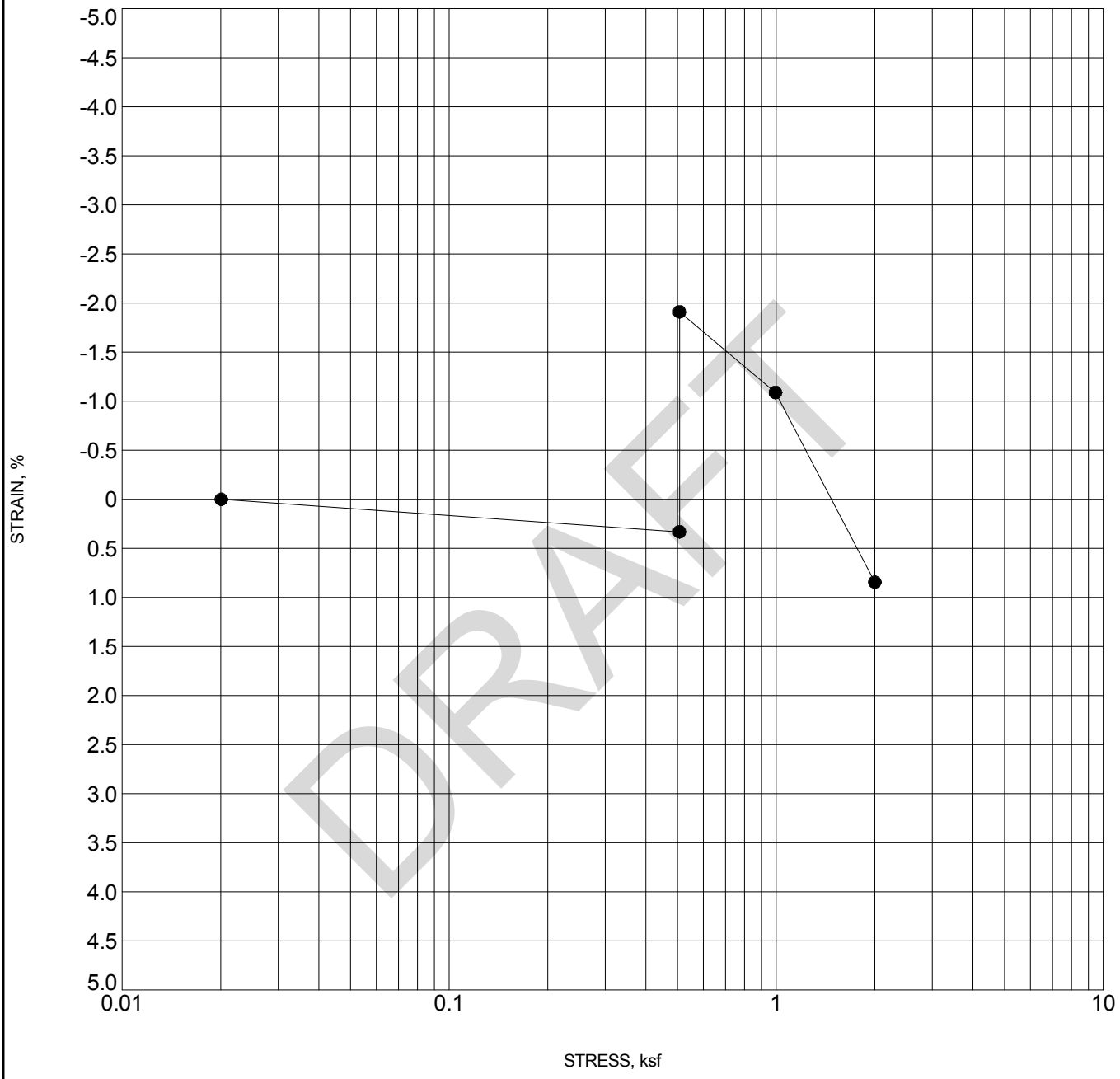
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-7 9**	**SAND, silty**	**-0.3**	**104.3**	**5.2**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



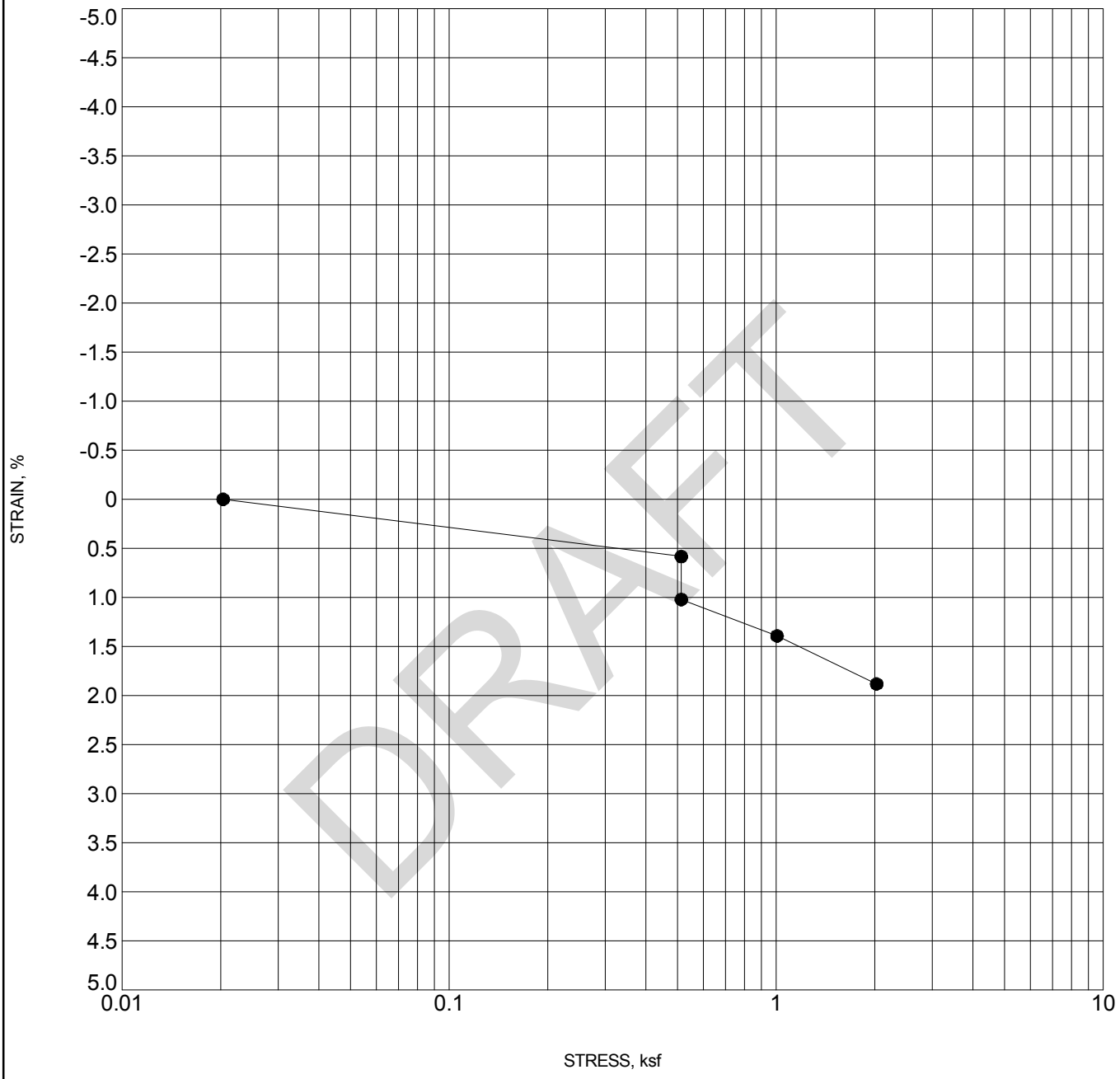
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-8**	**5**	**CLAY, sandy**	**2.2**	**115.3**	**15.2**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



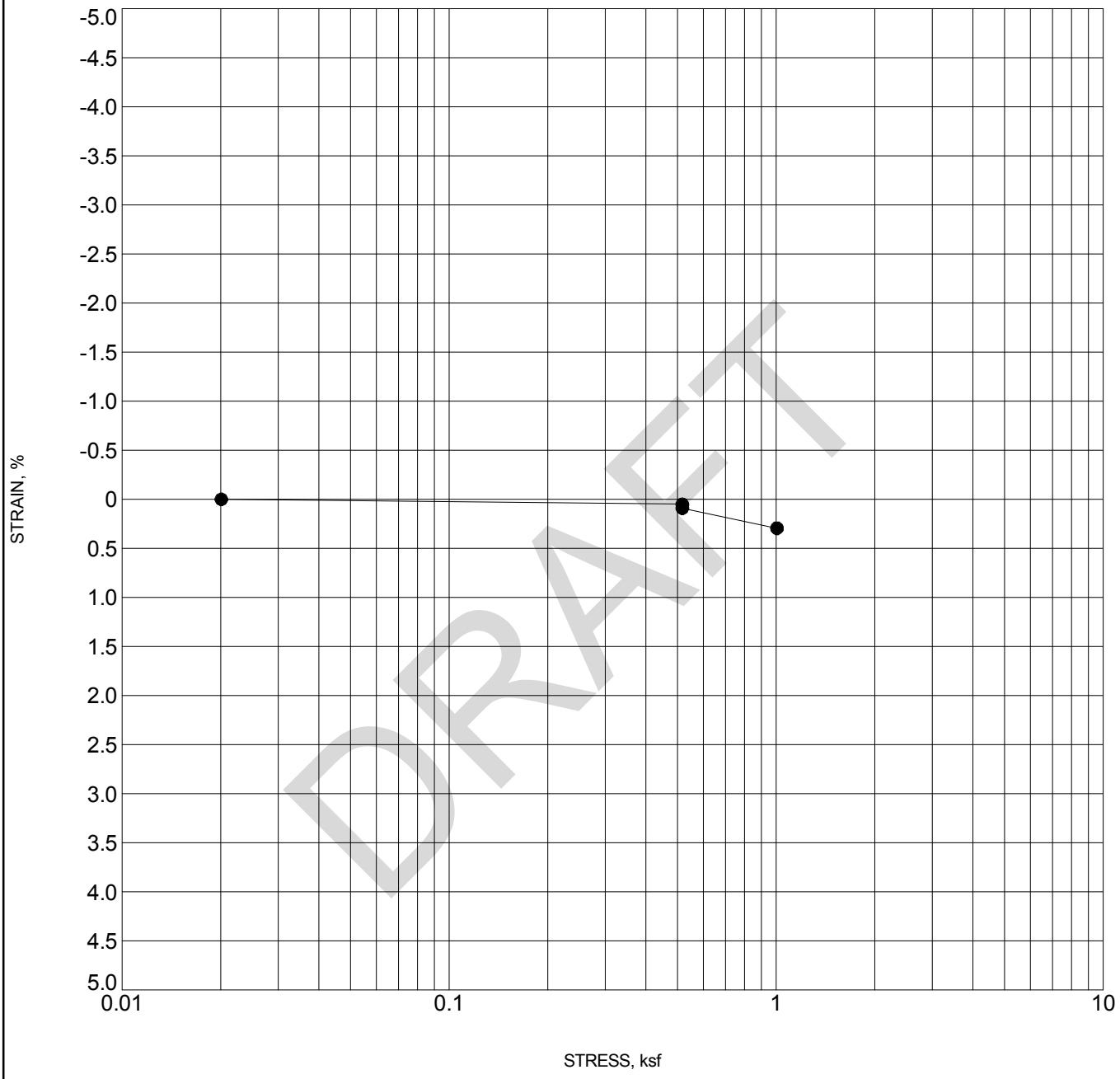
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-9 4**	**SAND, silty**	**-0.4**	**104.9**	**7.1**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



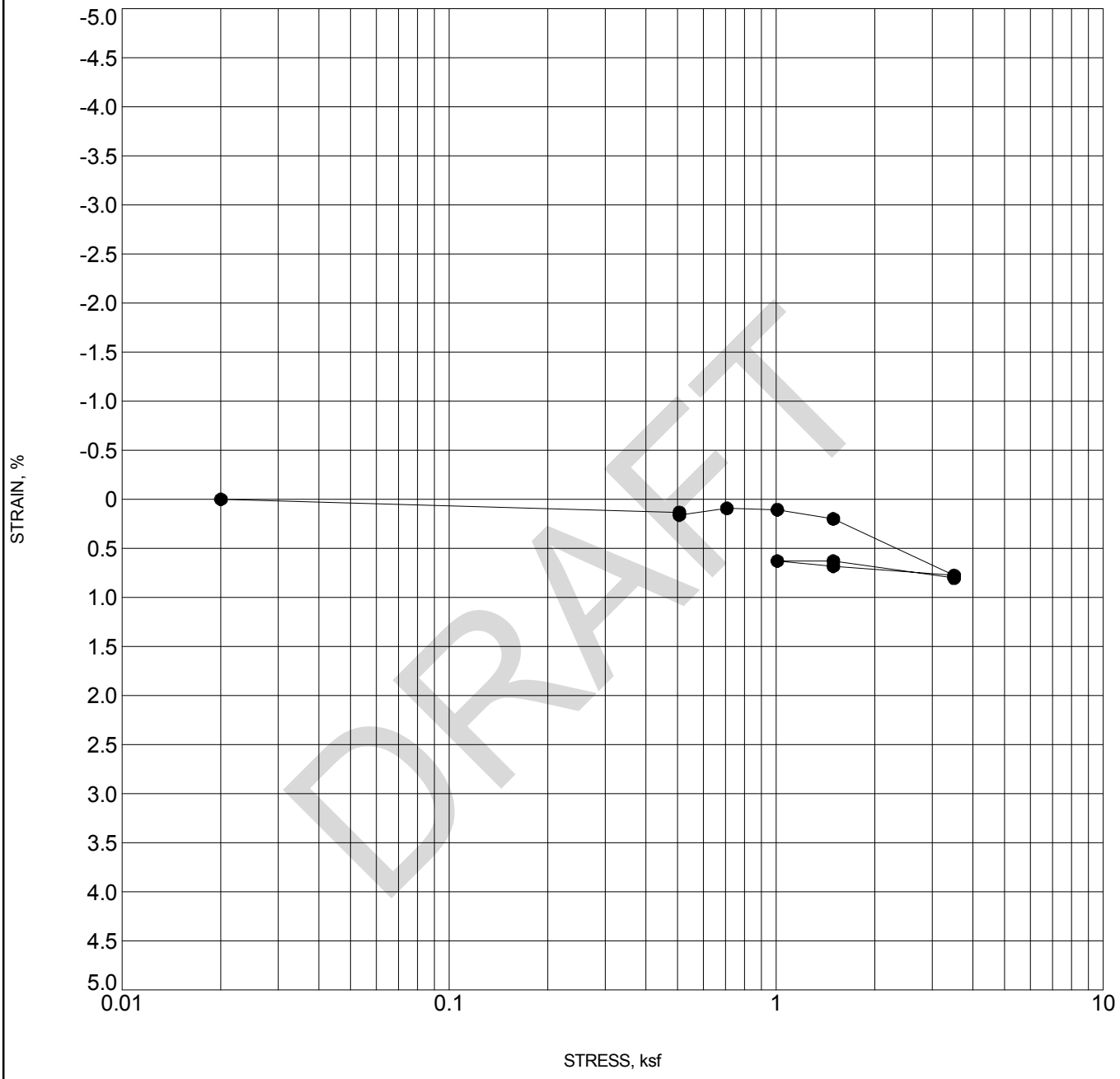
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-10** **4**	**SAND, silty**	**0.0**	**113.7**	**14.6**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



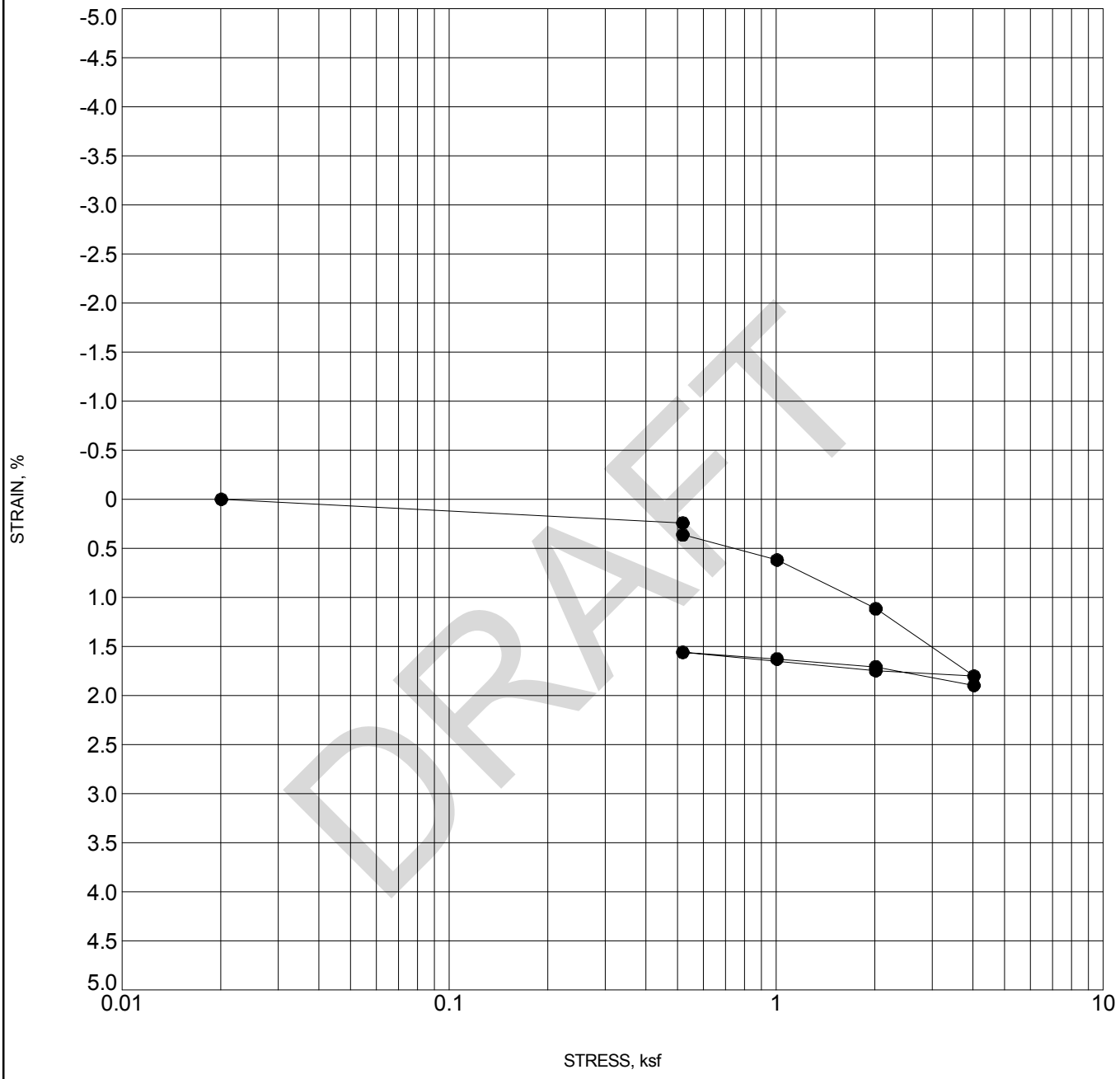
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-10**	**14**	**SANDY CLAY**	**0.0**	**107.3**	**19.2**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-10 19**	**CLAYEY SAND (SC)**	**-0.2**	**116.5**	**13.2**

APPENDIX D

TRAFFIC LOADING AND ESAL CALCULATION SHEETS

DRAFT

I-70 Havana Bridge Replacement Project Traffic Data (Provided by Parsons)
CDOT Project No. FBR 0704-230 (19339)

For I-70 Mainline

Current (2012) conditions

West of Havana - Sta Id: 103078	
ADT	193,000
single unit truck	7300
combination truck	8900
percent trucks	8.4%

East of Havana - Sta Id: 103079	
ADT	189,000
single unit truck	7400
combination truck	8900
percent trucks	8.6%

Average Havana Area	
ADT	191,000
single unit truck	7,350
combination truck	8,900
percent trucks	8.5%

Forecast to 2030 - using CDOT OTIS information

West of Havana - Sta Id: 103078	
ADT	248,584
single unit truck	9402
combination truck	11463
percent trucks	8.4%

East of Havana - Sta Id: 103079	
ADT	251,937
single unit truck	9864
combination truck	11864
percent trucks	8.6%

Average Havana Area	
ADT	250,261
single unit truck	9,633
combination truck	11,664
percent trucks	8.5%

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For I-70 Ramps at Havana (2012 ADT Data)

EB off – 10,394
EB on – 6,535
WB off – 7,401
WB on – 11,536

I-70 West of Havana
8 Lanes (Total)
RockSol Consulting Group, Inc.

Average Daily Traffic Volume

Existing	Future Year
2012	2030
193000	248584

Flexible Pavement Design Period 20 years

		Mid-Point YR		
Base Year	2015	2025	2035	Required Design Year
ADT	202328	233423	264517	

Rigid Pavement Design Period 30 years

		Mid-Point YR		
Base Year	2015	2030	2045	Required Design Year
ADT	202328	248970	295612	

ESAL Calculation

Flexible Pavement

Vehicle Type	Vehicle Percentage	Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.6	1,560,849,573	0.003	0.25	1,170,637
Single Unit Trucks	3.8	64,751,402	0.249	0.25	4,030,775
Combination Trucks	4.6	78,383,276	1.087	0.25	21,300,655
TOTAL	100.0	1,703,984,250			26,502,067

Design Lane Factor = 0.25

Rigid Pavement

Vehicle Type		Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.6	2,497,218,894	0.003	0.25	1,872,914
Single Unit Trucks	3.8	103,596,417	0.285	0.25	7,381,245
Combination Trucks	4.6	125,406,189	1.692	0.25	53,046,818
TOTAL	100.0	2,726,221,500			62,300,977

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I-70 East of Havana
8 Lanes (Total)
RockSol Consulting Group, Inc.

Average Daily Traffic Volume

Existing	Future Year
2012	2030
189000	251937

Flexible Pavement Design Period 20 years

		Mid-Point YR		
Base Year	2015	2025	2035	Required Design Year
ADT	203615	238999	274382	

Rigid Pavement Design Period 30 years

		Mid-Point YR		
Base Year	2015	2030	2045	Required Design Year
ADT	203615	256690	309765	

ESAL Calculation

Flexible Pavement

Vehicle Type	Vehicle Percentage	Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.4	1,594,645,792	0.003	0.25	1,195,984
Single Unit Trucks	3.9	68,042,873	0.249	0.25	4,235,669
Combination Trucks	4.7	82,000,385	1.087	0.25	22,283,605
TOTAL	100.0	1,744,689,050			27,715,258

Design Lane Factor = 0.25

Rigid Pavement

Vehicle Type		Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.4	2,569,030,527	0.003	0.25	1,926,773
Single Unit Trucks	3.9	109,619,465	0.285	0.25	7,810,387
Combination Trucks	4.7	132,105,509	1.692	0.25	55,880,630
TOTAL	100.0	2,810,755,500			65,617,790

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I-70 Eastbound Off Ramp at Havana, 5 Year ESAL
1 Lane
RockSol Consulting Group, Inc.

Average Daily Traffic Volume

Existing	Future Year
2012	TBD
10394	TBD

Flexible Pavement Design Period 5 years

		Mid-Point YR		
Base Year	2015	2017.5	2020	Required Design Year
ADT	10914	11330	11745	

Rigid Pavement Design Period 30 years

		Mid-Point YR		
Base Year	2015	2030	2045	Required Design Year
ADT	0	0	0	

ESAL Calculation

Flexible Pavement

Vehicle Type	Vehicle Percentage	Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.6	18,939,525	0.003	1.00	56,819
Single Unit Trucks	3.8	785,701	0.249	1.00	195,640
Combination Trucks	4.6	951,112	1.087	1.00	1,033,858
TOTAL	100.0	20,676,338			1,286,316

Design Lane Factor = 1.00

Rigid Pavement

Vehicle Type		Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.6	0	0.003	1.00	0
Single Unit Trucks	3.8	0	0.285	1.00	0
Combination Trucks	4.6	0	1.692	1.00	0
TOTAL	100.0	0			0

DRAFT

I-70 Eastbound Off Ramp at Havana, 10 Year ESAL
1 Lane
RockSol Consulting Group, Inc.

Average Daily Traffic Volume

Existing	Future Year
2012	TBD
10394	TBD

Flexible Pavement Design Period 10 years

		Mid-Point YR		
Base Year	2015	2020	2025	Required Design Year
ADT	10914	11798	12681	

Rigid Pavement Design Period 30 years

		Mid-Point YR		
Base Year	2015	2030	2045	Required Design Year
ADT	0	0	0	

ESAL Calculation

Flexible Pavement

Vehicle Type	Vehicle Percentage	Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.6	39,443,762	0.003	1.00	118,331
Single Unit Trucks	3.8	1,636,313	0.249	1.00	407,442
Combination Trucks	4.6	1,980,800	1.087	1.00	2,153,130
TOTAL	100.0	43,060,875			2,678,903

Design Lane Factor = 1.00

Rigid Pavement

Vehicle Type		Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.6	0	0.003	1.00	0
Single Unit Trucks	3.8	0	0.285	1.00	0
Combination Trucks	4.6	0	1.692	1.00	0
TOTAL	100.0	0			0

DRAFT

I-70 Eastbound Off Ramp at Havana, 20 Year ESAL
1 Lane
RockSol Consulting Group, Inc.

Average Daily Traffic Volume

Existing	Future Year
2012	TBD
10394	TBD

Flexible Pavement Design Period 20 years

		Mid-Point YR		
Base Year	2015	2025	2035	Required Design Year
ADT	10914	12606	14297	

Rigid Pavement Design Period 30 years

		Mid-Point YR		
Base Year	2015	2030	2045	Required Design Year
ADT	0	0	0	

ESAL Calculation

Flexible Pavement

Vehicle Type	Vehicle Percentage	Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.6	84,290,457	0.003	1.00	252,871
Single Unit Trucks	3.8	3,496,766	0.249	1.00	870,695
Combination Trucks	4.6	4,232,927	1.087	1.00	4,601,192
TOTAL	100.0	92,020,150			5,724,758

Design Lane Factor = 1.00

Rigid Pavement

Vehicle Type		Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.6	0	0.003	1.00	0
Single Unit Trucks	3.8	0	0.285	1.00	0
Combination Trucks	4.6	0	1.692	1.00	0
TOTAL	100.0	0			0

DRAFT

I-70 Eastbound On Ramp at Havana, 5 Year ESAL
1 Lane
RockSol Consulting Group, Inc.

Average Daily Traffic Volume

Existing	Future Year
2012	TBD
6535	TBD

Flexible Pavement Design Period 5 years

		Mid-Point YR		
Base Year	2015	2017.5	2020	Required Design Year
ADT	7080	7265	7450	

Rigid Pavement Design Period 30 years

		Mid-Point YR		
Base Year	2015	2030	2045	Required Design Year
ADT	0	0	0	

ESAL Calculation

Flexible Pavement

Vehicle Type	Vehicle Percentage	Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.4	12,118,383	0.003	1.00	36,355
Single Unit Trucks	3.9	517,086	0.249	1.00	128,755
Combination Trucks	4.7	623,155	1.087	1.00	677,370
TOTAL	100.0	13,258,625			842,480

Design Lane Factor = 1.00

Rigid Pavement

Vehicle Type		Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.4	0	0.003	1.00	0
Single Unit Trucks	3.9	0	0.285	1.00	0
Combination Trucks	4.7	0	1.692	1.00	0
TOTAL	100.0	0			0

DRAFT

I-70 Eastbound On Ramp at Havana, 10 Year ESAL
1 Lane
RockSol Consulting Group, Inc.

Average Daily Traffic Volume

Existing	Future Year
2012	TBD
6535	TBD

Flexible Pavement Design Period 10 years

		Mid-Point YR		
Base Year	2015	2020	2025	Required Design Year
ADT	7080	7559	8038	

Rigid Pavement Design Period 30 years

		Mid-Point YR		
Base Year	2015	2030	2045	Required Design Year
ADT	0	0	0	

ESAL Calculation

Flexible Pavement

Vehicle Type	Vehicle Percentage	Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.4	25,217,580	0.003	1.00	75,653
Single Unit Trucks	3.9	1,076,024	0.249	1.00	267,930
Combination Trucks	4.7	1,296,746	1.087	1.00	1,409,563
TOTAL	100.0	27,590,350			1,753,146

Design Lane Factor = 1.00

Rigid Pavement

Vehicle Type		Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.4	0	0.003	1.00	0
Single Unit Trucks	3.9	0	0.285	1.00	0
Combination Trucks	4.7	0	1.692	1.00	0
TOTAL	100.0	0			0

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I-70 Eastbound On Ramp at Havana, 20 Year ESAL
1 Lane
RockSol Consulting Group, Inc.

Average Daily Traffic Volume

Existing	Future Year
2012	TBD
6535	TBD

Flexible Pavement Design Period 20 years

		Mid-Point YR		
Base Year	2015	2025	2035	Required Design Year
ADT	7080	7788	8496	

Rigid Pavement Design Period 30 years

		Mid-Point YR		
Base Year	2015	2030	2045	Required Design Year
ADT	0	0	0	

ESAL Calculation

Flexible Pavement

Vehicle Type	Vehicle Percentage	Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.4	51,963,094	0.003	1.00	155,889
Single Unit Trucks	3.9	2,217,244	0.249	1.00	552,094
Combination Trucks	4.7	2,672,063	1.087	1.00	2,904,532
TOTAL	100.0	56,852,400			3,612,515

Design Lane Factor = 1.00

Rigid Pavement

Vehicle Type		Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.4	0	0.003	1.00	0
Single Unit Trucks	3.9	0	0.285	1.00	0
Combination Trucks	4.7	0	1.692	1.00	0
TOTAL	100.0	0			0

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I-70 Westbound Off Ramp at Havana, 5 Year ESAL
1 Lane
RockSol Consulting Group, Inc.

Average Daily Traffic Volume

Existing	Future Year
2012	TBD
7401	TBD

Flexible Pavement Design Period 5 years

		Mid-Point YR		
Base Year	2015	2017.5	2020	Required Design Year
ADT	7756	8071	8386	

Rigid Pavement Design Period 30 years

		Mid-Point YR		
Base Year	2015	2030	2045	Required Design Year
ADT	0	0	0	

ESAL Calculation

Flexible Pavement

Vehicle Type	Vehicle Percentage	Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.4	13,462,832	0.003	1.00	40,388
Single Unit Trucks	3.9	574,453	0.249	1.00	143,039
Combination Trucks	4.7	692,290	1.087	1.00	752,519
TOTAL	100.0	14,729,575			935,947

Design Lane Factor = 1.00

Rigid Pavement

Vehicle Type		Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.4	0	0.003	1.00	0
Single Unit Trucks	3.9	0	0.285	1.00	0
Combination Trucks	4.7	0	1.692	1.00	0
TOTAL	100.0	0			0

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I-70 Westbound Off Ramp at Havana, 10 Year ESAL
1 Lane
RockSol Consulting Group, Inc.

Average Daily Traffic Volume

Existing	Future Year
2012	TBD
7401	TBD

Flexible Pavement Design Period 10 years

		Mid-Point YR		
Base Year	2015	2020	2025	Required Design Year
ADT	7756	8442	9128	

Rigid Pavement Design Period 30 years

		Mid-Point YR		
Base Year	2015	2030	2045	Required Design Year
ADT	0	0	0	

ESAL Calculation

Flexible Pavement

Vehicle Type	Vehicle Percentage	Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.4	28,163,356	0.003	1.00	84,490
Single Unit Trucks	3.9	1,201,719	0.249	1.00	299,228
Combination Trucks	4.7	1,448,225	1.087	1.00	1,574,221
TOTAL	100.0	30,813,300			1,957,939

Design Lane Factor = 1.00

Rigid Pavement

Vehicle Type		Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.4	0	0.003	1.00	0
Single Unit Trucks	3.9	0	0.285	1.00	0
Combination Trucks	4.7	0	1.692	1.00	0
TOTAL	100.0	0			0

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I-70 Westbound Off Ramp at Havana, 20 Year ESAL
1 Lane
RockSol Consulting Group, Inc.

Average Daily Traffic Volume

Existing	Future Year
2012	TBD
7401	TBD

Flexible Pavement Design Period 20 years

		Mid-Point YR		
Base Year	2015	2025	2035	Required Design Year
ADT	7756	8920	10083	

Rigid Pavement Design Period 30 years

		Mid-Point YR		
Base Year	2015	2030	2045	Required Design Year
ADT	0	0	0	

ESAL Calculation

Flexible Pavement

Vehicle Type	Vehicle Percentage	Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.4	59,512,688	0.003	1.00	178,538
Single Unit Trucks	3.9	2,539,382	0.249	1.00	632,306
Combination Trucks	4.7	3,060,280	1.087	1.00	3,326,525
TOTAL	100.0	65,112,350			4,137,369

Design Lane Factor = 1.00

Rigid Pavement

Vehicle Type		Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.4	0	0.003	1.00	0
Single Unit Trucks	3.9	0	0.285	1.00	0
Combination Trucks	4.7	0	1.692	1.00	0
TOTAL	100.0	0			0

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I-70 Westbound On Ramp at Havana, 5 Year ESAL
1 Lane
RockSol Consulting Group, Inc.

Average Daily Traffic Volume

Existing	Future Year
2012	TBD
11536	TBD

Flexible Pavement Design Period 5 years

		Mid-Point YR		
Base Year	2015	2017.5	2020	Required Design Year
ADT	12090	12876	13662	

Rigid Pavement Design Period 30 years

		Mid-Point YR		
Base Year	2015	2030	2045	Required Design Year
ADT	0	0	0	

ESAL Calculation

Flexible Pavement

Vehicle Type	Vehicle Percentage	Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.6	21,524,809	0.003	1.00	64,574
Single Unit Trucks	3.8	892,951	0.249	1.00	222,345
Combination Trucks	4.6	1,080,940	1.087	1.00	1,174,982
TOTAL	100.0	23,498,700			1,461,901

Design Lane Factor = 1.00

Rigid Pavement

Vehicle Type		Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.6	0	0.003	1.00	0
Single Unit Trucks	3.8	0	0.285	1.00	0
Combination Trucks	4.6	0	1.692	1.00	0
TOTAL	100.0	0			0

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I-70 Westbound On Ramp at Havana, 10 Year ESAL
1 Lane
RockSol Consulting Group, Inc.

Average Daily Traffic Volume

Existing	Future Year
2012	TBD
11536	TBD

Flexible Pavement Design Period 10 years

		Mid-Point YR		
Base Year	2015	2020	2025	Required Design Year
ADT	12090	13481	14871	

Rigid Pavement Design Period 30 years

		Mid-Point YR		
Base Year	2015	2030	2045	Required Design Year
ADT	0	0	0	

ESAL Calculation

Flexible Pavement

Vehicle Type	Vehicle Percentage	Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.6	45,070,704	0.003	1.00	135,212
Single Unit Trucks	3.8	1,869,745	0.249	1.00	465,567
Combination Trucks	4.6	2,263,376	1.087	1.00	2,460,290
TOTAL	100.0	49,203,825			3,061,068

Design Lane Factor = 1.00

Rigid Pavement

Vehicle Type		Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.6	0	0.003	1.00	0
Single Unit Trucks	3.8	0	0.285	1.00	0
Combination Trucks	4.6	0	1.692	1.00	0
TOTAL	100.0	0			0

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I-70 Westbound On Ramp at Havana, 20 Year ESAL
1 Lane
RockSol Consulting Group, Inc.

Average Daily Traffic Volume

Existing	Future Year
2012	TBD
11536	TBD

Flexible Pavement Design Period 10 years

		Mid-Point YR		
Base Year	2015	2025	2035	Required Design Year
ADT	12090	13904	15717	

Rigid Pavement Design Period 30 years

		Mid-Point YR		
Base Year	2015	2030	2045	Required Design Year
ADT	0	0	0	

ESAL Calculation

Flexible Pavement

Vehicle Type	Vehicle Percentage	Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.6	92,969,924	0.003	1.00	278,910
Single Unit Trucks	3.8	3,856,831	0.249	1.00	960,351
Combination Trucks	4.6	4,668,795	1.087	1.00	5,074,980
TOTAL	100.0	101,495,550			6,314,241

Design Lane Factor = 1.00

Rigid Pavement

Vehicle Type		Total Design Life Volume	Equivalency Factor	Design Lane Factor	Design Lane 18k ESAL's
Passenger Cars and P.U. Trucks	91.6	0	0.003	1.00	0
Single Unit Trucks	3.8	0	0.285	1.00	0
Combination Trucks	4.6	0	1.692	1.00	0
TOTAL	100.0	0			0

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APPENDIX E

FLEXIBLE AND RIGID PAVEMENT CALCULATION SHEETS

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Rigid Pavement Design - Based on AASHTO Supplemental Guide

Reference: *LTPP DATA ANALYSIS - Phase I: Validation of Guidelines for k-Value Selection and Concrete Pavement Performance Prediction*

Results

Project # 304.01
Description: I-70 Mainline West of Havana

Location: I-70 at Havana

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Slab Thickness Design

Pavement Type	JPCP	
18-kip ESALs Over Initial Performance Period (million)	62.30	million
Initial Serviceability	4.5	
Terminal Serviceability	2.5	
28-day Mean PCC Modulus of Rupture	650	psi
Elastic Modulus of Slab	3,400,000	psi
Elastic Modulus of Base	25,000	psi
Base Thickness	6.0	in.
Mean Effective k-Value	88	psi/in
Reliability Level	95	%
Overall Standard Deviation	0.34	
Calculated Design Thickness	**12.94**	in

Temperature Differential

Mean Annual Wind Speed	8.8	mph
Mean Annual Air Temperature	50.3	°F
Mean Annual Precipitation	8.8	in
Maximum Positive Temperature Differential	**9.11**	°F

Modulus of Subgrade Reaction

Period	Description	Subgrade k-Value, psi
12	1	

Rigid Pavement Design - Based on AASHTO Supplemental Guide

Reference: *LTPP DATA ANALYSIS - Phase I: Validation of Guidelines for k-Value Selection and Concrete Pavement Performance Prediction*

Results

Project # 304.01
Description: I-70 Mainline East of Havana

Location: I-70 at Havana

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Slab Thickness Design

Pavement Type	JPCP	
18-kip ESALs Over Initial Performance Period (million)	65.70	million
Initial Serviceability	4.5	
Terminal Serviceability	2.5	
28-day Mean PCC Modulus of Rupture	650	psi
Elastic Modulus of Slab	3,400,000	psi
Elastic Modulus of Base	25,000	psi
Base Thickness	6.0	in.
Mean Effective k-Value	88	psi/in
Reliability Level	95	%
Overall Standard Deviation	0.34	
Calculated Design Thickness	**13.04**	in

Temperature Differential

Mean Annual Wind Speed	8.8	mph
Mean Annual Air Temperature	50.3	°F
Mean Annual Precipitation	8.8	in
Maximum Positive Temperature Differential	**9.14**	°F

Modulus of Subgrade Reaction

Period	Description	Subgrade k-Value, psi
12	1	

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I-70 East of Havana
8 lanes total
Buildout 2015 @ 20 year ESAL's
R-20

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	26,600,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	4,940 psi
Stage Construction	1
Calculated Design Structural Number	6.43 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	12.75	-	5.61
2	CDOT Class 6 ABC	0.14	1	6	-	0.84
Total	-	-	-	18.75	-	6.45

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
Total	-	-	-	-	-	-	-	-	-

*Note: This value is not represented by the inputs or an error occurred in calculation.

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I-70 West of Havana
8 lanes total
Buildout 2015 @ 20 year ESAL's
R-20

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	27,800,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	4,940 psi
Stage Construction	1
Calculated Design Structural Number	6.46 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	13	-	5.72
2	CDOT Class 6 ABC	0.14	1	6	-	0.84
Total	-	-	-	19.00	-	6.56

Layered Thickness Design

Thickness precision

Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
Total	-	-	-	-	-	-	-	-	-

*Note: This value is not represented by the inputs or an error occurred in calculation.

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EB Off Ramp
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5 Year Design

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,300,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	4,940 psi
Stage Construction	1
Calculated Design Structural Number	4.27 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	7.75	-	3.41
2	CDOT Class 6 ABC	0.15	1	6	-	0.90
Total	-	-	-	13.75	-	4.31

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
Total	-	-	-	-	-	-	-	-	-

*Note: This value is not represented by the inputs or an error occurred in calculation.

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10 Year Design

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	2,900,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	4,940 psi
Stage Construction	1
Calculated Design Structural Number	4.79 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	9	-	3.96
2	CDOT Class 6 ABC	0.15	1	6	-	0.90
Total	-	-	-	15.00	-	4.86

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
Total	-	-	-	-	-	-	-	-	-

*Note: This value is not represented by the inputs or an error occurred in calculation.

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EB Off Ramp
R-20
20 Year Design

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	5,750,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	4,940 psi
Stage Construction	1
Calculated Design Structural Number	5.26 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	10	-	4.40
2	CDOT Class 6 ABC	0.15	1	6	-	0.90
Total	-	-	-	16.00	-	5.30

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
Total	-	-	-	-	-	-	-	-	-

*Note: This value is not represented by the inputs or an error occurred in calculation.

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EB On Ramp
R-20
5 Year

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	850,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	4,940 psi
Stage Construction	1
Calculated Design Structural Number	4.01 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	7.25	-	3.19
2	CDOT Class 6 ABC	0.15	1	6	-	0.90
Total	-	-	-	13.25	-	4.09

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
Total	-	-	-	-	-	-	-	-	-

*Note: This value is not represented by the inputs or an error occurred in calculation.

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EB On Ramp
R-20
10 Year

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,800,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	4,940 psi
Stage Construction	1
Calculated Design Structural Number	4.48 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	8.25	-	3.63
2	CDOT Class 6 ABC	0.15	1	6	-	0.90
Total	-	-	-	14.25	-	4.53

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
Total	-	-	-	-	-	-	-	-	-

*Note: This value is not represented by the inputs or an error occurred in calculation.

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EB On Ramp
R-20
20 Year

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	3,600,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	4,940 psi
Stage Construction	1
Calculated Design Structural Number	4.93 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	9.25	-	4.07
2	CDOT Class 6 ABC	0.15	1	6	-	0.90
Total	-	-	-	15.25	-	4.97

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
Total	-	-	-	-	-	-	-	-	-

*Note: This value is not represented by the inputs or an error occurred in calculation.

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Flexible Structural Design Module

WB off Ramp
R-20
5 Year Design

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	950,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	4,940 psi
Stage Construction	1
Calculated Design Structural Number	4.08 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	7.25	-	3.19
2	CDOT Class 6 ABC	0.15	1	6	-	0.90
Total	-	-	-	13.25	-	4.09

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
Total	-	-	-	-	-	-	-	-	-

*Note: This value is not represented by the inputs or an error occurred in calculation.

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Flexible Structural Design Module

WB off Ramp
R-20
10 Year Design

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	2,000,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	4,940 psi
Stage Construction	1
Calculated Design Structural Number	4.54 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	8.5	-	3.74
2	CDOT Class 6 ABC	0.15	1	6	-	0.90
Total	-	-	-	14.50	-	4.64

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
Total	-	-	-	-	-	-	-	-	-

*Note: This value is not represented by the inputs or an error occurred in calculation.

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Flexible Structural Design Module

WB off Ramp
R-20
20 Year Design

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	4,200,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	4,940 psi
Stage Construction	1
Calculated Design Structural Number	5.04 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	9.5	-	4.18
2	CDOT Class 6 ABC	0.15	1	6	-	0.90
Total	-	-	-	15.50	-	5.08

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
Total	-	-	-	-	-	-	-	-	-

*Note: This value is not represented by the inputs or an error occurred in calculation.

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1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Flexible Structural Design Module

WB On Ramp
R-20
5 Year Design

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,500,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	4,940 psi
Stage Construction	1
Calculated Design Structural Number	4.36 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	8	-	3.52
2	CDOT Class 6 ABC	0.15	1	6	-	0.90
Total	-	-	-	14.00	-	4.42

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
Total	-	-	-	-	-	-	-	-	-

*Note: This value is not represented by the inputs or an error occurred in calculation.

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1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Flexible Structural Design Module

WB On Ramp
R-20
10 Year Design

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	3,100,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	4,940 psi
Stage Construction	1
Calculated Design Structural Number	4.83 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	9	-	3.96
2	CDOT Class 6 ABC	0.15	1	6	-	0.90
Total	-	-	-	15.00	-	4.86

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
Total	-	-	-	-	-	-	-	-	-

*Note: This value is not represented by the inputs or an error occurred in calculation.

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1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Flexible Structural Design Module

WB On Ramp
R-20
20 Year Design

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	6,350,000
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	4,940 psi
Stage Construction	1
Calculated Design Structural Number	5.33 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	10.25	-	4.51
2	CDOT Class 6 ABC	0.15	1	6	-	0.90
Total	-	-	-	16.25	-	5.41

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
Total	-	-	-	-	-	-	-	-	-

*Note: This value is not represented by the inputs or an error occurred in calculation.

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