RockSol
Consulting Group, Inc.

June 4, 2013

Parsons
1776 Lincoln Street, Suite 600
Denver, Colorado 80203

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

Subject: Foundation Investigation 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 subsurface investigation for the *Interim Construction Design* phase of the I-70 Havana Bridge Replacement Project. This Foundation Investigation Report presents preliminary geotechnical design parameters for drilled shaft and driven pile foundation systems and retaining wall foundation considerations for the proposed bridge structure and retaining wall systems based on the subsurface soil, groundwater, and bedrock conditions obtained from soil boreholes performed within the project limits for the *Interim Construction Design* phase. A brief discussion of local geologic conditions is also presented in this report. A *Soil Investigation Report* and a *Preliminary Pavement Design Report* for this project are presented by RockSol under separate covers.

Surface and groundwater hydrology, hydraulic engineering, and environmental studies including contaminant characterization were not included in RockSol's scope of work.

Project descriptions are based on information and preliminary plan sheets provided by Parsons titled *I-70 East Environmental Impact Statement (EIS), I-70 over Havana Street Interim Construction*, Sheets 1 through 5, dated 10/24/2012 and modified 11/8/2012. Subsequent to the drilling operations, Parsons provided RockSol the *I-70 Over Havana Street Design Build Wall Plan and Profiles 1 and 2, Project No. FBR 0704-230 (19339 CN)*, dated 5/21/2013, which included revisions to the EIS Interim Construction plans. 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

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 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 1,800 feet west and approximately 1,400 feet east of the bridge structure over Havana. Based

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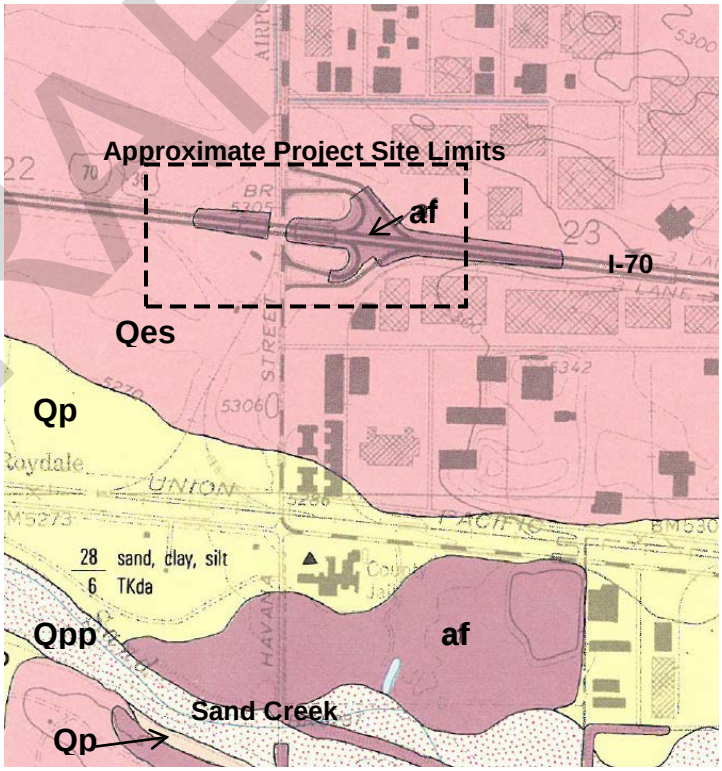
on information provided, no improvements or modifications are planned for Havana Street for the interim construction phase of the project.

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 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.

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) sands (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 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.

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Subsurface Investigation

In March 2013, RockSol drilled 24 boreholes to evaluate the subsurface conditions for the interim construction phase of the I-70 over Havana Bridge Replacement project. 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 were taken, the type of sampler used, and the blow counts that were obtained are shown on the Boring Logs for each borehole.

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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. On Havana, measured thickness of the existing asphalt pavement ranged from 2 inches within the raised center median of Havana to 17 inches within the southbound turn lane to eastbound I-70. 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.

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 encountered generally consisted of medium dense to very dense silty sand with sandy clay and gravel in parts. Based on laboratory test results, the fill material encountered predominantly classified as A-2-4(0) silty sand soils.

Native soils encountered below the fill material or ground surface 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 very hard claystone. Very hard clayey sandstone and siltstone bedrock layers were also noted in Boreholes BR-2 and BR-4. Bedrock was not noted to the maximum depths drilled (approximately 10 feet to 61 feet) at Boreholes PV-1 through PV-8 and 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 1. The approximate groundwater and bedrock elevations are rounded to the nearest foot and 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 1, there appears to be a decreasing gradient to the northwest. Based on the bedrock elevations presented in Table 1, the bedrock surface elevation appears to be decreasing in the northwest direction.

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Table 1 – 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 borehole logs are included in Appendix A. A summary of laboratory test results is presented in Appendix B. Engineering geology sheets showing the subsurface conditions at the bridge are presented on Figures 3A and 3B.

Bridge Foundation Recommendations

The sedimentary bedrock encountered in Boreholes BR-1 through BR-6 is considered suitable bearing material for supporting heavily loaded structures such as bridges. Drilled shaft foundations and driven steel piles are considered feasible deep foundation systems for the proposed bridge structure.

Drilled Shafts

Drilled shafts will provide support by embedment into sedimentary bedrock. Based on the subsurface conditions encountered, it is anticipated that very hard claystone, siltstone and sandstone bedrock will be encountered at an approximate elevation range of 5,211 feet to 5,230 feet. Based on our evaluation, recommended ultimate (unfactored) base resistance and side resistance values for the bedrock material are presented in Table 2.

Table 2 - Base and Side Resistance Values for Drilled Shafts in Bedrock

Bridge Location	Estimated Bedrock Elevation Range (feet)	Ultimate Resistance	
		Base Resistance (ksf)	Side Resistance (ksf)
West Abutment	5,211 (North End) to 5,230 (South End)	110	9.0
Mid Span	5,220 (North End) to 5,227 (South End)		
East Abutment	5,226 (North End) to 5,224 (South End)		

The side resistance is applicable to the portion of the shaft embedded in competent bedrock. When evaluating the side resistance of the drilled shaft, the lower 1.0-diameter length above the shaft tip should be ignored. Side resistance in the soil zone above competent bedrock should be neglected. For Load and Resistance Factor Design (LRFD) strength limit state evaluation, a resistance factor of 0.50 is recommended for base/ tip resistance and a resistance factor of 0.50 is recommended for side resistance evaluation for redundant single shafts. Per AASHTO LRFD

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(Section 10.5.5.2.4) the resistance factors for base/tip and side resistance should be reduced by 20 percent for non-redundant single shafts.

For axial bearing, a minimum shaft embedment into bedrock of 10 feet is recommended for shafts less than 5 feet in diameter. For shaft diameters greater than 5 feet, a minimum shaft embedment of 15 feet into bedrock is recommended.

Drilled shaft diameters shall be sufficient to satisfy axial, bending, and lateral load resistance requirements. In addition, the shaft diameters shall be sufficient to allow for use of casing, if required, and placement of reinforcement with adequate concrete cover.

Additional design and construction considerations are listed below.

(a) The construction of the drilled shafts should follow the guidelines specified in the "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), Section 503, 2011."

(b) During construction of the drilled shafts, casing or slurry displacement methods will be required to support the excavation where groundwater exists and or where holes are unstable due to soil conditions. Groundwater was encountered in Boreholes BR-1 through BR-6 at approximate elevations ranging from 5,251 feet to 5,260 feet. Caving conditions are anticipated in the sand layers encountered above bedrock. The bedrock is considered shale as described in SSRBC Section 503.07.

(c) Prior to the placement of the concrete, the drilled shaft excavation, including the bottom should be cleaned of all loose material. For wet conditions (more than two inches of water), concrete placement by "tremie" methods should be used.

(d) Special provisions should be specified for drilling operations and equipment where hard bedrock and or difficult subsurface conditions exist.

(e) Lateral load capacity of the drilled shafts should be evaluated. Geotechnical parameters for evaluation of lateral load capacity are provided in Table 3.

(f) All piers should be reinforced as required for resistance to axial, bending, lateral and uplift stresses.

(g) Drilled shafts should be constructed with spacing at least four shaft diameters center to center. For closely spaced drilled shafts, the axial and lateral capacities should be appropriately reduced. Group action of drilled shafts should be analyzed on an individual basis to assess the appropriate reduction.

(h) If drilled shafts are constructed where fill material will be placed, downdrag loads should be considered.

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Driven Piles

Alternatively, the I-70 over Havana bridge structure, including the abutments, may be supported on driven steel H-piles (Grade 50 steel). RockSol recommends the piles be driven to practical refusal in the bedrock. Based on the subsurface conditions encountered in our boreholes, practical refusal is estimated to occur within 4 to 6 feet of penetration into bedrock. Sedimentary bedrock was encountered at approximate elevations of 5,224 feet and 5,226 feet on the east side of Havana and 5,211 feet and 5,230 feet on the west side of Havana. Sedimentary bedrock was also encountered at approximate elevations of 5,220 feet and 5,227 feet near the mid span of the I-70 bridge structure over Havana.

For the LRFD method, a nominal (ultimate) geotechnical capacity of 36 ksi, based on the cross section area of the pile, can be used for Grade 50 steel. A resistance factor of 0.65 is recommended for LRFD strength limit state design for axial compression.

During construction, pile driving shall be monitored per CDOT requirements per Section 502 of the "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), 2011". Monitoring shall be conducted using a Pile Driving Analyzer (PDA) to determine the condition of the pile, the efficiency of the hammer and the static bearing capacity of the pile, and to establish the pile driving criteria. Additional design and construction details of the driven piles are presented below:

(a) Steel piling, pile driving equipment, and installation of the driven steel H-piles should follow the guidelines specified in "CDOT Standard Specifications for Road and Bridge Construction (SSRBC), Section 502, 2011".

(b) Lateral load parameters presented in Table 3 may be used for lateral load analysis. Battered piles may be used to resist the lateral loads. The battered piles inclination should be within one (1) horizontal to four (4) vertical.

(c) RockSol anticipates that 4 feet to 6 feet of pile penetration into bedrock will be required to achieve capacity and meet refusal criteria. The actual length of the piles should be determined during installation.

(d) Center to center pile spacing should not be less than 30 inches or 2.5 pile diameters. For evaluation of horizontal pile foundation movement, the effects of group interaction shall be evaluated in accordance with AASHTO LRFD Bridge Design Specifications, Section 10.7.2.4.

(e) Predrilling is not anticipated by RockSol based on the conditions encountered in our boreholes. If significant penetration (greater than 6 feet) into bedrock is necessary for lateral resistance requirements, pre-drilling may be required. Pile tips should be protected against damage using driving shoes during penetration into the sedimentary bedrock.

(f) Potential damage to adjacent properties or structures during pile installation due to noise and vibrations should be considered and evaluated, if necessary.

(g) If driven piles are constructed where fill material will be placed, downdrag loads should be considered.

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Lateral Resistance Parameters (Drilled Shaft and Driven Pile Foundations)

Recommended lateral resistance parameters for drilled shafts and driven piles constructed are presented in Table 3. The parameters listed are for use with LPILE® or equivalent COM624 software.

Table 3 - Drilled Shaft and Driven Pile Lateral Resistance Parameters

Borehole Material	L-Pile Soil Type	Undrained Shear Strength (Cohesion) (psf)	Angle of Internal Friction (degrees)	Subgrade Reaction Coefficient, (pci)	Strain Factor ε_{50} (%)	Unit Weight (pcf)
(Fill and Native) SAND, silty to clayey, above water table	Sand (#4)	0	32	90	--	120 (Total)
(Native) SAND, silty to clayey, below water table	Sand (#4)	0	32	60	--	60 (Submerged)
(Native) CLAY, sandy, below water table	Stiff clay w/ free water (#2)	500	20	100	0.020	60 (Submerged)
(Native) CLAY, sandy above water table	Stiff clay w/o free water (#3)	1,000	22	500	0.010	120 (Total)
Claystone Bedrock	Stiff clay w/o free water (#3)	8,000	0	2,000	0.004	125 (Total)
Siltstone Bedrock	Stiff clay w/o free water (#3)	4,000	0	1,000	0.004	120 (Total)
Sandstone Bedrock	Sand (#4)	0	38	1,500	--	125 (Total)

Total unit weight indicated in the table above includes soil plus moisture content. Depths at which groundwater were encountered are indicated on the attached borehole logs.

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Preliminary Retaining Wall Recommendations

Four new retaining wall structures associated with the bridge replacement and new ramp configurations are proposed along eastbound and westbound I-70 in the northwest, northeast, southwest and southeast quadrants. Retaining walls will be required to retain fill material along the I-70 grade approach embankment locations over Havana Street.

Mechanically stabilized earth (MSE) walls and cast-in-place (CIP) walls are being considered for the proposed retaining wall structures. Maximum retaining wall heights are anticipated between 5 feet to 22 feet for single height retaining wall systems. Descriptions of the proposed retaining wall systems for this project are presented in Table 4. Estimated wall heights and locations were provided by Parsons.

Three retaining wall systems are shown on the I-70 over Havana Street Interim Construction plans for the ramp connections to I-70. Based on the Design Build Wall Plans and information provided subsequent to the drilling operations, these three retaining wall systems are no longer being considered for the interim construction phase. The four new retaining wall systems shown on the *I-70 Over Havana Street Design Build Wall Plans and Profiles* extending to the

east and west from the proposed I-70 bridge over Havana along eastbound and westbound I-70 are now being considered for the interim construction phase. These retaining walls will extend up the existing embankment slopes of I-70.

Table 4 – Proposed Retaining Wall Summary

Wall Identification	Wall Type (cut or fill)	Associated Structure/Roadway	Approximate Wall Lengths (ft)	Approximate Wall Height (ft)	Corresponding RockSol Boreholes
Northwest	Fill	Westbound I-70, West of Havana	1,500	5 to 22	RW-1 through RW-4 and PV-1 through PV-3
Southwest		Eastbound I-70, West of Havana			
Northeast	Fill	Westbound I-70, East of Havana Street	400	5 to 20	BR-6, RW-4, RW-5, and PV-4
Southeast		Eastbound I-70, East of Havana Street			

Based on conditions encountered in the boreholes, preliminary ultimate (unfactored) bearing resistances are presented in Table 5 for shallow foundations bearing on existing soils and embankment fill material. The bearing resistances are considered preliminary. For final design, additional boreholes are anticipated along the retaining wall alignments.

For estimation of the bearing resistance, a footing width or reinforcement length of 0.7 times the design height of the proposed retaining wall structure was assumed. Service limit state, service bearing resistance was correlated to settlement potentials ranging from approximately 1 inch to 2 inches. For final design, total and differential settlement tolerances should be established for the specific structure foundation and estimated settlement should be checked against the bearing resistance.

Table 5 – Preliminary Bearing Resistances for Shallow Foundations

Soil Type	Ultimate (Unfactored) Resistance (psf)	Service Bearing Resistance (LRFD) (psf)
(Fill and Native Materials) SAND, silty to clayey	12,000	4,000
(Native) Clay with sand to sandy	5,500	1,800

For Load and Resistance Factor Design (LRFD) strength limit state evaluation, a resistance factor of 0.45 is recommended for cast-in-place concrete walls and a resistance factor of 0.65 is recommended for MSE walls.

To evaluate CIP wall system global stability, a foundation embedment depth of 3 feet and 5 feet was used. Foundation embedment depth is defined as the distance from the bottom of the footing or leveling pad to the finished, permanent ground surface. For preliminary design of the CIP wall system, a minimum embedment depth of 5 feet is recommended for wall heights greater than 10 feet and a minimum embedment depth of 3 feet is recommended for wall heights less than 10 feet.

To evaluate MSE wall system global stability, an embedment depth of 4 feet and 5 feet was used. For preliminary design, a 5-foot embedment with a reinforcement length to wall height ratio of 1.0 is recommended for MSE wall systems with heights greater than 10 feet. For MSE wall systems with heights less than 10 feet, a 4-foot embedment with a reinforcement length to wall height ratio of 1.0 is recommended.

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For the evaluation of sliding, parameters for the general soil types encountered at Boreholes RW-1 through RW-10 are presented in Table 6. For cohesionless soil, the nominal sliding resistance between soil and foundation per AASHTO LRFD Equation 10.6.3.4-2 is $R_t = V\tan\delta$. The value of tanδ is presented in Table 6. A resistance factor of 0.80 is recommended, per AASHTO LRFD Table 10.5.5.2.2-1 for evaluation of sliding with cast-in-place concrete on sand. A resistance factor of 0.90 is recommended, per AASHTO LRFD Table 10.5.5.2.2-1 for evaluation of sliding of soil on soil.

Per AASHTO LRFD Section 10.6.3.4, for footings that rest on clay subgrade, the sliding resistance may be taken as the lesser of: 1) The cohesion of the clay, or; 2) Where footings are supported on at least 6.0 inches of compacted granular material, one-half the normal stress on the interface between the footing and soil. A resistance factor of 0.85 is recommended, per AASHTO LRFD Table 10.5.5.2.2-1 for evaluation of sliding with cast-in-place concrete on clay. If passive resistance is included as part of the shear resistance required for resisting sliding, passive pressures may be estimated by AASHTO LRFD Equation 3.11.5.4-1. Consideration should be given to possible future removal of the soil in front of the wall foundation. If passive resistance is included, a resistance factor of 0.50 is recommended, per AASHTO LRFD Table 10.5.5.2.2-1.

Table 6 – Preliminary Sliding Resistance Parameters – Shallow Foundations

Foundation Bearing Material	Total Unit Weight (pcf)	Effective Friction Angle, ϕ′ (degree's)	Tan δ (Note 1)	Undrained Shear Strength (Cohesion) (psf)
(Fill and Native Material) SAND, silty to clayey (cohesionless)	120	32	0.625	0
(Native) Clay with sand to sandy (cohesive)	120	22	-	2,000

Note 1: For concrete cast against soil.

Drainage of retained soil behind all walls is recommended. Surface water infiltration of wall backfill zones may occur. Positive internal and external surface drainage to eliminate hydrostatic pressure is recommended.

Lateral Earth Pressure Parameters (Retaining Structures)

To assist with preliminary design, lateral earth pressure parameters are presented in Table 7 for the existing soils encountered in Boreholes RW-1 through RW-10 and BR-1 through BR-6. Also included are parameters for CDOT Class 1 Structure backfill material.

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Table 7 –Lateral Earth Pressure Parameters (Retaining Structures)

Soil Type	Total Unit Weight (γ) pcf	Effective Friction Angle, ϕ′ (degrees)	Cohesion (psf)	Lateral Earth Pressure Coefficients (Notes 1 and 2)			Passive Earth Pressure Coefficients (k_p) for Sloping Foreslope Conditions (Note 4)
				Active (k_a)	At-Rest (k_o)	Passive (k_p) (Note 3)	
CDOT Class 1 Structure Backfill (CDOT Section 703.08)	125	34	0	0.28	0.44	3.54	1.93
(Fill and Native Materials) SAND, silty to clayey	120	32	0	0.31	3.26	0.47	1.80
(Native) CLAY, with sand to sandy	120	22	1,000	0.46	0.63	2.20	1.24

Note 1: Based on Rankine Theory of earth pressure.
Note 2: For horizontal backslope and foreslope.
Note 3: Full value, no reduction applied.
Note 4: For horizontal backslope and 18 degree (3H:1V) sloping foreslope.

Temporary Soil Nail Wall System

A temporary soil nail wall retaining system may be necessary for the proposed retaining wall foundation excavations and working platforms within the existing I-70 embankment slopes to maintain a stable slope during construction of the proposed retaining wall foundation system. The soil nails would extend into the existing I-70 embankment materials. Lateral earth pressure parameters are presented in Table 8 for preliminary design of the soil nail wall system. Construction equipment and traffic surcharges are not included in Table 8 and should be considered. A slope of 3H:1V above the temporary retaining wall is assumed.

Table 8 –Preliminary Lateral Earth Pressure Parameters (Temporary Soil Nail Wall)

Soil Type	**Total Unit Weight (γ) pcf**	**Effective Friction Angle, φ′ (degrees)**	**Cohesion (psf)**	**Lateral Earth Pressure Coefficient (Notes 1 and 2)**
				Active (k_a)
(Fill and Native Materials) SAND, silty to clayey	120	32	0	0.36

Note 1: Based on Rankine Theory of earth pressure.
Note 2: For 3H:1V backslope above the wall.

Ultimate bond strength for soil nails can vary depending on the construction method used. For preliminary design, ultimate bond strength of 10 psi is estimated for an augured, pressure grouted soil nail constructed in the existing silty sand embankment material. Load test verification of the soil nail system is recommended during the construction phase.

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Subgrade Preparation

Prior to construction of foundations, the underlying subgrade should be properly prepared by removal of all organic matter (topsoil), debris, loose material, and any deleterious material identified by the Project Engineer followed by scarification, moisture conditioning and recompaction. Unless otherwise specified, the minimum depth of scarification, moisture conditioning and re-compaction in all cases shall be 6 inches following the compaction specifications outlined in Table 9. Cobbles greater than 6 inches in diameter, if encountered, should be removed from the scarification zone.

Compaction should be achieved near optimum moisture content. A representative of the geotechnical engineer should observe and test the operations. The minimum compaction recommended for specific applications is presented in Table 9.

Table 9 –Compaction Specifications (Structures)

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 T180	-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

Granular material is recommended for retaining wall backfill. To reduce the risk of excessive compaction induced lateral earth pressures on retaining walls, thin lifts (6 to 8 inches maximum) and small manually operated equipment should be used within 5 feet of the inside wall face.

Embankment Construction

The ground surface underlying all fills should be carefully prepared by removing all organic matter (topsoil), scarification to a minimum depth of 6 inches and recompacting to at least 95 percent of the maximum dry density (AASHTO T-99/ASTM D698) prior to fill placement. Claystone materials shall not be used for construction of permanent fill slopes. Materials used to construct embankments, including slopes, should meet requirements for soil embankment constructed with moisture density control as required in Section 203.07 (and subsequent revisions) of the CDOT Standard Specifications for Road and Bridge Construction.

Where fill material is to be placed on existing slopes steeper than 4 (H):1 (V), benching must be performed to tie the new fill into the existing slope. Benching into the native ground shall be sufficient to allow sufficient bench width to accommodate placing and compaction equipment to operate in a horizontal orientation.

New, permanent fill slopes constructed using on-site materials should not exceed (be steeper than) 3 horizontal (H) to 1 vertical (V).

Material Specifications

The following material specifications are presented for earthwork on the project. The geotechnical engineer should approve all fill used on the site prior to placement in order to determine its suitability.

1. Soil Embankment: Material shall be soil predominately of materials smaller than No. 4 sieve in diameter. Soil embankment shall be constructed with moisture and density control. RockSol recommends that soil embankment consist of non-swelling material with an R-Value of at least 20.

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2. Aggregate Base Course: Material shall be crushed stone, crushed slag, crushed gravel or natural gravel which conforms to the Colorado State Department of Transportation (CDOT) for Class 6 aggregate base course.

3. Retaining Wall Backfill: Shall consist of granular material meeting CDOT Structure Backfill (Class 1) requirements presented in Section 703.08 or CDOT Class 6 Aggregate Base Course presented in Section 703.03 of the CDOT Standard Specifications for Road and Bridge Construction (2011).

4. Utility Trench Backfill: Material excavated from the utility trenches may be used for backfill provided it does not contain unsuitable material (see Item 5) or particles larger than 4 inches.

5. Unsuitable Material: Vegetation, brush, sod, trash, and other deleterious substances shall not be placed in embankment, excavation backfill, or structural backfill. A geotechnical engineer should approve all fill utilized on the site prior to placement to determine its suitability.

Seismicity Discussion

Boreholes BR-1 through BR-6 terminated at depths less than 100 feet below the ground surface and shear wave velocity testing was not performed by RockSol. However, based on the subsurface conditions encountered, including blow counts and laboratory testing, it is our opinion that the I-70 over Havana Bridge Replacement site meets criteria for Seismic Site Class D, as defined by AASHTO LRFD Table 3.10.3.1-1. Soil conditions necessary for Site Class E and F were not encountered in RockSol's boreholes. For final design, RockSol recommends performing shear wave velocity testing or performing penetration tests to a depth of 100 feet to confirm the appropriate site class for seismic design, or use of Seismic Site Class D can be considered.

Seismic Design Parameters

Seismic design parameters were obtained from the 2007 United States Geological Survey (USGS) Seismic Design Parameters CD (Version 2.10) using the AASHTO Earthquake Motion Parameters Program. The values provided are for a 7 percent probability of exceedance in 75 years. Interpolated values for Peak Ground Acceleration Coefficient (PGA), horizontal response Spectral Acceleration Coefficient at Period 0.2 sec (S_s), and horizontal response Spectral Acceleration Coefficient at Period 1.0 sec (S_1) were obtained using the latitude and longitude for the bridge structure. The seismic acceleration coefficients obtained (data based on 0.05 degree grid spacing) are presented in Table 10:

Table 10 – Seismic Acceleration Coefficients

Structure Location (Latitude°/Longitude°)	Peak Ground Acceleration (PGA)	Spectral Acceleration Coefficient - S_s (Period 0.2 sec)	Spectral Acceleration Coefficient - S_1 (Period 1.0 sec)
I-70 over Havana (39.775721°/-104.865837°)	0.056	0.120	0.033

The seismic acceleration coefficients are then used to obtain Site Factors F_{pga}, F_a, and F_v based on the defined Site Class as shown in Tables 3.10.3.2-1, 3.10.3.2-2, and 3.10.3.2-3 of the *AASHTO LRFD*. A summary of the Site Factor values obtained for each station are shown in Table 11.

Table 11 – Seismic Site Factor Values

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Structure Location	F_{pga} (at zero-period on acceleration spectrum)	F_a (for short period range of acceleration spectrum)	F_v (for long period range of acceleration spectrum)
I-70 over Havana	1.6	1.6	2.4

Table 12 summarizes the Seismic Zone determination and horizontal response spectral Acceleration Coefficient (S_{D1}) obtained for the proposed bridge structure. Seismic Performance Zone determination is based on the value of the horizontal response spectral Acceleration Coefficient, S_{D1}, as determined by *Eq. 3.10.4.2-6* of the *AASHTO LRFD* ($S_{D1} = F_v \times S_1$). Values for F_v and S_1 are presented in Tables 10 and 11, shown above. The seismic performance zone was determined with *AASHTO LRFD* Table 3.10.6-1. The peak seismic ground acceleration coefficient A_S, as determined by *Eq. 3.10.4.2-2* of the *AASHTO LRFD* ($A_S = F_{pga} \times PGA$), is presented in Table 12. The value of F_{pga} is presented in Table 11 and the value of *PGA* is presented in Table 10.

Table 12 – Seismic Performance Zone

Structure Location	Acceleration Coefficient (S_{D1})	Seismic Zone (Note 1)	Acceleration Coefficient, A_S
I-70 over Havana	0.079	1	0.089

Note (1): Seismic Zone 1 is assigned when $S_{D1} \leq 0.15$.

Cement Type and Corrosion Resistance 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 13 and in the Standard Specifications for Road and Bridge Construction, dated 2011 (CDOT Table 601-2).

Table 13
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.

Water soluble chloride content, pH and electrical resistivity tests were performed on individual and bulk samples obtained from selected boreholes. Comparison of the results of the chloride,

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sulfate and pH testing performed with *Table 1 - Guidelines for Selection of Corrosion Resistance Levels as presented in the CDOT Pipe Materials Selection Policy,* dated May 7, 2012*,* suggests corrosion resistance (CR) levels ranging from CR 0 to CR 3 are present within the project limits.

Based on the laboratory electrical resistivity test results, an aggressive corrosion condition for steel pipe and piles and reinforcement bars is indicated at this site based on criteria presented in Table 3.9 of FHWA report FHWA0-IF-3-017, Geotechnical Engineering Circular No.7 – Soil Nail Walls. Additional geochemistry discussion is presented in the Soil Investigation Report, submitted under separate cover.

Additional testing for cement type and corrosion resistance is recommended for future phases of the ultimate design.

Limitations

This geotechnical investigation was conducted in general accordance with the scope of work. This report has been prepared for use by Parsons and the Colorado Department of Transportation (CDOT) exclusively for the project described in this report. The report is based on information provided by CDOT, RockSol's observations, and 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. The nature and extent of subsurface variations across the project site may not become evident until the construction phase of the project and when excavations are performed.

The conclusions and recommendations submitted in this report are based upon the data obtained from the boreholes drilled at the locations indicated on the boring location sheets and our understanding of the proposed type of construction. Additional field investigation is recommended and additional evaluation for development of final geotechnical recommendations for the final design phase is recommended. If the proposed construction is different than described in this report, RockSol should be notified to re-evaluate, or supplement, the recommendations contained in this report. RockSol is not responsible for liability associated with interpretation of subsurface data by others.

Prepared by RockSol Consulting Group, Inc.:

Ryan Lepro
Geological Engineer

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

Attachments:

Figure 1 - Site Vicinity Map
Figures 2A and 2B – Borehole Location Plan
Figures 3A and 3B – Engineering Geology Sheets

Appendix A – Legend and Individual Borehole Logs
Appendix B – Laboratory Test Results

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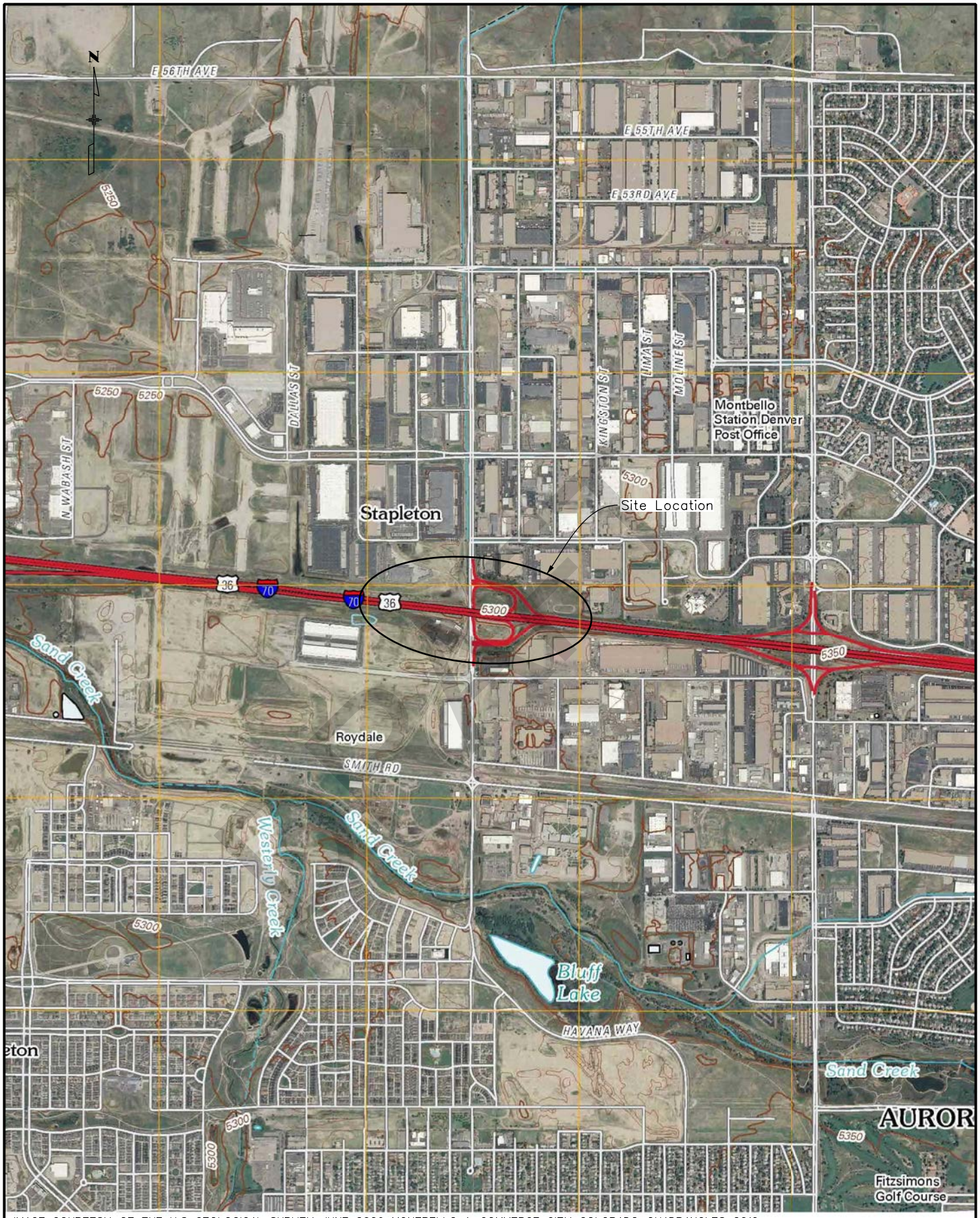

IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY, JUNE 2009, MONTBELLO & COMMERCE CITY, COLORADO QUADRANGLES, 2010

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		13599 (CN)
		Figure 1

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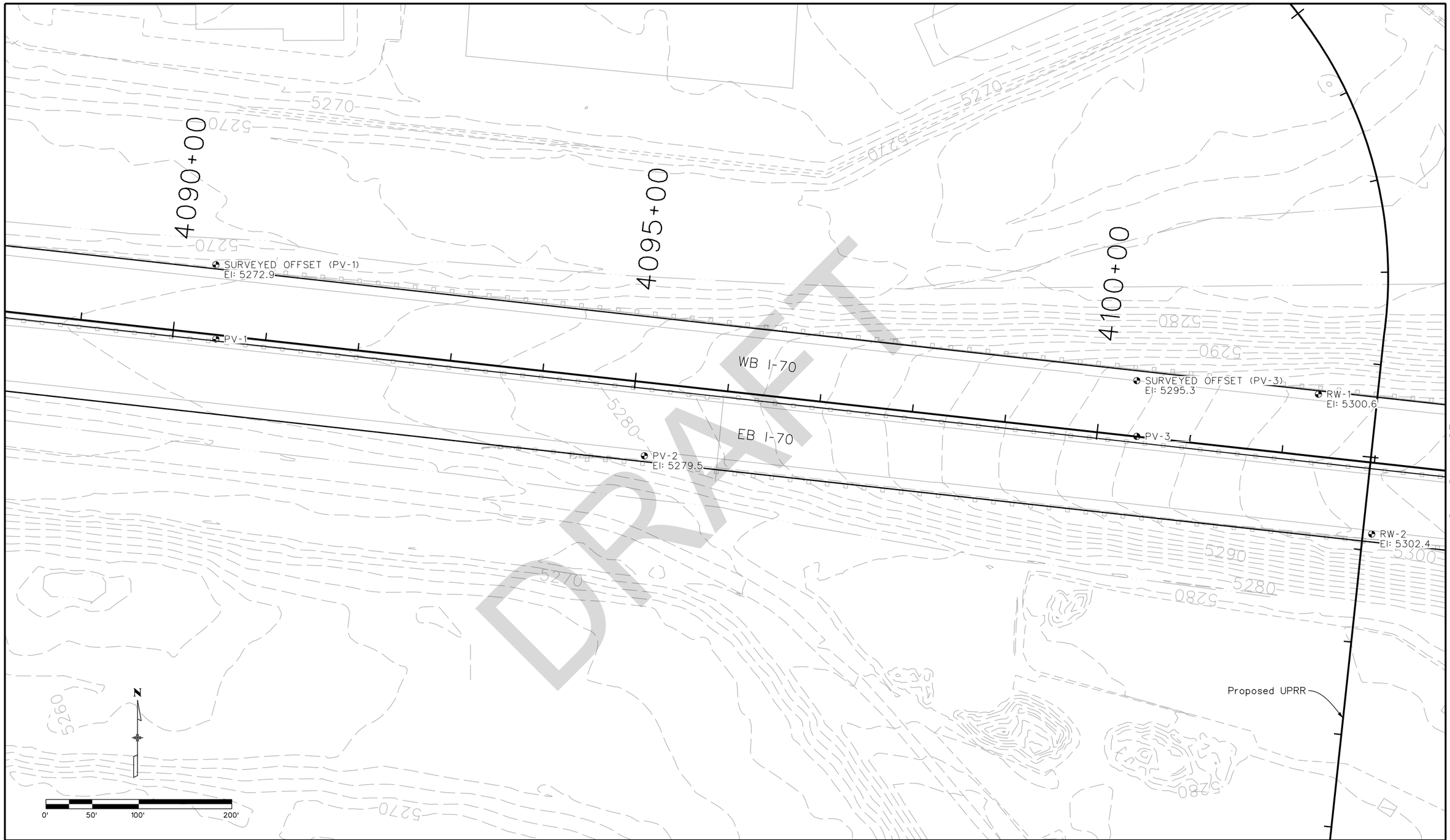

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I-70 OVER HAVANA STREET
DESIGN BUILD
BOREHOLE LOCATION PLAN

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

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

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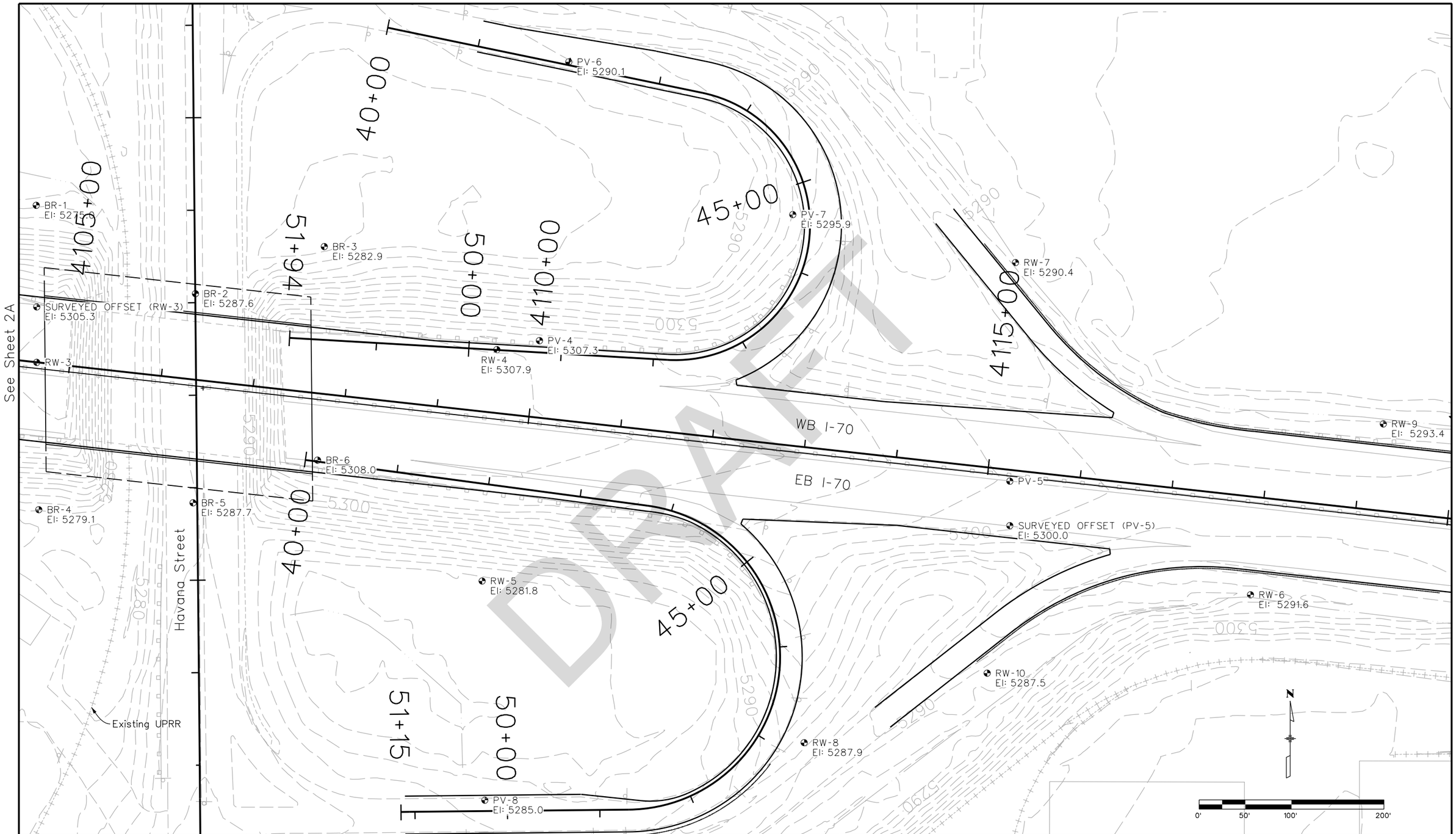

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Designer: D. Hunt
Detailer: D. Knight
Structure Numbers
Sheet Subset:
Subset Sheets: of

Project No./Code
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19339 (CN)
Figure Number 2B

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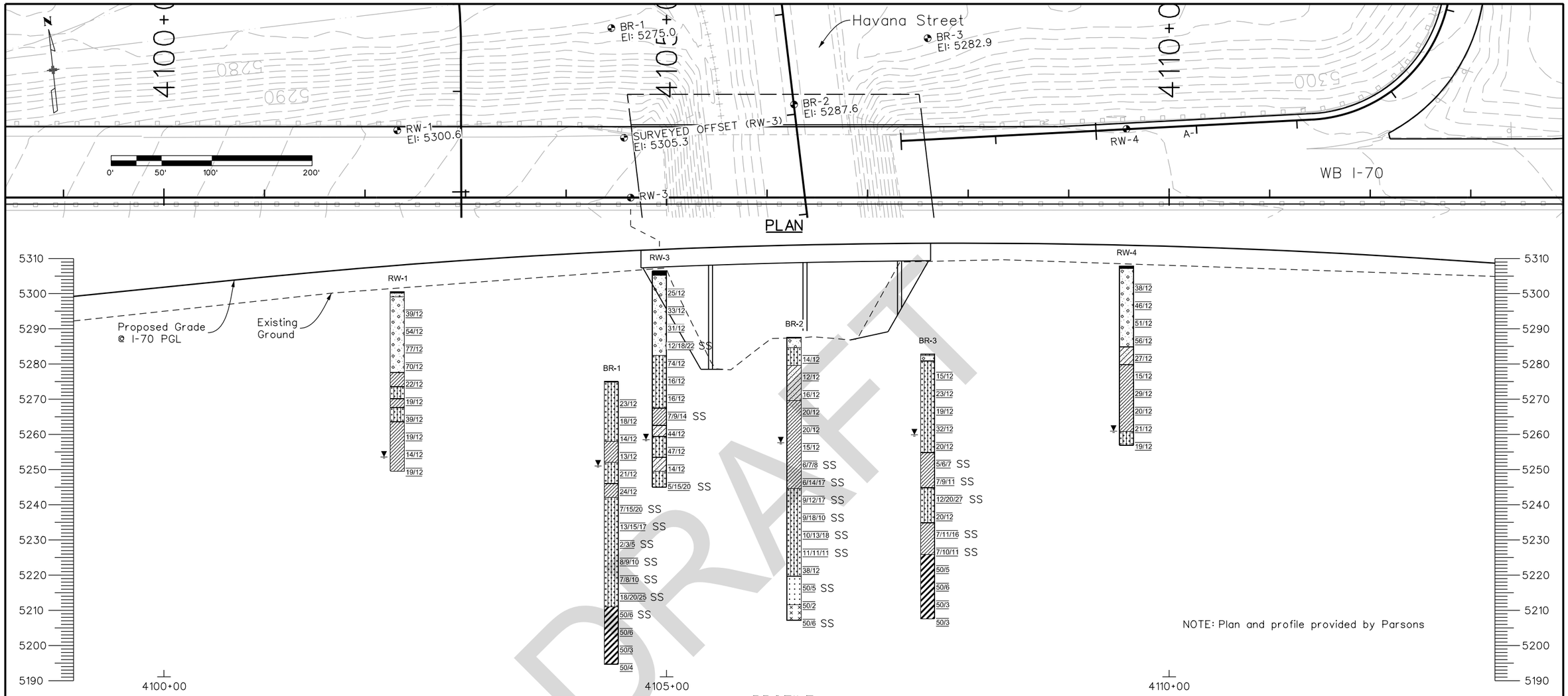

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SUMMARY OF TEST RESULTS

Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	%< #200 Sieve	Classification USCS	Classification AASHTO	Water Content (%)	Dry Density (%)	Sulfate (%)
BR-1	10	NP	NP	28	SM	A-2-4 (0)	13.2	105.1	
BR-1	20	51	33	55	CH	A-7-5 (14)	22.8	103.8	0.02
BR-1	25						18.2	114.9	
BR-1	30	74	49	93	CH	A-7-6 (52)	30.6	93.8	0.01
BR-1	40	NP	NP	10		A-3 (0)	17.5		
BR-1	50	29	13	32	SC	A-2-6 (1)	24.4		
BR-1	65	95	73	86	CH	A-7-6 (69)	44.9		0.01
BR-2	5	NP	NP	27	SM	A-2-4 (0)	13.3	118.1	
BR-2	10	29	15	52	CL	A-6 (4)	14.2	116.1	
BR-2	20	31	16	46	SC	A-6 (4)	18.8	106.1	0.00
BR-2	35	63	48	75	CH	A-7-6 (35)	28.1		0.00
BR-2	75			40			23.0		0.00
BR-2	80	79	40	80	MH	A-7-5 (37)	38.1		
BR-3	0-5	NP	NP	23	SM	A-2-4 (0)			0.08
BR-3	20	27	7	26	SC-SM	A-2-4 (0)	19.1	111.0	

Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	%< #200 Sieve	Classification USCS	Classification AASHTO	Water Content (%)	Dry Density (%)	Sulfate (%)
BR-3	30	72	51	88	CH	A-7-6 (49)	30.1		
BR-3	35						24.1		0.04
BR-3	40	NP	NP	8	SP-SM	A-1-b (0)	14.6		
BR-3	50	34	16	44	SC	A-6 (3)	25.7		
BR-3	60	69	38	66	CH	A-7-5 (25)	32.9	89.3	
RW-1	5	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	21	SM	A-2-4 (0)	9.6	124.9	
RW-1	25	26	13	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	33	56	CH	A-7-6 (15)	24.0	102.2	
RW-1	45						29.3	95.1	
RW-1	50						21.9	106.0	
RW-3	10	NP	NP	31	SM	A-2-4 (0)	9.9	119.9	

Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	%< #200 Sieve	Classification USCS	Classification AASHTO	Water Content (%)	Dry Density (%)	Sulfate (%)
RW-3	20						8.7		0.00
RW-3	30	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	25	59	CL	A-7-6 (12)	20.7		
RW-3	45			19			9.9	116.1	
RW-3	50	NP	NP	14	SM	A-1-b (0)	15.3	117.9	
RW-3	55						21.1	102.3	0.01
RW-4	0.75-10	NP	NP	11	SW-SM	A-1-b (0)			0.00
RW-4	5	NP	NP	16	SM	A-2-4 (0)	9.3	118.7	0.01
RW-4	15	NP	NP	16	SM	A-2-4 (0)	7.1	120.6	
RW-4	25	NP	NP	18	SM	A-2-4 (0)	6.3	116.7	0.01
RW-4	30						12.9	120.6	
RW-4	35	52	33	57	CH	A-7-6 (15)	19.2	111.3	
RW-4	40						18.2	110.8	
RW-4	45	47	33	49	SC	A-7-6 (11)	18.7	117.3	

TYPE OF MATERIAL

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

SEE INDIVIDUAL LOG SHEETS FOR ADDITIONAL DESCRIPTION OF MATERIAL ENCOUNTERED

LEGEND

TEST BORING

BR	Bridge Borehole
RW	Retaining Wall Borehole
	Ground Water Level At Time of Drilling
9/12	9 Blows for 12 Inches
50/3	50 Blows for 3 Inches
8/6/7 SS	Split Spoon Sampler Required 8 Blows for 6 Inches Required 6 Blows for 6 Inches Required 7 Blows for 6 Inches

BORING ID NOTED AT THE TOP OF LOG
BLOW COUNTS OBTAINED WITH SPLIT SPOON SAMPLERS ARE NOTED WITH "SS", ALL OTHER BLOW COUNTS OBTAINED WITH A MODIFIED CALIFORNIA BARREL SAMPLER
SEE INDIVIDUAL LOG SHEETS FOR MORE DETAIL

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I-70 OVER HAVANA STREET DESIGN BUILD
ENGINEERING GEOLOGY
WESTBOUND I-70

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

Project No./Code
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Figure Number 3A

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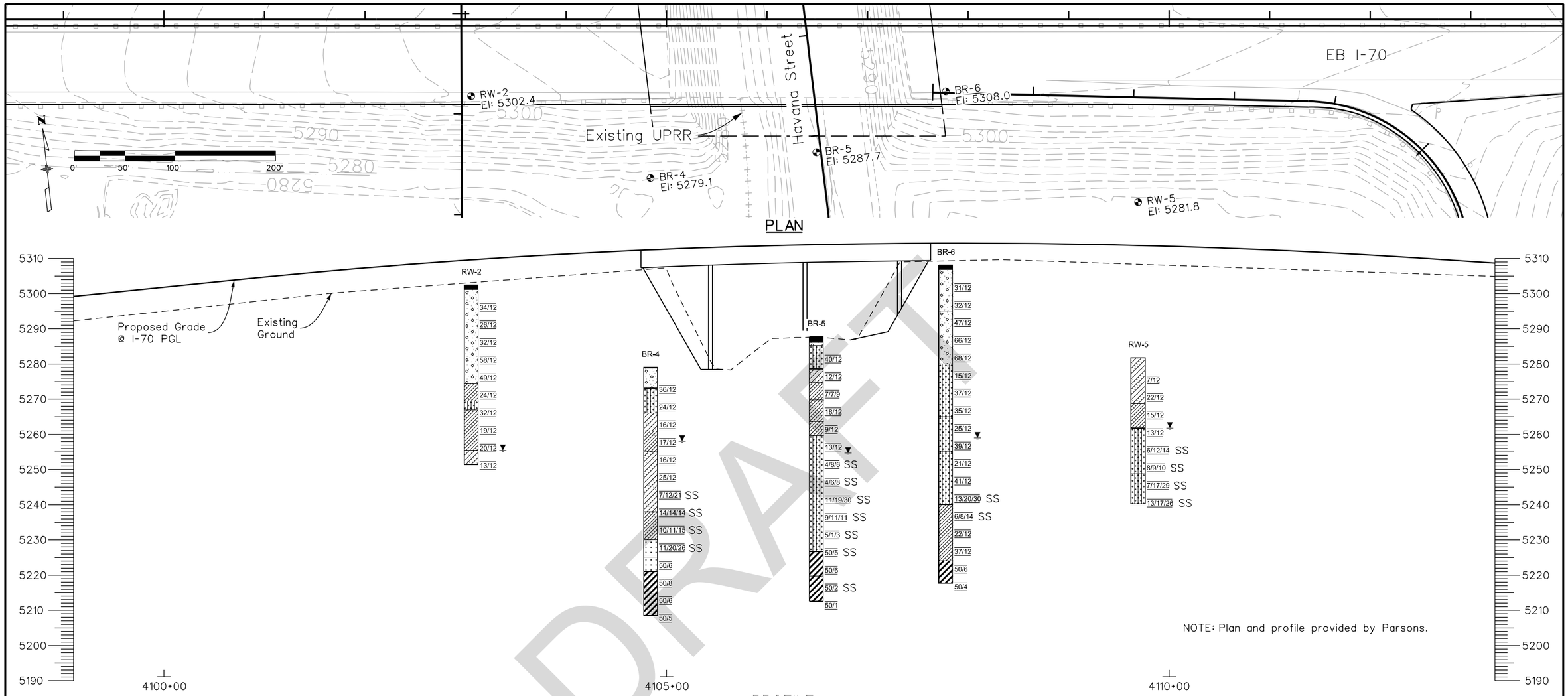

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SUMMARY OF TEST RESULTS

Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	%< #200 Sieve	Classification USCS	Classification AASHTO	Water Content (%)	Dry Density (%)	Sulfate (%)
BR-4	5	22	6	48	SC-SM	A-4 (0)	5.2	122.1	
BR-4	10	NP	NP	34	SM	A-2-4 (0)	6.3	103.5	
BR-4	20	32	17	56	CL	A-6 (6)	21.3	108.4	
BR-4	25						22.6	103.3	0.01
BR-4	30	28	5	32	SM	A-2-4 (0)	20.1	110.4	
BR-4	35	NP	NP	27	SM	A-2-4 (0)	20.7		
BR-4	45			50			25.8		
BR-4	55	57	27	49	SM	A-7-5 (10)	28.2	96.4	
BR-4	60	57	31	97	CH	A-7-6 (35)	27.6	117.7	
BR-4	65						27.1	94.7	0.00
BR-5	5	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	36	56	CL	A-7-6 (16)	18.6		
BR-5	20						18.0	109.0	
BR-5	25	44	28	56	CL	A-7-6 (12)	26.0	98.2	

Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	%< #200 Sieve	Classification USCS	Classification AASHTO	Water Content (%)	Dry Density (%)	Sulfate (%)
BR-5	30						18.9	106.5	
BR-5	40	30	16	41	SC	A-6 (2)	24.7		
BR-5	65	58	29	59	CH	A-7-6 (15)	28.6	95.1	
BR-5	70						27.5		
BR-6	1.25-10	NP	NP	14	SM	A-1-b (0)			0.01
BR-6	10						9.0	114.6	
BR-6	20						6.6	115.7	
BR-6	30						6.6	112.7	
BR-6	35	NP	NP	13	SM	A-1-b (0)	4.4	112.2	
BR-6	40						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	26	SM	A-2-4 (0)	22.2	101.3	
BR-6	60						14.1	126.0	
BR-6	70	44	25	62	CL	A-7-6 (13)	27.1		0.00

Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	%< #200 Sieve	Classification USCS	Classification AASHTO	Water Content (%)	Dry Density (%)	Sulfate (%)
BR-6	75						27.8	96.6	
BR-6	80	62	34	54	CH	A-7-6 (15)	36.8	85.1	
BR-6	85	65	33	45	SC	A-7-5 (10)	31.7	91.8	
BR-6	90						28.3	96.7	
RW-2	5						6.5	119.6	0.04
RW-2	10	25	10	22	SC	A-2-4 (0)	7.1	122.9	
RW-2	25	NP	NP	27	SM	A-2-4 (0)	11.5	124.1	0.04
RW-2	30						14.0	120.1	
RW-2	40	34	18	59	CL	A-6 (8)	22.7	102.4	
RW-2	50						20.4	109.6	
RW-5	5						5.8	92.8	0.00
RW-5	10	33	18	48	SC	A-6 (5)	14.7	114.2	
RW-5	15	54	35	62	CH	A-7-6 (19)	24.4	98.7	
RW-5	25	NP	NP	6		A-3 (0)	19.4		
RW-5	35	NP	NP	3		A-3 (0)	21.1		

TYPE OF MATERIAL

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

SEE INDIVIDUAL LOG SHEETS FOR ADDITIONAL DESCRIPTION OF MATERIAL ENCOUNTERED

LEGEND

TEST BORING

11/12 6/12 28/12 8/6/7 SS 50/6 50/6

- BR — Bridge Borehole
- RW — Retaining Wall Borehole
- Ground Water Level At Time of Drilling
- 9/12 — 9 Blows for 12 Inches
- 50/3 — 50 Blows for 3 Inches
- 8/6/7 SS — Split Spoon Sampler Required 8 Blows for 6 Inches Required 6 Blows for 6 Inches Required 7 Blows for 6 Inches

BORING ID NOTED AT THE TOP OF LOG
BLOW COUNTS OBTAINED WITH SPLIT SPOON SAMPLERS ARE NOTED WITH "SS". ALL OTHER BLOW COUNTS OBTAINED WITH A MODIFIED CALIFORNIA BARREL SAMPLER
SEE INDIVIDUAL LOG SHEETS FOR MORE DETAIL

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I-70 OVER HAVANA STREET DESIGN BUILD
ENGINEERING GEOLOGY
EASTBOUND I-70

Designer: D. Hunt
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Figure Number 3B

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APPENDIX A

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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RockSol Consulting Group, Inc.

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

DRAFT

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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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 (%)
			(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.										

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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.										

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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 B

LABORATORY TEST RESULTS

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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-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

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							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

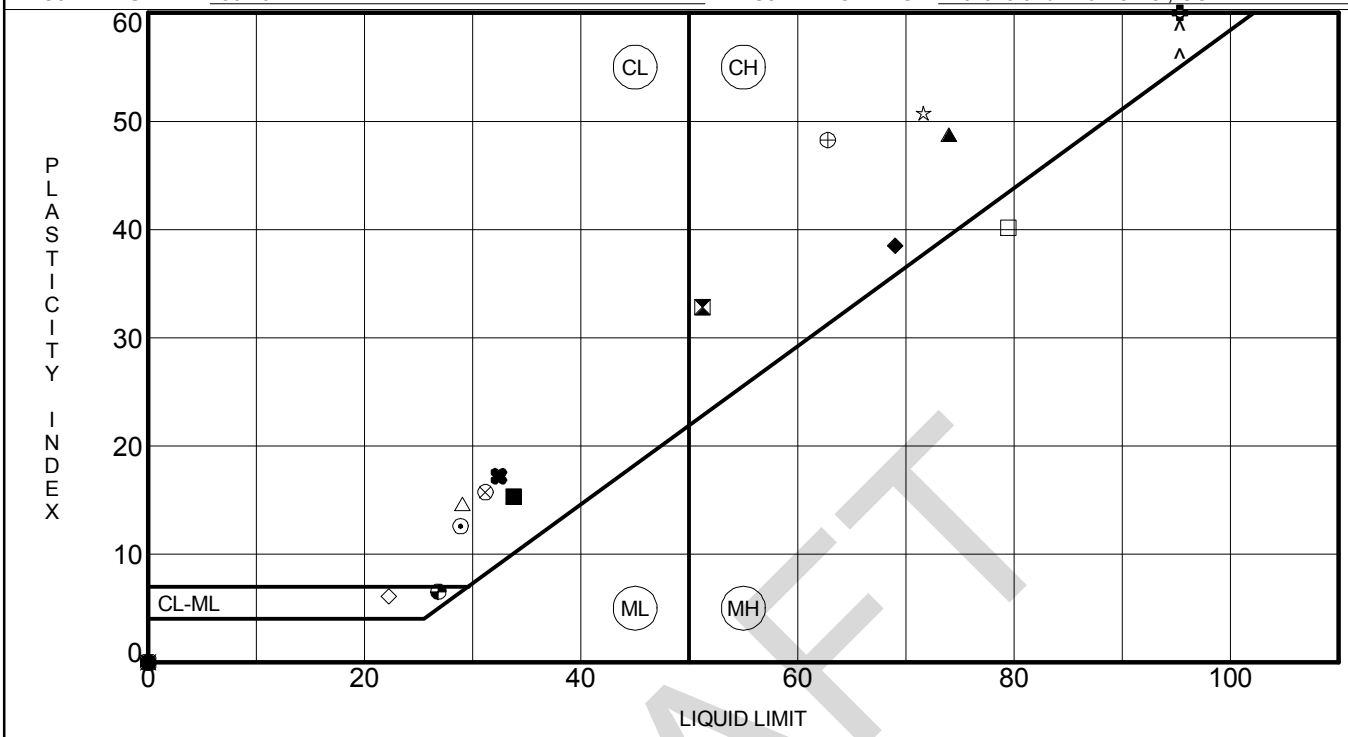
RockSol Consulting Group, Inc.

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

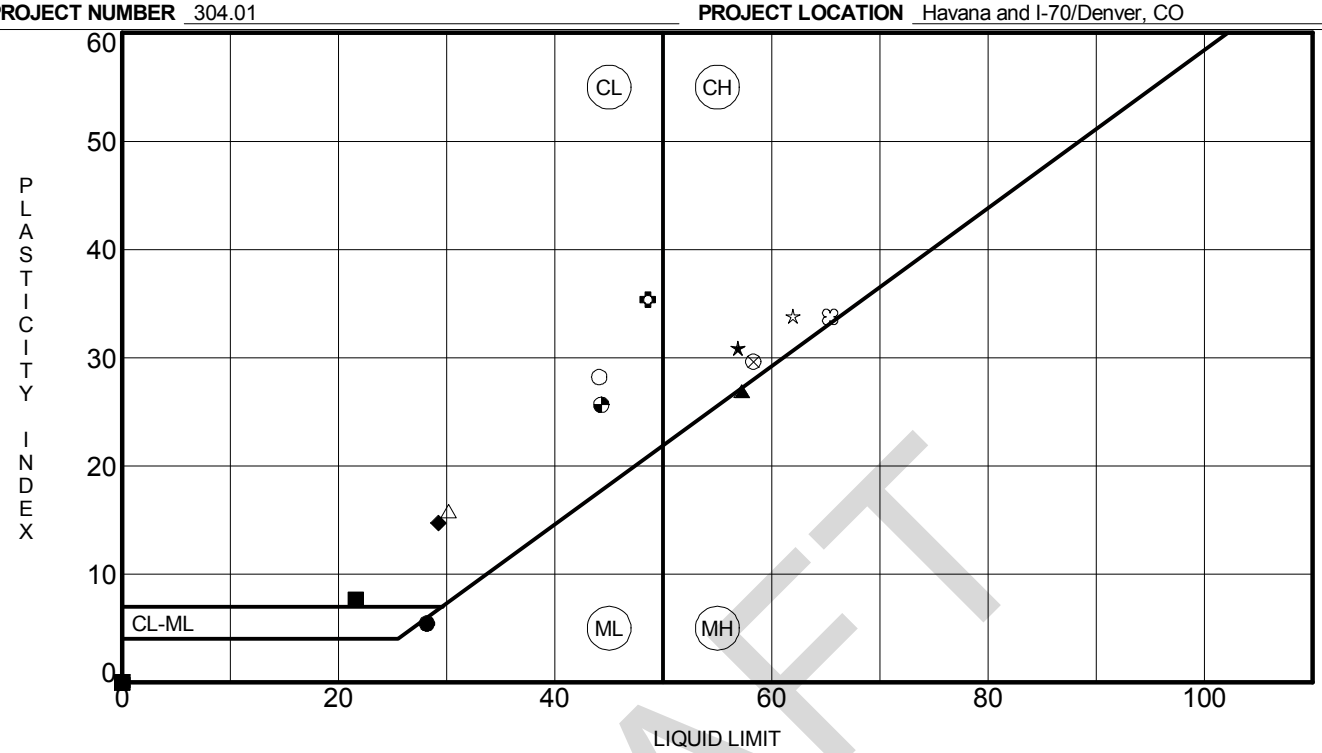
RockSol Consulting Group, Inc.

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

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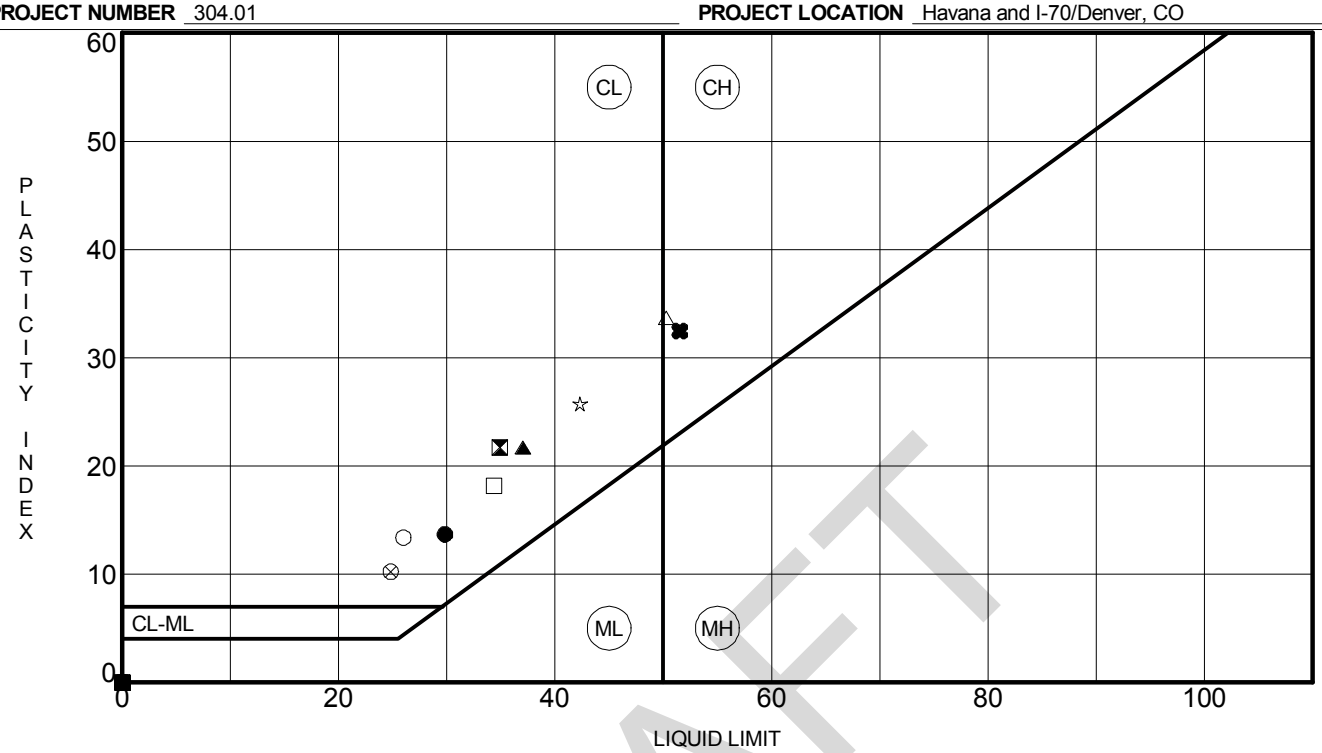
PROJECT NUMBER 304.01

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

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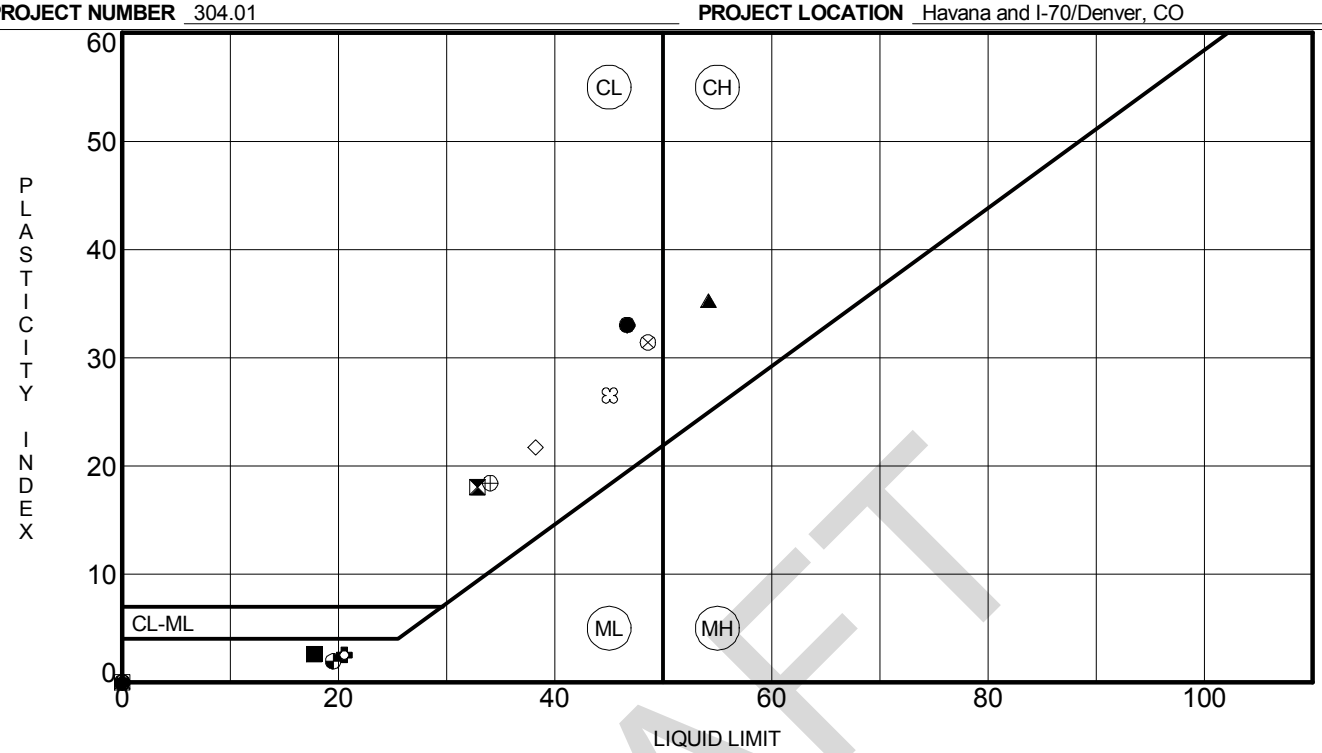
PROJECT NUMBER 304.01

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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RockSol Consulting Group Inc.
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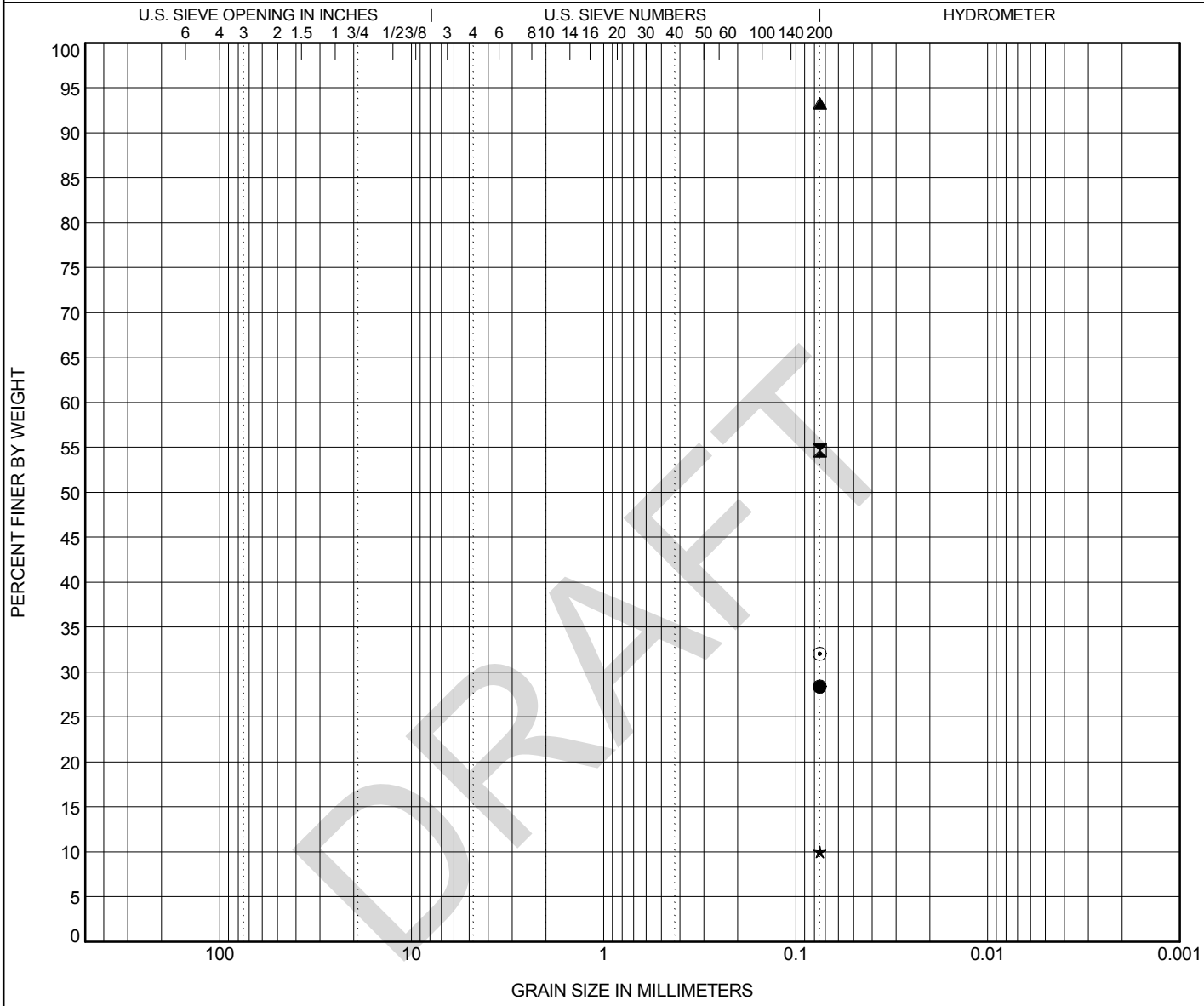
GRAIN SIZE DISTRIBUTION

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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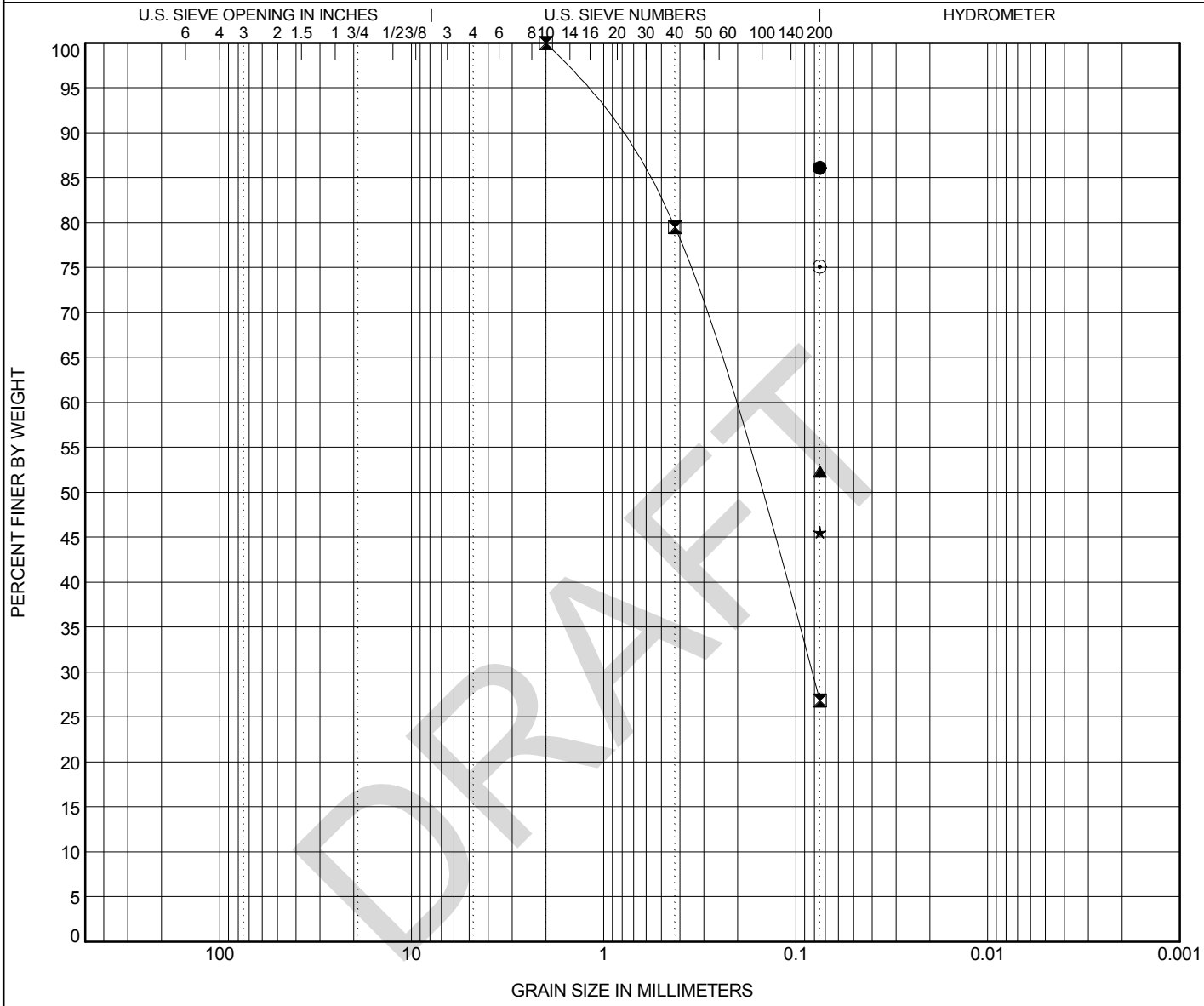

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	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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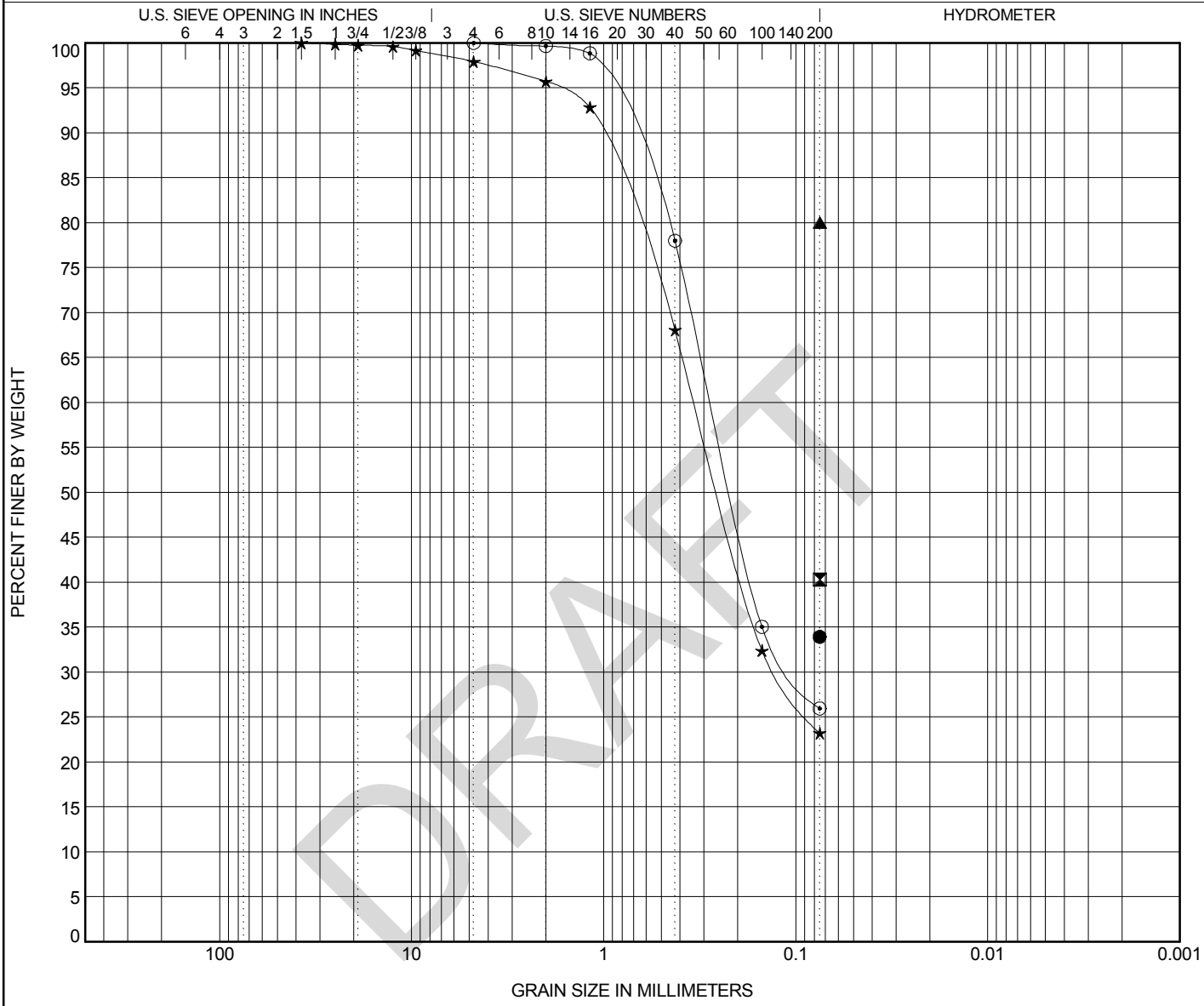

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

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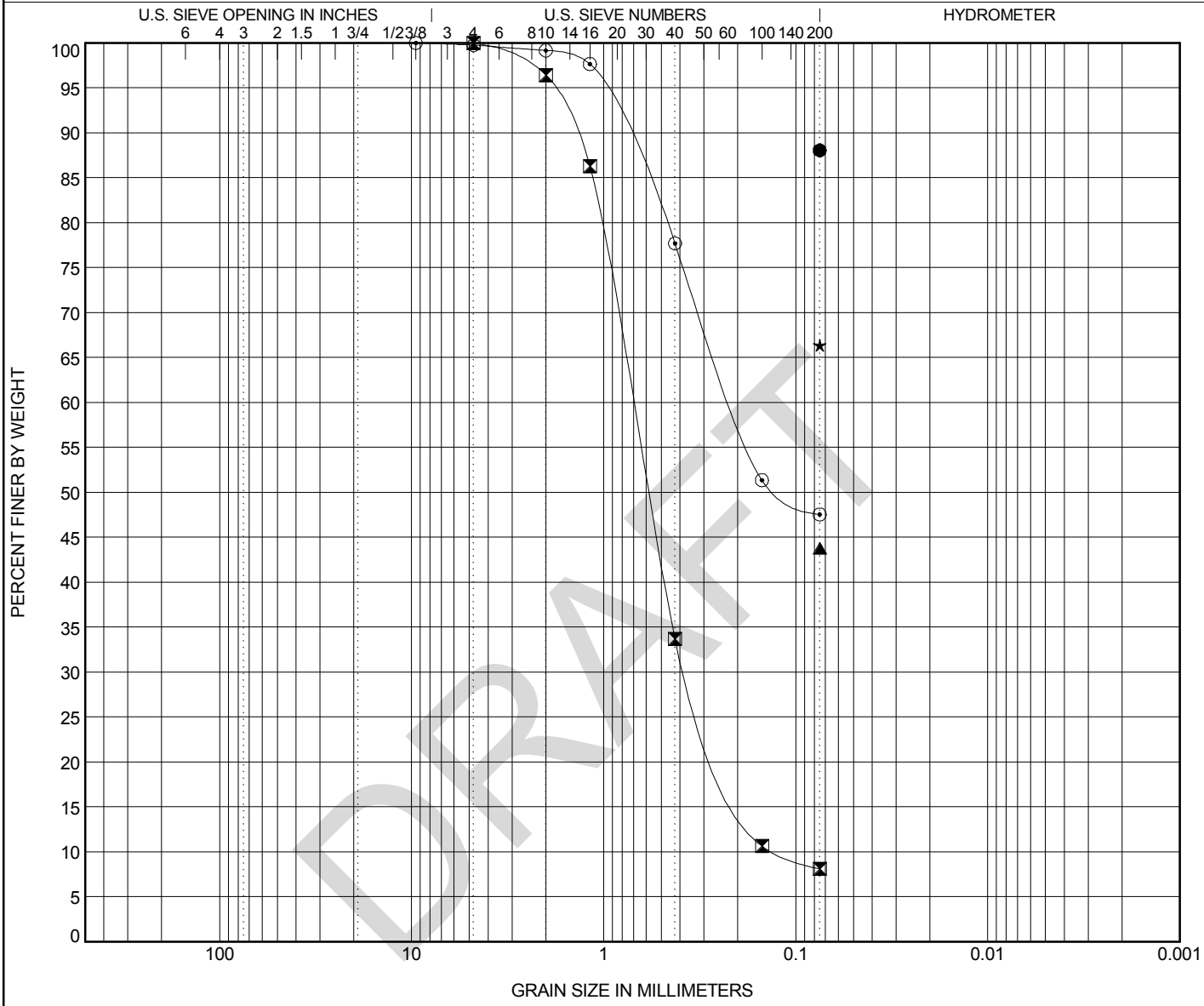
CLIENT Parsons **PROJECT NAME** I-70 Havana Bridge Replacement-Preliminary Engineering

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-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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GRAIN SIZE DISTRIBUTION

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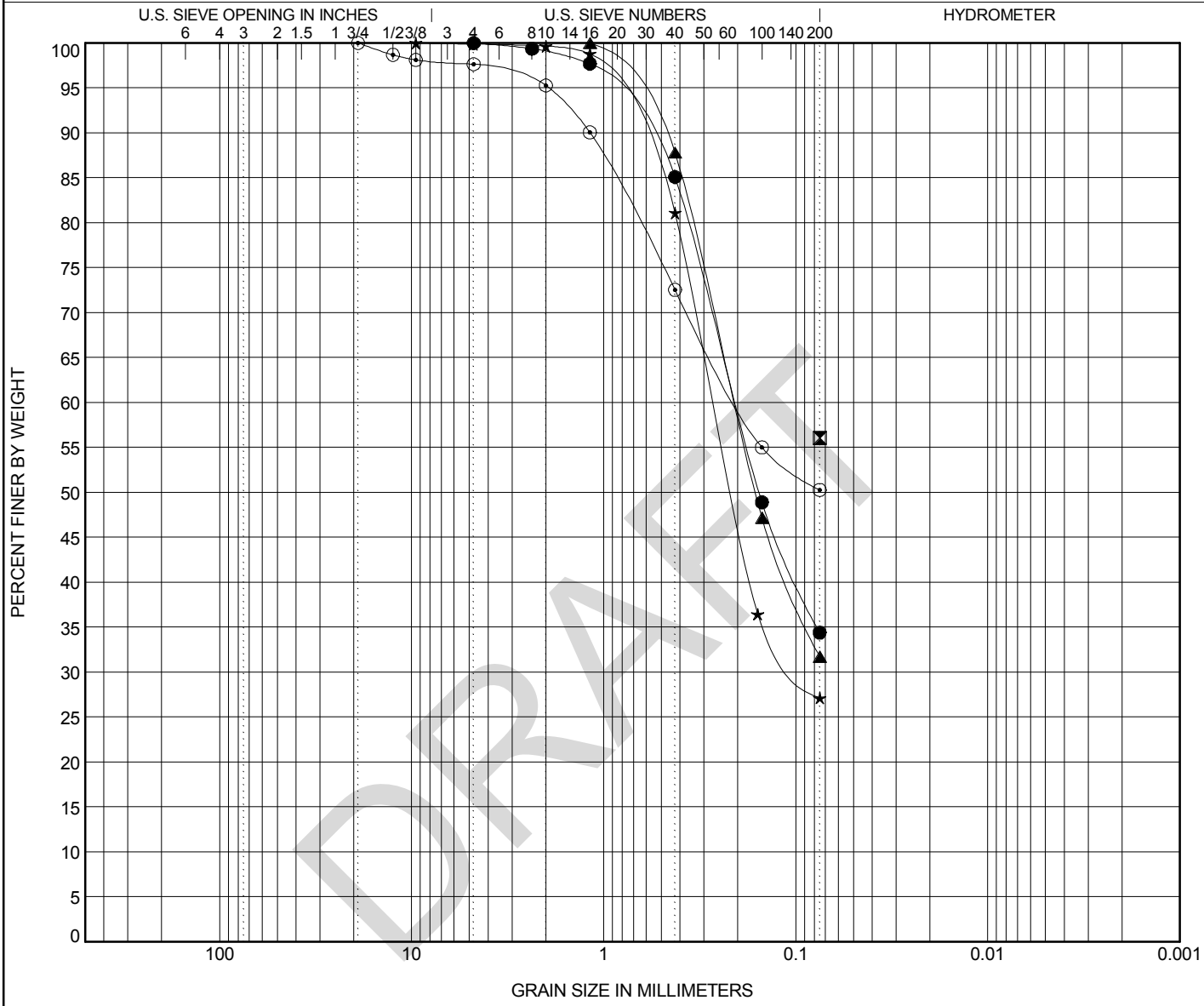
PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	BR-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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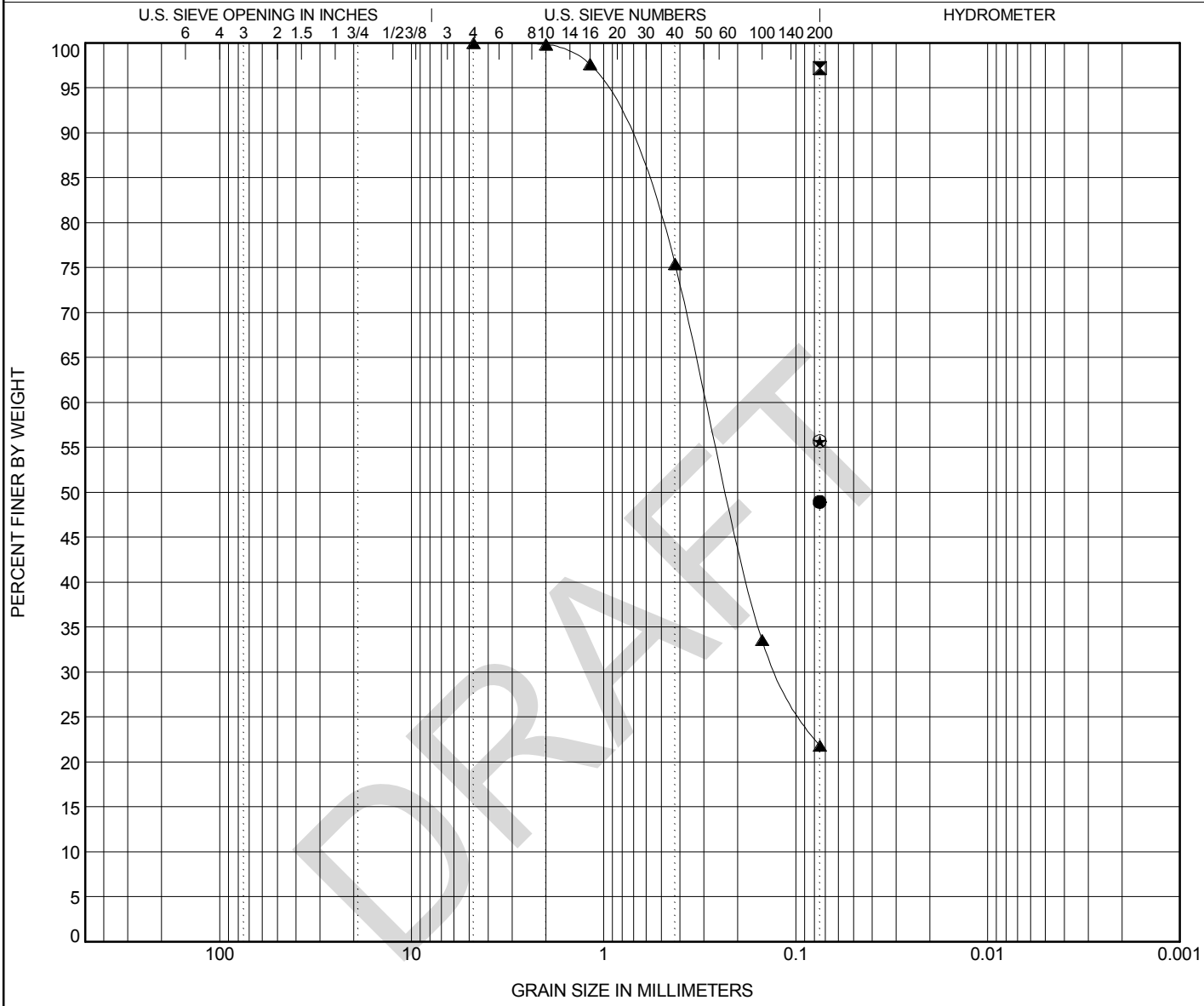

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	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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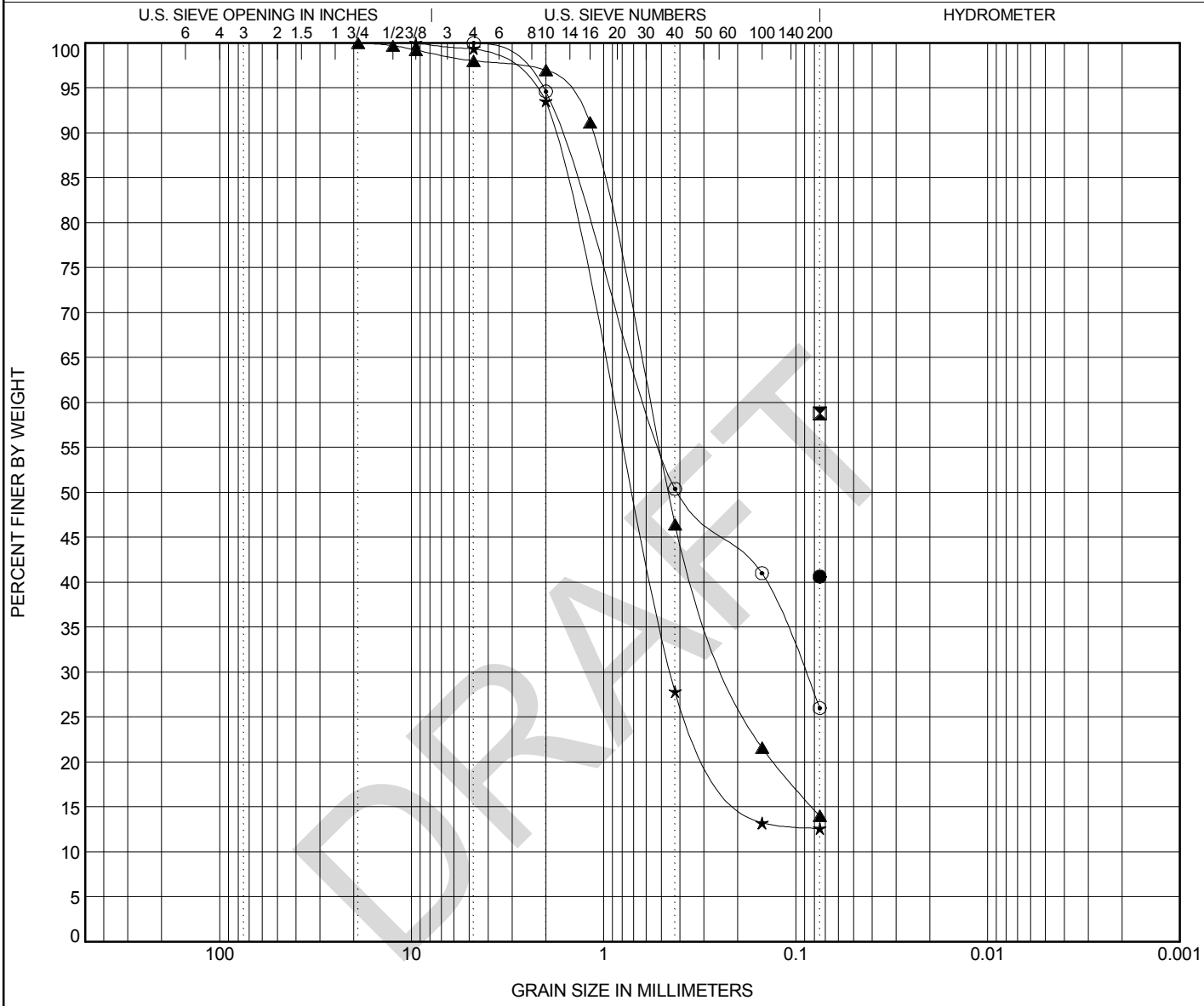

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	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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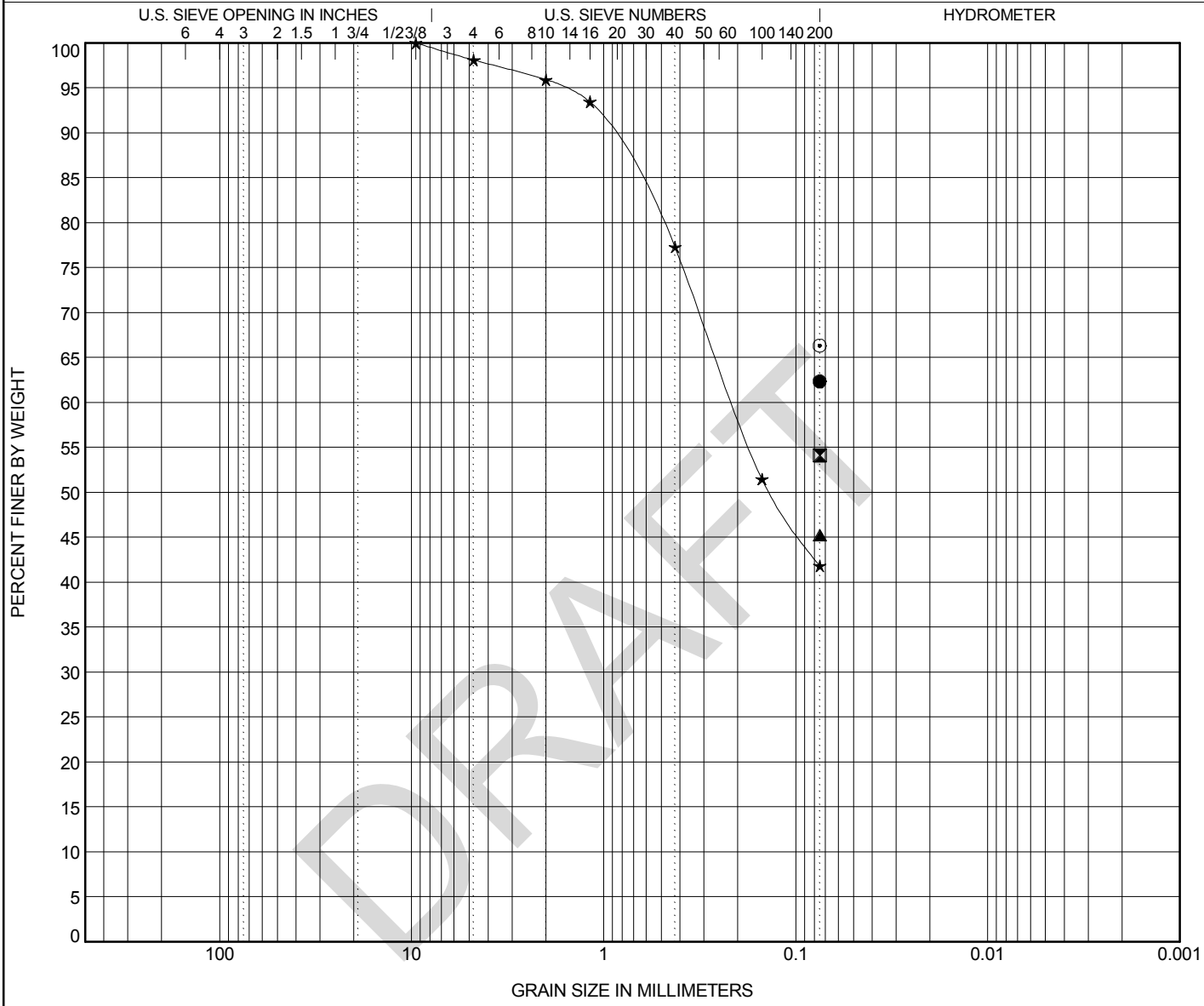

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	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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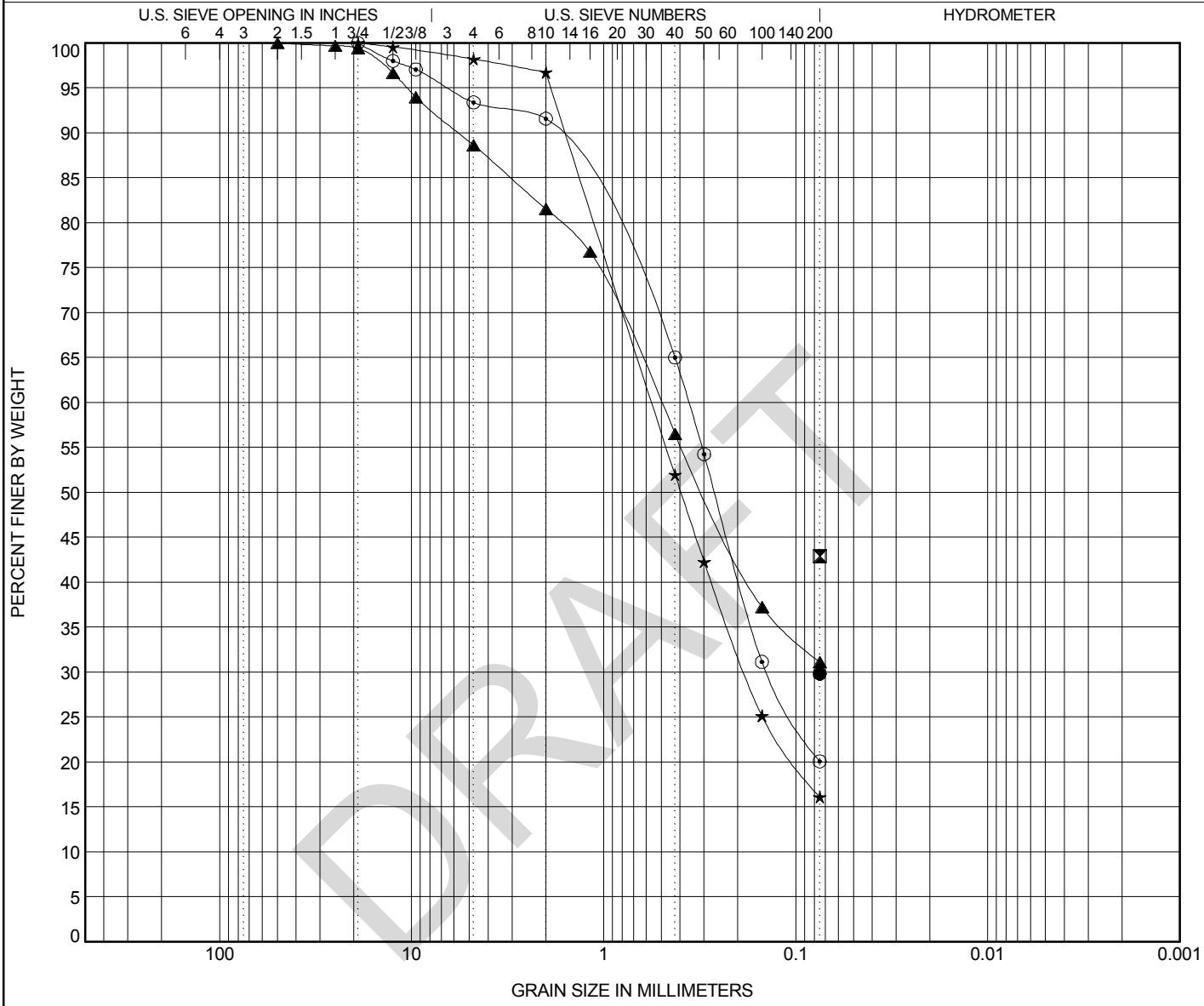

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	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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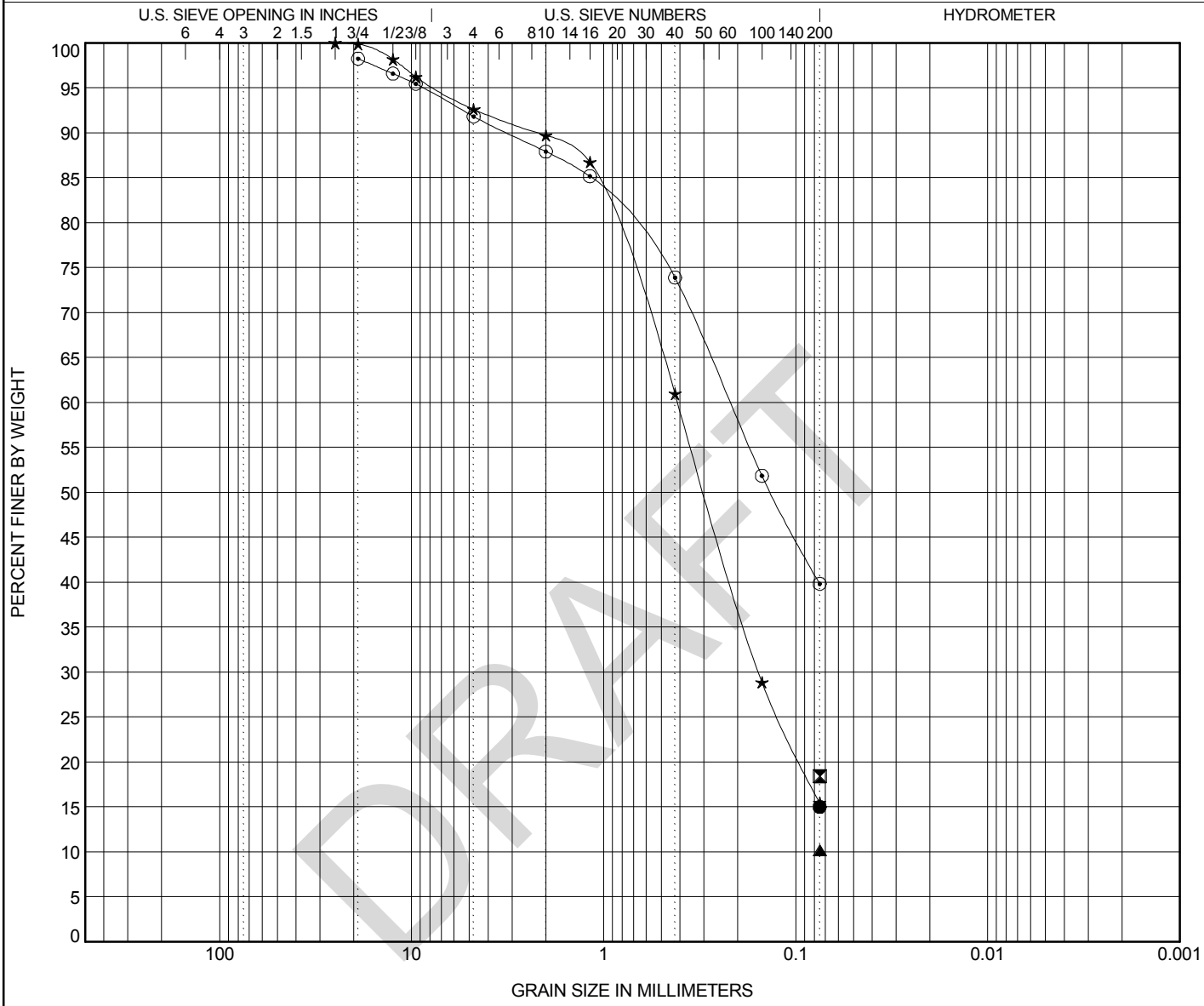

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	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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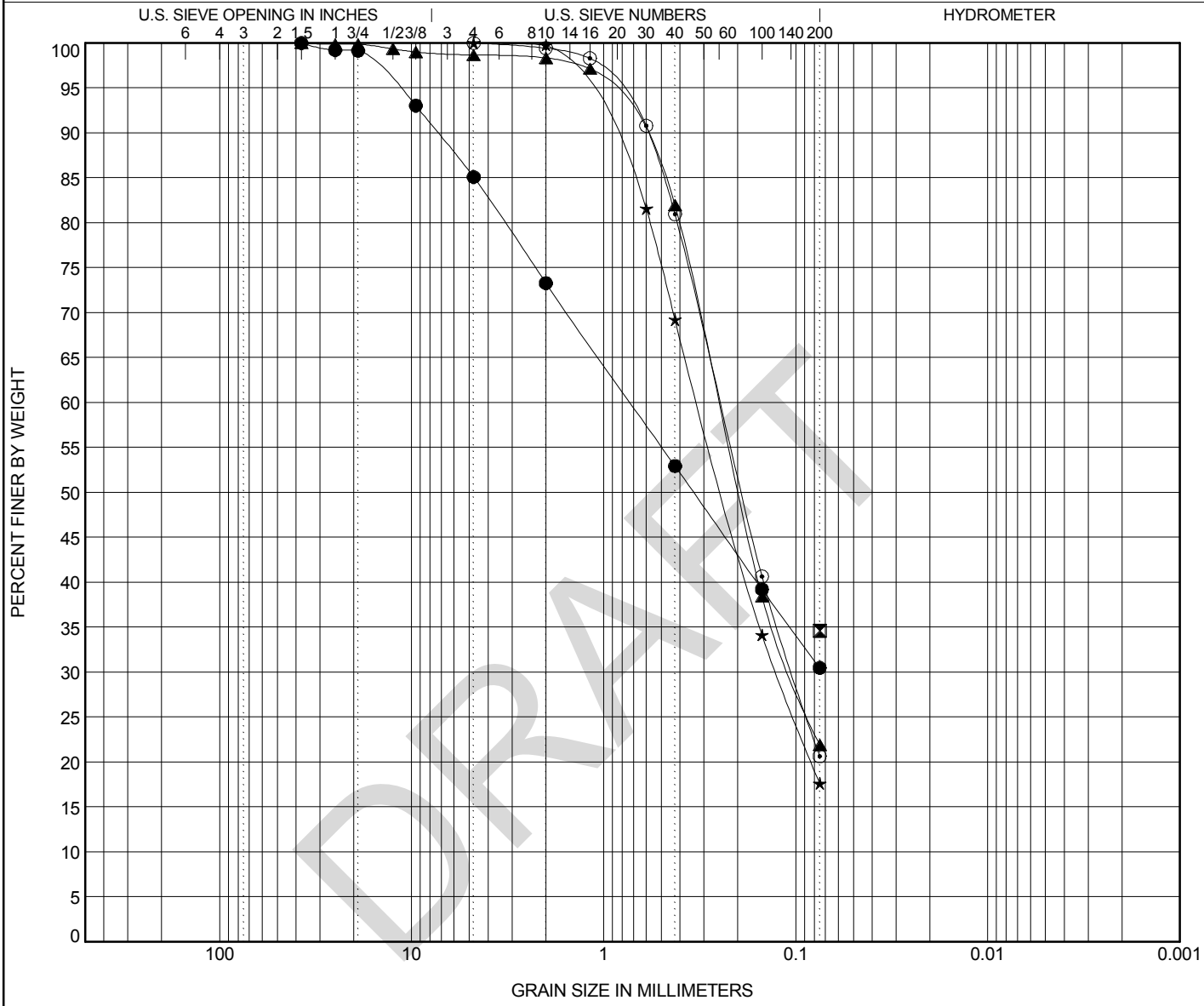

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	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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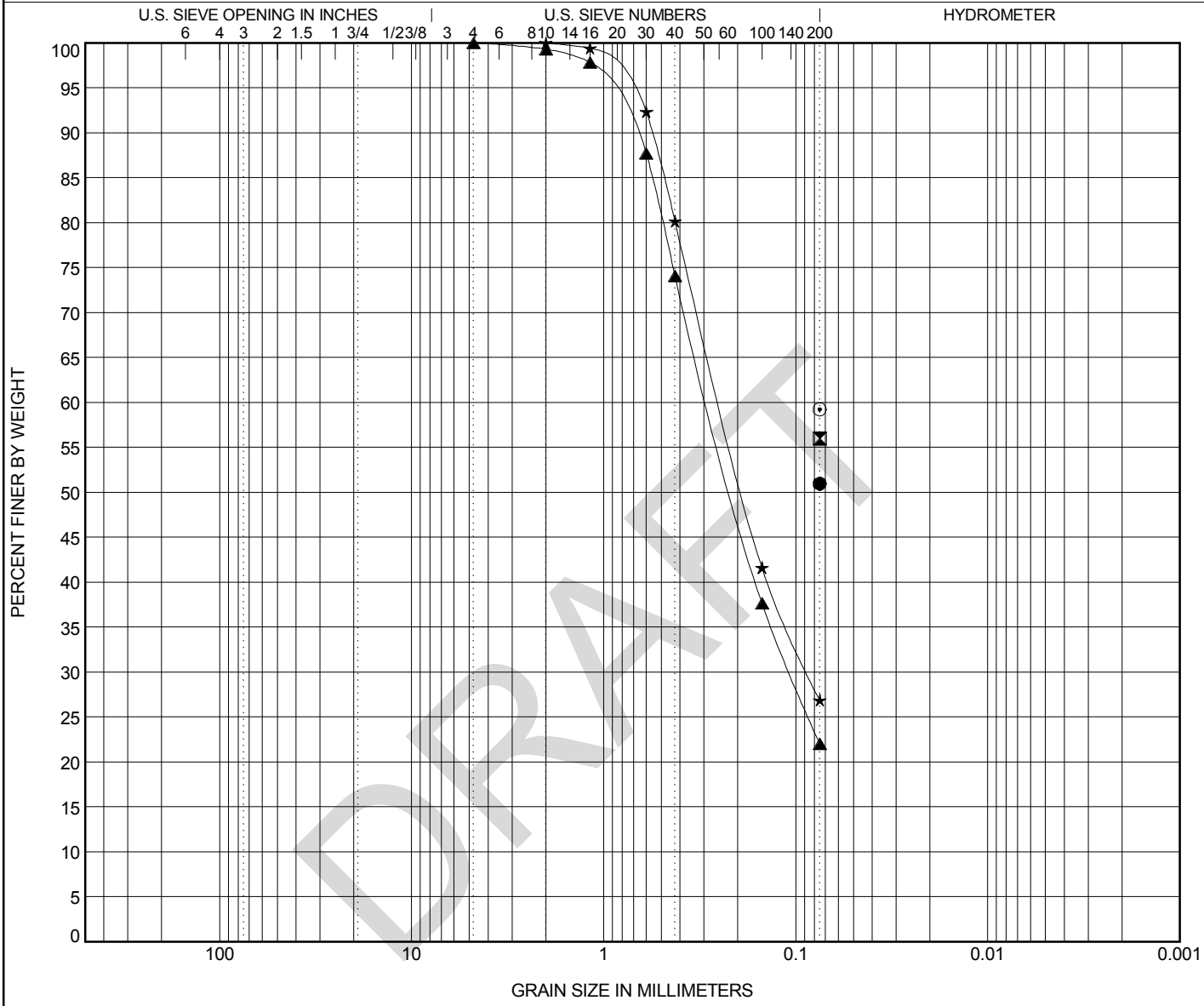

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	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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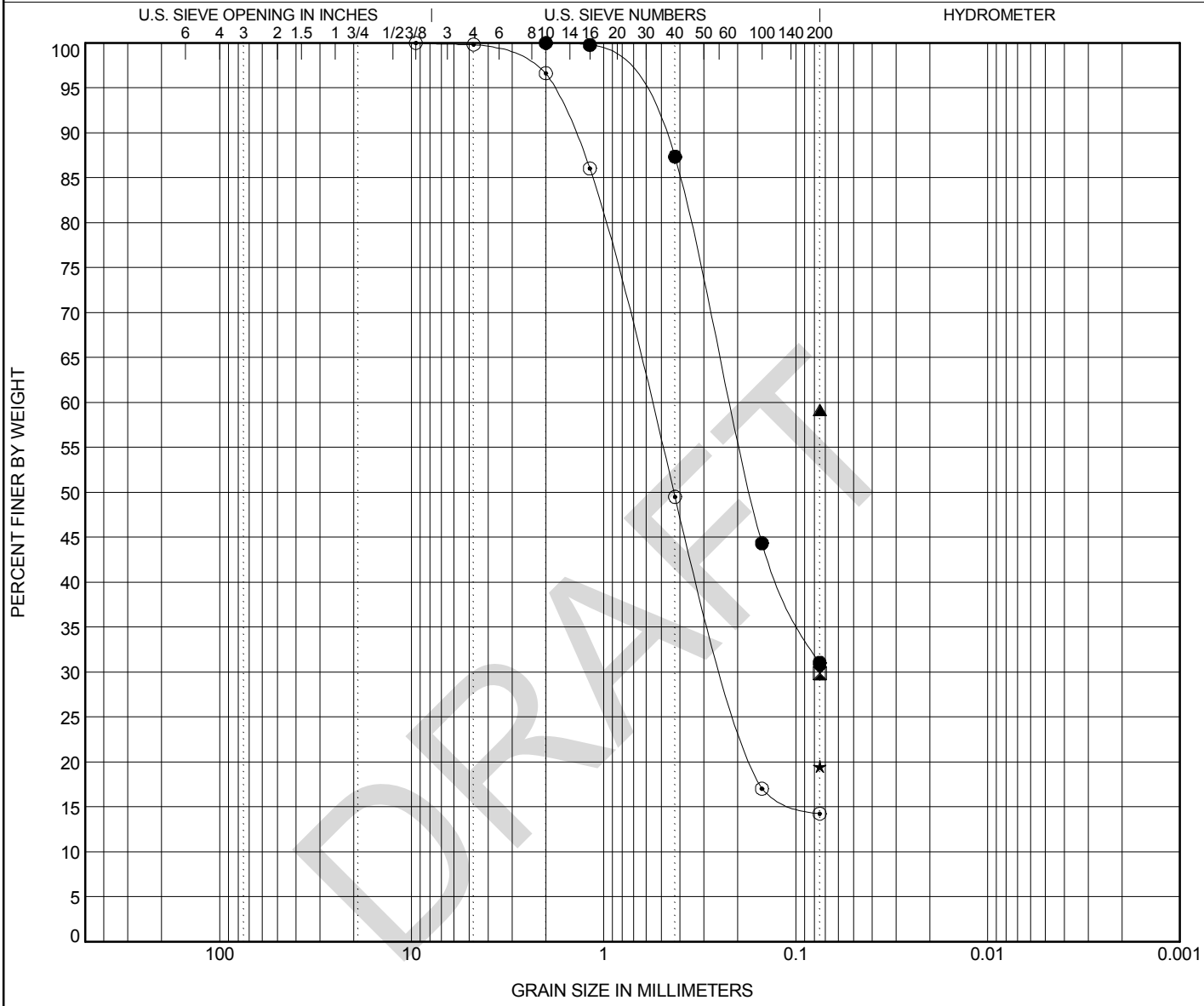

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	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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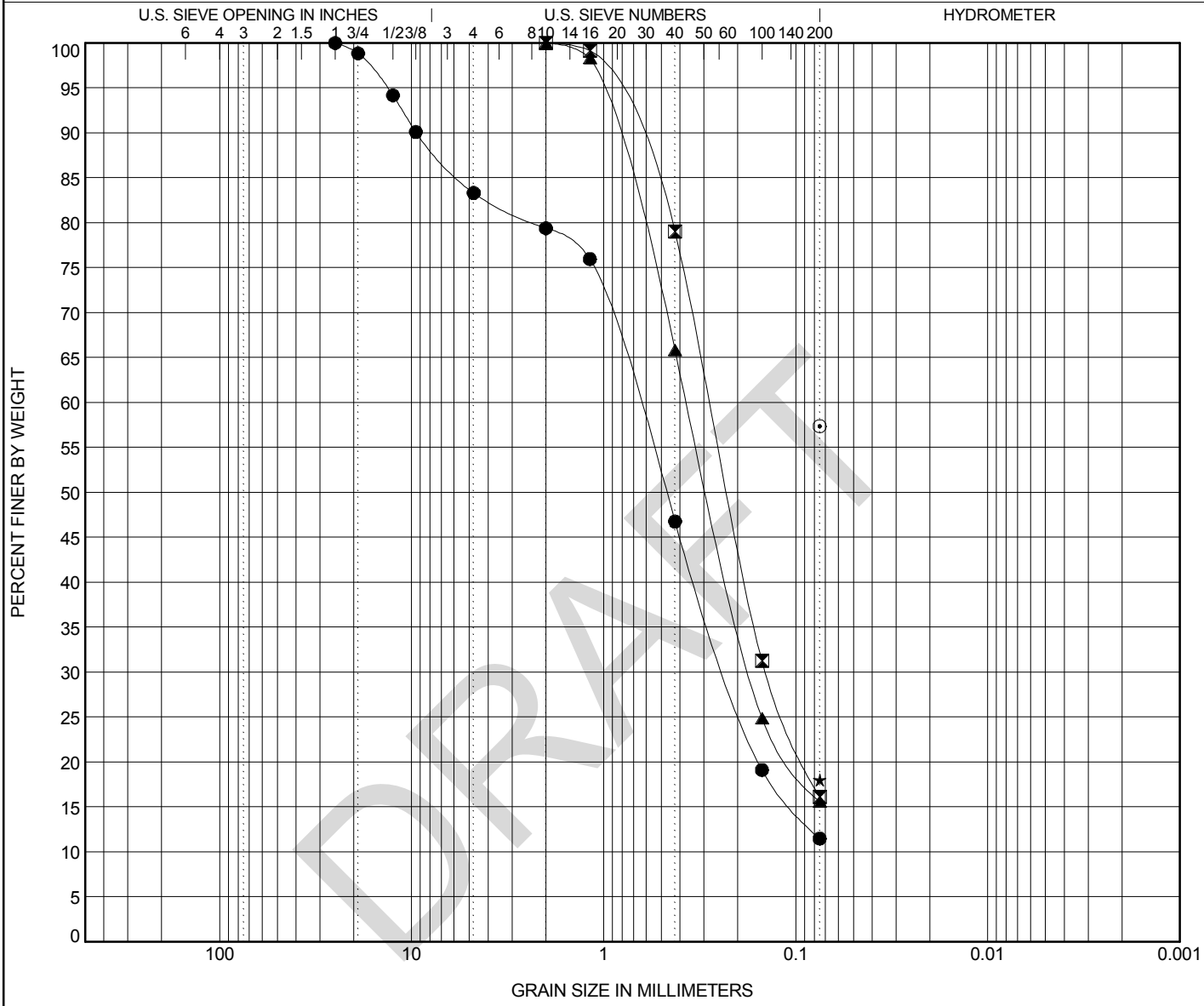

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	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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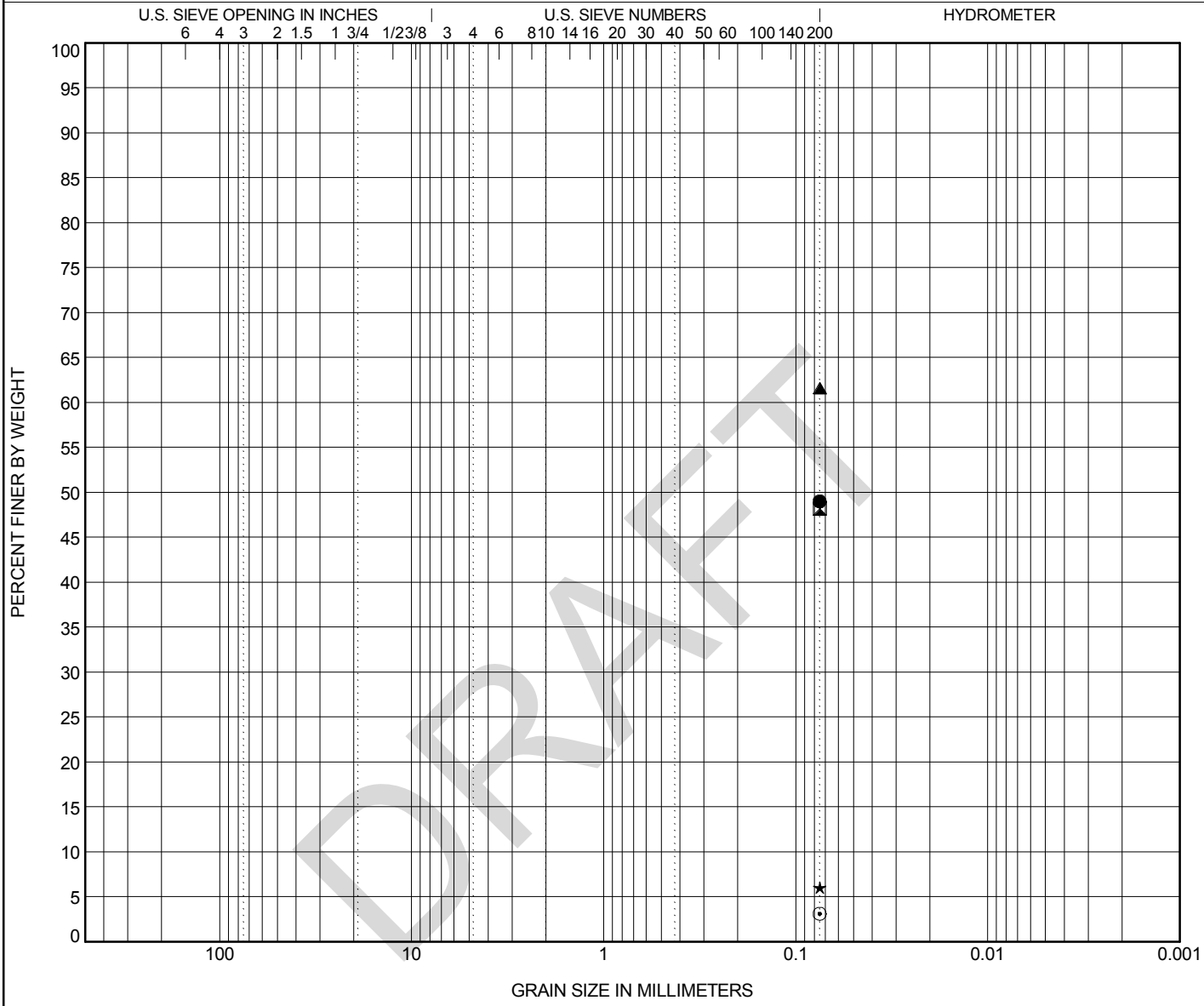

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	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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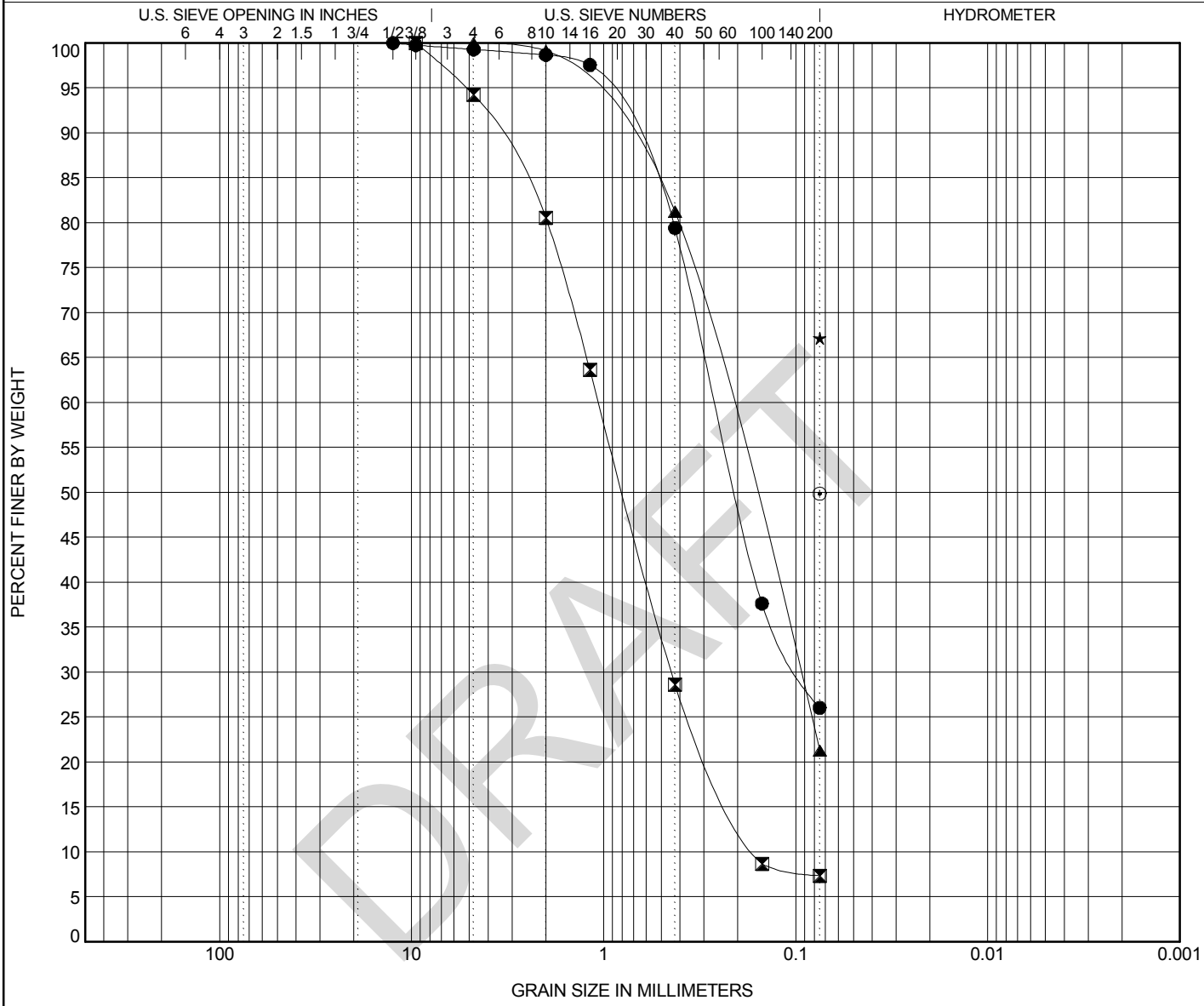

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	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	

RockSol Consulting Group Inc.
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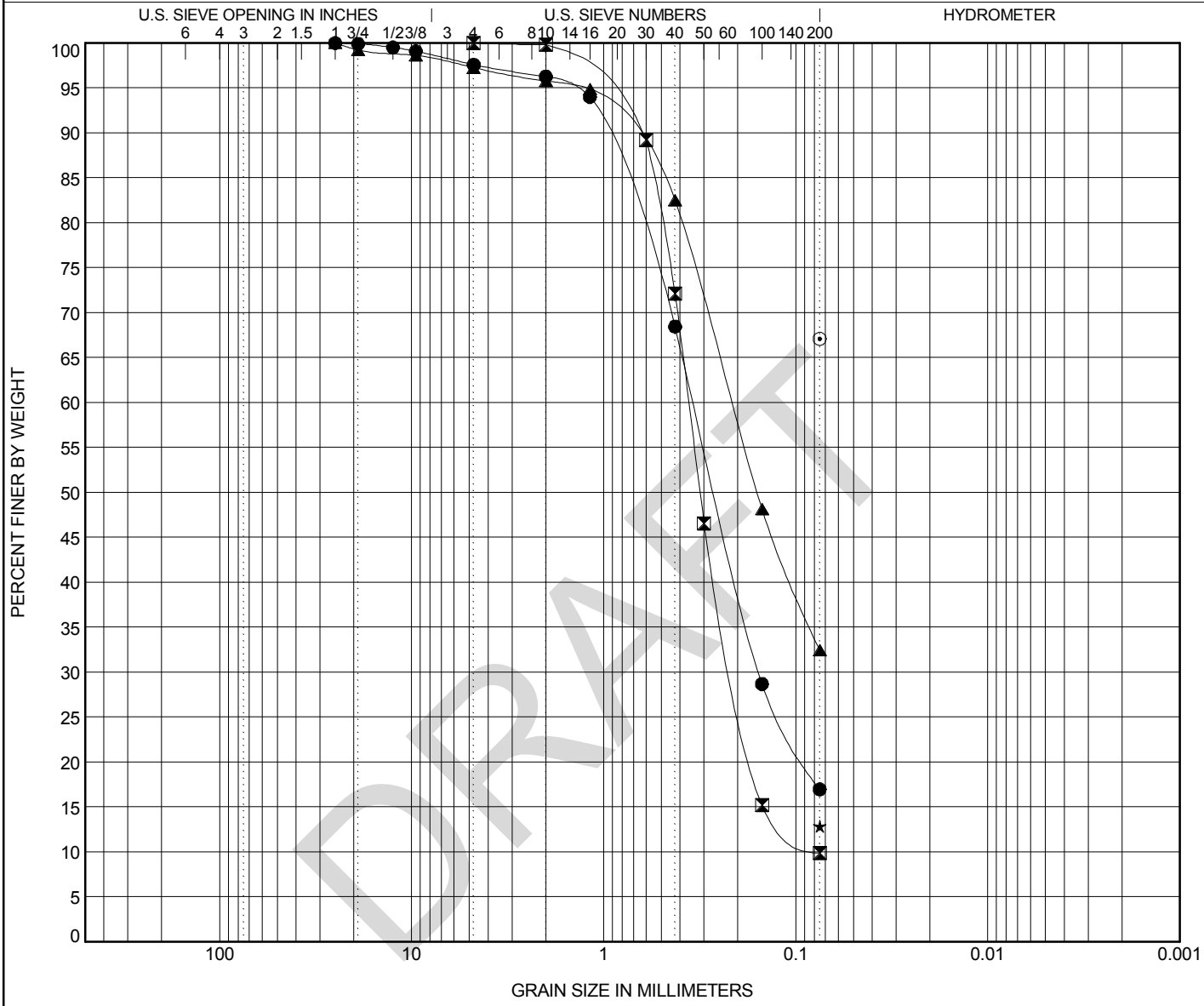
Westminster, CO, 80031
Telephone: 303-962-9300

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-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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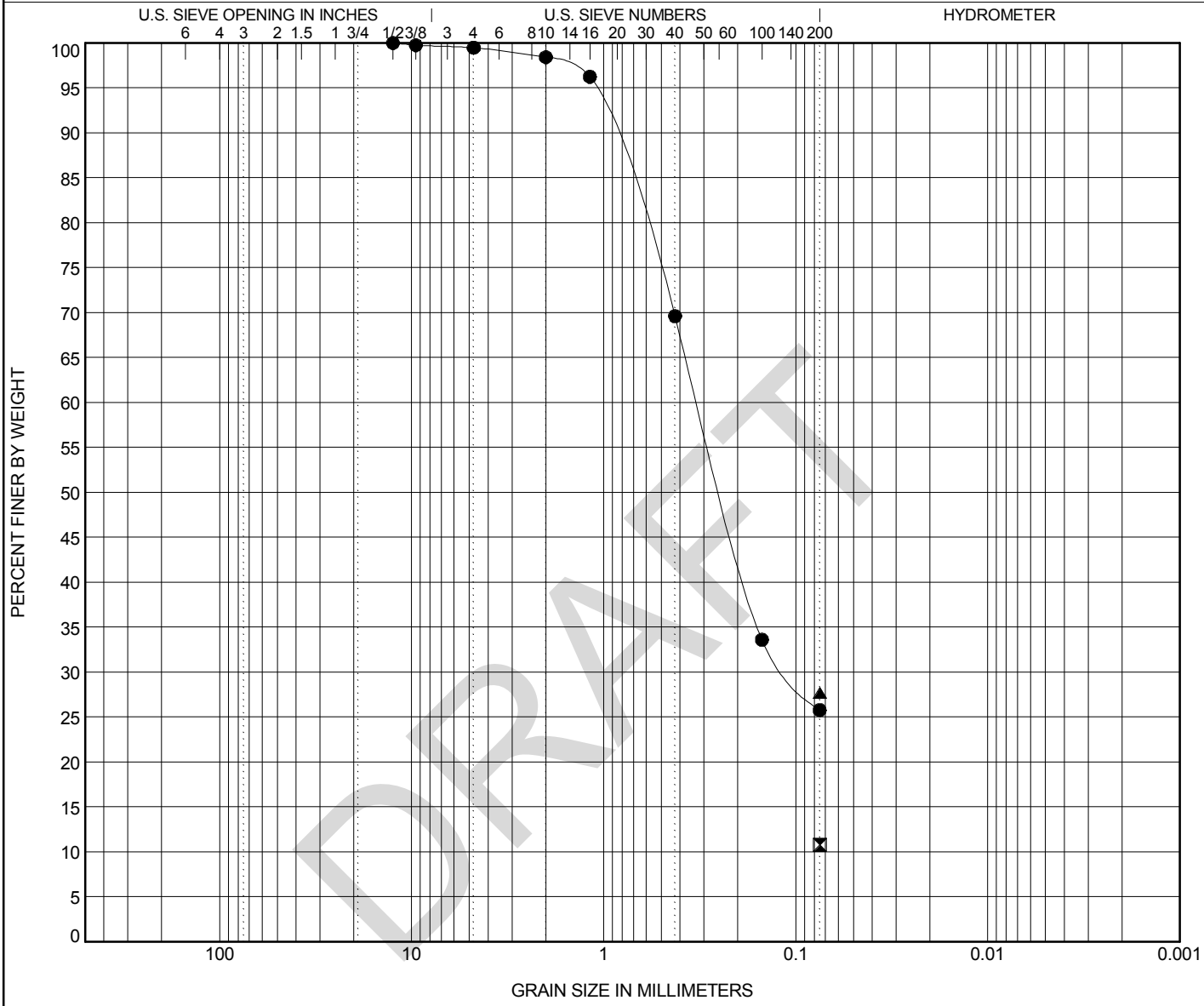

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	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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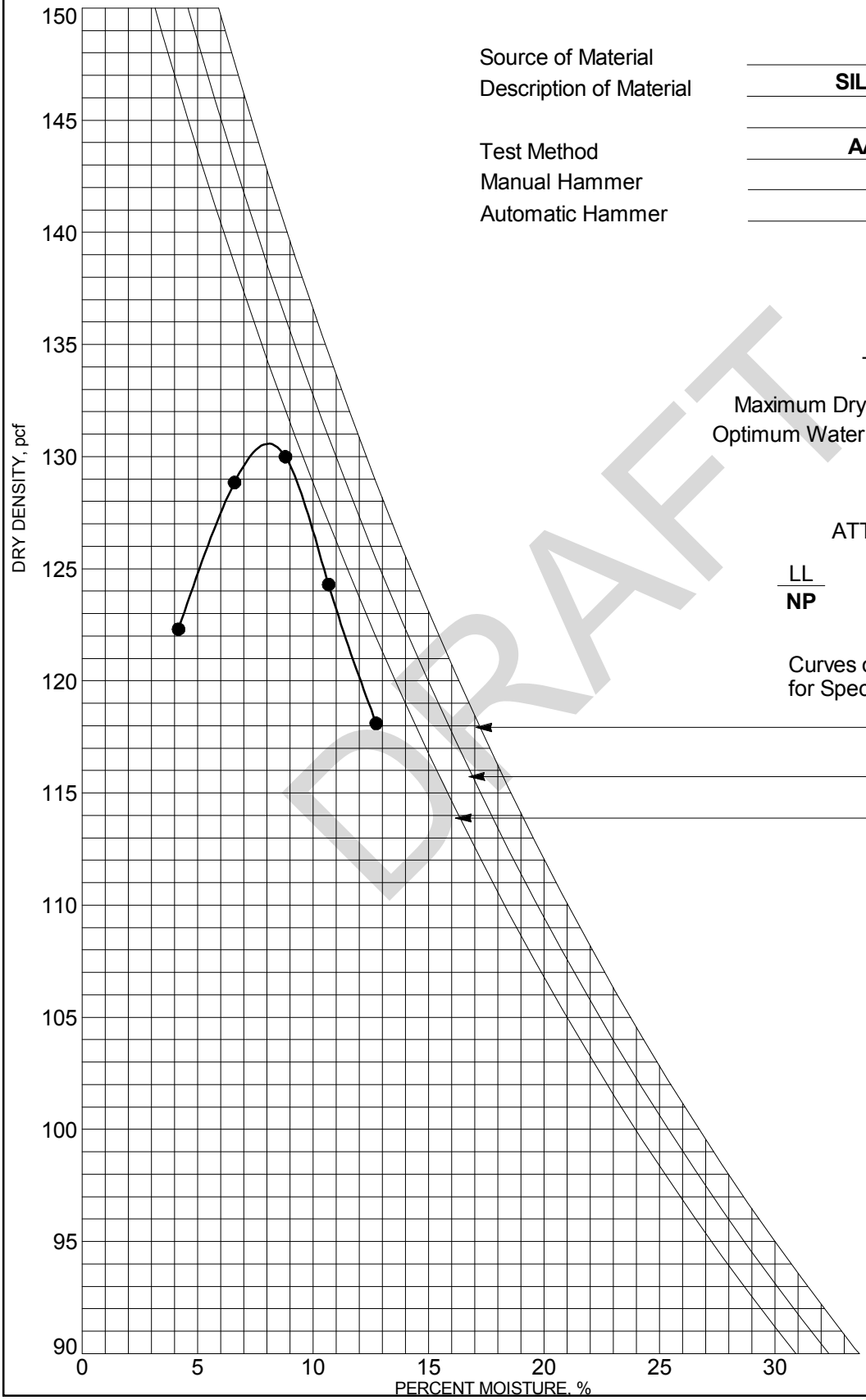

Source of Material	**BR-3 0-5'**
Description of Material	**SILTY SAND (SM)**
	A-2-4(0)
Test Method	**AASHTO T180**
Manual Hammer	X
Automatic Hammer	

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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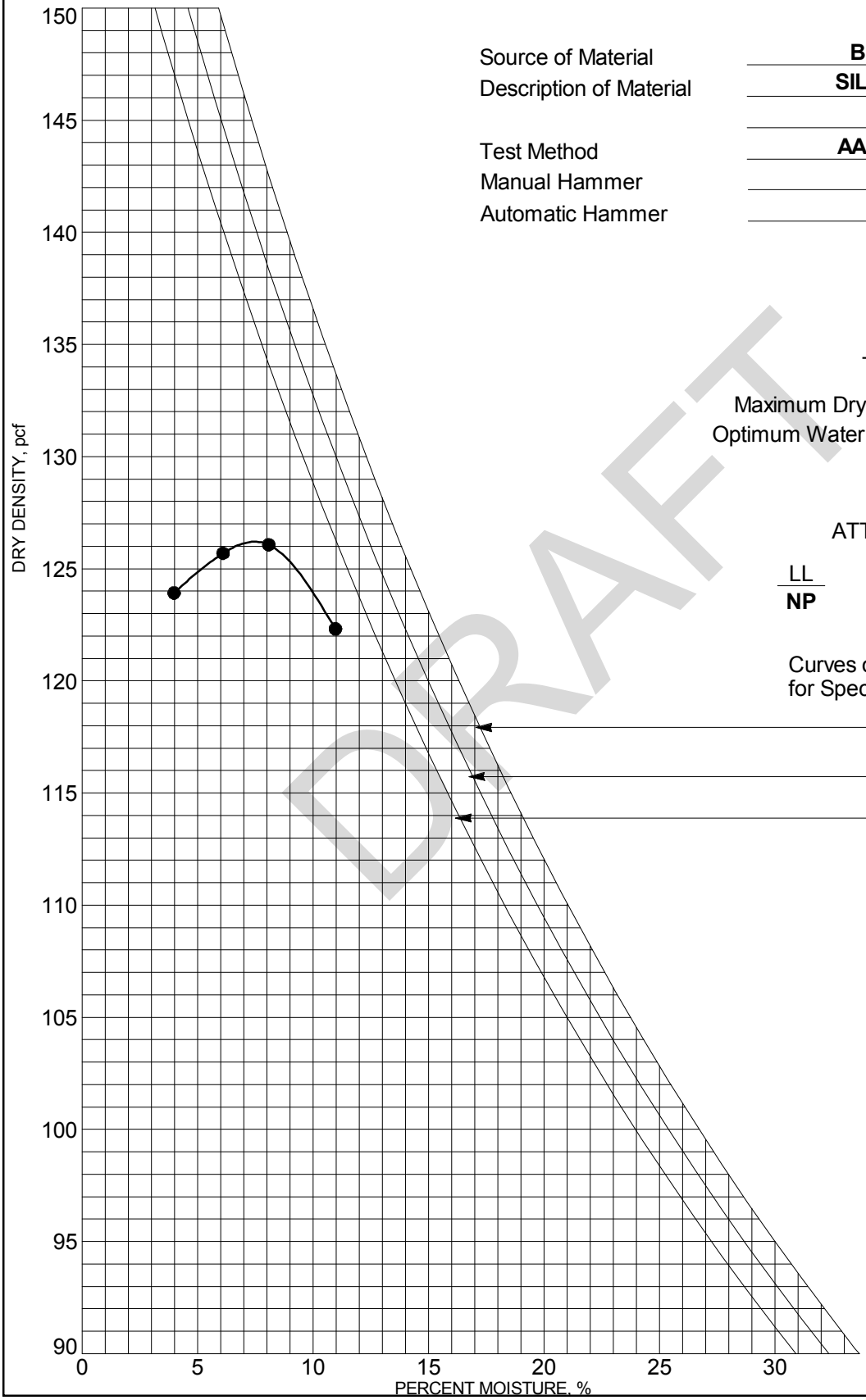


Source of Material	**BR-6 1.25'-10'**
Description of Material	**SILTY SAND (SM)**
	A-1-b(0)
Test Method	**AASHTO T180 A**
Manual Hammer	X
Automatic Hammer	

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

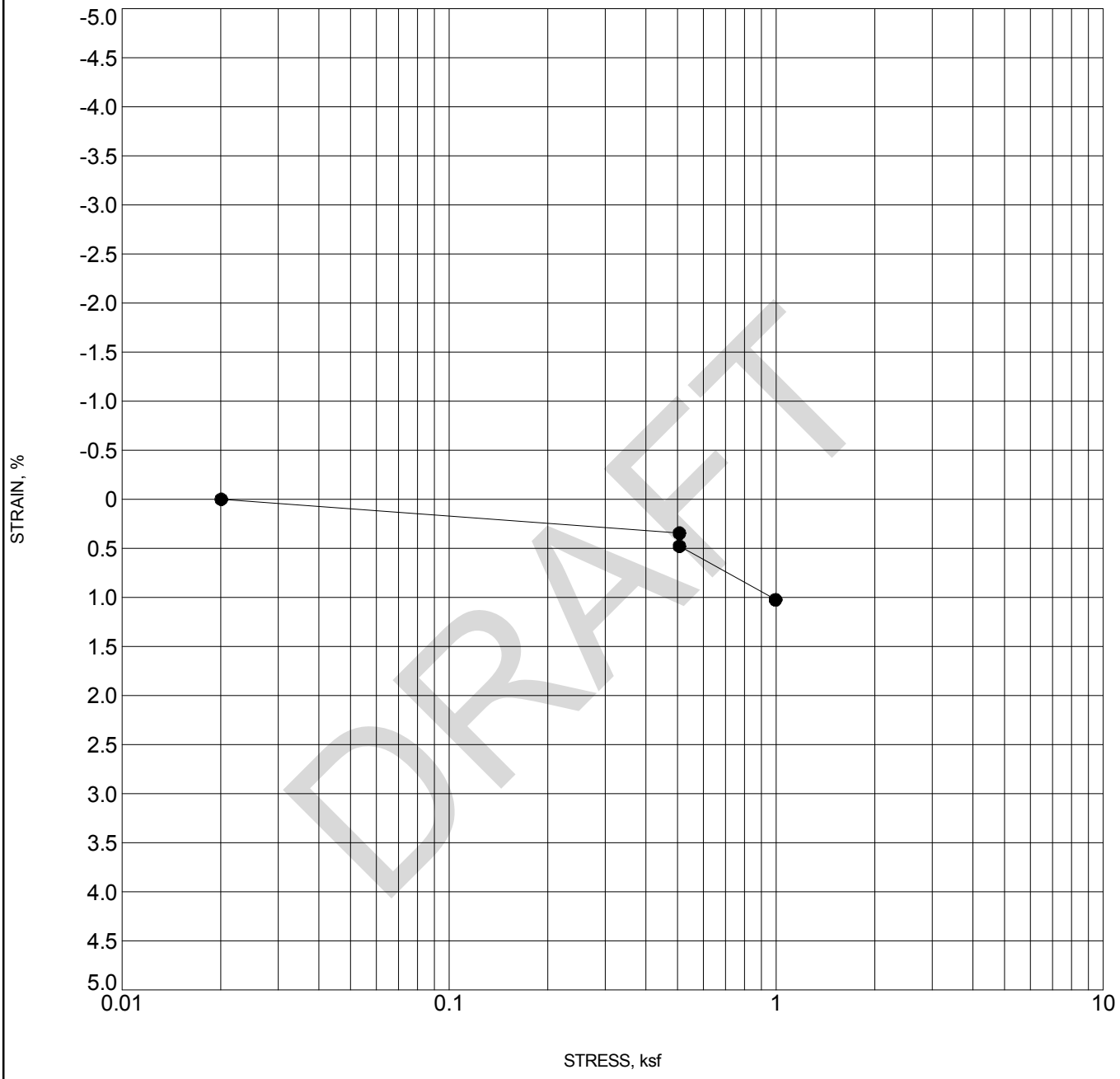
DRAFT

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

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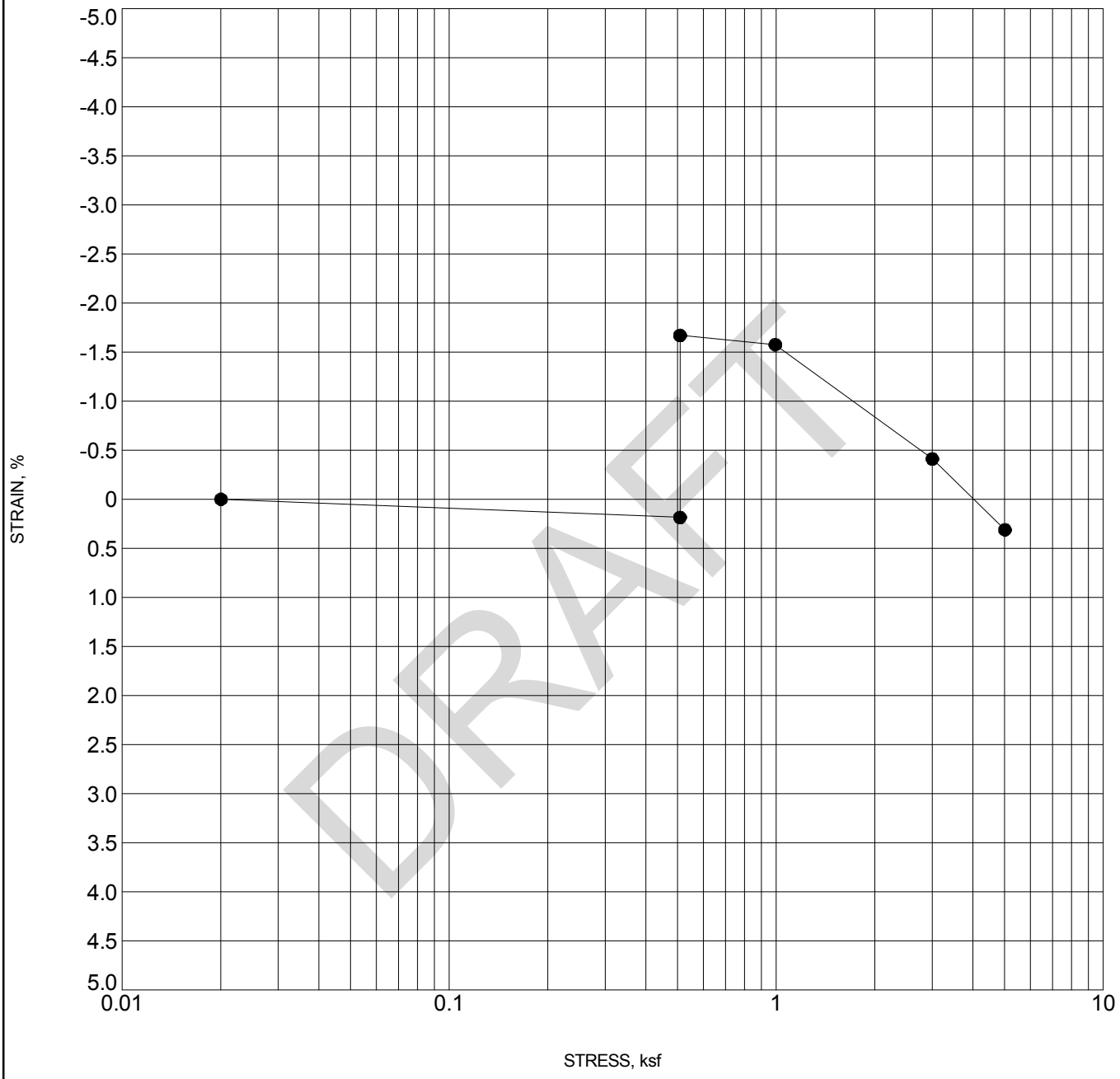
PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **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

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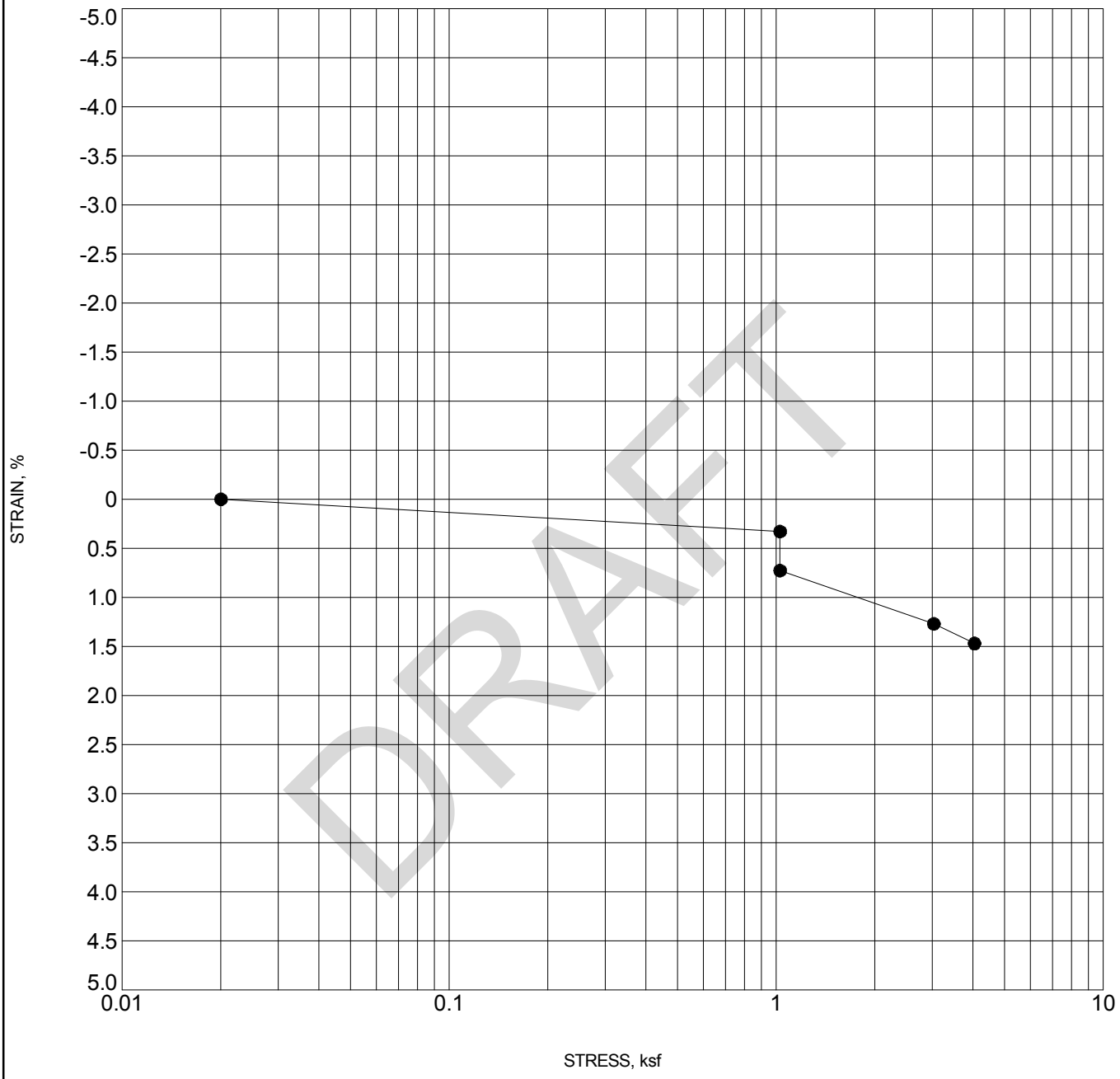
PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



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

SWELL - CONSOLIDATION TEST

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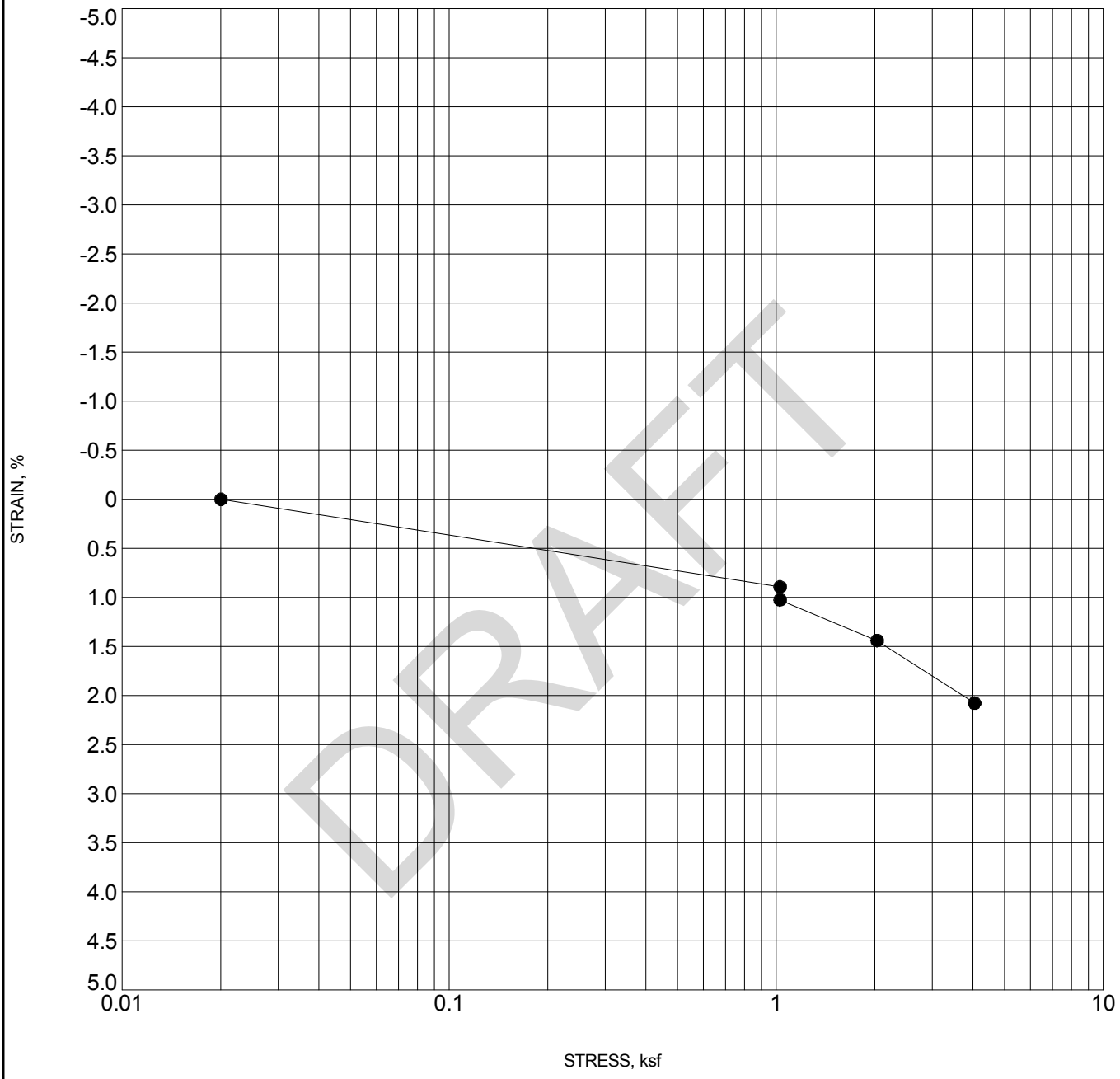

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-6**	**25**	**(Fill) SAND, silty**	**-0.1**	**121.3**	**9.8**

SWELL - CONSOLIDATION TEST

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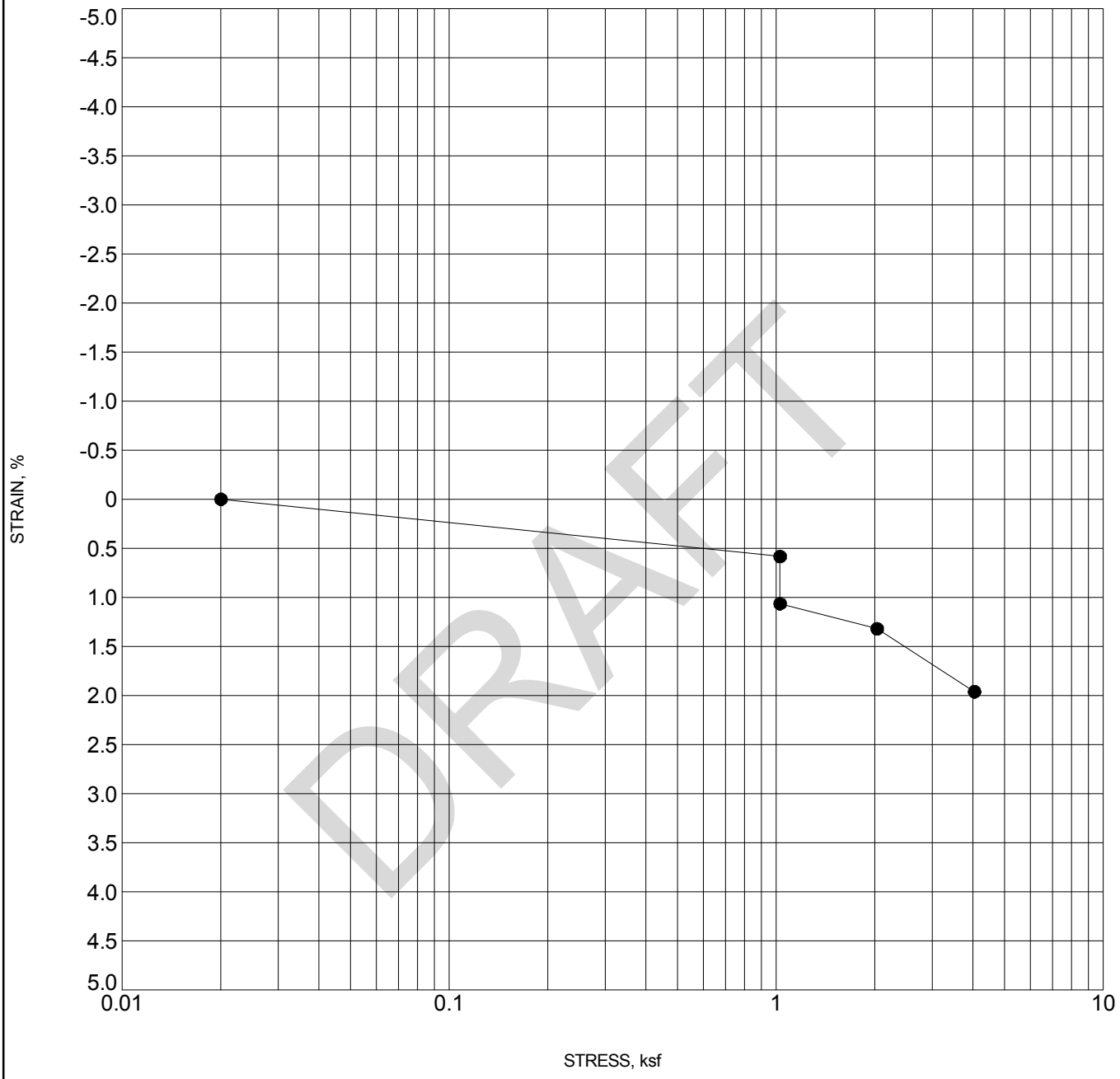

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **BR-6**	**40**	**SAND, silty**	**-0.5**	**109.0**	**13.2**

SWELL - CONSOLIDATION TEST

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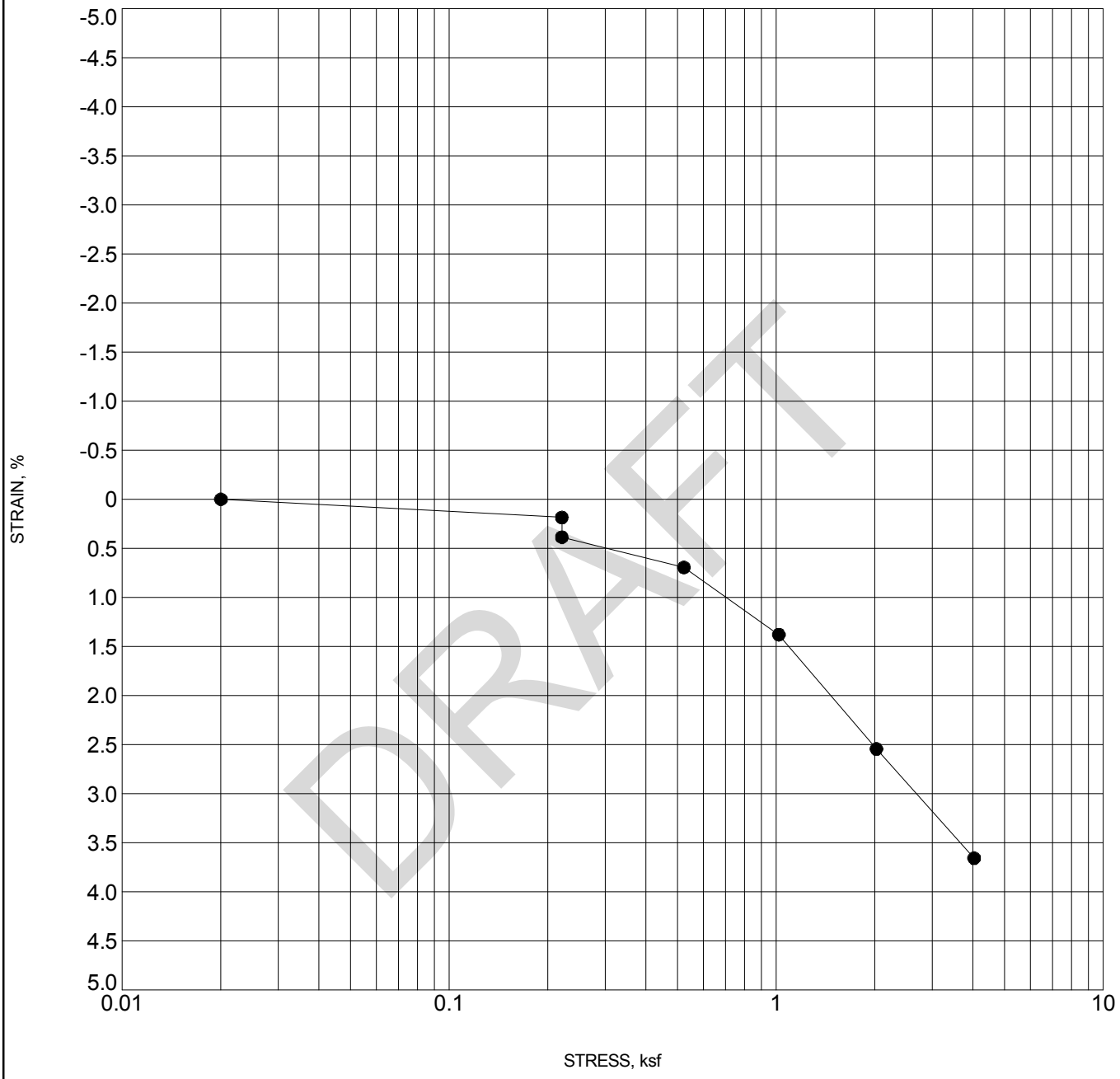
PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



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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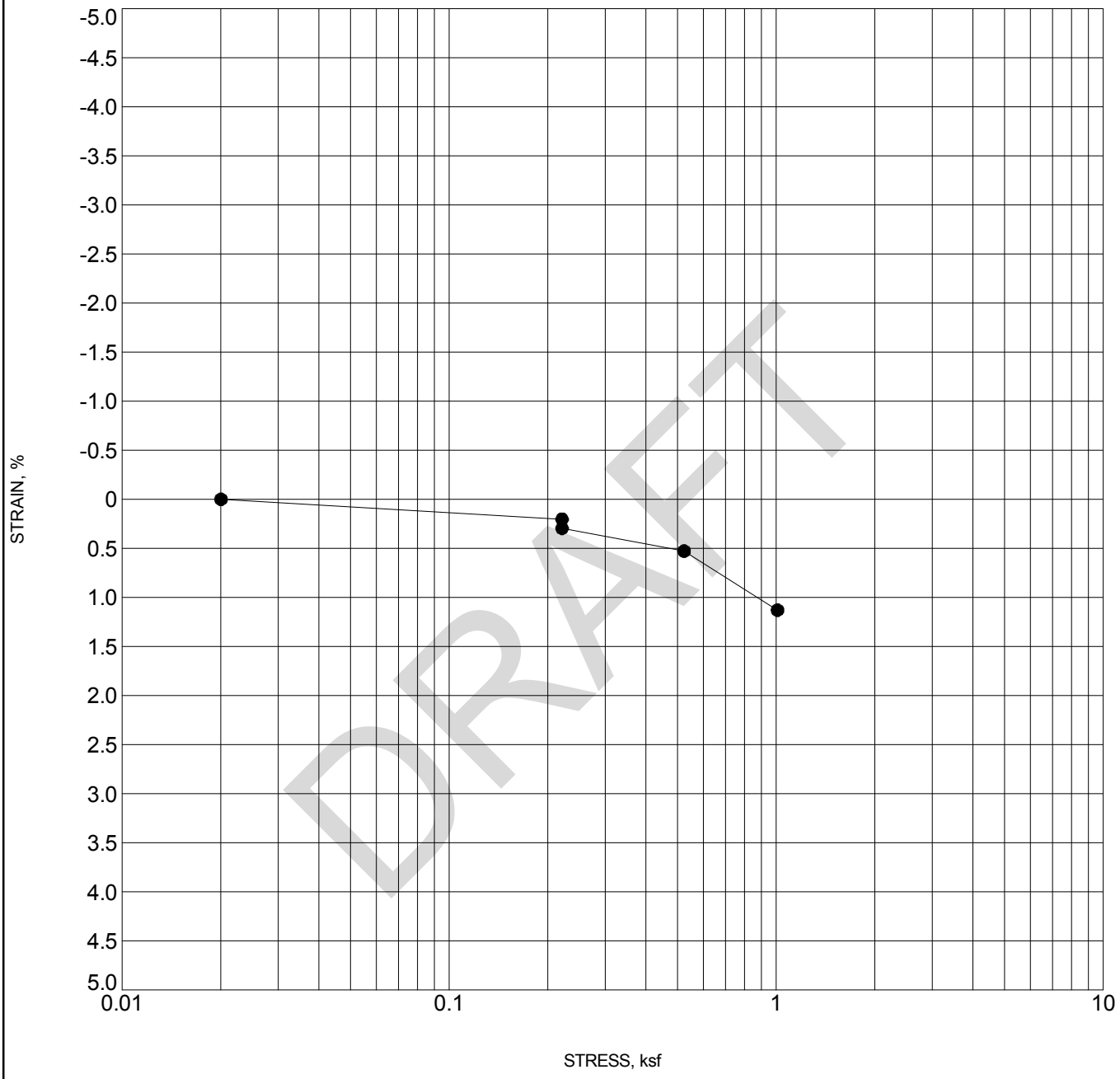

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **PV-2 4**	**(FIII) CLAY, sandy**	**-0.1**	**112.8**	**17.4**

SWELL - CONSOLIDATION TEST

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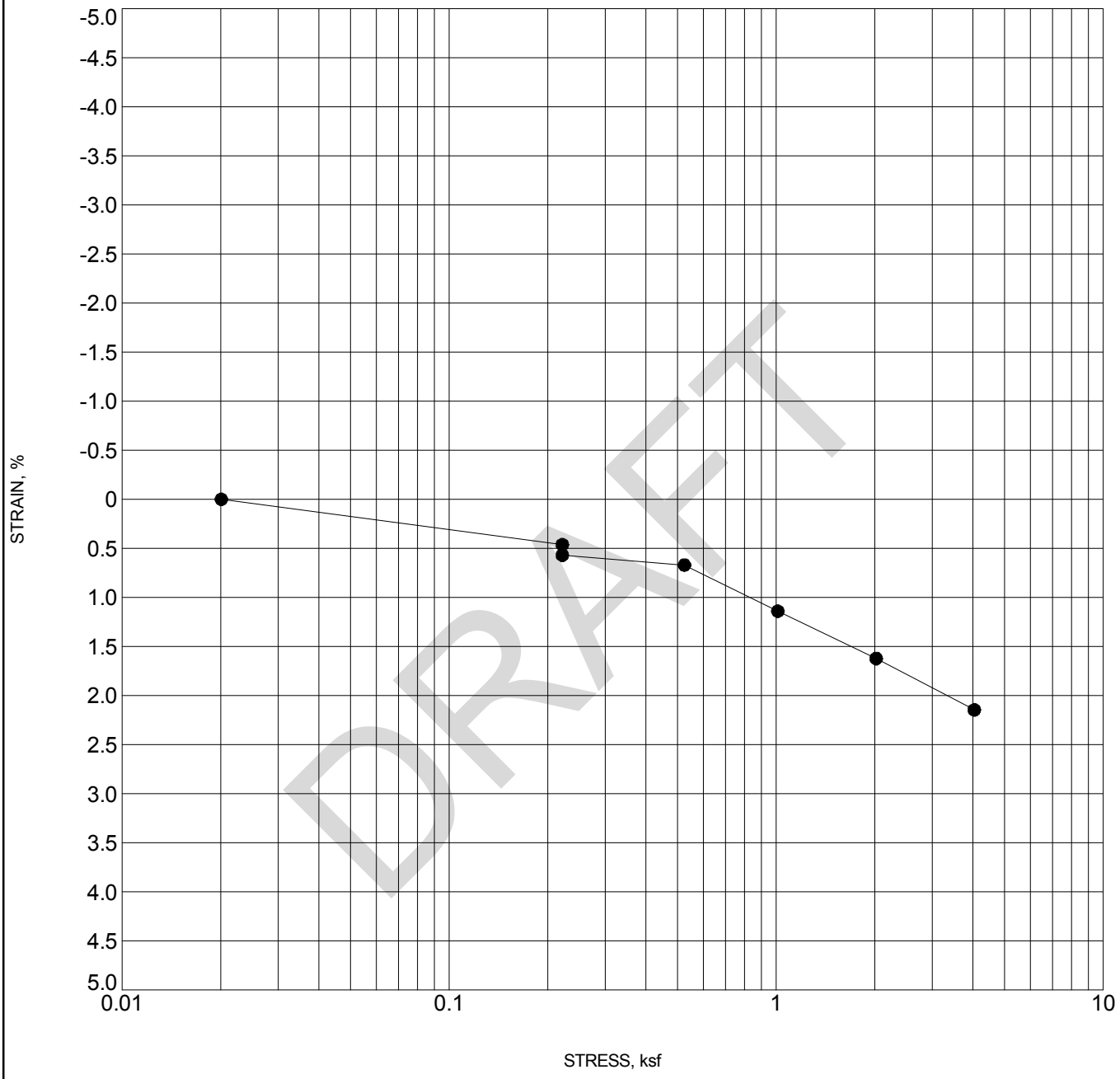

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **PV-3 2**	**(Fill) SAND, silty**	**-0.1**	**115.9**	**7.2**

SWELL - CONSOLIDATION TEST

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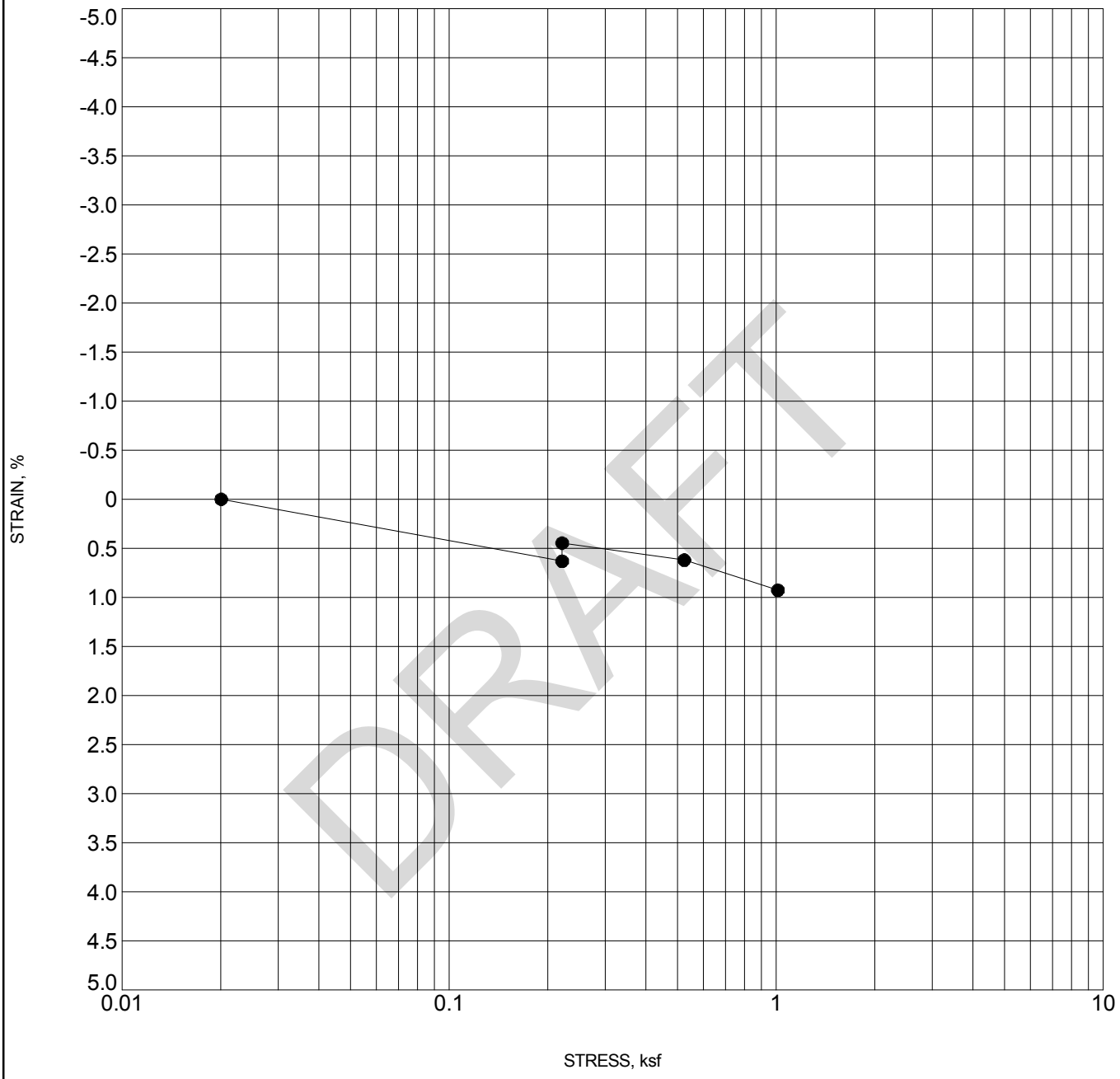

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **PV-6 2**	**(Fill) SAND, clayey**	**0.2**	**120.2**	**13.1**

SWELL - CONSOLIDATION TEST

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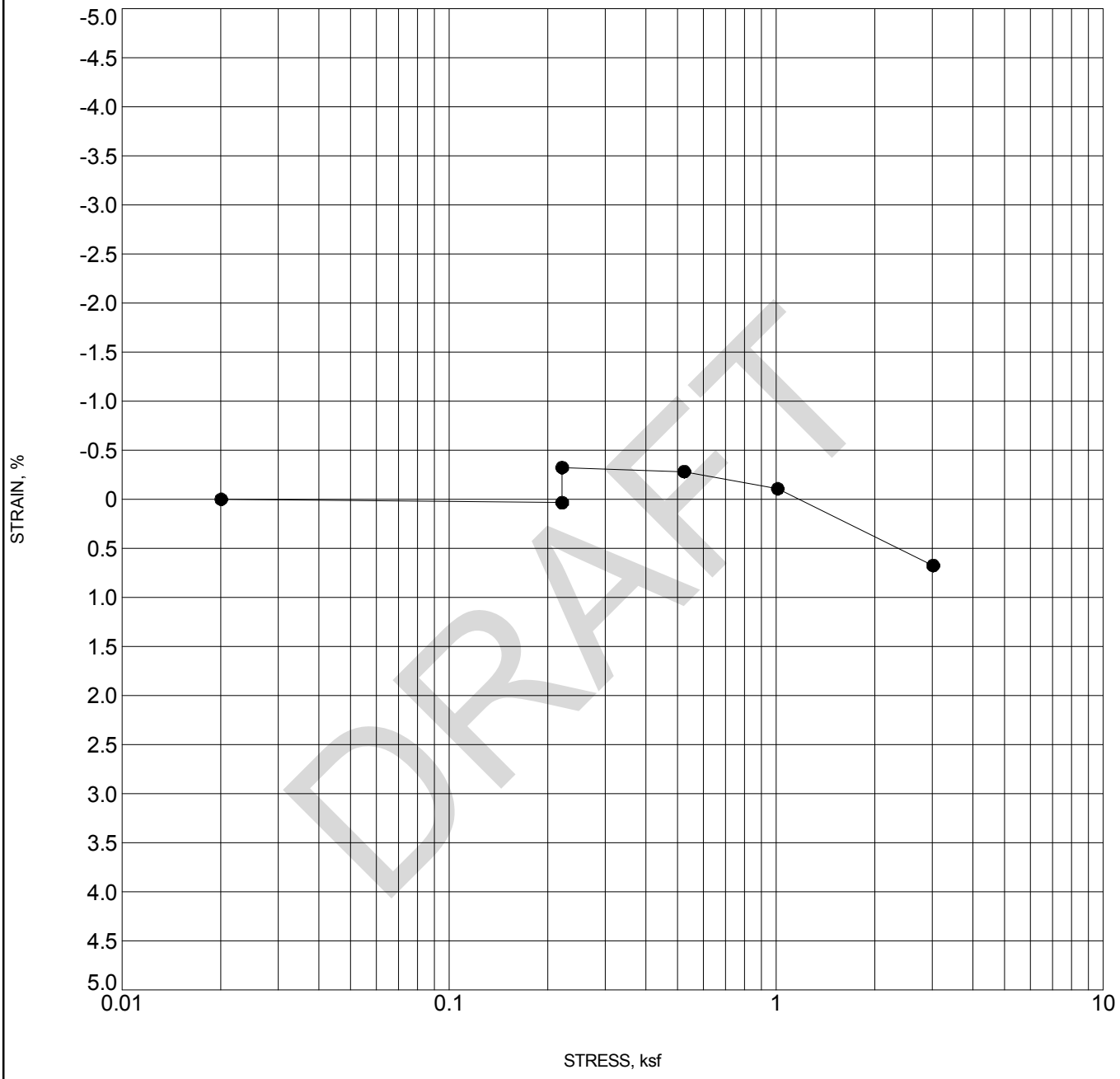

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **PV-7 2**	**(Fill) CLAYEY SAND (SC)**	**0.4**	**123.0**	**12.1**

SWELL - CONSOLIDATION TEST

RockSol Consulting Group, Inc.

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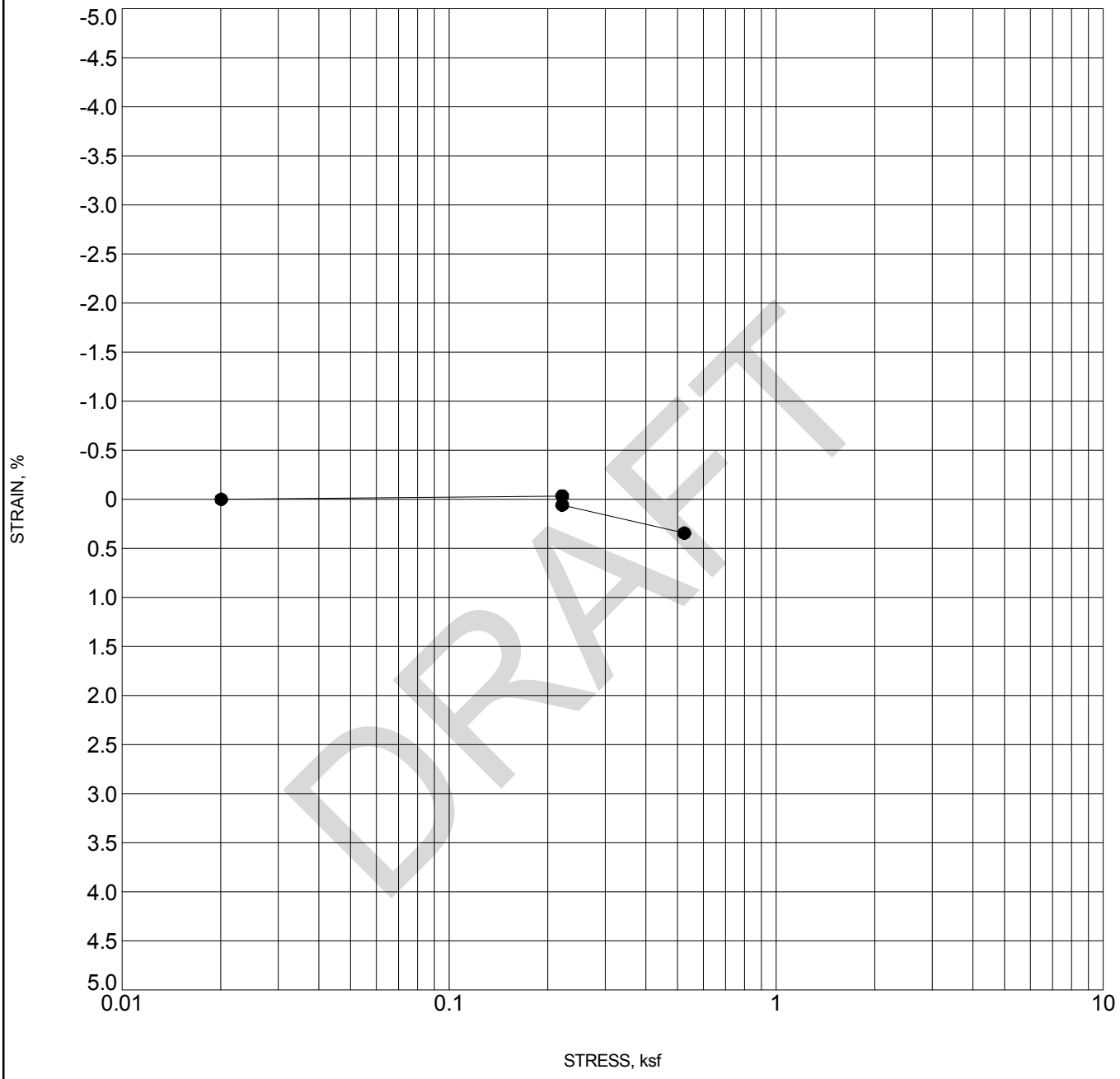
PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



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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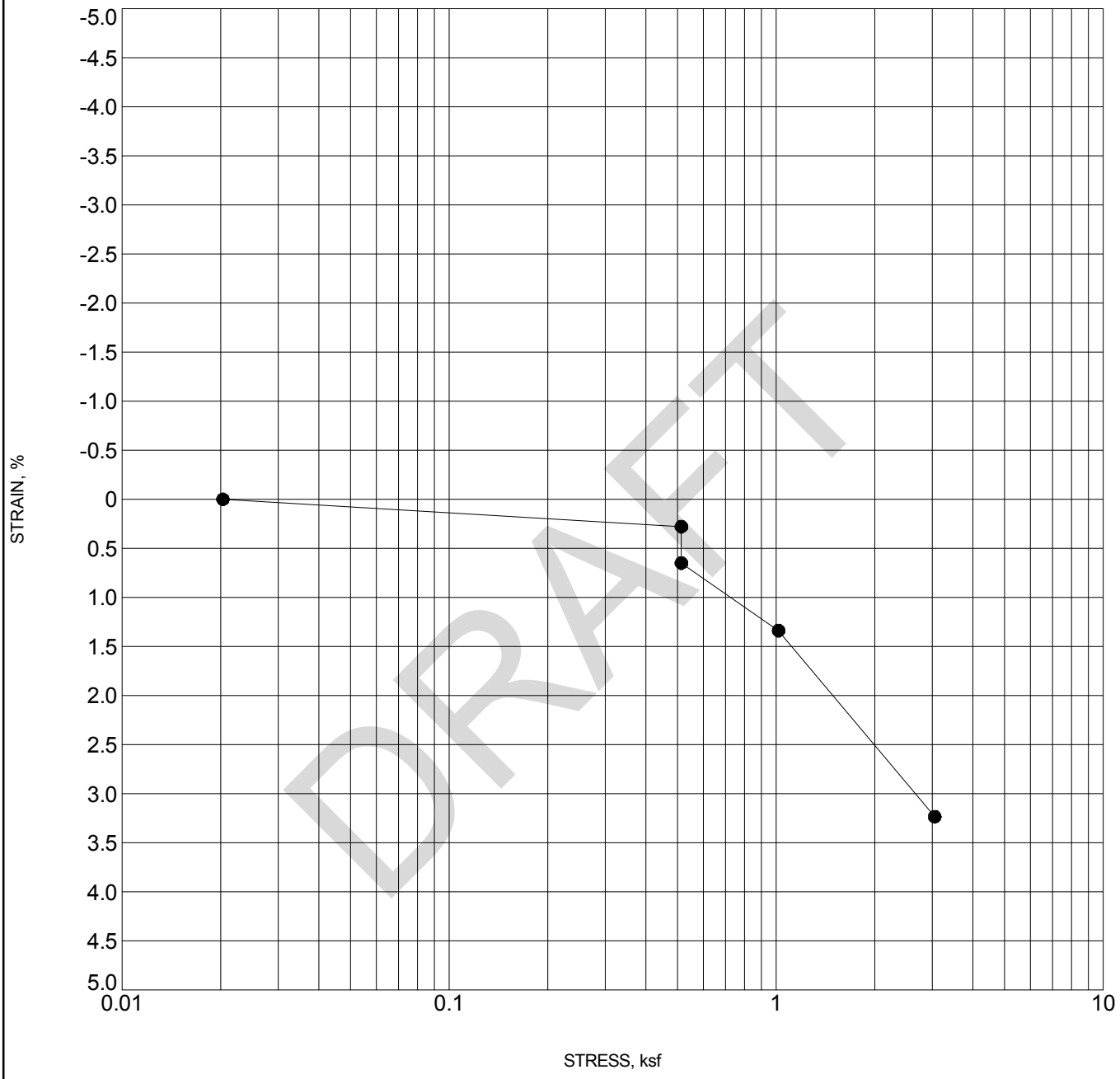

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-1**	**25**	**SANDY LEAN CLAY (CL)**	**-0.4**	**122.3**	**13.0**

SWELL - CONSOLIDATION TEST

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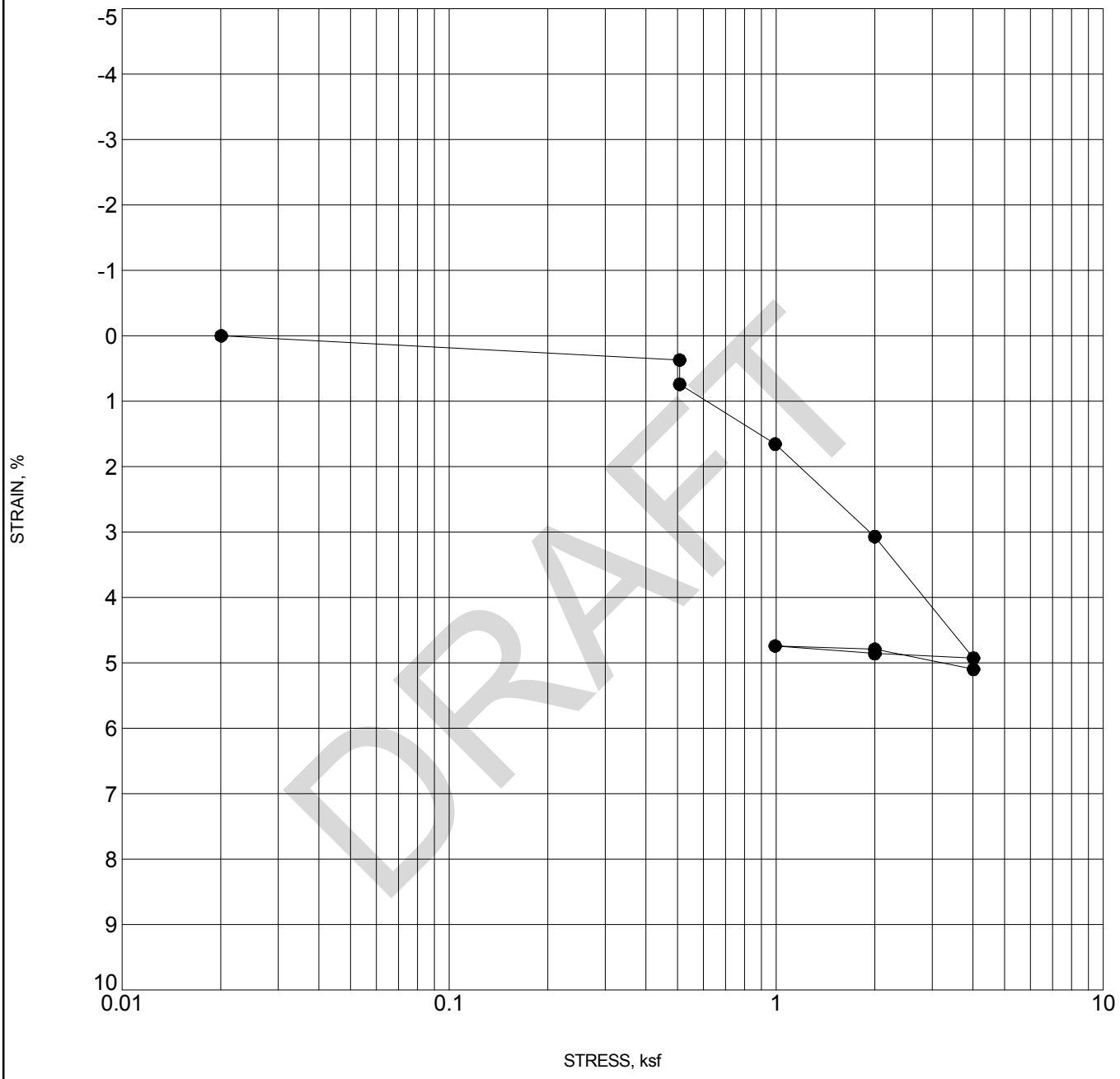

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-1** **45**	**CLAY, sandy**	**-0.4**	**95.1**	**29.3**

SWELL - CONSOLIDATION TEST

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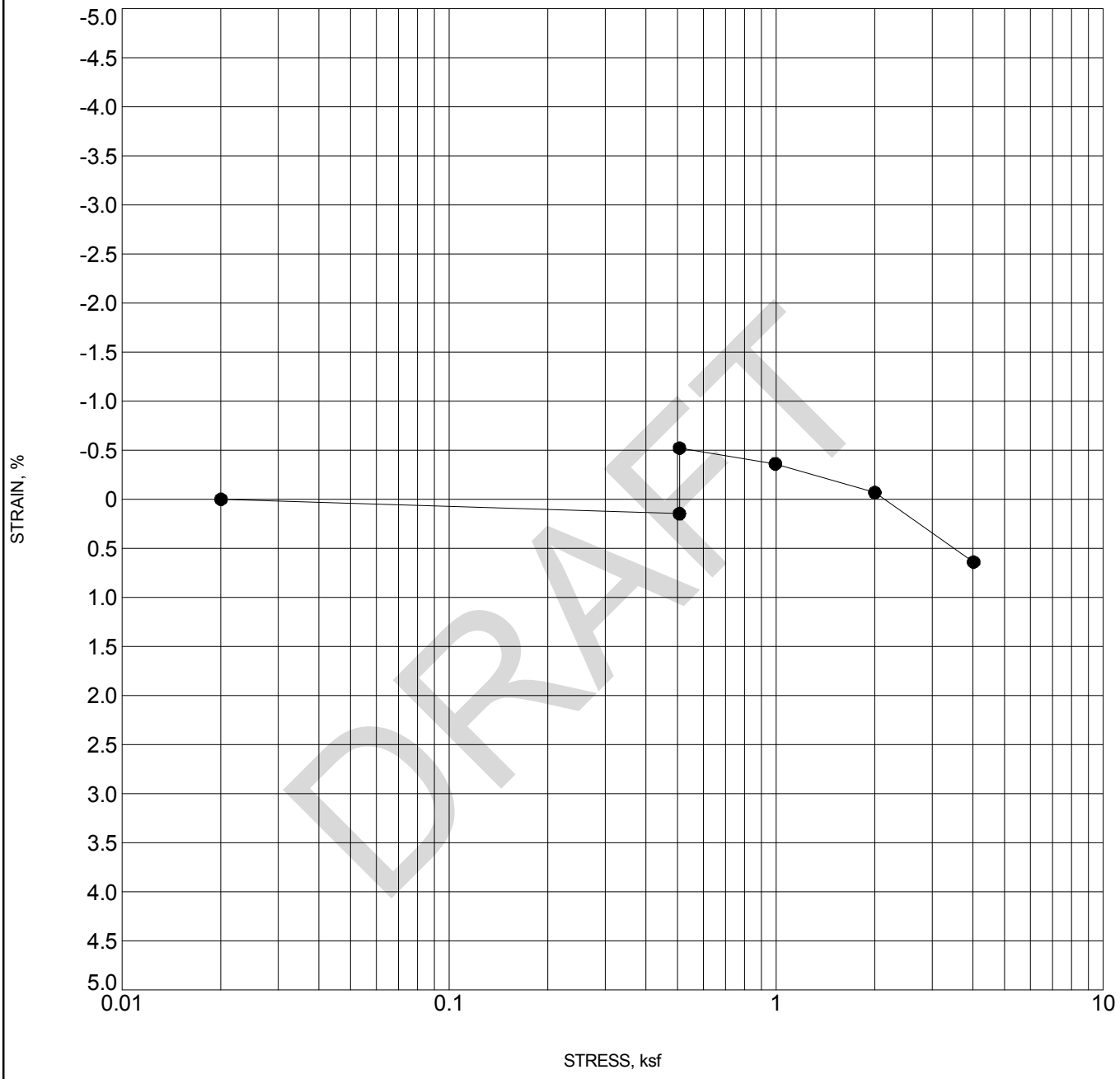

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-2**	**30**	**CLAY, silty**	**0.7**	**120.1**	**14.0**

SWELL - CONSOLIDATION TEST

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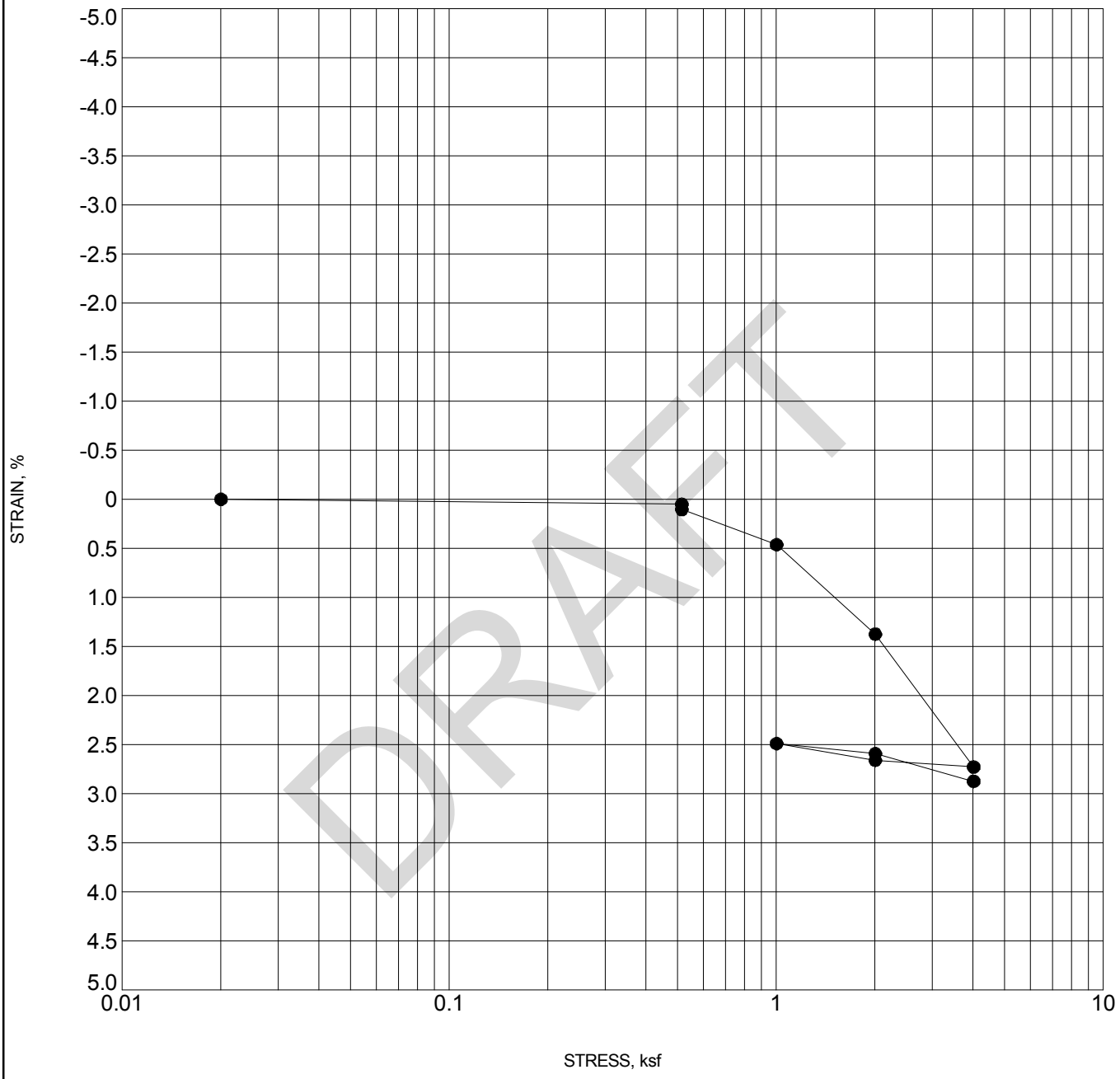
PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



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

SWELL - CONSOLIDATION TEST

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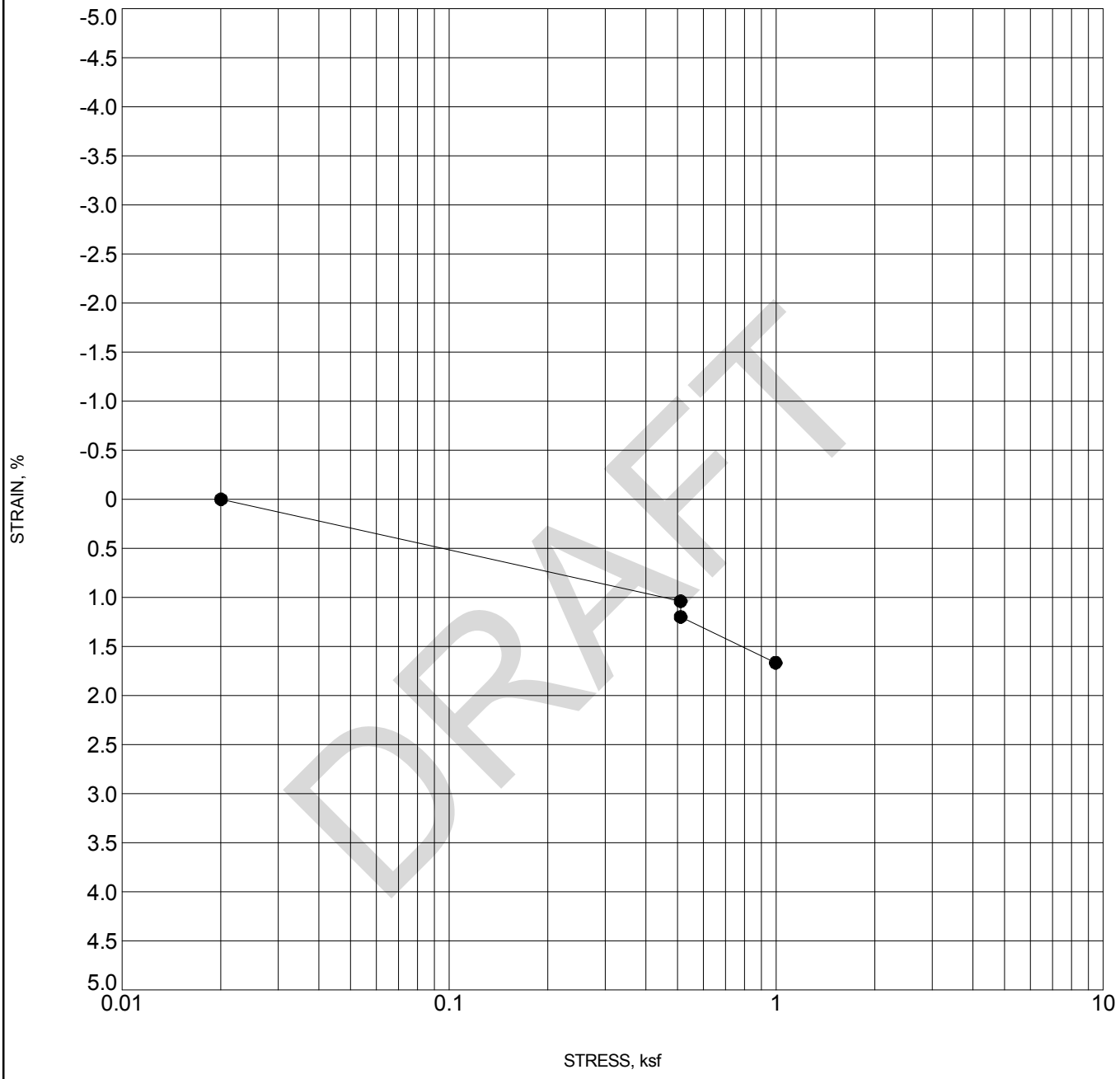

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-4**	**30**	**CLAY, very sandy**	**-0.2**	**120.6**	**12.9**

SWELL - CONSOLIDATION TEST

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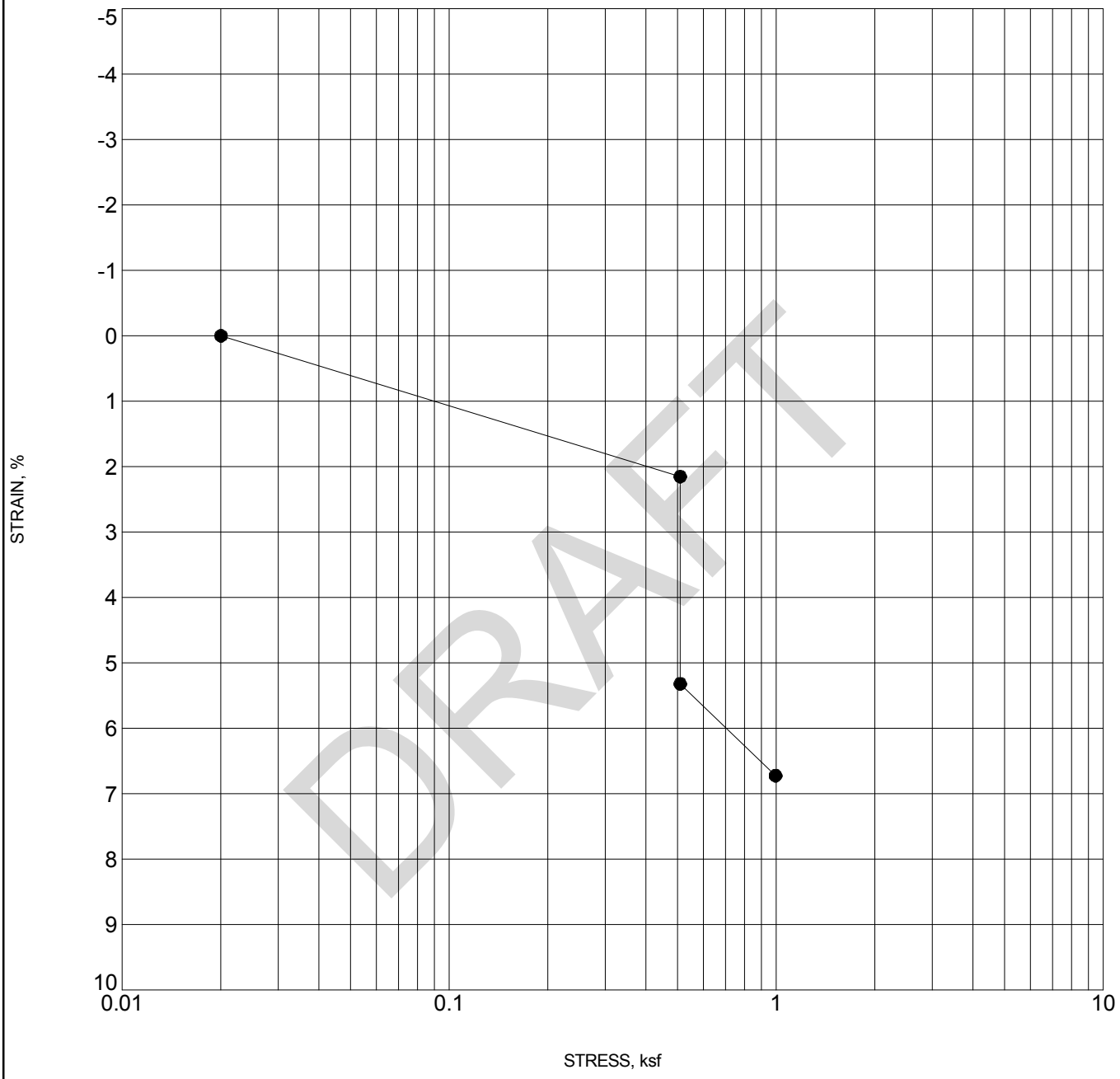

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-4**	**40**	**CLAY, sandy**	**-3.2**	**110.8**	**18.2**

SWELL - CONSOLIDATION TEST

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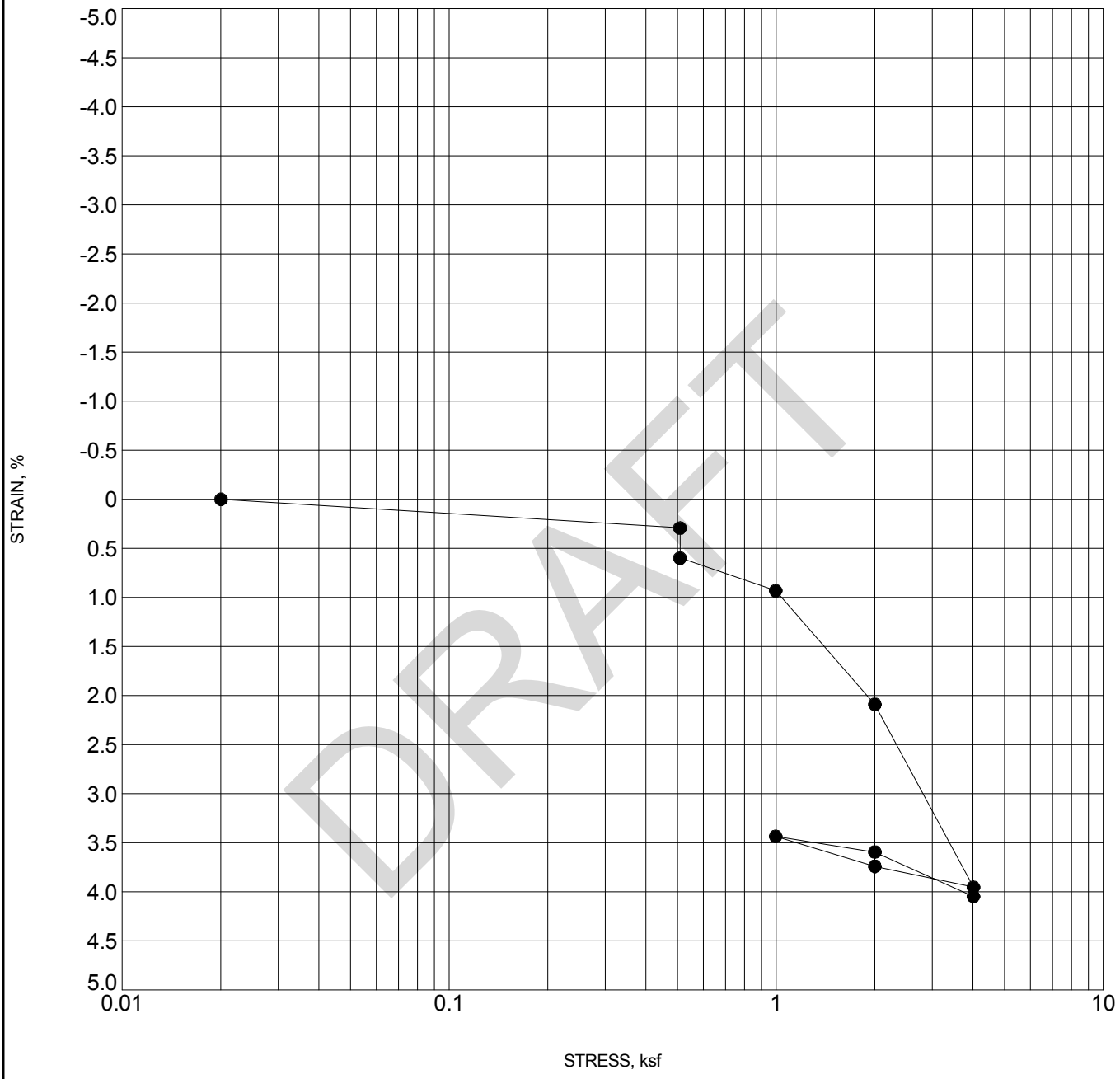

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-5 15**	**SANDY FAT CLAY (CH)**	**-0.3**	**98.7**	**24.4**

SWELL - CONSOLIDATION TEST

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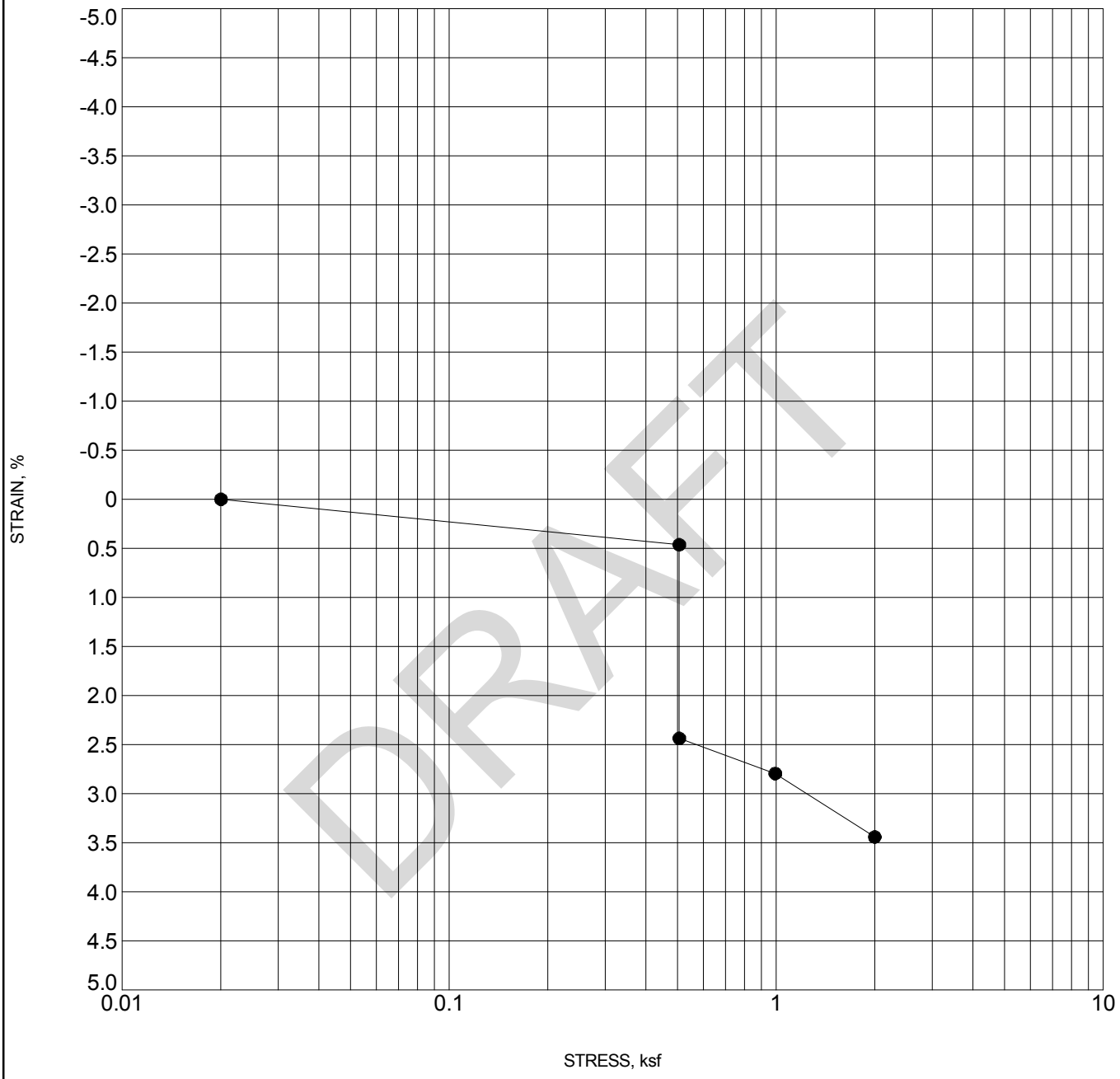

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-6**	**14**	**SAND, silty**	**-2.0**	**116.1**	**9.0**

SWELL - CONSOLIDATION TEST

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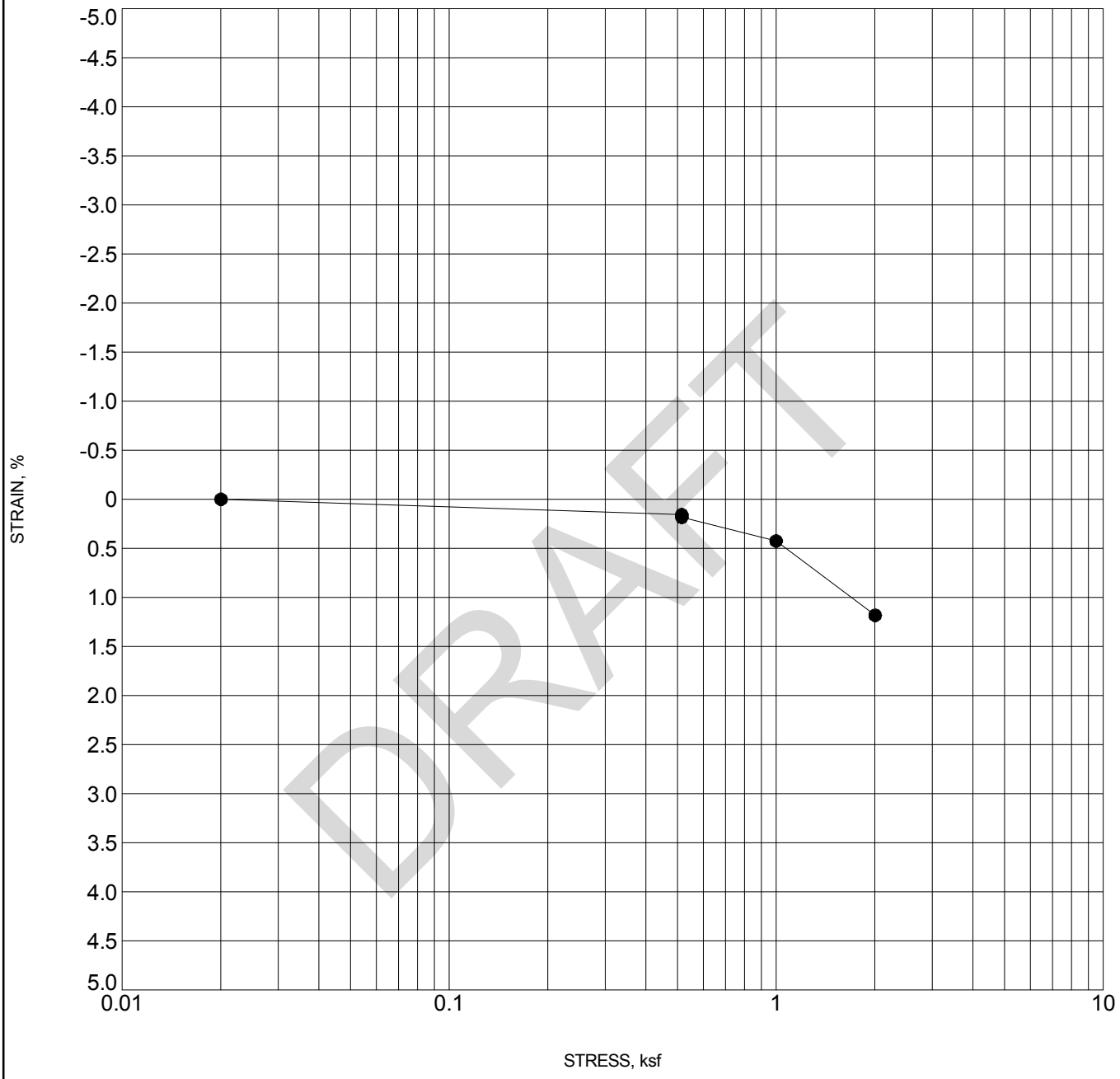

Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-6**	**19**	**CLAY, sandy**	**0.0**	**114.9**	**16.3**

SWELL - CONSOLIDATION TEST

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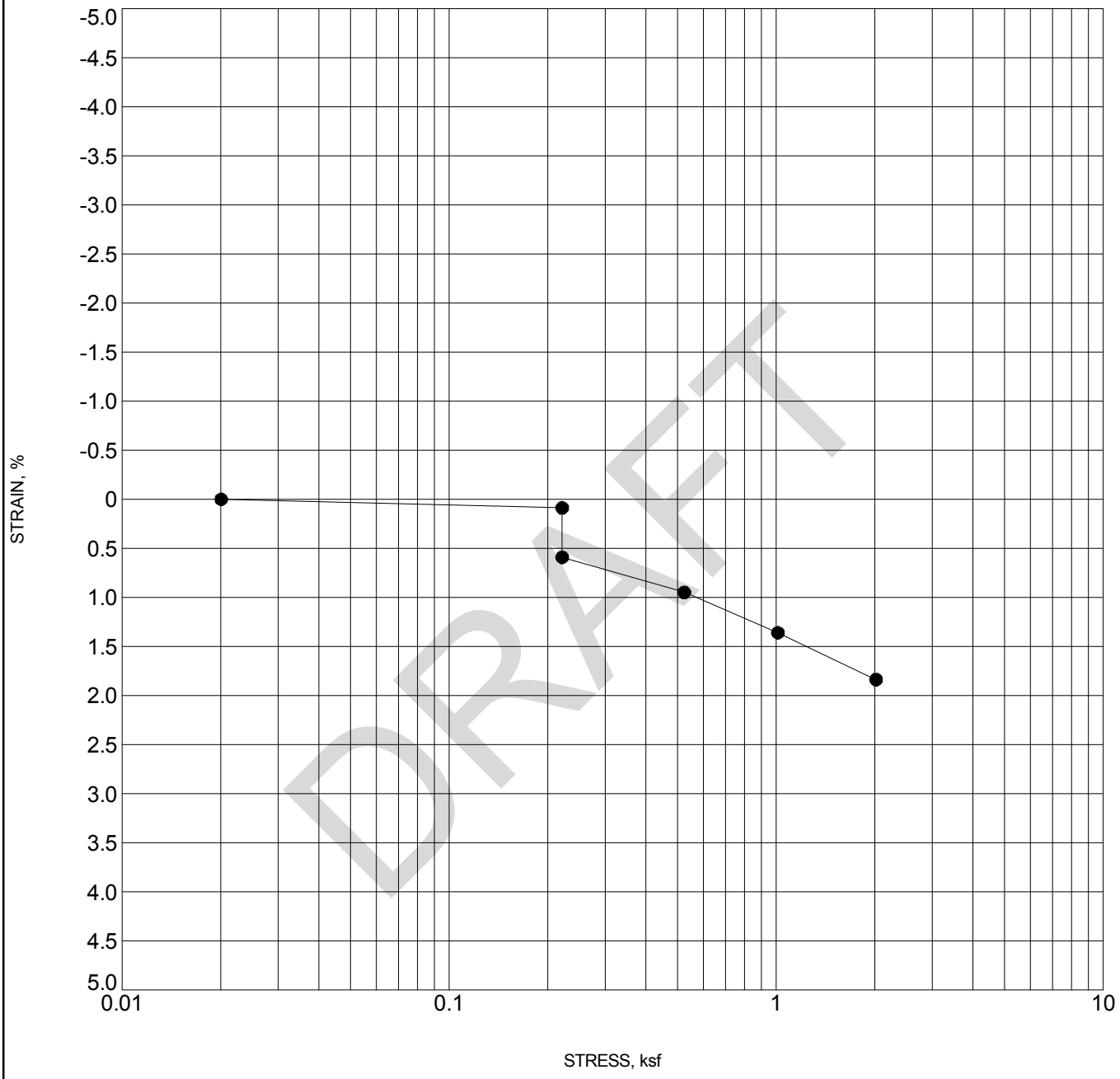

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-7 4**	**SAND, silty**	**-0.5**	**106.6**	**6.9**

SWELL - CONSOLIDATION TEST

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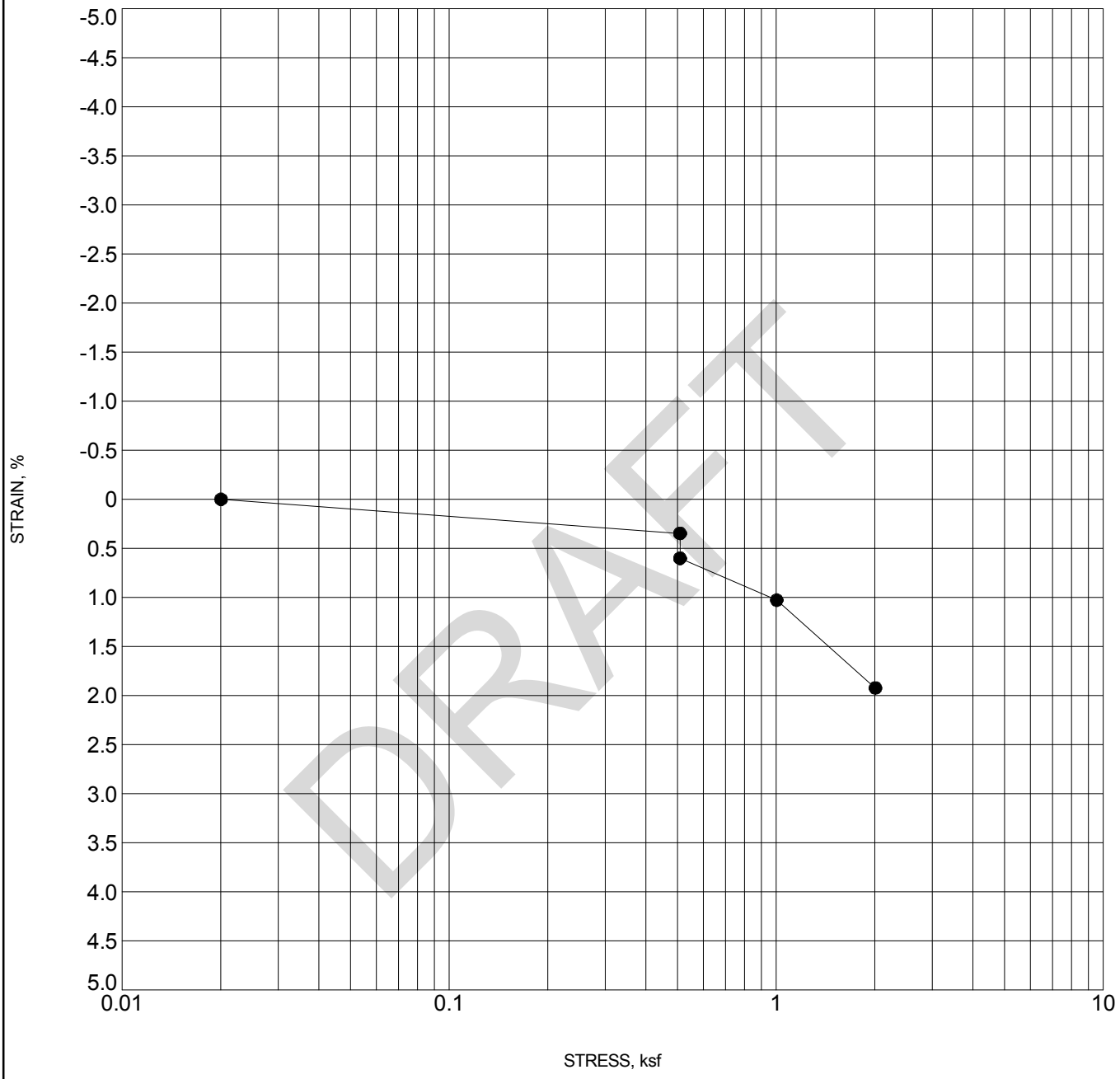
PROJECT NUMBER 304.01 **PROJECT LOCATION** Havana and I-70/Denver, CO



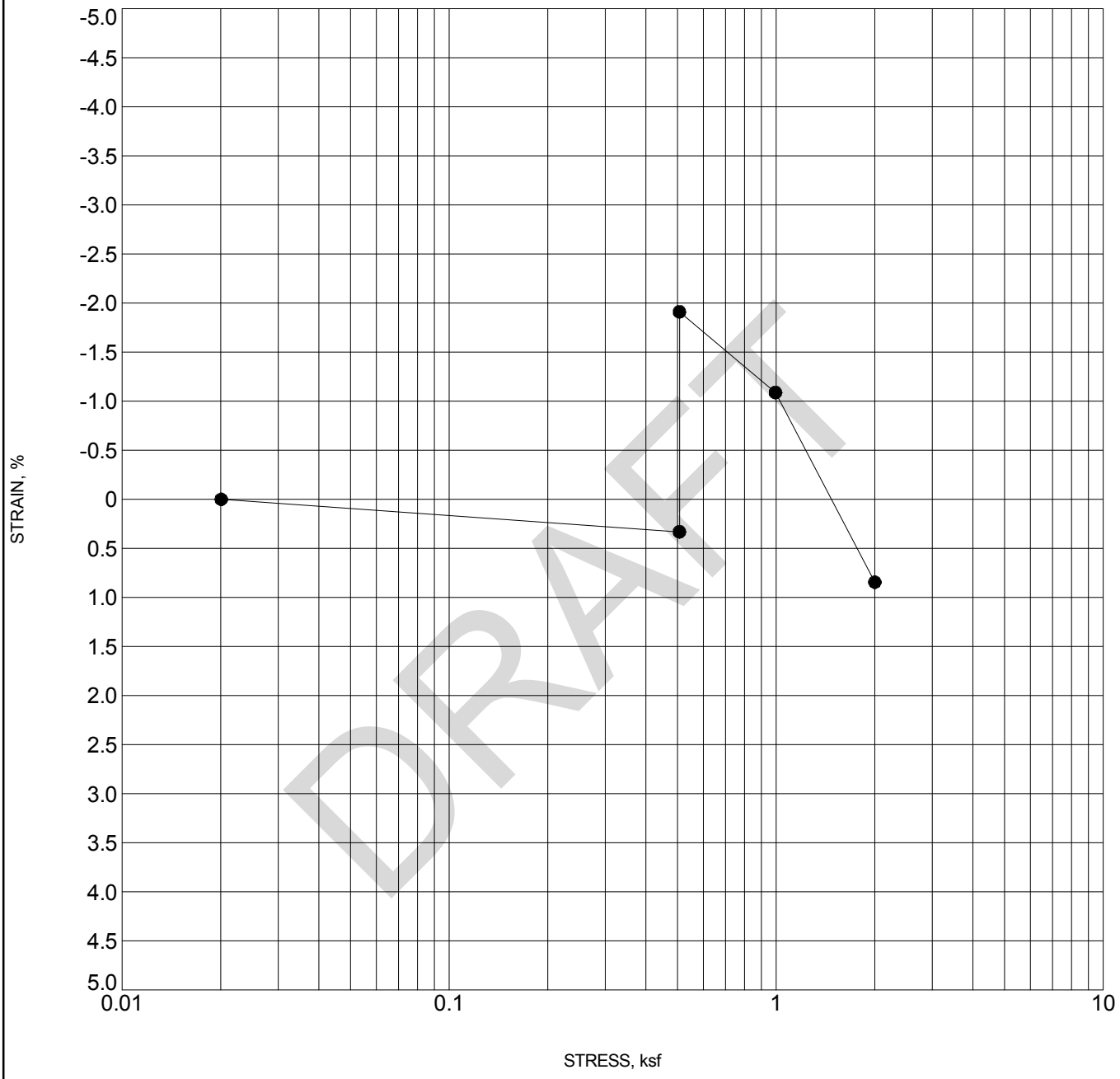
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-7 9**	**SAND, silty**	**-0.3**	**104.3**	**5.2**

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



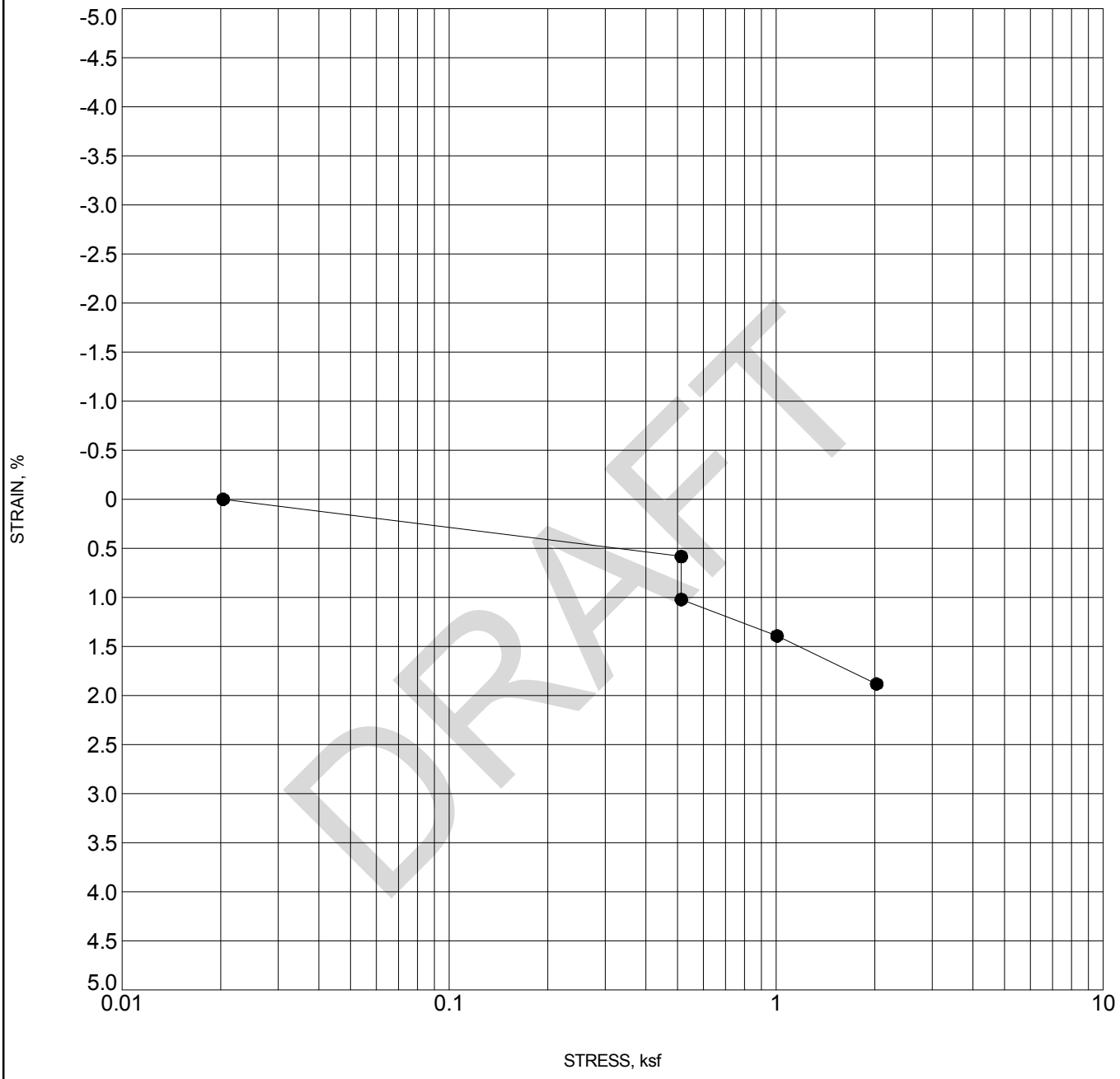
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-8**	**5**	**CLAY, sandy**	**2.2**	**115.3**	**15.2**

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



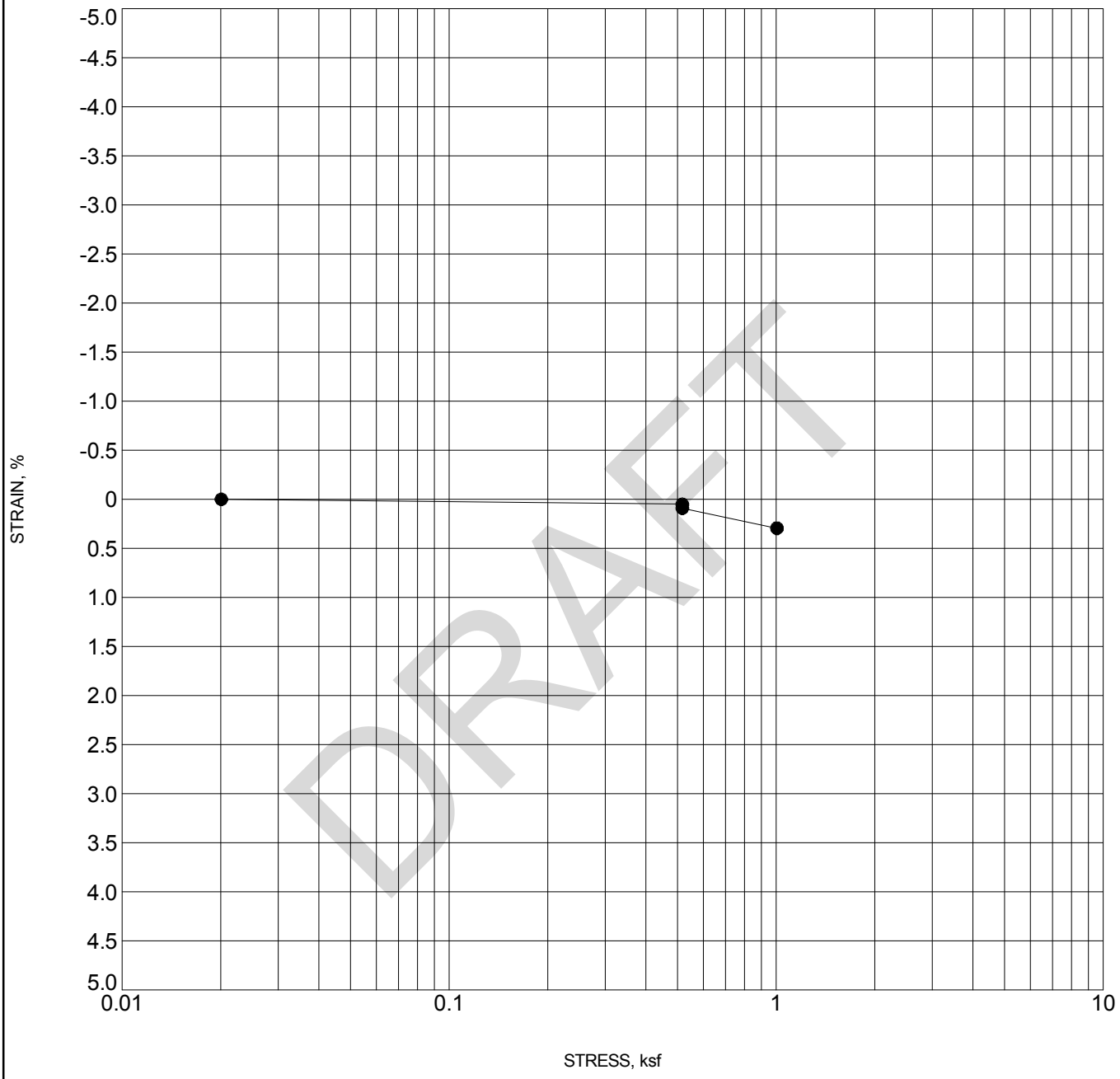
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-9 4**	**SAND, silty**	**-0.4**	**104.9**	**7.1**

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



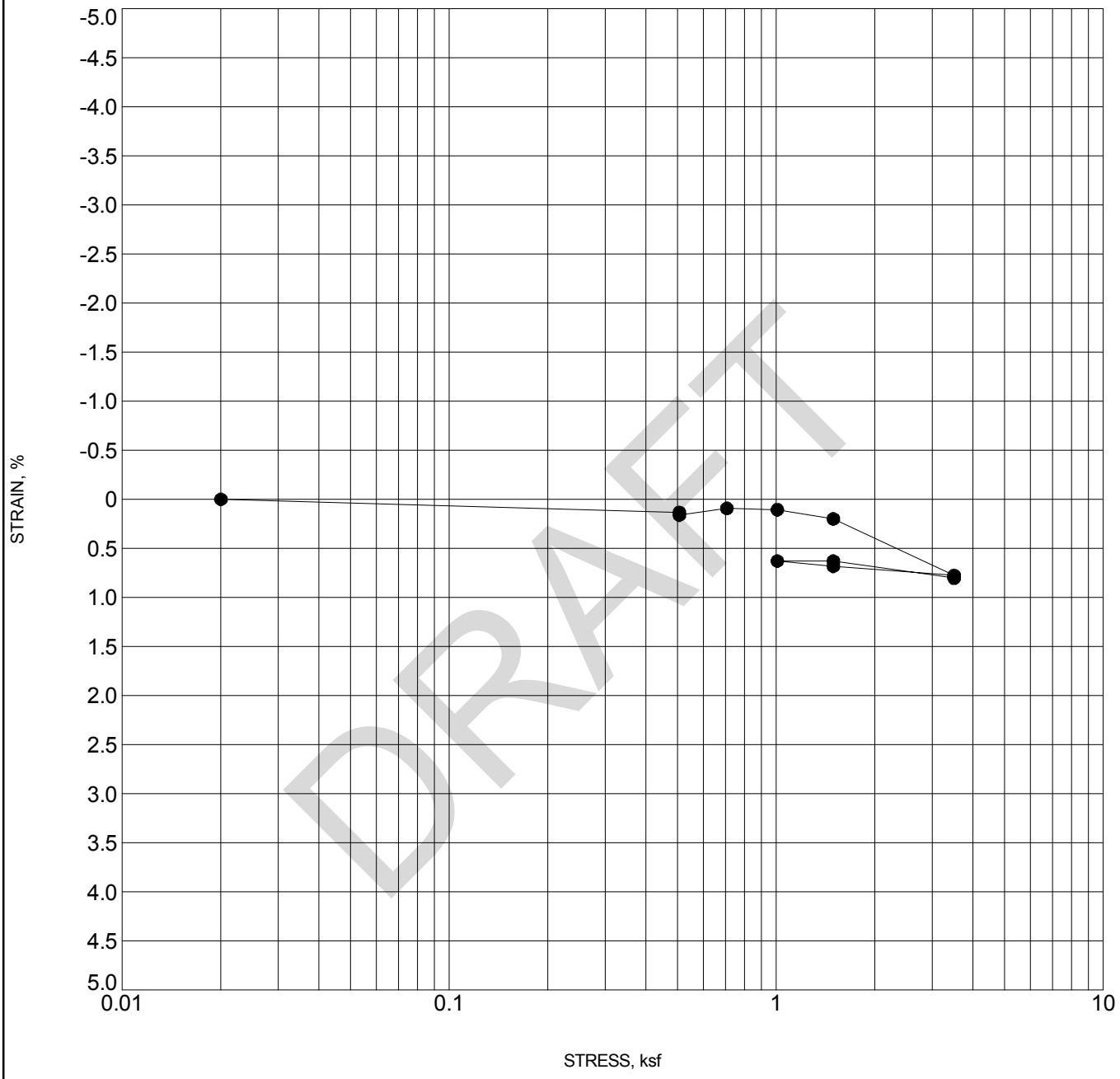
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-10** **4**	**SAND, silty**	**0.0**	**113.7**	**14.6**

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



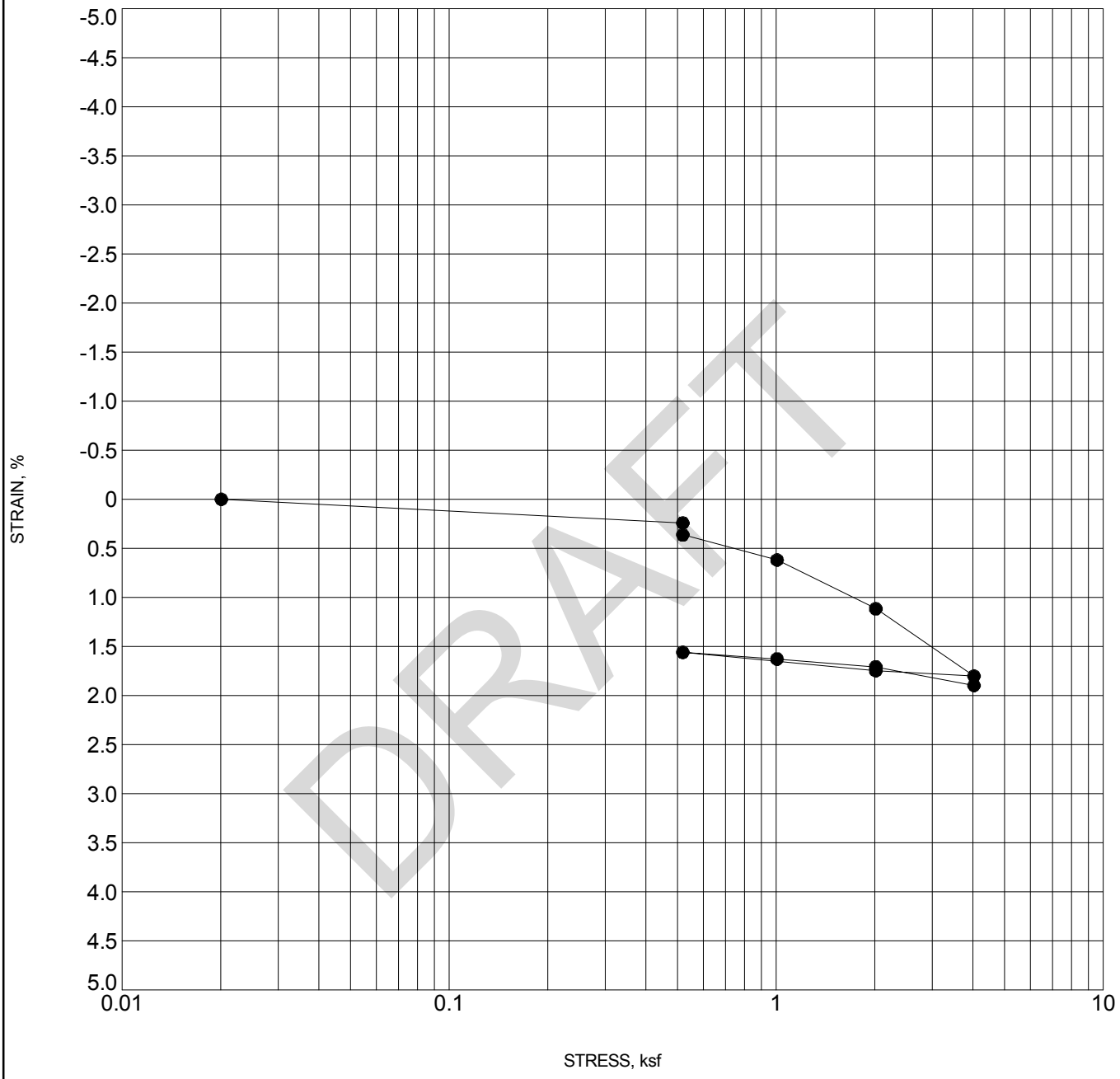
Specimen Identification		Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● **RW-10**	**14**	**SANDY CLAY**	**0.0**	**107.3**	**19.2**

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**