



August 25, 2015

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Attention: Mr. Gaurav Vasisht, PE, PTOE
Project Manager

Subject: Foundation Investigation Report, US 50 West – Westbound Preliminary Design, Purcell Boulevard to Wills Boulevard, CDOT Project No. STA 0503-088 (20448), Task Order No.7, Pueblo County, Colorado, RockSol Project Number 302.02

Dear Mr. Vasisht:

RockSol Consulting Group, Inc. (RockSol) has performed a geotechnical investigation for the US 50 West Westbound Preliminary Design Project in Pueblo County, Colorado (See Figure 1, Site Vicinity Map). This Foundation Report presents geotechnical design parameters for foundation systems for the westbound (WB) US 50 bridge over Wildhorse Creek, culvert extension at Williams Creek and the drainage structure beneath Purcell Boulevard. This report also provides preliminary design parameters for foundation systems for a future US 50 bridge over Pueblo Boulevard as part of a future grade separation at the US 50 and Pueblo Boulevard intersection. A brief discussion of local geologic conditions and the subsurface conditions encountered are presented in this report. Also presented is a summary of the lab testing performed on recovered soil and bedrock samples recovered from the project site. RockSol has prepared, under separate cover, a Soil Investigation Report and a Pavement Design Report for this project.

RockSol performed a geotechnical evaluation for eastbound (EB) US 50 within the project limits in 2013. Results of the 2013 geotechnical evaluation are presented in the Foundation Investigation, Pavement Design, and Soil Investigation Reports dated July 31, 2014 (See References 1 through 3, listed at the end of this report).

Surface and groundwater hydrology, hydraulic engineering, and environmental studies including contaminant characterization were not included in RockSol's scope of work. RockSol understands that additional geotechnical investigations will be performed at a later time for the ultimate build out design phase of the US 50 West Corridor Improvements from Swallows Road to Baltimore Avenue.

Project Description

Project descriptions are based on information provided in the Colorado Department of Transportation (CDOT) *Scope of Work Task Order 7* Memorandum dated September 24, 2014, *U.S. 50 Westbound Wills to Purcell WB Realignment (20448)* plan sheets dated March 5, 2015 and April 8, 2015, provided by J.F.Sato and Associates (J.F. Sato) and discussions with JF Sato.

The purpose of Task Order No. 7 is to develop a conceptual level of design for the US 50 PEL Preferred Alternative between Wills Boulevard and Purcell Boulevard, including grade separation at Pueblo Boulevard and preliminary level design for the improvement projects identified in the US 50 PEL Preferred Alternative Implementation Plan. Based on the information provided in the *CDOT Scope of Work Task Order No. 7*, these improvements include:

- Widening WB US 50 from 2 to 3 lanes from Wills Boulevard to approximately 1,500 ft west of Purcell Boulevard.
- Realigning WB US 50 to be parallel to the eastbound lanes in the vicinity of Pueblo Blvd. (Approximately 3,000 feet to the east and west of Pueblo Boulevard).
- Modifying the existing EB and WB US50 and Pueblo Boulevard intersections.
- Widening Pueblo Boulevard south of US 50 to accommodate additional turn lanes.
- Modifying the intersections at US 50 and Purcell Boulevard and US 50 and Wills Boulevard.
- Constructing a WB US 50 acceleration lane between Wills Boulevard and the Burlington Northern Santa Fe (BNSF) railroad bridge.
- Replacing the existing WB US 50 bridge over Wild Horse Dry Creek.
- Adding a temporary connection lane between the new WB US 50 lanes and the existing US 50 WB lanes.
- Modifying the slope paving, adjacent to the WB US 50 lanes, at the BNSF underpass to accommodate the additional WB US 50 through lane.
- Extending the Williams Creek Box Culvert (CBC) under US 50 to accommodate US 50 widening.
- Analyzing the Williams Creek CBC under Pueblo Blvd with regards to future grade separation at the US 50 and Pueblo Boulevard intersection.
- Providing a bike/pedestrian trail between Wills Boulevard and Pueblo Boulevard.
- Providing pedestrian access along the west side of Purcell Boulevard between Haley Lane and Kimble Drive.
- Extending the CBC under Purcell Boulevard to accommodate the proposed bike/pedestrian trail as well as future widening of US 50.

The new WB US 50 bridge over Wild Horse Creek is proposed as a three span structure with approximate 60 foot to 70 foot span lengths and will be a multi-lane bridge approximately 60 feet in width. Construction for the new WB US 50 bridge over Wild Horse Creek will also include placement of approximately 2 feet to 8 feet of embankment fill material within the existing center median area to match the existing EB US 50 roadway elevation.

Existing Site Conditions

The current alignment of WB US 50 was the original route for both EB and WB US 50 until two new lanes were constructed for EB US 50 in the mid 1970's, diverging from WB US 50 approximately 3,000 feet to the east and west of Pueblo Boulevard. Undeveloped land and a mix of commercial and residential development borders the project area and includes a CDOT maintenance facility located near the northwest corner of WB US 50 and Pueblo Boulevard and a wastewater treatment plant located south of US 50, between Pueblo Boulevard and Purcell Boulevard.

Topography at the site generally consists of flat to mild slopes with a general trend of decreasing elevation toward Wild Horse Creek and Williams Creek. Moderate to steep bank slopes were noted along both Wild Horse Creek and Williams Creek. Low to moderate bank slopes were noted along the drainage south of US 50 at Purcell Boulevard. Low water flow conditions were noted within Wild Horse, Williams Creek and the drainage south of US 50 at Purcell Boulevard during our field work.

The existing Williams Creek CBC structure beneath Pueblo Boulevard is dual celled and approximately 21 feet in width and 320 feet in length with approximately 12 feet of embankment cover material above it. The existing CBC structure beneath Purcell Boulevard, located south of US 50, is a single cell CBC approximately 108 feet in length and 15 feet wide.

Geologic Conditions

The project area lies between the High Plains and the Colorado Piedmont, east of the eastern foothills of the Front Range of the Southern Rocky Mountains. The eastern project site limit is located approximately two miles west of the geologic floodplain of the Arkansas River. The western project site limit is located approximately twelve miles east of the Front Range foothills. Based on the 1964 USGS *Geology Map of the Northwest and Northeast Pueblo Quadrangles, Colorado* by Glenn R. Scott (See Figure 2, Site Geology Map), the site is underlain by surficial soils and sedimentary bedrock.

The surficial soils encountered and mapped within the project generally consist of sandy clay and silty to clayey sand fill material with gravel associated with US 50 roadway construction and native soils consisting of Piney Creek Alluvium (Qp), Slocum Alluvium (Qs), Broadway Alluvium (Qb) deposits of generally consisting of silt, clay and sand with pebbles and limestone fragments, gravel and cobbles in parts. Colluvium (Qc) deposits are also mapped within the project limits and generally consist of silt and clay with pebbles and blocks of limestone and sandstone in parts. The surficial soils at the project comprise a relatively thin cover, typically less than 20 feet, over bedrock.

Bedrock of the Pierre Shale (Kpt) Formation and the seven members of the Niobrara (Ksus, Ksuc, Ksmc, Ksll, Ksls, Kssl, and Kf) Formation (both formations are Upper Cretaceous in age) are mapped at or near the surface within portions of the project limits. The Pierre Shale Formation generally consists of shale, siltstone sandstone and claystone and appears to be located near the eastern limits of the project. The Niobrara Formation generally consists of silty to chalky shale and chalky to fossiliferous limestone and appears to be under the majority of the project. Bentonite lenses within the bedrock formations have potential for swelling which can pose a risk to structures, roadways and utilities.

The sedimentary bedrock contained calcareous and/or gypsum minerals/crystals in parts. A slight hydrocarbon odor was also noted within the shale bedrock during RockSol's 2013 drilling operations/investigation. This odor is believed to be from a naturally occurring process associated with the organic content of the shale, primarily comprised of marine organisms, algae, and plant material deposited millions of years ago in an inland seaway.

Subsurface Investigation

RockSol drilled 18 boreholes to evaluate the subsurface conditions for the US 50 West – Westbound Preliminary Design, Purcell Boulevard to Wills Boulevard Improvements Project. The borehole locations are identified as BR-1, BR-2, CBC-1, CBC-2, WC-1, WC-2 and PV-1 through PV-12, as shown on Figures 3A through 3G, Borehole Location Plans. RockSol also obtained four pavement cores at borehole locations PV-3, PV-5, PV-10, and PV-11. The boreholes drilled for RockSol's 2013 investigation are also shown on the Borehole Location Plans.

Boreholes BR-1 and BR-2 were drilled at the approximate location of a future grade separation at the US 50 and Pueblo Boulevard intersection. Boreholes WC-1 and WC-2 were drilled at the approximate location of the proposed culvert extension at Williams Creek for the future widening of Pueblo Boulevard, between the current alignment of westbound and eastbound US 50. Boreholes CBC-1 and CBC-2 were drilled to assist with the proposed extension of the CBC under Purcell Boulevard to accommodate a proposed bike/pedestrian trail as well as future widening of US 50. Boreholes PV-1 through PV-12 were drilled to assist with pavement thickness recommendations for westbound US 50 and a temporary connection lane between the new westbound US 50 lanes and the existing US 50 westbound lanes. After drilling operations, the boreholes were located by field survey provided by CDOT. Horizontal and

vertical locations were then provided to RockSol for inclusion on the Borehole Location Plan and on the borehole logs.

A truck mounted CME-45 drill rig was used for drilling and sampling. The boreholes were advanced using 4-inch and 6-inch outside diameter solid stem augers to maximum depths ranging from approximately 5 feet to 30 feet below existing grades. The boreholes were logged in the field by a representative of RockSol then backfilled at the completion of drilling and groundwater level checks. Boreholes drilled within existing pavement were patched with an asphalt patch mix.

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 1 $\frac{3}{8}$ -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 an automatic lift system with 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.

Laboratory Testing

Soil samples retrieved from the borehole locations were examined by the project geotechnical engineer in the RockSol laboratory. Selected samples were tested and classified according to the Unified Soil Classification System (USCS). The following laboratory tests were performed in accordance with the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), and current local practices:

- Natural Moisture Content (ASTM D-2216)
- Percent Passing No. 200 Sieve (ASTM D-1140)
- Liquid and Plastic Limits (ASTM D-4318)
- Dry Density (ASTM D-2937)
- Gradation (ASTM D6913)
- Water Soluble Sulfates (CDOT CP-L 2103)
- Soil Classification (ASTM D-2487, ASTM D-2488, and AASHTO M145)
- Swell Test (ASTM D-4546)
- Water Soluble Chloride Content (AASHTO T291-91)

- Standard Test Method for pH of Soils (ASTM D4972-01 and AASHTO T289)
- Soil Resistivity (ASTM G187 - Soil Box)
- Resistance Value (CP-L 3101)

Resistance Value (R-Value) tests were performed by Cesare, Inc. Water Soluble Chloride Ion Content tests were performed by Colorado Analytical Laboratories. All other laboratory tests were performed by RockSol. Laboratory test results are presented in Appendix B and are also summarized on the Borehole Logs presented in Appendix A.

Surface and Subsurface Conditions

Flexible hot mix asphalt (HMA) or topsoil was encountered at the ground surface at the borehole locations. The HMA pavement thickness varied from approximately 6 inches to 11 inches within the lane, shoulder, and center median areas of WB US 50. The topsoil encountered was generally lightly organic silty to clayey sand and sandy clay which supported a sparse covering of grasses and weeds. A topsoil thickness of approximately 6 inches was estimated based on field observations. Beneath the pavement and topsoil, subsurface conditions encountered generally consisted of fill material, native soils, and sedimentary bedrock.

Fill material was encountered in eleven of the boreholes to approximate depths ranging from 2.5 feet to 13 feet below existing grades. The fill material is associated with roadway embankment and culvert backfill for the construction of US 50 and Purcell Boulevard. The fill material encountered generally consisted of loose to dense silty to clayey sand with gravel and sandy clay (reworked shale) in parts, medium stiff to very stiff sandy clay with gravel in parts, and medium dense slightly silty to gravelly sand.

Native soils encountered below the fill material or ground surface generally included medium stiff to very stiff sandy clay with silty to clayey sand and gravel in parts, loose to dense silty to clayey sand and gravelly sand. The native soils extended to depths ranging from 3 feet 18 feet below existing grades. The majority of the fill and native soils tested were classified as sandy clay and clayey sand soils (AASHTO A-6) with an average Plasticity Index of 14. AASHTO A-2-4, A-2-6, and A-4 soils were also encountered within the project limits.

Sedimentary bedrock was encountered beneath the fill material and native soils at depths varying from approximately 3 feet to 18 feet below existing grades. Sedimentary bedrock consisting of hard to very hard claystone, sandstone and shale was encountered in Boreholes BR-1, BR-2, WC-1 and WC-2 (US 50 and Pueblo Boulevard) at elevations ranging from 4,800 feet to 4,824 feet (approximate depths ranging from 3 feet to 18 feet below existing grades) during drilling operations.

The bedrock generally consisted of very hard silty to clayey shale. Very hard shale was also encountered in Boreholes CBC-1 and CBC-2 (Purcell Boulevard and US 50) at an approximate elevation of 4,968 feet (approximate depths of 8 feet and 12 feet below existing grades). Sedimentary bedrock consisting of very hard claystone and shale was also encountered in Boreholes PV-2, PV-7, PV-8, and PV-10 at elevations of 4,784 feet to 4,957 feet (approximate depths of 3 feet to 9 feet below existing grades) between Purcell Boulevard and Wills Boulevard along the existing and proposed westbound US 50 alignment.

Groundwater was encountered in four of the boreholes at elevations ranging from 4,804 feet to 4,971 feet (approximate depths ranging from 7 feet to 23 feet below existing grades) and is perched above the shale and claystone bedrock. Groundwater generally appears to be at an elevation consistent with the water elevations of Williams Creek and the drainage at the Purcell Boulevard CBC structure. However, it should be noted that groundwater elevations are subject

to change depending on climatic conditions, stream stages, local irrigation practices, changes in local topography, and changes in surface storm water management.

A summary of the bedrock and groundwater elevations encountered in RockSol's 2015 evaluation is presented in Table 1. In addition, a summary of the bedrock and groundwater elevations encountered in RockSol's 2013 evaluation is presented in References 1 through 3. 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 and the ground surface elevations provided by the project surveyor.

Table 1 – Approximate Groundwater and Bedrock Elevations

Borehole	Ground Elevation (feet)	Groundwater Elevation (feet)	Bedrock Elevation (feet)
BR-1	4,827	4,804	4,824
BR-2	4,827	NE	4,824
CBC-1	4,980	4,971	4,968
CBC-2	4,976	4,969	4,968
PV-2	4,965	NE	4,957
PV-7	4,864	NE	4,861
PV-8	4,834	NE	4,825
PV-10	4,792	NE	4,784
WC-1	4,823	4,806	4,805
WC-2	4,814	NE	4,800

Note: NE indicates not encountered.

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

Cement Type Discussion

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

Table 2 - 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 average concentration of water soluble sulfates measured in 21 soil samples obtained from RockSol's exploratory boreholes was 0.39 percent by weight. The water soluble sulfate concentrations ranged from 0.00 percent by weight to 1.72 percent by weight. Only one test result exceeded 1 percent (1.72 percent at Borehole PV-10). Based on the results of the water soluble sulfate testing, Exposure Class 2 is considered appropriate for concrete in contact with subgrade materials for this project. Additional testing is recommended for future phases of the ultimate design. Based on the water soluble sulfate test results, stabilization of subgrade soils through the use of lime, cement, or calcium-rich flyash is discouraged.

Culvert Extensions

Concrete box culvert (CBC) extensions are proposed at the upstream and downstream ends of the existing culvert structures along the Williams Creek drainage beneath Pueblo Boulevard, between EB and WB US 50 and the CBC structure located beneath Purcell Boulevard, south of US 50.

Based on information provided, the proposed culvert extension at Purcell Boulevard will consist of a one-cell structure matching the existing CBC and will be approximately 25 feet in length on the west side of Purcell Boulevard and approximately 12 feet in length on the east side of Purcell Boulevard with wing wall lengths of approximately 20 feet at both the west and east sides. The estimated bottom elevation of the new CBC extension is 4,970 feet at the inlet (west side) and 4,968 feet at the outlet (east side). RockSol Boreholes CBC-1 and CBC-2 were drilled near the proposed CBC extension structure beneath Purcell Boulevard with CBC-1 located on the west side and CBC-2 located on the east side of Purcell Boulevard.

Based on conditions encountered, it appears that stream channel is cutting into the shale bedrock formation at this location. Excavations away from the stream channel will likely encounter roadway embankment material and shale bedrock at shallow depths. Excavations within the existing stream channel will encounter alluvial deposits consisting of silty to clayey sand and sandy clay to depths up to 2 feet. Groundwater is anticipated within the CBC location at depths at and below the surface elevation of water within and extending to the shale bedrock. Groundwater was encountered at an approximate elevation of 4,969 feet at the east side of Purcell and 4,970 feet at the west side of Purcell. Shale bedrock was encountered at an approximate elevation of 4,968 feet on both the east and west sides of Purcell Boulevard.

The proposed Williams Creek culvert extension at Pueblo Boulevard will consist of a two-cell structure matching the existing CBC and will be approximately 10 feet to 20 feet in length with a 5 foot drop inlet and wing wall lengths of approximately 28 feet, at both the west and east sides. The estimated bottom elevation of the new CBC extension is 4,815 feet at the inlet (west side) and 4,807 feet at the outlet (east side). RockSol Boreholes WC-1 and WC-2 were drilled near the proposed CBC extension structure beneath Pueblo Boulevard with WC-1 located on the west side and WC-2 located on the east side of Pueblo Boulevard.

Based on conditions encountered, it appears that Williams Creek is cutting into claystone bedrock on the west side of Pueblo Boulevard and the shale bedrock formation on the east side of Pueblo Boulevard. Excavations away from the stream channel will likely encounter embankment fill material, claystone bedrock and shale bedrock at shallow depths. Excavations within the existing stream channel and adjacent stream banks may encounter alluvial silty to clayey sand, sandy clay, and sandy gravel to depths up to 2 to 5 feet. Groundwater is anticipated within the CBC location at depths at and below the surface elevation of water within Williams Creek and extending to the claystone and shale bedrock. Groundwater was encountered at an approximate elevation of 4,806 feet within Borehole WC-1. Claystone bedrock was encountered at an approximate elevation of 4,805 feet in Borehole WC-1 and shale bedrock was encountered at an approximate elevation of 4,800 feet in Borehole WC-2.

Swell risk appears low at both locations; however, due to the presence of flowing surface water within the stream channel, the potential for unstable subgrade conditions is anticipated at the time of construction. Replacement of subgrade soils to a minimum depth of 2 feet below the bottom of the CBC or to competent bedrock with properly compacted Colorado Department of Transportation (CDOT) Class 1 structural backfill is recommended. The intent of the replacement fill is to provide a uniform bearing surface and stable construction working platform. During construction alternative methods of stabilization (i.e. geotextile material) may also be considered based on the conditions encountered. Control of water flows will be required during construction of the CBC extension.

For the proposed CBC extensions at Purcell Boulevard and Pueblo Boulevard, an allowable bearing capacity of 4.0 ksf, after replacement of existing subgrade soils, is considered appropriate for design. A vertical modulus of subgrade reaction of 125 pci is also considered appropriate for design of the box culvert after replacing the existing subgrade soil with structural fill.

Based on subsurface conditions encountered by RockSol, materials encountered in the excavation for the Pueblo Boulevard and Purcell Boulevard CBC extensions are anticipated to be OSHA Type C soils (max slope of 1½H:1V). This information is provided for general information only and the contractor is responsible for providing a “competent person” to determine the appropriate soil type during excavation.

Vertical Earth Loads and Lateral Earth Pressures

Vertical earth loads and lateral earth pressures imposed on the CBC structures will be affected by whether the backfill condition is a trench condition or an embankment condition. Modification of vertical earth loads to address embankment and trench conditions is presented in the AASHTO LRFD Bridge Design Specifications, 2014, Section 12.11.2.2. Lateral earth pressures will also be influenced by the width of the backfill zone adjacent to the CBC walls. For narrow backfill zones, lateral earth pressures will be influenced by the native soils. For relatively wide backfill zones, lateral earth pressures will be influenced by the backfill soils. RockSol recommends the use of CDOT Class 1 Structure backfill material for backfill of the CBC extensions, including the wingwalls. RockSol considers the CBC extensions to be an embankment condition.

Vertical Earth Load Parameters

Vertical earth loads will be applied from soil placed above the CBC extension structures. RockSol recommends placement of CDOT Structure Backfill (Class 1) material adjacent to and above the structures. Where possible, a minimum of 1 foot of Structure Backfill (Class 1) material should be placed over the top of the CBC structures. Above the Structure Backfill (Class 1) material, roadway embankment material may be placed. For preliminary design, an unfactored earth load of 130 pounds per cubic foot (pcf) is recommended as a minimum value. Where minimal soil cover is provided, the CBC shall be designed to support all vertical loads applied.

Lateral Earth Pressure Parameters (CBC and Wingwalls)

Lateral earth pressures will occur from backfill soils adjacent to the sides of the CBC structures and behind the wingwalls. To assist with design, lateral earth pressure parameters are presented in Table 3 for CDOT Class 1 Structure backfill material.

Table 3 – Lateral Earth Pressure Parameters

Soil Type	Total Unit Weight (γ) pcf	Effective Friction Angle, φ' (degrees)	Cohesion (psf)	Lateral Earth Pressure Coefficients (Notes 1 and 2)		
				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

Note 1: Based on Rankine Theory of earth pressure

Note 2: For horizontal backslope and foreslope.

Note 3: Full value, no reduction applied.

Use of “at-rest” earth pressure is recommended for structural walls which are restrained from movement. Use of “active” earth pressure is recommended for structural walls which are not restrained and can tolerate movement. The lateral earth pressure parameters do not include hydrostatic pressure from water build-up behind the wall which must be superimposed to calculate loads unless a “behind the wall” drainage system is included. The lateral earth pressure parameters in Table 3 do not include surcharge loadings such as traffic, construction equipment or fill stockpiles. The lateral earth pressure coefficient values provided in this report assume light weight hand operated compaction equipment will be used to compact backfill adjacent to the CBC structures.

CBC Structure Backfill Recommendations

RockSol recommends backfill of the CBC structures meet the requirements for CDOT Structure Backfill (Class 1) as indicated in Section 206 of the CDOT Standard Specifications for Road and Bridge Construction. Structure Backfill (Class 1) shall be compacted to a density not less than 95 percent of maximum dry density determined by AASHTO T180. Roadway embankment placed above the structure fill material shall be compacted to the requirements indicated in Section 203.07 of the CDOT Standard Specifications for Road and Bridge Construction.

Previous Evaluations

Improvements for this task order also include replacing the existing westbound US 50 bridge over Wild Horse Dry Creek and extending the Williams Creek CBC under the proposed westbound US 50 to accommodate US 50 widening. Geotechnical foundation recommendations for the new US 50 Westbound bridge over Wild Horse Dry Creek and the CBC extension were provided in RockSol's 2014 Foundation Investigation Report (See Reference 1). Engineering Geology Sheets are included in this report (See Figures 5 and 6) for the proposed westbound bridge and CBC structures.

Preliminary Foundation Recommendations (US 50/Pueblo Boulevard Grade Separation)

The sedimentary bedrock encountered in Boreholes BR-1 and BR-2 is considered suitable bearing material for supporting heavily loaded structures such as bridges. Drilled shafts or driven piles embedded into bedrock are considered feasible foundation systems for bridge piers as well as bridge abutments. Spread footings bearing on, or within, the bedrock are also considered a feasible foundation option. RockSol understands that additional geotechnical investigations will be performed at a later time when additional design for the future US 50 and Pueblo Boulevard grade separation is completed.

For preliminary design purposes, ultimate (unfactored) base resistance and side resistance values for the bedrock material are presented below in Table 4 for the future US 50 and Pueblo Boulevard grade separation structure. Alternatively, the future structure may be supported on driven steel H-piles (Grade 50 steel). RockSol recommends the piles be driven to practical refusal in the bedrock. For the LRFD method, a nominal (ultimate) geotechnical capacity of 40 ksi, based on the cross section area of the pile, can be used for Grade 50 steel for preliminary design purposes.

**Table 4 – Preliminary Base and Side Resistance Values for Drilled Shafts in Bedrock
 Future US 50 and Pueblo Boulevard Grade Separation**

US 50 and Pueblo Boulevard	Estimated Bedrock Elevation (feet)	Preliminary Ultimate Resistance		Preliminary Bearing Resistance at Service Limit State	
		Base Resistance (ksf)	Side Resistance (ksf)	Base Resistance (ksf)	Side Resistance (ksf)
Boreholes BR-1 and BR-2	4,824 (sandstone and claystone)	92	7.5	31	2.5
	4,804 (shale)	184	15	62	5.0

Hard to very hard sandstone and claystone bedrock was encountered at an approximate elevation of 4,824 feet. Very hard cemented shale bedrock was encountered at an approximate elevation of 4,804 feet. If penetration into the shale bedrock is necessary for design requirements, pre-drilling into the shale bedrock is recommended.

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 Borehole BR-1 at an approximate elevation of 4,804 feet. The bedrock described in this report is considered shale as described in SSRBC Section 503.07. Special provisions should be specified for drilling operations and equipment where hard bedrock and or difficult subsurface conditions exist.

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. 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.

Claystone and shale materials are not recommended for construction of permanent fill slopes steeper than 4 horizontal (H) to 1 vertical (V).

Material Specifications

The following material specifications are presented for earthwork on the project. The project 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 40.
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, BR-2, CBC-1, CBC-2, WC-1 and WC-2 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 project 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. To determine if Site Class C or Site Class B conditions are present at the proposed structure locations, shear wave velocity testing and/or performing penetration tests to a depth of 100 feet would be necessary.

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 5:

Table 5 – Seismic Acceleration Coefficients

Project 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)
US 50 and Pueblo Blvd (38.315°/-104.661°)	0.052	0.115	0.036
US 50 and Purcell Blvd (38.323°/-104.702°)	0.053	0.116	

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 6.

Table 6 – Seismic Site Factor Values

Project 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)
US 50 and Purcell Blvd	1.6	1.6	2.4
US 50 and Pueblo Blvd			

Table 7 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 6 and 5, 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 7. The value of F_{pga} is presented in Table 6 and the value of PGA is presented in Table 5.

Table 7 – Seismic Performance Zone

Project Location	Acceleration Coefficient (S_{D1})	Seismic Zone ^(Note 1)	Acceleration Coefficient, A_s
US 50 and Purcell Blvd	0.086	1	0.083
US 50 and Pueblo Blvd			0.085

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

Limitations

This geotechnical investigation was conducted in general accordance with the scope of work. This report has been prepared for use by JF Sato 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. 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

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

Attachments:

- Figure 1 - Site Vicinity Map
- Figure 2 – Site Geology Map
- Figure 3 – Borehole Location Figure Index
- Figures 3A through 3G – Borehole Location Plans
- Figure 4 – Engineering Geology Sheet (Purcell CBC)
- Figure 5 – Engineering Geology Sheet (Williams Creek CBC)
- Figure 6 – Engineering Geology Sheet (Wild Horse Dry Creek Bridge)

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

References:

- (1) *Foundation Investigation Report, US 50 Preliminary Design, Purcell Boulevard to Wills Boulevard, CDOT Project No. STA 050A-022 (Project Code 19056), Task Order No.4, Construction Project No. FSA 0503-081 (Project Code 19751), Pueblo County, Colorado, RockSol Project Number 302.01, dated July 31, 2014*
- (2) *Pavement Design Report, US 50 Preliminary Design, Purcell Boulevard to Wills Boulevard, CDOT Project No. STA 050A-022 (Project Code 19056), Task Order No.4, Construction Project No. FSA 0503-081 (Project Code 19751), Pueblo County, Colorado, RockSol Project Number 302.01, dated July 31, 2014*
- (3) *Soil Investigation Report, US 50 Preliminary Design, Purcell Boulevard to Wills Boulevard, CDOT Project No. STA 050A-022 (Project Code 19056), Task Order No.4, Construction Project No. FSA 0503-081 (Project Code 19751), Pueblo County, Colorado, RockSol Project Number 302.01*



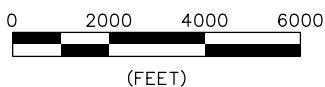
IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY, NORTHWEST PUEBLO, COLORADO QUADRANGLE, 2010

Print Date: 7/28/2015
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**US 50 WEST
 PURCELL BLVD. TO WILLIS BLVD.
 SITE VICINITY MAP**

Project No./Code

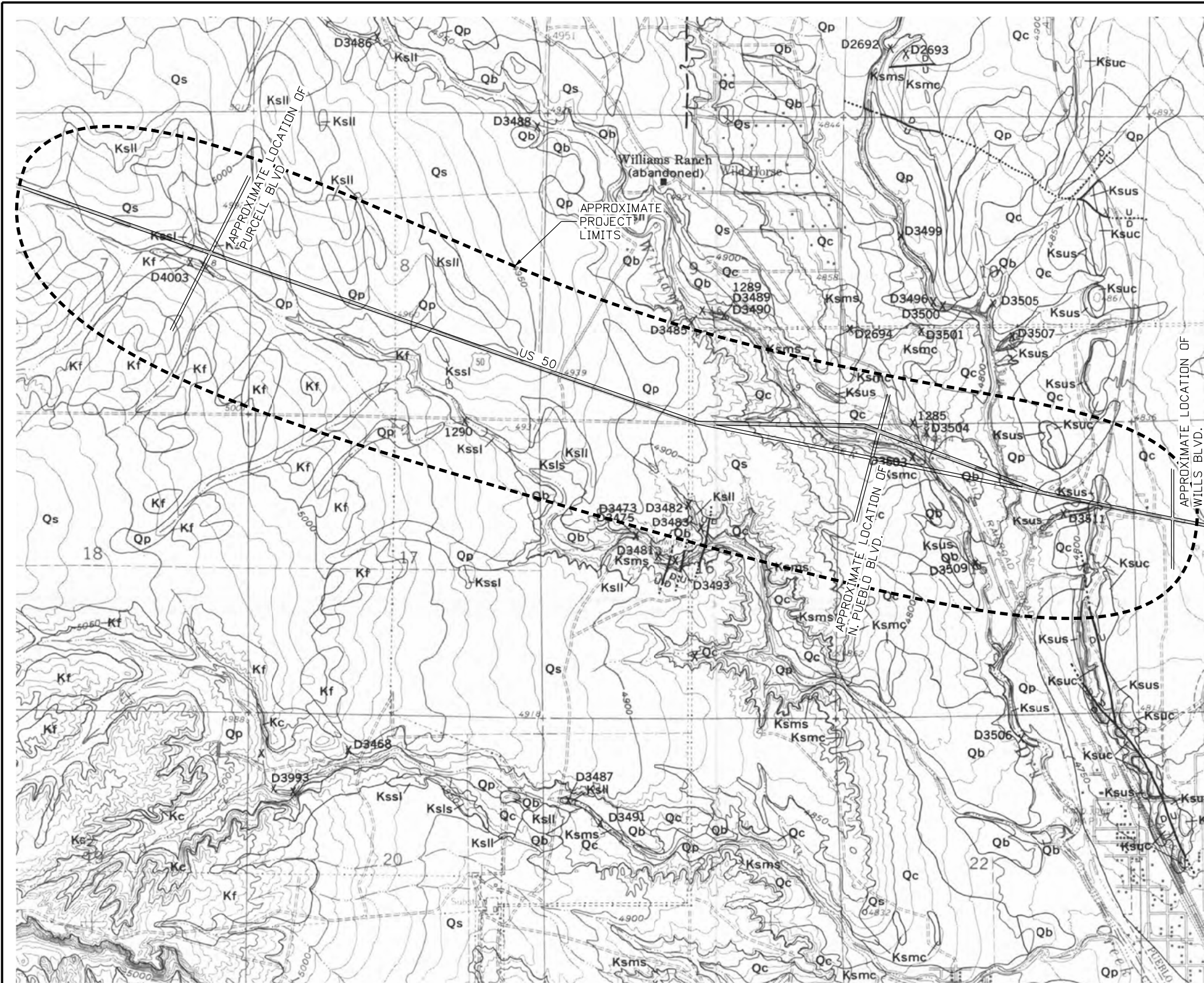
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 Detailer: D. Knight
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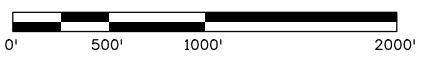
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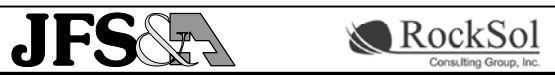
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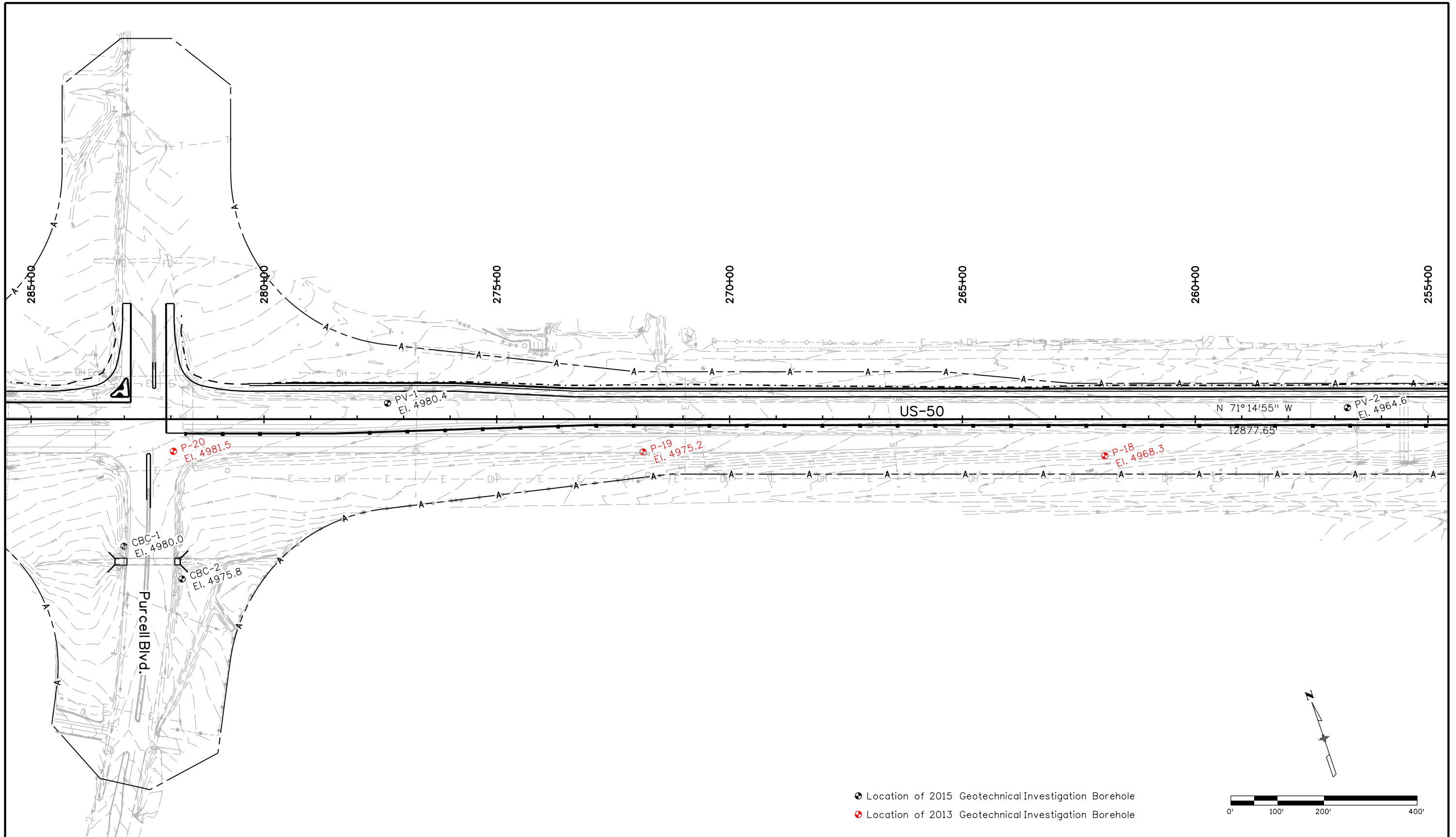
af	Artificial fill Reworked gray silt and clay, concrete waste, and rubbish	Kqtb	Pierre Shale
Qpp Qpp1	Post-Piney Creek alluvium Yellowish-gray poorly sorted cobbles, pebbles, sand, and silt forming floodplain and lowest terrace deposits along major streams. Generally less than 10 feet thick. Surface lies 0-10 feet above modern streams. Qpp1 indicates terrace deposit intermediate between Piney Creek Alluvium and post-Piney Creek alluvium.	Kpr	Kqtb, Tupper zone of Gilbert (1897).
Qc	Colluvium Yellowish-gray silt and clay containing pebbles, angular blocks of limestone, and sandstone derived from underlying bedrock and surficial deposits. Locally includes small increments of older colluvium	Kps	Kpr, Basal zone of Gilbert (1897).
Qp	Piney Creek Alluvium Yellowish-gray silt and clay along most valleys in area. Contains lenses of sand and pebbles in lower part. Locally 15 feet thick. Surface lies about 20 feet above modern streams	Kpa	Kps, Sharon Springs Member.
Qes	Eolian sand Yellowish-brown fine to coarse sand in rounded knolls east of Fountain Creek and north of the Arkansas River. Locally stony where mixed with colluvium. Locally more than 20 feet thick. Calcium carbonate-enriched early Recent Brown soil moderately developed in upper part of sand	Kpb	Kpa, Apache Creek Sandstone Member.
Qb Qba	Broadway Alluvium About 10-25 feet thick. Surface lies about 10 feet above modern streams. Qb, grayish-brown coarse sand along Fountain Creek; yellowish-gray calcareous silt containing pieces of limestone along Dry and other creeks. Qba, coarse cobble gravel along Arkansas River	Kpt	Kpb, transition member
Ql Qla Qla1	Louviere Alluvium About 20 feet thick. Surface lies 70-80 feet above modern streams. Calcium carbonate-enriched Wisconsin Brown soil strongly developed in upper part of alluvium. Ql, calcareous silt containing small pieces of limestone deposited by local streams; yellowish-brown coarse pebbly sand along Fountain Creek. Qla, yellowish-brown coarse cobble gravel of Arkansas River origin. Qla1, gravel of Arkansas River origin overlain by calcareous silt of local origin	Ksuc	Pierre Shale
Qs Qsa Qsa1	Shoem Alluvium About 25 feet thick. Surface lies 110-120 feet above modern streams. Calcium carbonate-enriched pre-Wisconsin Brown soil very strongly developed in upper part of alluvium. Qs, calcareous silt containing small pieces of limestone deposited by local streams. Qsa, yellowish-brown coarse cobble gravel of Arkansas River origin. Qsa1, gravel of Arkansas River origin overlain by calcareous silt of local origin	Ksus	Ksuc, upper cherty shale unit.
Qv	Verde Alluvium Grayish-brown calcareous coarse sand or calcareous silt with small pieces of limestone on pediments. Present only in northeast corner of map. About 20 feet thick. Surface lies 200-220 feet above modern streams.	Ksmc	Ksus, middle cherty unit.
Qr	Rocky Flats Alluvium Grayish-brown silty pebble gravel along east side of Escalante Mesa. Thickness as much as 100 feet. Surface lies 250-300 feet above modern streams	Kams	Kams, middle shale unit.
Qn	Nunahum Alluvium Moderate yellowish-brown well sorted pebble gravel on Escalante Mesa. Thickness as much as 100 feet. Surface lies 250-300 feet above modern streams	Kall	Kall, lower limestone unit.
		Kals	Kals, lower shale unit.
		Kssl	Kssl, shale and limestone unit.
		Kf	Kf, Fort Huys Limestone Member.



GEOLOGY MAP COMPILED FROM THE USGS GEOLOGY OF THE NORTHWEST AND NORTHEAST PUEBLO QUADRANGLES, COLORADO BY GLENN R. SCOTT, DATED 1964 AND MODIFIED BY ROCKSOL

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Location of 2015 Geotechnical Investigation Borehole
 Location of 2013 Geotechnical Investigation Borehole

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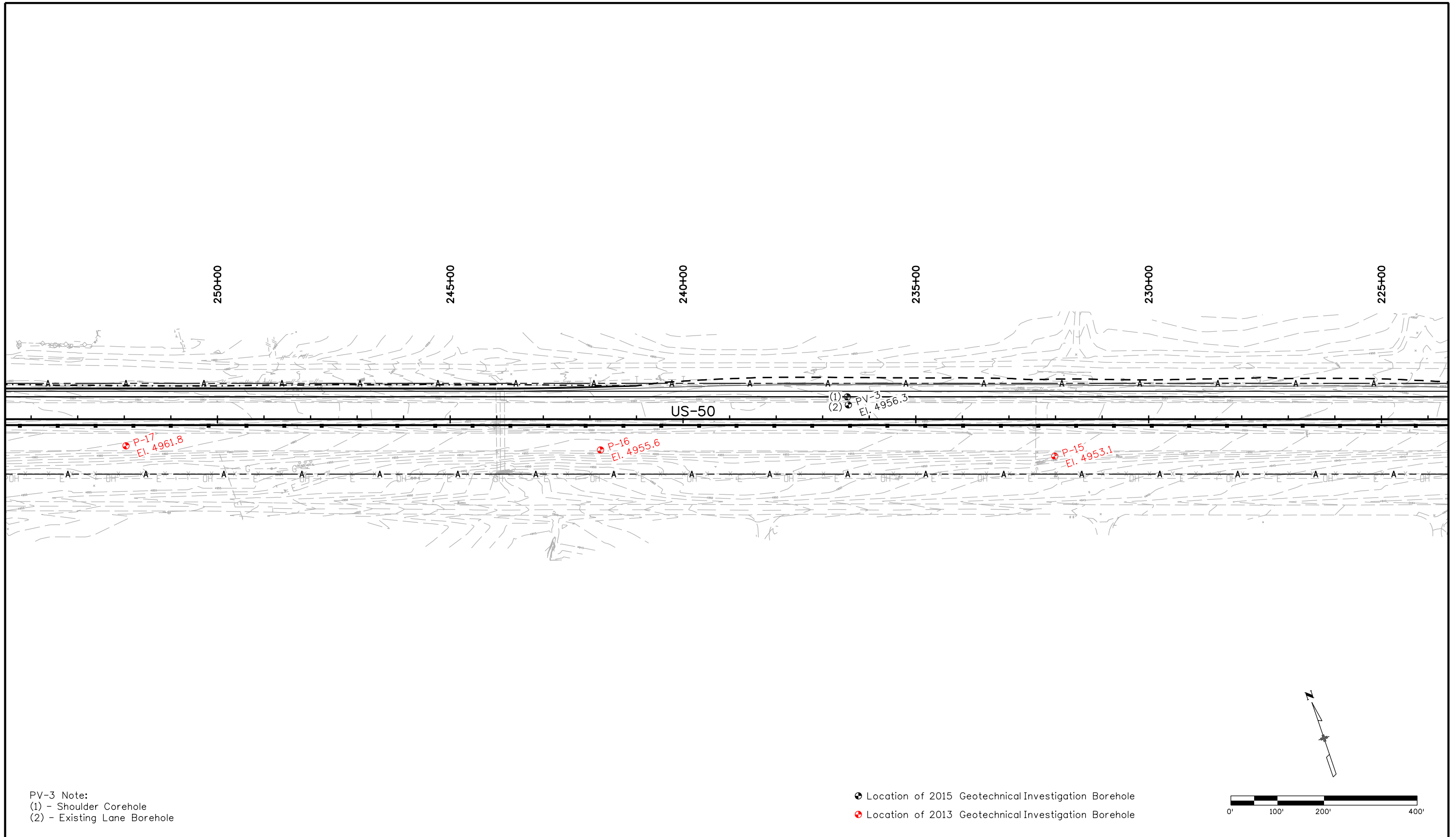
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**US 50 WEST
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 BOREHOLE LOCATION PLAN (1 OF 7)**
 Designer: R. Lepro
 Detailer: D. Knight
 Subset: Geotech

Project No./Code
 STA 0503-088
 20448
 Figure **3A**
 Subset Sheets: 2 of 11

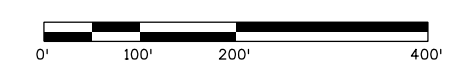
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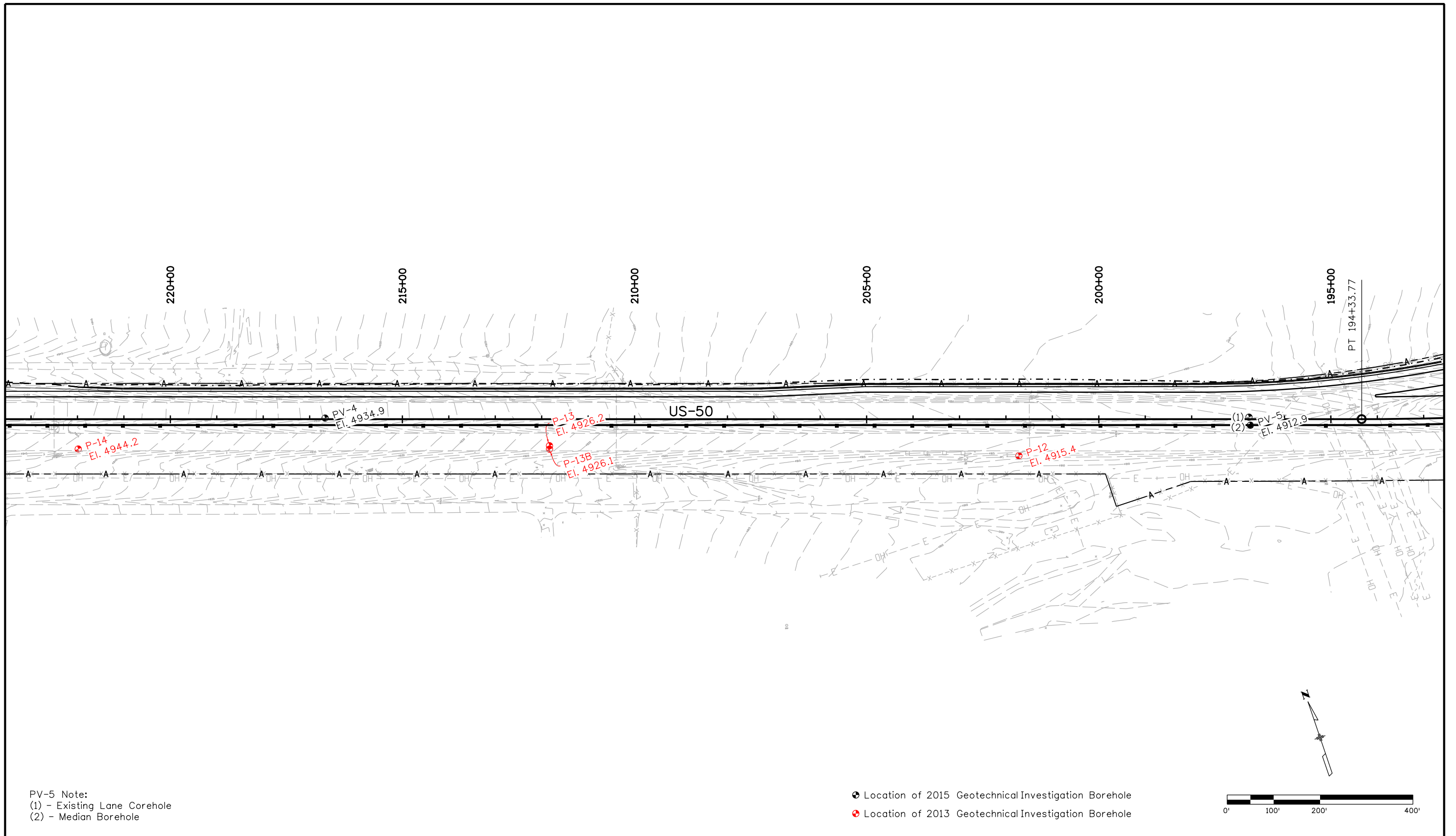


PV-3 Note:
 (1) - Shoulder Corehole
 (2) - Existing Lane Borehole

① Location of 2015 Geotechnical Investigation Borehole
 ● Location of 2013 Geotechnical Investigation Borehole



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Figure 3B																																										



PV-5 Note:
 (1) - Existing Lane Corehole
 (2) - Median Borehole

● Location of 2015 Geotechnical Investigation Borehole
 ● Location of 2013 Geotechnical Investigation Borehole

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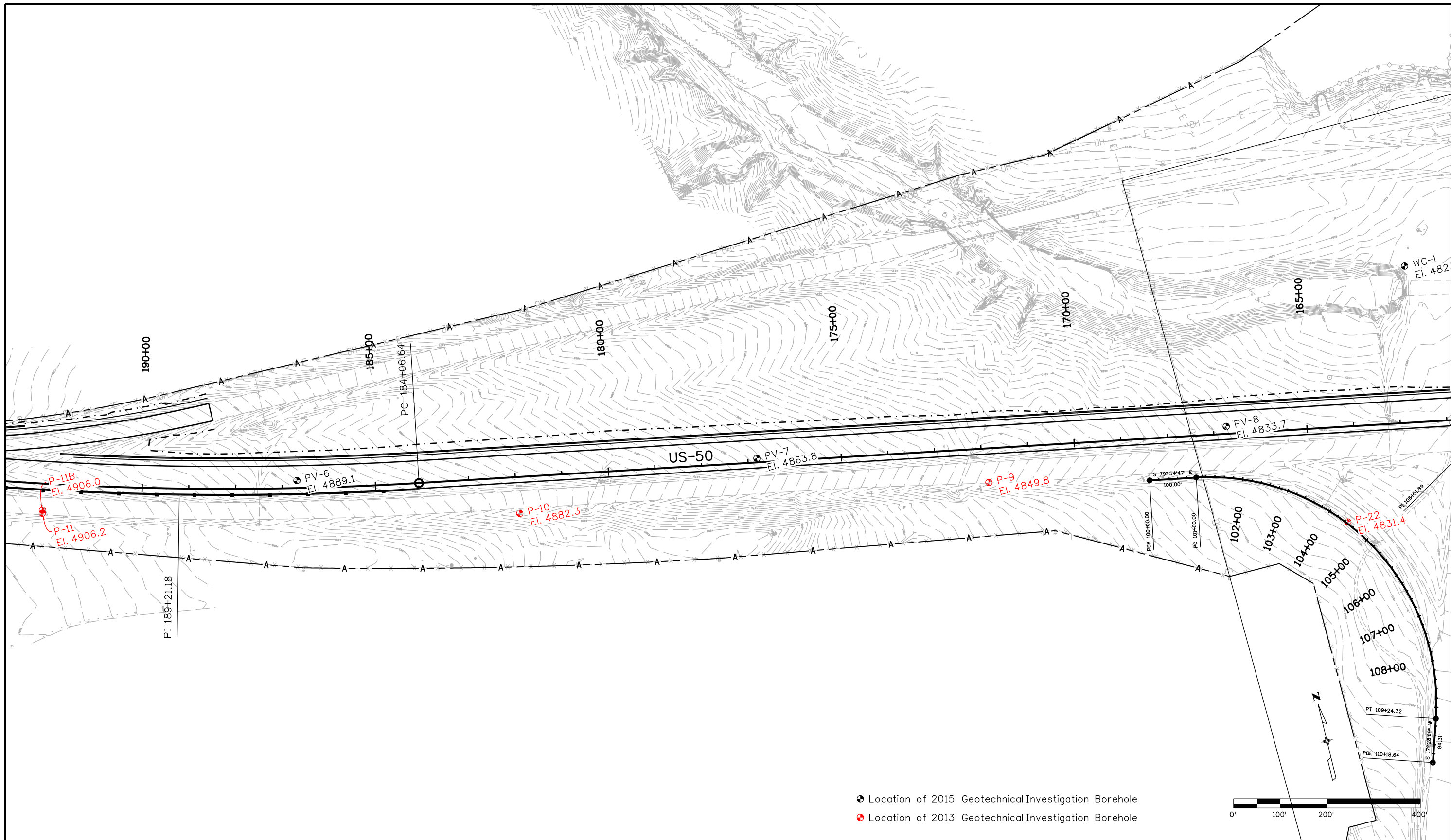
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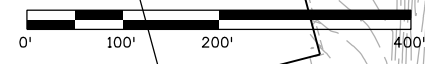
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Project No./Code
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● Location of 2015 Geotechnical Investigation Borehole
 ● Location of 2013 Geotechnical Investigation Borehole



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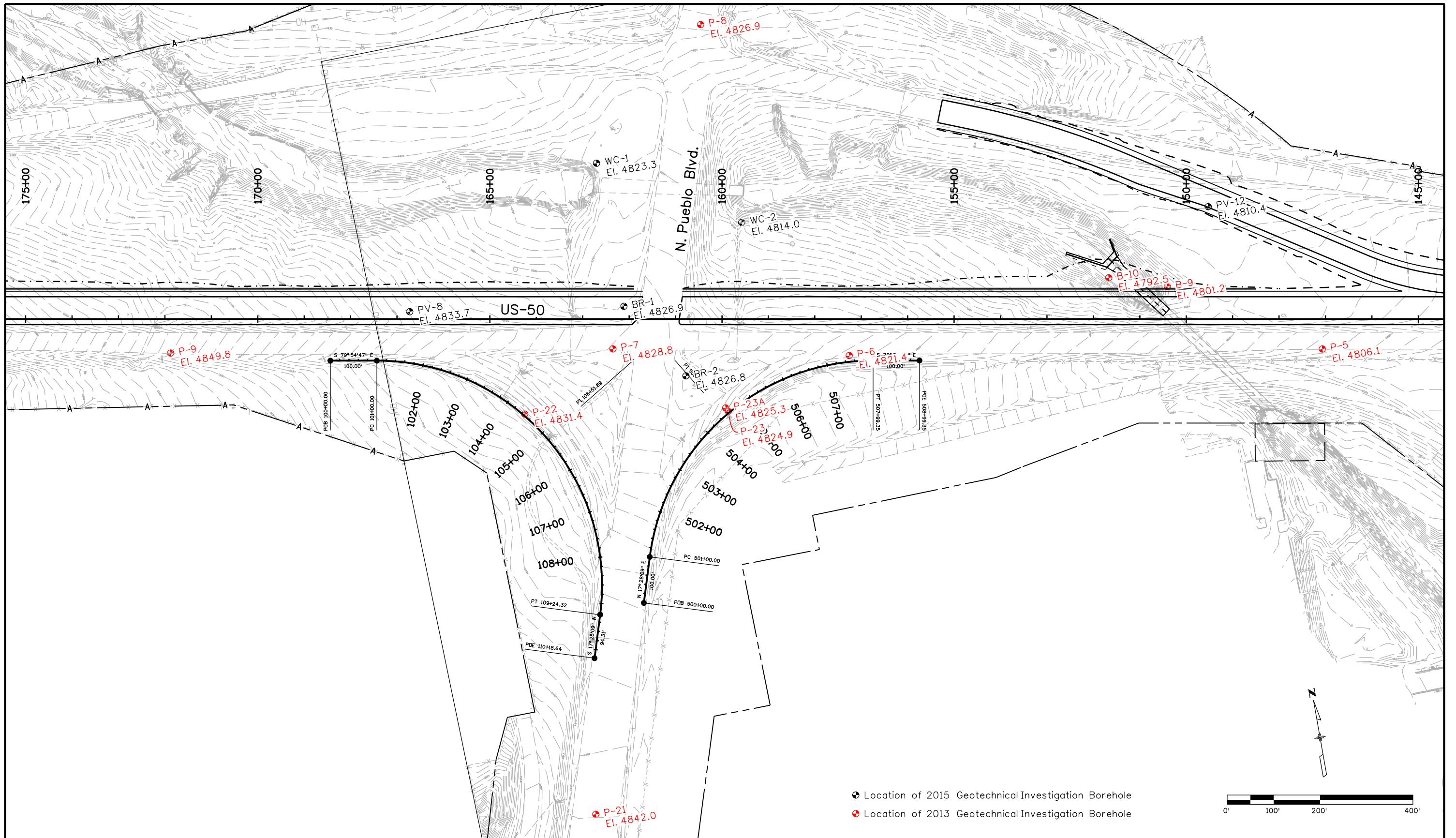
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 Detailer: D. Knight
 Subset: Geotech

Project No./Code
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 Figure 3D



Structure Numbers
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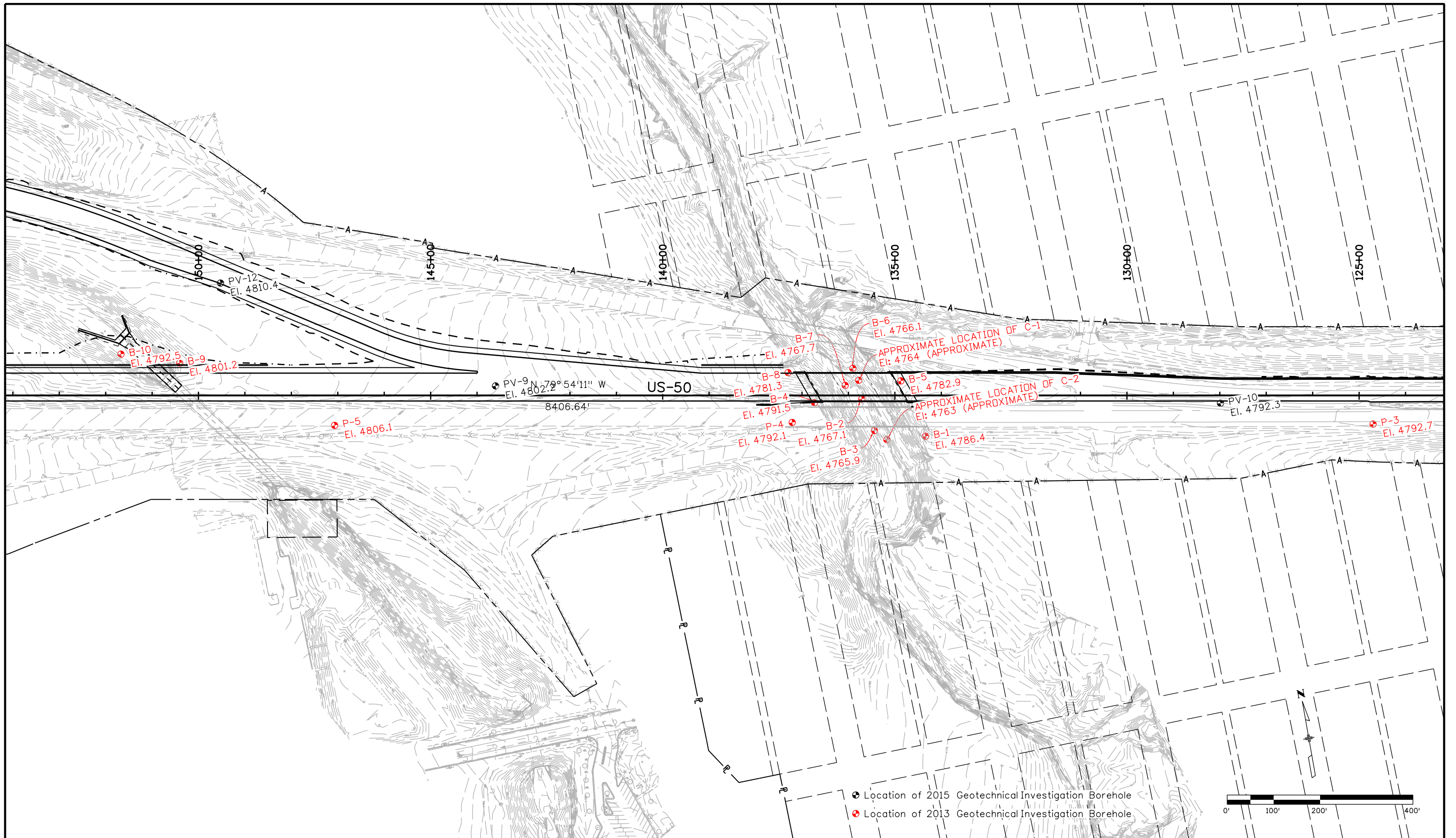
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 Detailer: D. Knight
 Subset: Geotech

Structure Numbers
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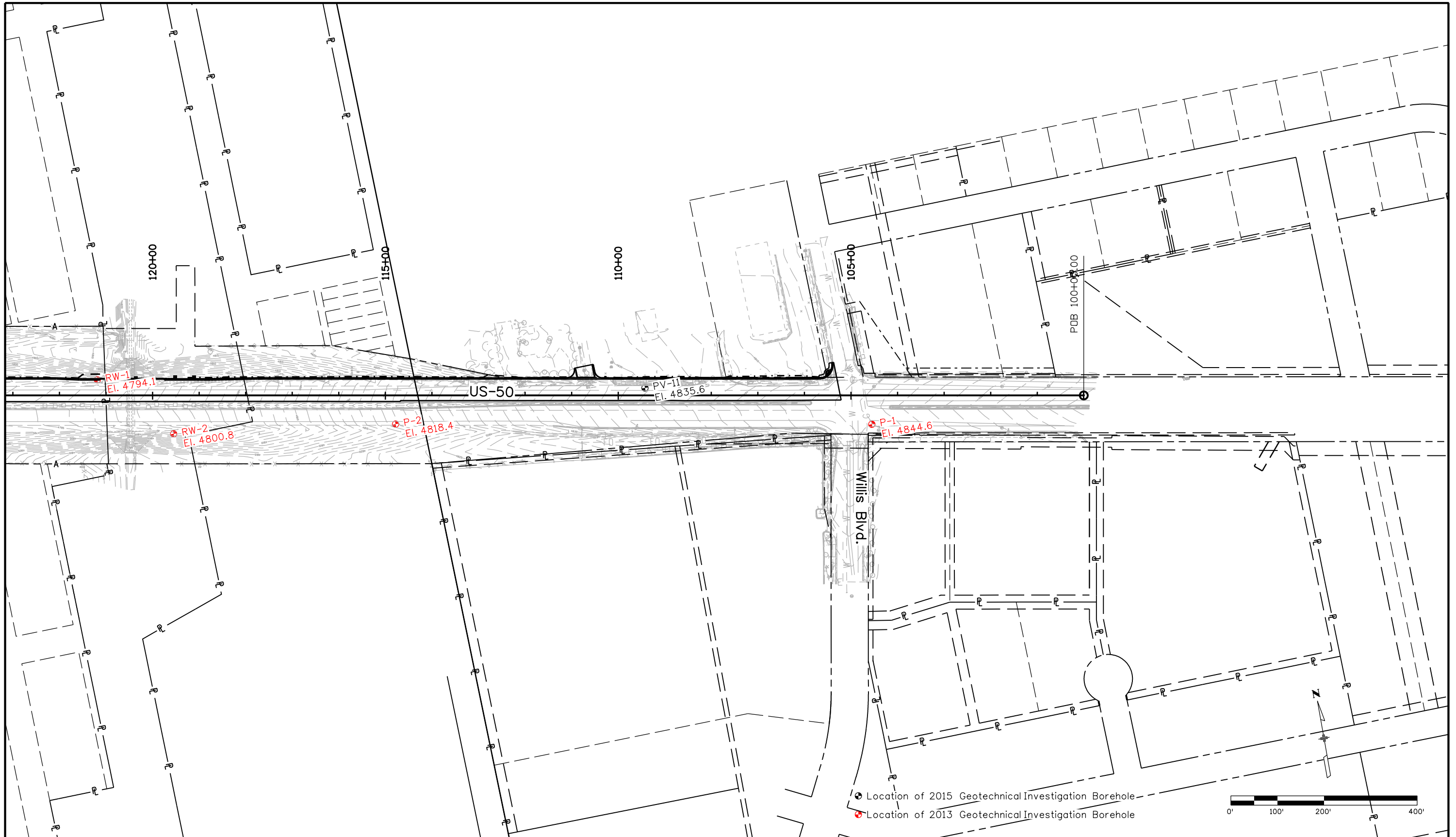
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Detailer:	D. Knight		
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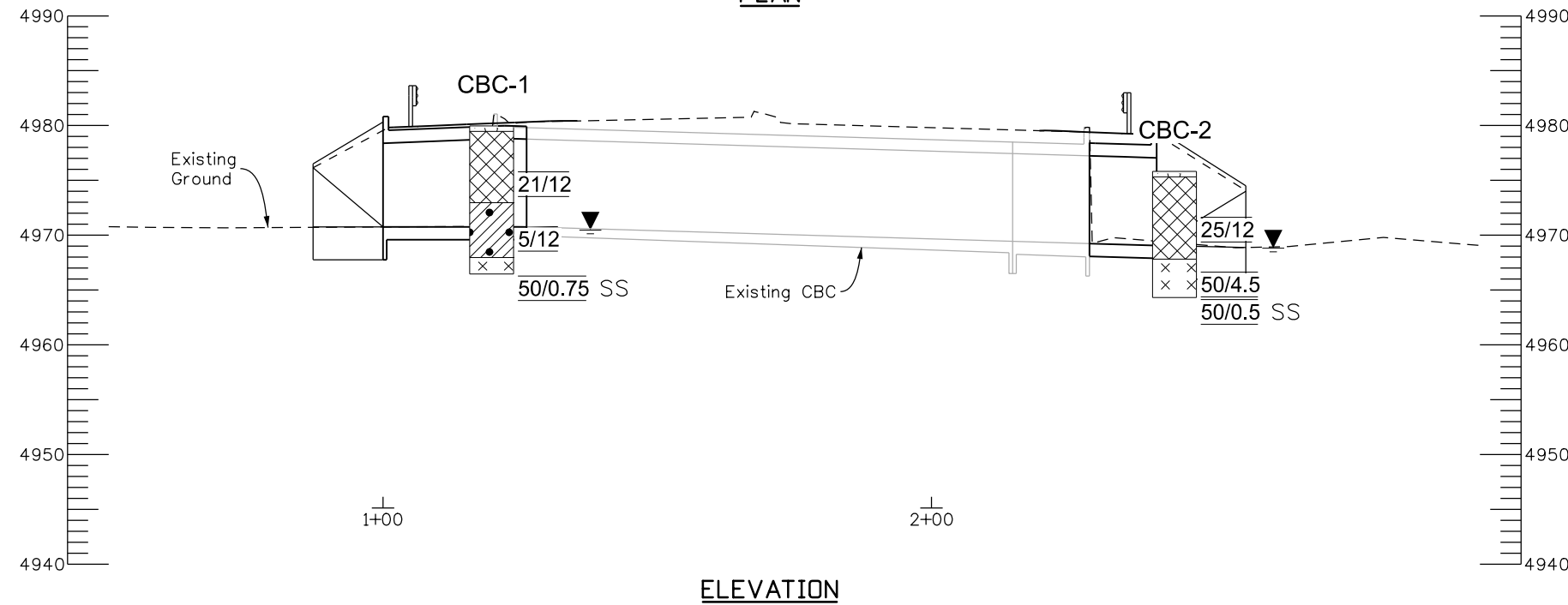
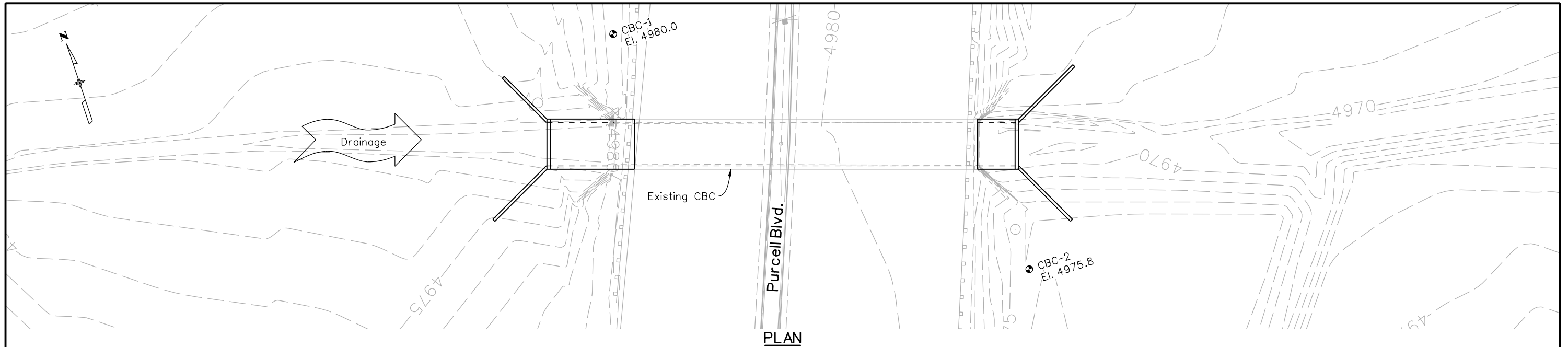
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SUMMARY OF TEST RESULTS																																					
Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	% < #200 Sieve	Classification		Water Content (%)	Dry Density (%)	Sulfate (%)	Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	% < #200 Sieve	Classification		Water Content (%)	Dry Density (%)	Sulfate (%)																		
					USCS	AASHTO									USCS	AASHTO																					

TYPE OF MATERIAL			
	Asphalt Pavement		Fill - Aggregate Base Course
	Fill - CLAY		Fill - SAND
	Fill - SAND		Fill - CLAY
	TOPSOIL		Native - SAND, silty
	Native - SAND, gravelly		Native - SAND, clayey
	Native - CLAY		Native - CLAY, gravelly
	Native - GRAVEL, silty		Native - CLAY, sandy
	Bedrock - SANDSTONE		Bedrock - CLAYSTONE
	Bedrock - SHALE		

LEGEND	
	B Bridge Borehole
	Ground Water Level At Time of Drilling
	9 Blows for 12 Inches
	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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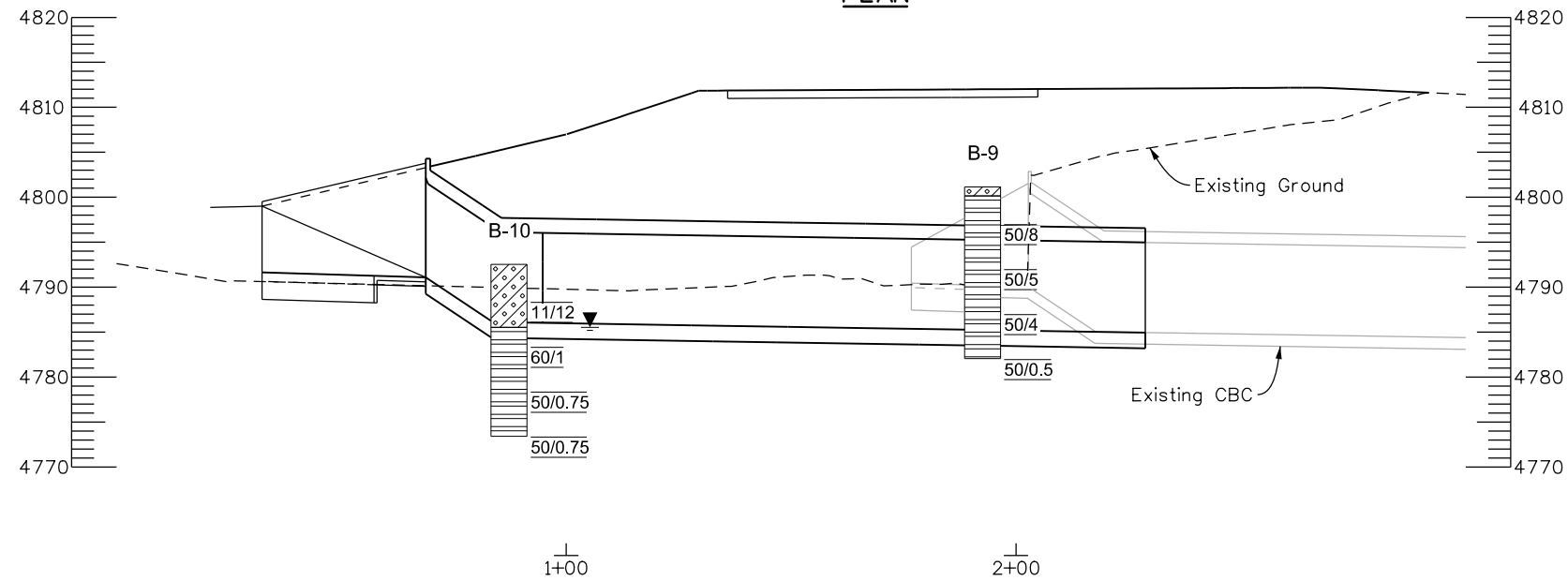
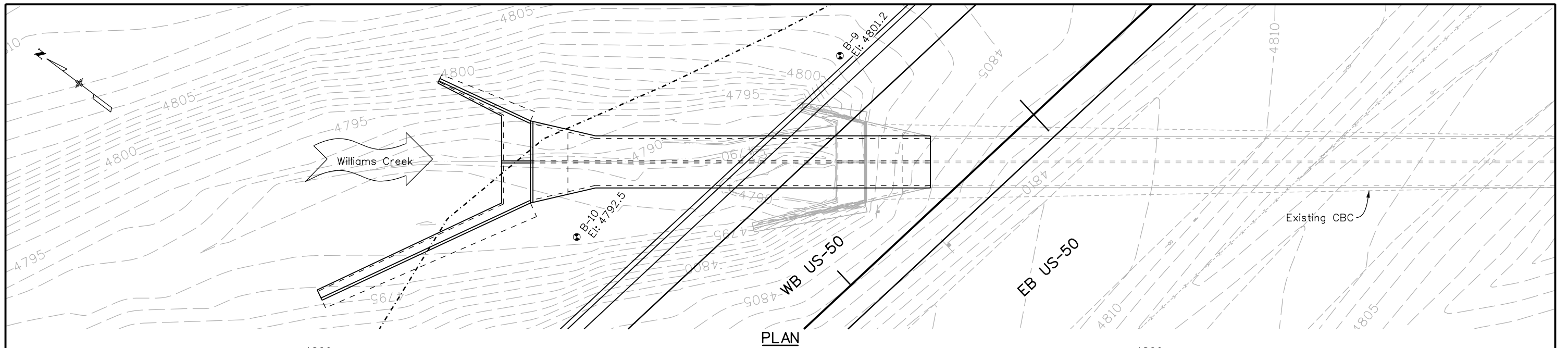
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 PURCELL CBC
 ENGINEERING GEOLOGY

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 Detailer: D. Knight
 Subset: Geotech

Structure Numbers: Subset Sheets: 9 of 11

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Figure 4

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SUMMARY OF TEST RESULTS																				
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B-9	9						8.3													
B-9	14						7.9													
B-9	19						4.3													
B-10	0-4	29	15	46	SC	A-6 (3)			0.40											
B-10	4	26	11	58	CL	A-6 (3)	20.3	113.3												

TYPE OF MATERIAL	
	Asphalt Pavement
	Fill - CLAY
	Fill - SAND
	TOPSOIL
	Native - SAND, gravelly
	Native - CLAY
	Native - GRAVEL, silty
	Bedrock - SANDSTONE
	Bedrock - SHALE
	Fill - Aggregate Base Course
	Fill - SAND
	Fill - CLAY
	Native - SAND, silty
	Native - SAND, clayey
	Native - CLAY, gravelly
	Native - CLAY, sandy
	Bedrock - CLAYSTONE

LEGEND	
	B Bridge Borehole
	Ground Water Level At Time of Drilling
	9 Blows for 12 Inches
	50 Blows for 3 Inches
	Split Spoon Sampler Required 8 Blows for 6 Inches Required 6 Blows for 6 Inches Required 7 Blows for 6 Inches

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.

Print Date: 7/28/2015
 File Name: 20448GED_F5 EngGeo-WC CBC.dgn
 Horiz. Scale: 1:40 Vert. Scale: 1:20

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation
 902 Erie Avenue
 Pueblo, CO 81001
 Phone: 719-562-5509 FAX: 719-546-5702
 Region 2 DTD

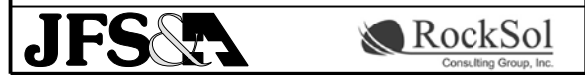
As Constructed
 No Revisions:
 Revised:
 Void:

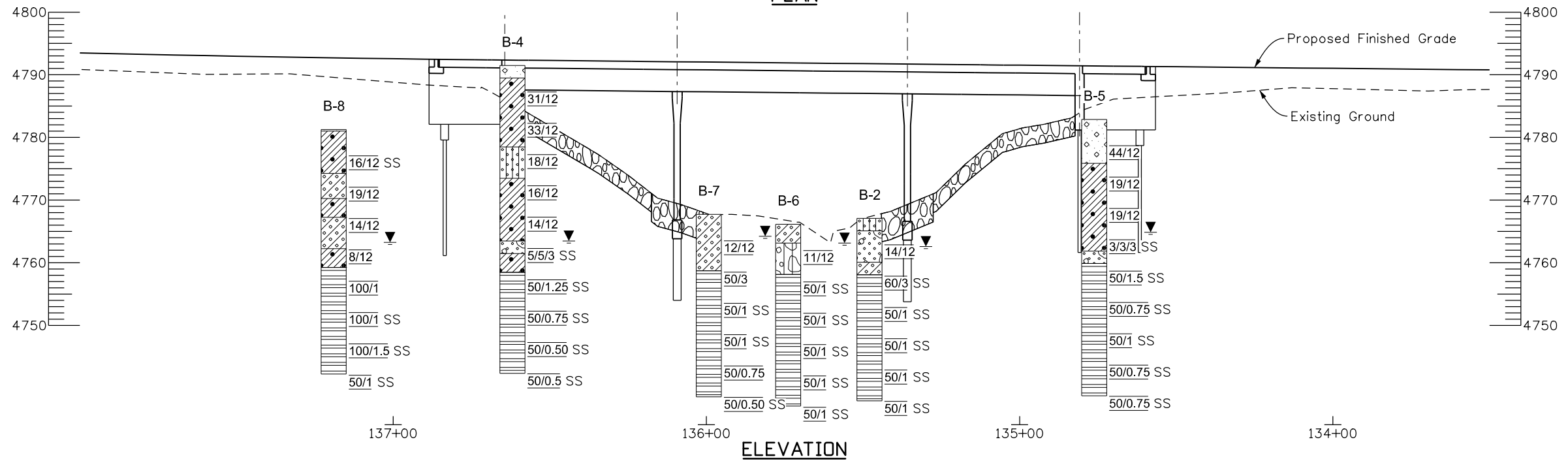
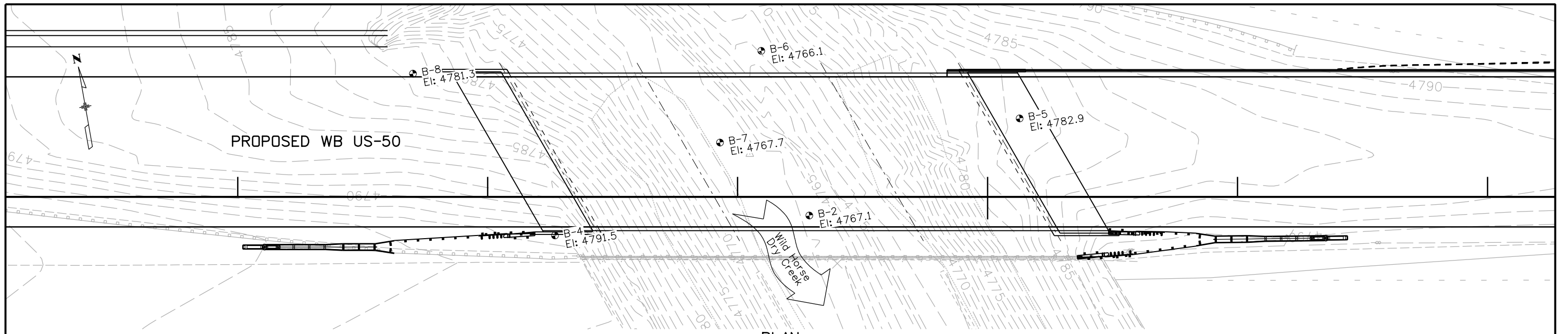
US 50 WEST WESTBOUND
 WILLIAMS CREEK CBC
 ENGINEERING GEOLOGY

Designer: R. Lepro
 Detailer: D. Knight
 Subset: Geotech

Structure Numbers
 Subset Sheets: 10 of 11

Project No./Code
 STA 0503-088
 20448
 Figure 5





SUMMARY OF TEST RESULTS																TYPE OF MATERIAL						LEGEND					
Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	% < #200 Sieve	Classification	Water Content (%)	Dry Density (%)	Sulfate (%)	Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	% < #200 Sieve	Classification	Water Content (%)	Dry Density (%)	Sulfate (%)	Sample ID	Depth (ft)	Liquid Limit	Plasticity Index	% < #200 Sieve	Classification	Water Content (%)	Dry Density (%)	Sulfate (%)	TEST BORING
B-2	0-4	26	9	51	CL A-4 (2)	11.2	125.9		B-4	39					15.8			B-6	19					9.3			B
B-2	4								B-4	44					10.9			B-6	24					13.8			↓
B-2	9					12.1			B-4	49					5.0			B-6	29					5.7			↕
B-2	9.5	24	8	22	SC A-2-4 (0)				B-5	4					9.3	131.0	2.07	B-7	0-4					9.3	128.9		9
B-2	14					12.6			B-5	9	30	17	72	CL A-6 (10)	13.4	120.1		B-7	4					8.4	128.9		14
B-2	19					9.4			B-5	14	32	17	80	CL A-6 (12)	17.7	112.5		B-7	9					6.5			19
B-2	24					10.6			B-5	19					21.8			B-7	14					15.2			24
B-4	0-15								B-5	24					8.7			B-7	19								29
B-4	4					10.7	124.0		B-5	29					6.4			B-7	24	24	10	43	SC A-4 (1)		0.44		34
B-4	9	30	16	54	CL A-6 (5)	11.2	128.5		B-5	34					10.2			B-7	29					14.2			39
B-4	14					47			B-5	44					1.9			B-8	4					13.4	115.8		44
B-4	19	35	20	94	CL A-6 (18)	18.2	110.8	1.74	B-6	0-4	29	15	60	CL A-6 (6)	12.5	125.9		B-8	9	23	8	91	CL A-4 (5)	11.7	114.6	1.26	49
B-4	24					20.6	107.4		B-6	4					7.2			B-8	14	27	12	56	CL A-6 (4)				54
B-4	29					13.9			B-6	5-8	NP	NP	5	SW A-1-a (0)				B-8	29					15.2	0.39		59
B-4	34					10.3			B-6	14								B-8	34	25	9	41	SC A-4 (0)	14.6			64

Print Date: 7/28/2015	Sheet Revisions		Colorado Department of Transportation		As Constructed		US 50 WEST WESTBOUND WILD HORSE DRY CREEK BRIDGE ENGINEERING GEOLOGY		Project No./Code				
File Name: 20448GED_F6 EngGeo-WHDC Bridge.dgn	Date:	Comments	Init.	902 Erie Avenue Pueblo, CO 81001 Phone: 719-562-5509 FAX: 719-546-5702		No Revisions:		STA 0503-088		20448			
Horiz. Scale: 1:40 Vert. Scale: 1:20					Region 2 DTD		Revised:		Designer: R. Lepro		Structure Numbers		
JFS&A		RockSol Consulting Group, Inc.				Void:		Detailer: D. Knight		Subset: Geotech		Subset Sheets: 11 of 11	
								Subset: Geotech		Figure		6	

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APPENDIX A

LEGEND AND INDIVIDUAL BOREHOLE LOGS

BR-1, BR-2, CBC-1, CBC-2, PV-1 through PV-12, WC-1, and WC-2













CLIENT J.F. Sato

PROJECT NAME US 50 West, WB Preliminary Design




PROJECT NUMBER 302.02

PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado

LITHOLOGY

- | | | | |
|--|--------------------------------|---|-------------------------------------|
|  | Asphalt Pavement |  | Fill - Aggregate Base Course |
|  | Fill - CLAY |  | Fill - SAND |
|  | Fill - SAND |  | Fill - CLAY |
|  | TOPSOIL |  | Native - SAND, silty |
|  | Native - SAND, gravelly |  | Native - SAND, clayey |
|  | Native - CLAY |  | Native - CLAY, gravelly |
|  | Native - CLAY, sandy |  | Native - GRAVEL, silty |
|  | Bedrock - CLAYSTONE |  | Bedrock - SANDSTONE |
|  | Bedrock - SHALE | | |

SAMPLE TYPE

- | | | | |
|---|---|---|--|
|  | Auger Cuttings |  | 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

CLIENT J.F. Sato **PROJECT NAME** US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/12/15 **COMPLETED** 5/12/15 **GROUND ELEVATION** 4826.8 ft **STATION NO.** 160+80
DRILLING CONTRACTOR Old Dirt Drilling **NORTH** 601255.1 **EAST** 241543.1
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25" **BORING LOCATION:** SE corner, EB US50 & Pueblo Blvd.
LOGGED BY J. Biller **HAMMER TYPE** Automatic **GROUND WATER LEVELS:**
NOTES **WATER DEPTH** None Encountered on 5/12/15

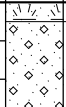


ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4827	0		(Fill) SAND, gravel, very moist, light brown, loose, approximately 6" in thickness (Fill) CLAY, sandy, moist, light brown, medium stiff										
4822	5		(Bedrock) CLAYSTONE, sandy, moist, light brown, hard to very hard	MC	50/12	1.6	0.70	126.4	12.7				
4817	10			MC	50/4			127.6	10.0	27	18	9	60.1
4812	15			MC	50/6		0.26	114.9	11.6	31	14	17	74.0
4807	20			SS	50/4								
4802	25		(Bedrock) SHALE, silty to clayey, slightly moist to moist, gray, very hard	SS	50/1								
			Bottom of hole at 28.0 feet.										

LOG - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

CLIENT J.F. Sato	PROJECT NAME US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02	PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/15/15 COMPLETED 5/15/15	GROUND ELEVATION 4980.0 ft STATION NO. 283+00
DRILLING CONTRACTOR Old Dirt Drilling	NORTH 604631.0 EAST 229793.8
DRILLING METHOD Solid Stem Auger HOLE SIZE 4.25"	BORING LOCATION: West of Purcell Blvd north of culvert
LOGGED BY H. Ochoa HAMMER TYPE Automatic	GROUND WATER LEVELS:
NOTES S of US50	▼ WATER DEPTH 9.5 ft on 5/15/15

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4980	0		TOPSOIL, clay, sandy, approximately 6 inches in thickness (Fill) CLAY, sandy, slightly moist to moist, brown, very stiff	BULK			0.03			27	15	12	63.9
4975	5		(Fill) CLAY, (reworked shale), very moist to wet, light brown, medium stiffness	MC	21/12			117.8	14.8				
4970	10		(Bedrock) SHALE, slightly moist, light brown, very hard	MC	5/12			131.1	7.9				17.4
			Bottom of hole at 13.5 feet.	SS	50/0.75								
			<p>Approximate Bulk Depth 0-5 Liquid Limit= 27 Plastic Limit= 15 Plasticity Index= 12 Fines Content= ERROR Sulfate= 0.03</p>										

CLIENT J.F. Sato **PROJECT NAME** US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/15/15 **COMPLETED** 5/15/15 **GROUND ELEVATION** 4975.8 ft **STATION NO.** 281+70
DRILLING CONTRACTOR Old Dirt Drilling **NORTH** 604524.5 **EAST** 229889.2
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25" **BORING LOCATION:** East side of Purcell Blvd, South side of culvert
LOGGED BY H. Ochoa **HAMMER TYPE** Automatic **GROUND WATER LEVELS:**
NOTES S of US50 **WATER DEPTH** 7.0 ft on 5/15/15

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4976	0		TOPSOIL, clay, sandy, approximately 6 inches in thickness, moist, brown, stiff to very stiff (Fill) SAND, clayey, sandy clay in parts (reworked shale), slightly moist to wet, light brown to brown, medium dense	BULK			0.77			27	14	13	49.4
4971	5			MC	25/12			127.8	8.9				
4966	10		(Bedrock) SHALE, slightly silty, slightly moist to moist, brownish gray, very hard, iron oxide staining	MC	50/4.5		0.10	134.4	7.9				
			Bottom of hole at 11.5 feet.	SS	50/0.5								
			Approximate Bulk Depth 0-5 Liquid Limit= 27 Plastic Limit= 14 Plasticity Index= 13 Fines Content= ERROR Sulfate= 0.77										

CLIENT J.F. Sato **PROJECT NAME** US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/12/15 **COMPLETED** 5/12/15 **GROUND ELEVATION** 4980.4 ft **STATION NO.** 277+40
DRILLING CONTRACTOR Old Dirt Drilling **NORTH** 604740.3 **EAST** 230428.8
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25" **BORING LOCATION:** WB US50, E of Purcell St.
LOGGED BY J. Biller **HAMMER TYPE** Automatic **GROUND WATER LEVELS:**
NOTES Right turn lane **WATER DEPTH** None Encountered on 5/12/15

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4980	0		Asphalt Pavement, approximately 11" in thickness										
			Aggregate Base Course, approximately 6" in thickness	BULK			0.03						
			(Native) SAND, clayey, very moist, light brown, loose to medium dense	MC	6/12	-0.1		108.7	15.7				34.1
4975	5			MC	9/12			111.1	17.0				
4970	10			MC	12/12			113.4	16.8				
			Bottom of hole at 10.0 feet.										
			Approximate Bulk Depth 0.91-5 Liquid Limit= Plastic Limit= Plasticity Index= Fines Content= ERROR Sulfate= 0.03										

CLIENT J.F. Sato **PROJECT NAME** US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/12/15 **COMPLETED** 5/12/15 **GROUND ELEVATION** 4964.6 ft **STATION NO.** 256+80
DRILLING CONTRACTOR Old Dirt Drilling **NORTH** 604068.4 **EAST** 232377.6
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25" **BORING LOCATION:** WB US50
LOGGED BY J. Biller **HAMMER TYPE** Automatic **GROUND WATER LEVELS:**
NOTES Lane 2 **WATER DEPTH** None Encountered on 5/12/12

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4965	0		Asphalt Pavement, approximately 10" in thickness										
			(Fill) SAND, clayey moist, light brown, loose	BULK			0.06			37	13	24	33.6
				MC	9/12	0.0		108.3	18.0				
4960	5		(Native) SAND, clayey, moist, light brown, loose	MC	6/12			106.2	17.9				
			(Bedrock) SHALE, silty to clayey, slightly moist to moist, dark gray, very hard	MC	SR								
			Bottom of hole at 9.0 feet.										
			Approximate Bulk Depth 0.83-5 Liquid Limit= 37 Plastic Limit= 13 Plasticity Index= 24 Fines Content= ERROR Sulfate= 0.06										





CLIENT J.F. Sato **PROJECT NAME** US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/12/15 **COMPLETED** 5/12/15 **GROUND ELEVATION** 4956.3 ft **STATION NO.** 236+50
DRILLING CONTRACTOR Old Dirt Drilling **NORTH** 603422.2 **EAST** 234300.1
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25" **BORING LOCATION:** WB US50
LOGGED BY J. Biller **HAMMER TYPE** Automatic **GROUND WATER LEVELS:**
NOTES Lane 2, core in shoulder **WATER DEPTH** None Encountered on 5/12/15

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4956	0		Asphalt Pavement, approximately 10" in thickness										
			(Native) CLAY, sandy, moist, light brown, medium stiff	BULK			0.20			30	14	16	51.7
				MC	7/12	0.1		104.9	18.4				
4951	5			MC	6/12			106.7	17.0				
			(Native) CLAY, sandy, moist, light brown, very stiff										
4946	10		Bottom of hole at 10.0 feet.	MC	20/12			118.3	12.1				
			Approximate Bulk Depth 0.83-5 Liquid Limit= 30 Plastic Limit= 14 Plasticity Index= 16 Fines Content= ERROR Sulfate= 0.20										



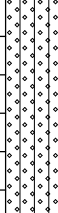
CLIENT J.F. Sato **PROJECT NAME** US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/12/15 **COMPLETED** 5/12/15 **GROUND ELEVATION** 4934.9 ft **STATION NO.** 216+80
DRILLING CONTRACTOR Old Dirt Drilling **NORTH** 602759.4 **EAST** 236164.2
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25" **BORING LOCATION:** WB US50
LOGGED BY J. Biller **HAMMER TYPE** Automatic **GROUND WATER LEVELS:**
NOTES Lane 1 **WATER DEPTH** None Encountered on 5/12/15

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4935	0		Asphalt Pavement, approximately 11" in thickness										
			(Fill) SAND, clayey to silty, moist, light brown to brown, loose	BULK			0.67			27	14	13	49.5
				MC	7/12	0.0		102.6	20.5				
4930	5			MC	6/12			105.8	18.0				
			(Native) CLAY, sandy, moist, light brown, very stiff										
4925	10			MC	17/12			105.3	21.1				
			Bottom of hole at 10.0 feet.										
			Approximate Bulk Depth 0.91-5 Liquid Limit= 27 Plastic Limit= 14 Plasticity Index= 13 Fines Content= ERROR Sulfate= 0.67										

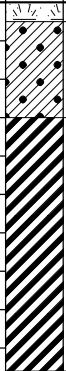
CLIENT J.F. Sato	PROJECT NAME US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02	PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/12/15 COMPLETED 5/12/15	GROUND ELEVATION 4912.9 ft STATION NO. 196+80
DRILLING CONTRACTOR Old Dirt Drilling	NORTH 602121.5 EAST 238049.4
DRILLING METHOD Solid Stem Auger HOLE SIZE 4.25"	BORING LOCATION: WB US50
LOGGED BY J. Biller HAMMER TYPE Automatic	GROUND WATER LEVELS:
NOTES Inside shoulder, core in Lane 1	WATER DEPTH None Encountered on 5/12/15

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4913	0		Asphalt Pavement, approximately 10.5" in thickness										
			Aggregate Base Course, approximately 6" in thickness	BULK			0.62			22	14	8	36.1
			(Fill) SAND, clayey with gravel, moist, light brown, medium dense	MC	27/12	0.9		122.7	12.5				
4908	5		(Native) CLAY, sandy with gravel in parts, moist, light brown, stiff	MC	13/12			110.3	14.5				
4903	10		Bottom of hole at 10.0 feet.	MC	10/12			123.2	10.5				
<p>Approximate Bulk Depth 0.875-5 Liquid Limit= 22 Plastic Limit= 14 Plasticity Index= 8 Fines Content= ERROR Sulfate= 0.62</p>													

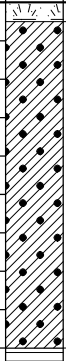
CLIENT J.F. Sato	PROJECT NAME US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02	PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/15/15 COMPLETED 5/15/15	GROUND ELEVATION 4889.1 ft STATION NO. 186+80
DRILLING CONTRACTOR Old Dirt Drilling	NORTH 601850.4 EAST 239018.7
DRILLING METHOD Solid Stem Auger HOLE SIZE 6.0"	BORING LOCATION: Median EB/WB Hwy 50
LOGGED BY H. Ochoa HAMMER TYPE Automatic	GROUND WATER LEVELS:
NOTES N side of EB US50, ~2500' W of Pueblo Blvd	WATER DEPTH None Encountered on 5/15/15

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4889	0		(Topsoil) SAND, clayey, moist, brown, medium dense, approximately 6" in thickness	BULK			0.18			20	15	5	24.6
			(Fill) SAND silty to clayey with gravel, slightly moist to moist, light brown, dense	MC	33/12	-1.0		123.1	4.8				
4884	5		(Native) SAND, silty, slightly moist to moist, brown, medium dense	MC	29/12			128.7	5.2				
4879	10		Bottom of hole at 10.0 feet.	MC	22/12			115.8	12.1				
<p>Approximate Bulk Depth 0-5 Liquid Limit= 20 Plastic Limit= 15 Plasticity Index= 5 Fines Content= ERROR Sulfate= 0.18</p>													

CLIENT J.F. Sato **PROJECT NAME** US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/15/15 **COMPLETED** 5/15/15 **GROUND ELEVATION** 4863.8 ft **STATION NO.** 176+90
DRILLING CONTRACTOR Old Dirt Drilling **NORTH** 601665.3 **EAST** 239987.9
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 6.0" **BORING LOCATION:** Median, Hwy 50
LOGGED BY H. Ochoa **HAMMER TYPE** Automatic **GROUND WATER LEVELS:**
NOTES N side of EB US50, approx 1500' E of Pueblo Blvd **WATER DEPTH** None Encountered on 5/15/15

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4864	0		(Topsoil) CLAY, sandy, moist, brown, stiff to very stiff, approximately 6" in thickness	BULK			0.14			32	14	18	79.0
			(Native) CLAY, sandy, slightly moist, light brown, very stiff	MC	41/12	7.5	124.0	9.9					
4859	5		(Bedrock) CLAYSTONE, slightly moist to moist, light brown, very hard	MC	50/10		129.8	9.6					
					MC	50/7		130.1	9.1				
			Bottom of hole at 9.6 feet.										
			Approximate Bulk Depth 0-5 Liquid Limit= 32 Plastic Limit= 14 Plasticity Index= 18 Fines Content= ERROR Sulfate= 0.14										

CLIENT J.F. Sato **PROJECT NAME** US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/15/15 **COMPLETED** 5/15/15 **GROUND ELEVATION** 4833.7 ft **STATION NO.** 166+80
DRILLING CONTRACTOR Old Dirt Drilling **NORTH** 601495.6 **EAST** 240981.6
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 6.0" **BORING LOCATION:** Median EB & WB US50
LOGGED BY H. Ochoa **HAMMER TYPE** Automatic **GROUND WATER LEVELS:**
NOTES N side of EB US50, approx 500' W of Pueblo Blvd **WATER DEPTH** None Encountered on 5/15/15

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)	
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX		
4834	0		(Topsoil) CLAY, sandy, moist, brown, stiff to very stiff, approximately 6" in thickness	BULK			0.08			28	16	12	60.1	
			(Native) CLAY, sandy, slightly moist to moist, light brown, stiff to very stiff	MC	13/12	0.8		99.7	5.9					
4829	5				MC	21/12			112.9	6.6				
				(Bedrock) SHALE, slightly silty to sandy, slightly moist to moist, light brown, very hard Bottom of hole at 9.5 feet.	MC	50/6			128.9	8.4				
			<p>Approximate Bulk Depth 0-5 Liquid Limit= 28 Plastic Limit= 16 Plasticity Index= 12 Fines Content= ERROR Sulfate= 0.08</p>											





CLIENT J.F. Sato **PROJECT NAME** US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/15/15 **COMPLETED** 5/15/15 **GROUND ELEVATION** 4802.2 ft **STATION NO.** 143+80
DRILLING CONTRACTOR Old Dirt Drilling **NORTH** 601094.8 **EAST** 243259.0
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 6.0" **BORING LOCATION:** Median WB/EB Hwy 50
LOGGED BY H. Ochoa **HAMMER TYPE** Automatic **GROUND WATER LEVELS:**
NOTES N side of EB US50, approx 1700' E of Pueblo Blvd **WATER DEPTH** None Encountered on 5/15/15

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4802	0		(Topsoil) SAND, silty to clayey, moist, brown, medium dense, approximately 6" in thickness	BULK			0.02			23	17	6	43.3
			(Native) SAND, silty to clayey with gravel in parts, slightly moist to moist, light brown, medium dense	MC	15/12	1.2		99.6	3.9				
4797	5			MC	10/12			103.7	3.9				
			(Native) CLAY, silty to sandy, slightly moist, light brown, stiff										
4792	10			MC	16/12			107.4	6.2				
			Bottom of hole at 10.0 feet.										
			Approximate Bulk Depth 0-5 Liquid Limit= 23 Plastic Limit= 17 Plasticity Index= 6 Fines Content= ERROR Sulfate= 0.02										

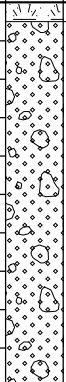
CLIENT J.F. Sato	PROJECT NAME US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02	PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/12/15 COMPLETED 5/12/15	GROUND ELEVATION 4792.3 ft STATION NO. 128+00
DRILLING CONTRACTOR Old Dirt Drilling	NORTH 600784.3 EAST 244789.9
DRILLING METHOD Solid Stem Auger HOLE SIZE 4.25"	BORING LOCATION: WB US50
LOGGED BY J. Biller HAMMER TYPE Automatic	GROUND WATER LEVELS:
NOTES Center median	WATER DEPTH None Encountered on 5/12/15

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4792	0	[Symbol]	Asphalt Pavement, approximately 6" in thickness										
		[Symbol]	Aggregate Base Course, approximately 6" in thickness	BY BULK			1.72			33	15	18	51.1
		[Symbol]	(Native) CLAY, sandy, slightly moist to moist, light brown, very stiff to hard	MC	17/12	0.0		114.1	16.3				
4787	5	[Symbol]		MC	41/12			105.0	19.2				
		[Symbol]	(Bedrock) CLAYSTONE, sandy, slightly moist, light brown, very hard	MC	50/11			113.6	17.1				
			Bottom of hole at 10.0 feet.										
			<p>Approximate Bulk Depth 0.5-5 Liquid Limit= 33 Plastic Limit= 15 Plasticity Index= 18 Fines Content= ERROR Sulfate= 1.72</p>										

CLIENT J.F. Sato **PROJECT NAME** US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/12/15 **COMPLETED** 5/12/15 **GROUND ELEVATION** 4835.6 ft **STATION NO.** 109+50
DRILLING CONTRACTOR Old Dirt Drilling **NORTH** 600491.1 **EAST** 246623.1
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25" **BORING LOCATION:** US50 W of Wills Blvd.
LOGGED BY J. Biller **HAMMER TYPE** Automatic **GROUND WATER LEVELS:**
NOTES Right turn lane **WATER DEPTH** None Encountered on 5/12/15

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4836	0		Asphalt Pavement, approximately 8.5" in thickness										
			(Fill) SAND, slightly silty to gravelly, moist, brown, medium dense	BULK			0.56			26	13	13	34.7
			(Native) CLAY, sandy to silty, moist, brown, stiff	MC	15/12	0.8		112.9	16.1				
4831	5			MC	12/12	0.1		104.6	20.5				
			Bottom of hole at 5.0 feet.										
			Approximate Bulk Depth 0.7-5 Liquid Limit= 26 Plastic Limit= 13 Plasticity Index= 13 Fines Content= ERROR Sulfate= 0.56										

CLIENT J.F. Sato **PROJECT NAME** US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/15/15 **COMPLETED** 5/15/15 **GROUND ELEVATION** 4810.4 ft **STATION NO.** 149+50
DRILLING CONTRACTOR Old Dirt Drilling **NORTH** 601416.6 **EAST** 242714.6
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 6.0" **BORING LOCATION:** Median EB/WB Hwy 50
LOGGED BY H. Ochoa **HAMMER TYPE** Automatic **GROUND WATER LEVELS:**
NOTES S side of WB US 50, approx 1000' E of Pueblo Blvd **WATER DEPTH** None Encountered on 5/15/15





ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)	
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX		
4810	0		(Topsoil) SAND, silty, slightly moist, light brown, loose to medium dense, approximately 6 inches in thickness	BULK			0.38			23	14	9	31.0	
			(Native) SAND, slightly clayey to silty with gravel, slightly moist, light brown to brown, medium dense	MC	17/12			113.8	2.5					
4805	5			MC	18/12			113.8	2.9					
4800	10			MC	23/12			115.5	3.0					
			Bottom of hole at 10.0 feet.											
			Approximate Bulk Depth 0-5 Liquid Limit= 23 Plastic Limit= 14 Plasticity Index= 9 Fines Content= ERROR Sulfate= 0.38											

CLIENT J.F. Sato **PROJECT NAME** US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/12/15 **COMPLETED** 5/12/15 **GROUND ELEVATION** 4823.3 ft **STATION NO.** 163+00
DRILLING CONTRACTOR Old Dirt Drilling **NORTH** 601739.7 **EAST** 241433.8
DRILLING METHOD Solid Stem Auger **HOLE SIZE** 4.25" **BORING LOCATION:** W side of Pueblo Blvd. at Williams Creek
LOGGED BY J. Biller **HAMMER TYPE** Automatic **GROUND WATER LEVELS:**
NOTES North side of culvert **WATER DEPTH** 17.0 ft on 5/12/15

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4823	0		(Topsoil) SAND, silty to gravelly, wet, brown, loose, approximately 6" in thickness (Fill) SAND, clayey, moist, light brown, dense										
4818	5			MC	48/12			127.9	10.1				
4813	10			MC	49/12			121.2	11.9	29	16	13	43.4
4808	15		(Native) CLAY, sandy with gravel and silty sand, very moist to wet, brown, medium stiff	MC	7/12	-0.5	0.00	111.5	15.9				
4803	20		(Bedrock) CLAYSTONE, sandy, moist, brown, very hard	MC	50/7			119.6	14.6				
4798	25		(Bedrock) SHALE, very moist to wet, dark gray, very hard	SS	100/1				16.0				31.2
			Bottom of hole at 29.1 feet.	SS	50/1				13.2				

LOG - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

CLIENT J.F. Sato	PROJECT NAME US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02	PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado
DATE STARTED 5/15/15 COMPLETED 5/15/15	GROUND ELEVATION 4814.0 ft STATION NO. 159+80
DRILLING CONTRACTOR Old Dirt Drilling	NORTH 601559.5 EAST 241719.2
DRILLING METHOD Solid Stem Auger HOLE SIZE 4.25"	BORING LOCATION: Median between WB & EB US50
LOGGED BY H. Ochoa HAMMER TYPE Automatic	GROUND WATER LEVELS:
NOTES E side of Pueblo Blvd @ Williams Creek, South side of culvert	WATER DEPTH None Encountered on 5/15/15

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS	SWELL POTENTIAL (%)	SULFATE (%)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
4814	0		(Topsoil) CLAY, sandy with gravel, slightly moist, light brown, approximately 6" in thickness (Fill) CLAY, sandy with gravel, slightly moist to moist, brown, stiff to very stiff	BULK									
4809	5		(Native) CLAY with sand to sandy, gravel in parts, slightly moist to moist, light brown, stiff to very stiff	MC	15/12			112.1	6.5				
4804	10		(Native) GRAVEL, sandy, wet, light brown, medium dense to dense	MC	13/12	0.7	0.14	115.9	13.8				
4799	15		(Bedrock) SHALE, moist, light brown, very hard	MC	50/4	0.8		132.6	11.4				
4794	20		(Bedrock) SHALE, slightly moist, dark gray, very hard	MC	50/1				7.3				
			Bottom of hole at 20.1 feet.										
			Approximate Bulk Depth 0-5 Liquid Limit= Plastic Limit= Plasticity Index= Fines Content= ERROR										

LOG - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

APPENDIX B

LABORATORY TEST RESULTS



SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT J.F. Sato

PROJECT NAME US 50 West, WB Preliminary Design

PROJECT NUMBER 302.02

PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado

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		
							USCS	AASHTO								S=Standard	M=Modified	MDD
BR-1	4	30	18	12		44	SC	A-6 (2)	9.9	112.9		0.73						
BR-1	9				0.1				10.2	123.1								
BR-1	14								9.7	123.4								
BR-1	19	33	17	16		85	CL	A-6 (12)	10.7			0.77						
BR-2	4				1.6				12.7	126.4		0.70						
BR-2	9	27	18	9		60	CL	A-4 (3)	10.0	127.6								
BR-2	14	31	14	17		74	CL	A-6 (10)	11.6	114.9		0.26						
CBC-1	0-5	27	15	12		64	CL	A-6 (5)				0.03						
CBC-1	4								14.8	117.8								
CBC-1	9					17			7.9	131.1								
CBC-2	0-5	27	14	13		49	SC	A-6 (3)				0.77						
CBC-2	4								8.9	127.8								
CBC-2	9								7.9	134.4		0.10						
PV-1	0.91-5					34						0.03	1150 ohms-cm @ 19.5%	6.9	0.0111			
PV-1	0.92																	
PV-1	2				-0.1				15.7	108.7								
PV-1	4								17.0	111.1								
PV-1	9								16.8	113.4								
PV-2	0.83-5	37	13	24		34	SC	A-2-6 (3)				0.06	385 ohms-cm @ 19.5%	7.3	0.1455			
PV-2	2				0.0				18.0	108.3								
PV-2	4								17.9	106.2								
PV-3	0.83-5	30	14	16		52	CL	A-6 (5)				0.20	900 ohms-cm @ 19.3%	8.0	0.0081			
PV-3	2				0.1				18.4	104.9								
PV-3	4								17.0	106.7								
PV-3	9								12.1	118.3								
PV-4	0.91-5	27	14	13		49	SC	A-6 (3)				0.67	860 ohms-cm @ 20.5%	7.1	0.0179			
PV-4	2				0.0				20.5	102.6								
PV-4	4								18.0	105.8								
PV-4	9								21.1	105.3								
PV-5	0.875-5	22	14	8		36	SC	A-4 (0)				0.62	920 ohms-cm @ 17.9%	7.5	0.0132			

SUMMARY - STANDARD LANDSCAPE 302.02 US 50 WEST.GPJ 7/28/15



SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT J.F. Sato

PROJECT NAME US 50 West, WB Preliminary Design

PROJECT NUMBER 302.02

PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado

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		
							USCS	AASHTO								S=Standard	M=Modified	MDD
PV-5	2				0.9				12.5	122.7								
PV-5	4								14.5	110.3								
PV-5	9								10.5	123.2								
PV-6	0-5	20	15	5		25	SC-SM	A-2-4 (0)				0.18	1800 ohms-cm @ 16.8%	7.6	0.0012			
PV-6	2				-1.0				4.8	123.1								
PV-6	4								5.2	128.7								
PV-6	9								12.1	115.8								
PV-7	0-5	32	14	18		79	CL	A-6 (12)				0.14	880 ohms-cm @ 25.7%	7.8	0.0029			
PV-7	2				7.5				9.9	124.0								
PV-7	4								9.6	129.8								
PV-7	9								9.1	130.1								
PV-8	0-5	28	16	12		60	CL	A-6 (4)				0.08	610 ohms-cm @ 21.6%	7.3	0.0462			
PV-8	2				0.8				5.9	99.7								
PV-8	4								6.6	112.9								
PV-8	9								8.4	128.9								
PV-9	0-5	23	17	6		43	SC-SM	A-4 (0)				0.02	1300 ohms-cm @ 18.6%	8.0	0.0044			
PV-9	2				1.2				3.9	99.6								
PV-9	4								3.9	103.7								
PV-9	9								6.2	107.4								
PV-10	0.5-5	33	15	18		51	CL	A-6 (6)				1.72	770 ohms-cm @ 22.5%	8.0	0.0130			
PV-10	2				0.0				16.3	114.1								
PV-10	4								19.2	105.0								
PV-10	9								17.1	113.6								
PV-11	0.7-5	26	13	13		35	SC	A-2-6 (1)				0.56	890 ohms-cm @ 19.8%	7.3	0.0226			
PV-11	2				0.8				16.1	112.9								
PV-11	4				0.1				20.5	104.6								
PV-12	0-5	23	14	9		31	SC	A-2-4 (0)				0.38	1200 ohms-cm @ 16.0%	6.7	0.0023			
PV-12	2								2.5	113.8								
PV-12	4								2.9	113.8								
PV-12	9								3.0	115.5								

SUMMARY - STANDARD LANDSCAPE 302.02 US 50 WEST.GPJ 7/28/15



SUMMARY OF PHYSICAL & CHEMICAL TEST RESULTS

CLIENT J.F. Sato

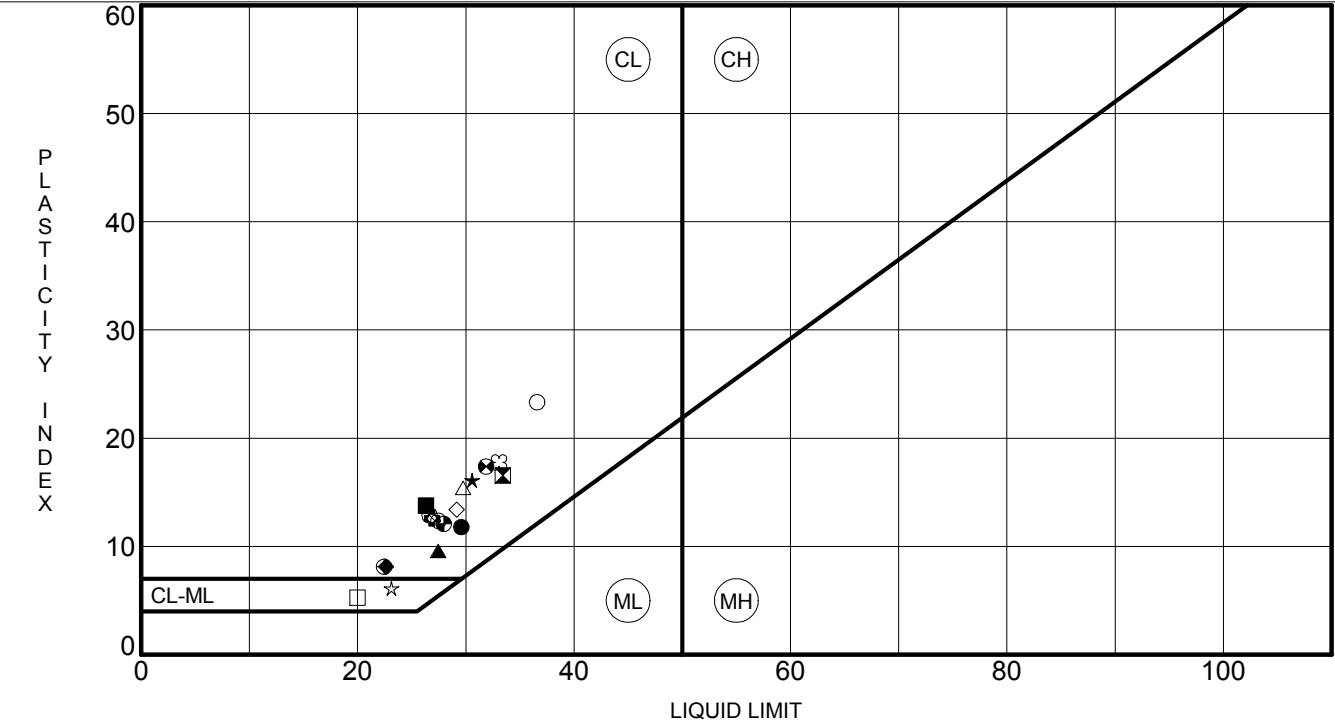
PROJECT NAME US 50 West, WB Preliminary Design

PROJECT NUMBER 302.02

PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado

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		
							USCS	AASHTO								S=Standard	M=Modified	MDD
WC-1	4								10.1	127.9								
WC-1	9	29	16	13		43	SC	A-6 (2)	11.9	121.2								
WC-1	14				-0.5				15.9	111.5		0.00						
WC-1	19								14.6	119.6								
WC-1	24					31			16.0									
WC-1	29								13.2									
WC-2	-5																	
WC-2	4								6.5	112.1								
WC-2	9				0.7				13.8	115.9		0.14						
WC-2	14				0.8				11.4	132.6								
WC-2	19								7.3									

CLIENT J.F. Sato PROJECT NAME US 50 West, WB Preliminary Design
 PROJECT NUMBER 302.02 PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado



Specimen Identification	LL	PL	PI	Fines	Classification
● BR-1	4.0	30	18	12	43.5 (Bedrock) SANDSTONE, clayey (SC) (A-6)
⊠ BR-1	19.0	33	17	16	85.5 (Bedrock) CLAYSTONE, sandy (CL) (A-6)
▲ BR-2	9.0	27	18	9	60.1 (Bedrock) SANDY CLAYSTONE (CL) (A-4)
★ BR-2	14.0	31	14	17	74.0 (Bedrock) CLAYSTONE with SAND (CL) (A-6)
⊙ CBC-1	0.0-5.0	27	15	12	63.9 SANDY LEAN CLAY (CL) (A-6)
⊕ CBC-2	0.0-5.0	27	14	13	49.4 CLAYEY SAND (SC) (A-6)
○ PV-2	0.8-5.0	37	13	24	33.6 CLAYEY SAND with GRAVEL (SC) (A-2-6)
△ PV-3	0.8-5.0	30	14	16	51.7 SANDY LEAN CLAY (CL) (A-6)
⊗ PV-4	0.9-5.0	27	14	13	49.5 CLAYEY SAND (SC) (A-6)
⊕ PV-5	0.9-5.0	22	14	8	36.1 CLAYEY SAND with GRAVEL (SC) (A-4)
□ PV-6	0.0-5.0	20	15	5	24.6 SILTY, CLAYEY SAND (SC-SM) (A-2-4)
⊕ PV-7	0.0-5.0	32	14	18	79.0 LEAN CLAY with SAND (CL) (A-6)
⊕ PV-8	0.0-5.0	28	16	12	60.1 SANDY LEAN CLAY (CL) (A-6)
★ PV-9	0.0-5.0	23	17	6	43.3 SILTY, CLAYEY SAND (SC-SM) (A-4)
⊗ PV-10	0.5-5.0	33	15	18	51.1 SANDY LEAN CLAY (CL) (A-6)
■ PV-11	0.7-5.0	26	13	13	34.7 CLAYEY SAND with GRAVEL (SC) (A-2-6)
◆ PV-12	0.0-5.0	23	14	9	31.0 CLAYEY SAND with GRAVEL (SC) (A-2-4)
◇ WC-1	9.0	29	16	13	43.4 CLAYEY SAND (SC) (A-6)

ATTERBERG LIMITS - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

GRAIN SIZE DISTRIBUTION



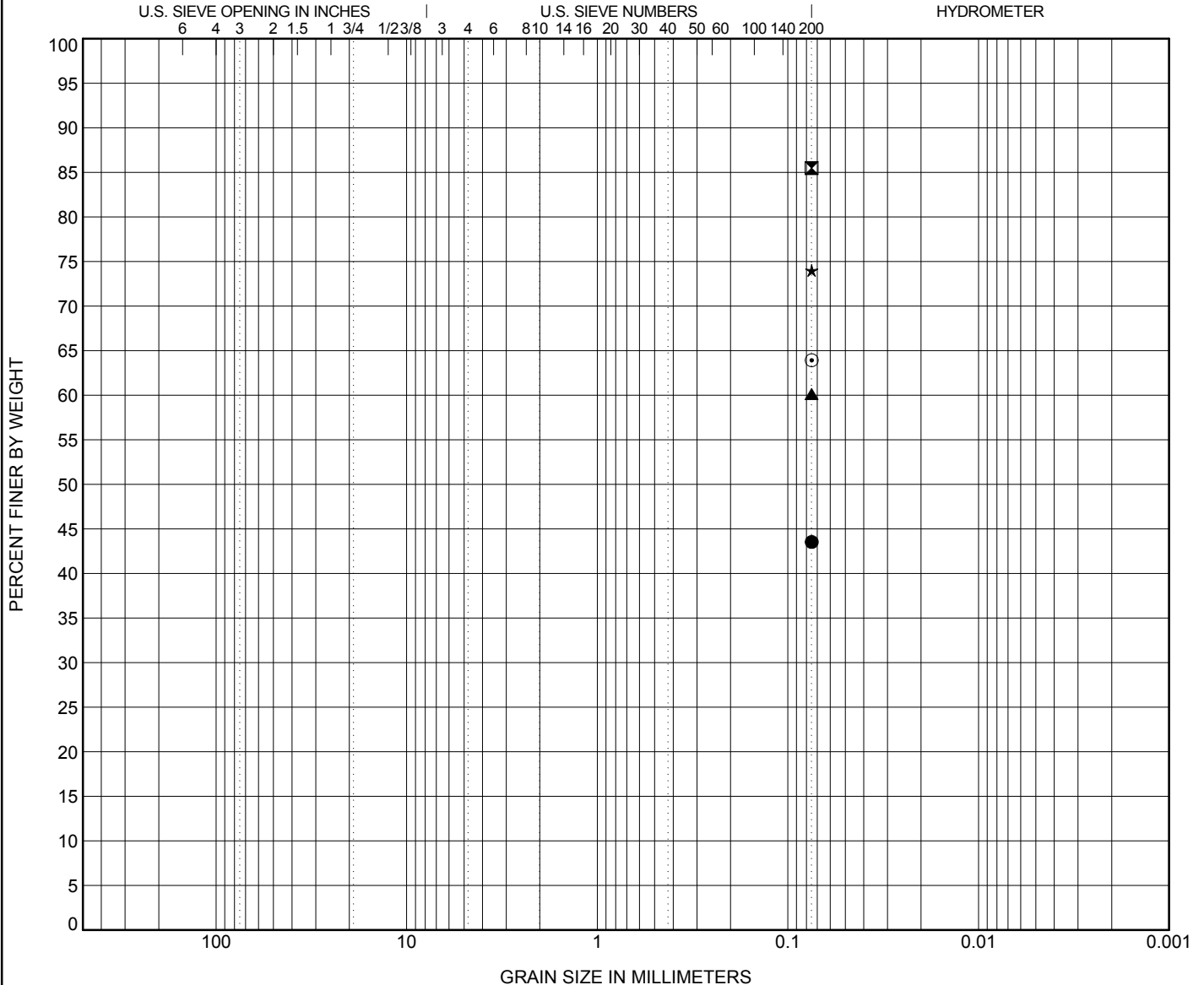
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CLIENT J.F. Sato

PROJECT NAME US 50 West, WB Preliminary Design

PROJECT NUMBER 302.02

PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu		
● BR-1 4.0	(Bedrock) SANDSTONE, clayey (SC) (A-6)	30	18	12				
☒ BR-1 19.0	(Bedrock) CLAYSTONE, sandy (CL) (A-6)	33	17	16				
▲ BR-2 9.0	(Bedrock) SANDY CLAYSTONE (CL) (A-4)	27	18	9				
★ BR-2 14.0	(Bedrock) CLAYSTONE with SAND (CL) (A-6)	31	14	17				
⊙ CBC-1 0.0-5.0	SANDY LEAN CLAY (CL) (A-6)	27	15	12				
Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● BR-1 4.0	0.075							43.5
☒ BR-1 19.0	0.075							85.5
▲ BR-2 9.0	0.075							60.1
★ BR-2 14.0	0.075							74.0
⊙ CBC-1 0.0-5.0	0.075							63.9

GRADATION - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

GRAIN SIZE DISTRIBUTION



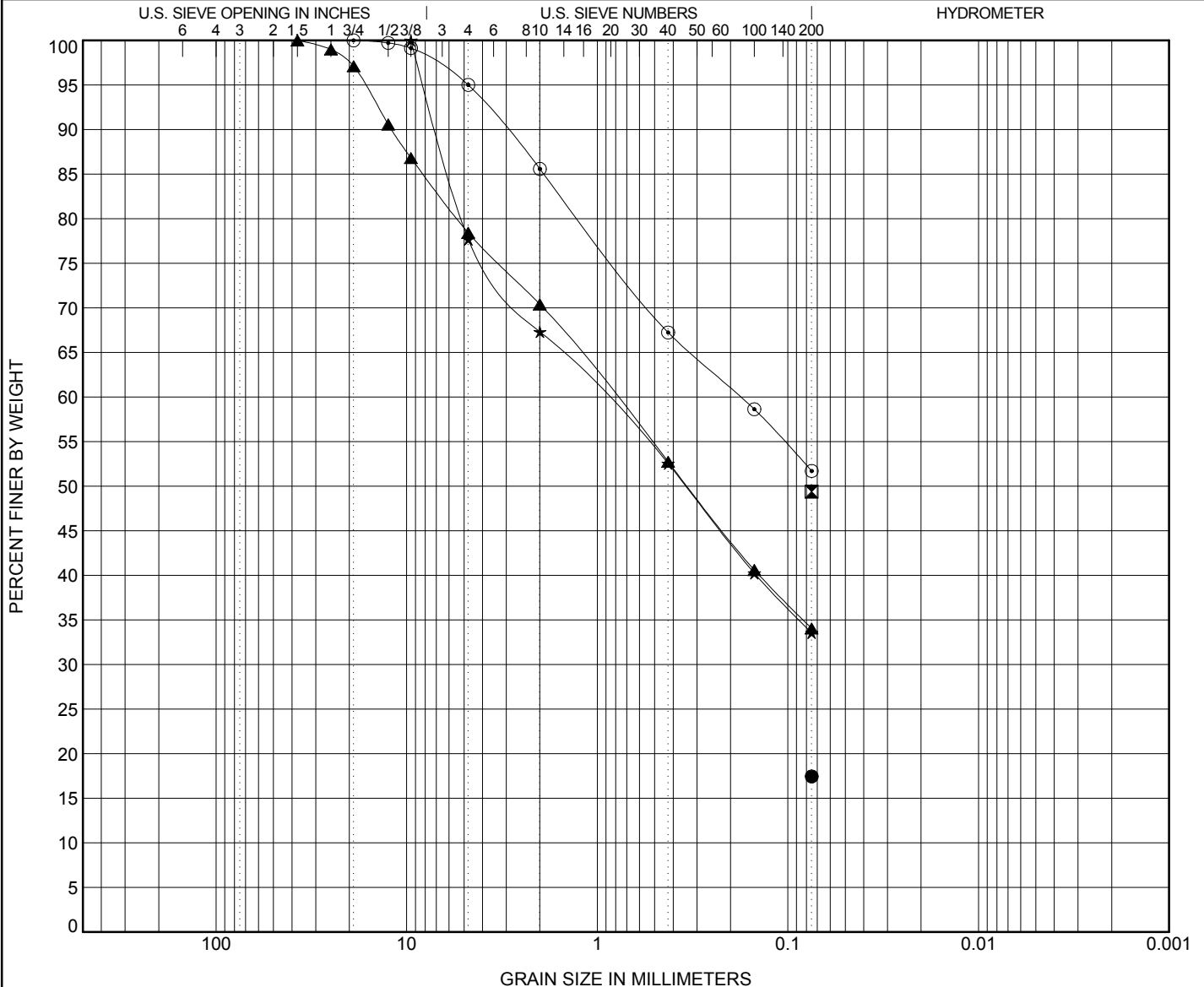
RockSol Consulting

CLIENT J.F. Sato

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PROJECT NUMBER 302.02

PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● CBC-1 9.0	(Fill) CLAY-Reworked Shale					
☒ CBC-2 0.0-5.0	CLAYEY SAND (SC) (A-6)	27	14	13		
▲ PV-1 0.9-5.0	SAND, clayey					
★ PV-2 0.8-5.0	CLAYEY SAND with GRAVEL (SC) (A-2-6)	37	13	24		
⊙ PV-3 0.8-5.0	SANDY LEAN CLAY (CL) (A-6)	30	14	16		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● CBC-1 9.0	0.075							17.4
☒ CBC-2 0.0-5.0	0.075							49.4
▲ PV-1 0.9-5.0	37.5	0.803			21.6	44.4		34.1
★ PV-2 0.8-5.0	9.5	0.929			22.3	44.1		33.6
⊙ PV-3 0.8-5.0	19	0.177			5.0	43.3		51.7

GRADATION - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15



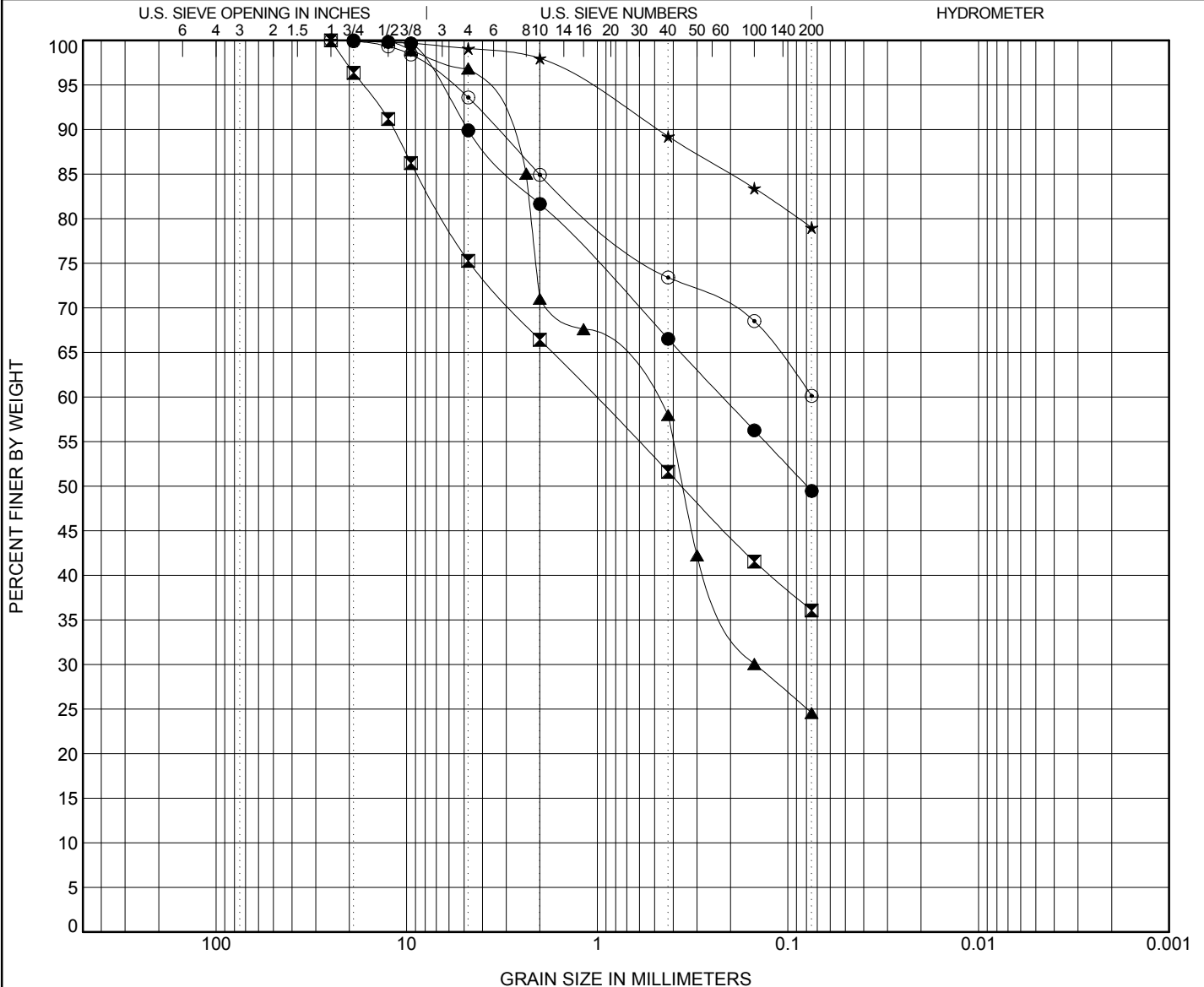
GRAIN SIZE DISTRIBUTION

CLIENT J.F. Sato

PROJECT NAME US 50 West, WB Preliminary Design

PROJECT NUMBER 302.02

PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification		LL	PL	PI	Cc	Cu
● PV-4 0.9-5.0	CLAYEY SAND (SC) (A-6)		27	14	13		
☒ PV-5 0.9-5.0	CLAYEY SAND with GRAVEL (SC) (A-4)		22	14	8		
▲ PV-6 0.0-5.0	SILTY, CLAYEY SAND (SC-SM) (A-2-4)		20	15	5		
★ PV-7 0.0-5.0	LEAN CLAY with SAND (CL) (A-6)		32	14	18		
⊙ PV-8 0.0-5.0	SANDY LEAN CLAY (CL) (A-6)		28	16	12		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PV-4 0.9-5.0	19	0.219			10.1	40.4	49.5	
☒ PV-5 0.9-5.0	25	1.022			24.7	39.2	36.1	
▲ PV-6 0.0-5.0	12.5	0.526	0.149		3.2	72.3	24.6	
★ PV-7 0.0-5.0	25				0.9	20.1	79.0	
⊙ PV-8 0.0-5.0	25				6.4	33.5	60.1	



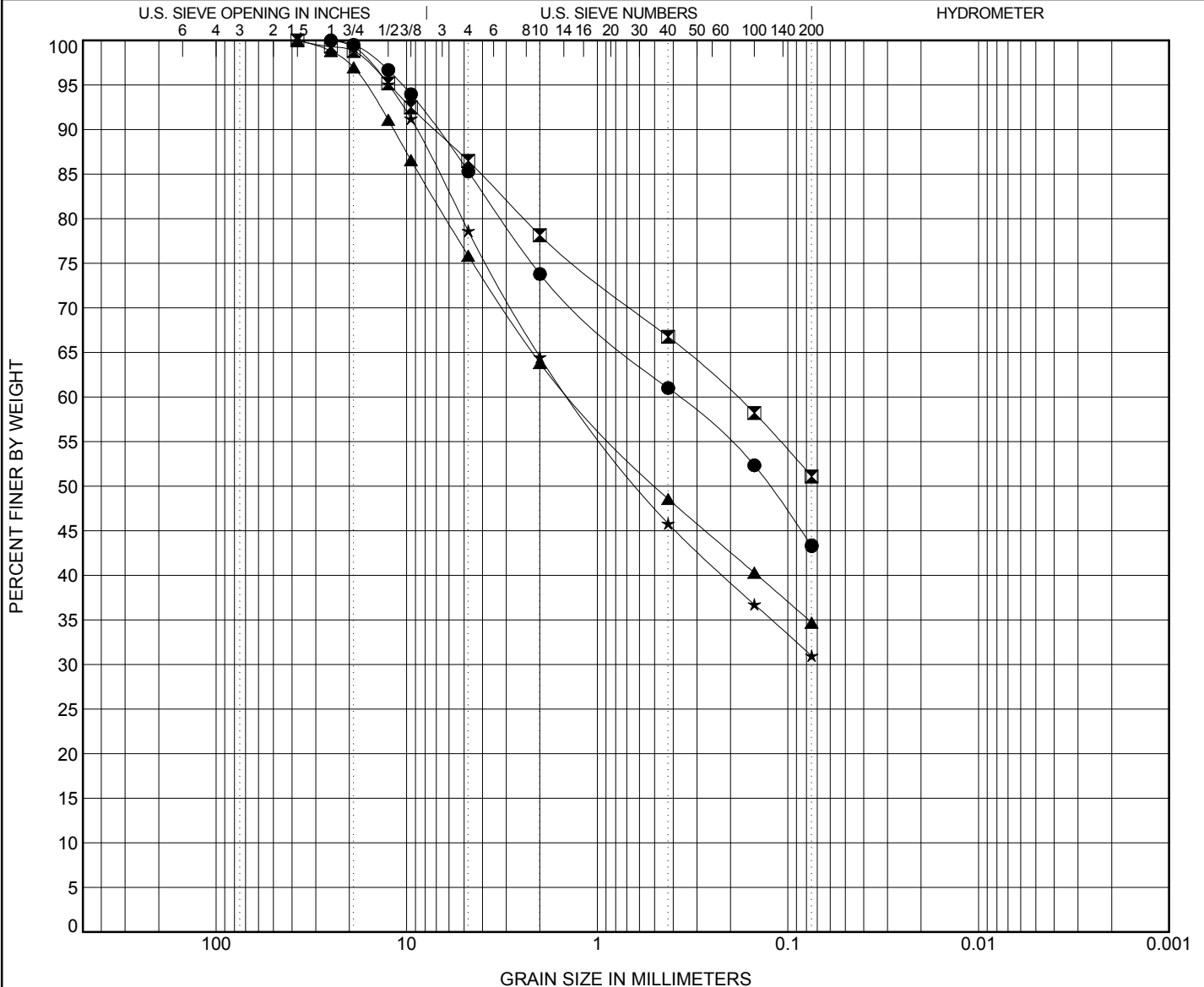
GRAIN SIZE DISTRIBUTION

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PROJECT NAME US 50 West, WB Preliminary Design

PROJECT NUMBER 302.02

PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification		LL	PL	PI	Cc	Cu	
● PV-9 0.0-5.0	SILTY, CLAYEY SAND (SC-SM) (A-4)		23	17	6			
☒ PV-10 0.5-5.0	SANDY LEAN CLAY (CL) (A-6)		33	15	18			
▲ PV-11 0.7-5.0	CLAYEY SAND with GRAVEL (SC) (A-2-6)		26	13	13			
★ PV-12 0.0-5.0	CLAYEY SAND with GRAVEL (SC) (A-2-4)		23	14	9			
⊙ WC-1 9.0	CLAYEY SAND (SC) (A-6)		29	16	13			
Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PV-9 0.0-5.0	25	0.377			14.7	42.0	43.3	
☒ PV-10 0.5-5.0	37.5	0.186			13.5	35.4	51.1	
▲ PV-11 0.7-5.0	37.5	1.358			24.2	41.1	34.7	
★ PV-12 0.0-5.0	25	1.379			21.4	47.7	31.0	
⊙ WC-1 9.0	0.075						43.4	



RockSol Consulting

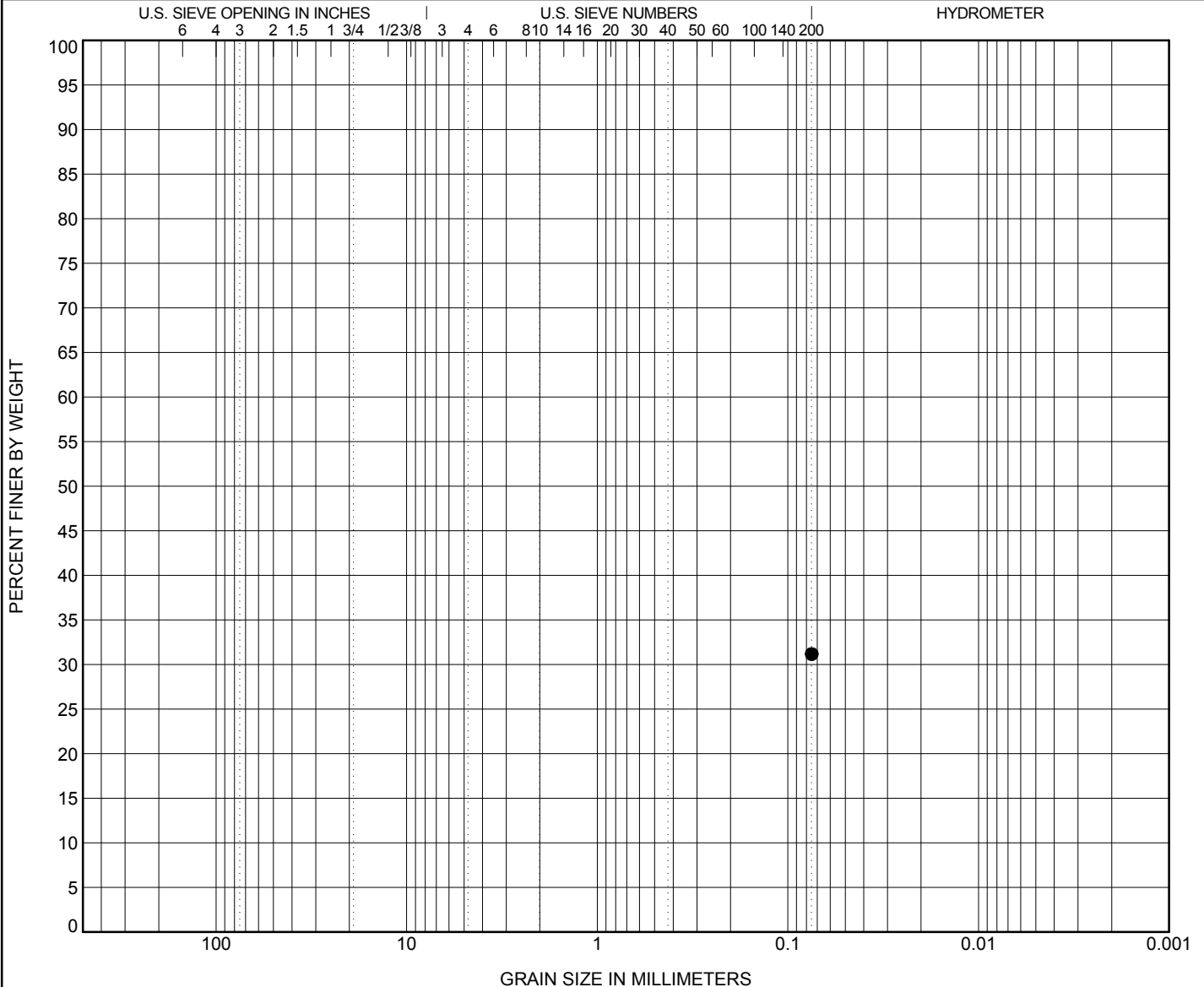
GRAIN SIZE DISTRIBUTION

CLIENT J.F. Sato

PROJECT NAME US 50 West, WB Preliminary Design

PROJECT NUMBER 302.02

PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado

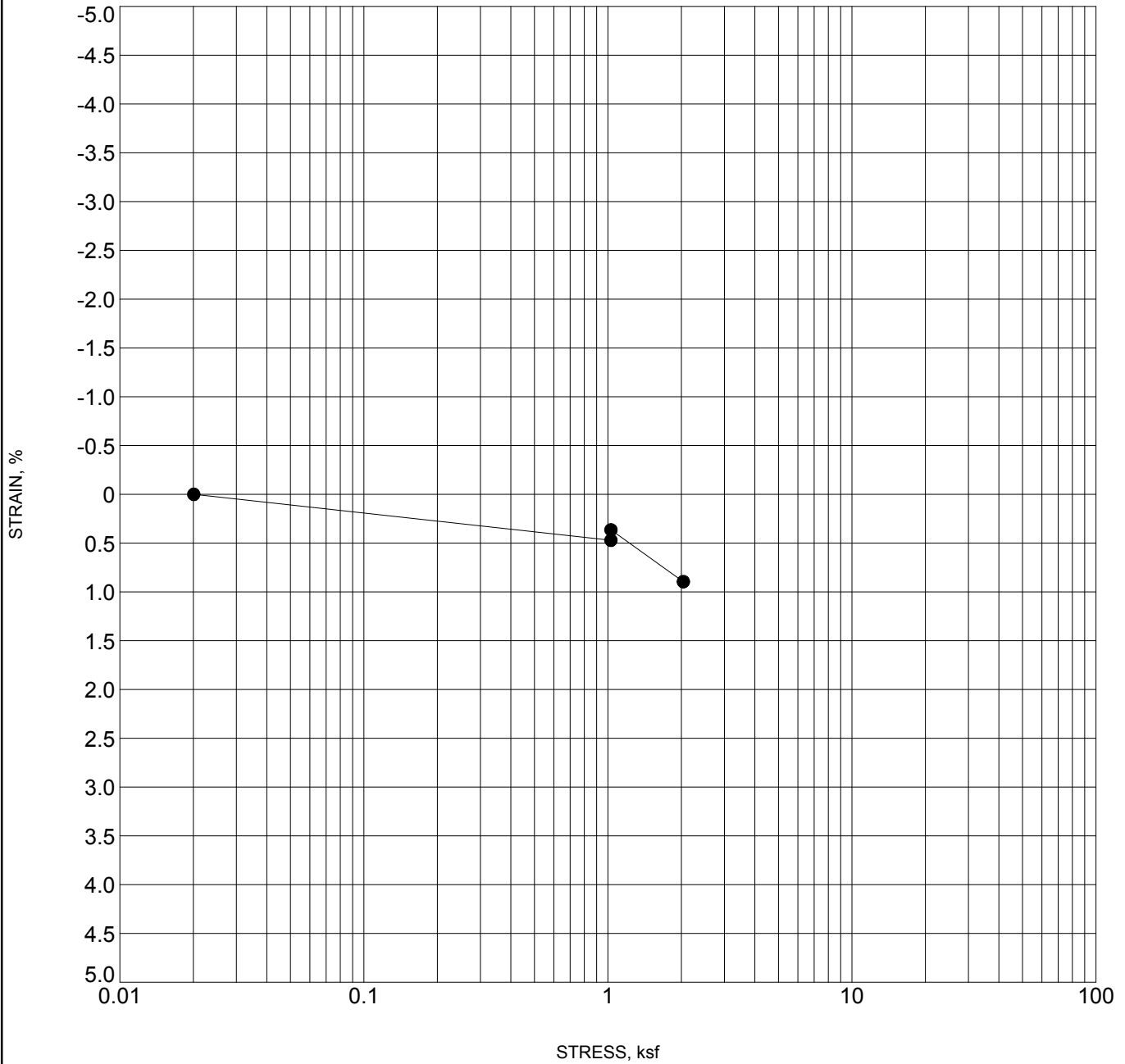


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification					LL	PL	PI	Cc	Cu
● WC-1 24.0	(Bedrock) SHALE									
Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay		
● WC-1 24.0	0.075						31.2			

GRADATION - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

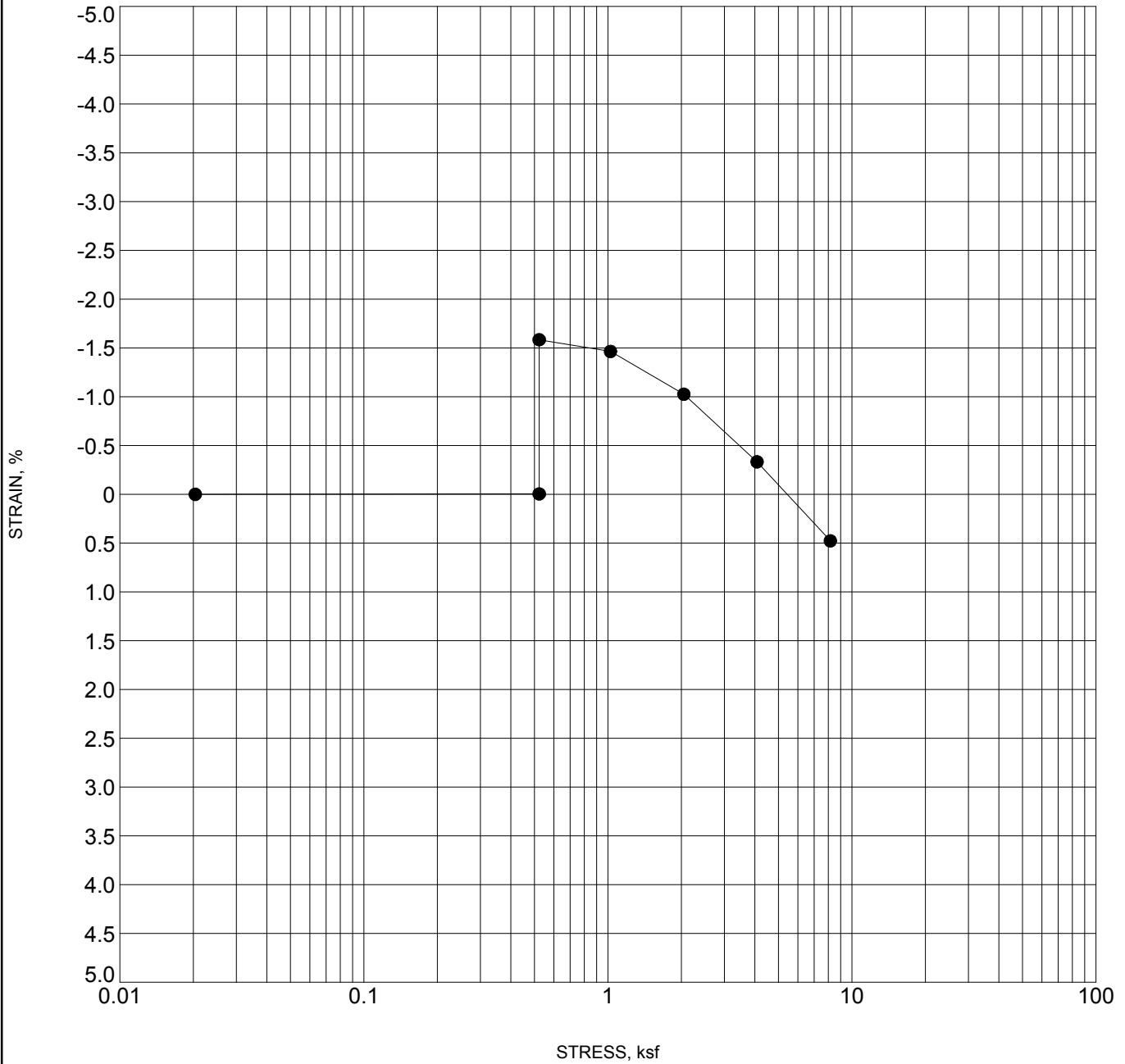
CLIENT J.F. Sato **PROJECT NAME** US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado



SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● BR-1 9	(Bedrock) SANDSTONE, clayey	0.1	123.1	10.2

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SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

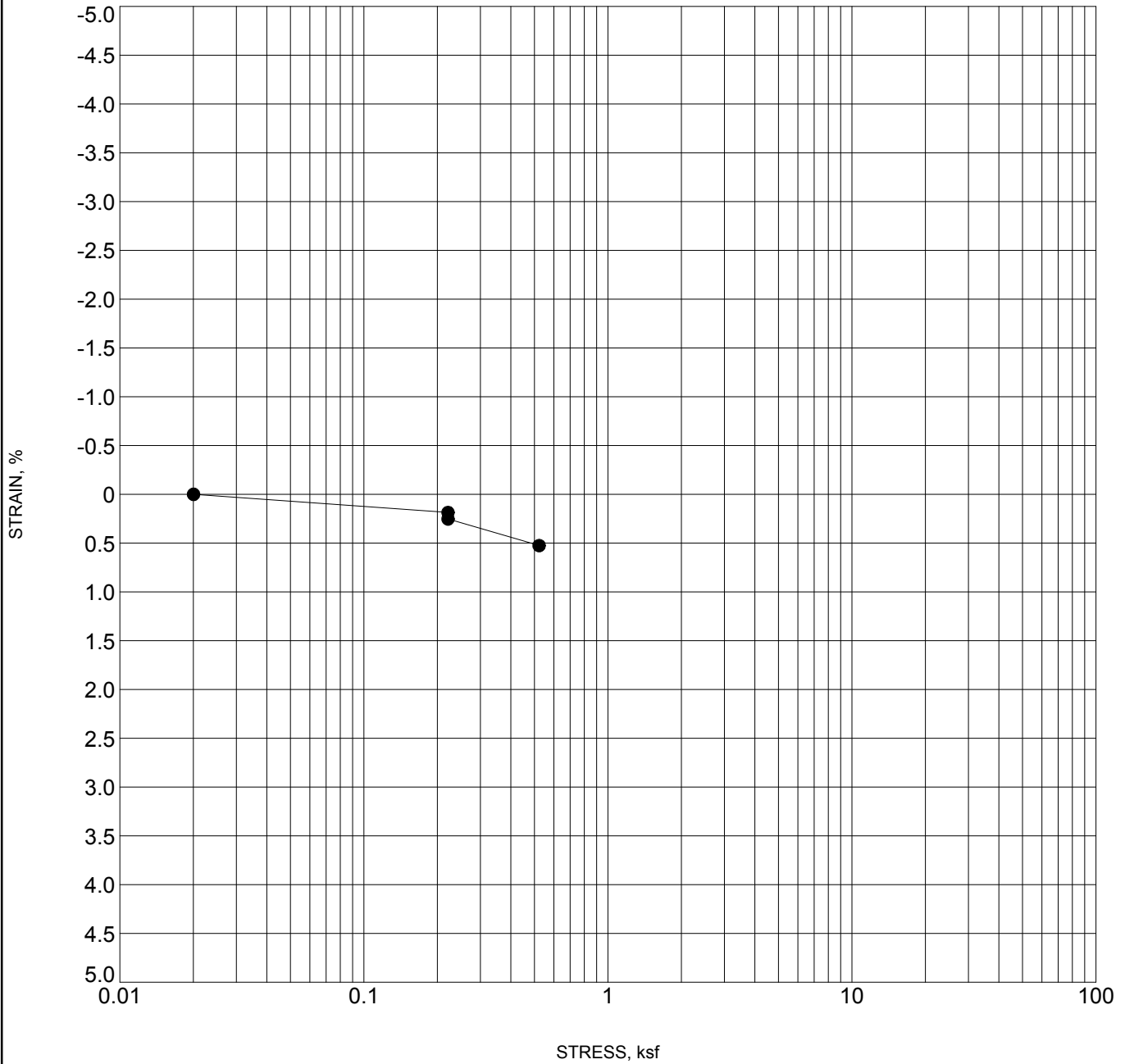
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● BR-2 4	(Bedrock) CLAYSTONE, sandy	1.6	126.4	12.7

CLIENT J.F. Sato

PROJECT NAME US 50 West, WB Preliminary Design

PROJECT NUMBER 302.02

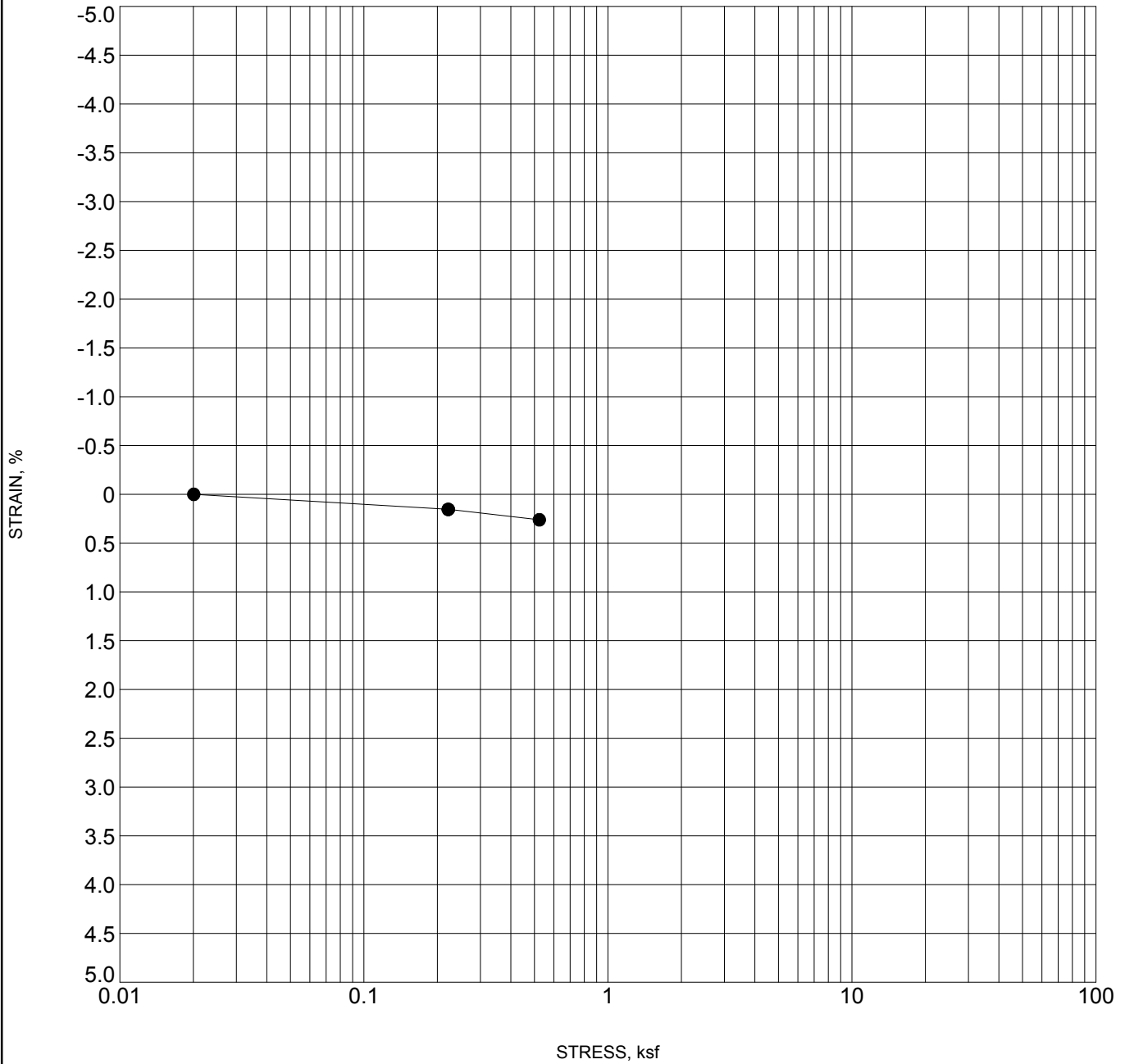
PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado



SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● PV-1 2	SAND, clayey	-0.1	108.7	15.7

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PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado



SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

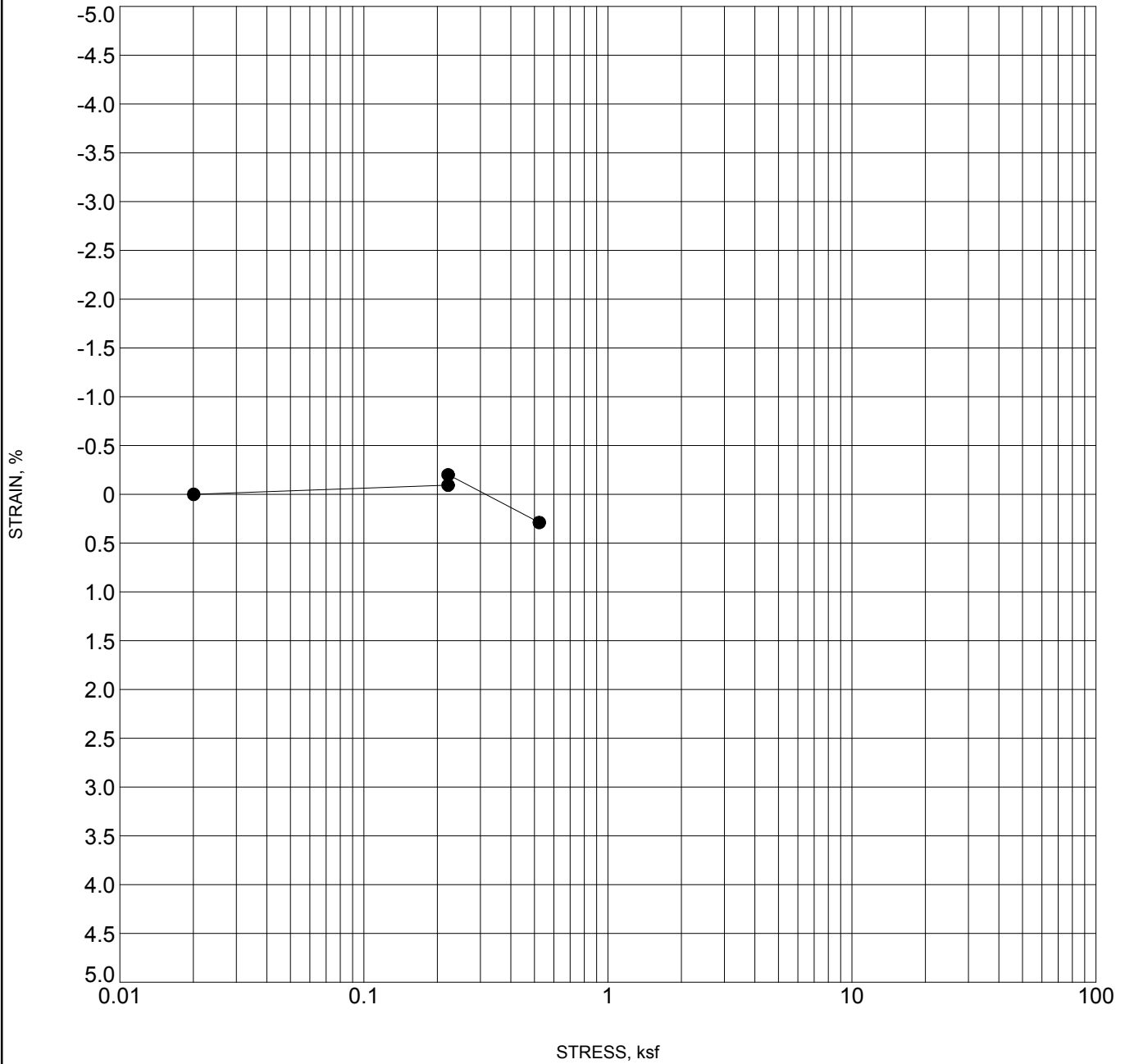
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● PV-2 2	(Fill) SAND, clayey	0.0	108.3	18.0

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SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

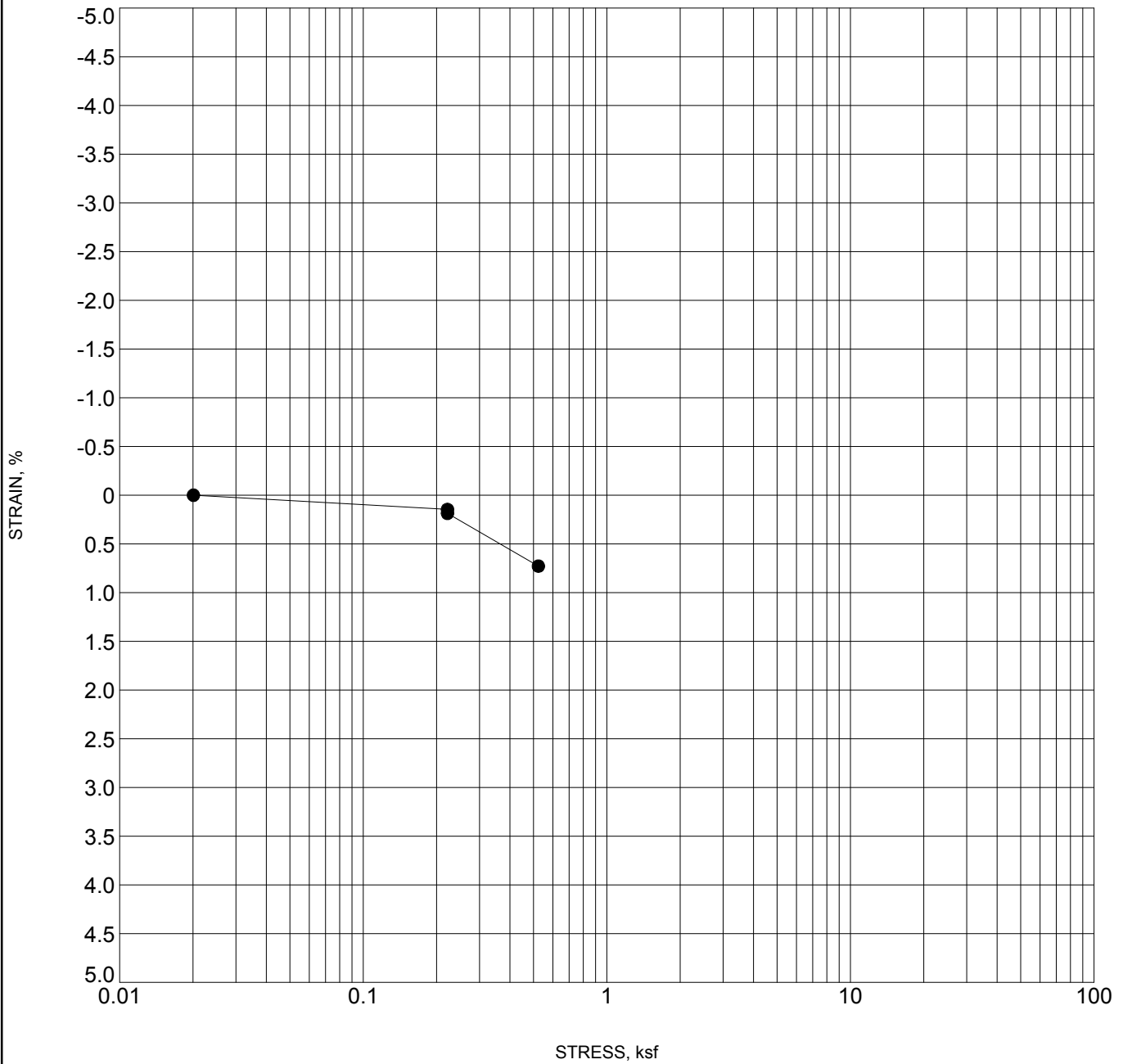
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● PV-3 2	(Native) CLAY, sandy	0.1	104.9	18.4

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PROJECT NUMBER 302.02

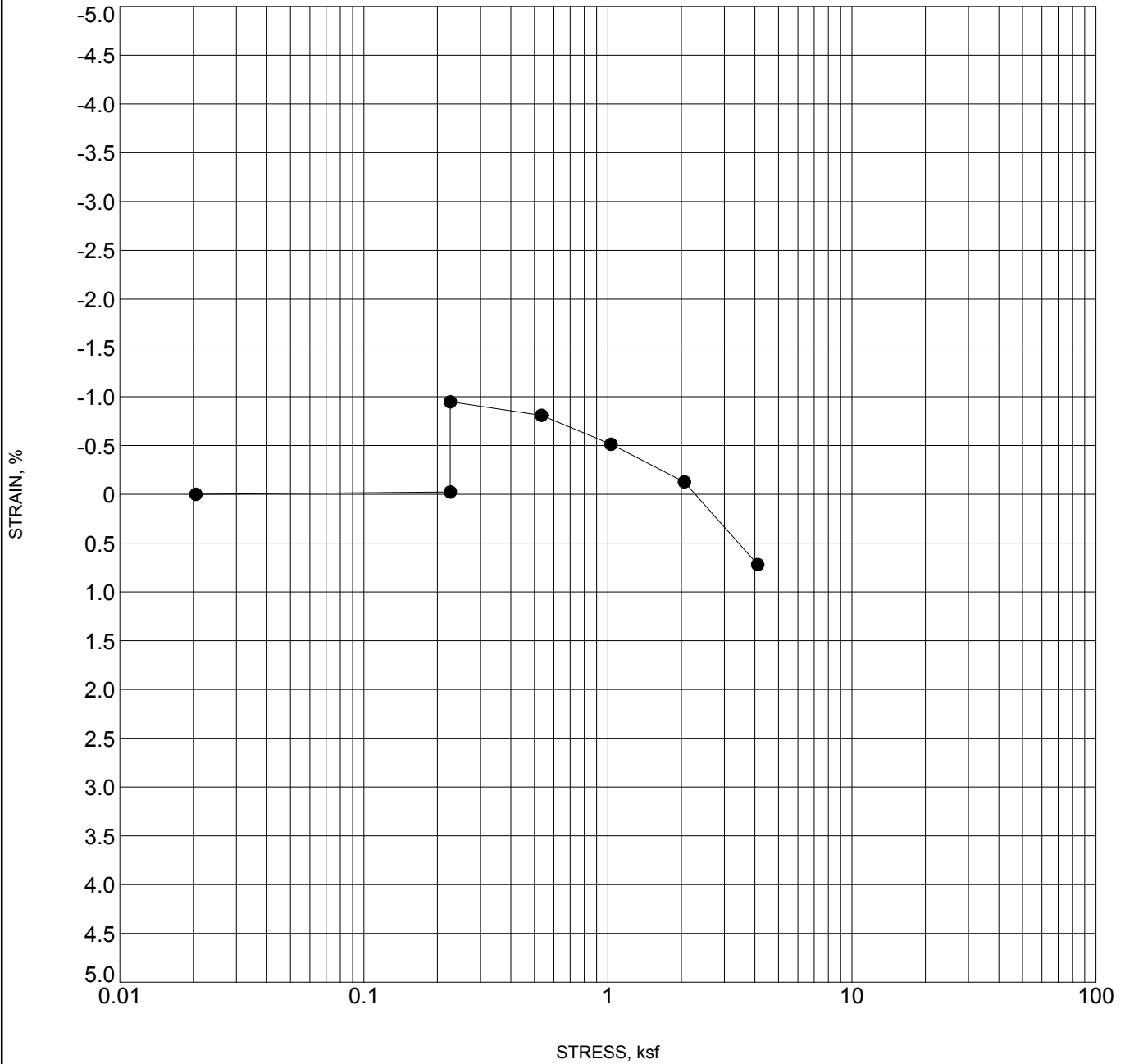
PROJECT LOCATION Wills Blvd. to Purcell Blvd., Pueblo, Colorado



SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● PV-4 2	(Fill) SAND, clayey	0.0	102.6	20.5

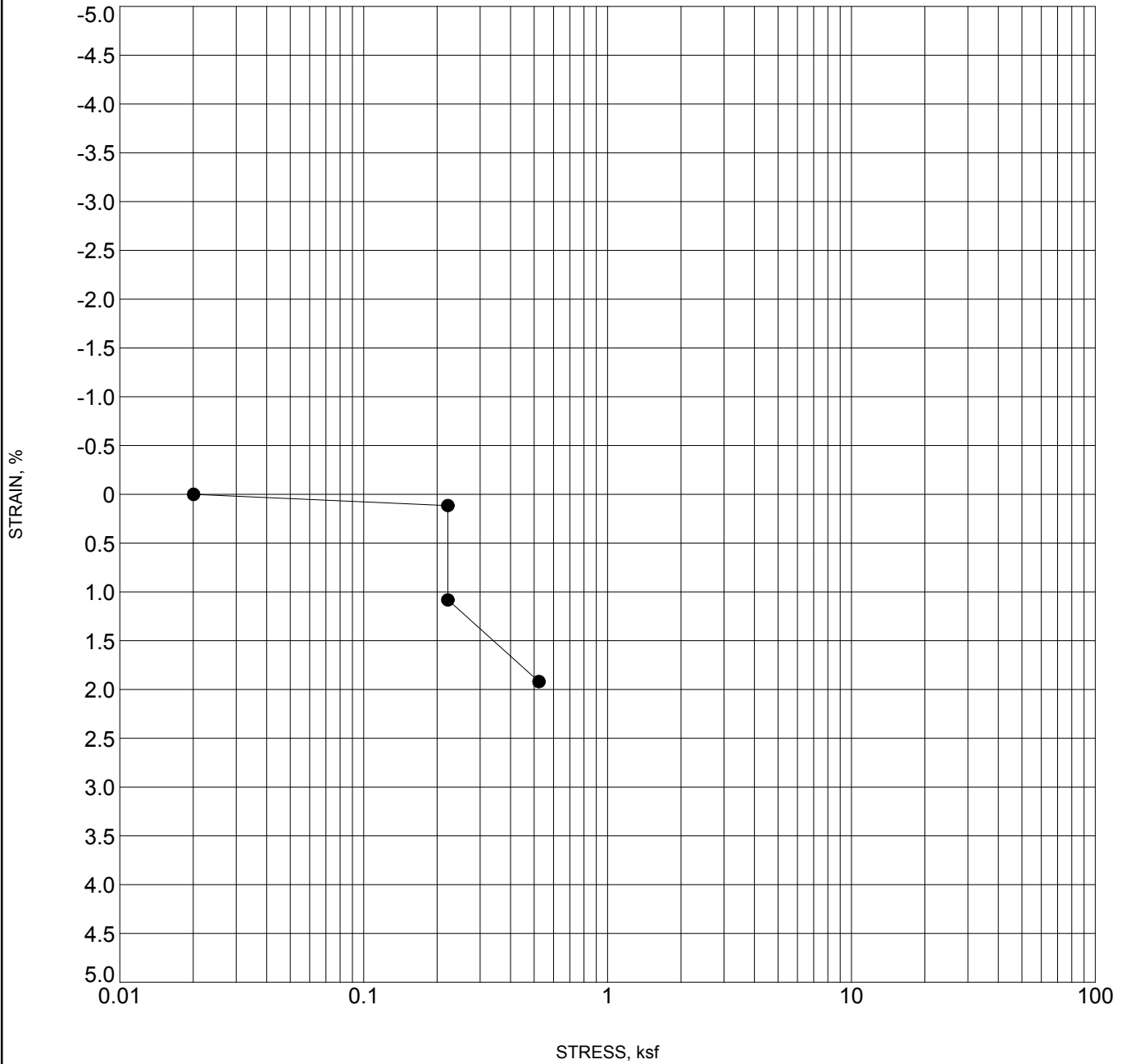
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PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado



SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● PV-5 2	(Fill) SAND, clayey with gravel	0.9	122.7	12.5

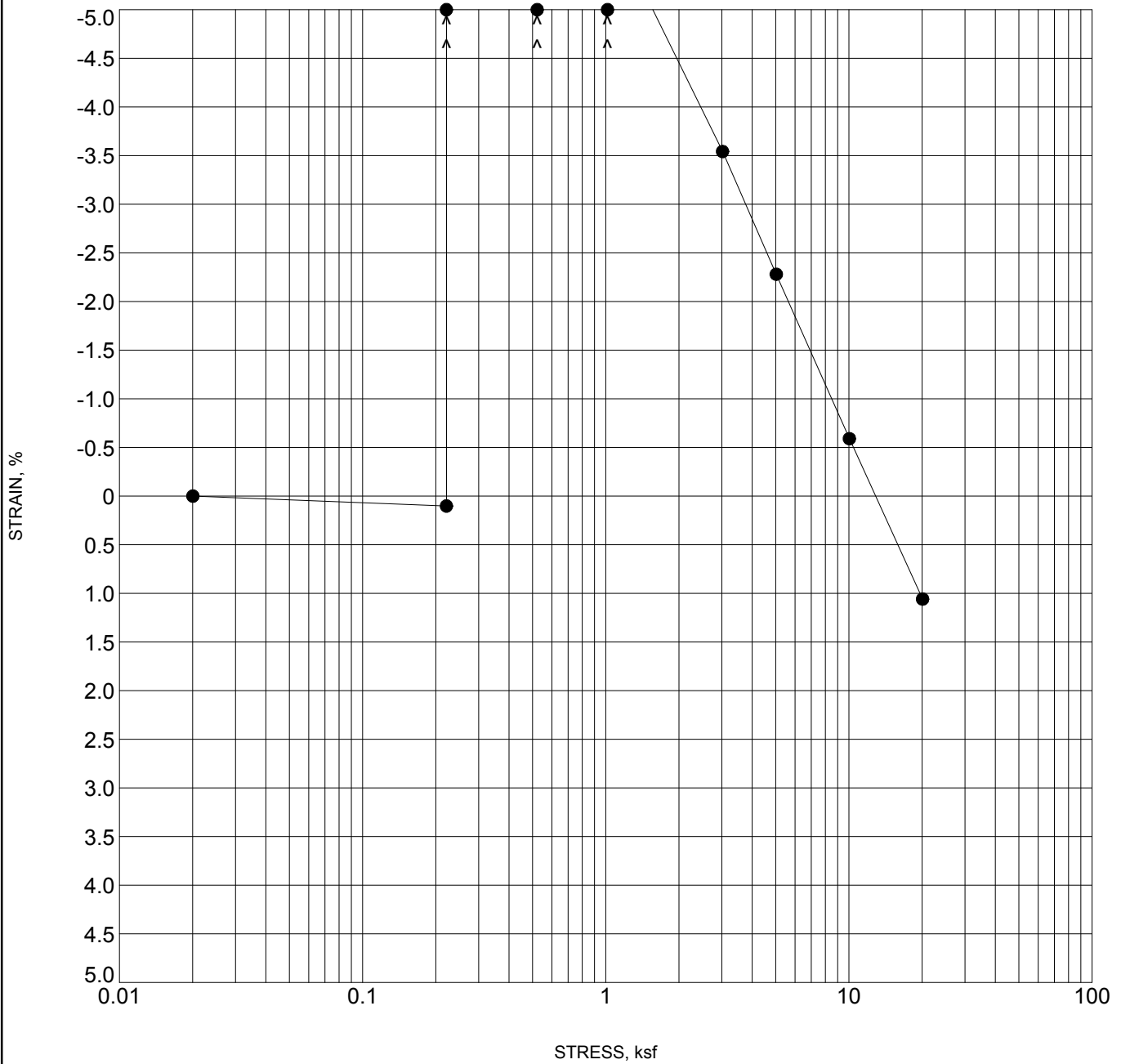
CLIENT J.F. Sato **PROJECT NAME** US 50 West, WB Preliminary Design
PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado



SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● PV-6 2	(Fill) SAND, silty to clayey with gravel	-1.0	123.1	4.8

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SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

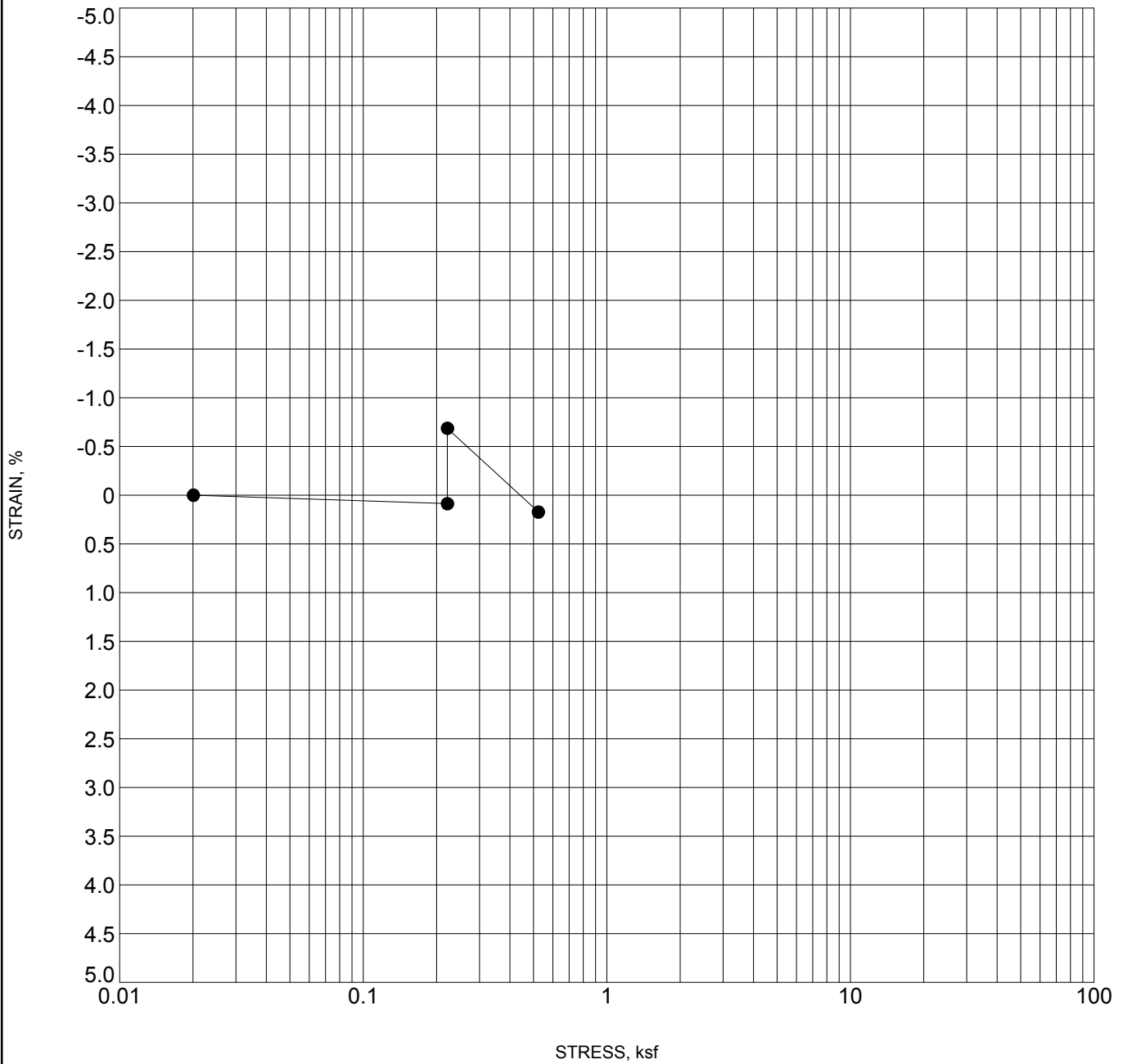
Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● PV-7 2	CLAY	7.5	124.0	9.9

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PROJECT NAME US 50 West, WB Preliminary Design

PROJECT NUMBER 302.02

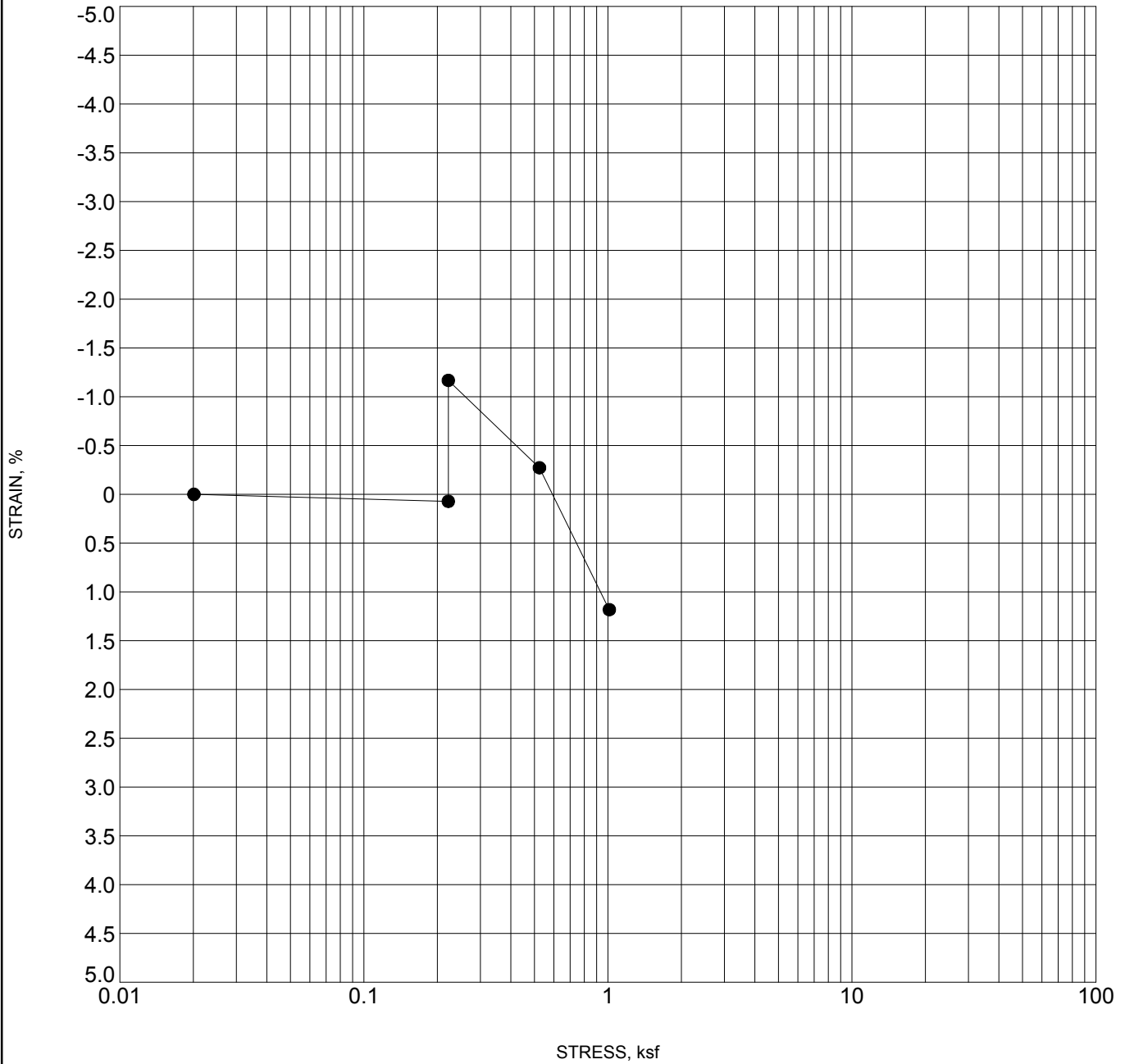
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SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● PV-8 2	CLAY, sandy	0.8	99.7	5.9

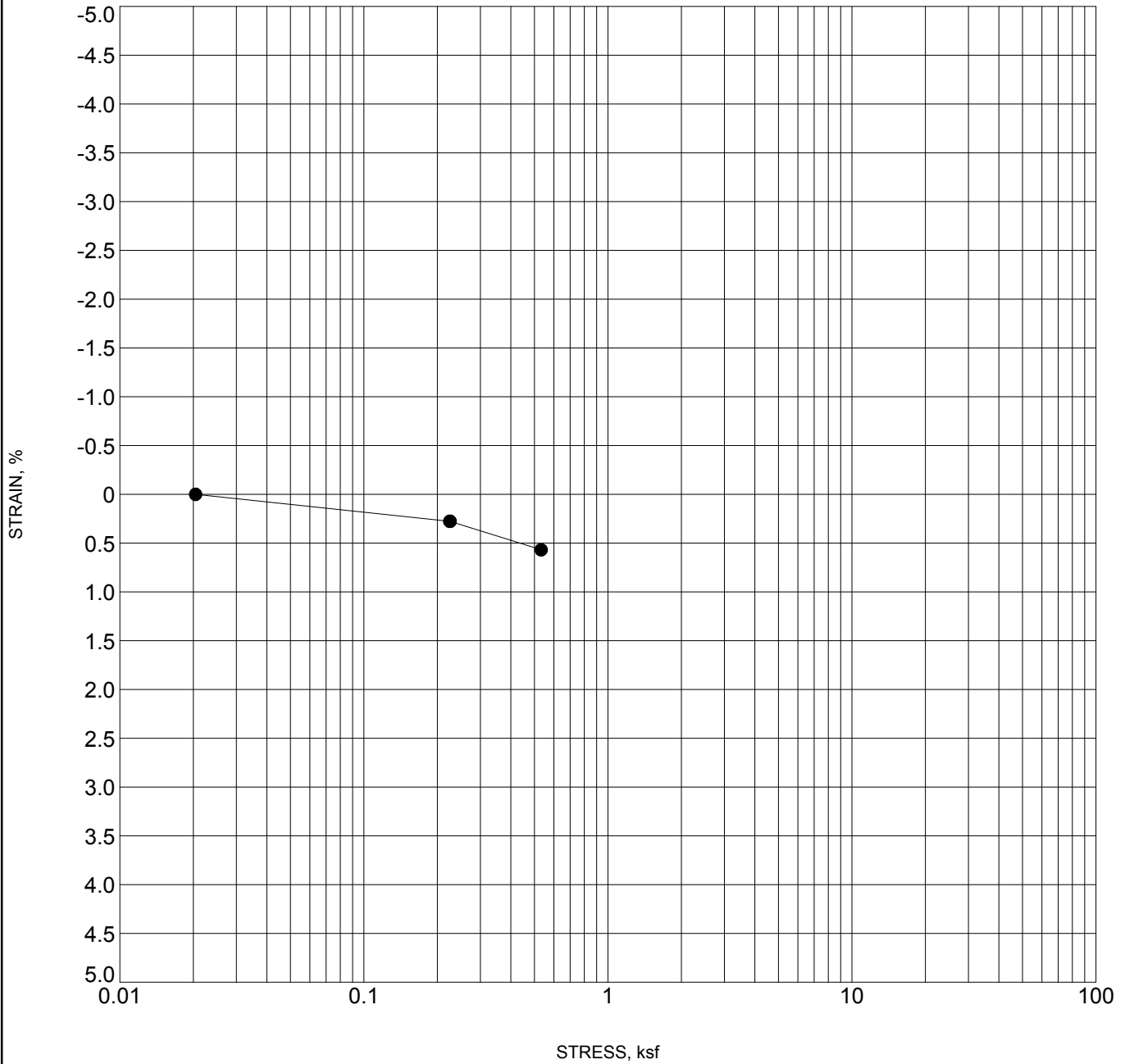
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SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● PV-9 2	SAND, silty to clayey	1.2	99.6	3.9

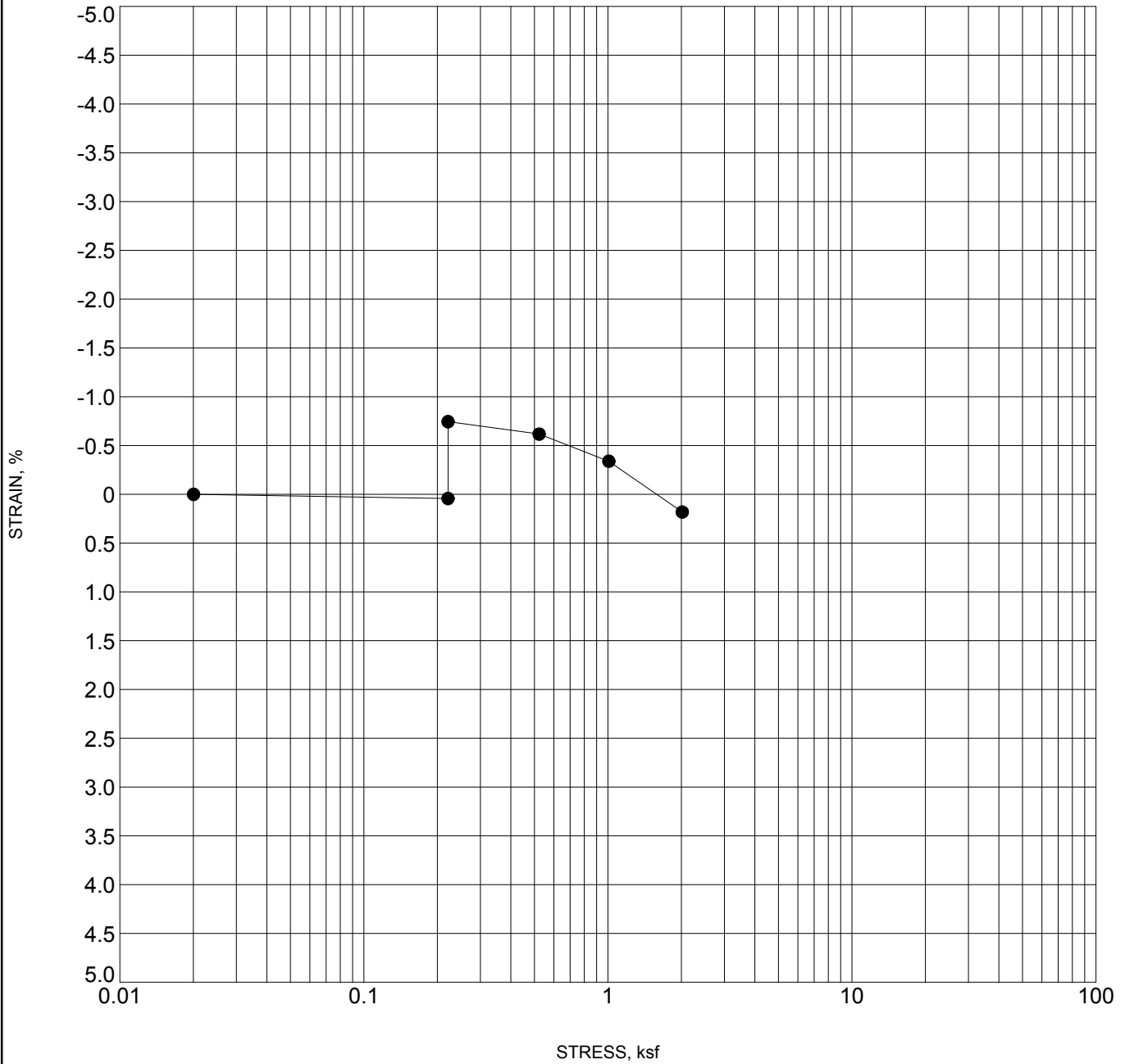
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SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● PV-10 2	(Native) CLAY, sandy	0.0	114.1	16.3

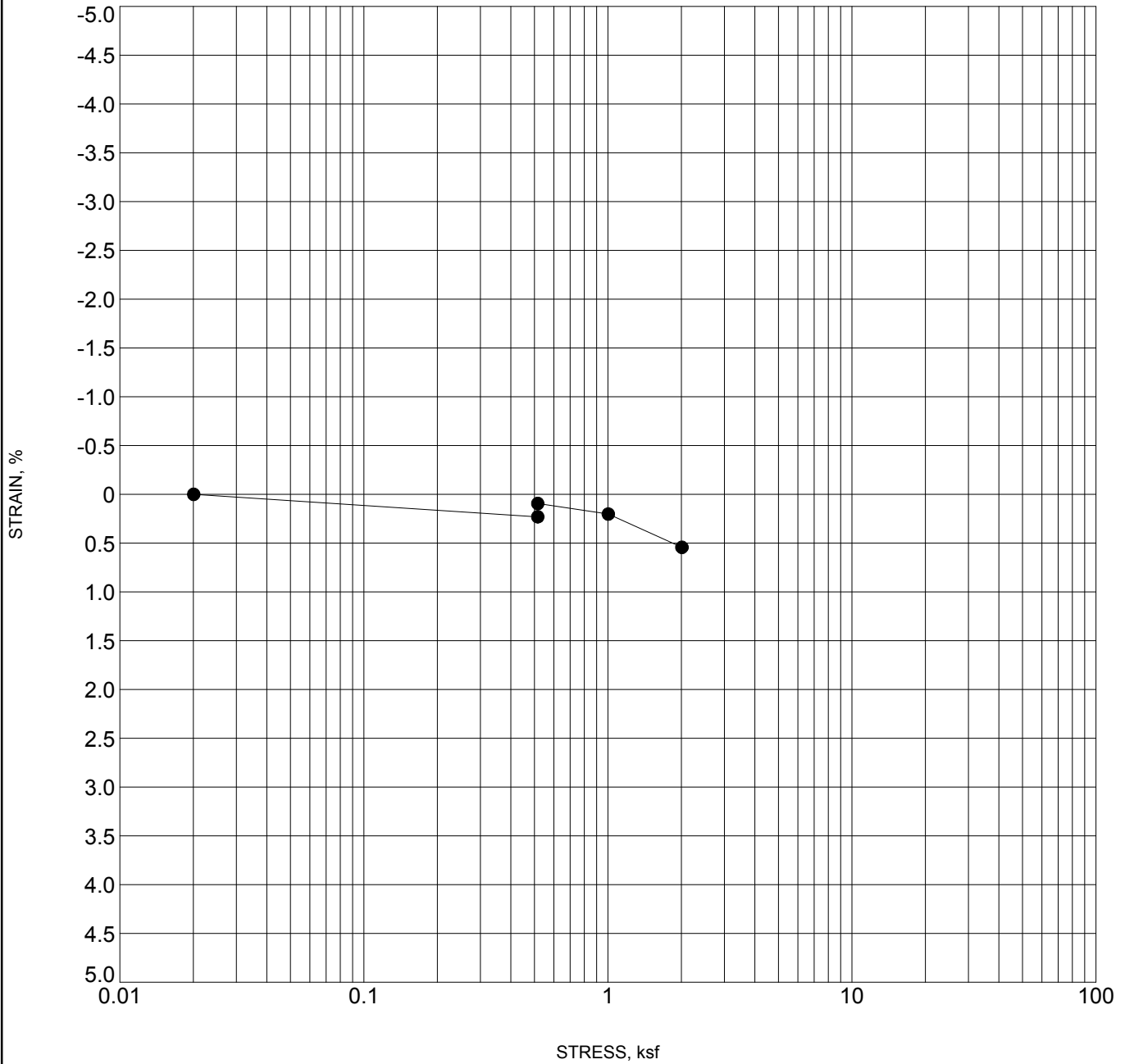
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SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● PV-11 2	SANDY CLAY	0.8	112.9	16.1

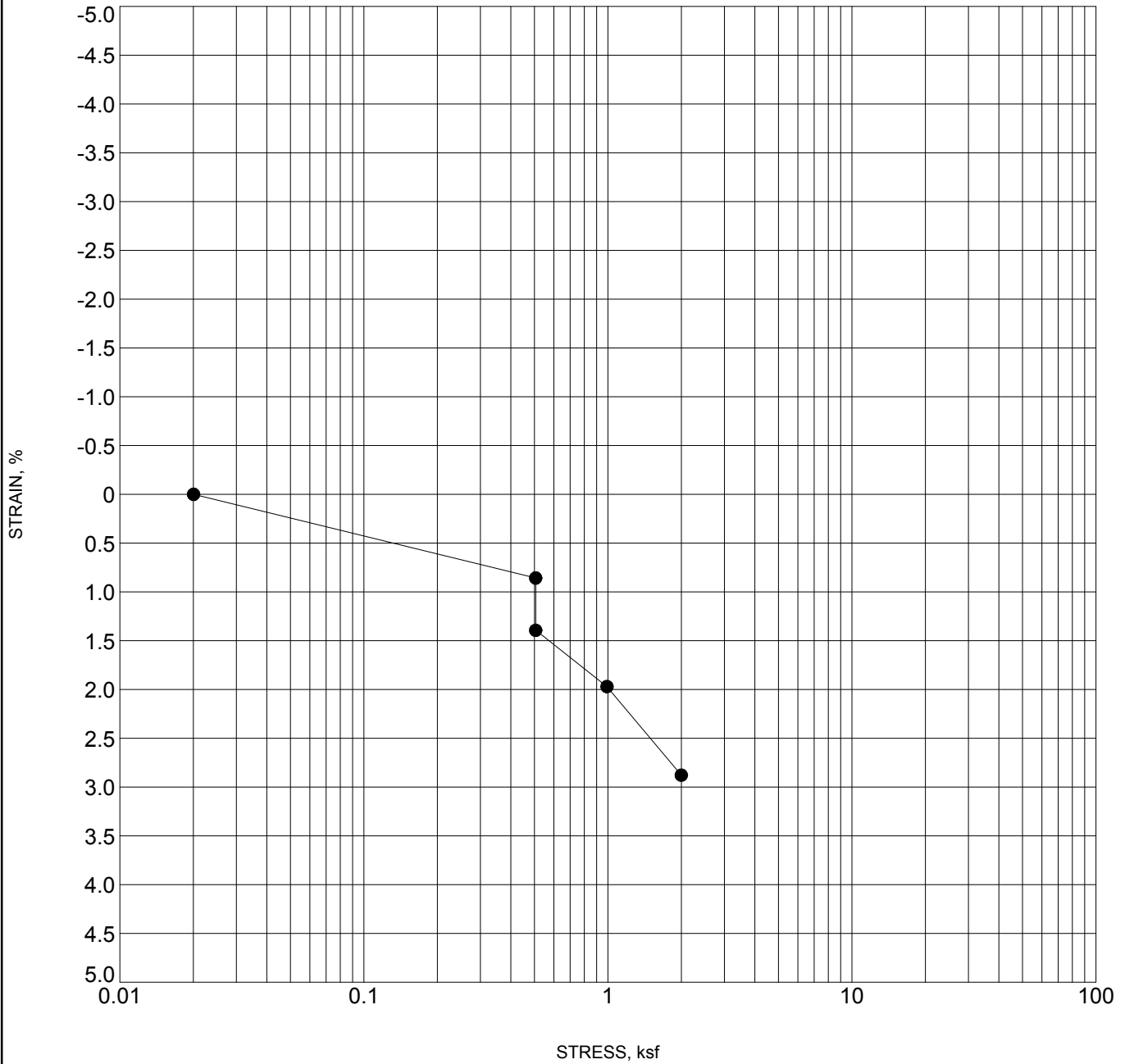
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SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● PV-11 4	SANDY CLAY	0.1	104.6	20.5

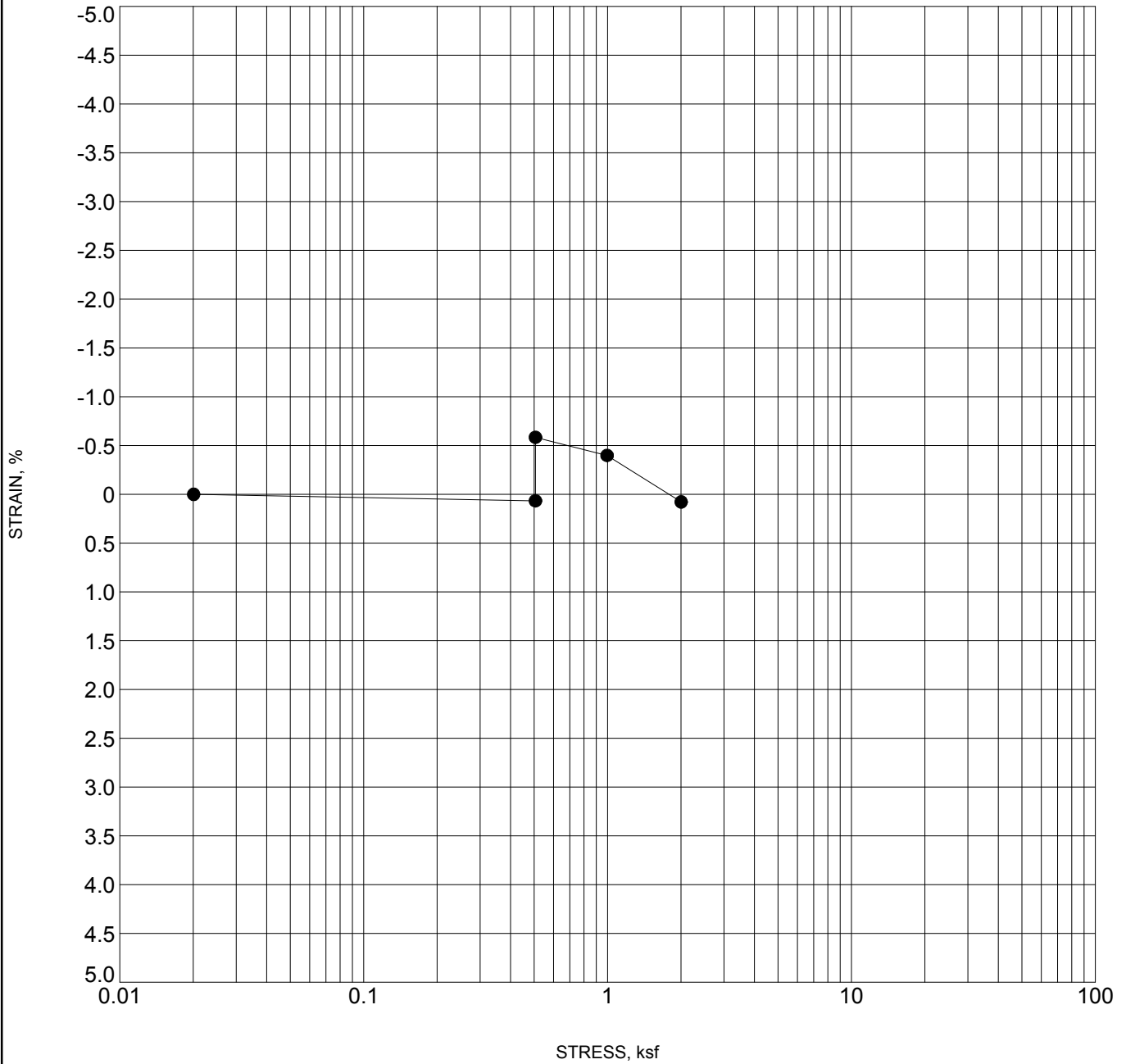
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SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● WC-1 14	(Native) CLAY, sandy with gravel	-0.5	111.5	15.9

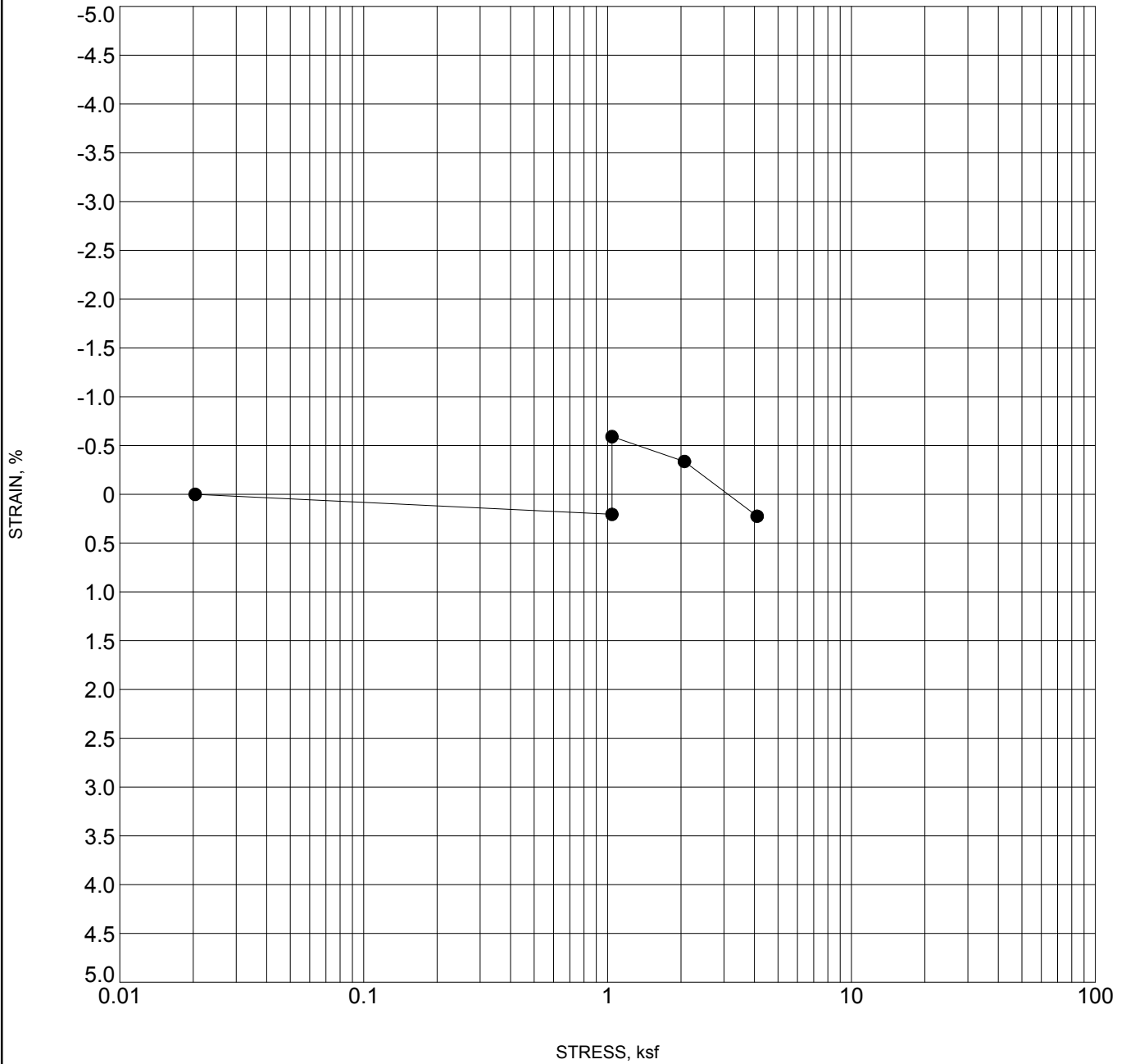
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PROJECT NUMBER 302.02 **PROJECT LOCATION** Wills Blvd. to Purcell Blvd., Pueblo, Colorado



SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● WC-2 9	CLAY, sandy	0.7	115.9	13.8

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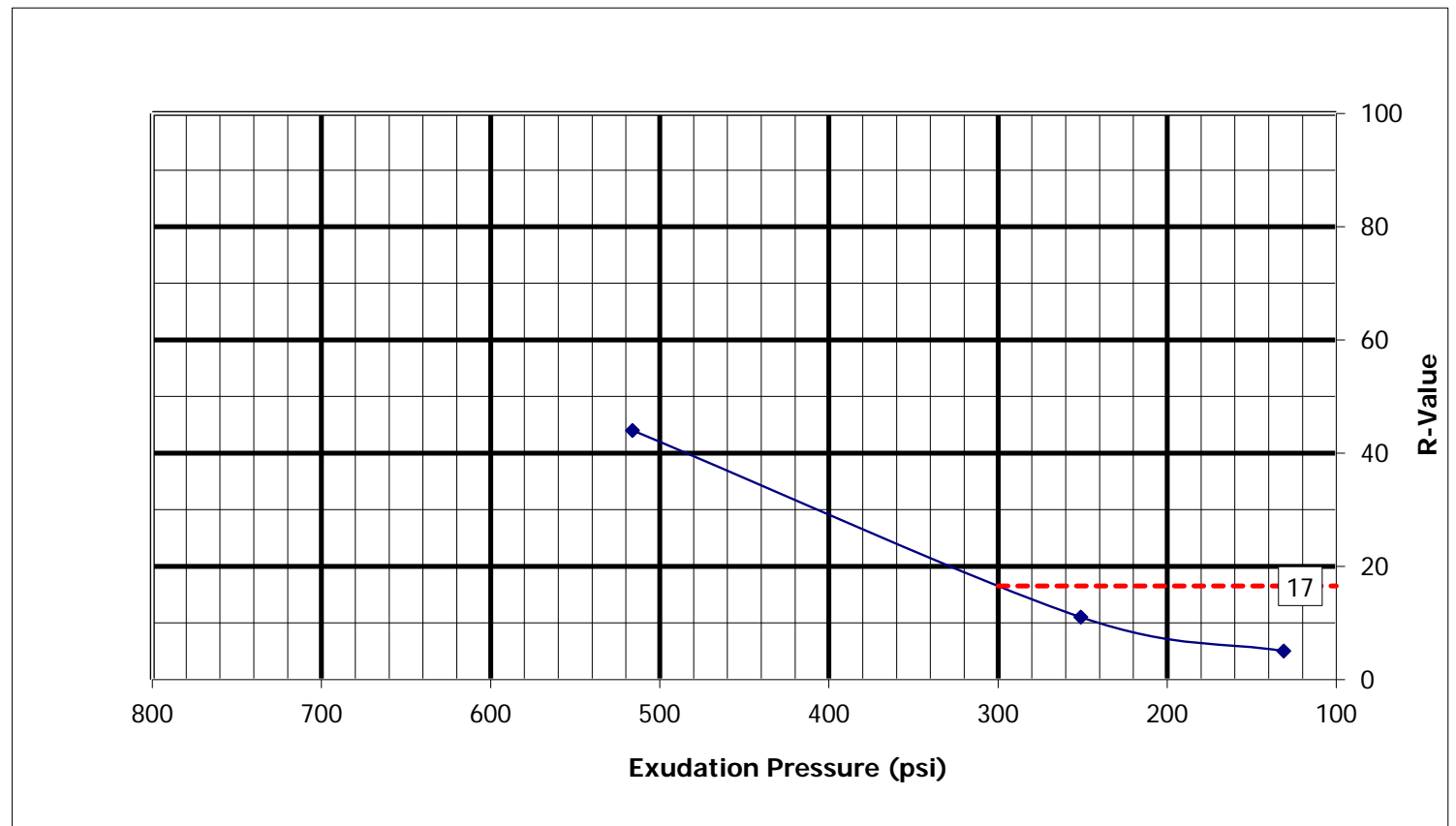


SWELL - STANDARD 302.02 US 50 WEST.GPJ ROCKSOL TEMPLATE.GDT 7/28/15

Specimen Identification	Classification	Swell/Consol. (%)	γ_d (pcf)	MC%
● WC-2 14	(Bedrock) SHALE	0.8	132.6	11.4

R-Value Test Graph (AASHTO T-190 / Colorado Procedure CP-L 3101)

Project Number:	15.024, Rocksol Consulting Group, LLC	Date:	29-Jun-15
Project Name:	US 50 W, Task order #5 (RockSol Project No. 302.02)	Technician:	DGB
Lab ID Number:	1521297	Reviewer:	RAZ
Sample Location:	WB US 50 - Composite sample PV-3, 4, 8, 10 at 1' to 5'		
Visual Description:	SAND, clayey, brown		



R-Value @ Exudation Pressure 300 psi: 17
Specification:

CDOT Pavement Design Manual, 2011.
Eq. 2.1 & 2.2, page 2-3.

$S_1 = [(R-5)/11.29] + 3$ $S_1 = 4.02$
 $M_R = 10^{[(S_1 + 18.72)/6.24]}$ $M_R = 4,406$
 M_R = Resilient Modulus, psi
 S_1 = the Soil Support Value
 R = the R-Value obtained

Test Specimen:	1	2	3
Moisture Content, %:	10.7	12.6	15.8
Expansion Pressure, psi:	1.06	0.33	-0.30
Dry Density, pcf:	119.8	115.5	108.7
R-Value:	44	11	5
Exudation Pressure, psi:	516	251	131

Note: The R-Value is measured; the M_R is an approximation from correlation formulas.