ENTECH
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SUBSURFACE SOIL INVESTIGATION
FREEDOM SPRINGS PERMANENT SUPPORTIVE HOUSING DEVELOPMENT
3.87 ACRE PARCEL
WESTERN & GREAT WESTERN DRIVES
COLORADO SPRINGS, COLORADO

Prepared for:

The Vecino Group
444 S. Campbell Avenue
Springfield, MO 65806

Attn: Chris Ball

February 12, 2018

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Daniel P. Stegman

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PROFESSIONAL ENGINEER

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Encl.

Entech Job No. 180088
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1.0 INTRODUCTION

The Vecino Group is planning the development a commercial building with a picnic area, community garden, playground, basketball court, parking, and parking areas and other associated site improvements located near the intersection of Western and Great Western Drives northeast of the intersection of Hathaway Dive and Western Drive, in the eastern portion of Colorado Springs, Colorado. The approximate location of the site is shown on the Vicinity Map, Figure 1. The planned layout of the proposed development is shown on Figure 2, Test Boring Location Map.

This report describes the subsurface investigation conducted for the planned development and provides recommendations for foundation design and construction. The subsurface soil investigation included drilling ten test borings on the site: five within the proposed building footprint, four in the parking areas, and one in the area of the proposed basketball court, collecting samples of soil, and conducting a geotechnical evaluation of the investigation findings. All drilling and subsurface investigation activities were performed by Entech Engineering, Inc. (Entech). The contents of this report, including the geotechnical evaluation and recommendations, are subject to the limitations and assumptions presented in Section 6.0.

2.0 PROJECT AND SITE DESCRIPTION

It is Entech Engineering, Inc. understanding that the project will consist of the development of the vacant parcel for the construction of a commercial permanent supportive housing development building with slab-on-grade floors and associated site improvements. The building area has a very gradual slope to the south. Vegetation is sparse consisting of weeds and grasses. Adjacent properties consist of existing commercial development to the west, multi-family development to the north and east, and Western Drive to the south. Building loads are expected to be moderate to heavy.

3.0 SUBSURFACE EXPLORATIONS AND LABORATORY TESTING

The subsurface conditions were investigated by drilling ten exploratory test borings: five in the footprint of the proposed building, one in the area of the basketball court, and four in the parking and drive areas. The borings were drilled to depths of 5 to 20 feet below the existing ground surface using a truck-mounted continuous flight auger-drilling rig supplied and operated by Entech Engineering, Inc. Boring Logs descriptive of the subsurface conditions encountered during drilling and subsequent to drilling are presented in Appendix A. At the conclusion of drilling, observations of groundwater levels were made in each of the open borings. The approximate locations of the test borings are indicated on Figure 2.

Soil samples were obtained from the borings utilizing the Standard Penetration Test (ASTM D-1586) using 2-inch O.D. split-barrel and California samplers. Results of the Standard Penetration Test (SPT) are included on the Test Boring Logs in terms of N-values expressed in blows per foot (bpf). Soil samples recovered from the borings were visually classified and recorded on the Test Boring Logs. The soil classifications were later verified utilizing laboratory testing and grouped by soil type. The soil type number is included on the Test Boring Logs. The Test Boring Logs are presented in Appendix A.

Water content testing (ASTM D-2216) was performed on the samples recovered from the borings, and the results are shown on the boring logs. Grain-Size Analysis (ASTM D-422) and Atterberg Limits Testing (ASTM D-4318) were performed on selected samples to assist in classifying the materials encountered in the borings. Soluble sulfate testing was performed on

select soil samples to evaluate the potential for below grade degradation of concrete due to sulfate attack. The laboratory testing results are summarized on Table 1 and are presented in Appendix B.

4.0 SUBSURFACE CONDITIONS

One soil type was encountered in the borings drilled for the subsurface investigation: Type 1; a slightly silty sand (SM-SW). Bedrock was not encountered in any of the test borings. The soil types were classified in accordance with the Unified Soil Classification System (USCS) using the laboratory testing results and the observations made during drilling.

4.1 Soil

Soil Type 1 classified as slightly silty sand (SM-SW). The sand was encountered in all the test borings at the existing ground surface and extending to the termination of the test borings (5 to 20 feet). Standard Penetration Testing on the sand resulted in SPT N-values of 8 to 26 blows per foot (bpf), indicating medium dense states. Water content and grain size testing resulted in water contents of approximately 4 to 15 percent with approximately 5 to 10 percent of the soil size particles passing the No. 200 sieve. Atterberg Limits testing on the sand resulted in liquid limits of no value and plastic indexes of being non-plastic. The soils likely exhibit a low expansive potential. Sulfate testing conducted on samples resulted in 0.00 to less than 0.01 percent soluble sulfate by weight, which indicates a negligible potential for below grade concrete degradation due to sulfate attack.

Additional descriptions and engineering properties of the soil encountered during drilling are included on the boring logs. Laboratory Testing Results are summarized on Table 1 and presented in Appendix B. It should be understood that the soil descriptions reported on the boring logs may vary between boring locations and sampling depths. Similarly, the lines of stratigraphic separation shown on the boring logs represent approximate boundaries between soil types and the actual transitions between types may be more gradual or variable.

4.2 Groundwater

Groundwater was not encountered in the test borings during or subsequent to drilling. Groundwater should not affect the construction of the shallow foundation with a slab-on-grade foundation proposed for this site. Development of this and adjacent properties, as well as seasonal precipitation changes, and changes in runoff may affect groundwater elevations.

5.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

The following discussion is based on the subsurface conditions encountered in the borings drilled in the planned building footprint. If subsurface conditions different from those described herein are encountered during construction or if the project elements change from those described, Entech Engineering, Inc. should be notified so that the evaluation and recommendations presented can be reviewed and revised if necessary.

The soils encountered on this site consisted of slightly silty sand. The sands were encountered at medium dense states and at slightly moist to very moist conditions. Although loose soils were not encountered in our test borings, areas of loose soils may be encountered in the building excavations or pavement subgrades. Loose zones, if encountered, should be penetrated to suitable underlying soils and recompacted in accordance to the "Structural Fill" paragraph to provide a uniform foundation subgrade. The proposed building is expected to have slab-on-grade type construction with no basement or below grade slab level. Given the subsurface conditions encountered at the time of drilling and the site development as described, a shallow foundation resting on the medium dense slightly silty sand or recompacted loose sands, is recommended. Design considerations are discussed in the following sections. Test Boring 10 was drilled in the sports court area. The soils encountered consisted of slightly silty sands. These soils will provide good support for a concrete or asphalt surface.

5.1 Subgrade Improvements and Bearing Capacity

The structure should be supported with a shallow foundation resting on the well-compacted slightly silty sand or recompacted loose silty sand. Loose soils, if encountered beneath foundation components or floor slabs, will require removal and recompaction. Expansive soils were not encountered on the site in the test borings. If expansive soils are encountered beneath

the foundation, they will require removal and replacement with non-expansive compacted structural fill. On-site granular sands may be used as structural fill, as approved by Entech Engineering, Inc.

Provided the above recommendations are followed, an allowable bearing pressure of 2400 psf is recommended for site sands and recompacted sands. For final design, continuous spread footings are recommended to have a minimum width of 16 inches, and individual column footings should have minimum plan dimensions of 24 inches on each side. Exterior footings should extend a minimum of 30 inches below the adjacent exterior surface grade for frost protection.

Following the above foundation subgrade preparation recommendations, and adhering to the recommended maximum allowable bearing pressure, it is expected to result in foundation designs, which should limit total and differential vertical movements up to 1 and ½ inches, respectively.

Foundation excavations are recommended to extend at least 4 feet horizontally beyond the foundation wall limits (inside and outside) in order to provide adequate space for installation of drain materials (if necessary) and placement of controlled fill, if required. All foundation excavation side slopes should be inclined at angles of $1^1/_2$ horizontal to 1 vertical or flatter, as necessary, to provide for excavation sidewall stability during construction or as required by OSHA regulations.

Entech should observe the foundation excavation subgrade to evaluate if the exposed conditions are consistent with those described in this report. Entech should also provide recommendations for overexcavation depth, if necessary, and the need for drain systems based on the excavation conditions observed at that time.

Foundation walls should be designed to resist lateral pressures generated by the soils on this site. An equivalent hydrostatic fluid pressure (in the active state) of 45 pcf is recommended for the site soils. It should be noted that these values apply to level backfill conditions. If sloping backfill conditions exist, pressures will increase substantially depending on the conditions

adjacent to the walls. Surcharge loading should also be considered in wall designs. Equivalent fluid pressures for sloping conditions should be determined.

5.2 Foundation Wall and Retaining Wall Design Values

The following values are recommended for use in designing below grade foundation walls with unbalanced lateral loading and retaining walls that may be associated with the project.

Recommended Design Values – Lateral Loading	
Equivalent fluid density for lateral earth pressure (active), pcf	45
Equivalent fluid density for lateral earth pressure (passive), pcf	300
Equivalent fluid density for lateral earth pressure (at rest), pcf	60
Soil density (compacted sand), pcf (requires import)	125
Angle of Internal Friction (loose sand), degrees	28
Angle of Internal Friction (compacted sand), degrees	34
Coefficient of sliding between concrete and silty sand	0.35

*Note: The above lateral loading design values are for level backslope angles and no surcharge loads. If wall backfill is submerged, water pressures must be taken into account as additional wall loading. If backfill slope angles are greater than zero degrees, if the backfill is surcharged, the design values must be adjusted to account for additional lateral loading. Appropriate drains should be installed.

5.3 Site Seismic Classification

Based on the subsurface conditions encountered at the site and in accordance with Section 1613 of the 2009 International Building Code (IBC), the site meets the conditions of a Site Class D.

5.4 On-Grade Floor Slabs

The floor slabs should be supported on well compacted sands. Loose sands encountered beneath floor slabs should be removed and recompacted. The floor slab subgrade should be scarified, moisture-conditioned, and compacted to 95 percent of Modified Proctor Density ASTM

D-1557. Backfill placed below floor slabs should be non-expansive and be compacted to a minimum of 95 percent of maximum Modified Proctor Dry Density (ASTM D- 1557).

Grade supported floor slabs should be separated from other building structural components and utility penetrations to allow for possible future vertical movement unless they are designed as part of the foundation system. Interior partition walls should be constructed in such a manner so as not to transfer slab movement into the overlying floor(s) and/or roof members, should slab movement occur. Control joints in grade-supported slabs are recommended and should be placed according to ACI Guidelines.

5.5 Surface and Subsurface Drainage

Positive surface drainage must be maintained around the structure to minimize infiltration of surface water. A minimum gradient of 5 percent in the first 10 feet adjacent to foundation walls is recommended. A minimum gradient of 2 percent is recommended for paved areas. All grades should be directed away from the structure. All downspouts should be extended to discharge well beyond the backfill zone of the structure.

A subsurface perimeter drain is not required providing the slab is located above exterior grade, interior and exterior backfill is properly compacted, surface grading is maintained and irrigation is minimized. A subsurface perimeter drain is recommended for useable space below finished grade. A typical drain detail is shown in Figure 3. The drain should be provided with a free gravity outlet or be connected to a sewer underdrain. If such an outlet or connection is not available within a reasonable distance from the structure, a sump and pump system would be required.

To help minimize infiltration of water into the foundation zone, vegetative plantings placed close to foundation walls should be limited to those species having low watering requirements and irrigated grass should not be located within 5 feet of the foundation. Similarly, sprinklers are not recommended to discharge water within 5 feet of foundations. Irrigation near foundations should be limited to the minimum amount sufficient to maintain vegetation. Application of more irrigation water than necessary can increase the potential for slab and foundation movement.

5.6 Concrete

Sulfate solubility testing was conducted on two selected soil samples to evaluate the potential for sulfate attack on concrete placed below surface grade. The test resulted in 0.00 to less than 0.01 percent soluble sulfate (by weight). The test results indicate the sulfate component of the in-place soil presents a low exposure threat to concrete placed below site grade.

Type II cement is recommended for concrete at this site. To further avoid concrete degradation during construction it is recommended that concrete not be placed on frozen or wet ground. Care should be taken to prevent the accumulation or ponding of water in the foundation excavation prior to the placement of concrete. If standing water is present in the foundation excavation, it should be removed by ditching to sumps and pumping the water away from the foundation area prior to concrete placement. If concrete is placed during periods of cold temperatures, the concrete must be kept from freezing. This may require covering the concrete with insulated blankets and adding heat to prohibit freezing.

5.7 Foundation Excavation Observation

Subgrade preparation for building foundations should be observed by Entech Engineering prior to construction of the footings and floor slab in order to verify that (1) no anomalies are present, (2) materials of the proper bearing capacity have been encountered or placed, and (3) no soft, loose, uncontrolled fill material, expansive soil or debris are present in the foundation area prior to concrete placement or backfilling. Entech should make final recommendations for over-excavation, if required, and foundation drainage at the time of excavation observation, if necessary.

5.8 Structural Fill

Areas to receive fill should have all topsoil, organic material or debris removed. Fill must be properly benched. The surface should be scarified and moisture conditioned to within 0 to +2 percent of its optimum moisture content and compacted to 95 percent of its maximum Modified Proctor Dry Density (ASTM D-1557) beneath footings or floor slabs prior to placing new fill. New fill beneath footings should be non-expansive and be placed in thin lifts not to exceed 6 inches after compaction while maintaining at least 95 percent of its maximum Modified Proctor Dry Density (ASTM D-1557). These materials should be placed at a moisture content

conducive to compaction, usually ±2 percent of Proctor optimum moisture content. The placement and compaction of fill should be observed and tested by Entech Engineering, Inc. Imported soils should be approved by Entech Engineering, Inc. prior to being hauled to the site and on-site granular soils prior to placement.

Compacted, non-expansive granular soil, free of organics, debris and cobbles greater than 3-inches in diameter, is recommended for filling foundation components and for filling beneath floor slabs. All fill placed within the foundation area should be non-expansive and be compacted to a minimum of 95 percent of the soils maximum dry density as determined by the Modified Proctor Test (ASTM D-1557).

Fill material placed beneath floor slabs should be compacted to a minimum of 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557. Fill material should be placed in horizontal lifts such that each finished lift has a compacted thickness of six inches or less. Fill should be placed at water contents conducive to achieving adequate compaction, usually within ±2 percent of the optimum water content as determined by ASTM D-1557. Mechanical methods can be used for placement and compaction of fill; however, heavy equipment should be kept at distance from foundation walls and below slab infrastructure to avoid overstressing. No water flooding techniques of any type should be used for compaction or placement of foundation or floor slab fill material.

5.9 Utility Trench Backfill

Fill placed in utility trenches should be compacted to a minimum of 95 percent of its maximum dry density as determined by the Standard Proctor Test (ASTM D-698) for cohesive soils and 95 percent as determined by the Modified Proctor Test (ASTM D-1557) for cohesionless soils. Fill should be placed in horizontal lifts having a compacted thickness of six inches or less and at a water content conducive to adequate compaction, within ±2 percent of the optimum water content. Mechanical methods should be used for fill placement; however, heavy equipment should be kept at a distance from foundation walls. No water flooding techniques of any type should be used for compaction or placement of utility trench fill.

Trench backfill placement should be performed in accordance with City of Colorado Springs specifications. All excavation and excavation shoring/bracing should be performed in accordance with OSHA guidelines.

5.10 General Backfill

Any areas to receive fill outside the foundation limits should have all topsoil, organic material, and debris removed. Fill must be properly benched into existing slopes in order to be adequately compacted. The fill receiving surface should be scarified to a depth of 12-inches and moisture conditioned to ± 2 percent of the optimum water content, and compacted to a minimum of 95 percent of the ASTM D-1557 maximum dry density before the addition of new fill. Fill should be placed in thin lifts not to exceed 6 inches in thickness after compaction while maintaining at least 95 percent of the ASTM D-1557 maximum dry density.

Fill material should be free of vegetation and other unsuitable material and shall not contain rocks or fragments greater than 3-inches. Topsoil and strippings should be segregated from all other fill sources on the site. Fill placement and compaction beneath and around foundations, in utility trenches, beneath roadways or other structural features of the project should be observed and tested by Entech during construction.

5.11 Excavation Stability

Excavation sidewalls must be properly sloped, benched and/or otherwise supported in order to maintain stable conditions. All excavation openings and work completed therein shall conform to OSHA Standards as put forward in CFR 29, Part 1926.650-652, (Subpart P).

5.12 Winter Construction

In the event construction of the planned facility occurs during winter, foundations and subgrades should be protected from freezing conditions. Concrete should not be placed on frozen soil and once concrete has been placed, it should not be allowed to freeze. Similarly, once exposed, the foundation subgrade should not be allowed to freeze. During site grading and subgrade preparation, care should be taken to avoid burial of snow, ice or frozen material within the planned construction area.

5.13 Construction Observations

It is recommended that Entech observe and document the following activities during construction of the building foundations.

- Excavated subgrades and subgrade preparation.
- Placement of drains (if installed).
- Placement/compaction of fill material for the foundation components or floor slab.
- Placement/compaction of utility bedding and trench backfill.

6.0 CLOSURE

The subsurface investigation, geotechnical evaluation and recommendations presented in this report are intended for use by The Vecino Group, with application to the planned commercial building to be located at the intersection of Western and Great Western Drives which is northeast of the intersection of Hathaway Drive and Western Drive, in the eastern portion of Colorado Springs, Colorado. In conducting the subsurface investigation, laboratory testing, engineering evaluation and reporting, Entech Engineering, Inc. endeavored to work in accordance with generally accepted professional geotechnical and geologic practices and principles consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession currently practicing in same locality and under similar conditions. No other warranty, expressed or implied is made. During final design and/or construction, if conditions are encountered which appear different from those described in this report, Entech Engineering, Inc. requests that it be notified so that the evaluation and recommendations presented herein can be reviewed and modified as appropriate.

If there are any questions regarding the information provided herein or if Entech Engineering, Inc. can be of further assistance, please do not hesitate to contact us.

TABLE

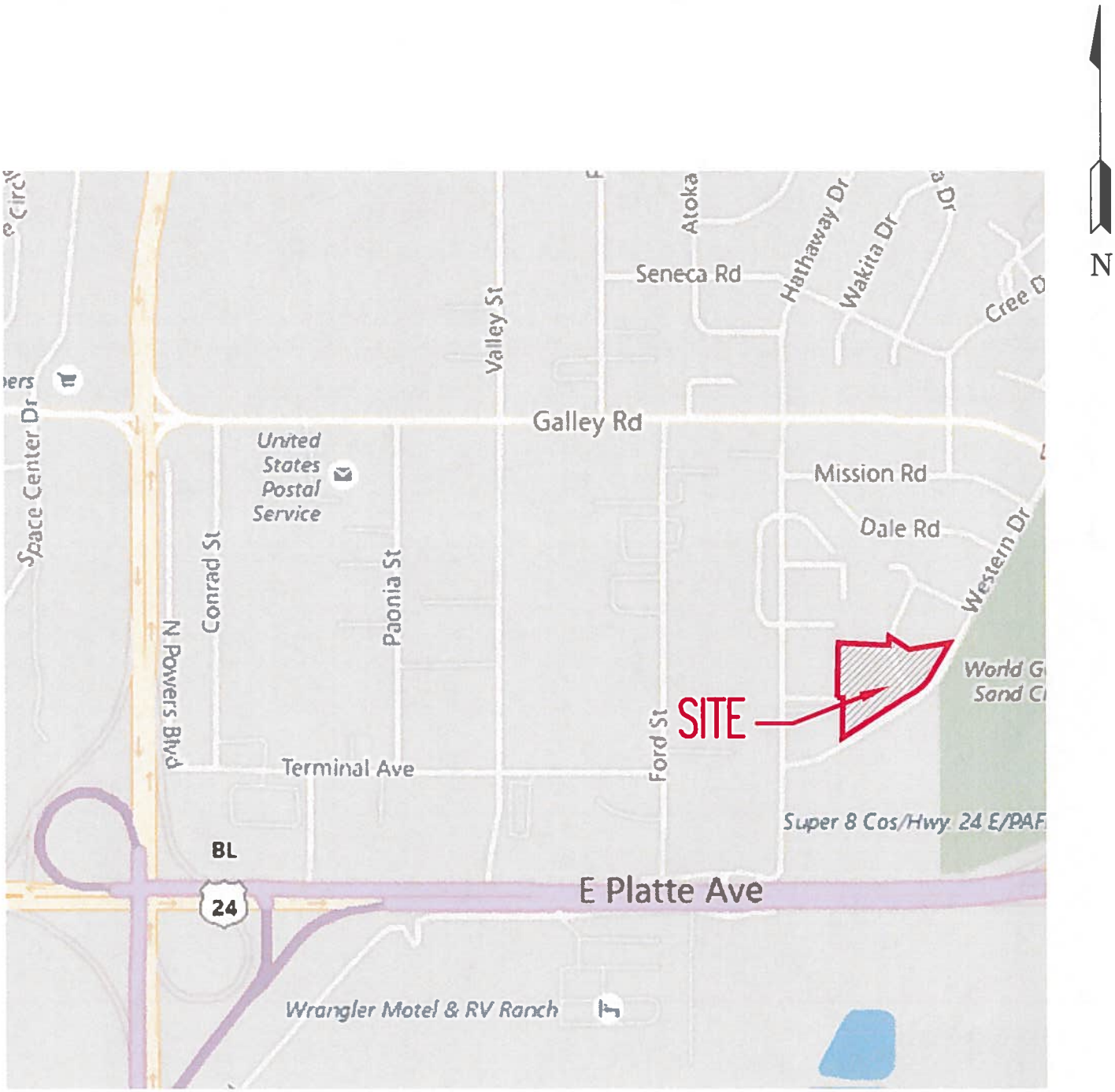
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT THE VECINO GROUP
PROJECT WESTERN & GREAT WESTERN
JOB NO. 180088

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	FHA SWELL (PSF)	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	1	2-3			9.2	NV	NP				SM-SW	SAND, SLIGHTLY SILTY
1	2	5			9.4	NV	NP				SM-SW	SAND, SLIGHTLY SILTY
1	3	10			6.1			<0.01			SM-SW	SAND, SLIGHTLY SILTY
1	4	5			5.8						SM-SW	SAND, SLIGHTLY SILTY
1	5	2-3			7.4						SM-SW	SAND, SLIGHTLY SILTY
1, CBR #1	6	0-3			9.9	NV	NP				SM-SW	SAND, SLIGHTLY SILTY
1	6	1-2			9.8	NV	NP	0.00			SM-SW	SAND, SLIGHTLY SILTY
1	7	1-2			7.4	NV	NP				SM-SW	SAND, SLIGHTLY SILTY
1	8	1-2			9.5	NV	NP				SM-SW	SAND, SLIGHTLY SILTY
1	9	1-2			5.2	NV	NP				SM-SW	SAND, SLIGHTLY SILTY
1	10	1-2			7.2	NV	NP				SM-SW	SAND, SLIGHTLY SILTY

FIGURES



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VICINITY MAP
HATHAWAY DR. AND WESTERN DR.
COLORADO SPRINGS, CO
FOR: THE VECINO GROUP

DRAWN BY:	DATE DRAWN:	DESIGNED BY:	CHECKED:
WM	1/30/18	SC	

JOB NO.: 180088

FIG. NO.: 1

TB-2- APPROXIMATE TEST BORING LOCATION AND NUMBER

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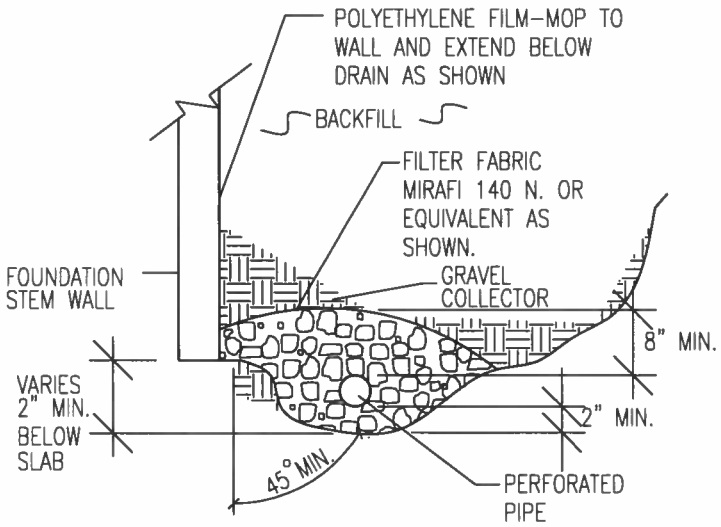
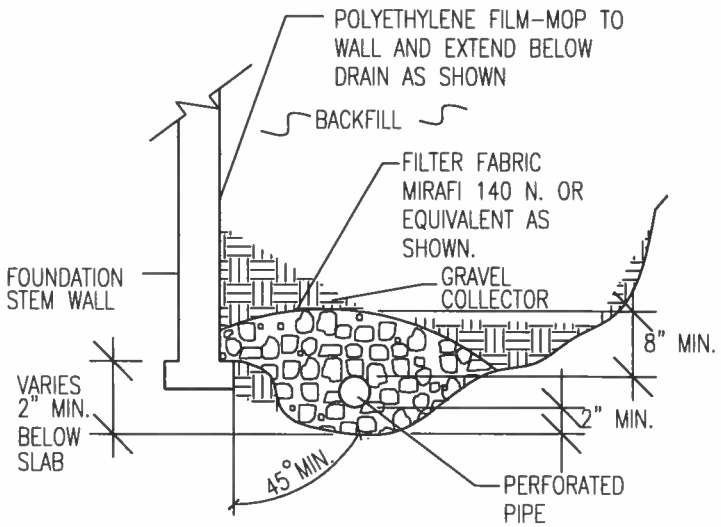
TEST BORING LOCATION MAP
HATHAWAY DR. AND WESTERN DR.
COLORADO SPRINGS, CO
FOR: THE VECINO GROUP

DRAWN BY:	DATE DRAWN:	DESIGNED BY:	CHECKED:
WM	1/30/18	SC	

JOB NO.: 180088

FIG. NO.: 2





NOTES:

-GRAVEL SIZE IS RELATED TO DIAMETER OF PIPE PERFORATIONS-85% GRAVEL GREATER THAN 2x PERFORATION DIAMETER.

-PIPE DIAMETER DEPENDS UPON EXPECTED SEEPAGE. 4-INCH DIAMETER IS MOST OFTEN USED.

-ALL PIPE SHALL BE PERFORATED PLASTIC. THE DISCHARGE PORTION OF THE PIPE SHOULD BE NON-PERFORATED PIPE.

-FLEXIBLE PIPE MAY BE USED UP TO 8 FEET IN DEPTH, IF SUCH PIPE IS DESIGNED TO WITHSTAND THE PRESSURES. RIGID PLASTIC PIPE WOULD OTHERWISE BE REQUIRED.

-MINIMUM GRADE FOR DRAIN PIPE TO BE 1% OR 3 INCHES OF FALL IN 25 FEET.

-DRAIN TO BE PROVIDED WITH A FREE GRAVITY OUTFALL, IF POSSIBLE. A SUMP AND PUMP MAY BE USED IF GRAVITY OUT FALL IS NOT AVAILABLE.

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PERIMETER DRAIN DETAIL

DRAWN:	DATE DRAWN:	DESIGNED BY:	CHECKED:
			DS

JOB NO.: 18088

FIG. NO.: 3

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 1/17/2018
Job # 180088

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 20', 1/17/18						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				16	6.5	1
	5			17	9.0	1
FINE GRAINED LENSES	10			10	11.6	1
	15			23	8.3	1
	20			26	8.1	1

TEST BORING NO. 2
DATE DRILLED 1/17/2018
CLIENT THE VECINO GROUP
LOCATION WESTERN & GREAT WESTERN

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 20', 1/17/18						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				17	6.8	1
	5			16	8.2	1
FINE GRAINED LENSES	10			10	15.1	1
	15			19	6.8	1
	20			25	5.6	1

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE: 1/26/18

JOB NO.: 180088
FIG NO.: A- 1

TEST BORING NO. 3
DATE DRILLED 1/17/2018
Job # 180088

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 20', 1/17/18						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				15	6.5	1
	5			14	4.0	1
	10			12	8.0	1
	15			21	6.5	1
	20			22	8.7	1

TEST BORING NO. 4
DATE DRILLED 1/17/2018
CLIENT THE VECINO GROUP
LOCATION WESTERN & GREAT WESTERN

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 20', 1/17/18						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				21	7.9	1
	5			15	7.3	1
FINE GRAINED LENSES	10			10	13.7	1
	15			22	9.7	1
	20			24	7.4	1

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088
FIG NO.: A- 2

TEST BORING NO. 5
DATE DRILLED 1/17/2018
Job # 180088

REMARKS

DRY TO 20', 1/17/18

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
	SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				
		■	17	5.1	1
5		■	17	9.7	1
10		■	12	7.0	1
15		■	14	8.7	1
20		■	24	4.7	1

TEST BORING NO. 6
DATE DRILLED 1/17/2018
CLIENT THE VECINO GROUP
LOCATION WESTERN & GREAT WESTERN

REMARKS

DRY TO 10', 1/17/18

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
	SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				
		■	15	7.9	1
5		■	17	7.9	1
10		■	11	7.2	1
15					
20					

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COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE: 1/26/18

JOB NO.: 180088
FIG NO.: A- 3

TEST BORING NO. 7
DATE DRILLED 1/18/2018
Job # 180088

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 1/18/18						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				16	6.9	1
	5			16	6.1	1
	10					
	15					
	20					

TEST BORING NO. 8
DATE DRILLED 1/18/2018
CLIENT THE VECINO GROUP
LOCATION WESTERN & GREAT WESTERN

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 1/18/18						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				14	3.6	1
	5			18	4.3	1
	10					
	15					
	20					

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088
FIG NO.: A- 4

TEST BORING NO. 9
DATE DRILLED 1/18/2018
Job # 180088

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 1/18/18						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				14	4.7	1
	5			14	5.3	1
	10			14	12.0	1
	15					
	20					

TEST BORING NO. 10
DATE DRILLED 1/18/2018
CLIENT THE VECINO GROUP
LOCATION WESTERN & GREAT WESTERN

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 1/18/18						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE TO LOOSE, MOIST				17	4.8	1
	5			18	6.2	1
FINE GRAINED LENSES	10			8	6.7	1
	15					
	20					

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ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

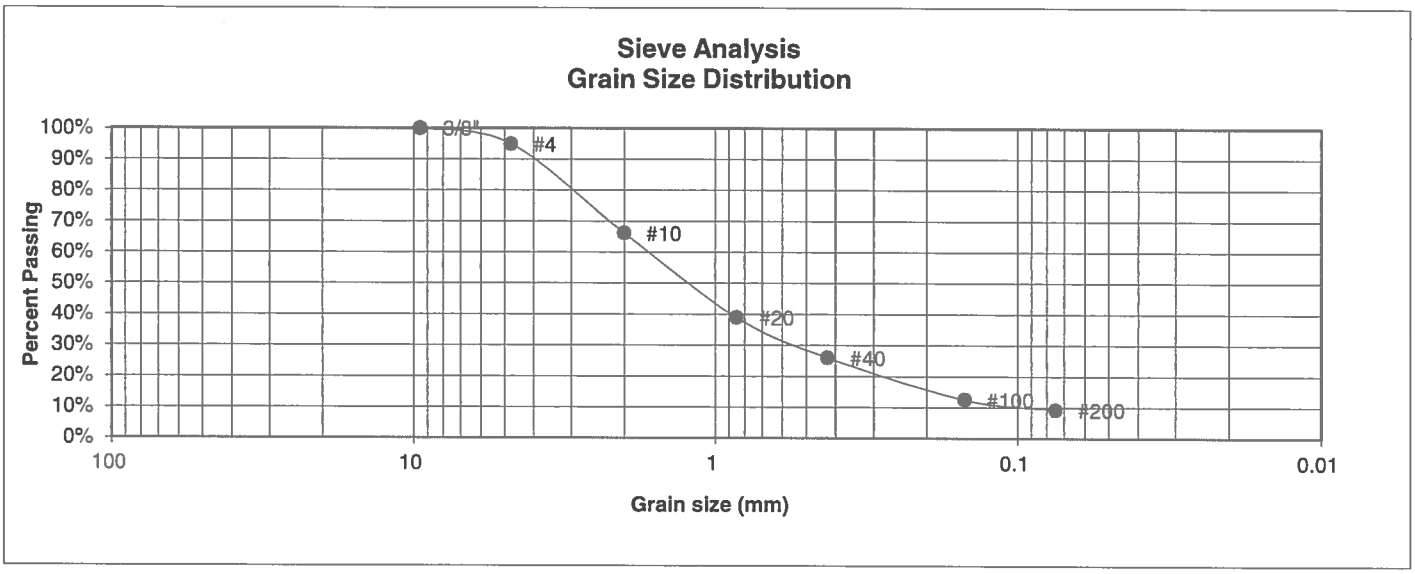
TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088
FIG NO.: A-5

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	1	JOB NO.	180088
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.9%
10	66.2%
20	38.9%
40	26.0%
100	12.5%
200	9.2%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

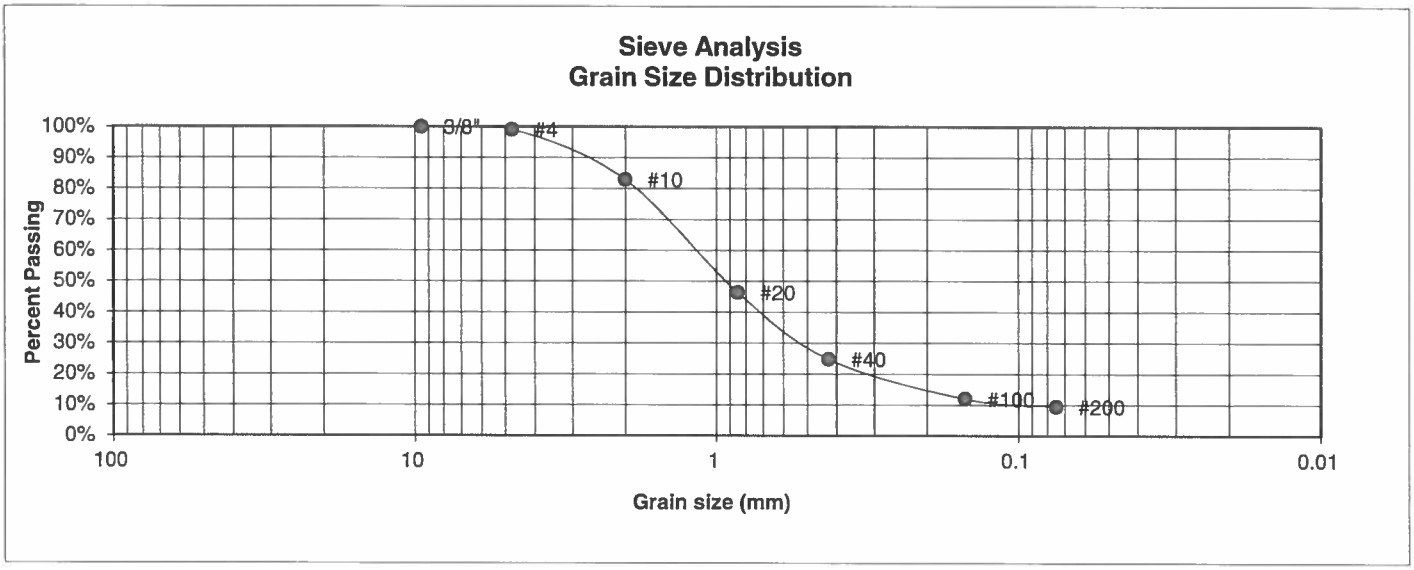
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 1/26/18

JOB NO.: 180088

FIG NO.: B-1

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	2	JOB NO.	180088
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.1%
10	82.9%
20	46.4%
40	24.7%
100	12.0%
200	9.4%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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COLORADO SPRINGS, COLORADO 80907

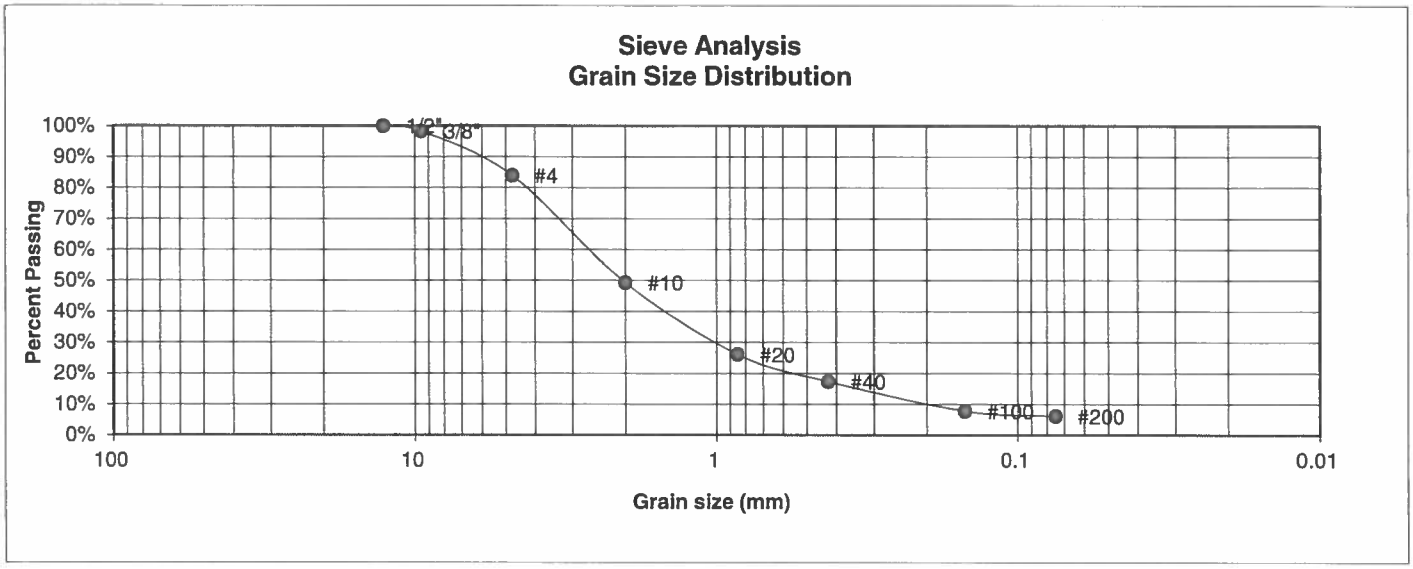
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/24/18

JOB NO.: 180088

FIG NO.: B-2

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	3	JOB NO.	180088
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.3%
4	83.9%
10	49.3%
20	26.1%
40	17.4%
100	7.8%
200	6.1%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

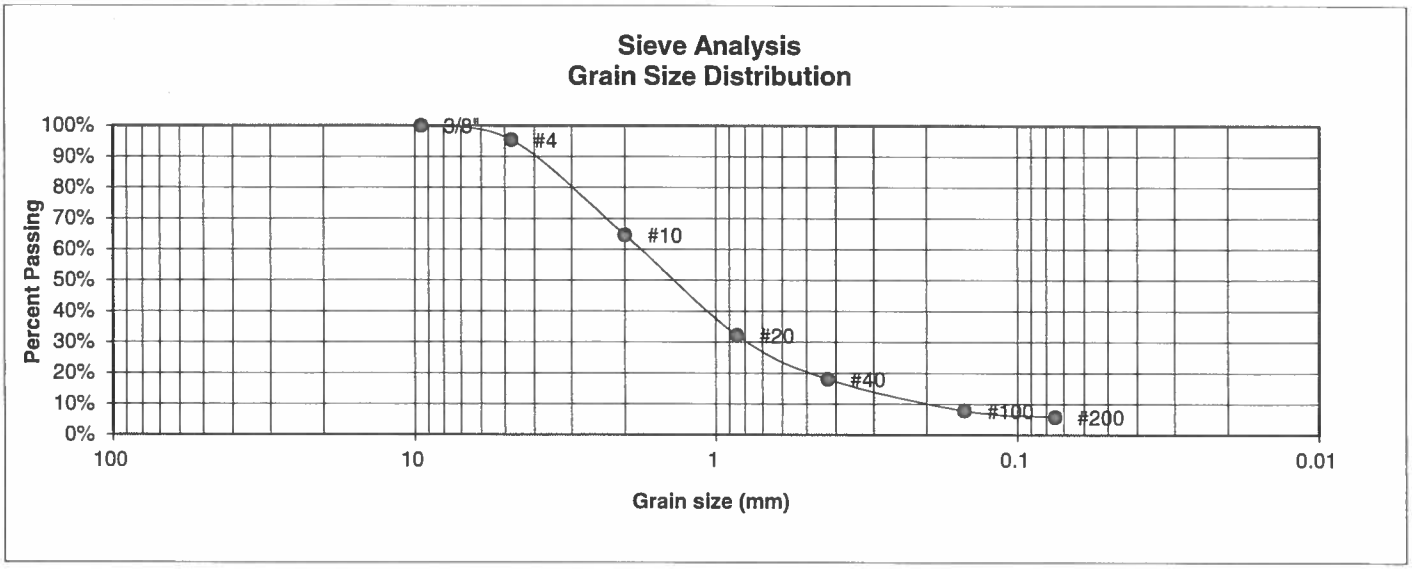
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088

FIG NO.: B-3

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	4	JOB NO.	180088
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.4%
10	64.6%
20	32.2%
40	18.0%
100	7.8%
200	5.8%

Atterberg Limits

Plastic Limit

Liquid Limit

Plastic Index

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

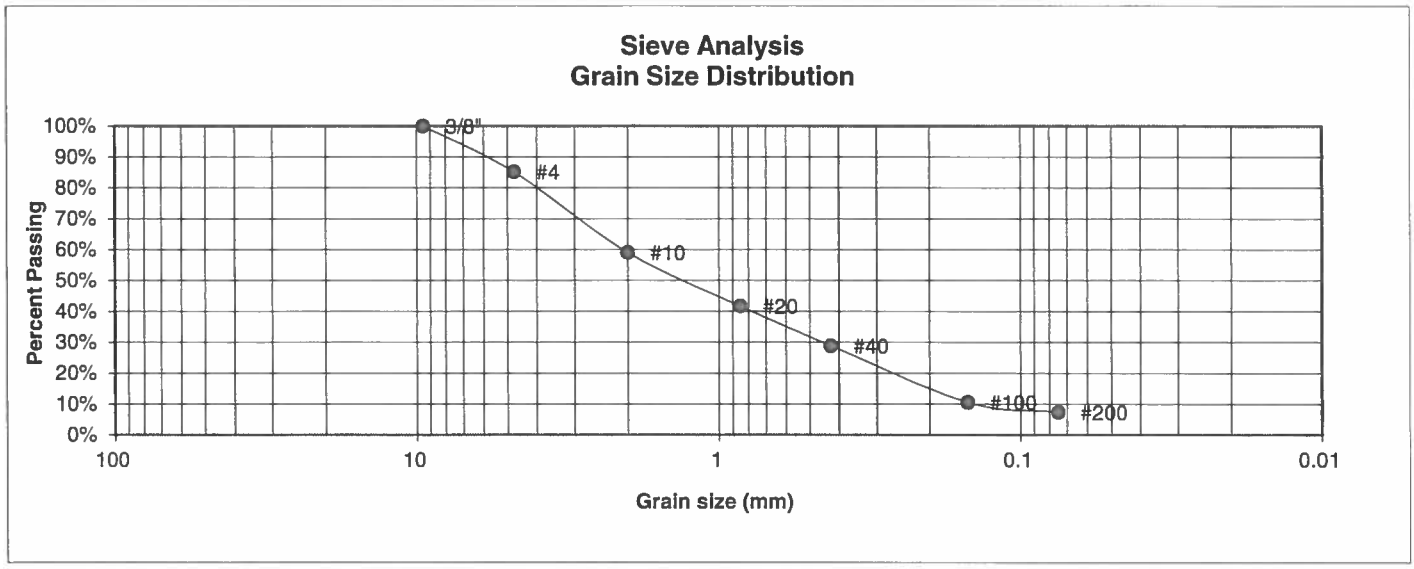
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088

FIG NO.: B-4

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	5	JOB NO.	180088
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	85.1%
10	59.0%
20	41.7%
40	28.9%
100	10.6%
200	7.4%

Atterberg Limits

Plastic Limit

Liquid Limit

Plastic Index

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

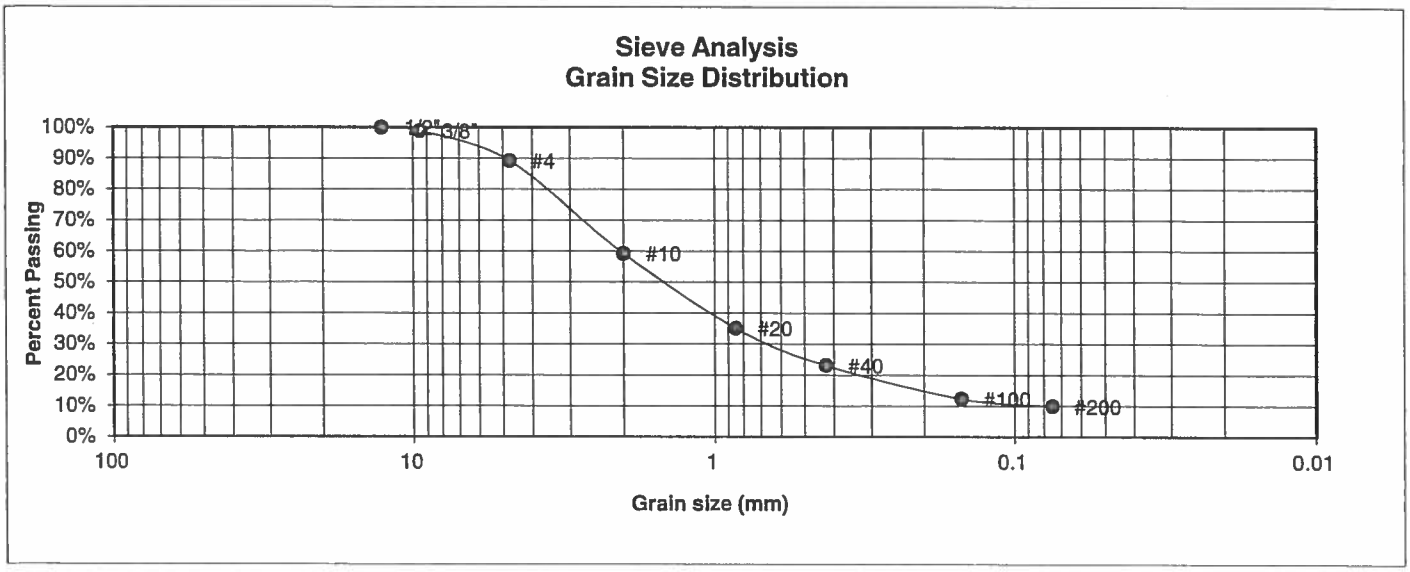
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088

FIG NO.: B-4

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1, CBR #1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	6	JOB NO.	180088
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.9%
4	89.2%
10	59.3%
20	35.1%
40	23.1%
100	12.3%
200	9.9%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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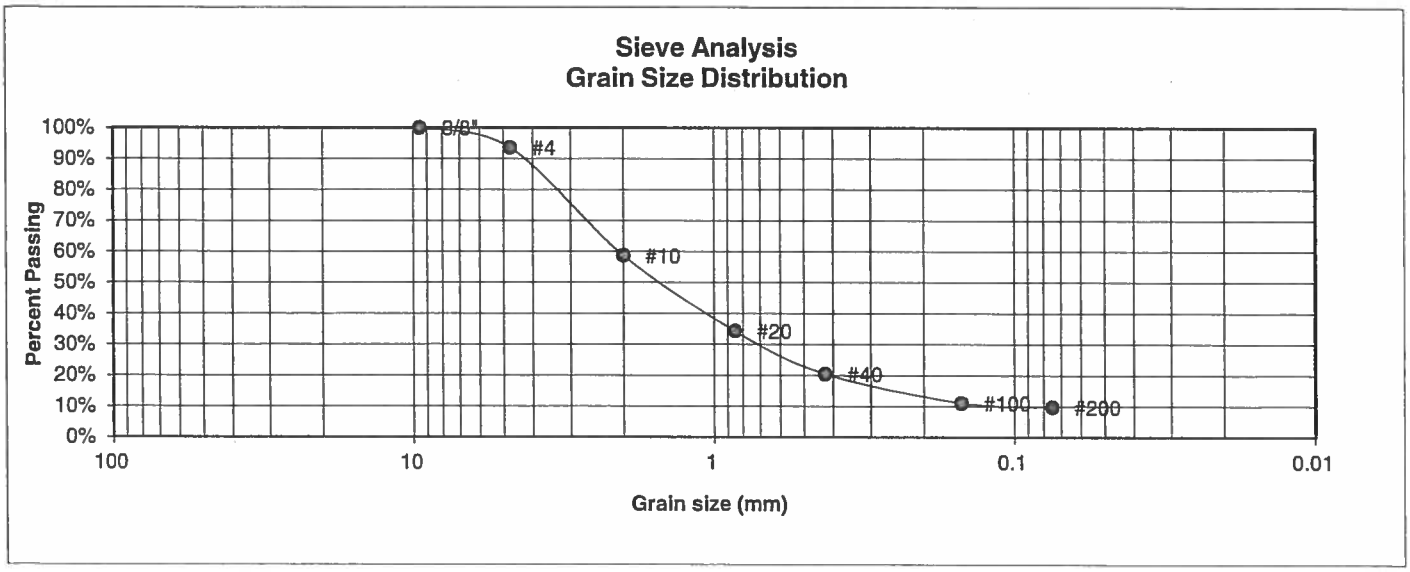
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088
FIG NO.: B-6

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	6	JOB NO.	180088
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.6%
10	58.7%
20	34.3%
40	20.5%
100	11.1%
200	9.8%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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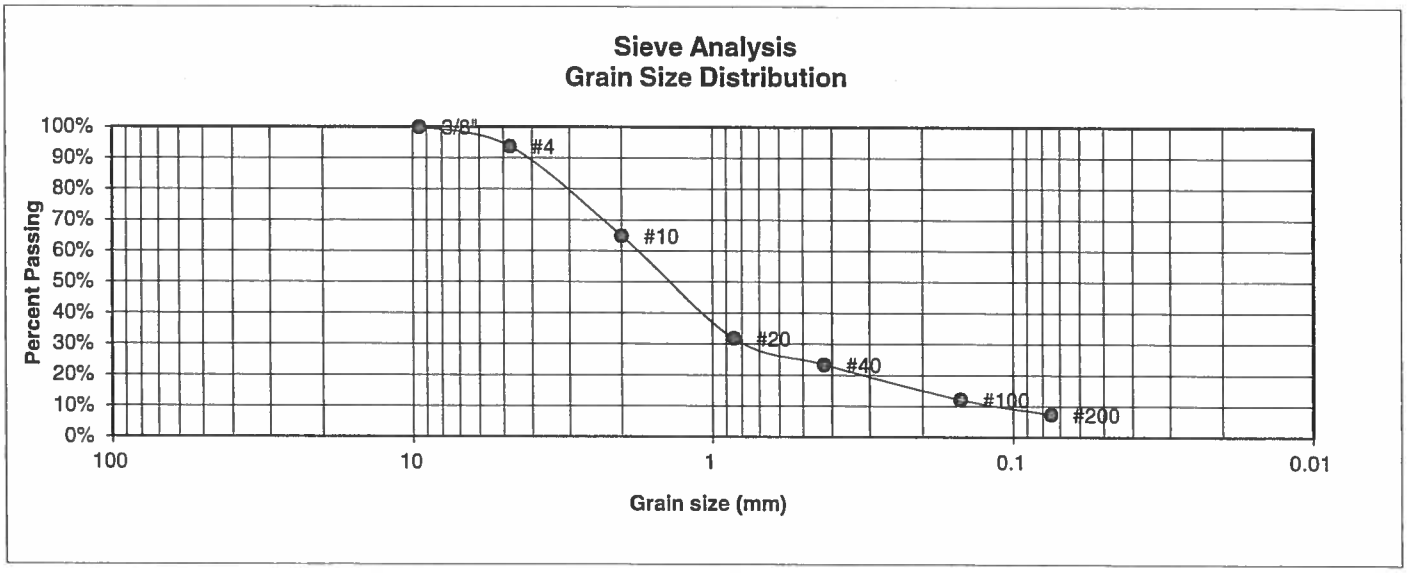
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088
FIG NO.: B-7

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	7	JOB NO.	180088
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.7%
10	64.8%
20	31.8%
40	23.4%
100	12.1%
200	7.4%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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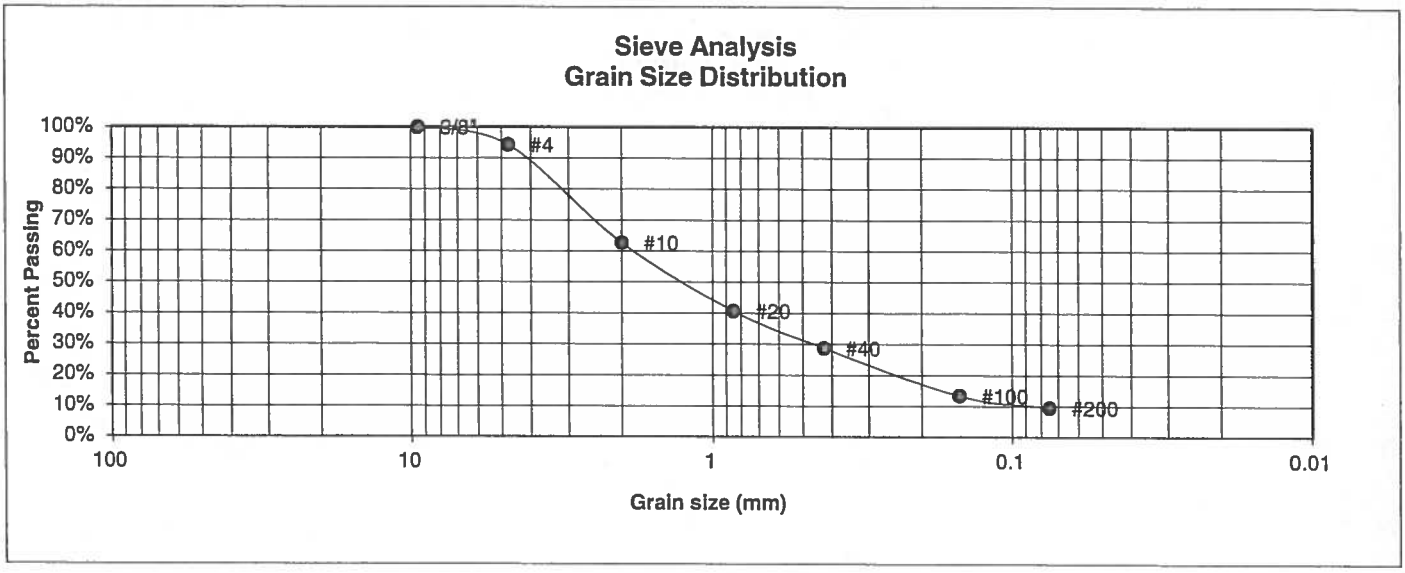
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 1/26/18

JOB NO.: 180088
FIG NO.: B-8

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	8	JOB NO.	180088
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.3%
10	62.7%
20	40.7%
40	28.8%
100	13.3%
200	9.5%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

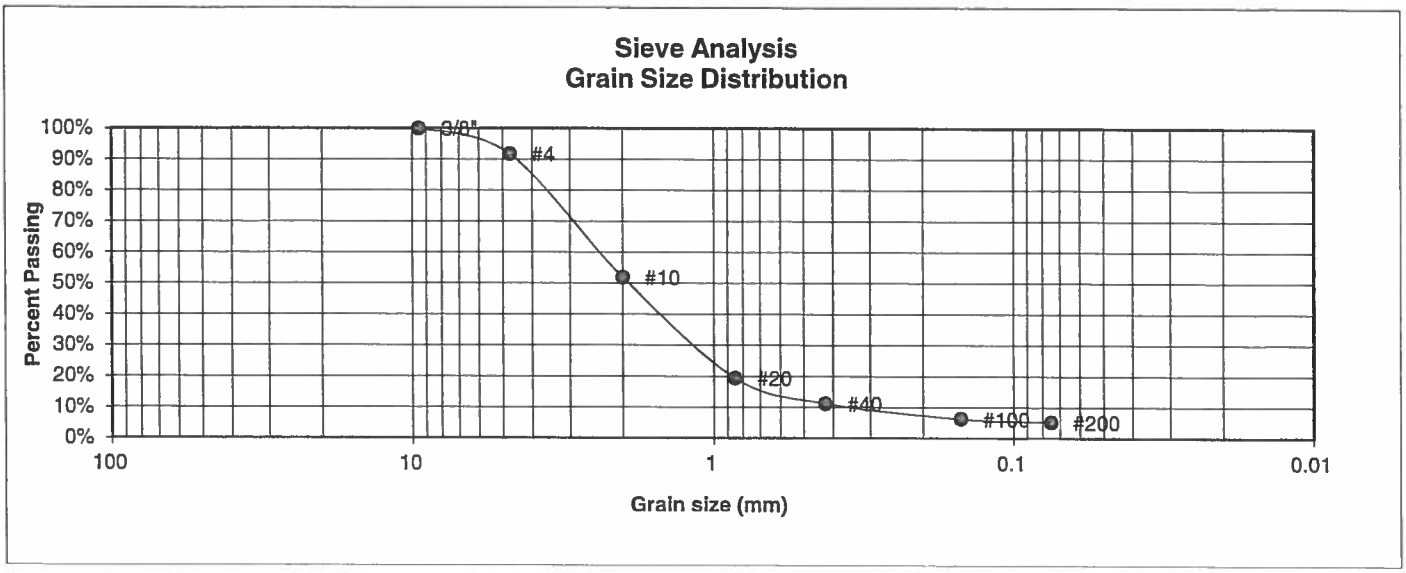
ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088
FIG NO.: B-9

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	9	JOB NO.	180088
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	91.7%
10	51.9%
20	19.4%
40	11.2%
100	6.3%
200	5.2%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

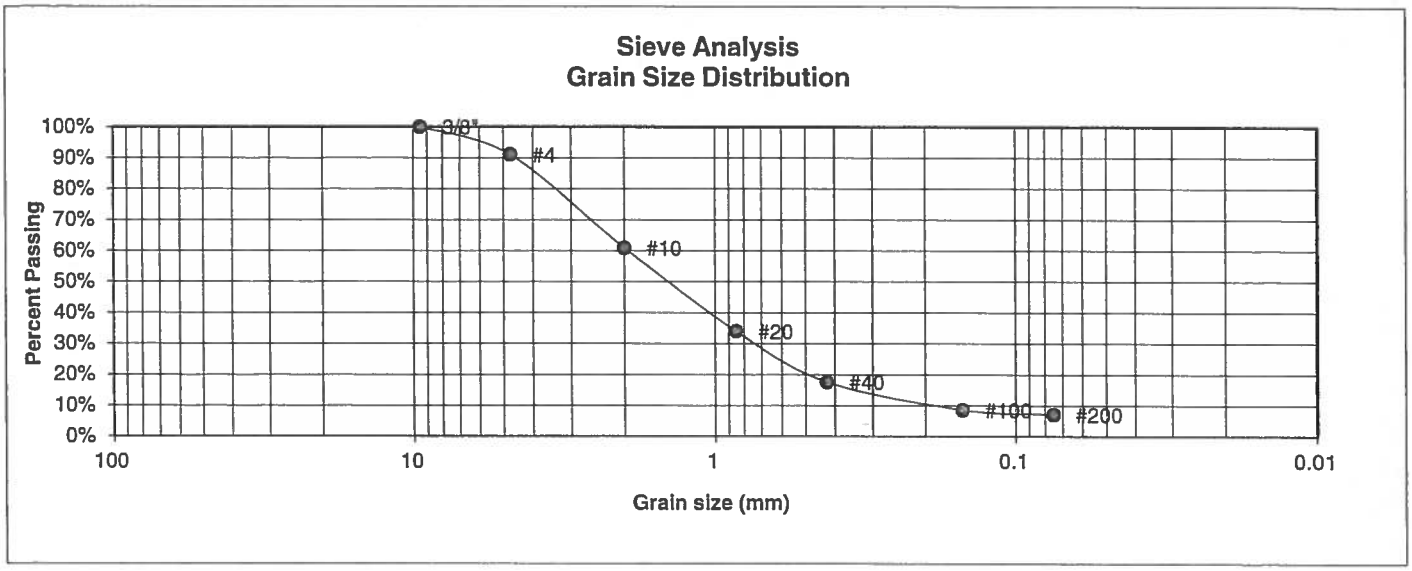
ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088
FIG NO.: B-10

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	10	JOB NO.	180088
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	91.0%
10	60.9%
20	34.0%
40	17.6%
100	8.6%
200	7.2%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088
FIG NO.: B-11

CLIENT	THE VECINO GROUP	JOB NO.	180088
PROJECT	WESTERN & GREAT WESTERN	DATE	1/23/2018
LOCATION	WESTERN & GREAT WESTERN	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-3	10	1	SM-SW	<0.01
TB-6	1-2	1	SM-SW	<0.01

QC BLANK PASS

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088
FIG NO.: B.12

February 12, 2018

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
FAX (719) 531-5238

The Vecino Group
444 S. Campbell Avenue
Springfield, MO 65806

Attn: Chris Ball

Re: Pavement Recommendations
Freedom Springs Permanent Supportive Housing Development
3.87 Acre Parcel
Western and Great Western Drives
Colorado Springs, Colorado

Dear Mr. Ball:

As requested, Entech Engineering, Inc. has obtained samples of the pavement subgrade soils from the proposed parking and drive areas at the above referenced site. This letter presents the results of the laboratory testing and pavement recommendations for the roadway sections.

Project Description

The project will consist of paving of the parking and drive areas and activity areas for a proposed commercial Permanent Supportive Housing Development. Subsurface Soil Investigation and laboratory testing were performed to determine the pavement support characteristics of the soils. The general layout of the site is presented in the Test Boring Location Map - Pavement in Figure 1. Pavement subgrade should be evaluated after site grading to verify if the pavement sections are appropriate.

Subgrade Conditions

Ten test borings were drilled on this site to depths of 5 to 20 feet. Test Boring Nos. 6 through 10 were drilled in the planned paved areas and basketball court. The soils in the pavement borings consisted of slightly silty sand. The Test Boring Logs are presented in Appendix A. Sieve Analyses and Atterberg Limit testing were performed on the soil samples obtained from the test borings for the purpose of classification. The percent passing the No. 200 sieve for the soils at subgrade depth ranged from approximately 5 to 10 percent. One subgrade soil type was determined through laboratory testing. The subgrade soils classify as A-1-b using the AASHTO classification. Groundwater was not encountered in the pavement test borings drilled on this site. Sulfate testing indicated the subgrade soils exhibit negligible potential for concrete degradation due to sulfate attack.

Swell testing was not required on the subgrade soils due to the low expansion and non-plastic soils encountered at anticipated pavement subgrade. Laboratory test results are presented in Appendix B and are summarized on Table 1.

California Bearing Ratio (CBR) testing was performed on the Type 1 Soil to determine the support characteristic of subgrade soils for the roadway sections. The results of the CBR testing, are presented in Appendix B and summarized as follows:

CBR No. 1

Soil Type 1 – Slightly Silty Sand

R @ 90% = 35.0
R @ 95% = 74.0
Use R = 45.0 for design

Classification Testing

Liquid Limit	NV
Plasticity Index	NP
Percent Passing 200	9.9
AASHTO Classification	A-1-b
Group Index	0
Unified Soils Classification	SM-SW

Pavement Design

The CBR test results were used to determine pavement sections for the access roads, parking areas, and drive areas. The pavement sections were developed utilizing the City of Colorado Springs Pavement Design Criteria. An 18k ESAL value of 30,000 was used for the parking areas, 50,000 was used to determine pavement sections for the drive areas, and an 18k ESAL value of 90,000 was used for the truck traffic areas to determine the pavement sections. Pavement sections for asphalt over base course are provided.

Design parameters used in the pavement analysis for the access roads and parking and drive areas are as follows:

Reliability - Local Residential	85%
Standard Deviation	0.44
Resilient Modulus (Soil Type 1)	11,183 psi
"R" Value Subgrade (Soil Type 1)	45.0
Δpsi	2.5
Hot Bituminous Pavement	0.44
Base Course	0.12

Pavement calculations are presented in Appendix C. Pavement sections recommended for the site are summarized as follows:

Pavement Sections

Parking Areas
Soil Type 1, R = 45.0

Alternatives	Asphalt (in)	Base Course (in)
1 – Asphalt Over Basecourse	4.0*	6.0*
2 – Full Depth Asphalt	5.0[1]*	–

Drive Areas
Soil Type 1, R = 45.0

Alternatives	Asphalt (in)	Base Course (in)
1 – Asphalt Over Basecourse	4.0*	6.0*
2 – Full Depth Asphalt	5.0[1]*	–

Truck Areas
Soil Type 1, R = 45.0

Alternatives	Asphalt (in)	Base Course (in)
1 – Asphalt Over Basecourse	4.0*	6.0
2 – Full Depth Asphalt	5.0[1]*	–

[1] Full depth sections are only allowed over chemically treated or suitable subgrade for city streets.
* Minimum sections required by City of Colorado Springs Pavement Criteria Manual.

Since the parking and drive areas are private, thinner sections can be considered for these areas of the project. Higher maintenance costs however should be anticipated if thinner sections are installed. Three (3) inches of asphalt and six (6) inches of base course or 4-inches full depth sections have been used successfully in areas that only receive automobile traffic. At trash enclosures, a minimum rigid 6- inch concrete section is recommended. Alternative thinner sections would not meet the City of Colorado Springs Pavement Design Criteria.

Pavement Construction

Prior to placement of the asphalt, the subgrade should be scarified, moisture-conditioned, compacted to a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 at ±2 percent of optimum moisture content and proofrolled after properly compacted. Any loose areas should be removed and replaced with suitable materials approved by Entech. Basecourse materials should be compacted to a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 at ± 2% of optimum moisture content. Special attention should be given to areas adjacent to manholes, inlet structures and valves.

The Vecino Group
Pavement Recommendations
Freedom Springs Permanent Supportive Housing Development
3.87 Acre Parcel – Western & Great Western Drives
Colorado Springs, Colorado

In addition to the above guidance the materials, subgrade conditions, compaction of materials, testing, inspections, and roadway construction methods shall meet the City of Colorado Springs Pavement Design Criteria.

We trust that this has provided you with the information you required. The pavement sections provided are based on general site soil types. If you have any questions or need additional information, please do not hesitate to contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Daniel P. Stegman

Reviewed by:

Mark H. Hauschild, P.E.
Senior Engineer

COLORADO LICENSED
MARK HOWARD HAUSCHILD
35140
2/15/18
PROFESSIONAL ENGINEER

DPS/rm

Encl.
Entech Job No. 180088
AAprojects/2018/180088 pr

TABLE

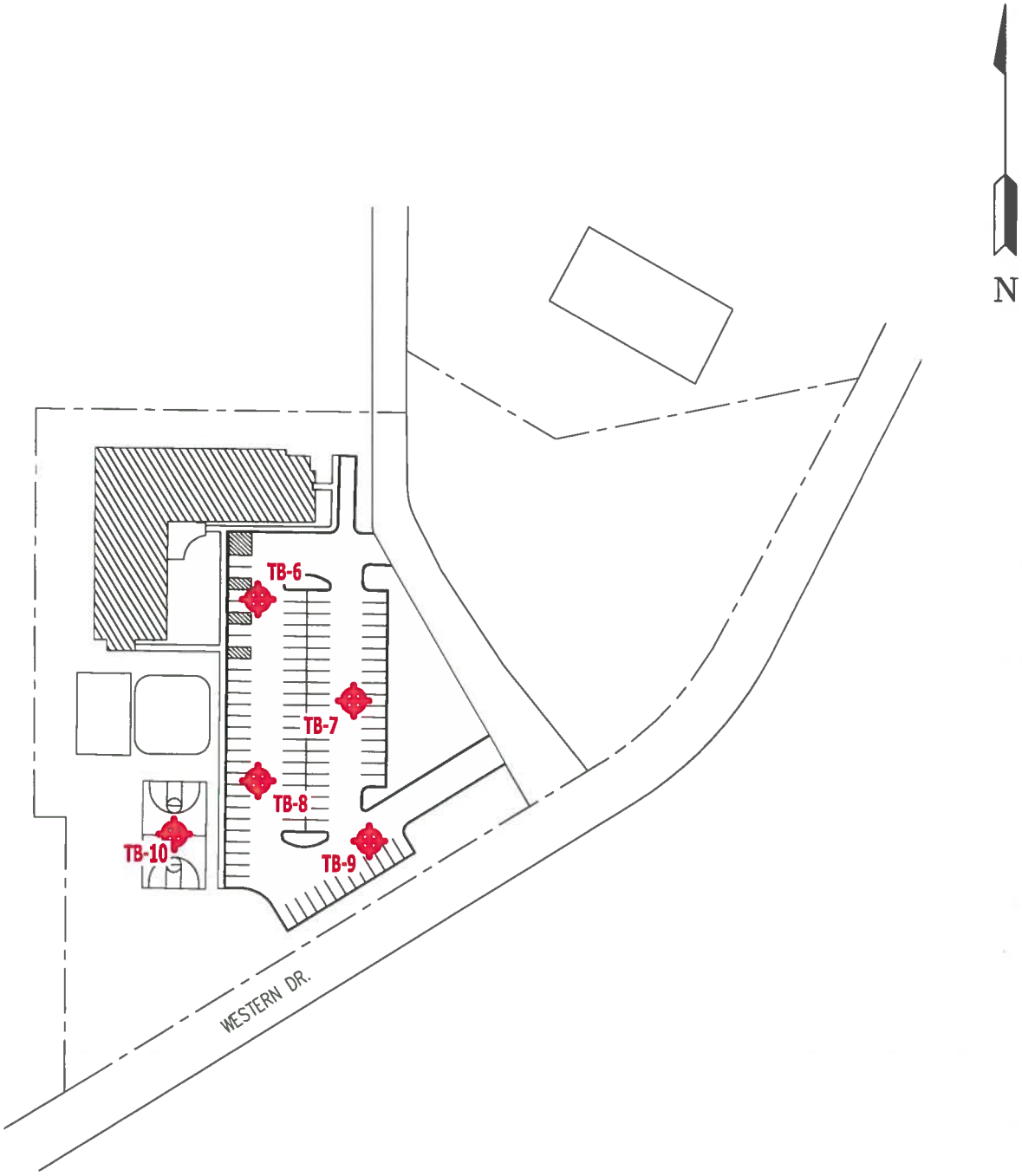
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT THE VECINO GROUP
PROJECT WESTERN & GREAT WESTERN
JOB NO. 180088

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	AASHTO CLASS.	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1, CBR #1	6	0-3			9.9	NV	NP		A-1-b		SM-SW	SAND, SLIGHTLY SILTY
1	6	1-2			9.8	NV	NP	<0.01	A-1-b		SM-SW	SAND, SLIGHTLY SILTY
1	7	1-2			7.4	NV	NP		A-1-b		SM-SW	SAND, SLIGHTLY SILTY
1	8	1-2			9.5	NV	NP		A-1-b		SM-SW	SAND, SLIGHTLY SILTY
1	9	1-2			5.2	NV	NP		A-1-b		SM-SW	SAND, SLIGHTLY SILTY
1	10	1-2			7.2	NV	NP		A-1-b		SM-SW	SAND, SLIGHTLY SILTY

FIGURE



TB-2- APPROXIMATE TEST BORING LOCATION AND NUMBER

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

TEST BORING LOCATION MAP - PAVEMENT
HATHAWAY DR. AND WESTERN DR.
COLORADO SPRINGS, CO
FOR: THE VECINO GROUP

DRAWN BY:	DATE DRAWN:	DESIGNED BY:	CHECKED:
WM	1/30/18	SC	

JOB NO.: 180088

FIG. NO.: 1

APPENDIX A: Test Boring Logs

TEST BORING NO. 6
DATE DRILLED 1/17/2018
Job # 180088

REMARKS

DRY TO 10', 1/17/18

SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			15	7.9	1
5			17	7.9	1
10			11	7.2	1
15					
20					

TEST BORING NO. 7
DATE DRILLED 1/18/2018
CLIENT THE VECINO GROUP
LOCATION WESTERN & GREAT WESTERN

REMARKS

DRY TO 5', 1/18/18

SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			16	6.9	1
5			16	6.1	1
10					
15					
20					

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		L	1/26/18

JOB NO.: 180088
FIG NO.: A- 1

TEST BORING NO. 8
DATE DRILLED 1/18/2018
Job # 180088

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 1/18/18						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				14	3.6	1
	5			18	4.3	1
	10					
	15					
	20					

TEST BORING NO. 9
DATE DRILLED 1/18/2018
CLIENT THE VECINO GROUP
LOCATION WESTERN & GREAT WESTERN

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 1/18/18						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				14	4.7	1
	5			14	5.3	1
	10			14	12.0	1
	15					
	20					

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088
FIG NO.: A- 2

TEST BORING NO. 10
DATE DRILLED 1/18/2018
Job # 180088

REMARKS

DRY TO 10', 1/18/18

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
	SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE TO LOOSE, MOIST		17	4.8	1
5			18	6.2	1
10			8	6.7	1
15					
20					

TEST BORING NO.
DATE DRILLED
CLIENT THE VECINO GROUP
LOCATION WESTERN & GREAT WESTERN

REMARKS

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5					
10					
15					
20					

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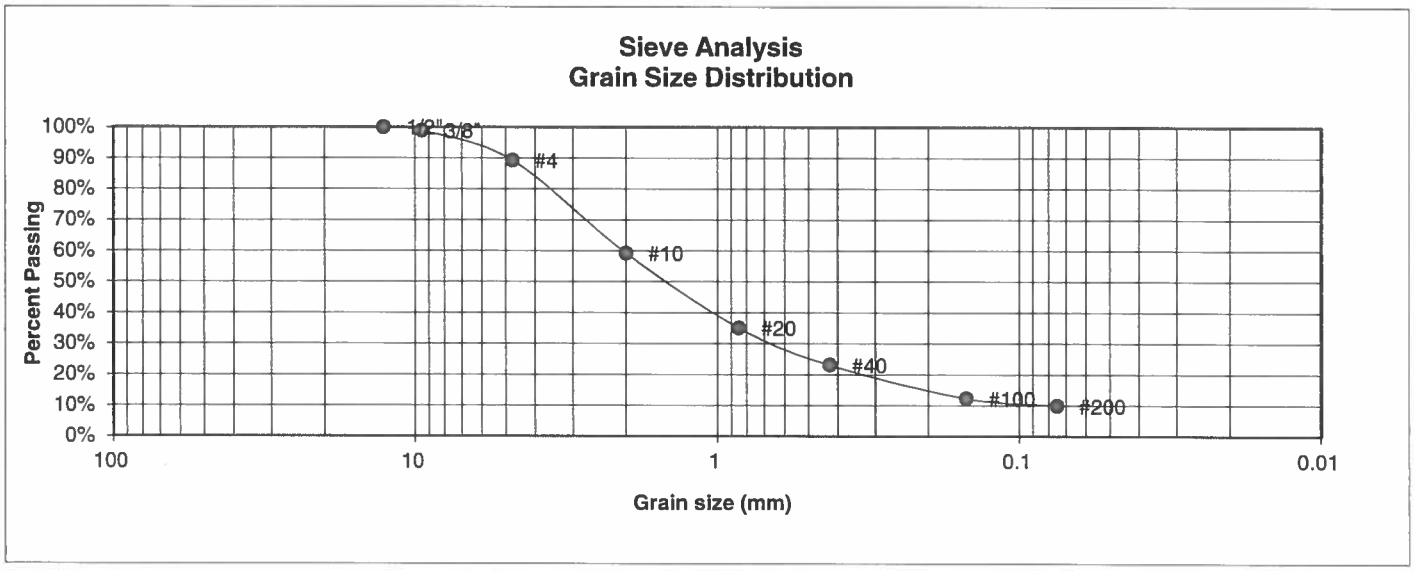
TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE: 1/26/18

JOB NO.: 180088
FIG NO.: A- 3

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1, CBR #1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	6	JOB NO.	180088
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.9%
4	89.2%
10	59.3%
20	35.1%
40	23.1%
100	12.3%
200	9.9%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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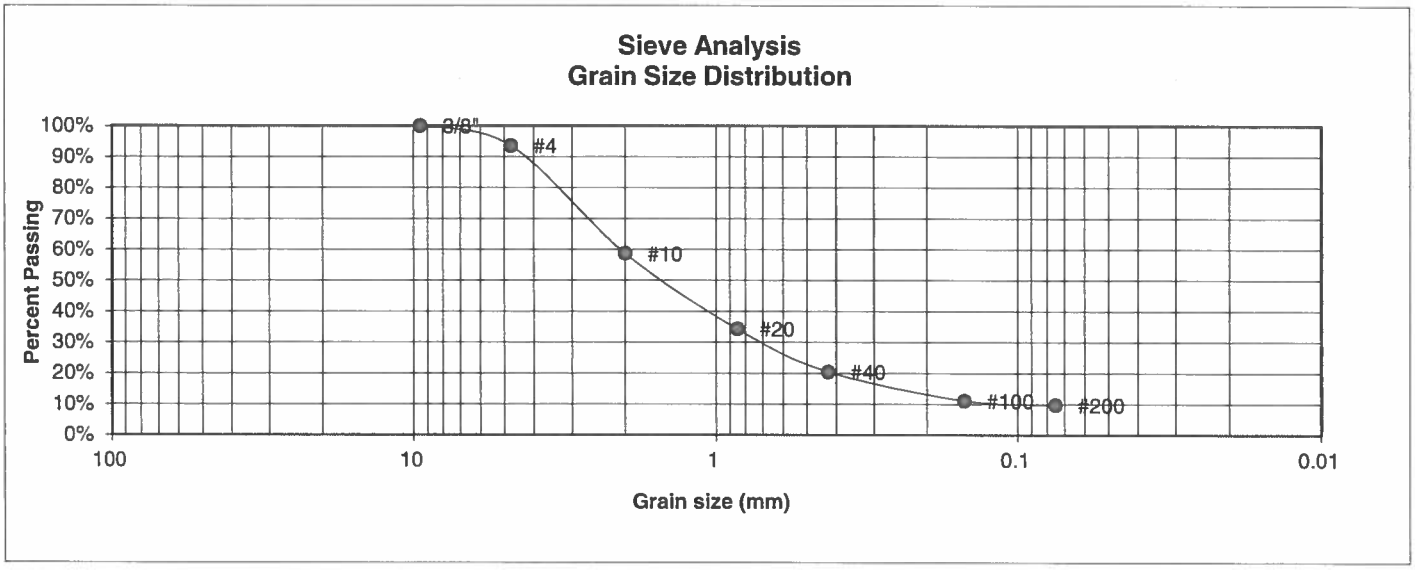
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/20/18

JOB NO.: 180088
FIG NO.: B-1

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	6	JOB NO.	180088
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.6%
10	58.7%
20	34.3%
40	20.5%
100	11.1%
200	9.8%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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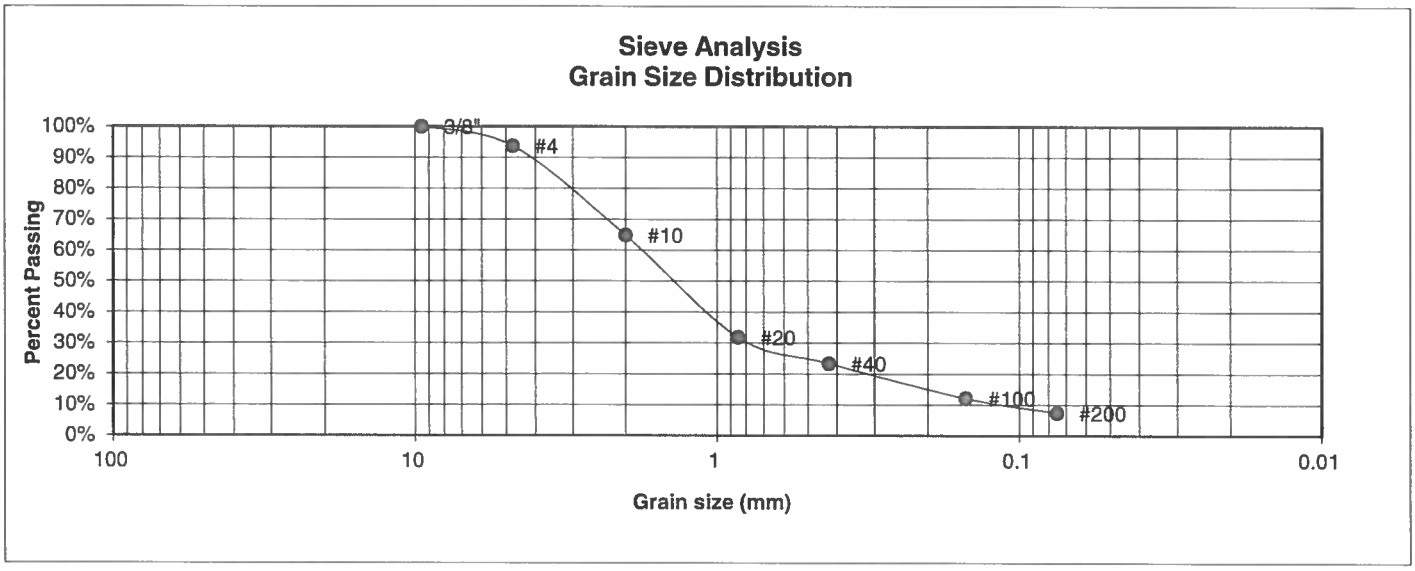
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088
FIG NO.: B-2

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	7	JOB NO.	180088
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.7%
10	64.8%
20	31.8%
40	23.4%
100	12.1%
200	7.4%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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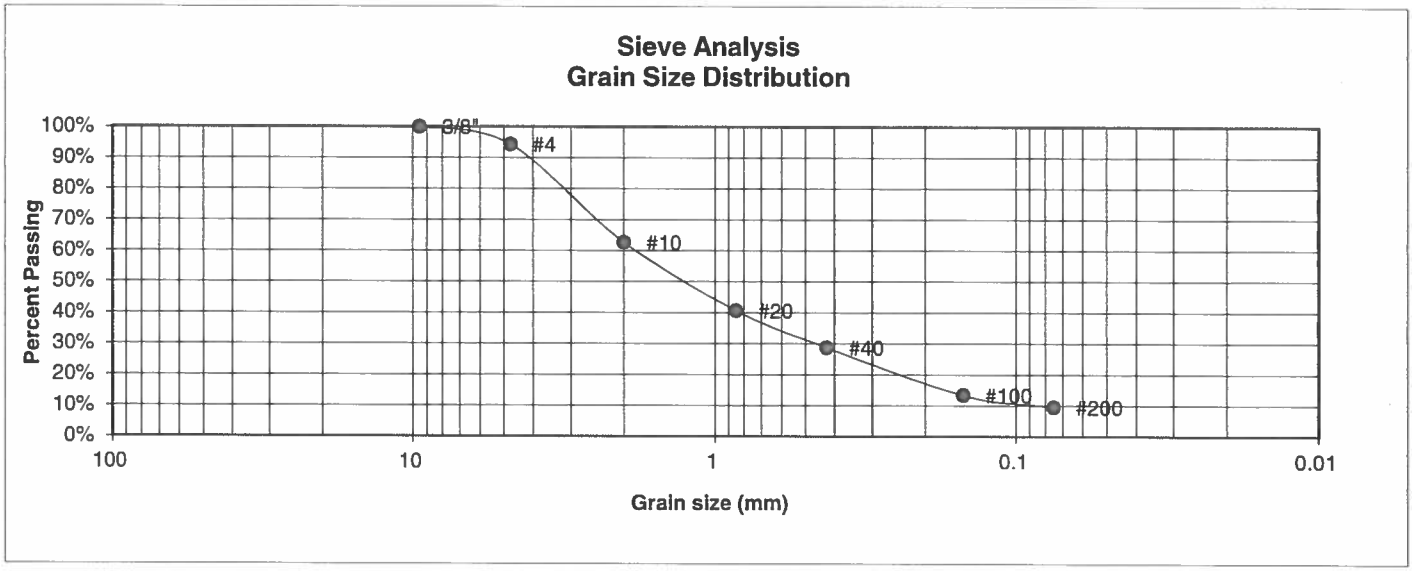
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088
FIG NO.: B-3

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	8	JOB NO.	180088
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.3%
10	62.7%
20	40.7%
40	28.8%
100	13.3%
200	9.5%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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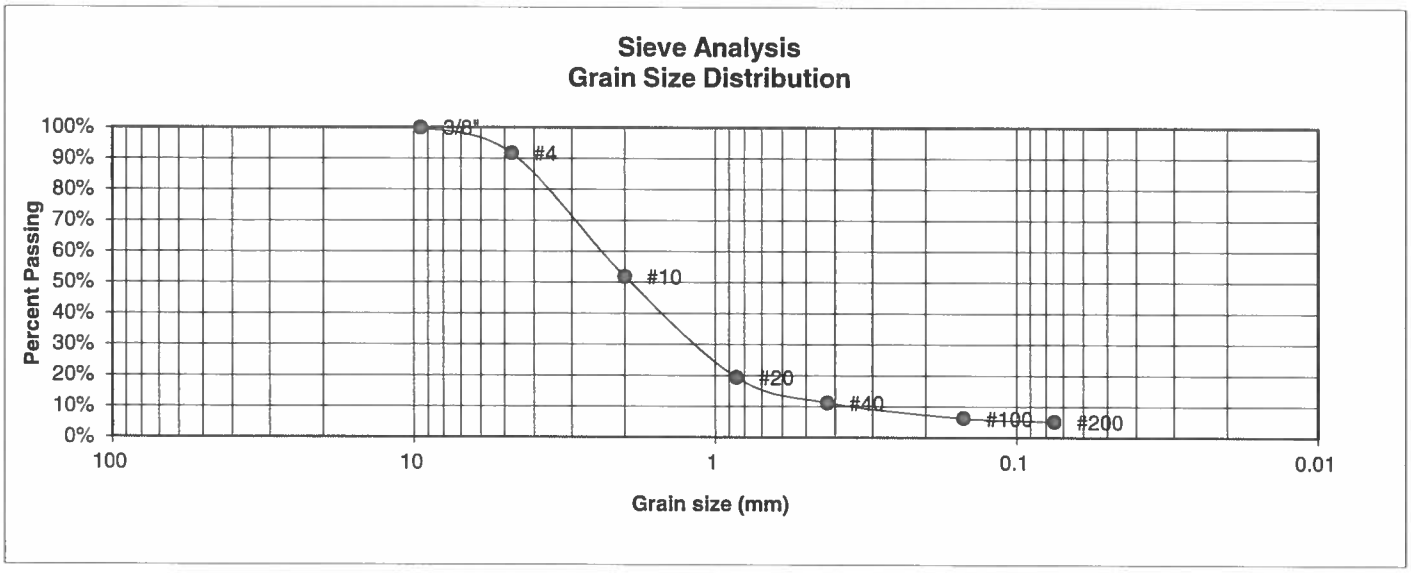
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		L	1/26/18

JOB NO.: 180088
FIG NO.: B-4

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	9	JOB NO.	180088
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	91.7%
10	51.9%
20	19.4%
40	11.2%
100	6.3%
200	5.2%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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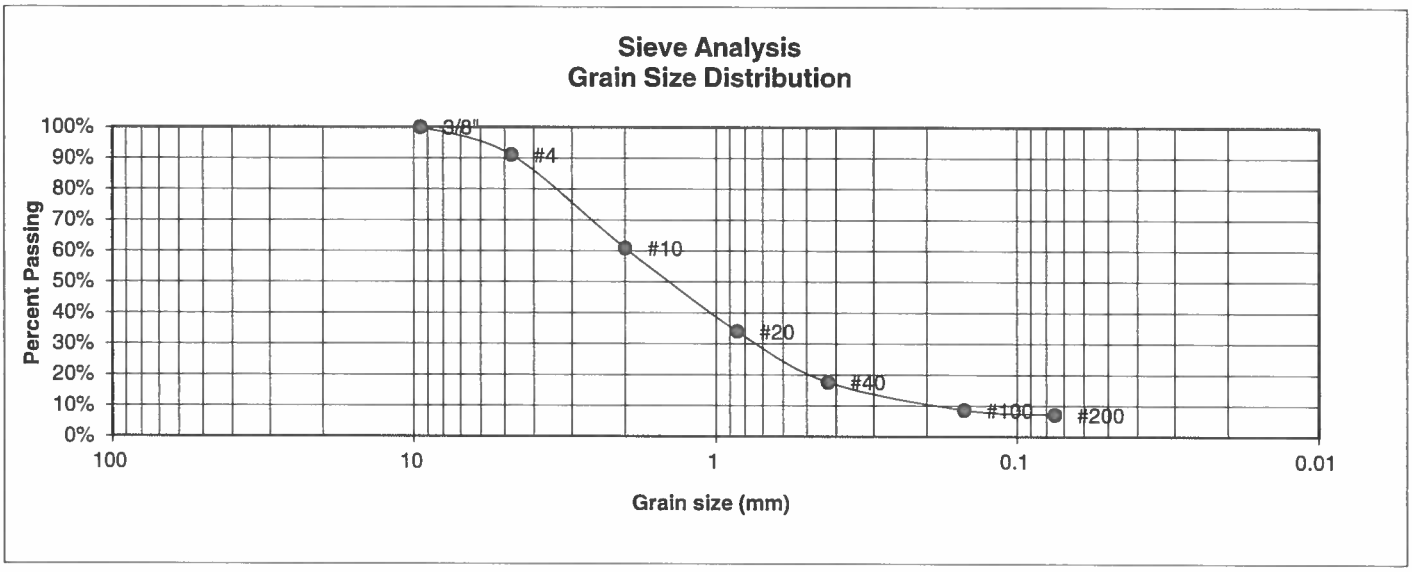
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088
FIG NO.: B-5

UNIFIED CLASSIFICATION	SM-SW	CLIENT	THE VECINO GROUP
SOIL TYPE #	1	PROJECT	WESTERN & GREAT WESTERN
TEST BORING #	10	JOB NO.	180088
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	91.0%
10	60.9%
20	34.0%
40	17.6%
100	8.6%
200	7.2%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		a	1/26/18

JOB NO.: 180088
FIG NO.: B-1

CLIENT	THE VECINO GROUP	JOB NO.	180088
PROJECT	WESTERN & GREAT WESTERN	DATE	1/23/2018
LOCATION	WESTERN & GREAT WESTERN	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-6	1-2	1	SM-SW	<0.01

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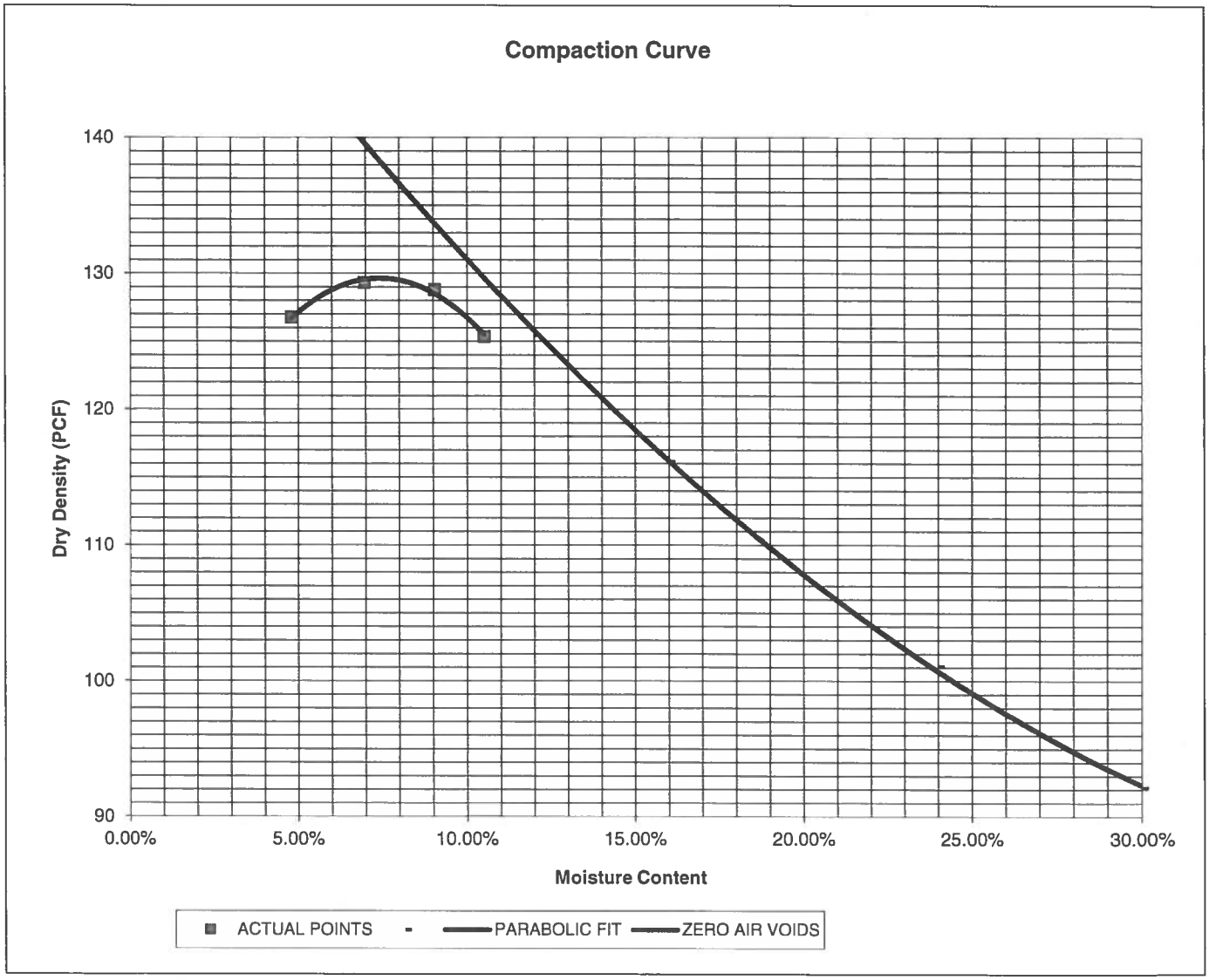
LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			1/26/18

JOB NO.: 180088
FIG NO.: B-7

PROJECT	WESTERN & GREAT WESTERN	CLIENT	THE VECINO GROUP
SAMPLE LOCATION	TB-6 @ 0-3'	JOB NO.	180088
SOIL DESCRIPTION	SAND, SLIGHTLY SILTY, TAN	DATE	01/19/18

IDENTIFICATION	SM-SW	COMPACTION TEST #	1, SOIL TYPE #1
TEST DESIGNATION / METHOD	ASTM D-1557-A	TEST BY	DC
MAXIMUM DRY DENSITY (PCF)	129.9	OPTIMUM MOISTURE	7.3%



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MOISTURE DENSITY RELATION

DRAWN:	DATE:	CHECKED:	DATE:
		W	1/26/18

JOB NO.: 180088

FIG NO.: B-8

CBR TEST LOAD DATA

JOB NO: 180088
CLIENT: THE VECINO GROUP
PROJECT: WESTERN & GREAT WESTERN
SOIL TYPE: 1, CBR #1

PISTON DIAMETER (cm)	PISTON AREA (in²)
4.958	2.99250919

PENETRATION DEPTH (INCHES)	10 BLOWS MOLD # 1 LOAD(LBS) (LBS)	STRESS (PSI)	25 BLOWS MOLD # 2 LOAD(LBS) (LBS)	STRESS (PSI)	56 BLOWS MOLD # 3 LOAD(LBS) (LBS)	STRESS (PSI)
0.000	0	0.00	0	0.00	0	0.00
0.025	218	72.85	337	112.61	642	214.54
0.050	367	122.64	635	212.20	1215	406.01
0.075	512	171.09	919	307.10	1831	611.86
0.100	632	211.19	1233	412.03	2501	835.75
0.125	743	248.29	1484	495.90	3156	1054.63
0.150	863	288.39	1723	575.77	3654	1221.05
0.175	965	322.47	1929	644.61	4047	1352.38
0.200	1065	355.89	2135	713.45	4542	1517.79
0.300	1319	440.77	2910	972.43	6000	2005.01
0.400	1477	493.57	3295	1101.08		
0.500	1580	527.99	3620	1209.69		

FINAL MOISTURE CONTENT

	MOLD # 1	MOLD # 2	MOLD # 3
CAN #	353	347	345
WT. CAN	6.88	7.08	6.92
WT. CAN+WET	201.2	227.97	215.1
WT. CAN+DRY	181.35	209.23	200.35
WT. H20	19.85	18.74	14.75
WT. DRY SOIL	174.47	202.15	193.43
MOISTURE CONTENT	11.38%	9.27%	7.63%

WET DENSITY (PCF)	125.3	130.5	136.5
DRY DENSITY (PCF)	116.8	121.6	127.2

BEARING RATIO	21.12	41.20	83.58

90% OF DRY DENSITY	114.5
95% OF DRY DENSITY	120.8

BEARING RATIO AT 90% OF MAX	11.54	~ R VALUE	35
BEARING RATIO AT 95% OF MAX	37.89	~ R VALUE	74

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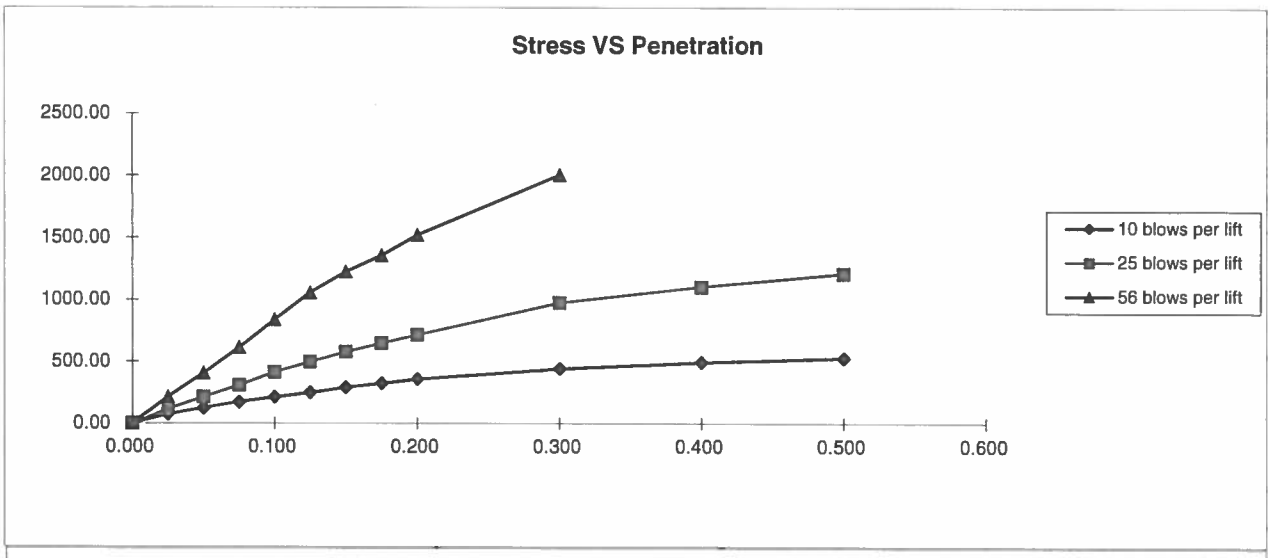
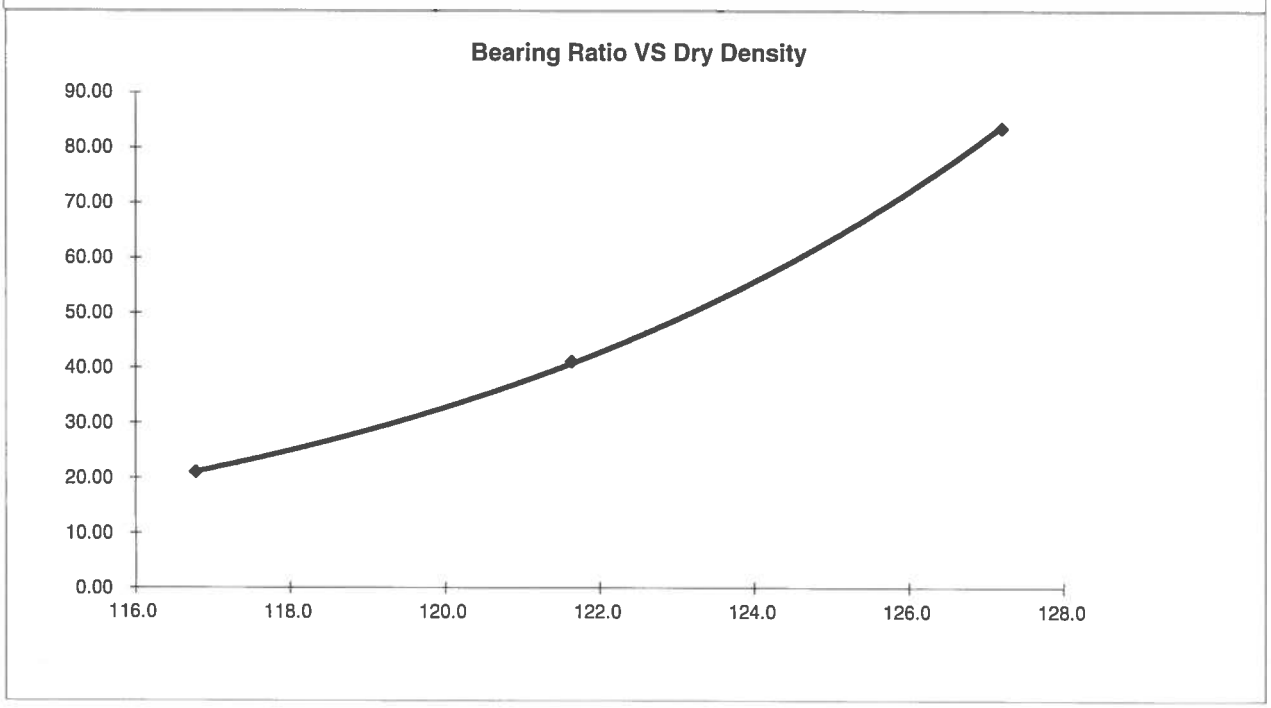
CBR TEST DATA

DRAWN:	DATE:	CHECKED:	DATE:
		h	1/26/18

JOB NO.: 180088
FIG NO.: B-9





BEARING RATIO AT 90% OF MAX	11.54	~ R VALUE	35.00
BEARING RATIO AT 95% OF MAX	37.89	~ R VALUE	74.00

JOB NO: 180088
SOIL TYPE: 1, CBR #1

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CALIFORNIA BEARING RATIO

DRAWN:	DATE:	CHECKED:	DATE:
		L	1/26/18

JOB NO.: 180088
FIG NO.: B-10

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

THE VECINO GROUP
3.87 ACRE PARCEL NEAR WESTERN & GREAT WESTERN DRIVES - PARKING AREAS

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	30,000
Hveem Stabilometer (R Value) Results:	R =	45
Standard Deviation	S_o =	0.44
Loss in Serviceability	Δpsi =	2.5
Reliability	Reliability =	85
Reliability (z-statistic)	Z_R =	-1.04
Soil Resilient Modulus	M_R =	11183

Weighted Structural Number (WSN): → WSN = 1.56

DESIGN TABLES AND EQUATIONS

$S_1 = [(R - 5) / 11.29] + 3$

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$

$\mathbf{M_R = 2555 * CBR^{0.64}}$

$k = M_R / 19.4$

Where:

M_R = resilient modulus (psi)

S_1 = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

Reliability (%)	Z_R (z-statistic)
80	-0.84
85	-1.04
90	-1.28
93	-1.48
94	-1.56
95	-1.65
96	-1.75
97	-1.88
98	-2.05
99	-2.33
99.9	-3.09
99.99	-3.75

$$\log_{10} W_{18} = Z_R * S_O + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$

Left	Right	Difference
4.48	4.48	0.0

Job No. 180088
Fig. No. C-1

DESIGN CALCULATIONS

DESIGN DATA

THE VECINO GROUP
3.87 ACRE PARCEL NEAR WESTERN & GREAT WESTERN DRIVES - PARKING AREAS

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	30,000
Hveem Stabilometer (R Value) Results:	R =	45
Weighted Structural Number (WSN):	WSN =	1.56

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.12 Strength Coefficient - Aggregate Base Course

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION

$D_1 = (WSN)/C_1 =$ 3.5 inches of Full Depth Asphalt
Use 5.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = 4 inches
$D_2 = ((WSN) - (t)(C_1))/C_2 =$ -1.7 inches of Aggregate
Base Course, use 6.0 inches

RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 6.0 inches of Aggregate Base Course, or
2. 5.0 inches of Asphalt

Job No. 180088
Fig. No. C-2

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

THE VECINO GROUP
3.87 ACRE PARCEL NEAR WESTERN & GREAT WESTERN DRIVES - DRIVE AREAS

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	50,000
Hveem Stabilometer (R Value) Results:	R =	45
Standard Deviation	S_o =	0.44
Loss in Serviceability	Δpsi =	2.5
Reliability	Reliability =	85
Reliability (z-statistic)	Z_R =	-1.04
Soil Resilient Modulus	M_R =	11183

Weighted Structural Number (WSN): → WSN = 1.70

DESIGN TABLES AND EQUATIONS

$S_1 = [(R - 5) / 11.29] + 3$

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$

$\mathbf{M_R = 2555 * CBR^{0.64}}$

$k = M_R / 19.4$

Where:

M_R = resilient modulus (psi)

S_1 = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

Reliability (%)	Z_R (z-statistic)
80	-0.84
85	-1.04
90	-1.28
93	-1.48
94	-1.56
95	-1.65
96	-1.75
97	-1.88
98	-2.05
99	-2.33
99.9	-3.09
99.99	-3.75

$$\log_{10}W_{18} = Z_R * S_O + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10}M_R - 8.07$$

Left	Right	Difference
4.70	4.70	0.0

Job No. 180088
Fig. No. C-3

DESIGN CALCULATIONS

DESIGN DATA THE VECINO GROUP
3.87 ACRE PARCEL NEAR WESTERN & GREAT WESTERN DRIVES - DRIVE AREAS

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	50,000
Hveem Stabilometer (R Value) Results:	R =	45
Weighted Structural Number (WSN):	WSN =	1.70

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.12 Strength Coefficient - Aggregate Base Course

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION

$D_1 = (WSN)/C_1 =$ 3.9 inches of Full Depth Asphalt
Use 5.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = 4 inches
$D_2 = ((WSN) - (t)(C_1))/C_2 =$ -0.5 inches of Aggregate
Base Course, use 6.0 inches

RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 6.0 inches of Aggregate Base Course, or
2. 5.0 inches of Asphalt

Job No. 180088
Fig. No. C-4

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

THE VECINO GROUP
3.87 ACRE PARCEL NEAR WESTERN & GREAT WESTERN DRIVES - TRUCK AREAS

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	90,000
Hveem Stabilometer (R Value) Results:	R =	45
Standard Deviation	S_o =	0.44
Loss in Serviceability	Δpsi =	2.5
Reliability	Reliability =	85
Reliability (z-statistic)	Z_R =	-1.04
Soil Resilient Modulus	M_R =	11183

Weighted Structural Number (WSN): → WSN = 1.88

DESIGN TABLES AND EQUATIONS

$S_1 = [(R - 5) / 11.29] + 3$

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$

$\mathbf{M_R = 2555 * CBR^{0.64}}$

$k = M_R / 19.4$

Where:

M_R = resilient modulus (psi)

S_1 = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

Reliability (%)	Z_R (z-statistic)
80	-0.84
85	-1.04
90	-1.28
93	-1.48
94	-1.56
95	-1.65
96	-1.75
97	-1.88
98	-2.05
99	-2.33
99.9	-3.09
99.99	-3.75

$$\log_{10} W_{18} = Z_R * S_O + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$

Left	Right	Difference
4.95	4.96	0.0

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Fig. No. C-5

DESIGN CALCULATIONS

DESIGN DATA THE VECINO GROUP
3.87 ACRE PARCEL NEAR WESTERN & GREAT WESTERN DRIVES - TRUCK AREAS

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	90,000
Hveem Stabilometer (R Value) Results:	R =	45
Weighted Structural Number (WSN):	WSN =	1.88

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.12 Strength Coefficient - Aggregate Base Course

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION

$D_1 = (WSN)/C_1 =$ 4.3 inches of Full Depth Asphalt
Use 5.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = 4 inches
$D_2 = ((WSN) - (t)(C_1))/C_2 =$ 1.0 inches of Aggregate
Base Course, use 6.0 inches

RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 6.0 inches of Aggregate Base Course, or
2. 5.0 inches of Asphalt

Job No. 180088
Fig. No. C-6