

Architecture
Structural
Geotechnical



Materials Testing
Forensic
Civil/Planning

ROCKY MOUNTAIN GROUP
EMPLOYEE OWNED

Job No. 167719

December 10, 2018

Palace Homes
1216 W. Colorado Ave. #110
Colorado Springs, CO 80904

Re: Geologic Hazard Report
975 Oak Ridge Rd
Site 346 Crystal Park, Filing No. 2
Manitou Springs, Colorado

Dear Gordon Stegner:

This report presents the findings of an evaluation performed by RMG – Rocky Mountain Group of the above-referenced site in El Paso County, Colorado. The purpose of our report is to evaluate the site conditions and present our opinions of the observed conditions on the proposed development with respect to the intended usage.

Revisions and modifications to the conclusions and recommendations presented in this report may be issued subsequently by RMG based upon additional observations made during grading and construction (which may indicate conditions that require re-evaluation of some of the criteria presented in this report) and/or upon receipt of review comments from El Paso County and/or any third-party reviewing agencies.

Qualifications of Preparers

This Geologic Hazard Study was prepared by a professional geologist as defined by Colorado Revised Statutes section 34-1-201(3) and by a qualified geotechnical engineer as defined by policy statement 15, "Engineering in Designated Natural Hazards Areas" of the Colorado State Board of Registration for Professional Engineers and Professional Land Surveyors. (Ord. 96-74; Ord. 01-42)

The principle investigators for this study are Kelli Zigler, P.G. and Tony Munger, P.E. Ms. Zigler is a professional Geologist with over 18 years of experience in the geological and geotechnical engineering field. Ms. Zigler holds a Bachelor of Science in Geology from the University of Tulsa. Ms. Zigler has supervised and performed numerous geological and geotechnical field investigations in Colorado. Tony Munger is a licensed professional engineer with over 18 years of experience in the construction engineering (residential) field. Mr. Munger and holds a Bachelor of Science in Architectural Engineering from the University of Wyoming.

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Central Office:
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Fort Collins: 970-616-4364
Monument: 719.488.2145
Woodland Park: 719.687.6077

Existing and Proposed Land Use

The site is to consist of an approximately 30,492 square foot parcel zoned as “PUD” Planned Unit Development per El Paso County zoning. The proposed land use is to create an approximately 0.70 acre single-family parcel known as Site S-346 within the Crystal Park subdivision.

Project Description

The proposed development of this site is to consist of the construction of a single-family dwelling with an onsite wastewater treatment system and well. This geologic hazards study was performed to evaluate geologic conditions that may impact the proposed development and provide recommendations for mitigation and design for residential construction.

Site Evaluation Techniques

The information included in this report has been compiled from

1. Field reconnaissance
2. Geologic and topographic maps
3. Review of previous reports performed by RMG in the same subdivision
4. Available aerial photographs
5. Geologic research and analysis
6. Site development plans prepared by others

Geophysical investigations were not considered necessary for characterization of the site geology.

Previous Studies and Field Investigation

Reports of previous geotechnical engineering/geologic investigations specifically addressed to this site were available for our review and are listed below:

1. *Subsurface Soil Investigation, Site #346, Crystal Park, Filing No. 2, Manitou Springs, Colorado*, prepared by Entech Engineering, Inc., Job 1080779, dated June 6, 2018.
2. *Site Plan, Steve and Gina Bigelow Residence, 975 Oak Ridge Road, Manitou Springs, Colorado*, prepared by BBKern DESIGNS, LLC, last dated June 27, 2018.

Site Conditions

We performed a site visit for field reconnaissance on September 7, 2018. At the time of the field reconnaissance, the site consisted of vacant land generally located 0.5 miles from Crystal Park entrance in El Paso County, Colorado. The ground surface within the proposed building area was covered with vegetation consisting of scrub oak, tall grasses, weeds. The driveway area was cleared. The remainder of the site contained a moderate to high growth of coniferous trees, aspens, and boulders scattered throughout the entire property. Topographically, the slopes within (and immediately below) the footprint of the proposed residence ranged up to approximately 33 percent, but slopes across the remainder of the site ranged up to a 40 (and in some small localized areas, up to 60) percent grade. The site has generally good drainage in the form of surface sheet flow directed to the east. Minor slope creep

was observed in the vicinity of the site as visible along the roadway cut for the driveway parallel to Oak Ridge Road. Surficial soil erosion was evidenced east of the proposed residence location down to Crystal Park Road.

General Geology

Based upon mapping presented by the Colorado Geological Survey (CGS) (¹Keller et al, 2003), the bedrock underlying the subject site is comprised The Pikes Peak Granite. However, outcroppings of the Sawatch Sandstone of Upper Cambrian Era and Migmatitic gneiss of Early Proterozoic are visible in the road cut along Oak Ridge Road. The Pikes Peak Granite is comprised of light-gray to pink and reddish brown, coarse grained, porphyritic granite. The Pikes Peak Granite often produces grus (disaggregated loose mass of constituent minerals) when weathered. Resistant outcrops typically are round and bouldery. The principal minerals composing the Pikes Peak Granite are perthitic microcline, quartz, biotite and plagioclase (oligoclase).

The surficial deposits as observed during our site visit consist of residuum and colluvium generally composed of sands and gravels with varying amounts of silt and clay. Evidence of natural rockfall or debris flow deposits was not observed in the vicinity of the building site.

The site is located in the vicinity of the Ute Pass Fault zone (to the west) and an unnamed fault is mapped approximately 1/2 mile to the east of the site. The Ute Pass Fault is located approximately within 200 to 300 feet to the west of the site. According to information presented by the CGS (²Kirkham et al, 2004-2007), several earthquakes have occurred in the vicinity of the Ute Pass Fault near Colorado Springs and Woodland Park. The earthquakes, with magnitudes in the range of 3.0 to 3.9, occurred approximately from 1962 to 2007.

Subsurface Materials

Based on the review of the soil report referenced above, two test borings were performed on May 3, 2018. The test borings encountered approximately 1-foot of silty sand overlying silty sandstone extending to the 20-foot termination depth of the test borings. Groundwater was not encountered at the time of drilling.

BEARING OF GEOLOGIC FACTORS UPON PROPOSED DEVELOPMENT

General Geologic Considerations

Based upon our evaluation of the geologic conditions, it is our opinion that the proposed development is feasible. The geologic hazards identified are not considered unusual for mountainous regions of Colorado. Mitigation of geologic hazards is most effectively accomplished by avoidance. However,

¹ Keller, John W., Siddoway, Christine, Morgan, Matthew L., Route, Erik E., Grizzell, Matthew T., Sacerdoti, Raffaello, and Stevenson, Adair, 2003 *Geologic Map of the Manitou Springs Quadrangle, El Paso and Teller Counties, Colorado*, Colorado Geological Survey, Open File Map 03-19.

² Kirkham, R. M., Rogers, W. P., Powell, L., Morgan, M. L., Matthews, V., and Pattyn, G. R., 2004-2007, *Colorado Earthquake Map Server*. Colorado Geological Survey Bulletin 52b.

<http://geosurvey.state.co.us/Default.aspx?tabid=270>

where avoidance is not a practical or acceptable alternative, geologic hazards should be mitigated by implementing appropriate planning, engineering, and local construction practices.

Potentially Unstable Slopes

Downslope creep, which is the slow downslope movement of superficial soil and rock materials, is common to the area. However, the potential for relatively rapid downslope movement at the site is considered to be low. Nevertheless, the structural design of the residence should consider its placement on the hillside and the additional pressures that could be generated by downslope creep and by retaining upslope materials. Proper surface grading and positive drainage away from the structure will reduce (but not eliminate) the potential for downslope creep to impact the proposed residence. Any landscaping should utilize xeriscape techniques in order to minimize the amount of irrigation necessary to maintain landscaping. Further, stormwater and snowmelt runoff from parking areas should be directed towards drainage channels and away from potentially unstable slopes, both during construction activities and upon completion of site development.

Rockfall

The subject site does have a steep slope to the west (uphill) of the proposed build area along the roadway cut for Oak Ridge Road. The material exposed in the roadway cut at the surface appeared to be sandstone and is relatively intact, with only minor weathering. The slope to the east (downhill) of the proposed home is also steep. However the slope to the east did not have large boulders at the surface to generate rockfall. The subject property is not considered to be prone to rockfall.

Debris Flows and Debris Fans

Terrain features consistent in the formation of debris flows and debris fans are not present in the vicinity of the property.

Seismicity

The Pikes Peak Regional Building Code, 2017 Edition, indicates maximum considered earthquake spectral response accelerations of 0.193g for a short period (S_s) and 0.063g for a 1-second period (S_1). Specific recommendations should be provided by the Geotechnical Engineer of Record during the design phase of the project.

Surface Drainage and Erosion

The permeability of the sands and gravels at the site is generally considered to be high, but the permeability of the sandstone is generally considered to be low. Surface runoff could also be rapid and the potential for rapid erosion of unvegetated slopes could be high. Long-term slopes should not be steeper than 3:1 (horizontal:vertical) in both cut and fill areas. Revegetation of any disturbed areas should be performed as soon as possible with revegetation/erosion mats placed as required. Excavation cuts and soil disturbance should be kept to a minimum. Proper surface drainage, as recommended in a geotechnical engineering report, should be provided and maintained by the Homeowner.

Radioactivity/Radon Gas

Based upon a Map of Radon Zones by the Colorado Department of Public Health and Environment (CDPHE) (Ref. 11), two zones of radon potential are indicated in Colorado, Zone 1 - High Radon Potential (probable indoor radon average >4 pCi/L) and Zone 2 -Moderate Radon Potential (probable indoor radon average 2-4 pCi/L). El Paso County is located within Zone 1.

Potential radon hazards are best mitigated at the building design and construction phases. Providing increased ventilation of basements, crawlspaces, creating slightly positive pressures within structures, and sealing of joints and cracks in the foundations and below-grade walls can help mitigate radon hazards.

CLOSING

This report has been prepared for the exclusive purpose of providing geologic hazards information and recommendations for development described in this report. RMG should be retained to review the final construction documents prior to construction to verify our findings, conclusions and recommendations have been appropriately implemented.

This report has been prepared for the exclusive use by the Client for application as an aid in the design and construction of the proposed development in accordance with generally accepted geotechnical and geological engineering practices. The analyses and recommendations in this report are based in part upon data obtained from site observations and the information presented in referenced reports. The nature and extent of variations may not become evident until construction. If variations then become evident, RMG should be retained to review the recommendations presented in this report considering the varied condition, and either verify or modify them in writing.

Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by geotechnical engineers practicing in this or similar localities. RMG does not warrant the work of regulatory agencies or other third parties supplying information which may have been used during the preparation of this report. No warranty, express or implied, is made by the preparation of this report. Third parties reviewing this report should draw their own conclusions regarding site conditions and specific construction techniques to be used on this project.

The scope of services for this project does not include, either specifically or by implication, environmental assessment of the site or identification of contaminated or hazardous materials or conditions. Development of recommendations for the mitigation of environmentally related conditions, including but not limited to biological or toxicological issues, are beyond the scope of this report. If the Client desires investigation into the potential for such contamination or conditions, other studies should be undertaken.

If we can be of further assistance in discussing the contents of this report or analysis of the proposed development, from a geotechnical engineering point-of-view, please feel free to contact us.

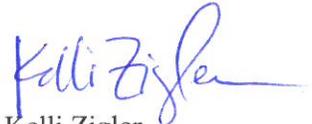
If we can be of further assistance in discussing the contents of this report or analysis of the proposed development, from a geotechnical engineering point-of-view, please feel free to contact our office.

Cordially,

Reviewed by,

RMG – Rocky Mountain Group

RMG – Rocky Mountain Group


Kelli Zigler
Project Geologist

Tony Munger, P.E.
Geotechnical Project Manager



June 6, 2018

Palace Homes
1216 West Colorado Ave, #110
Colorado Springs, Colorado 80904



ENTECH
ENGINEERING, INC.

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

Attn: Gordon Stegner

Re: Subsurface Soil Investigation
Site #346, Crystal Park Filing No. 2
Manitou Springs, Colorado

Dear Mr. Stegner:

Personnel of Entech Engineering, Inc. have drilled two shallow test borings at the site referenced above. Specific findings for the site are presented in this letter.

Soil Classification:

Soil types observed in the test borings drilled on this site were found to consist of a layer of silty sand overlying silty sandstone bedrock.

Allowable Bearing Capacity:

An allowable bearing pressure of 2600 psf for the imported structural fill or properly broken-down sandstone used as structural fill. An equivalent hydrostatic fluid pressure (in the active state) of 45 pcf is recommended for this site.

Soil Moisture Conditions:

Moist to dry.

Expansion Potential:

Low.

Fill:

None.

Special Considerations:

The Ute Pass Fault is mapped southwest of the site according to the *Geologic Map of the Cascade Quadrangle, El Paso County, Colorado* by M.L. Morgan, C.S. Siddoway, P.D. Rowley, J. Temple, J.W. Keller, B.H. Archuleta, and J.W. Himmelrich Jr., distributed by the Colorado Geological Survey in 2003 (Open-File Report 03-18).

Due to the very dense nature of the sandstone, track mounted equipment will likely be required for the excavation. To provide a uniform pad of similar bearing soils the foundation should bear on a 2-foot layer of granular structural fill. Fill placed below the foundation components should be compacted to a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 at moisture content within 2 percent of optimum. The extent of overexcavation should be

Palace Homes
Subsurface Soil Investigation
Site #346, Crystal Park Filing No. 2
Manitou Springs, Colorado

determined at the time of the open excavation observation. Site materials may be acceptable for use as structural fill pending approval by Entech.

Due to the moderate to steep slopes at this site, foundation stiffeners such as tie-beams, buttresses or additional reinforcement may be required. The need for stiffeners should be determined when final grading and construction plans are available.

Foundation Type:

A spread footing (16")/stemwall foundation system in conjunction with over excavation is anticipated for this site. Point load bearing pads should be sized for the allowable bearing capacity given. **This does not constitute a foundation design.** Qualified personnel should verify that building loads do not exceed the bearing value given in this letter. The bottoms of exterior foundations should be located at least 30 inches below finished grade for frost protection.

Foundation Configuration Remarks:

The configuration of the foundation system is critical to its performance. The position of foundation windows, jogs, steps and the relative elevation of adjacent and opposite walls determine foundation performance. Improper placement of the above can result in differential and lateral foundation movement. In addition, foundation walls over 4 feet in height should not span over 30 feet in length without specific design.

Reinforcing:

Reinforcing should be designed to permit foundation walls to span a minimum of 10 feet under the design load. Foundation walls retaining over 4 feet of soil should be designed to resist an equivalent fluid pressure (in the active state) of 45 pcf. Highly expansive soils should not be used as backfill material.

Floor Slabs:

Floor slabs-on-grade, if any, should be separated from structural portions of the building and allowed to float freely. Interior partitions must be constructed in such a manner that they do not transmit floor slab movement to the roof or overlying floor. Backfill placed below floor slabs should be compacted to a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557.

Drainage and Grading:

The ground surface must be sloped away from the building to provide positive drainage away from the foundation. We recommend an equivalent slope of 6 inches in the first 10 feet (5%) surrounding the structure, where possible, or as required to quickly remove surface water. Where a 5% slope cannot be achieved practically, such as around patios, at inside foundation corners, and between a building and nearby sidewalk, we believe it is desirable to establish as much slope as possible and to avoid irrigation in the area. Roof downspouts should discharge

Palace Homes
Subsurface Soil Investigation
Site #346, Crystal Park Filing No. 2
Manitou Springs, Colorado

beyond the limits of backfill. We recommend providing splash blocks and downspout extensions to discharge runoff beyond the limits of backfill.

Owners should maintain the surface grading and drainage installed by the builder to assure water is not directed toward the foundations and does not pond near the structure. Landscaping should be carefully designed to minimize irrigation adjacent to the foundation. We do not recommend use of impervious plastic membranes below landscaped areas near foundations; geotextile fabrics can control weed growth while allowing evaporation. Plants used close to foundations should be limited to those with low moisture requirements; irrigated grass should not be located within 5 feet of the foundation. Sprinklers should not discharge water within 5 feet of foundations. Irrigation should be limited to the minimum amount sufficient to maintain vegetation. Application of more water will increase the potential for slab and/or foundation movements.

Subdrain:

A subsurface perimeter drain should be placed around useable space below grade and is recommended around the entire structure if expansive soils are encountered in the foundation excavation. A typical drain detail is attached.

Backfill:

Backfill should be compacted to 95% of its maximum Modified Proctor Dry Density, ASTM D-1557. Backfill must be compacted by mechanical means. No water flooding techniques of any type should be used in the compaction of backfill on this site. Expansive soils are not to be used as foundation backfill.

Concrete:

Type II cement is recommended for all concrete on this site. Concrete should not be placed on frozen or wet ground. Care should be taken to prevent the accumulation and ponding of water in the excavations prior to the placement of concrete. If standing water is present in any excavation, it should be removed by installing sumps and pumping the water away from the building area. 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 heating to prohibit freezing.

Palace Homes
Subsurface Soil Investigation
Site #346, Crystal Park Filing No. 2
Manitou Springs, Colorado

Remarks:

The recommendations provided in this letter are based upon the observed soil parameters, anticipated foundation loads, and accepted engineering procedures. The recommendations are intended to minimize differential movement resulting from the heaving of expansive soils or resulting from settlement induced by the application of building loads. It must be recognized that the foundation may undergo movement. In addition, concrete floor slabs may experience movement; therefore, adherence to those recommendations which would isolate floor slabs from columns, walls, partitions or other structural components is extremely important, if damage to the superstructure is to be minimized. Owners should be apprised of the soil conditions and advised to maintain good practice in the future with regard to surface and subsurface drainage, framing of partitions above floor slabs, drywall and finish work above floor slabs, etc.

We trust this has provided you with the information you required. If you have any questions or need additional information, please do not hesitate to contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.


Brian W. Vasterling
Geologist

BWV/bv

Encl.

Entech Job No. 180779
AAProject/2018/180779 ssi



Reviewed by:


Mark H. Hauschild, P.E.
Senior Engineer

TEST BORING NO. 1
 DATE DRILLED 5/3/2018
 Job # 180779

TEST BORING NO. 2
 DATE DRILLED 5/3/2018
 CLIENT PALACE HOMES
 LOCATION 346 OAK RIDGE ROAD

REMARKS

REMARKS

DRY TO 20', 5/3/18

SAND, SILTY, TAN
 SANDSTONE, SILTY, FINE TO
 MEDIUM GRAINED, RED BROWN,
 VERY DENSE, MOIST TO DRY

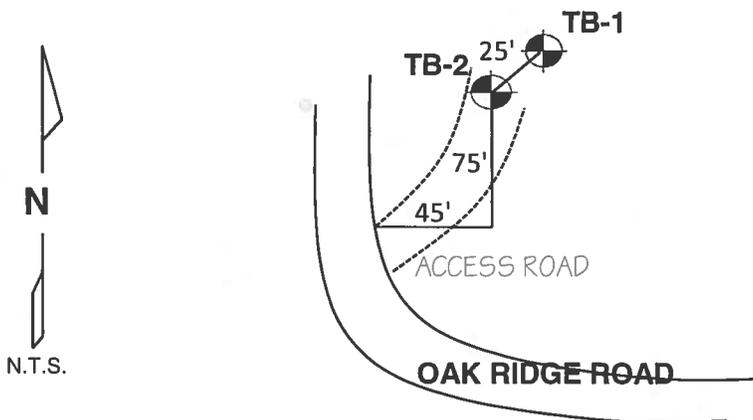
| Depth (ft) | Symbol | Samples | Blows per foot | Watercontent % | Soil Type |
|------------|----------|---------|----------------|----------------|-----------|
| 0-5 | [Symbol] | | * 50 3" | 2.9 | |
| 5-7 | [Symbol] | | 50 2" | 2.4 | |
| 7-10 | [Symbol] | | 50 2" | 2.5 | |
| 10-15 | [Symbol] | | * | 1.7 | |
| 15-20 | [Symbol] | | 50 2" | 1.8 | |

DRY TO 20', 5/3/18

SAND, SILTY, TAN
 SANDSTONE, SILTY, FINE
 GRAINED, RED BROWN, VERY
 DENSE, DRY TO MOIST

| Depth (ft) | Symbol | Samples | Blows per foot | Watercontent % | Soil Type |
|------------|----------|---------|----------------|----------------|-----------|
| 0-5 | [Symbol] | | 50 10" | 1.2 | |
| 5-7 | [Symbol] | | 50 4" | 2.3 | |
| 7-10 | [Symbol] | | 50 2" | 2.8 | |
| 10-15 | [Symbol] | | 50 1" | 2.0 | |
| 15-20 | [Symbol] | | 50 2" | 3.4 | |

* - BULK SAMPLE TAKEN



LOCATIONS OF TEST BORINGS ARE APPROXIMATE



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

TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE:

h 5/9/18

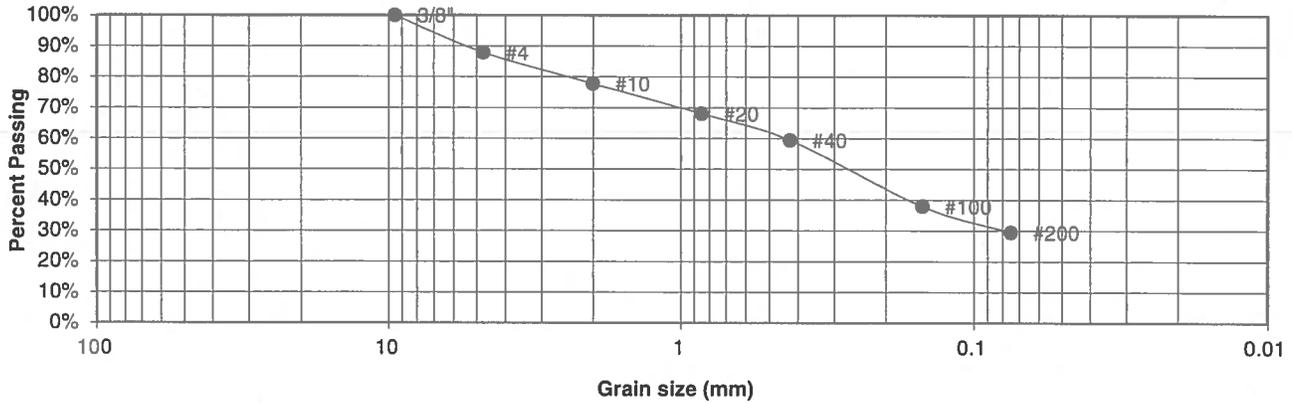
JOB NO.:
180779

FIG NO.:

1

| | | | | | |
|------------|--------------------|------------------------|----|---------|--------|
| BORING NO. | 1 | UNIFIED CLASSIFICATION | SM | TEST BY | BL |
| DEPTH(ft) | 2-3 | AASHTO CLASSIFICATION | | JOB NO. | 180779 |
| CLIENT | PALACE HOMES | | | | |
| PROJECT | 346 OAK RIDGE ROAD | | | | |

**Sieve Analysis
Grain Size Distribution**



| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | 100.0% |
| 4 | 87.9% |
| 10 | 77.8% |
| 20 | 68.1% |
| 40 | 59.4% |
| 100 | 37.9% |
| 200 | 29.5% |

Atterberg Limits
 Plastic Limit
 Liquid Limit
 Plastic Index

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



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ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST
RESULTS**

DRAWN:

DATE:

CHECKED: *h*

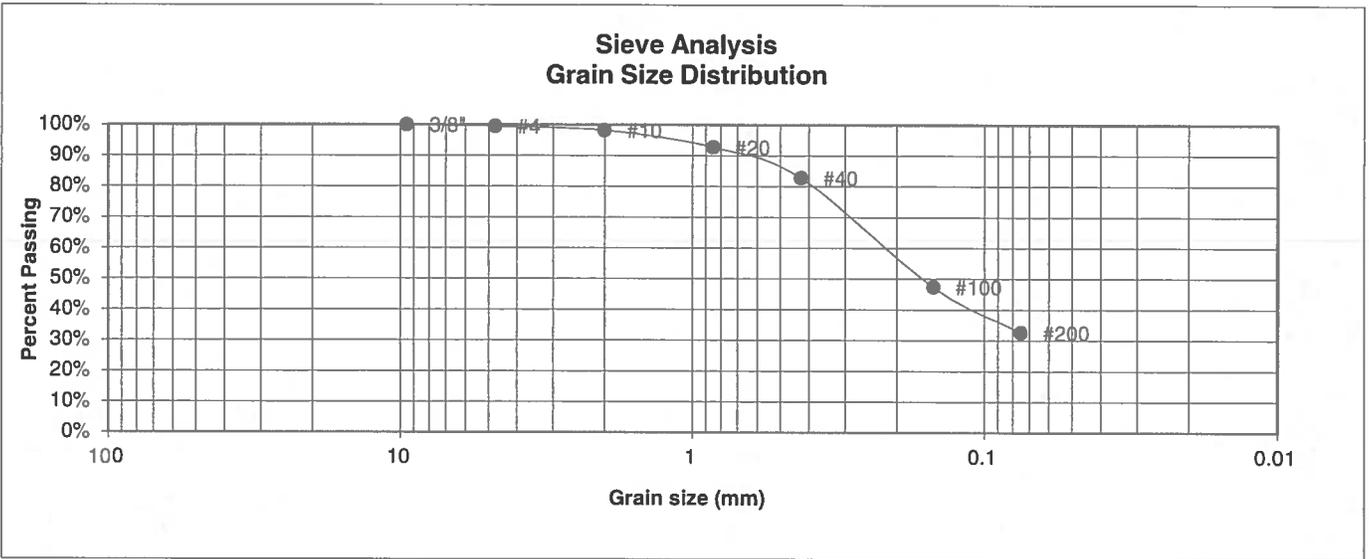
DATE: 5/9/18

JOB NO.:
180779

FIG NO.:

2

| | | | | | |
|------------|--------------------|------------------------|----|---------|--------|
| BORING NO. | 2 | UNIFIED CLASSIFICATION | SM | TEST BY | BL |
| DEPTH(ft) | 5 | AASHTO CLASSIFICATION | | JOB NO. | 180779 |
| CLIENT | PALACE HOMES | | | | |
| PROJECT | 346 OAK RIDGE ROAD | | | | |



| U.S. Sieve # | Percent Finer |
|--------------|---------------|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | 100.0% |
| 4 | 99.5% |
| 10 | 98.2% |
| 20 | 92.8% |
| 40 | 82.7% |
| 100 | 47.4% |
| 200 | 32.6% |

Atterberg Limits
 Plastic Limit
 Liquid Limit
 Plastic Index

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



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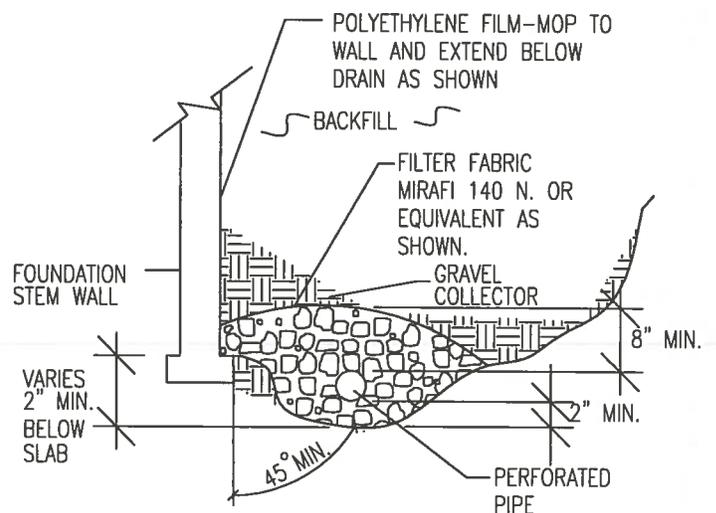
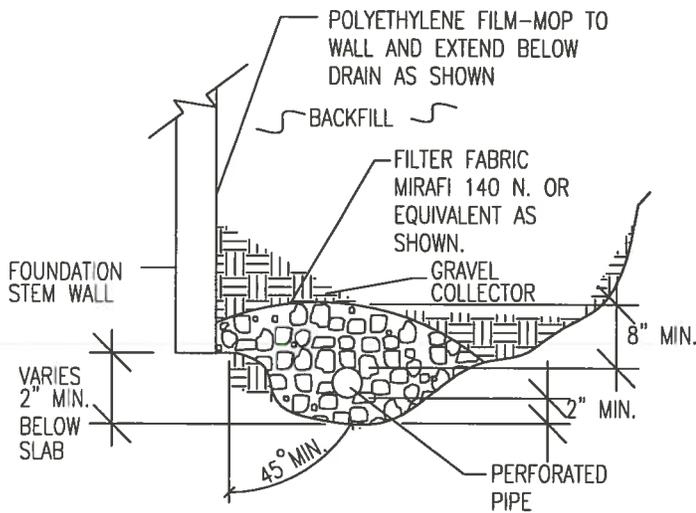
LABORATORY TEST RESULTS

| | | | |
|--------|-------|-------------------|--------------|
| DRAWN: | DATE: | CHECKED: <i>W</i> | DATE: 5/9/19 |
|--------|-------|-------------------|--------------|

JOB NO.:
180779

FIG NO.:

3



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 OUTFALL IS NOT AVAILABLE.



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

PERIMETER DRAIN DETAIL

| | | | |
|--------|-------|------------------------|-----------------------|
| DRAWN: | DATE: | DESIGNED: <i>PS</i> | CHECKED: <i>OV</i> |
|--------|-------|------------------------|-----------------------|

JOB NO.:
180779

FIG NO.:
4