WAYNE TING & ASSOCIATES, INC.
GEOTECHNICAL CONSULTANTS

Project No. 3907
25 July 2017

Mr. Siddiq Miakhail
2398 Rainbow Court
Hayward, CA 94542

Subject: **GEOTECHNICAL INVESTIGATION**
Proposed Single Family Home
2398 Rainbow Court
Hayward, California

Dear Mr. Miakhail:

In accordance with your authorization, **Wayne Ting & Associates, Inc. (WTAI)** has completed a geotechnical investigation at the subject site for the proposed residential structure. The purpose of this study was to investigate the site conditions and obtain geotechnical data for use in the design and construction of the proposed development. The scope of this investigation included the following:

a. A site and area reconnaissance by the Project Engineer.

b. The excavation, logging and sampling of 2 test borings.

c. The preparation and writing of this report which presents our findings, conclusions, and recommendations.

Our findings indicate that the proposed development is feasible from a geotechnical engineering standpoint provided the recommendations in this report are carefully followed.

SITE LOCATION AND DISCRIPTIONS

As presented on the Site Plan, Figure 1, the irregular shaped vacant lot is bounded to the west by Rainbow court, south by Parkside Drive, and to other sides by single-family homes. The site comprises an inclined slope which descends east toward west at approximately 2:1 (horizontal to vertical). The site is covered by grass.

PLANNED DEVELOPMENT

The proposed development will consist of a two-story residential structure with a basement. We anticipate that the proposed residential structure will utilize steel frame construction with raised wood floors and concrete slab-on-grade in the garage. Light to moderate building loads are typically associated with this type of construction.

FIELD INVESTIGATION

WTAI conducted field investigations on July 27, 2017. Two test borings were excavated by a pickaxe. The approximate locations of the test borings are shown on the Site Plan, Figure 1, Appendix A.

SUBSURFACE SOIL CONDITIONS

Subsurface soils consisted of 6.0 inches to 12 inches of light brown silty sand, medium dense and slightly moist, followed by light brown sandstone, medium dense, weathered, and fractured to the maximum depth excavated of 18 inches.

No ground water was encountered in any exploratory borings at the time of the field study. However, fluctuations in the groundwater table are anticipated to vary with seasonal rainfall.

SEISMIC CONSIDERATIONS

The significant earthquakes which occur in the Bay Area are generally associated with crustal movements along well defined active fault zones. According to the maps published by International Conference of Building Officials (I.C.B.O.), in February 1998, the nearest active fault to the subject site is the Hayward Fault which is located approximately 1.0 kilometer southwest. San Andreas is located at approximately 30.8 kilometers southwest. Therefore, the potential for surface fault trace rupture is considered to be negligible. We anticipate that the proposed structure will subject to strong ground shaking during the lifetime of the building structure.

CALIFORNIA BUILDING CODE SITE CHARACTERIZATION

The following design values are base on the geologic information, longitude and latitude of the site, and the USGS computer program. Furthermore, in accordance with Chapter 16 of the 2016 California Building Code (CBC), the site seismic design values are provided as follow:

CBC Category/Coefficient 2010 ASCE 7-10 (with July 2013 errata)	Design Value
Short-Period MCE at 0.2s, Ss	2.401
1.0s Period MCE, S1	0.999
Soil Profile Type, Site Class	C
S_{MS} = Fa x S_s Spectral Response Accelerations	2.401
S_{M1} = Fv x S_1Spectral Response Accelerations	1.299
S_{DS} = 2/3 x S_{MS} Design Spectral Response Accelerations	1.600
S_{D1} = 2/3 x S_{M1} Design Spectral Response Accelerations	0.866
** Latitude: 37.66032 Longitude: -122.0502	

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

GENERAL CONSIDERATIONS

1. Based on the results of our investigation, WTAI concludes that the subject site is geotechnically suitable for the proposed development. The proposed building can be constructed provided the recommendations presented in this report are incorporated into the project plans and specifications.

2. It is recommended that WTAI be given the opportunity to review the grading and foundation plans and specifications so that comments can be made regarding the interpretation and implementation of our geotechnical recommendations in the design and specifications.

3. It is further recommended that WTAI be retained for testing and observation during grading and foundation construction phases to help determine that the design requirements are fulfilled. Our firm should be notified at least two working days prior to grading and/or foundation operations on the property.

4. Any work related to the grading and/or foundation operations performed without the direct observation of WTAI will invalidate the recommendations of this report.

5. The following conclusions and recommendations are based on information provided, results of the subsurface investigation, and laboratory tests, as well as our experience with similar soil conditions. The possibility always exists that the subsurface conditions at the site may vary somewhat from those encountered in the exploratory borings. If there are any unusual conditions differing significantly from those described herein, this firm should be notified to review the effects on the performance of the designed foundations. The recommendations given in this report are applicable only for the design of the previously described structure and only at the location indicated on the site plan. They should not be used for any other purpose.

SITE PREPARATION AND GRADING

6. It is noted that the proposed pad grade will be completely excavated into the existing ground surface. All cut slopes should not be steeper than 2:1 (horizontal:vertical).

EXCAVATION OF BASEMENT

7. Before the proposed basement is excavated, WTAI recommends a temporary shoring system be constructed around the basement area, for the safety of the construction workers and for the protection of the existing structures of neighbors. The general contractor should carefully implement the safety plan according the recommendations of California Occupational Safety and Health Administration (Cal OSHA.) The contractors should be responsible for the stability of all temporary cut slopes and trenches excavated at the site, and design and construction of any required shoring

system. Unstable materials encountered on the slopes during the excavation and/or basement construction should be removed, even if this requires cutting the slope back at flatter inclinations.

8. The temporary shoring system can be achieved by constructing soldier piers. The piers should have a minimum diameter of 16 inches and a minimum embedment of 12 feet below the basement subgrade. The piers should equally be spaced at maximum 6 feet on centers. The piers can be filled with lean concrete. Steel reinforcement will be determined by the Project Structural Engineer.

9. The piers should be designed to resist a lateral earth pressure of 45 p.c.f. (Equivalent fluid pressure). Resistance to lateral forces may be provided by passive earth pressure mobilized along the pier length below the depth of the basement subgrade. Passive earth pressure may be computed as an equivalent fluid weight of 350 pounds per cubic foot acting on 2 pier diameters.

10. If the location of the basement is suitable for an open cut, the maximum allowable cut slope gradient is 2:1 (horizontal:vertical). The maximum vertical side cut at the bottom of the basement can be 5.0 feet or according to the OSHA requirements.

11. Additionally, the excavation operations, retaining wall construction, installation of drains, and wall backfilling operations should be made in continuous manner in order to minimize exposure time of temporary excavation slopes.

12. If unstable cut slope conditions are observed before the basement retaining walls are backfilled, the slope should be stabilized immediately. WTAI should be notified by the contractors.

FOUNDATION RECOMMENDATIONS FOR THE BASEMENT

13. The proposed basement walls may satisfactorily be supported on mat slabs. In addition, the proposed structure located behind the basement walls should be founded on pier and grade beam foundation.

Mat Slab Foundation

14. Modulus of subgrade reaction of 150 k.c.f. may be used in the design for mat slabs.

15. The slab should be designed based on the allowable bearing capacity of 2,000 p.s.f. due to dead loads plus design live loads, and 2,700 p.s.f. due to all loads which include wind or seismic forces.

16. The available resistance to lateral loads when utilizing structural slabs is limited to the sliding resistance along the base of the slab. Sliding resistance between the bottom of the slab and the underlying soil should be based on a friction value of 0.35.

Pier and Grade Beam Foundation.

17. Due to current standard of practice for hill side areas, the proposed structure located on the upper slopes should be supported on a straight walled, auger excavated, cast-in-place, concrete friction pier and grade beam foundation. The drilled piers should have a minimum diameter of 16 inches and a minimum embedment of 10 feet into the underlying rock. Therefore, due to the various thickness of on-site soil, WTAI estimates that pier depth may range from 10.0 to 13.0 feet. These piers should be designed for an allowable skin friction value of 600 pounds per square foot for dead plus live loads. This value is only applicable for piers constructed in the rock and can be increased by one-third for total loads which include wind or seismic forces. The validity of this value is based on a minimum pier spacing of 3 pier diameters measured center-to-center. All piers should be tied together with grade beams to act as a unit in resisting lateral loads. All reinforcement will be determined by the Project Structural Engineer.

18. Due to the slope gradient, the piers located within 10 feet form top of slope may be subjected to lateral loads. Therefore, the lateral pressures presented as the equivalent fluid weight of 65 p.c.f. should be assumed to act along the side in the upper 3 feet of the piers.

19. Resistance to lateral force may be provided by passive earth pressures mobilized along the pier length in the firm natural ground below a depth of 3 feet. Passive earth pressures may be computed as an equivalent fluid weighing of 350 pounds per cubic foot. For design of isolated piers, the allowable passive pressure may be increased by a factor of 2.

20. After completion of the pier drilling, the bottom of the pier excavations should be cleaned of excessive loose materials prior to placing the reinforcing steel and concrete.

21. Settlements under the anticipated fill and building loads are expected to be within tolerable limits for the proposed structure. We estimate that the total settlement will be less than 1 inch, and post-construction differential settlements across the building should not exceed approximately 1/2-inch during the life of the building following construction.

CONCRETE SLAB-ON-GRADE

22. Basement concrete slab-on-grade should be underlain by at least 4.0 inches of clean crushed, 3/4-inch size rock, to act as a cushion and capillary break between the subsoil and the slab.

23. In basement areas where moisture transmission through slabs is undesirable, a 15-mil membrane serving as a vapor retarder should be placed over the above recommended crushed rock to minimize condensation caused by temperature differentials under the floor covering. It is recommended that a better impermeable membrane should be used under the basement slabs according to the instruction of the manufacture and the specification of a foundation plan. It is noted that waterproofing for the basement should be designed by a waterproofing engineer.

RETAINING WALL

24. Retaining walls under 12 feet in height should be designed to resist lateral earth pressures from the backfill soils. The lateral earth pressures presented as an equivalent fluid weight for both unrestrained and restrained walls are shown as follow:

TABLE I

Slope Inclination Behind Wall (Horizontal : Vertical)	Equivalent Fluid Weight (Pounds Per Cubic Foot)	
	Unrestrained	Restrained
Flat	45	65
2:1	65	85

25. If surcharge loads are expected near the back of the basement wall, an additional uniform pressure equal to one-half of the surcharged pressure should be assumed to act against the back of the wall.

26. In addition, earthquakes induced lateral loads should be added for th basement wall design. These lateral loads should be taken as that imposed by an equivalent fluid weight of 30 p.c.f. However, the distribution of this load should be considered as a triangle with resultant force acting at a point 0.6 of the wall height above the base of the wall.

27. The above criterion is based upon a sufficient drainage system to be constructed behind the walls to prevent the build-up of hydrostatic pressures. The wall drainage system should consist of a gravel blanket with a minimum width of 12 inches and should extend vertically to 12 inches below the ground surface. The top 12 inches should be backfilled with on-site soils to provide a surface seal and be graded away from the wall. If the excavated area behind the wall exceeds 12 inches, the entire excavated space behind the 12-inch blanket material should be backfilled with gravel. The gravel blanket may consist of drainrock wrapped effectively with filter fabric.

28. A 4-inch diameter perforated pipe should be placed on bedding at the bottom of the gravel blanket. The perforations should be placed facing down toward. The bedding material should be at least 4 inches thick. The pipe should have a minimum gradient of 1.0 percent and should connect to an adequately controlled outlet facility away from the foundations. Drainage detail behind retaining walls is provided in Figure 4.

29. The retaining walls should be supported on the foundation system as designed in accordance with the recommendations presented previously under "Foundation Section." Proper factor safety factors should be applied for the wall design.

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DRAINAGE

30. All downspouts from the roof gutter system should be tied into a closed pipe system and discharged to an adequate drainage system.

31. Exterior flatwork should be sloped away from the building so that water will be drained away from the structure.

32. To minimize the water seepage underneath the foundation, a foundation drain should be provided along the perimeter grade beams on the upper pad. The foundation drain should be constructed at a lateral distance within 6.0 inches from the foundation and extend a minimum depth of 6.0 inches below the bottom of the grade beam. The recommended foundation drain detail is presented in Figure 5. The perforated pipe shown in Figure 5 will pass into a solid line pipe at the end drain then be directed to a sump pump or suitable discharge area. Cleanout risers should be provided at the upgradient end of the perforated pipe and at sharp bends.

LIMITATIONS AND UNIFORMITY OF CONDITIONS

33. Our professional services, findings, and recommendations were prepared in accordance with generally accepted engineering principles and practices. No other warranty, expressed or implied, is made.

34. The conclusions and recommendations contained in this report shall not be considered valid after a period of two (2) years, unless the changes are reviewed and conclusions of this report modified or verified in writing.

35. This report is issued with the understanding that it is the responsibility of the owner, or his representative, to ensure that the information and recommendations contained herein are brought to the attention of the Architect, Engineer, and Contractor for the project and incorporated into the plans and that the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field.

Should you have any questions relating to the contents of this letter, please contact our office at your convenience.

Very truly yours,

WAYNE TING & ASSOCIATES, INC.

Wayne L Ting, C.E.
Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
WAYNE L. TING
No. C 46276
Exp. 12/31/18
CIVIL
STATE OF CALIFORNIA

Copies: 3 to Mr. Miakhail

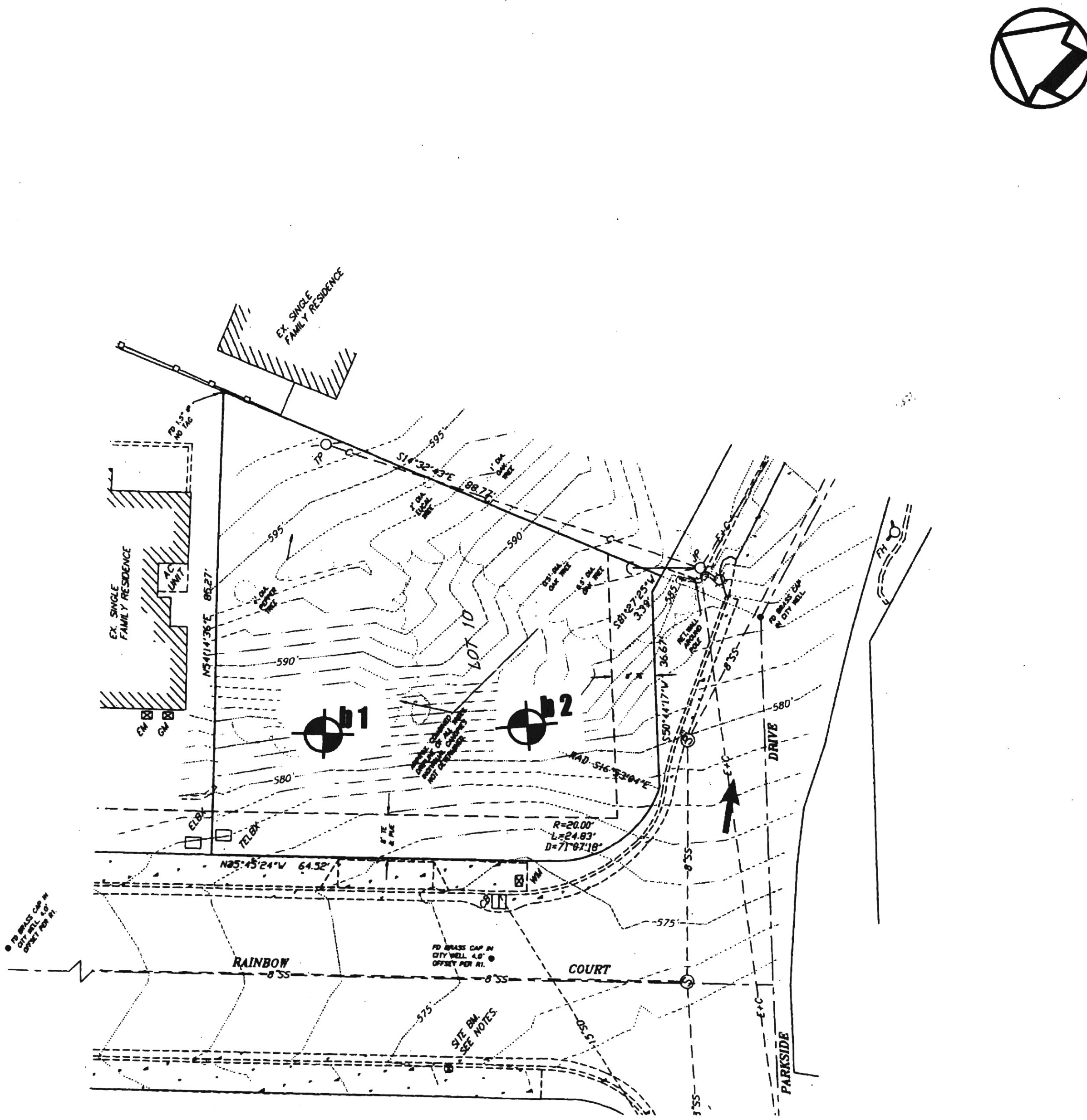
APPENDIX A

Site Plan, Figure 1

Test Boring Logs, Figure 2 and 3

Drainage Behind Wall Detail, Figure 4

Foundation Drain Detail, Figure 5



WAYNE TING & ASSOCIATES, INC.	Site Plan	Figure No. 1
GEOTECHNICAL CONSULTANTS	Scale: 1"=30'	Page No. 9

Depth (Feet)	Description	Sample No.	Unified Soil Classification	Blows/Foot (350 Ft.-Lbs)	Dry Density (P.C.F)	Moisture (% Dry Density)	Pocket Penet. (T.S.F)	Remarks
	Light brown silty sand, medium dense and slightly moist	1-1	SM					
1	Light brown sandstone, weathered, medium dense	1-2						
	Boring terminated at 1.5 feet.							
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WAYNE TING & ASSOCIATES, INC.	***BORING LOG NO. 1***	*Figure No. 2*
GEOTECHNICAL CONSULTANTS	*Date Drilled:* 27 June 2017 *By:* TB	*Page No. 10*

Depth (Feet)	Description	Sample No.	Unified Soil Classification	Blows/Foot (350 Ft.-Lbs)	Dry Density (P.C.F)	Moisture (% Dry Density)	Pocket Penet. (T.S.F)	Remarks
	Light brown silty sand, medium dense and moist	2-1	SM					
1	Light brown sandstone, weathered, fractured, and medium dense	2-2						
2	Boring terminated at 1.5 feet. No groundwater was encountered.							
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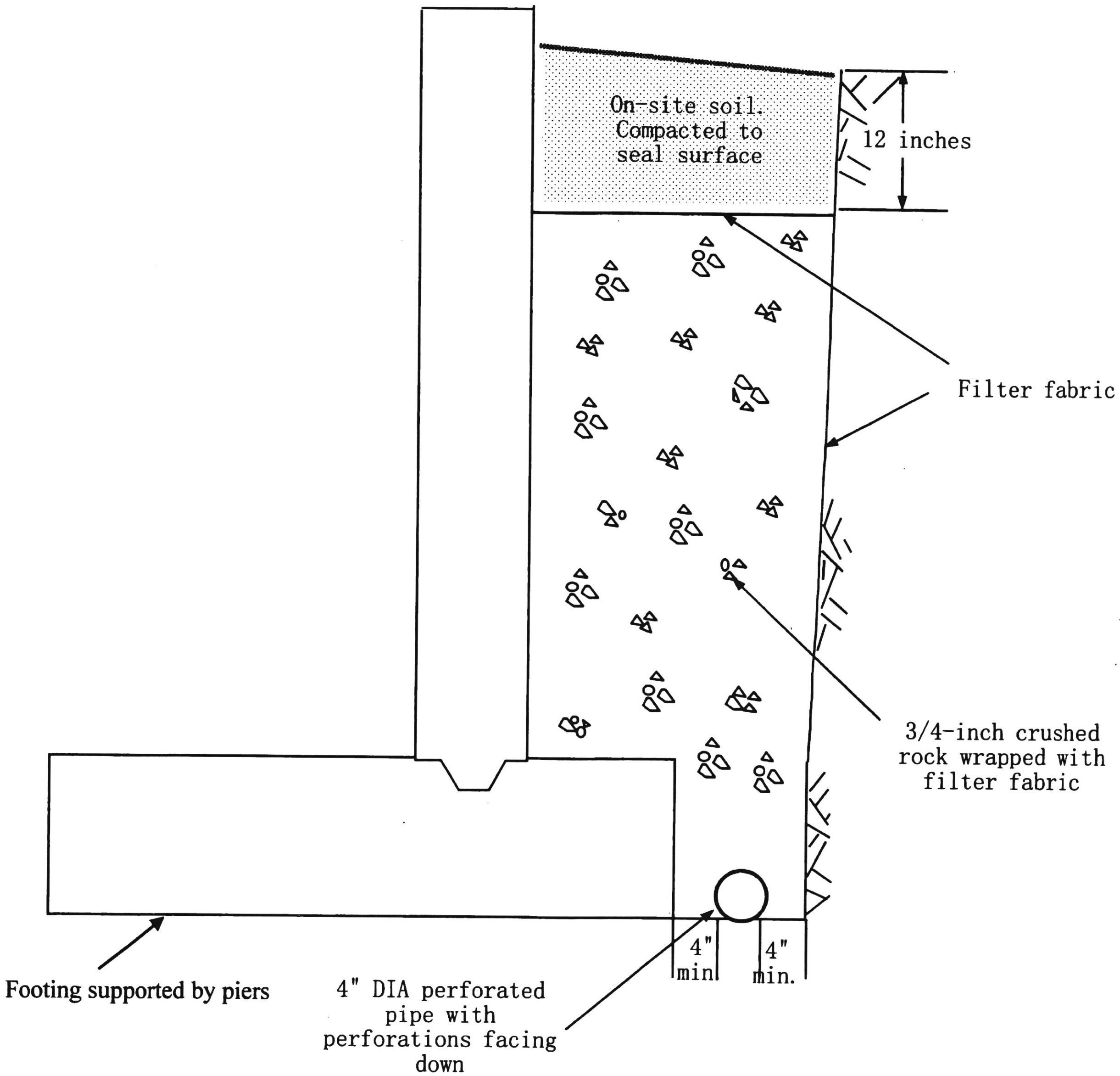
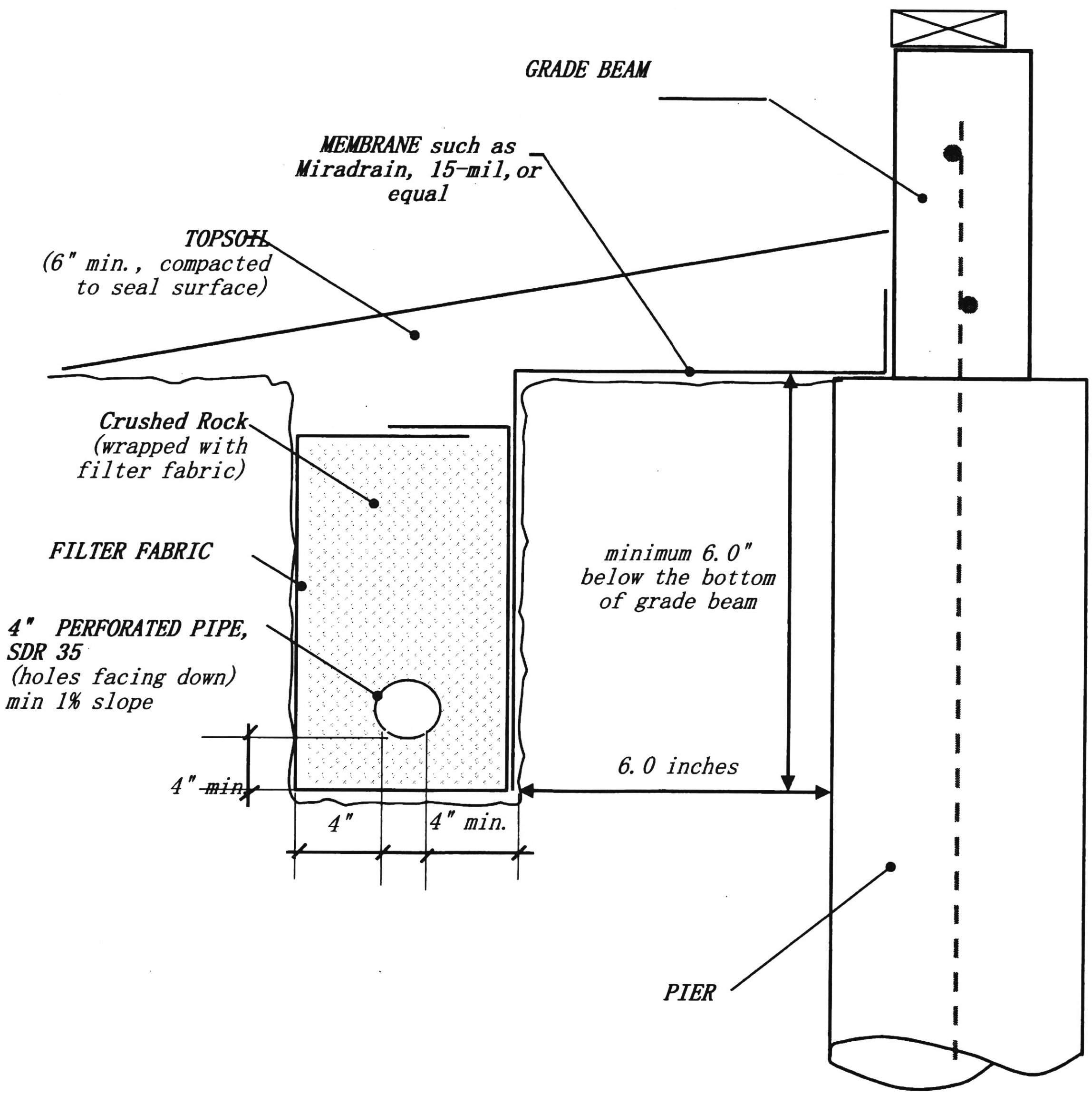


Note: 1. Bottom of the subdrain trench and pipe should be sloped at least 1.0 percent.
2. The perforated pipe may also be placed on top of footing.

WAYNE TING & ASSOCIATES, INC.	***DRAIN BEHIND THE RETAINING WALL***	*Figure No. 4*
GEOTECHNICAL CONSULTANTS	Scale: N/A	*Page No. 12*



WAYNE TING & ASSOCIATES, INC.	*FOUNDATION DRAIN*	*Figure No. 5*
GEOTECHNICAL CONSULTANTS	Scale: N/A	*Page No. 13*