EVALUATION OF APPARENT SLOPE STABILITY AND GENERAL RECOMMENDATIONS FOR PROPOSED CONSTRUCTION ON FOUR CONTIGUOUS LOTS ON BERRY STREET OLYMPIA, WASHINGTON

EXHIBIT I

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Bradley Noble Geotechnical Company
Geotechnical Consulting
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EVALUATION OF APPARENT SLOPE STABILITY AND GENERAL RECOMMENDATIONS FOR PROPOSED RESIDENTIAL CONSTRUCTION ON FOUR CONTIGUOUS LOTS ON BERRY STREET, OLYMPIA, WASHINGTON

This report presents the results of our subsurface investigation into the site geology at the four lots on the west side of Berry Street, north of its intersection with Milas Avenue. Our purposes in exploring the subsurface soil conditions were: 1) to evaluate site geology, 2) to evaluate probable slope stability, and 3) to present general recommendations for foundation support of residences. Work was authorized on behalf of the property owner by the American Dream Real Estate Company.

SURFACE CONDITIONS

The project site slopes to the west from an elevation of about 110 feet (City of Olympia Datum) at Berry Street to a toe elevation of about 45 feet at East Bay Drive. Average slope angles are about 24 degrees or about a 46% slope. We found the natural slope areas to be vegetated and no indications of instability were observed.

An existing loose fill section has been placed on the southern lots on the east side. This fill has created a level parking area adjacent to Berry Street. Construction of Berry Street appears to have required the placement of a fill section for support on the east side of the lots.

SUBSURFACE CONDITIONS

We explored the subsurface conditions by a test boring at a location that allowed for evaluation of the fill section and native soils. This exploration was made using a continuous-flight, hollow-stem auger to advance the borings and to provide borehole support between sampling intervals. Samples were obtained at standard intervals using a two-inch outside diameter, split-spoon sampler driven by a pin-guided, 140-pound weight free falling 30 inches. The blows per six-inch interval were recorded. The first six-inch drive interval is allowed for seating the sampler. The blow counts for two six-inch intervals, when combined, yield the Standard Penetration Resistance (N-value) of

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the soils encountered in the sample interval. The number of blows required to drive the sampler the last 12 inches provides a measure of the relative density of granular soils or the consistency of cohesive soils. The results obtained from the Standard Penetration Test, along with other tests and engineering judgments, were used to develop the recommendations of this report. After completion of the drilling and testing, the bore was filled solid with bentonite to seal the bore from any ground water intrusion.

Soil conditions encountered in our exploration are similar to those found in other work we have done in the area. Native soils in the project area at this elevation are interpreted as Vashon advance outwash and other Pre-Frasier non-marine deposits. Our exploration sampled the density and soil types for soils between approximately elevation 110 to elevation 71. We also allowed the bore hole to remain open overnight at various elevations to allow the evaluation of flows of ground water.

DISCUSSION

The existing fill section does not appear to have been placed as a controlled structural fill. In our drilling, we found layers that offered varying resistance to the penetration of the auger. We also observed some organics being returned by the auger.

This existing fill should not be relied on for support for standard spread footings. It appears to be loose, and prediction of potential long-term settlements is impossible to predict. This fill may have been placed on the slope without proper preparation of the slope to receive fill. Generally, removal of vegetation is required, and the fill should have been placed on a level cut bench to key the fill to the slope. As this fill section now exists, it should be considered as a wedge of uncontrolled fill that may be prone to consolidation and sliding.

Underlying the fill section, we encountered for the full depth of the exploration very dense soils consisting of fluvial/lacustrine deposits of sandy gravels, sands, silts, and silty, fine sands. Water bearing horizons were found during the drilling, but no significant accumulations of water flowed into the bore hole, even when left open over night.

Bowles, Foundation Analysis and Design, Table 3-2, presents empirical values for granular soils. Using the N-values for the native soils encountered in our exploration, this table presents expected angles of internal friction between 35 and 43 degrees. Since the angle of internal friction for the native soils is greater than the observed slope angle, slope stability is inferred. Soils encountered were found to be horizontal to very gently dipping and failure along bedding planes should not be a concern.

The upper few feet of soil on the slope is weathered and is considered to be active. Soil creep, the slow downslope movement of soils due to saturation and freeze-thaw cycles, appears to be the only erosional process active on the undisturbed native slopes. Sloughing of soils from the fill face may occur because of localized saturation.

Residential construction is feasible on these lots. The major difficulties that we foresee are not related to site geology or slope stability. We expect construction of foundations will be below the elevation of Berry Street at about elevation 100 to ensure that the foundations are in native soils. Complicating construction are the overhead power lines along the east side of these lots. These power lines will limit construction equipment access for foundation construction from Berry Street.

Surface storm water from impervious surfaces will need to be piped to the toe of the slope for disposal. Disposal onto the surface of the slope as point discharge may create areas of instability from saturation and should not be allowed.

The existing fill section should be removed, as it has the potential of being an unstable soil mass. Any fills placed on these lots should be constructed in strict conformance to the Earthwork Criteria section of this report.

Depending on the design solution proposed for these lots the foundation system may be either a standard spread footing placed on native bearing soils or augured cast-in-place piles. We are available to work with the design team to develop recommendations for the foundation system and design values once the design has been finalized.

Earthwork Criteria

In areas under structures, paving sections, and sidewalks, strip all topsoil and organic material, and any existing loose fills. For structural fill in areas under footings and slabs-on-grade, we recommend that all soils be compacted to a minimum density of 90 percent of ASTM D-1557. This includes proofrolling native soils exposed in the bottom of the excavation before placing fill. Materials under the paving section should also be compacted to the minimum density by proofrolling before placing the paving section. This includes proofrolling in-place soils, soils that have been disturbed during construction, and all structural fill materials.

For imported structural fill, we recommend that a clean, six-inch minus, well graded gravel or gravelly sand (classifying as GW or SW as determined by ANSI/ASTM test method D-2487), conforming to APWA specification 9-03.14 for gravel borrow, be used. We also recommend that no more than 7% by weight pass the number 200 screen as tested by ANSI/ASTM D-1140 test procedure.

All fill should be placed in uniform horizontal lifts of six- to eight- inch loose thickness. Each lift should be conditioned to the optimum moisture content and compacted to the specified minimum density before placing the next lift. We further recommend that all utility trench backfill be compacted as specified above. Earthwork should be performed under the continuous supervision and testing of Bradley-Noble Geotechnical Company to ensure compliance with the compaction requirements.

Placement of fill sections on slopes greater that 4:1 (horizontal to vertical) will be benched as directed into the native soils. Height and width of the bench will be determined in the field by the soils engineer or engineering geologist.

Unrestricted slopes shall not exceed 2:1 (horizontal to vertical) for fill embankments and cuts that expose native soils. All fill slopes will be rolled. The project's civil engineer is responsible for the protection of the constructed fill slopes from uncollected runoff. We recommend that all cut-and-fill slopes be seeded as soon as possible after construction, so that vegetation can protect the slopes from sheet washing.

No fill is to be placed during periods of unfavorable weather or while the fill is frozen or thawing. When work is stopped by rain, placement of fill will not resume until the soils engineer or engineering geologist determines that the moisture content is suitable for compactive effort and that the previously placed fill has not been loosened. The contractor will take appropriate measures during unfavorable weather to protect the fill already placed. Measures that may be required include limiting wheeled traffic and grading to provide temporary drainage of the fill. At the direction of the soils engineer or engineering geologist, the contractor will be responsible for the removal and reworking of fill that has softened or has less than the required compaction.

SUMMARY

1. Based on the data obtained in the exploration, the native soils have a high angle of internal friction and are well consolidated and are horizontally bedded. Slope stability is inferred based on these values and soils types.

2. The existing fill section does not appear to be suitable for support of foundations. It has the potential of being unstable.

3. Foundation support can be provided by either standard spread footings placed on dense native soils or the use of augured cast-in-place piles may be considered.

4. The slope is to be protected from point discharges of storm water.

5. Existing site conditions will impact construction activity and site excavation.

6. Good design and construction practices will be required in order to ensure the structure is constructed on soils that will provide long-term support and resist any tendency for sliding.

LIMITS OF LIABILITY

BRADLEY-NOBLE GEOTECHNICAL COMPANY is responsible for the opinions and conclusions contained in this report. These are based on the data relating only to the specific project and locations discussed herein. This report was prepared within the standard and accepted practices of our industry. In the event conclusions and recommendations based on these data are made by others, such conclusions and recommendations are not the responsibility of the soils engineer or engineering geologist unless he has been given an opportunity to review them and concurs in such conclusions or recommendations in writing.

The analysis and recommendations submitted in this report are based upon the data obtained in the explorations at the locations indicated on the attached plan. This report does not reflect any variations that may occur between these explorations. The nature and extent of variations between explorations may not become evident until construction is underway.

BRADLEY-NOBLE GEOTECHNICAL COMPANY

Report prepared by:

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Engineering Geologist

9 June 1994

Bradley-Noble Geotechnical Company

Geotechnical Consulting

Construction Testing and Inspecting Services

GENERAL NOTES
FOR SOIL INVESTIGATIONS CONDUCTED BY AUGERED BORINGS

SAMPLE IDENTIFICATION

All sample classifcations are reviewed by a soils engineer in accordance with the Unified Soil Classification System ASTM D-2487. Field soil classifications are in accordance with ASTM D-2488.

SOIL PROPERTY SYMBOLS

- Dd: Dry density, pcf
- PL: Plastic limit
- q_p: Penetrometer value, tsf
- q_u: Unconfined compressive strength, tsf
- LL: Liquid limit
- W : Moisture content
- q_s: Vane-shear strength, tsf
- PI: Plasticity index

- N: Penetration resistance per foot or fraction thereof, of standard 2-inch O.D., 1.3-inch I.D., split-spoon sampler driven with a 140-pound weight free falling 30 inches, in accordance with Standard Penetration Test Specifications ASTM D-1586
- __: Apparent ground water level at the time noted after completion

SOIL STRENGTH CHARACTERISTICS

COHESIVE SOILS

Comparative Consistency	Blows/Foot	Unconfined Compressive Strength (tsf)
Very soft	0 - 2	0 - 0.25
Soft	2 - 4	0.25 - 0.50
Medium	4 - 8	0.50 - 1.00
Stiff	8 - 15	1.00 - 2.00
Very stiff	15 - 30	2.00 - 4.00
Hard	30+	4.00+

NON-COHESIVE (GRANULAR) SOILS

Relative Density	Blows/Foot (N-Value)
Very loose	0 - 4
Loose	4 - 10
Firm	10 - 30
Dense	30 - 50
Very dense	50+

DRILLING AND SAMPLING SYMBOLS

- SS: Split spoon
- AU: Auger sample
- WS: Washed sample
- TC: Tri-core drilling
- ST: Shelby tube 3" O.D. (except where noted otherwise)
- DB: Diamond bit core
- CB: Carbide bit core
- RL: Ring-lined sampler

Bradley-Noble Geotechnical, Inc.

JOB: Berry Street
JOB NO. 94.06-04
DATE: 9 June 94 BY:

Exploration 1

0 — Surface elevation ≈ 110' City of Olympia datum

Blows/6" drive

3-2-4 S.S. Hard/soft layers of Fill
N = 8 Moist plastic silty sand, loose.

8-6-7 S.S. Firm saturated silty sandy gravel,
N = 13 Fill?

-10'

10-50 for 3" S.S. Very dense medium to coarse grained sandy gravel, water bearing.
N = 100+

12-32-50 for 5" S.S. Very dense gray laminated silts and very silty very fine sands, dry.
N = 90+

-20'

50 for 5" S.S. Very dense gray laminated fine silty sands, dry.
N = 100+

23-27-32 S.S. Very dense gray & blue green silts and silty fine sands, dry to moist.
N = 59

-30'

Hard/soft layers

26-23-34 S.S. Very dense gray silt, dry
N = 57

22-29-36 S.S. Very dense gray fine to medium moist sands
N = 65

-40'

Bottom elevation 71 feet

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