

February 28, 2019

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**SUBJECT: Preliminary Geotechnical/Roadway Assessment Report
Existing Tybren Heights Road and New Access (for Lots 12 & 13)
Kelso, Washington**

INTRODUCTION

Strata Design LLC (STRATA) has prepared this Report for the purpose of obtaining permits for residential development of Lots 12 and 13 along or near to Tybren Heights Road in Kelso, Washington (see Site Plan, Figure 1). The purpose of this report is to evaluate the existing roadways as it pertains to providing access to the two lots.

Project Description

Development plans includes extending a new private access road, west from the existing Tybren Heights Road (Figure 1). The private access evaluated for this study is the recently constructed subbase portion north of Lots 12 and 13. The portion of Tybren Heights Road evaluated for this study is shown on the attached Site Plan, identified as the segment between "Start Tybren Heights Road Evaluation" and "End Tybren Heights Road Evaluation" (Figure 1). A future private road to the west of Lot 12 may be proposed at a later date, and we recommend future geotechnical evaluation of that alignment once known.

Mapped Landslides

According to the Cowlitz County GIS mapping (NetMaps¹), two sub-segments of Tybren Heights Road are within an area mapped as active deep seated landslides (see Mapped Landslides, Figure 2). According to Cowlitz County Code (CCC 19.15.150), this portion of the road would require critical area study (Landslide Hazard) if new development (grading, etc) is proposed.

SITE RECONNAISSANCE

On February 21, 2019, STRATA performed a site reconnaissance and excavated four test pits within the existing roads at the locations shown in Figure 1. Overall, we identified no evidence of recent slope instability was observed within Tybren Heights Road. No subsidence, cracking, or indications of ground movements were observed.

The test pits were excavated within the existing roads using hand tool. The test pits were excavated through the road's rock section to the underlying soil subgrade, except test pit TP-4 which was

¹ <http://www.cowlitzinfo.net/netmaps25/index.html?App=EPIC&>

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terminated within the rock section. The rock sections observed in test pits TP-1 through TP-3 generally consisted of medium dense, angular gravel with well graded cobbles up to 10 inches in diameter. Test pit TP-4 encountered 4 inches of dense, 2"-0 angular gravel, overlying dense, angular gravel with cobbles up to 6 inches in diameter.

Dynamic Cone Penetrometer (DCP) tests were performed within the soil subgrade exposed in test pits TP-1, TP-2 and TP-3. DCP tests were performed to assess the suitability of the native soils for support of the gravel road. Tests were performed in general accordance with ASTM D6951/D6951M-09, Standard Test Method for Use of the Dynamic Cone Penetrometer in Shallow Pavement Applications. The average penetration per blow was used to determine the correlated California Bearing Ratio (CRB).

Rock Thickness and DCP Field Test Results

Test Pit	Test Location	Rock Thickness (Inches)	DCP Material Tested	DCP Depth Interval (feet)	Average Penetration Per Blow (mm)	Correlated CBR
TP-1	See Figure 1	13	Native Silt	1.1 – 3.0	9	12
TP-2	See Figure 1	7.5	Native Silt	0.6 – 2.7	12	8
TP-3	See Figure 1	8.3	Native Silt	0.7 – 2.7	10	10
TP-4	See Figure 1	> 15.5	NA	NA	NA	NA

Conclusions / Recommendations

The portions of the Access Drive and Tybren Heights Road evaluated for this study appeared stable. No indications of recent slope instability were observed. The recently constructed Access Lane is not expected to adversely affect slope stability of the site or nearby properties.

Tybren Heights Road consisted of more than 15.5 inches of dense gravels and cobbles and is considered suitable for support of anticipated traffic, including occasional use by large trucks such as emergency vehicles.

The recently constructed subbase for the access drive (at Lots 12 and 13) consisted of angular gravel and cobbles up to 10 inches in diameter and the rock section ranged in thickness from 7.5 inches to 13 inches. Underlying the rock section, competent, native soils were observed. These soils are anticipated to provide adequate stability and bearing capacity for the road. The rock material used to construct the Access Lane has an excessive amount of large cobble and does not provide a suitable driving surface. Except for a very small portion of the access near the intersection with Tybren Heights Road, no level course / driving surface rock was observed. We recommend a leveling course consisting of a minimum of 2 inches of 1.5"-0 crushed rock be applied over the existing road. Where the existing rock section has a thickness of less than 10 inches, the leveling course thickness should be increased to provide a total

rock section thickness of 12 inches. Aggregate base should be placed in one lift and compacted to not less than 95% of the modified Proctor maximum dry density (ASTM D1557).

Future Road or Access Drive Construction

Where areas of the exiting private road require widening or maintenance improvements, we recommend any surficial organic soils be removed to expose competent non-organic native soils. Soft soil encountered below the organic layer should be removed and replaced with stabilization material or otherwise mitigated through consultation with the qualified professional. Stabilization may be achieved by additional excavation to firm, stable subgrade, and replacement with compacted structural fill or stabilization rock (e.g. 4-inch-minus crushed rock). Separation geotextiles and geogrid reinforcement of subgrade soils can also be utilized to stabilize soft or yielding areas.

New road section should be constructed with a minimum of 9 inches of 2"-0 crushed aggregate base course and 3 inches of 1.5"-0 crushed aggregate surface course. The crushed rock should have no more than 5 percent of the material passing the U.S. Standard No. 200 Sieve, and be compacted to not less than 95% of the modified Proctor maximum dry density (ASTM D1557). If needed for stabilization, the first lift may consist of 4"-0 crushed aggregate. In our opinion, the recommended new road section is suitable for support of emergency vehicles with a gross vehicular weight of 75,000 pounds, with point loads up to 12,500 pounds.

Site drainage grades should be developed and maintained to promote surface runoff. This should include the use of ditches and culverts. Test pit TP-3 observed 3 inches of water within the rock section pooled above the silt soil subgrade. Ditches should be constructed to minimize ponding within the roadway.

Limitations

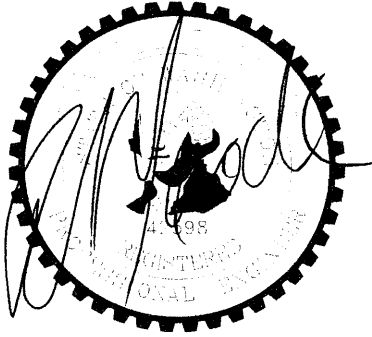
Our work has been conducted in general conformance with CCC 19.15.150 and the standard of care in the field of geotechnical engineering practice in the Pacific Northwest for projects of this nature and magnitude. No warranty, expressed or implied, exists on the information presented in this report. By utilizing the design recommendations within this report, the addressee acknowledges and accepts the risks and limitations of residential hillside lot development.

If the above proposal is amended or additional development plans arise beyond the above described assumptions, additional geotechnical assessment or analysis may be necessary in order to quantify the potential impact of slopes, landslide or other geologic hazards.

Statement of Qualification

Mr. Randall Goode, currently Licensed Washington Professional Engineer, conducted the site inspection, reviewed the applicable geologic publications and related records, and was the primary author of this report. Mr. Goode is a geotechnical professional with 25 years of related experience and has prepared and managed numerous geotechnical site assessments throughout Cowlitz County, and meets the requirements of professional qualifications, including those identified under CCC 19.15.050.

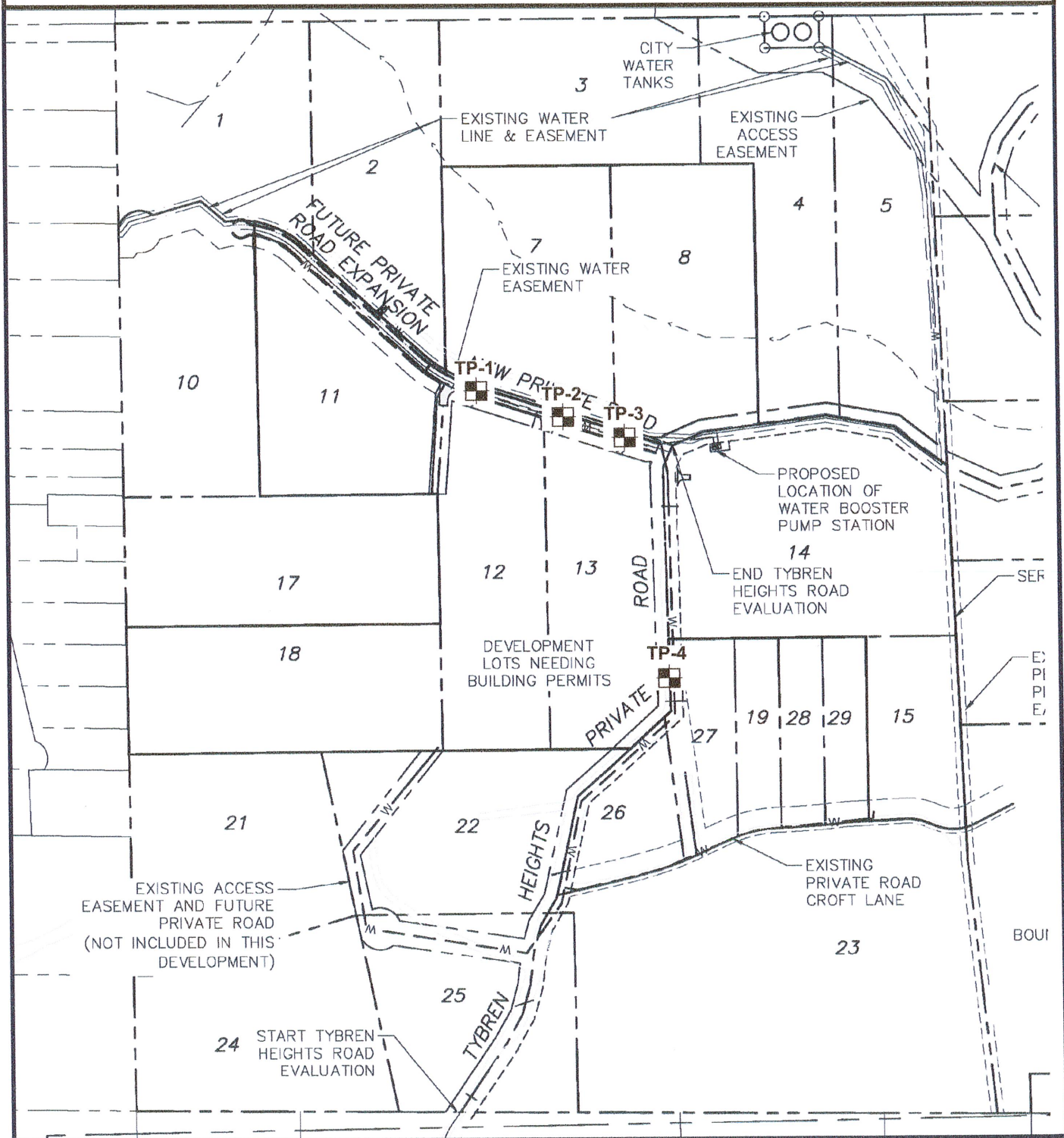
Sincerely,
STRATA DESIGN, LLC



Randy Goode. P.E.

Attachments:

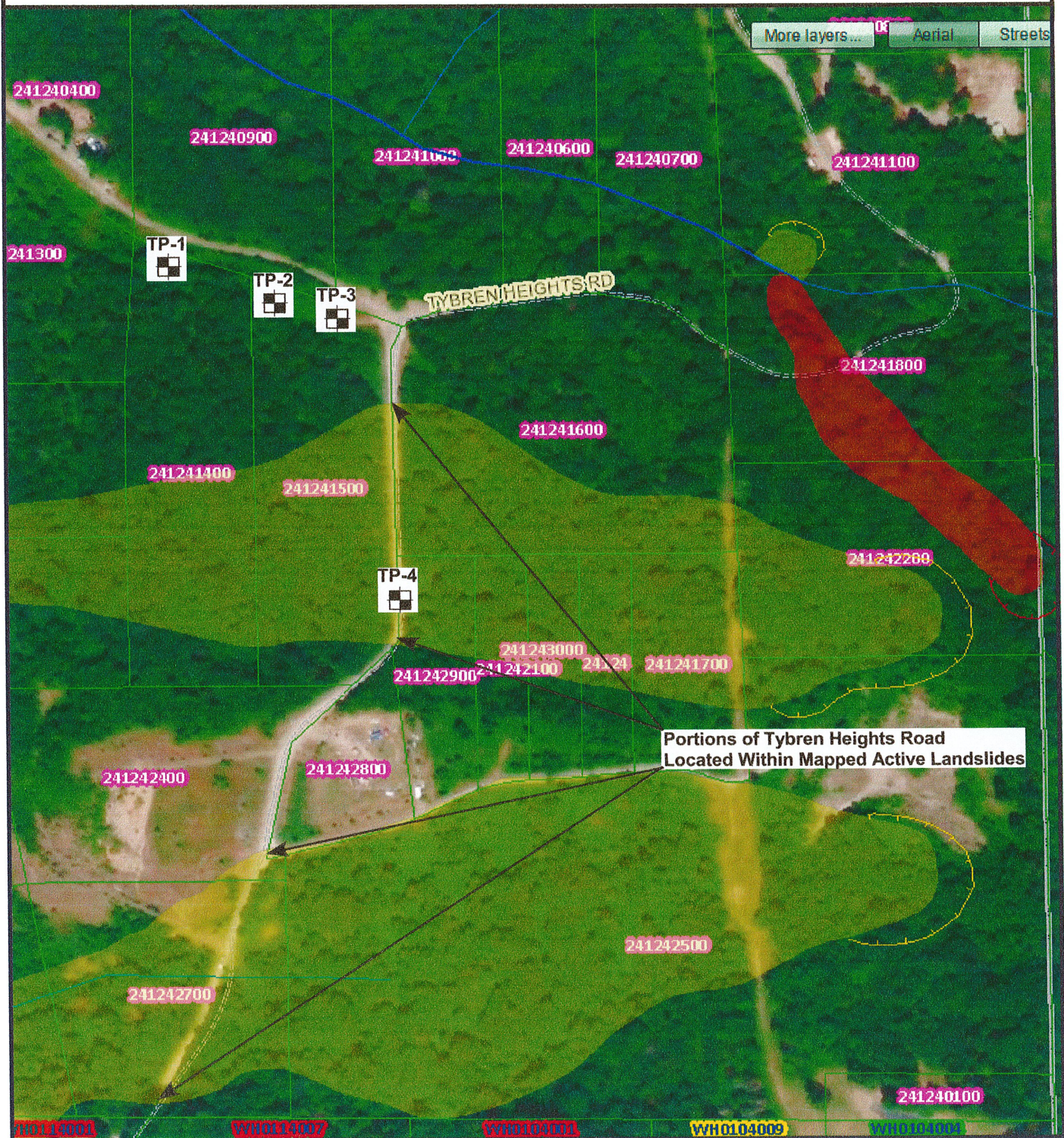
- Figure 1: Site Plan
- Figure 2: Mapped Landslides



Legend

TP-4
 Test Pit





Legend

TP-4
 Test Pit

Base map provided by Cowlitz County Netmaps

