November 13, 2020 FOI No: 2020-49

VIA E-MAIL – Redacted

Redacted

Dear Redacted

Re: Request for Records
Freedom of Information and Protection of Privacy Act

The City of White Rock has reviewed your request for access to the following records pursuant to the Freedom of Information and Protection of Privacy Act (the "Act"):

- *Geotechnical reports or landslide assessments for 1135 and 1155 Martin St*

Access to these records is available. However, some of the information in the records is excepted from the disclosure requirements of the Act. I have severed the excepted information so that I could disclose the remaining information to you as attached.

The severed information is excepted from disclosure under section 22 of the Act. Severing is necessary to avoid disclosing any third-party personal information without permission.

Please contact our office if you have any questions or concerns.

Sincerely,

Ken Overton
Manager, Property, Risk Management, and FOI
604-541-2104

Att.

If you believe that the City of White Rock has been unreasonable in its handling of your request, you may ask the Information and Privacy Commissioner to review our response. You have 30 days from receipt of this notice to request a review by writing to:

Office of the Information and Privacy Commissioner
3rd Floor, 756 Fort Street
Victoria BC V8W 1H2

Should you decide to request a review, please provide the Commissioner's office with:

1. your name, address and telephone number;
2. a copy of this letter;
3. a copy of your original request sent to the City of White Rock; and
4. the reasons or grounds upon which you are requesting the review.

— 1135 Martin St. —

#3 issued as a complementary supplementary letter to report dated Aug. 19/13

FRASER VALLEY ENGINEERING LTD.

CIVIL / GEOTECHNICAL / STRUCTURAL

101 – 33465 Maclure Road,
Abbotsford, B.C. V2S 0C4
Tel: 604-850-0364 Fax: 604-557-0390

Our File: FV0573-1

February 5th, 2014

OK'D @ Acting Director Richard Wilson FEB 12 2014

RECEIVED

FEB 07 2014

CITY OF WHITE ROCK
DEVELOPMENT SERVICES

Redacted S. 22

Dear **Redacted S. 22**

Re: Landslide assessment - Proposed Residential Building – Complementary letter
1135 Martin Street, White Rock, BC

Fraser Valley Engineering Ltd. (FVEL) completed a landslide assessment in the area of the proposed residential building, for Building Permit application, following the "Guidelines for Legislated Landslide Assessments for Proposed Residential Developments in BC", revised May 2010, by the Professional Engineers and Geoscientists of BC. We also issue a report dated August 19th 2013; this report concluded that "the land may be used safely for the use intended (a residential building) provided that the recommendations presented in the report were incorporated into the final design and construction". The report was preliminary as architectural drawings were not final.

After the report was issued, the house design was completely changed. In light of the new design, FVEL is issuing this letter to address the design changes and the impact in our previous geotechnical report. This geotechnical report is final and must be read in conjunction with the Landslide assessment report dated August 19th, 2013 unless the architectural design changes.

In addition to reviewing the design changes, we have also prepared an excavation plan which proposing encroaching into city property at the frontage of the house up to 10 feet.

A segmental wall design located in city property was also completed. Original segmental wall design drawings are attached to this letter. We estimate the construction cost of the segmental wall to be $ 1,800.00 excluding applicable taxes.

The bearing capacity section of the original report stated:

"Footings located below the 1V:1.5H projection line from the toe of existing timber tie wall and founded on the native, grey or brown compact fine sand and gravel with trace or structural fill can be designed with a factored Ultimate Limit State (ULS) bearing pressure of 190 kPa (3,900 psf), for a resistance factor φ = 0.5, per the National Building Code (2005). The Serviceability Limit State (SLS) pressure is 125 kPa (2,600 psf).

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That paragraph should read:

Footings located below the 1V:1.5H projection line from the toe of existing timber tie wall and founded on the native, grey or brown compact fine sand and gravel with trace or structural fill can be designed with a factored Ultimate Limit State (ULS) bearing pressure of 190 kPa (3,900 psf), for a resistance factor φ = 0.5, per the BC Building Code 2012. The Serviceability Limit State (SLS) pressure is 125 kPa (2,600 psf). The remaining section of that paragraph stays the same.

The client has eliminated the basement portion of the house under the garage to decrease the excavation depth under the garage area.

The excavation for the SW corner of the house must proceed in accordance to section 6.0 - Site preparation. Since the competent ground in this corner is located at an elevation lower than the required footings elevation, we recommend placing the footings in native competent ground which requires a relatively high foundation wall. To avoid excessive surcharge in the slope, it is proposed to partially backfill to accommodate a crawl space under the basement, instead of leaving an empty cavity under the subfloor.

We trust that this letter provides you with the information required for the final design. We recommend that FVEL review the site during construction to ensure that the intent of our recommendations is implemented. If you have any questions, please do not hesitate to call.

Yours truly,

Fraser Valley Engineering Ltd.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
J. PRADA
#27380

Jairo Prada, MSc, PE
Principal

Feb 6, 2014

#2 issued w/ BP application

FRASER VALLEY ENGINEERING LTD.

CIVIL / GEOTECHNICAL / STRUCTURAL

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Tel: 604-850-0364 Fax: 604-557-0390

Our File: FV0573-1

August 19th, 2013

Redacted S. 22

Dear **Redacted S. 22**

Re: Landslide assessment - Proposed Residential Building
1135 Martin Street, White Rock, BC

As requested, Fraser Valley Engineering Ltd. (FVEL) performed a landslide assessment in the area of the proposed residential building, for Building Permit application, following the "Guidelines for Legislated Landslide Assessments for Proposed Residential Developments in BC", revised May 2010, by the Professional Engineers and Geoscientists of BC.

In order to obtain geotechnical information, and to understand the configuration of the site, FVEL conducted a geotechnical investigation at the above-referenced project site. The purposes of the geotechnical investigation were to identify subsurface conditions, to determine the suitability of the site for the proposed development, and to prepare geotechnical recommendations for structural design and construction of the project.

This report includes drill hole and test pit locations (Figure 1), drill hole and test pit logs (Table 1), cross sections (Figure 2), a site plan by Widenmann Architectural Design (Figure 3), a lateral earth pressure diagram (Figure 4), and DCPT log (Table 2 and Figure 5). Ground conditions and findings of the investigation are summarized.

1.0 Site location and proposed development

The property is located at 1135 Martin Street, on the west side of the road in White Rock, BC. The property is rectangular in shape and has an approximate area of 625 square meters (6,730 square feet). The property is moderately inclined to the south-west.

At the time of our investigation, there was a house that will be demolished. The remainder of the property was covered with grass, bushes, and trees.

Based on the drawings by Widenmann Architectural Design, the proposed building will be a three storey single family residential building with the first two levels underground on the east side of the house. Moreover, retaining walls (approximately H= 1.8 – 6.7 m) will be built along the west and south property lines.

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2.0 Background Information

The following documents were reviewed:

- Draft Reference Document of Geotechnical Assessment Areas, dated August 4, 2010, with a scale of 1:6,358 from City of White Rock
- Topographical plan by Isaak Osman & Assoc., British Columbia Land Surveyors, dated July 9th, 2013
- Contour lines from White Rock Online Mapping System
- Widenmann Architectural Design, proposed building drawings sent by e-mail on August 6th, 2013
- The Geological Survey of Canada map 1484A titled "Surficial Geology New Westminster" with a scale of 1:50,000
- Seismic information obtained from the National Resources Canada website
- British Columbia Building Code 2010

3.0 Geotechnical investigation and laboratory testing

The fieldwork was carried out on August 1st, 2013. One drill hole, DH-1 was drilled using a tire mounted continuous auger to a maximum depth of 7.6 m (25 feet) at a north east corner of the property. As the slope is quite steep for a drilling rig to access the lower locations, two test pits (TP-1 and TP-2) were dug using a track mounted excavator to a depth of 2.6 m (8.5 feet). A FVEL field representative laid out the test pits, and also logged the soil and ground conditions. Soil samples were taken for classification and laboratory testing. Drill hole and test pit locations are shown in Figure 1, and drill hole and test pit logs are presented in Table 1.

4.0 Geology and soil conditions

4.1 Surficial geology of the area

According to the Geological Survey of Canada map 1484A "Surficial Geology New Westminster", the soils in the study area consist of Cd, marine glaciomarine stony to stoneless silt including till like deposits; loam to clay loam with minor sand and silt normally less than 3 m thick but up to 30 m thick, containing marine shells.

4.2 Soil conditions

The stratigraphy encountered in the test pits is consistent with the surficial geology outlined in section 4.1, above, and generally consists of

- an upper layer of top soil with an average thickness of 0.4 m (1.3 feet) underlain by
- a layer of brown firm to stiff fine sandy silt with trace of gravel and root to an average depth of 1.57 m (5.2 feet) overlaying
- grey or brown loose to compact sand and gravel with trace of silt to a max. depth of 5.2 m (17.0 foot)
- grey or brown dense to very dense fine sand and gravel with trace of silt up to investigation.

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No ground water or seepage was observed in the test pits. A detailed description of the stratigraphy of each drill hole and test pit is shown in Table 1.

5.0 Slope stability

Slope stability analyses were conducted for the final geometry of the slope. Static and seismic (pseudostatic) conditions were analyzed. The seismic acceleration coefficient for the site used in the pseudostatic analyses is k_{15} = 0.18g, which is compatible with 15 cm of slope displacement along the slip surface, for a probability of 2% in 50 years (0.000404 per annum), as recommended in the "Guidelines for Legislated Landslide Assessments for Proposed Residential Developments in BC", revised May 2010, by the Association of Professional Engineers and Geoscientists of BC.

The minimum Factors of Safety (FS) used for the global stability analyses are:

- Global Stability under Static conditions (FS GS/Static) = 1.5
- Global Stability under Dynamic conditions (FS GS/Dynamic) = 1.0

Using the Isaak Osman & Associates topographical plan with a scale of 1:250, two profiles of the ground were developed. However, the topo map did not generate contour lines beyond the west property line; therefore, the sections were developed with information from the City of White Rock Online Mapping System. The timber tie walls on the neighbouring property were assumed to be 4.5 m from the west property line. Visually, FVEL confirmed that the section reflects the site conditions. See Figures 1 and 2 for plan and sections of the property. However, the cross sections and the location of the timber tie wall must be confirmed by a contractor before starting excavation.

The slope stability analysis was carried out with section A - A using G-Slope computer software and the Modified Bishop's Method. The analyses were carried out with the assumption that the timber tie walls were supported by external forces of 20 kN/m^2.

The analysis revealed that under static conditions the safety factor of the slope at Section A - A is 1.37. For seismic conditions, the safety factor is 0.99. In other words, the slope stability analyses show that the factors of safety are below acceptable limits for static conditions and for an earthquake with a return period of 2,475 years (2% in 50 year probability of exceedance).

Accordingly, as a mitigation measure, FVEL proposes that the reinforced concrete retaining wall be built below a 1V:1.5H projection line from the toe of the existing timber ties wall (See Figure 2). The unstable portion of the slope will be confined to the upper part of the line, thereby not affecting future development.

The proposed reinforced concrete retaining wall must be designed taking into account the loading that the house will impose on it.

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With this mitigation measure, the slope stability analyses showed that under static and seismic conditions the safety factors of the slope at Section A - A are 1.83 and 1.33, respectively. Therefore, the safety factors are acceptable under static and seismic conditions.

Slope displacements along a slip surface were estimated using Bray and Travasarou's equation for slopes at Section A - A with PGA = 0.566g for a probability of 2% in 50 years (0.000404 per annum). The estimated median slope displacement is 3.8 cm. Using a tolerable slope displacement of 15 cm, the site would be considered suitable for the proposed development.

At the time of our investigation, the timber tie walls on the neighboring property show no indication of movement or failure; however, these walls will be deteriorated and will lose the functions as retaining walls in the future. The analysis without timber tie wall support revealed that under static and seismic conditions the safety factors of the slope at Section A - A are 1.39 and 1.04, respectively. In other words, the slope stability analyses show that the factors of safety are below acceptable limits for static conditions but acceptable for an earthquake with a return period of 2,475 years (2% in 50 year probability of exceedance). Considering the safety factors, when the timber tie walls lose support, the proposed buildings will not be affected; however, the timber ties wall must be rebuilt for the long term safety of the proposed development. Since the timber ties wall is outside the property line, the developer has no control of the reconstruction.

All run-off and perimeter drain water must be collected and discharged into a storm sewer system, or into an infiltration system located away from the slope. Infiltration of water into the ground or drainage onto the slope face may adversely affect slope stability, and therefore must be avoided.

6.0 Site preparation

As a minimum requirement, below the proposed footing and slab-on-grade, the upper layers of top soil and brown firm sandy silt with trace of gravel and root must be excavated into the layer of grey or brown loose to compact fine sand and gravel with trace of silt that is located at an average depth of 1.57 m (5.2 feet) below grade, minimizing disturbance of the sub-grade soil. Once the excavation of the unsuitable material is complete, the sub-grade must be compacted to a minimum density of 100% based on the Standard Proctor Maximum Dry Density Test (SPMDDT). FVEL must inspect the sub-grade once the excavation is complete, in order to verify the soil conditions found during the test pit investigation and to provide additional recommendations, if required.

If required, in order to achieve the finished grade, the stripped area can be replaced with structural fill approved by the geotechnical engineer, compacted to a minimum density of 100% based on the Standard Proctor Maximum Dry Density Test (SPMDDT), to the foundation elevation. Structural fill is defined as clean sand to sand and gravel containing less than 5% fines by weight, compacted in 300 mm loose lifts.

Temporary excavation slopes should not be steeper than 1.0 horizontal to 1.0 vertical and should be protected from erosion by surface runoff with polyethylene sheeting securely fastened at the top and toe of the slope. Permanent cut and fill slopes should not be steeper than 3 horizontal to 1 vertical and should

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be protected from erosion by surface water runoff with suitable plantings, hydroseeding, or erosion control mats placed immediately after completion of the site grading work.

6.1 Bearing capacity estimation

Footings located below the 1V:1.5H projection line from the toe of existing timber tie wall and founded on the native, grey or brown compact fine sand and gravel with trace or structural fill can be designed with a factored Ultimate Limit State (ULS) bearing pressure of 190 kPa (3,900 psf), for a resistance factor φ = 0.5, per the National Building Code (2005). The Serviceability Limit State (SLS) pressure is 125 kPa (2,600 psf). The minimum width of continuous footings should not be less than 0.45 m (18 inches), and the minimum dimension of column footings should not be less than 0.9 m (36 inches). A minimum embedment depth of 0.45 m (1.5 feet) must be provided for frost protection.

In terms of seismic design, the Site Classification for this property is D – stiff soil (in accordance with the BC Building Code 2010, Table 4.1.8.4.A). The Peak Ground Acceleration (PGA) for this site is 0.566g for a probability of occurrence of 2% in 50 years, which was obtained from the web-site of National Resources Canada. The Spectral Response Acceleration Values Sa(T), for Site Class C are:

$S_a(0.2) = 1.135$, $S_a(0.5) = 0.758$,
$S_a(1.0) = 0.348$, $S_a(2.0) = 0.176$

6.2 Temporary shoring requirements

According to the architectural drawings provided by Widenmann Architectural Design, cast in place concrete retaining walls are required along the north and east sides of the proposed building. The north foundation of the proposed building will be located at depths ranging from 0.0 m (0.0 feet) to 5.7 m (18.7 feet) below the existing ground elevation. For the east side of the excavation, the foundation of the building will be at depths ranging approximately from 1.2 m (3.9 feet) to 5.7 m (18.7 feet).

On the north side, the distance between the retaining walls and the north property line is 5.5 m. Therefore, the north section could be excavated with 1:1 cut slope without temporary shoring or with one or two rows high lock block wall not to encroach into adjacent property.

Considering that the distance between the proposed foundation/retaining walls and the property lines on both sides is approximately 1.5 m (5.0 feet), the excavation for the east and west walls have to be carried out in stages with vertical or near vertical cut slopes, using temporary shoring such as anchored shotcrete shoring or soldier piles with lateral struts to allow construction to proceed. However, if the developer gets permission from the city to encroach into the city property, the wall could be excavated with a 1:1 cut slope without temporary shoring.

The design of this temporary shoring system for the house, if required, is outside the scope of this report. Moreover, the contractor must notify FVEL when excavation starts to monitor the excavation process and recommend additional measures.

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6.3 Lateral Earth Pressure

Figure 4 present the earth pressure acting on the retaining walls in both yielding and non-yielding cases. Appropriate case should be considered for design based on the stiffness of the retaining walls. Presented load combinations shall be used for the structural stability of the walls. Since the reinforced concrete retaining wall will support the house foundation, add house loading in to the static diagram in figure 4 (lateral earth pressure), as 0.4xhouse load for non yielding case and 0.25xhouse load for yielding case.

6.4 Footing Drains

Perimeter drainage is required, and should consist of 100 mm (4-inch) perforated drain pipe surrounded by at least 300 mm (12 inches) of nominal 20 mm (¾-inch) drain rock or clear crushed gravel wrapped in filter fabric.

Water collected in the footing drains and roof drainage should be discharged through separate non-perforated pipes to the storm sewer system.

6.5 Floor slab-on-grade

Concrete floor slab-on-grade must be underlain by a 100 mm minimum layer of coarse, free draining granular material. A vapour barrier membrane consisting of a minimum of 0.15 mm thick polyethylene sheeting should be placed between the slab and the bedding layer. A thin layer of sand may be placed on top of the vapour barrier to protect the polyethylene sheeting from tearing during construction of footing forms and concrete pouring.

7.0 Conclusion

FVEL has performed a landslide assessment, and has observed the adjacent properties, confirming that there will be no future impacts. The land may be used safely for the use intended (a residential building) provided that the recommendations presented in this report are incorporated into the final design and construction.

8.0 Review and construction inspections

FVEL should review the final design to ensure that our recommendations have been incorporated into the design. We recommend that FVEL be retained for the following purposes:

- Subgrade field review prior to footings construction
- Review of structural fill material and its compaction, if required
- Review of compaction under slab on grade, if required
- Foundation wall backfill material compaction
- Excavation monitoring
- Temporary shoring design and monitoring (if required)

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- Review of shoring installation, if required

9.0 Limitation

This report is based on the geotechnical investigation of two test pits and one drill hole, a review of background information, and our knowledge of the area and the proposed project. We have prepared this report in substantial accordance with generally accepted geotechnical engineering practice, as it exists in the site area at the time of our study. No warranty is expressed or implied. This report may be used only by the client and only for the purposes stated, within a reasonable time from its issuance.

10.0 Closure

We trust that this report provides you with the information required for the final design. We recommend that FVEL review the site during construction to ensure that the intent of our recommendations is implemented. If you have any questions, please do not hesitate to call.

Yours truly,

Fraser Valley Engineering Ltd.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
J. PRADA
#27380

Jairo Prada, MSc, PEng
Principal

Fraser Valley Engineering Ltd.
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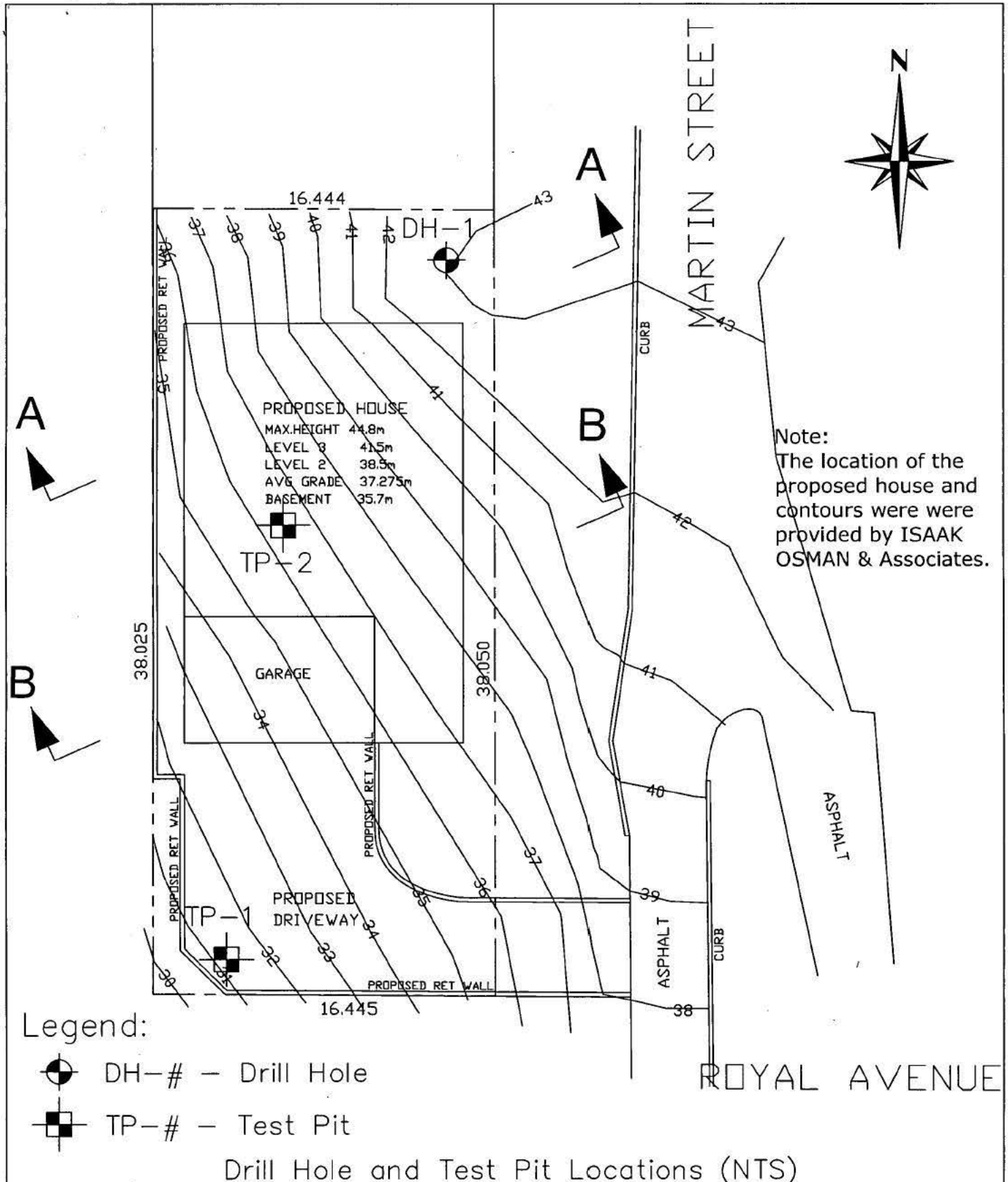
Phone : 604 - 850 - 0364
Fax : 604 - 557 - 0390

Table 1. Summary of Drill Hole and Test Pit Logs

Client: Redacted S. 22
Site: 1135 Martin Street, White Rock
Date of investigation: 01-Aug-13
File: FV0573-1

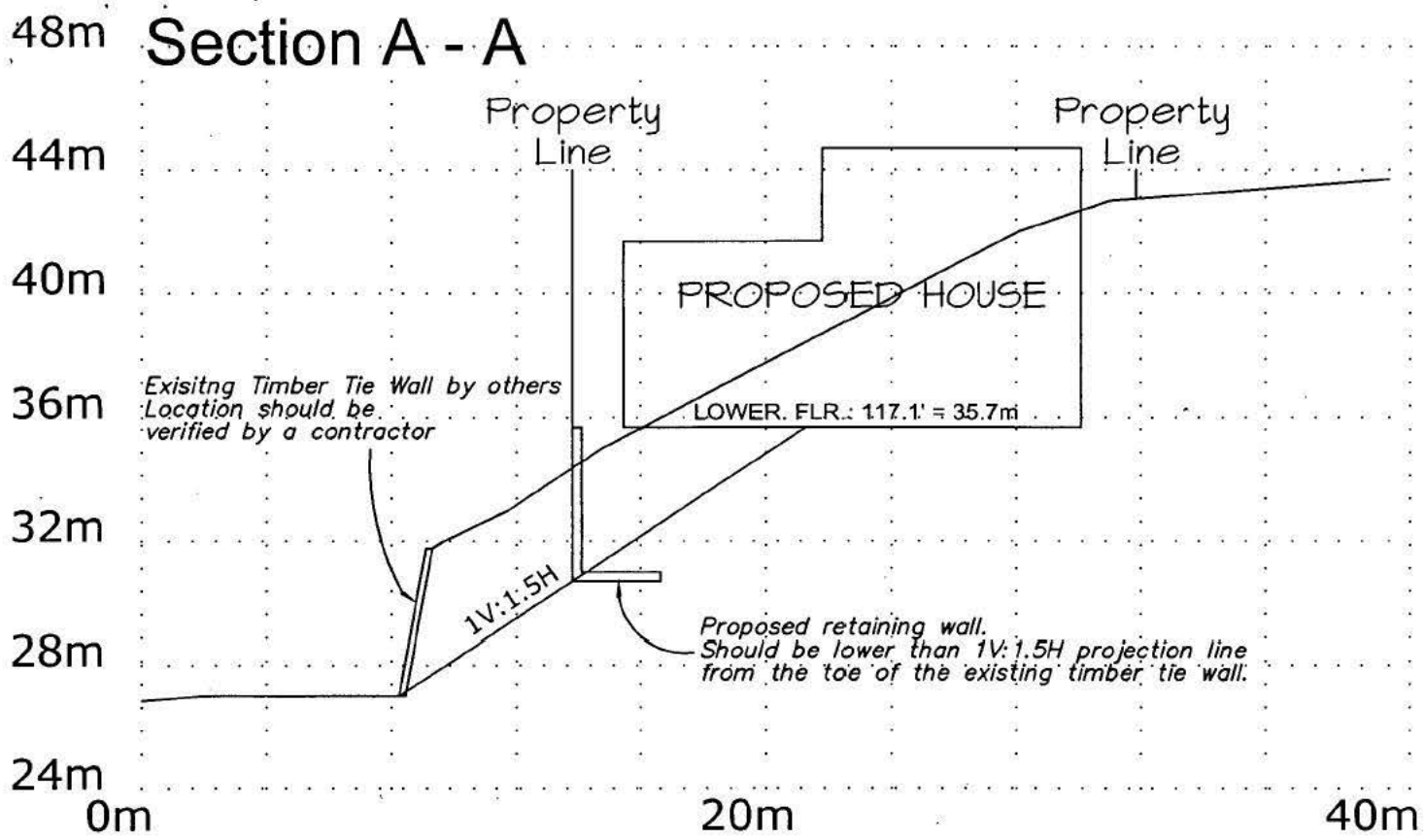
No.	Depth (m)	Depth (ft)	Soil description	Depth (m)	Moisture (%)
DH-1	0.00 (0.0) - 0.30 (1.0)		Top soil		
	0.30 (1.0) - 1.83 (6.0)		Brown, stiff sandy silt with trace of gravel	0.3	2.5
	1.83 (6.0) - 2.74 (9.0)		Brown firm sandy silt with trace of gravel	2.4	3.2
	2.74 (9.0) - 5.18 (17.0)		Grey compact fine sand and gravel with trace of silt	3.6	4.4
				4.2	4.4
	5.18 (17.0) - 5.49 (18.0)		Grey very dense fine sand and gravel with trace of silt	5.3	4.5
	5.49 (18.0) - 6.10 (20.0)		Grey very dense fine sand and gravel	5.8	3.6
	6.10 (20.0) - 6.71 (22.0)		Grey dense fine sand and gravel with trace of silt		
	6.71 (22.0) - 7.62 (25.0)		Grey very dense fine sand and gravel with trace of silt	7.0	3.1
			Discontinued @ 7.62 m		
TP-1	0.00 (0.0) - 0.46 (1.5)		Top soil		
	0.46 (1.5) - 0.91 (3.0)		Brown firm fine sandy silt with trace of gravel and root	0.9	3.2
	0.91 (3.0) - 1.52 (5.0)		Grey loose to compact fine sand and gravel with some cobbles	1.5	2.4
	1.52 (5.0) - 1.98 (6.5)		Brown dense fine sand and gravel with trace of silt	1.8	4.3
	1.98 (6.5) - 2.59 (8.5)		Grey dense to very dense fine sand and gravel with trace of silt	2.1	5.0
			Discontinued @ 2.59 m		
TP-2	0.00 (0.0) - 0.30 (1.0)		Top soil		
	0.30 (1.0) - 1.07 (3.5)		Brown firm fine sandy silt with trace of gravel and root	0.9	7.3
	1.07 (3.5) - 1.83 (6.0)		Brown compact fine sand and gravel with trace of silt	1.5	4.8
	1.83 (6.0) - 2.59 (8.5)		Grey dense to very dense silty fine sand with some gravel with trace of silt	2.1	4.8
			Discontinued @ 2.59 m		

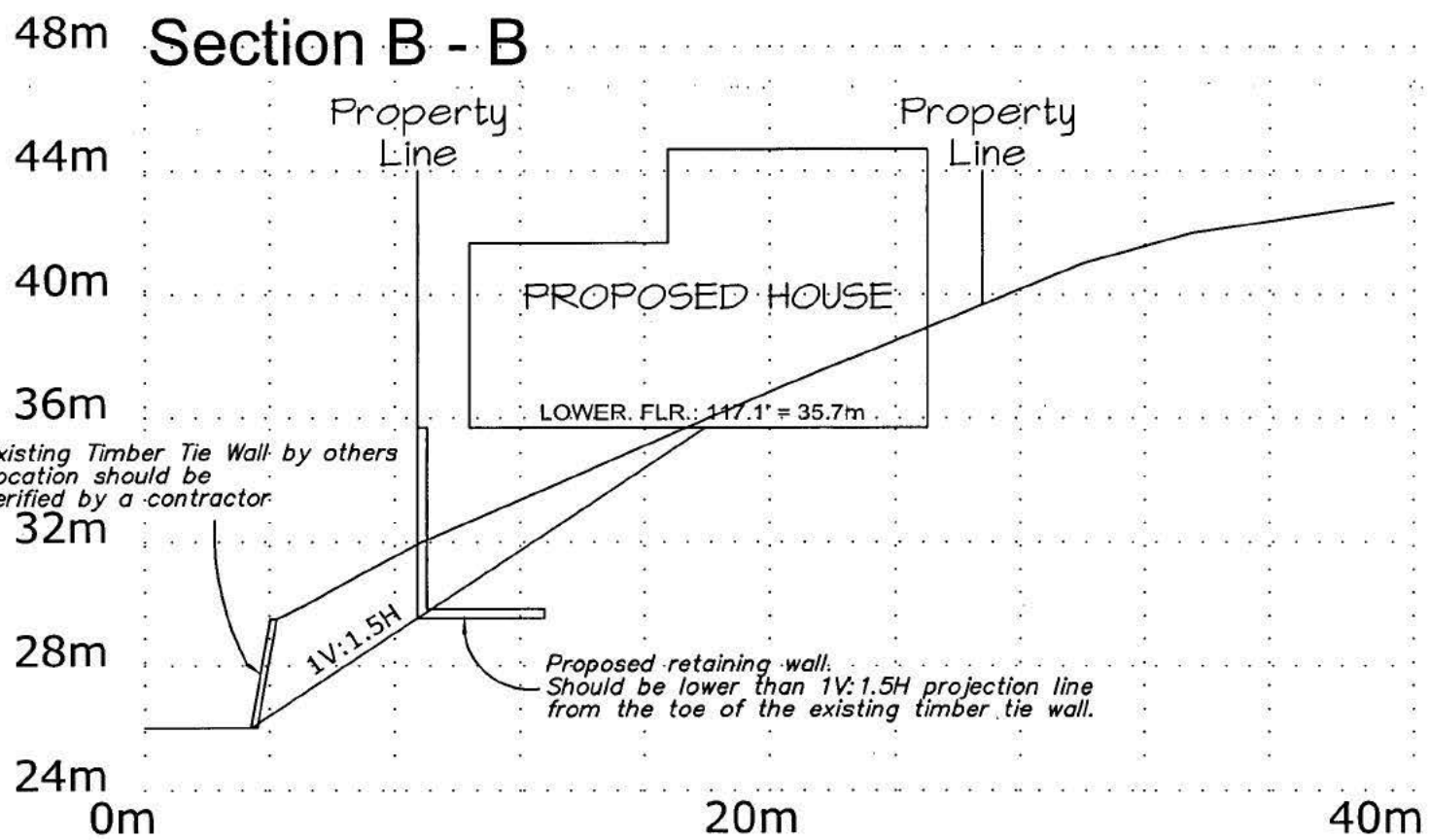
Note: All test pit depths are below existing ground surface.
Ground water or seepage was not observed at the depth of investigation.



Drill Hole and Test Pit Locations (NTS)

ENGINEER: FRASER VALLEY ENGINEERING LTD. Unit 101 - 33465 Maclure Rd Abbotsford, BC V2S 0C4 Phone :604-850-0364 Fax :604-557-0390	Client: Redacted S. 22 Site: 1135 Martin Street, White Rock, BC	Date: 19 August, 2013 File: FV0573-1	Figure 1





Cross Sections (NTS)

ENGINEER:
FRASER VALLEY ENGINEERING LTD.
Unit 101 - 33465 Maclure Rd
Abbotsford, BC V2S 0C4
Phone :604-850-0364
Fax :604-557-0390

Client: **Redacted S. 22**

Site: 1135 Martin Street,
White Rock, BC

Date: 19 August, 2013

File: FV0573-1

Figure 2

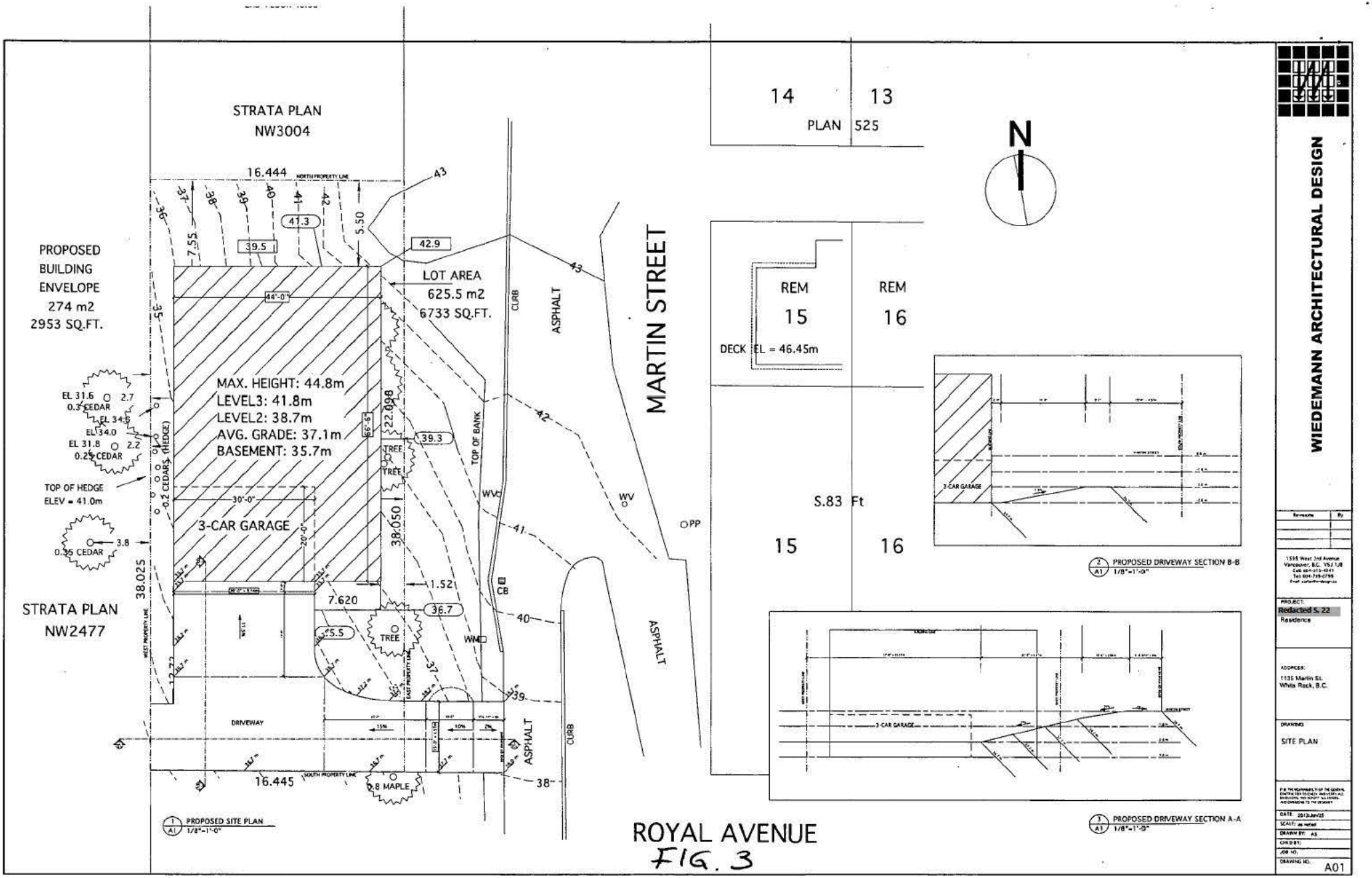
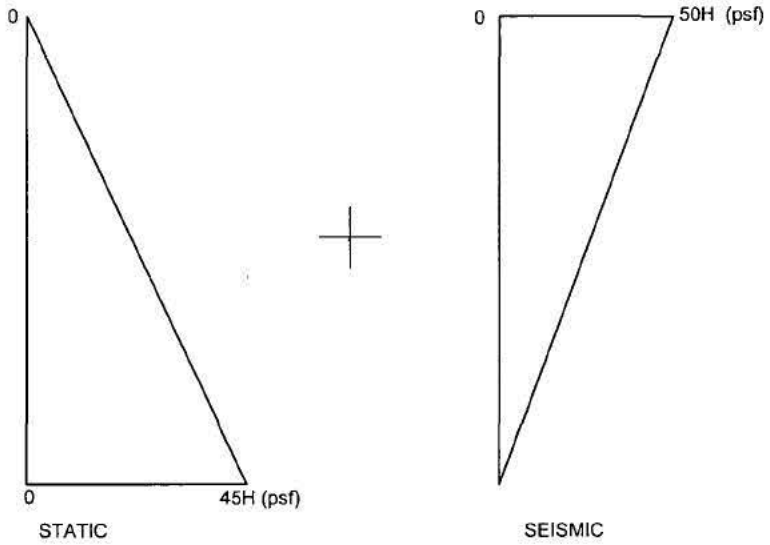


FIG. 3

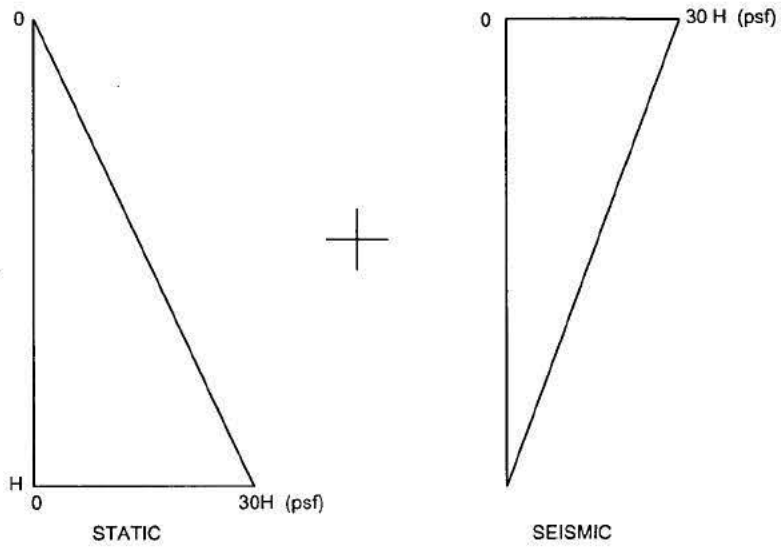
Figure 3

The foundation walls that are laterally restrained and not adjacent to the driveway can be built with lightly tamped backfill material. The foundation walls shall be designed based on the following lateral earth pressure diagram.



NON-YIELDING CASE

Laterally unrestrained foundation walls which are built with lightly tamped material can be designed based on the following lateral earth pressure diagram.



YIELDING CASE

Lateral Active Earth Pressure (NTS)

ENGINEER:
FRASER VALLEY ENGINEERING LTD.
Unit 101 - 33465 Maclure Rd
Abbotsford, BC V2S 0C4
Phone :604-850-0364
Fax :604-557-0390

Client: Redacted S. 22

Site: 1135 Martin Street,
White Rock, BC

Date: 19 August, 2013

File: FV0573-1

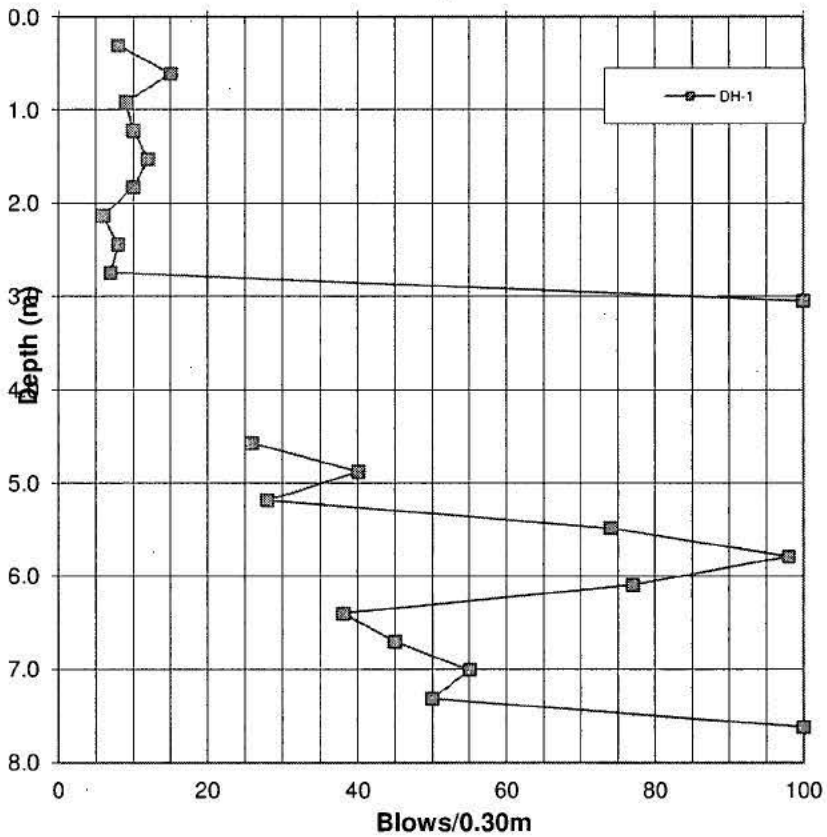
Figure 4

Fraser Valley Engineering Ltd.
Unit 101 - 33465 Maclure Rd
Abbotsford, BC V2S 0C4
Phone : 604 - 850 - 0364
Fax : 604 - 557 - 0390

Table 2. DCPT Blow Count

Depth (ft)	Depth (m)	DH-1 Blow/ft
1	0.3	8
2	0.6	15
3	0.9	9
4	1.2	10
5	1.5	12
6	1.8	10
7	2.1	6
8	2.4	8
9	2.7	7
10	3.0	100
11	3.4	
12	3.7	
13	4.0	
14	4.3	
15	4.6	26
16	4.9	40
17	5.2	28
18	5.5	74
19	5.8	98
20	6.1	77
21	6.4	38
22	6.7	45
23	7.0	55
24	7.3	50
25	7.6	100

Figure 5. DCPT Log 1135 Martin Street, White Rock



APPENDIX D: *LANDSLIDE ASSESSMENT ASSURANCE STATEMENT*

Note: This Statement is to be read and completed in conjunction with the "*APEGBC Guidelines for Legislated Landslide Assessments for Proposed Residential Development in British Columbia*", March 2006/Revised September 2008 ("*APEGBC* Guidelines") and the "2006 BC Building Code (BCBC 2006)" and is to be provided for *landslide assessments* (not floods or flood controls) for the purposes of the Land Title Act, Community Charter or the Local Government Act. Italicized words are defined in the *APEGBC* Guidelines.

To: The *Approving Authority* Date: August, 21st, 2013

City of White Rock

Jurisdiction and address

With reference to (check one):

- ☐ Land Title Act (Section 86) – Subdivision Approval
- ☐ Local Government Act (Sections 919.1 and 920) – Development Permit
- ☒ Community Charter (Section 56) – Building Permit
- ☐ Local Government Act (Section 910) – Flood Plain Bylaw Variance
- ☐ Local Government Act (Section 910) – Flood Plain Bylaw Exemption
- ☐ British Columbia Building Code 2006 sentences 4.1.8.16 (8) and 9.4 4.4.(2) (Refer to BC Building and Safety Policy Branch Information Bulletin B10-01 issued January 18, 2010)

For the Property:

Lot 3,plan 80190,Sec 10, Twp 1, NW Land District/1135 Martin Street

Legal description and civic address of the Property

The undersigned hereby gives assurance that he/she is a *Qualified Professional* and is a *Professional Engineer* or *Professional Geoscientist.*

I have signed, sealed and dated, and thereby certified, the attached *landslide assessment* report on the Property in accordance with the *APEGBC Guidelines*. That report must be read in conjunction with this Statement. In preparing that report I have:

Check to the left of applicable items

- X 1. Collected and reviewed appropriate background information
- X 2. Reviewed the proposed *residential development* on the Property
- X 3. Conducted field work on and, if required, beyond the Property
- X 4. Reported on the results of the field work on and, if required, beyond the Property
- X 5. Considered any changed conditions on and, if required, beyond the Property
- 6. For a *landslide hazard analysis* or *landslide risk analysis* I have:
  - X 6.1 reviewed and characterized, if appropriate, any *landslide* that may affect the Property
  - X 6.2 estimated the *landslide hazard*
  - X 6.3 identified existing and anticipated future *elements at risk* on and, if required, beyond the Property
  - X 6.4 estimated the potential *consequences* to those *elements at risk*
- 7. Where the *Approving Authority* has adopted a *level of landslide safety* I have:
  - ___ 7.1 compared the *level of landslide safety* adopted by the *Approving Authority* with the findings of my investigation
  - ___ 7.2 made a finding on the *level of landslide safety* on the Property based on the comparison
  - ___ 7.3 made recommendations to reduce *landslide hazards* and/or *landslide risks*
- 8. Where the *Approving Authority* has **not** adopted a *level of landslide safety* I have:

X 8.1 described the method of *landslide hazard analysis* or *landslide risk analysis* used

X 8.2 referred to an appropriate and identified provincial, national or international guideline for *level of landslide safety*

X 8.3 compared this guideline with the findings of my investigation

X 8.4 made a finding on the *level of landslide safety* on the Property based on the comparison

X 8.5 made recommendations to reduce *landslide hazards* and/or *landslide risks*

X 9. Reported on the requirements for future inspections of the Property and recommended who should conduct those inspections.

Based on my comparison between

Check one

☐ the findings from the investigation and the adopted *level of landslide safety* (item 7.2 above)

☒ the appropriate and identified provincial, national or international guideline for *level of landslide safety* (item 8.4 above)

I hereby give my assurance that, based on the conditions[1] contained in the attached *landslide assessment* report,

Check one

☐ for subdivision approval, as required by the Land Title Act (Section 86), "that the land may be used safely for the use intended"

Check one

☐ with one or more recommended registered covenants.

☐ without any registered covenant.

☐ for a development permit, as required by the Local Government Act (Sections 919.1 and 920), my report will "assist the local government in determining what conditions or requirements under [Section 920] subsection (7.1) it will impose in the permit".

☒ for a building permit, as required by the Community Charter (Section 56), "the land may be used safely for the use intended"

Check one

☐ with one or more recommended registered covenants.

☒ without any registered covenant.

☐ for flood plain bylaw variance, as required by the "Flood Hazard Area Land Use Management Guidelines" associated with the Local Government Act (Section 910), "the development may occur safely".

☐ for flood plain bylaw exemption, as required by the Local Government Act (Section 910), "the land may be used safely for the use intended".

Jairo Prada
Name (print)

August, 21st, 2013
Date

Signature

[1] When seismic slope stability assessments are involved, *level of landslide safety* is considered to be a "life safety" criteria as described in the National Building Code of Canada (NBCC 2005), Commentary on Design for Seismic Effects in the User's Guide, Structural Commentaries, Part 4 of Division B. This states:

"The primary objective of seismic design is to provide an acceptable level of safety for building occupants and the general public as the building responds to strong ground motion; in other words, to minimize loss of life. This implies that, although there will likely be extensive structural and non-structural damage, during the DGM (design ground motion), there is a reasonable degree of confidence that the building will not collapse nor will its attachments break off and fall on people near the building. This performance level is termed 'extensive damage' because, although the structure may be heavily damaged and may have lost a substantial amount of its initial strength and stiffness, it retains some margin of resistance against collapse".

101 - 33465 Maclure Road

Address

Abbotsford, BC

604 850 2364

Telephone

April 1, 2013

(Affix Professional seal here)

If the *Qualified Professional* is a member of a firm, complete the following.

I am a member of the firm Fraser Valley Engineering Ltd.
and I sign this letter on behalf of the firm. (Print name of firm)

GeoWest Engineering Ltd.
150 – 8621 201 Street
Langley, BC V2Y 0G3
info@geowestengineering.com
www.geowestengineering.com

MEMORANDUM

Attention:	Jim Gordon, Director of Engineering and Operations, City of White Rock	Date:	February 13, 2018
cc:	Mr. Dustin Abt, Manager, Public Works, City of White Rock	From:	Calum Buchan, P.Eng.
Project:	Landslide at 1155-57 Martin Street and 15025 Victoria Avenue, White Rock	File:	GA18-1022-00
		Sent Via:	Email
Subject:	**Emergency Stabilization – Summary of Stabilization Works**		

GeoWest Engineering Ltd. (GeoWest) was retained by the City of White Rock (the City) to complete the design and construction review of the emergency stabilization works on the private properties located at the above referenced addresses in connection with a landslide that occurred on January 29, 2018. The initial slope stabilization recommendations were provided by GeoWest in our field report dated January 30, 2018. We then maintained full-time engineering presence during the emergency stabilization process and provided additional geotechnical recommendations as needed.

Greystone Design Management Ltd. was retained by the City as the Prime Contractor for the emergency stabilization works. Details of the stabilization design and works completed were provided in our daily field reports and are summarized below:

1. Installation of a protective berm at the base of the slope and construction of a Lock Block retaining wall to protect the BC Hydro transformer and reestablishment of the fire hydrant and driveway access.
2. Pull-back of the unstable mass of the soil remaining near the top of slope including some general off-loading of uncontrolled fill encountered to the south of the house located at 1155 Martin Street.
3. Interception and diversion of two groundwater-fed springs. The larger spring was emanating from an eroded annular space that surrounded a broken and soil-infilled clay-tile footing drain at 1155 Martin Street.
4. Removal of the landslide debris from the suspended slab/patio of Unit 102, 15025 Victoria Avenue.
5. Removal of liquefied soil from the up-slope from the slab/patio of Unit 102, 15025 Victoria Avenue and replacement with a more stable rockfill material surfacing, to reduce the potential for future earthflow onto the patio. We caution that a considerable amount of loose landslide debris remains on the slope that will need to be considered for the permanent design to stabilize/retain the area.

6. Placement of reinforced shotcrete over the steep escarpment below the house at 1155 Martin Street. The shotcrete was supplemented by a series of fully grouted soil nails placed at approximate spacing of 1.5m. The sol nails were designed to be 3 m long with a 15° declination. However, two of the soil nails drilled in the near vertical scarp below the deck at 1155 Martin Street were extended due to encountering voids during drilling. Consequently, they were drilled to a length of 4.5m before grouting. The grout take was considerably higher in both of those soil nails.
7. Clearing of catch-basins at 15025 Victoria avenue of accumulated soil from the landslide.

The intent of the emergency stabilization was to provide safe conditions for the duration of the winter months. There is recently formed localized erosion on the steep slope immediately to the north of the shotcreted area, that sloughed after placing shotcrete. The erosion did not appear to be an immediate hazard to the safety of the 15025 Victoria and 1155-57 Martin. However, further visual monitoring is recommended on a regular basis. The City should review the landslide area during or shortly after heavy precipitation events. GeoWest should be advised of any observed deterioration of conditions.

The private property owners affected by the landslide are responsible for retaining their own professionals and contractors to reinstate lost property and to establish long term stable conditions. It is our considered opinion that the construction of the permanent stabilization works should be substantially completed by September 30, 2018.

It is recommended that the landslide-affected properties communicate the intent of their stabilization works with each other and actively involve their respective Geotechnical Consultants. The key elements of the design should be submitted by each party or together as an engineered design for review and approval by the City of White Rock prior to proceeding with construction.

We trust that the information provided meets your immediate needs. Should you require further assistance please contact the undersigned.

GeoWest Engineering Ltd.

Feb. 13, 2018
PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
C. BUCHAN
22251

Per: Calum Buchan, P.Eng., P.E.
Senior Geotechnical Engineer

Reviewed by:

Dejan Jovanovic, P.Eng.
Senior Geotechnical Engineer

FRASER VALLEY ENGINEERING LTD.
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February 5th, 2020

File: 18-0476

Greystone Design Management
2242 Woodstock Drive
Abbotsford, BC V2G 2E5
Attn: Mr. Brent Loates

Re: Updated report - Geotechnical Slope Assessment - 1155, 1157 Martin St, White Rock, BC

1.0 Introduction

Fraser Valley Engineering Ltd. (FVEL) issued a geotechnical report on September 25th, 2019 along with a follow up report and shoring design drawing on January 17th, 2020. FVEL provides this report as an update to the September 25th, 2019 report (This report supersede the September 25th, 2019 report). This report must also be read in conjunction with the report and shoring design drawing dated January 17th, 2020.

FVEL was retained by the client to assess the stability of the rear yard slope and to provide permanent stabilization recommendation in regards to the slope and the previous landslide area for the private property located at above referenced address.

As per information provided by the client and reports by GeoWest Engineering (Geowest), the landslide occurred at 5.00 PM on January 29th, 2018. Geowest visited the site in several occasions after the landslide occurred and provided recommendation for the emergency stabilization works. Those emergency stabilization works are considered temporary. The present exercise is intended to provide a permanent slope stabilization solution.

FVEL reviewed the following documents prior to writing this report:

- Landslide Assessment report for the Proposed Residential Buidling-1135 Martin St (adjacent property to the south), dated August 19th, 2013) By FVEL
- Preliminary Findings and Emergency Stabilization - Geotechnical Landslide Assessment (January 30th, 2018)
- Emergency Landslide Stabilization - Construction Monitoring (January 31st, February 1st, 2nd, 3rd, 6th and 7th 2018)
- Emergency Landslide Stabilization - (February 5th, 2018)
- Emergency Stabilization-Summary of Stabilization Work (February 13th, 2018)
- Topographic Survey Plan by Hobbs, Winter & MacDonald, B.C. Land Survey (HWM) dated May 31th, 2018
- BC Building Code 2018

2.0 Slope Stability

The slope profiles were generated using the topographic information supplied by the client. The analyses were completed using the commercial software SoilWorks 2016, V.1.1. The Limit Equilibrium Method was selected in the analysis. Both static and seismic (pseudo-static) conditions were taken into account in compliance with the "Guidelines for Legislated Landslide Assessments for Proposed Residential Developments in BC", revised May 2010, by the Association of Professional Engineers and Geoscientists of BC.
The Peak Ground Acceleration (PGA) for this site is 0.378g for a probability of occurrence of 2% in 50 years (0.000404

per annum), which was obtained from the web-site http://www.earthquakescanada.nrcan.gc.ca of National Resources Canada. The Spectral Response Acceleration Values Sa(T), for Site Class C are:

2015 National Building Code of Canada seismic hazard values

Sa(0.05)	Sa(0.1)	Sa(0.2)	Sa(0.3)	Sa(0.5)	Sa(1.0)	Sa(2.0)	Sa(5.0)	Sa(10.0)	PGA	PGV
0.461	0.701	0.874	0.877	0.774	0.435	0.261	0.082	0.029	0.378	0.566

A seismic acceleration coefficient k_{15} of 0.185g was used in the analysis. The k_{15} value was calculated using the Bray Travasarou Method, and is compatible with 15 cm of slope displacement along the slip surface in compliance with the APEGBC landslide assessment guidelines.

The following minimum Factors of Safety (FS) used for the global stability analyses are adopted:

- Global Stability under Static Conditions = 1.5
- Global Stability under Seismic Conditions = 1.0

The design parameters assumed are based on:

- Report by FVEL for 1135 Martin St in White Rock. located to the south of the subject property which includes a test pit investigation and one drill hole data
- Information provided by the client
- Geowest reports

Assumed soil properties for the onsite materials are:

Soil	Unit weight (kN/m3)	Saturated Unit weight (kN/m3)	Friction angle (Degree)	Cohesion (kPa)
Native soil	20	21	34	0

2.1 Area Below Deck (Failure Area) - Section A and B

Slope stability analyses were conducted for two sections (section A and B) of the landslide area as shown on Figure No.1. Slope stability was conducted for two different scenarios:

- To analyse the current condition of the site
- To achieve the acceptable minimum FS criteria (proposed mitigation work)

Slope Stability Analyses Results-Current Condition

	# of Anchors	Anchors length (m)	Static	Seismic
Section A	3	3.0	1.03	0.70
Section B	1	3.0	1.14	0.76

Slope Stability Analyses Results- with Proposed Mitigation Works (With Assumption of Water Table)

	# of Anchors	Anchor length (m)	Static	Seismic
Section A	3	7.3 (24 ft)	1.52	1.04
Section B	2	7.3 (24 ft)	1.54	1.02

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As it is shown on the tables above and figures attached, the current condition of the slope does not satisfy the minimum required factor of safety (FS) for the global stability of the slope. However by adding new anchors with longer length on the entire failure area, the FS criteria is achieved. Details and anchor drawings are attached to this report.

During the temporary stabilization of the slope, contractor removed some soil from under the proposed deck which contributes to reduce the amount of lateral/vertical load on the existing slope.

We have included horizontal sub-drains in the slope to lower the potential water table and improve stability conditions. However, this improvement has not been considered in the global stability analyses to be conservative.

The properties of the material used in the temporary stabilization works such as thickness and strength of shotcrete, size of the anchors, etc. were not considered for our final permanent design (no structural value assigned to be conservative). This means we solely rely on the permanent anchoring solution for the permanent stability of the slope. However for temporary stabilization analysis (pre construction of permanent works), we assumed 3 m long anchor and spacing as shown in the survey drawing to show that the temporary works is not stuffiest for permanent stability of the slope. Also the temporary shotcrete will not be removed and the new shotcrete with metal mesh will be added on top of the existing one.

FVEL reviewed the structural drawings by Latera Engineering Inc. The location of columns of the proposed deck are shown in the drawing, however the micro pile depth is not shown (we have been informed that the micro piles are 15 ft deep). To facilitate the stability analysis of the slope, we assumed a distributed deck load of 10 kPa below the existing grade.

2.2 Area below the House and North of Failed section - Section D and E

Slope stability analyses were conducted for section D and E which are to the north of the failed portion of the slope. Cross section locations are on Figure No.1.

Slope Stability Analyses Results-With/Without Anchor

	Anchor length (m)	Static	Seismic
Section D	0	1.5	1.04
	No anchor is needed		
Section E	0	0.76	0.56
	6	1.5	1.1

As it can be seen, cross section D does not require stabilization works. The current condition of the slope is stable for this portion of the slope. However the slope closer to the failure area is steeper than 1H:1V (cross section E) and slope stability analysis showed that slope stabilization works is needed for this portion.

3.0 Geotechnical Recommendations

As mentioned in section 2.0, the current temporary slope remediation (section A and B) and native ground condition (section E) do not satisfy the minimum SF criteria. In order to achieve a long-term or permanent stabilization, client must follow the recommendations provided below:

- Install permanent anchors in the steepest section of the slope. Anchors interval and details as per FVEL drawing dated January 17th, 2020.

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- Separate the perimeter drainage from the roof drainage. (This recommendation has been completed at the time if this report)
- Currently all the water from the perimeter and roof water leader has been directed to the city connections by gravity. All the seepage that concentrates in one point of the slope is caught in a sump and pumped to the city stormwater line (details on mechanical drawings by XT Engineering Ltd.)
- No development to be allowed in the slide area or slope unless a qualified geotechnical engineer reviews the permanent shoring jobs
- Contractor must review the structural drawings prior anchoring in order to make sure there will be no overlap between the anchors and micro piles.
- Horizontal sub-drains to reduce the hydrostatic pressure on the slope are required for anchor area 1 and 2 as shown in the drawings dated January 17th, 2020 (this recommendation is provided to be conservative).

4.0 Limitation and Closure

This report is based on the FVEL site visits, review of background information and our knowledge of the area of the proposed project. We have prepared this report in substantial accordance with generally accepted geotechnical engineering practice, as it exists in the site area at the time of our study. No warranty is expressed or implied. This report may be used only by the client and the City of White Rock, and only for the purposes stated, within a reasonable time from its issuance.

We trust that this report provides you with the information required for the final design. If you have any questions, please do not hesitate to call.

Yours Truly,

Fraser Valley Engineering Ltd.

Reviewed by,

Hamid Tavakolian Bana, MEng, EIT
Geotechnical Engineer

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA J. PRADA #27380

Jairo Prada, MSc, PEng
Principal

FEB 05 2020

Attachments:

Figure No.1: Cross section location
Slope stability analysis results

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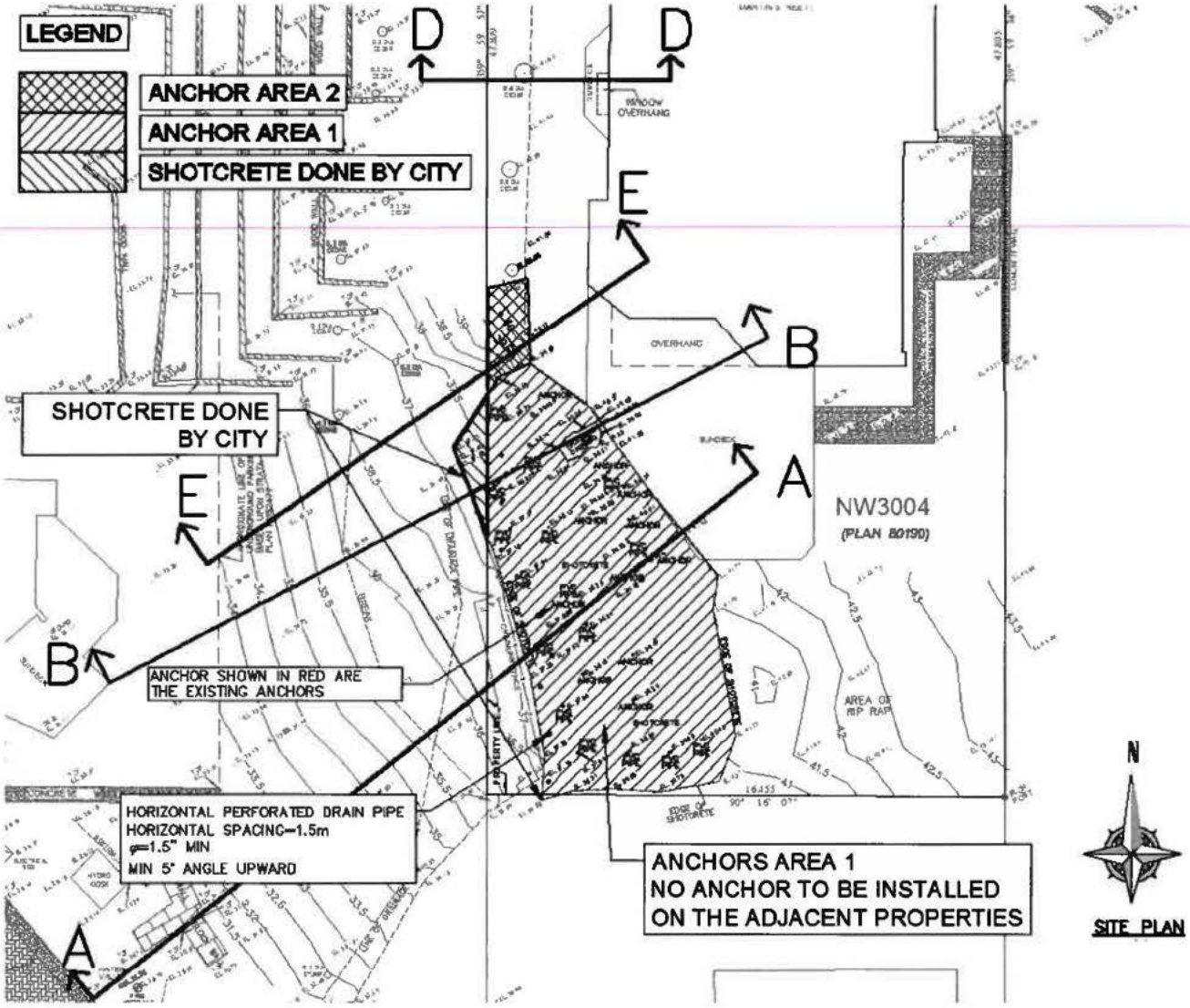

Figure No.1: Cross section Locations for slope stability analysis

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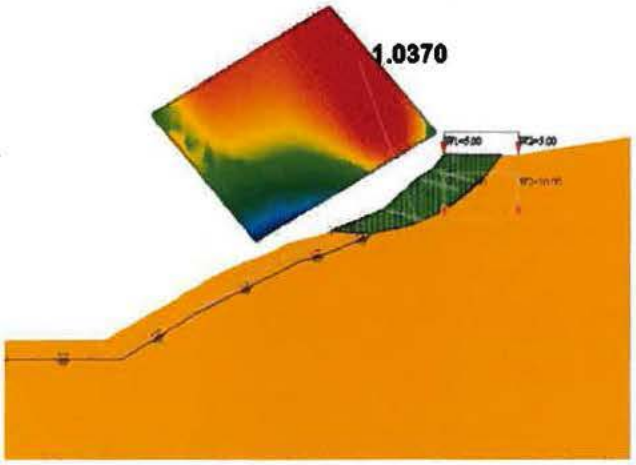
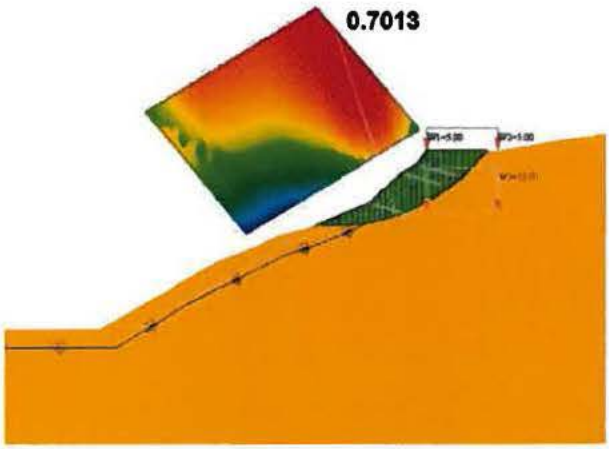
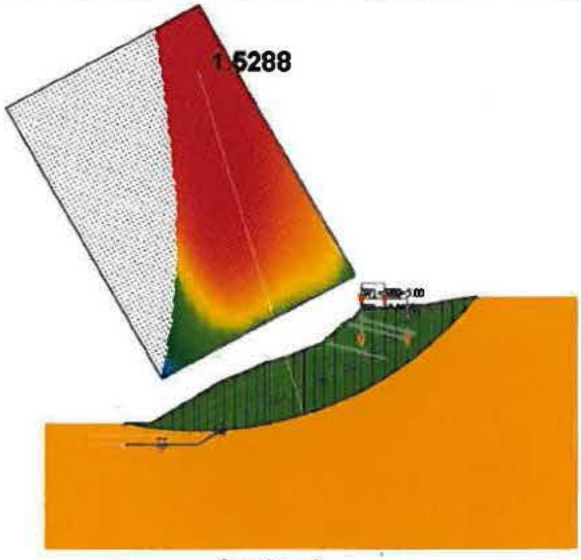


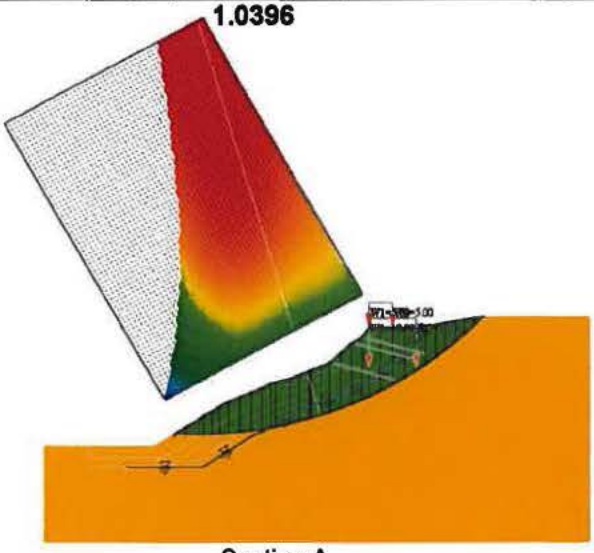
Section A
3.0 m Long Anchors, Static Condition



Section A
3.0 m Long Anchors, Seismic Condition



Section A
24 ft (7.3 m) Long Anchors, Static Condition



Section A
24 ft (7.3 m) Long Anchors, Seismic Condition

OQM CERTIFIED

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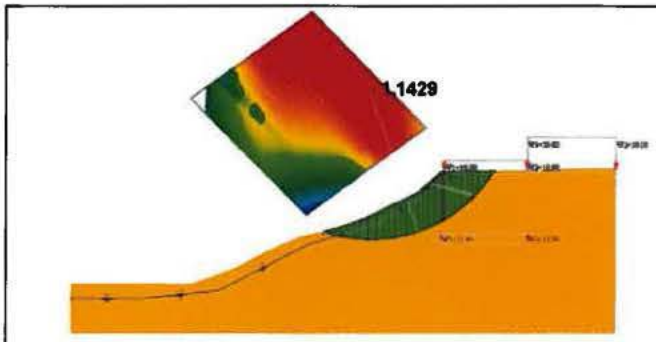
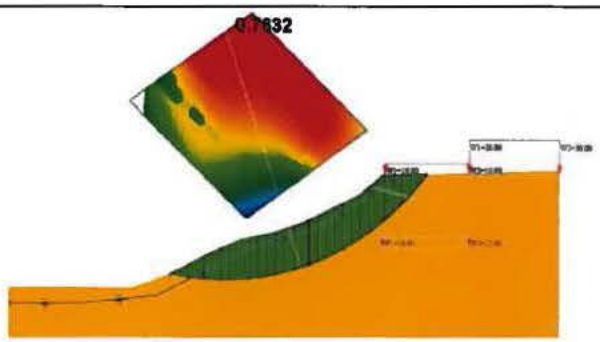
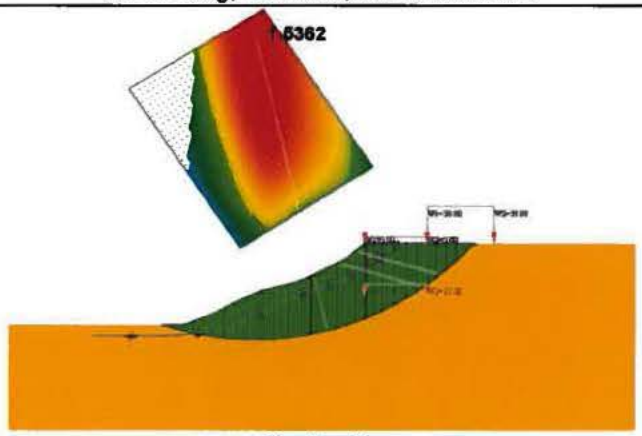


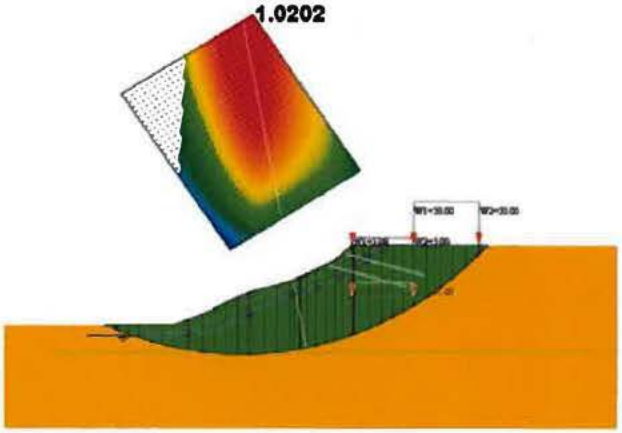
Section B
3.0 m Long, 1 Anchor, Static Condition



Section B
3.0 m Long, 1 Anchor, Seismic Condition



Section B
24 ft (7.3 m), 2 Anchors, Static Condition



Section B
24 ft (7.3 m), 2 Anchors, Seismic Condition

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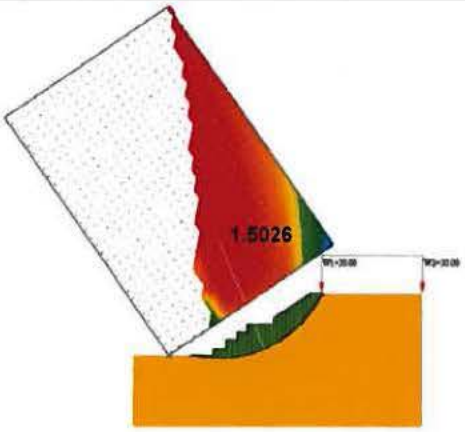
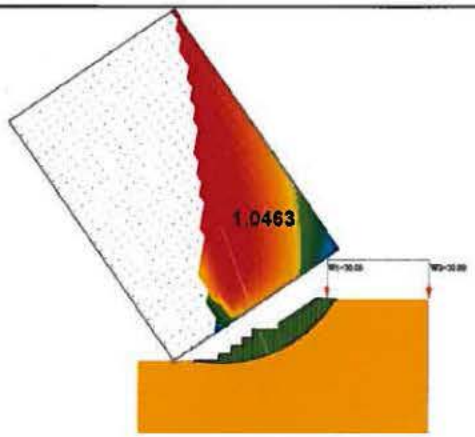
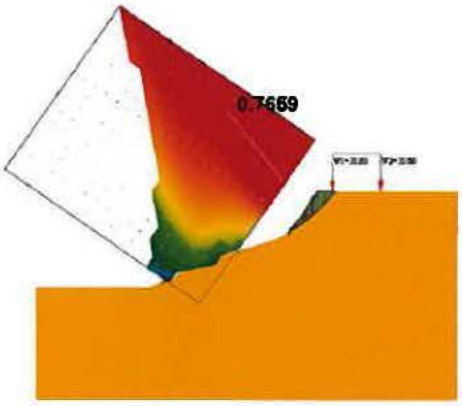


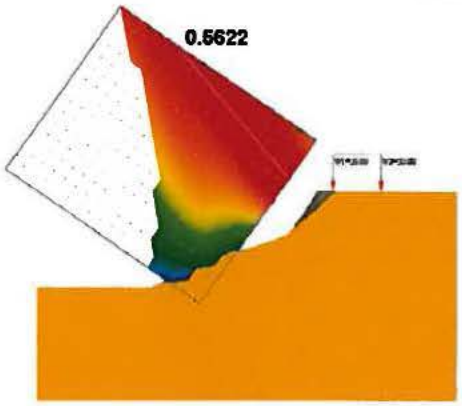
Section D- Static Condition



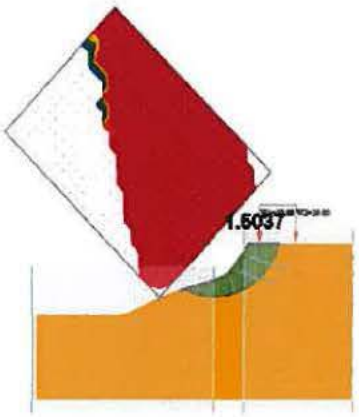
Section D- Seismic Condition



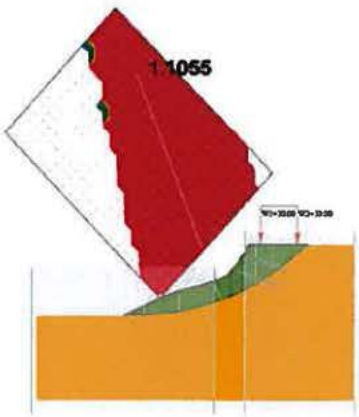
Section E
No Anchor - Static Condition



Section E
No Anchor - Seismic Condition



Section E
6 m Anchor - Static Condition



Section E
6 m Anchor - Seismic Condition

APPENDIX D: *LANDSLIDE ASSESSMENT ASSURANCE STATEMENT*

Note: This Statement is to be read and completed in conjunction with the "*APEGBC Guidelines for Legislated Landslide Assessments for Proposed Residential Development in British Columbia*", March 2006/Revised September 2008 ("*APEGBC* Guidelines") and the "2006 BC Building Code (BCBC 2006)" and is to be provided for *landslide assessments* (not floods or flood controls) for the purposes of the Land Title Act, Community Charter or the Local Government Act. Italicized words are defined in the *APEGBC* Guidelines.

To: The *Approving Authority* Date: January 9th, 2019

City of White Rock

Jurisdiction and address

With reference to (check one):

- ☐ Land Title Act (Section 86) – Subdivision Approval
- ☐ Local Government Act (Sections 919.1 and 920) – Development Permit
- ☒ Community Charter (Section 56) – Building Permit
- ☐ Local Government Act (Section 910) – Flood Plain Bylaw Variance
- ☐ Local Government Act (Section 910) – Flood Plain Bylaw Exemption
- ☐ British Columbia Building Code 2006 sentences 4.1.8.16 (8) and 9.4 4.4.(2) (Refer to BC Building and Safety Policy Branch Information Bulletin B10-01 issued January 18, 2010)

For the Property:

LOTs 1 & 2, SEC 10, NWD PL NWS3004, TWP 1,P/N: NWS3004 - 1155&1157 Martin St

Legal description and civic address of the Property

The undersigned hereby gives assurance that he/she is a *Qualified Professional* and is a *Professional Engineer* or *Professional Geoscientist.*

I have signed, sealed and dated, and thereby certified, the attached *landslide assessment* report on the Property in accordance with the *APEGBC Guidelines*. That report must be read in conjunction with this Statement. In preparing that report I have:

Check to the left of applicable items

- x 1. Collected and reviewed appropriate background information
- x 2. Reviewed the proposed *residential development* on the Property
- x 3. Conducted field work on and, if required, beyond the Property
- x 4. Reported on the results of the field work on and, if required, beyond the Property
- x 5. Considered any changed conditions on and, if required, beyond the Property
- 6. For a *landslide hazard analysis* or *landslide risk analysis* I have:
  - x 6.1 reviewed and characterized, if appropriate, any *landslide* that may affect the Property
  - x 6.2 estimated the *landslide hazard*
  - x 6.3 identified existing and anticipated future *elements at risk* on and, if required, beyond the Property
  - x 6.4 estimated the potential *consequences* to those *elements at risk*
- 7. Where the *Approving Authority* has adopted a *level of landslide safety* I have:
  - ___ 7.1 compared the *level of landslide safety* adopted by the *Approving Authority* with the findings of my investigation
  - ___ 7.2 made a finding on the *level of landslide safety* on the Property based on the comparison
  - ___ 7.3 made recommendations to reduce *landslide hazards* and/or *landslide risks*
- 8. Where the *Approving Authority* has **not** adopted a *level of landslide safety* I have:

x 8.1 described the method of *landslide hazard analysis* or *landslide risk analysis* used

x 8.2 referred to an appropriate and identified provincial, national or international guideline for *level of landslide safety*

x 8.3 compared this guideline with the findings of my investigation

x 8.4 made a finding on the *level of landslide safety* on the Property based on the comparison

x 8.5 made recommendations to reduce *landslide hazards* and/or *landslide risks*

x 9. Reported on the requirements for future inspections of the Property and recommended who should conduct those inspections.

Based on my comparison between

Check one

☐ the findings from the investigation and the adopted *level of landslide safety* (item 7.2 above)

☒ the appropriate and identified provincial, national or international guideline for *level of landslide safety* (item 8.4 above)

I hereby give my assurance that, based on the conditions[1] contained in the attached *landslide assessment* report,

Check one

☐ for subdivision approval, as required by the Land Title Act (Section 86), "that the land may be used safely for the use intended"

Check one

☐ with one or more recommended registered covenants.

☐ without any registered covenant.

☐ for a development permit, as required by the Local Government Act (Sections 919.1 and 920), my report will "assist the local government in determining what conditions or requirements under [Section 920] subsection (7.1) it will impose in the permit".

☒ for a building permit, as required by the Community Charter (Section 56), "the land may be used safely for the use intended"

Check one

☒ with one or more recommended registered covenants.

☐ without any registered covenant.

☐ for flood plain bylaw variance, as required by the "Flood Hazard Area Land Use Management Guidelines" associated with the Local Government Act (Section 910), "the development may occur safely".

☐ for flood plain bylaw exemption, as required by the Local Government Act (Section 910). "the land may be used safely for the use intended".

Jairo Prada
Name (print)

January 9th, 2019
Date

Signature

[1] When seismic slope stability assessments are involved, *level of landslide safety* is considered to be a "life safety" criteria as described in the National Building Code of Canada (NBCC 2005), Commentary on Design for Seismic Effects in the User's Guide, Structural Commentaries, Part 4 of Division B. This states:

"The primary objective of seismic design is to provide an acceptable level of safety for building occupants and the general public as the building responds to strong ground motion; in other words, to minimize loss of life. This implies that, although there will likely be extensive structural and non-structural damage, during the DGM (design ground motion), there is a reasonable degree of confidence that the building will not collapse nor will its attachments break off and fall on people near the building. This performance level is termed 'extensive damage' because, although the structure may be heavily damaged and may have lost a substantial amount of its initial strength and stiffness, it retains some margin of resistance against collapse".

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Address
Abbotsford, BC V2S 0C4
604 850 0364
Telephone

(Affix Professional seal here)

If the *Qualified Professional* is a member of a firm, complete the following.

I am a member of the firm Fraser Valley Engineering Ltd.
and I sign this letter on behalf of the firm. (Print name of firm)

FRASER VALLEY ENGINEERING LTD.
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File: 18-0476

September 16th, 2020

Greystone Design Management
2242 Woodstock Drive
Abbotsford, BC V2G 2E5
Attn: Mr. Brent Loates

Re: Micro Pile Design - Proposed Tiered Wall
1155 Martin Street and related common property to Strata Plan NW3004

1.0 Introduction

Fraser Valley Engineering Ltd. (FVEL) was retained by the client to provide a permanent shoring design for the site located at above noted address. FVEL has issued the following reports and drawings:

- Updated geotechnical slope assessment report dated February 5th, 2020
- Shoring design drawings dated January 17th, 2020

The previous reports and drawings were to provide a permanent stabilization recommendation in regard to the landslide area for the above reference address. The loading on the slope included the existing soil weight plus the proposed deck. However; FVEL was informed that the client is proposing a series of terraces to the south and west of the proposed deck (see attached drawings by Latera Engineering Inc.).

2.0 Design Assumption

As per email from Cameron Robinson of Latera (the structural engineer), they need about 21 stair risers to get from the top to the bottom of the slope. The preliminary section reveals that with 4-foot retaining walls, that can be accomplished to make it considerably more aesthetically pleasant.

As per conversation with Latera:

- Retaining walls would be doweled into the shotcrete with buttress walls and return walls to resist the lateral soil pressures. There would be no local bending moment transferred to the shotcrete at the base of the wall.
- 350 psf dead load and 100 psf live load was assumed for the series of terraces.

FVEL chose a micro pile system under the terracing to support each wall. Micro piles will transfer the total vertical load of the proposed structure to the tip of the pile which will be placed deeper than the slip surface calculated in our previous reports.

3.0 Pile Design

Location and horizontal spacing of the piles should be defined by the structural engineer. The minimum horizontal spacing between piles must be equal or greater than 3.0D, where D is the pile diameter. There are two methods to construct the micro piles as follow:

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- Dywidag Hollow bar grout injection Anchor (4" hole with DYWI drill hollow bar)
- Hollow pipe with grout injection (6" hole with 3" Galvanized Schedule 40 pipe)

The grout for the micro piles should be non-shrink cementitious material with a minimum compression strength of 21 MPa in 24 hours and 35 MPa in 28 days. **Table No.1** below presents the calculated micro piles capacity.

Table No.1: Micro Pile Capacity

Length		10 cm diameter hole (4")				15 cm diameter hole (6")			
		Ultimate Capacity, Qult		Allowable Capacity, Qall		Ultimate Capacity, Qult		Allowable Capacity, Qall	
(m)	(ft)	(kN)	(kips)	(kN)	(kips)	(kN)	(kips)	(kN)	(kips)
9	29.5	209.7	47.1	83.9	18.9	321.6	72.3	128.6	28.9
10	32.8	240.6	54.1	96.2	21.6	368.0	82.7	147.2	33.1
11	36.1	272.8	61.3	109.1	24.5	416.3	93.6	166.5	37.4
12	39.4	306.5	68.9	122.6	27.6	466.8	104.9	186.7	42.0

Please note that above mentioned values are capacities of the piles regardless of concrete and steel bar/pipe compression strength. The structural engineer must consider the compressive strength of the concrete pile column and steel bar/pipe when choosing the pile size and diameters. DYWI Drill Hollow Bar R32N or approved equivalent must be used.

Lateral movement on the proposed structure can be minimized by having a grade beam on top of the pile. Grade beam can minimized the lateral movement of the piles in both X and Y directions. If extra constraint is required, a connection plate and #8 galvanized bar can be used to connect the pile to the slope anchors.

4.0 Slope Stability

As noted above, the weight of the proposed wall will be transferred to the tip of the pile which will be placed deeper than the slip surface. However, the weight of the soil and live load will not be transferred to the pile and will be applied directly to the slope surface. For slope stability calculations these weight were applied to the entire surface of the slope.

As per shoring design drawings dated January 17th, 2020, horizontal slotted drain pipe has been considered throughout the entire slope to eliminate the hydrostatic pressure build up behind the slope. In our report dated February 5th, 2020, this water pressure was not eliminated. However; after reviewing the final drawings by XT Engineering Ltd. dated January 3rd, 2020 in regards to water drainage and implementing the sump pump, it is our professional opinion that the hydrostatic pressure can be eliminated for the purpose of slope stability analysis.

Table No.2: Slope stability analysis results- With Terrace Load

	Proposed permanent Anchor Length=7.3 m	
	A	B
Static	1.77	2.24
Seismic	1.16	1.44

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For details about seismic calculation, please refer to FVEL report dated February 5th, 2020. We did not change the slope configuration nor anchors layout. The only changes were, elimination of hydrostatic pressure and addition of terrace load. As can be seen in **Table No.2** and the slope stability results (attached) the safety factor under static and seismic conditions are higher than 1.5 and 1.0 respectively.

5.0 Review and Construction Inspections

FVEL should review the micro piles during the installation and witness the pull out test for all the piles to verify their capacities. The micro piles should be installed vertically. If any micro pile is out of plum, it must be reviewed by the structural engineer to verify its structural capacity.

6.0 Conclusion

The safety factors under static and seismic conditions are higher than 1.5 and 1.0 respectively. These values were obtained using previous design layout as per shoring design drawings dated January 17th, 2020. This means the shoring design does not need to be changed and shoring design drawings dated January 17th, 2020 can be used for situation of having terrace wall. However; addition of the micro pile is necessary for permanent functionality of the terrace wall and stability of the slope.

7.0 Limitation and Closure

We trust that this report provides you with the information required for the final structural design. If you have any questions, please do not hesitate to call.

Yours truly,

Fraser Valley Engineering Ltd.

Hamid Tavakolian Bana
2020.09.24 15:08:27 -07'00'

Hamid Tavakolian Bana, M.Eng, EIT,
Geotechnical Engineer

Reviewed by,

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
J. PRADA
#27380

Jairo Prada, M.Sc., P.Eng.
Principal

Attachments:

Landscape Drawings by Latera
Slope Stability Analysis Result

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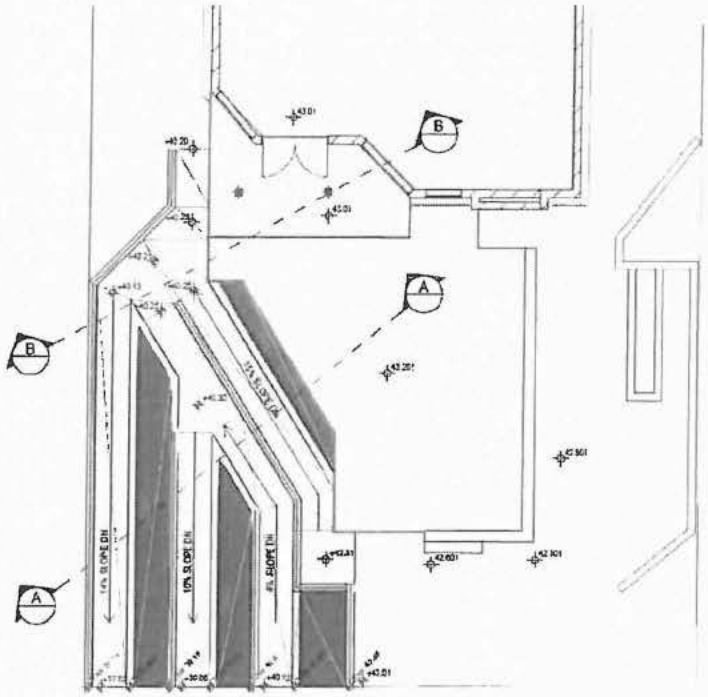
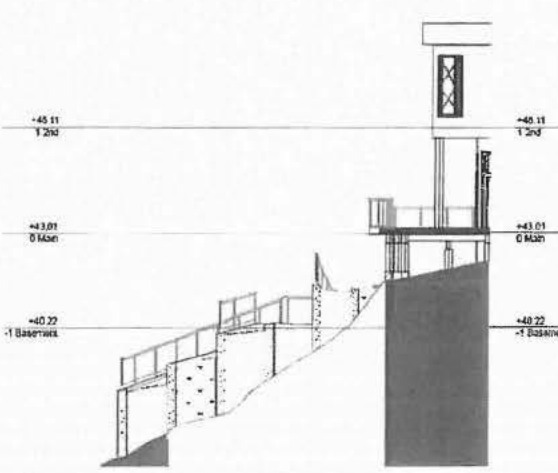
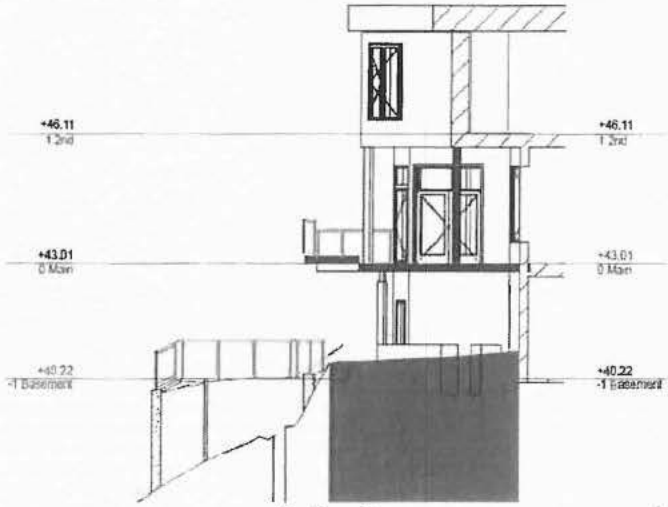




Section A



Section B

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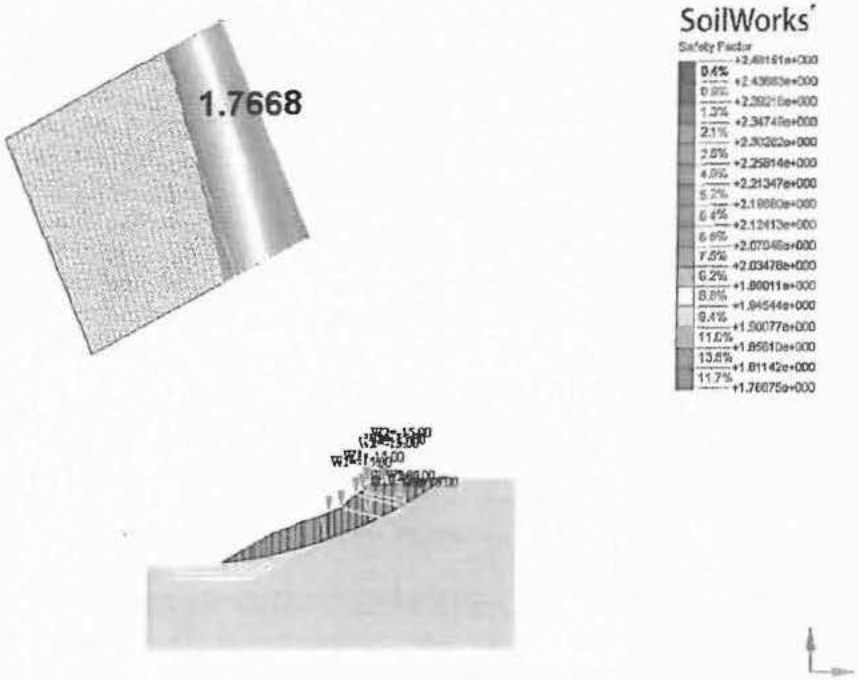
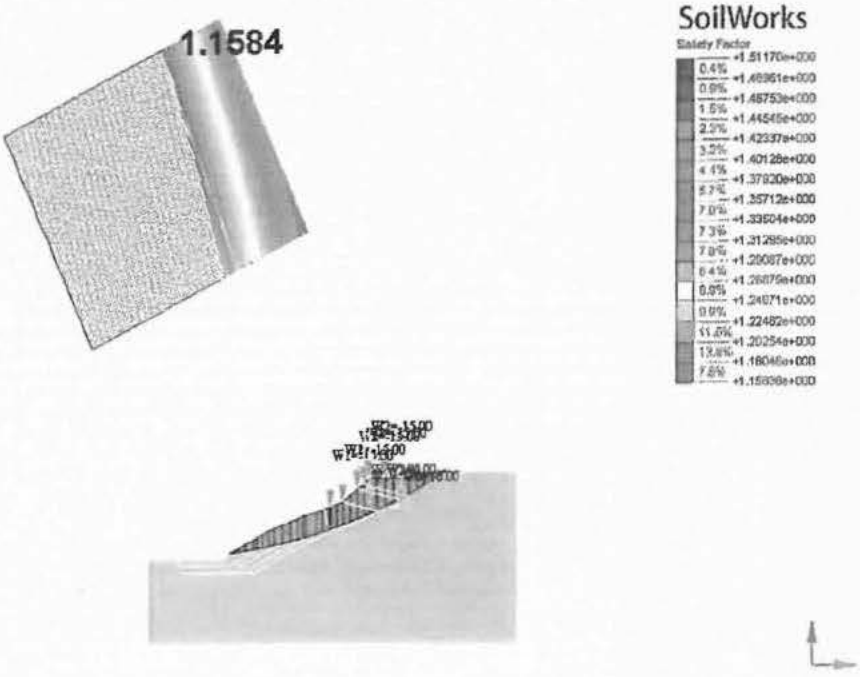


Section A-Static Condition



Section A-Seismic Condition