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DV000048

REPORT TO THE JUAN DE FUCA LAND USE COMMITTEE
MEETING OF TUESDAY, JUNE 21, 2016

SUBJECT **Floodplain Exemption for Lot 2, Section 2, Renfrew District, Plan VIP83339 – Waters Edge Drive**

ISSUE

A request has been made for a floodplain exemption in order to construct a single-family dwelling within the floodplain setbacks specified in Part 5 of the Juan de Fuca Land Use Bylaw, 1992, Bylaw No. 2040.

BACKGROUND

The vacant 1.12 ha property is located on Waters Edge Drive in Jordan River and is zoned Rural Residential 2A (RR-2A) in Juan de Fuca Land Use Bylaw, 1992, Bylaw No. 2040. The property is bounded by RR-2A zoned properties to the east and west, Waters Edge Drive to the north, and the Strait of Juan de Fuca to the south (Appendix 1). The applicants now propose to construct a single-family dwelling (Appendices 2 and 3).

The parcel was created in June 2007 as part of a 63-lot subdivision. As a condition of subdivision, a geotechnical engineer assessed the parcels for hazards, and the preliminary report (Appendix 4) was secured as a covenant on title. The covenant restricts building construction until such time as a site specific review has been conducted by a geotechnical engineer. An additional covenant was registered on title as part of the subdivision process restricting building within 30 m and not less than 4 m above the natural boundary of the sea.

CRD floodplain regulations were applied to the area in 2010 when the RR-2A zone was added to Bylaw No. 2040. The proposed building site on Lot 2 is within the floodplain setback as established in Part 5, Section 2.0 (2)(e) of Bylaw No. 2040, which states:

> *"Where the building site is at the top of a steep bank (30 metres or more from horizontal) and where the toe of the bank is subject to erosion and is closer than 15 metres from the natural boundary of the sea, the setback shall be a horizontal distance from the Top of Bank equal to 3 times the height of the bank as measured from the toe of the bank."*

A geotechnical engineer's report has been prepared assessing the proposed building site on Lot 2 and providing recommendations to ensure it is safe for the use intended (Appendix 5). As the proposed building site is within the floodplain setback, the applicant is requesting a floodplain exemption pursuant to Section 524(7)(b) of the *Local Government Act (LGA)*.

ALTERNATIVES

That the Land Use Committee recommends to the Capital Regional District Board:

1. That floodplain exemption DV000048 for Lot 2, Section 2, Renfrew District, Plan VIP83339 for the purpose of constructing a single-family dwelling be granted subject to the following conditions:

    a) That the proposed development comply with the recommendations outlined in the professional geotechnical engineer's report prepared by WSP Canada Inc., dated April 13 & 19, 2016;

    b) That the building setback be verified by survey prior to completion of the building permit; and

c) That the professional geotechnical engineer's report prepared by WSP Canada Inc., dated April 13 & 19, 2016, be secured via a restrictive covenant registered on title as part of the Building Permit process.

2. That floodplain exemption DV000048 be denied.

3. Refer the application back to staff for additional information.

LEGISLATIVE IMPLICATIONS

Section 524 of the *LGA* authorizes local governments to designate areas as floodplains and to specify flood levels, setbacks and other related provisions. Part 5 of Bylaw No. 2040 outlines requirements for floodplain management. Local government may exempt a person from the floodplain bylaw pursuant to Section 524(7) of the *LGA*.

PUBLIC CONSULTATION IMPLICATIONS

There is no statutory or bylaw requirement to notify members of the public about a request for a floodplain exemption. Notice of the Land Use Committee meeting is posted on the CRD website and in the newspaper. Any comments received from the public will be presented at the June 21, 2016, Land Use Committee meeting.

LAND USE IMPLICATIONS

The parcel is partially designated as a foreshore and steep slope development permit area in the Shirley/Jordan River Official Community Plan, Bylaw No. 3717; however, as the proposed building site is outside of the foreshore and steep slope development permit areas, a development permit is not required. Staff further note that the subject property is located outside the inundation zone for Jordan River that has been mapped by BC Hydro. The inundation zone relates to the area at risk of a catastrophic failure of the Diversion Dam brought about by a major earthquake.

The January 8, 2007, geotechnical engineer's assessment of the property identified potential for instability in the steep ocean foreshore slopes and recommended building setbacks from the slope crest. More accurate setbacks from the slope crest were to be determined at the time of construction. The report considered a frequency of occurrence of a potential hazard in terms of a 10% probability in 50 years.

The slope stability review by WSP Canada Ltd, dated April 13 and 19, 2016, is specific to Lot 2, and was conducted using the current slope stability guidelines of the 2012 *BC Building Code* (2% within 50 year probability of seismic event). The report determined that the house foundations should be a minimum of 20 m, laterally, from the crest of the foreshore slope. The geotechnical setback was established to allow for potential loss of land on the foreshore slope. The mature trees that exist within the setback area provide surficial stability to the slope and the report states that they should not be removed as part of the development. Subgrade excavation has been carried out and is considered suitable for support of a wood-framed, single-family dwelling on concrete foundations. Based on the observed subgrade conditions and the proposed 20 m setback, the engineer considers that house site is safe for the use intended.

The floodplain regulations, as outlined in Part 5, Section 2.0 (2)(e) of Bylaw No. 2040, specify that the flood plain setback is a horizontal distance from the crest of the slope equal to three times the height of the bank. Since the height of the embankment is approximately 42 m, the setback from the crest of the slope is approximately 126 m. This setback encompasses the entire property. The geotechnical engineer has reviewed the proposed building site and considers that a 20 m setback from the slope crest is safe for the intended use, subject to their construction recommendations. The report meets the requirements of Section 524(7)(b) of the *LGA* and, therefore, staff recommend granting a floodplain exemption subject to the conditions outlined in

the WSP Canada Ltd. report (Appendix 5), securing the report via a restrictive covenant, and verification of the building foundation location by a BC Land Surveyor.

CONCLUSION

The applicant is requesting a floodplain exemption on Lot 2, Section 2, Renfrew District, Plan VIP83339 for the purpose of constructing a single-family dwelling. A report, prepared by WSP Canada Ltd., specifies a minimum 20 m setback for the single-family dwelling from the crest of the slope, and provides specific recommendations for building construction to ensure the structure is safe for the use intended. Staff recommend exempting the subject property from the floodplain setback subject to the conditions of the geotechnical report, securing the report via a restrictive covenant, and verification of the building location by a BC Land Surveyor.

RECOMMENDATION

That the Land Use Committee recommends to the Capital Regional District Board:

That floodplain exemption DV000048 for Lot 2, Section 2, Renfrew District, Plan VIP83339 for the purpose of constructing a single-family dwelling be granted subject to the following conditions:

a) That the proposed development comply with the recommendations outlined in the professional geotechnical engineer's report prepared by WSP Canada Ltd., dated April 13 & 19, 2016;

b) That the building location be verified by a BC Land Surveyor prior to completion of the building permit; and

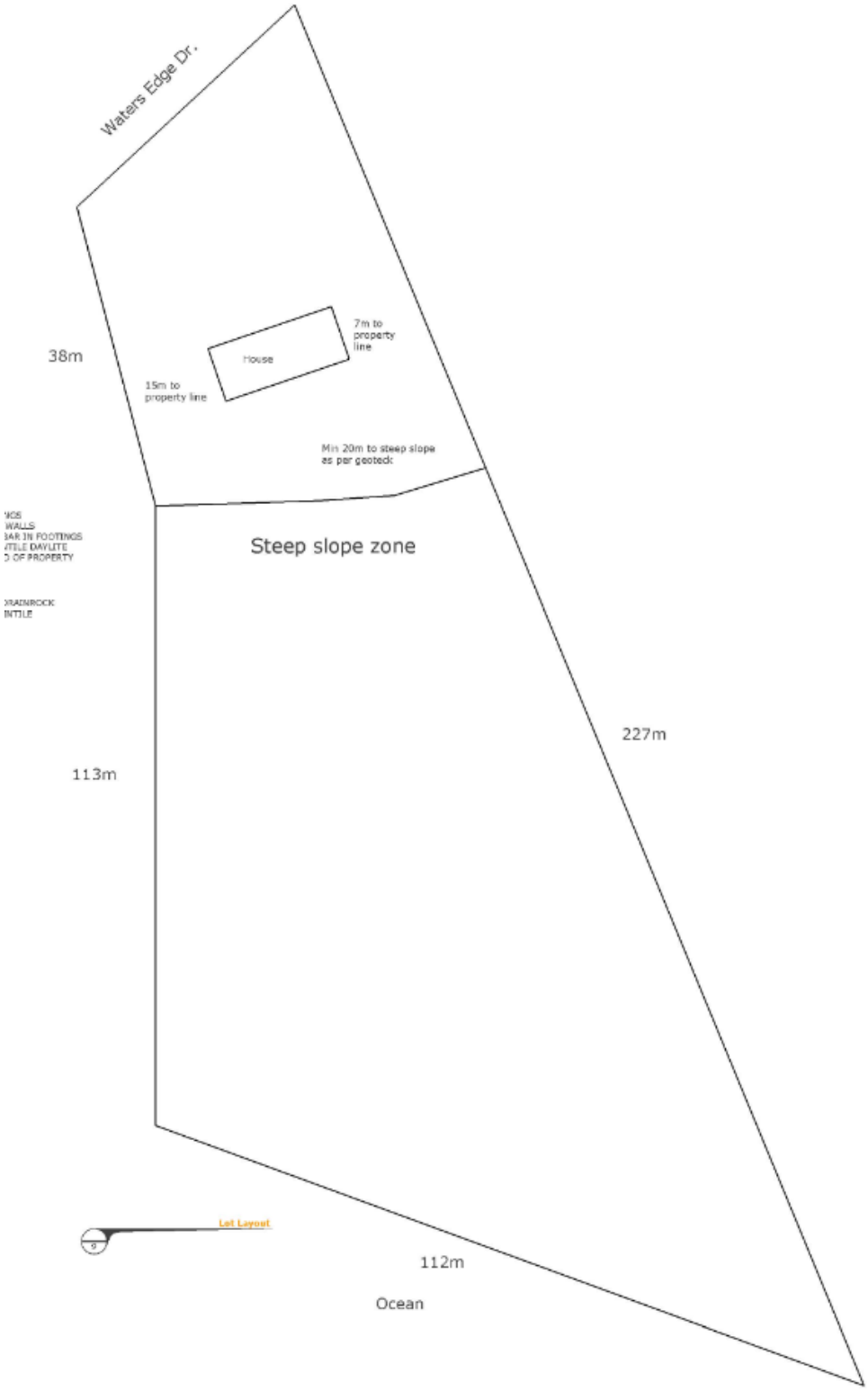
c) That the professional geotechnical engineer's report prepared by WSP Canada Ltd., dated April 13 & 19, 2016, be secured via a restrictive covenant registered on title as part of the Building Permit process.

Submitted by:	Emma Taylor, MCIP, RPP, Planner
Concurrence:	Iain Lawrence, Manager, Local Area Planning
Concurrence:	Kevin Lorette, P.Eng., MBA, General Manager, Planning and Protective Services
Concurrence:	Ted Robbins, B.Sc., C. Tech., Acting Chief Administrative Officer

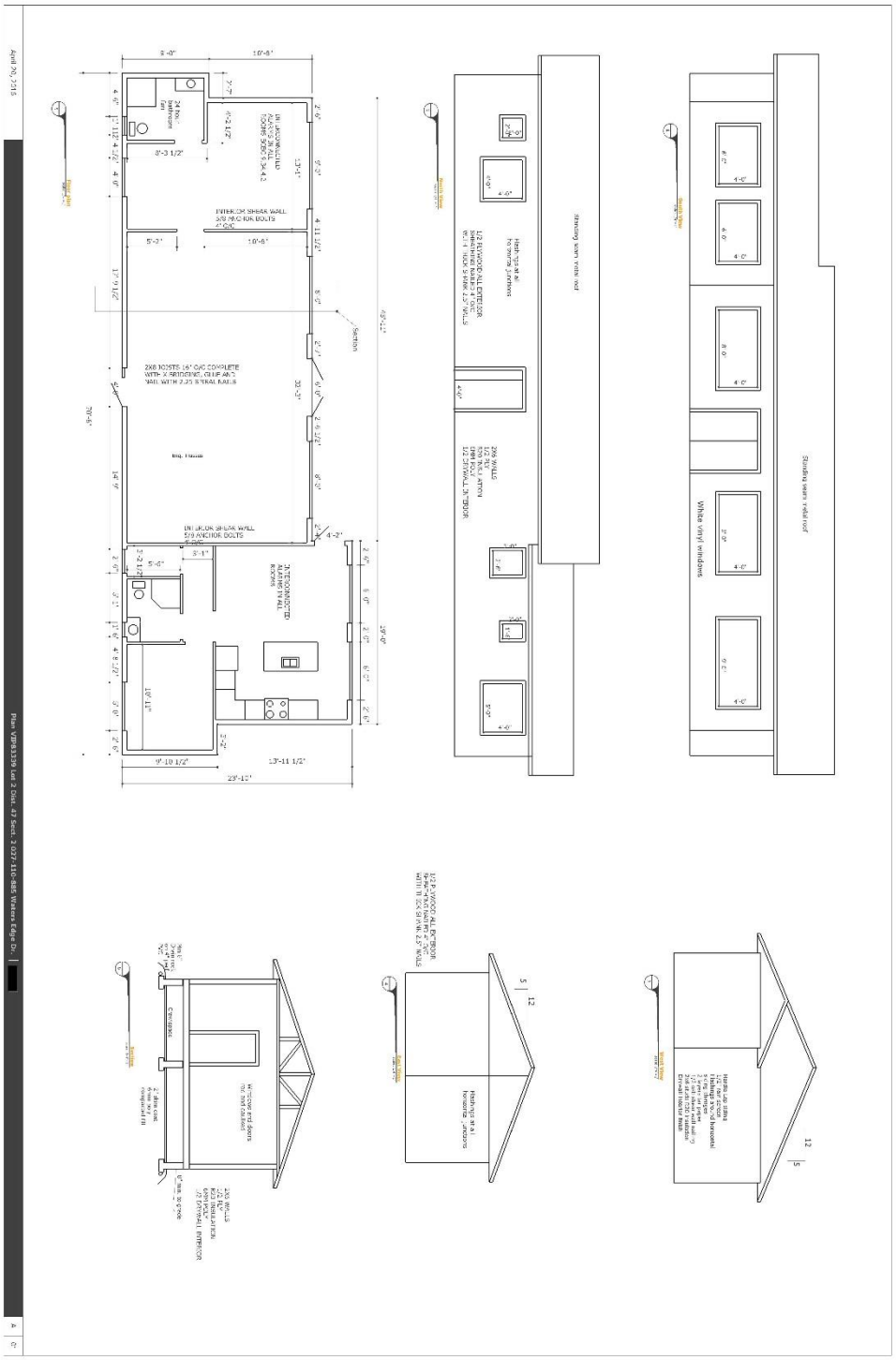
Appendix 1: Subject Property Map
Appendix 2: Site Plan
Appendix 3: Building Plans
Appendix 4: Levelton Engineering Solutions Report, January 8, 2007
Appendix 5: WSP Canada Ltd. Report, April 13 & 19, 2016

Appendix 1: Subject Property Map

Appendix 2: Site Plan



Appendix 3: Building Plans



Appendix 4: Levelton Engineering Solutions Report, January 8, 2007

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SCHEDULE A **PAGE 6**

LEVELTON
Engineering Solutions

January 8, 2007
File: 506-0164

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Construction Materials
Building Science
Geotechnical
Metallurgy and Corrosion
Environmental
Analytical Chemistry
Physical Testing

[redacted]

Attention: [redacted]

Dear Sir:

RE: Geotechnical Summary Report
Proposed 63-Lot Shores at Jordan River Subdivision
Lot 1, Section 2, Jordan River, BC

1. Introduction

Levelton Consultants Ltd (Levelton) was retained by 0745324 BC Ltd. to provide geotechnical review and materials testing services for the proposed two phase sixty three Lot residential subdivision known as the Shores at Jordan River. Our services included a design component that was focussed towards the determination of geotechnical setbacks for habitable structures and a construction support component that was provided in support of the civil design of roadways. At the time of writing, materials testing services were on-going for the majority of the roads.

This report presents the results of our geotechnical assessment for setback requirements for habitable structures from steep slopes. It also provides a summary of the testing results to date in support of a request from 0745324 BC Ltd. to gain authorization from the MOT to pave the roadways in Phase 1 of the subdivision. We anticipate that a supplementary letter report will need to be provided by Levelton once the testing is complete.

The project civil engineer, Focus Corporation, has developed recommendations for stormwater management that are reported under separate cover. Levelton's work was completed in general accordance with our proposal of October 16, 2006.

2. Background Information

The site is located on the south side of West Coast Road, immediately west of the town of Jordan River. The Strait of Juan de Fuca borders the property on the south side and West Coast Road borders the north and east sides of the property. The site occupies an area of approximately seventy eight hectares, as shown in Figures 1 and 2. Once complete, the subdivision will comprise sixty three single family residential lots that will be developed in two phases. The two phases are separated by the First Creek gully, which trends southwest through the site. Phase 1 comprises twenty five Lots and is located on the south side of First Creek. Phase 2 comprises the remaining thirty eight Lots and is located north of First Creek. The subdivision layout is shown in Figure 2.

The BC Ministry of Transportation (MOT) issued a preliminary layout approval (PLA) for the subdivision on June 16, 2006, subject to a series of conditions. One of the conditions identified on the PLA was the need to retain a geotechnical engineer to assess the potential for a natural hazard to exist on the lands. It was identified in the PLA that the geotechnical engineer should consider the frequency of occurrence of a potential hazard in terms of a 10% probability in 50 years. That return period corresponds to the design earthquake as defined in Building Regulation M268 of the recently adopted 2006 BC Building Code.

Mr. Carl Miller P.Eng., and Mr. Alec Morse, P.Eng. of Levelton's engineering staff visited the site at intervals during the course of construction. Based on our review of the site, it is our opinion that the potential natural hazard that is referred to in the MOT PLA pertains solely to the potential for instability in the steep ocean foreshore slope and/or in the First Creek river valley slopes. As such, the potential hazard has influence on the oceanfront Lots 1 through 11, 15, 16 and 26 and creek side Lots 19, 20, 21, 22, 25 and 27 through 32. Based on our reconnaissance of the site, we are not aware of other geotechnical natural hazards that would need to be considered in the design and construction of the subdivision. Accordingly, our design services have focussed towards the assessment of the stability of the steep slopes and the development setback from the crest of the slopes for habitable structures.

We are aware that a large underground metaliferous (copper) mine was worked in the early part of the twentieth century in an area north east of the subject property. Our research indicated that the abandoned workings of the mine were located approximately 1 mile upstream from the mouth of the Jordan River, on the east side of the river. Mining continued at intervals until about 1950 and resumed again in 1960's until a final closure in 1974. We are not aware of any commercial mining activity at that location since then.

Levelton obtained the available maps of the mining operations from the Ministry of Mines to establish that the workings were not of a concern to the subject property. The information indicated that all

activity occurred east of the Jordan River and, therefore, the risk of adverse geotechnical impact on the site was considered to be negligible.

3. Slope Stability Review and Assessment

3.1 Slope Reconnaissance

The site is largely forested with an undulating topography that ranges from sea level up to an elevation of about 75 m with the majority of the land to be developed lying between elevations of 40 to 75 m above sea level. The foreshore slope that bounds the southern edge of the subdivision ranges in height from about 45 to 55 m, the lower approximately 10 m of which typically becomes flatter. The inclination of the upper portion of the slope ranges from 30 to 40 degrees, as determined from survey provided to Levelton by the Focus Corporation. The First Creek valley side slopes increase in height from a minimum of about 8 m at the upper end of the valley to a maximum of close to 35 m at the ocean front. The inclination of the valley slopes range from typically 30 to 38 degrees with locally steeper slopes and areas of benching.

The foreshore slope was well vegetated with a mix of mature evergreen and deciduous trees and a dense understorey that required the use of machete to gain access. No signs of apparent instability or old landslides were observed in the upper and mid sections of the slope. The shape of the tree trunks in these areas was, in general, relatively straight and not deformed through slope creep. A traverse of the toe of the slope indicated that groundwater seepage from the lower portion of the slope was common to Lots 1 to 11 and 26. A number of large diameter spruce (1.5 m dia.) were observed in the toe area below Lots 4, 5, 6, 10 and in the First Creek mouth between Lots 11 and 26. The trees were estimated to be several hundred's of years in age.

Marine toe erosion appeared to be quite limited, likely due to the heavy armouring of cobbles, boulders and large woody debris on the foreshore. An estimated 0.5 to 0.8 m of toe erosion was noted at Lot 2, in the small bay area at Lot 5 and again at Lot 10. Indications of local sloughing and slope creep in the lower portion of the slope was evident from leaning trees and from local areas of slope material piled against tree trunks/stumps at Lots 7, 8 and 10. The vegetation in the lower area was very dense and difficult to access.

First Creek was accessed at the mouth and traversed into the site. It was noted that the vegetation of the valley slopes was quite dense and that several large diameter spruce were present in the flatter mouth area. The creek was present in the lower portion of the valley but disappeared to ground at an estimated elevation of 15m above high tide. Local sloughing and some distortion (pistol-butting) in tree stem growth was observed although no large scale or deep seated type movements were noted.

3.2 Subsurface Conditions

Soil exposures on both the oceanfront and creek side slopes were limited. An outcropping of heavily over-consolidated, hard, grey, clayey silt with a blocky texture was observed at sea level at the toe of Lot 1. A small exposure of very dense fine grained sand was observed at an estimated elevation of 15 m above high tide on the north side of First Creek. Soil exposures in the upper plateau level of the site were abundant and include compact to dense well graded sand and gravel with cobbles. The thickness of the sand and gravel in road cut exposures ranged up to approximately 6 m.

A number of water wells were being advanced at the time of our assessment. Levelton periodically reviewed the soil cuttings from several holes and corresponded with the waterwell contractor, Drillwell Enterprises Ltd., with respect to changes in lithology and depth to groundwater. The notes taken by Drillwell Enterprises Ltd, indicated that the surficial sand and gravel extended to depths of typically 20 to 25 m and was underlain by very dense, till-like clayey sand. Groundwater was encountered towards the interface of the sand and gravel with the till-like soils, which is supportive of the observations in First Creek.

A limited subsurface exploration program was undertaken by Levelton Engineering Ltd. in the 1990's. The investigation at that time was focussed towards the use of the site as a possible sand and gravel pit. All test holes were terminated in dense, clean, sand and gravel. No seepage was encountered in those test pits.

3.3 Discussion on Slope Stability

In order to assist in our assessment of the stability of the ocean foreshore and creek slopes, and to determine appropriate setback distances from the crest for the siting of habitable structures, Levelton has undertaken an assessment of the stability of the natural slopes. We note that the determination of a geotechnical building setback distance from the crest of a slope includes a review of the slope geometry, slope materials, vegetation, external loads, erosion, ground and surface water. The following sub-section briefly identifies the slope instability mechanisms and includes a brief explanation of the slope stability model used for static and dynamic (earthquake) conditions.

Based on the geometry, slope materials, and features at this site, Levelton anticipates two types of landslides that may affect the lots and they are described as:

- Shallow translational slides: which may occur at any point along the steep slopes but will likely be limited to approximately a 2m depth; and

- Deep-seated slides: which may occur under static or dynamic conditions where a steep back scarp leads down to a compound failure surface where the majority of lateral movement takes place close to the interface of the sand and gravel with the dense till.

The triggering event that causes slope instability may be from natural means, man-made causes or a combination of both. The two lists below highlight frequent causes of slope instability that potentially can affect this site.

Natural events which can cause slope instability at this site include:

- Excessive rainfall creating high groundwater tables;
- Loss of vegetation by strong wind events or fire;
- Toe erosion from the ocean or from the creek; and
- Earthquakes.

Man-made events which can cause slope instability at this site include:

- Redirected surface and ground water to the slope;
- Placement of fill materials at the crest and over the slope;
- Loss of vegetation through logging activities; and
- Change in slope geometry from construction of access trails to the toe of the slope (cut and fill).

The majority of these landslide initiation mechanisms would result in a shallow translational slide. However, it is the potential for a deep-seated compound failure that governs our recommended geotechnical setback distance. In particular, the dynamic or earthquake scenario has the potential for reaching the farthest from the crest of the slope. A brief discussion of the static and dynamic slope stability analysis for the deep-seated landslide is provided in the following section.

3.4 Slope Stability Analysis

Levelton completed slope stability analyses for a number of surveyed sections down the slope using the subsurface information described above. The computer model SlopeW Limit Equilibrium Slope Stability Software was used to model the deep seated stability of the slope. Table 1 summarizes the values used in the stability analysis.

Table 1: Slope Stability Model Parameters – Long term drained case

Material	Soil Unit Weight (kN/m³)	Cohesion (kPa)	Phi angle (degrees)
Dense Sand and Gravel	22	0	38
Dense Sand and Silt	22	0	40
Hard Till	22	0	42

An effective stress analysis was carried out on select lots using site specific survey data as provided through Focus to assess the long term stability of the slope. Two separate slope stability analysis were completed: static and dynamic. The static analysis represents the most common loading and water table conditions. The dynamic analysis includes the external earthquake acceleration to the ground. The design earthquake used for the dynamic case was the 1 in 475 year event for which both the MOT PLA permit and the December 14, 2006 Building Regulation M268 pertain. The Pacific Geoscience Centre was contacted and provided the seismic design information that is attached to this report. The peak ground acceleration values used in the analysis were reduced in accordance with the procedures described by Marcuson et al (1990).

The development setback was considered in terms of a theoretical factor of safety against deep seated sliding of 1.5 in the static analysis and above 1.0 for the 1 in 475 year dynamic analysis. As noted, the calculated setback results from the two cases were similar, as summarized in Table 2.

Table 2. Summary of Preliminary Geotechnical Setback for Habitable Structures

Lot No.	Setback under Static Conditions (m)	Setback under Dynamic (1 in 475 yr)	Recommended Minimum Geotechnical Setback (m)
1	19	19	19
3	17.5	17.5	17.5
4	14	13	14
7	25	25	25
11	21	21	21[1]
15	14	14.5	14.5
16	24	24.5	24.5
19	22	22	22
20	2	2	6[2]
21	3	3	6[2]
26	0	0	6[2]
28	0	0	6[2]
31	18	19	19

Note: [1] Lot 11 has creek and foreshore setbacks along with a crest ridge that we anticipate will be removed during site preparation. The tabled value reflects our anticipated final configuration and needs to be reviewed during design.
[2] The minimum recommended preliminary geotechnical setback is 6 m regardless of assessment due the potential requirements for access and uncertainty of conditions near the slope crest.

For the purpose of the MOT PLA, Levelton has developed a preliminary development setback line from an interpolation of the site specific slope stability analysis provided in Table 2. The interpolated preliminary setback line is shown on Figure 3 and its application discussed below.

4. Discussion and Recommendations

4.1 General

In general, the site is considered to be geotechnically suitable for the intended use of a single family home residential subdivision. Away from the steep slopes, the ground conditions are dominated by a thick deposit of compact to dense, relatively free draining sand and gravel. This natural deposit provides opportunity for favourable road subgrade and foundation support for proposed single family dwellings.

Our site assessment indicates that the potential natural hazard referred to in the MOT PLA relates to the steep slopes along the ocean foreshore and along First Creek. It is proposed that the potential hazard to habitable structures be mitigated through a development setback, as described in Section 4.2.

Road construction for the subdivision is nearing completion. Periodic field reviews have been made during the course of construction and it is our opinion that the construction meets with the intent and requirements of the MOT PLA as described in Section 4.3.

Stormwater management is discussed in two separate documents (Phase 1 and 2) prepared by Focus Corporation. Drainage considerations are outlined in Section 4.4, below.

4.2 Potential Geotechnical Hazards and Siting of Habitable Buildings

As described in Section 3, it will be necessary for habitable structures to be setback from the crest of the ocean foreshore slope and from the crest of First Creek. We note that riparian and municipal setbacks may also apply to the lots and that the minimum preliminary geotechnical setback given in Table 2 may not be the governing setback.

The geotechnical development setback is intended to site the habitable structures sufficiently far back from the crest of a slope that the potential for slope instability to impact the buildings over the normal design lifetime of the structures is acceptably low. For this project, the MOT has defined that criterion as being an approximately 10% chance of exceedance in 50 years. It is important to note that the use of a development setback does not preclude the potential of future instability in the area between the slope crest and the setback. There are active processes on and adjacent to a number of the lots which can influence stability. Notable processes include the potential for toe erosion and

earthquake shaking along with the man-made influences described in Section 3. It is possible that a loss of land, property value and enjoyment could result from future instability.

The interpolated preliminary setback line that is shown on Figure 3 is intended to provide the information necessary to meet the requirements of the MOT's PLA. This line should be considered preliminary in nature and we note that site specific geotechnical investigations may be undertaken to refine and/or determine an actual setback for a given property. In particular, site specific assessments should be undertaken if the proposed development of a property anticipates significant grade changes.

The definition of the slope crest is subject to interpretation and it is recommended that the Geotechnical Engineer visit each lot prior to house construction to define the crest and necessary setback distances for the building envelope.

As noted in Section 3.3, there are active natural processes along with the potential for man-made changes that can negatively impact the stability of a slope. We would advise that owner's make themselves aware of the processes discussed herein and that, in particular, an annual review of the slope toe area be conducted to review possible wave erosion and implement action, if needed.

In terms of foundation bearing for the proposed structures, we anticipate that a shallow foundation system supported on an approved surface of the native compact to dense sand and gravel will be suitable for foundation support. The excavated materials will be loosened by the excavation process and it will be necessary to recompact loosened material prior to the placement of foundation concrete. We recommend that an allowable bearing capacity of 150 kPa be utilized for foundation design subject to field review and conformation of bearing soils.

4.3 Roadways

The road system is shown on Figures 2 and 3. Phase 1 of the subdivision includes Road E and F. We understand that the originally planned Road G has been deleted. Phase 2 includes Roads A through D. A typical cross section provided by the MOT indicated that the road structure should consist of:

Material	Thickness (mm)
Class 1 medium mix hot asphalt	55
25 mm well graded base course	150
75 mm pit-run - SGSB	150
	Approved subgrade

Subsequently, it was identified by the MOT that the 75 mm material should be a crushed base course as opposed to pit run SGSB.

The subgrade throughout the site comprises sand and gravel. MOT and Focus have undertaken field reviews and proof rolling of the subgrade. Levelton has attended site periodically to undertake compaction test results. Final compaction tests taken to date for Roads E and F in Phase 1 of the subdivision, and for a portion of Road A in Phase 2, have met or exceeded the MOT requirements for roads E and F, as indicated in Appendix 1.

Our site observations indicate that road construction carried out to date has mainly consisted of excavation into the native sand and gravel and thorough compaction of the road subgrade with a heavy steel drum, vibratory roller. Some areas of structural filling were required to provide the design elevations of the roads. Filling was carried out in approximate 300mm thickness lifts, also compacted with the vibratory roller.

Gradation compliance testing to date has been undertaken for the following materials. Test results are included in Appendix 1.

Material	Testing and Comments
Natural Subgrade	
Road A	Gradation – 6.7% fines
Road B	Gradation – 3.0% fines
Road C	Gradation – 9.7% fines
Road D	No testing
Road E	Gradation – 6.3 and 4.2% fines
Road F	Gradation – 9 and 11% fines
25 mm well graded base course	Gradation – 4.5 % fines met MOT
75 mm crush gravel	Gradation – 4.3 % fines met MOT

* fines indicates material passing the 0.075 mm sieve size.

Further compaction testing and asphalt testing is to be undertaken to verify conformance with MOT specification requirements. Test results will be provided under separate cover once complete.

4.4 Drainage Considerations

The presence of a permeable native sand and gravel deposit and a relatively deep watertable affords opportunity for in-ground disposal of stormwater from roofs and from perimeter foundation drains. If in-ground disposal is to be considered, we recommend that a specific lot review be

completed by the Geotechnical Engineer once the lot development and roof area are known. We note that any private in-ground disposal system requires maintenance to remain effective.

Stormwater management for roadways is presented in two separate documents (Phase 1 and 2) prepared by Focus Corporation.

4.5 Further Geotechnical Input

This preliminary report has been prepared to address the MOT's PLA requirements with respect to the potential for a natural hazard and options that might be available to mitigate the hazard to level considered to be acceptable under their criteria of a 10 percent chance of exceedance in 50 years. In terms of quality assurance testing for the construction of roads and underground infrastructure for the subdivision, there have been periodic reviews throughout that process and further work is expected, the results of which would be presented under separate letter.

With respect to the proposed individual residential structures that are to be developed on the private Lots at some time in the future, there will need to be specific geotechnical review completed on a Lot by Lot basis for the steep slope properties to address the geotechnical items presented herein. We anticipate that such studies could lead to a refinement of the preliminary interpolated setback line that is present herein.

5. Limitation and Closure

This report has been prepared for the exclusive use of 0745324 BC Ltd. for application to the proposed development at the captioned site. The report has been prepared in accordance with standard geotechnical engineering practice. No other warrantee, expressed or implied, is made.

Any use of this report by an unauthorized third party, or any reliance on, decisions made, or actions taken based on it by such third parties, are their responsibility. Levelton does not accept responsibility for damages suffered, if any, by an unauthorized third party as a result of their use of this report. The BC Ministry of Transportation is considered to be an authorized third party and may rely on the report subject to the terms of engagement under which it was prepared. Contractors should make their own interpretation of the soil logs and the site conditions for the purposes of bidding and performing work on the site.

The discussion and recommendations contained in this report are based on information obtained from discrete locations. Subsurface conditions are based on well records and exposures and actual soil and groundwater conditions may vary. It is recommended that confirmatory reviews be completed to verify the preliminary setbacks presented herein.

We trust that this report is satisfactory for your current requirements. If any questions should arise or further information be required, please contact the writer at your convenience.

Yours truly,
LEVELTON CONSULTANTS LTD.

Reviewed by:

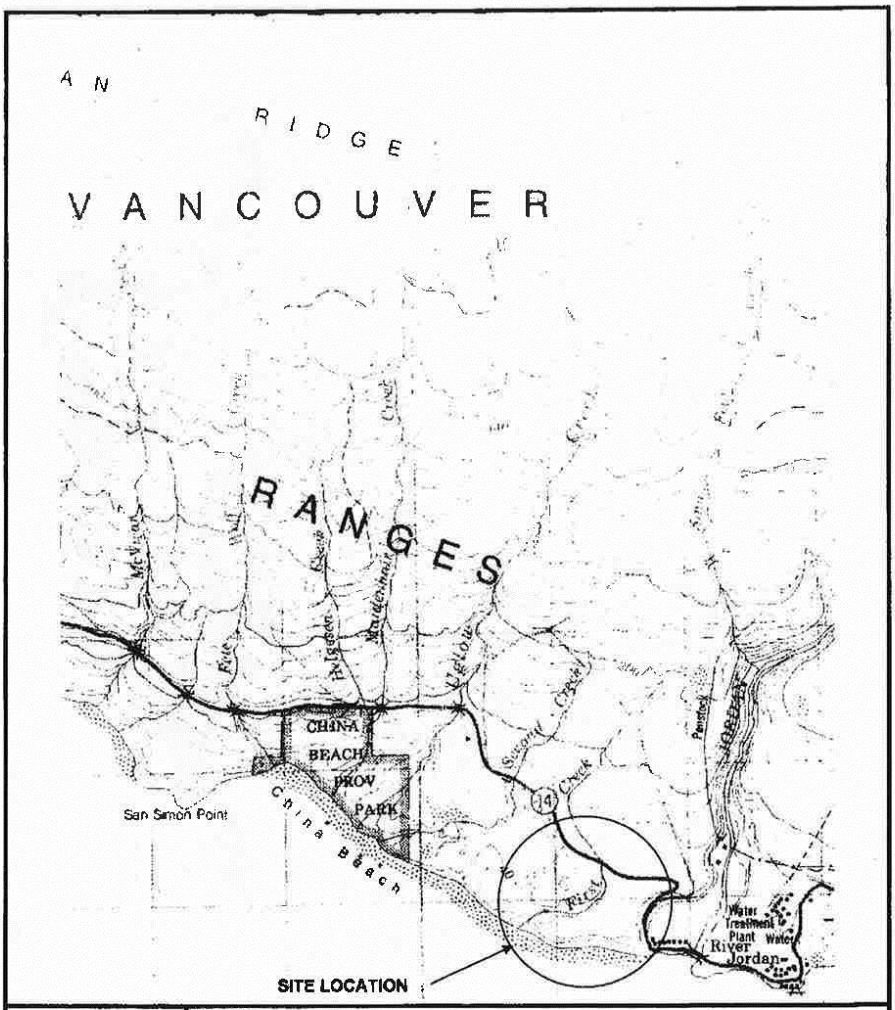
Per:
Carl Miller, M.Sc., P.Eng.
Senior Geotechnical Engineer

Don Kaluza P.Eng.
Senior Geotechnical Engineer

Attachments: Figures 1 to 3
Pacific Geoscience Seismic Design Calculations
Appendix 1. Construction Test Reports

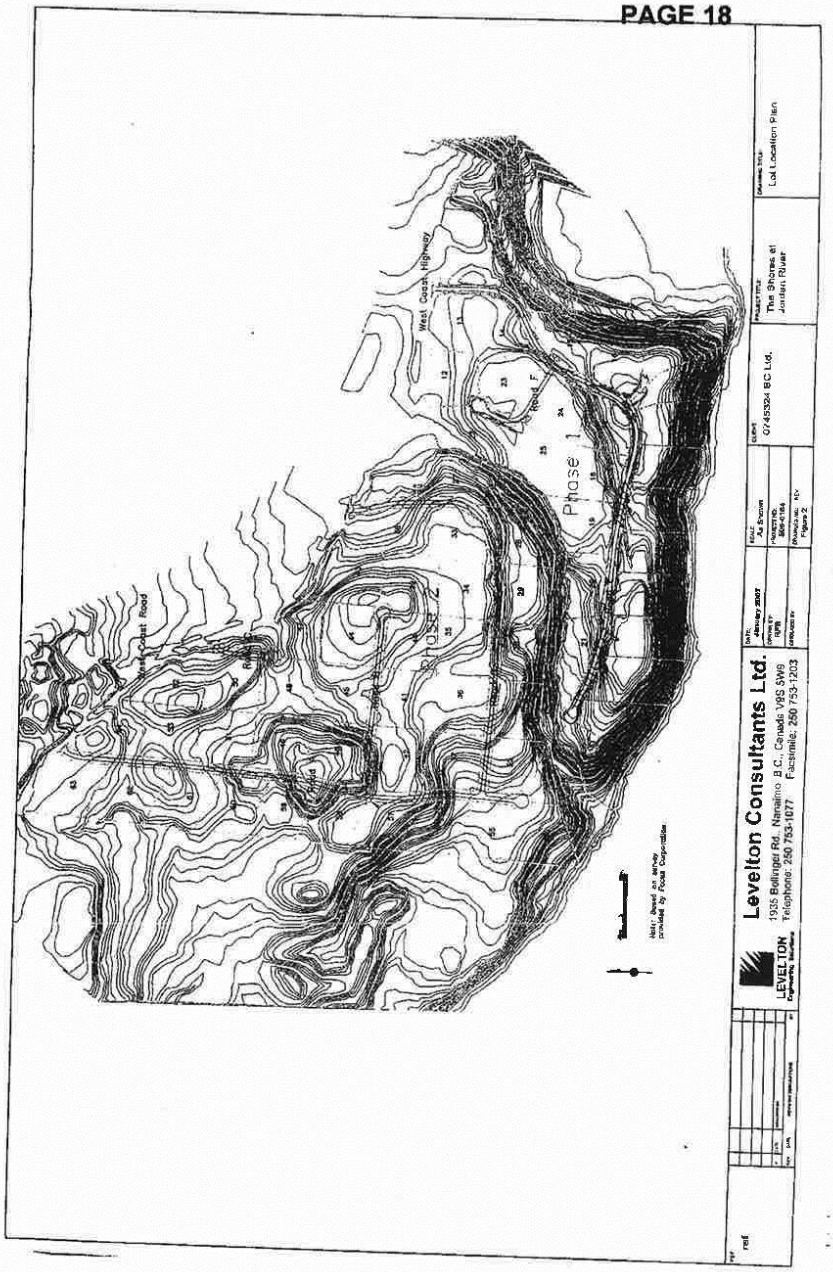
Status: Registered Doc #: FB67168 RCVD: 2007-06-29 RQST: 2014-12-04 16.14.00

PAGE 17



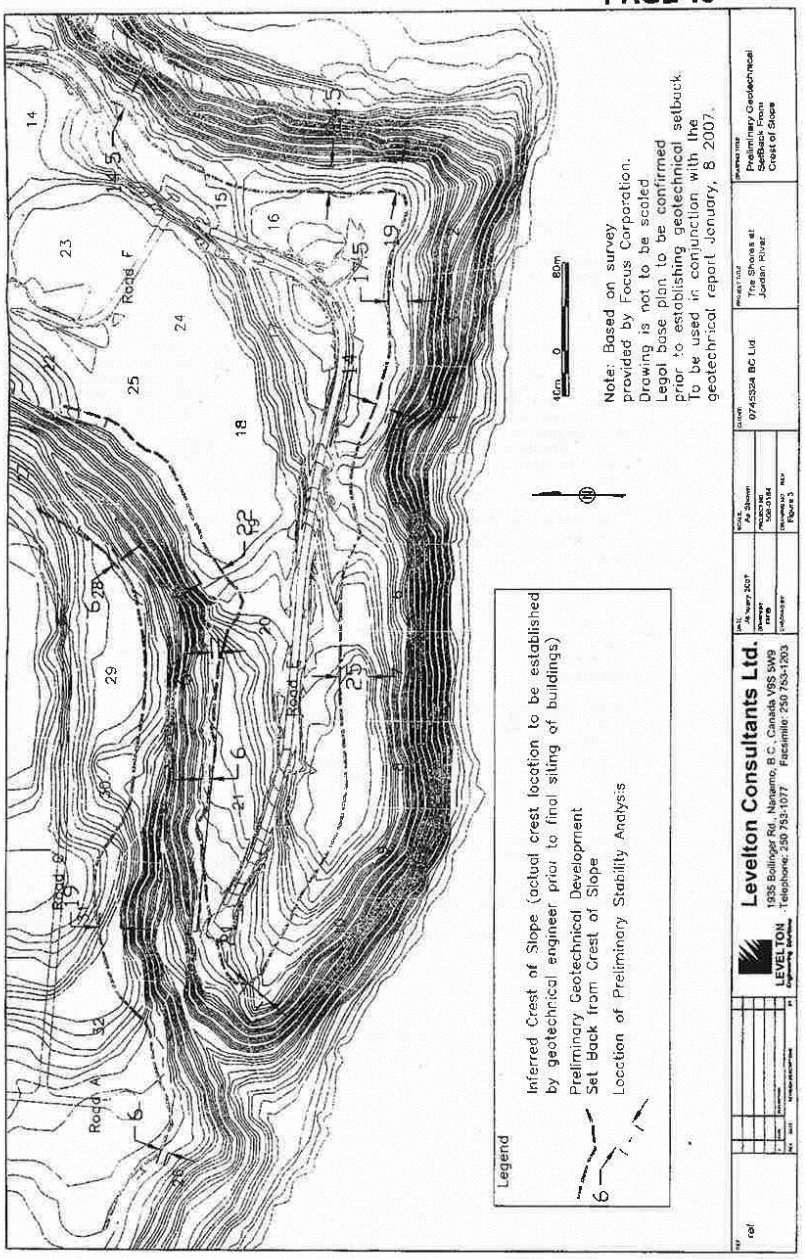
LEVELTON Engineering Solutions	PROJECT: THE SHORES OF JORDAN RIVER				
	TITLE: SITE LOCATION PLAN				
	CLIENT: [redacted]				
FIGURE NO.: 1	DATE: NOVEMBER 2006	FILE NO.: 506-0164	SCALE: NTS	DRAWN BY: KS	REV NO.:

Levelton Consultants Ltd., 1935 Bollinger Road, Nanaimo, B.C., V9S 5W9 Phone: 250/753-1077 Fax: 250/753-1203 Email: nanaimo@levelton.com


West Coast Road
West Coast Highway
Road F
Phase 1
Phase 2
Note: Based on survey provided by Focus Corporation.
Levelton Consultants Ltd.
1935 Bellinger Rd., Nanaimo B.C., Canada V9S 5W9
Telephone: 250 753-1077 Facsimile: 250 753-1203
LEVELTON
Engineering Partners
Date: January 2007
Drawn by: MB
Checked by: MB
Issue: As Shown
Project No: 0849-0184
Drawing No: Figure 2
Client: 0745304 BC Ltd.
Project Title: The Shores at Jordan River
Drawing Title: Lot Location Plan

Status: Registered Doc #: FB67168 RCVD: 2007-06-29 RQST: 2014-12-04 16.14.00

PAGE 19



2005 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Requested by: Carl Miller, Levelton

October 04, 2006

Site Coordinates: 48.4194 North 124.0666 West

User File Reference: Jordan River

National Building Code ground motions:
2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA (g)
1.020	0.793	0.404	0.179	0.470

Notes. Spectral and peak hazard values are determined for firm ground (NBCC 2005 soil class C - average shear wave velocity 360-750 m/s). Median (50th percentile) values are given in units of g. 5% damped spectral acceleration (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are tabulated. Only 2 significant figures are to be used. *These values have been interpolated from a 10 km spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the calculated values.* Warning: You are in a region which would be affected by the ground motion from a Cascadia subduction event. The interpolator includes consideration of the deterministic ground motions from Cascadia for 0.0021, 0.001 and 0.000404 per annum probabilities, but not for 0.01 per annum.

Ground motions for other probabilities:

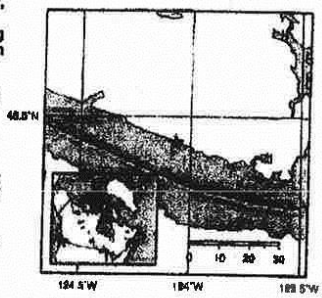
Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.2)	0.242	0.538	0.698
Sa(0.5)	0.163	0.414	0.508
Sa(1.0)	0.081	0.211	0.258
Sa(2.0)	0.039	0.087	0.120
PGA	0.121	0.254	0.337

References

National Building Code of Canada 2005 NRCC no. 47666; sections 4.1.8, 9.20.1.2, 9.23.10.2, 9.31.6.2, and 6.2.1.3
Appendix C: Climatic Information for Building Design in Canada - table in Appendix C starting on page C-11 of Division B, volume 2

User's Guide - NBC 2005, Structural Commentaries NRCC no. 46192
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File xxxx
Fourth generation seismic hazard maps of Canada: Grid values to be used with the 2005 National Building Code of Canada (in preparation)



See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français

Natural Resources Canada Ressources naturelles Canada

Canada

END OF DOCUMENT

Appendix 5: WSP Canada Ltd. Report, April 13 & 19, 2016

WSP CANADA INC.
Victoria Office
760 Enterprise Crescent
Victoria, BC V8Z 6R4
T: 250.475.1000 F: 250.475.2211
victoria@levelton.com
www.wspgroup.com

Field Review Report

Project:	Proposed House	**Project Number:**	161-05700-00
Location:	Lot 2, Waters Edge Drive, Jordan River	**Report Number:**	1
Contractor:	345 Builders Ltd.	**Date:**	April 13,19, 2016
Owner:		**Time:**	8:00 am
In Attendance:	Tim Nicholson, Alec Morse	**Weather:**	Sunny, mild

OBSERVATIONS/REMARKS/ACTIONS BY: **Alec Morse, P.Eng.**

Subgrade Review

1. WSP was called to the site by the Contractor to review geotechnical setback requirements and subgrade excavation for the proposed single family house to be constructed at Lot 2 within the Shores at Jordan River subdivision.
2. WSP, while operating as Levelton Consultants Ltd., provided geotechnical engineering services during subdivision construction, as summarized in the Geotechnical Summary Report dated January 8, 2007.
3. Slope stability review was carried out specific to Lot 2, using the current stability guidelines within the 2012 BC Building Code (2% in 50 year probability of seismic event), which determined that the house foundations should be a minimum of 20m, laterally, from the crest of the foreshore slope.
4. It should be noted that the geotechnical setback is established to allow for potential loss of land within the setback area, which has been identified on the foreshore slope. The mature trees that exist within the geotechnical setback area are providing surficial stability to the slope and should not be removed as part of the development.
5. Subgrade excavation had been carried out to expose native sand and gravel, which was classified as compact to dense in our site characterization.
6. The exposed subgrade is considered suitable for support of a wood-framed, single family house on conventional, reinforced concrete foundations.
7. Based on the observed subgrade conditions and the proposed 20m setback for the house foundations, the house site is considered safe and suitable for the use intended.

Attachment: Photo Table

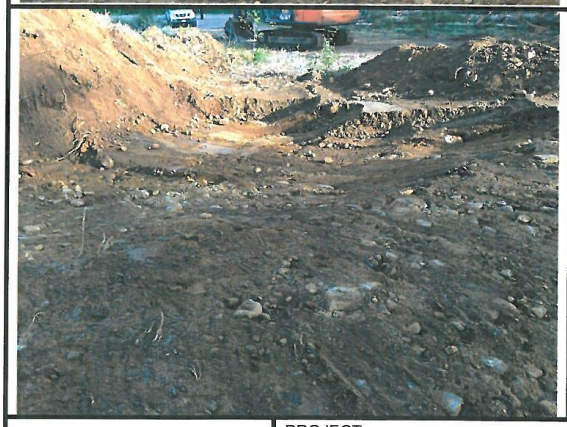
PROFESSIONAL PROVINCE OF A. A. MORSE June 10/16 BRITISH COLUMBIA ENGINEER

Distribution:
345 Builders: Tim Nicholson – td_nicholson@hotmail.com

WSP CANADA INC.
Per:
Reviewed by:

Subgrade excavation to natural sand and gravel within the house footprint for Lot 2.

A view along the rear edge of the Lot 2 excavation.



The western portion of the house footprint excavation.

WSP	PROJECT: Proposed House – Lot 2, Waters Edge Drive, Jordan River				
	TITLE: Photo Table				
	CLIENT: 345 Builders Ltd.				
DRAWING NO.: 1	DATE: April 13,19, 2016	FILE NO.: 161-05700-00	SCALE: NTS	DRAWN BY: TAM	REV NO.: