



**REPORT TO THE JUAN DE FUCA LAND USE COMMITTEE
MEETING OF TUESDAY, JULY 19, 2016**

SUBJECT **Floodplain Exemption for Lot 5, 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 0.935 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 (Appendix 2).

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 3) 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.

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.

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)*. In support of the exemption, a geotechnical engineer's report has been submitted, which specifies that a 17 m setback from the crest of the slope is safe for Lot 5 provided that the Engineer's recommendations are followed (Appendix 4).

ALTERNATIVES

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

1. That floodplain exemption DV000049 for Lot 5, 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 7, 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 7, 2016, be secured via a restrictive covenant registered on title as part of the Building Permit process.

2. That floodplain exemption DV000049 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 July 19, 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, since the proposed building site is outside of the foreshore and steep slope development permit areas, a development permit is not required. Staff also 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 previous erosion of the foreshore slope and the potential for ongoing 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 floodplain regulations, as outlined in Part 5, Section 2.0 (2)(e) of Bylaw No. 2040, specify that the flood plain setback for a slope that is subject to erosion by the sea 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 slope stability review by WSP Canada Ltd, dated April 7, 2016, is specific to Lot 5, 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 to allow for potential loss of land on the foreshore slope, the house foundations should be a minimum of 17 m, laterally, from the crest of the foreshore slope. The proposed house siting is considered safe and suitable for the use intended provided that the footings are constructed directly atop compact to dense, native sand and gravel. 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 4), 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 5, 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 17 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 DV000049 for Lot 5, 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 7, 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 7, 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, Acting Chief Administrative Officer

ET:wm

Appendix 1: Subject Property Map

Appendix 2: Site Plan

Appendix 3: Levelton Engineering Solutions Report, January 8, 2007

Appendix 4: WSP Canada Ltd. Report, April 7, 2016

Appendix 1: Subject Property Map



Appendix 2: Site Plan



Appendix 3: Levelton Engineering Solutions Report, January 8, 2007

Status: Registered

Doc #: FB67168

RCVD: 2007-06-29 RQST: 2014-12-04 16.14.00

SCHEDULE A

PAGE 6



January 8, 2007
File: 506-0164

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

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.

Richmond Victoria Nanaimo Courtenay Surrey Abbotsford Prince Rupert Calgary

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Doc #: FB67168

RCVD: 2007-06-29 RQST: 2014-12-04 16:14:00

PAGE 7



0745324 BC Ltd.
Geotechnical Assessment for Shores at Jordan River

File ref: 508-0164
Page 2

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

PAGE 8

0745324 BC Ltd.
Geotechnical Assessment for Shores at Jordan River

File ref: 508-0184
Page 3



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 36 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, 8, 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.

PAGE 9

0745324 BC Ltd.
Geotechnical Assessment for Shores at Jordan River

File ref: 506-0164
Page 4



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

PAGE 10

0745324 BC Ltd.
Geotechnical Assessment for Shores at Jordan River

File ref: 506-0164
Page 5



- 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.

PAGE 11



0745324 BC Ltd.
Geotechnical Assessment for Shores at Jordan River

File ref: 508-0164
Page 6

LEVELTON
Engineering Solutions

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

Material	Soil Unit Weight (kN/m ³)	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.

PAGE 12

0745324 BC Ltd.
Geotechnical Assessment for Shores at Jordan River

File ref: 508-0164
Page 7



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

Status: Registered

Doc #: FB67168

RCVD: 2007-06-29 RQST: 2014-12-04 16:14:00

PAGE 13

0745324 BC Ltd.
Geotechnical Assessment for Shores at Jordan River

File ref: 506-0164
Page 8



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

PAGE 14

0745324 BC Ltd.
Geotechnical Assessment for Shores at Jordan River

File ref: 506-0164
Page 9



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
<u>Natural Subgrade</u>	
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
<u>25 mm well graded base course</u>	Gradation – 4.5 % fines met MOT
<u>75 mm crush gravel</u>	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

PAGE 15

0745324 BC Ltd.
Geotechnical Assessment for Shores at Jordan River

File ref: 506-0164
Page 10



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 warranty, 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.

Status: Registered

Doc #: FB67168

RCVD: 2007-06-29 RQST: 2014-12-04 16.14.00

PAGE 16

0745324 BC Ltd.
Geotechnical Assessment for Shores at Jordan River

File ref: 506-0164
Page 11



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:

Carl Miller
A circular professional engineer seal for Carl Miller, P.Eng., with the number 907. The seal includes the text "PROFESSIONAL ENGINEER" and "C. MILLER".

Don Kaluza

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

Don Kaluza P.Eng.
Senior Geotechnical Engineer

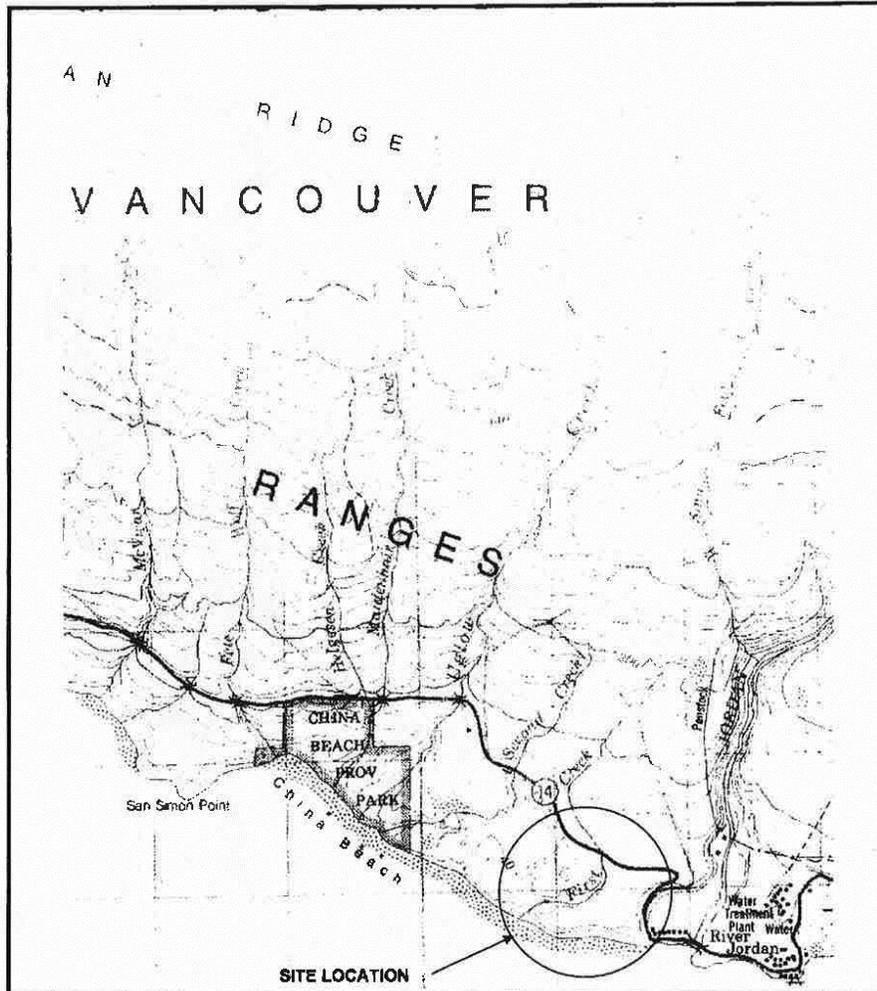
Attachments: Figures 1 to 3
Pacific Geoscience Seismic Design Calculations
Appendix 1. Construction Test Reports

Status: Registered

Doc #: FB67168

RCVD: 2007-06-29 RQST: 2014-12-04 16.14.00

PAGE 17



	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.:

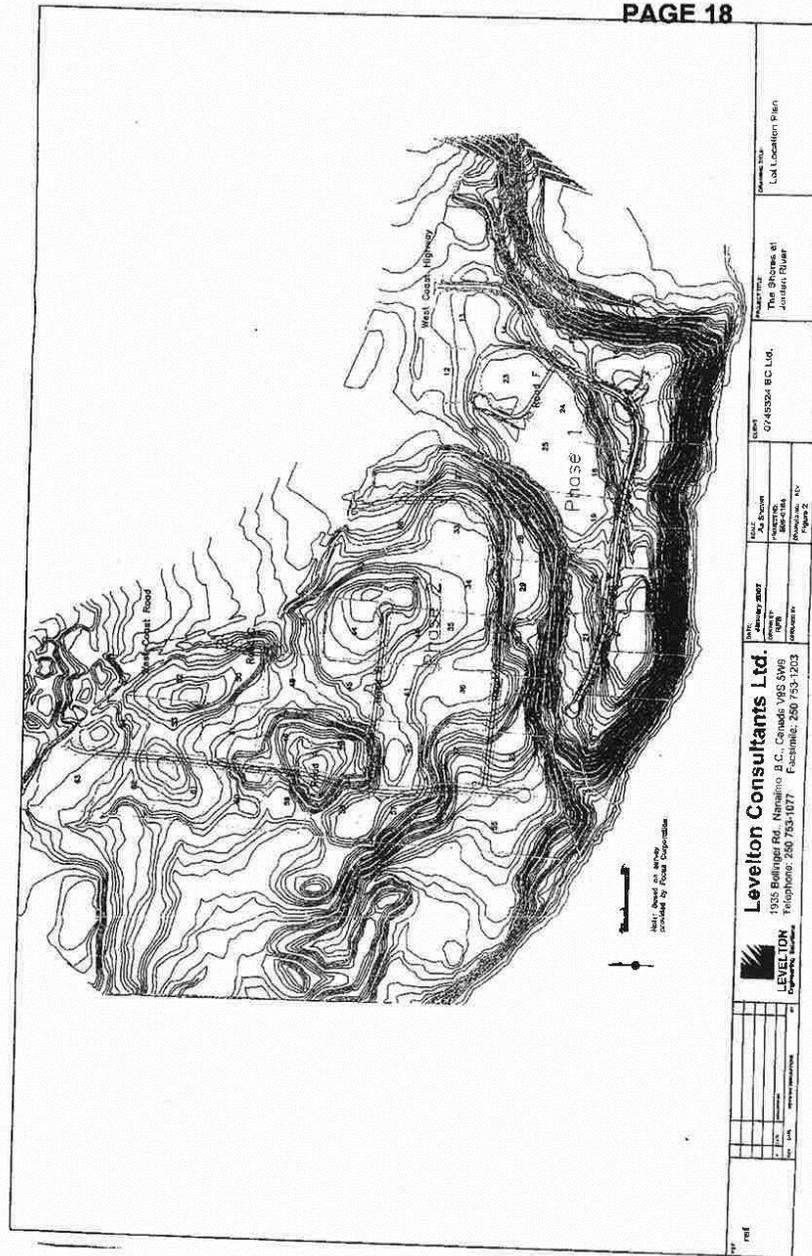
Levelton Consultants Ltd., 1935 Bollinger Road, Nanaimo, B.C. V9S 5W5 Phone: 250/753-1077 Fax: 250/753-1203 Email: nana.mo@levelton.com

Status: Registered

Doc #: FB67168

RCVD: 2007-06-29 RQST: 2014-12-04 16:14:00

PAGE 18



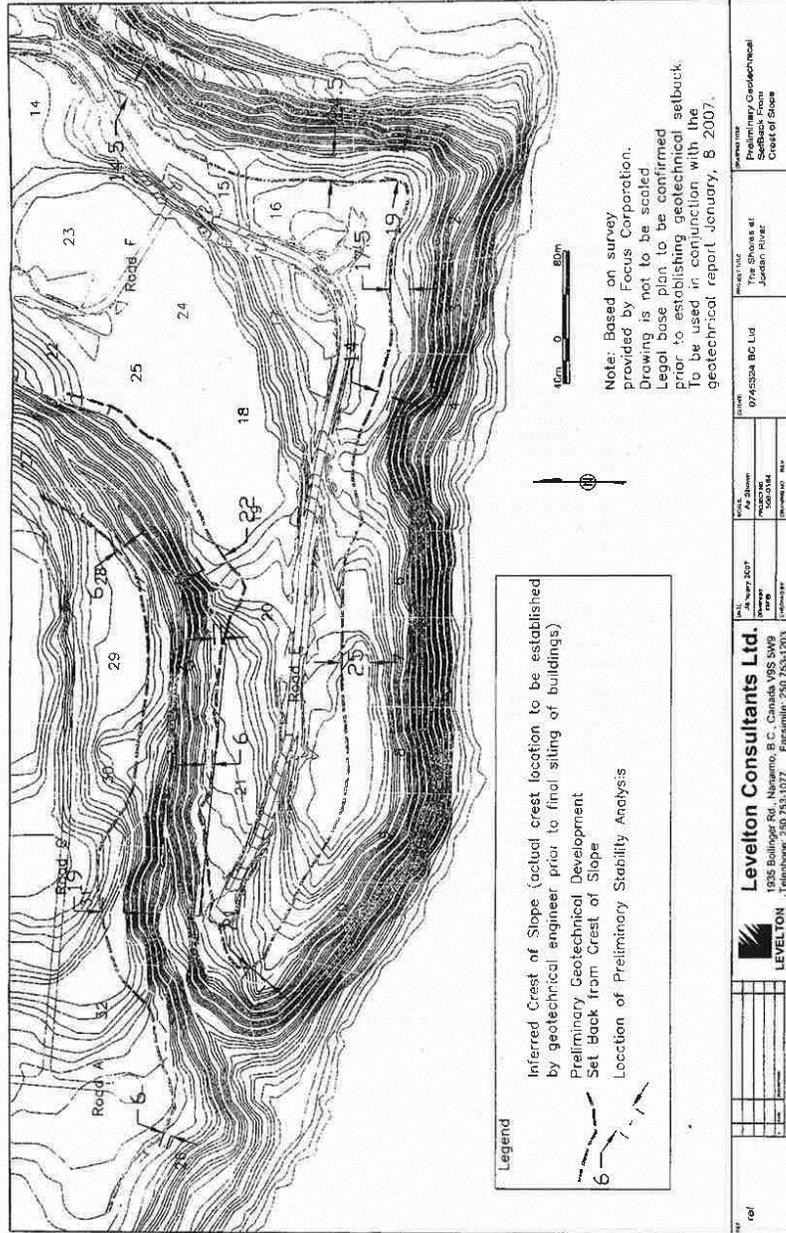
<p>DATE: 07/19/2016 PROJECT: Phase 1 DRAWING: LUC Location Plan</p>	<p>DATE: 07/19/2016 PROJECT: Phase 1 DRAWING: LUC Location Plan</p>	<p>DATE: 07/19/2016 PROJECT: Phase 1 DRAWING: LUC Location Plan</p>	<p>DATE: 07/19/2016 PROJECT: Phase 1 DRAWING: LUC Location Plan</p>
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Status: Registered

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PAGE 19



Status: Registered

Doc #: FB67168

RCVD: 2007-06-29 RQST: 2014-12-04 16:14.00

PAGE 20

2005 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8896
 Western Canada English (200) 363-6900 Facsimile (200) 363-6688

Requested by: Carl Miller, Levelton

October 04, 2006

Site Coordinates: 48.4194 North 124.0688 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 580-750 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 are within 2 percent of the associated 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)	0.183	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. 47689; sections 4.1.8, 8.20.1.2, 9.23.10.2, 9.31.8.2, and 8.2.1.3

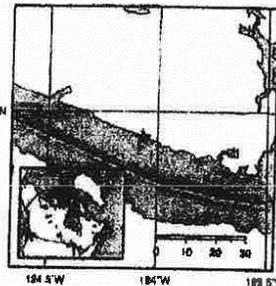
Appendix C: Climatic Information for Building Design in Canada - table in Appendix C starting on page C-11 of Division B, volume 2

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

Geological Survey of Canada Open File xxxxx
 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



Canada

END OF DOCUMENT

Appendix 4: WSP Canada Ltd. Report, April 7, 2016



April 7, 2016

WSP File No.: 161-03981-00



Attention:



**Subject: Proposed Single Family House – Lot 5, Shores at Jordan River
Report of Geotechnical Assessment**

Dear



As requested, WSP Canada Inc. (WSP) has performed a geotechnical assessment at the above-referenced site where it is proposed to construct a new house on a lot that has yet to be developed. Subdivision construction was conducted in 2006 and 2007, with geotechnical input provided by WSP (while operating as Levelton Consultants Ltd.). This work was conducted on Lot 5 specifically to assist with house setback requirements from the foreshore slope. Our geotechnical work was carried out in accordance with our March 16, 2016 contract.

At the time of subdivision construction, we performed slope stability analyses for all of the foreshore properties, and others with steep slopes, within the Shores at Jordan River subdivision. Our analyses were detailed in a summary report dated January 8, 2007, which provided setback requirements for each of the lots that contained steep slopes. Based on our review at the time of subdivision construction, it was recommended that house construction on Lot 5 be set back a minimum 17 m from the crest of the foreshore slope. It is understood that the front and side yard setbacks have been established as 7.5 m and 6 m, respectively.

Our analyses performed in 2006/07 was conducted under the then recently adopted Provincial Regulation M268 for the 2006 BC Building Code, which stipulated a 10% in 50 year probability of seismic event. In February 2010, the slope stability guidelines were changed to assess the 2% in 50 year seismic event under the current Provincial Regulation M297. This guideline considers a much larger earthquake for design but allows for a maximum of 150 mm of displacement at the house location, which is determined to be an appropriate amount of movement for safe egress.

A site walkover to review the current conditions at Lot 5 was conducted on March 16, 2016. The lot was observed to have a clearing within the eastern central portion of the lot, which is consistent with our records at the time of subdivision construction. The foreshore slope was reviewed at the time of our site walkover and it appears to have remained relatively

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consistent with its appearance since our involvement in 2006/07. The overall slope angle remains at approximately 35 degrees with some localized oversteepened areas that were measured to be 40 to 45 degrees. There is evidence of slope activity within the surficial soils by way of the bowed tree trunks on the slope and minor sloughing observed at the crest of the slope. The toe of the slope contains exposures of natural soils with some erosion protection provided by fallen trees and driftwood that has accumulated on the beach, however there is no seawall or other constructed form of erosion protection.

The subsurface conditions were not reviewed beyond a visual examination of soil exposures, review of previous work within the subdivision. The soil conditions are understood to be compact to dense, native sands and gravels throughout the lot. Sands and gravels were observed in exposures throughout the foreshore slope.

The embankment slope was modelled using SLOPE/W to assess the stability under static and seismic conditions. As discussed, modelling was conducted under the 2% in 50 year event for seismic modeling. Our preliminary slope stability modeling was carried out on a house structure at the same setback line as described in our January 2007 report (17 m). Our modelling indicates that the proposed setback of 17 m from the crest of the foreshore embankment allows for approximately 150 mm of displacement if the foundation is located at the existing ground surface. As the foundation is expected to be at least 1m below the existing ground level, further modelling indicates that lowering the foundation by 1m provides displacements of approximately 120mm under the design earthquake. Based on the foundation level being at least 1m below the existing ground level, we have shown the setback requirement to be unchanged from our initial assessment.

Provided footings are constructed directly atop the compact to dense, native sand and gravel subgrade throughout the building footprint, the proposed house siting described above is considered safe and suitable for the use intended. WSP confirms that provision of BC Building Code Schedules B (for the Geotechnical discipline) can be carried out when needed for the building permit process. It is important that all parties understand that the field reviews must be performed during the construction phase in order for the Geotechnical Engineer of Record to be in a position to provide the BC Building Code Schedule C-B to the Capital Regional District Building Department to confirm that the work was completed in general compliance with our geotechnical recommendations. We expect that WSP will be contacted when foundation construction is scheduled in order to carry out the necessary field reviews.

It will be important to ensure appropriate installation of perimeter drains around the foundation and that the collected groundwater and the storm water from the rain water leaders are disposed through the storm sewer connection on the site. Introduction of additional water at the crest of the slope could be detrimental to the slope stability.

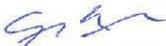
This report has been prepared by WSP Canada Inc. exclusively for Mr. Kerel Bergen for application of the project described herein. The Capital Regional District Building Dept. is considered an authorized user of this report. The report has been prepared in accordance with the attached Terms of Reference for Geotechnical Reports. No other warrantee, expressed or implied, is provided.



We trust that this report meets your current needs. Please do not hesitate to call if you have any further questions.

Yours truly,

WSP CANADA INC.


Alec Morse, P.Eng.
Geotechnical Engineer



Attachments: Terms of Reference for Geotechnical Reports



**TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS
ISSUED BY WSP CANADA INC.**

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WSP Canada Inc. ("WSP") prepared and issued this geotechnical report (the "Report") for its client (the "Client") in accordance with generally-accepted engineering consulting practices for the geotechnical discipline. No other warranty, expressed or implied, is made. Unless specifically stated in the Report, the Report does not address environmental issues.

The terms of reference for geotechnical reports issued by WSP (the "Terms of Reference") contained in the present document provide additional information and caution related to standard of care and the use of the Report. The Client should read and familiarize itself with these Terms of Reference.

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All documents, records, drawings, correspondence, data, files and deliverables, whether hard copy, electronic or otherwise, generated as part of the services for the Client are inherent components of the Report and, collectively, form the instruments of professional services (the "Instruments of Professional Services"). The Report is of a summary nature and is not intended to stand alone without reference to the instructions given to WSP by the Client, the communications between WSP and the Client, and to any other reports, writings, proposals or documents prepared by WSP for the Client relative to the specific site described in the Report, all of which constitute the Report.

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WSP prepared the Report for the Client for the specific site, development, building, design or building assessment objectives and purpose that the Client described to WSP. The applicability and reliability of any of the information, observations, findings, suggestions, recommendations and opinions contained in the Report are only valid to the extent that there was no material alteration to or variation from any of the said descriptions provided by the Client to WSP unless the Client specifically requested WSP to review and revise the Report in light of such alteration or variation.

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**TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS
ISSUED BY WSP CANADA INC. (continued)**

5. INTERPRETATION OF THE REPORT

- a. **Nature and Exactness of Descriptions:** The classification and identification of soils, rocks and geological units, as well as engineering assessments and estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1 above. The classification and identification of these items are judgmental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations or assessments utilizing the standards of Paragraph 1 involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to changes over time and the parties making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or when the Client has special considerations or requirements, the Client must disclose them to WSP so that additional or special investigations may be undertaken, which would not otherwise be within the scope of investigations made by WSP or the purposes of the Report.
- b. **Reliance on information:** The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site investigation and field review and on the basis of information provided to WSP. WSP has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, WSP cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.
- c. **Additional Involvement by WSP:** To avoid misunderstandings, WSP should be retained to assist other professionals to explain relevant engineering findings and to review the geotechnical aspects of the plans, drawings and specifications of other professionals relative to the engineering issues pertaining to the geotechnical consulting services provided by WSP. To ensure compliance and consistency with the applicable building codes, legislation, regulations, guidelines and generally-accepted practices, WSP should also be retained to provide field review services during the performance of any related work. Where applicable, it is understood that such field review services must meet or exceed the minimum necessary requirements to ascertain that the work being carried out is in general conformity with the recommendations made by WSP. Any reduction from the level of services recommended by WSP will result in WSP providing qualified opinions regarding adequacy of the work.

6. ALTERNATE REPORT FORMAT

When WSP submits both electronic and hard copy versions of the Instruments of Professional Services, the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding upon WSP. The hard copy versions submitted by WSP shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancy, the hard copy versions shall govern over the electronic versions; furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed and sealed versions of the Instruments of Professional Services maintained or retained, or both, by WSP shall be deemed to be the overall originals for the Project.

The Client agrees that the electronic file and hard copy versions of Instruments of Professional Services shall not, under any circumstances, no matter who owns or uses them, be altered by any party except WSP. The Client warrants that the Instruments of Professional Services will be used only and exactly as submitted by WSP.

The Client recognizes and agrees that WSP prepared and submitted electronic files using specific software or hardware systems, or both. WSP makes no representation about the compatibility of these files with the current or future software and hardware systems of the Client, the Approved Users or any other party. The Client further agrees that WSP is under no obligation, unless otherwise expressly specified, to provide the Client, the Approved Users and any other party, or any or all of them, with specific software and hardware systems that are compatible with any electronic submitted by WSP. The Client further agrees that should the Client, an Approved User or a third party require WSP to provide specific software or hardware systems, or both, compatible with the electronic files prepared and submitted by WSP, for any reason whatsoever included but not restricted to an order from a court, then the Client will pay WSP for all reasonable costs related to the provision of the specific software or hardware systems, or both. The Client further agrees to indemnify and hold harmless WSP, its officers, directors, employees, agents, representative or sub-consultant, or any or all of them, against any claim or any nature whatsoever brought against WSP, whether in contract or in tort, arising or related to the provision or use of any specific software or hardware provided by WSP.