ONSITE
Engineering Ltd.

Landslide Hazard Assessment for the Proposed Subdivision of Lot 1, Section 22, Township 21, Range 10, West of the 6th Meridian, Kamloops Division Yale District, Plan 38427

3453 Ford Road
Tappen, BC

Prepared for:
688490 BC Ltd.
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Table of Contents

List of Figures

List of Appendices

1.0 Introduction

As requested by Mike and Rhonda Zappone of 688490 BC Ltd., the property owners, Onsite Engineering Ltd. (OEL) was retained to carry out a Landslide Hazard Assessment for the proposed single lot and remainder lot subdivision of Lot 1, Section 22, Township 21, Range 10, West of the 6th Meridian, Kamloops Division Yale District, Plan 38427. The property is located in the rural community of Tappen, approximately 12km north of Salmon Arm, BC (see Figure 1).

This assessment is intended to provide assurance to the Columbia Shuswap Regional District (CSRD) approving officer that natural hazards which may be present at the site are quantified and mitigated as needed when the subdivision is submitted for approval. This report will identify the nature, extent, and probable frequency of the hazard or hazards and if required to recommend permanent protective works or appropriate building setbacks.

1.1 Scope of Assessment

This assessment addresses potential landslide *hazards*[1] on slopes within and adjacent to the property where they may impact the property. The objective of this landslide hazard assessment is to:

- Recognize and characterize landslides (active, inactive, dormant, and potential) within and adjacent to the property;
- Estimate associated landslide hazards and compare estimated hazards with a level of landslide safety[2] suggested by the approving jurisdiction; and
- If required, recommend permanent protective works or appropriate building setbacks.

The subject property consists of altered terrain used as a gravel pit operation and features dominantly gentle to moderate gradient slopes intersected by the steep gradient slopes of the excavations. The upper slopes of the property above the gravel pit feature moderate to moderately steep natural slopes extending up beyond the property to the west flank of Bastion Mountain. Due to these factors, a potential hazard to the property is identified as slope instability related to steep gradient terrain contained within the gravel pit and upslope areas.

Regional watershed mapping indicates that an unnamed stream originates approximately 130m upslope of the upper property line (see Figure 2). The mapping shows the stream following along the southern property line and then at approximately 160m upslope from the lower (west) property line, the mapping shows that the stream turns to the north to head through the centre of the gravel pit before turning west and heading along the northern property line to Ford Road. A prominent draw occupies the location of the mapped stream in the upper portion of the property but the draw diminishes along the southern property line in the lower portion of the property. No signs of significant surface flows were observed within the draw during the field review, however, there is potential for surface flow during an extreme runoff event. Flooding and/or debris flow hazards presented by the unnamed stream mapped on the property are identified as a potential hazard and are discussed further in this assessment.

1.2 Limitations

This assessment has been prepared in accordance with generally accepted geotechnical practises in British Columbia and in general conformance with the "Guidelines for Legislated Landslide Assessments for Proposed Residential Development in British Columbia". No other warranty expressed or implied is made.

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[1] For the purpose of this study a landslide includes: rock falls, rock slumps, rock slides, rock avalanches, rock creep, debris falls, debris slides, debris flows, debris floods, earth falls, earth slumps, earth slides, earth flows, flow slides and earth creep.

[2] Level of safety from the effects of landslides includes levels of acceptable landslide hazard and landslide risk. The MOTI has suggested the use of levels at 1:475 for damaging landslides and 1:10,000 for life-threatening catastrophic events.

General observations are made on the existing slope gradients, shape, morphology and the general stability. Information on the subsurface soil, groundwater and bedrock conditions is gathered from hand-dug test holes, bedrock outcrops and the cutslopes on the existing roads in the surrounding area. Sub-surface conditions other than those identified may exist, requiring a review of the recommendations contained in this report, with amendments made as needed. Variations (even over short distances) are inherent and are a function of natural processes. The classification and identification of the type and condition of the geological units present are based on observations, experience in similar geologic conditions, and knowledge of published research on geologic conditions and processes in areas with similar geological environments. OEL does not represent or warrant that the conditions listed in the report are exact and the user should recognise that variations may exist.

To our knowledge, the CSRD has not adopted a level of safety with respect to landslide hazards; however, the Ministry of Transportation and Infrastructure (MoTI) has suggested criteria for acceptable landslide likelihood where there is potential for a damaging or catastrophic landslide to impact a property. An estimate of the likelihood or probability of a specific hazardous landslide reaching or initiating on the subject property is provided. The estimated likelihoods have been compared to the criteria suggested by the MoTI; however, it is the responsibility of the approving authorities and other stakeholders to decide if the hazard levels assessed in this analysis are acceptable.

Where recommendations are given to reduce the likelihood of landslide occurrence and/or mitigate the risk, the residual rating (where given) applies only if the recommendations in this report are followed.

2.0 Office and Field Review

The following airphotos were reviewed as part of this assessment:

- BC1293 No. 48 to 49 (1951)
- BCC90092 No. 123 to 124 (1990)
- BCC94041 No. 189 to 191 (1994)
- BCC1026 No. 138 to 139 (2001)
- BCC07014 No. 35 to 36 (2007)

The following information was also reviewed as part of this assessment:

- Images and digital terrain model obtained from Google Earth, copyright Province of BC. 2018. The date of this imagery is listed as 2004.
- Canadian Climate Normals available at http://www.climate.weatheroffice.ec.gc.ca/climate_normals.
- BC Digital Geology mapping retrieved from http://maps.gov.bc.ca/ess/sv/imapbc/.

Fieldwork was completed by Rod Williams, P. Geo., and Larissa Laderoute, GIT, of OEL on April 19, 2018. Fieldwork included a foot traverse of the site and adjacent areas while recording observations of surface topography and exposed soils in road cuts, shallow (<1m) hand dug test pits, and excavations within the gravel pit. Representative site photos are included at the end of this report.

2.1 Conventions Followed

This assessment was completed in accordance with the document titled "Guidelines for Legislated Landslide Assessments for Proposed Residential Development in British Columbia[3]". Soil classifications follow the Unified Soil Classification System (USCS). Slope gradient classification, and landform descriptions use terminology defined in the publication Terrain Classification System for British Columbia B.C. Ministry of Environment 1997.

3 Association of Professional Engineers and Geoscientists in British Columbia (APEGBC), 2010.

3.0 Site Overview

The lower slopes of the subject property have been modified due to the gravel pit operations on the property which have been conducted since the early 1960s. The slopes within the gravel pit are separated into four distinct areas for simplicity and are the salt shed, lower pit, middle pit, and upper pit and are roughly shown in Figure 2. Terrain above the gravel pit has remained relatively untouched with the exception that the slopes were logged in the mid-2000s and a series of trails were constructed to facilitate harvesting. The natural slope profile of the property consists of an overall concave profile with gentle gradient slopes in the lower portion of the property that gradually increase to moderate at the toe of the valley sidewall and increase to moderately steep approaching the mid to upper slopes of the sidewall. A prominent ridge extends out from the valley sidewall which has been the area of focus for gravel extraction.

The slope gradient extending into the property from Ford Road and through the lower pit is generally 0-15% for approximately 140m. At the rear of the lower pit, the slope gradient increases to 70-75% for approximately 10m leading up to the middle pit. The slope gradient is generally 5-15% in the middle pit for approximately 140m before reaching the rear of the middle pit which is sloping at 80-90% for 15m and leads to the upper pit. The property owner has placed material in a berm at the edge of the upper pit to prevent noise pollution caused by gravel extraction activities from entering the valley. On the other side of the placed material, the slope gradient is 0-5% for approximately 110m leading to the toe of the current excavation in the upper pit which is approximately 27m tall and sloping at 160%. Extending from the top of the excavation and generally up the apex of the ridge that extends out from the valley sidewall, the slope gradient is roughly 35-40% for approximately 200m before increasing to 50% for another 200m to the upper property line. On either side of the ridge slopes generally fall away and blend into the overall valley sidewall.

Bedrock underlying the subject property is mapped as Lower Paleozoic mudstone, siltstone, and shale fine clastic sedimentary rocks of the Mount Ida Assemblage – Sicamous Formation. Bedrock observed in the field consisted of relatively weak, highly fractured shale consistent with the mapped lithology.

Surficial geology mapping for the area indicates that the surficial materials should consist of fan deposits composed of poorly sorted gravel, sand, silt, and clay above present base-level.

The subject property is located in the Interior Douglas-Fir (IDF) mw2 biogeoclimatic zone. Climate in this zone typically consists of short, warm and dry summers and cool winters with minimal precipitation. The closest climate station to the study area with sufficient data to determine climate normal is located in Salmon Arm, BC, approximately 14km south of the study site. Records at this station indicate that rainfall levels are highest from March to July and October to December with snow cover from December to March. The average annual precipitation in the region is 1468.1mm with 1313.9mm occurring as rainfall[4]. The station is located at an elevation of 70.1m asl.

The total area of the subject property is 18.3ha and is proposed for subdivision into two lots (Lot 1 and the Remainder). Proposed Lot 1 will be 2ha in size leaving 16.3ha for Remainder Lot 1. It is our understanding that proposed Lot 1 will be used as a commercial property for log home manufacturing. The property is currently used as a gravel pit and a salt shed is located on proposed Lot 1, but will be removed as part of the proposed development.

The property is currently accessed by three entry points from Ford Road (Gate 1 through 3). Gates 2 and 3 are located on proposed Lot 1, while Gate 1 is located on Remainder Lot 1. Gate 3 is proposed to be decommissioned and Gate 2 will be used and the single entry point to proposed Lot 1. Gate 1 will be used as the access point to the remaining gravel excavations on Remainder Lot 1. The driveway on Remainder Lot 1 extends approximately 350m along the southern property line from Gate 1 up to the terrain present on the top of the

[4] Environment Canada. (2013). Canadian Climate Normals. Retrieved from www.climate.weather.gc.ca

upper gravel pit. The driveway contains a ditchline on the southern side that is partially filled with sediment due to suspended sediment in the runoff from the gravel pit.

The slopes above the subject property extend to the height of land of a ridge on the west flank of Bastion Mountain that separates the White Creek and Farrell Creek drainages. Several dry swales and small draws originate on the slopes below the ridge (see Figure 2). The draw of the unnamed stream that is shown on the regional watershed mapping originates within this area. A second dry draw originates to the south of the subject property and merges with the mapped draw before diminishing above the road that accesses the terrain above the gravel pit. A more pronounced draw originates above the subject property and heads along the northern boundary of the property. The draw diminishes prior to reaching the development on the lower slopes of the hillside.

The largest draw features a 50-55% gradient and steep gradient slopes (up to 90% for 15m) were noted on the sidewalls. The sidewalls were generally rock controlled and no indicators of potential slope instability apart from minor erosion and weathering of bedrock exposures were noted. All of the draws are glacial meltwater features that no longer convey significant runoff. No alluvial channels are developed within the draws. The draws extend down into the property and converge approximately 270m upslope of the present extents of the gravel pit. Below the area of confluence a single broad draw extends down along the southern property line, broadening out and decreasing to a gradient of less than 20%. The draws may host runoff and small erosional event following a large stand replacing wildfire but under present conditions surface runoff and significant sediment movement are not expected. Additionally, any events that initiate following a disturbance event would runout in the upper portion of the property well upslope of the present gravel pit operation.

Within the upper portion of the property the draws are crossed by several trails constructed during timber harvesting on the property. The trail construction resulted in minor fill in the base of several of the draws. Evidence of minor erosion was noted during the field review but the trail fill is not resulting in significant diversion of surface flows in the draws. It appears that the draws experienced minor runoff in the recent freshet period.

The draws originating upslope of the property do not presently conduct significant surface flows. Within this region of BC draws similar to those found on this property that are formed by glacial meltwater generally do not experience significant runoff or debris flow/debris flood events under normal conditions. However, following disturbances such as large wildfire events, draws such as these can host runoff and mass wasting events if the fire results in loss of the canopy and vegetative mat and the development of hydrophobic soils. Large scale disturbance of the contributing slopes to these draws by a wildfire could lead to increased rates of runoff and surface erosion. This is a result of the loss of the stand canopy which reduces the rate of rainfall interception, the loss of the upper soil organic layer making the soils more susceptible to erosion and the possible development of hydrophobic soils which reduces the rates of soil infiltration. These three factors result in increased runoff and increased rates of soil erosion resulting in increased runoff and sediment loading. Increased rates of runoff and surface erosion can lead to landslide events on the gully sidewalls further contributing to the sediment load and the initiation of debris flows or debris floods. Wildfires within this biogeoclimatic zone in southwestern BC have a return period of 100 to 200 years. The frequency of mass wasting events following a disturbance such as a wildfire are also dependent on the occurrence of a rainfall event of an intensity and duration sufficient to induce significant runoff, surface erosion and resultant mass wasting events.

4.0 Landslide Hazard Assessment

The MoTI suggests "where life-threatening catastrophic events are identified as a potential natural hazard to a building lot, the Qualified Professional is to consider events having a probability of occurrence of 1 in 10,000 years and is to identify areas beyond the influence of these extreme events." In this case, a life-threatening event is defined as a landslide event that would runout to a building site or surrounding area on one of the proposed lots of the subdivision to cause significant damage to a house and potentially result in death or deaths of individual(s) in the structure. A review of the property and surrounding area concludes that there does not appear to be any

natural slopes steep enough or any other existing conditions (alluvial fans or active gullies) within or upslope of the property to warrant a concern for a life-threatening catastrophic landslide hazard. **Therefore, the results of our assessment conclude that a life-threatening catastrophic natural hazard warranting an assessment of the 1:10,000 year event is not foreseeable with the present lot layout for this property.** The only significant steep slopes identified are those within the current excavation of the gravel pit. This area is contained within an active mine permit area and is discussed below with respect to minimizing the risk presented by a damaging landslide.

4.1 Lot 1

4.1.1 Discussion

Proposed Lot 1 is located in the northwest corner of the property and is bound by private land to the north, proposed Remainder Lot 1 to the east and south, and Ford Road to the west. Lot 1 currently contains a salt shed that is planned to be removed following approval of the subdivision. It is our understanding that the proposed lot will be used as a commercial property for log home manufacturing and no permanent residential structures will be built on the property. A well has recently been installed on Lot 1 to service the proposed operations.

Lot 1 is currently accessed by Gates 2 and 3. Gate 3 provides access to the salt shed, while Gate 2 provides access to the lower pit. The ditchline of Ford Road flows under Gate 2 via a plugged and partially crushed 500mm diameter culvert to a crushed 400mm diameter culvert under Gate 3. Gate 3 is proposed to be decommissioned and the existing crushed 400mm diameter culvert will be removed and Gate 2 will be the only access to the proposed lot. Significant erosion and sediment deposition was observed in the ditchline and is likely the result of the lack of drainage measures in the gravel pit area within the property. A drainage ditch is present around the north and west side of the salt shed to drain water away from the structure and carry it down to Ford Road.

Terrain within Lot 1 features flat to gentle terrain in the northwest corner of the lot where the salt shed is currently located. The terrain to the south and east of the salt shed area leading to the lower pit contains an approximately 7m tall slope with a gradient of 65%. An access road is present extending from the east side of the salt shed to the lower pit. Terrain within the lower pit is generally flat; however, an approximately 5m tall mound of placed material and concrete waste is present in the centre of the lower pit.

It is our understanding that the property owners plan to remove the salt shed and fill in the area that contains the shed to create a 1% gradient slope extending up from Ford Road to the back of the proposed lot. The steep excavated slopes around Lot 1 will be sloped back to 67%, equivalent to a 1.5H:1V slope. A drainage swale will be constructed along the northern and southern property lines to drain surface flows to the ditchline of Ford Road. Additionally, a small ridge will be constructed along the northern property line to create a noise buffer.

Surficial materials observed within the gravel pit operations on the lot consisted of well drained gravelly sand to sand and gravel glaciofluvial material. Bedrock was not observed on the proposed lot, but was observed on the hillside upslope of the property. Evidence of surface flows or shallow subsurface flows was not observed on the proposed lot.

4.1.2 Results

Risk of a Damaging Event on the Property

The MoTI suggests that "when considering damaging events only, unless otherwise specified, a probability of occurrence of 1 in 475 years (10% probability in 50 years) for individual landslide hazards should be used as a minimum standard." In this case, a damaging event is defined as a landslide event that would runout to or impact business operations on proposed Lot 1 of the subdivision to cause significant damage to a structure.

Proposed Lot 1 contains generally flat to gentle gradient terrain with steep gradient slopes contained within the current excavations used for gravel pit operations. It is our understanding that the gravel excavation operations

within the lot will cease and the lot will be used to manufacture log homes. It is also our understanding that the property owners intend to fill in the area containing the salt shed excavate the terrain within Lot 1 so as to create a 1% slope extending up from Ford Road into the proposed lot. Additionally, the slopes immediately surrounding Lot 1 will be sloped back to an angle no steeper than 1.5H:1V and two drainage swales will be constructed along the northern and southern boundaries to prevent drainage from the gravel operations above from draining into the proposed lot. **The likelihood or probability of a landslide event occurring on the proposed lot is estimated as very low given that the site preparations are completed as described above. This is equivalent to an annual probability of a specific hazardous landslide of <1:2500.**

Proposed Lot 1 is situated at least 300m downslope of the area where the upslope draws converge and the gradient drops to less than 20%. There is no potential for a runoff or mass wasting event that descends the draws following a major disturbance to reach proposed Lot 1.

As a result of these factors, the hazard of a damaging landslide event initiating within or running out to proposed Lot 1 is less than the 1:475 level of landslide safety suggested by the MOTI.

4.1.3 Recommendations

No recommendations concerning landslide hazard mitigation are suggested for Proposed Lot 1 of the proposed subdivision given that the following assumptions are completed:

1. **All slopes bordering Proposed Lot 1 will be sloped back to an angle no steeper than 1.5H:1V.**
2. **The salt shed is removed and the area is filled in to create a 1% slope extending from Ford Road to the back of the property.**
3. **Drainage swales will be constructed along the northern and southern property lines to drain surface runoff towards the ditchline of Ford Road.**

4.2 Remainder Lot 1

4.2.1 Discussion

Proposed Remainder Lot 1 is an irregular shaped lot bound by the Turner gravel pit on the adjacent property to the north as well as proposed Lot 1 to the north, crown land to the east, the Lessard gravel pit on the adjacent property to the south, and Ford Road to the west. Remainder Lot 1 does not currently contain any structures, but is used as an active gravel pit that will remain functional following subdivision approval.

Remainder Lot 1 will be accessed by Gate 1 in the southeast corner of the property. The ditchline of Ford Road follows along the western boundary of the property. A newer, partially plugged 400mm diameter culvert carries ditch flows under Gate 1 to a partially plugged 600mm diameter culvert that carries ditch flows under Ford Road and into a small swale on the property west of Ford Road. Significant erosion and sediment deposition was observed in the ditchline and is likely the result of the lack of drainage measures in the gravel pit on the property.

Terrain within Remainder Lot 1 features flat to gentle terrain in the southwest corner of the lot. A small, flat bench is present along the western property line, presumably used for parking, and is separated from the flat to gentle gradient terrain within the property by an approximately 2.5m tall mound of placed material. The terrain is generally flat extending to the excavated face of the middle pit. The excavation is generally sloping at 70-80% with some steeper sections of 90-95% slope gradients and extends for approximately 10-12m to the upper pit. Material has been placed at the top of the excavation for the middle pit to prevent noise pollution from travelling into the valley from the gravel pit operations; however, tension cracks have developed along the edge. In the event that a landslide did occur, the event would consist of a small surficial slide that would deposit immediately below on the flat area within the middle pit.

Terrain at the base of the upper pit is generally flat extending to the excavated face which is sloping at a gradient of 160% for approximately 27m. Due to the lack of drainage or sediment control measures, runoff from the upper pit is flowing over the excavated face of the middle pit and depositing a slurry of material on the flat to gentle gradient terrain within the middle pit. Although the excavated slopes are over-steep, they are composed of relatively compact materials and do not appear to show any signs of instability.

The terrain on the hillside above the gravel pit generally contains 35-40% gradient slopes for approximately 200m and increases to 50% gradient slopes extending to the upper property line. Terrain above the property is described in section 3.0.

The terrain coming down into the property from the Turner gravel pit to the north features slope gradients of 120% to near vertical for 10 to 12m that decrease to 60% for 7 to 10m. The slope is composed of sandy glaciofluvial deposits with abundant cobbles.
It is our understanding that the terrain within the upper gravel pit will be sloped towards the north as to direct runoff from the upper gravel pit north to the swale constructed along the northern boundary of proposed Lot 1 and is to be carried to the ditchline of Ford Road. This will prevent runoff from flowing over the excavation of the middle pit and the deposition of sediment within the middle pit.

Surficial materials observed within the gravel pit operations on the lot consisted of a thick layer of gravelly silt overlying varying layers of sand, silt, and gravelly sand glaciofluvial material. These materials appear to be well drained. Evidence of surface flows or shallow subsurface flows was not observed on the proposed lot outside of eh gravel pit area. Bedrock was not observed on the proposed lot, but was observed on the hillside upslope of the property.

4.2.2 Results

Risk of a Damaging Event on the Property

Proposed Remainder Lot 1 contains generally moderate to moderately steep gradient terrain with steep gradient slopes contained within the current excavations for gravel pit operations. It is our understanding that there are no proposed structures on Remainder Lot 1 and that the property will still be used as a gravel pit. It is also our understanding that a drainage swale will be constructed through the upper pit to drain runoff to the north to the swale around proposed Lot 1 to be carried down to the ditchline of Ford Road. In addition, the mining activities conducted on the property are regulated by Mines Act and must be in agreement with its terms.

Under present conditions the steep gradient slopes of the excavations within the middle and upper pit have a significantly elevated likelihood of a landslide that could impact future development on the lot. The likelihood or probability of a landslide event occurring is estimated as high. A **high likelihood** means that **a landslide is likely** over the lifespan of the proposed development. Quantitatively, the probability of a landslide is estimated as 1/20 to 1/100 annual probabilities. **As a result, the hazard of a damaging landslide event initiating within the active gravel extraction areas on Proposed Remainder Lot 1 under present conditions greater than the 1:475 level of landslide safety suggested by the MOTI.**

4.2.3 Recommendations

It is our understanding that no buildings are proposed on Remainder Lot 1 as part of the current subdivision plan; however, the following recommendations are made with the potential for future development in mind:

1. **While the gravel pit is in operation a setback must be maintained from the top of the excavated face of the middle pit (see Figure 5). A 2H:1V line should be projected down from the slope crest. No development may occur upslope (east of) the set back until the excavated face is sloped back as indicated in recommendation 2 below.**

2. **Following completion of gravel pit operations within Remainder Lot 1, the excavated faces of the middle pit and the upper pit within Remainder Lot 1 must be sloped back to an angle no steeper**

than 1.5H:1V. Once this recommendation has been completed, the setback detailed in recommendation 1 above is no longer applicable and development can occur up to the toe of the re-contoured slope.

3. **The terrain within the upper pit must be sloped to the north to carry runoff from the upper pit to the swale around proposed Lot 1 in order to prevent runoff from flowing over the excavated face of the middle pit.**

4.2.4 Results

Risk of a Damaging Event Upslope of the Property

As discussed in Section 3.0 in this region, draws such as those present above the assessed property do have the potential to host mass wasting events following a large stand replacing wildfire event. In the case of the assessed property and the relatively small contributing area to the draws the likelihood of a mass wasting event with the potential to runout to the property is estimated to be in the range of 1/200 to 1/500. This estimate is based on a return period of 1/150 for a stand replacing wildfire and the conditions to initiate an event in the years after the wildfire. Such an event would not be expected to be large (i.e. not greater than 200m^3) and the runout would terminate either in the lower gradient reach of the draw near the upper property line or in an extreme case, down in the area where the draws confluence approximately 270m upslope of the present extents of the gravel pit. This area is well upslope of the recommended upslope limit for development suggested in recommendation 2 above and the likelihood of the event running out beyond this point is estimated as <0.1. **Therefore, the likelihood or probability of a hazardous landslide event occurring on the terrain upslope of proposed remainder Lot 1 and running out to and impacting developments on the lot is estimated as low to very low (i.e. 1/2000 to 1/5000 annual probability).**

As a result, the hazard of a damaging landslide event initiating on the terrain upslope of Proposed Remainder Lot 1 and running out to and impacting development on the lot is significantly less than the 1:475 level of landslide safety suggested by the MOTI and no further recommendations are required.

5.0 Closure

This assessment has been carried out in accordance with generally accepted geotechnical practices. Conclusions and recommendations presented herein are based on visual site inspections. Assessments of soils and slope stability are based on interpretation of surface features and limited sub-surface investigation; actual ground conditions may vary from those inferred.

Factual data and interpretation contained within this report were prepared specifically for 688490 BC Ltd. with whom Onsite Engineering Ltd. has entered a contract. The local government, provincial government or other approving agency may rely on the findings of this report; no other party may rely upon this report without the express written permission of OEL.

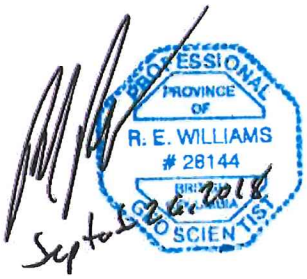
We trust that this report satisfies your present requirements. Should you have any questions or comments, please contact our office at your convenience.

Sincerely,

Onsite Engineering Ltd.

Prepared by:

Larissa Laderoute, GIT
Junior Geoscientist



Rod Williams, P. Geo.
Senior Geoscientist

Figure 1 Location Key Map

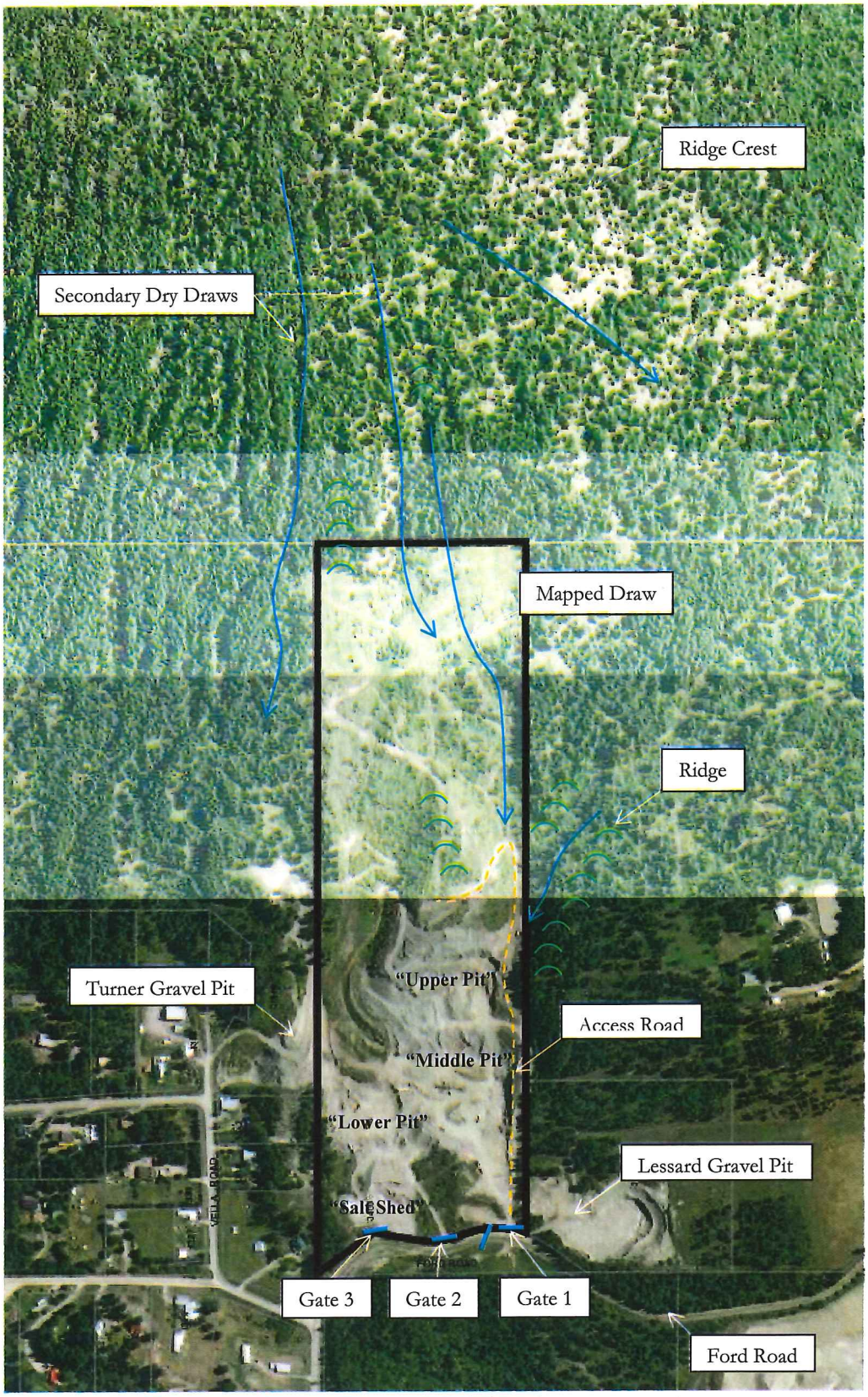


Figure 2: Detailed Site View

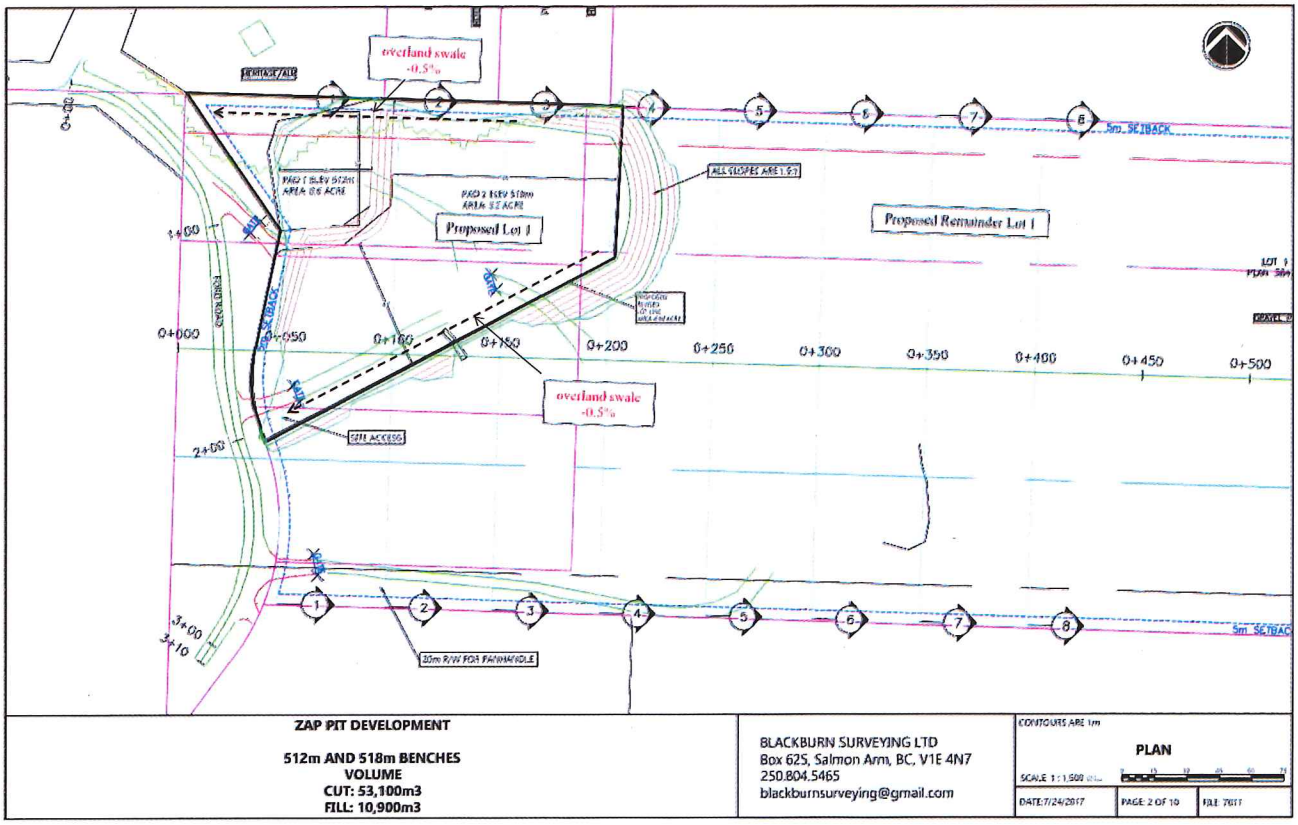


Figure 3 Proposed Lot Layout and proposed reclamation of proposed Lot 1.

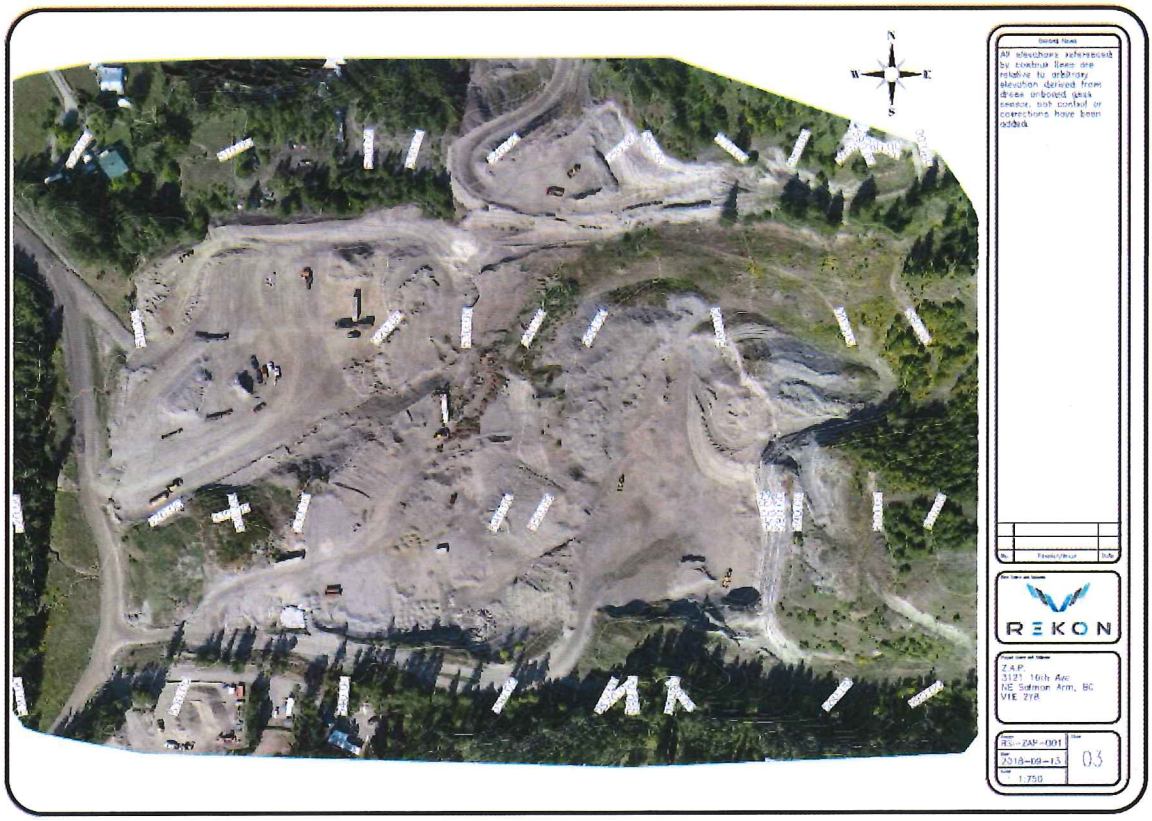
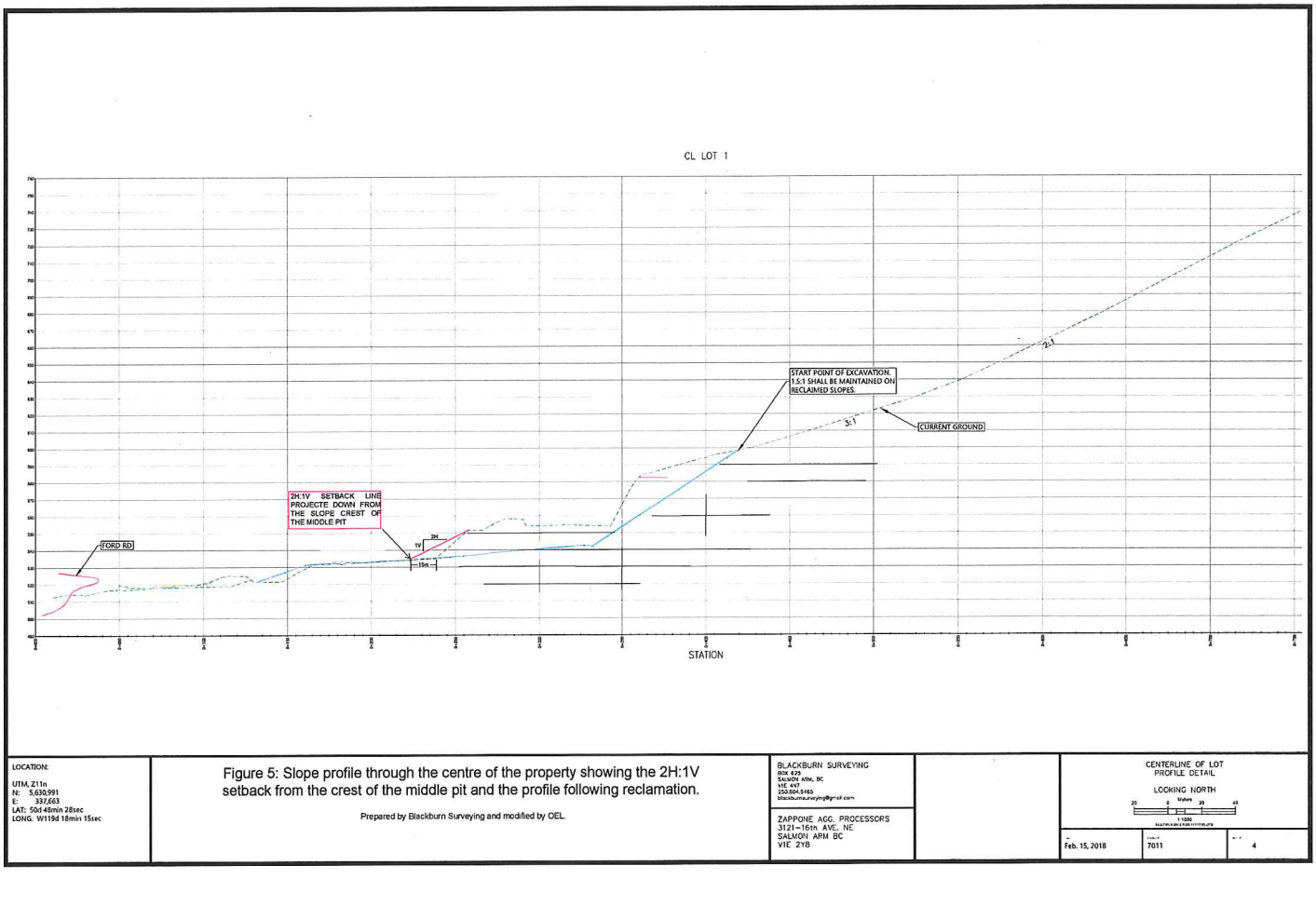


Figure 4 Aerial Imagery Site Plan of the subject property with contour and relative elevation data prepared by Rekon Solutions Inc. Note: The salt shed was remediated before this aerial image was recorded.



LOCATION:

UTM, Z11n
N: 5,630,991
E: 337,663
LAT: 50d 48min 28sec
LONG: W119d 18min 15sec

Figure 5: Slope profile through the centre of the property showing the 2H:1V setback from the crest of the middle pit and the profile following reclamation.

Prepared by Blackburn Surveying and modified by OEL.

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ZAPPONE AGG. PROCESSORS
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SALMON ARM BC
V1E 2Y8

CENTERLINE OF LOT
PROFILE DETAIL

LOOKING NORTH

1:1000

Feb. 15, 2018 | 7011 | 4

7011 ZAP PIT SURVEY– 4.5 ACRE OPTION–4.DWG–––

Photo 1 Gate 3 accessing the salt shed in the northwest corner of the property to be decommissioned, looking northwest.

Photo 2 Gate 2 accessing the lower pit in the central portion of the property, looking west.

Photo 3 Erosion from surface runoff on the access road at Gate 1, looking west.

Photo 4 The salt shed on proposed Lot 1 and the access road from the salt shed to the lower pit, looking north.

Photo 5 The lower pit on proposed Lot 1, looking east. Note: The ground will be excavated to be level with the terrain within the salt shed and the slopes will be sloped back to 1:5V:1H.

Photo 6 Piled material within proposed Lot 1 to be removed and/or sloped back to 1.5V:1H, looking northeast.

Photo 7 Steep terrain extending down from adjacent gravel pit into proposed Remainder Lot 1.

Photo 8 Runoff down coming from the upper pit to the middle pit causing a slurry of deposition, looking east.

Photo 9 Excavated face of the upper gravel pit, looking north.

Photo 10 Broad, low gradient swale in the location of the mapped drainage feature, looking east.

Photo 11 Looking down the access road along the southern property line.

Photo 12 Gentle to moderately steep gradient terrain extending up the hillside along the norther property line, looking east.

Photo 13 Gentle to moderately steep gradient terrain extending up the hillside along the northern property line, looking east.

Photo 14 Uniform moderately steep gradient terrain along the upper property line.

APPENDIX D: *LANDSLIDE ASSESSMENT ASSURANCE STATEMENT*

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

To: The *Approving Authority* Date: September 26, 2018

Columbia Shuswap Regional District

555 Harbourfront Dr NE, Salmon Arm, BC, V1E 4P1

Jurisdiction and address

With reference to (check one):

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

For the Property:

Lot 1, Section 22, Township 21, Range 10, W6M, KDYD, Plan 38427; 3452 Ford Road, Tappen, BC

Legal description and civic address of the Property

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

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

Check to the left of applicable items

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

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

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

✓ 8.3 compared this guideline with the findings of my investigation

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

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

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

Based on my comparison between

Check one

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

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

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

Check one

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

Check one

☑ with one or more recommended registered covenants.

☐ without any registered covenant.

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

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

Check one

☐ with one or more recommended registered covenants.

☐ without any registered covenant.

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

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

Rod Williams, P.Geo. — Name (print)

September 26, 2018 — Date

Signature

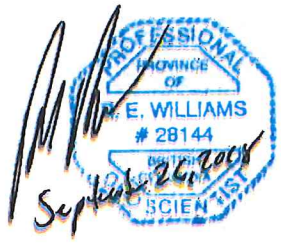
[1] When seismic slope stability assessments are involved, *level of landslide safety* is considered to be a "life safety" criteria as described in the National Building Code of Canada (NBCC 2005), Commentary on Design for Seismic Effects in the User's Guide, Structural Commentaries, Part 4 of Division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

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

#201-231 Trans Canada Hwy; PO Box 2012
Address

Salmon Arm, BC, V1E 4R1

250-833-5643
Telephone



(Affix Professional seal here)

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

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