



January 26, 2023

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City of Campbell River  
301 St. Ann's Rd  
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**Subject: Geotechnical Engineering Services - Preliminary Assessment of a landslide, located in the slopes of properties 739 and 751 Ash Street, Campbell River, BC**

## INTRODUCTION

Following a slope failure that occurred in the evening of January 17<sup>th</sup>, 2023, Mr. Oscar Aular, P.Eng., Operations Manager at the City of Campbell River, requested WSP Canada inc. (WSP) to complete a preliminary assessment of the landslide. Mr. David Feghali, P.Eng. of WSP, visited the site of the landslide on January 19<sup>th</sup>, 2023.

The landslide occurred on two private single family residential properties, located at 739 and 751 Ash Street in Campbell River. The residences on the properties are located some 20 m behind the crest of the slope and were not directly affected by the landslide. Run out from the landslide did, however, incur significant damage beyond the toe of the slope, where a three-storey condominium building is located at 738 Island Hwy South, which was impacted and evacuated. Considering its nature, the failure was classified as a mudslide.

The City of Campbell River has a statutory right of way (SRW) containing a sanitary sewer line that services the residences on Ash Street at the top of the slope. The SRW is located relatively close to the crest of the landslide but does not seem to have been directly affected at the moment by the landslide.

The intent of WSP's scope of work was to complete a preliminary review of the landslide with respect to possible public safety issues and the interests of the City in relation to maintaining operations of the sanitary sewer. This letter has been prepared to provide discussion related to public safety at the top and toe of the slope along with recommendations for preliminary measures to allow for site clean-up at the bottom of the slope, while assessing the safety of the area, at both the bottom and top of the slope. Preliminary recommendations on medium to long-term steps to rehabilitate the slope are also included in this letter.

## BACKGROUND INFORMATION

The failure occurred on an east facing slope, approximately 40 m high, with a relatively steep angle of 1.2H:1.0V to 1.4H:1.0V (35 to 40 degrees). This slope was historically a foreshore slope formed from marine erosion under a different sea level regime. Based on pre-landslide Lidar contour lines obtained from the City of Campbell River web site, along with observations of drainage measures and water loving vegetation at the slope toe (see below), there is believed to have been long-term seepage on the slope face at the location of the landslide. A review of precipitation data from local weather stations did not identify particularly high precipitation in the days prior to the landslides, but the data did indicate consistent light precipitation had been occurring for several days preceding the landslide. No particularly windy events were identified in the data from the weather stations nearby.

The slope on the property to the north of the landslide site, 723 Ash St, contains a local shallow landslide feature indicating that other portions of the slope may be prone to instability.

The escarpment runs parallel to the South Island Highway for several kilometers and has historically been subject to landslides of a similar nature, some of which have previously been assessed by WSP (previously Levelton). The slope is identified in the City’s Official Community Plan as a Hazardous Conditions Development Permit Area (Map 10b).

Published surficial geology mapping indicates that the slope is generally comprised of pre-Vasion deposits (Quadra sediments), that are overlain by glacial tills and a veneer of marine sediments. Quadra Sediments are typically very dense, comprised of fine-grained sand and silts, and water bearing.

## SITE RECONNAISSANCE

Mr. David Feghali P.Eng. completed a site visit on January 23, 2023, in the presence of representatives from the City of Campbell River. For safety and accessibility reasons, the visit was limited to the toe of the landslide, the northern side adjacent to the slide which offered a direct view on the Main Scarp, and the upland area of private residence behind the crest of the slope. Due to the present safety hazards, it was not possible to directly access the main surface of rupture. A summary of field observations is provided below. Select photos are presented in the Photolog:

- The landslide occurred in the upper half of the approximately 40 m high slope, creating a circular shaped scar that measured approximately 30 m laterally and about 15 m long parallel to the slope (main scarp). The depth of the slide was estimated from pre and post contours to range from zero to over 3.5 m as shown on Figure 1. Geologically, the upper part of the Main Scarp (2-3 m) consisted of very dense glacial till that was underlain by 15-20 m of dense sandy deposits laying on dense fine-grained material. In the Main Scarp, the upper 2-3 m of glacial till were almost vertical with some localized overhanging surficial soils. The underlying dense sandy deposits were interpreted as Quadra sands, which were exposed at an angle of approximately 40-45 degrees (see Photos 9 and 10). The underlying finer grained deposits were interpreted to be Quadra sediments and observations indicated that the bulk of the landslide had not affected their integrity. The failed slope material appears to have behaved like a fluid mass as it flowed into position. The surface of rupture seems to be located at the interface of the Quadra Sands and the underlying fine-grained sediments;

- Some trees were uprooted and damaged in the landslide, but most surrounding trees are mature and still stand on either side of the landslide;
- The debris at the toe of the landslide consisted mainly of sandy soils closest to the slope, and of finer grained soils (silt/clay) at the outer edge of the failed mass. The thickness of the debris deposited adjacent to the apartment building was approximately 0.15 m deep at the outer fringe, and up to 0.6 m near the original toe of the slope. The nature of the failed debris is shown in Photos 1, 3 and 7;
- Significant damage on some parking shelter structures was incurred at the toe of the slide, located mostly at 738 Island Hwy South. The two standing structures were completely damaged with one of the structures leaning on the condominium building, potentially affecting the building's structural integrity (see Photos 2 and 3);
- The Eastern Wall of the house located at 739 Ash Street is located approximately 15 m from the Crown of the landslide;
- A garage or shed at 751 Ash Street is located dangerously close to the southern side of the landslide;
- The City of Campbell River's sanitary sewer line that services the properties fronting Ash Street is currently unaffected. It is, however, expected to be within 5 to 10 m from the crown of the landslide;
- In the southern exposed face of the landslide (Minor Scarp), a significant and concentrated amount of groundwater emerges from the face and flows down the slope in the same eroded trajectory as the landslide debris (see Photo 11). The source of the groundwater appears to be natural, as it is located at the interface of the permeable sands of the Quadra Sediments and the impermeable fine-grained soils underneath;
- The City of Campbell River had completed a system check on their water mains and sewer lines and no breakages were detected. The heavy flow of water discredits the potential for the water to be the result of a drainage outlet from the residences;
- Drainage collection and conveyance measures had been constructed prior to the landslide and are indicative for historic drainage at this location. At the bottom of the slope, the measures included a concrete slab and a 100 mm dia. PVC pipe that was broken as a result of the slide;
- Following the rupture and damage to the drainage works, the water was observed to flow uncontrolled on the paved area to open ditching on the Island Hwy ditch (see Photos 5 and 6);
- To the north of the landslide, on the same slope, a small-scale erosion/ failure, was observed at the property located at 723 Ash Street. The feature corresponds with the rounded contour lines observed at this location. No seepage was observed at this location (see Photo 8);
- The area at the top of the slope, at 739 Ash Street, has a thick and impenetrable cover of blackberry bush, which prevented access to the crown of the landslide. Between the blackberry bushes and the house structure, is a gentle eastward sloping grass covered backyard, about 5 m wide. As shown on Photo 12, the surface of this area appeared to be disturbed with indications of straining towards the crest. Probing with a steel rod encountered areas of very loose soil or possibly voids. The present owner mentioned they have been always present and not newly created by the landslide;



## ADDITIONAL DATA AND DISCUSSION

Following the visit, the City of Campbell River provided WSP with some drone imagery and LiDAR data, taken following the landslide. The drone data provided some survey points which allowed post landslide contour lines to be defined at the location of the landslide. The adjacent tree covered ground could not be interpreted accurately with the drone data and the depth of possible debris within the landslide scar are also unknown. By transposing topographic surfaces pre and post landslide, it has been estimated that roughly 550 m<sup>3</sup> of soil have been displaced by the landslide. The landslide scar has been shaped from the data and is presented in the figure attached to this letter.

This initial assessment is specific to considerations of public safety. It is beyond the scope of this preliminary report to provide a detailed assessment or possible remedial measures. Our preliminary observations suggest that the concentrated spring like seepage likely caused saturation of the surficial colluvial type soil cover and a reduction in shear strength of the sandy deposits. It is also possible that the concentrated flow caused some erosion and local over-steepening of the slope. Given the nature of the failure (mudslide) the concentrated spring like discharge is considered to be central to triggering mechanism. Pre-landslide topography contours present evidence of historical erosion at that location.

No earthquakes exceeding 2.0 Magnitude in the days before the landslide have been recorded in Western Canada. It is not likely that an earthquake contributed to the failure.

The City of Campbell River has designated this slope as a hazardous steep slope within the context of its development permit approval process due to a history of slides of a similar nature. The recent observations made raise the potential concern for future failures of over steepened material adjacent to the failure scarp or associated with other areas of concentrated groundwater seepage.

## RECOMMENDATIONS

The recommendations for immediate action provided below are geared towards public safety, which is the main concern at this stage. It is understood that most of the immediate action items described below have already been actioned by the City following a meeting held on Friday January 20<sup>th</sup>, 2023. The preliminary recommendations for follow-up short term measures presented below are focused on improving the immediate slope stability, as well as general guideline items for the escarpment as a whole. It is noted that the slope is private property and that the City's involvement in medium and long-term recommendations has not been defined. It should be noted that immediate action items do not preclude additional potential failures in the slope.

### IMMEDIATE ACTION ITEMS – PUBLIC SAFETY AND PROTECTION OF THE ENVIRONMENT

- Obtain a structural engineering assessment of potential structural damage to the rear of the buildings and out structures impacted by the landslide;
- Obtain civil engineering services related to the collection and off-site conveyance of the concentrated seepage at the toe of the slope. This will need to include a component of erosion and sedimentation control due to the proximity of aquatic discharge. This work



should be completed in conjunction with geotechnical engineering input in relation to temporary stability and worker safety;

- Clean-up the debris at the bottom of the slope only (beyond the toe of the slope). Clean-up should only be completed in dry conditions or very light rain and should not follow any significant precipitation event within 24 hours after the occurrence. A geotechnical presence is recommended during the clean-up to observe potentially new findings and provide a periodic assessment of the condition of the slope;
- Residents evacuated from the lower buildings may be allowed to return, subject to positive findings from the structural engineering assessment. We would also recommend that at least temporary measures be completed to collect and safely convey the seepage prior to a full return of residents.

The parking structures at the rear of the building were impacted significantly and it is not clear if the structures can be salvaged or will need to be replaced. It is noted that the parking structures absorbed a substantial amount of energy from the mudslide that could otherwise have caused more serious damage to the rear of the building. The rear area currently used for parking has the greatest risk of impact from future landslides and we would recommend that it not be used until a risk mitigation plan has been developed (see below). Limited parking appears to be available at the front of the building and at the nearby Rotary Beach Park. ;

- Erect a safety perimeter at the top of the slope, as per the figure attached to this letter, restricting human access, on both backyard areas of properties located at 751 and 739 Ash Street pending the completion of short-term remedial works. The City of Campbell River public works crew may enter to address issues related to the sanitary sewer, but we would recommend that this be completed in conjunction with further geotechnical review.
- Establish a surveillance program to review the condition of the slope, seepage rates and monitor any change in conditions particular to the upslope. Select removal of the blackberries is recommended to allow a review of the crown area. We would recommend an initial regular two-week interval plus after prolonged periods of heavy rain.

#### **SHORT-TERM ACTION ITEMS ON SUBJECT PROPERTY (POTENTIALLY SUBJECT TO OWNER'S APPROVAL)**

- Create a risk mitigation plan in the event of additional failures regressing towards and/or affecting the City's sanitary sewer line at the top of slope. We would also recommend that the risk mitigation plan (or a separate plan) consider restrictions on usage at the rear of the lower building pending improvements to the stability of the slope;
- The immediate condition of the slope and the uncontrolled release of concentrated flow onto the slope face is not acceptable for the adjacent land use and improvements will need to be made to adequately improve the stability and/or mitigate the consequences of a future failure. Responsibilities and funding for such a task are yet to be determined. However, the City does have infrastructure within an area considered to be of marginal stability and, therefore, may wish to consider commissioning certain preliminary tasks (survey and geotechnical assessment) to allow a more detailed assessment to be completed to review remedial and/or mitigative options.
- Complete a detailed survey of the slope not limited to the scar of the landslide;
- Complete a joint geotechnical and hydrogeological assessment, including instrumented boreholes at the top of slope to characterize the properties of the deposits in place and gain a better understanding of groundwater conditions. The assessments would provide a basis for determining the stability of un-failed portions of the slope, and options available to remediate the slope, mitigate risks and manage the locally concentrated seepage. The



actual scope and extent of assessment will depend on a review of the responsibilities and funding and should be reviewed as part of the risk mitigation plan.

#### GENERAL GOOD PRACTICE RECOMMENDATIONS

- The January 2023 mudslide is one of many that have historically impacted this steep former foreshore slope. The January 2023 mudslide was a high velocity failure that extended well beyond the toe of slope and had the potential to be life threatening. The trigger for the slide appears linked to concentrated seepage in the upper slope area, the saturation of weaker soils on the slope face, reduced shear strength from elevated porewater pressures and possibly local erosion. The apparent implementation of drainage measures at the toe of the slope is suggestive that the concentrated seepage was historical and known;
- It is suggested that the City consider a program of community education related to good slope management practices for residents/strata councils with properties on/adjacent to the steep slope. A geotechnical engineer could be hired to work with the City to develop a guideline that would include landscaping waste end dumping, fill and landscape retaining walls, drainage control and other pertinent items. In the same train of thoughts, City Public Works personnel should also be trained to have basic knowledge of such practices;
- The City also wishes to commission a detailed reconnaissance survey along the slope to identify any potential instabilities or locations of concentrated water seepage that might be indicative of conditions of marginal stability.



## CLOSURE

WSP understand that most of the Immediate-Action items have already been addressed, including the restricted access at the top of the slope, organizing for the debris clean-up, water channeling and subsequent return of residents to their residences.

It should be noted that even though the bulk of the failed material has been cleaned-up, additional potential debris on the slope face and/or subsequent failures might occur following significant precipitation events that could impact both the toe and crest area. On-going periodic surveillance should be recognized as part of the risk mitigation plan recommended for this event.

This report has been prepared by WSP exclusively for the City of Campbell River for application to the failed slope on private properties 739 and 751 Ash Street in Campbell River, BC. The report has been prepared in accordance with generally accepted geotechnical engineering practice and the attached standard limitations. No other warrantee, expressed or implied, is made.

We appreciate the opportunity to have conducted this assessment and trust that this report meets your immediate requirements. If you have any questions or require further information, please contact our office at your convenience.

Yours sincerely,

Per: David Feghali, P.Eng. PMP  
Lead Geotechnical Engineer

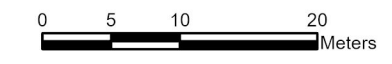
Reviewed by: Carl Miller, M.Sc., P.Eng.  
Senior Principal Engineer

DF/CM

Encl. Figure, Photography Report, Standard Report Limitations  
WSP ref.: 231-00730-00



- LEGEND**
- Landslide area
  - Elevation change, meters**
  - ≤ 0
  - ≤ 1
  - ≤ 2
  - ≤ 3
  - ≤ 3.5
  - /// Shallow landslide (Photo 8 of Photolog)
  - Recommended restricted area
  - Sewer
  - ParcelMap BC Parcel Fabric



1:550

**REFERENCES**  
Background image is provided by Suavair.

Parcel data contain information licensed under the Open Government License – British Columbia  
Spatial Reference: NAD 1983 UTM Zone 10N

**CLIENT**  
City of Campbell River

**PROJECT**  
Preliminary Geotechnical Assessment of a landslide, located at 739 and 751 Ash Street, Campbell River, BC

**TITLE**  
Landslide scar and recommended restricted area

CONSULTANT	YYYY-MM-DD
	2023-01-26
	DESIGNED DF
	PREPARED EM
	REVIEWED CM
	APPROVED

C:\Users\CAEM078671\Documents\ArcGIS\Projects\MyTestProject\MyTestProject.aprx





# Photograph report

Date:  
2023-01-24

**Project:**  
Geotechnical Assessment of a Landslide

**Location :**  
739 and 751 Ash Street, 738 South Island Hwy, Campbell River, BC

**Project #:**  
231-00730-00



Photo 1 : 738 South Island Hwy, mudslide deposit at toe of failed slope.



Photo 2: 738 South Island Hwy, damaged structure at toe of failed slope and soil debris from the landslide.



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2023-01-24

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Photo 3 : 738 South Island Hwy, damaged structure and torn out trees at toe of failed slope.

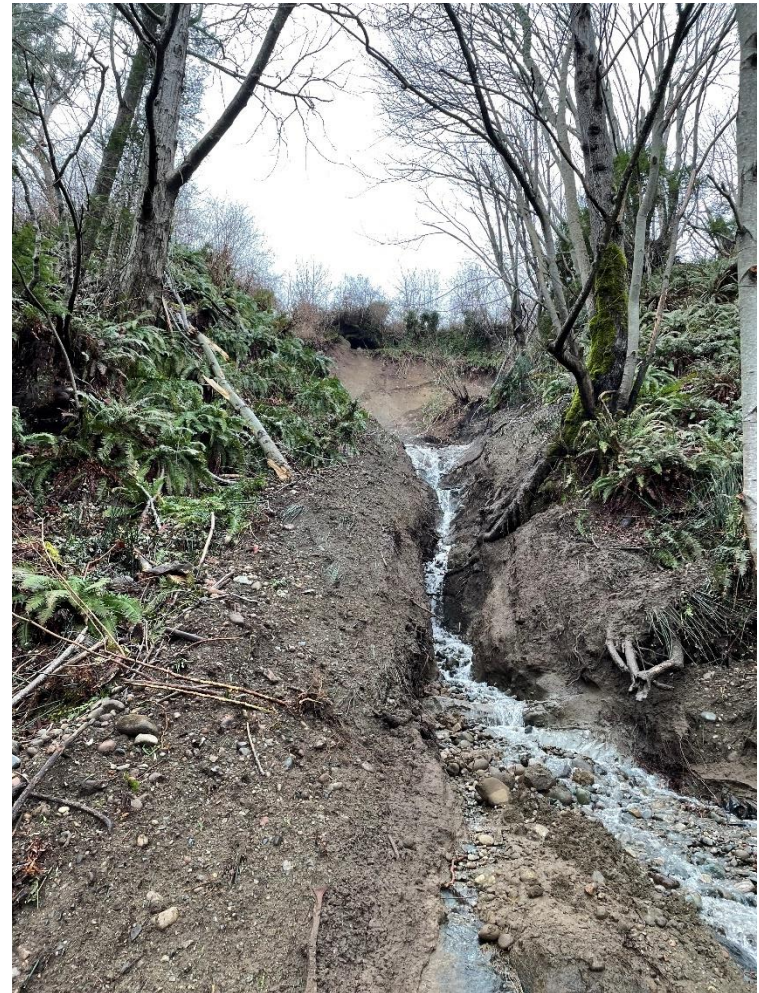


Photo 4 : Toe of slope, heavy water flow continuing two days after the slide event.



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Photo 5 : Water flow towards 738 South Island Hwy Building.



Photo 6 : Water flow towards South Island Hwy ditch.



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Photo 7: Debris at toe of failed slope.



Photo 8: Shallow slope failure in the slope on property 723 Ash Street, north of the assessed failed slope.



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Photo 9 : View of the head scarp from the north.

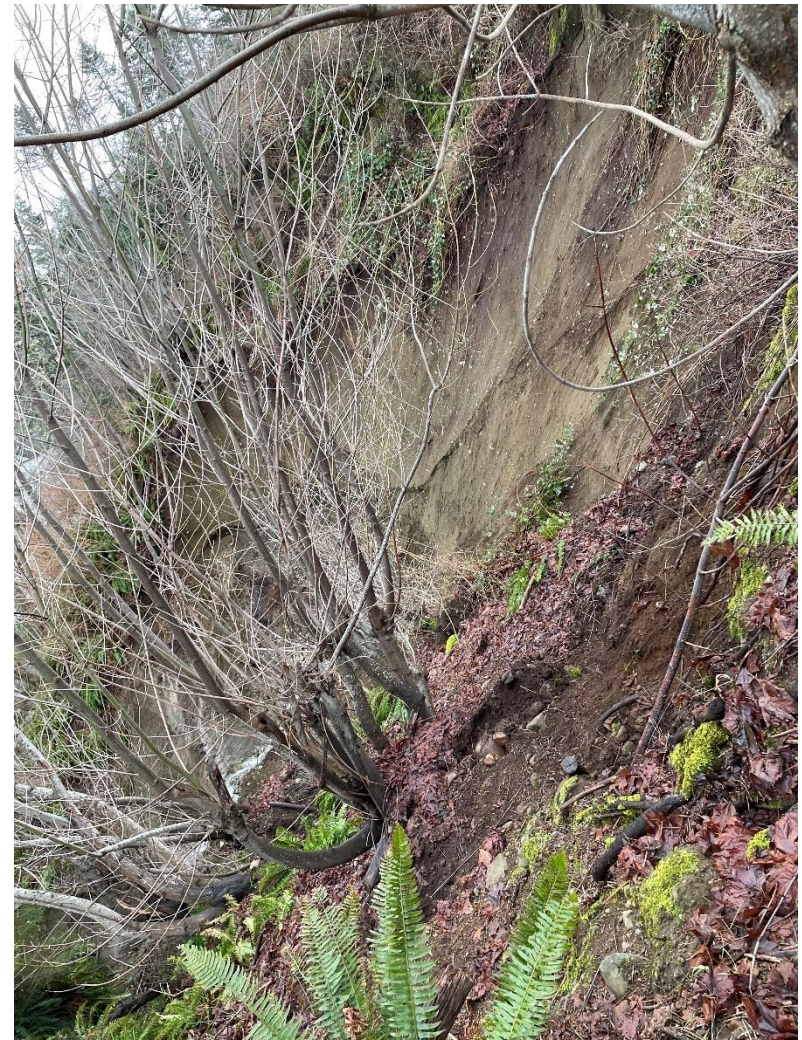


Photo 10 : Visible quadra sands in the scarp of the failure.



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Photo 11: Probable natural spring emanating from the southern face of the failure surface.



Photo 12: Grass covered backyard at 739 Ash Street. Possible tension crack visible in the grass area and void. City sewer line located between the visible crack and the crown of the landslide.



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Photo 13: Grass covered backyard at 739 Ash Street and shed/garage located at 751 Ash Street in the background.



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The conclusions presented in this report are based on work performed by trained, professional and technical staff, in accordance with their reasonable interpretation of current and accepted engineering and scientific practices at the time the work was performed.

The content and opinions contained in the present report are based on the observations and/or information available to WSP at the time of preparation, using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by WSP and other engineering/scientific practitioners working under similar conditions, and subject to the same time, financial and physical constraints applicable to this project.

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Overall conditions can only be extrapolated to an undefined limited area around these testing and sampling locations. The conditions that WSP interprets to exist between testing and sampling points may differ from those that actually exist. The accuracy of any extrapolation and interpretation beyond the sampling locations will depend on natural conditions, the history of Site development and changes through construction and other activities. In addition, analysis has been carried out for the identified chemical and physical parameters only, and it should not be inferred that other chemical species or physical conditions are not present. WSP cannot warrant against undiscovered environmental liabilities or adverse impacts off-Site.

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