Cariboo Regional District
Suite D, 180 N Third Avenue, Williams Lake, BC V2G 2A4
Tel: 250-392-3351 TF: 1-800-665-1636
Fax: 250-392-2812
mailbox@cariboord.ca

File: 0580-03

December 13, 2023

Dear Owner/Occupant

The Cariboo Regional District ("CRD") is providing this letter to you as your property is understood by the CRD to be within or proximate to the Hodgson Road and Dog Creek Road Landslide ("HRL") zone. We are writing to provide you with a copy of a letter and a memorandum for your information.

The CRD received a letter on August 31, 2023 from the Association of Professional Engineers and Geoscientists of the Province of British Columbia, attaching an August 16, 2023 letter from Calvin VanBuskirk, P. Eng. of Terratech Consulting Ltd. This letter addresses Mr. VanBuskirk's concerns pertaining to the HRL and "specifically regarding slope stability within the Dog Creek subdivision and the portion of the City of Williams Lake located both within and adjacent to the HRL" (together, the "Letter").

On December 7, 2023, the CRD received a technical memorandum from the Ministry of Transportation and Infrastructure (the "Memorandum"). The Memorandum reviews available information regarding risk from the HRL. It does not encompass provisions for further investigation, analytical testing, or assessment of any site conditions.

In releasing this information to affected residents, the CRD specifically disclaims any responsibility for the contents of either document, including any information, analysis or conclusion stated in the Letter or Memorandum, and strongly advises and warns interested parties to seek their own qualified professional engineering advice in order to evaluate and interpret the Letter and the Memorandum.

For further information concerning the HRL and other natural hazards within the CRD, please visit the following page on the CRD's website: https://www.cariboord.ca/naturalhazards

Sincerely,

Murray Daly
Chief Administrative Officer

Encl.

ENGINEERS & GEOSCIENTISTS BRITISH COLUMBIA

BY EMAIL: ian.pilkington@gov.bc.ca; mdaly@cariboord.ca; gmuraca@williamslake.ca

August 31, 2023

Ian Pilkington, P.Eng.
Chief Engineer
Ministry of Transportation & Infrastructure
PO Box 9055 Prov. Stn. Govt.
Victoria, BC V8W 9E2

Gary Muraca
Chief Administrative Officer
City of Williams Lake
450 Mart Street
Williams Lake, BC V2G 1N3

Murray Daly
Chief Administrative Officer
Cariboo Regional District
Suite D, 180 North Third Avenue
Williams Lake, BC V2G 2A4

Dear Ian Pilkington, Murray Daly, and Gary Muraca:

Re: Disclosure of information pursuant to ss. 25 and 33 of the *Freedom of Information and Protection of Privacy Act,* R.S.B.C. 1996, C. 165 ("FIPPA")
Our File No.: T21-051

We write on behalf of the Association of Professional Engineers and Geoscientists of the Province of British Columbia, also operating as Engineers and Geoscientists BC. We write pursuant to our obligations under sections 25 and 33 of FIPPA to disclose information we have obtained regarding the Hodgson Road Landslide ("HRL"), a historic landslide near the City of Williams Lake that appears to have reactivated in recent decades, to the BC Ministry of Transportation and Infrastructure ("MOTI"), the Cariboo Regional District, and the City of Williams Lake (collectively, the "Recipients").

Engineers and Geoscientists BC is currently investigating the work of a registrant of Engineers and Geoscientists BC related to a property within the Williams Lake Fringe Area Official Community Plan - Geotechnical Hazards Development Permit Area (the "Investigation"). As part of the Investigation, Engineers and Geoscientists BC retained Calvin VanBuskirk, P.Eng., P.Geo., as an independent expert reviewer (the "Expert"). While conducting his review of the materials and information obtained by Engineers and Geoscientists BC during the Investigation, the Expert expressed concerns regarding the HRL, specifically regarding slope stability within the Dog Creek subdivision and the

portion of the City of Williams Lake located within and adjacent to the HRL. The Expert's complete analysis, concerns, and recommendations are summarized in the August 16, 2023 letter enclosed with this letter (the "VanBuskirk Letter"). The Expert's general concerns are summarized below.

The VanBuskirk Letter identifies land use changes, surface water diversions and blockages the Expert believes caused the HRL reactivation and expansion in the past 25+ years. The Expert believes the issues identified through his review are still present, have not been mitigated, and may have been overlooked in prior studies of the HRL by the Recipients and others.

The VanBuskirk Letter describes the landslide risks as "very high with respect to infrastructure (including homes) and public safety. These risks extend beyond the currently identified landslide boundaries and include upslope and westward expansion of the slide." The VanBuskirk Letter warns that increased landslide movement and expansion may occur "during the next significant rain, rain on snow, or rapid snowmelt event." The VanBuskirk Letter further explains:

> With the drainage remaining diverted into the landslide, the timing for when the landslide movement will likely increase and expand will depend on the weather. Falls storms, such as those which occurred in 2020 and 2021 would likely result in renewed movement of the landslide and possible landslide expansion. This, in my opinion would represent a very high risk to those living within the landslide zone (both the active and the estimated expanded zone). Movement would also represent a very high risk to vehicle traffic traveling across the landslide zone, including but not limited to Dog Creek Road, Roberts Drive, Hodgson Road, and Highway 20.

The VanBuskirk Letter maps out the potential landslide expansion the Expert believes is likely if mitigation does not occur. After receiving the VanBuskirk Letter, Engineers and Geoscientists BC received GPS monitoring data for the HRL from 2015 to 2019 from the City of Williams Lake through a request for information pursuant to FIPPA. We understand McElhanney consultants provided this data. The Expert believes the data confirms the expansion of the HRL and suggests the HRL has already expanded into some of the area the Expert flagged as at risk for landslide expansion. We do not know if the Recipients possess more recent GPS monitoring data beyond 2019.

The VanBuskirk Letter provides two possible recommendations for mitigating the HRL: (1) stopping the diversion of Prima Creek down Gibbon Road, and (2) reconnecting Perreault Creek to Rutley Creek. The VanBuskirk Letter notes that assessment of the Prima Creek basin should be a priority as flows appear to be steadily increasing. The VanBuskirk Letter provides some specific suggestions on how to achieve these mitigative measures and things to consider while the mitigative measures are being undertaken.

FIPPA

Pursuant to section 25(1) of FIPPA, Engineers and Geoscientists BC "… must, without delay, disclose to the public, to an affected group of people or to an applicant, information

(a) about a risk of significant harm to the environment or to the health and safety of the public or a group of people, or

(b) the disclosure of which is, for any other reason, clearly in the public interest."

Engineers and Geoscientists BC takes the position that the VanBuskirk Letter indicates the HRL may pose a risk of significant harm to the environment or to the health or safety of the public or a group of people and as a result, believes the disclosure of this information is clearly in the public interest. We understand that existing infrastructure, including many residences, is potentially affected by the expansion of the HRL and understand there may be new developments planned and/or underway in affected areas. The VanBuskirk Letter identifies one development the Expert believes is currently under construction (Deer Park Terrace).

Pursuant to section 33(3)(a)(i) of FIPPA, Engineers and Geoscientists BC may also disclose personal information if the Privacy Head of Engineers and Geoscientists BC determines that "compelling circumstances that affect anyone's health or safety exist."

The Privacy Head of Engineers and Geoscientists BC has determined that sections 25(1)(b) and 33(3)(a)(i) of FIPPA are engaged in these circumstances. Prior to making this disclosure, we notified the registrant under investigation, the complainant, and the Office of the Information and Privacy Commissioner for BC of our intention to do so.

We understand MOTI is investigating landslides affecting Highway 20 at Hodgson Road/Dog Creek Road. We also understand the Cariboo Regional District commissioned and released a slope stability study within the City of Williams Lake and the surrounding fringe area in 2022. We do not know the full extent of the Recipients' investigations into the cause of the reactivation or the expansion of the HRL, nor do we know the extent of the Recipients' knowledge/information sharing about current risks that exist because of the HRL. Therefore, we are disclosing the VanBuskirk Letter on the basis that further information may assist all parties in ensuring the safety of the region.

Role of MOTI, Cariboo Regional District, and City of Williams Lake

The mandate of Engineers and Geoscientists BC is to protect the health, welfare, and safety of the public and the environment. Accordingly, we are disclosing the VanBuskirk Letter for your consideration.

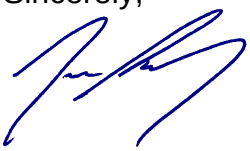
To clarify, the role of Engineers and Geoscientists BC as the licensing and regulatory body for professional engineers and geoscientists in British Columbia is limited to the investigation and discipline of its registrants and former registrants. Engineers and

Geoscientists BC does not have the authority or jurisdiction to take steps to mitigate the HRL. It is the Recipients' responsibility to ensure public safety in or around the HRL. We expect the Recipients to do everything in their authority to ensure the public is protected.

While the VanBuskirk Letter provides mitigation recommendations, Engineers and Geoscientists BC is aware the Recipients may have more information and knowledge related to the HRL than the Expert and Engineers and Geoscientists BC. Engineers and Geoscientists BC is not specifically recommending that the Recipients carry out the mitigation recommendations outlined in the VanBuskirk Letter. However, Engineers and Geoscientists BC does suggest that any geotechnical professionals assessing the HRL's reactivation consider the information and mitigation recommendations in the VanBuskirk Letter.

If you have any questions or concerns regarding this letter, please do not hesitate to contact me.

Sincerely,



Jesse Romano
Associate Director, Investigation and Discipline
Direct: 604.558.6647
Email: jromano@egbc.ca

cc Liza Aboud, Chief Operating Officer, Head of Privacy
Efrem Swartz, LLB, mMBA, Director, Legislation, Ethics and Compliance
Cheryl Cuddie, Investigation Manager
Kelly Firth, Investigator

Enclosures:

1. 2023-08-16 LF Calvin VanBuskirk to Engineers and Geoscientists BC

terratech CONSULTING LTD. (BRITISH COLUMBIA)

GEOTECHNICAL ENGINEERS &
TERRAIN SPECIALISTS

Terratech Consulting Ltd.
5272 Cordova Bay Road
Victoria, B.C
V8Y 2L4

16 August 2023

ENGINEERS AND GEOSCIENTISTS BC
200 – 4010 Regent Street
Burnaby, BC Canada
V5C 6N2

Attention: Kelly Firth

Email: kfirth@egbc.ca

Re: Hodgson Road Landslide – Williams Lake, BC

Dear Kelly

This letter is to highlight an important issue that I have identified in the course of ongoing professional services I am providing to EGBC. I have concerns regarding reactivation of the Hodgson Road Landslide (HRL), specifically regarding slope stability within the Dog Creek subdivision and the portion of the City of Williams Lake located both within and adjacent to the HRL.

As part of ongoing professional services provided to EGBC, I have conducted a review of the background information provided by EGBC; relevant information readily available on the internet; and historical aerial photographs (available from the UBC Airphoto Library). I have undertaken a preliminary (six hour) field review of the landslide site and relevant upslope area. I have commissioned the preparation of LiDAR images and 1m contour maps of the subject area using 2019 open-sourced LiDAR data.

The information I have collected and reviewed to date suggests that the reactivation of part of an "Ancient" Landslide, the HRL, is most likely caused by a combination of concentration and diversion of water from a significant watershed area upslope of the slide (the Prima Creek basin); the infilling of a spring (Carswell Creek) within the middle portion of the slide; and the diversion of another Creek (Perreault Creek) just upslope of the HRL. The rate of water flow into the landslide is estimated to be about 10 litres per second, which equates to a total annual volume of over 300,000 cubic metres (300 million litres). These diversion and blockages appear to agree temporally and spatially with the movement of the HRL. In addition, land use changes over the past several decades (including forest operations) have also likely increased the volume of surface run-off being directed towards the active landslide, resulting in accelerated movement and enlargement of the landslide.

Based on my experience investigating landslides over the past 30 plus years, the assessment of surface water flows and their contribution to slope instability is often overlooked during landslide investigations.

It is my understanding that the surface water issues I have identified in the HRL area are still present and have not been mitigated. I suspect landslide investigations to date have not identified these issues as factors in the reactivation and enlargement of the landslide.

I understand that the BC Ministry of Transportation and Infrastructure (MOTI) is currently undertaking another study of the HRL, which involves additional drilling investigations and installation of slope inclinometers and vibrating wire piezometers to measure slope movement at depth, and groundwater pressure, respectively. Past reports I have read refer to draining the landslide via wells, horizontal drains, or drainage adits. I have not seen any reports to date which have identified the surface water flows being diverted into the landslide headscarp.

As long as these diversions remain active, I believe the HRL will continue to move and likely enlarge, resulting in more damage to homes and infrastructure. Damage to roads often results in drivability issues and issues related to snow plowing, which can and do contribute to motor vehicle accidents. I feel the landslide risks very high with respect to infrastructure (including homes) and public safety. These risks extend beyond the currently identified landslide boundaries and include upslope and westward expansion of the slide. Both increased rates of movement and landslide expansion is possible during the next significant rain, rain on snow, or rapid snowmelt event.

The follow executive summary is provided as a brief explanation of the site conditions, causes of the landslide and practicable steps which should be taken to remediate slow / arrest the movement.

Executive Summary

The Hodgson Road Landslide (HRL) was first detected in about 1993. The original movement was confined to within the City of Williams Lake (CWL) and impacted roads, utilities, and buildings as well as Highway 20 (the jurisdiction of MOTI). Image 1 shows the location and initial extent of the HRL with respect to the responsible land jurisdictions. The initial landslide was in the order of 35 to 40ha and is situated mostly on gentle slopes. Between 1997 and 1999 the landslide was investigated by Golder Associated Ltd (GAL), and recommendations were made to dewater the landslide by installing pumped wells and / or horizontal drains.[1] It is my understanding that no stabilization measures have been undertaken to date.

The HRL expanded upslope (southward) in about 2015, crossing Dog Creek Road and entering the Cariboo Regional District (CRD) jurisdiction. The expanded landslide is about 48ha in size and involves an estimated 14 million cubic metres of material. As a result of this expansion out of the CWL and into the CRD, the landslide impacted more roads managed by MOTI as regional district roads are the responsibility of MOTI. The approximate boundaries of the expanded HRL are shown on Image 2. This

[1] Golder Associates Ltd. Technical Memorandum 3 Slope Stability Analysis Hodgson Road Slide Williams Lake, BC, October 1999.

image also shows the number of properties impacted and potentially impacted by instability in the HRL area.

None of the reports I have read studying the HRL appear to have considered the impact that residential development and other upslope land use practises have had on the stability of the HRL. The upslope development (within the Dog Creek subdivision) has resulted in a significant diversion of surface water flows into the HRL. The culverts and associated drainage paths through the subdivision and towards the HRL are shown on Image 3. Without the context of the upslope catchment areas (basin or watersheds), the significance of the drainage diversions within the subdivisions is not apparent. Image 4 provides some clarity to the significance of the drainage alterations within the Dog Creek subdivision.

The diversion of surface water flows towards the HRL has changed the contributing area from about 22.4ha prior to the completion of Gibbon Road the early 1970s to 317ha following Gibbon Road construction with the potential that an additional 48.4ha may also be draining into the landslide from potential diversions within the Esler area to the west-southwest. This would bring the total diverted area to 365.4ha, an increase of over 1500% since the early 1970s.

In addition, it appears that groundwater levels have risen considerably within the Prima Creek basin since the mid 1990s. This has resulted in a decrease in annual water storage capacity within the basin, which in-turn appears to have resulted in higher water flows within Prima Creek. The timing and recurrence of high-water flows within Prima Creek is confirmed by the numerous reports from local residence of flooding caused by Prima Creek and its diversion into the Dog Creek subdivision. https://www.wltribune.com/news/i-could-hear-the-water-roaring-outside-heavy-rain-in-williams-lake-floods-homes/

Between about 1994 and 1995 about 40 townhomes were constructed on the HRL southwest of the Cariboo College site. This development is known as Terra Ridge. The site grading for this development is understood to have resulted in the infilling of the Carswell Creek gully and the installation of a subdrain system for manage to the water flows. It is understood that this subdrain system was repaired in or about 2019 as water pressures behind an associated retaining wall had caused distress in the wall [2].

A reasonable estimate of the flow from a small catchment such as Carswell Creek, based on a typical annual yield, may be about 0.5 to 0.7 litres per second (L/s). Expanding the watershed basin area to around 360ha may have increased the flows to about 10 L/s. This average rate of flow equates to over 340,000 m^3 of water annually. Given the landslide involves about 48ha, this volume, evenly distributed over the surface, would be 0.72m deep. Assuming the drainage system at the Terra Ridge development is 50% effective, the annual water volume available to elevate the groundwater would be about 0.36m. If a porosity of the soils is assumed be between 15 and 25%, the diversion would have the potential to increase the groundwater levels within the HRL by 1.4 to 2.4m per year. Based on GALs slope stability

[2] Evergreen Geotechnical Inc, 2019 Williams Lake Pioneer Complex, 351 Hodgson Road, Annual Geotechnical Review, dated September 23rd, 2019 https://www.rbauction.com.mx/cms_assets/pdf/real-estate/williams-lake-2019157/2019-pioneer-complex-annual-geotechnical-review-report.pdf

analysis, this would decrease the factor of safety (FoS) of the landslide by about 5 to 10% per year. Assuming it took 3 to 4 years from the time the Carswell Creek was infilled in about 1993 and the time the landslide movement became problematic in late 1996 or early 1997, it is possible that the FoS of the slope was over 1.15 and possibly over 1.3 prior to the major diversions and subsequent infilling of Carswell Creek. In summary, it is likely that the combination of infilling the Carswell Creek channel, and diverting Prima and Perreault creeks into the landslide, combined to trigger the movement of the slope which has been ongoing for over 25 years.

Recommendations

Considering the above impacts of the observed drainage diversions into the HRL, the damage caused by the landslide, the risk of further damage to roads, buildings, and infrastructure, and the potential risk to public safety, I suggest the authorities be notified of the drainage issues so that mitigative actions can be taken prior to the fall of 2023.

Image 5 shows the location for mitigating the drainage issues related to the HRL hazard. The proposed mitigation for the HRL involves both 1 and 2 with 1 having two options. Both 1 and 2 also have the option of utilizing stormwater pipes to return flows to their original paths.

1. Stop the diversion of Prima Creek down Gibbon Road. This can be done by one of two options:

    - Option A – Reinstate the original stream channel by installing culverts at the appropriate locations on Gibbon Road and Conrad Cresent (two culverts). Channeling the flows between these two locations will require the cooperation of property owners. Culverts on Roberts Drive and Dog Creek Road are already in-place as these two roads existed prior to Prima Creek being diverted at Gibbon Road. If it is not practicable to obtain cooperation with the property owner, then it would be possible to reconnect Prima Creek with its original channel by using a combination of open ditches and stormwater pipes along the east side of Balsam Street.

    - Option B – Direct Prima Creek into an old gully to the west. This will require the installation, maintenance, replacement of a culvert on Roberts Drive. As the flows would reconnect with the original Prima Creek channel upslope of Dog Creek Road, no additional culverts would be required at Dog Creek Road.

    With either option the proposed channel paths, between Gibbon Road and Dog Creek Road, will need to be assessed in the field to determine any other measures which may be required to address issues such as private infrastructure development within / adjacent to the proposed channel.

2. The reconnection of Perreault Creek to Rutley Creek will require an assessment of the existing and old infrastructure to determine if some old drainage systems exist in this area which had connected Perreault and Rutley Creeks in the past. It is suspected that the development of the

trailer park on Dog Creek Road, which infilled a section of Rutley Creek, may have provided a culvert for Perreault Creek as two culverts were observed in the field to be emerging from the embankment fill across Rutley Creek. One of the culverts was flowing and aligned with the Rutley Creek Channel. The second culvert appeared to align more with Shaw and Dog Creek junction. However, this culvert could be for local site drainage. Determining a practicable approach to reconnecting Perreault Creek with Rutley Creek will likely require some cooperation with the owners of the Trailed Park. However, as with Prima Creek, it would be possible to direct Perreault Creek into Rutley Creek using a stormwater piping system. In this situation the water flows could be conducted across the Dog Creek Road at Shaw Road, then down the east side of Dog Creek, past the Trailer Park boundary, then east into the Rutley Creek gully. See Image 7 for a view of the Rutley Creek gully and associated culvert at the trailer park. Reconnecting Perreault Creek to Rutley Creek will require the assessment of the Rutley Creek channel between the Trailer Park and Hodgson Road.

3. Water flow paths along Winger Road and downslope to Roberts Drive should be assessed so that mitigative measures can be developed to correct the drainage issue and stabilize the Dog Creek Debris Flow. The potential for water concentrations and diversions upslope (west of highway 20) should also be assessed as part of a Dog Creek Debris Flow assessment.

For the proposed mitigation works noted in 1 above, the design will need to be mindful of the current drainage conditions along Hodgson Road between the South Lakeshore and Dog Creek. Image 8 shows the discharge from the combined, diverted drainage as of May 2021 and Image 9 shows the discharge from the Prima Creek channel location at 419 Hodgson Road. As Prima Creek will be flowing into the channel at 419 Hodgson Road, the channel and associated infrastructure, including consideration of the licensed water works in the area, will need to be considered.

If the water flows from Prima and Perreault creeks are not directed away from the HRL, it is likely that the landslide will continue to move and expand. This will likely affect existing development as well as development (houses) which is currently under construction, this includes the Deer Park Terrace development. Image 6 shows the approximate boundary of potential likely westward expansions of the HRL and the development likely to be impacted. In my opinion, the slide could expand from 48ha to possibly 80ha and involve dozens of residences in the upper slide zone.

With the drainage remaining diverted into the landslide, the timing for when the landslide movement will likely increase and expand will depend on the weather. Falls storms, such as those which occurred in 2020 and 2021 would likely result in renewed movement of the landslide and possible landslide expansion. This, in my opinion would represent a very high risk to those living within the landslide zone (both the active and the estimated expanded zone). Movement would also represent a very high risk to vehicle traffic traveling across the landslide zone, including but not limited to Dog Creek Road, Roberts Drive, Hodgson Road, and Highway 20.

As flows within the Prima Creek basin appear to be steadily increasing, future assessment of the basin should be undertaken as another priority issue, as Prima Pond has no outlet and is approaching a

condition of potential breach, which could result in significant damage to downslope residence in the Mountview, Gibbon, Balsam, and Conrad Cresent areas. Such a breach could potentially lead to injury and loss of life. Image 10 provides additional details regarding the Prima Pond area.

While assessments and mitigative works are underway, within the catchment areas of the HRL, it is recommended that forest operations be suspended / deferred.

Closure

Thank you for reviewing this letter and I hope that it has conveyed the level of concern I have regarding the slope stability issues present within the Dog Creek subdivision and the portion of the CWL located both within and adjacent to the HRL.

In keeping with Principle 1 of the Code of Ethics, I request that this information be brought to the attention of MOTI, the CWL, and the CRD so that diversion mitigation strategies can be developed and implemented prior to the fall rains of 2023 and spring freshet of 2024.

Please contact me if you have any questions.

Yours truly

Terratech Consulting Ltd.

Calvin VanBuskirk, P.Eng., P.Geo., FEC, FGC

Attachments: Images 1 to 10

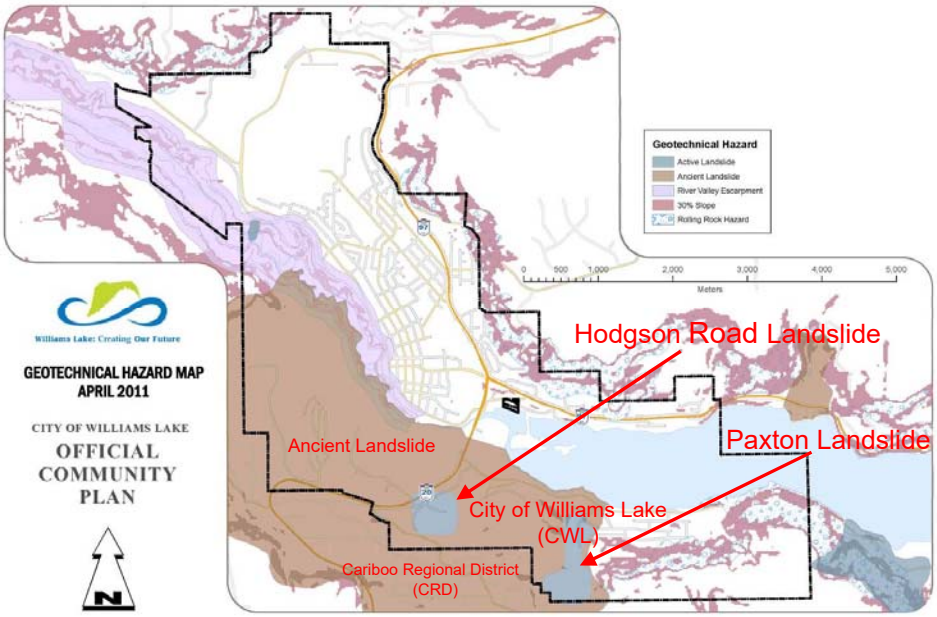


IMAGE 1 – CITY OF WILLIAMS LAKE GEOTECHNICAL HAZARD MAP (DOWNLOADED FROM THE CITY'S WEBSITE ON 6 JUNE 2023). ANNOTATIONS (IN RED) ADDED FOR REFERENCE PURPOSES.

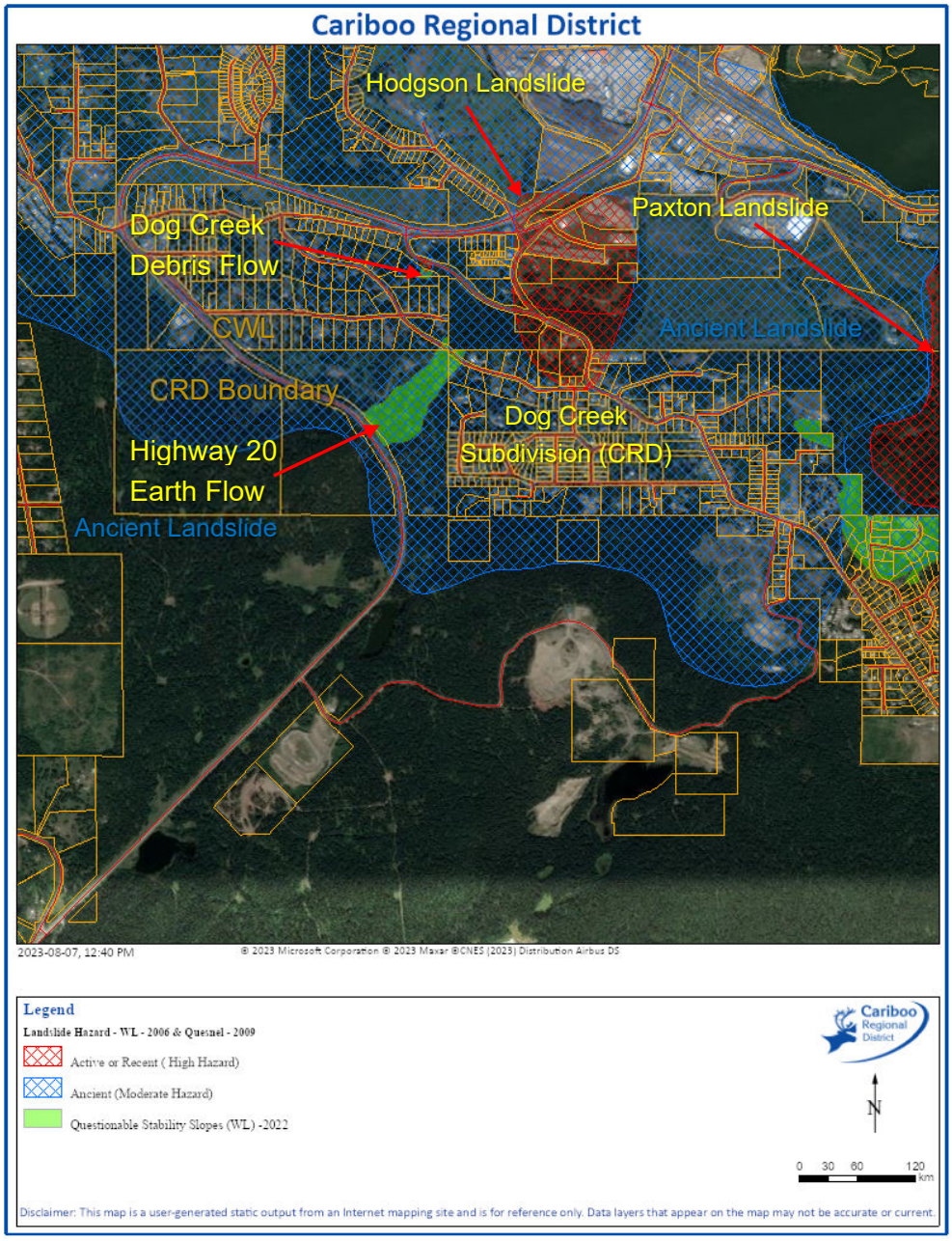


IMAGE 2 – CARIBOO REGIONAL DISTRICT GEOTECHNICAL HAZARD MAP DOWNLOADED 7 AUGUST 2023. KEY FEATURE ANNOTATIONS ADDED FOR DISCUSSION PURPOSES.

Engineers and Geoscientist BC (EGBC) 16 August 2023
Hodgson Road Landslide

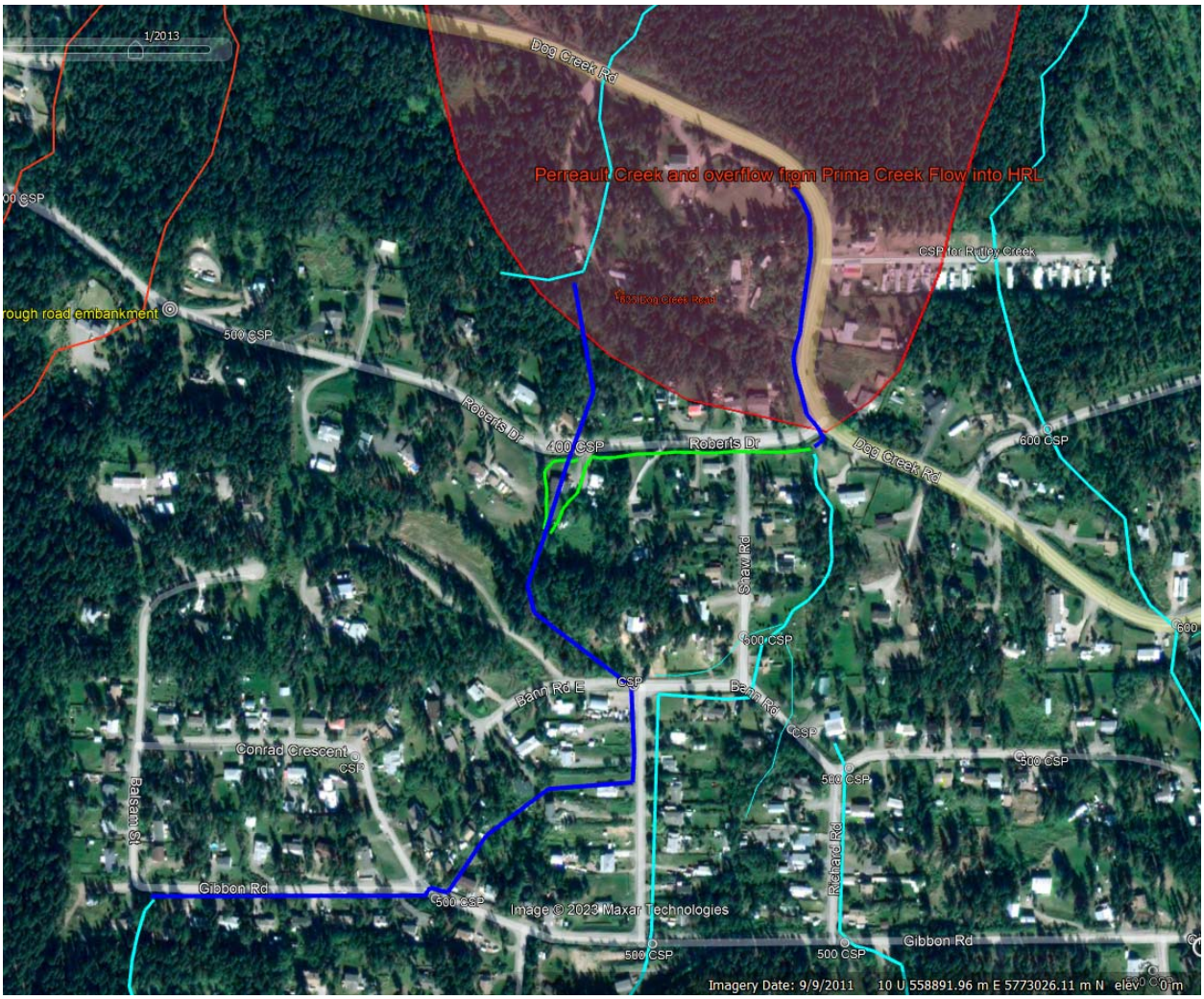


IMAGE 3 – DRAINAGE WITHIN THE DOG CREEK SUBDIVISION AS RELATED TO THE HODGSON ROAD LANDSLIDE. THE LIGHT BLUE ARE DRAINAGE PATHS, THE DARK BLUE ARE DRAINAGE PATHS CONSIDERED TO BE A SIGNIFICANT ALTERATION. THE LIME GREEN LINES ARE EXAMPLES OF TEMPORARY DIVERSIONS NOTED IN 2020. THE CULVERTS ARE CORRUGATED STEEL PIPE AND ARE ABBREVIATED AS CSP. THE NUMBER IN FROM FRONT OF THE CSP IS THE PIPE DIAMETER IN MM, WHERE KNOWN.

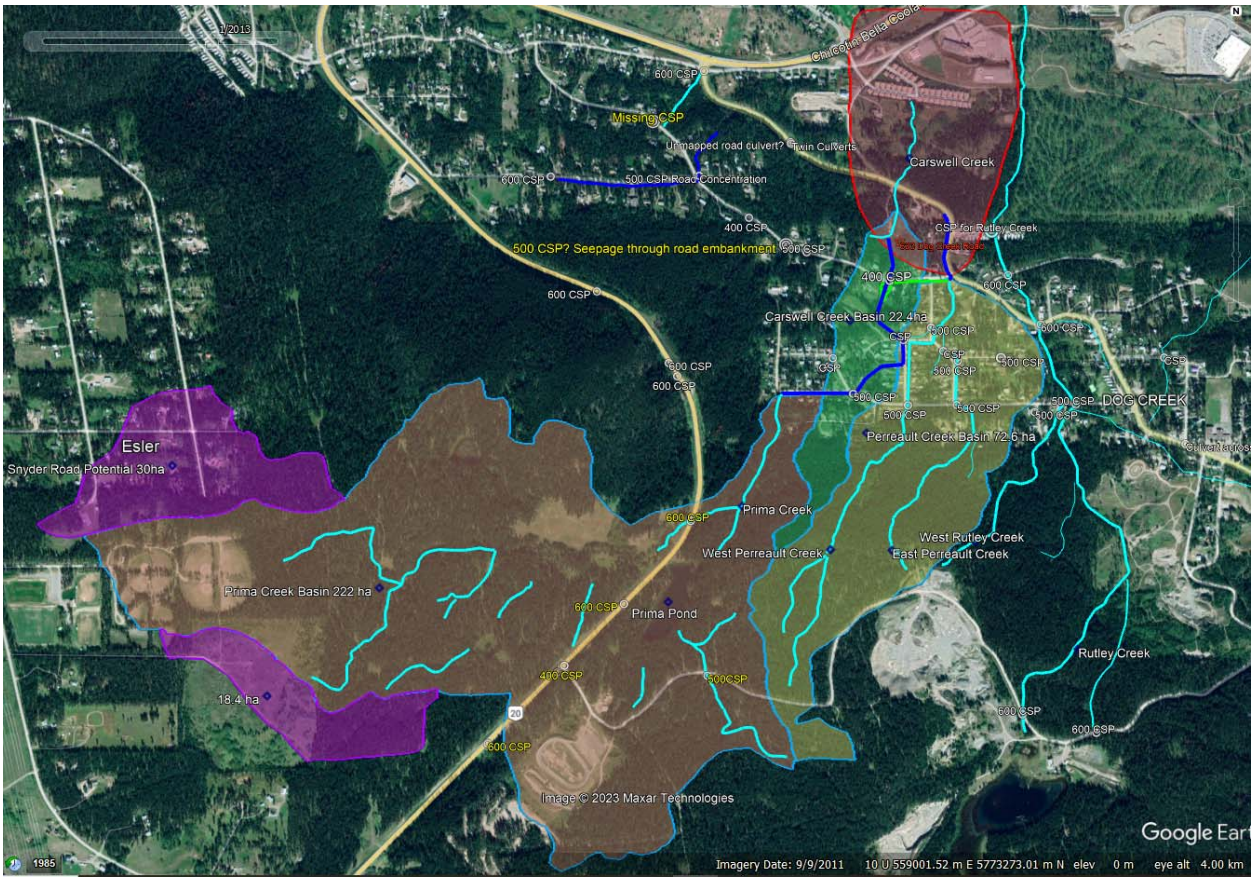


IMAGE 4 – BASIN AREA CONTRIBUTING SURFACE WATER AND LIKELY SUBSURFACE WATER FLOWS TOWARDS THE HODGSON ROAD LANDSLIDE.

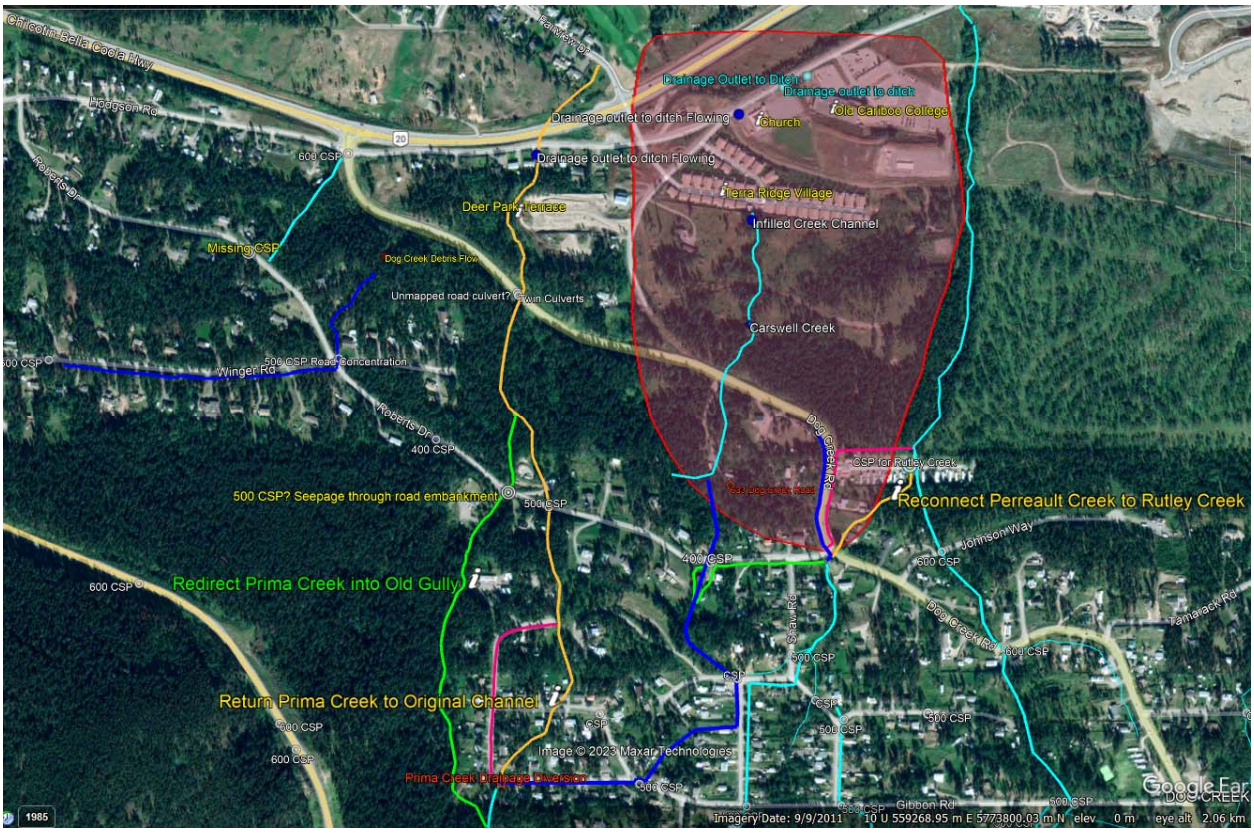


IMAGE 5 – PROPOSED LANDSLIDE MITIGATIVE MEASURES TO ADDRESS DRAINAGE ISSUES WITHIN THE DOG CREEK SUBDIVISION. RETURNING PRIMA CREEK TO THE ORIGINAL CHANNEL WILL REQUIRE THE ADDITION OF CULVERTS ON GIBBON ROAD AND CONRAD CRESENT. REDIRECTING PRIMA CREEK INTO AN OLD GULLY TO THE WEST, WILL REQUIRE THE INSTALLATION, MAINTENANCE, REPLACEMENT OF A CULVERT ON ROBERTS DRIVE. THE RECONNECTION OF PERREAULT CREEK TO RUTLEY CREEK WILL REQUIRE AN ASSESSMENT OF THE EXISTING AND OLD INFRASTRUCTURE TO DETERMINE IF SOME OLD DRAINAGE SYSTEMS EXIST IN THIS AREA WHICH HAD CONNECTED PERREAULT AND RUTLEY CREEKS. WATER FLOW PATHS ALONG WINGER ROAD AND DOWNSLOPE TO ROBERTS DRIVE SHOULD BE ASSESSED SO THAT MITIGATIVE MEASURES CAN BE DEVELOPED TO CORRECT THE DRAINAGE ISSUE AND STABILIZE THE DOG CREEK DEBRIS FLOW. THE POTENTIAL FOR WATER CONCENTRATIONS AN DIVERSIONS UPSLOPE (WEST OF HIGHWAY 20) SHOULD ALSO BE ASSESSED AS PART OF THE DOG CREEK DEBRIS FLOW ASSESSMENT.

Engineers and Geoscientist BC (EGBC) 16 August 2023
Hodgson Road Landslide

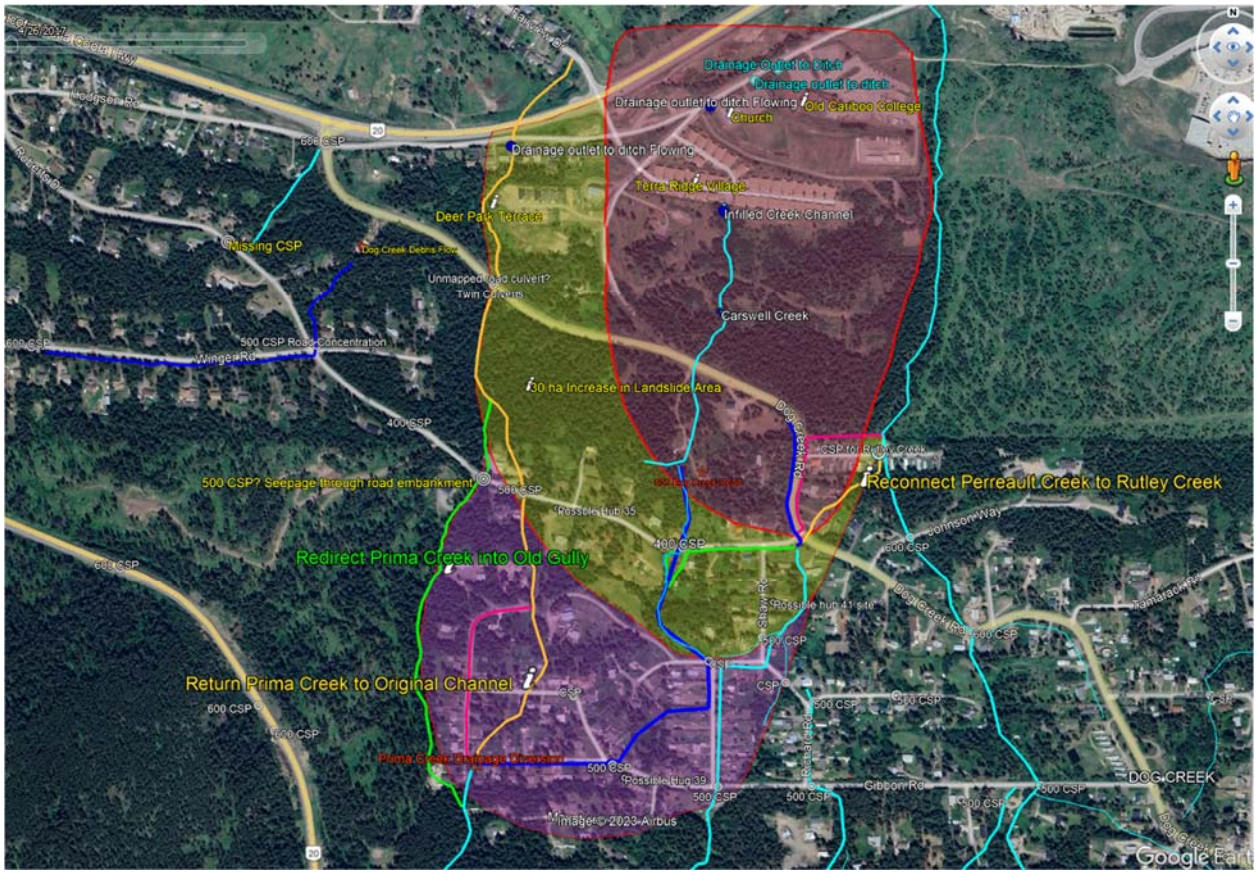


IMAGE 6 – POTENTIAL EXPANSION OF THE HODGSON ROAD LANDSLIDE WHICH IS LIKELY IF MITIGATION WORKS ILLUSTRATED ON IMAGE 5 ARE NOT UNDERTAKEN.

IMAGE 7 – VIEW LOOKING NORTH DOWN THE RUTLEY CREEK GULLY FROM THE EMBANKMENT FILL CONSTRUCTED ACROSS THE GULLY FOR THE TRAILER PARK. RECENT FILL ON THE SURFACE MAY HAVE BEEN PLACE HERE AS A RESULT OF RECENT ROAD WORKS AT SHAW AND DOG CREEK ROADS.

IMAGE 8 – STEADY WATER FLOWS FROM POND SOUTH OF 419 HODGSON ROAD. POND DOES CONNECT TO LICENSED WATER WORKS. FLOWS IN THE GULLY ARE SUSPECTED TO ALIGN WITH PRIMA CREEK. THERE ARE LICENSED WATER STRUCTURES ASSOCIATED WITH THIS LOCATION WHICH WILL NEED TO BE CONSIDERED WITH THE MITIGATIVE OF DRAINAGE FROM THE DOG CREEK SUBDIVISION AS THIS IS THE PRIMA CREEK CHANNEL.

IMAGE 9 – VOLUME OF WATER FLOW CAPTURED FROM THE COMBINED CARSWELL, PERREAULT, AND PRIMA CREEK BASINS BEING DISCHARGED INTO THE HODGSON ROAD DITCH JUST NORTH OF THE RESERVOIR ACCESS ROAD. THIS DRAINAGE SYSTEM IS UNDERSTOOD TO HAVE BEEN INSTALLED BEHIND A RETAINING WALL CONSTRUCTED FOR THE TERRA RIDGE DEVELOPMENT IN THE EARLY TO MIDDLE OF THE 1990S. IT IS UNDERSTOOD THAT WORK WAS DONE ON THE WALL AND DRAINAGE SYSTEM IN AROUND 2019.

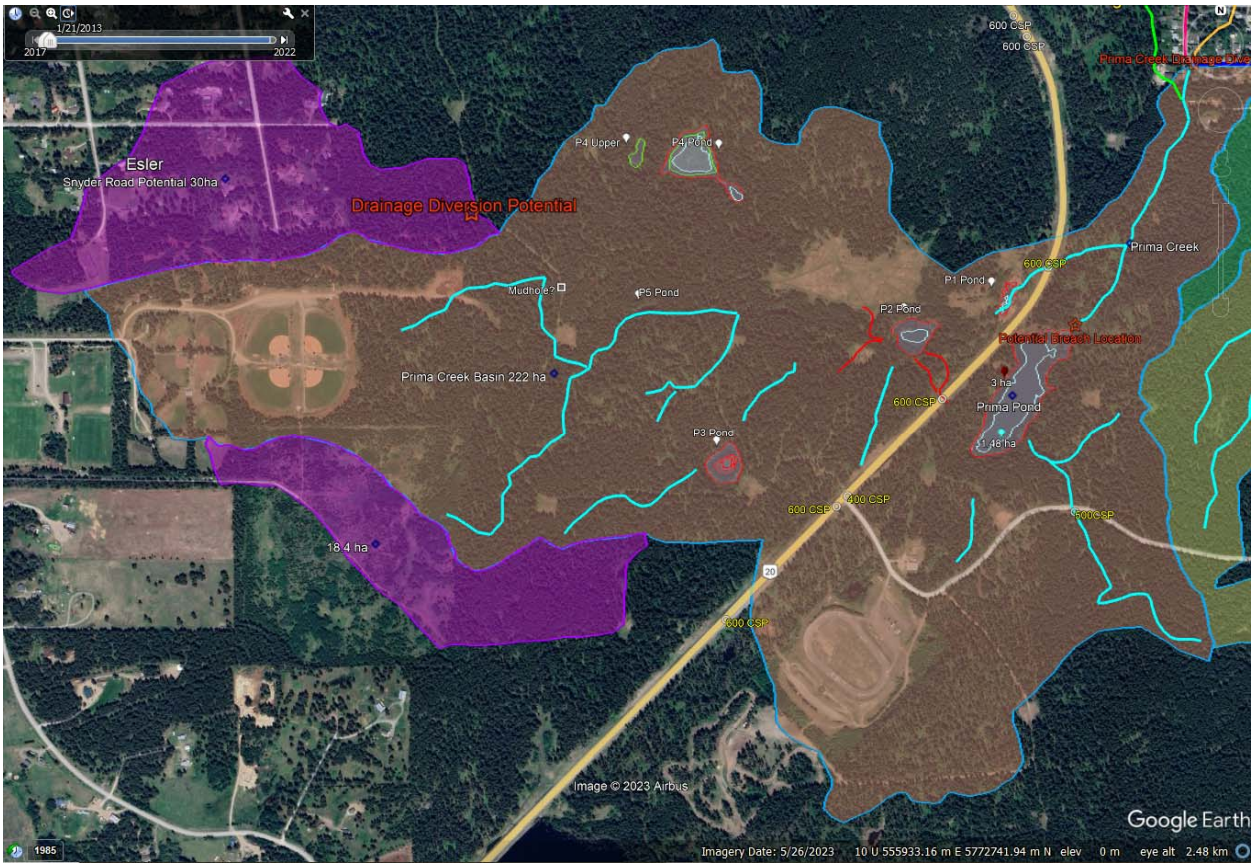


IMAGE 10 – DETAILS REGARDING THE PRIMA CREEK BASIN AND THE EXPANSION OF PONDS SINCE THE MIDDLE OF THE 1990S

TECHNICAL MEMORANDUM

DATE 6 December 2023 **Reference No.** 25502_ge_mem_0004_Hodgson_Risk_0

TO Tim Blackburn, PEng
Urban Systems Ltd.

CC Reid Drummond

FROM Ahmed ElMouchi PhD, PEng; Glen Rutherford, PEng, PMP **EMAIL ahmed.elmouchi@wsp.com; glen.rutherford@wsp.com**

HODGSON SLIDE RISK OVERVIEW, CARIBOO ROAD RECOVERY PROJECT, WILLIAMS LAKE, BC

As per the request from the Ministry of Transportation and Infrastructure (MOTI), WSP Canada Inc. (WSP) is pleased to present this technical memorandum summarizing the available information related to the risk associated with the creeping movement at 'Highway 20 (Hwy 20) at Hodgson/Dog Creek Road' site, hereinafter referred to as the Hodgson Slide site. This forms a crucial part of the Cariboo Road Recovery Projects (CRRP).

The Hodgson Slide project is one component of the comprehensive CRRP initiative led by MOTI to address various geohazards and concerns affecting, or with the potential to impact, highways in the Cariboo region. WSP is providing these services to Urban System Limited (USL) under a subconsultant agreement dated 28 October 2022., as part of the 'Cariboo Road Recovery Projects' prime agreement (The Prime Agreement) between MOTI and USL (contract reference number 268 CS 1825) dated 24 October 2022.

WSP's scope for this task is exclusively confined to reviewing available information regarding slide risk. It does not encompass provisions for investigation, analytical testing, or assessment of potential soil and/or groundwater contamination at the site, nor does it include considerations for archaeological, hydrogeological, hydrotechnical, or bio-environmental aspects.

Where comments are made on general site conditions and impacts on future construction, they are provided to highlight aspects that have the possibility of affecting the design of the project. Those requiring information on geotechnical aspects of the site beyond the scope of this memorandum must make their own interpretation of the subsurface information, particularly as it affects their proposed construction methods, costs, equipment selection, scheduling, etc.

This document to be read in conjunction with the "*Important Information and Limitations of This Report*" which is attached following the text of this memo. The reader's attention is specifically drawn to this information as it is essential for the proper use and interpretation of this Technical Memorandum. Further to these limitations, this report also provides written consent to the British Columbia Ministry of Transportation and Infrastructure, the contractors bidding on the Hodgson Slide Remediation Project and the successful construction contractor for the Hodgson Slide Remediation Project (the "Authorized Users") as outlined in the 268 CS 1825 Contract H0461d form, to rely on this report under the same terms and conditions as WSP has with its Client for the strict purposes of the Project design, only conditional upon and governed by the Authorized User's acceptance of the conditions presented following the text of this memo.

1.0 INTRODUCTION

Hodgson Slide is an active landslide located in Williams Lake with a documented history of movement and associated structural damage spanning the past 30 years.

Golder Associates Ltd., now operating under the name WSP, undertook multiple phases of work in the Hodgson Slide area. The Hodgson Road Slide was originally identified at the University College Cariboo (UCC) Williams Lake Campus Building (now owned by others) in the early 1990's. The total size of the slide has not been fully identified but could be as large as 800 m wide by 1600 m long (Golder, 2015). The lower portion of the slide has had some instrumentation, slope indicators and piezometers, installed by MoTI and Golder in the mid to late 1990's. Slope inclinometers installed near the UCC building indicated a failure plane depth of 20 to 30 metres (Golder, 2015). During the late 1990's, survey of various observations points showed movement of the slide as high as 25 mm per week, although it was not consistent across the interpreted slide area (Golder, 2015). It was noted that some time in 2014 the slide area had regressed upslope based on the observation of distress near the Shaw Road-Dog Creek Road intersection and the requirement for repairs to the Fortis BC gas main in that area.

This technical memorandum draws heavily from these earlier phases, notably relying on the findings outlined in the report titled 'Geotechnical and Hydrogeological Subsurface Investigation Report for Hodgson Slide Road, Williams Lake, British Columbia' (Report No. 214736619-007-R-RevB, dated September 30, 2022) (Golder 2022).

Additionally, BGC Engineering Inc. submitted a technical memo to MOTI titled 'Subjective Probability of Failure Estimates for CRRP Sites – Updated DRAFT' on March 8, 2023 (BGC 2023). This memo provides a probabilistic assessment of potential road condition deterioration or failure in response to the ongoing renewed landslide activity. Notably, the Hodgson Slide site along Highway 20 was among the areas assessed in this document.

Furthermore, WSP submitted a technical memo titled 'DRAFT-Hodgson Slide Displacement, Cariboo Road Recovery Project, Williams Lake, BC' on December 1, 2023 (WSP 2023). This memo presents the interpretation and analysis of Light Detection and Ranging LiDAR data, slope inclinometer SI data and monitoring hub survey (conducted by others) enabling the calculation of the average rate of slide displacement. This memo concluded that the slide could be classified as a "Very Slow" moving landslide (following Porter et al., 2022).

This memorandum hinges on the critical information presented in these three documents to evaluate the risks to the public associated with the Hodgson Slide movement, particularly focusing on the following key areas:

1) **Public Roads and Highways**: Assessing the potential impact on transportation routes and infrastructure vital to the community's mobility.

2) **Existing Utilities**: Examining the vulnerability of essential utility lines, including water, gas, electricity, sewer, and telecommunications, to the ongoing landslide activity.

3) **Existing Structures:** Evaluating the potential risks posed to structures and properties in the vicinity of the Hodgson Slide.

2.0 SLIDE DISPLACEMENT RATE

In the Hodgson Slide Displacement memo (WSP 2023), the slide displacement rate was determined utilizing change detection maps generated from LiDAR data, data from slope inclinometers and survey of monitoring hub conducted by Fortis BC. The conclusion drawn from the slope inclinometer readings was that the annual displacement of the slide falls within the range of 80 mm to 145 mm. The survey of the surface monitoring hubs conducted by Fortis BC revealed a maximum annual displacement up to 700 mm.

In accordance with the landslide velocity classification system initially introduced by Cruden and Varnes (1996) and subsequently refined by Porter et al., (2022), the Hodgson Slide is categorized as class (2b) – “Very Slow.” This classification pertains to landslides with typical velocities ranging from 160 mm/year to 1600 mm/year.

According to Porter et al. (2022), damage expectations associated with “Very Slow” landslides can vary significantly. At the lower end of the range (class 2a), the anticipated impact may primarily manifest as increased maintenance costs. However, at the higher end (class 2b), the potential consequences escalate to the point of complete loss of serviceability or, in the most severe cases, infrastructure collapse.

Even a very slow-moving slide can gradually inflict damage on critical infrastructure. If left undetected or unattended, this damage could escalate abruptly. For instance, leaks in water, septic, or storm services may lead to unforeseen increases in movement. Moreover, stretched electrical or gas services could pose risks of fires or explosions.

3.0 PROBABILITY OF FAILURE ESTIMATES

After reviewing BGC (2023) technical memo on the probability of failure estimates for the 10 landslides within the CRRP project, the characterization for Hodgson Slide (as it impacts Highway 20) is as follows:

(i) “State C” for Hwy 20 Road Condition:

- Defined as "Above Average Maintenance and Repairs."
- Anticipated cost for MoTI (the operating agency) includes increased resources for highway upkeep, geotechnical oversight, maintenance, and mitigation activities.
- Road users can expect traffic control, short-duration lane closures, and above-average impacts on mobility. Additionally, increased vehicle wear and higher potential for accidents are anticipated.

(ii) “Very Sensitive Road” for Sensitivity Rating to Displacement:

- Hwy 20 is classified as "Very Sensitive" to displacement, especially being a Higher Speed Paved Road.

(iii) “Class 2a” for Landslide Velocity Classification:

- WSP has re- classified this slide as a "Very Slow" landslide of "Class 2b”. This was changed from what was reported in BGC 2023, following WSP’s recent review of the surface monitoring data. This reclassification is documented in the Hodgson Slide Displacement memo (WSP 2023).

(iv) "Type A" for Landslide Behaviour Type:

Type A is characterized by the following:

- Typical geology of relatively intact shales and mudstones.
- Typical failure mechanism of Translations block slides and spreads. Basal shear surface with a typical inclination of sub-horizontal (between 0 to 5 degrees).
- Absence of toe erosion.

(v) 10% Chance of Transitioning to Road Condition State D within 2 years

State D is the state where the operating agency anticipates:

- Significant emergency response actions and funding for highway safety.
- Projects are considered large and substantial.
- Ongoing geotechnical oversight, monitoring, and mitigation activities.

Moreover, the user costs associated with State D are:

- Restricted speeds.
- Frequent lane closures, with one lane typically maintained open.
- High potential for vehicle damage or accidents if vehicles pass over the site at posted speed.

(vi) 10% Chance of Transitioning to Road Condition State F within 9 years

State F is the state where the operating agency anticipates:

- Impracticality of keeping the highway open due to exorbitant maintenance costs.
- Closures lasting more than a week and potentially becoming permanent.

Moreover, the user costs associated with Class F are:

- Severe mobility impacts.
- potential detours for access.
- High likelihood of accidents for vehicles approaching the site at posted speeds.

The progression to road condition states of D and F is based on the assumption that there will be no mitigation or maintenance of the traveled surfaces.

4.0 POTENTIAL DAMAGES DUE TO SLIDE MOVEMENTS

The Hodgson Slide has demonstrated a gradual and intermittently episodic pattern of movement over its historical record. Notably, spikes in movement rates have often coincided with significant antecedent precipitation patterns.

The Geotechnical and Hydrogeological Subsurface Investigation Report submitted by Golder Associates Ltd., now known as WSP, (Golder 2022) provides a detailed visual representation of ground movement indicators at the Hodgson Slide area in Figure 4 of the report (Please Refer to Attachment 1 in this memo).

We do not anticipate an even distribution of movement across the entire slide. Based on the slide's historical behavior, our assessment suggests that the primary and most noticeable movement will be the differential movement that will occur at both the head and toe. Specifically, we expect to observe evidence of separation and crack formation at the crest, alongside heaving at the toe. The most significant disruptions are anticipated at the head (crest) and the toe (base) of the slide.

Moreover, the lateral boundaries of the slide are likely to exhibit shear behavior, resulting in multiple slide blocks within the mass moving at varying relative rates. Consequently, the impact on the public will be more pronounced around the perimeter of the slide mass but also could be seen at inter-block boundaries. Numerous surface movement indicators have been identified at these lateral boundaries such as cracks and structure damages, and these will be discussed in this section. This is a spreading type of failure. Similar to other very large block failures, there are likely multiple internal blocks of ground (almost like tectonic plates) within the landslide along which there could also be some significant differential movements.

4.1 Public Roads and Highways

As shown on Attachment (1), the impact of the continuous movement on public roads and highways is outlined by the following notations:

- Notation #5 signifies the noticeable bump in the roadway observed prior to the recent milling and resurfacing work carried out by the City of Williams Lake.
- Notation #11 refers to the ongoing milling and resurfacing work on the Chilcotin Bella Coola highway (Hwy 20), which is a direct consequence of the landslide's movement.

Due to the ongoing movement of the Hodgson Slide, it will have a substantial impact on public roads and highways. The following potential impacts are identified:

- **Disruption of Traffic Flow:** Landslide movement can lead to road closures, diversions, and traffic delays. This disruption can significantly impact transportation efficiency and the mobility of communities.
- **Safety Hazards for Commuters:** Active landslides can create hazardous conditions for drivers, including road surface deformations, debris accumulation, and unstable terrain. This presents a significant increased risk of accidents and injuries.
- **Infrastructure Damage:** Continuous landslide activity can cause structural damage to roads, bridges, and related infrastructure (e.g., concrete sidewalks, curbing, retaining walls, traffic signal wiring etc.). This necessitates extensive and costly repair and maintenance efforts.

- **Increased Maintenance Costs**: Ongoing landslide activity requires heightened levels of maintenance, monitoring, and intervention, leading to increased operational costs for transportation agencies.
- **Emergency Response Impacts**: Landslide-related road closures can impede access for emergency vehicles, potentially delaying response times in critical situations.
- **Economic Consequences:** Disrupted transportation routes can hinder the flow of goods and services, impacting local economies and industries reliant on timely transportation.
- **Long-Term Stability Concerns:** The persistent threat of landslides may necessitate significant engineering measures to stabilize affected slopes, ensuring the long-term safety of road users.

For "Very Slow “moving landslides, implementing a regimen of frequent maintenance on public roads and highways can serve as a short-term strategy to mitigate the associated impacts. This approach involves regular inspections, repairs, and monitoring activities to promptly address any signs of deterioration or instability caused by landslide activity.

The following are some of the temporary measures that could be taken to reduce the slide impact on public roads and highways:

- **Timely Identification of Issues:** Frequent maintenance patrols allows for the early detection of signs of stress, strain, or damage on roads and highways. This timely identification enables swift response measures to be implemented before issues escalate. In other similar slides, regular patrols by geotechnical personnel familiar with the slide history are also used to document changes systematically and consistently in the landform.
- **Repairing Surface Imperfections:** Surface deformations, cracks, and minor structural issues resulting from landslide-induced movements can be promptly addressed through regular maintenance. Repairs to road surfaces and stabilization efforts can help ensure continued usability and safety.
- **Clearing Debris and Material Accumulation:** Landslide events often bring about the accumulation of debris and loose materials on road surfaces. Frequent maintenance activities, such as clearing operations, help maintain unobstructed traffic flow and reduce the risk of accidents.
- **Monitoring Movement Indicators:** Continual monitoring of ground movement indicators such as surficial GPS and advanced geotechnical instrumentation is an integral part of frequent maintenance. This allows for real-time tracking of any changes or escalations in landslide activity.

It is our understanding the MOTI is undertaking regular inspections and repairs to the affected portion of Hwy 20 and other public roads per which it is responsible for.

4.2 Existing Utilities

As depicted in Attachment (1), the movement of the Hodgson Slide has continued to impact certain existing utilities within and crossing its boundaries, as detailed below:

- Notation #9 illustrates the damage sustained by the Fortis gas main, located at the intersection of Dog Creek Road and Shaw Road.
- Although not indicated in this figure, recent incidents of water-main breaks have been reported in close proximity to or around the slide boundaries. These events have been covered in the news, with additional information available in the following links:
  - https://www.wltribune.com/news/hodgson-road-land-slippage-likely-cause-of-latest-williams-lake-water-main-break-city/
  - https://www.wltribune.com/news/two-williams-lake-water-main-breaks-slated-for-permanent-repairs/

The following impacts are identified to existing utilities based on the continuous movement of Hodgson Slide:

- **Infrastructure Disruption:** Landslide movement can damage or disrupt utility lines, including water, septic, storm, gas, electricity, and telecommunications. This can result in service outages, potentially affecting the safety and well-being of affected communities. Disruption of water bearing utilities have the potential to compound the problem by adding water load to a water sensitive system, possibly increasing the displacement rate.
- **Safety Hazards**: Disrupted utilities may pose safety risks, such as gas leaks or electrical hazards, which could lead to potentially dangerous situations for residents and emergency response personnel.
- **Repair and Replacement Costs**: Restoring utilities after landslide-related damage can be expensive and may require extensive repair or replacement efforts.

Outlined below are the temporary measures aimed at mitigating the impacts associated with slide movement on existing utilities:

- **Regular Inspections and Vulnerability Assessments**: Conducting routine inspections of utility lines and associated infrastructure can help identify vulnerable points and potential areas of concern. Further, repeatable leak detection surveys and usage monitoring (including metering of input into the area and comparing that to usage metering on individual properties). This proactive approach allows for the timely detection of signs of stress or damage caused by landslide activity.
- **Preventive Maintenance:** Implementing a schedule of preventive maintenance activities ensures that utilities are in optimal condition and less susceptible to disruptions. This can include tasks such as clearing vegetation near utility lines, reinforcing vulnerable areas, and conducting tests to identify potential weaknesses. In areas of high movement, replacement of conventional piping with more flexible piping options with isolation valved present to allow for quick repairs. It is our understanding that the ministry monitoring is completed by their maintenance contractor.

- **Swift Response to Emergencies:** Establishing an emergency response plan that outlines clear procedures for addressing utility disruptions is crucial. This plan should include protocols for rapid assessment, isolation of affected areas, and prompt repair or replacement of damaged components.
- **Enhanced Monitoring Systems:** Installing advanced monitoring systems that can detect early signs of ground movement or stress on utility lines is a proactive measure. These systems can provide real-time data, enabling swift responses to potential risks.
- **Coordination with Utility Providers:** Collaborating closely with other utility providers allows for a comprehensive understanding of their specific vulnerabilities and requirements. This partnership facilitates the implementation of tailored maintenance and mitigation strategies. Fortis BC and City of Williams Lake are aware of the slide movement.
- **Public Awareness and Education:** Educating residents and community members about the potential risks associated with landslide-induced utility disruptions is crucial. This awareness can lead to more vigilant reporting of any unusual signs or incidents, enabling timely intervention.

4.3 Existing Structures

Attachment (1) shows specific structures currently impacted due to the slide movement with the following notations:

- Notation#1: Pioneer complex damage and heave.
- Notation #3: Damage to the house at 505 Wotzike Drive.
- Notation #4: Bump in the driveway of the house at 505 Wotzike Drive.
- Notation #6: Ongoing damage to the Terra Ridge Senior complex.
- Notation#10: Cracking and damage to the house at 633 Dog Creek Road.
- While not noted on the plan, there are unconfirmed reports of damage or historical damage to other structures, typically on the perimeter of the slide.

The stability and integrity of the existing structures are jeopardized by the differential movement induced by the Hodgson Slide and the following impacts are identified:

- **Structural Damage**: Landslide movement can exert considerable pressure on buildings and infrastructure, potentially leading to structural deformation, cracks, or even severe damages rendering the structure uninhabitable. Cracks and deformations were observed in different structures listed above.
- **Foundation Instability:** The shifting ground caused by a landslide can compromise the stability of building foundations, posing significant risks to the structural integrity of the affected properties.
- **Loss of Property Value**: Damage caused by landslides can lead to a decrease in property value, affecting homeowners and potentially impacting the local real estate market.
- **Safety Concerns for Occupants**: Residents within affected structures may face safety hazards, including the risk of injury, particularly in the event of structural failure. This impact is typically more applicable to faster moving slides.

The following highlight the possible temporary mitigation measures for the impacts on the existing structures due to ongoing slide movement:

- **Structural Inspection and Retrofitting**: Conduct a thorough structural assessment of at-risk buildings. Implement temporary retrofitting measures, such as bracing and shoring, to enhance the stability of vulnerable areas.
- **Emergency Repairs:** Conduct immediate repairs to address any visible damage or structural weaknesses caused by landslide movement.
- **Monitoring Systems:** Implement temporary structural monitoring systems to provide real-time data on any shifts or movements, allowing for timely response.
- **Community Awareness and Education:** Educate residents about emergency response procedures and safety precautions, ensuring they are well-informed and prepared.
- **Abandonment:** In the case of severe structural damage, the structures may have to be abandoned/evacuated to protect residents from safety concerns to occupants. In other municipalities we have seen the adoption of different land use zoning/policies that only allow development changes (renovations, repairs, additions, replacements, grading etc.) that are at least net neutral to the slides condition but preferably positive in terms of the overall risk from landslide movements. In some extreme cases we have seen a sort of 'planned abandonment' whereby properties in the worst affected areas (potential greatest differential movements) are taken back as public green space and amalgamated with other lots for lower density.

5.0 DISCUSSIONS

Risk is typically defined as an outcome of probability (likelihood) of an event occurring vs consequence of that event. Sometimes a monetary value (Quantitative or specific measures) is used to represent the consequence and sometimes a relative ranking (Qualitative or judgement based) is utilized to represent consequence in the equation, resulting in the comparative risk. The following table was developed as a general and high-level project specific risk matrix. The likelihood and consequence are defined using the terminology typically used by the MOTI risk register. Please note that the likelihood timeframe was selected to match the service state change presented in BGC (2023) memo. Currently, there has been no wholistic tabulation of the cost of impacts (i.e. Quantitative assessment), as such we have selected to present a Qualitative risk ranking.

Table 1: Table 1 - Geotechnical Risk Matrix

Likelihood of Impact occurring within 5 years				
Rare (2.5%)	Very Low	Very Low	Very Low	Low
Unlikely (14.5%)	Very Low	Very Low	Low	Moderate
Possible (40%)	Very Low	Low	Moderate	High
Likely (72.5%)	Low	Moderate	High	Very High
Almost Certain (95%)	Moderate	High	Very High	Very High
Consequence	**Incidental**	**Minor**	**Major**	**Severe**
Mobility Impact (for roadway impacts)	Restricted Travel (reduced speed, irregular surface)	Temporary Closure	Prolonged Closure	Reroute/Closure
Impact to Fitness for Purpose (for impacts to structures or Utilities)	Inconvenience or Nuisance	Damaged but repairable (still fit for purpose but requires repairs to maintain operation) minor service delays	Damaged but Repairable (not fit for purpose on a temporary basis) however it may have significant service delays	Abandonment /evacuate
Personal Safety due to direct impacts of the slide	Minor Injury (not reported)	Minor Injury	Major Injury	Death

At this time, a reasonable mitigation measure for stopping or limiting the movement of the slide has not been identified, although work is being done to prove out reasonable measures to slow the slide and reduce its impacts to manageable or acceptable levels. As such, we have elected to assess the risks for the current impacts of the slide assuming that no holistic mitigation will be conducted over the risk period.

Using this risk matrix and the inputs from the sections above we have selected the various Likelihood and Consequences, which resolve into the following risks for the Hodgson Slide. As noted above, these risks are very high level and can be further discretized and segregated into subcategories with different risk levels.

Table 2: Hodgson Slide Risks

Category of Impact	Probability	Consequence	Risk Level (for 5-year period)	Comment
Public Roads	Almost Certain	Incidental	Moderate	The return period for the road damage is about 2-5 years but within that period the damage is typically managed through maintenance making it incidental for the risk period.
Existing Utilities	Likely	Minor	Moderate	The consequence is based on historical responses from the various utilities. For example, Fortis has a program to monitor and repair its infrastructure before consequences become severe.
Existing Structures a) Perimeter of slide b) Central to slide	 Possible Possible	 Severe Minor	 High Low	The ranking separates the structures to differing impact areas as there are different movement rates between the perimeter and the central mass. If a structure happens to fall on an inter-block boundary, it will likely be affected as if it were on the Perimeter of the slide.
Personal Safety	Rare	Severe	Low	The personal safety risk is low when directly attributed to the movement of the slide as its primary cause. For example, a direct impact could be soil fall hitting people. Indirect impacts would be those relating to what happens to people in structures after they have been damaged in slide movement and are addressed in the roads, utilities or structures consequence classification.

Please note that, unlike BGC (2023) memo, these risks are assessed assuming that current temporary mitigation measures summarized in sections 4.1 to 4.3 are implemented going forward.

The following list provides specific examples of temporary mitigation measures that the various stakeholders have been implementing within the affected area that we are aware of:

1) In 2021, MOTI undertook excavation and replacement work on the heaved section of Hwy 20. This led to the restoration of a more even road surface, thereby reducing risks back to those typically associated with driving on this portion of the highway.

2) MOTI is monitoring the movement of the slide using differential LiDAR maps and slope inclinometers.

3) The City of Williams Lake has responded to water-main breaks along Hodgson Slide by replacing old pipes with high-density polyethylene pipe. This type of pipe is welded-fused, eliminating the presence of joints that could potentially separate.

4) Utility providers have proactively undertaken repair work and have established emergency response plans to promptly address any disruptions caused by the slide movement.

5) Recent evaluations of surface water management indicated that the drainage network in the Dog Creek Subdivision was in poor repair. Maintenance activities are ongoing within the drainage network above the slide, the initial phase of this work was carried out in fall of 2023.

6) Geotechnical and hydrogeological studies have demonstrated that the movement of the slide is influenced by episodic events of high precipitation, indicating the potential contribution of surface water to the slide's movement. Consequently, Urban System Limited is in the process of preparing a surface water management study with the objective of redirecting surface water away from the slide boundaries.

7) While we are unable to quantify the exact percentage of the public who are aware of the ongoing movement of the slide, we have observed support from homeowners during our geotechnical investigation within the slide. Moreover, MoTI hosted an open house for a public information session about the slide in November of 2023 and these sessions are expected to occur throughout the project.

8) The Pioneer Family Complex (previously known as the UCC) is taking measures to address distress in one of their retaining walls on the site through structural retrofitting.

These example measures collectively represent a proactive approach by stakeholders to manage and mitigate the immediate effects of the slide’s movement. Although they serve as crucial interim solutions, the pursuit of a more comprehensive, long-term mitigation strategy remains a priority. This ongoing work is essential in ensuring the safety and stability of the affected area.

6.0 CONCLUSIONS

The Hodgson slide, initially identified in the 1990s, has exhibited ongoing movement, likely preceding its official recognition. Recent instrumentation monitoring classifies the slide as a 'Very Slow' moving slide, falling into 'Class 2b' based on surface movement surveys. Based on the work done to date, we have assigned a 'Low' risk to personal safety as a direct impact of the Hodgson Slide.

However, a nuanced risk assessment reveals varying levels of risk for different elements:

- Public Roads and Existing Utilities: These are identified as having a 'Moderate' risk, emphasizing the need for vigilance and potential mitigation strategies.
- Existing Structures on the Slide Perimeter or Inter-Block Boundaries: These structures face a 'High' risk, indicating the potential for abandonment or evacuation. Strategic interventions may be imperative in these areas.
- Existing Structures Within the Slide Mass, Not on Inter-Block Boundaries: These structures are deemed to have a 'Low' risk, but ongoing monitoring and preparedness remain essential.

In conclusion, while the overall risk to public safety is categorized as 'Low,' it's imperative to recognize the nuanced risks associated with specific elements like public roads, utilities, and structures. Proactive measures, ongoing monitoring, and potential interventions are key components of a comprehensive risk management strategy for the Hodgson slide. Continued collaboration among stakeholders and a commitment to adaptive strategies will be vital for ensuring the safety and resilience of the affected area over the long term.

7.0 CLOSURE

We trust the foregoing provides you with the information that you require at this time. Should you require additional information or have any questions, please do not hesitate to contact the undersigned at your earliest convenience.

WSP Canada Inc.

Ahmed ElMouchi, PhD., PEng
Senior Geotechnical Engineer

Glen Rutherford, PEng
Senior Principal Geotechnical Engineer

AE/GR/syd

Attachments: Attachment 1 – Ground movement Indicators: Extract Factual Report Issued by Golder Associates Ltd., RevB (Sep 2022)

https://wsponlinecan.sharepoint.com/sites/ca-221-11730-02/shared documents/06. deliverables/001-issued/25502_ge_mem_0004_hodgson_risk_0/25502_ge_mem_0004_hodgson_risk_0.docx

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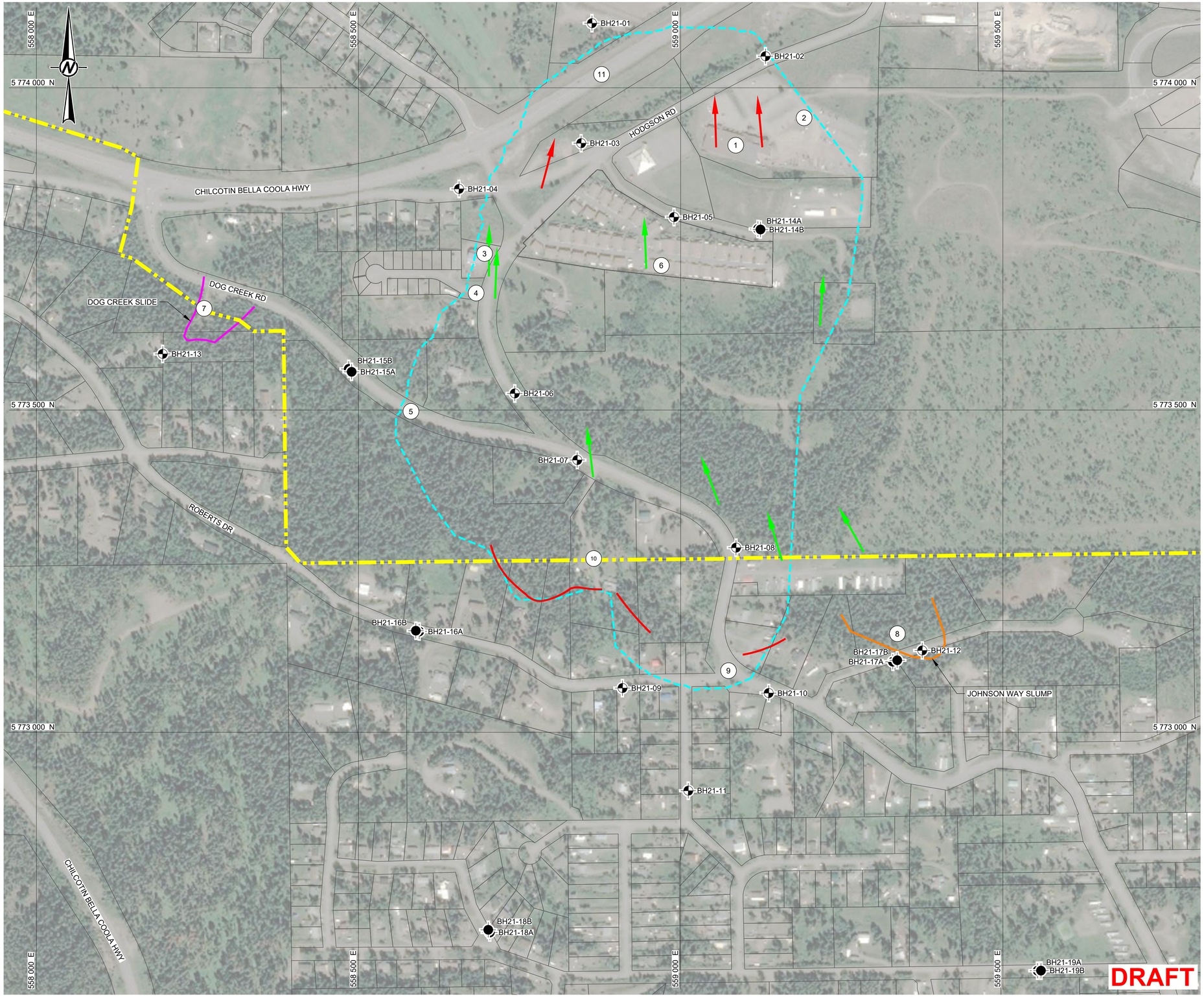
Tim Blackburn, PEng
Urban Systems Ltd.

Reference No. 25502_ge_mem_0004_Hodgson_Risk_0
6 December 2023

ATTACHMENT 1

Ground Movement Indicators: Extract from Geotechnical and Hydrogeological Subsurface Investigation Report Issued by Golder Associates Ltd., Rev B (Sep 2022)



LEGEND

- HYDROGEOLOGICAL BOREHOLE LOCATIONS
- GEOTECHNICAL BOREHOLE LOCATIONS
- PROPERTY BOUNDARY
- HODGSON SLIDE ESTIMATED EXTENTS
- DOG CREEK SLIDE
- JOHNSON WAY SLUMP
- CITY OF WILLIAMS LAKE BOUNDARY
- APPROXIMATE LOCATION OF TENSION CRACK FEATURE
- 1997 UCC CAMPUS MOVEMENT INDICATORS (APPROXIMATE DIRECTION, MAGNITUDE NOT INCLUDED)
- ONGOING MCELHANEY SURVEY 2021 DATA (APPROXIMATE DIRECTION, MAGNITUDE NOT INCLUDED)
- (#) APPROXIMATE LOCATION OF SURFACE INDICATOR (SEE TABLE FOR DETAILS)

NOTES

1. ALL DIMENSIONS IN METRES UNLESS OTHERWISE NOTED.
2. COORDINATES ARE IN NAD83(CSRS), UTM ZONE 10.
3. SURVEY DATA FOR BH21-12 AND BH21-13 WAS OBTAINED BY HANDHELD GPS IN THE FIELD AND ARE APPROXIMATE ONLY.

REFERENCES

1. © 2021 MICROSOFT CORPORATION © 2021 MAXAR © CNES (2021) DISTRIBUTION AIRBUS DS BING.
2. SURVEY OF TEST HOLES LOCATIONS BY WSP GLOBAL COMPANY, DATED: 2021-12-15.
3. BASE DATA CONTAINS INFORMATION LICENCED UNDER THE OPEN GOVERNMENT LICENCE - BRITISH COLUMBIA.

SURFICIAL MOVEMENT SUMMARY	
SURFICIAL	GENERAL DESCRIPTOR
1	1990S-CURRENT: BUILDING DAMAGE AND HEAVE
2	1990S: SLOPE INCLINOMETERS IDENTIFYING MOVEMENT AT APPROXIMATELY 20 AND 30 M DEPTH
3	PRE-2014: HOUSE DAMAGE
4	2020 - CURRENT: BUMP IN DRIVEWAY
5	2021: BUMP IN ROAD
6	ONGOING: DAMAGE
7	ONGOING: DOG CREEK SLIDE
8	ONGOING: JOHNSON WAY SLUMP
9	2014: DAMAGE TO FORTIS GAS MAIN
10	2020-CURRENT: CRACKING AND DAMAGE TO HOUSE AT 633 DOG CREEK ROAD
11	ONGOING - CHILCOTIN BELLA COOLA HIGHWAY MILLING AND RESURFACING ANNUALLY

0 100 200
1:3,000 METRES

Consultant Logo

WSP GOLDER

Rev	Date	Description	Init
B	2022-09-30	DRAFT	–

REVISIONS

BRITISH COLUMBIA

Ministry of Transportation & Infrastructure
Southern Interior Region

HODGSON SLIDE
GROUND MOVEMENT INDICATORS

PREPARED UNDER THE DIRECTION OF

ENGINEER OF RECORD

DATE 2022-09-30

SEAL

DESIGNED OK DATE 2022-09-30
CHECKED GR DATE 2022-09-30
DRAWN KDC DATE 2022-09-30
SCALE AS SHOWN
NEGATIVE No.

FILE No.	PROJECT No.	REG.	DRAWING No.
21473619-7000-7002-04.dwg	21473619		4 B

CANCEL PRINTS BEARING PREVIOUS LETTER

H-308-13-5(07-08)