Post-Wildfire Natural Hazard Risk Assessment for the Downton Lake Fire (K71649)

Report by

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Report to

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Draft: November 22, 2023
Final: December 14, 2023

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Introduction

In British Columbia, four of the most severe wildfire seasons of the last 100 years occurred in 2017, 2018, 2021, and 2023, with 2023 being the most severe wildfire season on record. After a century-long decline, fire activity increased from 2005 onwards due to rapid climate warming and increased evaporative demand. Stand conditions also affect fire behaviour, including insect outbreaks, and land-use practices (Forest Management). The compound effects of climate-induced moisture changes and altered fuels has led to a very high fire hazard (Parisien et al., 2023), especially in the dry interior forests of British Columbia.

This report presents a Post-Wildfire Natural Hazard Risk Assessment (PWNHR) for the Downton Lake Fire (K71649), located near Goldbridge, BC (Figure 1), one of the many fires that occurred in southwestern British Columbia in 2023. Downton Lake fire was identified as a fire of concern based on the following considerations:

- it was a large fire almost 10,000 ha. in size;
- it burned with moderate and high fire intensity over a large proportion of its footprint; and
- it is located above and encompasses populated areas, community watersheds, and transportation corridors.

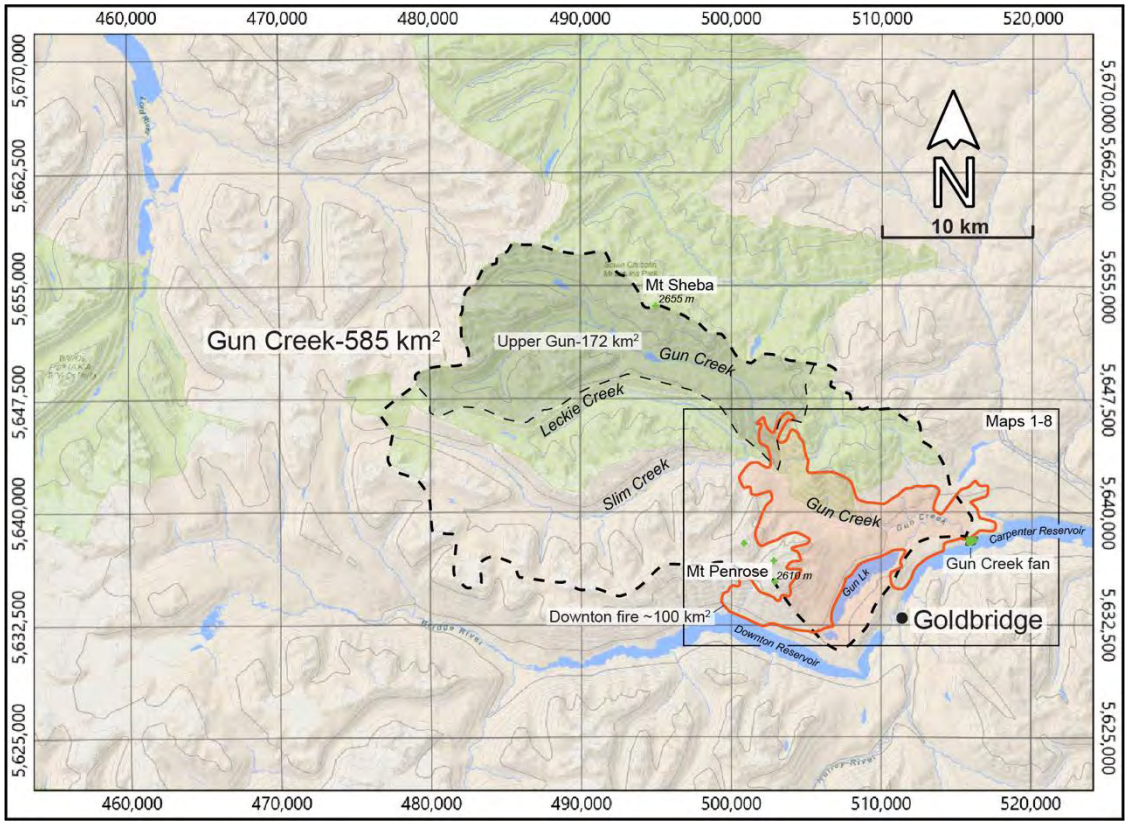

Figure 1. The Downton Lake Fire boundary as of September 17, 2023, near Goldbridge, BC.

Scope

The purpose of the PWNHR is to describe terrain hazard, the potential for downslope consequences to elements at risk, and the incremental geomorphic risk affecting those elements at risk in light of recent fire activity. A standardised approach to a typical post-wildfire risk assessment was provided by Hope et al. (2015), as summarised below:

- Assemble relevant mapping and background information.
- Identify any elements at risk from potential post-wildfire hazards including, but not limited to:
  - Residences or occupied public or private buildings.
  - Highways and arterial roads, transportation infrastructure, utilities, and industrial infrastructure.
  - Domestic and community water supplies, intakes, reservoirs, or other municipal infrastructure.
  - Recreational sites, agricultural land and any other values identified by designated MOF specialists or local authorities.
- Based on existing mapping, imagery, and/or reconnaissance of the wildfire area, identify the potential post-wildfire hazards which might affect the elements at risk. Post-wildfire hazards include:
  - Landslides, avalanches, rockfall, debris flows, debris floods, hyper-concentrated flows, or sediment laden floods, and clearwater flooding.
- Conduct field work as necessary in burned areas, to describe and map soil burn severity in relevant areas of the wildfire, and to examine potential terrain instability features.
- Conduct fieldwork to examine stream channels, alluvial fans, and potential elements at risk. Examine roads, fireguards, and other structures which might contribute to potential hazards.
- If not supplied by MOF, prepare a preliminary map showing vegetation burn severity and/or soil burn severity, and relevant natural hazard features.
- Conduct a partial risk analysis for each hazard or group of hazards, and for each element or group of elements at risk. This should include, where relevant, the background (pre-fire) risk, and the increased risk due to the wildfire.
- Identify the need for risk mitigation and provide conceptual risk mitigation options.
- Consult with representatives of local First Nations whose traditional territories may be affected by post wildfire natural hazards prior to commencing fieldwork.
- If during fieldwork or initial report preparation, potential hazards are identified which present an imminent risk to public safety, these are to be reported promptly to designated MOF and EMCR specialists.

Limitations

A Post-Wildfire Natural Hazard Risk Assessment (PWNHRA) is an emergency assessment. As such, due to time and budget limitations, the QP may not be able to apply the level of effort recommended by EGBC (2022) for a landslide assessment appropriate to the risk exposure. In the case of a PWNHRA, the intent is to conduct a rapid appraisal of the potential post-wildfire impacts affecting elements at risk within or downslope of a wildfire so that elements at risk that are subject to moderate or high post-wildfire geomorphic risks may be identified quickly and if required, mitigation measures conceptualised and implemented in advance of weather events that may trigger geomorphic response. In addition, because of time and budget constraints, it may not be feasible to have reports subject to external independent review. In that regard, the PWNHRA

must be regarded as a preliminary, or overview, assessment that directs where more detailed assessment is required to properly design and implement mitigation measures.

Hazard and Risk Definitions

The post-wildfire hazard cascade is outlined by Hyde et al. (2017): "First, the biophysical setting must include flammable vegetation on a steep, concave hillslope. Second, a moderate- to high-severity fire must occur (fire processes) that removes of a significant amount of the vegetation and changes soil properties (fire effects). Next, rainfall of sufficient intensity and duration to produce overland flow (surface runoff) must follow the fire. Runoff must accumulate and converge, entraining sediments, and flowing with sufficient force to down-cut and initiate a debris flow. The flowing mass of debris must intersect values-at-risk with sufficient volume and force to cause damage and loss. Without threat to valued resources, there is no hazard."

As outlined above, risk is the product of hazard and consequence. A hazard is usually represented by a magnitude and recurrence interval (see Table 1). Consequence (e.g., Table 2) is a product of factors, including whether a given hazard will reach a site, whether elements at risk will be present when the site is affected by the hazard, how vulnerable the elements at risk are to the hazard affecting the site, and the value of the elements at risk or the number of persons exposed. The product of the factors Hazard and Consequence equals Risk.

Table 1. Qualitative hazard frequency categories *affecting the element at risk* (i.e., PHA)

Qualitative frequency	Annual return frequency	Probability (%/50 yrs)	Comments
Very high	>1:20	>90	Hazard is well within the lifetime of a person or typical structure. Clear fresh signs of hazard are present.
High	1:100 to 1:20	40-90	Hazard could happen within the lifetime of a person or structure. Events are identifiable from deposits and vegetation, but may not appear fresh.
Moderate	1:500 to 1:100	10-40	Hazard within a given lifetime is possible, but not likely. Signs of previous events may not be easily noted.
Low	1:2500 to 1:500	2-10	The hazard is of uncertain significance.
Very low	<1:2500	<2	The occurrence of the hazard is remote.

Table 2. Simplified consequence assessment.

Consequence	Description
Very High	Direct impact with extensive structural damage; loss of life & limb.
High	Direct or indirect impact with some potential for structural damage; loss of life & limb.
Moderate	Indirect debris impact. No structural damage but damage to houses and property.
Low	Minor property damage only.
Very Low	Virtually no damage.

Landslide risk is calculated using the formula: PH * PS/H * PT/S * V * E, where

PH = probability of hazard occurring
PS/H = probability of spatial affect given the hazard
PT/S = probability of temporal effect given spatial effect
V = vulnerability of structure and risk of loss of life to persons in the home
E = element at risk

Post-Wildfire Natural Hazard Risk Assessments provide *partial* landslide risk assessment (Wise et al., 2004); whereby the assessment is concerned only with the potential for an element at risk to be affected by the hazard, where the probability of a hazard affecting, PHA = PH * PS/H.

In this report, the hazard expressed in Table 1 is defined as the hazard affecting (PHA). Alluvial fans are landforms formed at the mouth of a sub-basin by repeated debris flood/flow events depositing sediment and gradually developing into a fan-shaped deposit with <30% slope. Fans are a sedimentary archive of geomorphic history. They are also used for residential development; as such, fans are typically more hazardous than other gentle-ground building sites.

Since fans are the site of residential development, hazard frequency estimates derived from fan observations are implicit estimates of PHA. For this project, the existing hazard was estimated from investigations on the Walker Creek alluvial fan (Cordilleran 2015) and from field observations on other fans in the project area (Appendix 2). Moreover, Melton's ruggedness ratio is a watershed-based reach estimate that predicts the dominant hazard type at the fan apex (the location of elements at risk). It predicts the dominant process type presenting the PHA.

Risk Evaluation Criteria

No activity is free of risk, and the concept of safety embodies risk tolerance. In Canada and BC there is no legislated guidance for risk tolerance to landslides and associated phenomenon, and the term "safe" has not been defined. In considering risk tolerance, an important concept is that risk of loss of life from natural hazards should not add substantially to those that one is typically subject to (driving, health, recreation, etc) combined. For reference, the risk of death and injury from driving in Canada is approximately 1/10,000 and 1/1000 per annum, respectively (Transport Canada 2011).

In British Columbia, with respect to residential development the design flood level for normal hydrologic flood hazards is the 200-year return flood (WLAP 2004). Development should be safe from flood damage from the 200-year and more frequently occurring floods.

The SLRD has not adopted landslide life-safety criteria and relies on consultants to recommend appropriate criteria used in other jurisdictions. The Fraser Valley Regional District has adopted a natural hazards and risk policy (Cave, 1993; FVRD 2020) that defines what is meant by the term "safe" (Cave 1993; Table 3). The Cave matrices were developed for "residential" land use. Development categories vary from "minor repair" to "rezoning" and represent increasing "exposure" to loss of life from any given hazard type. Here we refer to new reconstruction and new building only (Table 3), as short-term response to wild-fire will involve building permit applications, not increased density by subdivision or rezoning.

As stipulated by EGBC (2012, 2022) the level of effort inherent in a detailed assessment is contingent on the level of life-loss exposure presented by the proposed development. Existing development (minor repair/renovation) to an existing home requires less rigour than reconstruction or new build; whereas, subdivision and rezoning must be subjected to greater scrutiny as they introduce greater potential for life loss.

This report is prepared for evaluation of reconstruction and new building (Table 3). Subdivision and/or rezoning that will substantially increase development density to flood and landslide risk must be subject to detailed assessment. Note that these criteria apply to residential buildings, and to storage space for goods damageable by flood waters. The criteria do not apply to agricultural buildings. With respect to Agricultural buildings, see Section 4 of WLAP (2004).

The selected hazards are those that have been identified as potentially affecting the properties affected by the Downton Lake Fire along Gun Lake Road West and Gun Creek Road. They consist of the flood hazards, debris flooding and stream avulsion; and landslide hazards, rockfall, debris flow/slide and landslip. Hazard frequencies expressed in report refer to values in Table 1.

Table 3. Hazard acceptability thresholds for Reconstruction and New Build applications considering select geologic hazards. See Cave (1993) for full description. Note the hazard levels listed at the column headings represent the estimated hazard level affecting a proposed development.

Debris flood	1:50	1:50-1:200	1:200-1:500	1:500-1:10,000	<1:10,000
Reconstruction	4	4	3	1	1
New building	4	4	3	1	1
Stream Avulsion	1:10	1:10-1:100	1:100-1:200	1:200-1:500	<1:500
Reconstruction	5	5	2	2	1
New building	5	5	4	2	1
Rockfall	1:100	1:100-1:500	1:500-1:1000	1:1000-1:10,000	<1:10,000
Reconstruction	5	4	2	1	1
New building	5	5	4	4	1
Debris flow/slide	1:50	1:50-1:200	1:200-1:500	1:500-1:10,000	<1:10,000
Reconstruction	5	5	4	3	1
New building	5	5	4	3	1
Small scale landslip	1:50	1:50-1:200	1:200-1:500	1:500-1:10,000	<1:10,000
Reconstruction	5	4	4	3	1
New building	5	4	4	3	1

1 – Approval without conditions relating to hazards.
2 – Approval without siting conditions or protective works conditions, but with a registered covenant against title.
3 – Approval, but with siting requirements to avoid the hazard, or with requirements for protective works to mitigate the hazard.
4 – Approval as (3) above, but with a registered covenant against title as well as siting conditions, protective works, or both
5 – Not approvable.

For sites subject to flood hazards, the threshold for development without conditions is 1/500 per annum (Table 3). In contrast, where landslide hazards apply, the threshold for development without conditions is 1/10,000 per annum (Table 3). This is a much more restrictive threshold. At Gun Lake and Gun Creek Road, provided building permit application is for a similar building footprint, and considering some properties are recreational use only, permits for reconstruction could be set at 1/500 per annum regardless of Flood or Landslide hazard classification (considering greater tolerability for development). However, these are local government policy discussions, and not the purview of the QP to decide.

Methods

Preparations for the field assessment included several tasks:

- A Burnt Area Reflectance Category (BARC) map was requested from and provided by BC MoF wildfire service.
- Georeferenced field maps were prepared showing the BARC mapping, TRIM 20-m contours and streams, the location of forest and public roads, private properties, water wells and water licences, and other elements at risk. Maps were loaded on an iPad mini using Avenza PDFmaps software with geo-location provided by the built-in GPS unit.
- The area affected by the fire was divided into landscape units on the basis of terrain (Howes and Kenk 1988), aspect, and the primary elements at risk at the base of slope. These landscape units are Downton Lake slopes, Penrose-Lajoie Lake, Gun Lake-Walker face, Walker Creek, Walker-Sumner face, Slim Creek FSR, South Chilcotin Park, Gun Creek Road, Lajoie Creek-Plateau Ponds, and Highway 40 slopes. Within each landscape unit, excepting Plateau Ponds, the terrain was subdivided into sub-basins with the downslope "pour-point" located at a road crossing or at the alluvial fan apex at the base of slope. The fire area was therefore divided into a series of sub-basins that concentrate potential post-wildfire impacts at those "pour-points," and smaller residual "face-units" located between adjacent sub-basins.
- First Nations representatives whose territories overlap the fire boundary were identified, and email and phone contact were established, and their concerns with respect to post-wildfire actions was sought.

Field work was conducted September 26-30, 2023. The following tasks were undertaken:

- We drove the majority of forest roads, stopping and inventorying the condition of drainage structures (primarily culverts) at identified sub-basin streams and ditch cross-drain locations.
- We conducted 31 burn intensity field assessments to calibrate/field-truth the BARC map using the field forms provided by Hope et al. (2015), with plots conducted in a selection of Low, Moderate and High burn intensity areas as indicated on the BARC map, and covering a range of aspects and elevations.
- We identified and visited alluvial fan areas, especially those occupied by residential properties on Gun Lake Road West and Gun Creek Road.
- Fieldwork was concentrated in sub-basins and face units above residential properties on Gun Lake Road West, as this area is the steepest terrain and was deemed to present the greatest hazard to areas with private property with residential zoning.

In the office, field observations, landform characterization, burn intensity and element at risk mapping was compiled to summarise the potential for post-wildfire hazards to affect the identified elements at risk. This involved several tasks:

- Sub-basin morphometric indices (top elevation, bottom elevation, basin area, and watershed length) were measured using Q-GIS. Melton's watershed ruggedness was calculated, and geomorphic domains (flood, debris flood, debris flow) affecting the element at risk at the sub-basin mouth, or "pour point" were estimated following Wilford et al. (2015) and other reports.
- Within each sub-basin the percent area of unburnt, Low, Moderate and High burn intensity area was estimated from the BARC rastor map using Q-GIS. The total area of Moderate and High burn intensity was summed and used to represent wildfire impact within each sub-basin.
- Partial Risk assessment was based on the following understanding. The existing hazard (frequency, type) estimated for an element at risk is the Hazard Affecting, or PHA (Table 1); that is, it embodies both the probability of the hazard occurring somewhere within a sub-basin (PH) and the probability that the same event reaches the sub-basin "pour-point" or mouth (PS/H; i.e., road crossing or alluvial fan apex).
- The existing, or pre-wildfire hazard threat level affecting (PHA) the element at risk (alluvial fan) was estimated from a detailed assessment of hazards affecting Walker Creek alluvial fan (Cordilleran 2015); the hazard type (i.e., flood, debris flood, debris flow) affecting the element at risk was estimated from the geo-domain screening (described above); while the post-wildfire hazard threat level affecting the element at risk (PHA) was estimated from a consideration of the existing hazard and the wildfire impact within the subbasin.
- Other hazards (rockfall, snow avalanche) were considered on a site-by-site basis, as required.

Maps appended to the report include:
- Map 1. Fire boundary and fire breaks on Ortho base map,
- Map 2. Burnt Area Reflectance Classification,
- Map 3. Traverse Route and Waypoints,
- Map 4. Slope Thematic Map,
- Map 5. Forest Cover and Logging History,
- Map 6. Elements at Risk,
- Map 7. Sub-basin Geo-domains, and
- Map 8. Post-wildfire Hazard.

Appendices include:
- Appendix 1. Archaeological Sites and the Heritage Conservation Act (HCA);
- Appendix 2. Field Observations;
- Appendix 3. Burn Intensity field plots, and
- Appendix 4. Post-wildfire Hazard and Affected Properties.

The Landscape affected by the Downton Lake Fire (K71649)

Landforms

In the area of the Downton Lake fire, the Bridge River valley bottom occupied by the Downton and Carpenter reservoirs is ~750 m asl and ~660 m asl, respectively; while on the Gun Lake plateau, Gun and Lajoie Lakes stand at 884 m asl and 907 m asl, respectively. Mount Penrose, standing at 2610 m asl, forms the divide between Downton Reservoir on the south and Gun Creek on the north, providing ~1700-1900 m relief above valley bottom areas (Photos 1, 2).

Photo 1. View WNW up Penrose Creek from Lajoie Lake showing high burn intensity on the faces either side of the drainage.

Photo 2. View north across the east slope of Mount Penrose above Gun Lake, and the distant south facing slopes above Gun Creek.

The potentially affected area can be divided into several Landform Units (LUs) with distinct attributes including relief, average slopes, slope configuration, hazards-affecting and elements at risk. They are described below:

1. Downton Reservoir Slopes (LU1). The northern shoreline of Downton reservoir from Lajoie Lake westwards a distance of 8-km covers about 1863 ha. In the east, the relief is on the order of 300 m, but climbs gradually to the summit of Mount Penrose with 1900 m relief. In this area there are seven sub-basins where debris flow and snow avalanche processes are active (High hazard). There are no residences or domestic water sources in this area. The elements at risk include Forest Road ID R06128 1890 and spurs and Downton reservoir.

2. Penrose-Lajoie Lake (LU2). Penrose Creek drains the east-southeast slopes of Mount Penrose, with a relief of 1700 m from Lajoie Lake to the summit of Mount Penrose. A secondary creek with 1100 m relief also drains this slope. The total area covers about 720 ha. Penrose Creek is prone to debris flow, debris flood and snow avalanche activity with an active debris fan between 1100-1200 m asl and a fluvial fan below 950 m asl forming the western lake shore. Elements at risk include the domestic water system for several Lajoie Lake properties, and the Forest Road crossing at the fluvial fan apex. No houses are potentially affected by post-wildfire hazards.

3. Gun Lake Penrose-Walker Face (LU3). The west shore of Gun Lake between Penrose Creek and Walker Creek forms a triangular face unit extending from Gun Lake at 884 m asl upslope to 2200 m asl, with ~1300 m relief. The area covers about 649 ha. The vertical slope profile is broken into a series of concave segments joined at convex breaks where benches

transition to steeper terrain below. Convex breaks are found at ~1500 m asl and 1100 m asl. Elements at risk include Gun Lake Road West, residential properties along Gun Lake Road West, domestic water intakes on a few small creeks, and forest roads on the benched terrain above. Four sub-basins in the landform unit are large and/or steep enough to have formed fans at their mouths along the Gun Lake shoreline, and these sub-basins present debris flood/flow hazards affecting residential properties.

4. Walker Creek (LU4). Walker Creek drains the east slope of Mount Penrose, with 1700 m relief from Gun Lake to the summit. It is formed by two parallel and very similar drainages that converge at 980 m asl, just above Gun Lake Road West. The area covers about 783 ha. Walker Creek has formed the largest alluvial fan on the Gun Lake shoreline; the fan is affected by debris flood/flow processes. Elements at risk include residential properties on the alluvial fan. Forest roads cross the watershed upslope.

5. Gun Lake-Sumner Creek face (LU5). The northwest shoreline of Gun Lake is a triangular face unit drained by Sumner Creek, extending from Gun Lake at 884 m asl upslope to 2200 m asl, with ~1300 m relief. The area covers about 628 ha. Topography is benched to irregular. Elements at risk include residential properties along the Gun Lake shoreline, domestic water intakes on a few small creeks, Gun Lake Road West, the Minto Communications Line, and forest roads, including the start of the Slim Creek FSR. Sub-basins 5-1 and 5-2 have formed Sumner Creek alluvial fan, which is vulnerable to debris flood processes which affect several residential properties. Debris flood processes from sub-basin 5-3 also affects several properties.

6. Slim Creek FSR above Gun Creek (LU6). This area consists of the north facing slopes above Gun Creek, extending from where Slim Creek FSR crosses the Sumner Creek pass to Gun Creek and extends ~9km upstream from that point. In this area, there is about 1450 m relief from Mount Penrose N1at 2445 m asl down to Gun Creek at ~1000 m asl. The area covers about 4438 ha. There are six larger sub-basins prone to debris floods and debris flows, including Jewel and Roxey Creeks below Mount Penrose N1, with the remainder of the area supporting ephemeral face drainages. The elements at risk consist of Forest and Mine roads, most importantly, Slim Creek FSR which follows the valley bottom, and Jewel Creek parking lot and trailhead used for access to South Chilcotin Mountains Park.

7. South Chilcotin Mountains Park (LU7). This area consists of the north side of Gun Creek, extending about 10 km along Gun Creek from the eastern divide of Freiberg Creek to the western divide of Gun Creek near the Slim/Leckie Creek junction. The area includes the Gun, Eldorado and Freiberg Creek basins and intervening faces. The landscape unit is very large, covering 22,350 ha, with the area contributed mostly by upper Gun Creek valley. Other than the recreational trails, there are no elements at risk.

8. Gun Creek Road (LU8). This area extends from the length of Gun Creek Road, encompassing the drainages of Mowson Pond in the east to Lick Creek in the west. There is ~1550 m relief extending up from 750 m on Gun Creek to 2290 m asl at the head of Pearson Creek. The area covers about 4,627 ha. Elements at risk include residential properties along Gun Creek Road. The relief in the vicinity of Gun Creek Road is subdued.

9. Lajoie Creek-Plateau Ponds (LU9). The area extending from the east end of Gun Lake to Gun Creek is an undulating plateau dotted with small ponds. The area covers about 1,268 ha. There is no post-wildfire hazard in this area, and no elements at risk. There are steep ravine slopes into Gun Creek. There are no elements at risk at the base of slope. Gun Creek crosses Highway 40 just downstream of the fan apex.

10. Highway 40 slopes (LU10). From the west end of Carpenter Reservoir, extending a distance of 8 km to the east, there are steep slopes directly above Highway 40 that have been burnt. Relief is ~200-300 m from the reservoir to the plateau surface, and slopes are moderately steep to steep. The area covers about 391 ha. Two larger basins have been identified and there is a series of smaller dry draws along the slope. Debris flood/flows from sub-basins and/or small gullies may affect Highway 40. There may also be an increased incidence of rockfall affecting Highway 40.

Bedrock Geology

Bedrock geology (http://maps.gov.bc.ca/ess/sv/imapbc/) consists of a complex assemblage of terrestrial and marine sedimentary rocks interleaved across a series of faults trending NW/SE, with intrusive plutons intruding the pendant rocks (Figure 2). No deep-seated instability has been identified in the study area.

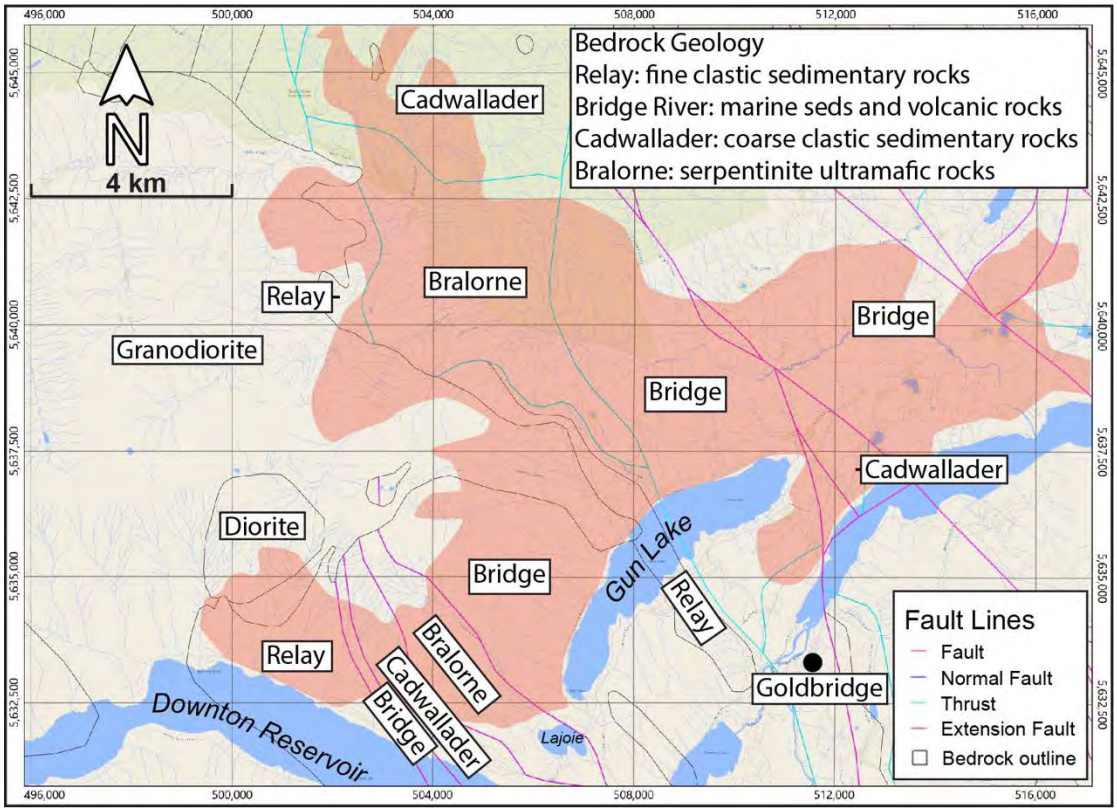

Figure 2. Bedrock geology in the study area. Downton Lake fire area is shown in red.

Surficial Geology

No reconnaissance level surficial geology or terrain stability mapping has been completed for the entire project area. A search for terrain related information covering the fire area was conducted using the link:
https://www.env.gov.bc.ca/esd/distdata/ecosystems/TEI_Index_Map_PDFs/TEI_TIM_PDF_ArchE_South_Coast.pdf

Only one reconnaissance terrain map was available (B01-4787.TIF), but it only covers the south half of the Gun Lake Plateau, and produces no valuable insights, other than noting till cover and an active midslope fan area on the south slopes below Mt Penrose. Similarly, several Terrain Stability Assessment (TSA) reports by Cordilleran Geoscience (2015, 2016, 2017) have been conducted for Aspen Planers covering areas along Slim Creek FSR, the benched terrain above Gun Lake Road West, and the lower slopes along the north side of Downton Reservoir. The blocks are mostly on gentle to moderate terrain, with low post-logging landslide potential. Some instability was noted along Gun Creek where the river undercuts the bank on the outside of river bends. On the south facing slope of Mount Penrose above Downton Reservoir, the alluvial fans were noted to be highly active, with old cottonwood trees experiencing significant amount of stem burial (~1 m) over their life time (many decades).

Based on local experience, surficial geology in the area consists of till and glaciofluvial gravels associated with the last, or Fraser Glaciation. Along Gun Creek there are thick sequences of glaciofluvial gravels deposited by meltwater issuing from headwater drainages of Slim, Leckie and Gun Creeks. On the Gun Lake plateau there is a till mantle over irregular bedrock topography, with the low areas dotted with kettle lakes (Plateau and Mowson Ponds). Till materials thin and eventually pinch out on the mountain slopes above. Angular colluvium exists on steep slopes in association with bedrock outcrop. Hillslope channels and creeks may have developed alluvial fans at their mouths, with the size of fans reflecting the amount of sediment transported and deposited over the millennia.

Bridge River volcanic ash, or tephra, derived from the 2400-year old eruption of Mount Meager 50 km to the southwest (Clague et al., 1995), forms a veneer over most of the landscape. The tephra layer, composed of granule to fine pebble gravel (coarse grains 1-10 mm diameter; Photo 3), is typically about 50 cm thick (Photo 4), and covers terrain that has remained stable, even on relatively steep (70-80%) slopes. However, it may be absent/buried on very steep (>80%) slopes, or in areas affected by active processes such as rockfall (Photo 5), snow avalanche or debris flow activity (Photos 6-8). As such it forms a useful marker horizon, providing a ready gauge of landform stability extending over 2400 years.

Photo 3. Bridge River tephra grain size, 1-10 mm diameter, sand to granule gravel.

Photo 4. Bridge River tephra in road cut. Forms veneer 0.5 m thick.

Photo 5. Rockfall fragments below rock outcrop form veneer covering tephra visible in road cut along Slim FSR.

Photo 6. Contrast between tephra covered surface on left and recent debris flow deposits on right on Penrose Creek.

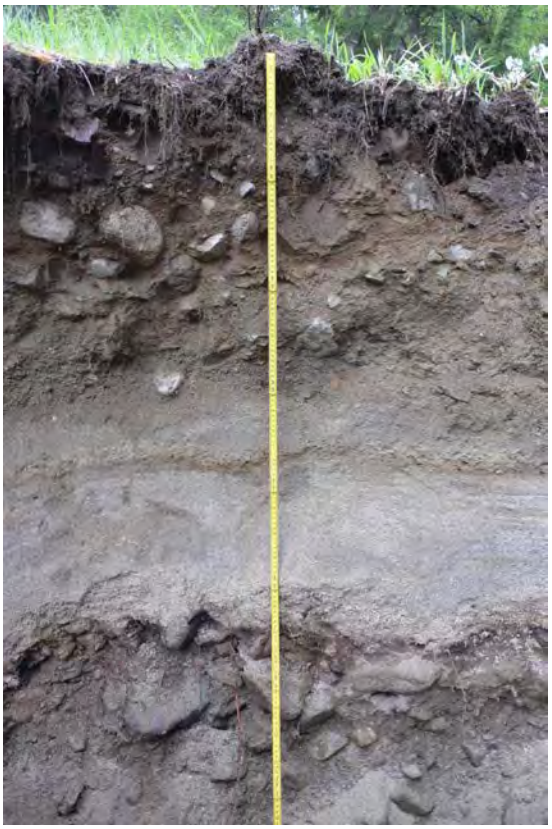

Photo 7. Bridge River tephra, 60-110 cm depth; 60-75 cm depth is reworked. Buried by surface debris flow deposit, Walker Creek fan (Cordilleran 2015).

Photo 8. Bridge River tephra, 200-250 cm depth, buried by reworked tephra, and two debris flood units (sand/fine gravel), Walker Creek fan. (Cordilleran 2015).

Climate

The study area is located on the lee side of the Coast Mountains and has a continental climate regime (Figure 3). At 1150 m asl on the north side of Gun Lake, mean annual temperature is 4.6

C and mean annual precipitation is 696 mm with the precipitation peak in winter with 34% falling as snow. Summers are warm with a diurnal range of 10 to 20 C in July and August, and winters are cold with diurnal temperatures of -8 to 0 C from mid-November through mid-February. Monthly average precipitation is around 30 mm from April through August, with a peak of 110 mm in November. Snowfall occurs from October through April.

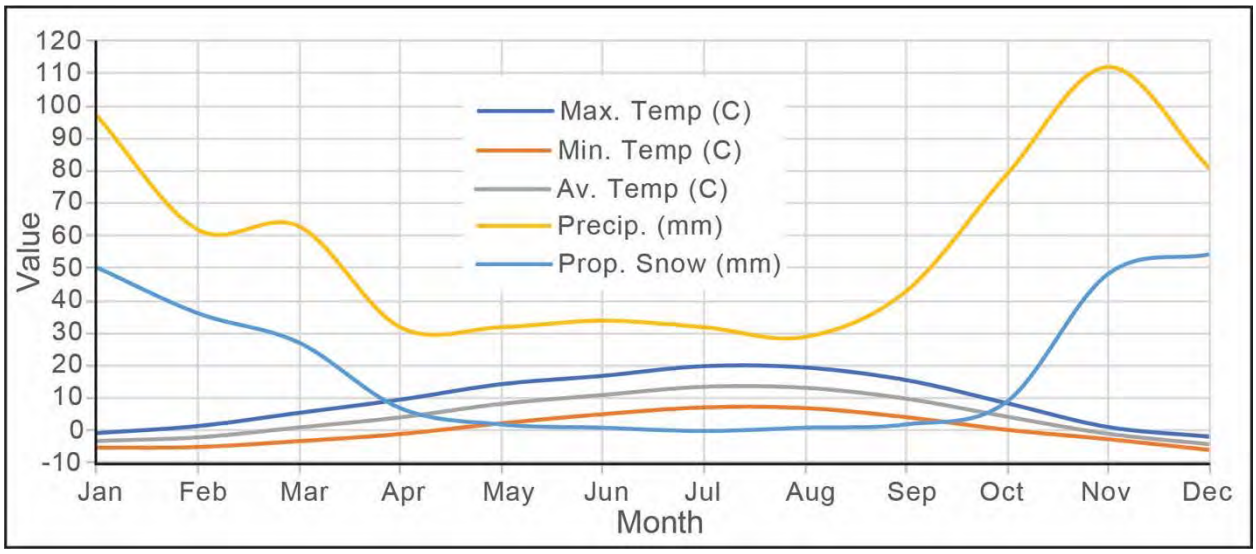

Figure 3. Climate normals 1991-2020 for the north side of Gun Lake at 1150 m asl (Latitude, 50.883º; Longitude, -122.897º). Estimated from https://climatebc.ca/mapVersion.

Rainfall Intensities

Rainfall intensities for a location on the west shore of Gun Lake at 1630 m elevation were estimated from the website IDF_CC (Simonovic et al., 2015; Table 4). The elevation 1630 m sits about halfway between Gun Lake at 884 m elevation and tree line at 2100 m elevation. The upper fire boundary coincides with treeline. At 1630 m elevation, hourly rainfall intensities of 6, 20 and 27 mm might be expected for 2, 50 and 100-year events, respectively; while 24 hr accumulations might reach 28, 79 and 92 mm for 2, 50 and 100-year events, respectively.

Table 4. Rainfall intensities (cumulative) for an ungauged site at 1630 m elevation (Simonovic et al., 2015), on a SE aspect above Gun Lake (Latitude: 50.86816º, Longitude: -122.92246º).

	Return period (years)						
Duration (hrs)	2	5	10	20	25	50	100
1	6.18 mm	8.49 mm	10.84 mm	14.22 mm	15.32 mm	20.25 mm	27.16 mm
24	28.12 mm	42.57 mm	53.06 mm	64.18 mm	67.57 mm	79.39 mm	92.21 mm

Hydrology

Stream flow in the Goldbridge area is dominantly snow melt driven (Figure 4). There are no small (<100 km^2) gauged drainage basins in the area, and the closest drainage basin with a relatively current record is Yalakom above Ore Creek (1983-2021). It shows a strong snowmelt freshet starting mid-April, peaking in June-July and gradually tapering through summer till the end of September. While this is the pattern for larger rivers, small hillslope creeks will also respond to rain and rain-on-snow events.

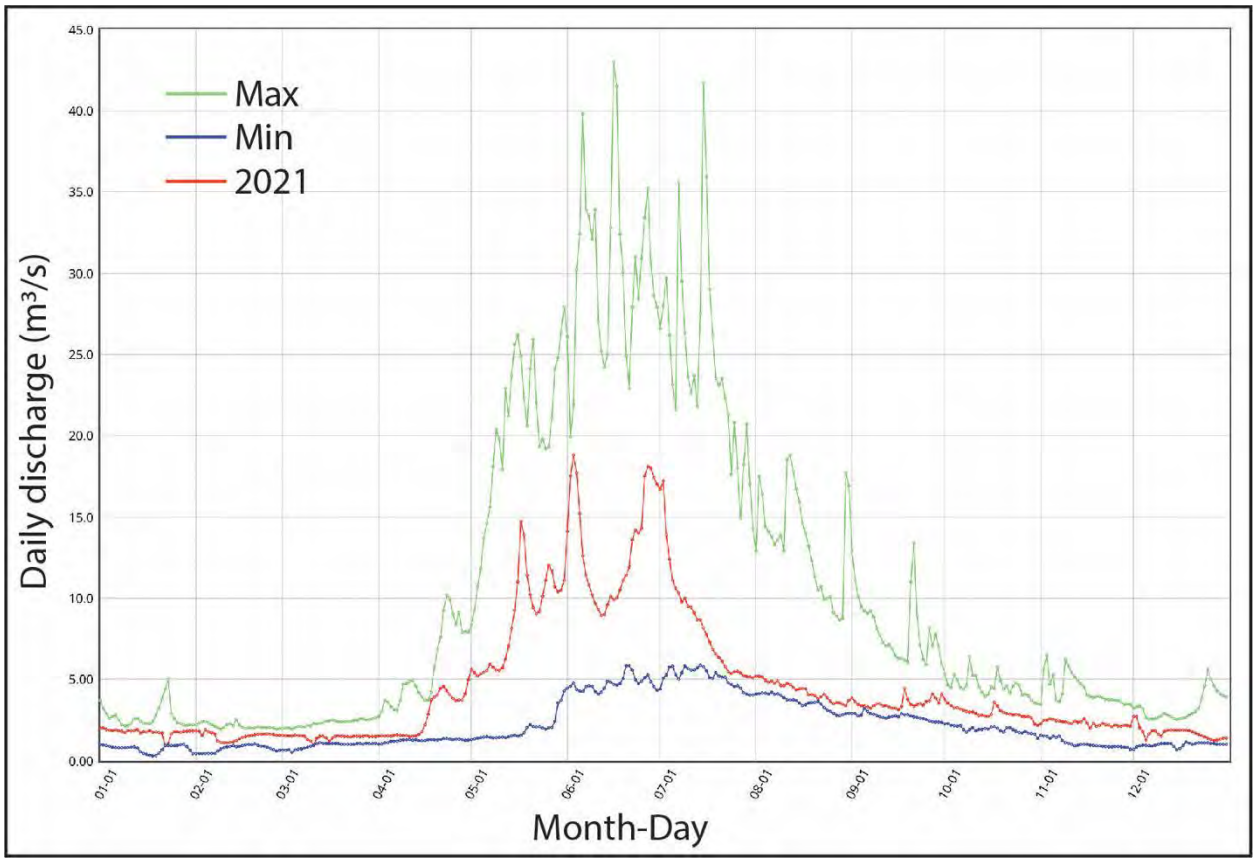

Figure 4. Yalakom Creek above Ore Creek. Latitude, 50° 54' 45" N; Longitude, 122° 14' 21" W; Drainage area: 581 km^2, Record length 41 years (1983-2021). Note that Yalakom Creek is much larger than sub-basins identified in the Downton Lake project area, and the daily discharge is not representative.

Forests

Forest types consist of Interior Douglas fir (IDFxc, dc), Montane Spruce (MSdc3) and Engelmann Spruce-Subalpine fir (ESSFdv2) at higher elevations. The zonal soil in the region is the dystric Brunisol (Valentine et al., 1986). Logging history has occurred at mid to low elevations, with three passes since the 1980s. Biogeoclimatic Zones and Cutblocks and Forest Roads are shown on Map 5.

Elements at Risk

Post-wildfire geomorphic risk assessment requires detailed catalogue of the elements at risk. For the Downton Lake fire, the elements at risk are listed below, in no order of preference (Map 6):

- St'at'imc First Nations culture-heritage sites and culture-resource values;
- Private property with existing unburnt and burnt residential structures and outbuildings;
- Domestic water intakes and rights of way;
- Transmission Lines and other linear infrastructure;
- Roads, including MoTI public roads, MoF road permit roads (RUP), Forest Service Roads (FSRs) and Non-Status Roads (NSRs), mining roads and other roads.

Sta'at'imc First Nations Values

As part of the Elements at Risk identification process, Cordilleran contacted Daryl Adrian, emergency manager for the Lillooet Tribal Council, to recommend contacts from representatives from Xwisten, Tsal'alh and N'Quatqua Bands for their input on the cultural and spiritual resources in their territories, and other items of concern. He supplied the following contacts (Table 5):

Table 5. First Nations Contacts for Sta'at'imc Bands whose Territories overlap with the Downton Lake Fire (K71649).

Xwisten First Nation (Bridge River Band) Travis Peters, Heritage Supervisor heritage-supervisor@xwisten.ca Work 250-256-7997	Tsal'alh First Nation (Seton Lake Band) Ida-Mary Peter idamary_tsalalh@yahoo.ca 250-259-8227
N'Quatqua First Nation (D'Arcy Band) Dennis Silzer-Smith, Councillor Phone (604) 452-3221 dennis.silzer-smith@nquatqua.ca	Tsal'alh First Nation (Seton Lake Band) Tim Peter timpeter2012@tsalalh.net 250-259-8227

On our way into the field, on September 26, 2023, we visited Dennis Silzer-Smith at N'Quatqua First Nation and Ida-Mary Peter at Tsal'alh First Nation. On several occasions, and while in the field, I talked on the phone with Travis Peters (Xwisten First Nation). From these discussions, the FN concerns and priorities as I understand them to be are summarised below:

- Before any ground disturbance is undertaken, there must first be a check for known heritage sites from BC Archaeology Branch records. We have completed this check and have been supplied with a list of 27 mapped sites within the fire area. Many are lithic sites found below the Bridge River tephra, so are >2400 years old. Appendix 1 contains instructions for work in and around archaeological sites. We have made the list of sites available to MoF and local First Nations, but have not presented the site locations on our maps for reasons of third-party confidentiality, as requested by the Archaeology Branch.
- In addition to registered sites, there may be unknown and/or unregistered sites and other areas of cultural/spiritual value. As such, there is an opportunity for First Nations communities to provide valuable assistance in identifying specific cultural/spiritual areas so as to avoid their disturbance. While in the field, we noted First Nation archaeology crews under the supervision of Travis Peters conducting inventories on behalf of Xwisten First Nation. Ida-Mary Peter noted the preference that where materials are found they be left as is.
- Deer habitat and wildlife abundance is of primary concern, and any post-fire mitigation measures must consider wildlife values. Tim Peter of Tsal'alhmec Guardians is a knowledgeable contact for wildlife research. Travis Peters, Heritage Manager for Xwisten First Nation stated that "green areas" within the fire boundary should be left for ungulate winter range, but "black areas" could be available for salvage harvest.
- With respect to economic development opportunities, it is noted that there is an Economic development agreement between participating St'at'imc communities and the Ministry of

Forests and Range.[1] Salvage logging of "black stand areas" within the Downton Fire boundary is in planning process with fieldwork well underway during our field assessment (Sept 26-30). Fieldwork consisted of First Nation crews conducting heritage surveys and local forest companies laying out timber under the auspices of St'at'imc communities (Travis Peters, Xwisten First Nation).

Private Properties

Private properties within and/or downslope of fire affected areas exist along the northwest shore of Gun Lake and along Gun Creek Road on the north side of Gun Creek. Michael Fusca, emergency coordinator with SLRD, supplied a list of residential properties with structural damage. On Gun Creek Road West, there are approximately 100 residential properties between the boat launch at the south end and Lajoie Creek at the north end of the lake, of which about 48 have buildings destroyed by the fire. On Gun Creek Road there are 22 properties between Tyaughton Road and the end of road at the park trailhead at Lick Creek, of which eight were recorded as burnt. It is expected that the areas at greatest risk are along Gun Lake, as the slopes above are steeper and the fire impact was greater, than along Gun Creek Road.

Any sites located along creeks or on alluvial fans are potentially affected by post fire geomorphic events. Areas on the plateau north and south of Gun Lake have no apparent post-wildfire hazard. Residential properties are shown on Maps 1-8, showing burnt vs unburnt condition.

Domestic Water

Residential properties rely on water from domestic intakes from a select number of creeks and from Gun Lake. Locations of registered water well and water right licences for domestic water intakes were downloaded from iMapBC and are shown on Map 6.

Linear Infrastructure

Transmission lines exist along Highway 40 and serving residential areas at Gun Lake and along Gun Creek Road. These lines were damaged by the fire, but rapidly repaired by BC Hydro following the fire. A newly constructed telecommunications network run by Minto Communications was also severely damaged by the fire. The damaged Minto lines on Slim Creek FSR had yet to be repaired as of September 30, 2023. Transmission/telecommunication lines are not affected in a significant way by post-wildfire geomorphic hazards, as towers and poles are generally not located along channels or on fans, and are not considered further.

Roads

The primary roads of concern that may be vulnerable to post-wildfire hazards include Highway 40, Gun Lake Road West, Gun Creek Road, Slim Creek FSR and secondary Road Permit and Non-Status Roads (NSRs). Appended Maps show roads, and Maps 3 shows our observation sites, indicating which roads were assessed in the field.

[1] https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/consulting-with-first-nations/agreements/forestry-agreements/statimc_community_eda_26may10.pdf

The Downton Lake Fire

Fire Progression

The Downton Lake fire (Figure 1) started on the east shore of Downton Reservoir near Goldbridge and burnt eastwards across the south slope of Mount Penrose and the Gun Lake plateau, then extended along the lower 15 km of the Gun Creek valley between the Carpenter Reservoir and the triple junction of Gun, Leckie and Slim Creeks, ending with the eastern boundary approximately 2-3 km east of Gun Creek. The total burnt area approached 10,000 ha.

The fire progression presented below (Figure 5) was compiled from SLRD and BC Wildfire public notices.

- July 13. First noted on the northeast shore of the Downton Reservoir. It was probably triggered by a lightning storm between July 7-9 (Figure 5). For the first two weeks the fire smoldered and gradually climbed the steep slopes on the west side of Mount Penrose.
- July 23. The Squamish-Lillooet Regional District (SLRD) issued an evacuation ALERT at 1630 hrs for Electoral Area A, Gun Lake Area.
- August 1. The fire showed significant growth to the north and east towards Gun Lake. The B.C. Wildfire Service said the fire's rapid movement was driven by wind. Some impacts to structures occurred along the west side of Gun Lake overnight. The SLRD issued an evacuation ORDER at 1300 hrs for all properties around Gun and Lajoie Lakes due to immediate danger to life safety (Figure 5). The fire was estimated to be 1,795 ha.
- August 6. Structure loss was recorded on nine parcels, including two single-family dwellings (seasonal recreational properties) and 12-14 outbuildings.
- Aug 17. A fire tornado was captured on film overnight by the Wildfire Service (Figure 6E). The region was coming out of a multi-day heat wave, followed by a strong cold front. As the front swept through the area, it brought strong southwesterly winds which stoked the fire. The relative humidity in the area fell to a low of 14% (Figure 5), while the dew point fell precipitously from the day before.
- Aug 18. Due to the hot and dry conditions, available fuel and strong winds, the fire continued to grow.
- Aug 21. Additional structures were lost on the northwest side of Gun Lake.
- Aug 23. The fire was estimated to be 7,410 ha., though heavy smoke limited the ability to gauge its size accurately.
- Aug 26. Consistent cooler temperatures and precipitation in the area kept fire activity low. The fire was estimated to be 8,450 ha.
- Aug 30. The size of the wildfire was updated to approx. 9,357 ha. The slightly increased area was attributed to more accurate mapping on the northwest corner of the fire boundary.
- Sept 13. The SLRD confirmed extensive structure loss in the Gun Lake and Gun Creek communities, with the loss of primary structures and outbuildings. A summary of the impact is as follows:
    - 43 properties experienced total structure loss
    - 11 properties experienced partial structure loss
- Sep 14. An access restriction was extended by Wildfire Service to allow mop up activities.
- Sep 25. Evacuation ALERT RESCINDED - Downton Lake Electoral Area A (Figure 5).
- Final size once extinguished: 9,565 ha.

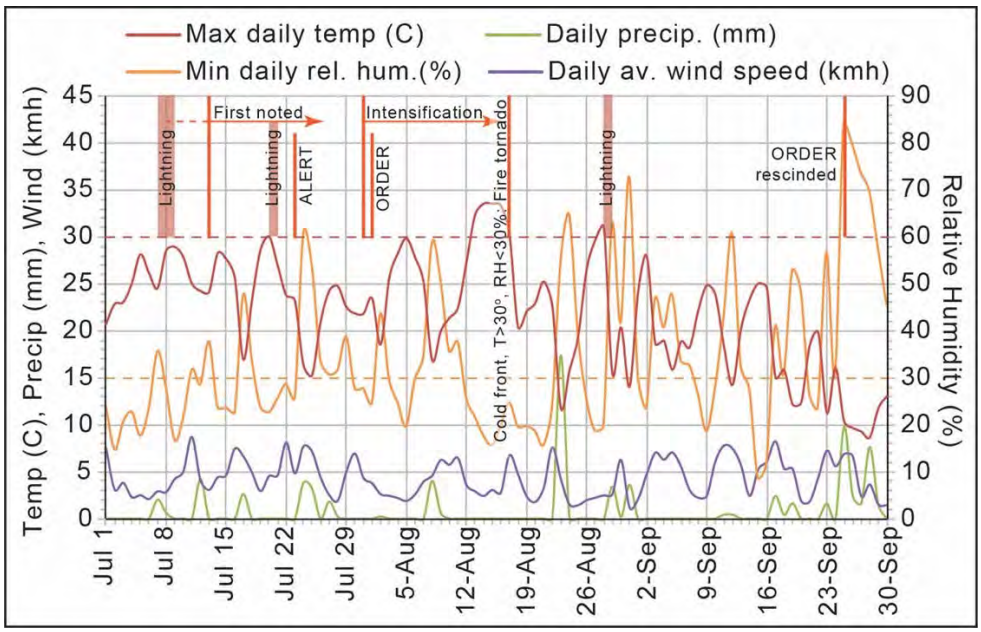

Figure 5. Weather conditions experienced during the progression of the Downton Lake Fire.

The Fire Tornado

A fire tornado (Figure 6E) is a rare phonomenon, requiring a combination of high ambient heat, very low relative humidity and dew point temperatures, and fanning winds (Figure 5). On the evening of August 17th, originating off Gun Lake, the fire tornado touched down at 13770 Gun Lake Road West (509974 m E, 5637022 m N) creating a damage corridor 300 m in diameter with the vortex throwing trees from the perimeter in to the center, with a few large diameter trees snapped indicating Storm Force (Force 10; 89-102 km/hr) or greater wind speeds (Photos 9, 10).[2]

Photo 9. Burnt structure on 13770 Gun Ck Rd West, affected by fire tornado. Note thrown and snapped trees and thrown roofing metal.

Photo 10. Burnt structure in area outside fire tornado. Roofing falls directly down on foundation.

[2] https://www.canada.ca/en/environment-climate-change/services/types-weather-forecasts-use/public/guide/elements.html#c4, https://www.canada.ca/en/environment-climate-change/services/general-marine-weather-information/understanding-forecasts/beaufort-wind-scale-table.html

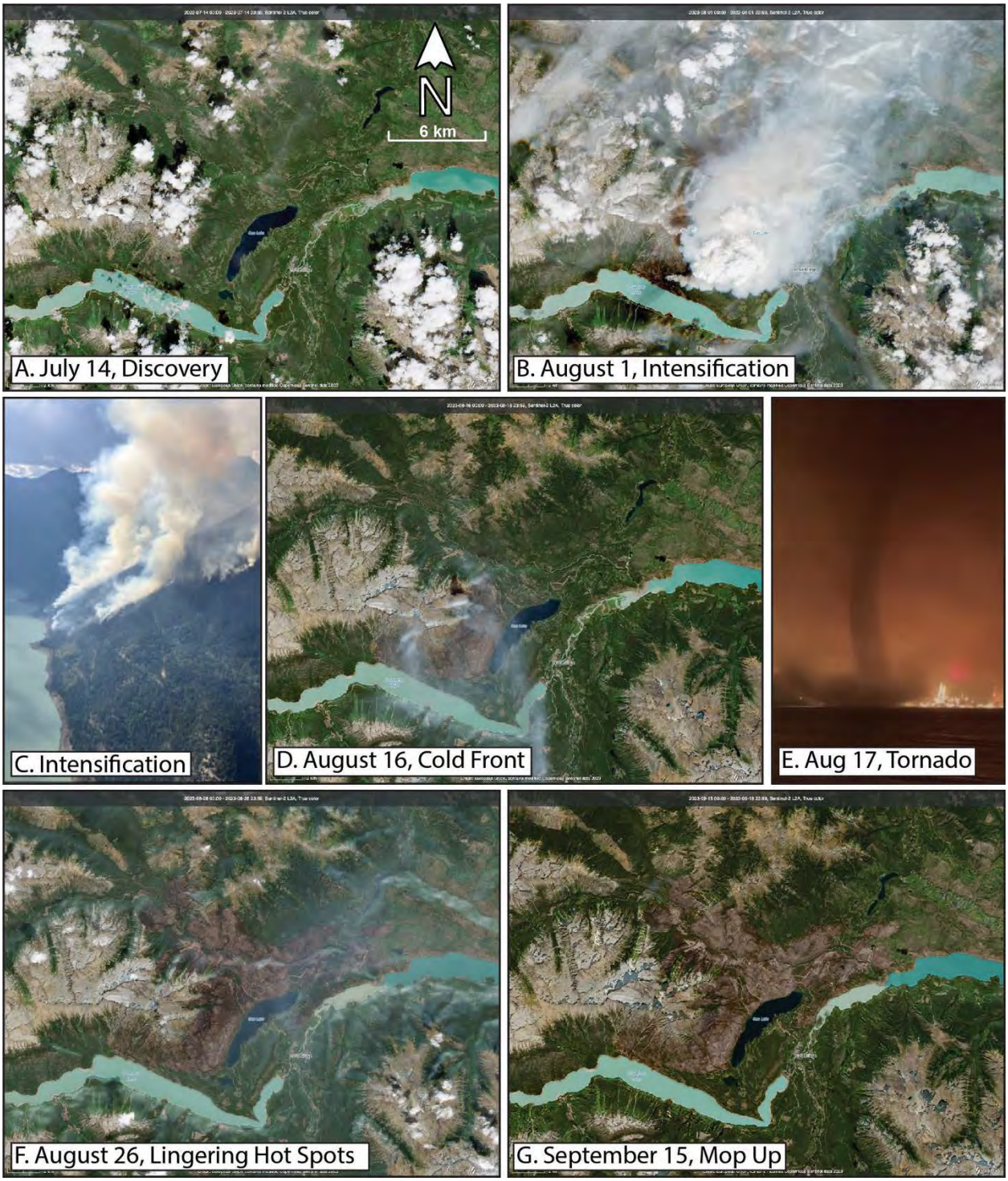

Figure 6. Progression of the Downton Lake Fire, July 14 to September 15, 2023. Satellite imagery (A, B, D, F, G) from https://dataspace.copernicus.eu/. Photos C, E from the BC Wildfire Service.

Fire Break Roads

A large number of firebreak roads were constructed within the Downton Lake fire boundary (Map 1). Typically, due to the urgency of the situation, firebreak roads are not constructed to forest road design and construction standards. In the Downton Lake fire boundary, most cross gentle (<30%) to moderate (30-50%) slopes, where drainage is the only concern (Photo 11). However, some cross moderately steep (50-70%) and steep (>70%) slopes where partial benching and endhaul would be prescribed in planning and design. In these areas water control and fillslope stability are of concern. As such, firebreak roads require deactivation measures appropriate to the terrain they cross and the risk they present to elements at risk downslope.

Photo 11. Firebreak road running straight downslope over moderate (30-50%) sloping terrain.

Burned Area Reflectance Classification (BARC)

Prior to our fieldwork, a Burned Area Reflectance Classification (BARC) map was provided by MoF Kamloops Region. Between Sept 26-30, 2023, we sampled 31 sites on various aspects, starting on the Downton Reservoir shoreline, then to the east-facing slopes of above Gun Lake, and the north-facing slopes above the Slim Creek FSR along Gun Creek. We found good correlation between the BARC classification and observed vegetation and soil burn severity. A finding also reported by Jordan and Covert (2009) for the 2003 wildfires. The BARC map is appended as Map 2 and Burn Intensity field plots as Appendix 3.

Vegetation Burn Severity

Vegetation burn severity describes the degree of fire impact on the forest canopy and understory (Photo 12). The following classification is used (after Curran et al, 2006):

- High – trees blackened and dead, needles consumed, understory consumed (Photo 13);
- Medium – Trees burned and dead, needles remain, understory mostly burned (Photo 14);
- Low – Canopy and trunks partially burned, understory lightly or patchily burned (Photo 15).

Photo 12. A mosaic of vegetation burn severities which was well reflected by the BARC mapping.

Photo 13. High vegetation burn severity with white stripes indicating locations of fully consumed coarse woody debris.

Photo 14. Moderate vegetation burn severity with trees burned and dead, needles remaining, understory mostly burned.

Photo 15. Low vegetation burn severity with canopy and trunks partially burned, understory lightly or patchily burned.

Soil Burn Severity

Soil burn severity refers to the degree of combustion of forest floor woody debris, litter and humic organics, which when losses are moderate to high may lead to the creation of a water-repellent layer (Photos 16-19). During combustion, the waxes, lipids, and other compounds vaporize and may diffuse into the mineral soil and condense, coating mineral soil particles in a waxy substance. The following classification is used (after Curran et al, 2006):

- High – forest floor consumed, mineral soil has altered porosity and structure;
- Moderate – litter consumed; duff consumed or charred, mineral soil unaltered;
- Low – litter scorched or consumed, duff and mineral soil unaltered.

Moderate to high soil burn severity, with complete combustion of soil organics, was widespread throughout the Downton Lake fire. We found that where we classified moderate to high soil burn

severity (Appendix 3), we found moderate to high water repellency in the soil (Photos 17, 19). We typically conducted drip tests at 5 cm depth, but at a few locations we tested repellency at 10 cm and 15 cm depths and found similar results. We found repellency when the soil was dry, but at sites where it had been wetted by rain, then repellency was absent. Water repellency makes it more likely that overland flow will be generated during high-intensity summer or early fall rains (generally following dry spells when water repellency is greatest). Note that we did not conduct water repellency tests in any unburnt areas.

High soil burn severity also causes reduced infiltration capacity, even without water repellency, and therefore can increase susceptibility to overland flows even in areas where water repellency was not observed. The partial or total loss of forest litter and duff layer in moderate and high soil burn severity areas results in a reduction in water storage capacity and increased surface run-off flow velocity.

Photo 16. TP19. Moderate soil and vegetation burn intensity. Note the needle drop.

Photo 17. TP19. After >40 seconds, 50% of drops not infiltrating. See 10 cm intervals.

Photo 18. TP20. High soil and vegetation burn intensity. All blackened, no needle drop.

Photo 19. TP20. After >40 seconds, 100% of drops not infiltrating. See 10 cm intervals.

Hazard Assessment

Hazard Types

Post-wildfire geo-hazards typically involve debris floods, rockfall, debris flows, and snow avalanches. Increased debris flood and debris flow activity may occur because of dramatic changes to watershed hydrology as a result the loss of forest evapotranspiration, canopy interception, ground surface roughness, the development of soil hydrophobicity following moderate to high severity fire, and changes to snow accumulation and melt. Unit-area peak discharges may increase several hundred-fold following wildfire (Moody and Martin, 2001), and this increases soil erosion and entrainment. During the time of recovery, watershed response is more sensitive to weather triggers, and hazard is temporarily elevated.

Increased rockfall hazards are due to loss of roots binding the soil and coarse fragments, tree fall dislodging coarse materials, and loss of standing and down wood that acts to impede travel. This is also a longer-term hazard that recovers with vegetation re-establishment.

Snow avalanche hazards can increase post-wildfire due to the loss of forest cover and a decrease in ground surface roughness. If burnt trees are swept away, fire-kill can increase the avalanche frequency, or if burnt trees become entrained in the debris, it can increase the magnitude of avalanches (Teich et al., 2012). This can persist until the vegetation is restored.

Basin Morphometry

Except for the gentle plateau areas east of Gun Lake and in the vicinity of Gun Creek Road and Mowson Ponds, the Landform Units within the Downton Fire support steep forested slopes, providing the conditions for hazardous post-wildfire events (Maps 4, 5).

Melton's Ruggedness, or the relief of a basin divided by the square root of the basin area, has been identified as a predictor of geomorphic process affecting fans at the mouths of watersheds (Jackson et al. 1987; Bovis and Jakob, 1999; Wilford et al., 2004; Millard et al., 2004). In the northwest interior of BC, Wilford et al., (2004) found that watershed ruggedness >60% conditioned debris flow, but where watershed length exceeded 2.7 km, debris became watered down such that only sediment floods reached the fan apex. In contrast for coastal fans, Millard et al., (2006) found that watershed length was not a factor. Bovis and Jakob (1999) and Millard et al., (2004) found that ruggedness >60% indicated debris flow prone watersheds.

In the debris flood/flow sub-basins, there may be site-specific conditions that lead to the conclusion that debris flows could occur and affect the alluvial fan. For example, in Walker Creek, the overall long profile is convex, with alpine hanging valleys storing debris, and the lower watersheds being steeper and confined in ravines. The steep slopes flanking the subalpine stream channels could initiate small landslides which could then mobilize debris flows affecting the fan.

Millard et al., (2006) concluded that "field work [is] the most reliable method of identifying fan process where deposition features can be identified with greater certainty. Site features such as large boulders, bouldery lobes and levees, and matrix-supported deposits are reliable indicators of past debris flows. Features that indicate water flood deposits include imbricated clasts, bar structure, and clast-supported sediments. Debris flood deposits are more difficult to identify.

Massive deposits of generally clast-supported sediments, but with little or no water flood features, generally indicate debris flood deposits."

Herein we classify four geomorphic domains (Figure 7; Map 7):
1) Flood (Fw, ruggedness <30%),
2) Debris flood (Fd, ruggedness >=30% & <60%),
3) Debris flood/flow (Fd/Df, ruggedness >=60%, watershed length >2.7 km), and
4) Debris flow (Df >=60% ruggedness, watershed length <=2.7 km).

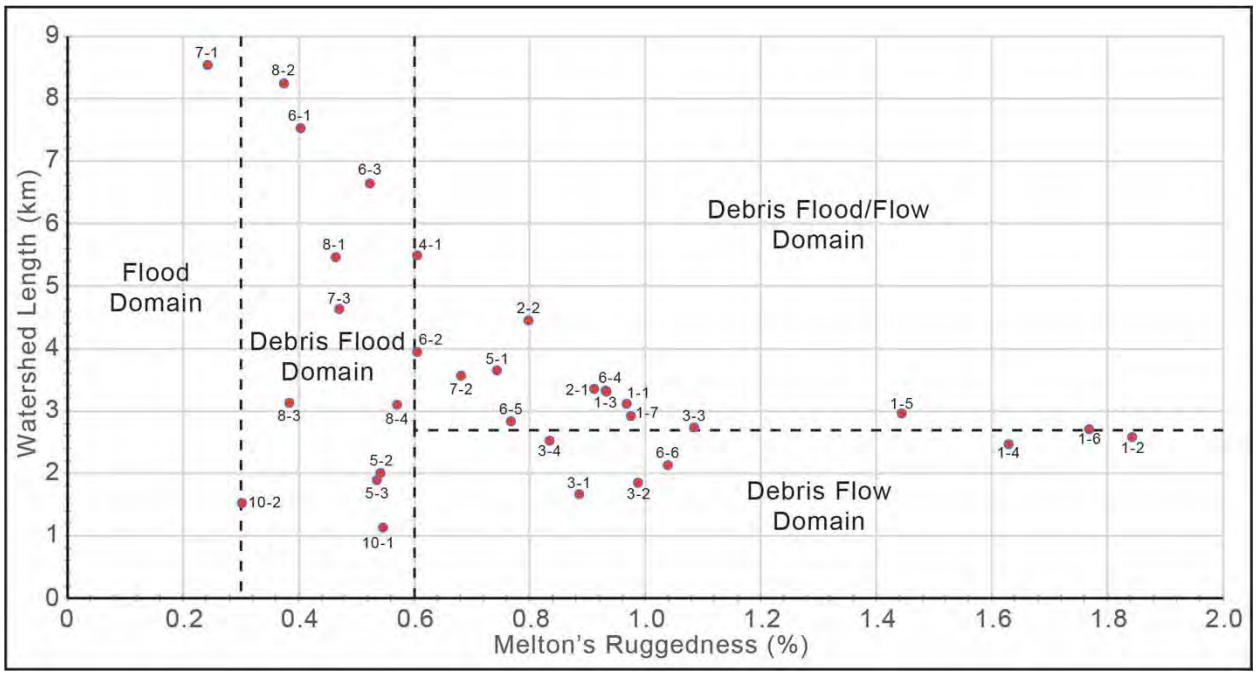

Figure 7. Geomorphic domains for sub-basins overlapped by the Downton Lake fire boundary.

Table 6 presents the results of the analysis for 31 sub-basins divided amongst nine landscape units. 66% of creeks have >60% ruggedness and are either debris flood/flow or debris flow Creeks. 33% of creeks are debris flood creeks. There are no steep sub-basins in landscape Unit 9, Lajoie-Plateau Ponds, so that area is not shown.

Table 6. Morphometric screening of sub-basins delineated within areas affected by the Downton Lake fire boundary.

Sub-basin	Sub-basin area (km^2)	Bottom Elev. (m)	Top Elev. (m)	Relief (m)	Melton Ratio (m/m)	Length (km)	Geo Domain
1. Downton Reservoir Slopes (LU1)							
1-1	3.17	870	2594	1724	0.97	3.1	Debris flood/flow
1-2	0.84	785	2473	1688	1.84	2.6	Debris flow
1-3	3.65	822	2605	1783	0.93	3.3	Debris flood/flow
1-4	0.85	835	2340	1505	1.63	2.5	Debris flow
1-5	1.54	795	2589	1794	1.44	3.0	Debris flood/flow
1-6	0.72	748	2247	1499	1.77	2.7	Debris flow
1-7	1.98	747	2117	1370	0.97	2.9	Debris flood/flow
2. Penrose-Lajoie Lake (LU2)							
2-1	1.60	926	2080	1154	0.91	3.4	Debris flood/flow
2-2	4.19	945	2578	1633	0.80	4.5	Debris flood/flow
3. Gun Lake Penrose-Walker Face (LU3)							
3-1	0.46	915	1513	598	0.89	1.7	Debris flow
3-2	0.58	909	1661	752	0.99	1.9	Debris flow
3-3	1.30	910	2149	1239	1.09	2.7	Debris flood/flow
3-4	1.63	927	1990	1063	0.83	2.5	Debris flow
4. Walker Creek (LU4)							
4-1	7.82	913	2606	1693	0.61	5.5	Debris flood/flow
5. Gun Lake-Sumner Creek face (LU5)							
5-1	2.88	910	2171	1261	0.74	3.7	Debris flood/flow
5-2	0.76	889	1361	472	0.54	2.0	Debris flood
5-3	1.00	884	1421	537	0.54	1.9	Debris flood
6. Slim Creek FSR above Gun Creek (LU6)							
6-1	13.93	1295	2802	1507	0.40	7.5	Debris flood
6-2	4.58	1142	2437	1295	0.61	4.0	Debris flood/flow
6-3	9.75	1153	2789	1636	0.52	6.6	Debris flood
6-4	1.86	1052	2322	1270	0.93	3.3	Debris flood/flow
6-5	2.59	1035	2269	1234	0.77	2.8	Debris flood/flow
6-6	0.95	1034	2047	1013	1.04	2.1	Debris flow
7. South Chilcotin Park (LU7)							
7-1	30.09	1143	2479	1336	0.24	8.5	Flood
7-2	2.89	1021	2171	1150	0.68	3.6	Debris flood/flow
7-3	7.89	925	2242	1317	0.47	4.6	Debris flood
8. Gun Creek Road (LU8)							
8-1	7.9	877	2181	1304	0.46	5.5	Debris flood
8-2	16.5	766	2289	1523	0.38	8.2	Debris flood
8-3	2.3	849	1425	576	0.38	3.1	Debris flood
8-4	2.0	860	1640	780	0.57	3.1	Debris flood
10. Highway 40 slopes (LU 10)							
10-1	0.58	667	1084	417	0.55	1.1	Debris flood
10-2	1.16	656	981	325	0.30	1.5	Debris flood

Wild-fire Impact on Existing Hazard

Table 7 summarizes the percentage burnt in each sub-basin by burn severity class. In the literature, authors typically refer to percentage of moderate and high burn severity when discussing post-wildfire hazard (Gartner 2005). In Table 8, we combined moderate and high burn severity categories to yield a wild-fire impact category, M+H (%burnt):

1) 0-24%, Low;
2) 25-49%, Moderate;
3) 50-74%, High; and
4) 75-100%, Very High.

Based on the Walker Creek benchmark (see Summary of Wildfire Impacts below), the existing hazard affecting Properties at risk was assumed to be Low (Tables 1), and it was adjusted for wildfire impact by the following protocol (Table 8):

1) The existing hazard cannot be reduced by wild-fire impact;
2) Low existing hazard plus Low wildfire impact equals Low post-wildfire hazard;
3) Low existing hazard plus Moderate wildfire impact equals Moderate post-wildfire hazard;
4) Low existing hazard plus High wildfire impact equals Moderate post-wildfire hazard;
5) Low existing hazard plus Very High wildfire impact equals High post-wildfire hazard; and
6) Low existing hazard, Very High wildfire impact, and debris flow equals Very High post-wildfire hazard
7) Moderate existing hazard plus Very High wildfire impact equals Moderate post-wildfire hazard;
8) High existing hazard equals High post-wildfire hazard

Table 7. Summary of burnt area by burn severity class for each sub-basin, Downton Lake Fire.

Map ID	Sub-basin area (km^2)	% Unburnt	% Low	% Medium	% High
1. Downton Reservoir Slopes					
1-1	3.17	98.09	1.15	0.71	0.05
1-2	0.84	46.16	12.04	30.60	11.20
1-3	3.65	61.72	10.33	14.38	13.58
1-4	0.85	47.02	22.86	26.71	3.41
1-5	1.54	56.36	21.95	19.56	2.12
1-6	0.72	33.87	23.39	31.78	10.96
1-7	1.98	37.75	17.66	27.86	16.73
2. Penrose-Lajoie Lake					
2-1	1.60	8.55	10.66	30.53	50.25
2-2	4.19	35.95	4.94	20.98	38.13
3. Gun Lake Penrose-Walker Face					
3-1	0.46	0.02	1.25	25.25	73.48
3-2	0.58	0.59	3.57	31.46	64.38
3-3	1.30	2.74	4.87	23.31	69.08
3-4	1.63	0.85	3.12	20.95	75.08
4. Walker Creek					
4-1	7.82	49.96	9.01	19.95	21.09
5. Gun Lake-Sumner Creek face					
5-1	2.88	8.97	8.58	31.57	50.88
5-2	0.76	0.12	1.73	26.49	71.66
5-3	1.00	0.53	3.87	50.04	45.56
6. Slim Creek FSR above Gun Creek					
6-1	13.93	97.29	0.88	1.06	0.77
6-2	4.58	82.61	4.68	7.15	5.56
6-3	9.75	78.45	4.46	9.13	7.96
6-4	1.86	54.36	4.01	11.14	30.49
6-5	2.59	36.93	2.58	5.70	54.79
6-6	0.95	8.92	7.65	22.23	61.20
7. South Chilcotin Park					
7-1	30.09	90.49	1.65	3.02	4.84
7-2	2.85	38.79	3.69	19.65	37.87
7-3	7.86	73.00	6.23	10.62	10.14
8. Gun Creek Road					
8-1	7.90	85.02	2.62	4.65	7.71
8-2	16.51	97.47	1.3	1.18	0.05
8-3	2.26	69.63	5.37	12.58	12.42
8-4	2.00	82.97	1.96	9.34	5.53
10. Highway 40 slopes					
10-1	0.58	29.87	35.62	29.25	5.26
10-2	1.16	19.51	24.77	40.30	15.43

Table 8. Temporary Impact of Wildfire (WF) on Existing Hazard Levels affecting sub-basins with Downton Fire Area. Geo-domains: Flood, Fw; Debris flood, Fd; Debris flow, Df; A, snow avalanche.

Sub-basin	Geo-domain	Existing Hazard	Burn Sev. M+H (%)	Wildfire Impact	Post WF Hazard	Elements at Risk (see Appendix 4. Elevated post-wildfire hazard affecting private properties on Gun Lake Road West and Gun Creek Road.)
1. Downton Reservoir Slopes						
1-1	Fd, Df, A	H	1	L	H	Forest Roads, Reservoir Shoreline
1-2	Df, A	H	42	M	H	Forest Roads, Reservoir Shoreline
1-3	Fd, Df, A	H	28	M	H	Forest Roads, Reservoir Shoreline
1-4	Df, A	H	30	M	H	Forest Roads, Reservoir Shoreline
1-5	Fd, Df, A	H	22	L	H	Forest Roads, Reservoir Shoreline
1-6	Df, A	H	43	M	H	Forest Roads, Reservoir Shoreline
1-7	Fd, Df, A	H	45	M	H	Forest Roads, Reservoir Shoreline
2. Penrose-Lajoie Lake						
2-1	Fd, Df	L	81	VH	H	010-934-260, *water intake; no structures affected
2-2	Fd, Df	L	59	H	M	010-934-260, *water intake; no structures affected
3. Gun Lake Penrose-Walker Face						
3-1	Df	L	99	VH	H	008-934-371, 008-212-236, 008-212-244, 008-934-347
3-2	Df	L	96	VH	H	*010-355-448
3-3	Fd, Df	L	92	VH	H	017-978-416, 013-496-859, 002-229-625, *water intake
3-4	Df	L	96	VH	H	023-342-676, 023-342-684, 004-480-422
4. Walker Creek						
4-1	Fd, Df	L	41	M	M	*Lots A-E (Cordilleran 2015).
5. Gun Lake-Sumner Creek face						
5-1	Fd, Df	L	82	VH	H	*008-931-160, *007-872-801
5-2	Fd	L	98	VH	H	*007-872-801, *004-716-531, *007-872-810
5-3	Fd	L	96	VH	H	*008-201-749, *008-201-722
6. Slim Creek FSR above Gun Creek						
6-1	Fd	L	2	L	L	Slim Creek FSR
6-2	Fd, Df, A	M	13	L	M	Slim Creek FSR
6-3	Fd	L	17	L	L	Slim Creek FSR
6-4	Fd, Df, A	H	42	M	H	Slim Creek FSR, Jewel Creek trailhead parking & bridge
6-5	Fd, Df, A	H	60	H	H	Slim Creek FSR, Jewel Creek parking entrance
6-6	Df, A	M	83	VH	H	Slim Creek FSR
7. South Chilcotin Park						
7-1	Fw	L	8	L	L	Lower Gun Creek Trail, Eldorado Creek
7-2	Fd, Df	L	58	H	M	Lower Gun Creek Trail
7-3	Fd	L	21	L	L	Lower Gun Creek Trail, Frieberg Creek
8. Gun Creek Road						
8-1	Fd	L	15	L	L	*101-328-821, *013-429-451
8-2	Fd	L	1.23	L	L	Gun Creek Road
8-3	Fd	L	25	M	M	Tyaughton Road
8-4	Fd	L	15	L	L	*018-005-632, 009-362-894, 011-389-087
10. Highway 40 slopes						
10-1	Fd	L	35	M	M	Highway 40
10-2	Fd	L	56	H	M	Highway 40

* Burnt (structure loss)

*Detailed geomorphic risk assessment by Cordilleran (2015) reconsolidated properties on Walker Creek fan to create five new residential lots. These have recommended measures to reduce risk, including siting constraints, lift of habitable space, foundation design and erosion protection, modified after WLAP (2004).

Bridge River Tephra

What makes the Downton Lake fire different from all wildfires reported in the BC literature is the existence of the 2400-year old Bridge River tephra (Photos 3-8). In the project area the tephra forms a veneer about 50 cm thick, and is granular in texture. In conducting forestry TSAs in the Bridge River area for over 30-years, Cordilleran has not noted any particular concern arise from the presence of tephra veneer. But that maybe because, other than along roads and skid roads, logging does not completely remove the forest floor organics. That most moderately-steep (50-70%) and steep (70-80%) slopes retain tephra veneer would suggest that over the last 2400 years there is some resiliency to erosion.

Nevertheless, the tephra is a sandy to granular pumice, it is vesicular and light weight, and may be characterized by low cohesion under dry conditions (Maeda et al., 1977, Warkentin, 1984) and high erodibility without vegetation cover (Rodríguez et al., 2002), and due to loss of physical obstructions on the ground by consumption of organic debris (Meyer, 2002). This effect could be quite pronounced in the Downton Fire area as the tephra covered slopes are very smooth, and where the fire severity was moderate to high, most of the organic ground structure is lost. As such, the presence of tephra could increase the probability of debris floods or flows (e.g., Meyer and Wells 1997; Neris et al. 2016).

Weather Triggers and Runoff

Strong snowmelt events, summer rainstorms and fall rain and rain-on-snow events are the primary triggers for landslide activity (Jordan and Covert, 2009). Perhaps the most important concept with respect to post-wildfire triggering relates to recurrence interval. Where under normal conditions a longer return period event is required to trigger geomorphic events, after fire even very short return period events (<1 yr to 2 yr return; Staley at al. 2020) may become triggers due to the accelerated pace of runoff and the increased erodibility of exposed soils.

Post-wildfire Debris Volumes

Channel Yield

As a first estimate, landslide volumes were estimated using the channel yield method. Channel segments were tallied by length, and a series of erosion event scenarios were defined, including: erosion of all-channels at once, erosion of the two longest channels or a single channel event. The all-channel scenario is highly unlikely, while the two- and single-channel scenarios are more likely. Assuming a low yield rate of 5 m^3/m, appropriate for thin debris or loose soil over bedrock (Hungr et al., 1984), the estimated debris flow volumes are shown in Table 9. This establishes an upper-bounds of 20,000-30,000 m^3 for large events, 10,000-20,000 m^3 for moderate sized events and <10,000 m^3 for smaller events.

Table 9. First order Debris flood/flow volume estimates for sub-basins affecting residential properties within the Downton Lake fire area. Mainstem reach angle is angle from upper fire boundary to element of concern (road/fan). Compare with predicted travel angle (Table 10).

	Channel Length & Debris Volume Scenarios						
	Sum total of all channels in sub-basin		Two longest channels		Single longest channel		
Sub-basin	Length (m)	Volume (m^3)	Length (m)	Volume (m^3)	Length (m)	Volume (m^3)	Mainstem reach angle (m/m)
2-1	3,650	18,250	..	..	2,980	14,900	0.34
2-2	8,340	41,700	4,830	24,150	2,860	14,300	0.17
3-1*	1,350	6,750	..	..	..	6,750	0.33
3-2*	1,240	6,200	..	..	..	6,200	0.32
3-3	3,550	17,750	..	..	2,330	11,650	0.40
3-4	5,285	26,425	3,370	16,850	1,970	9,850	0.41
4-1	11,070	55,350	5,860	29,300	3,490	17,450	0.32
5-1	8,162	40,810	5,116	25,580	3,906	19,530	0.27
5-2*	1,795	8,975	..	..	..	8,975	0.19
5-3*	1,615	8,075	..	..	..	8,075	0.23
8-4	3,785	18,925	..	..	2,840	14,200	0.14
Max		55,350		29,300		19,530	0.41
Min		6,200		16,850		6,200	0.14
Average		22,655		23,970		11,989	0.28

*Single channel sub-basins.

Regression functions: Volume = Slope * Burnt Area * Rainfall

Gartner (2005) used a series of stepwise multiple-regression analyses to develop a best-fit model to estimate potential debris-flow volumes in the Western U.S. Debris volume can be solved by,

$$\ln V = 0.65(\ln S) + 0.86(B)\ 1/2 + 0.22(R)\ 1/2 + 6.46$$

where V is debris-flow volume (m^3), S is basin area with slopes greater than or equal to 30 percent (km^2), B is basin area burned at moderate and high severity (km^2), and R is total storm rainfall (mm).

Other similar models are available for various regions for estimating debris flood/flow hazard and debris volumes (Cannon et al. 2010; Staley et al., 2016). We have not predicted potential debris flood or flow volumes based on regression modelling. Instead, we rely on the qualitative method described above. More detailed follow up studies would apply regression models to estimate post-wildfire debris yields affecting private properties below the identified sub-basins.

Landslide Runout or Travel

Landslides will typically travel to the base of slope, with the deposition zone being a 50-200 m wide belt of terrain less than 30% slope (Fannin and Rollerson 1993). Travel angle, H/L, or ratio of total drop to total horizontal length of the landslide is widely used to characterise travel distance (Corominas 1996), and this measure can be used in terrain hazard mapping as a first order estimate of potential impact areas. The representative sub-basin reach angles shown in

Table 9 were measured from potential start zones (steep slopes) near the upper fire boundary to the elements at risk (road/fan apex).

Corominas (1996) published runout data for a global population of landslides of different types, providing estimates of runout distance as a function of landslide volume. In Table 10 below we present travel angles estimated from the Corominas (1996) data set, selecting "all debris flows" for a range of volumes spanning the range of credible volumes in the Downton Lake fire boundary.

The Penrose-Walker Face (LU3) supports landslide reach angles of 0.32-0.41 (Table 9). This indicates that landslides equal to or larger that 5000 m^3 could affect the fan apex. Whereas, for Walker Creek (LU4), only landslides >10,000 m^3 may reach the fan, and debris flooding is more likely. Finally, slopes are gentler and elongate on the Gun Lake-Sumner face (LU5) and this results in debris flooding being dominant.

In this report, we use travel angle to evaluate site-specific hazards, such as road fill failures.

Table 10. Travel angle (H/L) estimated for "All debris flows" for various credible volumes within the Downton Lake fire boundary (after Corominas 1996).

Volume (m^3)	Angle (^{o})	Angle (m/m)
1000	25.2	0.47
5000	21.7	0.40
10,000	20.3	0.37
30,000	18.2	0.33
50,000	17.3	0.31

Debris flood/flow Damage Potential

Table 11 describes landslide impact potential. The debris volumes estimated in Table 9 range from Class 3 to small Class 4 landslides with the potential destroy buildings, damage concrete structures and bridges, damage roads and pipelines, and block creeks (Table 11). This indicates that potential post-wildfire events would have the potential to cause significant damage to private properties, and mitigation is indicated.

Table 11. Landslide size class ratings describing impacts for each class. Size classes are within the range of expected for forestry operations (Jakob 2005).

Class	Volume (m^3)	Peak discharge (m^3/s)	Potential consequences
1	$<10^2$	<5	Very localized damage, known to have killed forestry workers in small gullies and damaged small buildings.
2	10^2-10^3	5-30	Bury cars, destroy small wooden buildings, break trees, block culverts, and damage heavy machinery.
3	10^3-10^4	30-200	Destroy larger buildings, damage concrete structures, damage roads and pipelines, and block creeks.
4	10^4-10^5	200-1500	Destroy camps, destroy sections of infrastructure corridor, damage bridges and block creeks.
5	10^5-10^6	1500-12,000	Destroy camps and forest up to 2km^2 in area, block creeks and small rivers.

Duration of Post Fire Effects

Hydrophobicity is a short-term effect that typically takes 1-5 years to diminish. Loss of forest cover is long-term effect that gradually recovers as forest stands mature in the decades following the fire.

Summary of Existing Hazard and Wildfire impacts

1. **Downton Reservoir Slopes (LU1).** Evidence of active colluvial processes including snow avalanche, debris flood, debris flow and channel avulsion were noted on the fans bordering Downton Reservoir (Cordilleran, 2017). For this reason, the existing hazard in the Downton Reservoir Slopes sub-basins is considered high. Post-wildfire impacts are judged to be low to moderate; this does not alter the existing high hazard. Post-wild fire effects may see ongoing/increased debris flood/flow activity on fans, with impact to Forest Road ID R06128 1890. Snow avalanche paths may extend further downslope as mature trees providing slope resistance are pushed over and entrained by snow avalanches. Snow avalanches may deliver destroyed timber to the reservoir, leading to pulse of floating dead wood. Fire may burn wood from fillslope material creating soft road shoulders and fillslope instability.

2. **Penrose-Lajoie Lake (LU2).** Penrose Creek is an active system with snow avalanche and debris flow affecting the midslope fan area, where most energy is dissipated. Fire impact in the Penrose sub-basins was high to very high, and post-wildfire hazard is moderate (sub-basin 2-1) to high (sub-basin 2-2). The Forest Road R06128 28-713-220 crossing near the apex of the fluvial fan at 950 m asl has the potential to capture Penrose Creek and divert it eastwards. There is a water licence and intake on Penrose Creek above this road crossing, and a buried waterline runs a short distance along the road, and then down through private property (010-934-260). The property on the fluvial fan on Lajoie Lake does not have any homes vulnerable to geo hazards from Penrose Creek (sub-basin 2-2) or others (sub-basin 2-1).

3. **Gun Lake Penrose-Walker Face (LU3).** Between the boat launch at the south end of the lake and Walker Creek there are four sub-basins (3-1, 3-2, 3-3, 3-4) interspersed with five face units. Sub-basins are mapped as prone to debris flow with Very High wildfire impacts, and High post-wildfire hazard. Most of the properties in the area escaped structural fire damage, but as the sub-basins were impacted, the unburnt properties on the sub-basin fans may be affected by High post-wildfire hazard. A water intake was burnt on sub-basin 3-3. All face unit properties are assumed to have Low post-wildfire hazard. There is minor rockfall hazard from <6 m tall bedrock cuts along Gun Lake Road West.

4. **Walker Creek (LU4).** Cordilleran (2015) excavated 19 test pits ranging from 2-3 m depth across the Walker Creek fan and collected seven organic samples for radiocarbon dating. The results allowed a reconstruction of the geomorphic impacts affecting Walker Creek fan going back ~7400 years before present. Test pits encountered three main material types: Bridge River tephra; matrix-supported, poorly-sorted, boulder gravel, with subround to subangular clasts ranging from 0.25-2 m dia., interpreted to represent debris flow deposits; and stratified sands and pebble-cobble gravel interpreted to be debris flood sediment. Debris flood/flow events were estimated to range in volume from 5000-15000 m^3, with only 0-2 events covering

the fan Bridge River tephra in any given location. The average event return frequency for the last 2500 years was estimated to be between 1/500-1/2500 per annum, or Low (Table 1). No evidence of wildfire related activity was noted (i.e., by the presence of charcoal rich zones in the deposits). Given that Walker Creek is the largest watershed, with the largest fan, on the west side of Gun Lake, the results provide a benchmark for the other fans along the lake shore in Landscape Units 3. and 5; i.e., existing debris flood and debris flow hazards are judged to be Low unless recent evidence of geohazard activity documented in the field. Walker Creek experienced Moderate wildfire impact, and as such, post-wildfire hazard is judged to be moderate.

5. **Gun Lake-Sumner Creek face (LU5).** Between Walker Creek and the north end of Gun Lake there are three sub-basins (5-1, 5-2, 5-3) interspersed with three face units. There are two creeks (sub-basin 5-1, 5-2) that feed onto a fan. The larger creek, Sumner Creek (5-1) is reported to be a seasonal creek. We observed evidence of two debris flood/flow events on the fan post-dating the Bridge River eruption, indicating a Low hazard (Table 1). From the shoreline up to about 1300 m asl the Sumner Creek watershed is characterised by a series of benches with intervening gentle slopes. Only the headwater slopes above 1300 m asl are steep. On the basis of ample storage capacity on the benches below 1300 m asl, the creek process at the mouth may be downgraded from debris flood/flow to debris flood. As such, all the sub-basins are mapped as prone to debris flood with Very High wildfire impacts, and High post-wildfire hazard. All face unit properties are assumed to have Low post-wildfire hazard.

6. **Slim Creek FSR above Gun Creek (LU6).** There are six sub-basins and five face units affecting the base of slope. At their intersection with Slim Creek FSR, the largest sub-basins, 6-1 and 6-3, are debris flood creeks; sub-basins 6-2, 6-4 and 6-5 are debris flood/flow and snow avalanche creeks; and sub-basin 6-6 is a debris flow and snow avalanche creek. Sub-basins 6-1 and 6-3 experienced Low wildfire impact and have Low post-wildfire hazard. Sub-basins 6-2 has Moderate existing hazard and Low wildfire impact, yielding Moderate post-wildfire hazard. Sub-basins 6-4 and 6-5 affect the Jewel Creek trailhead, footbridge, and parking area. On these sub-basins there is evidence of ongoing debris flood/flow activity affecting Slim Creek FSR, and the existing hazard is estimated to be High. With Moderate to High wildfire impact the post-wildfire hazard affecting Jewel Trailhead is High. Sub-basin 6-6 is a debris flow creek with Very High wildfire impact, and High post-wildfire hazard affecting Slim Creek FSR. Furthermore, an old forest road (Table 11) and a firebreak road (Table 12) upslope have been identified as presenting a Moderate to High post-wildfire landslide hazard affecting Slim Creek FSR. At three sites (WPs DK175; 216-218; DK232-233), an increase in rockfall may affect Slim FSR. At DK215 fresh/active but pre-wildfire debris flow lobes were noted in the forest, indicating a localized debris flow hazard below steep slopes.

7. **South Chilcotin Park (LU7).** This area consists of the north side of Gun Creek, extending about 10 km along Gun Creek from the eastern divide of Freiberg Creek to the western divide of Gun Creek near the Slim Creek junction. The area includes the Gun, Eldorado and Freiberg Creek basins and intervening faces. Other than the recreational trails, there are no elements at risk. Upper Gun Creek above Leckie Creek, almost completely escaped the fire, Eldorado Creek and Frieberg Creek had Low wildfire impact, and Low post-wildfire hazard. Sub-basin

7-2 suffered High wildfire impact and assuming Low hazard, then post-wildfire hazard is judged to be Moderate. The Lower Gun Creek trail can expect Low to Moderate post-wildfire hazard at creek crossings.

8. Gun Creek Road (LU8). There are four sub-basins in this area, all classified as debris flood creeks. Lick (8-1), Pearson (8-2) and 8-4 creeks are the main drainages crossing Gun Creek Road. Lick Creek (8-1) affects two properties upslope of the road. Pearson Creek (8-2) borders the east side of Chilcotin Mountain Holidays Ranch property. The ranch property is situated on a high terrace. With the creek deeply incised in a ravine, Pearson Creek does not affect the Ranch. Sub-basin 8-4 potentially affects three properties, one burnt. They all sustained Low wildfire impact, and have Low post-wildfire hazard. A small unnamed creek (8-3) crosses Tyaughton Road at the Gun Creek Junction. It sustained Moderate wildfire impact, and has Moderate post-wildfire hazard. It does not affect private property.

9. Lajoie Creek-Plateau Ponds (LU9). The terrain on the Plateau Ponds and Mowson Ponds areas is gentle with no upslope hazards. No post wildfire hazard exists in these areas. The steep ravine sidewall slopes directly connected to Gun Creek may have post wildfire hazard, but there are no elements at risk below other that Gun Creek. Since Gun Creek is large (585 km^2) in comparison to the area of burnt sidewalls 45 km^2, 8%), it is judged there will be low impact to Gun Creek at Highway 40 on the alluvial fan and affecting Minto Camp and the BC Hydro Campground.

10. Highway 40 slopes (LU10). Within the fire perimeter, there are two defined sub-basins (10-1, 10-2) and several smaller dry gullies above Highway 40. The sub-basins are mapped as prone to debris flood with Moderate wildfire impacts, and Moderate post-wildfire hazard. All face unit areas are assumed to have Low debris flood/flow hazard, but could have rockfall hazard affecting the road.

Mitigation Measures

Properties on Gun Lake Road West

We have identified several properties (burnt & unburnt; Table 8) that are located on fans at the base of steep creeks that may be vulnerable to post-wildfire hazardous events. The post-wild fire hazard is identified as High (LU3, Gun Lake Penrose-Walker Face; LU5 Gun Lake-Sumner Creek face) to Moderate (LU4, Walker creek); and require mitigation by Cave (1993) criteria (Table 3). Faces between sub-basins are not large areas, display gentle to moderate grades (<50% slopes), and are not convergent slopes, and on that basis, we make the assumption that the existing Low hazard is not affected by wildfire impact, regardless of burn intensity. As such, properties below face units require no mitigation.

Several unburnt properties exist on sub-basin fans that face an elevated (intolerable) post-wildfire hazard (Table 8). It is recommended that these owners be identified and sent notification letters apprising them of the elevated post-wildfire hazard and weather conditions (rainfall intensities ~5 mm/hr; ~25mm/24 hr; Table 5; rapid snowmelt) when the threat is greatest. They may wish to conduct a hazard assessment (Hope et al. 2015; EGBC 2022) to assess and manage their risk, as required. Properties on Walker Creek are vacant except for an existing unburnt house on 11188 Gun Lake Road West (PID 030-727-952). Future development on Walker Creek's vacant lots requires mitigation after Cordilleran (2015), while the property with the existing home faces Moderate post wildfire hazard.

SLRD has posted policy for those interested in rebuilding on burnt properties within the Gun Lake fire.[3] The building permit approval process must consider sites with elevated post-wildfire hazard, such as, sites identified as being on or near sub-basin fans (Table 8). For these sites, it is recommended that owners are required to conduct legislated hazard assessments (Hope et al. 2015; EGBC 2023) prior to being granted building permits. Mitigation may consist of siting constraints, lift of habitable space, foundation design, and scour protection (WLAP 2004). The cost of a detailed assessment of one or all fans along Gun Lake Road West could be shared amongst affected properties.

Salvage logging is being planned for areas throughout the Downton Creek fire area. Any logging planned for sub-basin and face units that are located above Gun Lake Road West must consider the post-wildfire hazard rating (Table 8, Map 8), the impact of salvage logging on the hazard, and post-logging risk must be evaluated using life safety standards used for residential development (e.g., Cave 1993).

Properties on Gun Creek Road

No mitigation measures are indicated as post wildfire risk affecting properties is judged to be Low (Table 9).

[3] https://www.slrd.bc.ca/sites/default/files/231102%20Rebuilding%20–%20Planning%20and%20Permits%20SLRD%20Recovery.pdf

Domestic Water Intakes

Intakes on creeks could be vulnerable to debris floods or debris flows, while lake intakes could be vulnerable to deterioration of water quality due to inwash of pollutants from burnt properties. Where domestic water intakes are destroyed by wildfire or by post wildfire geohazard events, they will be replaced by the owner. The quality of lake water at depths used for intakes should be monitored by SLRD and or well owners and where unsafe levels are found of any post wildfire pollutants, then well owners should be notified immediately and water purified before use.

Public Roads

On Tyaughton Road at the Gun Creek Road intersection, basin 8-3 was identified as a debris flood hazard. We observed (WP DK 165) an ephemeral channel with a 600 mm metal culvert that was blocked. At this site, the culvert should be maintained or replaced.

On Gun Lake Road West, the Sumner Creek crossing supports a 4 m deep fill, with a V-shape, 10 m wide, crest to crest at the road shoulder elevation, and a 400 mm metal culvert at the base of the V. There is a high potential for blockage, and this could result in a breach affecting properties downslope. Fan gradient is 15-20% slope.

On Gun Lake Road West, the Walker Creek crossing is not well confined. The seasonal active channel dimensions are 3.5 m wide by 50-70 cm deep, and has a boulder step-pool morphology, with boulders up to 600 mm dia. Gradient 15-18%. There is no freeboard, and the creek could plug and follow a 100° bearing onto the north side of the fan where the existing residence is located. An avulsion at the fan apex caused by the original road was reported to have occurred in 1948 (David Kier, pers comm, 2015).

Culverts on public roads above residential properties should be sized properly for the 200-year flood plus allowance for debris and climate change, and intakes should be monitored and cleaned regularly. Berms and channel training providing sufficient capacity to accommodate at least 500-year debris flood/flow event should be installed. Detailed design and implementation of training structures should be considered for Sumner and Walker Creek crossings on Gun Lake Road West, and fan areas downslope.

On Highway 40 either side of the fire boundary, and on Gun Lake Road West at each end of the lake, signage should be placed warning of the potential for debris floods, debris flow and possible rockfall during inclement weather. Designate a no stopping zone in this area.

Forest Roads

Forest road drainage design has the potential to lead to water concentration from one hillslope sub-basin to another, and lead to elevated geohazard downslope. We reviewed crossing structures on roads we traversed (Appendix 2), and while we did record many damaged culverts needing replacement, we did not note any egregious water misalignment issues. Nevertheless, when planning salvage forest operations above private properties on Gun Lake Road West and Gun Creek Road, where existing roads cross sub-basin areas, detailed drainage plans (Green and Halleran 2002) must be conducted and natural drainage remediated as required.

Road signage could be posted at either side of post-wildfire hazard areas warning of elevated hazard conditions. Signage should indicate weather conditions that trigger debris flood/flow and snow avalanche activity. The following sites were noted (others may exist):

- Slim Creek FSR faces increased post-wildfire from debris floods, debris flow and snow avalanche activity on sub-basins 6-4, 6-5 and 6-6.
- Forest Road ID R06128 1890 and spurs face increased post-wildfire from debris and snow avalanche hazard on crossing sub-basins 1-2 to 1-4 and 1-6 to 1-7.
- Along Slim Creek FSR, at three sites (WPs DK175; 216-218; DK232-233), existing rockfall hazard was noted, and at DK215 fresh/active but pre-wildfire debris flow lobes were noted in the forest, indicating a localized debris flow hazard below steep slopes.

The Jewel Creek trailhead parking area may be affected by increased post wildfire debris and snow avalanche hazards, and signage should be posted there warning of upslope post-wildfire hazards. Signage should indicate weather conditions that trigger debris flood/flow and snow avalanche activity, and use of the parking area should be avoided at those times. Debris flow catchment or deflection structures, requiring more detailed design, should be considered as a structural measure to mitigate landslide risk affecting the trailhead.

Old roads in the project area were often built without sufficient benching and endhaul, and there may be areas where wood supports fill. With wildfire, the wood may become burnt out, and this results in unstable fill. A spur road off Slim FSR supports a High hazard (PH) fillslope with High reach (PSH) to Slim Creek FSR, indicating High risk (PHA) and requires fillslope pullback, as outlined in Table 12. The table does not prescribed water control, but water control measures should be conducted for the length of the road.

Table 12. Deactivation required Spur R06128-415-1 off and climbing above Slim FSR

WP	Latitude	Longitude	Description
DK 179	50.9052647	-122.89419	Over steepened fill, pistol butt trees, high burn intensity, steep below, burnt wood in fill. 2m thick fillslope held up by burnt stump. PoC pullback using 9 m reach.
DK 182	50.904992	-122.89625	End of over steep fill. PoT pullback.
DK 187	50.9039184	-122.9015	Sidewalls of gully need pull back, using 9 m reach.

On Downton Face, Road ID R06128 1890 supports sections where burnt wood is causing a collapsing road shoulder, and presenting a risk to driving safety (WPs DK6, 7; Photos 20, 21). These areas should be identified and repaired.

Photo 20. WP DK6. Burnt wood creating driving hazard.

Photo 21. WP DK7. Burnt wood creating driving hazard.

Crossing Penrose Creek, Road R06128 28-713-220 has a slight swale/dip in grade through the crossing (Photos 22, 23). The culvert should be monitored to ensure it does not plug, and the dip in grade needs to be maintained, a minimum sag and sag distance is 1 m over 20 m distance. If the culvert plugs or debris overwhelms the sag, then water and debris could be directed east down the road toward the junction with Gun Lake Road West.

Photo 22. WP DK103. View campside past Penrose Creek crossing on Road R06128 28-713-220. Ensure culvert is clear and sag is maintained.

Photo 23. WP DK103. View campside past Penrose Creek crossing on Road R06128 28-713-220 to lower side of road where avulsion could impact.

Firebreak Roads

All fire break roads should be permanently deactivated using water control measures prescribed and signed off by a Qualified Professional (QP; i.e., RPF, PGeo, PEng), and executed by persons knowledgeable in road deactivation measures (trained excavator operator). We noted several cross ditches installed in a firebreak that served to concentrate rather disperse water on the road (WPs DK48, 49, 50). Concentrating water by cross-ditching is incorrect and indicates a lack of knowledge. Firebreak roads constructed on steep terrain may require fillslope pullback. At these

sites a QP (i.e., PGeo, PEng) must prescribe and sign off on permanent deactivation measures. Rehabilitation of watercourses and wetlands should also be conducted (eg., Appendix 2, Alder Brook, PM1).

A non-status road branching off Road R06128 1910 at 1290 m asl has had a firebreak extended 1-2 km along the slope above Slim Creek. A portion of the road supports an oversteepened fillslope with tension cracking evident (Photo 24). The fillslope exhibits High hazard (PH) and Moderate reach (PSH) to Slim Creek FSR, yielding a Moderate risk (PHA) to Slim Creek FSR. Conduct permanent deactivation including fillslope pullback on this firebreak road (Table 13). Pullback must be signed off by qualified professional.

Table 13. Deactivation required on firebreak road midslope off NSR branching from R06128-191 at 1290 m asl.

WP	Latitude	Longitude	Description
DK 27	50.9017611	-122.91158	Unstable fill slopes due to burnt wood in fill, PoC pull back, using 9 m reach.
DK 29	50.9013747	-122.913	End of tension cracks, PoT pull back
DK 31	50.9018626	-122.91384	New road construction, no end haul across steep terrain. POC pullback using 9 m reach.
DK 32	50.9026008	-122.9142	End of new construction on steep terrain, PoT pull back

Photo 24. Firebreak road branching off Road R06128-191. Oversteeped fillslope with tension cracking presents landslide hazard above Slim Creek FSR. Permanent deactivation required.

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Closure

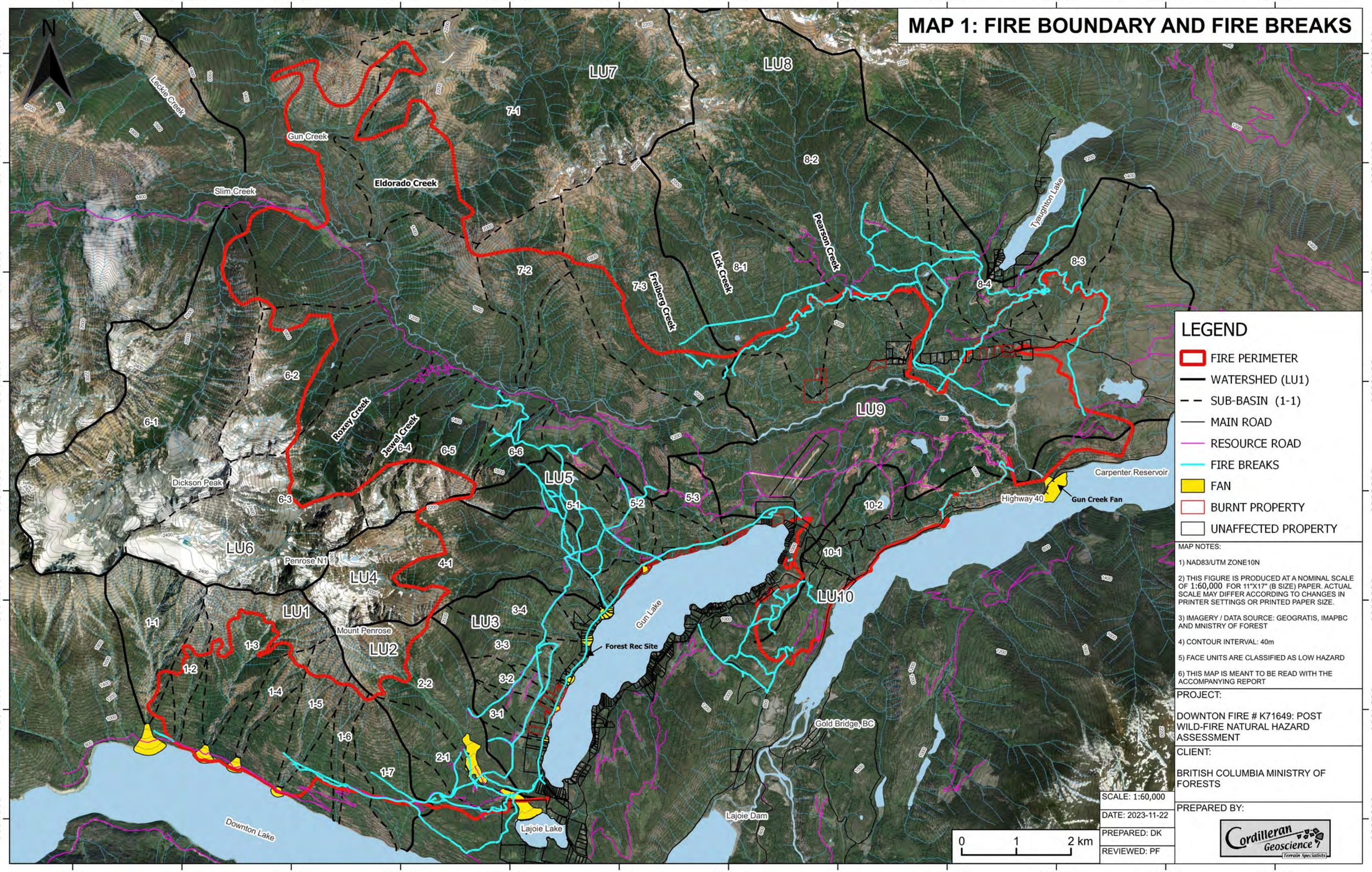
This report was prepared for use by BC Ministry of Forests, including distribution as required for purposes for which the report was commissioned. The work has been carried out in accordance with generally accepted geoscience practice. Judgment has been applied in developing the conclusions stated herein. No other warranty is made, either expressed or implied to our clients, third parties, and any regulatory agencies affected by the conclusions.

Should you have any questions please call.

Pierre Friele, P.Geo.
Permit to Practice 1002800

Reviewed by
David Kallai, GIT

MAP 1: FIRE BOUNDARY AND FIRE BREAKS



LEGEND

- FIRE PERIMETER
- WATERSHED (LU1)
- SUB-BASIN (1-1)
- MAIN ROAD
- RESOURCE ROAD
- FIRE BREAKS
- FAN
- BURNT PROPERTY
- UNAFFECTED PROPERTY

MAP NOTES:

1) NAD83/UTM ZONE10N

2) THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:60,000 FOR 11"X17" (B SIZE) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

3) IMAGERY / DATA SOURCE: GEOGRATIS, IMAPBC AND MNISTRY OF FOREST

4) CONTOUR INTERVAL: 40m

5) FACE UNITS ARE CLASSIFIED AS LOW HAZARD

6) THIS MAP IS MEANT TO BE READ WITH THE ACCOMPANYING REPORT

PROJECT:

DOWNTON FIRE # K71649: POST WILD-FIRE NATURAL HAZARD ASSESSMENT

CLIENT:

BRITISH COLUMBIA MINISTRY OF FORESTS

SCALE: 1:60,000

DATE: 2023-11-22

PREPARED: DK

REVIEWED: PF

PREPARED BY:

Cordilleran Geoscience
Terrain Specialists

MAP 2: BURNED AREA REFLECTANCE CLASSIFICATION (BARC)

N

498000 500000 502000 504000 506000 508000 510000 512000 514000 516000 518000 520000

5646000 5644000 5642000 5640000 5638000 5636000 5634000 5632000

LU1 LU2 LU3 LU4 LU5 LU6 LU7 LU8 LU9 LU10

7-1 7-2 7-3 8-1 8-2 8-3 8-4 6-1 6-2 6-3 6-4 6-5 6-6 5-1 5-2 5-3 4-1 3-1 3-2 3-3 3-4 2-1 2-2 1-1 1-2 1-3 1-4 1-5 1-6 1-7 10-1 10-2

Leckie Creek
Gun Creek
Eldorado Creek
Slim Creek
Pearson Creek
Lick Creek
Freiberg Creek
Tyaughton Lake
Roxey Creek
Jewel Creek
Dickson Peak
Penrose N1
Mount Penrose
Carpenter Reservoir
Highway 40
Gun Creek Fan
Gun Lake
Forest Rec Site
Gold Bridge, BC
Lajoie Dam
Lajoie Lake
Downton Lake

TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP8 TP9 TP10 TP12 TP13 TP14 TP15 TP16 TP17 TP18 TP19 TP20 TP21 TP22 TP23 TP24 TP25 TP26 TP27 TP28 TP29 TP30 TP31

LEGEND

- FIRE PERIMETER
- WATERSHED (LU1)
- SUB-BASIN (1-1)
- MAIN ROAD
- RESOURCES ROAD
- BURNT PROPERTY
- UNAFFECTED PROPERTY
- DRIP TEST (TP)
- WAYPOINTS
- Fan

VEGETATION BURN SEVERITY

- HIGH
- MEDIUM
- LOW
- UNBURNT

MAP NOTES:

1) NAD83/UTM ZONE10N

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3) IMAGERY / DATA SOURCE: GEOGRATIS, IMAPBC AND MNISTRY OF FOREST

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DOWNTON FIRE # K71649: POST WILD-FIRE NATURAL HAZARD ASSESSMENT

CLIENT:

BRITISH COLUMBIA MINISTRY OF FORESTS

PREPARED BY:

Cordilleran Geoscience
Terrain Specialists

SCALE: 1:60,000

DATE: 2023-11-22

PREPARED: DK

REVIEWED: PF

0 1 2 km

MAP 3: TRAVERSE

N

498000 500000 502000 504000 506000 508000 510000 512000 514000 516000 518000 520000

5646000 5644000 5642000 5640000 5638000 5636000 5634000 5632000

Leckie Creek
Gun Creek
Eldorado Creek
Slim Creek
Roxey Creek
Jewel Creek
Dickson Peak
Penrose N1
Mount Penrose
Downton Lake
Freiberg Creek
Lick Creek
Pearson Creek
Tyaughton Lake
Carpenter Reservoir
Highway 40
Gun Creek Fan
Forest Rec Site
Gun Lake
Lajoie Lake
Lajoie Dam
Gold Bridge, BC

LU1 LU2 LU3 LU4 LU5 LU6 LU7 LU8 LU9 LU10

1-1 1-2 1-3 1-4 1-5 1-6 1-7
2-1 2-2
3-1 3-2 3-3 3-4
4-1
5-1 5-2 5-3
6-1 6-2 6-3 6-4 6-5 6-6
7-1 7-2 7-3
8-1 8-2 8-3 8-4
10-1 10-2

TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP8 TP9 TP10 TP12 TP13 TP14 TP15 TP16 TP17 TP18 TP19 TP20 TP21 TP22 TP23 TP24 TP25 TP26 TP27 TP28 TP29 TP30 TP31

LEGEND

- FIRE PRIMETER
- WATERSHED (LU1)
- SUB-BASIN (1-1)
- WAYPOINTS
- DRIP TEST STIES (TP)
- MAIN ROAD
- RESOURCE ROAD
- FAN
- BURNT PROPERTY
- UNAFFECTED PROPERTY

MAP NOTES:

1) NAD83/UTM ZONE10N

2) THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:60,000 FOR 11"X17" (B SIZE) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

3) IMAGERY / DATA SOURCE: GEOGRATIS, IMAPBC AND MNISTRY OF FOREST

4) CONTOUR INTERVAL: 40m

5) FACE UNITS ARE CLASSIFIED AS LOW HAZARD

6) THIS MAP IS MEANT TO BE READ WITH THE ACCOMPANYING REPORT

PROJECT:

DOWNTON FIRE # K71649: POST WILD-FIRE NATURAL HAZARD ASSESSMENT

CLIENT:

BRITISH COLUMBIA MINISTRY OF FORESTS

SCALE: 1:60,000

DATE: 2023-11-22

PREPARED: DK

REVIEWED: PF

PREPARED BY:

Cordilleran Geoscience
Terrain Specialists

0 1 2 km

MAP 4: SLOPE

N

LU1 LU2 LU3 LU4 LU5 LU6 LU7 LU8 LU9 LU10

1-1 1-2 1-3 1-4 1-5 1-6 1-7 2-1 2-2 3-1 3-2 3-3 3-4 4-1 5-1 5-2 5-3 6-1 6-2 6-3 6-4 6-5 6-6 7-1 7-2 7-3 8-1 8-2 8-3 8-4 10-1 10-2

Leckie Creek, Gun Creek, Eldorado Creek, Slim Creek, Roxey Creek, Jewel Creek, Dickson Peak, Penrose N1, Mount Penrose, Freiberg Creek, Lick Creek, Pearson Creek, Tyaughton Lake, Forest Rec Site, Gun Lake, Carpenter Reservoir, Highway 40, Gun Creek Fan, Gold Bridge, BC, Lajoie Dam, Lajoie Lake, Downton Lake

LEGEND

- FIRE PRIMETER
- WATERSHED (LU1)
- SUB-BASIN (1-1)
- MAIN ROAD
- RESOURCE ROAD
- FAN
- BURNT PROPERTY
- UNAFFECTED PROPERTY

SLOPE (%)

- <= 30
- 30-50
- 50-60
- 60-70
- 70-90
- > 90

MAP NOTES:

1) NAD83/UTM ZONE10N

2) THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:60,000 FOR 11"X17" (B SIZE) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

3) IMAGERY / DATA SOURCE: GEOGRATIS, IMAPBC AND MNISTRY OF FOREST

4) CONTOUR INTERVAL: 40m

5) FACE UNITS ARE CLASSIFIED AS LOW HAZARD

6) THIS MAP IS MEANT TO BE READ WITH THE ACCOMPANYING REPORT

PROJECT:

DOWNTON FIRE # K71649: POST WILD-FIRE NATURAL HAZARD ASSESSMENT

CLIENT:

BRITISH COLUMBIA MINISTRY OF FORESTS

SCALE: 1:60,000

DATE: 2023-11-22

PREPARED: DK

REVIEWED: PF

PREPARED BY:

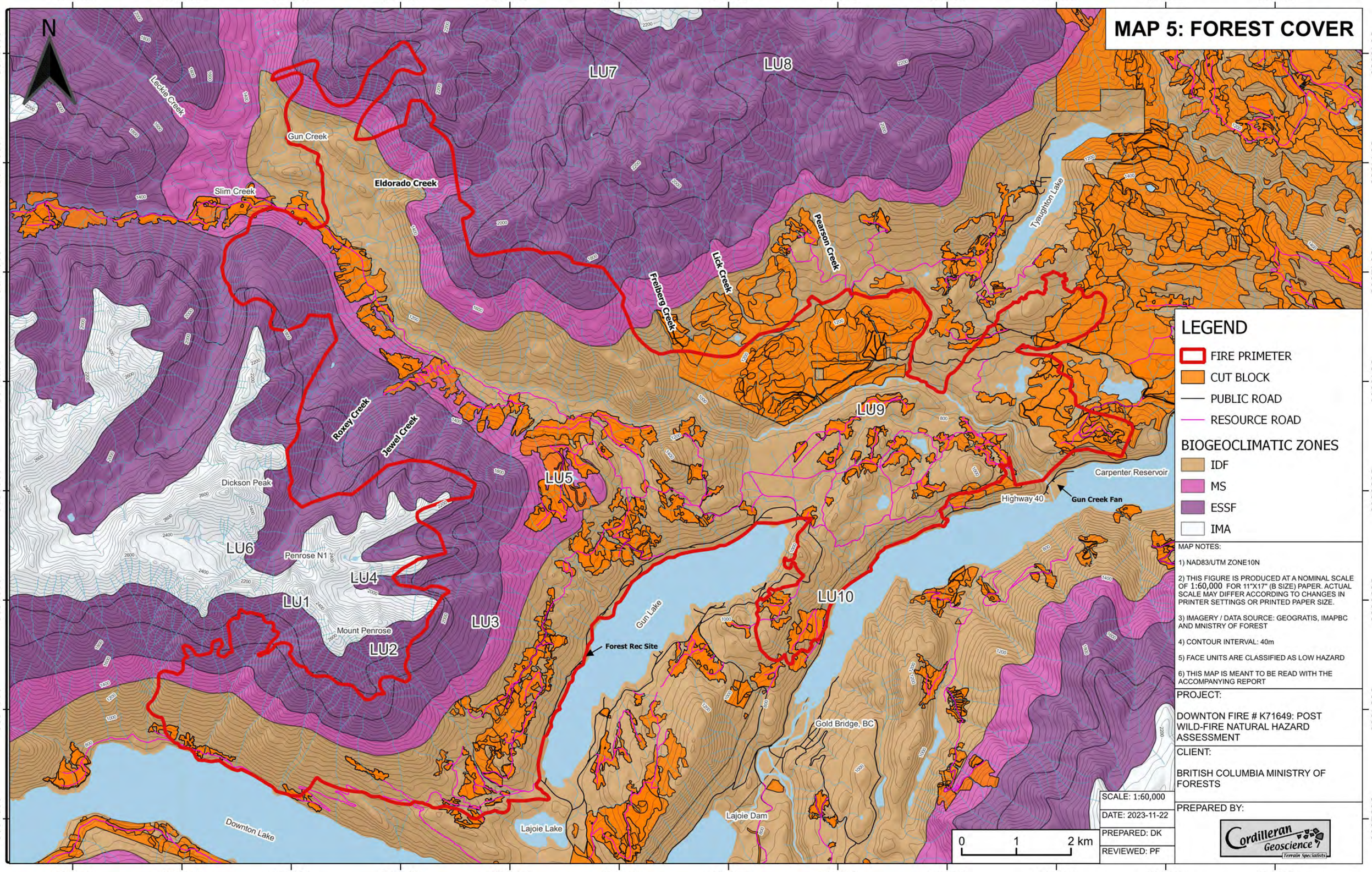
Cordilleran Geoscience
Terrain Specialists

0 1 2 km

498000 500000 502000 504000 506000 508000 510000 512000 514000 516000 518000 520000

5646000 5644000 5642000 5640000 5638000 5636000 5634000 5632000

MAP 5: FOREST COVER



LEGEND

- FIRE PRIMETER
- CUT BLOCK
- PUBLIC ROAD
- RESOURCE ROAD

BIOGEOCLIMATIC ZONES

- IDF
- MS
- ESSF
- IMA

MAP NOTES:

1) NAD83/UTM ZONE10N

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3) IMAGERY / DATA SOURCE: GEOGRATIS, IMAPBC AND MNISTRY OF FOREST

4) CONTOUR INTERVAL: 40m

5) FACE UNITS ARE CLASSIFIED AS LOW HAZARD

6) THIS MAP IS MEANT TO BE READ WITH THE ACCOMPANYING REPORT

PROJECT:

DOWNTON FIRE # K71649: POST WILD-FIRE NATURAL HAZARD ASSESSMENT

CLIENT:

BRITISH COLUMBIA MINISTRY OF FORESTS

SCALE: 1:60,000

DATE: 2023-11-22

PREPARED: DK

REVIEWED: PF

PREPARED BY:

Cordilleran Geoscience (Terrain Specialists)

MAP 6: ELEMENTS AT RISK

N

498000 500000 502000 504000 506000 508000 510000 512000 514000 516000 518000 520000

5646000 5644000 5642000 5640000 5638000 5636000 5634000 5632000

LU1 LU2 LU3 LU4 LU5 LU6 LU7 LU8 LU9 LU10

1-1 1-2 1-3 1-4 1-5 1-6 1-7
2-1 2-2
3-1 3-2 3-3 3-4
4-1
5-1 5-2 5-3
6-1 6-2 6-3 6-4 6-5 6-6
7-1 7-2 7-3
8-1 8-2 8-3 8-4
10-1 10-2

Leckie Creek
Gun Creek
Slim Creek
Eldorado Creek
Roxey Creek
Jewel Creek
Freiberg Creek
Lick Creek
Pearson Creek
Tyaughton Lake
Dickson Peak
Penrose N1
Mount Penrose
Gun Lake
Forest Rec Site
Lajoie Lake
Lajoie Dam
Downton Lake
Gold Bridge, BC
Carpenter Reservoir
Highway 40
Gun Creek Fan

SOUTH CHILCOTIN MOUNTAINS PARK
JEWEL CREEK PROTECTED AREA

LEGEND

- FIRE PERIMETER
- WATERSHED (LU1)
- SUB-BASIN (1-1)
- MAIN ROAD
- RESOURCE ROAD
- POWERLINE
- TRAIL
- CAMPGROUND & GUEST HOUSE
- WATER WELL
- WATER RIGHT LICENCES
- FAN
- PROVINCIAL PARK / RECREATION SITE
- MINTO COMMUNICATIONS
- BURNT PROPERTY
- UNAFFECTED PROPERTY

MAP NOTES:

1) NAD83/UTM ZONE10N

2) THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:60,000 FOR 11"X17" (B SIZE) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

3) IMAGERY / DATA SOURCE: GEOGRATIS, IMAPBC AND MNISTRY OF FOREST

4) CONTOUR INTERVAL: 40m

5) FACE UNITS ARE CLASSIFIED AS LOW HAZARD

6) THIS MAP IS MEANT TO BE READ WITH THE ACCOMPANYING REPORT

PROJECT:

DOWNTON FIRE # K71649: POST WILD-FIRE NATURAL HAZARD ASSESSMENT

CLIENT:

BRITISH COLUMBIA MINISTRY OF FORESTS

SCALE: 1:60,000

DATE: 2023-12-04

PREPARED: DK

REVIEWED: PF

PREPARED BY:

Cordilleran Geoscience
Terrain Specialists

0 1 2 km

MAP 7: GEO-DOMAINS

N

498000 500000 502000 504000 506000 508000 510000 512000 514000 516000 518000 520000

5646000 5644000 5642000 5640000 5638000 5636000 5634000 5632000

LU1 LU2 LU3 LU4 LU5 LU6 LU7 LU8 LU9 LU10

1-1 1-2 1-3 1-4 1-5 1-6 1-7
2-1 2-2
3-1 3-2 3-3 3-4
4-1
5-1 5-2 5-3
6-1 6-2 6-3 6-4 6-5 6-6
7-1 7-2 7-3
8-1 8-2 8-3 8-4
10-1 10-2

Leckie Creek
Gun Creek
Slim Creek
Eldorado Creek
Freiberg Creek
Lick Creek
Pearson Creek
Roxey Creek
Jewel Creek
Dickson Peak
Penrose N1
Mount Penrose
Forest Rec Site
Gun Lake
Tyaughton Lake
Carpenter Reservoir
Highway 40
Gun Creek Fan
Gold Bridge, BC
Lajoie Dam
Lajoie Lake
Downton Lake

LEGEND

- FIRE PRIMETER
- WATERSHED (LU1)
- SUB-BASIN (1-1)
- MAIN ROAD
- RESOURCE ROAD
- FAN
- BURNT PROPERTY
- UNAFFECTED PROPERTY

MELTON RATIO

- Debris Flow
- Debris Flood/Debris Flow
- Debris Flood
- Flood

MAP NOTES:

1) NAD83/UTM ZONE10N

2) THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:60,000 FOR 11"X17" (B SIZE) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

3) IMAGERY / DATA SOURCE: GEOGRATIS, IMAPBC AND MNISTRY OF FOREST

4) CONTOUR INTERVAL: 40m

5) FACE UNITS ARE CLASSIFIED AS LOW HAZARD

6) THIS MAP IS MEANT TO BE READ WITH THE ACCOMPANYING REPORT

PROJECT:

DOWNTON FIRE # K71649: POST WILD-FIRE NATURAL HAZARD ASSESSMENT

CLIENT:

BRITISH COLUMBIA MINISTRY OF FORESTS

SCALE: 1:60,000

DATE: 2023-12-04

PREPARED: DK

REVIEWED: PF

0 1 2 km

PREPARED BY:

Cordilleran Geoscience
Terrain Specialists

MAP 8: POST-WILDFIRE HAZARD

N

498000 500000 502000 504000 506000 508000 510000 512000 514000 516000 518000 520000

5646000 5644000 5642000 5640000 5638000 5636000 5634000 5632000

Leckie Creek
Gun Creek
Slim Creek
Eldorado Creek
Roxey Creek
Jewel Creek
Dickson Peak
Penrose N1
Mount Penrose
Downton Lake
Lajoie Lake
Forest Rec Site
Gun Lake
Freiberg Creek
Lick Creek
Pearson Creek
Tyaughton Lake
Carpenter Reservoir
Highway 40
Gun Creek Fan
Gold Bridge, BC
Lajoie Dam

LU1 LU2 LU3 LU4 LU5 LU6 LU7 LU8 LU9 LU10

1-1 1-2 1-3 1-4 1-5 1-6 1-7
2-1 2-2
3-1 3-2 3-3 3-4
4-1
5-1 5-2 5-3
6-1 6-2 6-3 6-4 6-5 6-6
7-1 7-2 7-3
8-1 8-2 8-3 8-4
10-1 10-2

LEGEND

- FIRE PRIMETER
- WATERSHED (LU1)
- SUB-BASIN (1-1)
- MAIN ROAD
- RESOURCE ROAD
- FAN
- BURNT PROPERTY
- UNAFFECTED PROPERTY

POST-WILDFIRE HAZARD

- HIGH
- MODERATE
- LOW

MAP NOTES:

1) NAD83/UTM ZONE10N

2) THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:60,000 FOR 11"X17" (B SIZE) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

3) IMAGERY / DATA SOURCE: GEOGRATIS, IMAPBC AND MNISTRY OF FOREST

4) CONTOUR INTERVAL: 40m

5) FACE UNITS ARE CLASSIFIED AS LOW HAZARD

6) THIS MAP IS MEANT TO BE READ WITH THE ACCOMPANYING REPORT

PROJECT:

DOWNTON FIRE # K71649: POST WILD-FIRE NATURAL HAZARD ASSESSMENT

CLIENT:

BRITISH COLUMBIA MINISTRY OF FORESTS

SCALE: 1:60,000

DATE: 2023-12-04

PREPARED: DK

REVIEWED: PF

0 1 2 km

PREPARED BY:

Cordilleran Geoscience
Terrain Specialists

Appendix 1. Archaeological Sites and the Heritage Conservation Act (HCA).

- Boundaries of archaeological sites are difficult to determine without subsurface testing. Mapped boundaries are approximate, and sites may be more extensive than mapped.
- Archaeological sites (both recorded and unrecorded) on Crown and private lands are protected under the Heritage Conservation Act and must not be altered or damaged without a site alteration permit from the Archaeology Branch.
- If land-altering activities are planned within the protected archaeological site, a Provincial heritage permit is required. Permit applications are available on the Archaeology Branch website. Most applicants engage a consulting archaeologist to review proposed activities, verify archaeological records, and work with the Archaeology Branch to identify permit requirements, prepare permit application(s), and conduct any required archaeological study.
- If land-altering activities are planned outside of the archaeological site, a Provincial heritage permit may not be required prior to commencement of those activities. However, known sites may be larger or new sites may be found, and a Provincial heritage permit will be required in those cases.
- Unpermitted damage or alteration of an archaeological site is a contravention of the HCA and requires that land-altering activities be halted until the contravention has been investigated and permit requirements have been established. The Archaeology Branch recommends engaging an archaeologist to review the proposed activities, verify archaeological records, and possibly conduct fieldwork to determine whether the proposed activities may damage or alter the archaeological site.
- Please notify all individuals involved in land-altering activities (e.g., owners, developers, equipment operators) that if archaeological material is encountered during development, they must stop all activities immediately and contact the Archaeology Branch for direction at 250-953-3334.
- If there are no plans for land altering activities on the property, no action needs to be taken at this time.
- This information is to be used for general planning purposes only and may not be used to make specific land and resource management decisions without the advice of an eligible consulting archaeologist or the Archaeology Branch. Archaeological information must not be shared or redistributed to a third party without the written permission of the Branch. Sharing of archaeological information is permitted when the third party is a representative of a First Nation government organization, a third party with a registered interest in the land (e.g., land owner, tenure holder, licensee), or an agent of a third party with a registered interest in the land (e.g., realtor, notary public). If archaeological information is shared with a third party (meeting one of the requirements previously stated), they should be informed that archaeological information must not be shared or redistributed without the permission of the Archaeology Branch.
- An eligible archaeologist is one who can hold a Provincial heritage permit. To verify eligibility, ask the archaeologist if they can hold a permit in your area, or contact the Archaeology Branch (250-953-3334) to verify an archaeologist's eligibility. Archaeologists are listed on the BC Association of Professional Archaeologists website (www.bcapa.ca) and in local directories.

Site	Latitude	Longitude	Description
LU1			
DK 4	50.8532610	-123.00326	Soil Burn TP1:
DK 5	50.8510365	-122.99660	New 600mm CMP, good, flowing stream
DK 6	50.8455697	-122.97807	Logs in road burnt, leaving cast-hollow and undermined road
DK 7	50.8451573	-122.97664	10m long tension crack, undermined from Downton Reservoir highwater, trees have pistal butting and burnt trees supporting the fill slope
DK 8	50.8428024	-122.95957	600mm, good
DK 9	50.8442634	-122.95988	Firebreak/trail going straight up slope, +40-50%, tephra. Ditch ponds water. Requires water-control deactivation,
DK 10	50.8450805	-122.95962	Fire road from below comes up to here
DK 11	50.8456661	-122.96215	Ghost rd ends
DK 12	50.8452144	-122.95993	No culvert, seepage at crest in grade
DK 13	50.8451551	-122.95881	From last point, seepage follows ditch then seeped through road at low point in grade here
DK 14	50.8425887	-122.94302	400 cmp, good
DK 15	50.8422460	-122.94071	Fire break, heads upslope.
DK 16	50.8426023	-122.93960	Fire break comes up to here.
PM1	50.8460000	-122.96100	Soil Burn TP2, mapped as high
LU2			
Alder Brook			
DK 72	50.8415580	-122.92334	Road not accessible
PM1	50.8430000	-122.93300	Firebreak into wetland/pond. Rehab trail and shoreline of wetland.
2-1			
DK 59	50.8580074	-122.92589	Deep cross ditch, flowing water
DK 74	50.8457371	-122.92383	Big landing with fire break roads going in 3 directions
DK 75	50.8463971	-122.92518	Flowing stream
DK 90	50.8463755	-122.92295	Post tephra, debris flow, hummock lobes, underneath is reworked older tephra debris flows.
DK 96	50.8430873	-122.91552	50cm of debris flow material over tephra
DK 97	50.843442	-122.91479	3 large boulders, likely colluvial/debris flood/flow. Up stream side has 1m high wedge, maybe older of two noted events

Site	Latitude	Longitude	Description
DK 99	50.8399805	-122.9125	Pebble, gravel cobble with course silty sand , no tephra indicating <2400 yrs old.
DK 100	50.839817	-122.91168	600mm culvert
2-2 Penrose Ck			
DK 2	50.8441358	-122.91207	600 cmp, good
DK 57	50.8567157	-122.92479	Water bar with erosion
DK 58	50.857588	-122.92567	Dry cross ditch.
DK 60	50.8579644	-122.9267	Stream gully
DK 76	50.8506659	-122.92502	Active snow avalanche path , 1:30 yr line
DK 77	50.8504473	-122.92461	6-8m thick lobe
DK 78	50.8484675	-122.9229	Seepage site with veg in mod burn site
DK 79	50.8486908	-122.92332	Soil Burn TP18,
DK 80	50.8488847	-122.92336	Wet seepage site with flowing overland flow
DK 81	50.849755	-122.92396	Stream confluence divided by younger lobe
DK 82	50.8507481	-122.92341	Edge of newer event
DK 83	50.8517218	-122.92227	Edge of fan, project line up slope, events looks to be wet
DK 84	50.849041	-122.92526	On fire break road. Road located on fan, water and debris diverted down the road.
DK 85	50.8507131	-122.92557	Water control required to re-establish access. Low priority. Old vet with flagging, all the way up the tree, snow avalanche path
DK 86	50.8531612	-122.92782	Soil Burn TP19
DK 87	50.853668	-122.92843	Soil Burn TP20, mapped high
DK 88	50.8528637	-122.92905	Soil Burn TP21, mapped low
DK 89	50.8510549	-122.92672	Fire break road, loose tephra, needs deact and drainage control
DK 91	50.8438347	-122.91649	2 white pvc pipes,
DK 92	50.8440212	-122.91681	Old water intake
DK 93	50.8445214	-122.91781	Water intake, with pipe heading up stream
DK 94	50.844858	-122.91798	Water intake
DK 95	50.843511	-122.91571	Water pipeline cross rd here, water pipeline follows rd ditch
DK 98	50.8435129	-122.91431	3 exposed boulders, surrounded by, newer pebble, cobble fines
DK 101	50.8406494	-122.90721	600 mm cmp, power generating building,
DK 102	50.8411471	-122.90628	Edge of recent fan, tephra present; Surface >2400 years old.
DK 103	50.8438846	-122.91297	Creek could jump grade and go down fire break road, down grade is 10%. Water control deact - ensure dip in grade in road

Site	Latitude	Longitude	Description
DK 154	50.847331	-122.92163	Surface material: 1 cm burn layer, 2-19 cm silty sand, 19-60 cm tephra, 60 cm down is sandy silty till
LU3			
3-1			
DK 145	50.8582072	-122.90365	Perched and damaged 600mm, dry. Upslope of culvert is collapsed. Potential for diverted flow to run down old road. Mitigation: deactivate or install large cross ditch.
DK 146	50.8583408	-122.90326	Old road in draw, potential debris flow channel.
PF86	50.8577985	-122.90215	Burnt houses
PF90	50.8597118	-122.90785	600 cmp, clear
PF91	50.8601477	-122.90748	600 cmp, clear
PF96	50.8603685	-122.9107	600 cmp, clear
12	50.858078	-122.90317	No culvert at road
3-2			
	50.866785	-122.9079	Start of fire break/ road
DK 64	50.8670972	-122.91082	Soil Burn TP14, in old cut block, trees ~15 years old
DK 65	50.8669428	-122.91187	White ash down, 5cm, then 8cm of grey ash, then brown mineral
DK 67	50.8664462	-122.90953	Cut block, 15-20 years old. Litter left on the ground and charred, pockets of white ash, live roots near surface, trees are sproutiing (small saplings), dead trees have needles, Moderate burn severity.
DK 140	50.8629639	-122.90009	There is defined 1m wide channel
DK 142	50.8625247	-122.89907	Plastic culvert
DK 143	50.8623233	-122.89884	Low spot, building could get hit by event
PF26	50.8676537	-122.90785	600 cmp on stream, 50% plugged, fill 10 m wide, v-shaped, 3 m deep, 15 m3
PF27	50.8670512	-122.90775	400 cmp cross drain
PF28	50.8658866	-122.90919	600 cmp cross drain
PF29	50.8652377	-122.90941	400 cmp cross drain
PF84	50.8628253	-122.89945	Debris cone, +20%, -15%
PF85	50.8625482	-122.9003	Road has altered evidence of channel, but there is a defined draw upslope
PF93	50.863177	-122.90699	600 cmp, clear
PF94	50.8636073	-122.90697	500 cmp, clear
PF95	50.8638093	-122.90725	Fire break heads north to upper road

Appendix 2. Field Observation sites.

Site	Latitude	Longitude	Description
PM1	50.863	-122.905	400cmp 70% plugged
3-3			
DK 55	50.8749048	-122.90384	600mm culvert, good
DK 138	50.8692388	-122.89641	Bedrock canyon, recent ravelling, with increased rockfall and ravelling hazard.
PF23	50.871805	-122.90618	Cross ditch
PF24	50.8707328	-122.90567	Cross ditch
PF25	50.870271	-122.90533	Cross ditch
PF81	50.8690705	-122.8956	Intake line burnt here
PF82	50.8690946	-122.89652	Intake structure, burnt
PF83	50.8691827	-122.89471	Fan 10-15% gradient
PM1	50.874	-122.905	Debris flow lobes, 50m wide zone
3-4			
DK 54	50.8776529	-122.90069	Ford, 2m wide by 10-20cm deep, good flow
DK 69	50.8791026	-122.89918	Soil Burn TP17
PF22	50.8789899	-122.89858	600 cmp
LU3 Face			
PM1	50.876	-122.901	600 cmp. Damaged, Replace.
DK 61	50.8561866	-122.92224	Soil Burn TP11,
DK 62	50.8597733	-122.91753	Soil Burn TP12
DK 63	50.864436	-122.91114	Soil Burn TP13
DK 66	50.8672054	-122.91181	Soil Burn TP15
DK 68	50.8760998	-122.90233	Soil Burn TP16, mapped Moderate
DK 136	50.8720462	-122.89273	No creek
DK 137	50.8710104	-122.89395	No creek
DK 139	50.8635666	-122.8989	6m high x 20m rock cut, rock fall hazard
DK 141	50.8627341	-122.89976	Culvert flows into dry channel here
DK 144	50.8606397	-122.90058	Burnt House right in mouth of draw. Moderate sloped face unit above.
DK 147	50.8567673	-122.90401	6m high 20m long rock cut, rock fall hazard.
DK 148	50.8561731	-122.90476	Start rock out crop
DK 149	50.8553685	-122.90489	End of rock outcrop
DK 150	50.8546473	-122.90546	6m x30m wide rock outcrop

Site	Latitude	Longitude	Description
DK 151	50.8530733	-122.90607	6m by 30 m rock outcrop
DK 152	50.8527788	-122.90547	Old channel , dry
DK 153	50.8509576	-122.90674	400 cmp
PF2	50.86575	-122.89447	Forest Rec Site
PF30	50.8634439	-122.91183	400 cmp cross drain
PF31	50.8580449	-122.92084	600 cmp dry draw
PF32	50.8564267	-122.92287	Firebreak heading southeast
PF87	50.8515539	-122.91273	Pond, sed catch basin before steep to Gun Lake
PF88	50.8536437	-122.91167	No creek or draw
PF89	50.8548788	-122.91132	Ephemeral creek draw, 600 cmp, outlet 50% crushed
PF92	50.8623005	-122.90688	600 cmp, inlet 50% crushed otherwise clear
PM2	50.862	-122.905	600 cmp, good condition.
PM3	50.864	-122.905	600 cmp, good condition.
PM4	50.865	-122.904	600 cmp, crushed. Needs replacement.
PM5	50.866	-122.905	600 cmp, good condition.
PM6	50.868	-122.904	Cross ditch.
LU4 Walker Ck			
DK 42	50.8902286	-122.90274	Road access ends
DK 43	50.8893884	-122.90539	600 mm cross drain, outlet 50% blocked
DK 44	50.8883996	-122.90698	Cross ditch, stream, 1x, 10-20cm, low flow
DK 45	50.8865182	-122.90859	Soil Burn TP8
DK 46	50.8880165	-122.90063	Large and long fire break down slope
DK 47	50.8875833	-122.90101	Firebreak, 40% grade, loose tephra. Will intercept and direct water down road grade. Deactivation recommended.
DK 48	50.887172	-122.90126	Backwards water bar, ineffective.
DK 49	50.8861313	-122.9011	Another backwards water bar, ineffective.
DK 50	50.8855375	-122.9011	Backwards water bar, ineffective.
DK 51	50.8826803	-122.89889	Cross ditch for seepage, good flow
DK 52	50.8824992	-122.89967	Dry swale and dip in grade
DK 53	50.8810691	-122.89941	Dry cross ditch
DK 135	50.8740153	-122.88978	Recent avulsion.
DK 155	50.8839848	-122.89742	Soil Burn TP23

Site	Latitude	Longitude	Description
PF21	50.8837294	-122.89686	Firebreak. 50 m dia cleared area
PM1	50.885	-122.91	Soil Burn TP9
PM2	50.885	-122.912	Soil Burn TP10, in gully, BARC map correct.
LU5			
5-1 Sumner Creek			
20	50.8813941	-122.88055	4 m deep fill, V-shape, 10 m wide crest to crest, 400 mm cmp at base of V-shape. High blockage, then breach of backwater pond, gradient 15-20 %
DK 40	50.8933234	-122.90147	Damage and plugged culvert , with water running on road, low risk due to gentle
DK 41	50.8897603	-122.90006	600 cmp, good, and dry
DK 70	50.8871821	-122.8895	Fire break road heading up and down slope.
DK 123	50.8808694	-122.87886	Start of old dry channel
DK 124	50.8809947	-122.87988	Younger Debris flow levee. LOT 1 DISTRICT LOT 6485 (PID 008-931-160)
DK 125	50.8810793	-122.88007	New and old channels on fan. Avulsion into old channel could put house at risk. LOT 1 DISTRICT LOT 6485 (PID 008-931-160)
DK 126	50.8809722	-122.88013	Water intake. LOT 1 DISTRICT LOT 6485 (PID 008-931-160)
DK 127	50.8810241	-122.88005	Edge of more recent debris flow lobe, older D fir, boulder, pebble and fines. LOT 1 DISTRICT LOT 6485 (PID 008-931-160)
DK 128	50.8811234	-122.88008	Flowing creek. LOT 1 DISTRICT LOT 6485 (PID 008-931-160)
DK 129	50.8808425	-122.87989	Tree cast, 1m deep x 60cm dia, surrounded by cobble, pebble gravel with tephra matrix , post-tephra event. LOT 1 DISTRICT LOT 6485 (PID 008-931-160)
DK 130	50.8814868	-122.88041	400mm pipe, good flow.
DK 156	50.8867678	-122.89019	Soil Burn TP24, on gully edge
PF3	50.8925437	-122.90168	Skid road/fire break heading off upslope northwest into block
PF4	50.8942123	-122.90134	Stream 600 mm MC
PF17	50.8888774	-122.88503	ATV road going down
PF18	50.8871747	-122.88949	Major fire break going up and down hill
PF19	50.8872236	-122.89037	600 cmp on stream, good condition.
PF20	50.8855783	-122.89121	600 cmp cross drain
PF74	50.8808332	-122.8791	LU 5-1, Sumner Creek. 1 m wide by 0.5 m deep. LOT 1 DISTRICT LOT 6485 (PID
PF76	50.8805971	-122.87909	Sumner Fan, lobate, +15%, -10%. LOT 1 DISTRICT LOT 6485 (PID 008-931-160)

Site	Latitude	Longitude	Description
PF77	50.8801581	-122.87954	Creek, 1 m wide, 50 cm deep, ephemeral. LOT 1 DISTRICT LOT 6485 (PID 008-931-160)
PF78	50.8798886	-122.88005	Right edge Sumner fan. LOT 1 DISTRICT LOT 6485 (PID 008-931-160)
PF79	50.8803142	-122.87992	Ephemeral spring from under old road grade. LOT 1 DISTRICT LOT 6485 (PID 008-931- 160)
PF80	50.8808271	-122.87984	Debris lobe, post-tephra. LOT 1 DISTRICT LOT 6485 (PID 008-931-160)
5-2 Sumner North			
DK 19	50.8925507	-122.88191	Fire break road, will divert drainage
DK 20	50.8918636	-122.88305	Firebreak road. Bottom of sub-basin 5-1 ravine. Restore stream, and deactivate
DK 21	50.8914283	-122.88356	PoC of trail
DK 22	50.8919349	-122.88393	600 cmp, intake 90% blocked
DK 121	50.8819765	-122.87876	No culvert. No stream
DK 122	50.8808531	-122.87819	Fan made of pebble gravel
DK 157	50.8922589	-122.88108	Cut block
DK 158	50.8930727	-122.87866	Soil Burn TP25
PF16	50.8919373	-122.88387	600 cmp cross drain
PF33	50.8941336	-122.88367	600 cmp cross drain
PF72	50.8810759	-122.87805	Left edge fan. 12266, 12284, 12300 Gun Lake Road West.
PF73	50.8806075	-122.8787	Right edge fan. 12266, 12284, 12300 Gun Lake Road West.
PF75	50.8812158	-122.87866	Apex of cone, no creek, hardly a draw, uncertain watershed. 12266, 12284, 12300 Gun Lake Road West.
5-3 Unnamed			
50	50.885833	-122.85968	No culvert at road. 13767 & 13770 Gun Lake Road.
DK 109	50.8854354	-122.85932	Collvium, below road at crossing. 13770 Gun Lake Road.
PF40	50.8851048	-122.85914	Ephemeral stream channel, 2 m wide by 0.5 m deep, 15% slope, pebble gravel wash eroded into tephra. 13770 Gun Lake Road.
PF68	50.8867805	-122.86077	Creek channel on bedrock, +40%, -30%, 2 m wide, confined in draw, has not eroded all tephra, no rounded gravels. 13767 Gun Lake Road.
PF69	50.8863635	-122.86006	Apex of narrow debris cone formed of subround to subangular cobble boulder material, +30%, -20%. 13767 Gun Lake Road.
PF70	50.8859358	-122.85943	Left edge cone at road. 13767 Gun Lake Road.

Site	Latitude	Longitude	Description
PF71	50.8857915	-122.85999	Right edge cone at road. 13767 Gun Lake Road.
5-Sumner face			
PF62	50.8874218	-122.85804	Throw 165S. Transition point
PF63	50.8873042	-122.85844	Throw 97E
PF64	50.8872746	-122.85928	Throw 71E
PF65	50.8872253	-122.85968	Head of dry draw against rock outcrop, limit of rockfall
PF66	50.8870908	-122.86006	Throw 290W
PF67	50.8869189	-122.86072	Throw 298NW, cluster in draw at edge of throw zone,
DK 71	50.882621	-122.87643	Firebreak road branches off Gun Lake Road West.
DK 104	50.8754595	-122.88788	5-6m tall rock cut, rockfall hazard effecting road, highly fractured, flagged off , 20-30m long section
DK 105	50.8882211	-122.85115	Burnt power line/com tower right of way
DK 106	50.8878296	-122.85271	Dry, draw
DK 107	50.8878005	-122.85351	Power line runs along road
DK 108	50.8868029	-122.85618	Dry draw
DK 110	50.8849013	-122.85923	Tornado area. Metal bent around trees in direction of wind.
DK 111	50.8853475	-122.85715	Tornado area. Few Broken tree tops, and snapped trees, broken end thrown 10-20m
DK 112	50.8866881	-122.85746	Soil Burn TP22, site in fire Tornado, lots of sand in pit, potential slope wash as the location was in centre of draw
DK 113	50.8863714	-122.85754	Dry draw with with 600mm culvert damaged
DK 114	50.885484	-122.86065	Dry draw
DK 115	50.8849852	-122.86278	Dry draw and culvert
DK 116	50.8848618	-122.86413	TRIM stream. No Stream, no draw.
DK 117	50.8843048	-122.86815	Culvert at dip in grade
DK 118	50.8841211	-122.86983	Dry draw
DK 119	50.884016	-122.87118	Dry draw
DK 120	50.8839723	-122.87276	TRIM stream. No creek, not really a draw.
DK 131	50.8792421	-122.8837	Dry draw
DK 132	50.8790497	-122.88406	TRIM stream. No stream.
DK 133	50.8775844	-122.88585	Small 10m w 6m high rock cut , rock fall hazard.
DK 134	50.8754355	-122.88779	No creek
DK 159	50.8939473	-122.8714	Soil Burn TP26, mod mapped

Appendix 2. Field Observation sites.

Site	Latitude	Longitude	Description
DK 160	50.894019	-122.87017	Soil Burn TP27
DK 238	50.8839014	-122.86747	Soil Burn TP31
PF34	50.8865689	-122.85851	Burnt building
PF35	50.8866575	-122.8589	Throw 84 E
PF36	50.8863426	-122.85907	Burnt building
PF37	50.8861675	-122.85917	Throw 57 NE
PF38	50.8854843	-122.85963	Throw 358 N
PF39	50.885254	-122.85936	Throw 94 E
PF41	50.8847979	-122.85922	Throw 74E
PF42	50.8849215	-122.85892	Throw 15N
PF43	50.8850762	-122.85843	Throw 22N and 76E
PF44	50.8854606	-122.85859	Throw 135SE
PF45	50.885502	-122.85845	Throw 74E
PF46	50.8856325	-122.85846	Throw 122SE
PF47	50.8857173	-122.8582	Throw 101E
PF48	50.8853405	-122.85764	Throw 353 N
PF49	50.885268	-122.85732	Throw 337N
PF50	50.8854316	-122.85708	Throw 316N
PF51	50.8855904	-122.85657	Throw 281W
PF52	50.8857973	-122.85611	Throw 288W and 235SW
PF53	50.8859756	-122.85566	Throw 238SW
PF54	50.8862096	-122.85553	Throw 240SW
PF55	50.8866235	-122.85802	Throw 305NW
PF56	50.8865639	-122.8571	Throw 287W
PF57	50.8868124	-122.85607	Throw 262W
PF58	50.8872578	-122.85641	Throw 235sw
PF59	50.8875168	-122.85664	Old adit entrance in dry draw
PF60	50.8875432	-122.85706	Throw 230SW
PF61	50.8874204	-122.85737	Throw 241SW
LU6 Slim Ck FSR			
PM1	50.899	-122.876	Rock cliff
PM1	50.912	-122.924	Jewel Creek Trailhead. Active Grizzly Bear sign

Site	Latitude	Longitude	Description
DK 23	50.8985933	-122.88897	Rock fall hazard on road
DK 24	50.9008398	-122.90233	500cmp
DK 25	50.900903	-122.90353	600mm, good
DK 26	50.9004665	-122.9071	Seepage with no drainage structure, dip in grade
DK 39	50.8994929	-122.9014	Cross drain, 600mm cmp
DK 173	50.897896	-122.88087	500 cmp, 80% blocked, cross ditch
DK 174	50.9019344	-122.88809	Looking to the North
DK 175	50.9029652	-122.89108	Rockfall hazard, road above with over steep end fill, need rehab
DK 176	50.9037771	-122.89019	Road joins here, had be deactived, but could use more
DK 191	50.9019818	-122.9057	Old slide, pre Bridge River tephra.
DK 195	50.9053461	-122.89929	Melted plastic pipe,need replacement
DK 196	50.9081674	-122.90341	Flowing stream, 500cmp, 50% crushed in middle of road
DK 197	50.9094681	-122.90902	Flowing stream, 400cmp
DK 198	50.9096811	-122.91204	600cmp, flowing creek culvert, concave and the outlet is partial blocked
DK 199	50.9093308	-122.91373	600cmp 30% crushed, flowing creek
DK 200	50.9094085	-122.9142	Sub-basin 6-6 Avalanche runout to Slim FSR.
DK 201	50.909491	-122.91539	Ncd drainage, 400cmp, 50%
DK 202	50.9099504	-122.91681	500cmp blocked cross ditch
DK 203	50.9113653	-122.922	Jewel Creek entrance LU 6-5. Recent debris flow deposits, 20m wide avalanche path.
DK 204	50.9118426	-122.92332	Jewel Creek entrance LU 6-5. Recent debris flow deposits has reached the road, trees
DK 205	50.9120234	-122.92383	Jewel Creek entrance LU 6-5. Creek which creates debris flow, 600cmp, blocked
DK 206	50.9127528	-122.92502	Jewel Creek Parking LU 6-4. Start recent debris flow deposits
DK 207	50.9129773	-122.92541	Jewel Creek Parking LU 6-4. Flowing stream; 2-culverts: 600 cmp in good condition; 500 cmp, blocked.
DK 208	50.9130934	-122.92593	Jewel Creek Parking LU 6-4. End recent debris flow deposits
DK 213	50.9185309	-122.94201	400 plastic pipe, flowing creek
DK 214	50.9181755	-122.94198	Soil Burn TP28, mapped as low
DK 215	50.9177272	-122.94167	Debris flow field with boulder levee, with no tephra, <2400 years old.
DK 216	50.9201583	-122.94515	Rock fall hazard
DK 217	50.9204298	-122.94405	600 plastic pipe, plugged near outlet
DK 218	50.9204679	-122.94646	Rock fall cliff, flat going up slope, Talus cone
DK 219	50.9214125	-122.94535	Stream, plastic 400cmp, need replacement

Site	Latitude	Longitude	Description
DK 220	50.9239615	-122.94823	500 cmp, good condition.
DK 221	50.9241794	-122.94851	LU 6-2, south branch. Large stream, flowing through 900 cmp, in good condition.
DK 222	50.9245355	-122.9489	Stream, 500cmp, good condition.
DK 223	50.9246366	-122.94899	LU 6-2. Stream, 800 cmp good condition.
DK 224	50.9249679	-122.94909	LU 6-2, north branch. Avalanche path affects Slim FSR.
DK 225	50.9269802	-122.95005	Photo
DK 226	50.9284625	-122.95223	Stream, 600 cmp, damaged.
DK 227	50.9309709	-122.95309	Cross drain, 500 plastic, good condition.
DK 228	50.9345978	-122.95947	400 cmp, stream. Culvert needs replacement
DK 229	50.9372926	-122.96349	600 cmp
DK 230	50.9383978	-122.96525	500 cmp, stream. Culvert needs replacement.
DK 231	50.9402112	-122.97271	Cross drain, 500 cmp, replace.
DK 232	50.9401798	-122.97352	Start of rockfall hazard
DK 233	50.9405046	-122.97763	End of rock fall hazard
DK 234	50.9358273	-122.96152	Soil Burn TP29, mapped as low
DK 235	50.9119708	-122.9242	Soil Burn TP30
DK 236	50.9021608	-122.88825	Road shoulder on steep slope, high burn intensity
DK 237	50.9008448	-122.88402	Soft shoulder over steep slope
PF5	50.8997805	-122.90179	600 cmp cross drain
PF6	50.90076	-122.90392	600 cmp cross drain
PF7	50.9009046	-122.90357	600 cmp cross drain
PF8	50.9009351	-122.90231	600 cmp cross drain
PF9	50.9004021	-122.89932	600 cmp cross drain
PF10	50.89983	-122.89859	600 cmp cross drain
PF11	50.8997748	-122.89718	600 cmp, stream on map
PF12	50.9015168	-122.88189	Earth flow
PF13	50.8992894	-122.89002	600 cmp cross drain
PF14	50.8966898	-122.88736	600 cmp cross drain
PF15	50.8961584	-122.88717	600 cmp cross drain
Lu6-Roxey Ck			
DK 209	50.9137361	-122.93294	High soil burn intensity. Mapped as mod
DK 210	50.9133407	-122.9344	Tension crack observed

Site	Latitude	Longitude	Description
DK 211	50.9122721	-122.93782	400 cmp culvert left with tension cracks
DK 212	50.9117967	-122.94051	Photo
LU6-Spur off Slim FSR			
DK 177	50.9046015	-122.89137	400cmp plastic cross drain,
DK 178	50.9047633	-122.89224	Cross ditch, dry
DK 179	50.9052647	-122.89419	Over steepened fill, pistal butted tree, burnt wood in fill, high burn intensity. Steep below, 40% reach to Slim FSR; High hazard affecting Slim FSR. Deactivate, heavy fillslope pullback, P9 m reach.
DK 180	50.9051545	-122.89464	Photo looking up valley
DK 181	50.9049117	-122.89528	2m high fill held up by high burnt stump, burn wood in fill, high hazard.
DK 182	50.904992	-122.89625	End of over steepened fillslope.
DK 183	50.9051619	-122.8965	Photo
DK 184	50.9037723	-122.89883	Dry draw , cross ditched filled-in, water could flow down road grade
DK 185	50.9038187	-122.89946	Dry draw, need cross ditch
DK 186	50.9040816	-122.9009	Need cross ditch, dry draw
DK 187	50.9039184	-122.9015	Cheeks to the gully, need pull back
DK 188	50.9037567	-122.90197	Dry draw, need cross ditch
DK 189	50.9039985	-122.90312	Dry draw, need cross ditch
DK 190	50.9041225	-122.90407	Dry draw, with larger fill, need to remove material and add cross ditch
DK 192	50.9041833	-122.90568	Dry draw, need cross ditch
DK 193	50.9037306	-122.90833	End landing
DK 194	50.904069	-122.90876	Confined draw with debris flow desposits, and snow avy
LU6-Spur midslope			
DK 27	50.9017611	-122.91158	Firebreak road. Steep fillslope on ravine sidewall. Unstable fill slopes due to burnt wood in fill. Low (26% angle) reach to Slim FSR. PoC pull back , poc pull back
DK 28	50.9016896	-122.91181	Tension crack
DK 29	50.9013747	-122.913	End of tension crack, PoT pull back
DK 30	50.9013074	-122.91328	High freq avalanche path, size 3-4
DK 31	50.9018626	-122.91384	New rd construction, no end haul across steep terrain. POC pullback
DK 32	50.9026008	-122.9142	End of new construction on steep terrain, PoT pull back
DK 33	50.9031671	-122.91865	Flowing stream, 0.50cm-1m, 10-20cm deep

Appendix 2. Field Observation sites.

Site	Latitude	Longitude	Description
DK 34	50.9038385	-122.91892	End landing
DK 35	50.9038267	-122.91868	Soil Burn TP5, edge of restocked older cut block
DK 36	50.9038746	-122.91339	Soil Burn TP6
DK 37	50.9040216	-122.91317	Firebreak roads heading right down slope through cut block from above jct
DK 38	50.9021017	-122.91125	Soil Burn TP7, mapped as high
LU7			
PM1	50.917	-122.927	Steep ravelling slopes, high burn intensity, effect trail
LU8			
DK 165	50.91782	-122.77078	600cmp blocked , dry,
DK 166	50.9155429	-122.79199	House burnt, house not mapped
DK 167	50.9153955	-122.80403	Houses all along the road,
DK 168	50.9151686	-122.80812	Houses
DK 169	50.9150951	-122.81549	Vulunable house
DK 170	50.915013	-122.81968	Burried culvert
DK 171	50.9140881	-122.8207	House
DK 172	50.9135361	-122.82162	Burnt house
LU9			
DK 17	50.8949314	-122.8521	Soil Burn TP3
DK 18	50.8915979	-122.85461	Localized rockfall from rock cliffs above
PM1	50.895	-122.851	Soil Burn TP4
PF1	50.8872659	-122.8367	Fire fighters widened Lakeview road to make fire break
LU10			
DK 1	50.879	-122.825	Re-opened steep trail for fire break, volcanic ash, high erosion potential, deactivate
DK 161	50.8876495	-122.82228	400cmp, blocked, 500cmp 50% plugged
DK 162	50.8887887	-122.81177	Steep gully, will hit road, high haz
DK 163	50.8892442	-122.80461	Large erosion hole in rd
DK 164	50.8962531	-122.775	Element at risk, Minto Camp, and Gun Creek camp ground
PF97	50.8887243	-122.81207	No litter or duff. An event 10 m wide, 20 cm deep and 600 m long could deliver 1200 m3 to Hwy 40

Appendix 3. Vegetation and Soil Burn Intensity Plots, Downton Lake Fire.

Burn Intensit		Site Descriptors					Veg Burn Indicators				Soil Burn Severity Indicators					Mineral Soil			Water Repellency (drip test results based on absorption time)					
BARC Map	Field Classification	TP#	Field Point	Lat	Long	Avg Slope (%)	Canopy Condition	% Green Understory	% Green Trees	% Brown/Black Trees	Litter	Duff (FH Layers)	Small Woody Debris	Logs- Woody Debris	Ash Colour	Exposure (%)	Change	Depth(cm) to live root	Trench Depth (cm)	None	Weak	Strong	Runoff	Soil Burn Severity
M	M	1	DK 4	50.8533	-123.003	20	Mostly dead	0	50	50	Consumed	Mostly consumed	Charred	Charred	Black	>40	No	0-5	5	90	10	0	No	L
H	M	2	PM1	50.8460	-122.961	28	Mostly dead	0	0	100	Consumed	Mostly consumed	Partly Consumed	Charred	White	5-40	No	0-5	5	0	0	100	No	H
H	H	3	DK 17	50.8949	-122.852	20	Dead trunk	0	0	100	Consumed	Mostly consumed	Partly Consumed	Mainly consumed	Black	>40	No	0-5	1	0	0	100	No	H
Unb.	Unb.	4	PM1	50.8955	-122.851	5	Mostly alive	100	100	0	Scorched	Intact	Charred	Charred	Black	<5	No	0	1	100	0	0	No	L
H	H	5	DK 35	50.9038	-122.919	15	Dead trunk	0	0	100	Consumed	Mostly consumed	Consumed	Mainly consumed	Black	>40	No	0-5	1	0	0	100	No	H
H	M	6	DK 36	50.9039	-122.913	35	Cut block*	n	n	n	Consumed	Mostly consumed	Consumed	Mainly consumed	Black	>40	Minor	0-5	0.5	0	0	100	No	H
H	H	7	DK 38	50.9021	-122.911	35	Dead trunk	0	0	100	Consumed	Mostly consumed	Consumed	Mainly consumed	Grey	>40	No	0-5	1	95	5	0	No	H
H	H	8	DK 45	50.8865	-122.909	20	Mostly dead	0	0	40	Consumed	Mostly consumed	Consumed	Charred	Black	>40	No	0-5	5	0	20	80	No	H
H	H	9	PM1	50.8848	-122.910	25	Mostly dead	0	0	100	Consumed	Mostly consumed	Consumed	Charred	Black	>40	No	0-5	5	0	0	100	No	H
H	H	10	PM2	50.8847	-122.912	75	Mostly dead	0	0	100	Consumed	Mostly consumed	Consumed	Mainly consumed	Black	5-40	No	0-5	5	0	100	0	No	H
H	H	11	DK 61	50.8562	-122.922	25	Dead trunk	0	0	100	Consumed	Mostly consumed	Consumed	Mainly consumed	Black	>40	No	0-5	5	0	0	100	No	H
M	M	12	DK 62	50.8598	-122.918	30	Mostly dead	0	0	100	Consumed	Spottily consumed	Partly Consumed	Charred	Black	<5	No	0-5	10	100	0	0	No	M
H	H	13	DK 63	50.8644	-122.911	10	Mostly dead	0	0	100	Consumed	Mostly consumed	Consumed	Mainly consumed	Black	>40	No	0-5	5	0	40	60	No	H
M	M	14	DK 64	50.8671	-122.911	30	Mostly dead	0	10	90	Mostly consumed	Spottily consumed	Partly Consumed	Some consumed	Black	5-40	No	0-5	5	0	50	50	No	M
M	L	15	DK 66	50.8672	-122.912	15	Mostly alive	100	100	0	Mostly consumed	Mostly consumed	Charred	Charred	Black	5-40	No	0-5	5	0	0	100	No	M
M	M	16	DK 68	50.8761	-122.902	10	Mostly dead	0	10	90	Scorched	Mostly consumed	Partly Consumed	Charred	Black	5-40	No	0	5, 15, 30	0, 0, 100	0, 0, 0	100, 100, 0	No	M
L	L	17	DK 69	50.8791	-122.899	10	Mostly alive	0	70	30	Scorched	Mostly consumed	Charred	Charred	Grey	5-40	No	0-5	5	50	0	50	No	M
M	M	18	DK 79	50.8487	-122.923	10	Mostly dead	0	0	100	Consumed	Mostly consumed	Charred	Charred	Black	5-40	No	0	5	0	100	0	No	M
M	M	19	DK 86	50.8532	-122.928	20	Dead trunk	0	0	100	Consumed	Mostly consumed	Partly Consumed	Charred	Black	>40	No	0-5	5	50	0	50	No	M
H	H	20	DK 87	50.8537	-122.928	20	Dead trunk	0	0	100	Consumed	Mostly consumed	Consumed	Mainly consumed	Black	5-40	No	0-5	5	0	0	100	No	H
L	L	21	DK 88	50.8529	-122.929	5	Mostly alive	50	90	10	Scorched	Intact	Charred	Charred	Black	<5	No	0	5	100	0	0	No	L
H	H	22	DK 112	50.8867	-122.857	8	Dead trunk	0	0	100	Consumed	Mostly consumed	Consumed	Mainly consumed	Black	>40	No	>5	5 , 10 , 30	0, 0, 100	10, 0, 0	90, 100, 0	No	H
M	M	23	DK 155	50.8840	-122.897	25	Mostly alive	10	90	10	Mostly consumed	Mostly consumed	Charred	Charred	Black	5-40	No	0-5	5	10	0	90	No	M
H	H	24	DK 156	50.8868	-122.890	10	Mostly dead	0	0	100	Consumed	Mostly consumed	Consumed	Some consumed	Black	>40	No	>5	5, 10, 15, 20, 25	60, 20, 20, 0, 0	0, 0, 0, 0, 0	40, 80, 80, 100, 100	No	H
H	H	25	DK 158	50.8931	-122.879	10	Dead trunk	0	0	100	Consumed	Mostly consumed	Consumed	Mainly consumed	Black	>40	No	0-5	5, 10	80, 80	0, 0	20, 20	No	H
M	M	26	DK 159	50.8939	-122.871	10	Mostly dead	5	40	60	Scorched	Intact	Charred	Charred	Black	5-40	No	0	5	100	0	0	No	L
M	M	27	DK 160	50.8940	-122.870	10	Mostly dead	0	0	100	Consumed	Mostly consumed	Partly Consumed	Charred	Black	>40	No	0	5	0	50	50	No	M
L	L	28	DK 214	50.9182	-122.942	45	Mostly alive	100	90	10	Scorched	Mostly consumed	Charred	Charred	Black	5-40	Minor	>5	10	40	10	50	No	L
L	L	29	DK 234	50.9358	-122.962	10	Mostly alive	40	80	20	Scorched	Intact	Charred	Charred	Black	5-40	No	0	5	60	0	40	No	L
M	L	30	DK 235	50.9120	-122.924	10	Mostly dead	0	0	100	Scorched	Intact	Charred	Charred	Black	<5	No	0-5	5	90	0	10	No	L
H	H	31	DK 238	50.8839	-122.867	20	Dead trunk	0	0	100	Consumed	Mostly consumed	Consumed	Mainly consumed	Black	>40	No	>5	5	10	0	90	No	H

Appendix 4. Downton Creek Fire - Post Wildfire Hazard and Affected Properties

Address	PID	Dwelling	Burnt (1)	Unburnt (0)	Sub-basin	Geodomain	Post Fire Hazard	Waypoint Obs
Lajoie Lake								
6581 Gun Lake Road West	010-934-260	2 Acres Or More (Single Family Dwelling, Duplex)		0	2-1, 2-2	Fd, Df	H	No houses affected by hazards
Boat Launch								
Unknown	006-206-212	Vacant		0			L	
Unknown	018-669-115	Vacant		0			L	
7524 Gun Lake Road West	029-183-901	Single Family Dwelling or Duplex (>=2 Acres)		0			L	
7648 Gun Lake Road West	013-320-645	Seasonal Dwelling		0			L	
7770 Gun Lake Road West	005-567-491	Seasonal Dwelling		0			L	
Unknown	005-567-505	Vacant		0			L	
7880 Gun Lake Road West	005-567-483	Vacant residential <2acres, no bldgs visible		0			L	
7990 Gun Lake Road West	005-567-467	Seasonal Dwelling		0			L	
Upslope, No address	008-934-347	Seasonal Dwelling		0	3-1	Df	H	
8000 Gun Lake Road West	005-567-459	Single Family Dwelling		0			L	
8020 Gun Lake Road West	005-567-441	Single Family Dwelling, Duplex		0			L	
8200 Gun Lake Road West	008-212-252	Single Family Dwelling		0			L	
8262 Gun Lake Road West	008-212-244	Seasonal Dwelling		0	3-1	Df	H	
8300 Gun Lake Road West	008-212-236	Seasonal Dwelling		0	3-1	Df	H	Debris cone. Drainage structures upslope (WPs PF88, PF31)
8362 Gun Lake Road West	008-934-371	2 Acres Or More (Single Family Dwelling, Duplex)		0	3-1	Df	H	
8386 Gun Lake Road West	008-934-380	Seasonal Dwelling	1				L	
8580 Gun Lake Road West	008-934-398	Seasonal Dwelling		0			L	
Unknown	013-496-816	Seasonal Dwelling		0			L	
8740 Gun Lake Road West	013-496-841	Seasonal Dwelling		0			L	
No address	016-058-658	Seasonal Dwelling	1				L	
9022 Gun Lake Road West	010-355-448	Seasonal Dwelling)		0	3-2	Df	H	Debris cone, burnt (WP PF86); Drainage structures upslope (WPs PF90,91,96)
9112 Gun Lake Road West	024-927-465	2 Acres Or More (Vacant)	1				L	
9158 Gun Lake Road West	009-859-560	Seasonal Dwelling	1				L	
9208 Gun Lake Road West	019-079-494	Seasonal Dwelling	1				L	WP DK144. At the mouth of a gully, but not classifed as a sub-basin
9278 Gun Lake Road West	017-251-150	Seasonal Dwelling	1				L	WP DK144. At the mouth of a gully, but not classifed as a sub-basin
9346 Gun Lake Road West	002-229-625	Single Family Dwelling, Duplex		0	3-3	Fd, Df	H	
9348 Gun Lake Road West	017-251-141	Seasonal Dwelling	1				L	
9388 Gun Lake Road West	002-229-617	Single Family Dwelling, Duplex		0			L	
9508 Gun Lake Road West	013-496-859	Seasonal Dwelling		0	3-3	Fd, Df	H	Debris cone (WP PF84, 85); Drainage structures upslope (WPs PF26, 27, 28, 29)
9560 Gun Lake Road West	017-978-416	Seasonal Dwelling		0	3-3	Fd, Df	H	
9602 Gun Lake Road West	017-978-424	Seasonal Dwelling		0			L	
9700 Gun Lake Road West	013-496-883	Seasonal Dwelling		0			L	
9818 Gun Lake Road West	013-496-891	Seasonal Dwelling		0			L	

Appendix 4. Downton Creek Fire - Post Wildfire Hazard and Affected Properties

Address	PID	Dwelling	Burnt (1)	Unburnt (0)	Sub-basin	Geodomain	Post Fire Hazard	Waypoint Obs
10100 Gun Lake Road West	004-878-612	Seasonal Dwelling		0			L	
Unknown	013-489-526	Seasonal Dwelling		0			L	
10300 Gun Lake Road West	004-480-422	Seasonal Dwelling		0	3-4	Df	H	
10320 Gun Lake Road West	023-342-684	Single Family Dwelling, Duplex		0	3-4	Df	H	Intake on creek burnt (WPs PF81, 82, 83), Drainage structures upslope (WPs PF23, 24, 25),
10404 Gun Lake Road West	023-342-676	Single Family Dwelling, Duplex		0	3-4	Df	H	
10488 Gun Lake Road West	023-342-668	Single Family Dwelling		0			L	
10500 Gun Lake Road West	023-342-650	Seasonal Dwelling		0			L	
10780 Gun Lake Road West	018-710-336	Vacant		0			L	
No address	008-444-595	Seasonal Dwelling		0			L	
10800 Gun Lake Road West	018-710-344	Seasonal Dwelling		0			L	
10870 Gun Lake Road West	027-060-888	Seasonal Dwelling		0			L	
11385 Gun Lake Road West	013-505-513	Seasonal Dwelling		0			L	
11188 Gun Lake Road West	030-727-952	Single Family Dwelling, Duplex		0	4-1 Walker	Fd, Df	M	Keir existing house. Lot A. See Cordilleran 2015
No Address	030-727-979	Seasonal Dwelling		0	4-1 Walker	Fd, Df	M	Keir Lot B; Cordilleran 2015
No address	030-727-987	Seasonal Dwelling		0	4-1 Walker	Fd, Df	M	Keir Lot C; Cordilleran 2015
No address	030-727-995	Vacant		0	4-1 Walker	Fd, Df	M	Keir Lot D; Cordilleran 2015
Unknown	030-727-961	Vacant		0	4-1 Walker	Fd, Df	M	Keir Lot E; Cordilleran 2015
11388 Gun Lake W Rd	011-816-619	Single Family Dwelling, Duplex		0			L	
10 Stafford Rd	004-402-162	2 Acres Or More (Single Family Dwelling, Duplex)	1				L	
116 Stafford Rd	016-685-636	Single Family Dwelling	1				L	
180 Stafford Rd	016-685-652	Seasonal Dwelling	1				L	
182 Stafford Rd	016-685-661	Seasonal Dwelling	1				L	
255 Stafford Rd	014-284-847	Seasonal Dwelling	1				L	
277 Stafford Rd	025-001-868	Single Family Dwelling	1				L	
303 Stafford Rd	015-774-180	Seasonal Dwelling	1				L	
345 Stafford Rd	159-187-761	Seasonal Dwelling (159-187-761)	1				L	
367 Stafford Rd	013-334-816	Seasonal Dwelling	1				L	
405 Stafford Rd	015-862-518	Seasonal Dwelling	1				L	
435 Stafford Rd	013-557-262	Seasonal Dwelling	1				L	
477 Stafford Rd	013-308-963	Single Family Dwelling		0			L	
499 Stafford Rd	013-998-625	Seasonal Dwelling	1				L	
521 Stafford Rd	017-244-480	Seasonal Dwelling	1				L	
Unknown	031-589-057	Vacant		0			L	
12520 Gun Lake Road West	031-589-049	Vacant		0			L	
LOT 1 DISTRICT LOT 6485	008-931-160	2 Acres Or More (Seasonal Dwelling)	1		5-1 Sumner	Fd, Df	H	Sumner Creek. We noted (WPs PF74-80; DK124-129) evidence of at least one debris flood/flow post Bridge River tephra.
12266 Gun Lake Road West	007-872-801	Seasonal Dwelling	1		5-1, 5-2	Fd, Df	H	Sumner fan (WPs PF72-PF80); drainages upslope (PF3, 4, 17-20); DONUT 20.

Appendix 4. Downton Creek Fire - Post Wildfire Hazard and Affected Properties

Address	PID	Dwelling	Burnt (1)	Unburnt (0)	Sub-basin	Geodomain	Post Fire Hazard	Waypoint Obs
12284 Gun Lake Road West	004-716-531	Seasonal Dwelling	1		5-2	Fd	H	North fan (WPs PF72, 73, 75) fan extents visible, but little evidence of stream; DK 123, 125, No culvert and no stream at road; dry and/or abandonned channels on north fan.
12300 Gun Lake Road West	007-872-810	Seasonal Dwelling (007-872-810)	1		5-2	Fd	H	
12340 Gun Lake Road West	007-872-828	Seasonal Dwelling	1				L	
12376 Gun Lake Road West	007-872-836	Single Family Dwelling	1				L	
12480 Gun Lake Road West	007-872-844	Seasonal Dwelling	1				L	
LOT 9 DISTRICT LOT 6485	007-872-852	Single Family Dwelling	1				L	
12600 Gun Lake Road West	031-589-031	Vacant	1				L	
12866 Gun Lake Road West	005-454-883	Seasonal Dwelling	1				L	
12900 Gun Lake Road West	004-026-551	Single Family Dwelling	1				L	
13000 Gun Lake Road West	008-562-148	2 Acres Or More (Single Family Dwelling, Duplex)	1				L	
34 Lee Road	008-562-121	Seasonal Dwelling	1				L	
64 Lee Road	008-562-113	Seasonal Dwelling	1				L	
96 Lee Road	008-562-105	Seasonal Dwelling	1				L	
114 Lee Road	013-505-505	Seasonal Dwelling	1				L	
13767 Gun Lake Road West	008-201-722	Single Family Dwelling	1		5-3	Fd	H	Creek notes(PF40, 68-71) Ephemeral stream channel, 2 m wide by 0.5 m deep, 15% slope, pebble gravel wash eroded into pumice. Tornado damage area.
13770 Gun Lake Road West	008-201-749	2 Acres Or More (Single Family Dwelling, Duplex)	1		5-3	Fd	H	Tornado damage area.
13800 Gun Lake Road West	008-201-731	Residential Outbuilding Only	1				L	Tornado damage area.
13888 Gun Lake Road West	023-475-447	2 Acres Or More (Single Family Dwelling, Duplex)	1				L	Tornado damage area.
13960 Gun Lake Road West	023-475-455	2 Acres Or More (Single Family Dwelling, Duplex)	1				L	Tornado damage area.
14000 Gun Lake Road West	017-164-818	Single Family Dwelling	1				L	Tornado damage area.
14044 Gun Lake Road West	017-164-826	Seasonal Dwelling	1				L	
14088 Gun Lake Road West	017-164-834	Single Family Dwelling	1				L	
14122 Gun Lake Road West	017-164-851	Residential Outbuilding Only	1				L	
14150 Gun Lake Road West	017-164-869	Single Family Dwelling	1				L	
14174 Gun Lake Road West	017-164-877	Seasonal Dwelling	1				L	
14200 Gun Lake Road West	539-901-011	No ownership?	1				L	
10 Sunshine Dr	023-608-480	Single Family Dwelling, Duplex		0			L	
50 Sunshine Dr	004-896-521	Seasonal Dwelling		0			L	
80 Sunshine Dr	003-019-306	Seasonal Dwelling		0			L	
110 Sunshine Dr	003-019-314	Seasonal Dwelling		0			L	
140 Sunshine Dr	003-019-322	Seasonal Dwelling		0			L	
180 Sunshine Dr	006-599-524	Single Family Dwelling		0			L	
200 Sunshine Dr	003-019-349	Seasonal Dwelling		0			L	
228 Sunshine Dr	013-423-835	2 Acres Or More (Single Family Dwelling, Duplex)	1				L	
Counts			**48**				**95**	

Appendix 4. Downton Creek Fire - Post Wildfire Hazard and Affected Properties

Address	PID	Dwelling	Burnt (1)	Unburnt (0)	Sub-basin	Geodomain	Post Fire Hazard	Waypoint Obs
Gun Creek Road								
555 Gun Creek Rd	011-389-087	Single Family Dwelling, Duplex		0			L	
600 Gun Creek Rd	008-936-731	Manufactured Home on Land		0			L	
770 Gun Creek Rd	009-362-894	Single Family Dwelling, Duplex		0			L	
950 Gun Creek Rd	018-005-632	Seasonal Dwelling	1				L	
1100 Gun Creek Rd	008-719-039	Single Family Dwelling or Duplex (>=2 Acres)	1				L	
1300 Gun Creek Rd	023-629-444	Single Family Dwelling, Duplex		0			L	
1500 Gun Creek Rd	008-719-047	Single Family Dwelling or Duplex (>=2 Acres)	1				L	
1550 Gun Creek Rd	023-657-456	Vacant		0			L	
1808 Gun Creek Rd	008-514-984	Seasonal Dwelling		0			L	
2100 Gun Creek Rd	008-638-349	Single Family Dwelling, Duplex		0			L	
2200 Gun Creek Rd	008-514-968	Seasonal Dwelling		0			L	
2350 Gun Creek Rd	008-514-917	Seasonal Dwelling		0			L	
2440 Gun Creek Rd	008-514-941	Single Family Dwelling, Duplex		0			L	
2600 Gun Creek Rd	013-284-428	Seasonal Dwelling		0			L	
3500 Gun Creek Rd	003-245-217	Seasonal Dwelling		0			L	
3300 Gun Creek Rd	003-246-787	Seasonal Resort		0			L	
3443 Gun Creek Rd	003-820-335	Single Family Dwelling, Duplex		0			L	
3555 Gun Creek Rd	003-820-360	Single Family Dwelling, Duplex		0			L	
3909 Gun Creek Road	004-044-932	2 Acres Or More (Single Family Dwelling, Duplex)	1				L	
District Lot 4582, Blk A	616-707-071	n/a (OCP= Resource mangment)	1				L	
District Lot 4582, Blk B	101-328-821	n/a	1		8-1	Fd	L	
District Lot 4582, Blk C	013-429-451	2 Acres Or More (Manufactured Home)	1		8-1	Fd	L	
Counts			**7**				**22**	