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BC Ministry of Forests, Lands, and Natural Resource Operations and Rural Development

POST-WILDFIRE NATURAL HAZARDS RISK ANALYSIS TROZZO FIRE (N51705)

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1. Introduction and Objectives

The Trozzo wildfire (N51705) started on July 9, 2021 and burned 5992 ha within the Lemon Creek, Trozzo Creek, Winlaw Creek and Grohman Creek drainages in southeastern B.C. (refer to Figure 1 and inset map on Map 1 Appendix A). The fire started in the upper Winlaw Creek drainage and quickly spread north into the Trozzo Creek and Lemon Creek drainages (Photos 1 through 4). Because the fire includes, or is adjacent to, several populated areas near the community of Winlaw in the Slocan Valley, it was considered by the Ministry of Forests, Lands, Natural Resource Operation and Rural Development (MFLNRO) to be a high priority to conduct a Post-Wildfire Natural Hazards Risk Analysis (PWNHRA). SNT Geotechnical Ltd. (SNTG) was retained by the Ministry of Forests Lands Natural Resource Operations (BC Wildfire Service) to complete this work. SNTG collaborated with Sitkum Consulting Ltd. (SCL) to complete the risk analysis, mapping, and reporting.

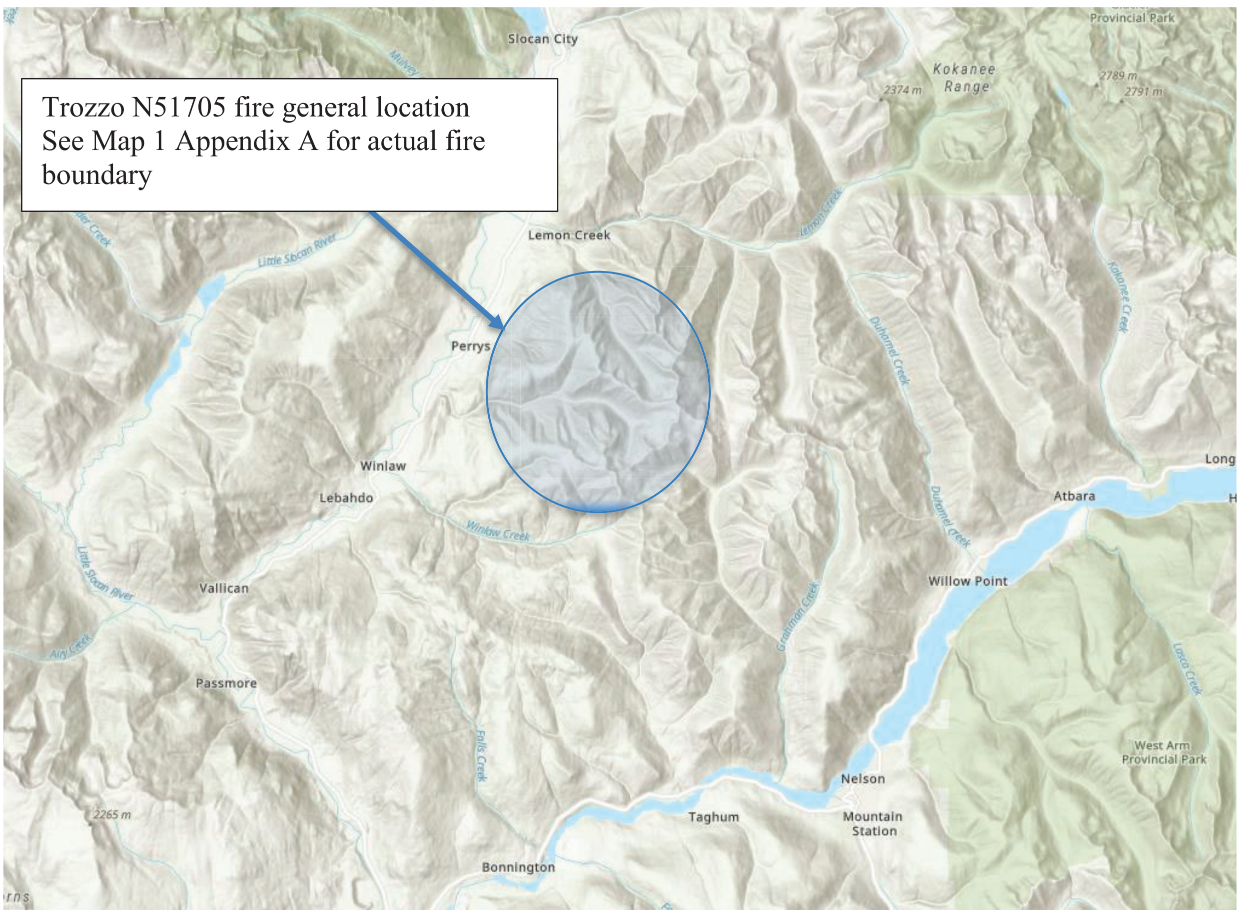

Figure 1. N51705 General Fire location

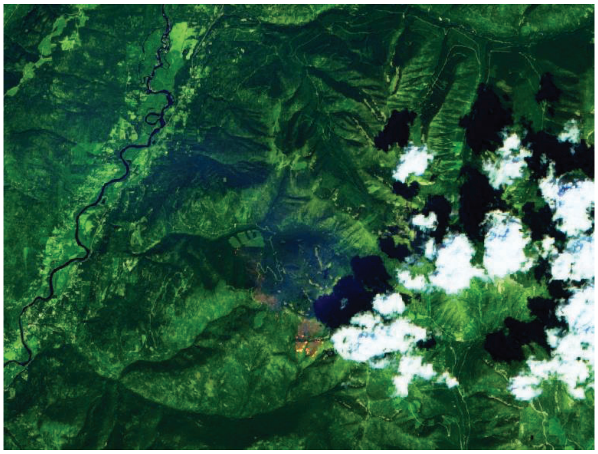

Photo 1. July 13h, 2021 Sentinel -2L1C Satellite Imagery

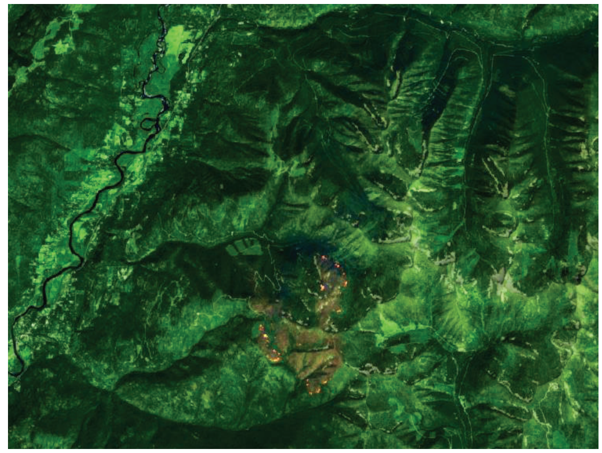

Photo 2. July 18th, 2021 Sentinel -2L1C Satellite Imagery

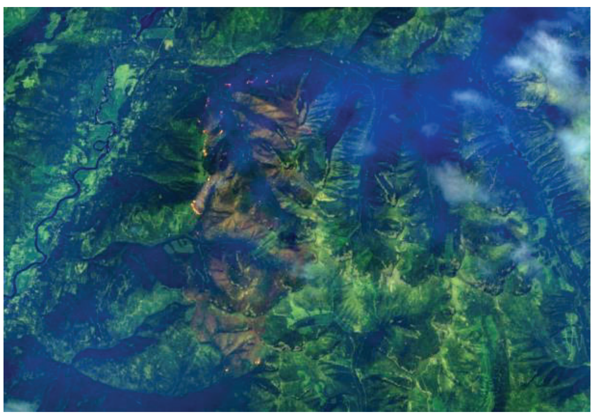

Photo 3. July 23rd, 2021 Sentinel -2L1C Satellite Imagery

Photo 4. July 30th, 2021 Sentinel -2L1C Satellite Imagery

While for many post wildfire assessments a reconnaissance risk analysis is conducted which involves a review of operational maps and other information from the Southeast Fire Centre, preliminary burn severity maps (Rapid Burned Area Mapping (RBAM)) and review of aerial imagery on Google Earth, a written reconnaissance risk analysis was not completed for the Trozzo fire as the resource values warranted a more detailed risk analysis.

The detailed risk analysis with field work was supported by burn severity mapping, with polygons representing unburned, low, moderate, and high burn severity areas. The detailed risk analysis includes, where relevant, recommendations for mitigation measures.

2. Potential Hazards as a Result of the Fire

Debris flows and floods following wildfires can occur as a result of high-intensity rainfall on severely burned and/or water-repellent soils, typically in mid to late summer. Examples in BC include the 2004 Kuskonook Creek and Jansen Creek debris flows near Creston, debris floods and flows following the 2017 Elephant Hill Fire (91 events, one causing a fatality on Highway 1) and debris floods in Kelowna and near Falkland, which followed the 2003 wildfires. This hazard is greatest in the first two to three years after the fire. Debris flows and floods can also occur during spring runoff as a result of rapid snowmelt in burned areas. Examples include several debris flows which followed the 2007 Springer fire near Slocan (one causing a fatality), and debris flows which followed a 2009 fire at Kelly Lake. They can also occur, although less commonly, during fall (2005 Mt. Ingersoll Fire with 15 channel failures and 7 hillslope landslides) or early winter rain-on-snow events. The springtime hazards are due to increased snow accumulation, more rapid snowmelt, and higher groundwater levels in burned areas, and can persist for several years or decades until revegetation occurs.

In the Trozzo Fire, debris flow and flood hazards exist both due to short-duration, high-intensity, rainfall events and snowmelt-caused events.

Water repellency was observed in areas of high soil burn severity and although not a necessary condition, 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). High soil burn severity also causes reduced infiltration capacity even without water repellency, and therefore can increase the susceptibility to overland flow even in areas where water repellency was not observed. In areas of moderate vegetation burn severity, needle fall from the dead trees can create an effective mulch, which tends to slow down surface runoff and promote infiltration. 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.

In August 2018, in the 2017 Elephant Hill fire near Cache Creek, there were several unusually intense, short-duration rainstorms which caused severe flooding and erosion in many small, steep creeks. Overland flow and flood damage occurred even in watersheds which drained moderate and low burn severity areas, including grassland. Some flooding also occurred in unburned watersheds, but it was much more extensive and severe in burned areas. These rainstorms were estimated to have a return period of 100 years or more in the most severely affected areas (that is, in any given year, the probability of occurrence is 0.01, based on historical data). Extreme rainstorm events are likely to cause widespread flooding and possibly landslides in all areas, burned or unburned; however, the Cache Creek events illustrate that burned areas are more susceptible to damaging events. In the post-wildfire risk analysis procedure, the hazard ratings are generally assumed to apply to flood or erosion events that may occur as a result of typical rainfall or snowmelt events that are likely to occur in the two to five years after a fire. Although the risk analysis focuses on a two-to-five-year time horizon, lingering hazards can extend for decades until forest regeneration occurs.

Soil erosion can be a significant process in high soil burn severity areas, due to exposed bare soil and lack of a protective litter and duff layer. Increased sediment load during flood events can contribute to flood damage, by blocking culverts and ditches. It can also contribute to the likelihood of debris flows in steep watersheds. Erosion from burned areas may result in adverse impacts to water quality in the creeks affected by the fire. In addition, peak flow in some extensively burned watersheds could result in additional sediment entrainment from bank erosion or through tributary debris deposition. In the first few rainstorms and snowmelt events after the fire, ash and soot can be washed downstream and enter water intakes. In addition to ash and sediment entrainment there have been documented increases of other types of water contamination including an increase in heavy metal concentrations post wildfire (Silins et al 2016, Bladen et al 2014.)

3. Methods

Field work in the burned areas was conducted on October 7 by Doug Nicol, P.Eng. (SNTG), Pete Wittstock, P.Eng. (SNTG), Tedd Robertson, P.Geo. P.L.Eng. (SCL), and Sarah Crookshanks, P.Geo. (MFLNRORD) and on January 8 by Doug Nicol.

The October 7 field work included a heli-reconnaissance with select landings to confirm the results of the BARC mapping and to compare the Vegetation Burn Severity (VBS) with the Soil Burn Severity (SBS). The January 8 field work focused on the Trozzo Creek and Winlaw Creek crossings at Highway 6.

Most of the potential higher hazard risk sites are located within tributaries to Lemon Creek, Trozzo Creek, and Winlaw Creek. The western facing slope units above Highway 6 were mostly unburned. The area burned in Grohman Creek was sufficiently small with very little High burn severity; as a result, it is not considered to represent a significant hazard and was not targeted for field work or further detailed assessment.

Mapping of potential post-wildfire hazards and the analysis of risks followed the general methodology outlined in Hope et al. (2015). In the simplest terms, *risk* is the product of *hazard* and *consequence*. For the purpose of post-wildfire risk analysis, usually only *partial risk* is considered; this is the probability that a hazardous event (e.g., a debris flow) will occur and that it will reach or affect the site of the element at risk (e.g., a house or highway) with consideration to the spatial and temporal probability but not the value or vulnerability of the elements at risk. Detailed risk analysis generally involves ground inspections of high value elements exposed to considerable hazards. Subjective terms (low, moderate, high) are used to describe hazard and risk, based on generally accepted definitions (Wise et al 2004). The qualitative risk matrix used for the determination of partial risk in this study is shown Figure 2. The risk was considered in an incremental context and not as an absolute risk which would also consider pre-existing natural hazards. For example; an element at risk may have been considered to be at high partial risk pre-fire, but if there is no significant increase in the assessed risk at the location of the element considered, the post wildfire risk would be assessed as low or non-existent. Lemon Creek is an example where there may be pre-existing hazards associated with landslides and flooding, but a cumulative evaluation of all watershed hazards and risks is beyond the scope of this assessment which focuses on effects of the Trozzo Wildfire.

P(HA), annual probability (likelihood) of occurrence of a specific hazardous landslide and it reaching or otherwise affecting the site occupied by a specific element		**P(S:H) × P(T:S) Probability (likelihood) that the landslide will reach or otherwise affect the site occupied by a specific element, given that the landslide occurs**		
P(HA) = P(H) × P(S:H) × P(T:S)		**High**	**Moderate**	**Low**
P(H), annual probability (likelihood) of occurrence of a specific hazardous landslide	Very high	*Very high*	*Very high*	*High*
	High	*Very high*	*High*	*Moderate*
	Moderate	*High*	*Moderate*	*Low*
	Low	*Moderate*	*Low*	*Very low*
	Very low	*Low*	*Very low*	*Very low*

Figure 2. Qualitative risk matrix for partial risk (Wise et al, 2004. Land Management Handbook 56)

4. Terrain and Watershed Conditions

The Trozzo Fire (N51705) is located approximately 8 km east of Winlaw B.C. The northern fire boundary is along Lemon Creek, and the southern boundary near Winlaw Creek.

The Trozzo Fire is situated in the Kokanee Range of the Selkirk Mountains, part of the Columbia Mountains within southeastern British Columbia. The general physiography of the region consists of serrated ridges and peaks above approximately 2100 m elevation and with rounded ridge crests and steep valley sides below 2100 m. Summit levels generally lie between 2100 m and 2700 m, and local relief of approximately 800 m to 1300 m is typical with elevations ranging from approximately 900 m near Lemon Creek to approximately 2200 m the subalpine ridgetops near Mt. Hoover (2275 m).

Below approximately 1500 m elevation within the fire perimeter the biogeoclimatic mapping indicates the Interior Cedar – Hemlock zone. Upslope of approximately 1500 m elevation lies the Engelmann Spruce – Subalpine Fir zone. Based on the precipitation modeling available from

ClimateBC_Map, the mean annual precipitation within the burn area ranges from approximately 950 mm to 1500 mm, generally increasing with elevation. This is consistent with reference data available from weather stations throughout the region.

The regional geology mapping available from iMapBC indicates the burn area is underlain by the Middle Jurassic aged Nelson Batholith consisting of primarily granodioritic bedrock. This is consistent with field observations.

Reconnaissance terrain stability mapping has been previously completed for the area affected by the Trozzo Fire, including the Lemon Creek, Trozzo Creek and Grohman Creek drainages. The majority of the main gully systems have been mapped as potentially unstable, with some areas of unstable terrain mapped along small, steep, gullied tributaries of Trozzo Creek and Lemon Creek.

5. Watershed Hazards and Burn Severity Mapping

Watershed boundaries in the area were delineated using LiDAR (sourced from LidarBC-Open LiDAR Data Portal) derived 5 m contours for most drainages, with TRIM based 20 m contours used for Lemon Creek due to the size of the drainage. In areas where flood and debris flow hazards might be present, the watersheds were subdivided into smaller units to delineate drainage basins above alluvial fans. Many streams are not named on published maps, so some names used for watershed identification in this report are arbitrary.

An approximate index of potential debris flow hazard is the relief ratio (which is the elevation range divided by the square root of watershed area). Based on research completed in B.C. (Wilford et al. 2009), if the relief ratio is greater than 0.6, then the watershed is likely to be susceptible to debris flows; if between 0.3 and 0.6, to debris floods. This is a very rough guideline, and debris flow susceptibility depends on many other geologic and hydrologic factors, but the relief ratio is still a valuable index to help confirm the field assessment of watershed hazards. The relief ratio for Winlaw Creek, Trozzo Creek, and Lemon Creek is included in Table 1 along with other watersheds characteristics.

Table 1: Watershed characteristics

Watershed	Winlaw Creek	Trozzo Creek	Lemon Creek
Area (km^2)	40.1	28.1	200.2
Length (km)	9.4	9.9	25
Elevation Range (m)	630-2080	560-2200	570 - 2400
Melton ratio	0.24	0.26	0.11
Typical fan slope*	4%	5%	1.8
Typical channel slope, mid-watershed	10%	8%	n/a
Typical channel slope, headwaters	20%	15%	n/a
Terrain stability “V” or “U”	1%	2%	6%

Watershed	Winlaw Creek	Trozzo Creek	Lemon Creek
Terrain stability "IV" or "P"	34%	27%	42%
"Gentle-over-steep" (burn on plateau draining into steep channels)	No	Yes	No
Main channel riparian zone severely burned	No	No	No
Vegetation Burn Severity: H	2%	7%	2%
Vegetation Burn Severity: M	12%	30%	6%
Burn Concentrated in:	Upper elev.	Upper elev.	Lemon tributaries
Fan or Deposition Slope	5%	3% to 10%	1.8%

*from Klohn-Crippen 1998

Klohn-Crippen (1998) completed reviews of Trozzo Creek, Winlaw Creek, and Lemon Creek as part of an inventory of alluvial and debris flow fans in the Kootenay Region. Table 2 is a summary of some of the fan characteristics published in the Klohn-Crippen report.

Table 2: Flood Hazard Klohn-Crippen 1998

Creek	% Active	Melton	Flood Potential	Fan Type	Consequences (Damage Rating)	Hazard
Winlaw	20	0.24	Low	Alluvial	High	Low
Trozzo	10	0.30	Low	Alluvial Fan prone to Debris Flow	High	Low
Lemon	30	0.11	Low	Alluvial	High	Moderate

Burn severity maps are used to assess the potential hydrologic effects of the fire in each watershed due to forest cover and soil changes. The definitions of high, moderate, and low vegetation burn severity (VBS) are given in Hope et al. (2015) and Parsons et al. (2010), as well as the procedure for preparing a burn severity map. Briefly, the vegetation burn severity categories are:

- High – trees dead (black); needles, twigs, and understory consumed
- Moderate – trees dead (orange); scorched needles remain on trees, understory burned
- Low – trees live (green); canopy mostly unburned, understory lightly burned.

Soil burn severity (SBS) is similarly classified as high, moderate, or low, and is based on the extent of consumption of the forest floor and fuels on the ground, and on the extent of exposed bare soil:

- High – forest floor and near-surface roots consumed, mineral soil structure altered
- Moderate – litter consumed, duff partly consumed or charred, mineral soil unaltered
- Low – litter scorched or partly consumed, often with patchy forest floor burn.

Vegetation and soil burn severity are usually, but not always, fairly well correlated. For example, a high VBS site most commonly has a high SBS, though may have moderate SBS and is unlikely to have a low SBS. Water repellency is often, but not always, present on high SBS sites. Where SBS is high, the infiltration capacity of the soil and storage capacity of the forest floor is often greatly reduced, and overland flow may be generated during heavy rain. If this occurs over large areas, soil erosion and downstream flooding can occur. If water repellency is present, the amount of overland flow can be considerably greater. Where VBS is moderate, dead needles remain on the trees. These soon fall, often covering the ground with an effective mulch which promotes infiltration and reduces the likelihood of overland flow. Therefore, fire related flood and debris flow hazards from rainstorms are generally high only where both VBS and SBS are high.

Increased flood hazard during spring snowmelt is due to loss of the forest canopy, which results in both a higher winter snowpack and more rapid snowmelt. The effect is similar to that of clearcutting. However, in the first one or two years, the effect of fire may be greater than clearcutting, due to the black colour of burned tree trunks and the soot and debris which falls on the snow. The reduced water storage and run-off attenuation form the loss of the litter and/or duff may also contribute to increased freshet related flood hazard although this is less of a factor during freshet as the litter/duff storage capacity is typically reduced in the during freshet. Also, because there is no longer transpiration from trees and understory vegetation, the water table and soil moisture may be higher when winter comes. The flood hazard in a watershed is a function of the area burned at high and moderate VBS; low VBS sites (in which many trees and shrubs have survived) generally do not contribute significantly to flood hazard.

A burn severity or Burned Area Reflectance Classification map (BARC) was prepared by FLNRORD both at the provincial and regional level, based on Sentinel 1 and Landsat 8 satellite images The two maps differed slightly in the classification of and extent of VBS. The authors compared the map results with their ground and aerial surveys and determined the most representative map was a combination of the two created by filling in the unburned area of the provincial map with the data from the regional map which included more low burn severity in these areas. The burn severity map used in this report and believed to be suitably representative of the Soil Burn Severity is shown in Appendix A.

A complete table of burn severities by watershed along with the watershed boundaries are shown on Map 1 Appendix A. In addition to the low, moderate, and high drainage VBS categorization, a weighted burned area classification (referred to as the effective burn severity index (EBSI)) was also used to assess the landslide hazard. The EBSI is calculated as the sum of 100% of the area of the high burn severity plus 50% of the area of moderate burn severity divided by the drainage area. If an area with an EBSI of greater than approximately 50% is situated at or above potential landslide initiation locations, then there is likely to be a significant increase in landslide hazard. Landslide occurrence is not only a function of the extent of moderate or high burn severity within a drainage area, but also depends on where the burn occurs within a watershed. High burn severity areas within the upper steep portions of small watersheds can be more hazardous than a similar burn severity located at the lower parts of a drainage where debris flow initiation is lower due to decreased sediment availability and increased channel stability.

Field data on vegetation and soil burn severity were collected at a limited number of ground plots, with more general visual observations made throughout the field assessments. The field observations were used to check the accuracy of the high, moderate, low, and unburned categories on the BARC map. The field observations were found to correspond reasonably well to the BARC map categories, and minimal adjustments to the map were required. The number of observation plots was insufficient to warrant a separate map of soil burn severity. Water repellent soils were found at most plots with high SBS.

Based on the above factors relating to the incremental increase in likelihood of landslides and flooding hazards due to the fire, in addition to the watershed conditions as presented above, hazard ratings have been assigned for select drainages identified in Map 1 Appendix A. The estimated hazard by drainage is shown in Table 3 below. It is noted the hazard is probabilistic as it is a function of the snow and rainfall events that will occur over the next 3 to 5 years. While the 1 in 100-year rainfall event after the Elephant Hill wildfire caused widespread landslide and flood events, much lower return period rainfall events after the Mt. Eneas fire failed to initiate post wildfire events.

Table 3: Hazard estimate by drainage

Drainage Name	Hazard	Burn Severity Description	Process	Value at Risk
South Lemon 1	High	40% moderate, 46% high	Debris Flow	MFLNRORD Road and Bridge
T4 (Trozzo Creek)	High	83% moderate, 12% high	Debris Flow	
T5 (Trozzo Creek)	High	64% moderate, 28% high	Debris Flow	
T6 (Trozzo Creek)	High	73% moderate, 21% high	Debris Flow	
W1 Trib (Winlaw Creek)	Moderate to High	63% moderate, 11% high	Debris Flow	
Upper L1	High	>50% high	Debris Flow	
Upper L2	High	>50% high	Debris Flow	
T3 Tributary	High	>50% high	Debris Flow	
L1 All	Moderate	20% moderate, 30% high	Debris Flow	
L2 All	Moderate	37% moderate, 21% high	Debris Flow	
L3	Moderate	47% moderate, 19% high	Debris Flow	
L4	Moderate	40% moderate, 7% high	Debris Flow	FSR Crossing
South Lemon	Moderate	28% moderate, 13% high	Debris Flow	
T2	Moderate	60% moderate, 10% high	Debris Flow	

T3	Moderate	42% moderate, 13% high	Debris Flow	
T7	Moderate	58% moderate, 12% high	Debris Flow	
Trozzo Mid	Moderate	47% moderate, 12% high	Debris Flow	
Trozzo Upper	Moderate	46% moderate, 15% high	Debris Flow	
W1	Moderate	63% moderate, 11% high	Debris Flow	
Lemon All	Low	6% moderate, 2% high	Flood and landslide blockage outwash	Houses, Highway 6, Domestic, Irrigation, and Industrial water infrastructure
Trozzo All	L-M	30% moderate, 7% high	Flood and landslide blockage outwash	Houses, Highway 6, Domestic, Irrigation, Commercial, and Industrial water infrastructure
Winlaw All	Low	12% moderate, 2% high	Flood	Houses, Highway 6, Domestic and Irrigation water infrastructure

Photos 5 through 11 show examples of high burn severity sites. Some landslides have already occurred post wildfire as showed on Photos 9 through 11.

Photo 5. Example of high burn severity area

Photo 6. Example of high burn severity area

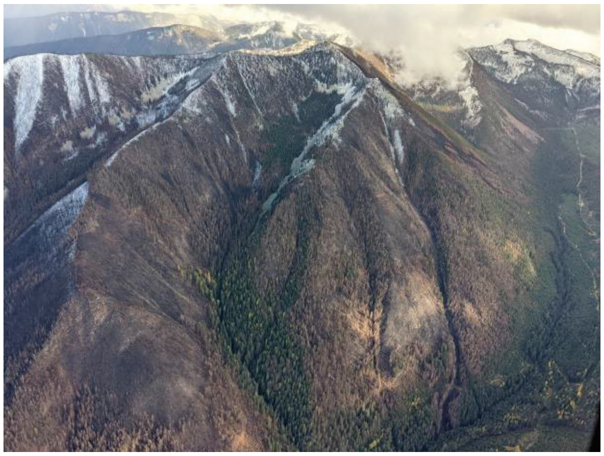

Photo 7. High Burn severity polygons - tributary to South Lemon

Photo 8. Representative of burned area divide (left side draining to South Lemon Creek: right side draining to Highway 6 face units)

Photo 9. High and moderate burn in Trozzo Drainage - 2 recent landslides noted believed to have occurred in August - Drainages T4 (burned 95% combined Moderate and High) and face unit between T4 and T5 (100% moderate).

Photo 10. Recent landslides originating in a high burn area of Drainage W1 of Winlaw Creek with a 74% Moderate and High Burn Severity

Photo 11. Landslides (date unknown) in upper Winlaw Creek drainage.

6. Elements at Risk and Partial Risk for Drainages of Interest

Property, infrastructure, and water supplies are often at risk from post-wildfire hazards, such as flooding or landslides. These areas or sites are referred to as "elements at risk" and include the following:

- houses, farms, outbuildings
- highways and other transportation infrastructure
- domestic, irrigation, industrial, commercial water supply infrastructure

Houses and other building locations are shown on Map 1 and are based on TRIM data with additional information added from available imagery (Google Earth and RDCK web mapping service). Houses and other structures are considered to be at risk if they are located on alluvial fans or near stream channels, or at the base of steep slopes below burned areas. The houses and highways infrastructure at risk due to the Trozzo fire are mostly located on the three fans (Lemon, Trozzo, and Winlaw). Maps are provided in Appendix A that show the Lemon Creek Fan (Map 2), the Trozzo Fan (Map 3) and the Winlaw Fan (Map 4). The fan boundaries provide an approximate zone in which flooding, erosion or debris deposition could occur. The fan boundaries of these creeks were delineated based on LiDAR data interpretation combined with limited field checking and comparison with previous mapping completed in the area.

Water license information was obtained from the BC Government water license query page, and from the POD (points of diversion) shown on iMap BC (the two sources give somewhat different information). Winlaw Creek, Trozzo Creek, and Lemon Creek have numerous domestic licenses in addition to some irrigation, commercial, and industrial use licenses (refer to Water License Summary Table in Appendix B). It is understood that rain events that occurred in August have already had a water quality impact on Trozzo Creek and Winlaw Creek (increased turbidity).

The overall burn severity within the Lemon Creek and Winlaw Creek drainages is low. It is unlikely that flooding will occur over these fans due only to post wildfire effects. However, it is possible that landslides will occur in the South Lemon 1, L1, L2 watersheds (Lemon Creek drainage) and W1 watershed (Winlaw Creek drainage) that could result in temporary blockages of the creeks resulting in debris floods (high sediment laden floods). Refer to Table 4 for a summary of partial risk. The likelihood of these occurring and causing infrastructure damage is considered low. Highway 6 crosses Lemon Creek with a clear span bridge and Winlaw Creek with an arch culvert. There is also a log stringer and log crib abutment bridge downstream of the Highway 6 arch culvert (accesses the highway maintenance yard). Winlaw Creek is not well incised at the highway location (only 2 m bank height upstream of bridge) and a debris flood could result in culvert inlet blockage and overtopping/diversion of the creek.

Trozzo Creek has a higher overall burn severity (than Lemon Creek or Winlaw Creeks) with 30% Moderate and 10% High. There are also more highly burned tributaries (T3, T4, T5, T6, T7) where debris flows could occur and potentially temporary block Trozzo Creek flows. These landslides, if they were to occur, would be more than 5 km upstream from the Trozzo Creek fan. Given the Trozzo Creek drainage length (10 km) the overall debris flow potential reaching the fan of Trozzo Creek is low (not withstanding that there have been some occurrences of >6 km debris flows - see Jordan 2011). The primary hazards to the Trozzo Creek fan consist of flooding and debris floods, some of which could be triggered by upper drainage debris flows blocking Trozzo Creek. The likelihood of flooding and/or debris floods is considered low to moderate (refer to Table 4). Flood or debris flood events could result in overtopping the highway culvert and/or result in flooding and damages to properties as shown in the fan area (Appendix A, Map 3).

Trozzo Creek passes through a corrugated metal culvert at the Highway 6 crossing with about 2 m bank height. Confinement is only about 1 m upstream of Highway 6 (adjacent to a private driveway); however, either plugging of the culvert at the highway or creek overtopping within 50m upstream of the highway crossing would likely result in flows being directed towards the Slocan River - where no houses are located. Overtopping of the Trozzo Creek banks near the fan apex (where the creek turns to the southwest) would result in higher flood consequences (a greater consequence of a flood event with multiple houses vulnerable). Refer to Table 4 below for a summary of partial risk ratings.

Table 4: Partial Risk summary table for select drainages in the Trozzo Fire

Drainage Name	Hazard	Process	Value at Risk	Partial Risk
South Lemon 1	High	Debris Flow	MFLNRORD Road and Bridge	Very High
L4	Moderate	Debris Flow	FSR Crossing	Moderate
Lemon Total	Low	Flood and landslide blockage outwash	Houses, Highway 6, Domestic, Irrigation, and Industrial water infrastructure	Low

Drainage Name	Hazard	Process	Value at Risk	Partial Risk
Trozzo Total	Low to Moderate	Flood and landslide blockage outwash	Houses, Highway 6, Domestic, Irrigation, Commercial, and Industrial water infrastructure	Low to Moderate
Winlaw Total	Low	Flood	Houses, Highway 6, Domestic and Irrigation water infrastructure	Low

7. Watershed Management Considerations

Salvage harvesting of burned areas has the potential to increase the associated hazards and risks associated with flooding and landslides. It is recommended that no salvage harvesting take place within the drainages where there is a Moderate or High likelihood of post wildfire landslide or flooding hazards without due consideration of the potential cumulative effects of hydrogeomorphic hazards within the watershed resulting from the wildfire, previous wildfires, previous harvesting, existing resource roads, and planned forest development. The potential impacts to high value downslope elements at risk should be evaluated as part of this assessment.

8. Summary of Recommendations

Recommendations are presented with land status or responsibility where known. The recommendations are not intended as an evaluation of the acceptability of either the present risk, total risk, or incremental risk due to the Trozzo Wildfire. The information is presented for the use of stakeholders to determine and assess whether the risk is acceptable or tolerable or whether further work is required.

1. It is recommended that the Winlaw Creek Highway 6 arch culvert be inspected and reviewed for hydrological capacity in the event of a debris flood (MoTI).

2. Residents and businesses on the fans of Winlaw Creek, Trozzo Creek, and Lemon Creek should be provided an electronic copy of this report. During periods of high stream flow, freshet conditions, and high intensity summer or fall rainstorm events residents should be diligent with regards to work/travel adjacent to the local creeks and be aware of any sudden changes to creek flows (rapid increase or decrease in flows, or flow pulses), colour, or debris (logs, boulders, sediment) transport. Residents should familiarize themselves with the creeks, their location relative to the creeks, and where damages would be sustained if

flooding were to occur. If changes are observed, they should be reported promptly to Emergency Management BC.

3. MFLNRORD and other road or road use permit holders should review and maintain culverts and other drainage control infrastructure in locations below significant burned areas as shown on Map 1. A MFLNRORD bridge located at the junction of the Lemon Creek FSR and South Lemon drainage and culverts located below drainages L1 to L4 are at increased likelihood of being damaged and/or plugged and should be inspected annually and following significant freshet or summer rainstorm events. Other road segment infrastructure is also at risk (road systems in L1, L3, below T4, T5, T6, and T7, and in Upper Trozzo) and will require an increase in road inspection frequency and review of drainage infrastructure to determine if upgrading is required.

4. Water quality could be affected by modified run-off conditions including changes to turbidity, biological contamination, flows (quantity and timing), and metal concentrations. It is recommended that a suitable water quality testing program be established on Lemon Creek, Trozzo Creek, and Winlaw Creek to assess and evaluate water quality.

5. It is recommended that no salvage harvesting take place within the drainages where there is a Moderate or High likelihood of post wildfire landslide or flooding hazards without due consideration of the potential cumulative effects of hydrogeomorphic hazards within the watershed resulting from the wildfire, previous wildfires, previous harvesting, existing resource roads, and planned forest development. The potential impacts to high value downslope elements at risk should be evaluated as part of this assessment.

9. Closure – Report Use and Limitations

This report was prepared for the exclusive use of the MFLNRO. The material in it reflects SNT Geotechnical Ltd.'s and Sitkum Consulting Ltd.'s best judgment and professional opinion in light of the information available to it at the time of preparation. Any use which a third party makes of this report or any reliance on or decision to be made based on it are the responsibility of such third parties. SNT Geotechnical Ltd. and Sitkum Consulting Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decision made or action based, or lack thereof, on this report. No other warranty is made, either expressed or implied.

The report and assessment have been carried out in accordance with generally accepted professional practices in B.C. The discussion and recommendations presented are based on available information and limited field investigation and inferences from surficial features. No subsurface investigation was carried out as part of this assessment or development of conclusions or recommendations. Inherent variability in local precipitation, run-off conditions, soil and vegetation burn severity, surface and subsurface conditions may create unforeseen situations. Property boundaries (private, municipal, reserve, crown) referred to on maps and in the text were obtained via publicly available cadastral layers overlain onto orthoimagery and is approximate and may not be accurate for the purposes of locating risk mitigation strategies. Boundaries should be confirmed prior to design and implementation of risk mitigation strategies.

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2022-02-04

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Appendices

Appendix A Maps

Map 1 Trozzo Fire Burn Severity

Map 2 Lemon Creek Fan

Map 3 Trozzo Creek Fan

Map 4 Winlaw Creek Fan

Drainage Name	Total Drainage Area (ha)	Modified Vegetation Burn Severity			
		Area Unburned within drainage (%)	Area Low burn severity within drainage (%)	Area Moderate burn severity within drainage (%)	Area High burn severity within drainage (%)
Elliot–South Lemon Face	138	79	13	7	0
G1	413	71	4	24	1
L1	139	22	28	20	30
L2	90	31	12	21	37
L3	155	24	9	47	19
L4	616	35	18	40	7
L5	1812	82	5	10	2
Lemon Total	20023	89	3	6	2
South Lemon	1852	43	16	28	13
South Lemon 1	236	9	5	40	46
South Lemon Face	121	76	17	7	0
T1	154	62	14	21	3
T2	255	2	28	60	10
T3	313	37	8	42	13
T4	17	0	5	83	12
T5	46	0	8	64	28
T6	10	0	6	73	21
T7	24	13	17	58	12
Trozzo Mid	1590	27	14	47	12
Trozzo Total	2808	54	10	30	7
Trozzo Upper	493	35	4	46	15
W1	474	10	16	63	11
W2	353	54	17	28	1
Winlaw Mid	2544	73	6	18	3
Winlaw North	745	96	0	3	1
Winlaw Total	4009	82	4	12	2
Winlaw Upper	1106	40	14	40	6

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FORESTS, LANDS, NATURAL RESOURCES OPERATIONS;
BC WILDFIRE SERVICE

TROZZO CREEK FIRE #N51705
MAP 1: TROZZO FIRE ADJUSTED VEGETATION BURN SEVERITY

PREPARED BY:
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&
SITKUM CONSULTING LTD.

LOCATION: TROZZO CREEK
MAPSHEETS: 82G072/073/082/083
NAD 1983 BC ENVIRONMENT ALBERS
PROJECT: 21-1741A
DATE: JANUARY 10, 2022
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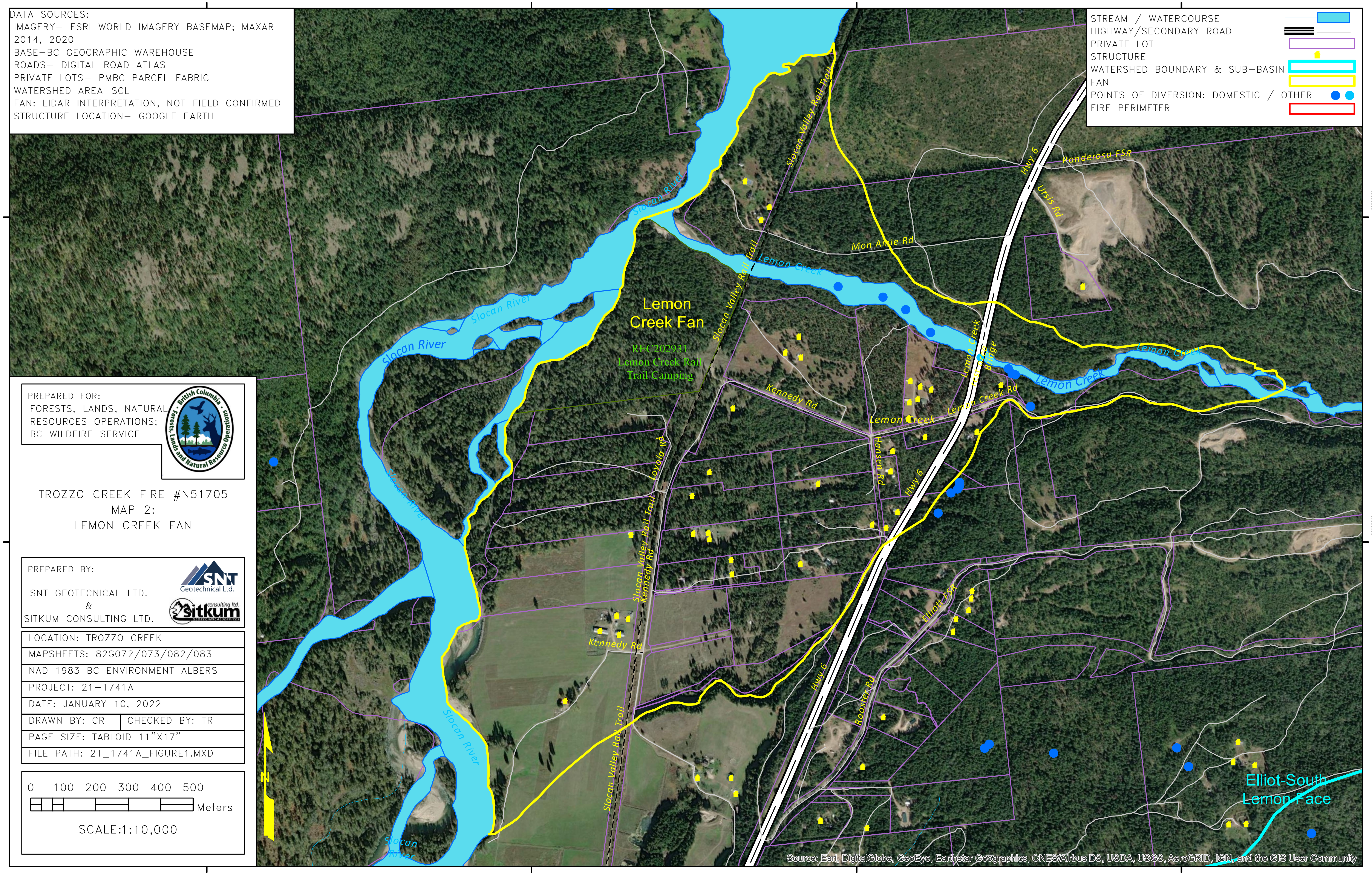
CONTOUR (LIDAR DERIVED): INDEX/INTERMEDIATE — 100m 20m
STREAM / WATERCOURSE
HIGHWAY/SECONDARY ROAD
PRIVATE LOT
WATERSHED BOUNDARY
WATERSHED SUB-BASIN BOUNDARY
POINTS OF DIVERSION: DOMESTIC / OTHER
STRUCTURES
FIRE PERIMETER
MODIFIED VEGETATION BURN SEVERITY RATING
HIGH
MODERATE
LOW
UNBURNED
FIELD OBSERVATION SITE
PROVINCIAL PARK / RECREATION SITE

FIELD ASSESSMENT COMPLETED ON OCTOBER 7 2021 BY DOUG NICOL, P.ENG. AND PETE WITTSTOCK P.ENG. OF SNTG, TEDD ROBERTSON, P.GEO. P.L.ENG. OF SCL, AND SARAH CROOKSHANKS, P.GEO. OF MFLNRORD

DATA SOURCES:
LIDAR– LIDAR BC PORTAL
BASE–BC GEOGRAPHIC WAREHOUSE
ROADS– DIGITAL ROAD ATLAS
PRIVATE LOTS– PMBC PARCEL FABRIC
WATERSHED AREA–SCL
STRUCTURE LOCATION– GOOGLE EARTH
BURN SEVERITY POLYGONS– BURN SEVERITY POLYGONS – MODIFIED FROM MOF BARC LAYERS BASED ON FIELD OBSERVATIONS; REFER TO REPORT FOR METHODS



DATA SOURCES:
IMAGERY- ESRI WORLD IMAGERY BASEMAP; MAXAR 2014, 2020
BASE-BC GEOGRAPHIC WAREHOUSE
ROADS- DIGITAL ROAD ATLAS
PRIVATE LOTS- PMBC PARCEL FABRIC
WATERSHED AREA-SCL
FAN: LIDAR INTERPRETATION, NOT FIELD CONFIRMED
STRUCTURE LOCATION- GOOGLE EARTH
STREAM / WATERCOURSE
HIGHWAY/SECONDARY ROAD
PRIVATE LOT
STRUCTURE
WATERSHED BOUNDARY & SUB-BASIN
FAN
POINTS OF DIVERSION: DOMESTIC / OTHER
FIRE PERIMETER
1611000
1612000
1613000
1614000
558000
557000
Slocan River
Lemon Creek
Lemon Creek Fan
REC202931
Lemon Creek Rail Trail Camping
Slocan Valley Rail Trail
Mon Amie Rd
Hwy 6
Ponderosa FSR
Ursis Rd
Kennedy Rd
Lemon Creek Rd
Lemon Creek Bridge
Hansen Rd
Loyola Rd
Elliott FSR
Rooster Rd
Elliot-South Lemon Face
PREPARED FOR:
FORESTS, LANDS, NATURAL RESOURCES OPERATIONS;
BC WILDFIRE SERVICE
British Columbia Forests, Lands and Natural Resource Operations
TROZZO CREEK FIRE #N51705
MAP 2:
LEMON CREEK FAN
PREPARED BY:
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&
SITKUM CONSULTING LTD.
SNT Geotechnical Ltd.
sitkum consulting ltd.
LOCATION: TROZZO CREEK
MAPSHEETS: 82G072/073/082/083
NAD 1983 BC ENVIRONMENT ALBERS
PROJECT: 21-1741A
DATE: JANUARY 10, 2022
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CHECKED BY: TR
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SCALE:1:10,000
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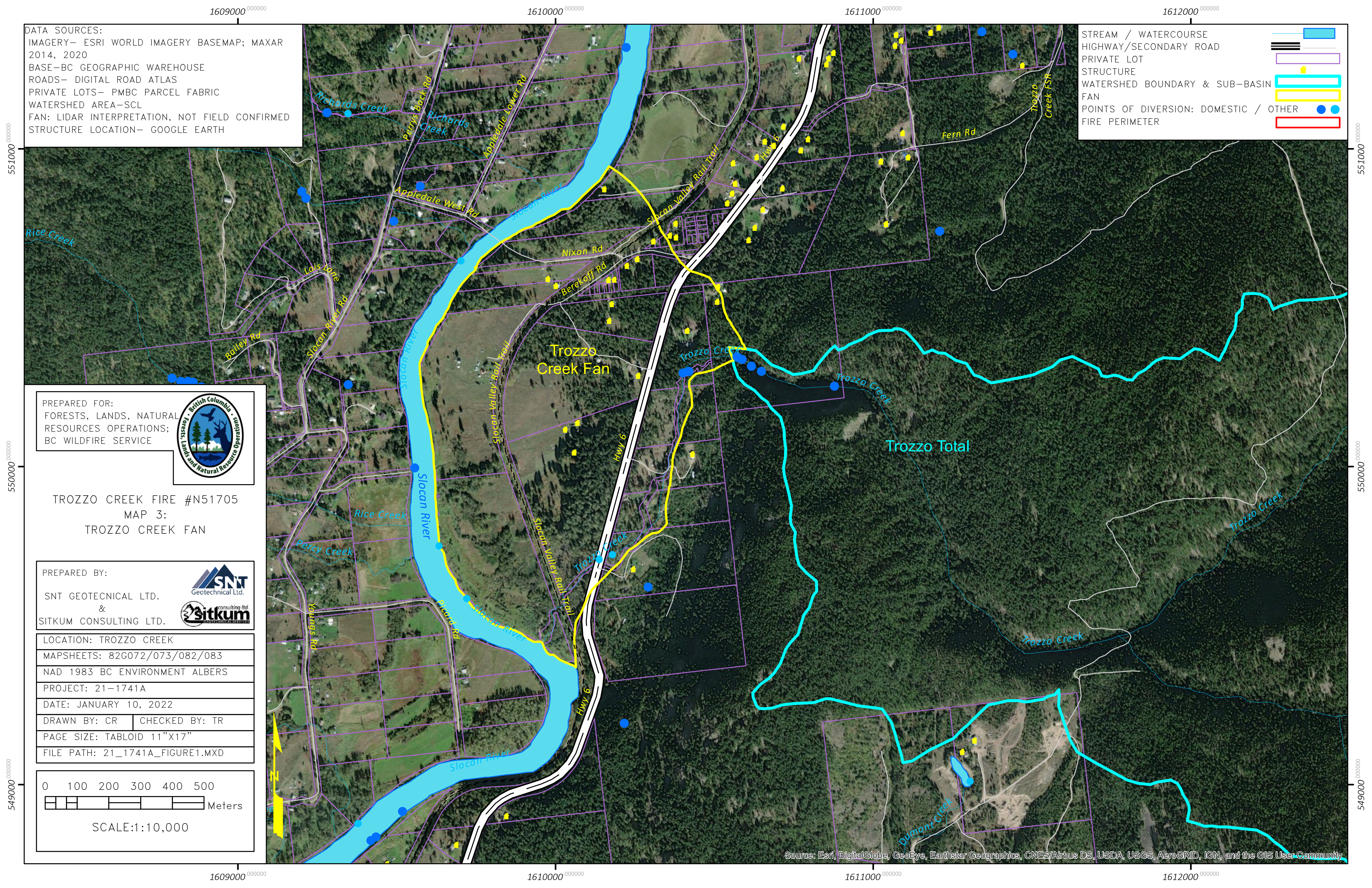
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community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BASE–BC GEOGRAPHIC WAREHOUSE
ROADS– DIGITAL ROAD ATLAS
PRIVATE LOTS– PMBC PARCEL FABRIC
WATERSHED AREA–SCL
FAN: LIDAR INTERPRETATION, NOT FIELD CONFIRMED
STRUCTURE LOCATION– GOOGLE EARTH
STREAM / WATERCOURSE
HIGHWAY/SECONDARY ROAD
PRIVATE LOT
STRUCTURE
WATERSHED BOUNDARY & SUB-BASIN
FAN
POINTS OF DIVERSION: DOMESTIC / OTHER
FIRE PERIMETER
PREPARED FOR:
FORESTS, LANDS, NATURAL RESOURCES OPERATIONS;
BC WILDFIRE SERVICE
British Columbia Forests, Lands and Natural Resource Operations
TROZZO CREEK FIRE #N51705
MAP 3:
TROZZO CREEK FAN
PREPARED BY:
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&
SITKUM CONSULTING LTD.
SNT Geotechnical Ltd.
sitkum consulting ltd.
LOCATION: TROZZO CREEK
MAPSHEETS: 82G072/073/082/083
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PROJECT: 21–1741A
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Trozzo Creek Fan
Trozzo Total
Slocan River
Trozzo Creek
Hwy 6
Slocan Valley Rail Trail
Rice Creek
Percy Creek
Richards Creek
Appledale West Rd
Appledale Lower Rd
Perrys Back Rd
Nixon Rd
Berekoff Rd
Lois Lane
Slocan River Rd
Bailey Rd
Youngs Rd
Picard Rd
Fern Rd
Trozzo Creek FSR
Dumont Creek
1609000
1610000
1611000
1612000
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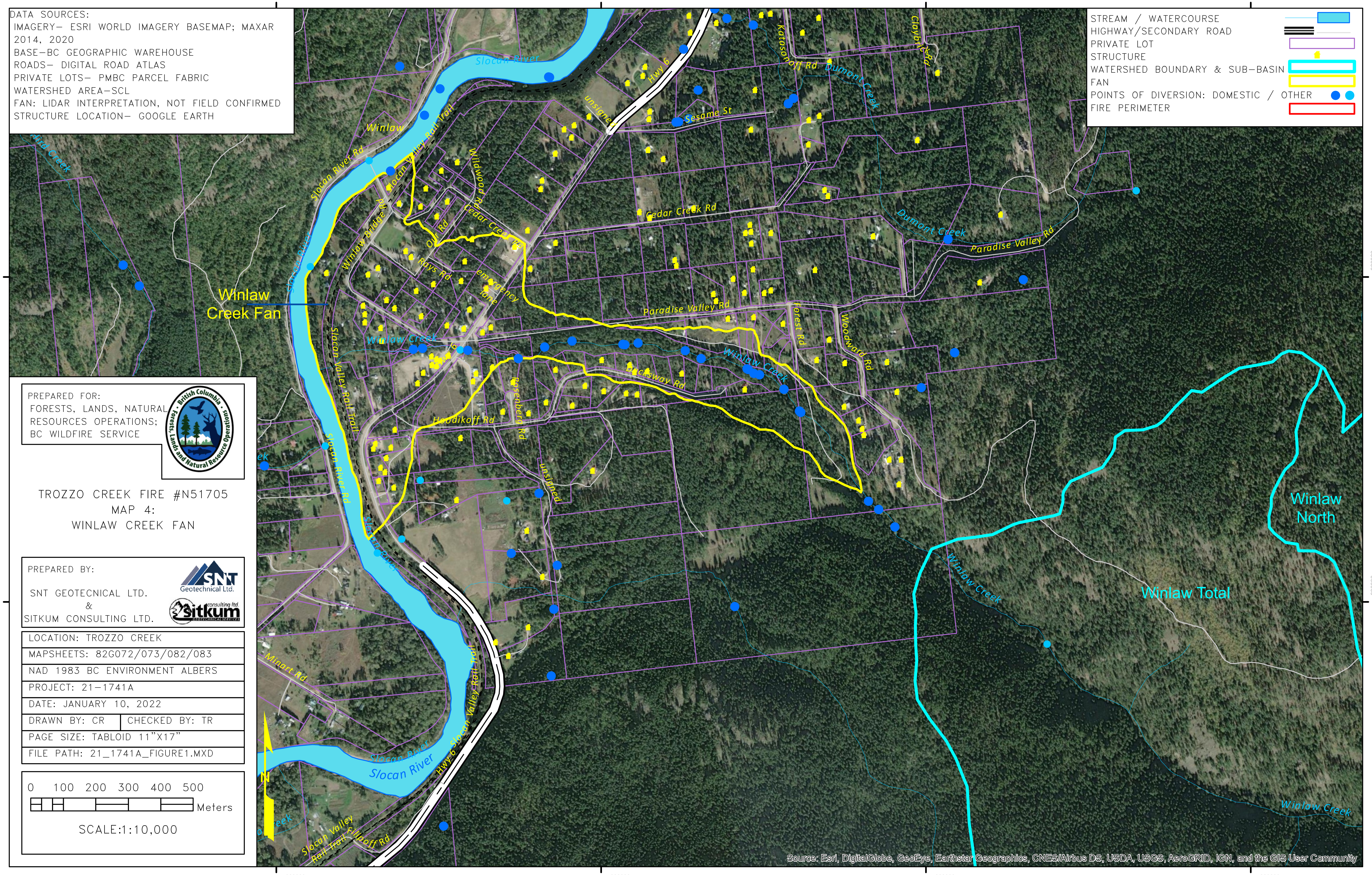
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community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BASE-BC GEOGRAPHIC WAREHOUSE
ROADS- DIGITAL ROAD ATLAS
PRIVATE LOTS- PMBC PARCEL FABRIC
WATERSHED AREA-SCL
FAN: LIDAR INTERPRETATION, NOT FIELD CONFIRMED
STRUCTURE LOCATION- GOOGLE EARTH
STREAM / WATERCOURSE
HIGHWAY/SECONDARY ROAD
PRIVATE LOT
STRUCTURE
WATERSHED BOUNDARY & SUB-BASIN
FAN
POINTS OF DIVERSION: DOMESTIC / OTHER
FIRE PERIMETER
PREPARED FOR:
FORESTS, LANDS, NATURAL RESOURCES OPERATIONS; BC WILDFIRE SERVICE
TROZZO CREEK FIRE #N51705
MAP 4:
WINLAW CREEK FAN
PREPARED BY:
SNT GEOTECNICAL LTD.
&
SITKUM CONSULTING LTD.
LOCATION: TROZZO CREEK
MAPSHEETS: 82G072/073/082/083
NAD 1983 BC ENVIRONMENT ALBERS
PROJECT: 21-1741A
DATE: JANUARY 10, 2022
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1608000
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1610000
1611000
547000
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Winlaw Creek Fan
Winlaw North
Winlaw Total
Slocan River
Winlaw Creek
Dumont Creek
Hwy 6
Sesame St
Cedar Creek Rd
Paradise Valley Rd
Slocan River Rd
Slocan Valley Rail Trail
Hoodikoff Rd
Rosenberg Rd
Woodward Rd
Forest Rd
Katasonoff Rd
Minart Rd
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Appendix B Water Licenses

Drainage	Source	PD number	License Number	Purpose	Latitude	Longitude
Lemon Creek	Lemon Creek	PD192939	500542	Misc. Industrial	49.698489	-117.46298
Lemon Creek	Lemon Creek	PD73858	C113211	Domestic	49.7011108	-117.478259
Lemon Creek	Lemon Creek	PD73857	C116662	Domestic	49.7011434	-117.478408
Lemon Creek	Lemon Creek	PD27775	C038261	Domestic	49.7012912	-117.47853
Lemon Creek	Lemon Creek	PD27775	C038261	Domestic	49.7012912	-117.47853
Lemon Creek	Lemon Creek	PD192929	500542	Misc. Industrial	49.701699	-117.479675
Lemon Creek	Lemon Creek	PD27774	C058151	Domestic	49.70255	-117.482
Lemon Creek	Lemon Creek	PD27774	C058151	Irrigation	49.70255	-117.482
Lemon Creek	Lemon Creek	PD27773	C060961	Domestic	49.703258	-117.48258
Lemon Creek	Lemon Creek	PD27773	C060961	Irrigation	49.703258	-117.48258
Lemon Creek	Lemon Creek	PD27772	C060961	Domestic	49.703679	-117.483481
Lemon Creek	Lemon Creek	PD27772	C060961	Irrigation	49.703679	-117.483481
Lemon Creek	Lemon Creek	PD27771	C043063	Domestic	49.70412	-117.485319
Lemon Creek	Lemon Creek	PD27771	C043063	Irrigation	49.70412	-117.485319
Trozzo Creek	Trozzo Creek	PD79118	C122782	Domestic	49.6390785	-117.526204
Trozzo Creek	Trozzo Creek	PD79118	C122782	Irrigation	49.6390785	-117.526204
Trozzo Creek	Trozzo Creek	PD79118	C120773	Domestic	49.6390785	-117.526204
Trozzo Creek	Trozzo Creek	PD79118	C120773	Irrigation	49.6390785	-117.526204
Trozzo Creek	Trozzo Creek	PD79118	C120769	Domestic	49.6390785	-117.526204
Trozzo Creek	Trozzo Creek	PD79118	C120769	Irrigation	49.6390785	-117.526204
Trozzo Creek	Trozzo Creek	PD26641	C038764	Domestic	49.6397344	-117.529278
Trozzo Creek	Trozzo Creek	PD26641	C038764	Irrigation	49.6397344	-117.529278
Trozzo Creek	Trozzo Creek	PD26640	C117344	Domestic	49.6399181	-117.529686
Trozzo Creek	Trozzo Creek	PD26640	C117344	Irrigation	49.6399181	-117.529686
Trozzo Creek	Trozzo Creek	PD26640	C112980	Domestic	49.6399181	-117.529686
Trozzo Creek	Trozzo Creek	PD26640	C112980	Irrigation	49.6399181	-117.529686
Trozzo Creek	Trozzo Creek	PD26640	C033971	Domestic	49.6399181	-117.529686

Drainage	Source	PD number	License Number	Purpose	Latitude	Longitude
Trozzo Creek	Trozzo Creek	PD26640	C033971	Irrigation	49.6399181	-117.529686
Trozzo Creek	Trozzo Creek	PD26640	C117345	Domestic	49.6399181	-117.529686
Trozzo Creek	Trozzo Creek	PD26640	C117345	Irrigation	49.6399181	-117.529686
Trozzo Creek	Trozzo Creek	PD26640	C100638	Domestic	49.6399181	-117.529686
Trozzo Creek	Trozzo Creek	PD26640	C100638	Irrigation	49.6399181	-117.529686
Trozzo Creek	Trozzo Creek	PD26639	C056512	Domestic	49.6401395	-117.530063
Trozzo Creek	Trozzo Creek	PD26639	C056187	Domestic	49.6401395	-117.530063
Trozzo Creek	Trozzo Creek	PD26639	C056187	Irrigation	49.6401395	-117.530063
Trozzo Creek	Trozzo Creek	PD26639	C125034	Irrigation	49.6401395	-117.530063
Trozzo Creek	Trozzo Creek	PD26639	C121242	Domestic	49.6401395	-117.530063
Trozzo Creek	Trozzo Creek	PD26639	C100637	Domestic	49.6401395	-117.530063
Trozzo Creek	Trozzo Creek	PD26639	C067509	Irrigation	49.6401395	-117.530063
Trozzo Creek	Trozzo Creek	PD26638	C034070	Domestic	49.6402075	-117.530223
Trozzo Creek	Trozzo Creek	PD26638	C034070	Irrigation	49.6402075	-117.530223
Trozzo Creek	Trozzo Creek	PD26638	C124696	Domestic	49.6402075	-117.530223
Trozzo Creek	Trozzo Creek	PD26638	C124697	Irrigation	49.6402075	-117.530223
Trozzo Creek	Trozzo Creek	PD26638	C033974	Domestic	49.6402075	-117.530223
Trozzo Creek	Trozzo Creek	PD26638	C033974	Irrigation	49.6402075	-117.530223
Trozzo Creek	Trozzo Creek	PD26638	C034072	Irrigation	49.6402075	-117.530223
Trozzo Creek	Trozzo Creek	PD26638	C124695	Domestic	49.6402075	-117.530223
Trozzo Creek	Trozzo Creek	PD26638	C124698	Domestic	49.6402075	-117.530223
Trozzo Creek	Trozzo Creek	PD26638	C124698	Irrigation	49.6402075	-117.530223
Trozzo Creek	Trozzo Creek	PD80697	C122787	Domestic	49.6402291	-117.530275
Trozzo Creek	Trozzo Creek	PD26636	C120849	Commercial Enterprise	49.6399821	-117.532418
Trozzo Creek	Trozzo Creek	PD26636	C025301	Domestic	49.6399821	-117.532418
Trozzo Creek	Trozzo Creek	PD26636	C120789	Domestic	49.6399821	-117.532418
Trozzo Creek	Trozzo Creek	PD26636	C120960	Domestic	49.6399821	-117.532418
Trozzo Creek	Trozzo Creek	PD26636	C100636	Domestic	49.6399821	-117.532418
Trozzo Creek	Trozzo Creek	PD26636	C120891	Domestic	49.6399821	-117.532418

Drainage	Source	PD number	License Number	Purpose	Latitude	Longitude
Trozzo Creek	Trozzo Creek	PD26636	C116675	Irrigation	49.6399821	-117.532418
Trozzo Creek	Trozzo Creek	PD26636	C056932	Domestic	49.6399821	-117.532418
Trozzo Creek	Trozzo Creek	PD26636	C056932	Irrigation	49.6399821	-117.532418
Trozzo Creek	Trozzo Creek	PD26636	C133704	Domestic	49.6399821	-117.532418
Trozzo Creek	Trozzo Creek	PD26634	F009631	Domestic	49.6399613	-117.532689
Trozzo Creek	Trozzo Creek	PD26634	F009631	Irrigation	49.6399613	-117.532689
Trozzo Creek	Trozzo Creek	PD183905	C127160	Irrigation	49.6350862	-117.536679
	Trozzo Creek	PD192938	500542	Misc. Industrial	49.634995	-117.537286
Winlaw Creek	Winlaw Creek	PD26763	F011274	Irrigation	49.6004701	-117.540376
Winlaw Creek	Winlaw Creek	PD26761	C050636	Irrigation	49.6042003	-117.546217
Winlaw Creek	Winlaw Creek	PD26761	C037812	Domestic	49.6042003	-117.546217
Winlaw Creek	Winlaw Creek	PD26761	C111624	Domestic	49.6042003	-117.546217
Winlaw Creek	Winlaw Creek	PD26761	C111624	Irrigation	49.6042003	-117.546217
Winlaw Creek	Winlaw Creek	PD26759	C121231	Domestic	49.6047351	-117.546808
Winlaw Creek	Winlaw Creek	PD26759	C121228	Domestic	49.6047351	-117.546808
Winlaw Creek	Winlaw Creek	PD26759	C121230	Domestic	49.6047351	-117.546808
Winlaw Creek	Winlaw Creek	PD26759	C116372	Domestic	49.6047351	-117.546808
Winlaw Creek	Winlaw Creek	PD26758	C118135	Domestic	49.6049956	-117.547201
Winlaw Creek	Winlaw Creek	PD26753	C059347	Domestic	49.6076584	-117.549607
Winlaw Creek	Winlaw Creek	PD26753	C059347	Irrigation	49.6076584	-117.549607
Winlaw Creek	Winlaw Creek	PD26753	C057329	Domestic	49.6076584	-117.549607
Winlaw Creek	Winlaw Creek	PD26753	C059348	Domestic	49.6076584	-117.549607
Winlaw Creek	Winlaw Creek	PD26753	C059348	Irrigation	49.6076584	-117.549607
Winlaw Creek	Winlaw Creek	PD26752	C116342	Domestic	49.6076955	-117.549661
Winlaw Creek	Winlaw Creek	PD26752	C116339	Domestic	49.6076955	-117.549661
Winlaw Creek	Winlaw Creek	PD26752	C116344	Domestic	49.6076955	-117.549661
Winlaw Creek	Winlaw Creek	PD26752	C116343	Domestic	49.6076955	-117.549661
Winlaw Creek	Winlaw Creek	PD26751	C070675	Domestic	49.6083438	-117.550204
Winlaw Creek	Winlaw Creek	PD26751	C071026	Domestic	49.6083438	-117.550204

Drainage	Source	PD number	License Number	Purpose	Latitude	Longitude
Winlaw Creek	Winlaw Creek	PD26751	C071025	Domestic	49.6083438	-117.550204
Winlaw Creek	Winlaw Creek	PD26751	C063746	Domestic	49.6083438	-117.550204
Winlaw Creek	Winlaw Creek	PD26751	C063747	Domestic	49.6083438	-117.550204
Winlaw Creek	Winlaw Creek	PD26751	C064772	Domestic	49.6083438	-117.550204
Winlaw Creek	Winlaw Creek	PD26751	C053398	Domestic	49.6083438	-117.550204
Winlaw Creek	Winlaw Creek	PD26751	C070676	Domestic	49.6083438	-117.550204
Winlaw Creek	Winlaw Creek	PD26751	C050637	Domestic	49.6083438	-117.550204
Winlaw Creek	Winlaw Creek	PD26751	C050637	Irrigation	49.6083438	-117.550204
Winlaw Creek	Winlaw Creek	PD26751	C104409	Irrigation	49.6083438	-117.550204
Winlaw Creek	Winlaw Creek	PD26751	C104409	Domestic	49.6083438	-117.550204
Winlaw Creek	Winlaw Creek	PD26547	C107946	Commercial Enterprise	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26547	C113426	Domestic	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26547	C113245	Domestic	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26547	C112943	Domestic	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26547	C118839	Domestic	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26547	C103067	Domestic	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26547	C103067	Irrigation	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26547	C113196	Domestic	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26547	C113196	Irrigation	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26547	C111459	Domestic	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26547	C113246	Domestic	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26547	C119003	Domestic	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26547	C119410	Irrigation	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26547	C111368	Domestic	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26547	C111368	Irrigation	49.6088242	-117.551166
Winlaw Creek	Winlaw Creek	PD26545	C114064	Commercial Enterprise	49.6088786	-117.551391
Winlaw Creek	Winlaw Creek	PD26545	C114069	Commercial Enterprise	49.6088786	-117.551391

Drainage	Source	PD number	License Number	Purpose	Latitude	Longitude
Winlaw Creek	Winlaw Creek	PD26545	C118211	Domestic	49.6088786	-117.551391
Winlaw Creek	Winlaw Creek	PD26545	C114065	Domestic	49.6088786	-117.551391
Winlaw Creek	Winlaw Creek	PD71595	C109940	Domestic	49.60901	-117.552
Winlaw Creek	Winlaw Creek	PD71595	C111258	Domestic	49.60901	-117.552
Winlaw Creek	Winlaw Creek	PD71595	C112800	Domestic	49.60901	-117.552
Winlaw Creek	Winlaw Creek	PD71595	C109932	Domestic	49.60901	-117.552
Winlaw Creek	Winlaw Creek	PD71595	C112801	Domestic	49.60901	-117.552
Winlaw Creek	Winlaw Creek	PD71595	C109939	Domestic	49.60901	-117.552
Winlaw Creek	Winlaw Creek	PD71595	C110314	Domestic	49.60901	-117.552
Winlaw Creek	Winlaw Creek	PD71595	C110472	Domestic	49.60901	-117.552
Winlaw Creek	Winlaw Creek	PD76051	C116269	Domestic	49.60903	-117.552
Winlaw Creek	Winlaw Creek	PD76051	C116270	Domestic	49.60903	-117.552
Winlaw Creek	Winlaw Creek	PD76044	C116267	Domestic	49.6094602	-117.553549
Winlaw Creek	Winlaw Creek	PD76044	C116268	Domestic	49.6094602	-117.553549
Winlaw Creek	Winlaw Creek	PD76044	C116265	Domestic	49.6094602	-117.553549
Winlaw Creek	Winlaw Creek	PD76044	C116266	Domestic	49.6094602	-117.553549
Winlaw Creek	Winlaw Creek	PD76044	C116271	Domestic	49.6094602	-117.553549
Winlaw Creek	Winlaw Creek	PD76044	C116264	Domestic	49.6094602	-117.553549
Winlaw Creek	Winlaw Creek	PD76043	C116272	Domestic	49.6097349	-117.554174
Winlaw Creek	Winlaw Creek	PD62666	C115659	Domestic	49.6100936	-117.556139
Winlaw Creek	Winlaw Creek	PD62666	C117129	Domestic	49.6100936	-117.556139
Winlaw Creek	Winlaw Creek	PD26540	C039308	Domestic	49.6100936	-117.556698
Winlaw Creek	Winlaw Creek	PD26540	C039308	Domestic	49.6100936	-117.556698
Winlaw Creek	Winlaw Creek	PD26540	C036704	Domestic	49.6100936	-117.556698
Winlaw Creek	Winlaw Creek	PD76042	C124847	Domestic	49.6101101	-117.556779
Winlaw Creek	Winlaw Creek	PD76042	C124848	Domestic	49.6101101	-117.556779
Winlaw Creek	Winlaw Creek	PD76042	C124801	Domestic	49.6101101	-117.556779
Winlaw Creek	Winlaw Creek	PD76042	C124802	Domestic	49.6101101	-117.556779
Winlaw Creek	Winlaw Creek	PD76042	C116263	Domestic	49.6101101	-117.556779
Winlaw Creek	Winlaw Creek	PD76042	C116259	Domestic	49.6101101	-117.556779

Drainage	Source	PD number	License Number	Purpose	Latitude	Longitude
Winlaw Creek	Winlaw Creek	PD76042	C116256	Domestic	49.6101101	-117.556779
Winlaw Creek	Winlaw Creek	PD76042	C116262	Domestic	49.6101101	-117.556779
Winlaw Creek	Winlaw Creek	PD71477	C110276	Domestic	49.6103731	-117.558919
Winlaw Creek	Winlaw Creek	PD71477	C111615	Domestic	49.6103731	-117.558919
Winlaw Creek	Winlaw Creek	PD76041	C116261	Domestic	49.6102967	-117.560103
Winlaw Creek	Winlaw Creek	PD76041	C116255	Domestic	49.6102967	-117.560103
Winlaw Creek	Winlaw Creek	PD76041	C116257	Domestic	49.6102967	-117.560103
Winlaw Creek	Winlaw Creek	PD76041	C116258	Domestic	49.6102967	-117.560103
Winlaw Creek	Winlaw Creek	PD76041	C111485	Domestic	49.6102967	-117.560103
Winlaw Creek	Winlaw Creek	PD26538	C106268	Irrigation	49.6100639	-117.561272
Winlaw Creek	Winlaw Creek	PD26538	C106268	Domestic	49.6100639	-117.561272
Winlaw Creek	Winlaw Creek	PD26538	C106265	Domestic	49.6100639	-117.561272
Winlaw Creek	Winlaw Creek	PD26538	C111425	Domestic	49.6100639	-117.561272
Winlaw Creek	Winlaw Creek	PD26538	C114105	Domestic	49.6100639	-117.561272
Winlaw Creek	Winlaw Creek	PD26538	C114104	Domestic	49.6100639	-117.561272
Winlaw Creek	Winlaw Creek	PD26535	C036704	Domestic	49.610461	-117.563372
Winlaw Creek	Winlaw Creek	PD192936	500542	Misc. Industrial	49.6105	-117.564
Winlaw Creek	Winlaw Creek	PD26534	C108820	Domestic	49.61066	-117.565
Winlaw Creek	Winlaw Creek	PD26534	C107015	Domestic	49.61066	-117.565
Winlaw Creek	Winlaw Creek	PD26534	C110538	Domestic	49.61066	-117.565
Winlaw Creek	Winlaw Creek	PD68144	C124223	Irrigation	49.61067	-117.566
Winlaw Creek	Winlaw Creek	PD68144	C124222	Domestic	49.61067	-117.566
Winlaw Creek	Winlaw Creek	PD68144	C124222	Irrigation	49.61067	-117.566
Winlaw Creek	Winlaw Creek	PD26758	C118135	Domestic	49.605	-117.547