

Twizel and Surrounds

Wildfire Risk Management Analysis

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1. Introduction

This wildfire risk analysis has been undertaken for Fire and Emergency New Zealand (FENZ) to better understand wildfire risk to life, property, and the environment in and near Twizel, and to determine appropriate wildfire risk reduction treatments. The area of interest includes the Twizel township rural urban interface (RUI), the rural-residential areas of Manuka Terrace, Pyramid Road and Hocken Lane described as rural intermix (RI) development, the Pukaki Airport, and the rural-residential RI between Lake Pukaki and the southern end of SH80 Mount Cook Road (refer Appendix 1). A wider scope area was applied to enable capture of ignition risk outside the area of interest where an ignition could result in wildfire spreading to the area of interest causing damage or injury.

There are a range of Mackenzie District Council (MDC) land zones within the area of interest, refer section 3 for definitions. Each MDC zone has a spatial extent and rules that determine what is permitted or not permitted (Mackenzie District Council District Plan, 2011). The zones include several residential zones, Manuka Terrace, Hocken Lane, and Pukaki Airport, as well as zones for industrial, visitor accommodation such as holiday parks, and recreation. Relevant to this analysis are details on zone location, property density, permitted activities, vegetation management and water supply, etc.

A community review exercise undertaken in 2022 identified a preferred growth option for Twizel (Mackenzie Spatial Plan, 2022). The preferred option included residential consolidation within the town, with large lot residential and low-density infill nearby. In time the current land zoning will be updated, but in the meantime this analysis will consider the current situation and the preferred option.

Twizel is a gateway to many outdoor pursuits and the area's population swells in the summer months, and during rowing regattas. The area of interest is bordered by Lakes Pukaki, Ruataniwha and Ohau, with the Southern Alps as a backdrop. There is a permanent population of approximately 1,600 projected to increase to 1,900 by 2025, with the addition of approximately 3,700 peak day visitors increasing to 7,500 by 2025 (Mackenzie District Growth Projections, 2020). The increased visitor numbers are fuelling growth mainly from increased tourism, lifestyle, and retirement.

2. Assumptions and Limitations

The Analysis is specific to the wildfire risks associated with the vegetation fire environment.

Wildfire ignitions occur from either natural causes such as lightning or are human caused through many activities and their associated heat sources. It is not possible to have control over naturally occurring ignitions or activities of those not directly related to the scope area, including deliberate ignitions with or without malicious intent.

There are numerous limitations and assumptions within the vegetation fire behaviour fuel models and systems. They are however based on sound science and constitute current best practice, and have been adjusted to represent the observed fuels within the area of interest.

Weather data from the Pukaki Aero RAWS long-term fire climate analysis may have some data errors that affect averages and data for specific hours on specific days. It may also not be fully representative of all locations and elevations within the scope area. Large terrain features such as

the surrounding lakes, the Ben Ohau Range and the valleys leading from the Southern Alps Main Divide will influence local weather, for example wind direction and speed, and rain shadows. For further detail refer to the *Twizel and Surrounds Prometheus Wildfire Risk Report Supplement*.

Fire behaviour modelling has been completed for 'likely' and 'worse' case (not the worst case) scenarios based on actual data from the long-term fire climate analysis, with findings detailed in the *Twizel and Surrounds Prometheus Wildfire Risk Report Supplement*. The scenarios are based on the High fire danger class for 'likely' case, and Extreme fire danger class for 'worse' case. Because the fire danger classes are High to Extreme it can be assumed that in the presence of continuous fuel a fire will spread (refer to New Zealand Fire Danger Class Criteria of Alexander, 2008). Additionally, these fire danger classes do not prevail at all times of year.

Damage potential is focussed on the direct impact from a wildfire on structures along the rural-urban interface (RUI), within the rural intermix areas (RI), on utility infrastructure, on environmental values including forest, and on recreation areas including holiday parks and their visitors.

Determination of firebreak widths or other vegetation modifications have been based on estimations of radiant heat levels and associated flame lengths derived from estimation of fireline intensities (kW/m).

Quantifying risk based on likelihood of ignition and spread uses fire return periods derived from a 10-year wildfire occurrence data set and assumes an ignition will spread. Estimation of the consequence component uses a range of descriptive terms that identify damage levels. A final risk level is determined by combining these likelihood and consequence estimates. The setting of the data ranges and descriptors is somewhat subjective, and can be adjusted for organisational risk tolerance if necessary.

3. Acronyms and definitions

Escape routes. Are routes that can be used to get to a safety zone if the primary route being used is cut off.

Entrapment. Are unexpected situations in which a wildfire poses an immediate threat to peoples' lives because the use of escape routes and safety zones are difficult or impossible. In such situations last resort sheltering may be required to increase survival probability.

Impact area. An area or location that has been risk assessed for possible damage potential from wildfire.

MDC land zones (current in September 2022, with proposed changes reported).

- 1) Residential 1 zone: Minimum front lots 400m², minimum rear lot 500m² (low density residential).
- 2) Residential 2 zone: Minimum lots 250m² (medium density residential).
- 3) Residential 3 zone: Minimum lots 2000m² (large lot residential).
- 4) Residential 4 zone: Minimum lots 4000m² (rural residential).

- 5) General industrial zone: primarily for industrial activities and other compatible activities, as well as activities that support the functioning of industrial areas.
- 6) Manuka Terrace rural-residential zone: lots between 2ha and 4ha.
- 7) Hocken Lane zone: is approximately 147 hectares, zoned rural-residential with a range of lot sizes.
- 8) Airport zone: provides for existing activities and some future airport development.
- 9) Recreation P (passive) zone: Provides for informal recreation such as walking, running, biking and playing, and maintains an open space or planted character.
- 10) Recreation A (Active) zone: Provides for active recreation and consists mainly of large recreation reserves used for active sports and organised games.
- 11) Ruataniwha Rowing zone: Provides for buildings and facilities to support the rowing venue for continued operation and public access.
- 12) Special Travellers Accommodation zone: provides for the operation of the holiday parks, and the addition of low-density tourist accommodation.

Risk ownership. A term used to define who owns a risk and how they own it.

Rural-urban interface (RUI). The area or zone where structures (houses) and other human development adjoin or overlap creating a line with flammable vegetation.

Rural Urban Intermix (RI). Is an area transitioning from a natural land use such as agriculture to a more urban land use.

Safety zone. Safety zones are places of refuge, where a person can be assured of their safety. Safety zone size is dictated by the fuel, terrain, weather conditions, and worst-case fire behaviour. Escape routes would lead to safety zones.

Wildfire. Unplanned vegetation fire. A generic term which includes grass fires, forest fires and scrub fires, both with and without a suppression objective (<https://knowledge.aidr.org.au/glossary/>).

Wildfire risk. The combination of the likelihood and consequence of a wildfire at a specific location under specified conditions.

Wildfire management. All those activities directed to prevention, detection, damage mitigation, and suppression of wildfires (<https://knowledge.aidr.org.au/glossary/>).

DOC Department of Conservation.

HFI Head fire intensity.

ROS Rate of spread.

HFROS Head fire rate of spread.

FDC Fire Danger Class.

- FENZ** Fire and Emergency New Zealand.
- FWI** Fire Weather Index.
- MDC** Mackenzie District Council.
- SH8** State Highway 8 (Tekapo Twizel Road).
- SH80** State Highway 80 (Mount Cook Road).

4. Stakeholders

Fire and Emergency New Zealand (FENZ).

Mackenzie District Council (MDC).

Department of Conservation (DOC).

Electricity infrastructure – Transpower, Alpine Energy, Meridian Energy Mountain Power.

Land management and subdivision contractors.

Communication supply service companies.

Commercial business operators (including farming, farm forestry and holiday parks).

Private property owners.

Community

5. Risk Context

The area of interest is spread across a large landscape and includes the township of Twizel and numerous larger property lot areas referred to in the analysis as rural intermix (RI). The level of risk varies across the landscape when considering the location of historic fire occurrences, the presence of ignition sources, values requiring protection such as life, structural assets and environmental (what is at risk), and the vegetation fire environment components of fuel, topography, and weather that determine fire danger and potential wildfire behaviour. For example, some locations have numerous ignition sources, while others have few.

Risk is dynamic in that certain combinations of the vegetation fire environment may lead to different levels of fire danger, or values requiring protection differ across locations. Examples are some locations that are more at risk from wildfire when wind is from the northerly quarter, while for others it is from the westerly quarter. The general vegetation cover is primarily a grass fuel type, but it is highly variable across the landscape, often due to a conifer component that has a range of age and density. There are also a few blocks of more mature conifer scattered around as well as scrub vegetation. The vegetation fuel loads are therefore extremely variable and for the purpose of analysis they have been categorised for each risk assessment zone (refer to the *Twizel and Surrounds Prometheus Wildfire Risk Report Supplement*). Topography also plays a part, especially slope steepness, smooth lake surfaces (stronger winds) and the general land shape that can direct wind.

To enable analysis of these differences, the area of interest has been divided into three risk areas which, in turn, have been sub-divided into eight zones (refer Appendix 2). This approach allows risk treatments to be targeted at specific locations. The analysis presents a range of risk treatment options aimed at reducing the likelihood or consequence from a wildfire. However, it is important to understand that modification of risk (controls and treatments) must consider the concept of residual risk, as it is not possible to reduce risk completely to zero.

Residential development is expanding on the southwest side of Twizel and to the northwest at Old Glen Lyon Road. Larger rural lot development is expanding in the areas of Manuka Terrace, Pyramid Road, and Hocken Lane, with even larger lots at the southwestern end of Lake Pukaki. The denser developed residential property lots are increasing the length of the rural urban interface (RUI), and at the same time increasing the number of residents (permanent or visitor) in the area. The larger lot properties tend to be bounded geographically and have been presented in the analysis as rural intermix areas (RI), including the Ruataniwha Holiday Park. As RI areas develop, their improved value increases and more people reside there.

The RUI comprises the boundary or overlap of residential and commercial structures that tend to form a line with flammable vegetation and where wildfire could have a direct impact. The RI comprises areas undergoing transition from other land uses such as agriculture to a more urbanised environment with structures more scattered.

The area of interest has approximately 26 kilometres of RUI including current developments. Wildfire impacting on specific parts of a RUI may also impact some of the wider built-up area through ember attack from either vegetation or structures burning upwind.

The RI is in 5 areas, with Manuka Terrace the largest by far. The overall area of the 5 RIs is approximately 1750 hectares with Manuka Terrace being 1049 of those hectares. Wildfire can spread relative easily across RI areas and spread embers within that area and further afield.

The main recreation areas are the two Twizel holiday parks, the Twizel Golf Course, the Twizel River, the northern shore of Lake Ruataniwha including the rowing area and adjacent recreation area, walking/biking trails on the northwest boundary of Twizel, and other locations.

Other values include the wider Twizel township, farm/station assets (including structures, machinery, stock, and crops), commercial forest and forest for shelter, power distribution assets, communication assets, environmental, historic, and cultural assets.

To mitigate the impact of wildfire on the RUI, RI, recreation areas and other assets, an understanding is required of how wildfire will behave and of the associated damage potential to values. To inform this understanding, likely and worse case fire behaviour has been modelled for a range of scenarios based on what is at risk. Specifically of interest is a wildfire's energy release in radiant heat, flame length, rate of spread (ROS), likely smoke plume direction and ember transfer.

The modelled fire behaviour informs decisions related to building survivability based on construction materials and vegetation setbacks. Other vegetation treatments including fuel reduction or fuel modification such as firebreaks, pruning and thinning or specific amenity plantings, and activity controls linked to risk levels, fire danger classes and fire season status.

The tools and techniques employed in these calculations are the New Zealand Fire Danger Rating System (Anderson, 2005; Alexander, 2008), NZ Fire Behaviour Toolkit (Scion, 2012) and Field Manual for Predicting Fire Behaviour in New Zealand Fuels (Pearce et al., 2012), representative remote automatic weather station data (<https://fireweather.niwa.co.nz/>), fuel flammability guidelines (e.g. Clifford et al., 2013; Scion, 2018; Wyse et al., 2016), and information on international fuel models relevant to wilding conifer stands from Canada (Forestry Canada Fire Danger Group, 1992).

6. Scope

6.1. In scope

A risk analysis report that assesses wildfire risk for the areas identified in the overall objective (section 7), along with a range of risk treatment objectives and recommended treatment actions.

6.2. Out of scope

Implementation of risk treatment recommendations, including compilation of management processes and procedures.

Review and update of any existing risk plans.

7. Risk Criteria

The risk assessment process and determination of risk treatments will consider risk Reduction, Readiness, and Response in the context of wildfire.

The criteria for determining risk levels and risk rating uses generic statements and is not directly aligned with FENZ organisational risk management due to multiple risk owners. It is acknowledged that other organisations have their own specific risk management approaches including tolerance for certain risks, and that stakeholder communication will be required to ensure a collective understanding of wildfire risk and ownership of its components.

7.1. Overall objective

To identify wildfire damage potential and available risk mitigations (treatments) for the rural-urban interface (RUI) of Twizel Township and the surrounding rural intermix (RI) areas of Manuka Terrace, Pyramid Road, Hocken Lane, Lake Pukaki and recreation areas including holiday parks.

7.2. Likelihood and consequence

The risk assessment process considers the vegetation fire environment and likely fire behaviour and damage potential. Ignition likelihood is based on the presence of ignition sources, fuel receptiveness, and history of fire occurrence.

7.2.1. Likelihood

Likelihood is concerned with whether a wildfire can ignite and spread within or adjacent to the areas stated in the overall objective. Ignitions that occur on land adjacent are only of interest if there is continuous vegetation that could spread fire to these areas.

To determine likelihood level, the return period of fire from annually to 10 years is considered along with ignition sources. The return period ranges are assigned a descriptor from Almost Certain to Rare.

It is a given that an ignited fire will spread due to the fire behaviour modelling using the High and Extreme fire danger classes (FDCs) for likely and worse case scenarios respectively (refer to assumptions in section 2).

7.2.2. Consequence

Consequence is concerned with the impact on values, including people. A wildfire's intensity or energy release determines damage potential which includes injury to people. Radiant and convective heat as well as smoke and ember hazards will impact values. The consequence assessment requires an understanding of how a fire will behave once ignited, followed by its potential impact.

To determine the consequence level, the most likely location of ignitions and subsequent fire spread have been identified, with fire behaviour modelled to determine the potential impact of each wildfire run on values for each area. Consequence levels range from insignificant to catastrophic, with each considering the effects to people, fixed assets, and the environment.

7.3. Approach to evaluating risk

7.3.1. Risk level

The likelihood and consequence levels are combined using the risk level matrix to determine a risk level. The risk levels have designators of Low to Very High with each having a range based on multiplying the likelihood and consequence level scores (refer Appendix 13).

The risk level outputs can be skewed if necessary to account for risk tolerance. Likelihood and consequence weightings could be adjusted or, rather than using a multiplier for risk levels, they could be assigned based on likelihood and consequence descriptors that in turn align with acceptable risk tolerance.

7.3.2. Risk tolerance and authority for continued tolerance of residual risk

For each risk level there would be an associated level of tolerance that informs risk treatment. Linked to risk treatments, a level of authority can decide to tolerate continued residual risk.

Because wildfire risk can have multiple risk owners, either for whole of risk or components of it, no risk tolerance and authority for accepting residual risk has been included. It would be up to the risk owners to determine their own position and collaborate with others to agree risk level and appropriate treatment options.

7.4. Risk treatment planning

7.4.1. Specific treatment objectives

Risk treatments can be considered under one or more specific objectives and where applicable assigned a function of reduction, readiness, and response. The combination of

treatments from across these objectives would aim to reduce risk to a tolerable level.

Options include:

- 1) To reduce the likelihood of ignitions.
- 2) To reduce the consequence on values.
- 3) To share the risk with other parties.
- 4) To transfer the risk to another party.
- 5) To retain or accept the risk.
- 6) To avoid the risk.

8. Risk identification

Wildfires are a threat in areas of vegetation and develop based on the environment in which they are burning. The vegetation fire environment consists of three components that interact to determine how a fire will behave. The three components are the fuel available to burn, the topography (terrain) the fire is burning in, and the prevailing weather with its cumulative effect on the underlying level of dryness that can lead to drought. The ability of a fire to ignite, develop, spread, and do damage is dependent on the environmental conditions at any one time and place. These conditions vary in time and space, with weather (air temperature, relative humidity, wind speed and direction, and rainfall) the most dynamic, and fuel condition (moisture content) close behind. Fuel is the one component that can be easily manipulated to reduce relative fire behaviour. Refer to Appendix 5 for vegetation classification for the risk assessed areas.

In terms of terrain, the area is generally flat to undulating with steep escarpments here and there, as well as some hillocks around Ben Ohau Station and the edge of Lake Pukaki. The southern slopes of the Ben Ohau Range are much steeper and can be greater than 40°.

A heat source of enough temperature is required before a wildfire can ignite and develop. Once again, the likelihood of ignition is dynamic in regards fuel condition and weather. To have a wildfire there must be a capable heat source, a receptive fuel bed, and a mechanism that brings these two things together.

In New Zealand, more than 98% of wildfires are caused by human activity, whether through careless use or poor maintenance of machinery or cooking equipment, discarding of lighted material, accidental circumstances, or malicious activities. Because of the human factor there is an excellent opportunity available to control activities that are sources of heat, sparks or flame that could cause a wildfire.

The area of interest has been divided into risk areas and subdivided into zones for application of fire behaviour prediction and risk reduction treatments. There is wide variation of fuels within the area of interest requiring the rural urban interface (RUI) and the rural intermix (RI) to be divided into sections or parts. Subsequent risk treatments can be identified for each to reduce the likelihood of ignitions and the damage and injury potential.

Fire behaviour outputs are calculated equilibrium head fire rate of spread (HFROS) and intensity (HFI) in a range of fuels at points where there is potential for damage and/or injury (refer Table 17). Scenarios are a likely case (High FDC) and a worse case (Extreme FDC) using Fire Weather Index parameters taken from the Pukaki Aero long-term fire climate analysis and modified for the Manuka Terrace area. Days from the long-term climate analysis, including those adjusted for Manuka Terrace, were identified to match a range of wind directions and to produce both High and Extreme FDCs. One day was selected for each of the High and Extreme FDCs where it was at a higher end.

8.1. Risk Area 1 – Twizel township and surrounds (RUI).

The area is approximately 4600 hectares, comprising the land from the northern shore of Lake Ruataniwha and east of the Lake Pukaki hydro canal to a line east of State Highway 8. It encompasses the wider Twizel area and includes the Pukaki Airport, Ruataniwha Holiday Park, Pyramid Road RI, and Hocken Lane RI. The area is subdivided into four zones: A, B, C and D (refer Appendix 2).

8.1.1. Zone A: Twizel township and surrounding built-up areas

The zone covers the Twizel township and other connected built-up areas along Glen Lyon and Old Glen Lyons roads, Boundary Terrace, Max Smith Drive and The Drive. The zone is predominantly built-up or under residential development, covering approximately 830 ha with a complex RUI.

Vegetation fuel

Vegetation is predominantly grass, but with varying fuel loads due to being natural or modified (mown or grazed) or with a tree component. There is conifer plantation fuel in compartments, pockets, rows or scattered that are of varying age and species. The larger properties at the RUI often have continuous vegetation to the next set of properties, and in some locations there are large areas of parkland or undeveloped land that fire could spread through. There are many undeveloped land parcels on the RUI that are vegetated. Refer to vegetation and RUI detail in Appendix 4 (RUI summary).

Topography

The land is relatively flat and undulating with an escarpment on the south side of The Drive and a constructed hill known as Man-made Hill. There are several roads surrounding Twizel that could act as barriers to fire spread, or at least prevent a fire from fully developing before impact on a RUI. Other RUI segments have no or ineffective barriers to fire spread, and are exposed to sufficient continuous vegetation that a developing fire could reach its maximum damage potential before impacting a RUI. Examples of this are the northwest side of North West Arch, both sides of The Drive and Woodley Avenue, etc.

People and pursuits

There is a current permanent population of approximately 1,600 that is projected to increase to 1,900 by 2025, with the addition of approximately 3,700 peak day visitors increasing to 7,500 by 2025 (Mackenzie District Growth Projections, 2020).

There are many people living along the RUI, and many more in the urbanised and industrial areas including at the Twizel Holiday Park between Glen Lyon Road and Mackenzie Drive. Subdivision construction continues to occur on the south side of Twizel and the Resource Recovery Centre is located on Hooker Crescent.

There is a golf course between Ohau Road and Mackenzie Drive and a pony club area near the corner of Glen Lyon Road and North West Arch. The Twizel Walkway follows the Twizel River and skirts the northwest side of Twizel.

Crop and livestock farming extends to the RUI boundaries northwest of Twizel and around the Glen Lyon Road/Old Glen Lyon Road and RUI-10 areas.

Access/egress

Several roads surround and intertwine through Twizel, with SH8 to the southeast. People should be able to move away from a threatening wildfire, but smoke exposure will impact on health.

The RUI areas off Old Glen Lyon Road, Mackenzie Way and Boundary Terrace, as well as the four properties associated with RUI-10, would use Glen Lyon Road in either direction.

Built environment and RUI

The zone contains all ~26 kilometres of RUI divided into 16 sections for ease of risk identification. Appendix 3 shows the locations of RUI segments, and Appendix 4 presents RUI specific information for each of the 16 segments including the number of structures at the RUI and the land area ranges for property parcels in a RUI segment. Approximate total number of dwellings on the RUI is 238, with 103 other structures such as garages, and 83 unimproved sections.

Often the RUI land parcels are relatively large (>0.5ha) and vegetated, where under certain conditions wildfire could spread unimpeded to properties further in from the RUI. Additionally, ember transport (or attack) could ignite fires some distance downwind (medium range 200 – 500m) from a RUI depending on fuel, fire intensity, wind, and convection. Depending on an ignition location, fuel condition and wind direction, embers as well as smoke could impact on the higher density property areas of the Twizel township.

Of the six Prometheus fire growth simulations undertaken for this analysis, four would threaten this zone if they burnt under fire danger levels of high or greater. For simulation details refer *Twizel and Surrounds Prometheus Wildfire Risk Report Supplement*.

Infrastructure

The Twizel water treatment facility is located on Glen Lyon Road with the water reservoir covered with a HDPE plastic liner.

Overhead powerlines are in several places and are of interest from both an ignition point of view and an asset that may be damaged by wildfire. Apart from powerlines within the older part of Twizel township there are approximately 6 km of overhead line and 110 poles.

Powerlines run in the following locations:

- 1) On the northwest side of SH8 south of Ostler Road and along Ostler Road to number 30.
- 2) Associated with point 1 above is a substation on Benmore Place.
- 3) Lines cross SH8 into the zone on the northeast side of the Glen Lyon Road/SH8 junction.
- 4) On the northeastern side of Glen Lyon Road from near Nuns Veil Road more or less along RUI-12 crossing to the southwest side and running up to North West Arch. The line divides at 207 Glen Lyon Road and crosses to the northeastern side and on into the Hocken Lane RI.
- 5) On the southeastern side of Old Glen Lyon Road.
- 6) A short section of line across Glen Lyon Road to RUI-10 (the remainder of this line is in zones B and D).

Other values

Amenity trees, fencing and recreation opportunity.

8.1.2. Zone B: Pyramid Road RI, Ben Ohau Station

Includes the Pyramid Road RI, Ben Ohau Station, and surrounding farmland to the Twizel RUI boundaries covering approximately 1300 ha.

Vegetation fuel

Vegetation is predominantly grassland associated with farming, but with varying fuel loads depending on time of year and farming operations. There is conifer plantation fuel in compartments, pockets and rows of varying age and species, with an area of mixed scrub and plantation fuels on the western side of Ben Ohau Station. There are deciduous treelines and scattered trees along waterways. Some properties along Old Glen Lyon Road have planted *Macrocarpa* on road frontage boundaries and this conifer is known for its flammability and production of airborne embers.

Topography

The land is relatively flat and undulating with a raised terrace and hillock area between Glen Lyon Road, Old Glen Lyon Road, and the Canal Road. The zone is bounded to the northwest by the Canal Road and canal, to the northeast by Glen Lyon Road and is dissected by Old Glen Lyon Road, Pyramid Road and many farm access and service roads and tracks.

People and pursuits

The zone is private land with people associated with farming operations and the smaller rural intermix properties within the Pyramid Road RI.

Access/egress

Old Glen Lyon Road and Pyramid Roads are dead ends. The way out from these is via Old Glen Lyon Road to Glen Lyon Road and then either direction.

Built environment

Structures associated with the large lot properties within the Pyramid Road RI being ~12 dwellings, ~7 other buildings and 3 unimproved sections. The land parcels range from ~2.4 – 30 ha.

There are 2 dwellings and several other buildings on Ben Ohau Station.

Infrastructure

Overhead powerlines are in several places and are of interest from both an ignition point of view and an asset that may be damaged because of wildfire. There are approximately 6.3 km of overhead line and 97 poles.

Powerlines run in the following locations:

- 1) Lines service Ben Ohau Station facilities from two points on Glen Lyon Road.
- 2) Along the remaining Old Glen Lyon Road from RUI-9 to the end at the canal road where it crosses the canal.
- 3) Off Old Glen Lyon Road along the Pyramid Road RUI boundary to near The Drive.
- 4) Junction off the line in point 3 above parallel with The Drive to near Woodley Avenue.

Other values

Farm crops, farm feed stocks, plantation trees, fencing and stockyards, and water reticulation and irrigation equipment.

8.1.3. Zone C: Ruataniwha Hoilday Park RI and surrounds

Includes the holiday park, rowing area and recreation area surrounding the holiday park and southwest of Max Smith Drive to SH8, and farmland, covering approximately 255 ha.

Vegetation fuel

Vegetation is a mix of grass and plantation of varying density, height and pruning. The plantation on the escarpment below The Drive and the tongue leading out to Max Smith Drive is tightly-spaced and unpruned with branches to the ground, whereas in the holiday park trees are in scattered small pockets and pruned. Trees in the recreation and rowing area are in larger pockets with not all trees pruned.

The escarpment between the lake and Max Smith Drive is a mix of grass and scrub.

Topography

The land is generally flat with terrace faces from the lake to The Drive. Lake Ruataniwha forms a barrier to fire spread as do the numerous roads and tracks within the holiday park, rowing area, recreation area and Max Smith Drive. There is a cleared track below Max Smith Drive at the base of the escarpment leading from the holiday park.

People and pursuits

People living along the RUI on The Drive and Max Smith Drive. The holiday park has many visitors with the rowing and recreation areas having daily visitor numbers in the thousands during summer.

Access/egress

Roads and tracks that exit to Max Smith Drive with travel in both directions and along Ostler Road.

Built environment and RUI

Refer to zone A for built assets on The Drive and along Max Smith Drive. Ruataniwha Holiday Park is considered a RI due to the scattered nature of the built assets and the varying number of mobile property assets such as caravans and mobile homes. The Holiday Park has many structures ranging from motels and lodges to small cabins that are spread over approximately 20 ha.

There are 13 buildings associated with the Meridian Rowing Complex on the shore of Lake Ruataniwha, and a dwelling and an associated building off the end of The Drive.

Infrastructure

Recreation assets such as playground and picnic equipment, rowing boat racks and boats at certain times.

Ecological

Lake margins of Lake Ruataniwha and recreation opportunity within the Ruataniwha Recreation Reserve.

Other values

Farm crops, plantation and amenity trees, fencing, and water reticulation and irrigation equipment.

8.1.4. Zone D: Hocken Lane RI, Pukaki Airport, and surrounds

The zone covers the area northeast of Glen Lyon Road to the canal, and is bounded to the east by Pukaki Airport and a line east of the Meridian Energy Twizel office and substation. It includes the Hocken Lane RI made up of a mix of lifestyle and smaller farming blocks ranging in size from 2 – 19 ha. The zone covers approximately 2300 ha.

Vegetation fuel

Vegetation is predominantly grass with varying fuel loads as well as cropping in some parts. There is deciduous vegetation with mixed conifers along the waterways of the Twizel River, Fraser and Dry Streams. The Hocken Lane RI has a highly variable vegetation mix of mature deciduous and conifer trees and grass understory, with grass as the primary fuel for fire spread.

Topography

The land is relatively flat and undulating. Glen Lyon Road, Canal Road and SH8 are barriers to fire spread. Additionally, the road servicing Hocken Lane, farm roads and tracks, and the

Pukaki Airport runway, taxiways, and service roads and Harry Wigley Drive could act as barriers to fire spread.

People and pursuits

There are several private residences within the Hocken RI, the farm operations at Omahau Downs and Bendrose Stations, many people utilizing the Pukaki Airport, three scattered rural properties along SH 8 near the Twizel River, and recreation pursuits along the Twizel River and Fraser Stream.

There are people associated with the Meridian electricity operation on the eastern side of SH8 at the southern end of Twizel.

Access/egress

The zone is almost surrounded by a road network. However, Hocken Lane off Glen Lyon Road has a relatively narrow roadway, and a number of dead-ends with some long driveways. Other properties including the Pukaki Airport are accessed off SH8.

Built environment

Hocken Lane contains one industrial site, ~14 dwellings, ~8 other structures and four unimproved land parcels. Land parcel sizes range from 2 – 19 ha.

There is a cluster of farm buildings between Fraser and Dry Streams northwest of Hocken Lane.

Off SH8 are structures related to Omahau Downs and Bendrose Stations and scattered residential buildings. There are ~9 dwellings with ~22 other buildings.

Off SH8 there are 8 buildings associated with the Meridian Energy facility.

There are several businesses based at the Pukaki airport, located on the subdivision roads running alongside the runway with 12 structures. These include commercial aviation operations, vehicle rental, and accommodation providers.

Infrastructure

The Pukaki Airport has all services and facilities required by both commercial and private pilots for refuelling. A BP refuelling system is located at the northern end of the airfield adjacent to the taxiway turnaround. The aboveground tank comprises 20,000 litres of Jet A-1 and 15,000 litres of Avgas. Remote fuel dispensers are located on a concrete pad, with sealed approach and departure taxiways. The concrete pad contains spillage interceptors. Refilling of the bulk tank is carried out from a concrete pad to the side of Harry Wigley Drive clear of the Airport Operational Area.

There are overhead transmission lines, powerlines, and a substation within the zone. Three transmission lines enter the zone from the south and terminate at the substation where two transmission lines leave the substation to the north, changing direction to the northeast before they leave the zone.

There are powerlines to the south and west of the Meridian Energy facility and to the east of SH8 between Glen Lyon Road and just south of Ostler Road. At Glen Lyon Road the line

crosses SH8 and heads generally north to the canal. It has side lines to Omahau Downs and Bendrose Stations, and Pukaki Airport.

Other lines include off Glen Lyon Road along Hocken Lane, from the southeast back into Bendrose Station and across the northern end of the zone from the canal to SH8.

There are approximately 2 km of transmission lines with 10 towers, and 13 km of overhead powerlines with 144 poles.

Ecological

Riparian margins of the Twizel River, Fraser and Dry Streams as well as the Omahau Downs Conservation Area in the Twizel River, and the access section to the Ben Ohau Conservation Area off SH8.

Other values

Farm crops, farm feed stocks, plantation trees, fencing, and water reticulation and irrigation equipment.

8.2. Risk Area 2 – Manuka Terrace (RI)

This risk area is approximately 4500 ha in size and is divided into 3 zones E, F and G covering the Manuka Terrace large lot development, the surrounding faces of the Ben Ohau Range, and the undeveloped land zoned rural residential between the hydro canal and the Ohau River.

8.2.1. Zone E:

This is the rural residential area known as Manuka Terrace located between the base of the Ben Ohau Range and the Ohau and Pukaki hydro canals. The zone covers approximately 1100 ha with property parcels ranging in size from 1.8 – 57 ha.

Vegetation fuel

Vegetation is predominantly grass with a wide variety of fuel loads depending on grass height and the component of wilding pine. Wilding pine is especially evident from the top of the upper terrace escarpment to Lake Ohau.

There are also plantation compartments of Douglas Fir in two areas off Ben Ohau Road and another along the escarpment between the two main terraces in the zone (halfway along Manuka Terrace). There are also several conifer shelterbelt rows.

The vegetation from the lower terrace near Flanagans Lane up the escarpment and on to the upper terrace is highly variable. An area of dense cover Manuka spreads off the base of the Ben Ohau Range and becomes a grass/Manuka/conifer mix within the large lot properties out to Manuka Terrace roadway. It then continues over Manuka Terrace but quickly gives way to a Manuka/Conifer mix and then to just wilding conifers and the Douglas Fir plantation compartment on the escarpment. There are a couple of areas of grass and mixed scrub along the canal road at the escarpment end and along the base of the Ben Ohau Range.

Topography

The zone is mainly gently sloping and can be generally divided into two main terraces and a third smaller terrace section near Ben Ohau Road. The two main terraces are separated by an escarpment facing west through south and is more rolling near the base of the Ben Ohau Range, steepening from Manuka Terrace to the canal road, and steepening again beside the roadway. The escarpment slope angle ranges from 10° to around 40° with the lower terrace at an elevation of ~512 m and the upper terrace ~560 m, with the high point 595 m.

To the southeast, the zone has a barrier to fire spread consisting of the canal road, the Ohau canal and the road on the opposite side. To the northeast, the Ben Ohau Road and farm track to Omahau Hills Station create a barrier, with Manuka Terrace running almost the full length of the zone from the canal road to near Lake Ohau effectively dividing the zone in two. Flanagans Lane runs between Manuka Terrace and the canal road at the base of the escarpment between the two main terraces.

There are many long, shared driveways of varying width, as well as farm tracks at the base of the Ben Ohau Range.

People and pursuits

Residents associated with the large lot properties and the management activities on these properties. This would include forestry activities and wilding pine control, as well as lifestyle farming practices.

Access/egress

Access to some properties is along dead-end accessways that can be up to 1 km long off Manuka Terrace and Ben Ohau Road, and 500 m long off Flanagans Lane. Both ends of Manuka Terrace connect to the canal road and could be used in either direction. The Lake Ohau end of Manuka Terrace has a 1.5 km dead-end accessway to several properties.

Flanagans Lane connects to both Manuka Terrace and the canal road (note there is a gateway at the canal road end).

Ben Ohau Road comes off the canal road and eventually becomes the farm access road to Omahau Hills Station and is essentially dead-end.

Built environment

On the upper terrace there are ~64 dwellings with ~26 other buildings. The lower terrace and escarpment has ~16 dwellings and 8 other buildings. Across the zone there are numerous storage units such as containers and 132 unimproved land parcels.

There are two buildings associated with the industrial salmon farm on the northwest corner of the Ohau and Pukaki canals.

Infrastructure

There is industrial equipment at the salmon farm site.

There are three main overhead powerlines running through the zone from the Ben Ohau Road end to Lake Ohau with several other side lines. The lines are of interest from both an

ignition point of view and an asset that may be damaged because of wildfire. There is approximately 21.4 km of overhead line and 288 poles.

Lines run in the following locations:

- 1) There is a 9.2 km line with 134 poles along Manuka Terrace from where it crosses the canal from Old Glen Lyon Road to where it kinks off to the canal road near Lake Ohau. From this point it follows a property accessway in a dog-leg to the last property before the lake.

There are several side lines off this main line as follows:

- a. A 200 m line runs northeast through 42 Manuka Terrace with three poles.
 - b. A 700 m long line runs north along the plantation edge opposite 105 Manuka Terrace with ~12 poles.
 - c. A 550 m line runs northwest along the accessway beside 320 Manuka Terrace with 7 poles.
 - d. A 1 km long line runs beside Flanagans Lane and switches back to the southwest along the boundary of 64 Flanagans Lane with 18 poles.
- 2) There is a 1.3 km long line with 13 poles running from Ben Ohau Road beside the Pukaki canal, across Manuka Terrace to cross the Ohau canal into zone G.
 - 3) There is an 8.2 km long line with 101 poles running from the salmon farm industrial site along the terraces on the northwest side of the Ohau canal. The line runs to near one of the last properties just before Lake Ohau and turns southeast to cross the Ohau canal into zone G.

Other values

Farm crops, farm feed stocks, plantation trees including shelter trees, amenity trees, fencing, and water reticulation and irrigation equipment.

8.2.2. Zone F:

The zone covers the southeast slopes of the Ben Ohau Range, Omahau Hills Station, and the large forestry block to the northeast. The northwest boundary is the ridgeline from The Pyramid to Greta Track just below the Ben Ohau peak. The southwest boundary is with zone E, and the northeast is the large forest area and developed farmland southwest of Fraser Stream to the canal.

Vegetation fuel

The vegetation is highly variable with forest, grass, and scrub present. The foothill slopes leading to the steep faces are exotic grasses of varying fuel load, or a mix of exotic grass, Manuka and grey scrub or full cover Manuka. In the northeast is a large Douglas Fir plantation, and developed farmland to the canal. On the steeper slopes lower down are grey scrub and tall tussock giving way to shorter tussock higher up.

Topography

The slopes vary from undulating to very steep between 5° and >50°, with an elevation range between 530 m to 1200 m. The land faces predominantly south through northeast. In the northeast section there is a farm track running along the base of the steep faces with another along the ridgeline above the faces. There is the Ben Ohau Road and farm tracks off its end through Omahau Hills Station to the SkyScape structures and on to the Douglas Fir plantation and back out to the canal road opposite Ben Ohau Station.

People and pursuits

Mainly farming and the SkyScape tourist operation. Recreation in the Ben Ohau Range in the Ruataniwha Conservation Area.

Access/egress

Access is off the Ben Ohau Road or farm tracks off Manuka Terrace and the canal road.

Built environment

The 3 Omahau Hills Station structures and the 3 accommodation structures associated with SkyScape.

Infrastructure

An overhead powerline runs within the zone parallel to the Pukaki canal road from Ben Ohau Road to the farm track south of Fraser Stream, and then continues northwest. The line is ~2 km long with 25 poles.

Ecological

The Ruataniwha Conservation Area below Ben Ohau peak.

Other values

Farm crops and grazing, farm feed stocks, the large Douglas Fir plantation block, fencing, and water reticulation and irrigation equipment.

8.2.3. Zone G:

The zone covers the area bounded between the Ohau canal and the Ohau River and zoned rural residential but with no development undertaken. The zone is more a place holder for the analysis, but there is current risk, and future risk if any development were to take place, due to the presence of vegetation and possible ignitions related to powerlines as well as road access. A fire spreading from the southwest through west could start spot fires over the canal in the Pyramid Road RI and spread on to the Twizel RUI.

Vegetation fuel

There are large areas of predominantly grass, but with varying fuel loads from depleted to a high fuel load due to a tree component. There are wilding pine compartments, as well as clusters and scattered trees that are of varying age density and height. Most of this fuel is in the northeast section of the zone closer to the canal section separating it from the Pyramid Road RI in zone B.

Topography

The land is relatively flat and undulating with escarpments in the northeast section, the Lake Ohau end, and beside the Ohau River. The zone is bounded by the hydro canals, the Ohau River and Lake Ohau. There is the canal road and a metal road beside Lake Ohau that then follows the Ohau River for a distance to join back with the canal road.

People and pursuits

People use the canal roads for access to fishing, sightseeing and biking.

Access/egress

Roads both sides of the canals and along the lake front to the Ohau River Weir, crossing to the south side if it is not closed due to water levels.

Built environment

One structure on the shore of Lake Ohau, by the launching area.

Infrastructure

There is a quarry below Ohau A power station near the Ohau River.

There is an electrical substation below Ohau A power station with a powerline running from it across the zone to the Ohau canal near the salmon farm. A second line joins this from the power station. The total length is 2.9 km of line with 33 poles.

There is another line in the southwest of the zone near Lake Ohau with 1.3 km of line and 16 poles.

Ecological

Riparian margins of the Ohau River and canals, as well as the Ohau Terminal Moraine Scenic Reserve.

8.3.Risk Area 3 – Lake Pukaki

This risk area is approximately 478 ha in area, with a single zone H. It encompasses the land east of SH80 (Mt Cook Road) from the SH80/SH8 junction to just north of Pukaki Downs Station. It also includes the teardrop of land between the Pukaki canal and SH8 near the Lake Wardell campsite.

8.3.1. Zone H:

Vegetation fuel

The land east of SH80 was burnt in a wildfire in late August 2020. Vegetation cover has been changing as burnt and unburnt wilding pine is removed. Remaining wilding pine is of mixed structure and current fire behaviour models are only loosely associated with this vegetation. In the areas of tree removal, grass is the predominant cover interspersed with forest slash windrows. There are also areas of mixed grass and scrub.

The Lake Wardell land section has all but been cleared of wilding pine leaving forest slash windrows. The only part not cleared is the area around the Lake Wardell campsite.

Topography

From Lake Pukaki, the land rises quickly to a series of high points along the 4.5 km length Mt Cook highway section, dropping with lower angles to SH8 at the southern end. The width is approximately 1.5 km at the south end and 600 m at the north end. The highest point is 632 m, being 108 m above the lake. This section is bounded to the south and west by SH8 and SH80, to the east by Lake Pukaki, with no barrier to fire spread at the north end. There are accessways that run generally west to east on land parcels with dwellings and other buildings.

The Lake Wardell section is a teardrop shape of relatively undulating land that is approximately 700 m at its widest. It is fully surrounded by roads and tracks with the Pukaki canal on the southeast side.

People and pursuits

Residential, tourist operations and farming are located on the SH80 section, with recreation on the Lake Wardell section including the campsite frequented by motorhomes.

Access/egress

The SH80 section is property accessways to SH80 then in either direction. Lake Wardell is to SH8 or the canal road.

Built environment and RUI

The SH80 properties have ~6 dwellings, and ~16 other buildings plus service and storage type structures. There are no structures at the Lake Wardell section.

Infrastructure

Overhead powerlines intersect with SH80 near 86 Mount Cook Road, crossing it to the eastern side. From here the line runs northwest beside the road before moving slightly east where there is a junction and short line to the southeast. The line continues north crossing the accessway to 398 Mount Cook Road with a second junction and line running back across SH80 to the farm buildings on the west side of the highway. There is a third junction a little further on that runs east to eventually follow the accessway towards structures. The main line then terminates a little further north. The powerlines are of interest from both an ignition point of view and an asset that may be damaged by wildfire. The powerline length including the three junctions is ~3.6 km with ~38 poles.

Other values

Grazing, amenity trees including shelter trees, fencing, and water reticulation and irrigation equipment.

8.4.Weather

8.4.1. Weather

The Met Service climate zone (NZMS 1983) for the area of interest is F2 but the area of interest is on the boundary for F3. Climate Zone F2 is characterised by cooler and wetter climate than F1, with rainfall in the range of 800 to 1,500 mm. Northwesterlies predominate

with occasional very strong gales, especially along river valleys. Snow may lie for weeks in winter. Climate Zone F3 is characterised by semi-arid areas with annual rainfall 300 to 500 mm, and very hot summers and cold winters.

The Twizel area is also affected by two wind patterns. The first is the hot and dry Fohn wind coming from the west to northwest over the Main Divide. This is created by the orographic effect as air is lifted over the mountains. The second is the Canterbury Wind, which is a thermally driven condition causing easterly winds to increase on hot afternoons as cooler coastal air comes in to replace the rising warmer air. This is why the Mackenzie Basin is renowned for gliding.

The FENZ Pukaki Aero remote automatic weather station (RAWS) located near the Pukaki Airport and the MetService Pukaki Aerodrome automatic weather station (AWS) located at the Pukaki Airport were both used to produce the long-term fire climate data for this report and the *Twizel and Surrounds Prometheus Wildfire Risk Report Supplement*.

The long-term fire climate record (from 2000) comprises data mainly the FENZ RAWS, noting the MetService AWS was only operating later 2008. Daily climate data recordings have been used for the fire behaviour analysis in this report.

The weather stations are considered representative for the area of interest except Risk Area 2 (includes Manuka Terrace). For Risk Area 2 the wind speed and rainfall data were adjusted, with wind speeds increased by 20% for wind directions from 235° to 36° via north to account for the channelling by Lake Ohau and wind off the Ben Ohau Range. Rainfall was increased by 10% to account for being closer to the rain shadow created by the mountain ranges. The data set has 21 years of continuous data from 2000.

Using the monthly rainfall averages from Pukaki Aero, the annual rainfall is around 520 mm (range 337 – 772 mm), and for the months of the fire season (October through to the end of April) is 312 mm (range 190 – 573 mm). For the fire season months, the maximum monthly rainfall recorded was 183 mm in the month of February, and minimum of 2.1 mm in the month of November.

For the fire season months, the average noon temperature was 17.3 °C, with a maximum of 31.9 °C in the month of January and a minimum of 1.6 °C in the month of November. Minimum relative humidity recorded was 10% in the month of January, and at some time in the 21-year record, relative humidity was recorded below 30% for every month in a year.

Twizel and the surrounding area can be very windy as winds are funnelled down major river valleys and across lakes. The strongest winds predominantly come from the west through northwest direction, but from time-to-time very strong winds do come from the northeast and southwest and occasionally from all other directions (refer Appendix 7). For fire season months, the average noon daily wind speed was 12 km/h, with a maximum 10-minute average of 64 km/h (as opposed to a gust) from the northwest in the month of October and a minimum of 0.9 km/h in the month of April. However maximum 10-minute wind speeds exceeding 45 km/h have been recorded at some time in all months of the year.

8.5. Ignition sources and causes – all risk areas

Heat sources are those with enough temperature to ignite vegetation fuel, with around 300 °C required. Heat sources have been categorised below and include those that may be present in the scope area.

8.5.1. Maintenance and construction equipment, heavy machinery, and motor vehicles

- 1) Chainsaws, mowers and cutters/slathers striking solid material such as rocks, wire or cables.
- 2) Welding, heating, steel cutting (gas and manual) and other spark hazardous operations.
- 3) Engine exhaust emission of hot carbon.
- 4) Exhaust system failures resulting in very hot parts that can break away (catalytic converters).
- 5) Liquid fuel and hydraulic fluid igniting on hot exhausts.
- 6) Direct vegetation contact with hot exhaust parts.
- 7) Friction on accumulated vegetation within vehicle systems.
- 8) Electrical failures resulting in fire.
- 9) Vehicle and machinery accidents.
- 10) Motorhome/caravan fires.

8.5.2. Open air burning or cooking

- 1) Use of outdoor barbeques, braziers, stoves (liquid and gas), and other oven types. This includes picnickers, hikers/trampers and freedom camper activities.
- 2) Traditional cooking fires and bonfires.
- 3) Private dwellings in the vicinity burning rubbish or tree trimmings, etc.
- 4) Escaped burn-offs (e.g., of forestry slash or scrub), including re-ignitions.

8.5.3. Natural

- 1) Lightning.
- 2) Spontaneous combustion e.g., stacked hay, landfill, commercial compost heaps, and bark heaps.

8.5.4. Powerline infrastructure

- 1) Line breakages and line clashing.
- 2) Line contact or arcing with vegetation.
- 3) Line disconnects from insulators and arcs on poles and cross arms.
- 4) Transformer and fuse failures.

8.5.5. Careless discarding of hot material

- 1) Lighted cigarettes discarded.
- 2) Home fire ashes discarded.
- 3) Fireworks, flares and other incendiaries.

8.5.6. Deliberate lighting of fire

- 1) Malicious lighting of fire.

8.5.7. Mountain bikes and personal accessories

- 1) Electric bike battery failure, generally home built systems, or any system whilst on charge).
- 2) Electrical device battery failures such as mobile phones, etc.

8.5.8. Structure fire

- 1) Structure fire spreading to vegetation (includes electrical cause).

8.6. People

People and their activities are mostly the mechanism that bring heat sources into contact with a receptive fuel bed causing a fire. This may be homeowners/occupiers, visitors, campers, construction personnel, service contractors or someone causing a fire further away that later impacts the area.

The scope area is surrounded by all or some of the following: public and private roads and tracks and accessways, farming operations, commercial forestry, private land, reserve and other protected land, communications, and electricity infrastructure.

The following categorises people for consideration of their activities that may cause a fire.

8.6.1. Recreation visitors

Visitor numbers in the area of interest are large. Recreation predominantly centres around walking/hiking, biking, horse riding and pony club, boating including rowing, fishing, and camping. Refer to commercial operators below for their operation type.

8.6.2. Property owners

Property owners within the area of interest. This includes those residing or using residential type property in urban or rural intermix settings, farm owners and their staff, and those associated with lands administered by Councils, Department of Conservation, and electricity companies.

8.6.3. Commercial and other approved operators

Recreation businesses and other operations catering for clients operate within the area of interest. These include but are not limited to the Twizel and Ruataniwha Holiday Parks, other tourist stays such as farm stays and boutique accommodation, Ruataniwha rowing operation, subdivision construction, salmon farming, and the Pukaki Airport operations.

8.6.4. Council

Council staff, volunteer groups, and contractors undertake road and other services maintenance, Resource Recovery Centre (rubbish) operation, track construction and maintenance, as well as spraying and mowing operations. The State Highways 8 and 80 are maintained by contractors.

8.6.5. Electricity and communication suppliers

There are high voltage transmission lines and lower voltage lines within and outside the area of interest and electricity substations. Electricity company staff and contractors access these for maintenance purposes, including track and vegetation maintenance.

Communication company staff and contractors undertake equipment and site maintenance or installation.

9. Risk Analysis

To analyse the risk of a fire starting, spreading, and doing damage, three factors must be present, i.e., enough dry fuel adequately arranged, a heat source, and a way to bring them together (in most cases, human activities).

9.1. Fuel condition

The fire environment determines fuel condition and the ability for fuel to burn. The New Zealand Fire Danger Rating System is used to help determine how fuels will burn under given conditions. The New Zealand Fire Danger Class Criteria are used to give qualitative ratings of fire danger based on available fuel to burn and its propensity to spread in the three broad New Zealand fuel types: forest, grass, and scrub, with fire danger classes calculated for the Pukaki long-term fire climate data and the adjusted data for Risk Area 2 based on components of the Fire Weather Index (FWI) System. The Fire Danger Classes occurring within the scope area for both data sets (Twizel and Manuka Terrace) are grassland and forest Low through to Very Extreme and, for scrub, all classes except Moderate.

Topography affects wildfire behaviour with slopes increasing spread rate and fire intensity, thereby increasing the damage potential. The Fire Danger Classes do not account for slope effects. However, slope effects have been included in Prometheus fire growth modelling undertaken for individual zones.

An analysis of the annual average number of days in a year that each class prevailed is presented using 21 years of fire weather data from the Pukaki Aero RAWS up to the end of December 2021. The following tables summarise the average number of days per year in each fire danger class for each of the three New Zealand fuel types and for each data set. Refer to Appendix 6 for table data and bar graphs.

Fire Danger Class (FDC) annual frequencies based on the Pukaki Aero RAWS:

Table 1: FDC frequencies for forest fuel types

Fire Danger Class	Number of days annually	Months of occurrence	Number of days in the fire season	Months of occurrence in fire season
Low	201	All months	66	All months
Moderate	93	Aug to June	78	All months
High	38	Sept to April	36	All months
Very High	14	Sept to March	14	Oct to March
Extreme	13	Oct to April	13	All months
Very Extreme	6	Nov to March	5	Nov to March

Table 2: FDC frequencies for grassland fuel types

Fire Danger Class	Number of days annually	Months of occurrence	Number of days in the fire season	Months of occurrence in fire season
Low	84	All months	23	All months
Moderate	188	All months	104	All months
High	64	Aug to May	58	All months
Very High	18	Sept -March	16	Oct to March
Extreme	10	Oct to March	10	Oct to March
Very Extreme	1	January	1	January

The degree of curing is a measure of the proportion (%) of dead grass fuels present, which affects the ease of fire spread. The lower the percentage, the more live green component is present.

Table 3: Degree of grass curing (DoC%) based on annual cycle for Canterbury High Country

Month	July	A	S	O	N	D	J	F	M	A	M	June
DoC%	60	60	70	70	70	80	80	80	70	60	60	50

Table 4: FDC frequencies for scrub fuel types

Fire Danger Class	Number of days annually	Months of occurrence	Number of days in the fire season	Months of occurrence in fire season
Low	76	All months	27	All months
Moderate	0	None	0	All months
High	62	All months	20	All months
Very High	45	All months	20	All months
Extreme	72	All months	50	All months
Very Extreme	110	All months	95	All months

Fire Danger Class (FDC) annual frequencies based on the Pukaki Aero RAWS adjusted for Risk Area 2 (Manuka Terrace).

Table 5: FDC frequencies for forest fuel types

Fire Danger Class	Number of days annually	Months of occurrence	Number of days in the fire season	Months of occurrence in fire season
Low	204	All months	68	All months
Moderate	90	August to June	77	All months
High	37	Sept to May	34	All months
Very High	14	Sept to April	13	All months
Extreme	13	Oct to April	13	All months
Very Extreme	7	Nov to March	7	Nov to March

Table 6: FDC frequencies for grassland fuel types

Fire Danger Class	Number of days annually	Months of occurrence	Number of days in the fire season	Months of occurrence in fire season
Low	84	All months	23	All months
Moderate	182	All months	100	All months
High	65	July to May	57	All months
Very High	17	Sept to April	16	All months
Extreme	15	Sept - March	14	Oct to March
Very Extreme	2	Dec to Feb	2	Dec to Feb

The degree of curing is a measure of the proportion (%) of dead grass fuels present, which affects the ease of fire spread. The lower the percentage, the more live green component is present.

Table 7: Degree of grass curing (DoC%) based on annual cycle for Canterbury High Country

Month	July	A	S	O	N	D	J	F	M	A	M	June
DoC%	60	60	70	70	70	80	80	80	70	60	60	50

Table 8: FDC frequencies for scrub fuel types

Fire Danger Class	Number of days annually	Months of occurrence	Number of days in the fire season	Months of occurrence in fire season
Low	77	All months	28	All months
Moderate	0	None	0	None
High	59	All months	19	All months
Very High	44	All months	19	All months
Extreme	70	All months	48	All months
Very Extreme	115	All months	98	All months

9.2.Wildfire history - ignitions

Tables 9, 10 and 11 present a 10-year summary of the FENZ fire incidents up to the 11th of February 2023 that could impact the area of interest. A ten-year data set has been used to ensure the information is applicable to current human behaviour related to wildfire risk and for determining general return periods. There was a total of 63 fire related incidents over the period, with nearly half of these being vegetation fires.

Table 12 is the full list of fires that are of interest, and Table 13 breaks these into their specific zones. Zones A and H have the highest number of fires with zone G having none. Deliberately lit fires account for over half the fire causes, although this includes legitimately lit fires, followed by mechanical and undetermined fire causes.

Table 9: Summary of fire types

Fire Type	Number
Vegetation	29
Other	17
Mobile Property	8
Structure	4
Rubbish	5
Total Fires - 10 years	63

Table 10: Summary fire causes

Fire cause	Number
Deliberately lit – compliant and non-compliant	33
Mechanical	10
Exposure fire	2
Other fire or undetermined	11
Careless with heat or smouldering	3
Incendiaries	2
Power	2
Total Fires – 10 years	63

Table 11: Number of fires by Risk area and zone

Risk Area	Zone	Number of fires
Area 1	A	21
	B	6
	C	3
	D	8
	Total fires	38
Area 2	E	6
	F	1
	G	0
	Total fires	7
Area 3	H	18
	Total fires	18

Table 12: Fire occurrences of interest within the scope area over the past 10 years

Date	Fire Type	Fire Cause	General Location
28/01/2014	Vegetation	Mechanical	Hocken Lane
29/03/2014	Vegetation	Deliberately Lit	Hocken Lane
23/04/2014	Mobile Property	Mechanical	Max Smith Drive
23/04/2014	Vegetation	Exposure fire	Max Smith Drive
23/04/2014	Mobile Property	Exposure fire	Max Smith Drive
20/06/2014	Mobile Property	Mechanical	Old Glen Lyon Road
1/07/2014	Structure	Mechanical	Freda Du Faur Ave
10/09/2014	Vegetation	Other	Mount Cook Road
11/09/2014	Vegetation	Deliberately Lit	Tekapo-Twizel Rd
4/01/2015	Vegetation	Other	Old Glen Lyon Road
4/03/2015	Mobile Property	Mechanical	Mount Cook Road
18/03/2015	Rubbish	Deliberately Lit	Hooker Crescent
20/10/2015	Vegetation	Deliberately Lit	Mount Cook Road
24/10/2015	Mobile Property	Mechanical	Old Glen Lyon Road
23/11/2015	Vegetation	Deliberately Lit	Ben Ohau Road
1/12/2015	Other Fire - not classified	Deliberately Lit	Ben Ohau Road
30/01/2016	Other Fire - not classified	Deliberately Lit	Manuka Terrace
7/02/2016	Other Fire - not classified	Deliberately Lit	Hocken Lane
4/03/2016	Vegetation	Other	Mount Cook Road
11/04/2016	Other Fire - not classified	Deliberately Lit	Benmore Place
18/04/2016	Other Fire - not classified	Deliberately Lit	The Drive
1/05/2016	Vegetation	Deliberately Lit	Glen Lyon Road
11/10/2016	Vegetation	Other	Tekapo-Twizel Rd
31/12/2016	Vegetation	Deliberately Lit	Freda Du Faur Ave
12/01/2017	Other Fire - not classified	Deliberately Lit	Lake Wardell
8/02/2017	Vegetation	Mechanical	Old Glen Lyon Road
25/03/2017	Mobile Property	Mechanical	Twizel-Omarama Road

Date	Fire Type	Fire Cause	General Location
25/04/2017	Other Fire - not classified	Deliberately Lit	Benmore Place
5/10/2017	Mobile Property	Mechanical	Glen Lyon Road
8/12/2017	Vegetation	Deliberately Lit	The Drive
18/12/2017	Vegetation	Deliberately Lit	Rhoboro Downs Rd
1/04/2018	Other Fire - not classified	Carelessness	Glen Lyon Road
20/08/2018	Rubbish	Deliberately Lit	Ostler Road
22/01/2019	Vegetation	Incendiaries	Glencairn Road
16/07/2019	Other Fire - not classified	Deliberately Lit	North West Arch
1/09/2019	Vegetation	Other	Rhoboro Downs Rd
1/09/2019	Vegetation	Deliberately Lit	Rhoboro Downs Rd
5/09/2019	Vegetation	Deliberately Lit	Ben Ohau Road
13/09/2019	Vegetation	Deliberately Lit	Glen Lyon Road
11/12/2019	Vegetation	Deliberately Lit	Glen Lyon Road
31/12/2019	Rubbish	Deliberately Lit	Ostler Road
13/01/2020	Vegetation	Power	Tekapo-Twizel Rd
30/03/2020	Other Fire - not classified	Deliberately Lit	Tekapo-Twizel Rd
30/08/2020	Vegetation	Other	Mount Cook Road
26/09/2020	Vegetation	Carelessness	Mount Cook Road
24/10/2020	Other Fire - not classified	Deliberately Lit	Manuka Terrace
2/12/2020	Other Fire - not classified	Deliberately Lit	Manuka Terrace
17/12/2020	Vegetation	Deliberately Lit	Huxley Place
2/01/2021	Structure	Other	North West Arch
29/01/2021	Other Fire - not classified	Deliberately Lit	Tekapo-Twizel Rd
30/01/2021	Other Fire - not classified	Deliberately Lit	Lake Wardell
7/02/2021	Other Fire - not classified	Deliberately Lit	North West Arch
21/04/2021	Rubbish bin	Deliberately Lit	The Drive
10/09/2021	Vegetation	Other	Mount Cook Road
1/03/2022	Other Fire - not classified	Deliberately Lit	Lake Wardell
30/03/2022	Structure	Carelessness	Hooker Crescent
22/06/2022	Mobile Property	Other	Freda Du Faur Ave
21/12/2022	Other Fire - not classified	Deliberately Lit	Lake Wardell
27/12/2022	Rubbish	Other	The Drive
1/01/2023	Vegetation	Incendiaries	Lake Wardell
30/01/2023	Structure	Other	Ostler Road
9/02/2023	Vegetation	Power	Ohau Canal
11/02/2023	Vegetation	Mechanical	Mount Cook Road

Table 13: Fires of interest by zone

Zone	Date	Fire Type	Cause	Location
A	23/04/2014	Mobile Property	Mechanical	Max Smith Drive
	23/04/2014	Vegetation	Exposure fire	Max Smith Drive
	23/04/2014	Mobile Property	Exposure fire	Max Smith Drive
	18/03/2015	Rubbish	Deliberately Lit	Hooker Crescent
	11/04/2016	Other Fire	Deliberately Lit	Benmore Place
	18/04/2016	Other	Deliberately Lit	The Drive
	25/04/2017	Other	Deliberately Lit	Benmore Place
	8/12/2017	Vegetation	Deliberately Lit	The Drive
	1/04/2018	Other	Carelessness with Heat Source	Glen Lyon Road
	20/08/2018	Rubbish	Deliberately Lit	Ostler Road
	22/01/2019	Vegetation	Incendiaries	Glencairn Road
	16/07/2019	Other	Deliberately Lit	North West Arch
	11/12/2019	Vegetation Fire	Deliberately Lit	Glen Lyon Road
	31/12/2019	Rubbish	Deliberately Lit	Ostler Road
	17/12/2020	Vegetation Fire	Deliberately Lit	Huxley Place
	2/01/2021	Structure	Other	North West Arch
	7/02/2021	Other Fire - not classified above	Deliberately Lit	North West Arch
	21/04/2021	Rubbish	Deliberately Lit	The Drive
	30/03/2022	Structure	Carelessness with Heat Source	Hooker Crescent
	27/12/2022	Rubbish	Other	The Drive
	30/01/2023	Structure	Other	Ostler Road
B	20/06/2014	Mobile Property	Mechanical	Old Glen Lyon Road
	4/01/2015	Vegetation	Other	Old Glen Lyon Road
	24/10/2015	Mobile Property	Operating Failure	Old Glen Lyon Road
	1/05/2016	Vegetation	Deliberately Lit Fire	Glen Lyon Road
	5/10/2017	Mobile Property	Mechanical Failure	Glen Lyon Road
	13/09/2019	Vegetation	Deliberately Lit	Glen Lyon Road
C	1/07/2014	Structure	Mechanical	Freda Du Faur Ave
	31/12/2016	Vegetation	Deliberately Lit Fire	Freda Du Faur Ave
	22/06/2022	Mobile Property	Other	Freda Du Faur Ave
D	28/01/2014	Vegetation	Mechanical	Hocken Lane
	29/03/2014	Vegetation	Deliberately Lit	Hocken Lane
	11/09/2014	Vegetation	Deliberately Lit	Tekapo-Twizel Road
	7/02/2016	Other	Deliberately Lit	Hocken Lane

Zone	Date	Fire Type	Cause	Location
	25/03/2017	Mobile Property	Mechanical	Twizel-Omarama Rd
	13/01/2020	Vegetation Fire	Power	Tekapo-Twizel Road
	30/03/2020	Other	Deliberately Lit	Tekapo-Twizel Road
	29/01/2021	Other	Deliberately Lit	Tekapo-Twizel Road
E	1/12/2015	Other	Deliberately Lit	Ben Ohau Road
	30/01/2016	Other	Deliberately Lit	Manuka Terrace
	5/09/2019	Vegetation	Deliberately Lit	Ben Ohau Road
	24/10/2020	Other	Deliberately Lit	Manuka Terrace
	2/12/2020	Other	Deliberately Lit	Manuka Terrace
	9/02/2023	Vegetation	Power	Ohau Canal
F	23/11/2015	Vegetation	Deliberately Lit	Ben Ohau Road
G	None			
H	10/09/2014	Vegetation	Other	Mount Cook Road
	4/03/2015	Mobile Property	Mechanical	Mount Cook Road
	20/10/2015	Vegetation	Deliberately Lit	Mount Cook Road
	4/03/2016	Vegetation	Other	Mount Cook Road
	11/10/2016	Vegetation	Other	Tekapo-Twizel Road
	12/01/2017	Other	Deliberately Lit	Lake Wardell
	8/02/2017	Vegetation	Mechanical	Old Glen Lyon Road
	18/12/2017	Vegetation	Deliberately Lit	Rhoboro Downs Rd
	1/09/2019	Vegetation	Other	Rhoboro Downs Rd
	1/09/2019	Vegetation	Deliberately Lit	Rhoboro Downs Rd
	30/08/2020	Vegetation	Other	Mount Cook Road
	26/09/2020	Vegetation	Smouldering material	Mount Cook Road
	30/01/2021	Other	Deliberately Lit	Lake Wardell
	10/09/2021	Vegetation	Other	Mount Cook Road
	1/03/2022	Other	Deliberately Lit	Lake Wardell
	21/12/2022	Other	Deliberately Lit	Lake Wardell
	1/01/2023	Vegetation	Incendiaries	Lake Wardell
	11/02/2023	Vegetation	Mechanical	Mount Cook Road

9.3.Fire Behaviour

Once a wildfire ignites, it goes through an acceleration phase before reaching its optimal forward rate of spread (equilibrium ROS) and head fire intensity (HFI) for the fuel, weather and topographical conditions. It is the HFI at the equilibrium ROS that helps determine damage potential. Fuel loads are estimated in tonnes per hectare (t/ha), ROS in metres per hour (m/h), and HFI in kilowatts per linear metre (kW/m) of the fire front. ROS is determined from the Initial Spread Index (ISI) component, plus Buildup Index (BUI) for forest fuel types, of the Fire Weather Index (FWI) System.

Prometheus fire growth modelling was undertaken from several ignition points identified using historic fire locations and local knowledge. Fire growth modelling was applied to the High and Extreme fire danger classes, using weather data from the Pukaki long-term climate data, and adjusted for Risk Area 2. The modelled inputs and outputs have been compiled in a separate report supplement titled *Twizel and Surrounds Prometheus Wildfire Risk Report Supplement*. There are a range of vegetation types in each zone likely to impact on values. Based on field observations, vegetation was therefore categorised for alignment with available fuel models for New Zealand (Pearce et al., 2012) and similar Canadian (Forestry Canada Fire Danger Group, 1992) fuel types to determine likely fire behaviour. Refer *Twizel and Surrounds Prometheus Wildfire Risk Report Supplement* for detail on the fuel characteristics and models selected.

The 28 vegetation types have also had equilibrium ROS and HFI calculated for a range of slope angles. Calculations were conducted for the 'likely' scenario based on the High fire danger class and for the 'worse' scenario based on the Extreme fire danger class. Input fire behaviour indices (ISI and BUI) were selected from a single day for each of the High and Extreme fire danger classes and applied to all 28 vegetation types. A grass curing of 80% for pasture grasses and 100% for tussock has been used for both scenarios.

The HFI outputs were used to determine relative firebreak widths for forest fuel, grass with no spot fire potential at 90% holding, and grass with spotting potential at 90% holding (Pearce et al., 2012; Scion, 2012). Tree prune heights were also determined using the critical surface fire intensity needed for crown fire initiation (Pearce et al., 2012).

The ROS, HFI, firebreak width and prune height outputs are contained in an analysis spreadsheet, with the ROS and HFI outputs for High and Extreme fire danger classes summarised in Section 10, Table 17.

9.4.Recreation visitor numbers

The recreation areas and the Twizel and Ruataniwha Holiday Parks are extremely well used during the summer months including both shoulder seasons, with lower numbers during the rest of the year. Visitor projections for 2025 indicate a peak daily number of between 7,000 and 8,000 with a daily annual average of around 1,500.

9.5.Existing treatments

9.5.1. Plans and awareness

- 1) South Canterbury High Country Strategic and Tactical Fire Management Plan SC_P (May 2013), with reference to RUI planning for Twizel and other risk reduction treatments.

Fire growth and predetermined response modelling was completed for an ignition in Zone B off Old Glen Lyon Road and another outside Zone H west of SH80 at Baikie Hut. Modelling was undertaken for a prevailing northwest wind direction and under High, Very High, and Extreme fire danger classes using fire weather data for the Pukaki long-term climate analysis.

- 2) MDC's Ruataniwha Reserve Plan is currently in process, with submissions now closed.
- 3) MDC Spatial Plans (September 2021) look at the future of townships and rural settlements in the Mackenzie District and inform the District Plan.
- 4) MDC District Plan Review - Section 32 Report: Plan Change 21 – Implementing the Spatial Plans (Residential, Commercial and Industrial Zoning and Zone Frameworks).

9.5.2. Operating guidelines and regulation

- 1) Fire and Emergency New Zealand (FENZ) in collaboration with industry have compiled activity guidelines for organisations undertaking spark hazardous or hot works activities in the open air. These include specific activity control guidelines for forestry operations, and general spark hazardous operations such as roadside mowing, welding, as well as power reclosure systems. Organisations involved in activities covered in the guidelines are strongly encouraged to adopt them as standard practice. Additionally, there is a guideline on firebreaks.
- 2) Electricity supply companies undertake line and tower/pole maintenance which reduces the likelihood of failures that can cause fires. They also maintain fuel reduced corridors for transmission and powerlines.
- 3) MDC manages reticulated water supplies that are accessible to emergency services through pressure hydrants located on most sealed roads in Twizel as well as along the developed section of Glen Lyon and Old Glen Lyon roads, and Boundary Terrace.

Rural properties are required to have 30,000 litres of water storage with suitable couplings for fire services.

- 4) MDC, DOC, and private landowners can close areas to the public or restrict operations on their lands when fire dangers exceed their risk tolerance, or an event occurs that impacts the ability to deal with a wildfire. Examples of restrictions that can be imposed are on the use of chainsaws or other motorised machinery that limit operating hours to starting and finishing early before the hot and dry part of a day. FENZ can also regulate activities and close areas.
- 5) FENZ regulates the use of fire in the open air using a tiered system of personal responsibility (Open fire season), permits required (Restricted fire season), and fires

totally banned (Prohibited fire season). As fuels dry out, the restrictions on activities that could start fires become stronger.

- 6) FENZ manages fire signage related to wildfire risk. During restricted and prohibited fire seasons, related signage is erected at strategic locations to inform the public.

9.5.3. Local initiatives

- 1) There has been continuing liaison with the Twizel community to modify the green belt surrounding the township. This has the benefit of preventing wildfire incursions into Twizel township from the settlements and rural area surrounding the township. Actions achieved to date include.
 - a. Ladder fuels removed.
 - b. Forest thinned.
 - c. Grass kept mowed around walkways and along the rear of North West Arch properties.
 - d. Subdivision and development reducing fuel loads.
- 2) FENZ has historically engaged with property owners between SH80 and Lake Pukaki about fire mitigation measures and creation of defensible space around the structures on their properties.
- 3) There has been engagement with Pukaki Downs Station about the ongoing removal of wilding pines from the property.
- 4) There has also been significant and ongoing clearance of wilding pines on neighbouring Aoraki Downs and Rhoboro Downs Stations.
- 5) FENZ is engaged with Scion regarding vegetation fire behaviour research on Pukaki Downs and Aoraki Downs Stations, and this is ongoing with further live fire behaviour research burns planned.

9.5.4. Emergency response

- 1) FENZ provide an emergency service response to fires.

Table 14: FENZ emergency service response

Station/Resource	Estimated arrival time from notification
Twizel Volunteer Fire Brigade	- Total <u>20 minutes to lower Manuka Terrace</u>, with 5 minute muster and approximately 15 minute drive-time. Distance is approximately 19 km @ 75 km/h. - Total <u>13 minutes to Manuka Terrace</u> with 5 minute muster, and approximately 8 minute drive-time. Distance is approximately 10 km @ 75 km/h. - Total <u>12 minutes to SH8/SH80 junction</u> with 5 minute muster and approximately 7 minute drive-time. Distance is approximately 9 km @ 75 km/h.

Omarama Volunteer Fire Brigade	• Total <u>43 minutes to lower Manuka Terrace</u>, with 5 minute muster and approximately 38 minute drive-time. Distance is approximately 48 km @ 75 km/h. • Total <u>36 minutes to Manuka Terrace</u> with 5 minute muster, and approximately 31 minute drive-time. Distance is approximately 39 km @ 75 km/h. • Total <u>35 minutes to SH8/SH80 junction</u> with 5 minute muster and approximately 30 minute drive-time. Distance is approximately 38 km @ 75 km/h.
Tekapo Volunteer Fire Brigade	• Total <u>59 minutes to lower Manuka Terrace</u>, with 5 minute muster and approximately 54 minute drive-time. Distance is approximately 68 km @ 75 km/h. • Total <u>52 minutes to Manuka Terrace</u> with 5 minute muster, and approximately 47 minute drive-time. Distance is approximately 59 km @ 75 km/h. • Total <u>43 minutes to SH8/SH80 junction</u> with 5 minute muster and approximately 38 minute drive-time. Distance is approximately 48 km @ 75 km/h.
Mount Cook Volunteer Fire Brigade	• Total <u>65 minutes to lower Manuka Terrace</u>, with 5 minute muster and approximately 60 minute drive-time. Distance is approximately 75 km @ 75 km/h. • Total <u>58 minutes to Manuka Terrace</u> with 5 minute muster, and approximately 53 minute drive-time. Distance is approximately 66 km @ 75 km/h. • Total <u>49 minutes to SH8/SH80 junction</u> with 5 minute muster and approximately 44 minute drive-time. Distance is approximately 55 km @ 75 km/h.
NZ Defence	Only if on location in the Lake Tekapo Training Area. (Travel times would be similar to Tekapo VFB).

10. Risk Evaluation

Wildfire responds to fuel, weather, and topography, with fuel being the one component that is easily modified. To sustain fire, fuel (vegetation), oxygen and heat are all required. Removal of any one of these will result in no fire. In the presence of slopes and gullies, fires will travel faster and be more intense than those on flat ground. Fuel types and species have different flammability levels resulting in different ignitability, development and spread potential. Wildfire poses a risk to the area of interest, and as fire danger increases so too does the probability of ignition and damage potential.

Ignition may occur within the area of interest, or outside it in the wider scope area where fire may then spread towards the area of interest. Depending on ignition location and prevailing wind direction, a spreading wildfire could threaten people and property in all risk zones. When modelling the wildfire impact on zones, wind directions were selected from the climate data set based on respective zone scenarios presented in the *Twizel and Surrounds Prometheus Wildfire Risk Report Supplement*. For example, modelled ignitions for Manuka Terrace were under southwest and

northeast wind directions. The modelled ignitions that impact Twizel township were under north to northeast, northwest, and southwest wind directions.

Wildfire ignitions that develop in the presence of continuous vegetation over a distance present a higher wildfire damage potential than those contained by barriers and originating close to impact points. The reason for this is that as fire spreads it accelerates towards equilibrium ROS and HFI, with acceleration time to equilibrium generally accepted to be around 20 to 30 minutes, although in highly cured dry grass it can be a lot shorter. For example, a fire starting in zone B near Old Glen Lyon Road and spreading towards North West Arch will have time to accelerate and form a head fire before impacting on the RUI in zone A, as opposed to an ignition on the very edge of that RUI which would be far less likely to develop before impacting that RUI or being suppressed.

Of the 63 recorded fire occurrences, 24 are located where they potentially have time to accelerate towards equilibrium ROS and HFI. There are several other fires that if fuel conditions were favourable could have developed enough to cause property damage. The locations of these fires indicate that all risk zones except zone G could be impacted; however, the risk levels vary due to ignition return periods being different in each zone. Evaluation of the average greatest number of days in a month where forest, scrub and grassland fire danger levels are Moderate to Very Extreme indicates that if there is ignition, fire is likely to spread on more than 20 days in all months of the fire season. The month of January has an average number of days where fire can spread in forest fuel of 25 days, scrub fuel 28 days and 29 days for Manuka Terrace, and 28 days for grass fuel.

Fire behaviour modelling of the varied vegetation types across and within zones indicates the HFI will vary at different parts of impact areas. This will therefore cause variation in the level of damage potential leading to variation of risk consequence.

The following zone risk scores are based on the modelled ignitions presented in the *Twizel and Surrounds Prometheus Wildfire Risk Report Supplement*, as well as recorded ignitions for areas not modelled where fire could reach equilibrium ROS and HFI. The likelihood score is based on the month of January using the average number of days where fire could spread (refer Appendix 13 for descriptions of the Likelihood, Consequence and Risk levels).

Table 15: Overall zone risk scores

Zone	Likelihood	Consequence	Risk level
Zone A	Almost certain (5)	Major (4)	Very High
Zone B	Likely (4)	Moderate (3)	High
Zone C	Likely (4)	Minor (2)	Medium
Zone D	Likely (4)	Moderate (3)	High
Zone E	Likely (4)	Extreme (5)	Very High
Zone F	Possible (3)	Moderate (3)	Medium
Zone G	Rare (1)	Minor (2)	Low
Zone H	Almost certain (5)	Major (4)	Very High

With effective risk reduction treatments, the risk rating can be lowered over the long term, but there will always remain a level of residual risk. Determining a level of acceptable residual risk at points along the development timeline will help determine the quantum and type of risk treatments that can be applied, and when.

Reducing the likelihood of ignitions is the priority both inside and outside the area of interest. This would require targeted wildfire awareness with neighbours and recreation users, and a requirement for any works operations to adopt and implement appropriate risk reduction activity guidelines. This will require collaboration with the Community, MDC, DOC, Electricity companies and other commercial operators.

The consequences from wildfire can be considered on a scale from insignificant to catastrophic depending on prevailing fire danger. At risk are people's lives, the environment, utility infrastructure, built assets and recreation assets (including trails). Where possible, measures need to be employed to reduce consequences to these values.

In all cases, preventing ignitions is primary followed by engineering works to limit fire behaviour, as well as fire detection and early fire suppression, and evacuation to keep people safe. Because wildfires develop and spread faster during elevated fire danger, the application of treatments would need to keep pace with increasing fire danger levels.

10.1. Fire Danger

The Fire Danger Classes relevant to the Scope Area include Forest, Grassland, and Scrub. Presented in Table 16 and based on the 21-year record of fire climate, is the average number of days in a fire season that fire danger is Very High to Very Extreme and where fire suppression will be difficult. For forest and grass fuels, this amounts to around 30 days between October and April, and 165 days for scrub. With scrub fuel having so many days conditioned for burning, a greater emphasis needs to be applied to risk reduction treatments in these areas.

Table 16: Average number of days in the fire season fire danger is Very High to Very Extreme

Location	Forest	Grassland	Scrub
Zones A, B, C, D & H	32	27	165
Zones E, F & G	33	32	165

10.2. Ignition risk

Analysis of ignition sources, ignition history and existing treatments suggest that ignitions are most likely to occur on rural land, on or near roads, access points, tracks, campsites, powerline corridors and within structures.

63 recorded fire occurrences are of specific interest and have been grouped by zone and listed in Tables 12 and 13. Nearly half of these were vegetation fires, with another 20% recorded as other type fires. Over 50% were deliberately lit, 16% mechanical and another 16% recorded as undetermined. Others relate to powerlines, incendiaries, careless use of heat, and exposure fires (buildings or vehicles). Ignition likelihood has been scored by zone, with scores ranging from likely to unlikely. Refer to Table 15.

10.3. Fire Behaviour

Vegetation varies from zone to zone and within a zone, with topography generally similar across zones except zones F and H where there is rolling and very steep slopes. In addition to the Prometheus fire growth modelling, fire behaviour under the likely and worse case scenarios has been calculated for areas or locations where people or values require protection.

The fire behaviour calculations apply to 28 specific vegetation types with the resulting equilibrium ROS and HFI presented for both the likely and worse case scenarios (refer to Table 17). Because the ROS and HFI are calculated for equilibrium spread, they can give an indication of peak damage potential for a wildfire's impact at points or areas of interest where values require protecting.

Risk treatments related to vegetation modifications, firebreaks, fuel-breaks, and tree prune heights have been considered using the HFI outputs for the high and extreme scenario outputs. In some cases, there is a need to apply multiple modifications to achieve a tolerable outcome; for example, reducing surface fuel load beneath forest to enable a feasible tree prune height that limits crown fire involvement which would also reduce airborne embers and the likelihood of spot fire ignitions. In other cases, fire behaviour may be outside the limits of feasible modification and other risk reduction treatments would need to be considered; for example, evacuation.

Table 17: ROS and HFI for specific vegetation

Ref #	Risk zone	Fuel type	Scenario	Slope °	ROS m/h	HFI kW/m
1	A, B, C & E	Depleted 2 – 5 cm and hieracium.	Likely	0	946	710
			Worse	0	2817	2113
2	A, B, D, E & H	Grazed or mown 2 – 10 cm.	Likely	0	946	710
			Likely	15	1959	1469
			Likely	minus 15	331	248
			Worse	0	2817	2113
			Worse	15	5831	4373
			Worse	minus 15	986	739
3	A, B,C, D, E & F	Ungrazed grass, 30 cm low bulk some thatch.	Likely	0	973	2433
			Likely	15	2014	5035
			Likely	minus 15	341	851

Ref #	Risk zone	Fuel type	Scenario	Slope °	ROS m/h	HFI kW/m
			Worse	0	3506	8764
			Worse	15	7256	18,140
			Worse	minus 15	1227	3067
4	E, F & H	Ungrazed, 20 – 30 cm low bulk some thatch with scattered pines or groups of pines – tree height range 30 cm to 10 m.	Likely	0	973	2433
			Worse	0	3506	8764
5	A & F	Ungrazed 40 cm with heavy thatch.	Likely	0	973	2433
			Worse	0	3506	8764
6	A & H	Sparse under pruned trees 5 cm with cone litter at tree bases.	Likely	0	946	710
			Worse	0	2817	2113
7	D	Ungrazed, 20 – 30 cm with rosehip and other scattered grey shrubs.	Likely	0	973	2433
			Worse	0	3506	8764
8	H	Ungrazed 20 – 30 cm with windrows.	Likely	15	2014	15,105
			Likely	minus 15	341	2554
			Worse	15	7256	54,420
			Worse	minus 15	1227	9202
9	E & F	Short tussock, 20 to 30 cm and 20 – 30% cover mix with rest grass 20 – 30 cm.	Likely	0	973	3406
			Worse	0	3506	12,270
10	F	Short tussock predominant.	Likely	0	973	3406
			Worse	0	3506	12,270
11	D	Standing crop.	Likely	0	973	4865
			Worse	0	3506	17,528
12	F	Tall tussock 1m.	Likely	20	4637	46,370

Ref #	Risk zone	Fuel type	Scenario	Slope °	ROS m/h	HFI kW/m
			Worse	20	16,706	167,059
13	E	Douglas fir, other fir and nigra (Corsican) – 10 to 15 m.	Likely	0	232	2361
			Worse	0	1112	11,906
14	A & H	Douglas and mixed species, medium density openish.	Likely	0	232	1140
			Worse	0	1112	6641
15	A, B, C, E & F	Douglas fir 15 – 20 m (medium to tight spacing) with cone litter and 2 cm duff.	Likely	0	83	839
			Likely	5	100	1015
			Likely	15	171	1737
			Likely	20	236	2400
			Likely	minus 20	21	210
			Worse	0	802	8580
			Worse	5	969	10,374
			Worse	15	1659	17,759
			Worse	20	2292	24,533
			Worse	minus 20	200	2145
16	A & B	Douglas 10 m tight spacing branched to ground, cone litter and 2 – 3 cm duff.	Likely	15	171	1737
			Worse	15	1659	17,759
17	E	Nigra and contorta 10 – 15 m.	Likely	0	222	2258
			Worse	0	1858	19,884
18	E	Nigra and contorta 10 – 15 m mixed with manuka in places 50/50.	Likely	0	695	7069
			Worse	0	2332	24,955

Ref #	Risk zone	Fuel type	Scenario	Slope °	ROS m/h	HFI kW/m
19	H	Contorta, tight wilding pine 10 – 15 m.	Likely	15	1438	14,631
			Likely	minus 15	243	2474
			Worse	15	4826	51,652
			Worse	minus 15	816	8734
20	H	Contorta, medium density 10 – 15 m.	Likely	15	480	4887
			Likely	minus 15	81	826
			Worse	15	2303	24,643
			Worse	minus 15	389	4167
21	H	Contorta, open and pruned to 2 or 3 m.	Likely	15	480	2360
			Likely	minus 15	81	399
			Worse	15	2303	13,746
			Worse	minus 15	389	2324
22	F	Grey scrub 1.5 m.	Likely	10	1747	11,964
			Worse	10	3332	22,826
23	E	Grey scrub, grass and rosehip 1.5 m.	Likely	20	3215	22,026
			Likely	minus 20	281	1926
			Worse	20	6135	42,021
			Worse	minus 20	536	3674
24	E & F	Manuka 1.0 – 1.8 m, medium density.	Likely	10	3493	35,806
			Likely	20	6431	65,917
			Worse	10	6664	68,311
			Worse	20	12,269	125,758

Ref #	Risk zone	Fuel type	Scenario	Slope °	ROS m/h	HFI kW/m
25	E & F	Manuka, Matagouri (1.5 m) and grass mix.	Likely	0	1125	7703
			Likely	10	1747	11,964
			Worse	0	2145	14,697
			Worse	10	3332	22,826
26	B	Gorse 1.5 m.	Likely	10	3493	53,097
			Worse	10	6664	101,300
27	F	Manuka 1 m 50% cover, with grass ungrazed 20 – 30 cm with some thatch 50% cover.	Likely	10	2519	12,594
			Worse	10	5843	29,214
28	A & D	Mature Willow and other deciduous species with some conifer on river margins with grass component.	Likely	0	132	587
			Worse	0	504	2407

10.4. Life risk

Permanent population of Twizel is around 1600, with anecdotal information indicating this can increase by 3,700 visitors during the summer months. Projections indicate this will quickly increase over the next few years (refer section 8.1).

Residents and recreationists at the northwest RUIs and Twizel Walkway in Zone A, within the RI in Zone E and H, and along the Twizel River are the most at-risk people from wildfire. Spreading fire could impact directly on the RUI boundaries and Twizel Walkway running through them with people not able to evacuate in time or remaining to defend property. Fire spread may be rapid on and through the RI rural intermix properties and give little time for people to evacuate. The situation would be more severe in scrub and wilding pine areas.

People in the wider built-up area of Twizel and visitors using the two holiday parks and local reserves are likely to be impacted by smoke and embers depending on fire location and wind direction. People have a range of mobility, with some able to quickly move to safe areas and others much slower, especially young children. Property owners and visitors should remove themselves from fire impacted properties, or heavy smoke and ember attack situations.

Those working or operating within vegetation areas could be impacted by a threatening wildfire, such as farming or power company contractors and those operating outdoor businesses with clients.

10.5. Asset risk

These include the residential and commercial structures, ecological and recreational assets, power transmission and distribution utilities, communication, and other utilities. Refer section 8 for more detail.

10.5.1. Buildings

Zone A:

- 1) There is approximately 26 km of RUI around Twizel with ~238 dwellings and 103 other buildings.
- 2) The Twizel Holiday Park will house mobile homes, tents, and other motor vehicles.

Zone B:

- 1) There are approximately 14 dwellings, 6 associated structures and a few farm buildings.

Zone C:

- 1) The Ruataniwha Holiday Park has many structures ranging from motels and lodges to small cabins spread over approximately 20 ha. It will house many mobile homes, tents, and other motor vehicles.
- 2) The rowing facility has 13 structures and will house tents and many motor vehicles.
- 3) Single property off the end of The Drive with 1 dwelling and one other building.

Zone D:

- 1) There are 14 dwelling and 8 other structures on Hocken Lane, with a cluster of buildings northwest of here.
- 2) There are 8 buildings associated with Meridian Energy facility.
- 3) There are 12 structures at the Pukaki Airport.

Zone E:

- 1) There are ~80 dwellings and 34 associated buildings.
- 2) There are 2 buildings associated with the salmon farm at the Ohau canal.

Zone F:

- 1) There are 6 structures on Omahau Hills Station.

Zone G:

- 1) There is 1 structure on the shore of Lake Ohau.

Zone H:

- 1) There are 6 dwellings and 16 associated other buildings plus service/storage units.

10.5.2. Utility infrastructure and other

Zone A:

- 1) Overhead powerlines are in five locations with a total of ~6 km of overhead lines and ~110 poles. There is also an electricity substation on Benmore Place.
- 2) The Twizel water treatment plant with associated building and reservoir cover.
- 3) Residential and farm fencing.

Zone B:

- 1) Overhead powerlines are in four locations with a total of ~6.3 km of overhead lines and 97 poles.
- 2) Farm crops, farm feed stocks, plantation trees, fencing and stockyards, water reticulation and irrigation equipment, plus other farm equipment.

Zone C:

- 1) Campground and picnic equipment, boat racks and boats.
- 2) Grazing, amenity trees, fencing, water reticulation and irrigation equipment.

Zone D:

- 1) There are 5 overhead transmission lines with a total length of ~2 km and 10 towers.
- 2) There is a substation at the Meridian Energy site that the transmission lines come to and leave from.
- 3) There are 9 overhead powerlines with a total length of ~13 km with 144 poles.
- 4) Farm crops, farm feed stocks, plantation, and amenity trees, fencing and water reticulation, irrigation equipment and other farm equipment.

Zone E:

- 1) There is one industrial salmon farm with equipment at the edge of the Ohau canal.
- 2) There are three main overhead powerlines with several side-lines with a total length of 21.4 km and 288 poles.
- 3) Farm crops, farm feed stocks, plantation, and amenity trees, fencing and water reticulation, irrigation equipment.

Zone F:

- 1) There is 1 overhead powerline ~2 km in length with 25 poles.
- 2) Farm crops and grazing, farm feed stocks, the large Douglas Fir plantation block, fencing and water reticulation, irrigation equipment, other farm equipment.

Zone G:

- 1) There is an electricity substation below Ohau A power station.
- 2) There are 3 overhead powerlines with a total length of 4.2 km with 16 poles.
- 3) There is a quarry below Ohau A power station.

Zone H:

- 1) There is 1 overhead powerline with 3 side-lines with a total length of 3.6 km with 38 poles.
- 2) Grazing, amenity trees including shelter trees, fencing and water reticulation, irrigation equipment.

10.5.3. Environmental

This risk relates to the loss of biomass, ecosystems (fauna and flora), soil (through erosion) and water quality, as well as the invasion of pest plants and animals.

If damaged by fire, the aesthetics of the wide-open vistas of grassland would be an eyesore until recovered, with likely weed invasion.

Recreational trail aesthetics would be damaged by fire through the removal of vegetation leaving a destroyed environment that would take many years to recover. Trails and tracks themselves are more likely to be damaged during fire suppression operations or post-fire events through heavy machine operation and heavy rains washing them out. An affected area would need to be closed until roads and tracks are made safe, including the felling of damaged trees.

Key areas include the riparian margins of the Twizel River, Fraser and Dry Streams, as well as the Omahau Downs Conservation Area in the Twizel River, the Ruataniwha Conservation Area, and the access section to the Ben Ohau Conservation Area off SH8.

Additionally, there are the riparian margins of the Ohau River and the Ohau Terminal Moraine Scenic Reserve.

10.5.4. Businesses

Businesses most at risk from wildfire are those that are situated where fire can have a direct impact. This includes those that are within or on the boundary with continuous vegetation, including in the RUI.

Most businesses within the area of interest could be affected by wildfire even if it is only from smoke and embers. However, some businesses could be directly affected through loss of assets, for example, electricity infrastructure, and farm assets including livestock or stock grazing; while others could experience loss of trade due to such things as evacuations or visitors passing by and not stopping.

Examples of businesses that could be impacted are.

- 1) Electricity transmission and supply.
- 2) Farming operations and other enterprises such as boutique tourist accommodation.
- 3) The Ruataniwha and Twizel Holiday Parks.
- 4) The Meridian Rowing Complex.
- 5) Pukaki Airport operations and businesses.
- 6) Wider business within the Twizel township.
- 7) Businesses leveraging recreation opportunity off local facilities like the Alps 2 Ocean Cycle Trail.

10.5.5. Cultural, historic, and archaeological

Iwi have a long history in the area and an interest in protecting many locations of value that are kept secret to them. There are also multiple kainga mahinga kai sites of significance in the area surrounding Twizel and Lake Ohau. European settlement occurred in the 1850s when farming began to establish.

There will likely be sites or buildings of historic significance such as hydroelectricity sites and buildings significant to Twizel's history.

11. Risk treatment recommendations

This section outlines wildfire risk treatments aimed at managing wildfire risks identified within and near the area of interest. It is presented by risk area and associated zones, with each risk treatment aligning with a specific treatment objective.

Note that the risk treatments have been developed in consideration of the extreme scenario. Two important aspects to this are that firstly, the fire behaviour scenarios are model based (refer to the assumption and limitations), and secondly, the extreme scenario is not the worst-case wildfire damage potential that could occur. Therefore, those undertaking risk reduction treatments must consider the level of residual risk following risk treatment implementation.

Also note that estimated firebreak widths and tree pruning heights have been identified based on the extreme scenario head fire intensities (HFIs). Where these widths and heights are unachievable, it will be necessary to either re-evaluate the treatment or accept the residual risk associated with not completely meeting a treatment's requirement.

In relation to vegetation setbacks for plantation forestry, there are requirements pursuant to the Resource Management Regulations 2017. The requirements are not specific to wildfire, but they could be considered in the wider context of a modified vegetation cover that reduces wildfire damage potential or for new plantations greater than one hectare. As mentioned above, the wildfire vegetation modifications and firebreak widths are based on the extreme scenario HFIs. The risk treatment setback distances are based on radiant heat flux using around 15 kW/m^2 , where as firebreak widths are determined based on flame length. A heat flux of around $15\text{-}17 \text{ kW/m}^2$ is within the range $13 - 25 \text{ kW/m}^2$ which corresponds with identified thresholds for ignition of *'non-piloted ignition of timber (from heat without flame) after a long exposure time occurs at about 25 kW/m^2 ' (NZS 4232: 1988), and 'peak heat ratings for metal cladding products around $22\text{-}30 \text{ kW/m}^2$ (e.g., Kingspan external cladding, 24 kW/m^2)'*.

The risk treatments use a priority of medium to very high ranking to indicate which risk treatments should be undertaken first (very high) and last (medium). The ranking medium does not mean the risk treatment should not be completed at some point.

Table 27 is a summary list of risk treatment recommendations categorised by risk area and zone. Priority order for implementation is at Tables 28 for very high priority, and 29 for high and medium priority. During implementation planning, synergies should be identified from across the range of treatment levels. For example, if technical equipment is needed for a very high treatment and there is a nearby medium treatment requiring the same equipment, it may be sensible to complete both.

Refer to Appendix 12 for a map of risk treatment locations that may be difficult to locate. Those without clear location descriptions may not appear on the map.

11.1. All risk areas

Table 18: Treatments for all risk areas

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
A1	Very High	Transmission and powerline corridors	To reduce likelihood and consequence	Reduction	1) Maintain vegetation in powerline corridors to a level that: • will not touch overhead lines considering height, lateral line sway and tree fall where possible. • have non-fuel areas beneath poles and towers. • a fire's energy output beneath and beside the lines is low enough not to damage the lines.	Transmission and electricity companies
A2	Very High	Powerline network	To reduce likelihood & consequence	Reduction	1) Discuss with relevant power companies the applicability of applying the FENZ <i>Power Line Auto Re-Closure System Triggers - Fire Risk Guidelines</i> , and if applicable encourage its use.	Electricity companies
A3	Very High	Transmission and powerline infrastructure	To reduce likelihood	Reduction	1) Encourage electricity transmission and distribution companies to maintain their overhead line infrastructure to a standard that minimises faults that may cause ignitions.	Transmission and electricity companies
A4	Very High	Scope area	To reduce likelihood & consequence	Reduction	1) Require work operations, including volunteer work to apply activity control guidelines (below) based on the New Zealand Fire Danger Rating System. For organisations, ensure relevant parts of these guidelines are within operating plans and are extended to contractor and concessionaire agreements:	ALL

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					• <i>Fire Prevention Guidelines for Forestry Operations</i> are available from FENZ and New Zealand Forest Owners Association. • <i>Fire Prevention Guidelines for Heat and Spark Hazardous Activities / Hotworks</i> is available from FENZ.	
A5	High	Area of interest	Reduce consequence	Reduction Readiness	1) Prepare a vegetation planting guideline specific for the Twizel environment and for a range of applications. Consider including the following: • Species already not permitted within MDC zoning rules. • Identify species that are more flammable and likely to create airborne embers that could start spot fires downwind of a wildfire. Identify safe planting and management approaches for these and /or recommend/not recommend their use. • Preferred native and exotic species that will tolerate the local environment (shelter/no shelter, dry/wet, fertile/non-fertile soil). • Planting layout techniques to reduce fire intensity and spread, including mixed flammability and mixed native and exotic, tree maintenance that limits crown fire, planting density and non-contiguous planting areas.	MDC and FENZ

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					Present concept plant layouts for a small and large lot property, and that include a long driveway and long boundaries. 2) Make the guideline available to the community, stakeholders, and developers.	
A6	High	Highways and roads	To reduce consequence	Reduction	1) Maintain road verges and water tables as short grass.	New Zealand Transport Authority & MDC
A7	Very High	Scope area	To reduce likelihood and consequence To share the risk	Reduction	1) Maintain community awareness of prevailing fire danger conditions and appropriate behaviours for each fire danger class.	MDC, DOC, FENZ
A8	Very High	Area of Interest	To reduce likelihood and consequence To share the risk	Reduction	1) Encourage property owners to apply the FENZ 'Get Fire Safe at the Interface' guidance. 2) Encourage property owners to plant lower flammability species on the road boundary, not Tussock and Toe Toe that are receptive to ignition.	FENZ and MDC
A9	High	Area of Interest	To reduce consequence To share the risk	Reduction	1) Encourage those building new homes or other structures to reference the FENZ 'Wildfire Safer Housing Guide'.	FENZ and MDC

11.2. Risk area 1

11.2.1. Zones A

Table 19: Risk area 1 – Zone A

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
ZA -1	Medium	RUI-1	To reduce likelihood and consequence To share the risk	Reduction	1) Apply treatments A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space (there are a couple of good example properties along this RUI), A9 Safer Housing and A4 for spark hazardous works. 2) Extend the application to all properties between Max Smith and Temple Drives and Max Smith Drive and the eastern section of The Drive.	FENZ, MDC and all property owners
ZA -2	Very High	RUI-2	To reduce likelihood and consequence To share the risk	Reduction	1) Apply treatments A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, A9 Safer Housing and A4 for forestry and spark hazardous works. 2) Engage with property owners on the south side of The Drive and raise awareness of the risk wildfire poses to their properties and options available to reduce it: • The vegetation setback required for the plantation vegetation on 20° slope is minimum 30 metres or greater. If plantation trees are thinned to achieve open canopy and pruned as high as possible and cut material	FENZ, MDC and all property owners

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					removed, then the setback can be reduced to 15 metres or greater. - Remove the dense conifer trees from sections; or - Reduce tree density, create small pockets of trees with short grass understory, and remove limbs to as high as possible (>6 metres) above the ground and clear all cut material. 3) Urgently engage with the owner of #75 The Drive where the structure is within dense forest cover.	
ZA -3	Very High	RUI-3	To reduce likelihood and consequence To share the risk	Reduction	1) Apply treatments A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, A9 Safer Housing and A4 for forestry and spark hazardous works. 2) Discuss with the landowner farming north of The Drive, Woodley Avenue and Ostler Road to maintain the farm tracks behind the residential properties as a 5-metre non-fuel break and, if possible, extend this behind all properties. If extending is not possible then consider a 7-10 metre strip of short grass.	FENZ, MDC and all property owners
ZA -4	Very High	RUI-4 (old rubbish dump site)	Reduce consequence	Reduction	1) Maintain the Twizel Walkway track with no less than a 2-metre-wide bare earth surface with non-fuel or very short grass or sprayed edges to 2 metres either side. 2) The area of conifer trees southwest of #58, 62 and 64 North West Arch:	FENZ, MDC

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					- Remove the trees between the residential property boundaries and the Twizel Walkway track and maintain a short-mown grass; or - Remove some trees so the tree line is discontinuous, prune remaining trees as high as possible (>6 metres) removing all cut material, and maintain a short mown grass surface. - On the southwest side of the Twizel Walkway track, undertake further thinning to create small, disconnected tree pockets with short mown grass surface, prune trees as high as possible (>6 metres) above the ground and clear all cut material. 3) The conifer tree compartment behind #70 and 72 North West Arch on the southwest of the Twizel walkway track: - From the track edge remove trees for 5 metres and create a strip of mown grass. - From the edge of the grass strip, create a 10 metre strip of trees in small, disconnected pockets with short grass surface to give an open park situation and prune trees as high as possible (>6 metres) removing all cut material. - For the remainder of trees in the compartment, thin and prune to as high	

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					as possible (>6 metres) above the ground removing all cut material.	
ZA -5	Very High	RUI-5 Twizel Walkway land and neighbouring farmland	To reduce likelihood and consequence To share the risk	Reduction	1) Apply treatments A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, A9 Safer Housing and A4 for forestry and spark hazardous works. 2) Maintain the Twizel Walkway track with no less than a 2 metre-wide bare earth surface with non-fuel or very short grass or sprayed edges to 2 metres either side. 3) On the southwest boundaries of #42, 46, 48, 50 and 54 North West Arch: - Remove the trees between the residential property boundaries and the Twizel Walkway track and maintain short mown grass; or - Remove some trees so the tree line is discontinuous or creates small pockets of trees, prune remaining trees as high as possible (>6 metres) removing all cut material, and maintain a short-mown grass surface. - On the southwest side of the Twizel Walkway track, prune remaining trees as high as possible (>6 metres) above the ground and clear all cut material.	FENZ, MDC

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					4) On the northwest boundaries from #2 to #42 North West Arch: • Continue to maintain the ~30 metre-wide mown grass fuelbreak; and • Consider maintaining the whole recreation area as mown grass including in and around remaining trees or pockets of trees once pruned; and • Consider a 5 metre-wide non-fuel strip at the rear property boundaries (this could be a sprayed and disced and the rough surface may help deter it being used as an alternative recreation track). • Where tree pockets have formed between the Twizel Walkway track and the residential boundaries, remove individual trees to break the canopy cover and form small pockets or clusters, prune all remaining trees to as high as possible (>6 metres) above the ground, removing all cut material. 5) Discuss with the landowner farming on the boundary with the Twizel Walkway land to maintain a disced strip or short grass to a width of 15 metres if planting crop and 7 metres if pasture. This will decrease HFI as it nears the line of trees beside the Twizel Walkway thereby	

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					increasing the probability that fire will not enter the tree crowns. 6) In considering the long shelterbelt treeline and pockets of trees on the northwest side of the Twizel Walkway track to the farm boundary, if point 5) above is achievable then do the following: • Either thin the trees to open the canopy or strategically break the continuous treeline in 3 or 4 places by removing some trees. This will limit the treeline acting as a wick for fire to travel along during north to northeast winds. • All remaining trees to be pruned to 4-5 metres above the ground with cut material removed. • The surface vegetation beneath the trees and out to the walking track to be maintained as mown grass.	
ZA -6	Very High	RUI-5 Residential properties NW of North West Arch	To reduce likelihood and consequence To share the risk	Reduction	1) Apply treatments A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, A9 Safer Housing, and A4 for forestry and spark hazardous works. 2) Where properties have continuous conifer trees in compartments, pockets or lines from the rear boundary to North West Arch: • For the tree maintenance points below, maintain a short grass surface beneath trees to ensure that a prune height of	FENZ, MDC and all property owners

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					4-5 metres will be sufficient to reduce crown fire initiation. If the surface cannot be maintained as short grass and is a higher fuel load, then tree prune heights will need to be closer to 7 metres. • Thin trees to form an open canopy and prune remaining trees to 4-5 metres above the ground and remove all cut material, or • Break compartments into smaller pockets and prune trees to 4-5 metres above the ground and remove all cut material, or • Strategically remove some trees so there is not a continuous line of trees between the rear boundary and North West Arch, or • Replace conifer trees with species less flammable and less likely to produce airborne embers, or • A combination of the above points. 3) Encourage property owners to replace rear boundary plantings with species less flammable and less likely to produce airborne embers. 4) Encourage property owners to maintain grass areas as short as possible, and accessways and driveways clear of vegetation.	

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					5) Target properties with the FENZ 'Get Safe at the Interface' education material that are within 600 metres of the southeast side of North West Arch.	
ZA -7	Very High	RUI-5 Twizel township	Reduce consequence	Reduction	1) The large property at #190 Mackenzie Drive. Maintain grass area short and as boundary trees grow keep the lower branches pruned.	FENZ, MDC and property owner
ZA -8	Very High	RUI-6 & 7	To reduce likelihood and consequence To share the risk	Reduction	1) Apply treatments A1-3 for power, A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, A9 Safer Housing and A4 for forestry and spark hazardous works. 2) For the large grass area southwest of the Glen Lyon Road properties, maintain a short grass cover and prune trees to 4-5 metres above the ground and remove cut material. 3) Maintain the walking track from Mackenzie Drive around the rear of properties on Tekapo Drive to Glen Lyon Road to 2 metre-wide and short grass edges. 4) Prune the tree pocket at the Glen Lyon Road end of the above track to 4-5 metres above the ground and remove cut material.	FENZ, MDC, Electricity companies, and property owners
ZA -9	Very High	RUI-8, 9 & 10	To reduce likelihood and consequence To share the risk	Reduction	1) Apply treatments A1-3 for power, A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, A9 Safer Housing and A4 for forestry and spark hazardous works. 2) Emphasise the application of treatment A5 in selecting landscaping species that are less	FENZ, MDC, Electricity companies, and property owners

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					flammable and less likely to produce airborne embers. Note there are young Macrocarpa planted in this location. 3) Discuss with the landowners farming on the RUI boundaries to maintain a disced strip or short grass to a width of 10 metres from the boundary if planting crop and 7 metres if planting pasture.	
ZA -10	High	RUI-11		Reduction	1) Apply treatments A1-3 for power, A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, A9 Safer Housing and A4 for forestry and spark hazardous works. 2) Trees on the rear of these properties near Fraser Stream could be pruned to 3-4 metres above the ground and remove cut material. 3) Emphasise the application of treatment A8.	FENZ, MDC, Electricity companies, and property owners
ZA -11	High	RUI-12 & 15	To reduce likelihood and consequence To share the risk	Reduction	1) Apply treatments A1-3 for power, A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, A9 Safer Housing and A4 for forestry and spark hazardous works. 2) Trees on the rear of these properties could be pruned to 4-5 metres above the ground and remove cut material. 3) Where possible keep grass short behind the rear property boundaries or maintain existing bare earth as behind RUI-12. 4) Maintain the recreation tracks between the rear property boundaries and the Twizel	FENZ, MDC, Electricity companies, and property owners

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					River with bare earth surfaces and managed vegetation edges (keep grass short). 5) Emphasise the application of treatment A8.	
ZA -12	Medium	RUI-13 & 14	To reduce likelihood and consequence To share the risk	Reduction	1) Apply treatments A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, and A4 for forestry and spark hazardous works. 2) Prune all trees between Glen Lyon Road and the boundary with Twizel Holiday Park including within their property and maintain short grass under and around. A lower prune of 2-3 metres would suffice due to short grass and the distance fire could spread. 3) Maintain a mown grass strip of no less than 6 metres behind the properties on RUI-14 and prune boundary trees to 2-3 metres above ground with all cut material removed.	FENZ, MDC and property owners
ZA-13	High	RUI-16	To reduce likelihood and consequence To share the risk	Reduction	1) Apply treatments A1-3 for power, A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, A9 Safer Housing and A4 for forestry and spark hazardous works. 2) Apart from the treeline along SH8, remove trees that are within 10 metres of the property boundaries and maintain the strip as short grass. 3) For the treeline along SH8, prune the trees that are beside the structures and electrical	FENZ, MDC, Electricity companies, and property owners

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					substation on Benmore Place to 2-3-metres above the ground and remove cut material. Maintain existing grass areas mown. 4) For ongoing removal of trees prioritise work back from the cleared strip thereby widening it as work progresses.	

11.2.2. Zone B

Table 20: Risk area 1 – zone B

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
ZB-1	Very High	Powerlines	Reduce likelihood and consequence	Reduction	1) Apply treatments A1-3 for power infrastructure along Old Glen Lyon Road and between this and The Drive and Woodley Avenue. Also, powerlines to Ben Ohau Station.	FENZ & Electricity companies
ZB-2	Very High	Pyramid Rd RI	To reduce likelihood and consequence To share the risk	Reduction	1) Apply treatments A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, A9 Safer Housing and A4 for spark hazardous works. 2) Emphasise the application of treatment A5 in selecting landscaping species that are less flammable and less likely to produce airborne embers.	FENZ and property owners
ZB-3	Very High	Ben Ohau Station	To reduce likelihood and consequence To share the risk	Reduction	1) Apply treatments A5 for vegetation planting, A8 property maintenance and defensible space, A4 for spark hazardous works.	FENZ and property owners
ZB-4	High	Between RUI-3 and 5	To reduce consequence	Reduction	1) Discuss with farmer the feasibility of planting non-contiguous crops to produce a mosaic of	FENZ and landowner

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
		and Old Glen Lyon Road			low and high fuel loads, with lower loads closer to the RUIs.	
ZB-5	Medium	Future development area out to Old Glen Lyon Road	To reduce consequence	Reduction	1) During the planning phase, prepare a landscape planting plan utilising treatment A5. 2) Plan the track and roading system to dissect the land area thereby compartmentalising it. 3) Avoid long treelines and other continuous vegetation that could act as wicks that then quickly carry fire to other areas. 4) Socialise the above with developers and subsequent section owners and include consideration of treatment A9 during architectural design.	MDC

11.2.3. Zone C

Table 21: Risk area 1 - zone C

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
ZC-1	Very High	All of zone	To reduce likelihood and consequence To share the risk	Reduction	1) Apply treatments A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, A9 Safer Housing and A4 for forestry and spark hazardous works.	FENZ, MDC and property owners
ZC-2	Very High	Ruataniwha Holiday Park RI	To reduce likelihood and consequence	Reduction and readiness	1) Apply treatments A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, and A4 for forestry and spark hazardous works.	FENZ, MDC and park management

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					2) Maintain the track at the base of Max Smith Drive embankment on the northeast side of the park as either bare earth or short grass. 3) Either prune trees in a strip 10 metres off the park track on the southeast side to 2-3 metres off the ground and remove cut material or remove the trees and create a 10-metre-wide grass strip. 4) Discuss with the Holiday Park's management what their emergency response and evacuation process is should the park be impacted by airborne embers and smoke.	
ZC-3	Very High	Meridian Rowing Complex and camping	To reduce likelihood and consequence	Reduction	1) Apply treatments A8 property maintenance and defensible space, and A4 for spark hazardous works. 2) Ensure very short grass where motorised vehicles park off the road surface.	MDC and Meridian Rowing operations
ZC-4	High	Recreation Reserve	To reduce likelihood and consequence	Reduction	1) Apply treatments A6 for road edge fuel reduction, A5 for vegetation planting, and A4 for forestry and spark hazardous works. 2) Continue to maintain the existing vehicle track/road system. During redevelopment, plan the roading system to compartmentalise the area so a wildfire cannot spread far before encountering a barrier. 3) Prune all trees between Max Smith Drive and the metal road near the lake running between Kate Cameron Drive and Frea Du Faur Avenue to	MDC

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					2-3 metres above the ground and remove all cut material. 4) Review fire prevention signage at entrances and key parking areas within the reserve. This includes the area between the rowing complex towards Ohau A power station.	
ZC-5	Very High	Escarpment plantation trees and flats to Max Smith Drive	Reduce Consequence	Reduction	1) Discuss with the owner of the trees the willingness and feasibility of running a fire break along the base of the treeline including separating the tongue of trees running from Max Smith Drive. 2) Maintain the flats as short grass cover.	FENZ and landowner
ZC-6	Very High	Residential property off the end of The Drive.	To reduce likelihood and consequence	Reduction	1) Apply treatments, A8 property maintenance and defensible space, and A4 for spark hazardous works. 2) Emphasise the risk of fire in the trees to the south and encourage extending the cleared area further down the escarpment.	FENZ and landowner

11.2.4. Zone D

Table 22: Risk area 1 – Zone D

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
ZD-1	Very High	Powerlines	Reduce likelihood and consequence	Reduction	1) Apply treatments A1-3 for power infrastructure running from Meridian Energy facility to the Twizel River, along Hocken Lane, opposite Ben Ohau Station, into Bendrose and Omahau Downs Stations, into the Airport and up to the canal road (2 lines).	FENZ & Electricity companies

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
ZD-2	Very High	Hocken Lane RI	Reduce likelihood and consequence	Reduction, readiness, and response	1) Apply treatments A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, A9 Safer Housing, and A4 for forestry and spark hazardous works. 2) Emphasise the need to maintain vegetation edges along the narrow road and sufficient side and height clearances for large response vehicles.	FENZ, MDC and property owners and land managers
ZD-3	Very High	Hocken Lane RI	Reduce consequence and share risk	Reduction, readiness, and response	Hocken Lane is a dead-end relatively narrow accessway to several large lot properties. 1) In conjunction with property owners and FENZ, including the Twizel Fire Brigade, prepare an evacuation process and response plan that among other things identifies: • A residents notification system. • Preparation of escape plans. • Livestock welfare plan. • Awareness of incoming response resources along a narrow road and with possible limited visibility/ • Alternative way/s out if parts of Hocken Lane are cut off by fire. • Locations that could be consider safety zones or sheltering of last resort. • Access points to water in the Twizel River from the eastern end of Hocken Lane/	FENZ, property owners and land managers

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					- Other water supplies along Hocken Lane including open ponds and access to and couplings on dwelling firefighting water supplies. - FENZ initial emergency response actions.	
ZD-4	High	Farmland	Reduce the consequence	Reduction	1) Discuss with farmers surrounding the development the feasibility of strategically planting areas of crop to produce a mosaic of low and high fuel loads.	FENZ and landowner
ZD-5	High	Omahau Downs & Bendrose Stations, Private dwellings east side SH8 near Twizel River and Bendrose Stream	Reduce likelihood and consequence	Reduction	1) Apply A6 for accessway fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, and A4 for spark hazardous works. 2) Discuss maintaining a disced strip or short grass to a width of 15 metres from structures if planting crop and 7 metres if planting pasture.	FENZ and landowner
ZD-6	Medium	Meridian Energy facility	Reduce likelihood	Reduction	1) Apply A3 - Encourage electricity transmission and distribution companies to maintain their overhead line infrastructure to a standard that minimises faults that may cause ignitions. 2) Maintain vegetation around buildings and substation footprint as short grass.	FENZ and electricity companies

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
ZD-7	Medium	Pukaki Airport	Reduce consequence	Reduction	1) Continue to maintain the mown grass strip that surrounds the airport facilities and runway to the north, east and south.	Pukaki Airport operations, MDC

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11.3. Risk area 2

11.3.1. Zone E

Table 23: Risk area 2 – Zone E

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
ZE-1	Very High	Powerlines	Reduce likelihood and consequence	Reduction	1) Apply treatments A1-3 for power infrastructure running along the Ben Ohau and canal roads, along Manuka Terrace including side-lines and along Flanagans Lane.	FENZ & Electricity company
ZE-2	Very High	Manuka Terrace RI	Reduce likelihood and consequence	Reduction	1) Apply treatments A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, A9 Safer Housing, and A4 for forestry and spark hazardous works. 2) Encourage property owners to maintain accessways and driveways to a minimum 3-metres wide nonfuel, with little vegetation such as short grass for 2 metres on either side and an open tree canopy above. This is to dissect the landscape and help hinder fire spread.	FENZ, MDC and property owners
ZE-3	Very High	Properties that have structures within or close to plantation compartments smaller pockets or treelines	Reduce consequence	Reduction	1) The vegetation setbacks required for flat ground are 10-15 metres or greater. If plantation trees are thinned for a distance of 20-30 metres or greater to achieve open canopy and pruned as high as possible (>6 metres) and cut material removed, then the setback can be reduced to 7-10 metres. 2) To reduce the chance of torching and crown fires, pruning and thinning of trees should	FENZ and property owners

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					be undertaken to achieve a relatively open canopy of mature trees. Prune as high as possible (>6 metres) above ground and remove all cut material. 3) To reduce continuous fire spread along shelterbelt treelines, interrupt the continuity by having breaks in a treeline that are either: • A full break in continuity by removing all trees in a break width. • A partial break in continuity by reducing density to a point that tree canopies are not touching within the break width.	
ZE-4	Very High	Properties on Ben Ohau Rd and Manuka Tce that are within 400m of the Pukaki Canal	Reduce consequence	Reduction	1) To reduce the potential for airborne embers to carry across the canal and start new fires that could potentially impact Twizel. Discuss directly with the landowners the best planting approach that will achieve reduced fire intensity and airborne embers.	FENZ and property owners
ZE-5	Very High	Manuka Tce escarpment / slope between the 2 main terraces.	Reduce consequence	Reduction	1) Properties within this area that are in or near plantation, scrub or mixed plantation and scrub: • The vegetation setbacks required for plantation on 15° slope is 20 metres or greater and 20° slopes is 30 metres or greater. If plantation trees are thinned for a distance of 20-30 metres or greater to achieve open canopy and pruned as	FENZ and property owners

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					high as possible (>6 metres) and cut material removed, then the setbacks can be reduced on 15° slope to 15 metres or greater and on 20° slopes to 20 metres or greater. - The vegetation setbacks required for Manuka on 10° slope is 80 metres and for 20° slopes is 120 metres. - Undertake pruning and thinning of plantation trees to achieve a relatively open canopy of mature plantation trees. Prune as high as possible (>6 metres) above ground and remove all cut material. - Maintain Manuka scrub areas so they are thinned and/or dissected into compartments or pockets so a fire has less chance of reaching its potential ROS and HFI.	
ZE-6	High	Lower Manuka Terrace properties.	Reduce consequence	Reduction	1) To reduce and prevent increasing fuel load leading to higher intensity fires, manage the spread and growth of wilding pines.	FENZ, MDC and property owners
ZE-7	Very High	Manuka Terrace RI	Reduce consequence	Reduction, readiness & response	Manuka Terrace RI is approximately 9 km long. Fire growth modelling for extreme fire danger indicates that fire spreading from the west could involve complete terraces. Manuka Terrace has more than one way out except the properties below the western end where it meets the canal road.	FENZ and property owners

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					The Ben Ohau Road runs into farm tracks to the northwest. 1) In conjunction with property owners and FENZ, including the Twizel Fire Brigade, prepare an evacuation process that among other things identifies: • A residents notification system. • Preparation of escape plans. • Livestock welfare plan. • Routes to escape along depending on fire spread direction. • Locations that could be consider safety zones or sheltering of last resort. • Water points other than the canal system and lake, including open ponds, and access to and couplings on dwelling firefighting water supplies. 2) FENZ to consider planning for initial response to the Manuka Terrace RI considering the northeastern end is 10 km away and approximately 13 minutes response time, with the southwestern end 19 km and approximately 20 minutes response time. Some considerations include: • Approach directions depending on fire location and fire spread direction. • Initial response resourcing during times of High to Extreme fire danger. Fast mobile resources may be required to	

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					keep pace and/or assist people to get out of the way of spreading fire. • Water points other than the canal system and lake, including open ponds, and access to and couplings on dwelling firefighting water supplies. • Likely locations to achieve containment. • Contingency actions for a situation where embers from the main fire cross the canal system and start new fires that threaten the wider Twizel area. • Transition from reactive response to proactive response as incident complexity increases.	

11.3.2. Zone F

Table 24: Risk area 2 – Zone F

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
ZF-1	High	Powerlines	Reduce likelihood and consequence	Reduction	1) Apply treatments A1-3 for power infrastructure running along the Pukaki Canal.	FENZ & Electricity company
ZF-2	Medium	Omahau Hills Station	Reduce likelihood and consequence	Reduction	1) Apply treatments A6 for road edge fuel reduction, A8 property maintenance and defensible space, and A4 for forestry and spark hazardous works.	FENZ and property owner

11.3.3. Zone G

Table 25: Risk area 2 – Zone F

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
ZG-1	Medium	Powerlines	Reduce likelihood and consequence	Reduction	1) Apply treatments A1-3 for power infrastructure within the zone.	FENZ & Electricity company

11.4. Risk area 3

11.4.1. Zone H

Table 26: Risk area 3 – Zone H

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
ZH-1	Very High	Powerlines	Reduce likelihood and consequence	Reduction	1) Apply treatments A1-3 for power infrastructure running along Rhoboro Downs Road to SH8 and then north to the SH80 and along the highway to its end point.	FENZ & Electricity company
ZH-2	Very High	All properties	Reduce consequence		1) Apply treatments A6 for road edge fuel reduction, A5 for vegetation planting, A8 property maintenance and defensible space, A9 Safer Housing, and A4 for forestry and spark hazardous works. 2) The zone was affected by a wildfire in August 2020 and areas of burnt pine have been cleared and windrowed. These areas are now predominantly grass and suggested future management may be: • Maintain as grass and use grazing or other means to keep grass short and limit weed invasion.	FENZ and property owners

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					- Over time replant with species that are less flammable and less likely to produce airborne embers. - Consider any replanting to be in small, separated compartments or pockets where fuel continuity is broken, and fire spread potential reduced. 3) Properties within this area are in or near mature wilding pine. - The vegetation setback required for wilding pine on 15° slope is 40 metres. - For areas that are mixed ungrazed grass and forest slash windrow fuels, the setback on a 15° slope would be around 40 metres for heat flux effect and a 60 metre-wide firebreak for 90% probability of holding (this assumes airborne embers from the windrows). - If plantation trees are thinned for a distance of 20-30 meters or greater to achieve open canopy and pruned as high as possible (>6 metres) and cut material removed, then the setbacks can be reduced on a 15° slope to 15 metres. - Maintain tree areas so they are dissected into compartments or pockets, so a fire has less chance of reaching its potential ROS and HFI. - Along accessways and the first few metres of compartment trees that face structures,	

Ref #	Priority	Location	Treatment Objective	Function	Action/activity	Groups concerned
					undertake pruning as high as possible (>6 metres) above ground and thinning to achieve an open canopy that cannot carry fire. Remove all cut material. Encourage property owners to maintain accessways and driveways to a minimum of 3 metres wide non-fuel, with little vegetation such as short grass for 1-2 metres on either side and an open tree canopy above. This is to dissect the landscape and help hinder fire spread.	
ZH-3	Very High	RI Pukaki large lots	Reduce consequence	Reduction, readiness & response.	Accessways are dead-end and relatively narrow to all properties. 1) In conjunction with property owners and FENZ, including the Twizel Fire Brigade, prepare an evacuation process and response plan that among other things identifies: - A residents notification system. - Preparation of escape plans. - Livestock welfare plan. - Awareness of incoming response resources along narrow accessways and with possible limited visibility. - Alternative way/s out if egress is cut off. - Locations that could be consider safety zones or sheltering of last resort. - Access points to water supplies including open ponds and access to and couplings on dwelling firefighting water supplies.	

11.5. Risk treatment summary

Table 27: Risk treatment summary

Ref#	Table #	Priority	Location	Action/activity	Groups concerned
All Risk Areas					
A1	18	Very High	Throughout area of interest	Vegetation management -powerline corridors	Transmission and electricity companies
A2	18	Very High	Throughout area of interest	Auto reclosure	Electricity companies
A3	18	Very High	Throughout area of interest	Electricity infrastructure maintenance	Transmission and electricity companies
A4	18	Very High	Throughout the scope area	Activity control guidelines for forestry and spark hazardous activities	All
A5	18	High	Throughout area of interest	Specific vegetation planting guideline	MDC and FENZ
A6	18	High	Highways/roads	Vegetation maintenance	New Zealand Transport Authority & MDC
A7	18	Very High	Throughout the scope area	Public awareness	FENZ and MDC
A8	18	Very High	Throughout area of interest	Defensible space guidelines	FENZ and MDC

Ref#	Table #	Priority	Location	Action/activity	Groups concerned
A9	18	High	Throughout area of interest	Guidelines for safer housing	FENZ and MDC
Risk area 1 - zone A					
ZA-1	19	Medium	RUI-1	Refer A4, A5, A6, A8 and A9 risk treatments	FENZ, MDC and all property owners
ZA-2	19	Very High	RUI-2	Refer A4, A5, A6, A8 and A9 risk treatments, and specific vegetation works	FENZ, MDC and all property owners
ZA-3	19	Very High	RUI-3	Refer A4, A5, A6, A8 and A9 risk treatments, and specific vegetation works	FENZ, MDC and all property owners
ZA-4	19	Very High	RUI-4 (old rubbish dump)	Refer A4, A5, A6, A8 and A9 risk treatments, and specific vegetation works	FENZ and MDC
ZA-5	19	Very High	RUI-5 Twizel Walkway	Refer A4, A5, A6, A8 and A9 risk treatments, and specific vegetation works	FENZ and MDC
ZA-6	19	Very High	RUI-5 Residential North West Arch and wider township	Refer A4, A5, A6, A8 and A9 risk treatments, and specific vegetation works	FENZ, MDC and all property owners
ZA-7	19	Very High	RUI-5 Twizel township	Vegetation maintenance	FENZ, MDC and all property owners
ZA-8	19	Very High	RUI-6 & 7	Refer A1-6, A8 and A9 risk treatments, and specific vegetation works	FENZ, MDC, Electricity companies, and property owners
ZA-9	19	Very High	RUI-8, 9 and 10	Refer A1-6, A8 and A9 risk treatments, and specific vegetation works	FENZ, MDC, Electricity companies, and property owners
ZA-10	19	High	RUI-11	Refer A1-6, A8 and A9 risk treatments, and specific vegetation works	FENZ, MDC, Electricity companies, and property owners
ZA-11	19	High	RUI-12 and 15	Refer A1-6, A8 and A9 risk treatments, and specific vegetation works	FENZ, MDC, Electricity companies, and property owners

Ref#	Table #	Priority	Location	Action/activity	Groups concerned
ZA-12	19	Medium	RUI-13 and 14	Refer A1-6, A8 and A9 risk treatments, and specific vegetation works	FENZ, MDC, Electricity companies, and property owners
ZA-13	19	High	RUI-16	Refer A1-6, A8 and A9 risk treatments, and specific vegetation works	FENZ, MDC, Electricity companies, and property owners
Risk area 1 - zone B					
ZB-1	20	Very High	Old Glen Lyon and Pyramid Roads	Refer A1-3 risk treatments	FENZ & Electricity companies
ZB-2	20	Very High	RI Pyramid Road	Refer A4, A5, A6, A8 and A9 risk treatments, and specific vegetation works	FENZ and property owners
ZB-3	20	Very High	Ben Ohau Station	Refer A4, A5, and A8 risk treatments	FENZ and landowner
ZB-4	20	High	Area between RUI-3 and 5, and Old Glen Lyon Road	Vegetation management	FENZ and landowner
ZB-5	20	Medium	Between North West Arch and Old Glen Lyon Road	Future landscape planning	MDC
Risk area 1 – zone C					
ZC-1	21	Very High	All of zone	Refer A4, A5, A6, A8 and A9 risk treatments, and specific vegetation works	FENZ, MDC and property owners
ZC-2	21	Very High	Ruataniwha Holiday Park	Refer A5, A6 and A8 risk treatments, and specific vegetation works. Evacuation arrangements	FENZ, MDC and park management
ZC-3	21	High	Meridian Rowing Complex and camping	Refer A4 and A8 risk treatments, and specific vegetation works.	MDC and Meridian Rowing operations
ZC-4	21	High	Recreation reserve	Refer A4, A5 and A6 risk treatments, and specific vegetation works, road maintenance and signage	MDC

Ref#	Table #	Priority	Location	Action/activity	Groups concerned
ZC-5	21	Very High	Between Max Snith Drive and The Drive	Firebreak feasibility	FENZ and landowner
ZC-6	21	Very High	End of The Drive	Refer A4 and A8 risk treatments, and specific vegetation works.	FENZ and property owner
Risk area 1 – zone D					
ZD-1	22	Very High	Across the zone	Refer A1-3 risk treatments	FENZ & electricity companies
ZD-2	22	Very High	RI Hocken Lane	Refer A5, A6, A8 and A9 risk treatments, and specific vegetation works	FENZ, MDC and property owners and land managers
ZD-3	22	Very High	RI Hocken Lane	Evacuation process	FENZ, property owners and land managers
ZD-4	22	High	Farmland within zone	Vegetation management	FENZ and landowner
ZD-5	22	High	Omahau Downs and Bendrose Stations	Refer A4, A5, A6 and A8 risk treatments	FENZ and landowners
ZD-6	22	Medium	Meridian Energy facility	Refer A3 risk treatment and specific vegetation works	FENZ and electricity companies
ZD-7	22	Medium	Pukaki Airport	Vegetation maintenance	Pukaki Airport operations, MDC
Risk area 2 – zone E					
ZE-1	23	Very High	Across the zone	Refer A1-3 risk treatments	FENZ & electricity companies
ZE-2	23	Very High	RI Manuka Terrace	Refer A4, A5, A6, A8 and A9 risk treatments, and specific vegetation works	FENZ, MDC and property owners
ZE-3	23	Very High	Properties close to plantation trees	Vegetation management and maintenance	FENZ and property owners
ZE-4	23	Very High	Properties close to the canal	Vegetation type limitation	FENZ and property owners

Ref#	Table #	Priority	Location	Action/activity	Groups concerned
ZE-5	23	Very High	Properties on or near the main Manuka Terrace escarpment	Vegetation management and maintenance	FENZ and property owners
ZE-6	23	High	Lower Manuka Terrace	Vegetation maintenance	FENZ, MDC and property owners
ZE-7	23	Very High	RI Manuka Terrace	Evacuation process and initial response planning	FENZ and property owners
Risk area 2 – zone F					
ZF-1	24	High	Across the zone	Refer A1-3 risk treatments	FENZ & electricity companies
ZF-2	24	Medium	Omahau Hills Station	Refer A4, A6 and A8 risk treatments	FENZ and property owner
Risk area 2 – zone G					
ZG-1	25	Medium	Across the zone	Refer A1-3 risk treatments	FENZ & electricity companies
Risk area 3 – zone H					
ZH-1	26	Very High	Across the zone	Refer A1-3 risk treatments	FENZ & electricity companies
ZH-2	26	Very High	All properties	Refer A4, A5, A6, A8 and A9 risk treatments, and specific vegetation works	FENZ and property owners
ZH-3	26	Very High	RI Pukaki large lots	Evacuation process and initial response planning	FENZ and property owners

11.6. Risk treatment work priority

Table 28: Very High priority risk treatment order for implementation

The following table is the recommended order for implementing the Very High priority risk treatments with VH-1 being the first and VH-48 last.

Ref#	Table #	Order of Priority	Location	Action/activity	Groups concerned
A1	18	VH-1	Throughout area of interest at ZA 8-11 and 13; ZB 1; ZD 1; ZE 1; ZF 1; ZG 1; and ZH 1.	Vegetation management -powerline corridors	Transmission and electricity companies
A2	18	VH-2	Throughout area of interest at ZA 8-11 and 13; ZB 1; ZD 1; ZE 1; ZF1; and ZH 1.	Auto reclosure	Electricity companies
A3	18	VH-3	Throughout area of interest at ZA 8-11 and 13; ZB 1; ZD 1 and 6; ZE 1; ZF 1; and ZH 1.	Electricity infrastructure maintenance	Transmission and electricity companies
A4	18	VH-4	Throughout the scope area and includes ZA 2-3, 5-6, 8-13; ZB 2and 3; ZC 2-4 and 6; ZD 2 and 5; ZE 2; ZF 2; ZH 2.	Activity control guidelines for forestry and spark hazardous activities	All
ZA-2	19	VH-5	RUI-2	Specific vegetation works	FENZ, MDC and all property owners
ZC-5	21	VH-6	Between Max Snith Drive and The Drive	Firebreak feasibility	FENZ and landowner
ZA-6	19	VH-7	RUI-5 Residential North West Arch and wider township	Specific vegetation works	FENZ, MDC and all property owners
ZE-5	23	VH-8	Properties on or near the main Manuka Terrace escarpment	Vegetation management and maintenance	FENZ and property owners
ZE-3	23	VH-9	Properties close to plantation trees	Vegetation management and maintenance	FENZ and property owners
ZH-2	26	VH-10	All properties	Specific vegetation works	FENZ and property owners

Ref#	Table #	Order of Priority	Location	Action/activity	Groups concerned
ZE-7	23	VH-11	RI Manuka Terrace	Evacuation process and initial response planning	FENZ and property owners
ZD-3	22	VH-12	RI Hocken Lane	Evacuation process	FENZ, property owners and land managers
ZH-3	26	VH-13	RI Pukaki large lots	Evacuation process and initial response planning	FENZ and property owners
ZC-2	21	VH-14	Ruataniwha Holiday Park	Evacuation arrangements and specific vegetation works	FENZ, MDC and park management
ZC-3	21	VH-15	Meridian Rowing Complex and camping	Refer A4 and A8 risk treatments, and specific vegetation works.	MDC and Meridian Rowing operations
A8	18	VH-16	Throughout area of interest at ZA 1-3, 5-6, 8-13; ZB 2 and 3; ZC 1-3 and 6; ZE 2; ZF 2 and ZH2.	Defensible space guidelines	FENZ and MDC
A7	18	VH-17	Throughout the scope area	Public awareness	FENZ and MDC
ZA-5	19	VH-18	RUI-5 Twizel Walkway	Specific vegetation works	FENZ and MDC
ZA-3	19	VH-19	RUI-3	Specific vegetation works	FENZ, MDC and all property owners
ZA-4	19	VH-20	RUI-4 (old rubbish dump)	Specific vegetation works	FENZ and MDC
ZA-8	19	VH-21	RUI-6 & 7	Specific vegetation works	FENZ, MDC, and property owners
ZA-7	19	VH-22	RUI-5 Twizel township	Vegetation maintenance	FENZ, MDC and all property owners
ZA-9	19	VH-23	RUI-8, 9 and 10	Specific vegetation works	FENZ, MDC, Electricity companies, and property owners
ZC-6	21	VH-24	End of The Drive	Specific vegetation works	FENZ and property owner
ZB-2	20	VH-25	RI Pyramid Road	Refer A4, A5, A6, A8 and A9 risk treatments, and specific vegetation works	FENZ and property owners
ZB-3	20	VH-26	Ben Ohau Station	Refer A4, A5, and A8 risk treatments	FENZ and landowner

Ref#	Table #	Order of Priority	Location	Action/activity	Groups concerned
ZD-2	22	VH-27	RI Hocken Lane	Specific vegetation works	FENZ, MDC and property owners and land managers
ZE-2	23	VH-28	RI Manuka Terrace	Specific vegetation works	FENZ, MDC and property owners
ZE-4	23	VH-29	Properties close to the canal	Vegetation type limitation	FENZ and property owners

Table 29: High and Medium priority risk treatment order for implementation

The following table is the recommended order for implementing the HIGH priority risk treatments with H-1 being the first and H-22 last.

Ref#	Table #	Order of Priority	Location	Action/activity	Groups concerned
ZF-1	24	High	Across the zone	Refer A1-3 risk treatments	FENZ & electricity companies
A5	18	H-1	Throughout area of interest at ZA 1-4, 6 and 8-13; ZB 2,3 and 5; ZC 2 and 5; ZE 2, and ZH 2.	Specific vegetation planting guideline	MDC and FENZ
A6	18	H-2	Highways/roads	Vegetation maintenance	New Zealand Transport Authority & MDC
ZA-13	19	H-3	RUI-16	Specific vegetation works	FENZ, MDC and property owners
ZA-11	19	H-4	RUI-12 and 15	Specific vegetation works	FENZ, MDC and property owners
ZA-10	19	H-5	RUI-11	Specific vegetation works	FENZ, MDC, Electricity companies, and property owners
ZC-4	21	H-6	Recreation reserve	Specific vegetation works, road maintenance and signage	MDC

Ref#	Table #	Order of Priority	Location	Action/activity	Groups concerned
ZB-4	20	H-7	Farmland between RUI-3 and 5, and Old Glen Lyon Road	Vegetation management	FENZ and landowner
ZD-4	22	H-8	Farmland within zone	Vegetation management	FENZ and landowner
ZD-5	22	H-9	Omahau Downs and Bendrose Stations	Specific vegetation management	FENZ and landowners
ZE-6	23	H-10	Lower Manuka Terrace	Vegetation maintenance	FENZ, MDC and property owners
A9	18	H-11	Throughout area of interest at ZA 1-3, 5, 6, 8-10, 11, and 13; ZB 2; ZD 2; ZE 2; and ZH 2.	Guidelines for safer housing	FENZ and MDC
ZG-1	25	M-1	Across the zone	Refer A1-3 risk treatments	FENZ & electricity companies
ZF-2	24	M-2	Omahau Hills Station	Refer A4, A6 and A8 risk treatments	FENZ and property owner
ZA-12	19	M-3	RUI-13 and 14	Specific vegetation works	FENZ, MDC, Electricity companies, and property owners
ZD-7	22	M-4	Pukaki Airport	Vegetation maintenance	Pukaki Airport operations, MDC
ZD-6	22	M-5	Meridian Energy facility	Specific vegetation works	FENZ and electricity companies
ZB-5	20	M-6	Between North West Arch and Old Glen Lyon Road	Future landscape planning	MDC

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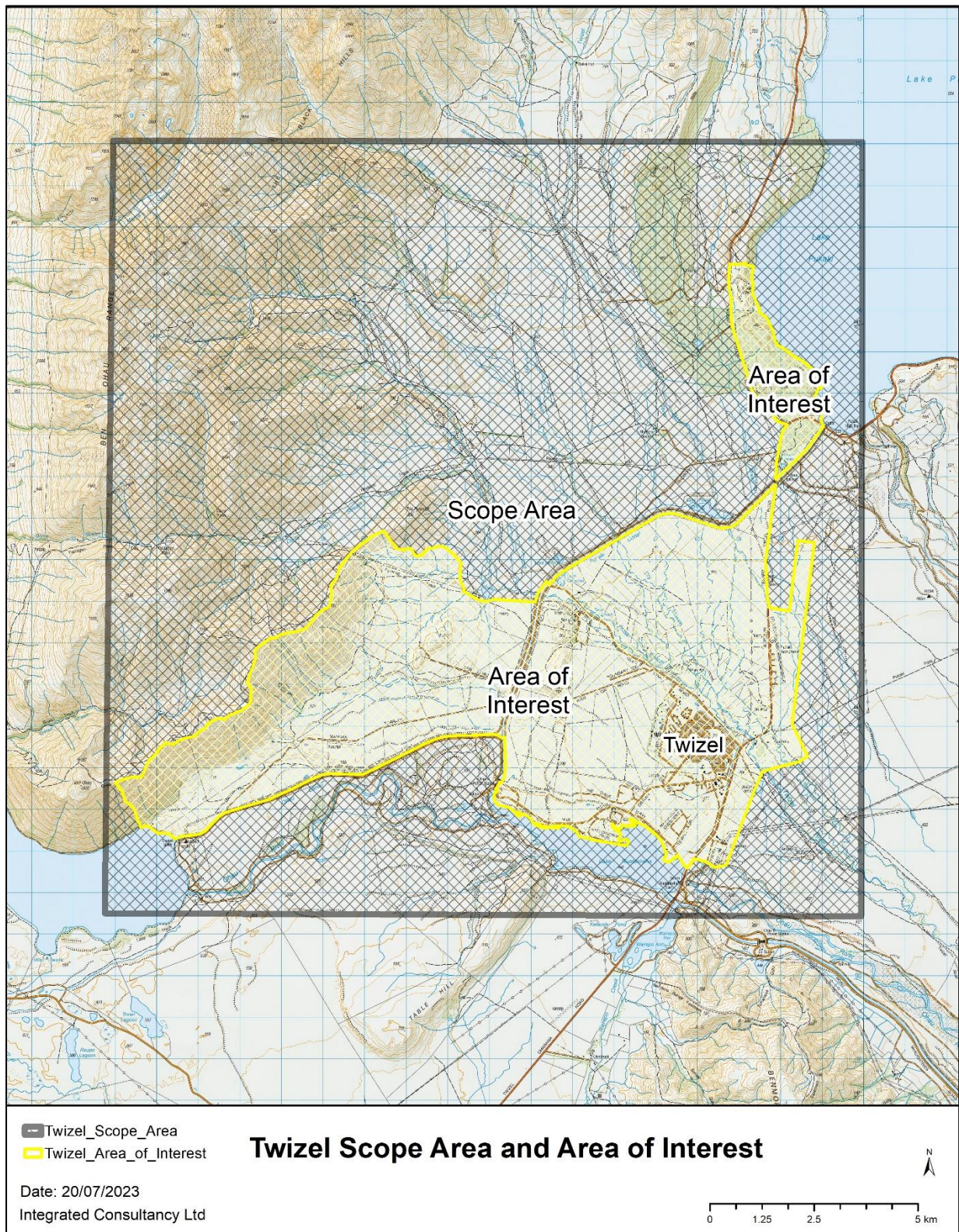
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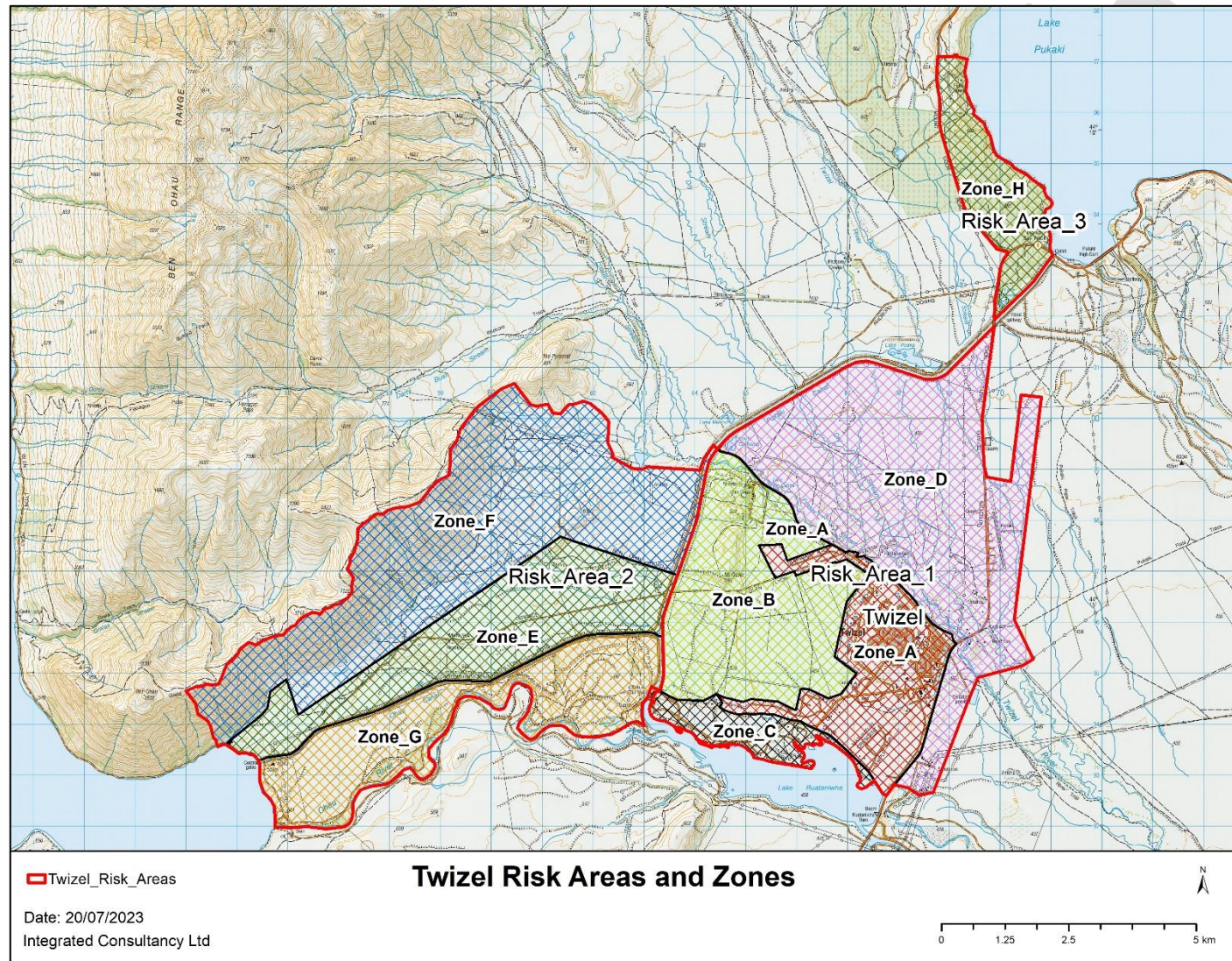
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13. Appendices

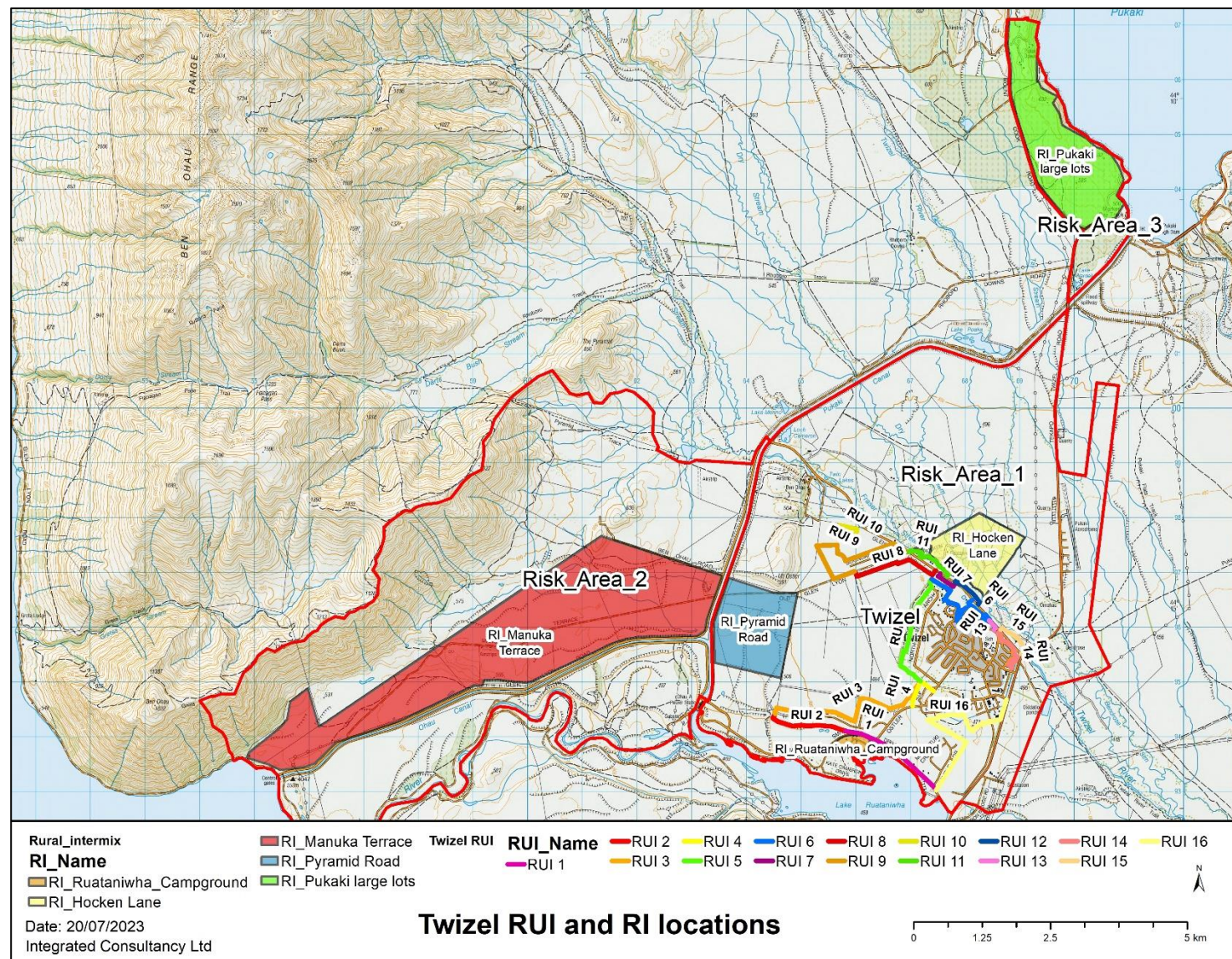
13.1. Appendix 1: Scope area and area of interest

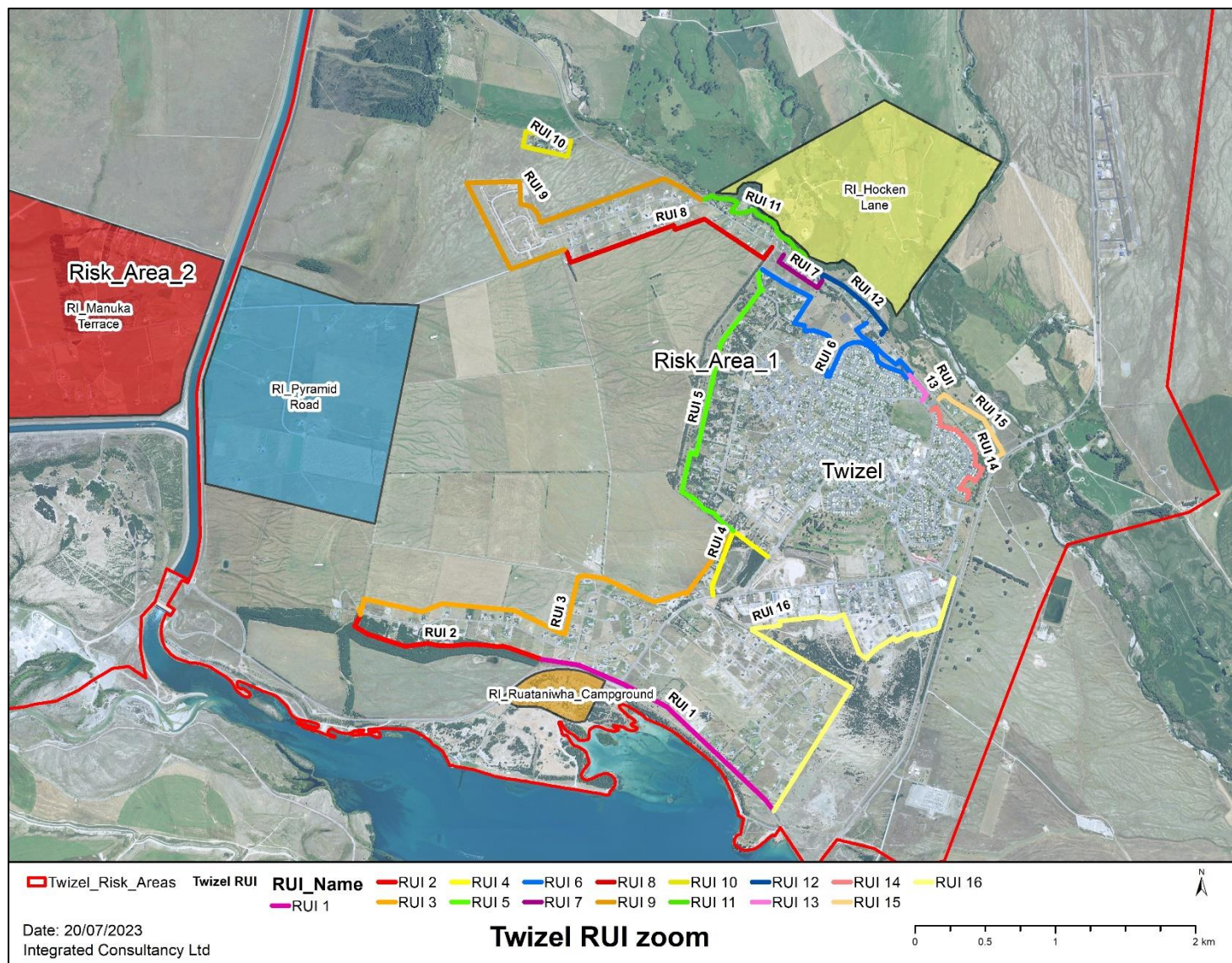


13.2. Appendix 2: Risk areas and zones



13.3. Appendix 3: RUI and RI locations





13.4. Appendix 4: RUI and RI summaries

Table 30: Risk area 1: RUI segment summaries

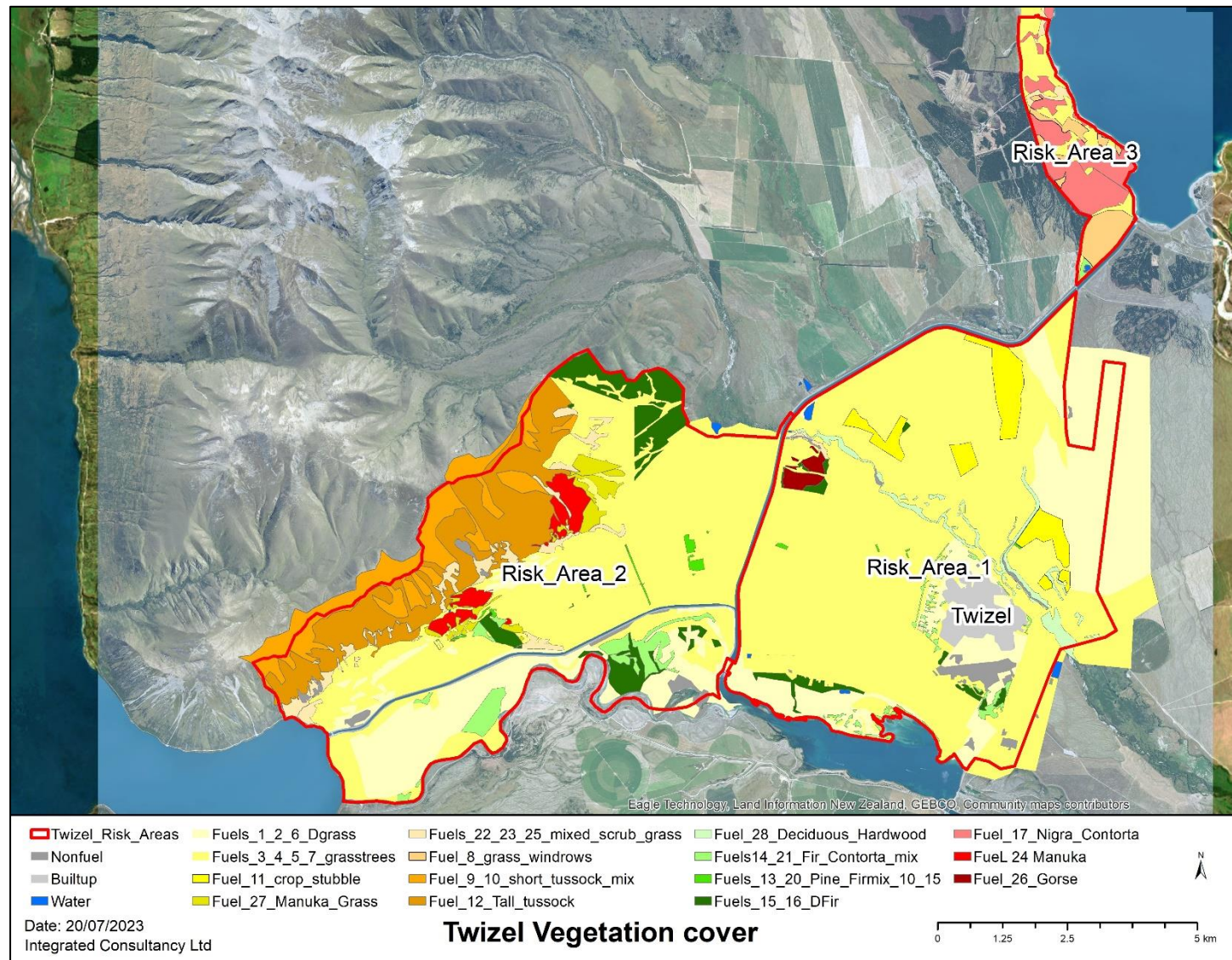
RUI section # or reference	Location	Vegetation at RUI	Vegetation nearing RUI	Terrain	People	Assets	Section Density
RUI-1	Max Smith Drive	Grass, amenity plantings scrub and tussock, odd 10-15 m conifers	None, 8 m road	Low angle	Private residence	14 x dwellings. 10 x other buildings. 6 x sections.	~ 0.2 – 2 ha
RUI-2	Rear boundary of properties on south side of The Drive	Douglas Fir, fuels 15 and 16. Grass, fuels 3 and 5.	Douglas Fir, fuels 15 and 16.	Escarpment @ 30 – 40°	Private residence	11 x dwellings. 6 x other buildings. 6 x sections.	~ 1 – 1.9ha
RUI-3	Rear boundary of properties on north side of The Drive, Woodley Ave., and Ostler Drive	Grass, fuels 3 and 5.	Grass, fuels 3 and 5. Metal access road along part of Woodley Ave properties and 4x4 track along part of The Drive properties.	Low angle	Private residence and one industrial	31 x dwellings. 19 x other buildings. 15 x sections. 1 x Industrial buildings.	~ 0.5 – 1ha
RUI-4	SE boundary #18 Ostler Rd and along driveway #16 Ostler Rd SW boundary North West Arch between properties #72 and #58	Mainly metal driveway Ostler Rd. Metal road and track NW Arch but with Grass, fuel 4	Grass, fuels 3, 4 (tree component) and 5. Plantation, fuels 14 and 21	Low angle	Private residence	10 x dwellings. 3 x other buildings. <i>Don't double count 5 dwellings.</i>	~ 0.44 – 0.9ha
RUI-5	NW – SW boundaries of North West Arch between properties #3 and #54	Highly variable. Grass, fuels 2 (mown), 3, 4 (tree component), and 5. Plantation, fuels 14 and 21	Highly variable. Grass, fuel 2 (mown), 3, 4 (tree component), 5 and 6. Plantation, fuels 14 and 21	Low angle	Private residence	22 x dwellings. 10 x other buildings. 12 x sections.	~ 0.4 – 2.2ha
RUI 6	NE side of Twizel. NE boundaries off North	Grass, fuels 1, 2 and 4	Grass, fuels 1, 2 and 4	Low angle	Private residence	60 x dwellings. 35 x other buildings.	~ 0.06 – 2.2ha

RUI section # or reference	Location	Vegetation at Rui	Vegetation nearing Rui	Terrain	People	Assets	Section Density
	West Arch, Glencairn Rd & Tekapo Drive. SW boundaries of properties #105-133 SW side of Glen Lyon Rd.					9 x sections. <i>Don't double count 1 dwelling.</i>	
RUI-7	SW boundary of properties on SW side of Glen Lyon Rd #193 – 207.	Grass, fuels 3 and 5. Plantation (hedge), fuel 15.	Grass, fuels 3 and 5.	Low angle	Private residence and industrial	3 x dwellings. 4 x other buildings.	~ 0.2 – 0.6ha
RUI-8	SW boundary of properties on SW side of Glen Lyon Rd #235 - 325. SE properties rear boundary Old Glen Lyon Rd #19-101	Grass, fuels 3 and 5.	Grass, fuels 3 and 5. Plantation (hedge row end), fuel 15.	Low angle	Private residence	15 x dwellings. 5 x other buildings. 9 x sections.	~ 0.4 -1ha
RUI-9	SE boundary #99 Boundary Tce. NE boundary #6 Old Glen Lyon Rd. NE-NW boundaries even #4-100 Boundary Tce. Rear boundaries odd #1-57 plus #38 Musterers Way. Rear boundaries odd #5-17 Cameron Place.	Old Glen Lyon Rd - 8m Musterers Way mineral track - 3m	Grass, fuels 3 and 5.	Low angle	Private residence	14 x dwellings. 11 x other buildings. 23 x sections.	~ 0.5 – 0.9ha

RUI section # or reference	Location	Vegetation at Rui	Vegetation nearing Rui	Terrain	People	Assets	Section Density
RUI-10	Block of 4 dwellings with access 1 km NW along Glen Lyon Rd from Old Glen Lyon Rd.	Grass, fuels 3 and 5. Plantation, fuel 14 SE.	Grass, fuels 3 and 5. Plantation, fuel 14 east side. Metalled Road 2 thirds of NE side.	Low angled	Private residence	4 x dwellings. 1 x other building.	~ 0.8ha
RUI-11	N- NE boundary of properties on the NE side of Glen Lyon Rd from #210 to #270.	Grass, fuels 3 and 5. Plantation, fuel 14 Deciduous Hardwoods, fuel 28	Grass, fuels 3 and 5. Plantation, fuel 14 Deciduous Hardwoods, fuel 28. Riverbed of Fraser Stream.	Low angled	Private residence	12 x dwellings. 10 x other buildings 1 x section	~ 0.3 – 0.8ha
RUI-12	N-NE boundary of properties on the NE side of Glen Lyon Rd from #120 to #160.	Grass, fuels 1 & 3 Mineral earth track along some.	Grass, fuels 1 & 3	Low angled	Private residence	6 x dwellings. 3 x other buildings 1 x section	~0.25 – 0.45
RUI-13	Twizel Holiday Park #122 Mackenzie Drive.	Plantation, fuels 14 and 21 Grass, fuels 3 & 5	Some wooden fencing. Plantation, fuels 14 and 21 Grass, fuels 3 & 5 Glen Lyon and Nuns Veil roads.	Low angled	Commercial holiday park	7 x structures Mobile property Tents	Holiday park
R-14	NE boundaries of properties #88-102 Mackenzie Drive, odd #1-59 Jollie Rd., #1-15 Huxley Place and #1-7 Dobson Place.	Grass, fuels 3 & 5 Plantation, fuels 14 and 21	Grass, fuels 3 & 5 Plantation, fuels 14 and 21. Glen Lyon Rd – 8m SH 8 – 10m	Low angled	Private residence	42 x dwellings. 38 x other buildings 1 x section	~ 0.06 – 0.13ha

RUI section # or reference	Location	Vegetation at Rui	Vegetation nearing Rui	Terrain	People	Assets	Section Density
RUI-15	N-NE boundary of properties on the NE side of Glen Lyon Rd from #12 to #52	Grass, fuels 3 & 5 Deciduous Hardwoods, fuel 28	Grass, fuels 3 & 5 Deciduous Hardwoods, fuel 28	Low angled	Private residence	7 x dwellings. 5 x other buildings 1 x section	~ 0.45 – 1ha
RUI-16	SE of Ostler Road subdivisions Mackenzie Park and Tussock Bend. SE boundaries of properties on Temple Drive, Hooker Cres, Lakeland Ave (to be constructed), Hydro Ave, Grandvue Drive and Batchter Rd.	Grass, fuels 1, 2 & 3 Plantation, fuel 14, 15 and 21 &16 Mineral earth areas.	Grass, fuels 1, 2 & 3 Plantation, fuel 14, 15 and 21 &16 Mineral earth areas. Batchter Rd – 5m. Max Smith Drive – 8m SH 8 – 10m	Low angled	Private residence Industrial	18 x dwellings. 10 x other buildings. 28 x sections. 9 x Industrial buildings	~ 0.6 – 2.5ha

13.5. Appendix 5: Vegetation classification



13.6. Appendix 6: Fire Danger Class summary

Table 31: Pukaki Aero – Forest Fire Danger Class

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	YEAR	FIRE SEASON
Low	30.8	29.6	19.2	14.5	7.5	9.0	6.1	6.3	8.8	13.9	26.3	29.0	201.0	66.1
Moderate	0.2	1.2	9.0	11.6	12.0	10.9	9.8	9.3	12.2	12.1	4.0	0.9	93.2	77.9
High	0.0	0.1	1.2	3.2	5.6	5.2	6.8	6.5	6.0	2.7	0.4	0.1	37.9	36.1
Very High	0.0	0.0	0.6	1.0	2.0	2.6	3.2	3.1	1.7	0.3	0.2	0.0	14.7	13.9
Extreme	0.0	0.0	0.0	0.6	2.9	3.3	5.0	3.1	2.4	1.0	0.0	0.0	18.4	18.3
Extreme	0.0	0.0	0.0	0.6	2.0	2.5	3.5	1.9	1.7	0.7	0.0	0.0	12.8	12.7
Very Extreme	0.0	0.0	0.0	0.0	0.9	0.8	1.5	1.2	0.7	0.3	0.0	0.0	5.6	5.6

Table 32: Pukaki Aero – Grassland Fire Danger Class

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	YEAR	FIRE SEASON
Low	14.0	10.0	3.7	3.4	2.6	2.9	2.2	2.4	3.2	6.4	11.7	21.5	83.9	23.0
Moderate	16.7	20.0	20.6	18.1	14.0	11.8	8.9	10.6	19.0	21.5	18.2	8.3	187.9	104.0
High	0.3	1.0	4.1	6.8	8.8	10.4	12.1	11.2	6.5	1.9	1.0	0.1	64.2	57.7
Very High	0.0	0.0	1.3	1.9	3.0	3.3	4.5	2.0	1.6	0.2	0.2	0.0	18.0	16.5
Extreme	0.0	0.0	0.3	0.8	1.5	2.6	3.3	2.0	0.8	0.0	0.0	0.0	11.3	11.0
Extreme	0.0	0.0	0.3	0.8	1.5	2.5	3.0	1.9	0.8	0.0	0.0	0.0	10.7	10.4
Very Extreme	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.1	0.0	0.0	0.0	0.0	0.5	0.5

Table 33: Pukaki Aero – Scrub Fire Danger Class

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	YEAR	FIRE SEASON
Low	11.2	8.0	4.4	4.5	3.5	3.9	3.1	2.9	3.5	5.7	10.7	14.2	75.7	27.1
Moderate	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3	0.0
High	11.8	9.8	4.5	4.1	2.0	2.7	1.8	1.8	3.3	4.3	7.3	9.0	62.4	20.1
Very High	4.7	6.4	4.2	3.3	2.1	2.7	1.5	2.1	3.5	4.9	5.8	3.3	44.5	20.1
Extreme	3.1	6.8	17.0	19.0	22.5	21.7	24.5	21.4	20.7	15.1	7.1	3.4	182.4	145.0
Extreme	2.2	4.5	9.5	6.7	5.6	6.1	5.3	7.0	9.3	9.9	4.2	1.8	72.3	50.1
Very Extreme	0.9	2.3	7.4	12.3	16.9	15.5	19.2	14.5	11.3	5.2	3.0	1.6	110.1	94.9

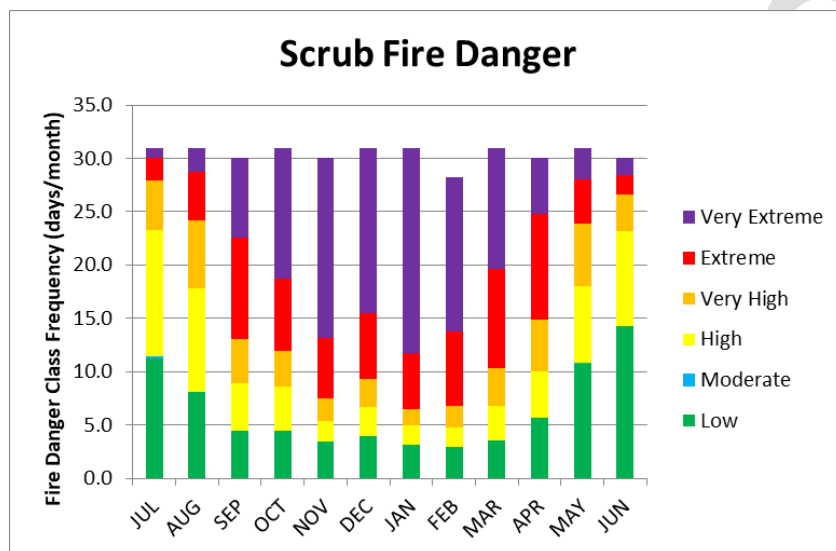
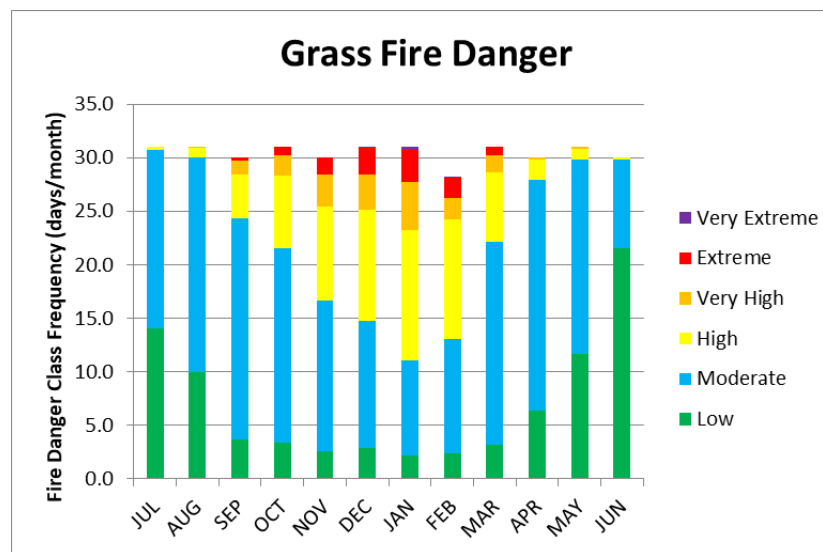
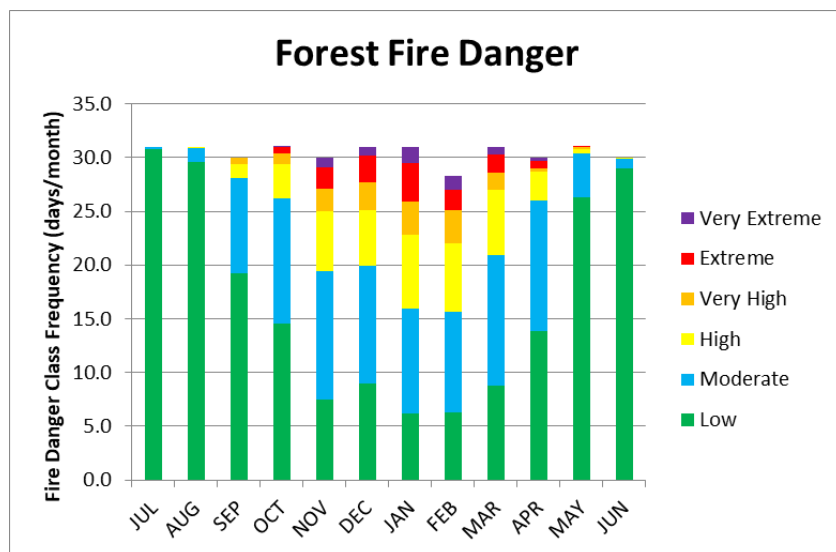


Table 34: Pukaki Aero adjusted for Risk Area 2 (Manuka Terrace) – Forest Fire Danger Class

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	YEAR	FIRE SEASON
Low	30.8	29.6	20.1	15.0	7.7	9.0	6.3	6.3	9.0	14.3	26.7	28.9	203.9	67.7
Moderate	0.2	1.2	8.0	11.3	11.5	11.1	9.6	9.2	12.0	11.8	3.6	0.9	90.5	76.6
High	0.0	0.2	1.2	3.2	5.6	4.5	6.8	6.5	5.7	2.4	0.5	0.2	36.7	34.7
Very High	0.0	0.0	0.7	0.8	2.2	2.7	2.7	2.9	1.7	0.5	0.2	0.0	14.3	13.5
Extreme	0.0	0.0	0.0	0.7	2.9	3.6	5.6	3.3	2.6	1.0	0.0	0.0	19.8	19.7
Extreme	0.0	0.0	0.0	0.7	1.7	2.7	4.0	1.8	1.6	0.6	0.0	0.0	13.2	13.1
Very Extreme	0.0	0.0	0.0	0.0	1.2	0.9	1.6	1.4	1.0	0.4	0.0	0.0	6.7	6.7

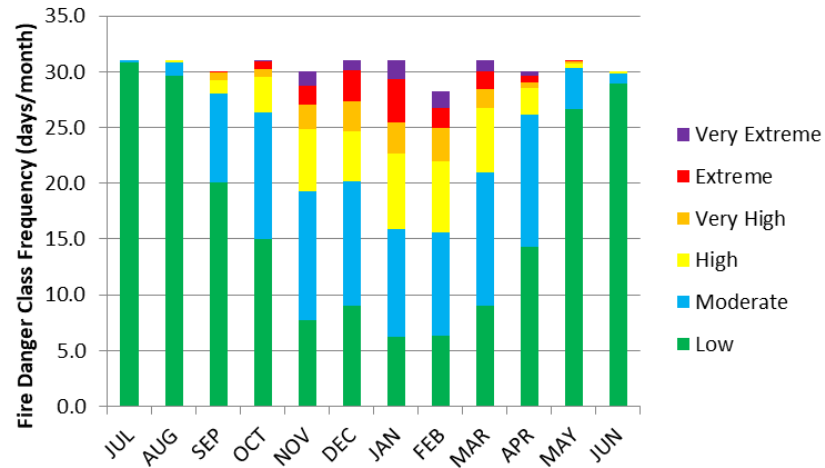
Table 35: Pukaki Aero adjusted for Risk Area 2 (Manuka Terrace) – Grassland Fire Danger Class

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	YEAR	FIRE SEASON
Low	13.6	10.1	3.8	3.6	2.6	3.0	2.1	2.3	3.2	6.5	11.7	21.3	83.7	23.3
Moderate	16.9	19.7	19.7	16.9	13.0	11.3	8.5	10.2	18.7	21.0	17.7	8.4	182.0	99.6
High	0.5	1.1	4.4	6.9	8.8	10.5	12.0	11.2	6.2	2.0	1.3	0.3	65.3	57.6
Very High	0.0	0.0	1.4	1.9	3.0	2.9	3.9	1.8	1.6	0.5	0.3	0.0	17.4	15.7
Extreme	0.0	0.0	0.7	1.7	2.6	3.4	4.5	2.6	1.3	0.0	0.0	0.0	16.8	16.2
Extreme	0.0	0.0	0.7	1.7	2.6	2.9	3.9	2.0	1.3	0.0	0.0	0.0	15.1	14.4
Very Extreme	0.0	0.0	0.0	0.0	0.0	0.5	0.6	0.6	0.0	0.0	0.0	0.0	1.8	1.8

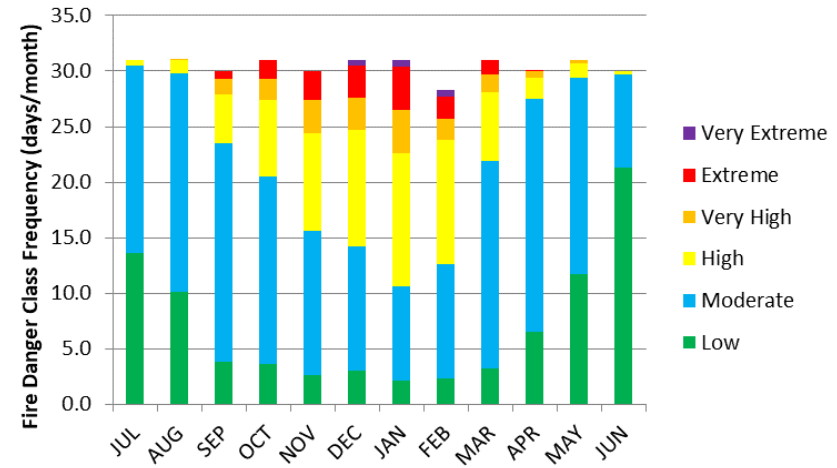
Table 36: Pukaki Aero adjusted for Risk Area 2 (Manuka Terrace) – Scrub Fire Danger Class

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	YEAR	FIRE SEASON
Low	11.3	8.5	4.5	4.6	3.5	4.1	3.2	3.0	3.7	5.8	10.8	14.2	77.3	27.9
Moderate	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.4	0.0
High	11.2	9.1	4.1	3.9	1.9	2.5	1.5	1.8	3.1	4.2	7.0	8.6	58.9	18.9
Very High	5.0	6.2	3.8	3.4	1.8	2.4	1.5	1.9	3.4	4.7	5.8	3.4	43.4	19.2
Extreme	3.4	7.1	17.5	19.0	22.8	22.0	24.8	21.5	20.7	15.2	7.3	3.7	185.3	146.2
Extreme	2.3	4.5	9.7	6.5	5.5	5.8	5.0	6.7	8.7	9.7	4.0	1.9	70.2	47.9
Very Extreme	1.1	2.6	7.9	12.6	17.3	16.2	19.8	14.8	12.1	5.5	3.4	1.8	115.1	98.3

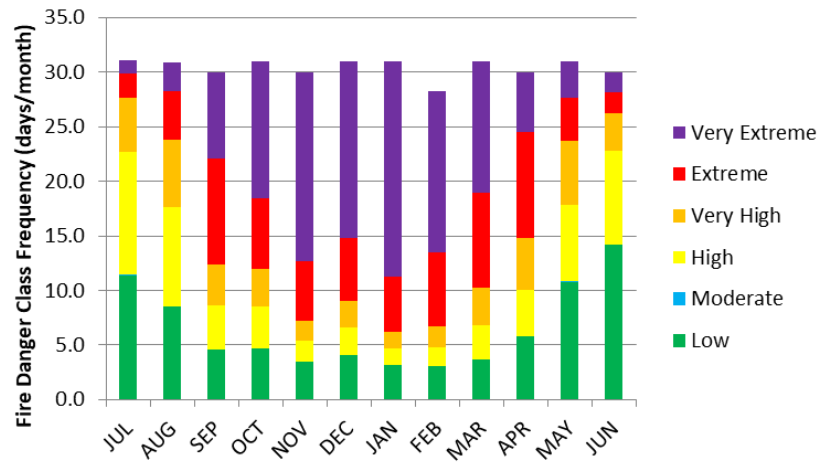
Forest Fire Danger



Grass Fire Danger



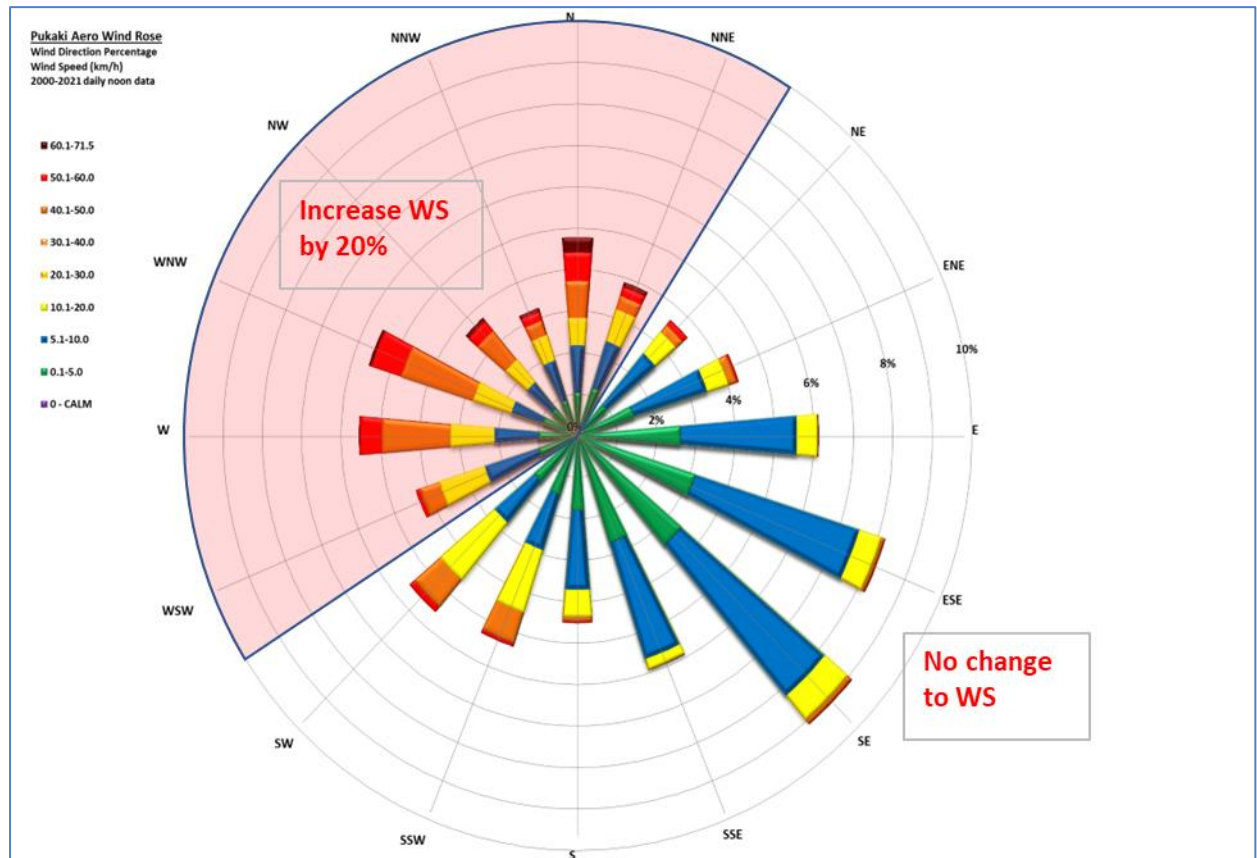
Scrub Fire Danger



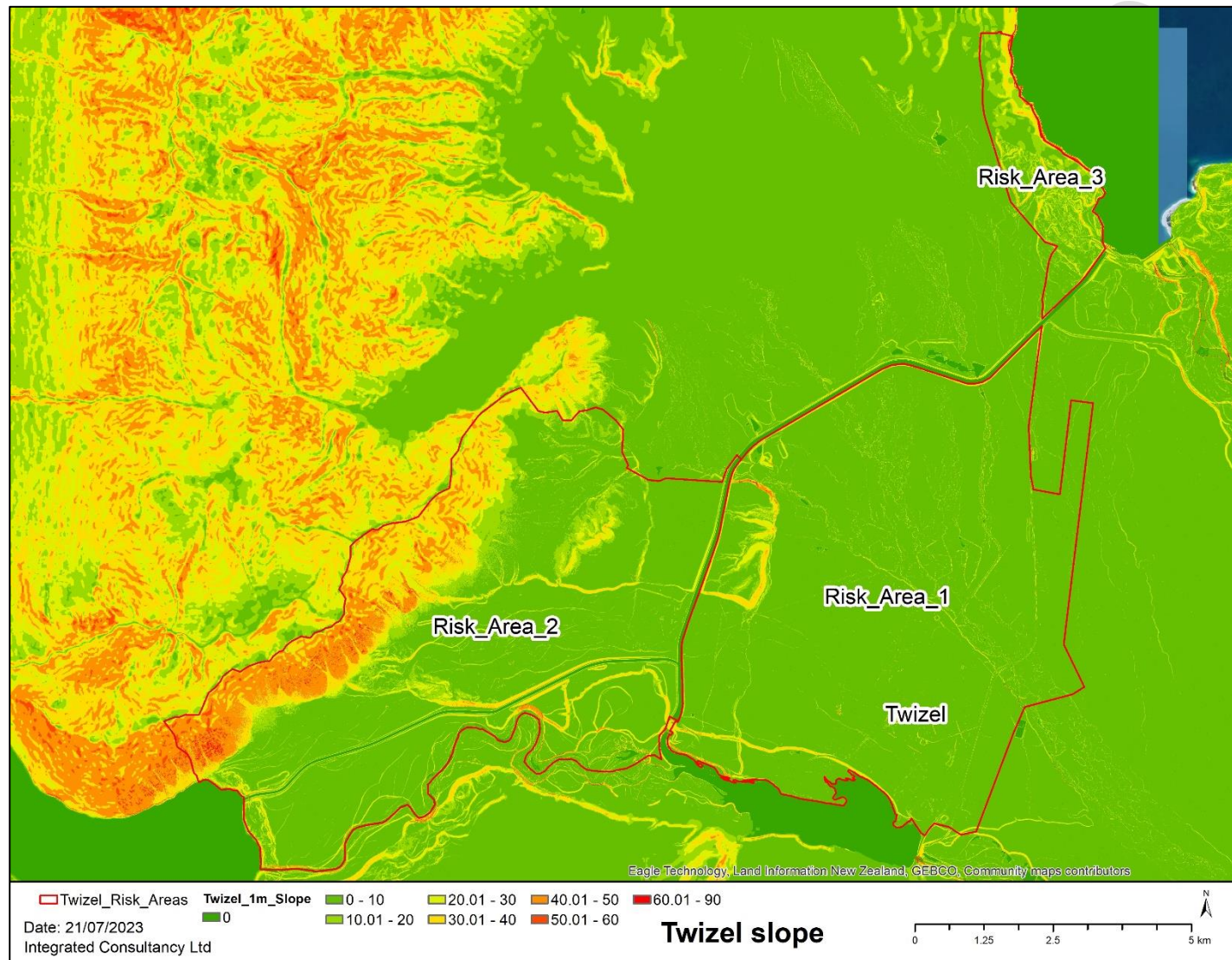
13.7. Appendix 7: Fire Weather Index Summary

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	FIRE SEASON
Temperature, degrees Celsius														
mean	20.6	20.1	17.4	13.3	8.8	4.7	4.2	7.1	11.2	14	16.8	19	13	17.3
median	20.6	20.1	17.4	13.2	8.4	4.5	3.9	7	11.2	14.1	16.9	19.2	13.3	17.2
max	31.9	31.1	28	24.9	23.4	17.5	16.1	17.9	21.6	24.6	27.1	28.3	31.9	31.9
min	9.9	7.6	3.3	3.4	-2.4	-9.8	-6.4	-0.2	0.6	2.9	1.6	6.1	-9.8	1.6
Relative Humidity, %														
mean	45.4	48.3	54.2	61.9	72.7	79.9	78.5	71.6	56.6	49.7	45.8	47	59.5	50.4
median	43	47	53	61	73.8	84	80	72	55	47	43	45	57	48
max	100	100	100	100	100	100	100	100	100	100	100	99.1	100	100
min	10	11	12	16	15	27	29	23	15	17	11	15	10	10
Wind Speed, km/h														
mean	13.3	10.7	10	8.7	8.7	7	6.8	8.5	12.1	13.4	14.7	13	10.6	12
median	9.2	7.2	6.4	5.4	5.2	4.6	4.3	5.4	7.6	9.4	10.1	8.6	6.8	7.9
max	47.3	44.6	49	45.1	49	48.7	58.8	57.5	71.5	64.4	53.5	60.8	71.5	64.4
min	1.6	1.6	1.8	0.9	0	0	0	0	0.6	1.4	2.2	1.2	0	0.9
24-hr Rainfall, millimeters														
mean	1.6	1.5	1.1	1.4	1.6	1.9	1.3	1	1.2	1.4	1.6	1.8	1.4	1.5
median	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0
max	38.6	65.2	32	35.8	42.4	69	49.2	29.6	46.2	48.8	65.6	66.6	69	66.6
min	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monthly Rainfall, millimetres														
mean	48.4	43.4	35.2	40.3	48.2	55.5	38.3	30.7	32.6	43.4	49.2	55	43.4	45
max	124.2	183.2	74.2	93.4	102.8	150.8	128	66.2	83.2	98.8	119.2	122.8	183.2	183.2
min	4.8	2.2	5	2.2	19.6	9.6	9	3.8	4.6	7.6	2.1	11.4	2.1	2.1
Seasonal Rainfall, millimetres														
mean													520.4	312.9
max													772.3	572.6
min													337	189.7
Fine Fuel Moisture Code, FFM														
mean	82.5	82.2	80	74.3	64.4	56.5	62.8	67.4	76.2	77.4	81.1	80.4	73.7	79.7
median	88.5	87.8	85.9	83	73.1	62.4	70.9	74.6	82.6	84.3	87.5	87.1	81.6	86.4
max	96.4	96.6	95.5	93.4	92	90.2	87.8	90.5	93.9	93.9	95.8	95.4	96.6	96.6
min	7.3	14.1	10.9	3	3.7	2.3	3.6	2.8	14.6	16.4	5.6	13.1	2.3	3
Duff Moisture Code, DMC														
mean	38.4	43.9	40.4	26.1	8.6	3.1	1.8	3.7	11.9	19.7	31.2	33.8	21.8	33.3
median	33.1	42.8	35.5	24	5.9	1.7	1.3	2.7	9.7	16.8	26.1	30.5	14.2	28.4
max	158.7	113.9	122	80.5	58.1	22.5	12.4	17.8	45.2	69.8	104.2	108.7	158.7	158.7
min	1.7	2.5	2.4	0	0	0	0	0	0	1.3	3.4	1.5	0	0
Drought Code, DC														
mean	351.5	422	460.3	458.1	365.2	264.9	174	141	142.8	167.8	223.2	289.8	289.5	339.9
median	335	418.6	453.5	454.5	372.6	263.3	166.7	121.8	131.2	168.8	209.8	271.1	273.8	339.3
max	656.4	718.1	738	739.6	731.6	519.8	371.7	382.8	400.9	441.6	420.6	521.2	739.6	739.6
min	134.6	45.5	46.9	34.5	8.2	0.1	0.7	0	0.7	1.6	15.3	74	0	1.6
Initial Spread Index, ISI														
mean	7.9	6.4	5	3.2	1.9	1.1	1.1	1.7	3.9	5.3	7.5	6.5	4.3	5.9
median	5.5	4.7	3.4	2.2	1	0.7	0.8	1.1	2.6	3.4	4.9	4.4	2.1	3.9
max	59.2	46.4	52.8	38.7	28.5	24.6	15.8	29.7	54.2	58.2	51.9	57.1	59.2	59.2
min	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buildup Index, BUI														
mean	58.2	67.8	64.1	44.2	15.7	5.9	3.2	6.2	18.1	28.2	43.7	50.7	33.7	51
median	53.1	68.3	59.7	42.1	11.1	3.4	2.4	4.8	14.7	25.8	38.9	46.5	24.1	45
max	196.9	144.9	163.8	123.7	96.9	40.2	22.3	29.9	64.8	78.5	118.1	137	196.9	196.9
min	3.2	4.9	4.6	0	0	0	0	0	0	1.7	5.1	2.8	0	0
Fire Weather Index, FWI														
mean	18.5	17.1	13.7	7.9	2.6	1	0.6	1.4	5.6	9	15.2	14.8	8.9	13.7
median	15.6	14.7	10.7	5.4	0.6	0.2	0.3	0.5	3.1	6	11.8	11.5	3.7	10.2
max	104.5	92	103.1	64.2	37.9	28.5	15	35.3	46	69.9	90.6	67.4	104.5	104.5
min	0	0	0	0	0	0	0	0	0	0	0	0	0	0

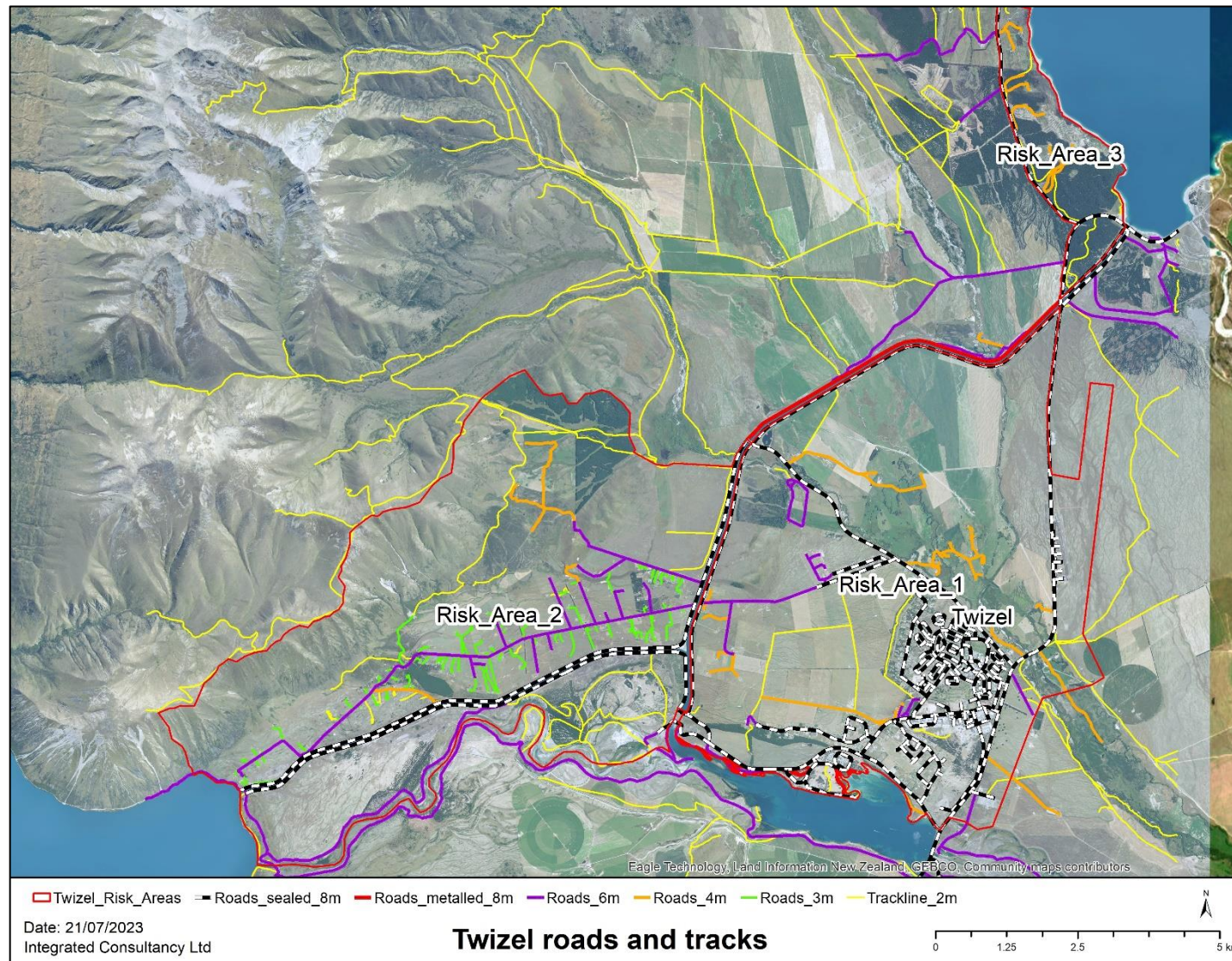
Windrose – percentage wind direction and speed with Manuka Terrace adjustment



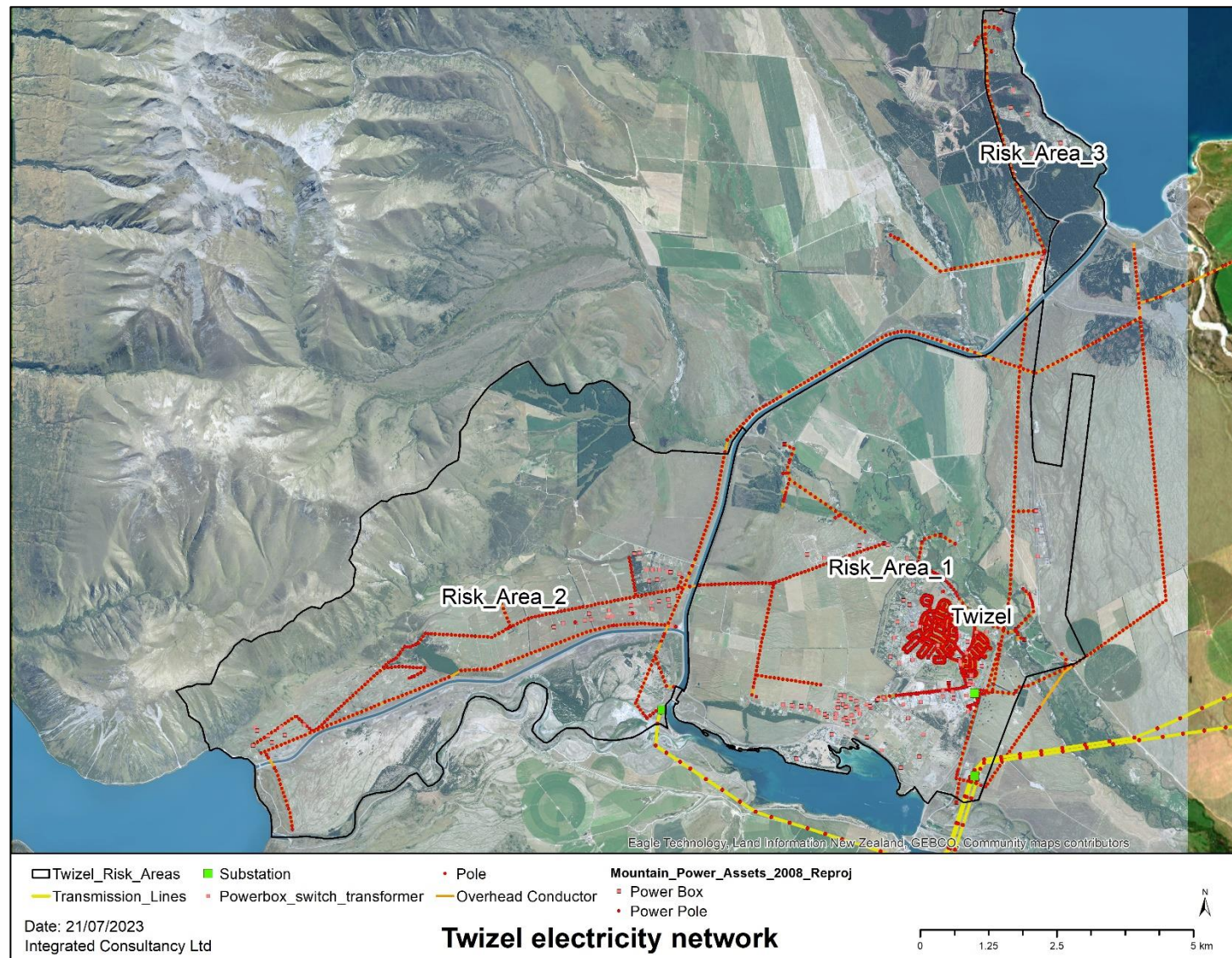
13.8. Appendix 8: Slope



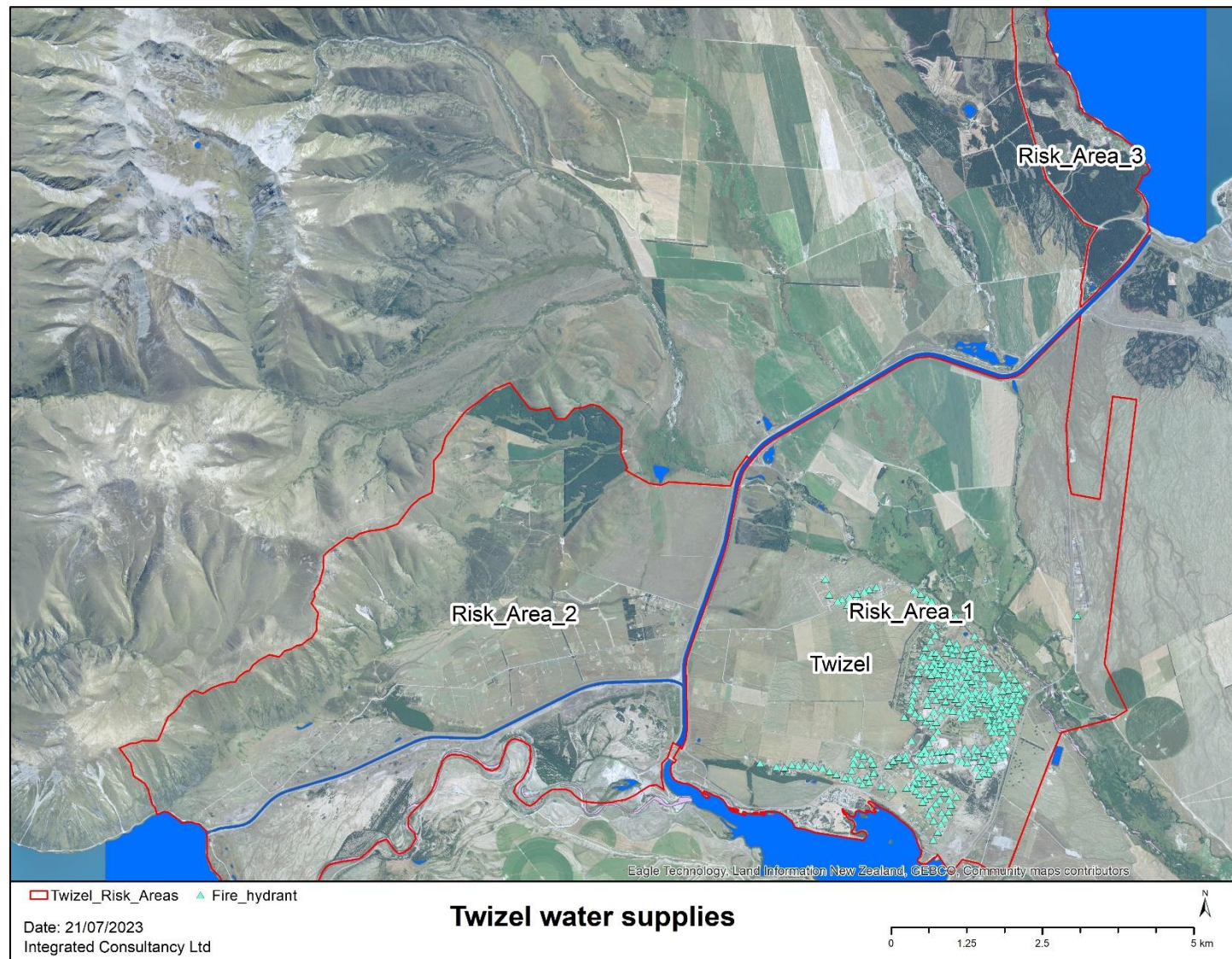
13.9. Appendix 9: Road and track layout



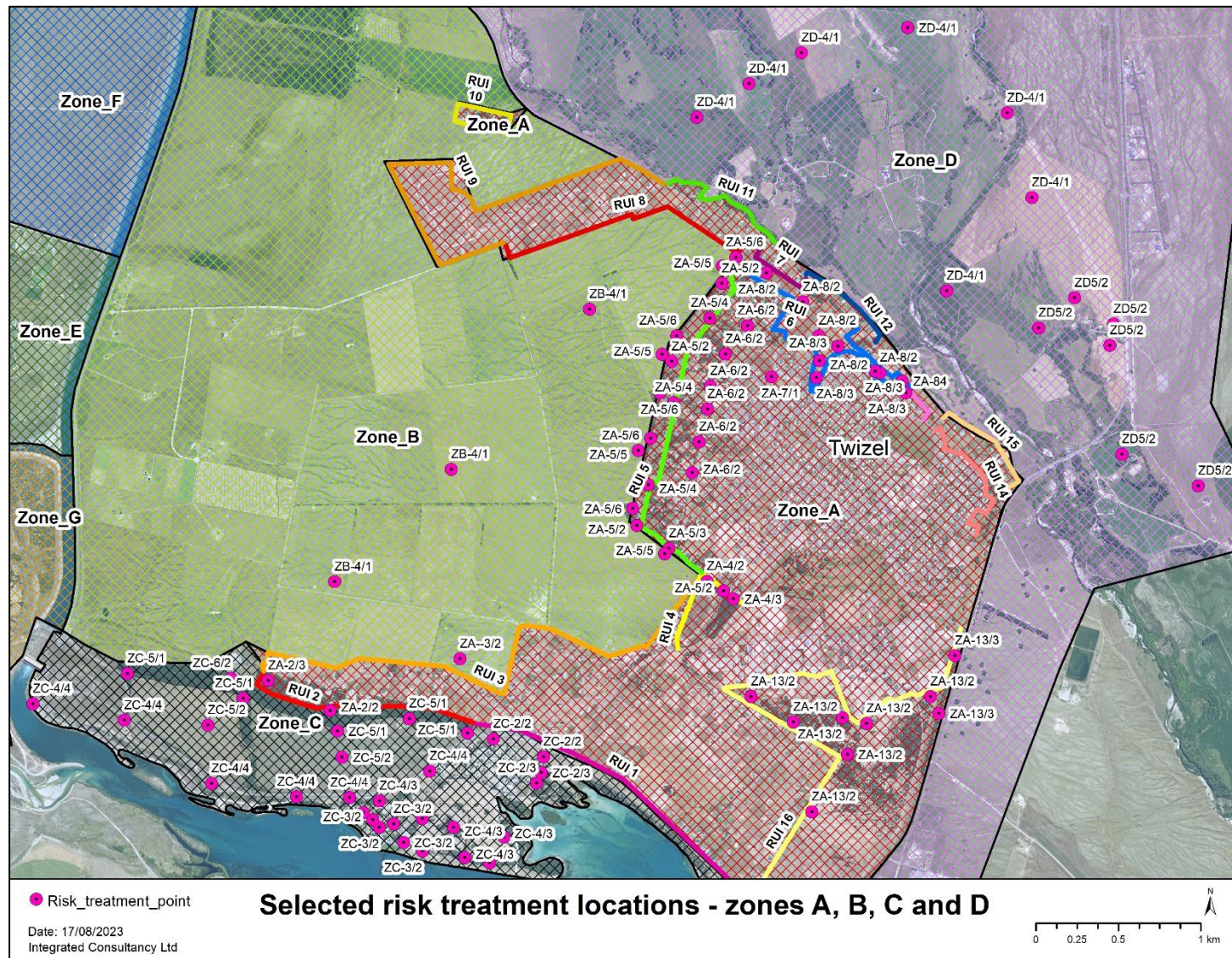
13.10. Appendix 10: Electricity network

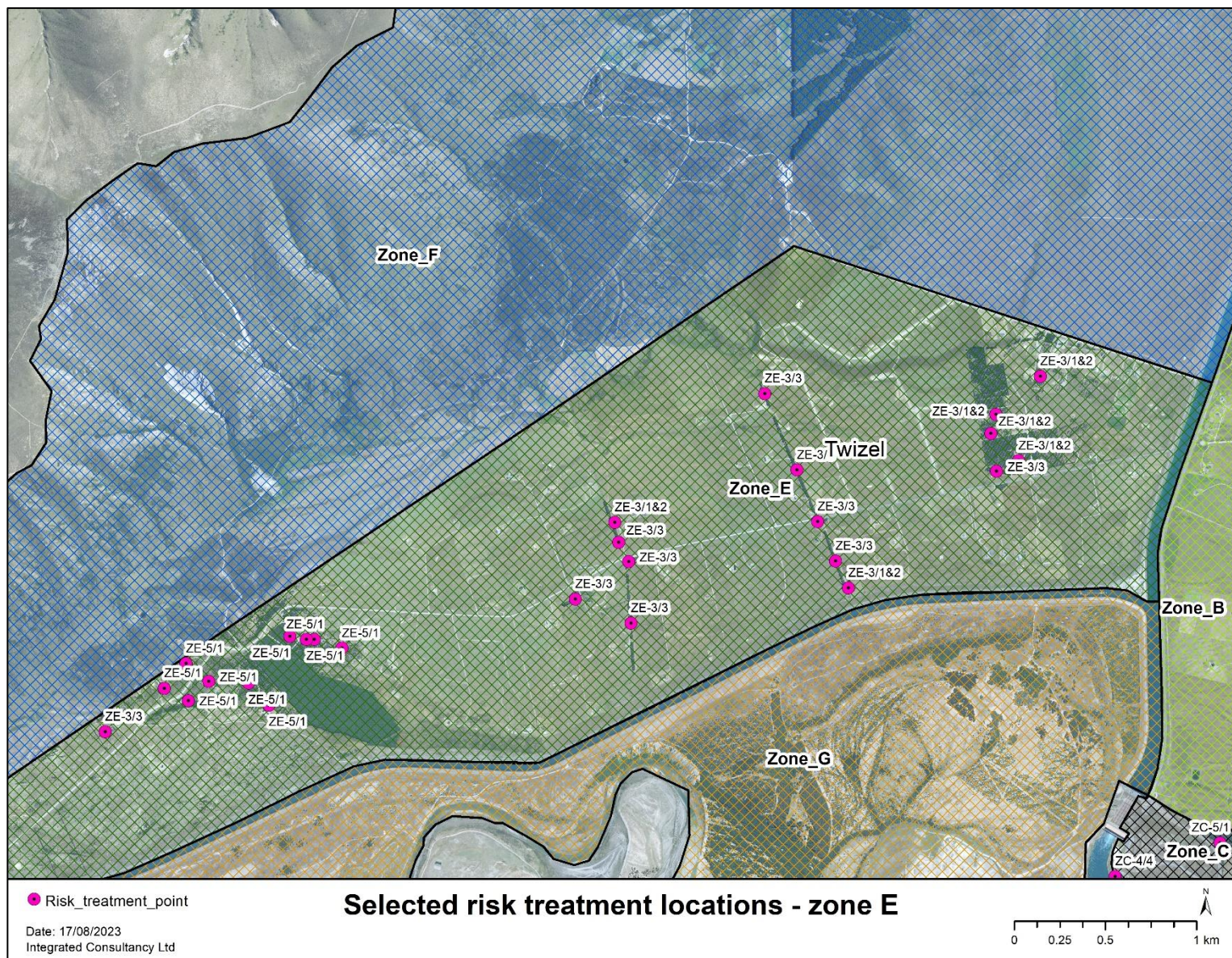


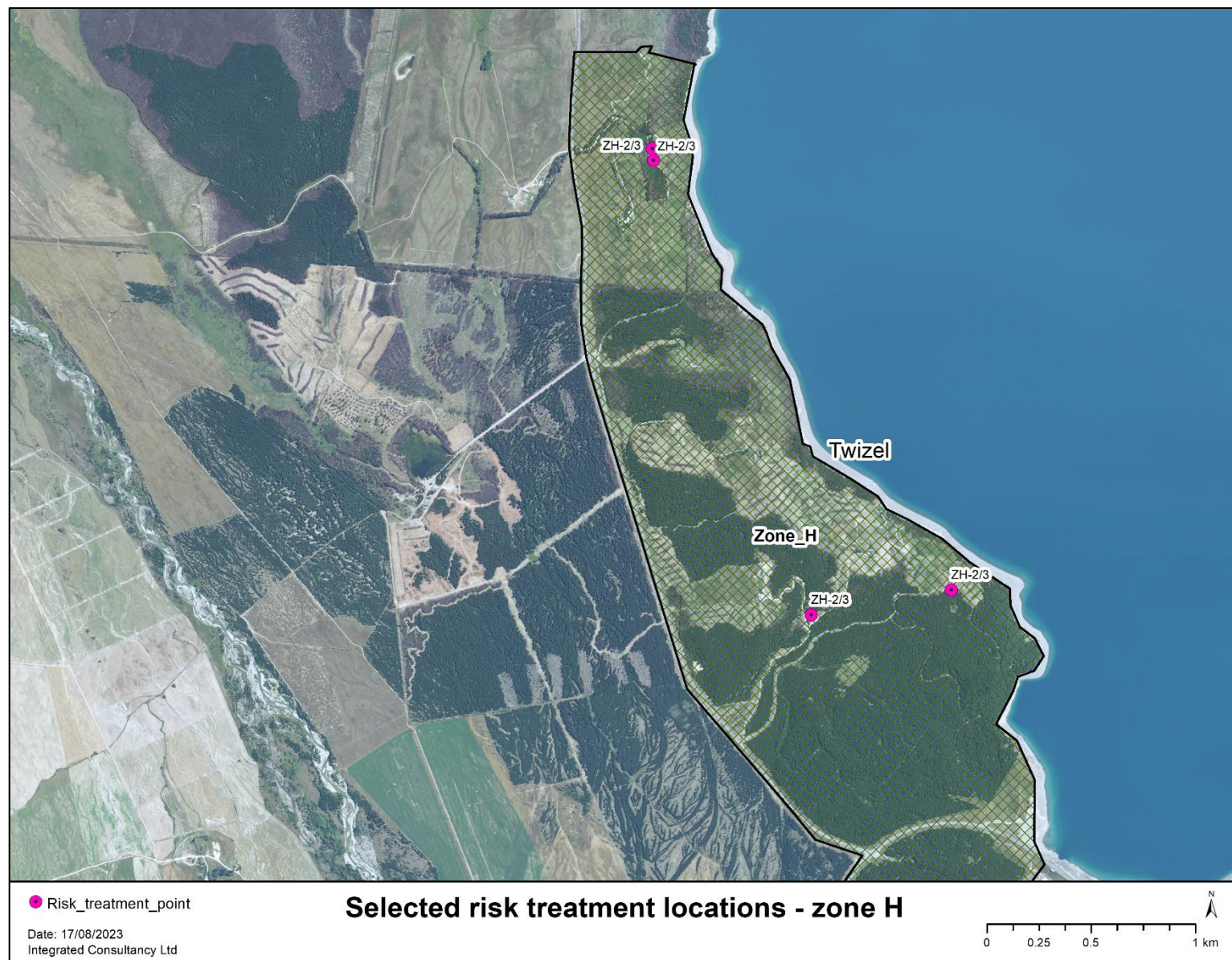
13.11. Appendix 11: Water supply



13.12. Appendix 12: Risk treatment locations







13.13. Appendix 13: Risk level matrices

Likelihood of ignition and spread

Likelihood of ignition and fire spread matrix						
Descriptor	Description	Number of days in a month that fire danger is Moderate to Very Extreme				
		30/31	24 - 29	16 - 23	7 - 15	1 - 6
Almost certain (5)	Expected to occur one or more times every year.	100.0	92.9	74.0	51.0	30.0
Likely (4)	Expected to occur once every two years.	89.9	83.5	66.5	45.8	27.0
Possible (3)	Expected to occur once every three to five years.	49.9	46.4	36.9	25.4	15.0
Unlikely (2)	Expected to occur once every six to ten years.	19.9	18.5	14.7	10.1	6.0
Rare (1)	Expected to occur once every eleven to thirty years.	9.0	8.4	6.7	4.6	2.7

Consequence level

Consequence level					
Consequence level	Wildfire ignition and spread	Evacuation opportunity and safety zones	Level of harm to people	Level of property damage (losses)	Level of environmental, cultural and historic damage (losses)
Catastrophic (6)	Location of ignition and the subsequent fire spread will impact values in a very short time.	No time to evacuate, and no adequate vegetation clear areas that could be used as safety zones. Burn-over of people will most likely occur.	Multiple fatalities. Search and rescue involvement. Incident investigated by coroner.	Greater than \$10 million.	Permanent loss of nationally significant values
Extreme (5)	Location of ignition and the subsequent fire spread will impact values in a short time.	There is little time to evacuate and no adequate vegetation clear areas that could be used as safety zones. There is no place for people to shelter from an advancing fire, or little time to move sufficiently away from it to a safe location. Access/egress may only be one way in and one way out as well as narrow roads and traffic congestion.	Multiple fatalities. Search and rescue involvement. Incident investigated by coroner.	Between \$5 and \$10 million.	Permanent loss of nationally significant values
Major (4)	Location of ignition and the subsequent fire spread will impact values in a relatively short time .	There are vegetation clear areas of sufficient area, and time to re-locate to them, or to evacuate to somewhere clear of a spreading fire. People who are not particularly mobile may not move fast enough to a clear area or are unable to evacuate quickly. Access/egress may only be one way in and one way out as well as narrow roads and traffic congestion.	Single person fatality or major injury to multiple (more than 3) subjects. Search and rescue involvement. Incident investigated, possibly by coroner.	Between \$500,000 to \$5 million	Permanent loss of regionally significant values
Moderate (3)	Location of ignition is somewhat away from values and may develop sufficiently to cause damage. Subsequent fire spread may eventually cut off evacuation routes.	Generally there is time to evacuate or move sufficiently away to a safe location. People may be impacted if travel away from a fire is difficult, including very narrow roads and/or traffic congestion, steep up and down tracks or zig zagging tracks, poor track surface, no track. A fire may cut off their evacuation route or some peoples mobility may result in slow evacuation.	Serious injuries to an individual requiring rescue party, or moderate injuries to multiple subjects. Incident investigated. Medical treatment required, including immediate off site assistance, e.g., follow-up emergency medical treatment. Incident reported.	Between \$50,000 and \$500,000 million.	Significant damage with long term recovery time required (>20y) or district level losses.
Minor (2)	Direction of fire spread is not aligned for a direct impact on values, or a fire is unlikely to develop sufficiently to cause too much damage to nearby values, however dense smoke and ash maybe dispersed over or near them, or a flanking	People would either evacuate or move sufficiently away to avoid smoke and ash fallout or a flank fire impact.	Minor injuries requiring first aid treatment - managed by those on site, e.g., minor cuts and bruises. No incident follow-up.	up to \$50,000.	Moderate damage with medium term recovery time required (up to 20y) or local level losses.
Insignificant (1)	Direction of fire spread disperses low density smoke over values, or values are well away from a spreading fire and are not directly effected. Visual only	People do not need to take evasive action to protect themselves. Evacuation may be precautionary in situations where people have existing health issues. People may continue to go about their activities.	No injuries, "fright factor". No incident follow-up.	Minor or no cost	Minor damage only - short recovery time.

Risk level

Risk levels							
Likelihood level	Almost certain (5)	Medium	Medium	High	Very High	Very High	Very High
	Likely (4)	Low	Medium	High	High	Very High	Very High
	Possible (3)	Low	Medium	Medium	High	High	High
	Unlikely (2)	Low	Low	Medium	Medium	High	High
	Rare (1)	Low	Low	Low	Medium	Medium	Medium
		Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Extreme (5)	Catastrophic (6)
	Consequence level						