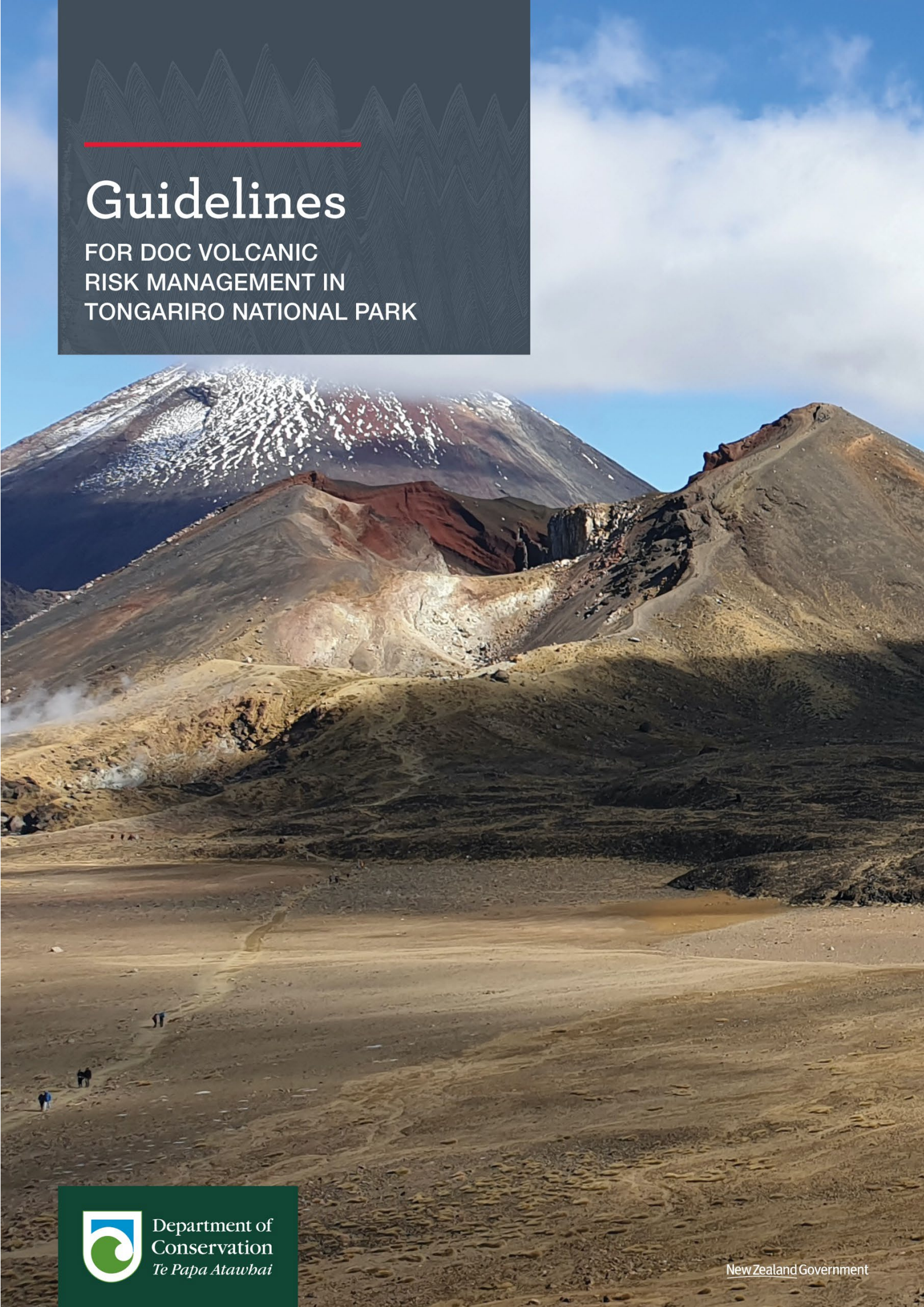
Guidelines

FOR DOC VOLCANIC RISK MANAGEMENT IN TONGARIRO NATIONAL PARK



Department of Conservation
Te Papa Atawhai

New Zealand Government

GUIDELINES FOR DOC VOLCANIC RISK MANAGEMENT IN TONGARIRO NATIONAL PARK

Document Control Document Ref: DOC-1130183				Department of Conservation Tongariro District Office	
Revision No.	**Date**	**Description**	**Author**	**Reviewed**	**Approved**
10.0	May 2023	1. Updates to introduction and purpose to reflect recent shifts in DOC's approach. 2. Inclusion of risk management maps for Ruapehu and Tongariro. 3. Inclusion of DOAS gas monitoring results check in 'Cool Mode' at Ruapehu. 4. Changes to volcanic risk management at Tongariro (Tongariro Alpine Crossing and Tongariro Northern Circuit) to ensure risk is not under, or over-managed, and to better align with Ruapehu and lessons learned there: • New decision-making process for spatial vs total closures, including vent specific 3 km radius closures. • TEDS alerting now only enabled during unrest (VAL 1 and 2) due to the system's susceptibility to wind triggered false positives, and the extremely low likelihood of eruption at VAL 0. • Responsiveness to Tongariro unrest at VAL 0 regarding discussion on enabling TEDS alerting.	[redacted]	[redacted]	CNI Director Operations: Damian Coutts

NOTES:

- Review of this document is required annually (usually in April) in conjunction with the Initial Response Plan for Volcanic Activity in Tongariro National Park DOCDM-1193248
- Earlier versions of this document can be found on DOCCM.

Cover photo: Theo Chapman

Contents

1. Introduction and purpose

These guidelines outline how the Department of Conservation (DOC) manages volcanic risk within Tongariro National Park (TNP) during quiet periods, periods of volcanic unrest, non-eruptive events, eruptions of Ruapehu, Tongariro and Ngāuruhoe volcanoes and their associated vents, and the eventual de-escalation of volcanic activity.

They explain how DOC coordinates with GNS Science (GNS), the New Zealand Police, local iwi and hapū (who have an intrinsic relationship with the volcanoes of the TNP – Ngāti Tūwharetoa through Ngāti Hikairo ki Tongariro, Ngāti Rangi, and Uenuku), stakeholders, and other agencies to respond to escalating (and de-escalating) volcanic activity. The guidelines also outline the process for closing areas of TNP and DOC assets in response to increasing risk from volcanic unrest or activity, but do not outline a detailed plan for reopening. The reopening phase will be planned and addressed alongside iwi, hapū and GNS.

The reflex risk management tools and actions from the DOC Risk Management Stages described in tables 1, 2, 3, 4 and 5 of this document are Trigger Action Response Plans (TARPs) to enable the decisive application of visitor risk management during volcanic unrest. The TARPs are targeted at reducing risk from the probable impacts of an initial eruption (the first event). The focus is reducing human vulnerability to volcanic hazards within TNP during periods of volcanic unrest.

Once an eruption has occurred, the Department may need to modify its approach based on the volcanic unrest and eruptive behaviour at the volcano, and the insights provided by GNS and other subject matter experts.

DOC's volcanic risk management approach in TNP utilises research and monitoring, alerts and public warnings, and simple systems and processes that enable staff to respond in quick, confident, and knowledgeable ways (Figs 1 & 2).

This document remains live and will evolve in response to greater understanding of volcanic unrest. DOC's approach to risk management is subject to change as improvements are identified, and progress is made in the fields of volcanology and risk management.

The Initial Response Plan (IRP) is the primary document that guides DOC's initial response to an eruption within TNP, or a false positive activation of the Volcanic Alert Network (VAN).

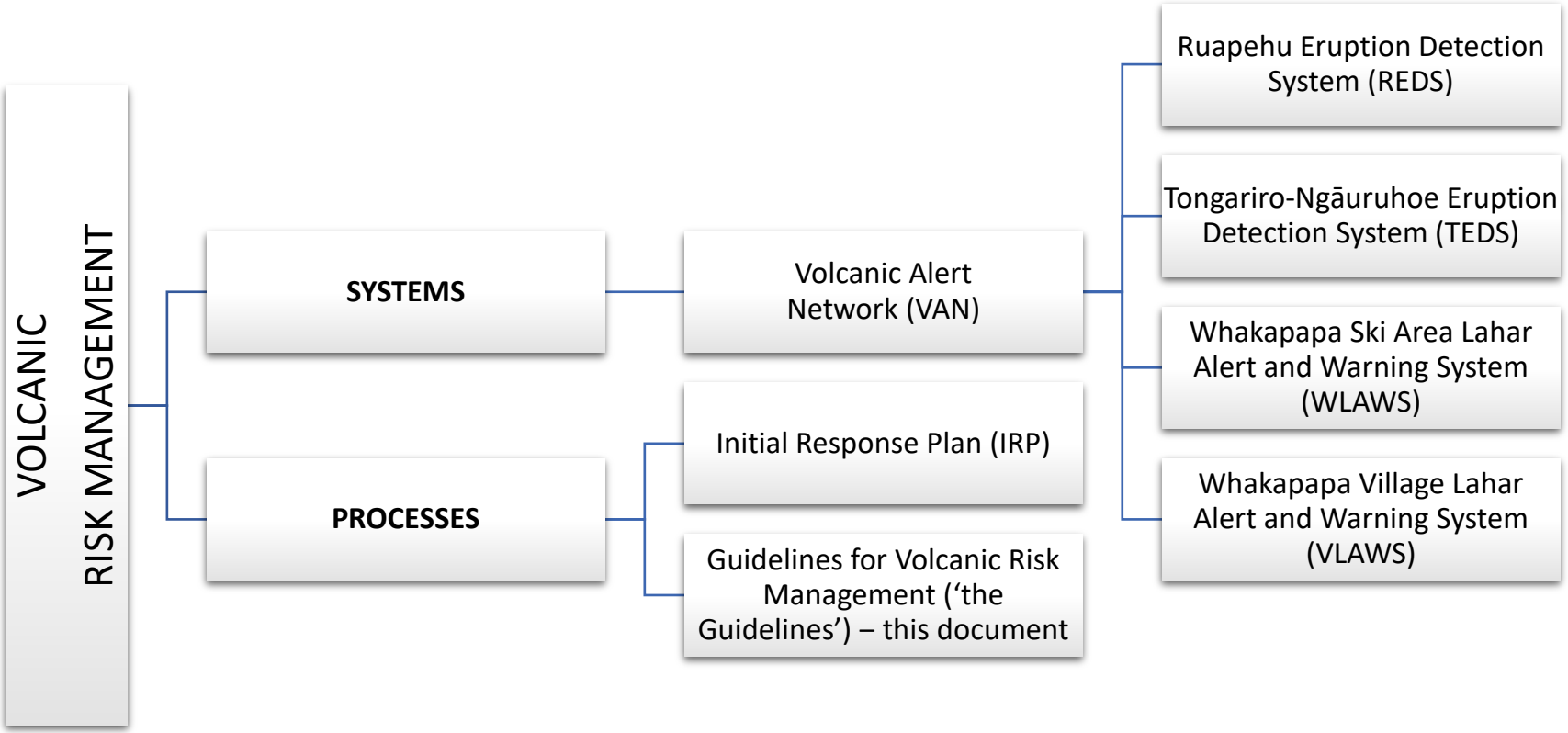


Figure 1. Diagram showing the Department of Conservation's volcanic risk management approach within Tongariro National Park.

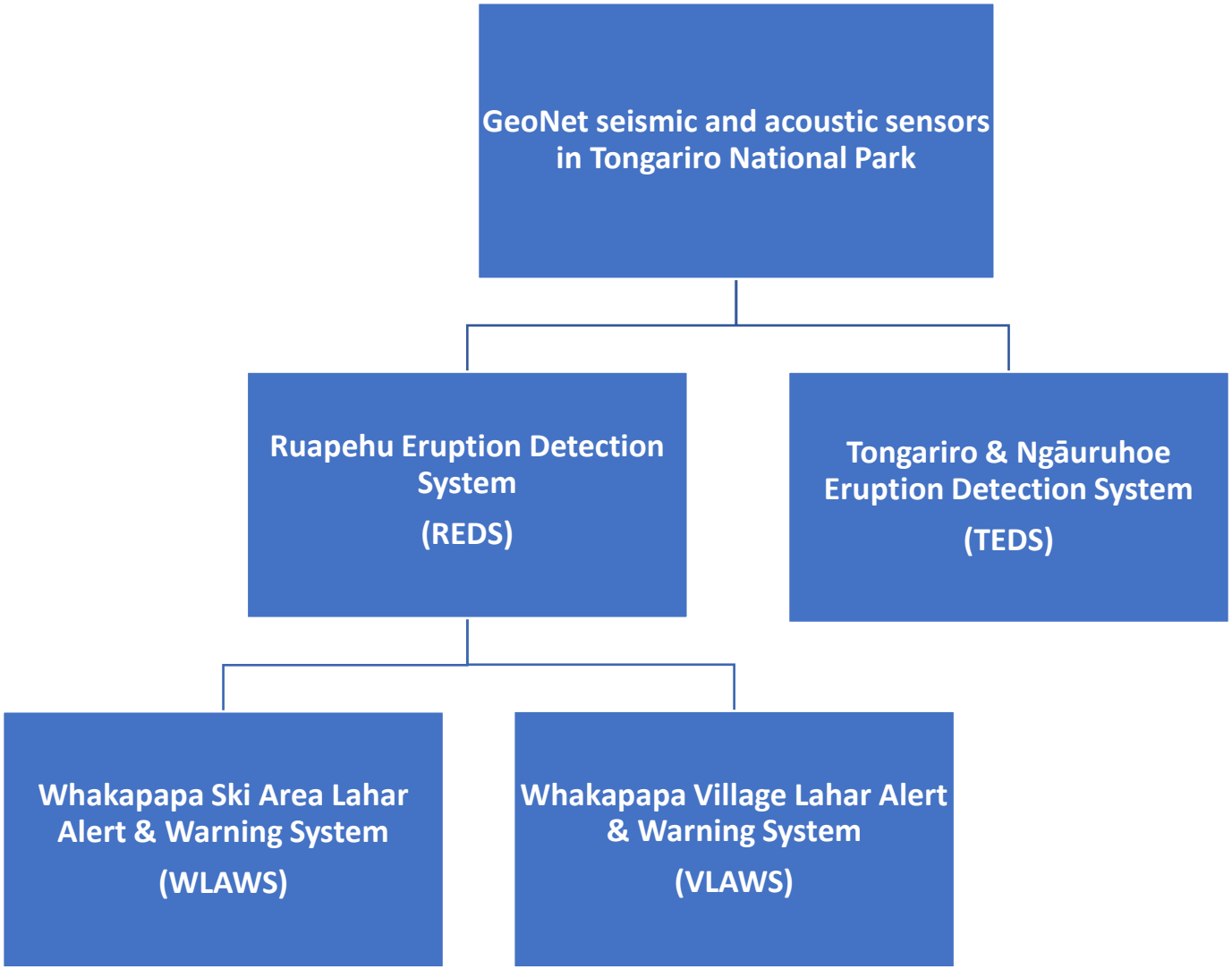


Figure 2. Diagram showing the Volcanic Alert Network (VAN) in Tongariro National Park.

2. VOLCANIC PHENOMENA AND RISKS IN TONGARIRO NATIONAL PARK

2.1 Background

Mounts Ruapehu, Tongariro and Ngāuruhoe are active volcanoes. Records of their most recent eruptions over the last 120+ years, complemented with research by many science agencies, indicate the most likely range and extent of the volcanic phenomena that may occur during their eruptions. Evidence from major eruptions over the last 10 000-15 000+ years indicates the maximum severity of the volcanic activity that might occur, or other vents that might become active (e.g. Pardo et al. 2012; see Appendix 1 for references).

The volcanoes erupt at irregular intervals, with warnings from days to weeks or more or, sometimes, little to no warning at all. The last major eruptions from Ruapehu occurred in 1995–96 and a typical short-lived event occurred in September 2007. The last major eruptions at Ngāuruhoe were in 1974/75 with a small event in 1977. At Tongariro, there were two small eruptive events at Te Maari Crater in August and November 2012. DOC's internal planning and preparation for volcanic events at TNP predominantly focuses on one-offs or short-lived events. Research from Massey University and the University of Auckland focused on revealing details of prehistoric multi-phase and long-term eruptions of these volcanoes to ascertain likely durations and scales of major eruptive events has been completed and may inform future planning.

At present, the main threats from volcanic phenomena in TNP are:

- flying rocks (ballistics),
- Lahars (volcanic mud flows),
- Pyroclastic density currents (PDCs),
- Ashfall and gas – but these are generally of minor concern compared with the first three threats listed.

At Ruapehu, lahars are the phenomena most likely to injure people and damage property, although flying rocks and blasts are also a threat. Lahar paths exist throughout TNP, but in relation to proximity of visitors, lahars through the Whakapapa Ski Field and Whakapapa Village are the most significant risk.

Based on previous eruptions, the time for a lahar to reach the top of the Whakapapa Ski Field from Te Wai ā-moe (Crater Lake) is approximately 1–5 minutes; to the bottom of the Whakapapa Ski Area is 15 minutes; and to Whakapapa Village is 25 minutes. Larger lahars travel faster, especially after heavy rain.

On Tongariro, the recent 2012 eruptions at Te Maari Crater damaged sections of the Tongariro Alpine Crossing with flying rocks (inundating the now removed Ketetahi Hut) and producing a heat blast hot enough to damage a significant amount of vegetation on the northern flanks of the mountain west of Te Maari. These recent and historical events are reminders of the variability and range of volcanic phenomena present within TNP.

Appendix 2 provides further information on volcanic phenomena, activity and scenarios, along with a summary of volcanic risks.

2.2 Volcano monitoring, New Zealand Volcanic Alert Levels (VALs) and Volcanic Activity Bulletins (VABs)

All volcanoes within the TNP are constantly monitored by GNS through GeoNet. When a change in volcanic unrest or activity is detected, various pre-determined actions are carried out to reduce

the risk to people. For DOC, this may include closing parts of the ski fields on Ruapehu or closing the Tongariro Alpine Crossing on Tongariro.

Figure 3 shows the Volcanic Alert Levels (VALs) that are applied to all volcanoes within New Zealand. These levels are set by GNS via GeoNet and provide a necessary and valuable guide to assessing the current volcanic unrest or eruptive status of volcanoes. Their limitation is that they do not provide for current or future scenarios or even predictions. These may be assessed within Volcanic Activity Bulletins, available from GeoNet.

GeoNet website: www.geonet.org.nz
GNS website: www.gns.cri.nz

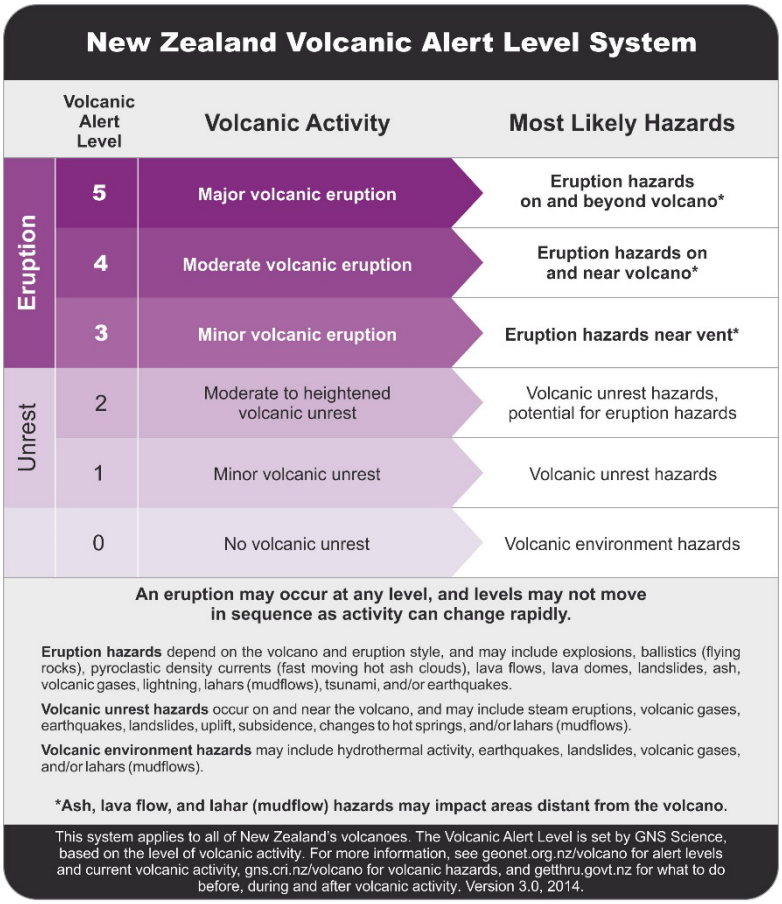


Figure 3. Diagram of New Zealand Volcanic Alert Level System.

3. Overview of approach to volcanic risk management

The **response** component focuses on how DOC will function in response to an event. This will involve DOC executing plans and management actions in conjunction with and alongside other agencies. The **recovery** phase for DOC in response to volcanic events is dependent on the nature of the volcanic event, the timeframe of de-escalation of volcanic activity and the impacts resulting from the event. This will remain a case-by-case basis.

3.1 Summary of how volcanic risks are managed in Tongariro National Park

The volcanic risk mitigation system and management at TNP can be summarised under ten categories:

1. Land use as a national park, including the TNP Management Plan, policies, legislated controls, concession management and volcanic maps.
2. Infrastructure located away from at-risk areas or designed appropriately for the environmental conditions. Alternatively, if infrastructure is located in areas of volcanic risk, appropriate mitigation measures are in place to address this ongoing risk.
3. Operational practice including Health and Safety policy and procedures when conducting work in the field.
4. Volcanic monitoring by the GeoNet geological hazard monitoring system and research by GNS, universities and others.
5. Alerts of changing volcanic conditions received through VALs and VABs (from GNS) and appropriate responses taken.
6. Communication to decision-makers, duty staff, local iwi and hapū and appropriate agencies when volcanic risk changes.
7. Management decisions and procedures, including advisories or temporary closure of facilities and ensuring that the '4Rs' are sufficiently covered.
8. Public awareness work to ensure visitors have access to volcanic risk information and are informed of changing volcanic conditions when risk changes.
9. The VAN (using GeoNet seismic and acoustic sensors on the flanks of the volcanoes) detecting eruptions and providing real time alerts to DOC staff, TNP stakeholders and emergency managers, and sounding siren and voice message warnings for the public in at-risk terrain in Whakapapa Ski Area and Whakapapa Village.
10. Response plans including interagency coordination and training. The Senior Ranger Public Safety and Technical Advisor Volcanology are responsible for training on response plans/actions.

While DOC has made significant attempts to reduce volcanic risk to visitors within TNP, we recognise that residual risk will always remain due to visitor behaviour, their proximity to vents and practical constraints on warning systems within at-risk areas.

3.2 DOC staff and visitor safety roles

Overview

DOC's Visitor Risk Management Policy, SOP and Guidelines outline the organisation's overall responsibility and approach to visitor safety (more-specific volcanic risk management obligations are provided within DOC-3136467). During volcanic unrest and eruptions, DOC's role is to address the safety of visitors, concessionaires, and staff within TNP. The primary and most effective means of managing volcanic risk is to **close at-risk destinations within TNP prior to eruptions occurring**. DOC uses volcanic alert levels and other information about volcanic unrest from GNS to make these management decisions.

In response to eruptions (usually triggered by VAN activations) our role is informing managers and activating supporting staff as necessary, making decisions about facility closures and any immediate response needs in collaboration with the Police. In an emergency response context, the Police are the main agency with statutory responsibility for public safety in New Zealand. Within the boundaries of TNP, it is DOC's role to assist them.

The IRP phone callout will notify local iwi and hapū, concessionaires and key agencies of an event. The Minister of Conservation and other senior managers will need to be advised as soon as practical, and this responsibility will sit with DOC's Central North Island (CNI) Director Operations or be initiated by the Tongariro Operations Manager in the Director's absence. Other management decisions and actions to further address visitor, concessionaire and staff safety will take place in the ensuing period.

As a Person Conducting Business or Undertaking (PCBU), DOC has a legal role regarding staff and concessionaire safety. DOC has a duty to share information about hazards and risk management with concessionaires and staff. Concessionaires – particularly guides and registered adventure activity operators – have responsibility for the safety of their customers.

Staff safety

Staff safety is paramount and will be managed by communicating heightened volcanic risk and risk mitigation options to staff who are working in at-risk areas (e.g. Hut Rangers and Tongariro Alpine Crossing Rangers during the Great Walk Season). Again, the most effective risk mitigation option is to eliminate exposure by closing areas prior to eruption (if possible).

Staff health and safety management controls are detailed in the Safety Plan for the Tongariro District Operations Team – see Risk Manager (DOC Intranet). These hazards are updated annually in Risk Manager or as required, considering the volcanic risk present, hazard type and likelihood of occurrence.

A Job Safety Analysis (JSA) is always conducted before any fieldwork is conducted.

Visitor safety

The severity of risk to visitors depends on the following factors:

- Location of visitors in relation to the volcanoes or volcanic vents
- Proximity of visitors to areas of high risk
- Probability and severity of volcanic phenomena
- Length of time visitors are exposed
- Visitors' ability to move out of harm's way.

Risks are highest within the Hazard Zones around active or recently active vents and, subsequently, in paths of lahar or pyroclastic density currents, and along the Tongariro Alpine Crossing. Huts and other tracks in TNP around the volcanoes are at lesser risk unless eruption magnitude increases. Posters outlining typical volcanic phenomena impacts and spread for both Tūroa and Whakapapa Ski Areas are provided in Appendix 2.

Despite closures being the most effective mitigation option, volcanic activity is often unpredictable. DOC's ability to manage the exposure of visitors to volcanic risk can be limited – especially since the volcanoes are one of the main attractions in TNP. Decisions about access should always rely on good information, especially from GNS regarding the status of the volcanoes. Risk assessments are part of decision making but will never be sufficient to ameliorate all risk.

DOC recognises that visitors are generally responsible for their own safety within TNP, especially when entering volcanic hazard zones. However, DOC must provide quality pre-visit and on-site information, so visitors are able to make informed decisions on the level of risk they are taking.

3.3 DOC's core partners, stakeholders and science/research and emergency management organisations

DOC's core partners and other associates in management of volcanic activity in TNP are:

- Ngāti Hikairo and Ngāti Tūwharetoa
- Ngāti Rangi
- Uenuku
- Other iwi and hapū of the Kāhui Maunga who may wish to be involved
- GNS
- Police.

Stakeholders impacted by volcanic activity in or from TNP:

- Ruapehu Alpine Lifts (RAL)
- Tūkino Alpine Sports Club
- Tongariro Alpine Crossing Transport and Guides group (TACTAG)
- Other concessionaires in TNP
- Genesis Energy, NZ Army, Transpower and KiwiRail
- Ruapehu Mountain Clubs Association, Iwikau and Whakapapa Village communities.

Science/research and emergency management organisations:

- Civil Defence and Emergency Management (CDEM) agencies including Taupō and Ruapehu district councils (TDC and RDC) with Central Plateau Volcanic Advisory Group (CPVAG) having a coordinating role during non-eruptive periods.
- Universities and other science/research agencies.

3.4 Coordination with GNS, Police and CDEM

<u>GNS Science</u>
GNS is responsible for monitoring volcanic activity, setting Volcanic Alert Levels (VALs) and issuing Volcanic Activity Bulletins via GeoNet. As such, they are an indispensable agency and DOC **must** maintain close communications with them during periods of volcanic unrest, periods following eruptions and emergencies and during quiet times. DOC and GNS have an important and well-tested Memorandum of Understanding (MOU). DOC and GNS are working on a national Multi-Service Agreement, which details the relationship further, including cooperation regarding working with the media.

In relation to volcanic risk management actions, DOC should inform, discuss and seek input on major decisions or external communications with GNS. GNS would usually advise us when a Volcanic Activity Bulletin is being developed and released, but time constrains may limit this.

<u>Police and CDEM</u>
This document recognises the Police's statutory role regarding public safety during an eruption. More recently, the roles and responsibilities of all agencies, including DOC's fundamental role within TNP, have been outlined within the Tongariro Volcanic Centre Contingency Plan. Outside TNP, councils and other CDEM agencies have the statutory role and DOC will assist as much as possible.

DOC maintains its decision-making role within TNP in all cases; however, if an Emergency Declaration is made, CDEM agencies will take over the decision-making role. Declaration criteria and dependent scales for this decision needs to be clearer, and DOC should have input into this. Criteria such as VALs should be used in complementary ways by the various agencies, to ensure that a collective response and consistent messaging is maintained across all organisations and is consistent with the actual risk. A poorly calibrated perception of risk should not be the driver of response.

3.5 Communications plan

The communications plan has received a significant update that has refined and isolated the key tasks required in response to changing volcanic unrest and initial response to eruptions. The purpose of the document is to disseminate information that is critical to protecting the safety of the public and informing TNP users of the changing volcanic conditions. The communication plan directs the DOC-specific response and also recognises the role and discussions required within the wider CPVAG Public Information Management (PIM) context that is outlined within the Tongariro Volcanic Centre Contingency Plan.

3.6 Performance monitoring

DOC monitors volcanic risk management performance via Key Performance Indicators (KPIs), standards and measures, as detailed in Appendix 3.

4. VOLCANIC RISK MANAGEMENT METHODOLOGY

4.1 Introduction: response to slow escalation of volcanic activity in TNP

It is usual for volcanic activity or unrest to escalate slowly over days, weeks or longer. It is imperative that DOC works alongside GNS, the Police, local iwi and hapū and local councils and that our procedures work in effectively with theirs. Involving our local iwi and hapū in discussions and key decisions about escalating volcanic activity, and maintaining this involvement, is critically important. The other agencies have actions that are also coordinated by Central Plateau Volcanic Advisory Group (CPVAG) and summarised in the Contingency Plan (CPVAG 2018). In the case of rapid escalation of volcanic activity, many of the roles DOC has and the actions that will need to be taken within TNP will be the same as for slow escalation. However, outside the TNP area the other agencies will have time to carry out their normal roles regarding public safety and emergency management.

4.2 Information required for decision-making during volcanic unrest

During escalation of volcanic unrest or activity, in addition to basic considerations such as weather conditions, time of day and location of staff, management decisions should also include the following scientific data and advice:

1. VAL increase from 0 to 1 or 1 to 2. This and other information are distributed via VABs or are available directly from the GNS Duty Volcanologist and www.geonet.org.nz

2. When the VAL is at 2 but not quite 3 (based on discussions with and advice from GNS), considerations to be aware of include:
   - Increased concerns based on monitored GeoNet parameters such as seismic magnitude increase, decreasing depth of seismic activity, increased gas flux, changing chemistry of fluids, increased ground deformation.
   - Visual evidence obtained from ongoing field observations or forecasts that raise concern. Some examples are local small-scale eruptive activity, debris or ash accumulations, secondary events such as impounded water, forecasts of heavy rain, wind direction, changing levels of Te Wai ā-moe or other lakes involved.
   - With rapid escalation of unrest, DOC may need to act independently from GNS and other agencies to protect public safety.

3. Indicators of potential increase of risk such as modes of cool or hot temperatures, levels of lakes or other situations as described earlier.

4.3 General DOC management actions during volcanic unrest

The range of management actions required during escalation of volcanic activity in order of increasing need for rapid action in response to increased risk is as follows, but not necessarily in this order:

1. Communications with staff supervisors about the locations of DOC staff in the field, including providing instructions to them if needed.
2. Initiating a skeleton crew CIMS (Coordinated Incident Management System) structure in preparation for an eruption, with closer collaboration with GNS, police and iwi.
3. Temporary closure of one or more DOC huts that may be at higher risk from an eruption.
4. Entry restrictions or closures of areas, tracks and/or facilities near the unrest site and at-risk zones. This may require additional checking of tracks and erection of signs.
5. Closures of the Bruce, Mountain, Tūkino, Ketetahi, Mangatepōpō and other roads in or near TNP with police support in the emergency phase and councils/CDEM agencies outside TNP as long-term management gets underway.

6. Obtain situational awareness (if it is considered safe to do so) to gain further understanding of what volcanic activity is occurring. Helicopters that may be requested for use are listed in DOC's National helicopter service directory.
7. Discussion and liaison with local iwi and hapū and development of joint actions including volcanic risk management and mitigation measures.
8. Ministerial briefings as regularly as required.
9. DOC media releases per communications plan integrated with or immediately following GNS VABs or other agency media releases with specific messages as required. If time permits, drafts of these releases should be sent to iwi, hapū and appropriate agencies prior to release.
10. Engagement with media to assist them in carrying out their roles (where this does not conflict with other management).
11. Further monitoring of specific volcanic phenomena such as potential lahar paths and areas where secondary volcanic events may occur (e.g. debris-dammed lakes or thick ash deposits).
12. Support for GNS and other science agencies monitoring a vent or vents before or after eruptions.
13. Revision of existing risk assessments and response plans or preparation of new ones.
14. Considerations for the development of a recovery plan to prepare for the post-eruption phase. This could include emergency funding and staffing, track repairs, safety plans, development of additional mitigation tools and advocacy.

There are various other specific tasks that might be needed, but which are not DOC's primary responsibility. DOC would usually respond with all resources necessary in support of, or in conjunction with, the police and other agencies. These tasks could include SAR, emergency care, disaster control, law enforcement.

4.4 Managing Ruapehu volcanic unrest

Ruapehu predominantly sits at VAL 1 which is indicative of its constant state of minor unrest and the need for consistent monitoring of volcanic activity. While the VAL 1 status is maintained most of the time, there have been three instances since the last eruption in September 2007 when this changed. Ruapehu moved to VAL 2 from May to July 2016 due to a combination of elevated unrest conditions including higher temperatures at Te Wai ā-moe, elevated and changing volcanic gas emissions, changing water chemistry and elevated levels of tremor, again in December 2020 to January 2021, and again in March 2022 to July 2022.

After these periods the volcano returned to VAL 1 status. The rise and fall of these unrest conditions usually go hand in hand with the periodic temperature cycle at Te Wai ā-moe. In some instances, elevated temperatures at Te Wai ā-moe do not always constitute a change in VAL if other unrest conditions are not similarly elevated, or they remain within the accepted ranges for VAL 1. For the most part, higher parameters of unrest conditions at Ruapehu do not result in an eruption.

GNS monitors various features at Ruapehu, including real time short-term or long-term trends of temperature at Te Wai ā-moe, seismicity and monthly gas and water chemistry (mostly through sampling completed manually by GNS staff). GNS has recently installed two permanent gas monitoring stations on the eastern and western sides of the volcano.

Te Wai ā-moe temperature modes and lake levels

Te Wai ā-moe exhibits periodic cycles of heating and cooling. These reflect deeper magmatic heating and vent conditions which result in changes in lake temperature, water chemistry and gas outputs at the surface. Short-term and long-term temperature trends at Te Wai ā-moe are maintained by GeoNet (and are available to the public). These provide an index of the expected temperature ranges at Te Wai ā-moe (Fig. 4).

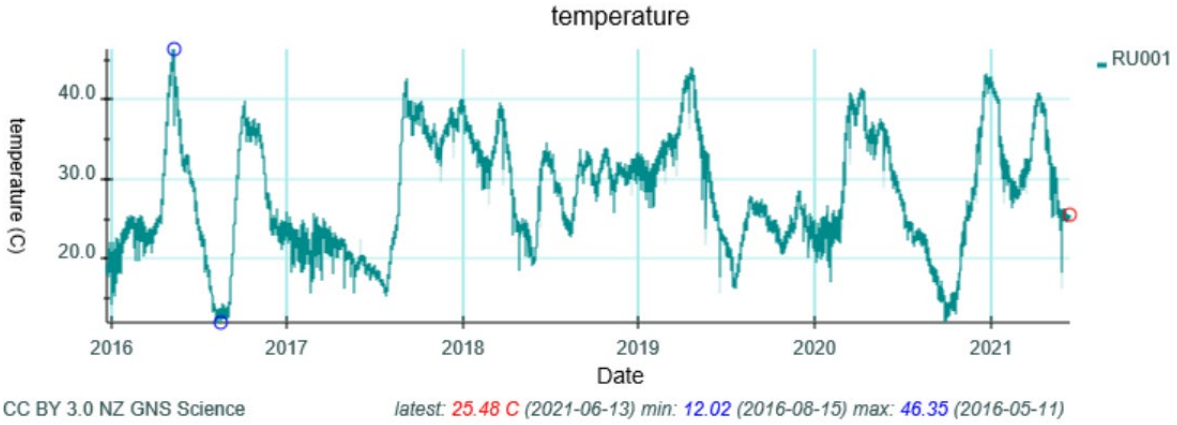


Figure 4. Diagram of Te Wai ā-moe temperature graph, Ruapehu from 2016 to 2021.

Temperature ranges and changes at the lake surface serve as prompts for discussion both internally (at a district level) in DOC and with GNS which are described in Table 1 (p. 18). Higher temperatures are typically accompanied by water chemistry changes, increased and sometimes changing gas emissions and are often preceded by volcanic tremor. All of these factors are an indication that the vent is open. Cooler surface temperatures can reflect lower temperatures at depth, and often decreased levels of volcanic unrest. However, it can be concerning if low lake temperatures are accompanied by reduced gas outputs, lower lake levels, lack of visible upwelling and sulphur slicks on the surface. This could indicate the vent is blocked, or partially blocked by a sulphur seal which can limit heat and gas reaching the surface, with the possibility that the volcanic system becomes pressurised. The recent March – July 2022 unrest phase prompted concerns of a partial blockage at the vent beneath the lake due to the lack of response in temperature to strong and ongoing volcanic tremor. Strehlow et al (2017) describes eruption occurrences based on statistical analysis of temperature trends, indicating that eruption probability increases with both significantly higher and significantly cooler lake temperatures. Therefore, two indicative temperature modes have been defined by DOC – cool lake mode and hot lake mode (Fig. 5).

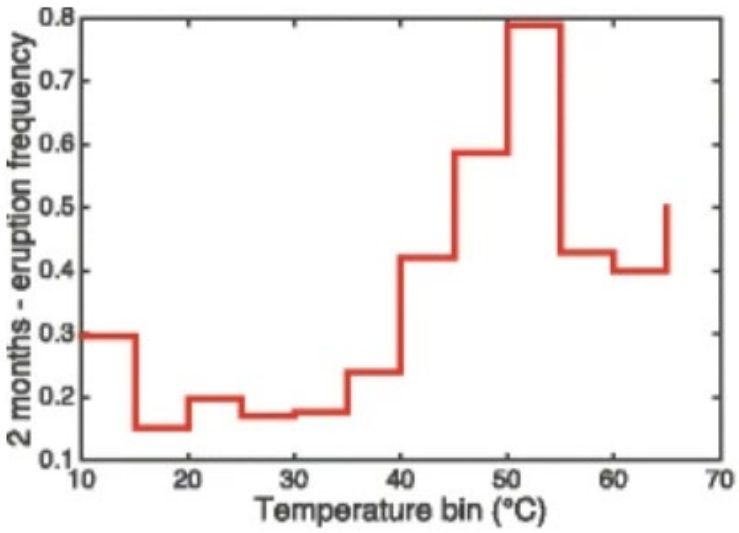


Figure 5. Diagram of frequency of eruption occurrence and temperature at Crater Lake, Ruapehu.

Cool lake mode:

- If the lake temperature is trending downwards towards 17.5°C, conduct discussions with GNS on likely temperature trends and wider vent conditions to ascertain whether further indicators of unrest are present. Consider the presence or absence of intermittent upwellings or sulphur slicks during cooler temperatures and check in on DOAS gas monitoring results as they will likely indicate whether the vent is open or not.
- DOAS gas monitoring results will inform whether further action is required at 15°C or lower.

Hot lake mode:

- Temperatures trending towards and above 40°C should initiate heightened monitoring and ongoing discussions with GNS to understand other vent conditions and unrest parameters.

In addition to water temperatures, Te Wai ā-moe has had significant variance in lake levels post the 1945 and 1995–96 eruptions where erupted material raised the rim of the crater basin and blocked the outlet, allowing the volume of water housed in Te Wai ā-moe to increase. This significantly increased lahar risk and how DOC had previously addressed this risk is discussed further in DOC 1999 (prepared for the then Minister of Conservation). This leads to a third (refilling lake) mode:

Refilling lake mode:

- Close monitoring of a rising lake level towards or above previous levels is required for risk management purposes. Establishing warning levels and management decisions in response to lake level will be required.
- Warning levels and management decisions based on 1997–2007 lahar activity are documented in 'The Eastern Ruapehu Lahar Emergency Response Plan' (docCM-50552) and Keys & Green 2008. These documents can be used to guide preparation and implementation of responses to potential lahar situations.

There may be other indicators of increased risk at Ruapehu and the other TNP volcanoes. These include small rockfalls and larger landslides (also known as flank failures or sector collapses), increased seepage from lakes and land deformation. Identifying and monitoring these could help to detect possible events before they occur.

Therefore, a fourth mode of risk is identified:

Slope deformation mode:

- Indications of possible slope instability can be obtained from changes in key landscape features (cracks) or positions of established benchmarks. Monitoring of survey benchmarks and/or cracks (e.g. on the crater rim at Ruapehu (Energy Surveys 2011), the west rim of Upper Te Maari at Tongariro, increased seepage from a tephra dam (Keys & Green 2008; Jolly et al. 2014), and stability of the crater rim (Schaefer et al. 2018)) and management decisions in response to any surface changes and advice are required.

Table 1. Ruapehu volcanic unrest triggers and risk management actions.

DOC Risk Management Stage	VAL	Considerations and potential triggers from volcano and GNS	Management tools	Management actions	Timeline
A	**1**	**Normal volcanic unrest, including periodic cycling of water temperatures at Te Wai ā-moe (Crater Lake) and resumption of this cycling**	**Public advised not to enter the crater basin *(700 m radius from centre of Crater Lake)*, not to camp in the Summit Plateau and to take care when travelling in known lahar paths.**	• Ensure recommendations and risk reduction advice are current and effective online: www.doc.govt.nz/volcanicrisk • Install volcanic risk sign at bottom of Clary's Track at Turoa and top of the Sky Waka at Whakapapa during summer months.	Normal heating/cooling cycle including resumption of it.
B	**1**	**Increased volcanic unrest but no VAL change – situation not entirely 'normal'** Questions and uncertainty. Could include any of, but not limited to, the following: • VAB released on elevated unrest, but may not be enough to change VAL. • Increased volcanic tremor or earthquake activity. • Anomalous temperature trend – period of cool or hot temperatures (trending well beyond 40°C or well below 15°C). • Increased gas emissions. • No gas emissions (vent blocked?).	**Public advised not to enter the Summit Plateau (*1.5 km radius from centre of Crater Lake*) and to take care when travelling in known lahar paths.** **Suspend concessions within the 1.5 km radius.** Communicate with GNS on potentially elevated unrest parameters. Gauge likelihood of a VAL change. Ensure Guidelines (this document) and IRP are up to date and revisited by key staff (Volcanic Rangers/Ops Manager).	• Ensure public information, advice and recommendations are available and up to date per Comms Plan. • Install 'DOC recommends you do not enter the 1.5 km area' signs at Whakapapa, Turoa and Tukino ski areas. • Notify concessionaires with permits to undertake activities within the 1.5 km area that their concessions are suspended. • Prepare for VAL 2 to be reached. • CNI Director, Ops Manager and PIM advised (current situation, concerns, and likely scenarios). • Initial (email) communication to local iwi and hapū, RAL,	Management actions and messaging should be tailored to activity level, likelihood of VAL change, or uncertainty. It could be that: 1. Normal heating cycle is not entirely present; or: 2. There is other anomalous volcanic activity or activity is trending towards a VAL change, or there is a lot of uncertainty. The intensity of DOC's response should reflect which of these scenarios is being managed.

		• Absence of upwelling (sulphur slicks) on Crater Lake surface.		and National Park, and Taupō Police on current activity. • Perform daily checks of REDS/WLAWS and VLAWS. Consider doing a full 'end to end' test. • Ensure Tongariro District staff are informed and Volcanic Rangers (VR) re-familiarised with key response actions.	
C	2	**VAB has been released and VAL change has occurred** Additional or more significant volcanic unrest parameters present, including seismic activity (e.g. low-frequency volcanic tremor, earthquake swarm magnitude/location/depth changes), ground deformation, anomalous lake level/discharge changes or chemistry, or other anomalous activity more directly related to likely volcanic activity.	**Close access to the 2 km radius from centre of Crater Lake.** Inform the public not to enter this area. **Suspend concessions that operate within the 2 km radius until further notice.** This includes the High Noon Express Chair Lift at Turoa. **Advise the public not to enter the upper Whakapapaiti and Whangaehu catchment areas** (from the 2 km radius down to just above Round the Mountain Track) **and suspend concessions in these areas.** **Suspend RAL's concession for the Far West T Bar and associated trails *(Whakapapaiti catchment)* at Whakapapa Ski Area.** While outside of the 2 km radius, this is a high-risk lahar path in any eruption. Lahar is the	• Advise CNI Ops Director, Tongariro Ops Manager and Tongariro PIM of the current situation, concerns, and likely scenarios. • Release advisory that the 2 km radius is closed and advise the public not to enter the upper Whakapapaiti and Whangaehu catchments – include a map. • Install 2 km closure signs at Whakapapa, Turoa and Tukino ski areas. • Install DOC/GNS VAL 2 volcanic hazard map signs at Round the Mountain Track entrances. • Notify concessionaires with permits to undertake activities within the 2 km closed area that their concessions are suspended. • Notify RAL that they cannot operate the High Noon	When volcanic unrest parameters are more definitive.

			primary volcanic hazard at Ruapehu. **RAL apply their Risk Management Stage C operational plan,** including intensified operational risk management in the other lahar paths at Whakapapa Ski Area. **Use the 2 km to 3 km closure extension, or 3 km to 2 km closure retraction consideration process** each time that GNS provides eruption elicitation results, a Volcanic Activity Bulletin is released, volcanic unrest escalates, or as requested by the CNI Operations Director. The decision maker is the CNI Operations Director. **If the 2 km closure is extended to 3 km:** **Close access to the 3 km radius from centre of Crater Lake** – inform the public not to enter this area. **Apply intensified lahar path risk management on Round the Mountain Track and Whakapapa Ski Area.** **Meet with RAL** to discuss/agree operational lahar risk controls for the Whakapapanui catchment and discuss/agree operating	Express at Turoa, or Far West T Bar at Whakapapa Ski Area. • Schedule meeting with RAL as soon as possible to discuss the situation and application of agreed operational mitigations. • Organise hui with local iwi and hapū, RAL, Police (OC National Park, OC Taupō), RDC and TDC on situation and eruption preparation. • Discuss outcomes from above hui with CPVAG. • DOC PIM to liaise with CPVAG PIM personnel. • Perform daily checks of REDS/WLAWS and VLAWS. Consider doing a full 'end to end' test. • Hold a hui with the Tongariro District Leadership Team (DLT) on Incident Management Team (IMT) roles and responsibilities in preparation for further escalation. • Maintain regular contact and communication with GNS Team Leader Volcanology. • Run the 2 km to 3 km, or 3 km to 2 km exclusion zone extension/retraction consideration process per criteria. Document the process and decision. The	

			protocols for lifts that are just inside the 3 km radius. **Advise the public not to use Round the Mountain Track** due to elevated lahar risk **and suspend concessions on the track.**	decision maker is the CNI Operations Director. **If closure extended to 3 km:** • Install 3 km closure signs at Whakapapa, Turoa and Tukino. • Release advisory that the 3 km radius is closed and advise the public not to enter the upper Whakapapaiti and Whangaehu catchments – include a map. • Install signs at Round the Mountain Track entrances advising the public not to use the track due to the elevated likelihood of lahars occurring. • Notify concessionaires with permits to undertake activities within the 3 km zone and on Round the Mountain Track that their concessions are suspended. • Notify RAL and Tukino that they cannot operate the parts of their ski areas within the 3 km closure. • Schedule a meeting with RAL as soon as possible to discuss the situation. • Schedule a meeting with Tukino as soon as possible to discuss the situation.	

Table 2.

DOC Risk Management Stage C – VAL 2 – Consideration process for extending the 2 km closure to 3 km and intensified lahar path risk management at Ruapehu

Step 1:
Criteria for immediate extension to a 3 km closure radius and intensified lahar path risk management:
1. Clear eruption precursor activity is present? E.g. Severely heightened activity indicating that an eruption could be imminent.
*Answered **yes** to the above criteria? Extend the 2 km closure to 3 km and apply intensified lahar path risk management immediately.* *Answered **no** to the above criteria? Proceed through the following questions:*

Step 2:
Criteria for considering extension to a 3 km closure radius and intensified lahar path risk management:
2. GNS suggests that the most likely first eruption scenario would produce surges, ballistics, and pyroclastic density currents beyond the 2 km radius? (A moderate to large eruption). ***And/Or:***
3. Large uncertainty exists about the forecast activity that the volcanic unrest may produce? ***And/Or:***
4. The GNS eruption probability from their elicitation is 20% mean or greater, and/or 20% median or greater in the next four weeks?
*Answered **no** to all the above criteria? Further assessment is not required. Maintain the 2 km closure and standard lahar path risk management.* *Answered **yes** to one or more of the above criteria? Proceed through the following questions:*

Step 3:
Further criteria for considering extension to a 3 km closure radius and intensified lahar path risk management:
5. Are there consistent views across volcano subject matter experts and/or small probability spreads from GNS eruption elicitation participants?
6. Are mitigations/controls in place that lower risk, such as effective risk communication, ski area operational controls and lahar hazard zone restrictions?
7. Are the Ruapehu Eruption Detection System and Whakapapa Ski Area Lahar Alert and Warning System fully operable?
8. Is the GeoNet volcanic monitoring system operable – is a comprehensive suite of data available?
9. Are our treaty partners supportive of the current controls?
Answered **no** to any of the above questions? This is a red flag – extension to 3 km closure may be justified.

This process supports the decision-maker to reach a decision. It is a decision support tool; other than the first criteria it is not absolute. The decision-maker should also consider the role and relevance of other risk management approaches, with special regard given to cultural mitigation measures from our Treaty partner (such as rāhui). *The decision-maker is the CNI Operations Director.*

Table 3.

DOC Risk Management Stage C – VAL 2 – Consideration process for retracting the 3 km closure back to 2 km and standard lahar path risk management at Ruapehu

Step 1:
Criteria for maintaining the 3 km closure radius and intensified lahar path risk management without further consideration:
1. Clear eruption precursor activity is present? E.g. Severely heightened activity indicating that an eruption could be imminent.
*Answered **yes** to the above criteria? Maintain the 3 km closure and intensified lahar path risk management.* *Answered **no** to the above criteria? Proceed through the following questions:*

Step 2:
Criteria for considering retraction to a 2 km closure radius and standard lahar path risk management:
2. GNS suggests that the most likely first eruption scenario would produce surges, ballistics, and pyroclastic density currents beyond the 2 km radius? (A moderate to large eruption). ***And/Or:***
3. Large uncertainty exists about the forecast activity that the volcanic unrest may produce? ***And/Or:***
4. The GNS eruption probability from their elicitation is 20% mean or greater, and/or 20% median or greater in the next four weeks?
*Answered **yes** to one or more of the above criteria? Further assessment is not required. Maintain the 3 km closure and intensified lahar path risk management.* *Answered **no** to all the above criteria? Proceed through the following questions:*

Step 3:
Further criteria for considering retraction to a 2 km closure radius and standard lahar path risk management:
5. Are there consistent views across volcano subject matter experts and/or small probability spreads from GNS eruption elicitation participants?
6. Are mitigations/controls in place that lower risk, such as effective risk communication, ski area operational controls and lahar hazard zone restrictions?
7. Are the Ruapehu Eruption Detection System and Whakapapa Ski Area Lahar Alert and Warning System fully operable?
8. Is the GeoNet volcanic monitoring system operable – is a comprehensive suite of data available?
*Answered **no** to any of the above questions? This is a red flag – maintaining the 3 km closure may be justified.*

This process supports the decision-maker to reach a decision. It is a decision support tool; other than the first criteria it is not absolute. *The decision-maker should also consider the role and relevance of other risk management approaches, with special regard given to cultural mitigation measures from our Treaty partner (such as rāhui).* *The decision-maker is the CNI Operations Director.*

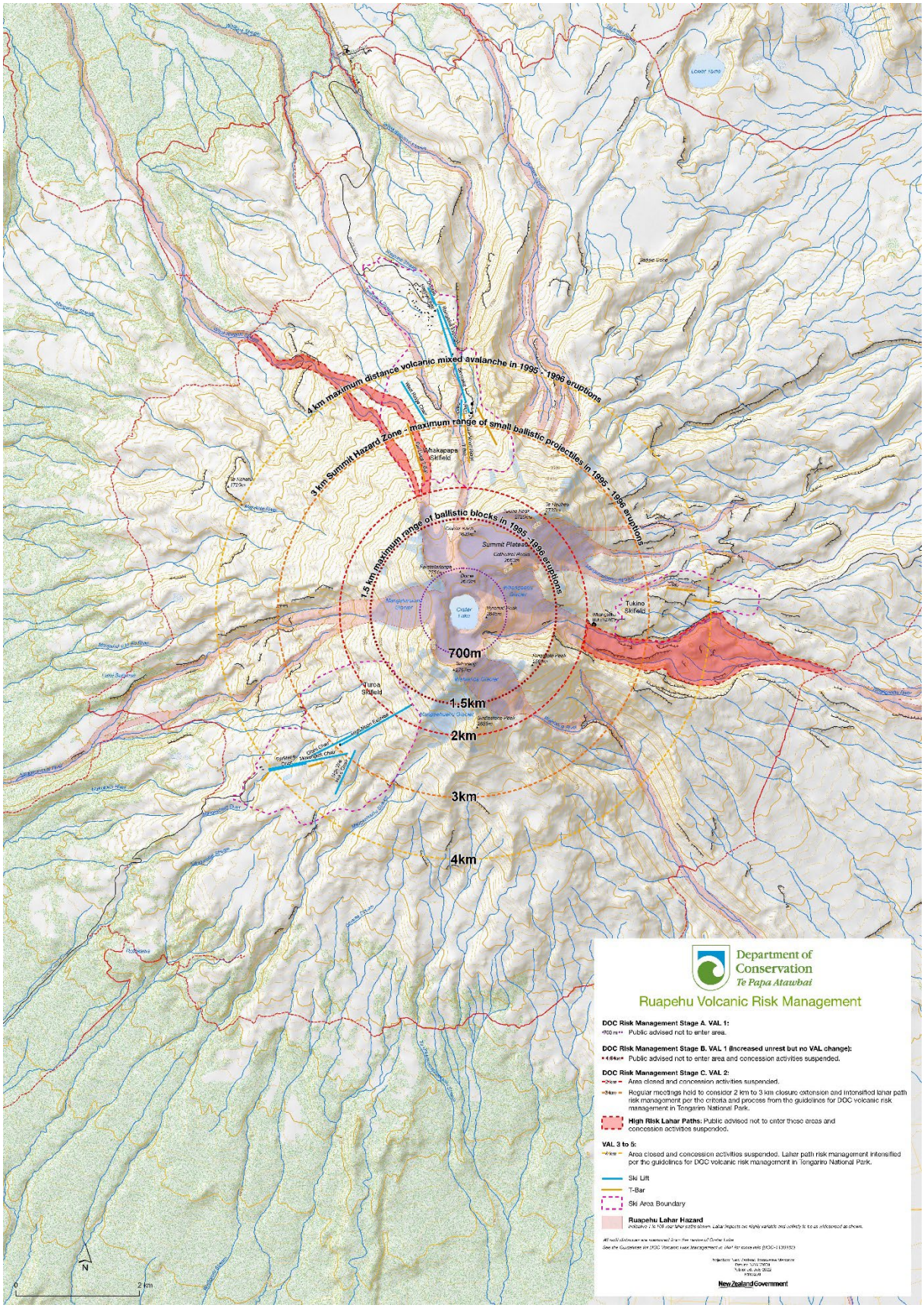


Figure 7. Map showing the various management radii for the DOC Risk Management Stages at Ruapehu.

4.5 Managing Tongariro volcanic unrest

Unlike Te Wai ā-moe (Crater Lake) – the current singular source of eruption at Ruapehu – there are multiple vents across the Tongariro Volcanic Massif that volcanic activity and eruptions could originate from. This adds complexity to the management of unrest at Tongariro – especially when the Summer/Great Walk season brings major foot traffic to the Hazard Zones of Ngāuruhoe, Red Crater and Te Maari.

The lesson from the Te Maari eruptions in August and November 2012 was the need to be decisive in managing increasing unrest at any of the three Tongariro vents – Ngāuruhoe, Red Crater and Te Maari. Both the Tongariro Alpine Crossing and Tongariro Northern Circuit traverse Red Crater and Emerald Lakes. The proximity of visitors to these potential eruption sources is a major consideration when access decisions are made during periods of volcanic unrest. Due to the large volume of visitors and their proximity to potential eruption sources, a conservative management approach is essential.

DOC is highly responsive to any changes in volcanic activity[1] on Tongariro and has clear management actions to mitigate increasing risk when unrest occurs. Risk management procedures for Tongariro are shown in tables 4 and 5. As with Ruapehu, the DOC Risk Management Stages described in these tables act as a TARP for the different levels of unrest.

DOC needs to be prepared for potential long-term volcanic unrest (VAL 1 and VAL 2) at Tongariro and the de-escalation period following an eruption. In the event of prolonged volcanic unrest, DOC should consider commissioning a risk assessment from GNS or alternative risk and impact specialist providers to assess residual risk outside of current volcanic risk mitigation measures.

Further scenarios and lessons that are indirectly tied to volcanic activity are captured in Appendix 4.

[1] DOC applies volcanic risk mitigation measures and management actions appropriate for the individual volcano, taking into consideration to the following, but not limited to;

- historical research,
- volcano type,
- typical expected volcanic phenomena,
- individual volcano expression of unrest activity; and
- proximity of visitors to volcanic vent.

Table 4. **Tongariro volcanic unrest triggers and risk management actions for Tongariro Alpine Crossing and Northern Circuit.**

DOC Risk Management Stage	VAL	Management tools	Management actions
A	0	• TEDS eruption alerts disabled (default setting) due to system's susceptibility to wind triggered false positives. • Tongariro District Volcanic Ranger (VR) duty system. • Guidelines for DOC volcanic risk management (this document). • Initial Response Plan (IRP) for volcanic activity. • Comms plan for volcanic activity. • Strong, working relationship with GNS Science. • Strong, working relationship with Ngāti Hikairo. • Pre-visit and on-site hazard and risk information for visitors. • Tourism industry understands (but doesn't have to support) the risk management approach for Tongariro, so management actions are easier to implement when required. • Quality discussion and decision-making in response to changing and increase in monitoring parameters.	• Key staff to maintain familiarity with IRP, Guidelines and Comms plan documents. • Conduct annual review of the IRP, Guidelines and Comms Plan. • Maintain close relationship with Ngāti Hikairo by meeting with key contacts regularly. Consult and collaborate with them on changes to this plan. • Maintain close relationship with GNS Science by meeting with key contacts regularly. Share changes to this plan with them and get feedback if possible. • Conduct annual review of the Volcanic risk in Tongariro National Park webpage. Ensure the latest information, advice and volcanic hazard maps are available. • Conduct annual review of the DOC's role in managing volcanic risk at Tongariro National Park webpage. Ensure the latest version of this document is available. • Share any significant changes to the risk management approach with TACTAG. • Discussions held around enabling TEDS due to possible increase in gas emissions and seismic activity.
B	1 & 2	**Closure of all, or parts of, the Tongariro Alpine Crossing and affected sections of the Tongariro Northern Circuit per the decision process in table 5 on the next page.**	**Immediately apply the closure decision process in table 5. The decision-maker is the CNI Operations Director. Implement closure decisions quickly.**
		• Rapid delivery of communications to partners, public and stakeholders about closure settings. • TEDS eruption alerts enabled to improve situation awareness. • Regular communication with key contacts at GNS. • Regular communication and scenario planning with CNI Director, Ops Manager and PIM. • Situational and risk information shared with partners and stakeholders. • Pre-visit and on-site hazard and risk information for visitors.	• Urgently notify Ngāti Hikairo of closure settings. • Urgently notify the public, partners and concessionaires of closure settings and risk reduction advice. • Enable TEDS alerts in the TNP VAN SCADA system: tnpvan.nz. • Connect with GNS key contacts regularly. Ensure monitoring, elicitation, scenarios, and other important information is shared with DOC in a timely manner. • Urgently facilitate any GNS requests for deployment of additional monitoring equipment etc.

		• Track closure signage and barriers as required. • Readiness for possible eruption. • CPVAG forum and multi-agency readiness and planning. • Updated comms plan.	• Share VAB with local iwi and hapū, Police (OC National Park, OC Taupō) and explain DOC's risk management actions. • Organise hui with local iwi and hapū, Police (OC National Park, OC Taupō), RDC/TDC and GNS relating to DOC management actions. • Consider holding a hui with Ngāti Hikairo at a local marae to discuss possible scenarios and management actions. • Hold a meeting with TACTAG members, possibly in conjunction with the wider community, to outline situation and discuss possible scenarios. • Update the Volcanic risk in Tongariro National Park webpage with track access information and risk reduction advice. Ensure the latest information, advice and volcanic hazard maps are available. • Update the DOC's role in managing volcanic risk at Tongariro National Park webpage as required. Ensure the latest version of this document is available. • Update comms plan as comms response evolves. **TAV and SR-PS to support the Ops Manager in the following:** • Incident Control Point planning and IMT roles established, a roster for key roles *may* be required. • Police and local helicopter pilots advised and 'on standby' as necessary. • Field staff procedures implemented for locations at risk. • Meeting with VRs and note IMT discussions and preparation.

Table 5.

Process for deciding complete track closure or vent specific 3 km spatial closure for the three active vents of Tongariro – Ngauruhoe, Red Crater, and Te Maari. Applies to the Tongariro Alpine Crossing and Tongariro Northern Circuit.

Apply this process at all levels of Tongariro volcanic unrest – VAL 1 and 2.

<table>
<tr><th colspan="2">Step 1:</th></tr>
<tr><th colspan="2">Criteria for deciding complete track closure, or vent specific 3 km (radius) closure around the source of unrest:</th></tr>
<tr><td colspan="2">1. GNS have identified the vent where the unrest is located and are confident it is the potential eruption source? And:</td></tr>
<tr><td colspan="2">2. The unrest is definitively located at a single vent and not multiple locations? And:</td></tr>
<tr><td colspan="2">3. The unrest is located at either Ngauruhoe or Te Maari?</td></tr>
<tr><td colspan="2">Answered yes to all the above criteria? Continue to step 2 and apply vent specific closure and management approach.

Answered no to any of the above criteria? Apply complete track closure to the Tongariro Alpine Crossing and any parts of the Tongariro Northern Circuit within the 3 km hazard zone(s) of the affected vent(s). E.g. Unrest at Red Crater means Northern Circuit is closed above Oturere Hut.

Note: Unrest at Red Crater or multiple vents = Complete closure of the Tongariro Alpine Crossing at the carparks. This includes the Tongariro Alpine Crossing portion of the Tongariro Northern Circuit between Oturere Hut and the intersection with the Whakapapa Village Track – 'the Ditch Track'.</td></tr>
<tr><th colspan="2">Step 2:</th></tr>
<tr><th>Unrest is located at Ngauruhoe?</th><th>Unrest is located at Te Maari?</th></tr>
<tr><td>• Apply a 3 km closure radius (per map) around Ngauruhoe and close the southern section of the Tongariro Alpine Crossing from Mangatepopo carpark to the southern extent of Emerald Lakes. Mangatepopo Hut should also be closed despite being just outside the 3 km radius.
• Install clear closure signage and robust temporary barriers across the track. Maintain access to the Oturere Valley for the Northern Circuit.</td><td>• Apply a 3 km closure radius (per map) around Te Maari and close the northern section of track from the Ketetahi carpark to the northern extent of Emerald lakes.
• Install clear closure signage and robust temporary barriers across the track. Maintain access to the Oturere Valley for the Northern Circuit.</td></tr>
</table>

• The Tongariro Alpine Crossing is now a return trip to Emerald Lakes from Ketetahi car park. • The turnoff down the Oturere Valley to Oturere Hut remains open. The Tongariro Northern Circuit now begins at Ketetahi car park.	• The Tongariro Alpine Crossing is now a return trip to Emerald Lakes from Mangatepopo car park. • The turnoff down the Oturere Valley to Oturere Hut remains open. The Tongariro Northern Circuit is unchanged.
The decision-maker should also consider the role and relevance of other risk management approaches, with special regard given to cultural mitigation measures from our Treaty partner (such as rāhui). *The decision-maker is the CNI Operations Director.*	

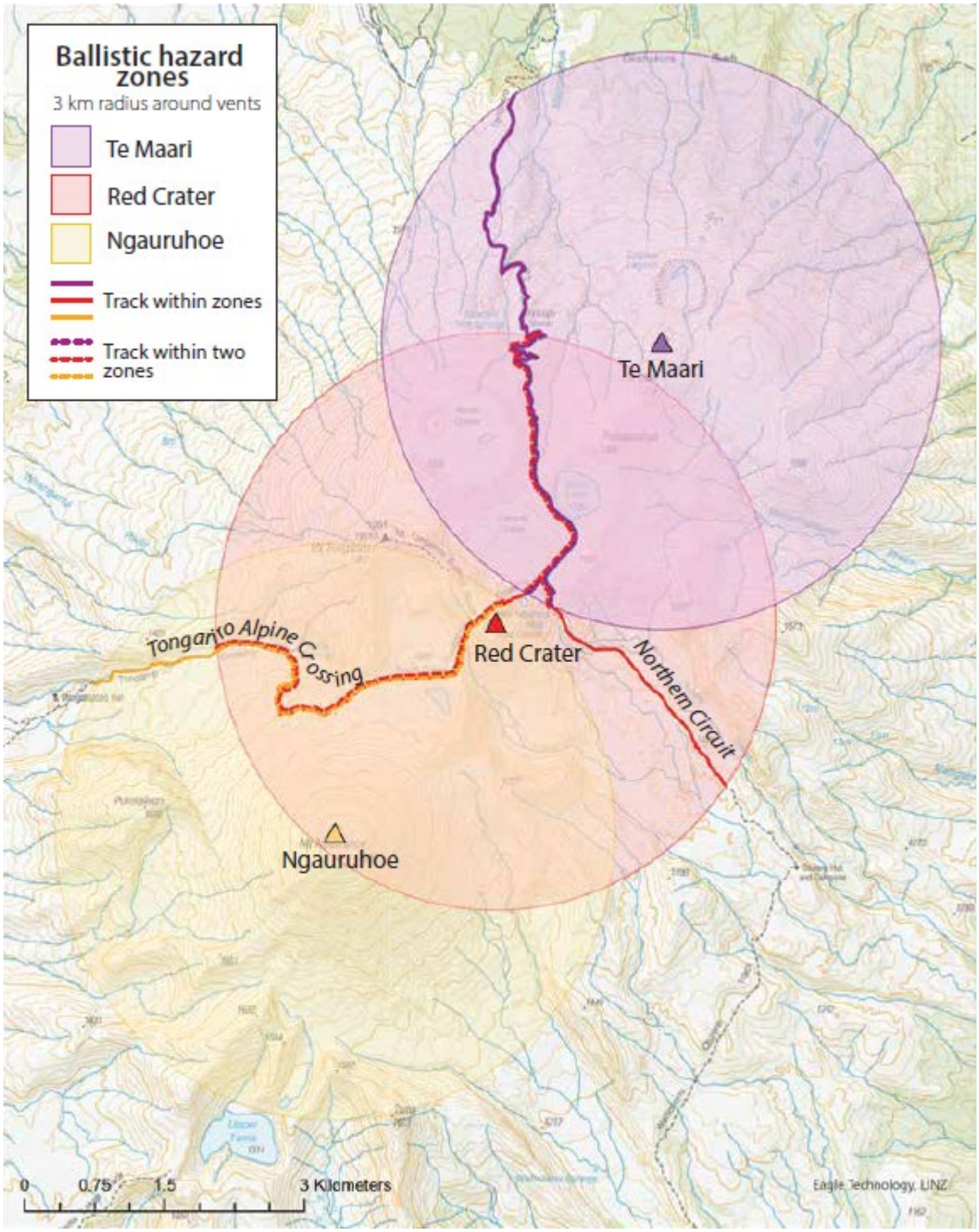


Figure 8. Map showing the 3 km management radii (hazard zones) around Ngauruhoe, Red Crater and Te Maari vents. These are the areas described in the closure decision process in table 5.

5. Managing volcanic eruption and de-escalation of volcanic activity

5.1 Rapid escalation of volcanic activity

The Initial Response Plan (IRP) is to be used in response to sudden volcanic activity within the TNP. The rostered Volcanic Ranger will activate the appropriate procedures outlined within this document to, firstly, confirm event with GNS Duty Volcanologist; secondly to alert and/or confirm an event to stakeholders alerted by the VAN.

All reflex actions and key tasks are outlined within the IRP and the Volcanic Rangers (VR) should be well versed with these procedures. It is important for DOC to understand the status, scale and location of the event and to then execute the appropriate tasks. For large eruptions, DOC may need to initiate a CIMS working with and alongside the wider DOC team, and other agencies. Incident Action Plans from the 2012 Te Maari eruption have been prepared to assist response to such as event (see DOC-1279700).

Understanding the nature of historical events can help assist planning and preparations for future eruptions. Significant magmatic eruptions such as the 1945, 1995–96 eruptions of Ruapehu deposited a substantial amount of volcanic material on the crater rim, which enabled a higher volume of water to be contained within the lake. The eventual collapse of the crater lake rim caused two large lahars: one in 1953, which resulted in the deaths of 151 train passengers (following the washout of the rail bridge at Tangiwai) and again in 2007, with no injuries or death. Alternatively, a lake may be created by a debris avalanche such as happened during the 2012 eruption episode of Te Maari on Tongariro.

5.2 Initial Response Plan

As described above, the IRP is the fundamental response document for any volcanic events (or a false positive activation of the VAN). It contains initial reflex tasks and the phone callout to key stakeholders required within the first hour of an activation of the following components of the VAN, which are all located within TNP:

- Ruapehu Eruption Detection System (REDS) and Whakapapa Ski Area Lahar Alert and Warning System (WLAWS),
- Whakapapa Village Lahar Alert and Warning System (VLAWS),
- Tongariro Eruption Detection System (TEDS),

The IRP is used to alert key agencies and stakeholders with interests in the TNP of a real or false positive volcanic event. This document is primarily used by the Volcanic Ranger (VR), but during an event or ongoing events, other staff may be tasked to execute the phone call out section. The Trello app (on VR phones) is a digital version of the callout lists.

The VAN is operated by DOC and GNS. It has been developed over the last 30 years to mitigate volcanic risk from sudden eruptions. Following the 1969 and 1975 Ruapehu eruptions, a lahar warning system was installed in 1983 at Whakapapa Ski Area and an extension of the warning system in Whakapapa Village was installed sometime after this.

REDS and WLAWS have operated since 1999 and received major upgrades in 2012 and 2021. VLAWS was rebuilt and reconfigured in 2013. TEDS was commissioned in 2014 after the Te Maari eruptions. The systems are regularly maintained and receive frequent capital investment for hardware and software upgrades to keep them reliable.

After almost 20 years of service, the Eastern Ruapehu Lahar Alert and Warning System (ERLAWS) was retired in June 2022. ERLAWS was built to mitigate the lahar risk from the tephra

dam created by the 1995 and 1996 eruptions of Ruapehu. It successfully detected the lahar caused by the tephra dam's collapse on 18 March 2007. There is no longer a tephra dam at Ruapehu. A new lahar detection and warning system for the Whangaehu River is operated by Genesis Energy and Horizons Regional Council.

When an activation of the VAN occurs, a series of automated messages (SMS and email) are sent to the DOC VR and affected stakeholders. For WLAWS and VLAWS, sirens and voice messages are extra measures that are set off during activations.

The VAN is mostly self-monitored automatically, and the individual systems are tested on various predetermined time scales.

5.3 CIMS Structure in response to a volcanic event

The standard CIMS structure will be applied by DOC in response to a volcanic event to ensure an effective and collaborative interagency response, as illustrated in Figure 7.

The responsibilities of each function are described in Table 3.

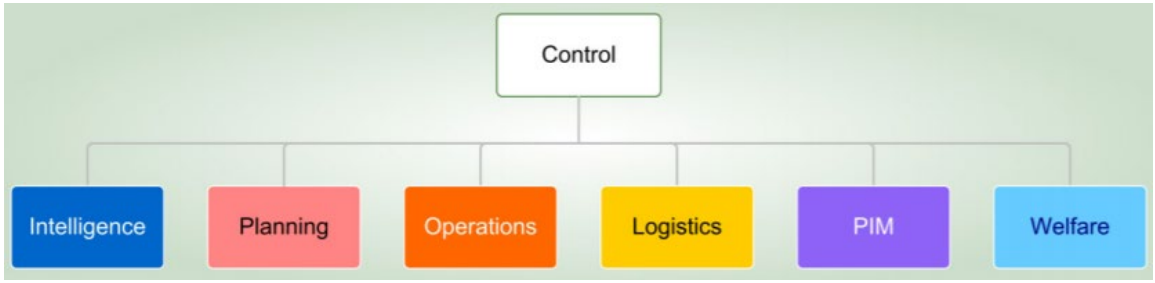


Figure 9. DOC's response structure for managing volcanic eruptions and events.

5.4 Decision-making in DOC and the Volcanic Home Page

Major decision-making by DOC during an eruption is the responsibility of the Tongariro District Operations Manager, who will assume the role of Incident Controller. If for some reason the Operations Manager is unavailable, either they will have delegated someone to assume this role, or the CNI Director Operations will task someone. Decision making during an eruption should draw on this document with advice from the Technical Advisor Volcanology and/or the Senior Ranger Public Safety, Volcanic Ranger, or the Planning and Intelligence function of the Incident Management Team following advice from GNS. Information for decisions will consider health and safety of staff, visitor safety, scientific assessments and management considerations.

A Volcanic Homepage has been developed to list key documents used in managing volcanic risk. This includes response plans, risk assessments, communications and briefings. The risk assessments provide important background for decisions and decision-making, including Volcanic Alert Levels and risk levels. Cross references to specific risk assessments are made below, e.g. for access to Ruapehu Summit Hazard Zone (SHZ) (see DOC-1135716 and DOC-2789674).

Table 6. Breakdown of CIMS functions and responsibilities.

Function	Responsibilities
Control	Coordinates and controls the response
Intelligence	Collects and analyses information and intelligence related to context, impact and consequences; also distributes intelligence outputs
Planning	Leads planning for response activities and resource needs
Operations	Provides detailed direction, coordination, and supervision of response elements on behalf of the Control function
Logistics	Provides personnel, equipment, supplies, facilities, and services to support response activities
Public Information Management	Develops and delivers messages to the public, directly and through the media, and liaises with the community if required
Welfare	Coordinates the delivery of emergency welfare services and resources to affected individuals, families/whanau, and communities

5.5 Managing Ruapehu volcanic eruptions

Table 7 below details the actions required by DOC in response to volcanic eruptions at Ruapehu.

Table 7.

VAL	Triggers from GNS monitoring, VAL, or local observations	DOC Management tools	Management Actions	Timeline
3	**Eruption or eruptions with VAL 3 (i.e. eruption phenomena only near vent), increased gas detection in crater basin or plume.** **VAB released.**	Increased communication with GNS required. Close everything in the *4 km radius from the centre of Te Wai ā-moe (Crater Lake)* – no public access and suspension of concessions within this area. Work with local iwi and hapū and Police on actions and decisions, inform RAL of actions and impacts.	IRP initiated. IMT structure in place and staff responding to eruption. Liaise with CPVAG on actions taken Closures and actions communicated via PIM function. Application of cultural mitigation measures provided by local iwi and hapū. Release advisory that the 4 km radius is closed and advise the public not to	When eruptions occur.

			enter the upper Whakapapaiti and Whangaehu catchments – include a map. Install signs at Round the Mountain Track entrances advising the public not to use the track due to lahar hazard.	
4-5	**Eruption with VAL 4–5 (i.e. eruption phenomena on volcano's slopes or beyond it as per VAL definition, and also trends including earthquakes, deformation etc. related to volcanic activity.** **VAB released.**	Wider closures (beyond 4 km radius) required in response to larger eruption. Liaise with CDEM on wider eruption response. Ruapehu District Council Emergency Declaration is likely. Work with local iwi and hapū and Police on actions and decisions, inform RAL of actions and impacts.	IRP initiated. IMT structure in place and staff responding to eruption. Liaise with CPVAG on actions and wider eruption response Closures and actions communicated via PIM function. 24/7 response or standby in conjunction with CDEM and CPVAG. Application of cultural mitigation measures provided by local iwi and hapū. Release advisory that the 4 km radius is closed and advise the public not to enter the upper Whakapapaiti and Whangaehu catchments – include a map. Install signs at Round the Mountain Track entrances advising the public not to	When eruptions occur.

			use the track due to lahar hazard.	

5.6 Managing Tongariro volcanic eruptions

Table 8 below details the actions required by DOC in response to volcanic eruptions at Tongariro – the Tongariro Alpine Crossing and Tongariro Northern Circuit.

Table 8.

DOC partners or management tools	VAL 3–5 (or still 2 but GNS/VAB note some possible increase in unrest, or an eruption is likely)	VAL decrease
Iwi and hapū	Work with Ngāti Hikairo to coordinate actions, which may include cultural mitigation measures such as rāhui. Ensure discussion with other local iwi and hapū occurs.	Ensure Ngāti Hikairo and other local iwi and hapū are kept involved, informed and aim to keep response appropriate and proactive.
GNS Science	Ongoing close communications and cooperation.	
DOC response and access decisions	IRP initiated. IMT structure in place and staff responding to eruption. Close the Tongariro Alpine Crossing and affected sections of the Tongariro Northern Circuit. Communicate closure to the public and concessionaires via PIM function. Liaise with CPVAG on actions and wider eruption response 24/7 response or standby in conjunction with CDEM and CPVAG.	Management actions for reopening and other risk management concerns, consultation etc. evolve as required including appropriate locations of barriers, signage, website, media on when facilities can be reopened. Risk assessment review during de-escalation of activity.
Media and communication plan	PIM function executing Comms Plan – developed with other agencies involved including Ngāti Hikairo, police and GNS. Minister and DOC Wellington Office (Conservation House) informed, and briefings/decision documents prepared as necessary. PIM function also to liaise with CPVAG PIM group on actions taken.	
TACTAG	Keep updated, as feasible.	Keep updated, especially including development and implementation of new management actions.

5.7 Management of ongoing volcanic events

DOC's key responsibilities throughout any ongoing volcanic events would remain the same, managing public safety within the confines of TNP is DOC's primary responsibility. This may include ensuring the closure of facilities for the length of the ongoing event to mitigate continuing risk from volcanic phenomena. Staff work in the field needs to be assessed against the volcanic risks presented from the ongoing eruptions and, if required, work should be focused well away from possible impacts until the eruption sequence is over.

The CIMS structure will remain in place and staff rotated accordingly depending on the eruption duration to ensure ongoing management of the event occurs; this will include regular liaison and

discussion with GNS, Police, local iwi and hapū and other stakeholders. Support will be provided to DOC from local district councils and CDEM through CPVAG who will play a key role with ongoing events and the size and spread of the volcanic phenomena and its associated impacts on people and property outside of the park.

5.8 Decreasing or de-escalating volcanic activity

Further management decisions are required when volcanic activity starts decreasing or is regarded as being over. It is generally not easy to be sure when that is – it can take years – and ongoing guidance from GNS will be required.

However, many sudden onset eruptions of Ruapehu have been one-offs, such as occurred in 1969, 1988, 2006 and 2007. Only one of the sudden onset eruptions in historic time (1975) had a second smaller eruption that occurred three days after the first. DOC should be cognisant that eruptions can be one-offs and be aware of perceived risk vs actual risk when making decisions. DOC should work closely with GNS, local iwi and hapū and other agencies during post-eruption decision making periods.

While the DOC Risk Management Stages provided in these Guidelines can be used as a de-escalation pathway (deescalating by following the same path down as the initial escalation up), it is important to note that it may not be appropriate to follow them. It may instead be necessary to diverge from these Guidelines after an eruption has occurred, especially when there is a large amount of uncertainty about what the volcano is going to do next, and limited information from GNS. In the face of significant uncertainty, a more conservative approach may be required. Every eruption is different, and risk will need to be carefully assessed after each event, particularly where secondary hazards are present, such as the tephra dam that formed at the Crater Lake outlet from the 1995/96 eruptions at Ruapehu.

As the length of time since an eruption increases, decisions will be based more on, and involve, the following:

- Volcanic Alert Level decrease
- Length of time since peak of monitored parameter (e.g. days or weeks since last event etc.)
- Specific qualitative and quantitative risk assessments for Ruapehu and Tongariro
- Ministerial briefing (e.g., risk mitigation for Tongariro Alpine Crossing, see DOC-1177849)
- Media releases integrated with or immediately following GNS VABs, media releases (or CPVAGs), with specific messages as required
- Specific mitigation plans
- Reductions in restrictions, opening of facilities.

Appendix 1

References

CPVAG (Central Plateau Volcanic Advisory Group) 2018: Tongariro Volcanic Centre Contingency Plan (DOC-5722587)

DOC (Department of Conservation) 1999: Environmental and risk assessment for mitigation of the hazard from Ruapehu Crater Lake. Assessment of Environmental Effects prepared for Minister of Conservation. Department of Conservation, Turangi, 142 p.

Energy Surveys 2011: Report on the Ruapehu crater rim deformation survey 24 March 2011. Energy Surveys Ltd, PO Box 1905, Taupo, 12 pp. + figures and tables.

Hodgson, KA.; LeCointre, J.A.; Neall, V.E. 2007: Onetapu Formation: the last 2000 year of laharic activity at Ruapehu volcano, New Zealand. *New Zealand Journal of Geology & Geophysic 50*: 81–99.

Jolly, G.E; Keys, H.J.R.; Procter, J.N.; Deligne, N.I. 2014: Overview of the coordinated risk-based approach to science and management response and recovery for the 2012 eruptions of Tongariro Volcano, New Zealand. *Journal of Volcanic and Geothermal Research* 286: 184–207. http://dx.doi.org/10.1016/j.jvolgeores.2014.08.028

Keys, H.J.R.; Green, P.M. 2008. Ruapehu Lahar New Zealand 18 March 2007: Lessons for Hazard Assessment and Risk Mitigation 1995–2007. *Journal of Disaster Research* 3: 284–296.

Pardo, N.; Cronin, S.; Palmer, A.; Procter, J.; Smith, I. 2012: Andesitic plinian eruptions at Mt Ruapehu: quantifying the uppermost limits of eruptive parameters. *Bulletin of Volcanology 74*: 1161–1185.

Schaefer, L.; Kennedy, B.; Villeneuve, M.; Cook, S.; Jolly, A.; Keys, H.; Leonard, G. 2018: Stability assessment of the Crater Lake/Te Wai ā-moe overflow channel at Mt. Ruapehu (New Zealand), and implications for volcanic lake break-out triggers. *Journal of Volcanology and Geothermal Research 358*: 31–44.

Strehlow, K.; Sandri, L.; Gottsmann, J.; Kilgour, G.; Rust, A.; Tonini, R. 2017: Phreatic eruptions at crater lakes: occurrence statistics and probabilistic hazard forecast. *Journal of Applied Volcanology 6(4)*: DOI10.1186/s13617-016-0053-2

Appendix 2

Volcanic phenomena and risks in TNP

The main areas of risk to people on Ruapehu are in the areas exposed to severe volcanic phenomena around the vents and within catchments prone to lahar and/or pyroclastic density currents as shown on the Ski Area Volcanic Hazard Maps (Figs A2.1 and A2.2).

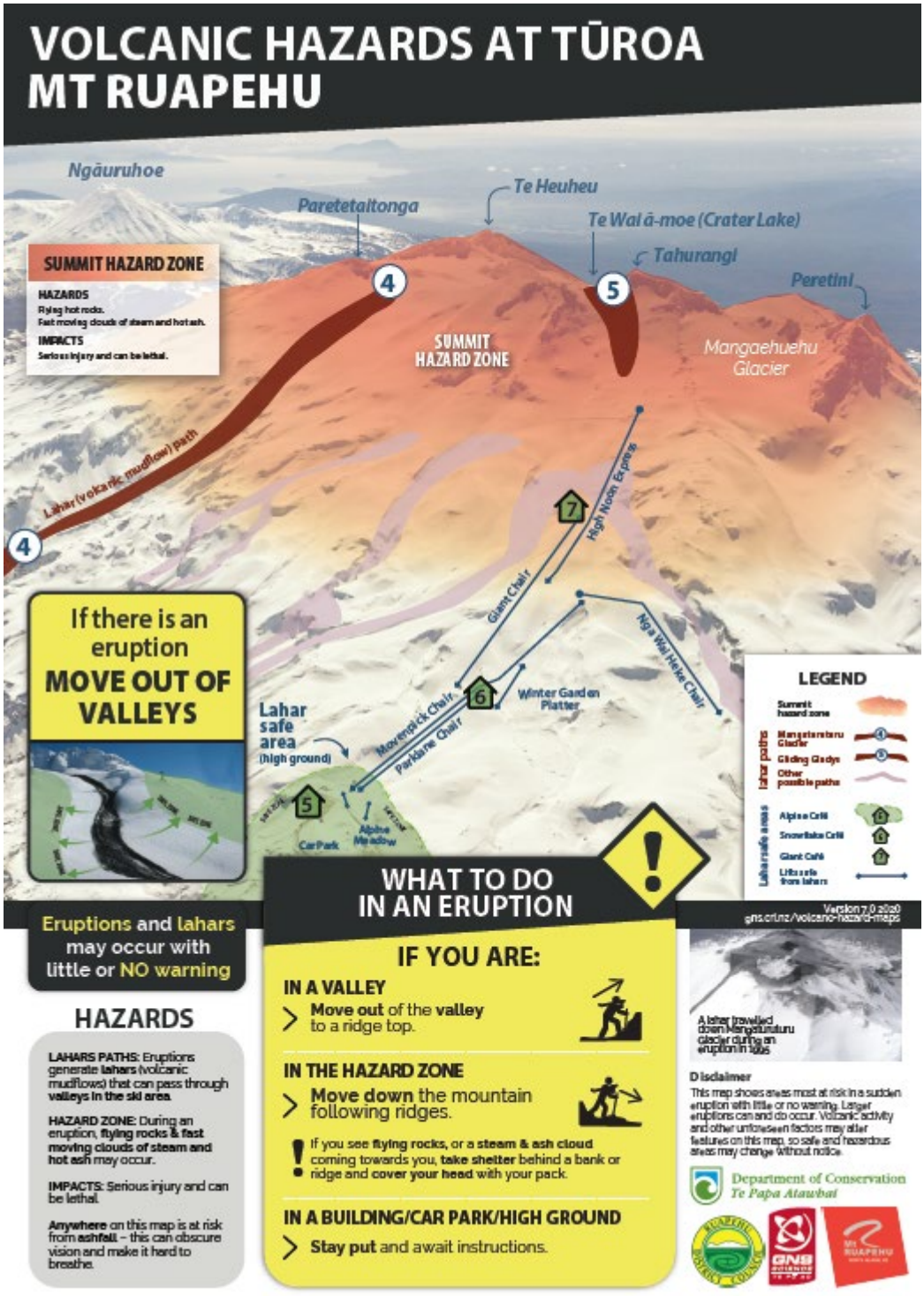


Figure A2.1 Volcanic hazards at Tūroa Ski Field.

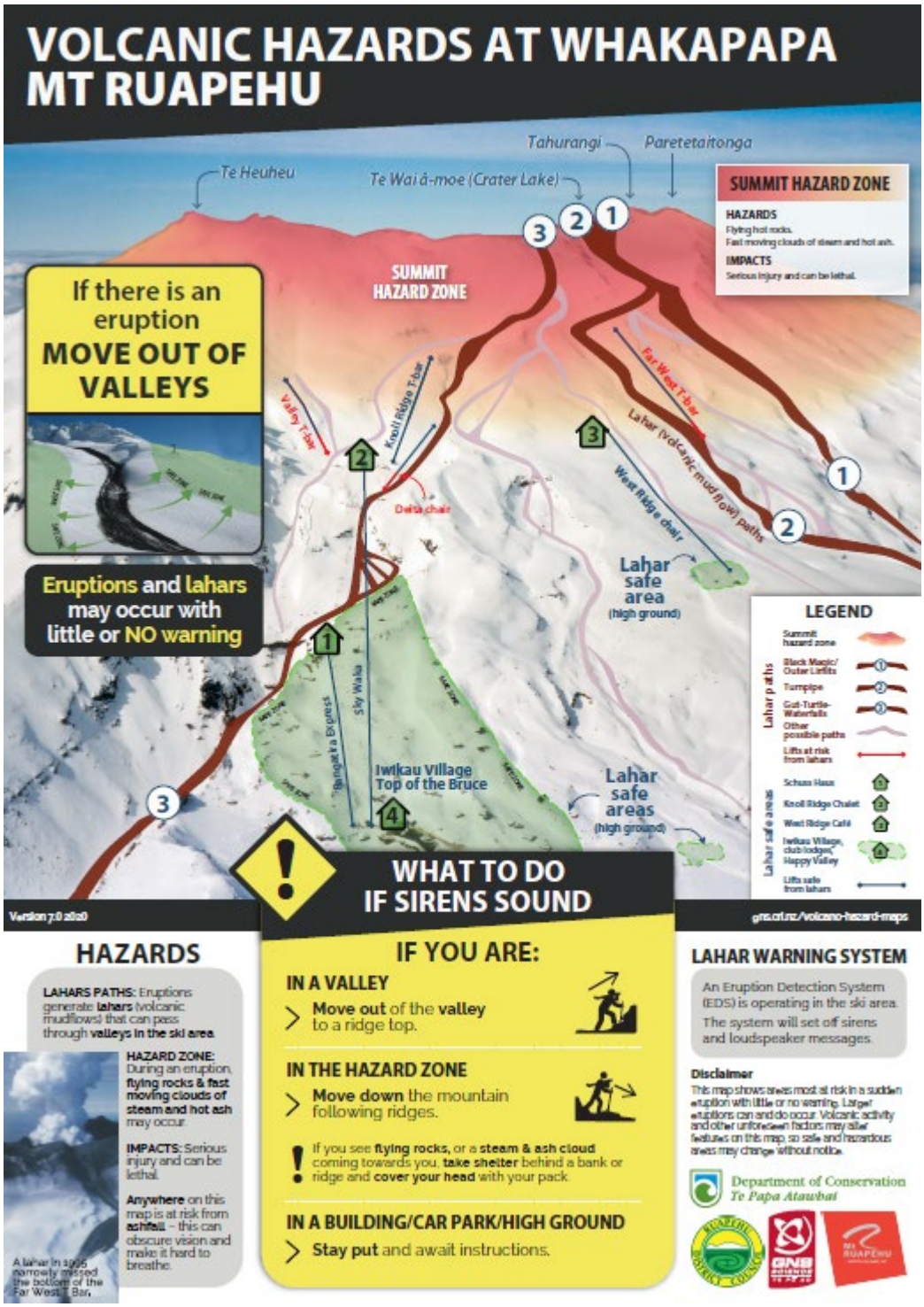


Figure A2.2 Volcanic hazards at Whakapapa Ski Field.

Elsewhere, risks will normally be much less. In large eruptions, people and infrastructure are at risk, and these risks and locations are outlined below:

Ruapehu

- Ruapehu SHZ: **flying rocks, tephra jets, surges and lahars.**
- Whakapapa Ski Area and possibly Tūroa Ski Area: **lahars and flying rocks.**

- Whakapapa Village: **lahars**.
- State Highway 48 bridges over the Whakapapanui Stream**: lahars.**
- Whangaehu, Mangaturuturu valleys and Round the Mountain Track crossings of other streams: **lahars**. (NB. Research by Hodgson et al (2007) indicates that large lahars have travelled down the Whangaehu Valley over the last few hundred years. Potentially caused by rim weakening resulting from magmatic pressure, seismicity or even through chemical (Schaefer et al. 2018) or other weakening during non-volcanic periods.
- Anywhere in the upper cone especially above the level of the road ends and in valleys on the Round The Mountain Track: **pyroclastic density currents (PDCs)** (NB. If Te Wai ā-moe (Crater Lake) empties or dries out during an eruption, or the magma otherwise becomes separated from the lake water, there is an increased change of PDCs being formed from a collapsing eruption column, similar to what occurred in November 1945).

Tongariro and Ngāuruhoe

- Tongariro Alpine Crossing: **Flying rocks during eruptions and PDCs, secondary lahars during or after heavy rainfall**.

Surrounding villages and towns

- Papakai and Rotoaira basin: **ashfall, possibly extreme PDCs or secondary lahars.**
- Ohakune, Waiouru, Tūrangi, National Park: **ashfall**.

Table A2.1 summarises the volcanic phenomena likely to be experienced in TNP, and the areas likely to be affected.

Table A2.1. Volcanic phenomena inside Tongariro National Park from Tongariro, Ngāuruhoe or Ruapehu.

Volcanic phenomena	Distribution
Volcanic gas.	Local craters.
Lightning from eruption columns.	Approx. 1 km depending on ash plume size.
Local ash and mud fall (e.g. gravelly to fine–sandy-sized and smaller material).	Potentially minor-moderate hazard within 1–2 km depending on eruption and wind strength and direction. Ash fall may occur ≥ 100 km away.
Lava flows including rockfalls from leading edge or sides.	Approx 10–100 m distance from flow edge but 1–3 km or more from vent depending on flow volume, thickness etc.
Fire fountaining.	1–1.5 km.
Surges (blasts) and tephra/muddy jets and other subaerial flows	1–3 km or more.
Flying rocks and shrapnel (bombs and blocks on ballistic trajectories and in impact areas).	Approx. 2.5 km during eruptions like that at Te Maari 6 August 2012. 3 km or more during the large eruptions at Ruapehu during 1995–96.
Lahars, debris flows and debris avalanches.	Down valleys for several km or to the sea in the case of large lahars down the Whangaehu and then Whanganui River.
Pyroclastic density currents (pyroclastic flows or ground hugging burning clouds).	Down slopes and valleys for several km.
Secondary lahars and debris flows.	Down valleys for several km.
Bush/forest/scrub fires from incandescent rocks and lava.	Close to hot material and downwind from it.

The biggest risk created by these volcanic phenomena is loss of life or severe injury depending on the extent of the hazard, people's proximity to it and the length of time they are in hazard zones. TNP is popular with hikers, skiers, snowboarders and climbers – there are around one million visitors to the park annually.

People in volcanic hazard zones (a 3 km radius from active vents) will be most at risk from volcanic phenomena. Risk is next highest in valleys near active vents from lahars and PDCs. People staying in DOC huts are much less exposed to risk as these are now outside the current recognised volcanic hazard zones. Residents living on slopes and in valleys below the Park's active vents are the next most at risk. People visiting active areas for short times during scientific monitoring or SAR activities will also at be risk, but the exposure time (time spent) in hazard zones is main factor for the amount of risk taken at an individual level.

People travelling on highways within 5 km or so from craters may be at some risk from lahars and large PDCs if bridges or culverts are damaged; this includes the bridges above and below Whakapapa Village. Most road bridges and other structures have now been designed and built to withstand most of these phenomena; however, research has shown that the largest eruption lahars that have occurred in the last 2000 years (Hodgson et al 2007) are likely to exceed the design parameters of some bridges on the Desert Road.

More information on volcanic phenomena is available, and GNS has a useful webpage: https://www.gns.cri.nz/Home/Learning/Science-Topics/Volcanoes/Volcanic-HazardsRisks. Risks from ashfall and general public concerns will normally be addressed by local territorial authorities and other agencies.

The CPVAG contingency plan 2018 (CPVAG 2018) moves further than its predecessor by adding in various scenarios from the three TNP volcanoes to articulate different eruption magnitudes associated phenomena which are shown in Tables A2 .2 –A2.5 below.

Table A2.2. Ruapehu volcanic activity scenarios from CPVAG 2018.

Eruption State:	Quiescence	Unrest	Small	Moderate	Large	Very Large
Likelihood			1 per year	1 in 10 years	1 in 50 years	1 in 500 years
Area at Risk	None	None	Summit area Whangaehu Valley Crater Lake edge	Summit area Whangaehu Valley Whakapapa Skifield	Summit area Whakapapa, Tūroa and Tūkino Skifields Ashfall beyond the ringplain	
Magma Volumes			<0.001 km^3	<0.01 km^3	<0.01 – 0.1 km^3	<0.1 km^3
Lahar Volumes (% of lake volume)			<1%	<1–10%	<10–30%	<30%
Associated Hazards	None	Increased gas at summit area Possible felt seismicity	Geysering in lake, increased wave action	Ballistics to 3 km Lahar in 2 or 3 catchments Ashfall to <10 km	Ballistics, ashfall to >10 km Lahars in multiple catchments	Ballistics and lahars in multiple catchments Significant ashfall
Typical Duration			Hours to weeks	Days – weeks	Days – weeks – months	Months – years

Table A2.3. Ruapehu landslide scenarios from CPVAG 2018.

Landslide Scale:	Small	Moderate	Large	Very Large
Description	Minor landsliding	Landslips at lake = lahar from lake overflow	Landslides from outlet area may result in lake breakout	Landslides from any flank = debris avalanche
Phenomena	Increased sediments to rivers	Overflow of lake	Size of breakout flood dependent upon landslide volume	Significant proportion of flank collapse
Volume	1–10^2 m^3	10^2–10^3 m^3	10^4–10^6 m^3	>10^6 m^3
Area at Risk	Steep slopes	Whangaehu Valley	Whangaehu Valley, possible overflow into Tongariro Catchment	Any flank possible, but Whangaehu most likely
Likelihood (estimated)	1 per month	1 per year	1 in 50 years	1 in 5000 years

Table A2.4. Tongariro activity scenarios from CPVAG 2018.

Eruption State:	Quiescence	Unrest	Small	Moderate	Large	Very Large
Activity Style		Steam and gas emissions as seen in 2013–18	Explosive activity as in November 2012	Explosive activity and PDCs as in 1892, 1896–97, August 2012	Event about 500 years ago producing lava flow and the accompanying explosions	
Area at risk	None	Active vents	Within about 500–1000 m	Up to 3 km	Explosions; 3 km lava flows; up to many kms	
Associated Hazard	None	Increased gases	Ballistics, small PDCs, minor ashfall	Ballistics, small PDCs, moderate ashfall	Ballistics, small PDCs, Moderate ashfall	
Magma Volume			About 0.00001 km^3	About 0.0001 km^3	About 0.001 km^3	
Eruption Duration			Hours to days	Hours to weeks	Weeks to years	
Consequence Duration	Years to decades	Months to years	Months	Months to years	Years	
Comments	Nothing unusual seen or recorded	Some form of volcanic unrest apparent	Minor eruptive activity, most likely phreatic in nature	Stronger eruptive activity, mostly likely phreato-magmatic in nature	Longer duration eruptive activity, primarily of a magmatic nature	

Table A2.5. Ngāuruhoe volcanic activity scenario from CPVAG 2018.

Eruption State:	Quiescence	Unrest	Small	Moderate	Large	Very Large
Activity Style		Steam and gas emissions as seen in 1975–90	Explosive activity as seen in 1904–17, 1924–28, 1934–37	Explosive activity and PDCs as seen in 1974–75	As seen in 1870, 1949, 1954; producing lava flows and the accompanying explosions	
Area at Risk	None	Active vents	Within about 500–1000 m	Up to 3 km	Explosions: 3 km, lava flow: many kms	
Associated Hazard	None	Increased gases	Ballistics, minor ashfall	Ballistics, small PDCs, moderate ashfall	Ballistics, small PDCs, moderate ashfall	
Magma Volume			About 0.00001 km^3	About 0.0001 km^3	About 0.001 km^3	
Eruption Duration			Hours to days	Hours to weeks	Weeks to years	
Consequence Duration	Years to decades	Months to years	Months	Months to years	Years	
Comments	Nothing unusual seen or recorded	Some if volcanic unrest apparent	Minor eruptive activity, most likely phreatic in nature	Stronger eruptive activity, most likely phreato-magmatic in nature	Longer duration eruptive activity, primarily of a magmatic nature	

APPENDIX 3

VOLCANIC RISK MANAGEMENT PERFORMANCE MONITORING

Table A3.1. Performance monitoring and measures

KPI	STANDARD	MEASURES
Relationships.	Close working relationships maintained with GNS, local iwi and hapū, Police, RAL and other partner agencies.	Regular communication, collaborative work and planning, pre-winter and summer meetings, contribution to CPVAG.
Health and Safety.	All field work carried out with close regard to hazards and risk mitigation.	Use of JSA and toolbox talks and annual review/update of Risk Manager hazard controls.
Volcano status updates and communication with GNS etc.	Live knowledge of volcano status via GNS and GeoNet including Te Wai ā-moe (Crater Lake) and other active vents in TNP.	Communication with GNS Duty Volcanologist or Team Leader Volcanology at least fortnightly but daily if necessary, especially in association with VAL changes and VAB releases.
		Updating managers, iwi etc. during periods with elevated unrest or concern.
		Frequent (e.g. daily) updating during cool and warm periods of Te Wai ā-moe and advice to RAL etc. on risk management.
Access decisions and implementation of them.	Use of information from GNS etc. and risk assessments to facilitate decisions on access and follow up communications.	Wherever possible (best endeavours) quantitative risk assessments are available for Tongariro and Ruapehu.
		Media release according to Comms Plan.
		Signs deployed and barriers erected (if appropriate/possible) for facility closures.
Volcanic Risk Management.	IRP and Guidelines are current, operative and distributed.	Guidelines signed off by the CNI Operations Director and IRP approved by the Tongariro Operations Manager.
		Latest documents held on the Volcanic Home Page, and by Volcanic Rangers and Operations Manager.
		6-monthly check of IRP phone callout lists, in addition to updates as required.
		Documents reviewed annually.
Volcanic Alert Network.	REDS/WLAWS/VLAWS/TEDS. Annual inspection of Matarangi Bunker (during Summer).	≥90% of the sites operating to design standard ≥90% of the time.
		Daily WLAWS speaker testing by RAL at all operating locations. Weekly WLAWS radio tone testing by RAL. Daily SCADA checks by Senior Ranger Public Safety and Volcanic Rangers. All system repairs within 7 days – weather permitting.
		VAN automatic comms testing (SMS and email alerts) 3x weekly – Monday, Wednesday, Friday.
Response – DOC.	Rapid response to VAN activations (or visual observations) as per IRP.	Response to alerts within 1 minute and completion of initial response reflex actions within 15 minutes (not including time to complete phone call out if required).
	IMT established and initial reflex tasks completed, Action Plan developed, and	Conference call for eruption events within 30 minutes.

	tasks assigned for first hour, and repeated as necessary.	Action plan tasks executed and sitreps completed and distributed, further action plans developed.
	Training and development.	Annual training and refreshers for Volcanic Rangers and annual exercises for Ruapehu or Tongariro (maybe in conjunction with testing and/or other agencies).
	VLAWS – Whakapapa Village – people evacuated from identified at risk areas within 15 minutes.	Village exercise (if no major false positive events) every 2 years. Notices and signage reviewed every 2 years.
	Lessons learnt from tests and events with incorporation in response and other plans as necessary.	Reports developed and circulated with lessons learned for eruptions, tests/exercises and false positive activations of the VAN.
Response – ski areas.	Pre and post season volcanic risk management and eruption response planning meetings with RAL, GNS, Police and RDC. (Tailor meeting attendees to the specific agenda and requirements).	Pre and post season meetings held, and actions/notes written up and circulated.
	Operative eruption response plan for ski areas.	Ensure RAL have an up to date and well-maintained eruption response plan.
		Additional risk management with RAL for high-risk modes of Crater Lake including contingency for WLAWS operating below standard.
	WLAWS – Whakapapa Ski Area – people moved to a safe area within 2–5 minutes and Gondola evacuation within 5 minutes of activation.	Annual Open and Blind tests (at least two per year, but false positive events may alleviate the need) – determine this in discussion with wider team and RAL.
	The public is aware of the threats and the required actions. Latest version of volcanic hazard map posters in toilets, congregation areas and club lodges.	Senior Ranger Public Safety to ensure RAL has access to latest posters. Annual public survey as part of GNS research (if funded).
Response – Whakapapa Holiday Park.	Operative evacuation plan.	Biannual staff training to confirm plan is operational.
	All guests and staff evacuated within 15 minutes and heading to the Chateau.	Village exercise (if no major false positive events) every 2 years. Notices and signage reviewed every 2 years.
WLAWS testing – Whakapapa Ski Area.	Speakers and radio alerts tested by RAL at agreed timescales. Daily SCADA checks by DOC.	SCADA checks and discussions with RAL if testing not occurring.

Appendix 4

Further scenarios

There were some key lessons from the management of the debris dam that was formed after the Te Maari August 2012 eruption on Tongariro. It is therefore important for these Guidelines to also address this type of phenomena in case it occurs in future eruptions or as a result of landslides not associated with volcanic activity.

Table A4.1. Te Maari Dam and associated DOC actions and response.

Te Maari Lahar Scenario (periodic monitoring required)	Other factors to consider	Initial response	Follow-up response
Te Maari former lake infilled with water and no threat at last check [Jan 2018], breached and stable surface outlet, no recent heavy rain, no signs of significant change in breach area or west rim of Te Maari, no significant earthquakes.	Stream flow and lake level and trends, GNS or Massey advice to DOC. Also be mindful of: • Number and locations of DOC staff in field, including hut rangers. • Weather conditions affecting visibility, flying conditions etc. • Time of day affecting visibility etc. • Reported volcanic activity and degree of confirmation. • Factors may need review after change of activity, e.g. Te Wai ā-moe (Crater Lake) or other vent condition/lake level, dam burst or landslide activity.	DOC decisions based on monitoring and advice including updates in hazard assessments.	Ongoing monitoring and readiness. Monitoring of west rim, delineation of lahar path.
Te Maari Lake dammed again [1307.8 m maximum reached before breach on 14 October 2012], outlet/dam possibly becoming unstable, recent heavy rain and/or significant earthquakes.	Landslide or major earthquake, increasing stream flow and rising lake level, reports from public or concessionaires.	As above plus warnings and preparations for closing facilities; if necessary, initiate CIMS	As required, including media and direct contact to TACTAG.
Small lahar or debris flow confirmed across any track or new debris avalanche reported.	Accompanied or unaccompanied by heavy rain.	As above plus warnings and closing of track with signage, call police (National Park) and CDEM, initiate CIMS	Start response according to time of day, weather.
Large debris flow across any track or road.	Reports. If injuries etc discuss with CDEM about need for other action		