

AER/AGS Roles and Responsibilities Manual for the Turtle Mountain Monitoring Program, Alberta

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Abstract

The Turtle Mountain Monitoring System (TMMS) is a near-real-time remote monitoring system that provides data from a network of sensors located at Turtle Mountain in the Crowsnest Pass, site of the 1903 Frank Slide. As of April 1, 2005, the Alberta Energy and Utilities Board, now the Alberta Energy Regulator (AER), through the Alberta Geological Survey (AGS), took ownership of this system and manages the Turtle Mountain Monitoring Program.

The Turtle Mountain Monitoring Program conducts ongoing monitoring and research focused on understanding the kinematics of movements of Turtle Mountain's unstable eastern slopes, including an annual detailed review of the TMMS data stream. To help with this interpretation, the AGS has initiated specific studies to better understand the structure of the mountain and its relationship to the style and rate of movement seen in recent and historical deformations of South Peak. These studies also better define the unstable volumes of rock from the South, North and Third Peak areas.

This report provides information about the AGS's ownership of the TMMS and the specific roles and responsibilities of AER/AGS staff during normal operations, for long-term monitoring, interpretation of data during varying alert levels, and notification of the Alberta Emergency Management Agency (AEMA) should significant rock movements occur. A separate document prepared by the AEMA outlines the action plans for the stakeholders and first responders in the Crowsnest Pass, Alberta.

1 Introduction

In 2005, the Alberta Geological Survey (AGS) assumed responsibility for the long-term monitoring and studying of a large, slowly moving rockslide at Turtle Mountain, the site of the 1903 Frank Slide (Figure 1). The initial priority for monitoring and studying Turtle Mountain was to provide an early warning to residents of the Crowsnest Pass in the event of a second catastrophic rock avalanche originating from South Peak. In July 2016, the Turtle Mountain Monitoring Program (TMMP) transitioned from a near-real-time early warning monitoring system to a near-real-time remote monitoring system.

Over the past decade, the AGS has been studying Turtle Mountain and providing on-call staff 24 hours a day. In July 2013, a one-day workshop about Turtle Mountain was held in Waterton, Alberta, to review the previous decade of monitoring. Following the workshop, an independent international expert panel prepared a report (included as appendix 3 in Wood et al., 2016) for the AGS providing recommendations for the current and future TMMP. The report outlines the mountain site characterization and hazard assessment, reviews the early warning monitoring system practices, and makes recommendations for the future of the program. The panel found the risk of a large-scale rockslide to be very low. The transition to a near-real-time remote monitoring system will eliminate the requirement that staff be on-call 24 hours a day and will allow the AGS to withdraw some non-operational monitoring equipment. The AGS is still responsible for long-term monitoring and retains the capacity for early warning if necessary.

Based on a review of the sensor configurations, a system of four alert levels (green, yellow, orange, and red) was developed by AMEC (Froese et al., 2005). This system has been incorporated into the Alberta Emergency Management Agency's (AEMA's) Emergency Response Protocol (ERP) for Turtle Mountain (Alberta Emergency Management Agency, 2017). Tables 3– 6 provide an overview of the AGS's Turtle Mountain alert levels and corresponding responses that have been incorporated into external agencies' ERPs.

All internal Alberta Energy Regulator (AER) roles and responsibilities pertaining to the Turtle Mountain Monitoring System (TMMS) will also be referenced to the same four-stage alert system to maintain consistency for all parties involved.

2 General Responsibilities

The AER/AGS is responsible for determining the appropriate alert level for a potential or actual emergency at Turtle Mountain and for providing geotechnical expertise to the AEMA and the Municipality of Crowsnest Pass (MCNP) during an event. These AER/AGS roles will ensure that the main geotechnical objectives of the AEMA Emergency Response Protocol (ERP; Alberta Emergency Management Agency, 2017) are fulfilled.

The AER/AGS Turtle Mountain (TM) Team is responsible for timely and efficient information review and delivery, both internally to the AER and externally to the AEMA. The internal AER/AGS emergency response team for Turtle Mountain consists of the TM leader, TM staff, the AGS management representative, the Emergency Management Group, the Executive Leadership Team (ELT), and Security and Network Services (SecNet). The external TM Emergency Response Group (ERG) includes organizations that respond to an emergency at Turtle Mountain under a unified command structure. ERG members are coordinated by the AEMA and MCNP with geotechnical support and assistance provided by the AER/AGS. During varying alert levels not all response positions would necessarily be activated throughout the AER and ERG.

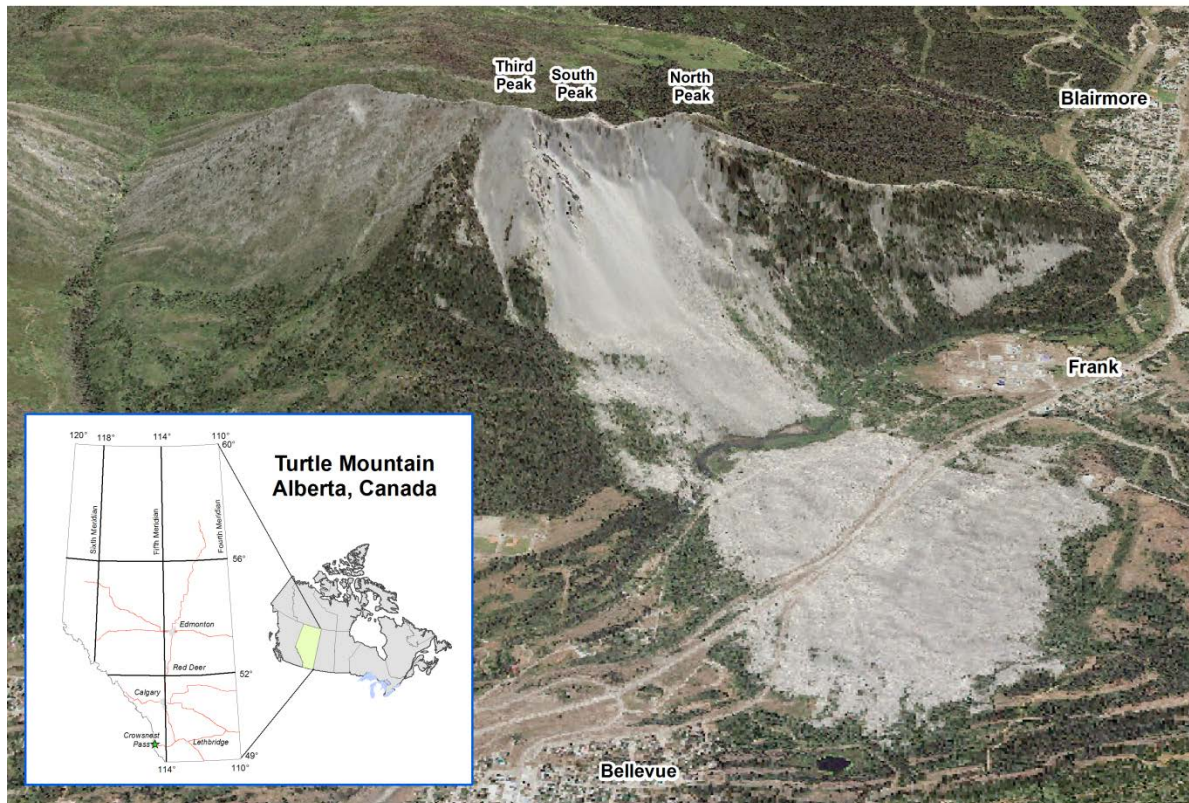


Figure 1. Location of Turtle Mountain in southwestern Alberta and full-extent aerial view of the Frank Slide.

This document establishes the chain of command, identifying key individuals at the AER and AGS who will fill each position and clearly defining their roles and responsibilities so they can effectively manage any alert situation. A geotechnical structure is also defined for reporting rock-displacement alerts and other critical information to appropriate individuals at each stage of the response. An organized response by the AER is established on the development and communication structure based on the *AER Internal Guides 26 and 34*; and Incident Command System (ICS) Canada. Further information on ICS Canada can be found on their website at www.icscanada.ca.

It should be noted that the number of people notified will increase as the level of alert rises and decrease as it moves toward its conclusion (e.g., all communications and notifications are internal during alert level green). To avoid false alarms, any call for a modification of the alert level must be evaluated in the context of typical seasonal fluctuations in displacement and experience gained over time in interpreting those fluctuations. This plan is designed to consider a careful evaluation of a displacement alarm and to have the appropriate response based on that evaluation.

The primary Crownsnest Pass, Emergency Coordination Centre (ECC), previously called the Emergency Operations Centre (EOC), will be provided by the MCNP during orange and red alerts. This site is located at the MDM Community Centre in Bellevue, Alberta (Figure 2). The ECC must have sufficient communication equipment (telephones, computers, two-way radios, etc.), copies of geotechnical reports, white boards, and tables and chairs to meet the needs of those individuals assigned to the location. High-speed Internet access must also be available, as this is the primary mode of communication between staff and all parties involved. An alternate ECC, if needed will be set up at the Crownsnest Pass Provincial Building in Blairmore, Alberta (Figure 3).

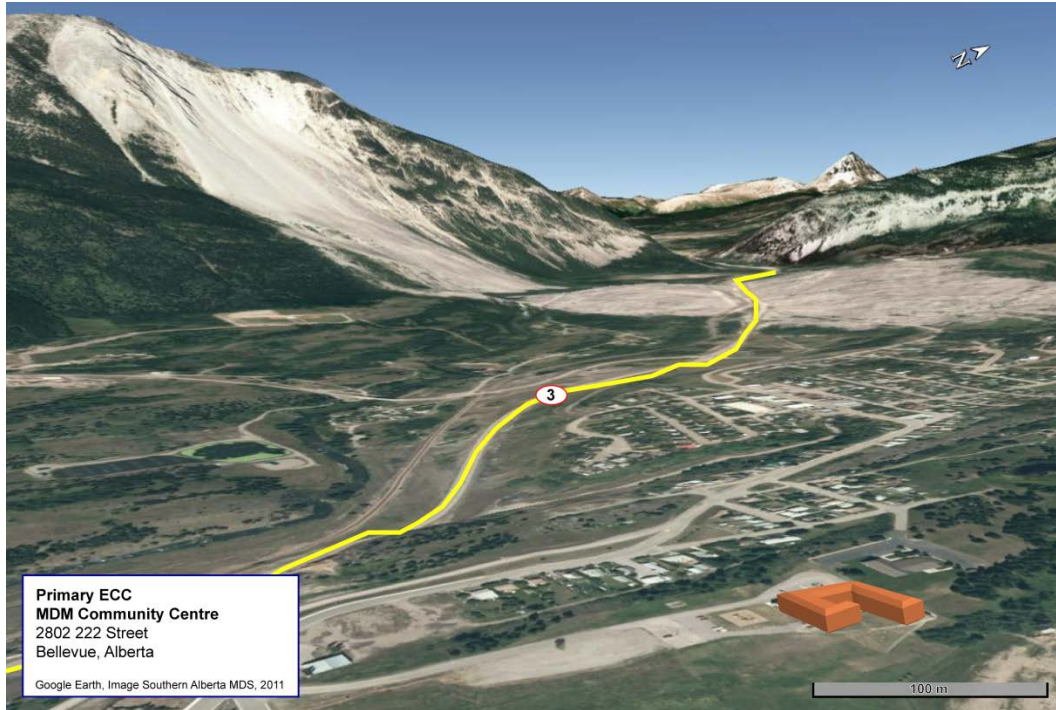


Figure 2. Location of the Emergency Coordination Centre at the MDM Community Centre (highlighted orange) in Bellevue, Alberta.

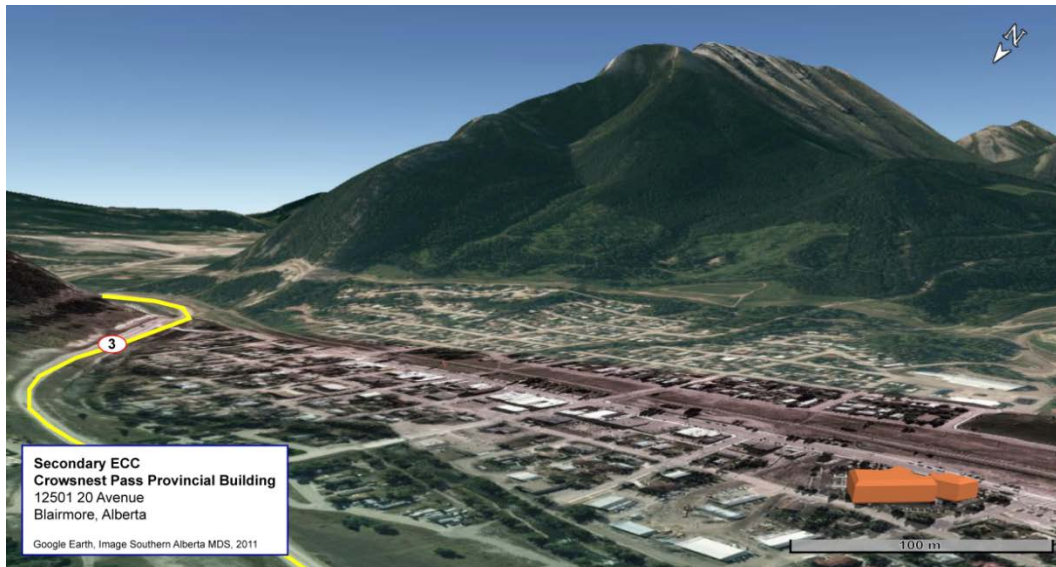


Figure 3. Location of the alternate Emergency Coordination Centre at the Crowsnest Pass Provincial Building (highlighted orange) in Blairmore, Alberta.

The AER will also host its own Corporate ECC, located at the AER head office in Calgary. The AGS management representatives will be required to relocate to the Corporate ECC during alert level orange and red.

2.1 AGS Turtle Mountain Leader

The AGS TM leader is accountable for the TM Team and its operation by

- ensuring the AER/AGS TM Team (AGS TM staff and AER SecNet) fulfills its delegated response and tasks (including procedures for data review and reporting);
- briefing AGS management representatives, the Provincial Operations Centre (POC), MCNP, and AEMA Provincial Duty Officer (PDO) (by phone or email; Table 1) when the alert level is changed;
- presenting a periodic assessment to the AEMA Provincial Duty Officer (PDO) (by phone; Tables 3–6) of continuing risks and of any changes in alert level;
- implementing the response actions according to the alert level;
- determining what resources are required to adequately deal with the alert level;
- communicating effectively with all participants involved in the emergency, including those outside of the AER command structure (Figures 4, 6, 8, and 10; and Table 1);
- acting as an interagency liaison to ensure a cohesive and coordinated response;
- providing accurate information at the appropriate time to the emergency response agencies or individuals responsible for receiving and managing information on site before, during, and after a rock-slope failure at Turtle Mountain;
- establishing and maintaining policies and procedures for regular data review, reporting, and actions;
- ensuring proper allocation of personnel to address issues with the monitoring system; and
- ensuring the AER/AGS TM Team meets its roles and responsibilities.

Table 1. Example of Turtle Mountain emergency contact numbers.¹

Organization	Primary contact	Alternate contact	Alternate contact
AER/AGS	Name, Position (xxx) xxx-xxxx	Name, Position (xxx) xxx-xxxx	Name, Position (xxx) xxx-xxxx
AEMA	Name, Position (xxx) xxx-xxxx	Name, Position (xxx) xxx-xxxx	Name, Position (xxx) xxx-xxxx
MCNP	Name, Position (xxx) xxx-xxxx	Name, Position (xxx) xxx-xxxx	Name, Position (xxx) xxx-xxxx
...	Name, Position (xxx) xxx-xxxx	Name, Position (xxx) xxx-xxxx	Name, Position (xxx) xxx-xxxx
...	Name, Position (xxx) xxx-xxxx	Name, Position (xxx) xxx-xxxx	Name, Position (xxx) xxx-xxxx

¹ Phone numbers are updated and distributed to each organization on the phone list annually. Phone numbers and names are omitted intentionally in the example above. See Appendix 2 for organization acronyms.

2.2 AGS Turtle Mountain Staff

The AGS TM staff report to the AGS TM leader and are responsible for

- conducting system diagnostic checks, appropriate to the alert level, to confirm instrument functionality, power supply, radio links, and hardware functionality;

- scheduling maintenance and repair, as required, of equipment supported by AGS TM staff and notifying the AER SecNet of any functionality problems found in the software and network equipment supported by that group;
- notifying the AER SecNet of any updates or upgrades made to hardware or software;
- identifying and maintaining a set of spare parts for the most critical components of the instrumentation system, supported when necessary by TM contractors;
- being available to receive communications from TM contractors, which includes
 - a) conducting timely review of data and reporting and evaluating whether an increase (or decrease) in alert level is required; following the procedure shown in Figures 5, 7, 9, and 11; if the alert level increases or decreases, notify the AGS TM leader and the AER SecNet representatives; and
 - b) taking the lead role or helping in the absence of the AGS TM leader to liaise between the external emergency response agencies and the AER;
- reporting changes in alert level to
 - a) the AGS TM leader (by phone or email) and
 - b) the AGS management representatives (by phone or email);
- undertaking system upgrades (only during alert level green) and repairs, as necessary, to maintain a reliable monitoring system;
- reviewing reports after a change in alert level and communicating to all team members; and
- notifying the AER SecNet of
 - a) any escalation or decrease in alert level, and
 - b) any reclassification of elements identified as being of primary, secondary, or tertiary importance in the Service Level Agreement (SLA; see Section 8) as the emergency event progresses.

2.3 AGS Management

The AGS management (vice president and directors) is responsible for

- providing sufficient resources (capital, full-time employee positions, etc.) for the project to meet its requirements and deliverables;
- requesting contingency funds to address extreme events or occurrences from the AER Executive Leadership Team (ELT); and
- taking the lead role during the absence of the AGS TM leader or TM staff, and acting as the main liaison between the external emergency response agencies and the AER; this may involve retaining internal technical experts to ensure that expertise remains available throughout the incident.

2.4 AEMA Provincial Operations Centre

The responsibilities at the POC include

- ensuring that the POC maintains its 24/7 capability;
- verifying that the AGS TM leader or TM staff have acknowledged the change in alert level with the AEMA PDO and MCNP; and

- helping contact appropriate government and agency representatives during alert level changes (Table 1), for information relay.

2.5 AER Security and Network Services

The AER SecNet will have responsibility (under the SLA; see Section 8) for working with the AGS TM leader and TM staff to

- determine the roles and responsibilities of the AGS TM Team in conjunction with the relevant participating members of the SecNet Team, and review them regularly (once per year);
- conduct diagnostic checks of server accessibility by means of a ping script to confirm functionality, power supply, and connectivity of supported server and network equipment, with frequency of diagnostic checks based on the requirements at the different alert levels; and schedule maintenance as required;
- notify the AGS TM leader or TM staff of any planned or unexpected system outages that may affect access to data or alarm notifications, with notification time based on the requirements at the different alert levels (Table 2);
- upgrade and regularly maintain software and hardware equipment to maintain a reliable system, notifying the AGS TM leader or TM staff members of any upgrade and maintenance using notification time outlined in Table 2, with maintenance and upgrades scheduled only during alert level green;
- ensure that parts for maintaining the TMMS are accessible from third-party vendors or are available in-house;
- contact staff at the Crowsnest Pass Provincial Building and at the Frank Slide Interpretive Centre (FSIC) (by phone) when access to TM computing infrastructure housed in their facilities is required, with notifications to be made on a schedule deemed appropriate but as soon as possible to meet the maximum equipment downtime constraints outlined in the SLA (Section 8);
- liaise with the Internet provider when Internet modem problems occur or upgrades are required; and
- follow the technical, administrative, and operational responsibilities for the normal operation of the software and network equipment installed as outlined in the SLA (Section 8).

Table 2. Diagnostic checks frequencies and notifications based on Turtle Mountain alert levels.

Alert level	Frequency ¹	Time ²
Green	Daily (as needed)	Business hours
Yellow	Daily	Business hours + Extended hours ³
Orange	Hourly	24 hours/day, 7 days/week
Red	Hourly	24 hours/day, 7 days/week

¹ Period of system diagnostic checks to be allocated to the TMMS during varying alert levels.

² Amount of time to be allocated from ISB to the TMMS for system diagnostic checks during varying alert levels.

³ As per the AER Offsite Extended Support agreement.

2.6 AER Information Services Branch

AER Information Services Branch (ISB) management is responsible for

- providing sufficient resources (capital and manpower) for the Infrastructure Services, SecNet, to meet its requirements and deliverables; and
- providing contingency funds to address extreme events.

Table 3. AER/AGS and the AEMA POC response during alert level green for Turtle Mountain.


Alert level	Activity level	Response
Green Normal Operations 	<ul style="list-style-type: none"> • Background noise or seasonal fluctuations • Ongoing trends independent of seasonal effects • Minimal displacements occur within specified limits 	AER/AGS <ul style="list-style-type: none"> • Normal operations • Continue monitoring and check system as appropriate • Further evaluate as to whether a yellow alert level is appropriate AEMA POC <ul style="list-style-type: none"> • Normal operations

Table 4. AER/AGS and the AEMA POC response during alert level yellow for Turtle Mountain.


Alert Level	Activity Level	Response
Yellow Watch 	<ul style="list-style-type: none"> • Monitoring detects movement trends that are considered non-seasonal 	AER/AGS <ul style="list-style-type: none"> • Increase frequency of data review • Provide daily briefings to POC, AEMA PDO, AER SecNet staff, and external contractors • Continue monitoring and prepare for possible relocation to ECC in the Crowsnest Pass • AGS TM leader evaluates alert level and recommends response AEMA POC <ul style="list-style-type: none"> • Confirm change in alert level with AEMA PDO and MCNP • Inform appropriate government and agency representatives

Table 5. AER/AGS and the AEMA POC response during alert level orange for Turtle Mountain.

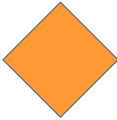

Alert Level	Activity Level	Response
<p>Orange Warning</p> 	<ul style="list-style-type: none"> Monitoring exhibits acceleration of data trend 	<p>AER/AGS</p> <ul style="list-style-type: none"> Increase frequency of data review and relocate to ECC in the Crowsnest Pass Act as subject matter expert (SME) for AEMA PDO, POC, MCNP, ERG, and emergency services Provide geotechnical information to the ERG to evaluate the alert level and if necessary, prepare a geotechnical report for notification to NAV Canada to issue a Notice to Airmen (NOTAM). Provide daily geotechnical briefings to ERG members SecNet staff ensures monitoring system and network communication are operational <p>AEMA POC</p> <ul style="list-style-type: none"> Confirm change in alert level with AEMA PDO and MCNP Inform appropriate government and agency representatives

Table 6. AER/AGS and the AEMA POC response during alert level red for Turtle Mountain.

Alert Level	Activity Level	Response
<p>Red Event in Progress</p> 	<ul style="list-style-type: none"> High or catastrophic acceleration on monitoring system; initiation of full-scale rock-mass movement 	<p>AER/AGS</p> <ul style="list-style-type: none"> Contribute to hourly collective evaluations and briefings at the ECC with all ERG members SecNet staff ensures monitoring system and network communication are operational Conduct visual checks of mountain from safe remote location <p>AEMA POC</p> <ul style="list-style-type: none"> Confirm change in alert level with AEMA PDO and MCNP Inform appropriate government and agency representatives

3 Responsibilities during Alert Level Green

Alert level green is defined as the normal operating state for the system, where minimal displacements occur within specified limits. At this alert level, the tasks outlined below are to be undertaken by the various groups within the AER/AGS TM Team to ensure that data are being reviewed and reported in a reliable and repeatable manner.

3.1 AGS Turtle Mountain Leader

In addition to the roles identified in Section 2.1, the AGS TM leader will

- determine the roles and responsibilities of the AGS TM Team in conjunction with the relevant participating groups and review them regularly (once per year);
- maintain contact with all contractors involved in the TMMP;
- review all documentation, such as reports, research, and data logs, provided to the AGS by contractors;
- conduct weekly or monthly reviews of day-to-day operations with the AGS TM Team;
- conduct debriefing sessions for all groups participating in the AER/AGS TM Team after any decrease in alert level to green and after drilling exercises to help identify lessons learned in the immediate post-response period;
- provide internal training and drill sessions every five years, or as AGS management sees fit, to ensure that project staff can respond to various alert levels;
- make amendments to the *AER/AGS Roles and Responsibilities Manual for the Turtle Mountain Monitoring Program, Alberta*, as required, based on the conclusions drawn from debriefing sessions and drills and on the modifications proposed by every group on the AGS TM Team after their own internal debriefings and drills; and
- ensure that modifications are incorporated into relevant procedures in a reasonable timeframe, help disseminate the modifications to all designated groups and individuals, and report major modifications to AGS management.

3.2 AGS Turtle Mountain Staff

In addition to the duties identified in Section 2.2, the AGS TM staff will collaborate with each other and

- help the AGS TM leader with duties when required;
- conduct daily system diagnostic checks (Monday to Friday, office hours) to confirm instrument functionality, power supply, radio links, and hardware functionality; staff will schedule maintenance and repair of software and equipment supported by AGS TM staff, as required, or will notify SecNet of any functionality problems found in software and network equipment supported by the AER SecNet Team; if the alert level has not increased, staff will only issue notification during regular business hours;
- send notification to the SecNet inbox (during regular business hours) of any updates or upgrades made to software and hardware supported by AGS TM staff;
- prepare and distribute to the AGS TM leader weekly and monthly updates with assessment of continuing hazards and potential for elevation of alarm level, following the procedures outlined in Figures 5, 7, 9, and 11;

- advise the TM leader of incident command structure (Figure 4) when no alarm has been generated; otherwise activate incident response shown in Figures 6, 8, and 10 in the event of an alarm;
- prepare annual data and interpretation summaries for the annual AGS TM Open File Report;
- review historical monitoring data to establish a baseline or typical value for seasonal fluctuation in displacement that will be used to review threshold levels and to detect non-seasonal displacements in quarterly reports;
- evaluate threshold levels annually, based on instrumentation data, and review quarterly reports and the data and recommendations of the external technical-assistance provider;
- once an alert level has been downgraded to green or after a drill, participate in debriefing session with all parties to identify improvements to procedures; and
- ensure that new procedures are implemented in a reasonable timeframe and report back to the AGS TM leader.

3.3 AGS Management

In addition to the roles identified in Section 2.3, the AGS management representative will, during alert level green,

- take the lead role in the absence of the AGS TM leader and TM staff;
- act as the main liaison between the external emergency response agencies and the AER ELT;
- propose modifications to the *AER/AGS Roles and Responsibilities Manual for the Turtle Mountain Monitoring Program, Alberta* as required, based on the conclusions drawn from internal debriefing sessions and drills; and
- ensure that new procedures are implemented in a reasonable timeframe by the AGS TM leader and TM staff.

3.4 AEMA Provincial Operations Centre

In addition to the roles identified in Section 2.4, the 24-hour POC staff will, during alert level green,

- determine their roles and responsibilities with the AGS TM leader and review them regularly (once per year);
- conduct internal debriefing sessions to help identify improvements to procedures;
- hold internal training sessions and drills to ensure that POC staff can perform their roles;
- propose modifications to the *AER/AGS Roles and Responsibilities Manual for the Turtle Mountain Monitoring Program, Alberta*, as required, based on the conclusions drawn from internal debriefing sessions and drills; and
- implement new procedures in a reasonable timeframe and report all changes to the AGS TM leader and TM staff.

3.5 AER Security and Network Services

In addition to the roles identified in Section 2.5, AER SecNet staff will, during alert level green,

- determine their roles and responsibilities with their leader and the AGS TM leader, and review them regularly (once per year);
- hold internal training sessions and drills (once every five years) to ensure that everyone involved has the skills required to perform their roles;
- propose modifications to the *AER/AGS Roles and Responsibilities Manual for the Turtle Mountain Monitoring Program, Alberta* as required, based on the conclusions drawn from internal debriefing sessions and drills; and
- implement new procedures in a reasonable timeframe and report all changes to the AGS TM leader and TM staff.

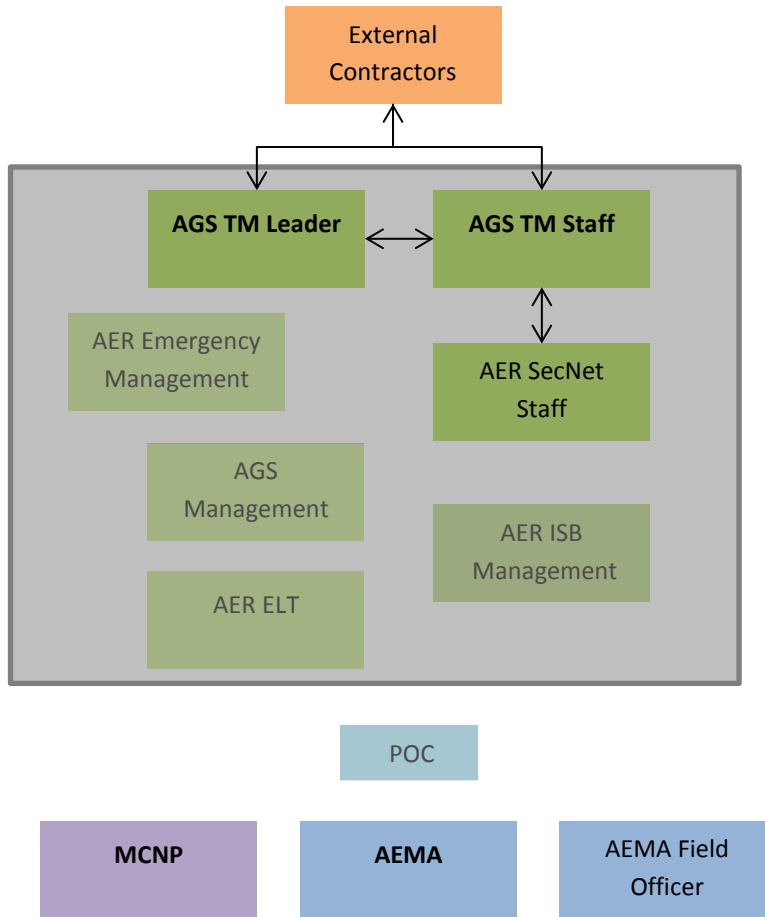


Figure 4. Incident command structure and function sequence for AER/AGS staff during a green alert level. Grey box encases internal branches within the AER. Outside boxes refer to external, non-AER organizations and staff.

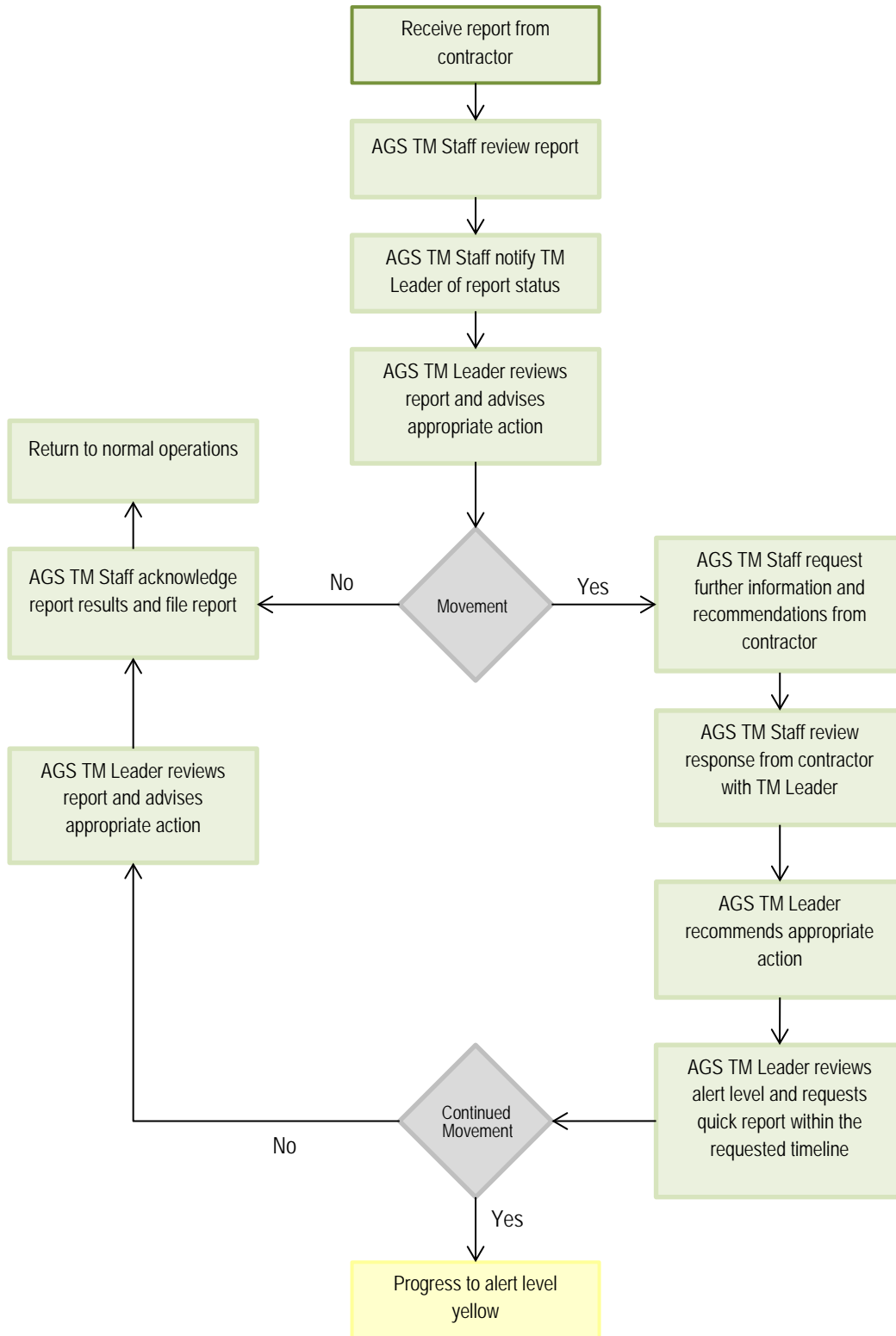


Figure 5. Recommended AER/AGS staff procedures for monitoring during alert level green.

4 Responsibilities during Alert Level Yellow

Alert level yellow occurs when a systematic trend of movements begins to increase in velocity and the trend is deemed significant by AGS TM staff, in conjunction with external contractors, and internal SME. From this point on, the monitoring system will be monitored daily by all AGS TM staff and external contractors. Daily communication briefings will be reviewed by all AGS TM staff, the TM leader, and external contractors. These communication briefings will continue daily until the alert has either returned to green level status (Section 3) or has been escalated to orange alert level (Section 5).

4.1 AGS Turtle Mountain Leader

In addition to the roles identified in Section 2.1, the AGS TM leader will, during alert level yellow,

- conduct periodic joint assessments and briefings to ensure a coordinated and considered response to new developments, escalations, or changes in operational requirements;
- supervise all decisions and key events being captured in the emergency-event log, which is to be reviewed by AGS management;
- evaluate threshold levels based on current instrumentation data compared with historical AGS equipment data;
- review the preceding contractor's quarterly and quick reports, and review the data and recommendations of the external technical-assistance provider;
- conduct daily communication briefings with all AGS TM staff, external contractors, and AER SecNet staff;
- check the communication briefing summary prepared by AGS TM staff for management; and
- prepare to relocate the AGS TM Team down to the Crowsnest Pass ECC in anticipation of an alert level increase (orange alert level).

4.2 AGS Turtle Mountain Staff

In addition to the roles identified in Section 2.2, AGS TM staff will, during alert level yellow,

- help the AGS TM leader with duties when required;
- conduct daily system diagnostic checks (Monday to Friday, business hours) to confirm instrument functionality, power supply, radio links, and hardware functionality; staff will schedule maintenance and repair of software and equipment supported by AGS TM staff, as required, or will notify SecNet of any functionality problems found in software and network equipment supported by the AER SecNet Team;
- produce daily communication briefings during regular business hours for the AGS TM leader, the AER SecNet Team, and contractors;
- send notification to the SecNet inbox (during business hours) of any required TMMS updates or upgrades;
- evaluate threshold levels based on current instrumentation data compared with historical AGS equipment data;
- review the preceding contractor's quarterly and quick reports, and review the data and recommendations of the SME;

- email summarized communication briefings to AGS management of daily events and major decisions. Include assessment of the continuing hazard and of the potential for upgrade or downgrade of the alert level;
- participate in debriefing sessions (if alert level has been downgraded to green) and help identify, to all participants involved (contractors, SME, agencies, internal AER staff, etc.), improvements to procedures; and
- prepare to relocate the AGS TM staff down to the Crowsnest Pass ECC in anticipation of an alert level increase (to an orange alert level).

4.3 AGS Management

During alert level yellow, the AGS management representative will have the responsibilities identified in Sections 2.3 and 3.3.

4.4 AEMA Provincial Operations Centre

During alert level yellow, the POC will have the responsibilities identified in Section 2.4.

4.5 AER Security and Network Services

During alert level yellow, the AER SecNet will have the responsibilities identified in Section 2.5 and will

- increase SecNet Team support (in Calgary) to the AGS TM leader and staff (in Edmonton) via email and telecommunication, following Table 2 frequency and recommended hours;
- review the network and system remotely to investigate functionality in anticipation of a possible alert level increase (orange alert level); and
- prepare to relocate two SecNet Team members down to the Crowsnest Pass ECC in anticipation of an alert level increase (orange alert level).

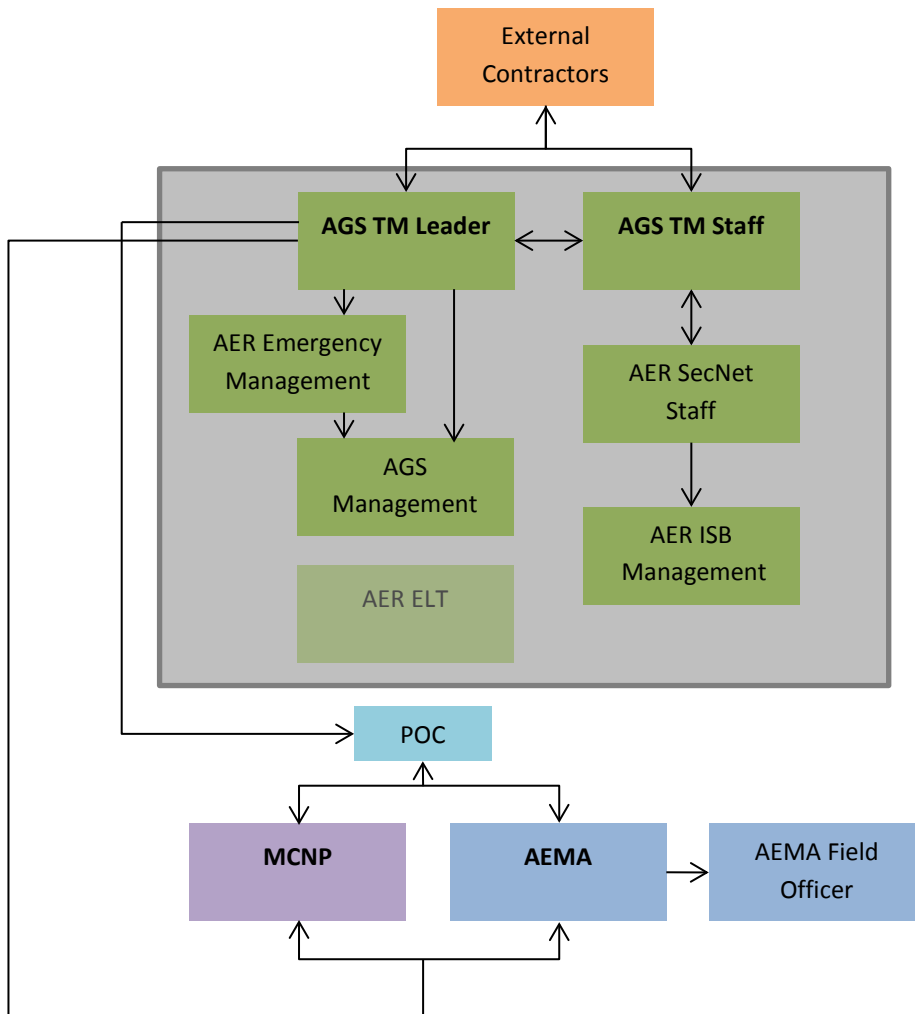


Figure 6. Incident command structure and function sequence for AER/AGS staff during a yellow alert level. Grey box encases internal branches within the AER. Outside boxes refer to external, non-AER organizations and staff.

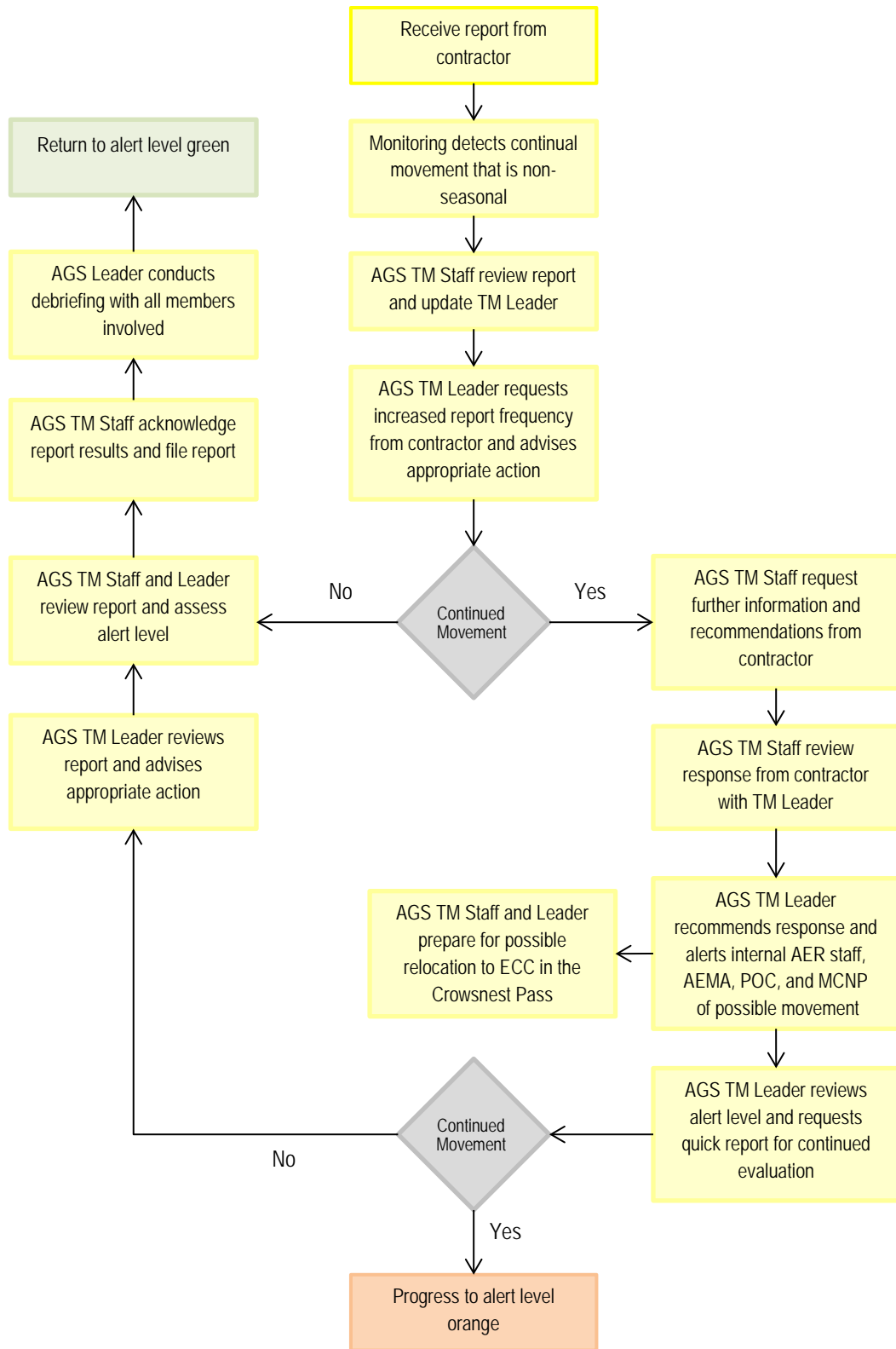


Figure 7. Recommended AER/AGS staff procedures for monitoring during alert level yellow.

5 Responsibilities during Alert Level Orange

Alert level orange corresponds to a systematic acceleration of readings that suggest that a rock-slope movement is leading to the failure stage. During an alert level orange, the TM leader, staff, and contractors are not to visit the mountain slopes because slope failure is extremely hazardous. Under no circumstances will the AER or the AGS ask any member of the ERG to work within the run-out model zones.

5.1 AGS Turtle Mountain Leader

In addition to the roles identified in Section 2.1, the AGS TM leader will, during alert level orange,

- mobilize to the Crowsnest Pass with TM staff members to serve as subject matter experts for the AEMA; under no circumstances will the AER allow its staff access to the mountain on foot;
- conduct hourly collective evaluations and briefings at the ECC with all ERG participants (contractors, SME, agencies, internal AER staff, etc.);
- coordinate with the ERG on all new developments, escalations, and changes in operations;
- supervise all decisions and key events being captured in the emergency-event log, which is to be reviewed by AGS management and the ELT;
- conduct daily communication briefings with all AGS TM staff, external contractors, and AER SecNet staff;
- retain the ability to communicate with external technical experts throughout the event;
- provide technical support to the AEMA, MCNP, and ERG during decision-making throughout the event;
- provide recommendations at the appropriate time to the ERG or to individuals responsible for receiving and managing information at the ECC, before and during rock-slope failure;
- assist in identifying areas to which the media have access;
- work with AER Public Affairs on all public media releases, following ICS protocol;
- act as a liaison on behalf of the AER, and provide SME information for media briefings as needed;
- review the daily communication briefing summary prepared by AGS TM staff for the ERG;
- evaluate, in conjunction with the ERG, whether it is necessary for NAV Canada to issue a NOTAM, advising pilots of restrictions in the airspace above the emergency zone or of closure of the airspace in a certain radius around the emergency zone. This includes drones and private aircraft used by the public or media; and
- ensure that the AER and AGS staff are available 24/7 to respond to the event. Shift work will be implemented for the AER and AGS staff during an orange alert level at the ECC, to the best of the AER's ability.

5.2 AGS Turtle Mountain Staff

In addition to the roles identified in Section 2.2, the AGS TM staff will, during alert level orange,

- help the AGS TM leader with duties when required;

- mobilize at Turtle Mountain to visually verify movements and to act as subject matter experts for AEMA; under no circumstances will the AER allow its staff access to the mountain on foot;
- conduct hourly system diagnostic checks to confirm instrument functionality, power supply, radio links, and hardware functionality; staff will schedule maintenance and repair of software and equipment and will notify on-duty AER SecNet staff of any functionality problems found with software and network equipment;
- work with the AGS TM leader to provide SME recommendations for media briefings;
- be a liaison linking the external SME and contractors with AGS management and the TM leader;
- prepare and distribute daily communication briefings for the internal AER emergency event log;
- email daily summarized communication briefings to the ERG, including an assessment of the continuing hazard or of the potential for upgrade of alert level (Tables 3–6); and
- ensure that the AGS TM staff are available 24/7 to respond to any network or system inquiries. Shift work will be implemented for the AER and AGS staff during an orange alert level at the ECC, to the best of the AER’s ability.

5.3 AGS Management and AER Executive Leadership Team

During alert level orange, the AGS management representative and the AER ELT will have the responsibilities identified in Sections 2.3 and 3.3, and will

- ensure that the AER and AGS staff are available 24/7 to respond to the event. Shift work will be implemented for the AER and AGS staff during an orange alert level at the ECC, to the best of the AER’s ability.

5.4 AEMA Provincial Operations Centre

During alert level orange, the POC will have the responsibilities identified in Section 2.4.

5.5 AER Security and Network Services

During alert level orange, the AER’s SecNet Team will have the roles identified in Section 2.5 and will

- mobilize two SecNet team members to the Crowsnest Pass to provide on-site support and technical assistance to the AGS TM leader, TM staff, and all AER emergency support staff;
- provide remote support from the AER Calgary Head Office to the AGS TM leader, TM staff, and all AER emergency support staff;
- continue to help the AER and AGS staff with network and system diagnostics and ensure that the TMMS remains online, to the best of the AER SecNet’s ability;
- help the AGS TM staff check systems to confirm instrument functionality via the internet, check radio links (help third-party vendor), and complete system hardware replacements as needed; and
- ensure that AER SecNet staff are available 24/7 to respond to any network or system inquiries. Shift work will be implemented for all AER staff during an orange alert level at the ECC, to the best of the AER’s ability.

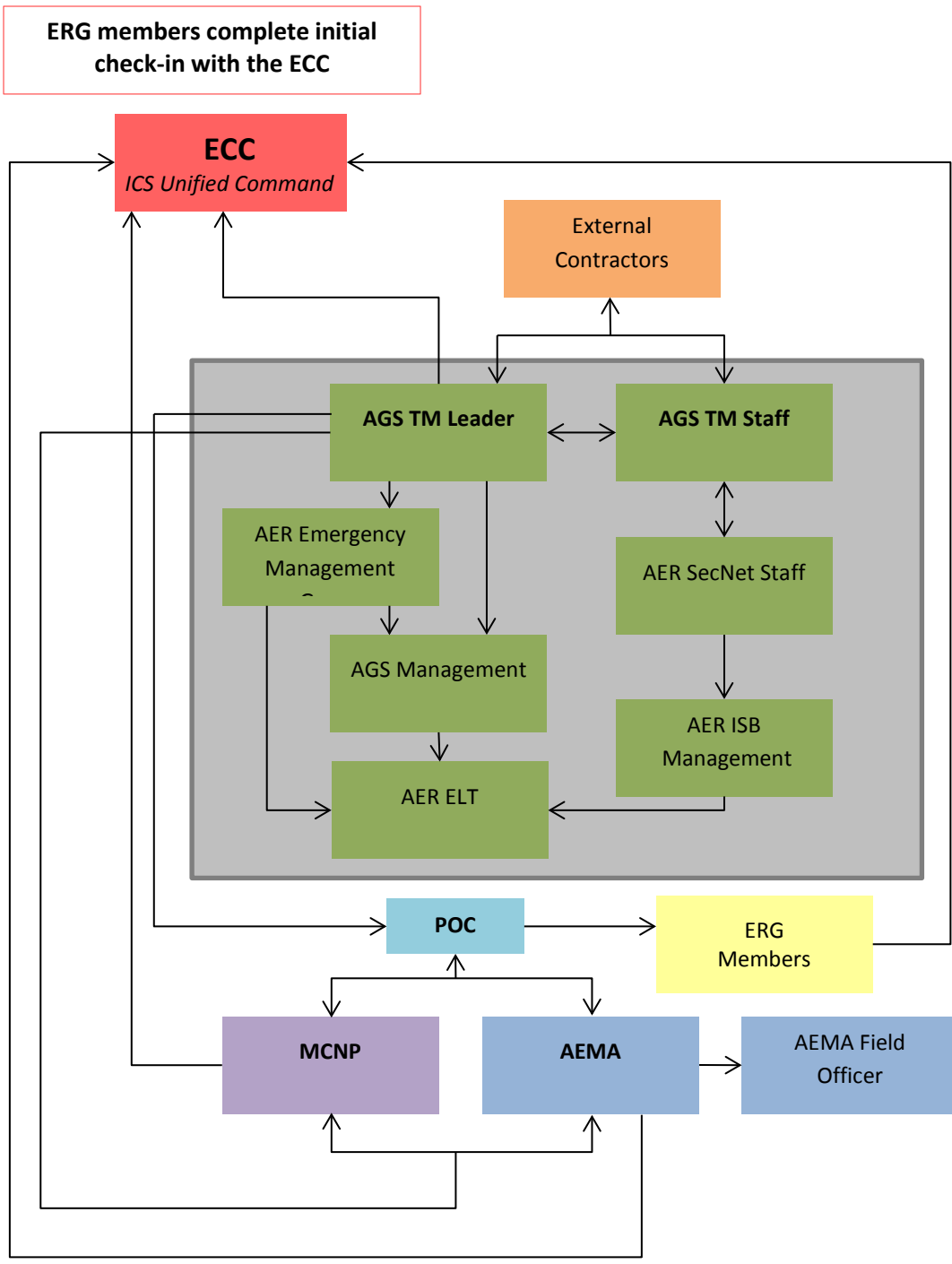


Figure 8. Incident command structure and function sequence for AER and AGS staff during an orange alert level. Grey box encases internal branches within the AER. Outside boxes refer to external, non-AER organizations and staff.

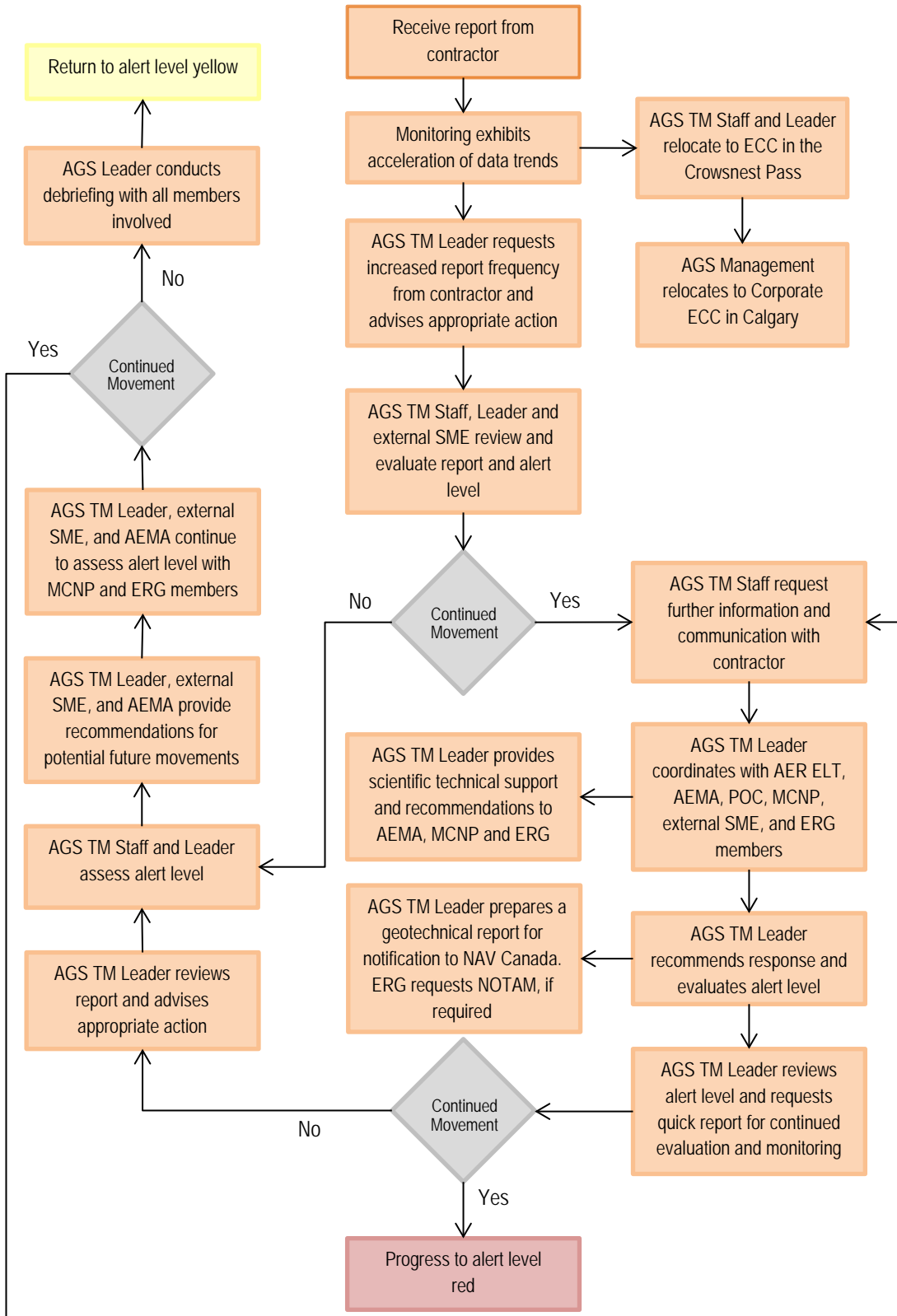


Figure 9. Recommended AER and AGS staff procedures for monitoring during alert level orange.

6 Responsibilities during Alert Level Red

Alert level red corresponds to the final stages in the development of a rockslide, where movements have accelerated beyond the point at which a slide is imminent and where there is visual verification that a catastrophic failure is underway. During an alert level red the TM leader, staff, and contractors are not to visit the mountain slopes because slope failure is forthcoming. Under no circumstances will the AER or the AGS ask any member of the ERG to work within the run-out model zones.

6.1 AGS Turtle Mountain Leader

In addition to the roles identified in Section 2.1, the AGS TM leader will, during alert level red,

- remain on site to provide geotechnical SME advice to the AEMA;
- conduct hourly collective evaluations and briefings at the ECC with all ERG participants (contractors, SME, agencies, internal AER staff, etc.);
- coordinate with the ERG on all new developments, escalations, and changes in operations;
- supervise all decisions and key events being captured in the emergency-event log, which is to be reviewed by AGS management and the ELT;
- conduct daily communication briefings with all AGS TM staff, external contractors, and AER SecNet staff;
- retain the ability to communicate with external technical experts throughout the event;
- provide recommendations at the appropriate time to the ERG or to individuals responsible for receiving and managing information at the ECC, before and during rock-slope failure;
- communicate to the AEMA run-out models for both North and South Peak;
- work with AER Public Affairs on all public media releases, following ICS protocol;
- act as a liaison on behalf of the AER and provide technical SME information for media briefings as needed; and
- ensure that AER and AGS staff are available 24/7 to respond to the event. Shift work will be implemented for all AER and AGS staff during a red alert level at the ECC, to the best of the AER's ability.

6.2 AGS Turtle Mountain Staff

In addition to the roles identified in Section 2.2, the AGS TM staff will, during alert level red,

- help the AGS TM leader with duties when required;
- conduct hourly system diagnostic checks to confirm instrument functionality, power supply, radio links, and hardware functionality; staff will schedule maintenance and repairs of software and equipment and will notify the on-duty AER SecNet staff of any functionality problems found with software and network equipment;
- work with the AGS TM leader to provide SME recommendations for media briefings;
- be a liaison between the external SME and contractors for AGS management and the TM leader;
- prepare and distribute daily communication briefings for the internal AER emergency event log;

- email daily summarized communication briefings to the ERG, including an assessment of the continuing hazard or of the potential for upgrade of alert level (Tables 3–6); and
- ensure that the AGS TM staff are available 24/7 to respond to any network or system inquiries. Shift work will be implemented for AER staff during a red alert level at the ECC, to the best of the AER’s ability.

6.3 AGS Management and AER Executive Leadership Team

During alert level red, the AGS management representative and AER ELT will have the responsibilities identified in Sections 2.3, 3.3, and 5.3.

6.4 AEMA Provincial Operations Centre

During alert level red, the POC will have the responsibilities identified in Section 2.4.

6.5 AER Security and Network Services

During alert level red, the AER’s SecNet Team will have the roles identified in Section 2.5 and will

- provide on-site support and technical assistance to the AGS TM leader, TM staff, and all AER emergency support staff;
- provide remote support from the AER Calgary Head Office to the AGS TM leader, TM staff, and all AER emergency support staff;
- continue to help AER and AGS staff with network and system diagnostics and ensure that the TMMS remains online, to the best of the AER SecNet’s ability; and
- ensure that AER SecNet staff are available 24/7 to respond to any network or system inquiries. Shift work will be implemented for AER staff during a red alert level at the ECC, to the best of the AER’s ability.

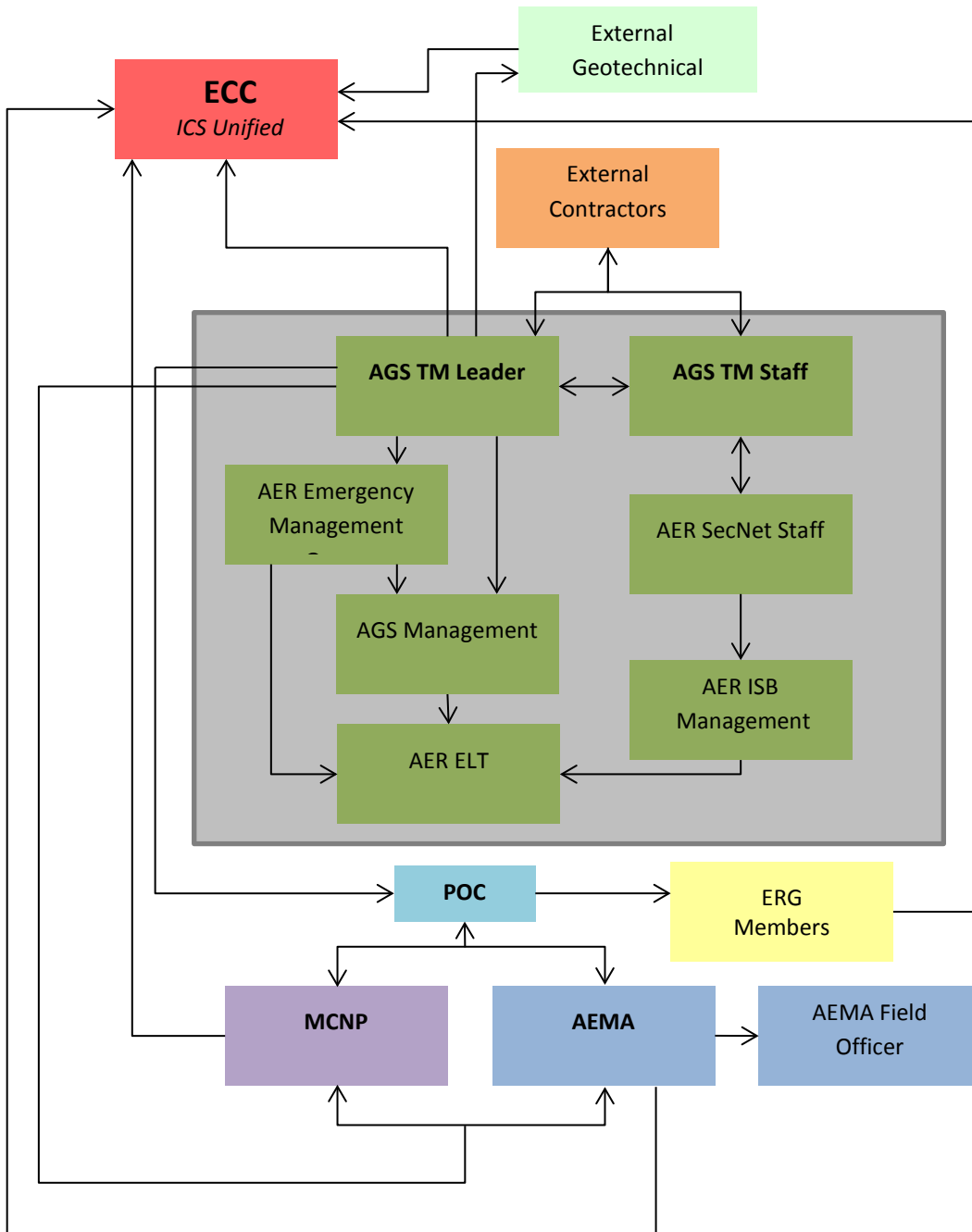


Figure 10. Incident command structure and function sequence for alert level red. Grey box encases internal branches within the AER. Outside boxes refer to external, non-AER organizations and staff.

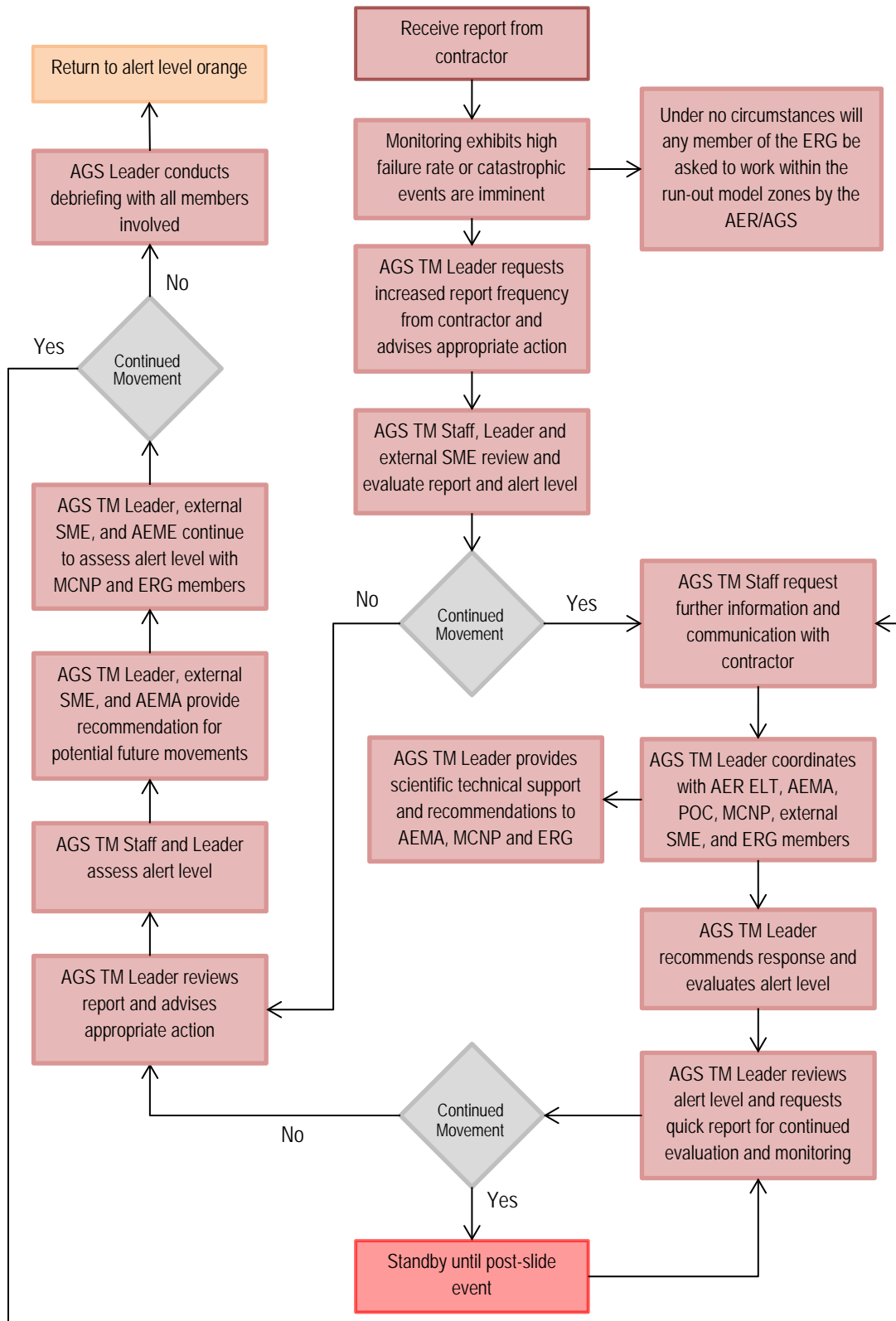


Figure 11. Recommended monitoring procedures for the AER and AGS during alert level red.

7 Post-Slide Response

After complete collapse of Turtle Mountain, a post-slide investigation team will evaluate areas for stability. Only essential AER staff and ERG individuals will be included in the post-slide investigation team. If partial collapse is discovered and imminent failure is present, return to alert level red.

7.1 AGS Turtle Mountain Leader

In addition to the roles identified in Section 2.1, the AGS TM leader will, during the post-slide period,

- retain external technical experts to ensure that such expertise remains available during post-slide assessment and investigation;
- coordinate a post-slide investigation team at the site—only essential AER staff and the ERG will be included;
- provide continuity and follow up for the technical lessons learned by integrating, disseminating, and archiving information for future research;
- provide technical support to the AEMA, MCNP, and ERG during decision-making after the event;
- review all decisions and key events being captured in the emergency-event log, which the AGS management and the AER ELT will review post-slide;
- act as a liaison on behalf of the AER and provide technical SME information for media briefings as needed; and
- assist in identifying areas to which the media have access.

7.2 AGS Turtle Mountain Staff

In addition to the roles identified in Section 2.2, the AGS TM staff will, during a post-slide period,

- help the AGS TM leader with duties when required;
- accompany the post-slide investigation team and help with visual checks on the mountain to assess stability;
- engage with external experts and ensure post-slide investigation report delivery; and
- publish an AER post-slide technical review report to identify the mountain's collapse, external expert post-slide investigation results, and technical attainments for similar future landslide events.

7.3 AGS Management and AER Executive Leadership Team

During the post-slide period, AGS management and the AER ELT will have the responsibilities identified in Sections 2.3, 3.3, and 4.3.

7.4 AEMA Provincial Operations Centre

During the post-slide period, the POC will have the responsibilities identified in Section 2.4.

7.5 AER Security and Network Service

During the post-slide period, the AER's SecNet Team will have the roles identified in Section 2.5 and will

- provide on-site support and technical assistance to the AGS TM leader, TM staff, and all AER emergency support staff;
- provide remote support from the AER Calgary Head Office to the AGS TM leader, TM staff, and all AER emergency support staff;
- continue to help AER/AGS staff with network and system diagnostics, and ensure that the TMMS remains online or help restore the TMMS post failure, to the best of the AER SecNet's ability; and
- remotely support AGS staff with system requirements post failure until the AGS TM staff publish an AER post-slide report with future program recommendations.

8 Service Level Agreement

The AGS is responsible for maintaining the instrumentation owned by the AER on Turtle Mountain. As part of this responsibility, the AGS does an annual detailed review of the data stream. To help with this interpretation, the AGS initiated specific studies to better understand the structure of the mountain and its relationship with the style and rate of movement seen in recent and historical deformations. These studies also better define the unstable volumes of rock from the North, South, and Third Peak areas.

To fulfill this role, the AGS and the AER SecNet Team consolidated to support the TMMS. Support for the monitoring program is appointed because the AGS will service or will arrange vendor service for all geotechnical monitoring equipment and communication elements (e.g., radios, antennas, LiSAMobile, etc.). The AER SecNet Team will provide support and service for all networking equipment (e.g., router, server, modem, etc.). The required level of support and service varies among different alert levels (as described in Sections 2.5, 3.5, 4.5, 5.5, 6.5, and 7.5).

8.1 System Summary

The types of sensors most suitable for providing a near-real-time remote monitoring system are grouped into the following categories:

- 1) Primary monitoring: includes the newly installed LiSAMobile system, leased to the AGS by Ellegi of Milan, Italy. The LiSAMobile system is an advanced ground-based InSAR instrument (GB-InSAR). In June 2014, LiSAMobile was installed at the Bellevue pump house station for monitoring displacements on the east face of Turtle Mountain.
- 2) Secondary monitoring: includes monitoring campaigns selected by the AGS based on monitoring frequency, such as photogrammetry, satellite-based deformation monitoring, aerial LiDAR scanning, terrestrial laser scanning (TLS), and periodic dGPS monitoring.
- 3) Tertiary monitoring: includes images obtained from the Bellevue and South Peak web cameras.
- 4) Historical monitoring: includes all project data and documentation obtained from 2003 onwards. The TM Team requires ongoing access to the historical data because it is regularly synthesized with new data to make comparisons and draw conclusions. Historical information and data provides evidence of past movements observed on Turtle Mountain and is crucial when reviewing the total rock movements observed over the past 100 years of collaborative monitoring. The retention and disposition schedule for TMMP contains items for research and historical value and must remain with the AGS for long-term permanent retention.

8.2 Service Levels

The service levels are based on the data access requirements during different alert levels. The method of access will also affect how the service-level requirements are met (Tables 7 and 8).

Link A: The primary data site functions as a main network HUB site connecting to the AER's corporate network for the AGS's monitoring, to the radio network for local data transmission, and to the public Internet for external and third party users monitoring access (e.g., LiSAMobile). It also provides network communication infrastructure for unprocessed data (pictures and videos) transmission to and from the AER Turtle Mountain monitoring program public website <http://ags.aer.ca/activities/turtle-mountain-monitoring-program.htm>.

Link B: Functions as the radio HUB site that connects to the Bellevue pump house, the Turtle Mountain monitoring web cameras, and the Crowsnest Pass Provincial Building equipment.

Link C: Radio connection back to FSIC for providing monitoring RAW data to a third-party company through the Internet connection located at the Crowsnest Pass Provincial Building site (Link A).

Table 7. TMMS links A–C maximum down time, per alert level.

Link	Access point	Maximum downtime ¹			
		Green	Yellow	Orange	Red
A	Crowsnest Pass Provincial Building	3–5 days	1 day	1 hour	1 hour
B	Frank Slide Interpretive Centre	5 days	2 days	1 day	1 day
C	Bellevue pump house	5 days	2 days	1 day	1 day

¹Measured from the time that AER SecNet has acknowledged the inquiry.

Table 8. Software and network equipment supported by AER SecNet at the Crowsnest Pass Provincial Building.

Quantity	Vendor	Part number	Description	Location	AGS	IT support
1	Checkpoint	Checkpoint 2200	Firewall	Mechanical room 205	I/C	A/R
1	UPS	APC	Uninterrupted power supply	Mechanical room 205	I/C	A/R
1	Shaw Cable		Internet (modem)	Telecom room	I/C	A/R
1	Shaw Cable		Internet (subscription)	Telecom room	I/C	A/R
1	NCIX	CPS 1000 AVR	Battery backup (UPS)	Telecom room	I/C	A/R
1	Cisco	Cisco 2921	AER WAN router	Telecom room	I/C	A/R
1	UPS	APC	Uninterrupted power supply	Telecom room	I/C	A/R

Turtle Mountain Monitoring System Architecture

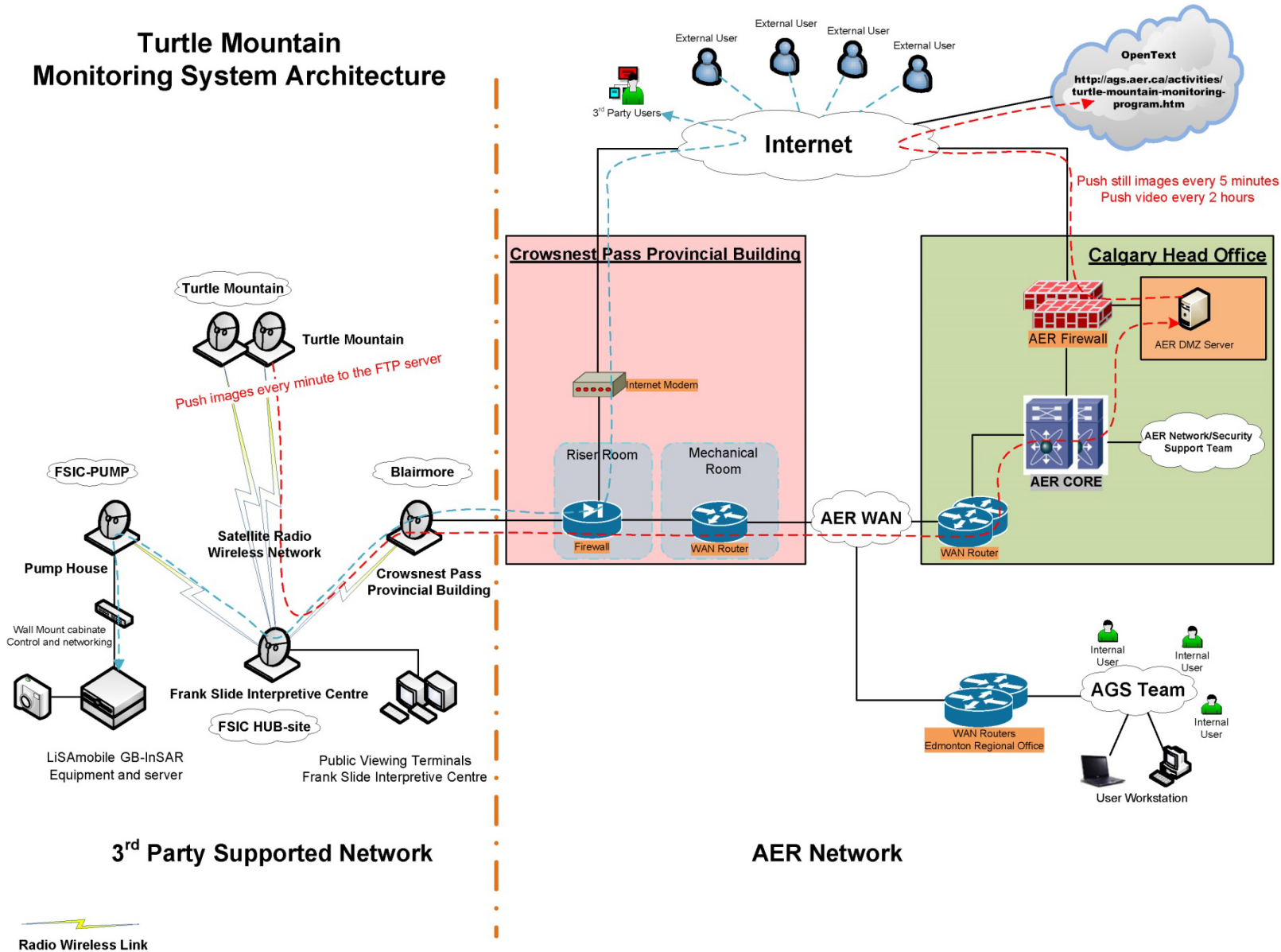


Figure 12. Turtle Mountain Monitoring System architecture supported by the AER and third-party vendors.

9 Training and Exercises

Training and drills are essential for successful emergency response. Training gives everyone involved the means to acquire the skills necessary to fulfil their roles during different alert levels. Review drills should be held about every five years, hosted by the AGS. The review drills should include the following:

- 1) Orientation session: these include basic instruction and explanation of the ERP and action plan procedures of each ERG participant (to include contractors, agencies, internal AER staff, etc.). The AGS is to review its ERP with ERG members to ensure that duties are understood during different alert levels. External ERPs should be reviewed with the AGS TM leader and staff every five years or when substantial changes have been made externally. The AGS may provide written tests to be used to ensure that the attendees have a minimum level of comprehension.
- 2) Tabletop exercises: these are hands-on review sessions to test emergency response procedures and the effectiveness of communication between different members of the ERG during varying alert levels. Exercise participants will be presented with a fabricated event and must discuss potential responses for each ERG member. The TM leader will facilitate the exercise and help develop the scenario through each alert level, eventually including post-slide response. The results will be shared with all participants and reviewed to identify areas of improvement for each ERG representative.

Tabletop exercises will be limited to testing internal procedures at the AER and AGS related to the ERP for Turtle Mountain; it will therefore be restricted to testing the roles of AER and AGS employees. External ERG members are encouraged to participate in the AER/AGS tabletop exercise as well as conduct their own review session within their organization every five years or as required.

The AGS TM leader will be responsible for coordinating the drill test to evaluate the coordinated response between AER/AGS TM Team groups; however, each AER/AGS TM Team will have ultimate responsibility for testing all operations within their own branch within the AER.

10 Debriefing

There is substantial value to be gained from a review of the response to any alert level by all participating personnel. This provides an opportunity to evaluate efficiency and gain experience, and also provides information to help in ensuing inquiries.

Facts emerging from debriefings should be documented, and areas of improvement should be identified. Lessons learned should be shared with those involved in the emergency incident response. It is essential that all lessons learned are identified and, where considered appropriate, incorporated into relevant future response procedures within an agreed timeframe.

The debriefing process might cumulate in a multiagency forum, which includes all ERG responders involved in the incident response and any other personnel deemed necessary.

11 Conclusions

Recent application of modern characterization, monitoring, and modelling technologies has greatly increased our understanding of the 1903 Frank Slide and of the existing rock-slope hazard at Turtle Mountain. Analysis of the data from the near-real-time remote monitoring system in these areas does not indicate any type of significant movement—that is, any movement, if occurring, is below the detection limit of the sensors (less than a few millimetres per year). The rate of displacement is significantly below any level of concern and has remained essentially constant over the years of monitoring.

We publish the most recent results annually (Froese et al., 2005; Moreno and Froese, 2006, 2008a, 2008b, 2009a, 2009b, 2011, 2012; Moreno et al., 2013; Warren et al., 2014, 2016; and Wood et al., 2016, 2017)

and present them in public meetings with the municipal officials and residents in the affected zones. Updates are also available on the “Turtle Mountain Monitoring Program” page of the Alberta Geological Survey website (<http://ags.aer.ca/turtle-mountain-monitoring-program.htm>).

The emergency response protocol is revised as often as is required to ensure that its current version reflects best practice and is fit for its purpose. At least one internal review is done every year. The next review will be completed in 2017 to ensure that all changes made to the system in 2016 are considered. The AGS will provide internal training sessions and drills to ensure that skills required are managed within AER branches every five years. The roles and responsibilities manual will be reviewed and modified as often as required to provide updated information for AER and AGS incident response staff.

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Appendix 1 – Acronyms and Abbreviations

24/7	24 hours per day, 7 days per week
AEMA	Alberta Emergency Management Agency
AER	Alberta Energy Regulator
AGS	Alberta Geological Survey
CPR	Canadian Pacific Railway
DEM	Director of Emergency Management (AEMA)
dGPS	Differential Global Positioning System
ELT	Executive Leadership Team
ECC	Emergency Coordination Centre
ERG	Emergency Response Group, Turtle Mountain response members
ERP	Emergency Response Plan
FSIC	Frank Slide Interpretive Centre
GB-InSAR	Ground-based Interferometric Synthetic Aperture Radar
GoA	Government of Alberta
GPS	Global Positioning System
IA	Immediate Action
ICS	Incident Command System (Canada)
ISB	Information Services Branch
IT	Information Technology
LiDAR	Light Detection and Ranging
MCNP	Municipality of Crowsnest Pass
MCNP Fire	Municipality of Crowsnest Pass Fire and Rescue Service
NOTAM	Notice to Airmen
PDO	Provincial Duty Officer (AEMA)
POC	Provincial Operations Centre (AEMA)
RCMP	Royal Canadian Mounted Police
SecNet	Security and Network Services
SLA	Service Level Agreement
SME	Subject Matter Expert
TLS	Terrestrial Laser Scanner
TM	Turtle Mountain
TMFL	Turtle Mountain Field Laboratory
TMMP	Turtle Mountain Monitoring Program
TMMS	Turtle Mountain Monitoring System
TRANS	Alberta Transportation

Appendix 2 – AER/AGS Turtle Mountain Definitions

Turtle Mountain Emergency Response Team	Includes internal AER/AGS employees who respond to an incident or elevated alert level on Turtle Mountain. To include the TM leader, TM staff, AGS management, AER Emergency Management Group, the AER Executive Leadership Team (ELT), and AER Security and Network Services (SecNet).
Authority	The AER First Duty Officer has the responsibility to coordinate with the AGS and notify the lead agency, AEMA POC, and PDO. This includes the right to control, command, and adjudicate on behalf of the AER prior to unified command structure.
Emergency Response Group	Includes organizations that respond to an emergency at Turtle Mountain under a unified command structure.
Hazard	A situation with potential to harm persons, property, or the environment.
Incident	An unexpected occurrence or event that requires action by emergency personnel to prevent or minimize the impacts on people, property, and the environment.
Incident Response	An AER employee who conducts this type of work will respond to a reported incident.
Leader, Manager, or Director	AER team leader or designate.
Limitation	An AER/AGS employee is bound by the constraints of the organization to complete their role or duty as outlined in this manual.
LiSALab	Technology and trademark of Ellegi srl.
LiSAMobile	A ground-based interferometric synthetic aperture radar instrument used to measure ground displacements. LiSAMobile is leased to the AGS from Ellegi srl.
NAV Canada	Canada’s civil air navigation services provider, with operations coast to coast. NAV Canada provides air traffic control, flight information, weather briefings, aeronautical information services, airport advisory services, and electronic aids to navigation.

Ownership	Oversees monitoring on Turtle Mountain and collaborates with external organizations for the Turtle Mountain Field Laboratory.
Physical Constraint	An AER/AGS employee is restricted from accessing a hazardous working zone, during an elevated alert level (e.g., alert level orange or red).
Representative	An individual who has authority to make decisions for their organization.
Responsibility	An AER/AGS leader is accountable for the incident or incident response within the limitations of the organization.
Role	An AER/AGS employee is obligated to respond appropriately as outlined in this manual to their specific duty or task within the limitations of the organization.
Turtle Mountain Field Laboratory	Site of ongoing monitoring and research focused on understanding the structure and kinematics of movements observed on Turtle Mountain. The field laboratory site uses new and evolving forms of technology for monitoring; which data is used in research globally.
Turtle Mountain Monitoring System	Near-real-time remote monitoring system that provides data from a network of primary, secondary, and tertiary monitoring systems. The primary monitoring system consists of the LiSAMobile system; the secondary network includes monitoring campaigns selected by the AGS based on monitoring frequency; and the tertiary monitoring system includes images obtained from the Turtle Mountain web cameras.
Turtle Mountain Monitoring Program	As of April 1, 2005, the AGS took ownership of the monitoring system and the responsibility of long-term monitoring, interpretation of data, and notification of the AEMA should significant movement occur. As part of the responsibility, the AGS performs an annual detailed review of the data stream. To help in this interpretation, the AGS initiated specific studies to better understand the structure of the mountain and its relationship to the style and rate of movement seen in recent and historical deformation of South and North Peak. These studies also better define the unstable volumes of rock from the South, North, and Third Peak areas.

Appendix 3 – AER/AGS Turtle Mountain Emergency Response Reports, Models, and Guides

- Alberta Emergency Management Agency (2008): Emergency response protocol for Turtle Mountain; report prepared for Alberta Municipal Affairs, 32 p.
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