Report 09-103: Passenger Train 1608, collision with slip and derailment,
Tunnel 1, Wairarapa Line, Maymorn, 23 July 2009
(incorporating investigation 08-106, collision with slip and derailment on the Johnsonville Line)

# Final Report

Rail Inquiry 09-103
Passenger Train 1608, collision with slip and derailment, Tunnel 1, Wairarapa Line, Maymorn, 23 July 2009
(incorporating investigation 08-106, collision with slip and derailment on the Johnsonville Line)

Approved for publication: September 2010

# Transport Accident Investigation Commission

## About the Transport Accident Investigation Commission and this report

The Transport Accident Investigation Commission (Commission) is an independent Crown entity responsible for inquiring into maritime, aviation and rail accidents and incidents for New Zealand, and co-ordinating and co-operating with other accident investigation organisations overseas. The principal purpose of its inquiries is to determine the circumstances and causes of the occurrence with a view to avoiding similar occurrences in the future. Its purpose is not to ascribe blame to any person or agency or to pursue (or to assist an agency to pursue) criminal, civil or regulatory action against a person or agency. The Commission carries out its purpose by informing members of the transport sector, both domestically and internationally, of the lessons that can be learnt from transport accidents and incidents.

## Commissioners

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# Important notes

## Nature of the final report

This final report may not be used to pursue criminal, civil or regulatory action against any person or agency. The Transport Accident Investigation Commission Act 1990 makes this final report inadmissible as evidence in any proceedings with the exception of a Coroner's inquest.

## Ownership of report

This report remains the intellectual property of the Transport Accident Investigation Commission.

This report may be reprinted in whole or in part without charge, provided that acknowledgement is made to the Transport Accident Investigation Commission.

## Citations and referencing

Information derived from interviews during the Commission's inquiry into the occurrence is not cited in this final report. Documents that would normally be accessible to industry participants only and not discoverable under the Official Information Act 1980 have been referenced as footnotes only. Other documents referred to during the Commission's inquiry that are publically available are cited.

## Photographs, diagrams, pictures

Unless otherwise specified, photographs, diagrams and pictures included in this draft final report are provided by, and owned by, the Commission.

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## Figures

## Abbreviations

| | |
|---|---|
| CIMS | Coordinated Incident Management System |
| CTC | Centralised traffic control |
| EOC | Emergency operations centre |
| hr | hour(s) |
| HRV | High rail vehicle. A road vehicle with a set of rail wheels that can be extended below the normal tyres to enable travel on the railway tracks. |
| kg/m | kilograms per metre |
| km/h | kilometres per hour |
| KiwiRail | KiwiRail Limited |
| m | metre(s) |
| NCM | Network Control Manager. Shift manager responsible for managing the 24/7 network control at the national train control centre on that shift. |
| NIWA | National Institute of Water & Atmospheric Research |
| NIMT | North Island main trunk railway line |
| NRSS | National rail system standard. Standards number from 1 to 11. |
| NTCC | National train control centre (see network control) |
| RIC | Rail incident controller |
| t | tonne(s) |
| TAIC | Transport Accident Investigation Commission |
| UHF | Ultra high frequency. Radio transmission in the range 300 MHz – 3 GHz. |
| UTC | Universal time coordinated |
| VHF | Very high frequency. Radio transmission in the range 30 MHz – 300 MHz |

## Glossary

| | |
|---|---|
| above-track drainage | a term used in this report to describe the groundwater drainage systems on slopes above the track that discharge onto the cess drain. |
| cess drain | a surface drain located just beyond the ballast at track formation level that runs parallel to the track. Intended to remove water that has percolated through the ballast. The cess drain is also used to channel away ground and rain water discharged near the track from above-track drainage systems to the nearest natural drain |
| colluvial soil | soil created from the deposits of weathered rock that has naturally gravitated towards the lower slopes. Typically made up of a mixture of gravel, sand and silt |
| detailed inspection | a type of track or structures inspection that is reasonably infrequent but very thorough and detailed in scope |
| driver | the driver of a train referred to within the industry as the locomotive engineer |
| EM 80 | specialised, self-propelled track inspection vehicle |
| essential features list | an essential feature is a structure or area of track that is considered to present a greater risk to operations than normal, so is listed on the essential features list for that line to ensure that it is specifically inspected more frequently. The listed essential features are always inspected during a severe weather event initiated special inspection |
| general inspection | a type of track or structures inspection that is reasonably frequent and thorough but does not go into the intricate detail that a detailed inspection would |
| greywacke | rock formed from a mixture of sandstone and mudstone |
| high rail vehicle | a road vehicle with an additional set of rail wheels that can be extended below the normal tyres to enable travel on the railway tracks |
| left-hand or right-hand side of track | the side when facing the direction of increasing track kilometre distance ie. in the same direction as the track distance markers are numbered. For this report the travel direction is from Wellington towards Masterton, which is the same as the track markers |
| loess | a type of soil created from wind-blown deposits, typically of sand and silt |
| loop | a track laid parallel to the main line for a short distance. Usually located at stations and at passing bays on single-track lines |
| main scarp | the top end of a landslide where the split from remaining soil shows a vertically penetrating crack. When a slip is compared with a boot or footprint, it is the heel area |
| network control | the national train control centre operations, including the network control managers, train controllers, signal box operators and administrative support staff managing the '155' help desk. The building is referred to as the national train control centre or NTCC |
| Ontrack | KiwiRail Network's trading name at the time of this accident |
| on-track/off-track | A rail term used to describe the process of getting an HRV off the road and onto the railway track or vice versa |

| | |
|---|---|
| special inspection | a track inspection carried out to check that the track is still safe for use during periods of severe weather |
| selcal | a selective call feature built into a radio network that suppresses the squelch function to prevent non-intended recipients on the same channel hearing a broadcast message. Used in the train control radio system to voice call selected recipients and to send emergency alarm tone calls to train control. |
| toe (of slip) | representative description of a slip when compared to a boot or footprint. The toe is the bottom edge of the mass of soil that has slipped |

## Data summary

| | |
|---|---|
| **Train type and number:** | Train 1608, (1733 Wellington to Masterton). 'Wairarapa Connection' service |
| **Classification:** | locomotive DCP4818, generator car SWG3422, standard car SW3294, servery car SWS5723, standard cars SW3339 and SW5646 (listed in standing order from the locomotive) |
| **Year of manufacture:** | locomotive 1960s ex Canada, refurbished in New Zealand and commissioned into service 1978-1980 |
| | carriages ex British Rail, refurbished and commissioned into service in New Zealand during 2007 |
| **Date and time:** | 23 July 2009 at 1817 |
| **Location:** | 37.226 kilometres (km) Wairarapa Line, Tunnel 1 portal 2 |
| **Persons on board:** | crew: 4 |
| | passengers: approximately 240 |
| **Injuries:** | crew: nil |
| | passengers: nil |
| **Damage:** | locomotive and generator car derailed with minor damage. Line closure for 5 days to clear slip debris and re-rail the train, plus earthworks to gain access and clear residual unstable ground above track |
| **Operator:** | TranzMetro (an operating division of KiwiRail) |
| | Ontrack (rebranded as KiwiRail Network, an operating division of KiwiRail) |
| **Investigator-in-charge:** | B Stephenson |
| **Time:** | all references to time quoted in this report are stated in New Zealand standard time (UTC + 12 hours) and expressed in the 24-hour mode |

# 1. Executive summary

On the evening of Thursday 23 July 2009, the Wellington region was experiencing a storm that brought heavy rain and strong winds. At 1817, a scheduled commuter train travelling from Wellington to Masterton with approximately 240 passengers and crew in 5 carriages, collided with a slip that partially blocked the northern portal of Tunnel 1 on the Wairarapa Line. This point was about 4 km north of Upper Hutt station and about 1 km before the Maymorn station. The locomotive and generator carriage were embedded in the slip and derailed, while the remaining carriages were still on the track but standing within the tunnel. Emergency services were called to rescue the passengers and crew.

The damage to the train was minimal and no injuries were reported. The Wairarapa Line was closed for approximately 5 days while the mud was cleared and the track repaired.

Police assumed management of the accident's rescue phase using the New Zealand Coordinated Incident Management System (CIMS) and activated a full tunnel response. The locomotive from a following Masterton-bound passenger train was used to haul the rear 3 carriages from the disabled train back to Upper Hutt with all passengers on board.

The landslide had occurred suddenly, less than one hour before the train collided with it. It had partially blocked the northern end of Tunnel 1. The landslide was a first-time occurrence on a risk-prone slope that was covered in regenerating bush. The Transport Accident Investigation Commission determined that the landslide occurred from natural causes after 62 millimetres (mm) of rainfall fell in the area during a 6-hour period.

Train 1608 had been travelling at normal speed when the driver saw the landslide, but he had had insufficient clear distance ahead to stop the train before impact. Network control had not warned the driver that the Wairarapa Line was subject to both 'heavy rain' and 'strong wind' warnings at the time.

Network control had received an updated severe weather warning message to the active severe weather event 24 hours before the accident, but network control had not distributed this message and several following messages to area managers. Even if it had, the area manager for the Maymorn area would not have received them because he was new to the job and his contact details had not been recorded in the system.

The track inspection regime was based upon checking specific items along the track, so was not capable of assessing the potential risk of slope failures, although this type of risk was common in the Wellington area and documented in a railway structures guidance manual.

The severe weather warnings and track inspection systems, if followed, could have mitigated the consequences of a slip falling across the track but would not necessarily have prevented trains running into it.

The passengers were kept in the carriages within the tunnel for some 3 hours. Improvements in the communications around the emergency response and rail recovery operations could have reduced this time by up to 30 minutes, but the recovery was safely coordinated and resulted in no injuries to the passengers and crew. The location of the derailment and the general disruption to transport services throughout the region due to the severe weather meant the response to this event was reasonable.

Four safety recommendations have been made to the NZ Transport Agency to address issues around the track inspection process, the severe weather warning system and the National Rail System Standard (NRSS) for incident response.

During the course of this inquiry, KiwiRail initiated several safety actions that were directly relevant to the Commission's findings. The safety actions are described in section 6 of this report and include the development of a slope hazard risk assessment for the rail network, improvements to the train control facilities and changes to the failure mode of the internal 'S' Car pneumatically operated passenger doors.

# 2. Conduct of the inquiry

## 2.1. Investigation methodology

2.1.1. The Commission had investigated a train colliding with a slip and derailing on the Johnsonville Line in 2006 and published inquiry report 06-108. At 1935 on 23 July 2008, another Johnsonville train collided with a landslide on the Johnsonville Line just out of Tunnel 1. The Commission opened an inquiry 08-106 into that occurrence. While inquiry 08-106 was still underway, the Maymorn derailment occurred. Owing to some similarities with the second Johnsonville derailment and Maymorn, the 2 latest inquiries were merged into a single report that focuses mainly upon the circumstances of the Maymorn occurrence.

2.1.2. The Commission was notified of the Maymorn accident by the NZ Transport Agency within an hour of its occurrence. The investigation started with the site inspection to secure and collect evidence. Interviews were conducted during the next few months with the train crew, train controller, network control manager (NCM), network manager, passenger operations managers, past and present track inspectors and area managers, structures inspector, ganger, General Manager Operations and a passenger. The investigators also attended a Hutt Valley Civil Defence Emergency Management debrief meeting run by New Zealand Police and met with representatives from both the Greater Wellington Regional Council (GWRC) and the Upper Hutt City Council.

2.1.3. Evidence was gathered from: the train control records; on-board train recording devices; operational staff incident reports; company process descriptions, standard operating procedures and rules; National Rail System Standards, Police communications records and the Police incident log. Much of this evidence is not available to the public, but the publicly accessible documents are cited. Company documentation that would only be available to industry participants is referenced in text or as footnotes. A sequence of events was developed from the evidential records and interviews, then time synchronised to the train control radio time standard. This is presented in the appendix as a timeline.

## 2.2. Report format

2.2.1. The report concentrates upon the safety issues that were identified during the investigation and does not attempt to record every aspect of the issues considered during the investigation. The factual section covers the essential information that a reader may require to understand the analysis, but minor facts and conclusions are also raised and discussed within the analysis section where they may help with comprehension.

2.2.2. On 18 August 2010 the Commission approved draft final report 09-103 for circulation to interested persons for comment, which included operating staff, management for the operating company and the regulator.

2.2.3. Submissions were received from the operator and regulator, whose comments have been considered and included in the final report where appropriate.

# 3. Factual information

## 3.1. The occurrence

### Location

3.1.1. The landslide completely blocked the Wairarapa Line at portal 2 of Tunnel 1 at 37.226 km along the Wairarapa Line from Wellington station (Figure 1). The slip had originated 20 metres (m) up slope and landed across the track.

3.1.2. Tunnel 1 had also been referred to as the Maymorn tunnel and the Maoribank tunnel because respective ends of the tunnel were located near those suburbs. Within the rail industry it was officially known as Tunnel 1 on the Wairarapa Line. Tunnel 1 is a 572 m long straight tunnel with tight right-hand (in the direction of travel) track curves outside each end. Train 1608 entered the Wellington side on a curve radius of 400 m and would have exited the other end on a 600 m radius curve. The western end closest to Upper Hutt and Wellington was called portal 1 and the other end portal 2. The tunnel was aligned very close to an easterly bearing from portal 1 (see Figure 1). The tunnel exit at portal 2 ran along a natural gully that drained towards the Mangaroa River.

3.1.3. The bank along the right-hand side of the track immediately adjacent to portal 2 was a steep natural slope (about 45 degrees) covered with regenerating bush and scrub. The slope was cut from about 3 m above track level and retained behind a wing wall that ran out from portal 2 and extended further with a short crib retaining wall (Figure 6). Just beyond the crib wall there was a steep (80 degree) unsupported cut bank along the right-hand side that was approximately 4 m high (Figure 2). Above the steep cut, the ground continued to rise steeply but at a considerably shallower angle. The steep cut area had previously been the source of many small slips onto the track.

3.1.4. The natural valley drainage watercourses led to the slope above the crib wall at portal 2. When the tunnel was built this watercourse was diverted and brought down onto the track cess drain near the portal. Originally thought to be a wooden drain, a newer surface-mounted concrete drainage chute (Figure 5) ran down the bank to the portal then down the sloped concrete wing wall to the cess drain. Installation dates were not confirmed, but the concrete chute would have been in place for at least 20 years and more likely considerably longer.

3.1.5. The left-hand bank at portal 2 (Figure 3) was in a more natural state of the original gully with a shallower slope of approximately 40 degrees and regenerating scrub and bush. There were some short sections of cut bank just beyond the portal on this side of the track, but they were generally lower than those on the right-hand side.

3.1.6. The area along the ridge above the tunnel had been recently developed for low-density, semi-rural housing. The bush and scrub cover along the ridge had been removed to create a new gravel access road and the clearance extended down from the ridge for a distance of approximately 50 m (Figure 9). Rain water and storm drainage channels had been formed along the new road and directed to concentration discharge points (Figure 8) towards the same gully to which the water would have naturally drained before the ridge was cleared. The run-off from a short section of this new road flowed into the water-collection gully area above portal 2 of Tunnel 1.

### Severe weather

3.1.7. The slip occurred on the fourth day of a 5-day severe weather event as defined by New Zealand MetService severe weather warning criteria. Ontrack had a standard process defined in its operating rules and procedures to manage weather-related risks to the track. This process was initiated when MetService issued the first severe weather warning message for the weather event to the network controller. MetService issued updated warning messages during the event until the weather conditions subsided below the threshold criteria, when it issued an event cancellation message.

3.1.8. The standard severe weather mitigation process depended upon the area manager, who was responsible for maintaining the section of track that might be affected by the weather, being advised of the impending event. This advice was provided by the network control manager to whom the MetService warning messages were originally sent. The area manager was expected to assess the risk and take precautionary or mitigation actions to minimise the risk to rail operations. Once the area manager had been advised of the severe weather event, the network control manager would monitor the situation via feedback from train drivers or track staff and take any actions that would affect operations that the area manager requested.

### The accident

3.1.9. Train 1608 impacted on a slip on the Wairarapa Line at 1817 on 23 July 2009. Train 1608 had just departed Upper Hutt and was travelling at the normal speed limit to the next stop at Maymorn station. It was dark at the time, with heavy rain falling. The train passed a small slip just before Tunnel 1 and the driver was accelerating from 60 kilometres per hour (km/h) through the tunnel to match the 85 km/h speed limit applicable from the other end. At about 150 m into the tunnel, the driver noticed an unusual shape at the tunnel exit illuminated by the headlamp, then realised that it almost blocked the tunnel portal. He applied emergency brakes and braced himself for impact with his feet against the control panel. After the brakes took effect, the train slowed down from 58 km/h to about 50 km/h before the moment of impact, then came to a halt within 30 m.

3.1.10. On impact the driver's window was instantly covered in mud that obscured his forward vision. The driver later said that, 'the locomotive felt like it rocked around and lifted off the rails'. Deceleration was very rapid, with the locomotive and half of the generator car stopping clear of the tunnel and the remainder of the train standing in the tunnel. The locomotive had derailed on a tangential line to the curve that started at the tunnel portal and was leaning against the left-hand bank, which prevented it completely rolling over. The carriages remained coupled but the generator car front bogie had derailed and the car was buried up to the windows in mud (Figure 4).

3.1.11. The emergency brake had automatically initiated an emergency selcal to train control, which alerted the controller to the emergency. A few minutes later, after the driver had regained his composure and the radio had finished sending the emergency calls, the driver was able to contact train control and explain the situation. The train manager promptly made his way through the train and with his assistants checked the passengers for injuries. The train manager was able to establish radio contact with the driver and between them confirm to train control that there were no injuries.

3.1.12. The driver shut down the locomotive engine to prevent any further damage or risk to the engine and went back to meet the train manager. A consequence of shutting the locomotive engine down was that the air compressor shut down, and eventually there was insufficient air pressure to maintain services. Pressurised air was used to operate the internal carriage doors and the toilet flushing system, which both stopped working after a short delay. The diesel generator in the first car was considered safe to be left running because the diesel exhaust was outside the tunnel. The diesel generator provided electric power for air conditioning, general passenger services and lighting throughout the carriages.

3.1.13. The train manager conferred with his crew, who then informed the passengers about the situation as they walked through the train talking to the passengers individually. The train manager proceeded to open the train end door to provide an emergency exit through the tunnel at the rear of the train. By this stage the air pressure had dropped and the automatic corridor doors had failed in whatever position they had been in upon loss of air pressure. It required the combined force of 3 people at each closed door to open them manually. Opening the end doors also allowed fresh air to be drawn through the train and into the tunnel.

3.1.14. The train manager then left the train for approximately 30 minutes and walked through the tunnel to portal 1 to get cellphone coverage. He made a call to the TranzMetro customer services supervisor at Wellington station to check on rescue activities and to the train manager on the following Wairarapa service (Train 1610) before returning to the train. He also checked the state of the train from the outside.

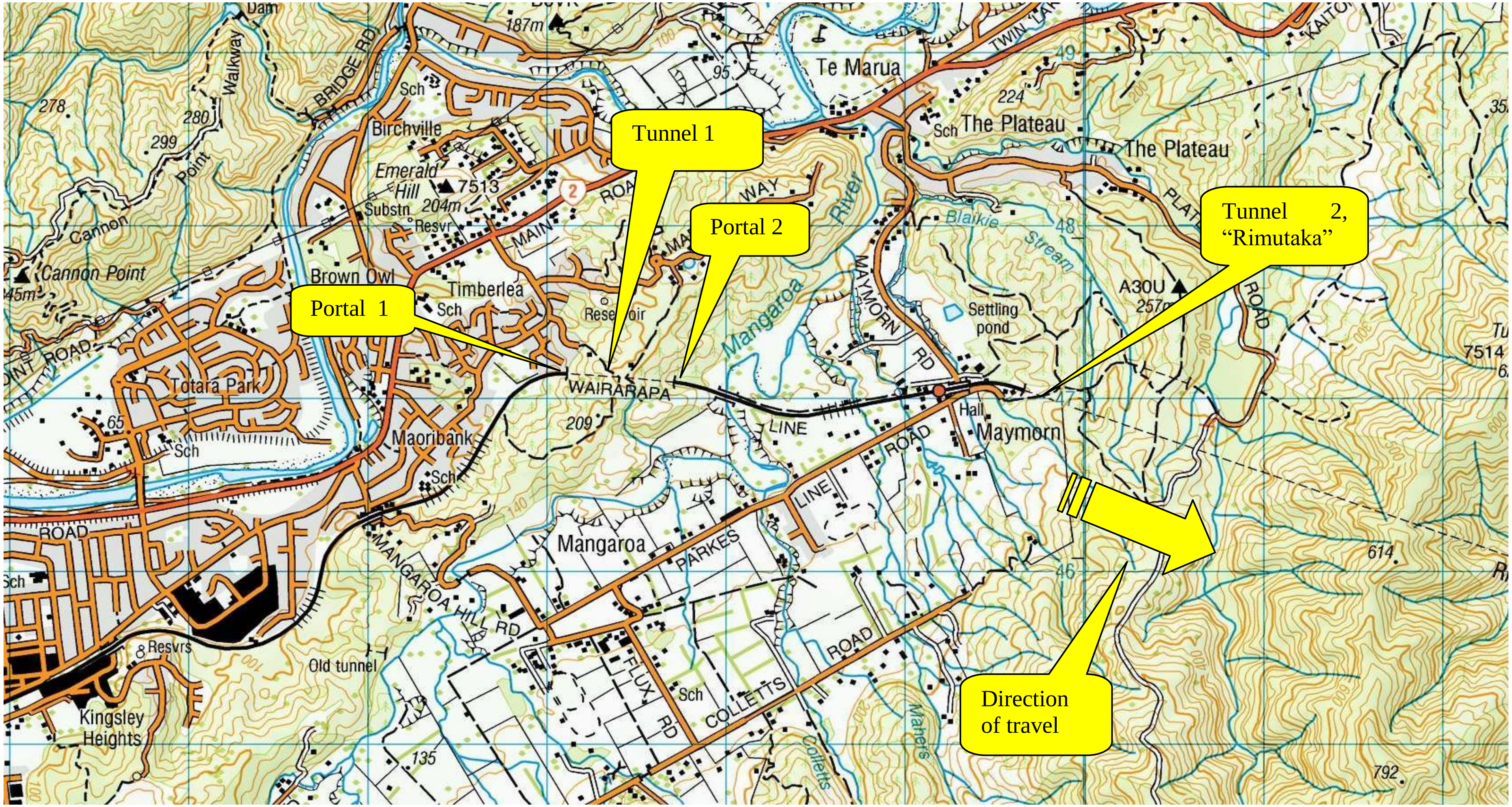


Figure 1
Location Map – Upper Hutt, New Zealand

Map provided with Map Toaster Topo/NZ licensed to the Transport Accident Investigation Commission.

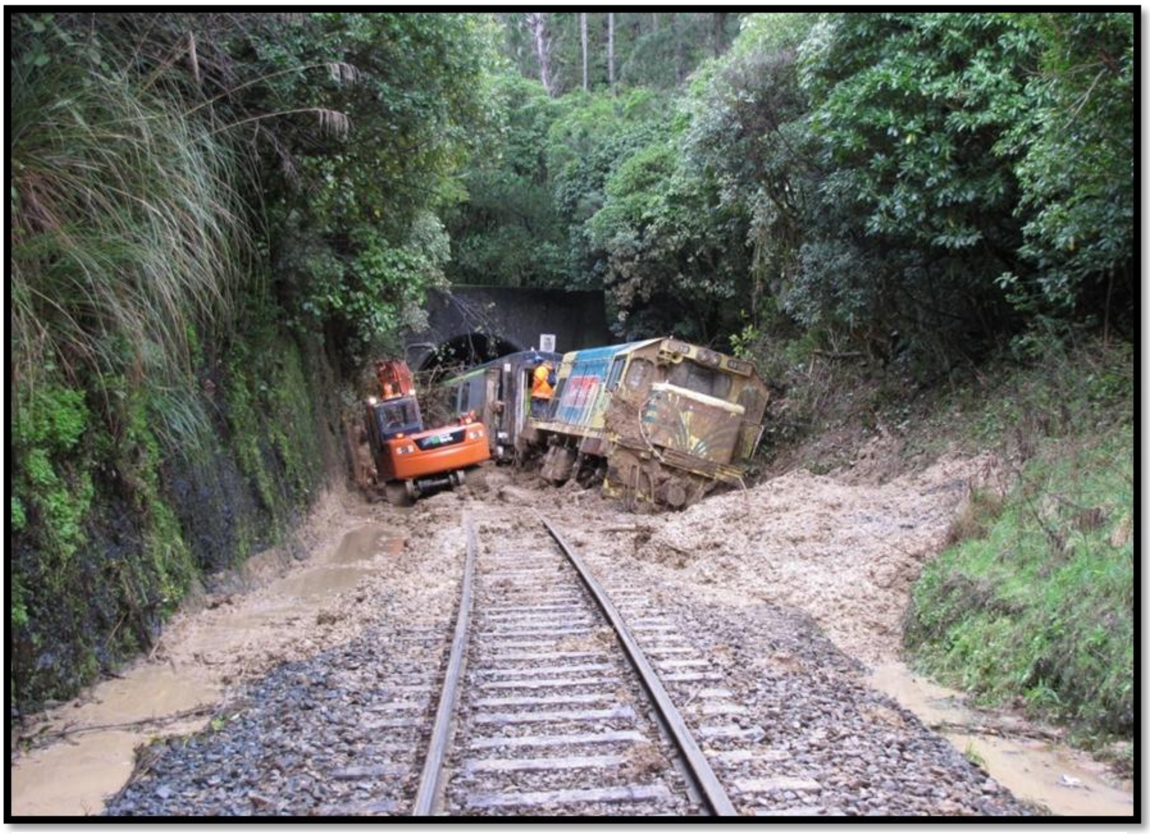

Figure 2
Resting position

Figure 3
Portal 2, Left-hand side

Figure 4
Portal 2, Right-hand side

Figure 5
Formed drainage chute

Figure 6
Portal 2, Drain to track

Figures 5 to 7 provided by Ontrack

Figure 7
Landslide footprint

Figure 8
Drainage from ridge towards tunnel

Figure 9
Cleared ridge above tunnel

### Injuries and material damage

3.1.15. There were no reported injuries after the impact. Passengers were unprepared for the emergency stop and impact with the landslide, so some were involuntarily thrust forward. The force was generally counteracted by normal muscle reactions to an extent that people moved but did not lose control. Baggage on the overhead racks remained in place, but some items sitting on the passenger tables slid across the surface.

3.1.16. The damage to the train did not look significant, but major costs would have been associated with: the disruption to Wairarapa services for approximately 5 days while the line was closed; the construction of an access track from the adjacent private road; the removal and disposal of approximately 700 cubic metres of slip debris; the use of heavy cranes to lift the locomotive back onto the tracks; and the repair of the track. The slip and the train also severed 2 major telecommunications fibre-optic trunk cables that ran through the tunnel, so there would have been related costs for the respective owners to reinstate the cables after the track had been cleared.

### Rescue arrangements

3.1.17. Train control notified the Police of the accident, who then notified the New Zealand Fire Service and ambulance. The Police activated its CIMS-based incident management response and established an Incident Control Point at Maymorn Station for all emergency services. Emergency services personnel were at the scene within 40 minutes of the accident.

3.1.18. Passengers and crew of Train 1608 were not at immediate risk, but were effectively isolated with no cellphone or radio coverage within the tunnel. Lights were all operating normally and fresh air had been flowing through the train since the front and rear doors were opened.

3.1.19. A recovery plan was conceived among the rail specialists responding to the accident and agreed some time between 1850 and 1900. The plan was to use the locomotive from the following Masterton service (Train 1610) to haul the rear 3 or 4 carriages from the disabled train back to Upper Hutt with all passengers and crew on board. Details would have to be confirmed during a site examination, but the plan was not expected to change significantly. This was promptly communicated to the incident controller within the field by the manager of network operations and later logged with Police communications by a constable when he became aware of the plan after talking to the ganger.

3.1.20. The track ganger responsible for the section of track where the slip had occurred arrived at the site from Featherston with his high rail vehicle (HRV) at 1930, approximately 1.25 hour after the accident. He was the first rail person to reach the accident site. The ganger checked the train then confirmed to train control at 1954 that the proposed recovery plan was realistic and safe.

3.1.21. The network control manager advised several rail managers of the accident, who then responded separately. The regional manager and area manager responsible for the maintenance of rail tracks around Wellington made their way to the site by road. Owing to weather-related delays in the road network they boarded a scheduled electric unit at Taita and continued their journey to Upper Hutt. The regional manager had been appointed by the network control manager to act as the rail incident controller (RIC). The manager of network operations travelled by road to Upper Hutt station, but due to weather-related delays on the road network he boarded a scheduled electric unit at Manor Park to reach his destination. The service support manager for KiwiRail Passenger Group made his way to Wellington station by road. On the way he collected the General Manager Passenger Group and organised 2 other managers to go to Upper Hutt station to organise assistance for the passengers who had been offloaded at Upper Hutt and for those still trapped in the tunnel who were to be brought back to Upper Hutt.

3.1.22. Train 1610 was directed by train control to berth at Upper Hutt main platform, discharge passengers, place the carriages on the loop, then return the light locomotive to the main line to await authority to approach the disabled train in the tunnel.

3.1.23. The recovery locomotive departed Upper Hutt station at 2026 with the RIC on board and arrived at Tunnel 1 portal 1 at 2034. The recovery locomotive was parked outside the tunnel while it was not required inside, to minimise the risk from diesel exhaust gases in the tunnel. Preparations were made inside the tunnel to part the disabled train and shift passengers to the rear 3 carriages. The locomotive entered the tunnel and the coupling was completed, then it hauled the rear 3 carriages back to Upper Hutt station, arriving at 2129.

3.1.24. The passengers from Train 1608 had been in the tunnel for 3 hours.

3.1.25. A holding facility at the Upper Hutt Cosmopolitan Club had been arranged by TranzMetro for stranded passengers from both trains. Buses met the passengers there to take them to their original destinations. By 2200 the majority of the stranded passengers had left Upper Hutt in alternative transport.

## 3.2. Background to the accident

### The train

3.2.1. Train 1608 consist was one locomotive and 5 carriages. A combined passenger/generator car was immediately behind the locomotive, then a standard car, servery car and 2 standard cars. The identification numbers are listed in the Data Summary sheet in the standing order.

### The crew and passengers

3.2.2. The train crew consisted of a KiwiRail Freight driver, TranzMetro train manager and 2 part-time passenger assistants.

3.2.3. The driver had 24 years' experience as a driver and he said that he had been well rested at the start of his shift. He had been on leave but had just returned that week and was on standby relieving duty at the time.

3.2.4. The train manager had 36 years' rail experience, with 31 as a guard/train manager on the Wairarapa service.

3.2.5. The train was full with approximately 240 passengers on board.

### Signalling system

3.2.6. The Wairarapa Line between Upper Hutt and Featherston was a single track controlled by signals under the centralised traffic control system. This was a standard system used in New Zealand where all signals and train movements were controlled from a central point: train control. Train locations, signal status and track switch positions were detected automatically and displayed on a mimic screen in front of the train controller.

3.2.7. Operational rules and automatic controls under this system ensured that each section of track was clear before the signals could be set for another train to enter that section. The section where the slip occurred extended from Upper Hutt to Featherston. Once the derailed train was disabled within the section, the signals at both ends of the section were held at stop (red light). Other trains or rail vehicles (including the ganger's HRV) were not allowed to enter this section until authority had been gained from train control to pass a signal at stop.

### Communications

3.2.8. The national radio coverage for the train control radio system was provided using a backbone repeater network and 3 very high frequency (VHF) channels (Channels 2, 3 and 4) to the trains. The channels were repeated throughout the country but selected to give geographical separation for train control areas. Trains also had 2 other VHF channels (Channels 1 and 5) dedicated for use as direct communications (not via a repeater) with track staff, work parties and other train crew.

3.2.9. Train drivers had a separate ultra-high frequency (UHF) portable radio that they could remove from the cab and crosslink back to the base radio in the cab to enable them to walk around their train but remain in contact with train control.

3.2.10. The train manager had a portable VHF radio equipped with Channel 1 only, for communicating with the driver. The train manager normally communicated about passenger issues with the customer services supervisor back at the Wellington platform using his cellphone.

3.2.11. The section of track between Upper Hutt and Featherston had very poor radio coverage with train control radio, and limited public cellphone coverage. A large proportion of this track was within tunnels and the section between Tunnel 1 and Tunnel 2 near Maymorn station was in a rural valley. The train control radio system did not work within these tunnels, so trains were isolated until they emerged.

3.2.12. As Tunnel 2 was very long, a land-based alternative communications system was installed. Tunnel 2 also had an automatic 'train-in-tunnel-too-long' check system at train control, but there was nothing of this nature provided for the much shorter Tunnel 1.

3.2.13. The driver of Train 1608 had radio communications with train control and the train manager. There was no cellphone coverage in the tunnel or from near portal 2, but there was coverage near portal 1. The train manager had radio communication to people outside the tunnel via the driver.

### Alternative train crewing

3.2.14. Normal train crewing required 2 people in the cab, but along lines that had reliable communications with train control, alternative train crewing was permitted. Alternative train crewing conditions allowed the train to be operated with a one-man crew: the driver. The Wairarapa Line did not meet the alternative train crewing standard, but scheduled passenger trains on this Line were exempted from having 2 crew in the cab under rule S10/R3 [1] because the train manager was able to act in the capacity of the assistant to the driver. The train manager was normally located within the passenger compartment and had radio contact with the driver on Channel 1.

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[1] Section 10, Rule 3 of the Rail Operating Rules and Procedures.

3.2.15. Passenger Train 1608 was operating in a non-alternative train crewing area under the Rule exemption where the train manager was considered to be the driver's assistant. The train manager had been trained and was capable of inspecting the train from the outside prior to operations and coupling/uncoupling carriages under the driver's direction.

### The emergency call

3.2.16. The train emergency brakes were linked into the train radio system in such a way that whenever the emergency brakes were applied, train control would be immediately notified of the event. The signal was received by train control at 1817.

3.2.17. The driver contacted train control soon after the emergency signal had been sent to say that his train was derailed. A few minutes later, after talking with the train manager, the driver advised that there were no injuries and that the majority of the passenger carriages were still on the track but in the tunnel.

3.2.18. Train control contacted the Police communications centre and the Police assumed primary control of the accident from that point. The responsibility for the safety of the people trapped inside the tunnel transferred to the emergency services, supported from the rail industry by the RIC or the most senior rail person at the scene before the RIC arrived.

### Civil defence emergency management response

3.2.19. Police received the emergency call from train control at 1823 and promptly forwarded it to the Fire Service and ambulance for a joint response.

3.2.20. The Upper Hutt Police Area Commander took charge of the emergency response. After receiving contradictory information from train control about the derailment location, he directed resources to check the Wellington end of Tunnel 2. He declared a level 1 Civil Defence Emergency Management situation at 1843, calling for a full tunnel response. A level 1 response (CDEM: Wellington, 2010) was the basic level of civil defence emergency response requiring normal day-to-day resources but with a central control centre using the NZ Coordinated Incident Management System (CIMS) (Emergency Services, 1998) for coordination and control between the multi-agency responses.

3.2.21. An Incident Control Point was initially established at Maymorn Station at 1900 but later relocated to Upper Hutt Station.

3.2.22. Other civil defence agencies responsible for the Upper Hutt area were also advised through the civil defence emergency management network and they started their own callout system to make their respective services available to the emergency services. Several civil defence emergency management member groups were prepared and ready to respond for a tunnel rescue.

3.2.23. Police and the Fire Service were able to penetrate the traffic jams caused by slips onto roads and reach the accident site. They were also able to allocate significant resources from around the area to assist with rescue operations and crowd control. Most of the railway staff responding to the emergency had been delayed in traffic, but some were able to use the trains to reach Upper Hutt station. The Police arrived at portal 1 at 1853 and the Fire Service reached the train from near portal 2 at 1910, then checked on the condition of the passengers as they walked through the train.

3.2.24. Emergency services were unable to communicate with train control by radio, so placed their own people with radios at key points to act as relays.

3.2.25. After the incident controller was satisfied that the passengers were safe and uninjured and that recovery plans were in place, he scaled the emergency response down at 1936.

### 3.3. Weather conditions at the time

3.3.1. MetService issued an initial severe weather warning for the period leading up to the accident at 0803 on Monday 20 July 2009. As conditions changed, MetService issued updated warnings at regular intervals. A cold front was predicted to move quickly across the South Island on Tuesday and be preceded by a burst of heavy rain, particularly on the west coast, and strong or gale-force north-westerlies in eastern areas. A strong wind warning was attached for eastern Otago and Canterbury and a heavy rain warning for Fiordland. The heavy rain was extended in updated messages as the system moved across the country, with the strong winds reaching the Wellington area on Tuesday night.

3.3.2. An updated message (at 0817 on 22 July) issued on Wednesday morning said that the strong westerly flow over New Zealand was easing slowly and the strong wind warning for Wairarapa and Rimutaka Hill Road had been lifted. It also noted that a new low was developing over the south Tasman Sea and expected to bring more heavy rain and gales onto New Zealand over Wednesday night. An update later in the morning (1120 on 22 July) advised of heavy rain in the Tararuas Thursday afternoon and evening, with up to 80mm on the lower slopes. A strong wind warning was also attached for the Wellington and Wairarapa areas. This warning update was re-issued 20 minutes later (at 1140 on 22 July) with an extension of the area affected by the strong winds further north to Eketahuna.

3.3.3. An update issued at 2058 on Wednesday night (MetService, 2009) listed widespread heavy rain warnings from Fiordland to eastern Bay of Plenty for Thursday afternoon and evening. This included a specific warning around the Maymorn area:

> Tararua Ranges and north of the Wellington region: In the 9 to 12 hours from about 10 am Thursday, expect up to 100 mm about higher slopes of the Tararuas and 50 to 80 mm lower down including the hills about Hutt Valley and Kaitoke.

3.3.4. Strong winds were also predicted for the Wellington and Wairarapa areas over the same general period, particularly in exposed places about hill tops and near the ranges. This message was repeated on Thursday morning (at 0923 on 23 July).

3.3.5. Two more updates were issued from MetService on Thursday night and Friday morning as the front passed over the country. The severe weather warning was finally lifted for the Wellington area with an update message on 24 July 2009 at 0832.

3.3.6. The severe weather warnings and updates issued by MetService to the national train control centre are listed below with the effects they had upon the Wellington and Wairarapa areas for this period of severe weather.

Table 1

| Item | Date | Day | Time | Description | Wind/Gust (km/h) | Rain (mm) |
|---|---|---|---|---|---|---|
| 1 | 20/7/09 | Mon | 0803 | Initial warning of severe weather approaching from the south | Nil | Nil |
| 2 | 21/7/09 | Tue | 0823 | Update to initial situation | Nil | Nil |
| 3 | 21/7/09 | Tue | 1113 | Strong winds expected for Rimutaka Hill and Wairarapa Tuesday night | 65/120 | Nil |
| 4 | 21/7/09 | Tue | 2046 | Continuation of strong winds above, lifted warnings for South Island | 75/140 | Nil |

| Item | Date | Day | Time | Description | Wind/Gust (km/h) | Rain (mm) |
|---|---|---|---|---|---|---|
| 5 | 22/7/09 | Wed | 0817 | Strong wind warning for Rimutaka Hill and Wairarapa lifted | Lifted | Nil |
| 6 | 22/7/09 | Wed | 1120 | Strong wind and heavy rain expected during Thursday in the Tararuas and lower slopes | 70/130 | 100 upper and 80 lower slopes |
| 7 | 22/7/09 | Wed | 1140 | Previous warning extended further northwards to Havelock North | 70/130 | 100/80 |
| 8 | 22/7/09 | Wed | 2058 | Tararua Ranges and north Wellington region including hills around Hutt Valley and Kaitoke for the 9-12 hours from about 1000 Thursday | 70/130 | 100 upper, 50-80 lower |
| 9 | 23/7/09 | Thu | 0923 | Tararua Ranges and north Wellington region, including hills around Hutt Valley and Kaitoke, for the 9-12 hours from about 1000 Thursday | 70/130 | 100 upper, 50-80 lower |
| 10 | 23/7/09 | Thu | 2056 | Heavy rain in the Tararuas for 3 hours from 2000 tonight then it will ease. Strong wind warning in area lifted but still expect gusts to 2300 tonight | 0/100 | 30 |
| 11 | 24/7/09 | Fri | 0832 | Severe weather warning event no longer in force | Lifted | Lifted |

3.3.7. The publicly accessible rainfall data monitoring site in the upper Mangaroa River catchment area (Tasman Vaccine Ltd) recorded 62 mm of rainfall over the period 1100 to 2000 on 23 July 2009 (GWRC a). This matched the MetService prediction.

3.3.8. The July 2009 hydrological summary produced by the Greater Wellington Regional Council (GWRC b) showed that the percentage long term average rainfall in the Kaitoke area during July 2009 was at 86%. The months of June and July in 2009 were noted in the summary as being particularly dry compared with previous years.

## 3.4. The landslide

3.4.1. A senior engineering geologist employed by Ontrack[2] investigated the slip at Maymorn and wrote an internal report[3] on the event. The following paragraphs highlight selected key points paraphrased from that report:

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[2] Ontrack was the trading name at the time but it is now called KiwiRail Network, an operating division of KiwiRail.

[3] Geotechnical Assessment, Derailment due to landslide at Tunnel 1; WL37.23 km.

### Geological setting

3.4.2. The base rock in the area was heavily weathered greywacke with a layer of colluvial soil and loess soil on top. This was a similar geology to many areas around Wellington city.

3.4.3. Portal 2 of Tunnel 1 was at the base of 3 relatively large drainage gullies from surrounding slopes on the north, west and southern sides of the track. Natural slopes adjacent to the portal were up to 80 m high and inclined at up to 40 degrees above horizontal. The western slope was covered in mature pine trees, while the north and south slopes were covered in regenerating bush.

3.4.4. A natural watercourse from the gullies entered the landslide area near the toe. This was diverted to a shallow concrete open channel that dropped down the slope to the portal wing wall then along a formed drain down to the track.

### Description of the landslide

3.4.5. The toe was 20 m upslope from the track. The toe was approximately 10 m across and the landslide width increased to approximately 16 m at the top main scarp which was 20 m above the toe. The average depth was 1.5 m (Figure 7).

3.4.6. The slip was a shallow movement of free-draining surface loess soil.

### Likely cause

3.4.7. The slip was a first-time landslide and was likely to have been initiated by high water pressure within the surface loess soils lying on a relatively impervious colluvial soil layer and greywacke rock base.

### Conclusions of the Ontrack report

3.4.8. The Ontrack report concluded that movement may have been partly exacerbated by the saturation of the toe of the slide from high water levels in the water course to the right-hand side of the slide when looking from the track (Figure 5). The report noted that the slip occurred at the end of a 6-hour rainfall event when the soil was likely to be at maximum saturation combined with high run-off.

3.4.9. The Ontrack report further concluded that this type of slip was a relatively common natural occurrence in the Wellington region and that there may be a significant length of track in the Wellington commuter network that is at risk from slides under high rainfall or seismic events. As demonstrated by similar landslides throughout the Wellington region, the risk of asset damage is present but the risk to loss of life at Tunnel 1 was not considered to be significant. The report further rationalised that the risk to the rail network was unlikely to be significantly higher than that posed to private property and public infrastructure throughout the Wellington region.

3.4.10. The Ontrack report suggested a risk-rating system and proposed a plan to rank the risk to the commuter rail network, then outlined possible risk-mitigation measures such as reductions to slope angles or drainage improvements and consequence reductions, such as track relocation, early warning systems and speed restrictions.

### Landslide statistics

3.4.11. Statistics were obtained from network control records on the number of slips that had occurred within the Wellington rail commuter network. Landslides had blocked rail tracks in the Wellington area about 4 times per year. During the 5-year period from 2004 to mid-2009 there had been 23 slips reported to Ontrack network control for this area. The Johnsonville Line had had at least one slip every year, with 14 over the period. The North Island Main Trunk section of line up to Paraparaumu and the Wairarapa Line had had 5 and 4 slips respectively during the same period.

## 3.5. Severe weather actions

3.5.1. The process for managing severe weather warnings is described in Section 1, Rule 6(b) of the Rail Operating Rules and Procedures. The general process is described below.

### Actions upon receipt of the warning message

3.5.2. A severe weather event would be started when MetService issued a severe weather warning to subscribers to its service. This message would be received by the national train control network office in Wellington and assessed by the duty network control manager. This message would be regarded as a level 1 severe weather warning. The network control manager would start an event log clipboard file that would be added to as the event progressed.

3.5.3. The network control manager would reinterpret the message into the relevant rail track areas, which are different from the metrological areas in New Zealand. The essential content of the message would then be rewritten as a text message and sent to standard severe weather warning recipients via a web-based text distribution message system (Telecom eTXT) using a pre-programmed distribution list.

3.5.4. The message would also be manually rewritten as a very short text message and entered into the Speed Restriction and Condition system as a condition warning to operators. This would be automatically distributed around the country and appear on the work orders issued to train drivers before they started on jobs. The condition warnings would only appear on work orders if the track lengths to be travelled were affected by the severe weather warning. Such a warning would be prefixed with CON for condition as opposed to a speed restriction and could say something like 'heavy rain, high wind', or 'snow' along with a status symbol to indicate if it was a new warning, an update or a pending, lifted or active warning.

3.5.5. The network control manager would also call the area managers responsible for the affected track length and verbally warn them that a severe weather warning had been issued. This call would be marked on an Aide Memoire sheet with a tick to indicate to subsequent duty network control managers that the area manager had been contacted. The Aide Memoire had a list of the area managers with contact details and a note space beside each name.

3.5.6. The train controllers responsible for the affected track lengths would be advised by the network control manager and they would mark the train control diagram with blue highlighter for the period in which the warning was active. They would do this to be aware of the situation in the field, but would take no other action.

### Area manager's assessment

3.5.7. After receiving the warning call or a text message from the network control manager the area manager would assess the risk to operations for their area. There was no guidance in the Rules on how to make that assessment but the Rules stated that the level must be raised to level 2 – Adverse if any of the following conditions existed:

- reports from the field indicated an immediate escalation was required
- adverse weather was warranted
- the line was blocked due to an accident.

3.5.8. The area manager would contact the network control manager if the level had to be escalated, but not usually otherwise. The area manager would advise what speed restriction would apply, with a default maximum of 40 km/h, and if additional inspections were required before subsequent trains entered the area.

### Network control actions with level 2

3.5.9. When the area manager confirmed that a level 2 situation existed, train control would stop all trains in the affected area and arrange for a special inspection.

3.5.10. No further action would be required until the weather event abated or a cancellation message was received from MetService, but the area manager and network control manager were expected to remain in close contact during the remainder of the weather event about the track condition and rail movements.

3.5.11. Upon cancellation, the area manager would inspect the track. If the track was safe to use, the area manager would advise the network control manager to cancel all track restrictions. The network control manager would then close the severe weather running log file.

## 3.6. Track maintenance and inspection

3.6.1. The investigation considered the possibility that track inspections and maintenance programmes would have identified the potential for a landslide. This section describes the processes that were in place at the time.

3.6.2. The track was divided into 2 general interest areas, the track and structures. The track was the running road for trains and the structures were the other items that had a component of structural integrity required to support or protect the track. Track maintenance and inspections were conducted continually, with a range of inspections carried out from the train cabs and slow-moving HRVs, by walking and by specialised automatic track inspection vehicles such as the EM 80. Each type of inspection usually looked at a specific area of interest and had to be planned to not interrupt scheduled services.

3.6.3. There were 3 general types of inspection that were relevant to this investigation: general inspection, detailed inspection and special inspection. The general inspection was carried out more often, while the detailed inspection looked at specific sections of the track or structures more closely than a general inspection and would take longer to conduct but occur at longer intervals. Special inspections were carried out when there was a concern that the line may have been damaged or be at risk from weather-related events, so focused on a list of critical features along the length of track called the 'essential features list'. It was intended to check that critical features were still intact and serviceable for the line to remain open, but not intended to delve into technical details of the features covered by other inspections.

### Applicable codes

3.6.4. Inspection guidelines were defined in the Ontrack Infrastructure Code. The track inspections were defined in section T003[4] and an associated handbook T200. Structures inspections were defined in section W004[5] and by an associated manual W200[6].

3.6.5. The track inspection code required track inspections twice per week on the Wairarapa Line, supplemented by locomotive cab runs every 4 months. Track signage and speed boards would be inspected every 6 months and an engineering inspection carried out every 12 months. At least once per year the EM 80 would also check and record track geometry. These types of inspection primarily focused on track running conditions, the condition of listed essential features and general conditions in the immediate vicinity of the track.

3.6.6. A separate set of inspections was carried out to look at the structures, such as cuttings, retaining walls, bridges and culverts under the track and tunnels. The code requirements for structures to be inspected and the inspection frequency were set down in the Structures Code and the risks and methodology were described in the W200: Structures Inspection Manual.

### Essential features list

3.6.7. The essential features list was a list of features along a length of track that were deemed to be so critical for the safe operation of that track that they had to be checked during every inspection of the length, or features that should be specifically checked on a special inspection. The list

[4] Infrastructure Group Code, section Track, T003 Track.

[5] Infrastructure Group Code, section Bridges and Structures, W004 Structures.

[6] Ontrack Structures Inspection Manual, W200, Issued 30/10/00.

included sections of track where problems had existed in the past or where weather events might have an adverse affect upon operations, such as slip-prone areas or flooding risks.

3.6.8. The list was maintained in an electronic record and a printout was usually carried to refer to while the track was being inspected. The process for reviewing and updating the list was not formally defined apart from the requirement that it be reviewed by senior management at regular intervals.

#### Maintenance process

3.6.9. The area manager had overall responsibility for track maintenance in his designated area. The organisation structure of the track maintenance group in Wellington is shown in Appendix 2. The area manager was supported by several specialist inspectors and groups of gangers to carry out the maintenance and repairs identified from inspections. The inspectors would look at track wear and fixings, ballast, signs, bridges, tunnels, cuttings, retaining walls etc and record the out-of-code conditions in a report along with priorities for repair.

3.6.10. This report would pass through the management levels to gain approval and funding, then be handed to a ganger team leader to carry out the work. Each ganger team was allocated responsibility for a set length of track from point A to point B (the length). The ganger teams were constantly out on the track carrying out repairs, clearing drains, removing obstacles or animals, clearing trees and branches or organising small work parties for larger jobs. They also carried out special inspections on their length of track when they were required.

### 3.7. Safety management system

3.7.1. Ontrack is a licensed rail participant under the Railways Act (NZ Government, 2005) which requires it to provide a Safety Case[7] describing how it intends to manage risks associated with its operations. Ontrack has 2 documents to meet this requirement: a Safety Case that matches clauses in the Act with specific responses; and its Rail Safety System Manual[8] describing its intended operations. Underpinning the Rail Safety System Manual is a range of in-house codes, manuals and instructions that are listed in the Rail Safety System Manual.

3.7.2. The rail regulator, the NZ Transport Agency, requires that every rail participant also comply with the publicly available National Rail System Standards (numbers 1 to 11) as a condition of its licence. The NRSS is a set of joint industry standards that are administered by Ontrack through an executive group of representatives from all operators and made available to the public through Ontrack's website.

### 3.8. Previous incidents

#### TAIC 06-108 Johnsonville line derailment

3.8.1. At 0907 on 26 August 2006, a Wellington commuter train travelling to Johnsonville on the Johnsonville Line collided with a slip just after leaving Tunnel 1 at 2.474 km (Transport Accident Investigation Commission, 2006). A severe weather warning had been issued by MetService that day, warning of 40 mm to 50 mm rain falling between 0800 and 1200 that morning, but it was not received by train control until 20 minutes after the collision, so the driver had not been informed of the severe weather warning. Other drivers on the Line had reported evidence of severe weather and flooding to train control earlier that morning, and the last driver handing the train over to the new driver had commented upon the severity of the rain he had just seen coming in from Johnsonville.

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[7] Ontrack Safety Case, Issue 1, 4 April 2008.

[8] Ontrack Rail Safety System Manual, Issue 3, 4 April 2008.

3.8.2. The maximum speed limit on the Johnsonville Line was 50 km/h and the driver was travelling at approximately 35 km/h through a tight curve when she saw the slip and applied emergency brake. The train was not able to stop within the clear track ahead and derailed on the rock debris across the track.

3.8.3. The Commission made 4 safety recommendations from that investigation relating to severe weather forecasting, weather-proofing the Johnsonville Line, clearly defining responsibilities when a severe weather event exists and the practice of carrying out routine track inspections at night associated with inadequate special inspection guidelines.

3.8.4. The comparative points with the Maymorn incident were:

1. A severe weather warning was current, with heavy rainfall after a prolonged period of lighter rain. A severe weather warning had been received but in this case it was after the event.

2. The driver had been advised by another driver that the line was at risk from flood damage, but was not aware of the severe weather warning.

3. The slip occurred suddenly without warning because the track had been clear when a train passed through the area 10 minutes earlier.

4. The driver was travelling at normal speed but was unable to stop within the available clear track.

5. No speed restriction had been applied or special inspection carried out.

3.8.5. At the time, no risk assessment or landslide protection/mitigation works had been carried out along the slip-prone line.

TAIC Inquiry 08-106 Johnsonville line derailment

3.8.6. At 1935 on 23 July 2008, a Wellington commuter train travelling to Johnsonville on the Johnsonville Line collided with a landslide just out of Tunnel 1 at 2.46 km. A severe weather warning was in force at the time, with heavy rain of 20 mm to 40 mm expected to fall in the area between 1700 and 1900 that day. The speed limit was 50 km/h and the driver was travelling at approximately 40 km/h when he noticed the slip, but he was unable to stop within the clear distance ahead so collided with the rock debris. The driver's visibility was restricted at the time because he was driving an older English Electric unit with poor forward visibility, bright reflection interference on the windscreen from internal lights, non-illuminated instruments and a low-power headlight.

3.8.7. The comparative points with the Maymorn incident were:

1. A severe weather warning was in force at the time, predicting heavy rain in the area.

2. The driver was aware of the severe weather warning so kept a careful lookout.

3. The slip had occurred suddenly, because the track had been clear when a train passed through 10 minutes earlier.

4. The driver was travelling at normal speed but was unable to stop the train within the available clear track.

5. No speed restrictions had been applied or special inspection carried out.

3.8.8. Both of these derailments on the Johnsonville Line were within slip-prone zones listed on the essential features list. The Maymorn derailment was not in a slip-prone zone but a slip zone was noted on the essential features list 450 m away from portal 2.

# 4. Analysis

## 4.1. Overview

4.1.1. Three trains were disabled by slips on the Johnsonville and Wairarapa Lines that occurred during severe weather events. In all 3 cases, the drivers detected the rail blockage visually but were unable to stop their trains within the clear distance ahead before colliding with the debris. The drivers were travelling in or near slip-prone areas of track during severe weather events at the normal allowable speeds. Only one of the 3 drivers had been advised via network control that a severe weather warning of heavy rain was active at the time. In all 3 cases speed restrictions had not been applied nor special inspections conducted.

4.1.2. There were no significant injuries resulting from any of the occurrences, but the disruption to services was significant, and in the Maymorn derailment the consequent damage to the infrastructure was significant also.

4.1.3. The risk to people on the Johnsonville Line was not significant because trains travelled at low speed on that line all of the time, although the consequences could have been high. On the Wairarapa Line trains can travel at up to 100 km/h. A train striking a slip at that speed could have significant implications for transport safety.

4.1.4. A review of the then-current KiwiRail track and structures inspection regime revealed that it was unlikely that the Maymorn slip could have been predicted because it was a first-time slip, its origins were further away from the track than was currently inspected, and it was masked by vegetation. This type of slip could therefore occur at other locations around the network in similar weather conditions unless a different approach to inspections is introduced.

4.1.5. A review of the then-current KiwiRail severe weather procedures revealed that they were not effective in preparing the train operation for the severe weather event. Had they been, the risk could have been mitigated but realistically could not have been entirely removed, short of closing down operations altogether.

4.1.6. These points are discussed in more detail in what follows.

## 4.2. Cause of the landslide

4.2.1. Several factors may have contributed to this slip occurring on this particular day and not during previous heavy rainfall events. To pick one reason with absolute confidence would be speculation, but based upon the Ontrack report (footnote 3), which the Commission has no reason to doubt, the mechanics of the landslide were clear. The topsoil layer at the slip face became saturated and the resulting water pressure at the topsoil interface to the impervious subsoil layer reduced adhesion. The topsoil layer then evacuated downhill, landing across the track at Tunnel 1 portal 2.

4.2.2. The ground composition around the tunnel portal is similar to that in a large proportion of slip-prone slopes in the Wellington area. The Greater Wellington Regional Council published general information about emergency management on its website (GWRC c) in a landslide hazard fact sheet. This sheet states that the areas of highest risk from large landslides around the Wellington region are: steep slopes greater than 35 degrees; slopes that have been altered; and slopes that have an underlying layer of weathered rock. All of these factors were present at the Maymorn landslide.

4.2.3. Slips occur naturally and are a normal part of the gradual but continual erosion process. Whenever the natural lie of a slope is modified by man-made alterations, protection is required to retain and drain the modified slope to prevent it encroaching upon the alterations. The man-made changes to the natural watercourse, installed when the tunnel was built decades ago, carried some degree of risk of landslides near portal 2, but the right combination of factors did not occur until July 2009. Some level of residual risk of a landslide is an accepted rationale from an economic perspective and perhaps justified for Maymorn, but the risk of a landslide causing a derailment is something that should be avoided as far as practicable. The effect of the new subdivision and cleared bush above the tunnel was considered. The catchment area had not changed nor had any drains from other slopes been diverted into it by the road construction, so the development was unlikely to have influenced the stormwater drainage flow at portal 2.

4.2.4. Heavy rain at the time of the landslide may have been so intense that the slope around portal 2 became saturated and failed naturally. The landslide occurred at the end of an intense 6-hour period of heavy rain, totalling 62 mm during a relatively dry period. This proved sufficient to initiate what had always been a potential landslide.

## 4.3. Why was the potential for a landslide not found by track inspections?

4.3.1. The inspection regime was based upon observable deviations from code conditions within a short distance from the track, and not upon risk to the track in accordance with the framework described in NRSS 4 (Ontrack, 2007 a).

4.3.2. The track and structures inspection regimes were focused on immediate evidence of problems rather than potential risk. There may have been earlier signs up the slopes from Tunnel 1 portal 2 that the risk of a slope failure was present. The guidelines described in the Regional Council's 'Landslide Hazard' fact sheet (GWRC c) listed potential signs that the ground may be moving prior to a landslide as: new cracks or strange bulges in the ground; leaning trees or retaining walls; and springs, seeps or waterlogged ground in areas that were not usually wet.

4.3.3. Track staff generally expected that signs at the track level would indicate that a future slip was likely. Typical signs they expected to see included recent debris having fallen onto the track, excessive water flow from drains or discharge at an odd angle, and ground subsidence that was visible from the track. The area beyond the 3-5 m track envelope was out of their normal physical inspection range. While recent debris may have been valid signs of a slip for steep-cut banks adjacent to the track, it was less likely to be true for landslides like the one at Maymorn.

4.3.4. The time between warning signs of a slip at track level and a slip occurring could be close. The 2 Johnsonville Line derailments were caused by landslides that occurred within 10 minutes of a previous train, whose driver had not noticed any warning signs. The Maymorn landslide occurred within one hour of the previous train passing through the area, whose driver had not noticed any warning signs. The nature of the Maymorn landslide meant that it was also unlikely to have produced track-side warning signs that it was about to occur.

4.3.5. A review of the track and structures inspection codes showed these did not look at risk of slope failure. The structures code was the most likely to consider the stability of slopes above the track and associated drainage systems, but Code W004 section W47(a) specifically excluded stormwater systems from the inspection scope and they were not covered in the track inspection code. The W200 Structures Inspection Manual published in 2000 was more risk focused and recognised the potential risk to the track from slope failure due to water retention. An extract from pages 7.16-1 and 2 of the W200 Manual stated that:

> Appropriate and effective drainage systems will have been constructed to carry excessive water away from exposed slopes. Slopes, except for the steepest of cut batters, will have been grassed or covered with other appropriate vegetation. Slips are the main problem associated with earth structures and the most likely cause of these slips is water getting into the soil and being retained in embankments and cuttings. Slips may be small, localised surface failures or deep seated earth movements. Drainage systems may become inoperative, allowing water to accumulate or to be diverted into critical areas, perhaps at the tops of slopes.

4.3.6. The drain that ran down from the slip face (see Figure 5) was not listed on the essential features list and the structures inspector for that line could not recall having ever inspected the drainage system above the track. This was a reflection not of his inspection quality but of the codes that he followed.

4.3.7. In summary, inspections were not based upon future risk but on a codified inspection process that listed items to look at for current evidence of failure. The inspection codes concentrated upon observable code deviations to be checked at fixed time intervals between inspections. Normal rail observations for slip hazards looked for evidence visible at track level, while signs that may have indicated the potential for a landslide were beyond the physical range of the normal track inspection envelope. It would have been unlikely under the present code-based inspection regime for the normal track inspection process to have identified the potential risk of a future slope failure at Tunnel 1.

4.3.8. Given this inherent lack of risk assessment in the then-current track inspection regime and that even a risk-based slip inspection system would not provide an absolute guarantee that a slip would not occur, there was a need to consider other risk-mitigation measures, such as severe weather warning procedures.

### 4.4. Management of the severe weather warnings for Maymorn

4.4.1. The MetService severe weather warning period started with the initial warning issued at 0803 on Monday 20 July 2009 and extended with update messages during the week until the severe risk had passed the Wellington area (refer to Table 1 in the Factual Information).

4.4.2. The network control manager promulgated the severe weather warning using a contact list that was at least 10 months out of date. The new Wellington area manager‘s name and cellphone number were not included on the network control manager’s Aide Memoire sheet or on the Telecom eTXT distribution list. The area manager was also unfamiliar with the severe weather warning process and his responsibilities associated with them, because he was new to the role. This reflected a weakness with his induction process.

4.4.3. As the week progressed, MetService issued several updates that defined new areas, changed strong wind and heavy rain warnings and lifted warnings in areas over which the frontal system had passed. Some of the severe weather warning update messages were passed on by the network control manager, but critical ones during the latter part of the week predicting a resurgence of strong winds and heavy rain in Wellington were not. A severe weather warning was issued by MetService at 2058 the day before the accident, warning of heavy rain expected to be 50-80 mm at Kaitoke during the Thursday afternoon (MetService, 2009). Kaitoke is just north of Maymorn in the adjacent valley, but both areas are within the lower slopes of the Rimutaka Ranges where the warning was intended to apply. This message was not distributed by the network control manager via text message nor was it entered into the speed restriction system. This fact was confirmed during the interviews and from copies of the speed restriction printouts. The new Wellington area manager was not sent any update messages or contacted. The ganger for the Wairarapa Line was not contacted either.

4.4.4. Train drivers were expected by network control to advise train control if they had any concerns with the weather. Two trains and a track inspection team passed through Tunnel 1 during 23 July. The track inspection was at 1100 when the weather was fine, and the trains passed the tunnel at 1.5 hours and one hour before the accident, while it was raining but still during daylight. Neither the drivers nor the track inspectors noticed anything untoward around Tunnel 1.

4.4.5. Train 1608 departed from Upper Hutt with the driver expecting the track to be safe but with a condition on the speed restriction printout showing strong winds were expected. This was actually an out-of-date condition that should have been cancelled during the week then reactivated for this period. Throughout 23 July, both strong wind and heavy rain warnings were active along the Wairarapa Line but they had not been promulgated. The wind warnings were near Force 9, which according to the Track Inspection Code T003 Rule P96, required the ganger to inspect the length then observe the passage of trains. The ganger had not been advised of the severe weather warning and had not taken these actions.

4.4.6. In summary, the severe weather warning system failed on 2 accounts: firstly the Wellington area manager was not on the distribution list for receiving alerts, and secondly not all the severe weather warning alerts for the period were promulgated as required under the procedures current at the time.

### 4.5. Effectiveness of severe weather warning rules

4.5.1. The current rule that defines actions during a severe weather event is Rail Operating Rules and Procedures, Section 1, Rule 6(b) – Adverse Weather. The Rule appears to have been originally duplicated from Section 11 – Emergency Procedures, Rule 35 but has since diverged considerably as the source Rule does not appear to be used. Depending upon which Rule is followed, the resulting actions would be in conflict. The correct location of the Rule should be decided by the rule management committee and the duplicate removed.

4.5.2. The Aide Memoire was a printed document used by the network control managers to guide them through the stages of a severe weather warning. It had contact names and numbers for people who had to be advised of the warning and a note space to record that a phone call had been made or text message sent. Aide Memoire sheets had been created for 21 and 22 July but not for the 23rd. The text distribution list was set up as a group text address for 'severe weather warnings'. Both contact references were out of date.

4.5.3. Once a warning message or phone call had been made to the area managers, the network control managers would not usually follow up to check that it had been received or enquire about their planned actions. Each year there would be approximately 150 warnings from MetService for about 60 weather or heat events. Only about 4 events would progress to level 2 warnings, so area managers rarely responded to network control managers about severe weather warning messages.

4.5.4. Once notified, the area managers carried the responsibility for assessing the risk and initiating mitigating actions during severe weather events. Each area manager would make the decision to upgrade severe weather warnings to a level 2 condition or not based upon their experience and the advice from their staff who were either familiar with the track or observing the conditions on or near the track at the time. The early warning messages allowed preparations to be made in advance of the event.

4.5.5. The Rules were written in a way to allow area managers the freedom to evaluate the MetService severe weather reports against their own and their staff's collective experience and have a choice of actions they could take, depending upon their assessment of risk to train services operating within their area.

4.5.6. If an area manager wanted to raise the level of weather warning to level 2, they would contact the network control manager and request that the level be raised. The consequence would be that the train controller would stop all trains running on that line until a special inspection had been completed and the network control manager would impose a blanket speed restriction of 40 km/h for the remainder of the severe weather event.

4.5.7. If no action was taken, the area manager would have no obligation to keep the network control manager informed. On the other hand the network control manager would not check with the area manager either.

4.5.8. The managers interviewed from network control did not see their role as being important in the severe weather warning system; that they were limited to being the receivers and disseminators of severe weather warnings to others in the system. The result was that no-one had assumed overall responsibility for the management of severe weather events across the country, where a single event could affect more than one area.

## 4.6. Risk-mitigating actions

4.6.1. There were several options available to Ontrack to mitigate the risk of slips, including tailored weather advice provided by professionals. Formal slip hazard identification, modifications to retain and drain the surrounding slopes, special inspections and speed restrictions are discussed below.

4.6.2. A specialised risk assessment had been carried out for the slopes around Tunnel 1 on the Johnsonville Line after the July 2008 derailment (TAIC investigation 08-106). Work had been done recently on some sections of the Johnsonville Line during Christmas 2008/9, at the same time as works to extend passing loops and lower tunnel floors were carried out. Slopes above the track in these areas were cut back away from the track then stepped to catch small slips before they reached the track, and some slopes were contained by surface-mounted netting.

4.6.3. Drivers were expected to advise train control if they saw signs of severe weather on the track that concerned them. The intention was to initiate a special inspection of the track. Although this was an important option for drivers to help manage weather-related risks on the track, it was rarely used. The drivers interviewed for Maymorn did not recall anything worth passing to train control. A similar situation applied for the drivers of the trains noted in the other 2 Commission investigations in this report, but one driver had reported track flooding several kilometres distant from the eventual landslides.

4.6.4. A special inspection could be conducted to ensure that the track was safe to use during severe weather. Track staff acknowledged that special inspections had some value, but they were also aware that a special track inspection would only give assurance for an instant of time, so the effectiveness was limited. The Maymorn landslide might have been detected if a special inspection had been carried out, but as the landslide occurred without warning, one inspection would not have guaranteed that the track would remain clear for trains scheduled after that point in time. Special inspections included the essential features lists at its core, but the essential features were historical events that had been recognised rather than events proactively sought out as potential essential features. This limited the value gained from including them in the special inspection.

4.6.5. A blanket speed restriction would be applied if the area manager considered that the track was at risk from a severe weather event. The normal speed restriction would be 40 km/h, with the intention to reduce the severity of a derailment and possibly to enable a driver to see a potential hazard with sufficient advance warning to stop before hitting it.

4.6.6. A speed restriction for severe weather would normally be applied for a controllable section that enclosed the risk zone, so with Maymorn it would have been applied from Upper Hutt to Featherston. A large proportion of this section was underground where a weather-related speed restriction would be unwarranted. Shorter sections of track subject to heat expansion are currently speed restricted, so the technique is already familiar to the industry and there appears to be no reason why it could not be applied to severe weather events.

4.6.7. A speed restriction may have been effective at Maymorn in reducing the effect of the impact, but a speed restriction would not necessarily prevent a train from hitting a landslide. Depending upon the braking distance of the train, the train brake reaction time, the driver's forward visibility solely from the locomotive's headlight and his reaction time, a speed of 40 km/h might have been too fast to stop the train before the impact. The driver estimated that he saw the portal looked different from about 400 m, when he applied emergency brakes. The train slowed from 58 km/h to approximately 50 km/h before impact. At this rate, if the train had been travelling at a restricted speed of 40 km/h, the impact speed would have been reduced to 32 km/h but the train would have still hit the landslide.

4.6.8. If the network control manager had issued the correct warnings through the speed restriction system for Maymorn, the driver of Train 1608 would have had 'strong wind' and 'heavy rain' listed as conditions on his work order. Armed with this warning, the driver might have altered his behaviour and slowed to less than 40 km/h in what he considered to be high-risk areas from flooding and slips, and as a result could have had time to stop his train within the visible track ahead. Existing driver behaviour demonstrated in the 2 Johnsonville derailments and this Maymorn derailment indicate that drivers were reluctant to drop too far below the signposted speed limits, so any change in this direction would also require support and encouragement from network control.

4.6.9. The regional councils generally monitor rain fall, river levels, river flows and ground saturation levels and some publish the data on public websites for anyone to use. A quick scan of the publicly available data-monitoring sites on the Greater Wellington Regional Council website (GWRC a) showed that the Mangaroa River flow was rising quickly during the afternoon of 23 July 2009, from the usual flow rate of under one cubic metre per second towards the 2-year flood level of 150 cubic metres per second. The river level also rose during the same period, from about 1 m to over 3 m. Rainfall data in the same period showed that the Mangaroa River catchment (Tasman Vaccine Ltd site) had 62 mm in rainfall between 1100 and 2000. MetService had accurately predicted 50 mm to 80 mm for this area during this period and had issued an update warning at 2058 the day before. Network control did not look at this validating information or assess it with the severe weather warnings. Analysis of this data would likely yield some useful information to help correlate weather and river conditions with risk to essential features. Together with a risk assessment of slopes around the rail network, Ontrack could develop a more meaningful database of essential features and weather-prone areas.

4.6.10. GNS has conducted research into slip events in the Wellington region (Hancox & Nelis, 2009) and observed associations between slip occurrences and the long-term mean rainfall, the slope, stabilisation of the face and rainfall duration. The GNS research report concludes that prolonged and higher-than-normal rainfall in Wellington (135%) during the winter of 2008 triggered many landslides, but that other preconditions appeared to have also been a factor. This indicates that it was not a simple relationship between rainfall and landslides, but expert advice is available locally in Wellington that may be able to help Ontrack define a general guide. The GNS report states that, 'Most of the landslides occurred towards the end of several wet periods from June to August 2008, during which 50 mm – 120 mm rain fell over 5 – 10 days'.

4.6.11. An automatic landslide warning system is currently used in Japan by the JR East Railway Company to manage the risk of landslides affecting its railway network. A research paper into the operation of existing rainfall warning systems on the Japanese railway carried out during 2006 (Suzuki, Yamamura, & Shimamura, 2006) outlined a better mathematical model for assessing the ground water saturation and the risk of landslides. The paper also outlined some of the proceedings from a conference in Japan on the examination of the technology required for the introduction of the new rainfall index to the train regulation, held from 2004 to 2006, so landslide warning systems appeared to be quite common in Japan and formally required under its operating rules.

4.6.12. Ontrack managers expressed their preference, in a meeting 12 months after this accident, to install landslide-detection systems at known slip-prone areas to detect when a slip has occurred and provide automatic warnings to train control. A more informative database of slip-prone areas on the network would provide useful information for determining the best location for such detection systems elsewhere on the network.

## 4.7. Network control and rail emergency management

4.7.1. The procedures for dealing with occurrences contained in the NRSS 5 document (Ontrack, 2004) were comprehensive and as long as they were able to be followed they should have resulted in an effective recovery, making allowances for any unique features of events and recovery operations.

4.7.2. A key element missing from the NRSS 5 document was the interoperability with the CIMS emergency management model used by emergency services (Emergency Services, 1998). Under that model one of the emergency services, the Police on this occasion, manages the event, yet the NRSS 5 document was designed around the rail personnel (the network control manager and the appointed RIC) managing the process. This omission could immediately hinder the efficiency of any recovery plan.

4.7.3. For occurrences involving the emergency services, there would be some benefit in having an equivalent to the RIC appointed to the Police command centre. This person could then become the rail expert assisting the Police operation, and ideally should become the focal point for rail communications until the site is handed back to the rail operation, whereby the appointed RIC would take control of reinstating the line.

4.7.4. Emergency services were told soon after the Maymorn derailment that nobody on board the train had been injured. From that point the urgency of the response was downgraded and it became more focused on the recovery of the passengers and crew from the train stuck within the tunnel. With the remote location and limited access for vehicles large enough to remove all passengers, the response team soon realised that a rail recovery was the best option. Plans for this were already being made within the rail team and in spite of the communication difficulties with people not having ready access to the site and so many people involved, the plan to send the locomotive from the following train to recover the passenger carriages back to Upper Hutt had been established, confirmed and conveyed to the Police incident controller by 1934, one hour 17 minutes after the derailment. By that time the ganger had arrived at the site and made a formal safety assessment on whether the plan was feasible.

4.7.5. As with any emergency response, a review after the event will always reveal areas for improvement. The passengers were left on the train for some 3 hours while plans were made and put in motion. To those on board this would have seemed a long time, but not so for those involved in the response. The only significant delay to the plan was the delay in having the recovery locomotive ready in place to begin the recovery, and this was mainly due to the recovery plan not being conveyed to the train controller who was managing train movements in the Upper Hutt region.

4.7.6. Other events mentioned below that possibly caused delay or frustration among those involved in the emergency response are only mentioned in the interest of learning for similar operations in future and should be read in that context, rather than as criticisms.

4.7.7. The emergency response from the network controller was managed in accordance with the 'General emergency plan and procedures for tunnels and remote (non-urban) areas' as described in Rail Operating Rules and Procedures table 12.4 of Section 11, Rule 12. The process is also shown in Figure 1 of the National Rail System Standards NRSS 5: Occurrence management (Ontrack, 2004) in which the responsibility of the RIC is defined. If the incident fitted the description of a crisis, NRSS 10: Crisis management plan (Ontrack, 2007 b) would also become applicable.

### Management of the emergency

4.7.8. This incident was more complex than the usual small occurrences that occur, but senior rail managers decided that the emergency did not meet the conditions for activating the crisis management plan and could be managed within the normal network control facilities. This was a reasonable decision with the knowledge that there were no injuries. Within 15 minutes of the accident, the network control manager had appointed a RIC and the emergency services had taken over control of the situation under the Coordinated Incident Management System (CIMS) (Emergency Services, 1998).

4.7.9. Several managers from different areas stepped in to assist the network control manager. Two senior rail managers assisted with planning in the national train control centre and the Wellington train controller handled external calls and radio work. Out in the field the manager of network operations and the RIC were working with the Police incident controller directly. TranzMetro passenger operations responses were managed between the service operations manager in the field, the customer services supervisor at the Wellington station platform and a project manager in the national train control centre. A third person, the TranzMetro security manager, was informally liaising between TranzMetro and the Police incident controller outside the proper communications channel.

4.7.10. The Wellington train controller was fully occupied communicating with rail responders in the field and the Police. She was on the phone almost continuously for the first 45 minutes. Meanwhile the 'Central' train controller (central North Island area) shared the Wellington booth and managed both Central and Wellington train movements apart from those related to the line beyond Upper Hutt

4.7.11. The RIC was responsible for site safety from a rail perspective and would have had to work closely with the incident controller then take control of the site after the emergency services departed. As soon as the RIC was appointed he was expected to take leadership in the recovery operation in accordance with NRSS 5. He was driving to the site and using a cellphone, so his capability to grasp the situation, devise a recovery plan and coordinate all the many resources that he might have required was limited. The person best placed to manage the situation in the meantime would have been the network control manager with a deputised RIC on the site as soon as possible to act as his eyes and ears. According to NRSS 5, the most senior rail person on site should be appointed by the network control manager to carry the RIC's responsibility until the RIC arrives. This did not occur even though there were several possible candidates available, including the ganger and train manager from the derailed train. The RIC was unable to reach the site until about 2030, 2.25 hours after the accident.

### Sharing the emergency planning information

4.7.12. Information about the accident and recovery was exchanged between these key people during individual telephone conversations.

4.7.13. What appeared to be lacking was a direct link between the Police incident controller and the network control manager and a means of sharing the growing situational knowledge about the rescue among the network control team and rail responders and with the incident controller.

4.7.14. One train controller was managing the movements of trains to Upper Hutt and had the opportunity to get the recovery locomotive to Upper Hutt and prepared for the recovery operation sooner than it was, but he was not aware that the locomotive was required. The 2 train controllers first became aware of the proposed plan after it had been decided and was described to them over the radio at 1851, about 30 minutes after the accident. Until that time they were expecting passenger recovery with HRVs. The RIC was appointed by the network control manager within 15 minutes of the accident, but the train controllers had still not been informed who it was about an hour later at 1930.

4.7.15. Communications may have been further complicated by people in the field talking directly with the incident controller but not keeping the network control manager or RIC informed, and the limitations of cellphone batteries, coverage, engaged lines and one-to-one conversations.

4.7.16. Sharing information was discussed in a meeting with KiwiRail management 12 months after the accident. The view expressed was that some participants in the response team, such as the respective train controllers, did not immediately need to know the options being considered until those options were confirmed as being achievable in those circumstances. From that point, the respective train controller would be responsible for implementing the recovery plan and would be the central point of contact between all people in the field, the incident controller and the network control manager.

4.7.17. While there would be merit in keeping the train controller focussed on controlling the network, in practical terms as demonstrated during this incident, the train controller would have been drawn in and inextricably involved with an incident from the moment it occurred. There would also be merit in keeping the train controller informed as plans developed.

### Network control facilities

4.7.18. The train control facilities at the time of this accident hindered the ability of network control to separate emergency operations from normal activities in 3 aspects.

1. The 10 train controllers were exposed to and contributed to surrounding conversational noise. The controllers used microphones and speakers to communicate over the train control radios, rather than headsets and an audio matrix switching system commonly used in high-density operating facilities such as call centres and help desks where an operator needs to concentrate and switch off from surrounding noise distractions.

2. The train control radio system had limited channel capacity to shift an emergency to a dedicated channel away from normal traffic. The emergency radio communications for Maymorn shared the same channel as normal traffic in Hutt Valley, Johnsonville and north from Otaki.

3. The train control mimic had limited ability to be transferred to another booth or control centre. Some flexibility was provided within the train control system that enabled a less active control area to be merged with adjacent, more active areas as rail traffic tapered off each evening. An emergency operating area could not be isolated and controlled from a nominated booth.

4.7.19. The Wellington train controller task loads during the evening were high and therefore increased the potential for mistakes. While managing the emergency-related communications on the radio and phone, the usual Wellington rail commuter traffic was much more intense than usual. A radio repeater failure at Pukerua Bay and a track fault south of Paraparaumu created a significantly greater quantity of radio and telephone communications between commuter train drivers on the Paraparaumu Line and the Wellington desk train controller. The train controller from the adjacent booth (Central desk) merged his control area with the Wellington desk and shared the Wellington booth. From that point on the Central area train controller managed all train movements for the Wellington and Central areas and the Wellington train controller managed all communications related to the emergency by sharing the single set of facilities. This was a good example of teamwork, but it also created additional noise pollution within the one-person Wellington booth, which could have been eliminated if the emergency management had been transferred to a dedicated booth.

4.7.20. According to Rail Emergency Procedures: Rule S11/R30.8[9], train control should have had a prepared access route to the tunnel portals. This would have been particularly important for commuter lines where any train emergency could involve a significant risk to the public. Network control did not have a prepared plan to pass on to emergency services with the tunnel location and the nearest road access point.

4.7.21. Train control confused the Police about the location of the derailment for about 10 minutes, as several colloquial names were used to describe the same tunnel. At first it was called the Maoribank tunnel, then the Maymorn tunnel, then train control provided grid coordinates and described it as being south of Maymorn station. This was actually a reference to the general direction of the track when compared with Wellington and Masterton, but a compass bearing to the south of Maymorn station points towards Mount Climie while the tunnel portal was directly west of the station.

4.7.22. It may be useful to compare the New Zealand national train control centre with another network control centre such as the London Underground control centre. It had a dedicated emergency control centre room to which control would be transferred at the start of an emergency situation and managed for the duration. A large clock would start counting up the seconds from the incident at zero time, reminding all operators how long the passengers and crew had been trapped underground and focussing efforts on a rapid response. If the time approached 30 minutes, alternative rescue plans could be implemented. Emergency resources would be at hand within the room, such as plans, photos, maps, manuals, rules, contact details, computer network connections, phones, spare office desks, whiteboard and signals and interlocking diagrams for any part of the network. This standard of train control facility ensured that incident knowledge was focused at the control centre and immediately shared among the response team manning the facility.

4.7.23. New Zealand commuter railways will not carry anywhere near the 4 million passenger trips per day that the London Underground would, but the example might set a good framework for improving the network control facilities in New Zealand.

### Guidance rules

4.7.24. NRSS 5 did not set the most efficient template for managing the emergency. The main deficiencies in NRSS 5 highlighted by the Maymorn example were:

1. The role and responsibility of the network control manager was not defined or described as the manager of the occurrence and responsible for coordination and sharing of information among the network control team.
2. The RIC was expected to manage the occurrence from the moment of appointment, but it would not be practical or safe to take on that responsibility until the RIC was on site.
3. The interim responsibility for managing an incident site before the RIC arrived was not considered.

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[9] Rail Operating Rules and Procedures.

4. The ongoing support role that network control should be providing to the RIC was not defined.

5. The concept of the CIMS model to coordinate rail information through network control and share it with the rail emergency responders and with the incident controller was not foremost in the role descriptions. NRSS 5 described the network control manager's role as passively waiting to be contacted rather than pushing information towards the incident controller and handing responsibility for coordination to the RIC.

4.7.25. The crisis management guidelines described in NRSS 10 also lacked clarity about how it interacted with the occurrence management in NRSS 5 and the CIMS model to ensure that the crisis was managed and information coordinated and shared.

## 4.8. Crew, passenger and train safety

4.8.1. The train manager and his team followed standard operating procedures in looking after the people issues for the passengers and delivering reassurance, but communication with the passengers was not conducted with the public address system.

4.8.2. The rail operating code supplement CSR 3.2 describes the train emergency procedures that are to be followed after derailments and for train emergencies and delays. These procedures are general to allow the train manager flexibility depending upon the type of emergency, but include key points relevant to Maymorn. The supplement advises that the safest place for passengers may be to remain in the train, but also that evacuation may be necessary. It identifies the importance of keeping passengers informed of the reason for any problems with expected delay duration and making suitable interim announcements if those details are not known at the time. The use of the public address system is optional, but if it is not used the train manager must brief their assistants who then walk through the train and inform all the passengers. The train manager is also expected to contact train control and formulate a plan to manage the passenger situation.

4.8.3. In the Maymorn accident, the train manager was preoccupied during the first 15 minutes with checking his passengers, contacting the driver and preparing for possible evacuation. He had briefed his assistants, who then talked to the passengers but did not use the public address system. Most concerns of the passengers could have been satisfied in an instant with a few short announcements over the public address system.

4.8.4. The Emergency Plan for Tunnels[10] states that if passengers are to remain in the carriages longer than 15 minutes they should be evacuated through the tunnel. The relative safety of the disabled train, fresh air, available power for lighting, the difficulty in walking through the tunnel in office shoes and the heavy rain outside the tunnel were considerations that led to the decision to keep passengers in the carriages.

4.8.5. Once the locomotive had shut down, air pressure was lost for the operation of the central carriage doors and they failed in their current positions. The closed doors each required 3 people to force them open. This would have been a safety hazard in a tunnel if the carriage had been on fire.

[10] Rail Operating Rules and Procedures, Section 11 Emergency Procedures, Rule 12.

# 5. Findings

The following findings are not listed in any order of priority.

5.1 Train 1608 derailed as it exited Tunnel 1 because it ran into material from a landslide that had come down from the hillside above less than one hour before the train arrived.

5.2 The landslide was a natural event that happened when the topsoil overlying a base of greywacke rock became saturated towards the end of a 6-hour period of intense rain when the rate of water run-off was still high.

5.3 The landslide would not have been foreseeable from the normal track and structures inspection process, because that process was based on identifying observable deviations from code conditions within a short distance from the track, whereas the origins and potential indicators of this pending landslide were further up the slope and masked by vegetation.

5.4 Apart from known areas at risk from landslides that have been identified through previous landslide activity, there has been no systematic risk assessment made of the rail corridor to identify new areas that might be at risk due to slope instability, soil type and groundwater conditions.

5.5 The available responses to severe weather, of imposing speed restrictions or conducting special track inspections, would not necessarily have prevented this derailment because the landslide could have occurred at any time after a special track inspection had been conducted, and at a temporary speed restriction of 40 km/h Train 1608 would not have been able to stop in time once the slip became visible to the driver.

5.6 For the passengers on board the disabled train, waiting 3 hours to be rescued would have seemed a long time, but given the circumstances of the accident (the remote location, the weather conditions, and the general disruption the severe weather was having on the entire Wellington transport system), the rescue was conducted safely, within reasonable time and with adequate resources.

5.7 Most emergency responses to accidents can offer unique challenges from which valuable lessons can be learned. In this case, the NRSS 5, for dealing with occurrence management, and the NRSS 10, dealing with crisis management, could be better aligned with the coordinated incident management system used by emergency services to achieve better communication and improved response to rail emergencies.

5.8 The KiwiRail system for responding to severe weather alerts lacked a central focal point for assessing the risk to the network because it was an open-loop system, where those expected to take action were not required to report back or follow through; consequently, there was no assurance that everyone involved in the system was kept informed and updated of the weather risks as the situation changed.

# 6 Safety Actions

## 6.1. General

The Commission classifies safety actions by two types:

(a) safety actions taken by the regulator or an operator to address safety issues identified by the Commission that would otherwise have resulted in the Commission issuing a recommendation

(b) safety actions taken by the regulator or an operator to address other safety issues that would not normally have resulted in the Commission issuing a safety recommendation.

The following safety actions are not listed in any order of priority.

## 6.2. Slope risk assessment (Type a)

6.1.1 KiwiRail provided a draft document that demonstrated its proposed risk-ranking system for assessing the slip hazard risk along the rail corridor. It included a method to assess potential groundwater conditions, slope stability, soil type, surface cover, slope alterations and rail traffic and outlined a framework to come up with a risk rating. The proposed rollout of this system was over the next 2 financial years but this had not been confirmed at the time of writing.

## 6.3. Improvements to network control facilities (Type a)

6.1.2 Upgrade works were already in progress for the train control area and network control managers' planning facility. The Auckland train control desks were being migrated to the national train control centre in Wellington; a duplicate Wellington area control booth was to be created; the signalling SCADA software was being upgraded to enable a more flexible transfer of control areas to other desks; the radio communications dispatch software was being upgraded to enable flexibility to transfer communication links between desks; the incident support area and network control manager's office were being expanded; and additional tools were being provided for incident management. These works were underway and expected to be completed late 2010.

## 6.4. Safety improvements to the 'S' cars (Type a)

6.1.3 The pneumatic interior doors in the 'S' Cars were modified in late 2009 to move automatically to the full open position upon failure of the compressed air supply.

# 7 Recommendations

## 7.1. General

7.1.1 The Commission may issue, or give notice of recommendations to any person or organisation that it considers the most appropriate to address the identified safety issues, depending on whether these safety issues are applicable to a single operator only or to the wider transport sector. In this case, recommendations have been issued to New Zealand Transport Agency.

7.1.2 In the interests of transport safety it is important that these recommendations are implemented without delay to help prevent similar accidents or incidents occurring in the future.

## 7.2. Recommendations

The following recommendations are not listed in any order of priority.

7.2.1. On 23 September 2010 the following recommendations were made to the Chief Executive of the NZ Transport Agency:

7.2.2. The present severe weather warning system described by Rail Operating Rules and Procedures Section 1, Rule 6(b) does not require feedback from area managers to the network control manager on receipt of severe weather alerts, which creates an open loop information flow and prevents the network control manager from maintaining an overview of severe weather actions being taken across the entire network. Network control managers spoken to did not see maintaining an overview of actions during severe weather as their responsibility. In this case the network control manager did not monitor the severe weather alerts as they were being updated by MetService, with the result that neither the area manager nor his staff nor the locomotive engineers of trains in that area were aware of the current severe weather alert. Current contact details for recipients of severe weather warnings from network control were also allowed to lapse.

The Commission recommends that the New Zealand Transport Agency oversee a review of KiwiRail's severe weather warning system and underlying processes for effective communication of warnings to ensure that it results in an appropriate level of awareness, actions and responses to severe weather events across the entire rail system. (039/10)

7.2.3. KiwiRail provided a draft document that demonstrated its proposed risk-ranking system for assessing the slip hazard risk along the rail corridor. It included a method for assessing potential groundwater conditions, slope stability, soil type, surface cover, slope alterations and rail traffic and outlined a framework to come up with a risk rating. The proposed rollout of this system was over the next 2 financial years but this had not been confirmed at the time of writing. Analysis of available data such as rainfall, river flows and slip activity can be a useful activity to complement the proposed risk-ranking system for determining slip hazard risk, but this data is not currently used by the rail industry. Until the risk-ranking system has been completed, the risk to the rail network from unpredicted slips is likely to be higher than is reasonably acceptable.

The Commission recommends that the NZ Transport Agency work with the rail industry to implement a risk-management system for the slip hazards along the rail corridor. (040/10)

7.2.4. The existing track and structures inspection codes were prescriptive and did not embrace the risk assessment principles documented in the more recent Structures Inspection Manual W200 or required for rail systems under National Rail System Standard (NRSS) 4.

The Commission recommends that the NZ Transport Agency oversee KiwiRail Network's internal review of its track and structures inspection regimes defined in the codes T003 and W004 to ensure that the outcome is a combined track inspection process that covers all aspects of the track risk assessment using a methodology guided by that defined in NRSS 4: Risk Management. (041/10)

7.2.5. NRSS 5 (Occurrence Management) refers to the Coordinated Incident Management System (CIMS) as if it only applies to a specific incident site and does not take into account that, for a larger or more complex emergency response, the incident command centre could be somewhere else. NRSS 10 (Crisis Management), which is designed to work in parallel with NRSS 5, does not refer to the CIMS but refers to the civil defence model as being separate from the CIMS model, when instead it forms part of it.

The Commission recommends that the NZ Transport Agency oversee a review of NRSS 5 and NRSS 10 to ensure they are consistent and integrate efficiently with the CIMS used by emergency response agencies. (042/10)

7.2.6. On 8 October 2010, the Rail Safety Manager of the NZ Transport Agency replied in part:

> We intend to work closely with KiwiRail to oversee the internal reviews of documentation and procedures and implementation of a risk management system for slip hazards on the rail corridor with and aim to implementing and closing these recommendations as soon as practicable.
>
> Discussions on them will commence on publication of the report and will be ongoing. Any outstanding Transport Accident Investigations Commission (TAIC) recommendations also form an integral part of our annual safety assessments of the rail industry.
>
> When these reviews and implementation are concluded and the appropriate evidence has been gathered, we will be liaising with TAIC with a view to closing these safety recommendations.

# 8 Works cited


CDEM: Wellington. (2010). *Wellington Region Civil Defence Emergency Management Group Plan.* Retrieved May 25, 2010, from Greater Wellington Regional Council: http://www.gw.govt.nz/assets/Emergencies--Hazards/Emergency-Planning/CDEMPlanMay2005WEB2051006114636.pdf

Emergency Services. (1998). New Zealand Coordinated Incident Management System [CIMS]. *Teamwork in Emergency Management* . Wellington, New Zealand: New Zealand Fire Service Commission.

GWRC a. (n.d.). *Environmental Monitoring*. Retrieved August 14, 2009, from Greater Wellington Regional Council: www.gw.govt.nz

GWRC b. (n.d.). *Monthly hydrological summaries.* Retrieved July 6, 2010, from Greater Wellington Regional Council: www.gw.govt.nz/monthly-hydrological-summaries

GWRC c. (n.d.). *Emergencies & Hazards, Landslides.* Retrieved July 23, 2010, from Greater Wellington Regional Council: http://www.gw.govt.nz/assets/Emergencies--Hazards/landslide_hazard.pdf

Hancox, G. T., & Nelis, S. (2009). *Landslides caused by the June-August 2008 rainfall in Auckland and Wellington, NZ.* Lower Hutt: GNS Science report 2009/04.

MetService. (2009, July 22). Severe Weather Warning. *8:58 pm* .

NZ Government. (2005). Railways Act 2005. New Zealand.

NZ MetService. (n.d.). *Severe weather warnings*. Retrieved from metservice: www.metservice.com

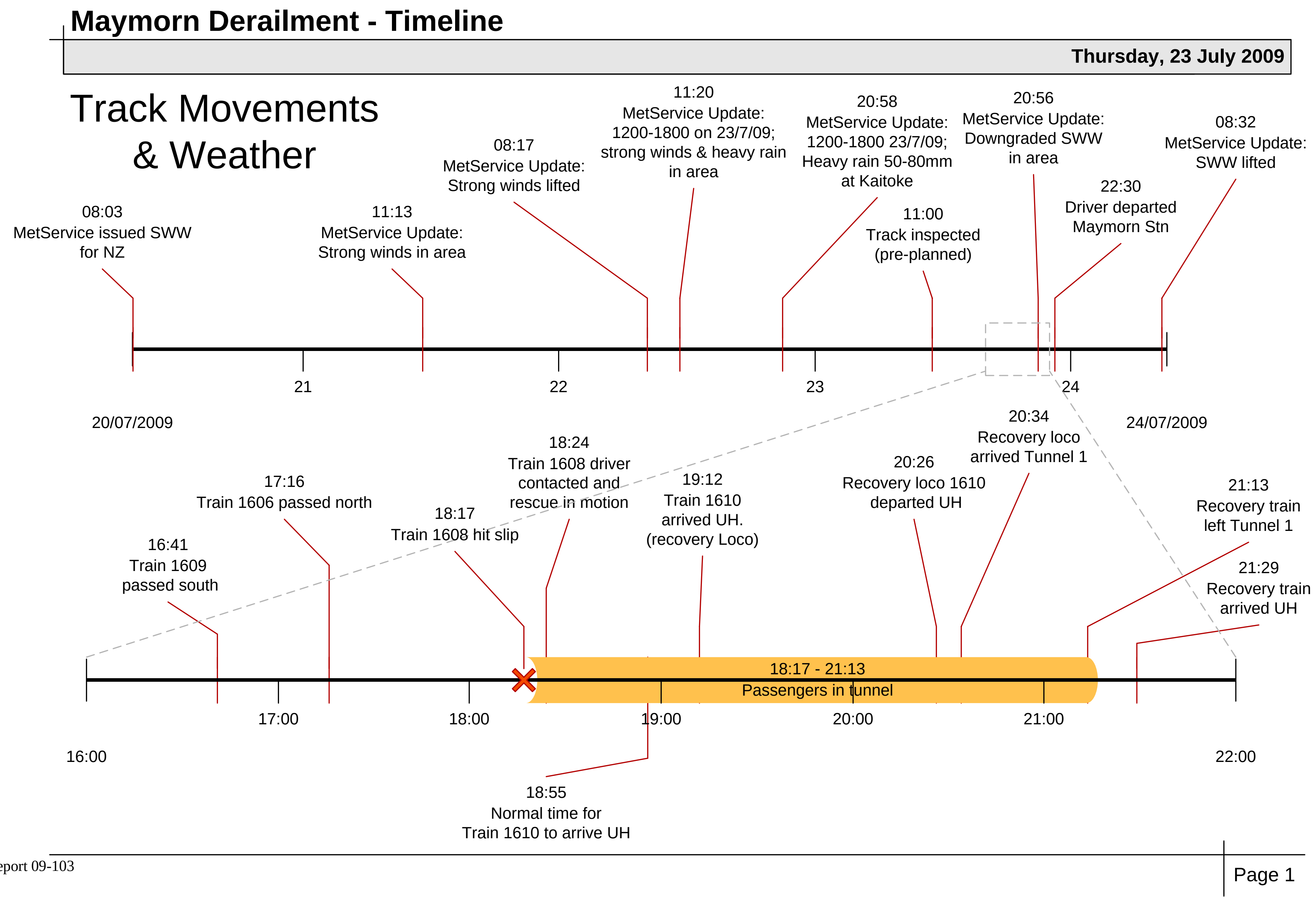
Ontrack. (2007 b, June 11). National Rail System Standard (NRSS) / 10. *Crisis Management (2)* .

Ontrack. (2007 a, June 11). National Rail System Standard (NRSS) / 4. *Risk Management (2)* .

Ontrack. (2004, July 9). National Rail System Standard (NRSS) /5 . *Occurrence Management (1)* .

Suzuki, O., Yamamura, K., & Shimamura, M. (2006). *A study on the regulation of train operation with effective rainfall index.* Unknown: Unnown.

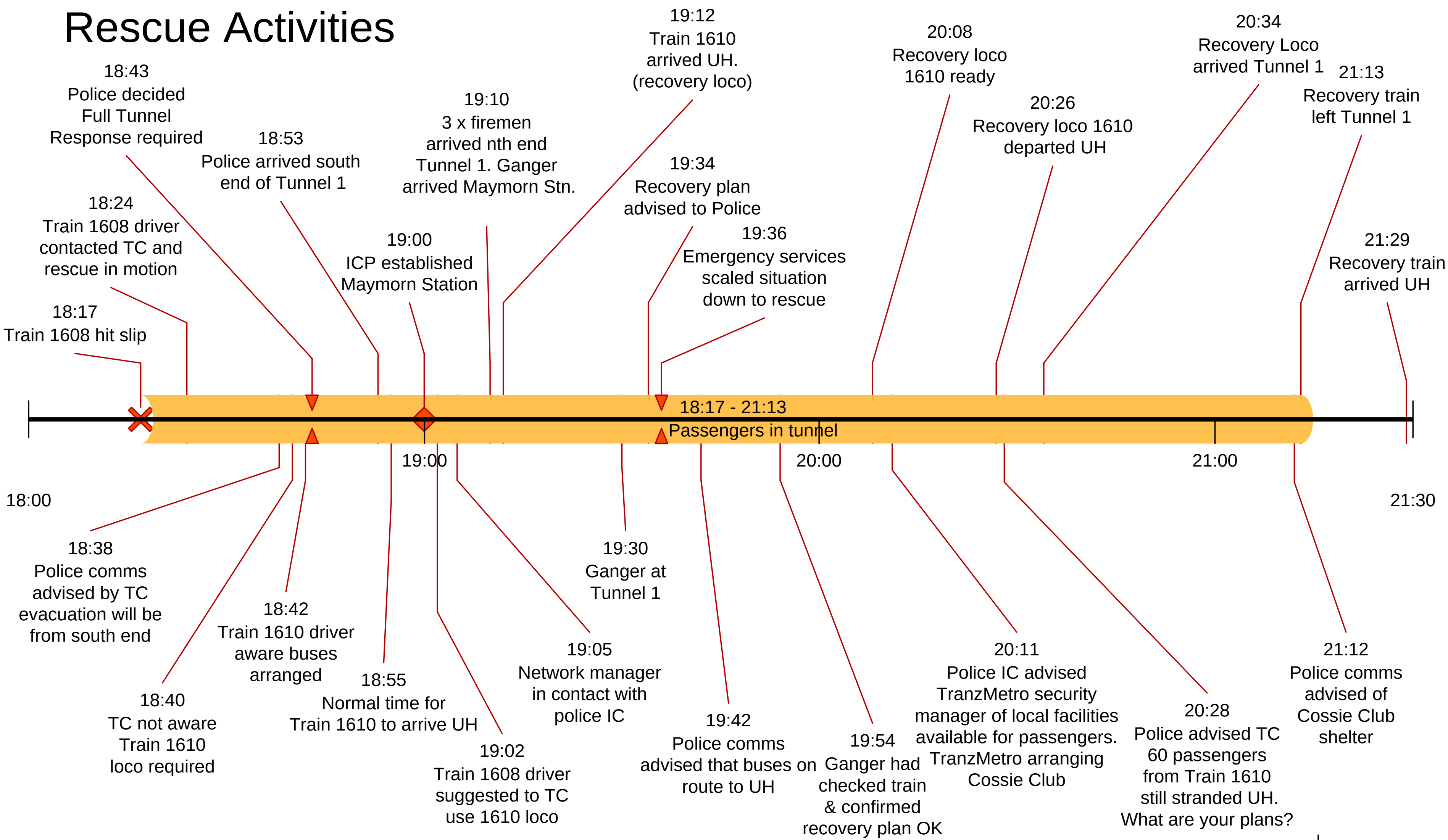
Transport Accident Investigation Commission. (2006). *Report 06-108: Passenger train 9328 derailed after running into lanslide debris at 2.474km Johnsonville line.* Wellington: TAIC.


Maymorn Derailment - Timeline
Thursday, 23 July 2009
Track Movements & Weather
08:03 MetService issued SWW for NZ
11:13 MetService Update: Strong winds in area
08:17 MetService Update: Strong winds lifted
11:20 MetService Update: 1200-1800 on 23/7/09; strong winds & heavy rain in area
20:58 MetService Update: 1200-1800 23/7/09; Heavy rain 50-80mm at Kaitoke
11:00 Track inspected (pre-planned)
20:56 MetService Update: Downgraded SWW in area
22:30 Driver departed Maymorn Stn
08:32 MetService Update: SWW lifted
21
22
23
24
20/07/2009
24/07/2009
16:41 Train 1609 passed south
17:16 Train 1606 passed north
18:17 Train 1608 hit slip
18:24 Train 1608 driver contacted and rescue in motion
19:12 Train 1610 arrived UH. (recovery Loco)
20:26 Recovery loco 1610 departed UH
20:34 Recovery loco arrived Tunnel 1
21:13 Recovery train left Tunnel 1
21:29 Recovery train arrived UH
18:17 - 21:13 Passengers in tunnel
16:00
17:00
18:00
19:00
20:00
21:00
22:00
18:55 Normal time for Train 1610 to arrive UH
Page 1

# Maymorn Derailment - Timeline

**Thursday, 23 July 2009**

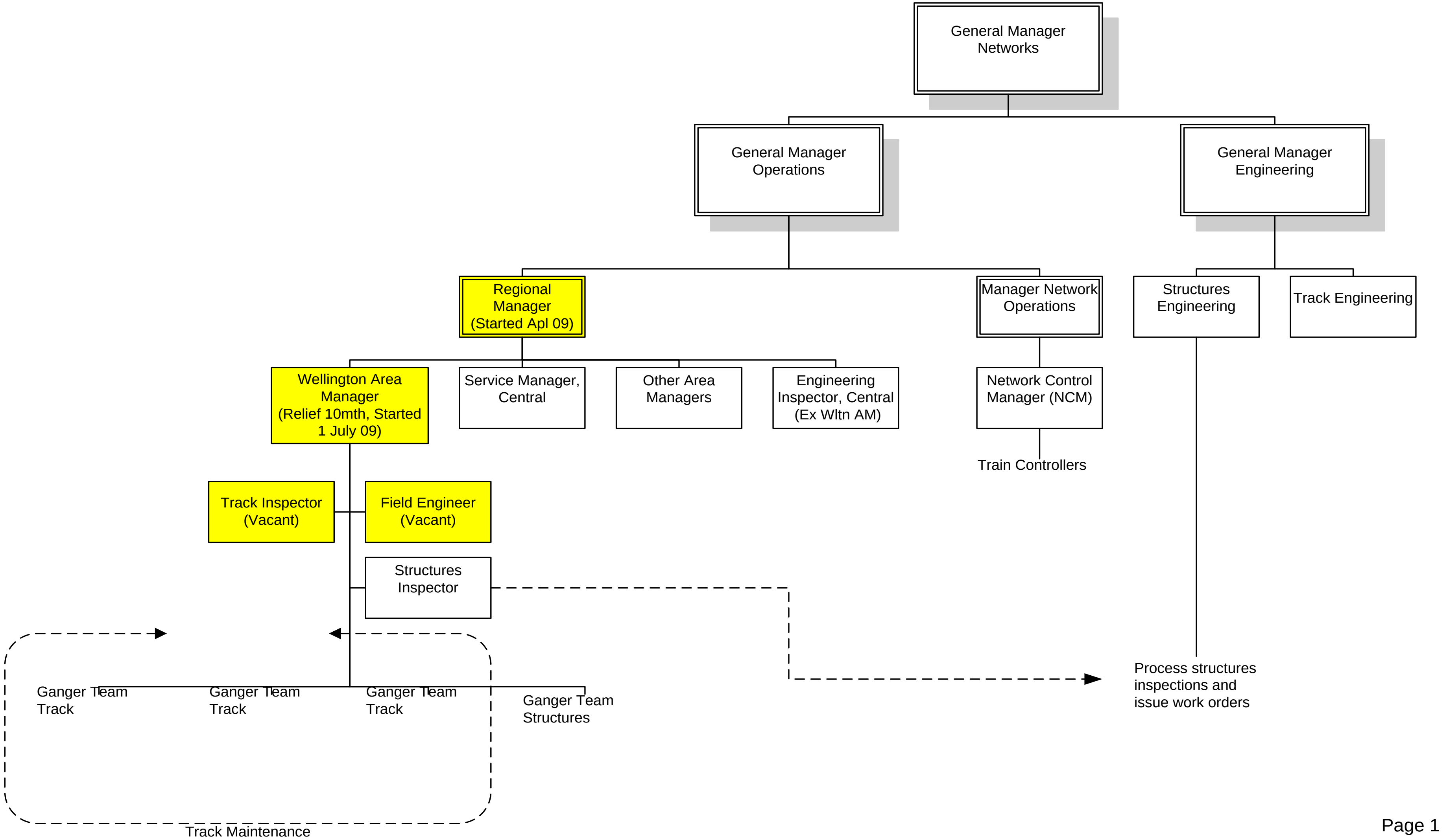
## Rescue Activities



## Appendix 2 – Track maintenance organisation chart

# Ontrack Track Maintenance Organisation

As at July 2009



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