Report 06-108, passenger Train 9328, derailed after running into landslide debris, 2.474 km Johnsonville Line, between Wellington and Wadestown, 26 August 2006

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Report 06-108

passenger Train 9328

derailed after running into landslide debris

2.474 km Johnsonville Line

between Wellington and Wadestown

26 August 2006

Abstract

On Saturday 26 August 2006, at 0907, the lead bogie on passenger Train 9328 derailed when it ran into landslide debris covering the track at 2.474 kilometres (km) on the Johnsonville Line between Wellington and Wadestown. Heavy rain had been falling in the area prior to the derailment.

There were no injuries and only minor damage to the train and track.

Safety issues identified included:

- regolith nature of the steep terrain above the Johnsonville Line
- train control role and responsibilities
- routine and special track inspections on the Johnsonville Line
- risk management of the Johnsonville Line during periods of heavy rainfall.

Four safety recommendations have been made to the Director of Land Transport New Zealand to deal with these issues.

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Abbreviations

GNS	Geological and Nuclear Sciences Limited
km	kilometre(s)
km/h	kilometre(s) per hour
Land Transport NZ	Land Transport New Zealand
m	metre(s)
mm	millimetre(s)
NIMT	North Island Main Trunk
Toll Rail	Toll NZ Consolidated Limited
UTC	coordinated universal time

Data Summary

Train number:	passenger Train 9328
Train type:	electric multiple unit
Date and time:	Saturday 26 August 2006, at 0907[1]
Location:	2.474 km Johnsonville Line, between Wellington and Wadestown
Persons on board:	crew: 3 passengers: about 8
Injuries:	nil
Damage:	minor to track and rolling stock
Operator:	Toll NZ Consolidated Limited (Toll Rail)
Investigator-in-charge:	Vernon Hoey

[1] Times in this report are New Zealand Standard Time (UTC + 12 hours) and are expressed in the 24-hour mode.

1 Factual Information

1.1 Narrative

1.1.1 On Saturday 26 August 2006, Train 9325 was a scheduled Tranz Metro[2] electric multiple unit passenger service travelling from Johnsonville to Wellington. The train consisted of trailer car D2489 and motor car DM510, and departed Johnsonville at 0830.

1.1.2 An increasing intensity of rain began falling in the area of the Johnsonville Line from 0200 on 26 August 2006. Beyond the area of the Johnsonville Line, line blockages attributable to widespread heavy rain had occurred in the Waikanae and Featherston areas that morning.

1.1.3 At 0838, the locomotive engineer of Train 9325 reported to train control that there was a blocked drain about 50 metres (m) north of Tunnel 7, and that "a ton of water was running off the platform and over the rails at the south end of Box Hill station" (see Figure 1). The train controller recorded the details on the train control diagram and informed the network control manager. The network control manager was heard passing on the details to the help desk,[3] requesting that a ganger attend the scene.

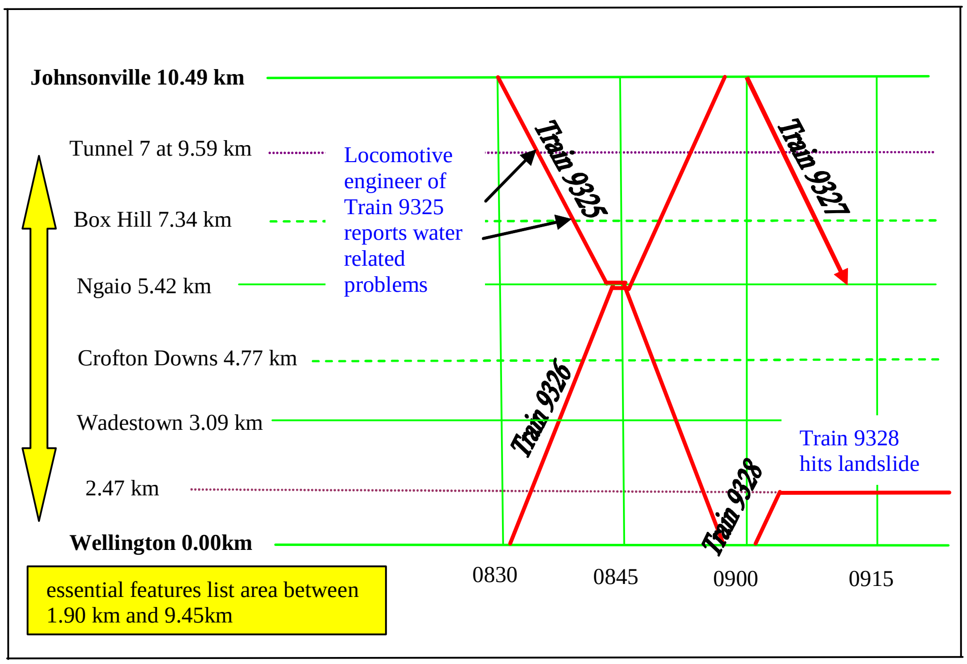

Figure 1
Details of train movements as recorded on train control diagram (not to scale)

1.1.4 Train 9326 was the other train running on the Johnsonville Line at the same time. It crossed[4] Train 9325 at Ngaio and continued to Johnsonville. There was no comment from the locomotive engineer of Train 9326 to the train controller on the conditions reported by Train 9325. The train controller made one radio call to the locomotive engineer of Train 9326, but there was no response.

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[2] Tranz Metro was the group within Toll Rail with responsibility for the operation of suburban train services in Wellington.
[3] The help desk, located adjacent to the national train control centre, coordinated the calling out of field personnel to attend infrastructure-related incidents and faults.
[4] The passing of 2 trains travelling in opposite directions at a properly equipped location on a single line railway.

1.1.5 Train 9325 arrived in Wellington at 0851, where it formed Train 9328, the scheduled 0902 service to Johnsonville. A crew change took place and the incoming locomotive engineer informed the outgoing locomotive engineer that flooding had worsened at one of the stops and to watch out for it. The outgoing locomotive engineer, who had driven a return service on the Johnsonville Line some hours earlier, commented that "during the first trip [between 0600 and 0700] it was raining like crazy and flooding was starting in several spots up the line".

1.1.6 Train 9328 departed Wellington on time with 3 crew members: the locomotive engineer, a train manager and a trainee passenger operator. There were 8 passengers on board.

1.1.7 At about 0907 and as Train 9328 exited Tunnel 1 at a speed of about 35 kilometres per hour (km/h), the locomotive engineer was looking out for debris on the right-hand side of the track and a signal aspect beyond. The locomotive engineer then saw the debris covering the opposite side of the track and applied the emergency brake. The train travelled about 23 m before stopping. The lead bogie derailed when it struck the debris (see Figure 2).

Figure 2
Derailed train (left) and origin of landslide debris from up hill face (right)

1.1.8 The locomotive engineer radioed train control and advised details of the incident. The passengers and crew were evacuated to Wellington in Ontrack's hi-rail vehicles.

1.1.9 The line remained closed until the Sunday evening while the derailed train and debris were cleared and a helicopter operation with a monsoon bucket sluiced other loose debris from the steep faces above the track in the vicinity of the derailment.

1.2 Train control

1.2.1 Ontrack's operating rules and procedures said that train control was the centre from where the movement of all trains in a specified area was brought under the direction of a train controller. All staff connected with the running of trains were required to cooperate with train control in obtaining the optimum results in the matter of train operation and must be ready to respond to any directions issued by train control.

1.2.2 Train controllers were required to have a good knowledge of the various operating instructions, including operating rules and instructions, operating procedures, controlled network instructions and operating codes. Train controllers were to make suitable arrangements in connection with various types of failure and other emergency situations that could arise.

1.2.3 When brought to the attention of train control, track irregularities of any nature were to be promptly investigated. Infrastructure staff were to be advised and traffic be held pending a response from the infrastructure person regarding the movement of trains through the affected area. Where doubt existed concerning the safety of the track, arrangements were to be made to have it inspected prior to any train movements.

1.3 The Johnsonville Line

Historical features

1.3.1 The section of line between Wellington and Johnsonville was originally part of the North Island Main Trunk (NIMT) and was opened in 1885. In 1937, the NIMT was deviated to a new alignment and the old NIMT track north of Johnsonville was removed. In 1938, electrified suburban services began running between Wellington and Johnsonville.

1.3.2 The Johnsonville Line was 10.42 km long and was steeply graded throughout (see Figure 3). There were 7 tunnels, 4 rail bridges and many curves on the line. The track between Wellington and Crofton Downs followed steep hillside terrain. Between Crofton Downs and Johnsonville, the track followed less rugged terrain and was bounded on both sides by residential housing.

1.3.3 The gradient in the vicinity of the landslide was a rising 1 in 40 compensated[5] and the track was on a 160 m left-hand tight radius curve in a narrow cutting. Because of the terrain, parallel road access was not possible between Wellington and Crofton Downs.

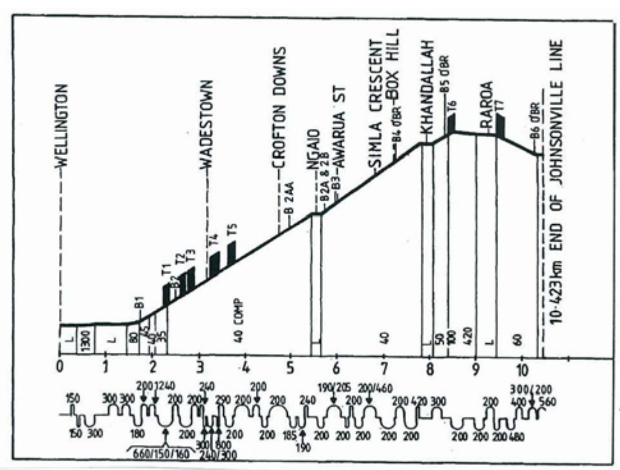

Figure 3
Gradient profile and track alignment detail of the Johnsonville Line (not to scale)

[5] Curved track on a gradient for which the gradient has been eased to compensate for the increased resistance that would be caused by the curves.

Operational features

1.3.4 Train movements on the Johnsonville Line were controlled from the national train control centre in Wellington. Centralised traffic control was the signalling system in use. The points and signals on the line were remotely operated by a train controller. A proceed indication on the departure signals located at Wellington, Wadestown, Ngaio, Khandallah and Johnsonville was the authority for trains to enter the sections of single line track between those stations.

1.3.5 The Johnsonville Line carried a total of 410 scheduled services between Monday and Friday and 66 scheduled services on Saturday and Sunday. These services mostly ran between 0400 and midnight each day.

1.3.6 Planned infrastructure maintenance and repairs that required a total possession of the line was normally carried out on weekends after Tranz Metro had arranged alternative road transport.

1.3.7 The maximum operating speed in the area of the landslide was 50 km/h.

1.4 Geotechnical assessment of NIMT

1.4.1 This information has been included as an example of the work done on another area that, like the Johnsonville Line, was prone to the effects of landslides.

1.4.2 In October 2005, a geotechnical assessment of the Waimiha to Poro-o-tarao section (between Taumarunui and Te Kuiti) in the central NIMT was prepared by a civil engineering consultancy firm for Ontrack. The objective of the report was to identify and describe specific geotechnical risk sites. The report included a collection of existing geological and geotechnical studies, current Ontrack database information, and results from new site investigations.

1.4.3 A number of geotechnical problem sites had been identified in this section of track, which had a history of slope and embankment instability. Most of the problems were attributable to deferred maintenance, historic instability of slopes and embankments, and storm damage.

1.4.4 The report identified the geotechnical problem sites, provided recommendations and priorities for remedial action, and provided recommendations where more detailed geotechnical information was required. The report concluded that the greatest issue for that section of track was deferred maintenance of drainage systems such as surface channels, subsurface drains, flumes, sumps and culverts. In places where embankments cross natural gullies, there was inadequate drainage that had allowed groundwater to infiltrate and saturate the embankments.

1.4.5 Earlier investigations prior to, during and after the building of the new Poro-o-tarao tunnel in the same area revealed that slope stability was sensitive to small changes in the groundwater, which was directly related to seasonal fluctuations in precipitation. Monitoring of the groundwater and ground deformation revealed that most sliding occurred at the colluvium/mudstone interface.

1.5 Landslides

1.5.1 The landslide debris that derailed Train 9328 had originated about 15 m above the track. About 5 to 10 m^3 of weathered rocky material had subsided onto the track. The landslide was known in geological terms as a regolith[6] landslide and was New Zealand's most widespread and noticeable type of landslide.

1.5.2 Regolith landslides occurred mainly after heavy rainfall had saturated the loose surface material causing it to slide away from the underlying bedrock. The water that entered the surface material particles increased its weight, and, when the ground was fully saturated, the water pressure began to force the particles apart, making the surface materials more likely to slide.

[6] Regolith is the covering of solid and loose rock fragments overlying the earth's bedrock.

1.5.3 MetService advised that a significant contributing factor to landslides was the occurrence of episodes of moderate to heavy rainfall during the preceding few months. In these conditions, a single episode of moderate to heavy rainfall was a trigger (and one of several possible) that set off the loose material on the slope, which had been progressively destabilised over several weeks.

1.5.4 Besides already having a "severe weather warning" system in place with national coverage and wide distribution, MetService advised that it was in the process of developing a warning system for severe local storms.

1.5.5 Research into regolith landslides in New Zealand dated back to 1921. While landslides of this nature were generally not life-threatening, they exacted a financial burden on road, rail and farm infrastructure, and pasture production. It was more usual for large numbers of regolith landslides to occur simultaneously over wide areas during heavy rainfalls, but they could occur individually, as in this instance.

1.5.6 MetService was aware that Geological and Nuclear Sciences Limited (GNS) has proposed a study to assess the history of regolith landslides in relation to rainfall in the area of the Johnsonville Line. MetService had considerable experience and expertise in installing and maintaining telemetered rain gauges to monitor rainfall in real time and it would be happy to work with GNS to see how it could assist in protecting the Johnsonville Line and other lines.

1.5.7 During the Commission's site investigation, a developing landslide was seen above the eastern portal of Tunnel 2, located about 100 m beyond the derailment site. Further debris, which was sluiced from the area by helicopter, fell and covered the track at the portal (see Figure 4).

Figure 4
Developing landslide above Tunnel 2 (left) and debris blocking the track after sluicing (right)

Line blockage data

1.5.8 A review of Ontrack's SAP[7] database showed the following line blockages on the Johnsonville Line for the previous 3 years:

Date	Locations	Description
2 June 2004	at 2.74 km and 3.63 km	clear slips
18 August 2004	not recorded	flooding and line blockages
4 October 2004	between 2.48 km and 3.84 km	remove slip material
9 April 2005	5.75 km	clear slip-blocking drain
17 June 2006	north end Tunnel 3	slip
12 July 2006	2.45 km	formation slip clearing
17 July 2006	between Tunnels 1 and 2	slip

1.6 Special precautions for safe operation

Procedural development and application

1.6.1 A bulletin was a numbered instruction that could be regularly issued by the officer controlling train running and that contained information which was supplementary to the instructions contained in Ontrack's operating documentation.

1.6.2 Ontrack's bulletin no. 534 dated 18 July 2006 supplemented the provisions of Rule 6(b), Reporting of Severe and Adverse Weather Conditions. The bulletin had been issued as a result of a safety recommendation arising from the Commission's investigation into the derailment of a milk train at Oringi during a heavy rainfall event on 16 February 2004 (Rail Occurrence Report 04-103). The safety recommendation focused on the reporting of adverse weather conditions and the actions to be taken following notification. The bulletin stated in part:

> **(b) Reporting Bad weather conditions (additional instruction)**
> Two Weather Warning "state levels" have been established. These are:
> **Level 1 Severe** and **Level 2 Adverse**
>
> **Level 1 Severe –** weather conditions, which may result in damage to the line due to storm, flooding or other cause that could result in a significant safety risk for Locomotive Engineers, maintenance staff and the public.
> Examples are:
> • Above average rainfall, or high winds
> • Rivers flowing from catchment areas with heavy rainfall
> • Consistent periods of poor weather
>
> **Train Control/Network Control Manager must be made aware of these conditions from:**
> • Maintenance staff
> • Locomotive Engineers
> • Toll Rail staff
> • Members of the public
> • Weather information services
> NOTE: The Meteorological Service issues a Severe Weather Warning advice. The Network Control Manager must arrange for the issue of a bulletin advising the area covered and notify the respective Area Coordinator.
> • Councils etc
> NOTE: Details of the Canterbury Regional Council notification arrangements are held in Train Control.

[7] SAP was an Ontrack accounting system for general ledger and projects systems, among other purposes.

Action required on advice of a "Level 1 Severe Weather Warning"
Who/Action Required
Train Control – Draw in the affected area on the Train Control Diagram (Blue highlighter)
Advise the Network Control Manager
Network Control Manager – Notify the Area Coordinator, (local ganger if unable to contact immediately)
Area Coordinator – After assessing the situation decide if it is necessary to declare a Level 1 condition or the situation requires a further escalation to a Level 2 condition.
The Level 2 situation would be decided after:-
• reports from the field indicate an immediate escalation to Level 2 Adverse Weather is warranted, or
• line is blocked due to an accident.

Upon escalation to Level 2 (Adverse Weather Condition)

<u>Who/Action Required</u>
Area Coordinator – Advise Train Control the condition of the line.
• Determine whether safe to run trains through the affected area to a maximum of 40 km/h or slower speed, advise Train Control/Network Control Manager.
• Determine if additional inspections are to take place before subsequent trains.
• Provide continuous updates to Train Control/Network Control Manager of the situation.
Train Control – Stop all trains in the affected area
Arrange for a special inspection of the affected area, if required.
Network Control Manager – If necessary arrange for the bulletin advising of the weather conditions to be updated to include any special arrangements/restrictions.

Cancellation
The Level 1 or Level 2 Weather Condition will be lifted when the unusual conditions have abated.

<u>Who/Action Required</u>
Area Coordinator – Inspect the track (if warranted) and advise when safe for normal speed running.

Train Control – Endorse the clearance certificate on the Train Control diagram. Update the Network Control Manager on the situation.

Network Control Manager – Arrange for any special bulletins concerning the weather conditions to be cancelled.

1.6.3 Ontrack advised that training for the management of severe/adverse weather conditions was given exclusively to infrastructure staff during an "intermediate track skill" module. The module covered theoretical aspects of inspections, what to observe, codes and standards, operating rules and bulletins. Identification of potential hazard sites was included in field training.

1.6.4 Training of train controllers and network control managers in the same subject extended to the issue of the bulletin and on-the-job training.

1.6.5 A heavy rain warning for Wellington, issued by MetService at 0823 on the day of the incident, advised that between 0800 and 1200 a further 40 – 50 millimetres (mm) of rain was expected about the hills of Wellington. This warning was not received at Ontrack until 0923.

1.6.6 Ontrack advised that closing a line or portion of a line in the event of inclement weather was a joint decision between the network control manager and the area co-ordinator. Ontrack's Rule one stated that the first and most important duty of every employee was to provide for the safety of the public and other employees. Additionally Ontrack's Rule 904 required a train controller to protect an obstruction during an emergency by applying blocking when radio communication was available.

1.6.7 Ontrack's general operating instructions stated in part that motive power units with electric traction motors could run through flooded areas at a maximum speed of 10 km/h provided the track was safe and the tops of the rails were clear of water.

Track inspections

1.6.8 Ontrack's Infrastructure Group Code T003, Inspections stated in part:

> **P22 SPECIAL INSPECTIONS**
>
> In time of possible danger special inspections shall be carried out. The Infrastructure Maintenance Service Provider must arrange for such inspections as considered necessary to safeguard the passage of trains when:
>
> - There is a likelihood of damage or obstruction of the line due to storm, flooding, earthquake, fire or wind.
>
> Special inspections by any qualified staff member do not relieve the Track Inspector from their inspection.
>
> **P24 THE REQUIREMENTS OF A TRACK INSPECTION**
>
> (a) Observe the track, including on bridges, looking for any significant change to top or line, and checking they are satisfactory
> (c) Check drains and waterways are clear
> (i) Check areas which have been specially listed in the essential features list
> (j) Check for any other matters which could affect the safe running of trains, including clearance encroachments.

1.6.9 Ontrack's position description for a track inspector stated in part:

> Responsibilities Inspect and report within the prescribed standards, the condition of sleepers, rail condition, gauge, cant, alignment, rail creep, anchors, fastenings, joints, ballast, turn-outs, switching devices, bridges and culverts, cuttings and embankments, water drainage, road crossings, signs, restriction and warning boards, vegetation growth etc with in the relevant discipline of track and structures.

Essential features list

1.6.10 Ontrack's Infrastructure Group Code T003, Track required that an essential features list was to be completed by the infrastructure maintenance service provider for each track length, and a copy held by the ganger and track inspector. The list should record any features on the length which were to be specially checked during every inspection of the length or features that should be specifically monitored on a special inspection, e.g. slips or flood level at bridges during heavy rainfall.

1.6.11 The original copy of the list was to be held by the line manager and was to be reviewed and reissued as required. The list must be signed by the line manager and show the date of issue. Essential features lists were to be available to any staff that may be required to carry out a track inspection or special inspection.

1.6.12 The essential features list for the Johnsonville Line included:

ESSENTIAL FEATURES LIST							**Date** 01/09/2006
Line	**Track**	**From**	**To**	**Feature**	**Date**	**Reason/Comment**	**Frequency**
GANG: MT01							
Jvil	MainL	1.900	9.450	Formation	04/11/2002	**SLIPS, ROCK FALLS & DROP OUTS** Check specially around tunnels and After Earthquakes	During Heavy Rain
Jvil	MainL	7.400	7.400	Drainage	04/11/2002	**CULVERT PRONE TO BLOCKING**	During Floods
Jvil	MainL	8.200	8.400	Drainage	04/11/2002	**FLOODS DURING HEAVY RAIN**	During Heavy Rain

1.7 Monitoring systems for natural events

1.7.1 Across the network, Ontrack operated or had access to several types of remotely monitored, natural activity monitoring systems and associated procedures to protect the rail corridor. These systems/procedures included the following.

Wind

1.7.2 Two anemometers were installed between Shannon and Tokomaru on the NIMT. Wind speed was monitored and relayed automatically to train control. Procedures were in place to alert local infrastructure staff, who verified the wind speed after which trains could be stopped.

Seismic activity

1.7.3 In the event of an earthquake, there were guidelines to be followed. The guidelines were based on the Modified Mercalli Earthquake Intensity Scale, which provided a measure of the seismic activity intensity by the visible damage and perception that infrastructure staff felt and observed. The guidelines then provided some basis for how staff were expected to respond and initiate inspections of structures on the rail corridor following the earthquake.

Hot weather

1.7.4 Heat sensors were installed across the network to measure rail temperature during the summer months. When a threshold temperature (generally about 40° Celsius) was reached, train control was alerted automatically and procedures were put in place to slow trains through sections of track with a likelihood of misalignments and to conduct special inspections by local infrastructure staff.

Falling debris

1.7.5 An earthslide/rockfall detection system was installed between Pukerua Bay and Paekakariki on the NIMT. In the event of a debris landslide, train control was automatically alerted and procedures applied to stop trains.

River levels

1.7.6 A lahar warning system was installed on the Whangaehu River upstream of the Tangiwai rail bridge. When a lahar surge occurred, the warning system alerted train control and trains were stopped until the lahar had subsided and the bridge was inspected. River levels in the upper reaches of the Waimakariri, Rakaia and Selwyn Rivers were monitored by the Canterbury Regional Council, who notified train control when threshold levels were reached. Local infrastructure staff were then called out to monitor the threat posed by the high volumes of water on downstream rail bridges and embankments.

Rainfall

1.7.7 Ontrack had no system that automatically monitored rainfall levels anywhere on the network.

1.8 Measured rainfall data in the area of the Johnsonville Line

1.8.1 The Commission approached 3 agencies that operated automated rainfall gauges at various sites near the Johnsonville Line as follows:

- the Greater Wellington Regional Council at Seton Nossiter Park, Glenside
- the Wellington City Council at Khandallah
- MetService at Kelburn.

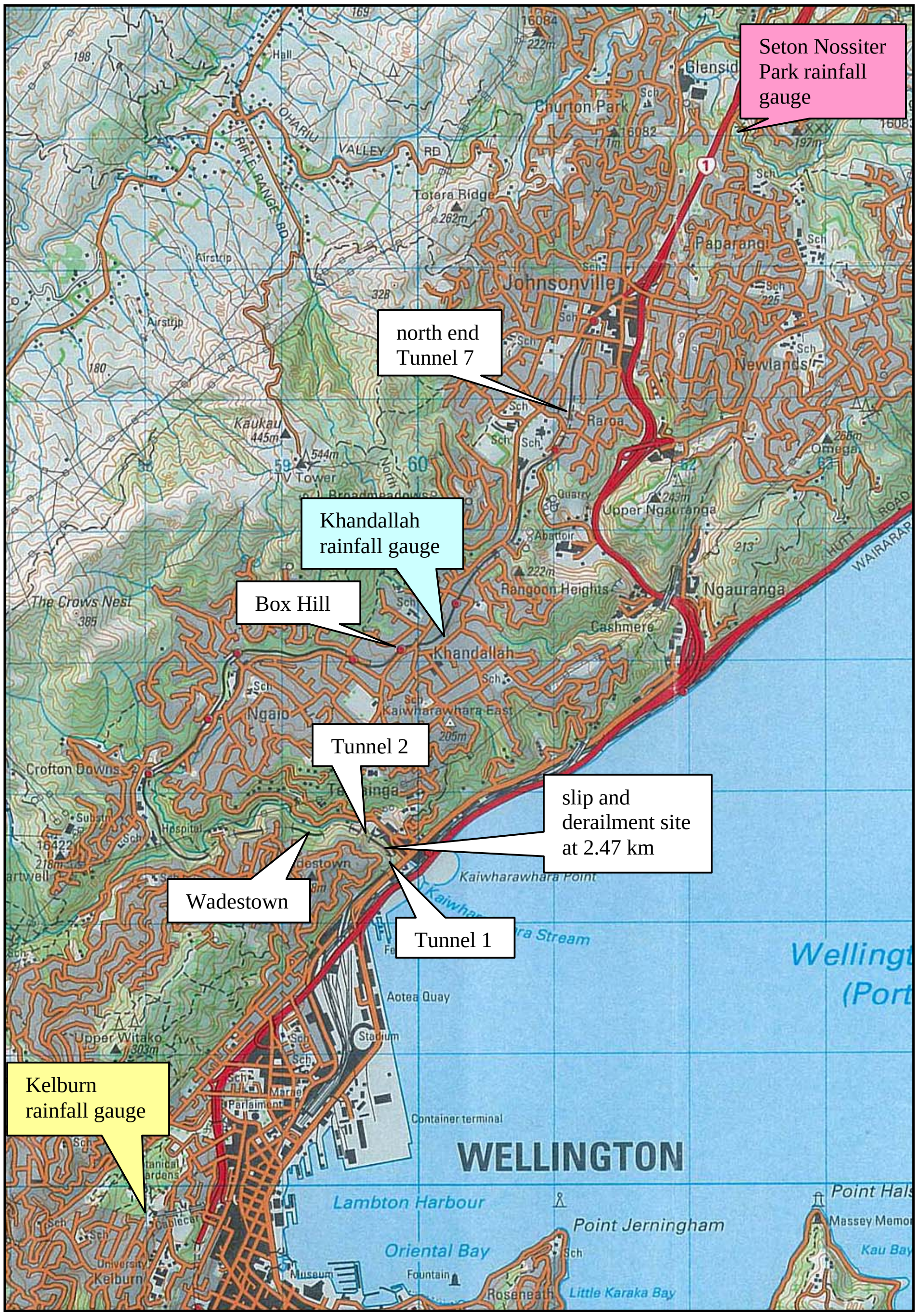

Figure 5
Map of Johnsonville Line

1.8.2 Data from the gauges for the time period 0001 to 0900 on the day of the incident is tabled below:

Time	Gauge 1 mm	Gauge 2 mm	Gauge 3 mm
0001 – 0100	1.2	1.2	1.0
0100 – 0200	1.4	1.2	0.8
0200 – 0300	2.4	1.8	2.0
0300 – 0400	6.0	6.4	5.6
0400 – 0500	5.2	7.2	6.4
0500 – 0600	9.0	13.8	12.6
0600 – 0700	2.8	16.0	18.2
0700 – 0800	22.2	11.6	6.8
0800 – 0900	8.0	14.8	5.8
9-hour total	**58.2**	**74.0**	**59.2**
Total between 0500 and 0900	**42.0**	**56.2**	**43.4**

1.8.3 A review of the average August rainfall recorded at the Gauge 1 and 3 sites since their installation showed the following:

Gauge	Period	Average for August
1	14 years	107.5 mm
3	144 years	119.5 mm

Gauge 2 was a recent installation and no historic rainfall data was available.

1.8.4 A review of the July and August 2006 recordings and the historical average rainfall data from the Gauge 1 site showed the following:

	Monthly average	Actual
July	135.3 mm	247.0 mm
August	107.5 mm	178.6 mm*

* Up to 26 August only.

1.9 Personnel

Train controller

1.9.1 The train controller had over 20 years' experience in the role. On the day of the incident, he booked on at 0650 and assumed control of the Wellington-Otaki and Wellington-Woodville sections, the Johnsonville, Marton-New Plymouth and Palmerston North-Gisborne Lines.

1.9.2 The train controller said that he thought the information from the locomotive engineer of Train 9325 did not warrant the closure of the line because the locomotive engineer did not suggest that it needed to be closed. The train controller said that he thought he could only close the line after an incident, but regardless, he added that he intended to stop trains between Johnsonville and Ngaio but had not sent a blocking command to the departure signal at Johnsonville to hold Train 9327 there. Instead the train controller passed on the details to the network control manager, requesting that a ganger be called out to check the track condition at Tunnel 7 and Box Hill.

Locomotive engineer Train 9328

1.9.3 The locomotive engineer of Train 9328 joined Tranz Metro in 2004 as a passenger operator. In 2005 she commenced training as a locomotive engineer and was certified in March 2006. Her certification was current.

1.9.4 When the locomotive engineer was advised about the weather information from her colleague from Train 9325, she informed the train manager. Because her colleague had already advised train control, she did not. She was unsure of the adverse weather procedures contained in the semi-permanent bulletin.

1.9.5 The locomotive engineer said that she was surprised by the extent of the landslide because it had covered both rails and she expressed surprise that gangers had not been called out to inspect the track beforehand.

Track inspector

1.9.6 The track inspector had worked for Ontrack and its predecessors for about 26 years and at the time of the incident was based at Waikanae. His duties required a series of weekly track inspections of the Johnsonville Line. The inspection schedule followed a set routine, with a night inspection by hi-rail vehicle early in the week followed by a daylight inspection from an EMU cab later in the week.

1.9.7 The track inspector said the darkness limited his inspection ability but was necessary because of the train timetable. Although his hi-rail vehicle was equipped with spotlights, he did not feel that was a substitute for natural daylight for such inspections.

1.9.8 Time constraints also caused by the train timetable limited the amount of minor track repair work he could undertake during his inspection runs. He was able to complete a one-way journey by hi-rail and one return journey by train between Wellington and Johnsonville every week. He added that even the daylight run on the train restricted his inspection ability because of the lack of all-round visibility offered from the front window of the EMU.

1.9.9 The track inspector added that a person called out to undertake a special inspection faced problems because occupation time was not available due to the train timetable. Inspections of the Johnsonville Line in such circumstances were normally conducted from a train, and he said that "if anything wrong was found, then the train was going to find it first". He was not comfortable with this situation but was aware that he had the authority to stop trains if he considered there was an element of danger in allowing them to run.

Ganger

1.9.10 The ganger joined the rail industry as a track worker at Porirua in 1975. He had worked in the Wellington area throughout his career and had attained his current position of ganger 3 years previously. His area of responsibility included the Johnsonville Line. His role required him to repair track faults identified by the track inspector and he was required to undertake 3-monthly track inspections of his area of responsibility.

1.9.11 The ganger said that he routinely responded to call-outs from the area coordinator or the help desk but had never gone out of his own accord, even during periods of heavy rain. He was routinely called out to attend reported track defects.

1.9.12 On the day of the incident, the ganger was called out by the help desk to inspect the blocked drain near Tunnel 7 on the Johnsonville Line. He was about to leave his home in Porirua when he was notified that the derailment had occurred.

1.10 Event recorder

1.10.1 The event recorder was downloaded from the EMU and the data made available for analysis.

2 Analysis

The derailment

2.1 Train 9328 derailed when it ran into landslide debris, mostly comprising fragmented rocky material that had fallen from the steep hillside terrain above the narrow curved cutting. The terrain in the area had been saturated by a period of heavy rain. Although the locomotive engineer had Train 9328 under control and at an appropriate speed when exiting Tunnel 1, the restricted visibility and view-lines limited her ability to see the obstruction earlier and stop the train before running into the debris.

2.2 The cutting's narrow profile meant that the debris from the slip had nowhere to go but across the track. Any EMU encountering a similar slip in this area was more likely to derail than to plough through it. If the derailment had occurred a short distance further on, the potential for a more serious outcome was possible because the terrain on the right-hand side of the train in the direction of travel dropped away to a deep parallel gorge through which the Kaiwharawhara stream flowed (refer left-hand picture in Figure 4 and topographical map in Figure 5).

2.3 The amount of debris that fell on this occasion was relatively small in comparison with other historical landslides that geologists have investigated throughout New Zealand. The landslide had originated in the regolith material, a common feature of such landslides. Again, and probably in common with New Zealand's landslide history, on this occasion the regolith material had been saturated by heavy rain. Comparisons made between the average recordings from the day of the incident and the historical recordings from 2 of the 3 rainfall gauges showed that, in the 9-hour period between 0001 and 0900, almost 47% of the average August rainfall fell, with 43% falling in the 4 hours prior to the derailment. The rainfall intensity was high just prior to the derailment.

2.4 Analysis of the available data provided by Ontrack from the previous 3 years showed that all recorded line blockage occurrences caused by landslides had occurred between Wellington and Ngaio where the line traversed the steepest terrain. However, the Johnsonville Line, unlike other principal rail lines on the network, had not been weatherproofed to reduce the risk of landslides blocking the track, nor had a landslide warning system been installed. For these reasons the Johnsonville Line was being operated at a comparatively higher level of risk than other lines in the metropolitan area. An engineering review of the line to establish the level of risk and what could be done to mitigate that risk is required to ensure the safe passenger service. A safety recommendation has been made to the Director of Land Transport New Zealand (Land Transport NZ) to deal with this issue.

Train operating safety

2.5 The first occasion that the control centre became aware of the effects the rain was having on the Johnsonville Line was the information radioed in by the locomotive engineer of Train 9325, 24 minutes before Train 9328 departed Wellington. The train controller thought that he had fulfilled his obligations in dealing with this situation when he passed on the request to the network control manager to call out a ganger to inspect the 2 sites, but without recommending or suggesting the suspension of train services in the meantime. He probably based this course of action on his misunderstanding that he did not possess the authority to arbitrarily suspend train services in any situation other than if there had been an incident.

2.6 The fact is that the train controller did have the authority to suspend services at that time and should have immediately done so between Ngaio and Johnsonville. The instruction that the tops of the rails had to be clear of water, and were not in this instance, was sufficient grounds to suspend services. Established rules and procedures, across sections in several manuals, stated what was required of a train controller under circumstances where safety was at risk. If there was any doubt, Rule one should have been applied. This rule applied to all rail operators, irrespective of who employed them. The Johnsonville Line signalling system was operated from the train control desk and provided a quick means to enter a blocking command to immediately stop trains.

2.7 The principal procedure that covered the management of severe/adverse weather events was specified in a semi-permanent bulletin which was another level of documentation in Ontrack's document management system. These procedures required information to be potentially relayed between 5 people before a Level 1 severe weather condition could be declared by an area coordinator when a MetService weather forecast had not been received.

2.8 On the day of the incident, and despite the heavy rain being experienced in the hours beforehand, it was apparent that the risk this posed was not realised by all those involved with the ongoing safe running of the Johnsonville Line services. Considering the weather-related events that were occurring on the morning of the incident, the lack of an overview appreciation of the adverse weather cues that were being reported across the area increased the level of risk of an incident occurring.

2.9 Ontrack said that, because the area coordinator had a working knowledge of the essential features list and other intimate rail corridor information, he was in the best position to make the severe weather declaration. Furthermore, an escalation of the situation to the next level was also the responsibility of the area coordinator, who was required to make a judgement call once feedback had been obtained, either after his staff had arrived on site or when the line had become blocked following an accident. While the area coordinator had an overview of a specific geographical area, the Commission feels that it was the network control manager who had the overview of the whole network, including activity in neighbouring area coordinators' areas that could be, or could be about to be, similarly affected. Such a person with an overview of the whole network would typically be better placed to make consistent high-level decisions such as declaring Level 1 severe or Level 2 adverse weather conditions for an area, on advice from the relevant area coordinators.

2.10 A declaration of a Level 1 severe weather condition was only advisory and any risk-mitigating measures, such as a frequently applied "slow speed" restriction, would probably not have prevented Train 9328 from running into the landslide debris but may have reduced the likelihood of it derailing. For safety reasons the Commission believes a decision to suspend train services at times of heavy rainfall in a Level 2 adverse weather condition, or even a Level 1 severe condition, should be at the forefront of the semi-permanent bulletin process, rather than being a possible end result of a lengthy procedural process requiring contact, conferring, agreement and execution of instructions potentially involving 5 people. A safety recommendation has been made to the Director of Land Transport NZ to deal with this issue.

Natural event monitoring

2.11 Ontrack's manuals and procedures contained guidelines for actions to be taken following high winds, seismic activity and other natural events. There were no corresponding guidelines to gauge the effects of heavy rainfall. While heavy rainfall events were mostly forecasted, their effects on the land were usually unpredictable and unpreventable. Ontrack's and Toll Rail's understandable response was to mitigate the risk to the rail corridor from heavy rain events with compliance-based manual procedures.

2.12 Historical heavy rainfall events in New Zealand often tended to be localised and were sometimes repetitive in the same localised area. It was very likely that the effects and recovery from these events had placed a high financial burden on Ontrack and its infrastructure management predecessors. There appeared to be a heavy reliance on local staff interpreting the rainfall intensity that was being experienced at their current location, which during off-duty times would mostly be where they lived. On this occasion, the local staff responsible for the Johnsonville Line, and the track inspector, lived some distance away.

2.13 Despite the slip-prone terrain which the Johnsonville Line traversed, the regolith geology of the land, the potential for localised heavy rainfall events and the history of landslides on the line – particularly from the steep terrain above the track between Wellington and Ngaio – Ontrack did not have access to automated rainfall information from the nearby rainfall gauges monitored by MetService and the 2 local government agencies.

2.14 While access to this information would not have prevented the landslide, it could have allowed the control centre to monitor current rainfall intensity that had contributed to the water problems reported by the locomotive engineer of Train 9325. If the control centre could monitor a collation of the hourly rainfall measurements being recorded at the 3 gauges during rainfall events, then it could provide some pre-warning of the situation. It is believed that, with the development of a suitable scientific computer model, the control centre could be alerted when rainfall intensities reached a level where the potential risk of landslides was high. At that time, and based on the real-time data, proactive steps could be taken to assess the risk and suspend train services before the risk became unacceptable; or at least have pre-warning of heavy rainfall events so that those managers who are responsible for deciding when to initiate stoppages or special track inspections are at a heightened level of awareness beforehand.

2.15 The Commission believes that procedures based on this real-time data would provide the basis for a more consistent and rational process to coordinate the situation from the control centre. A safety recommendation has been made to the Director of Land Transport NZ to deal with this issue.

Track inspection

2.16 Routine track inspections, particularly of a line that carries only passenger trains such as the Johnsonville Line, were an integral and critical part of a safety system. The responsibility placed on the track inspector to conduct such inspections during night hours limited his ability to monitor developments that were occurring on the steep uphill faces above, and for that matter below, the track, particularly between Wellington and Ngaio. It was also apparent that he did not have sufficient time to accomplish the minor track repair tasks that he was required to do. As such, weekly inspections from a hi-rail vehicle during daylight hours should have been scheduled and the train timetable designed to cater for such inspections.

2.17 There was also the uncertainty of how special track inspections by hi-rail vehicle were to occur on the Johnsonville Line. The essential features list affirmed the need to check for risk of line blockages over an extended distance of about 7.5 km during heavy rain events. This distance represented about 75% of the total length of the line. These situations required clearly defined decision-making processes that needed to incorporate the suspension of train services so that the special inspections could be undertaken at any time. Current procedures lacked clarity on how this was to be achieved.

2.18 The Commission believes that special and/or routine inspections from the cab of a scheduled passenger train were unsatisfactory and did not adequately manage the risk that the person undertaking the inspection was expected to assess. A safety recommendation has been made to the Director of Land Transport NZ to deal with this issue.

3 Findings

Findings are listed in order of development and not in order of priority.

3.1 Heavy rain had saturated the terrain above the track, causing the regolith material to slide. The narrow cutting then restricted the spread of the landslide debris so that, when it fell, the debris covered the track, causing Train 9328 to derail.

3.2 The Johnsonville Line was susceptible to regolith landslides because of the steep-faced terrain it traversed between Wellington and Crofton Downs. The alignment formation through this area had not kept pace with modern civil engineering standards and was mostly unchanged from when it had been opened up in 1885.

3.3 Sufficient information was available to have identified the risk the weather conditions posed for train operations before the derailment.

3.4 The risk to passenger train operations was not realised because:

- there was insufficient forecast and real-time weather information available to staff who had the responsibility to suspend train services
- responsibilities and accountabilities for monitoring or suspending train services were not clearly defined
- staff responsible for the monitoring of severe/adverse weather events were not sufficiently aware of their responsibilities.

3.5 There was insufficient room in the train timetable to conduct effective routine and, when circumstances dictated, special inspections of the track and surrounding topography of the Johnsonville Line.

4 Safety recommendations

Safety recommendations are listed in order of development and not in order of priority.

4.1 On 20 March 2008, the Commission made the following safety recommendations to the Director of Land Transport NZ:

4.1.1 The Commission considers that the lack of effective severe/adverse weather forecasting, and real-time monitoring of rainfall in the Johnsonville Line area, and other areas of track prone to closure during heavy rainfall events to be a safety issue and recommends the Director of Land Transport NZ addresses this safety issue (003/08).

4.1.2 The Commission considers that not having a weather proofing engineering review done of the Johnsonville Line is a safety issue and recommends the Director of Land Transport NZ addresses this safety issue (004/08).

4.1.3 The Commission considers that clearly defining procedures outlining responsibilities for monitoring, intervening or cancelling train operations during severe/adverse weather events is a safety issue and recommends the Director of Land Transport NZ addresses this safety issue (005/08).

4.1.4 The Commission considers it is a safety issue that the practice of conducting routine track inspections at night, and the lack of clear guidelines for the conduct of special track inspections of the Johnsonville Line is not in line with sound engineering practices. The Commission recommends the Director of Land Transport NZ addresses this safety issue (006/08).

4.2 No response to these safety recommendations had been received from the Director of Land Transport NZ at the date of publication of this report.

Approved for publication on 20 March 2008

Hon WP Jeffries
Chief Commissioner

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