Australian Government

Australian Transport Safety Bureau

Derailment of train 7SP3

Roto, New South Wales | 4 March 2012

Investigation

ATSB Transport Safety Report

Rail Occurrence Investigation

RO-2012-002

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Published by: Australian Transport Safety Bureau
Postal address: PO Box 967, Civic Square ACT 2608
Office: 62 Northbourne Avenue Canberra, Australian Capital Territory 2601
Telephone: 1800 020 616, from overseas +61 2 6257 4150 (24 hours)
Accident and incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6247 3117, from overseas +61 2 6247 3117
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

Addendum

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Safety summary

What happened

Floodwater adjacent to track

Source: Local resident

On the morning of 4 March 2012, freight train 7SP3 operated by Pacific National derailed after entering floodwaters that had overtopped the track near Roto in New South Wales.

The flooding had caused scouring of the track formation, compromising its capacity to support the train.

The lead locomotive remained on the track but the trailing locomotive derailed and uncoupled. None of the trailing wagons derailed although a number sustained damage. The flooding and subsequent derailment of the second locomotive of train 7SP3 damaged approximately 130 m of track. The crew were shaken, but physically unhurt.

What the ATSB found

The ATSB determined that runoff from the heavy rain that had fallen in the catchment area adjacent to Roto the morning of 4 March 2012 caused a flash flood event. The volume of floodwater exceeded the capacity of a drainage culvert, which resulted in water overtopping the track formation with ballast and sub-grade scouring on either side of the culvert.

The magnitude of the scouring meant that the track could not support the weight of train 7SP3 as it passed over the affected areas. The resulting deformation in the alignment of the track initiated the derailment.

The ATSB also found that the track manager's systems and operational procedures provided limited information and guidance to assist the network control staff in identifying and assessing the potential threat to the safety of rail traffic resulting from the significant localised weather event.

What's been done as a result

The track manager is trialling the use of flood sensors at high-risk locations and has engaged the services of a third party to provide early warning information on potential high-risk weather events.

Safety message

It is essential that rail transport operators have robust systems in place to monitor and mitigate the risks to infrastructure from significant weather events to ensure that the safety of rail operations is not compromised.

Contents

The occurrence

Events prior to derailment

In the days prior to the derailment of Pacific National (PN) train 7SP3, a slow moving low-pressure trough generated a broad rainband across New South Wales. The Bureau of Meteorology (BoM) had forecast severe weather and issued flood warnings for various areas of the State.

At 0543 on 3 March 2012, the BoM predicted rain for the Riverina District (including Roto at the northern extremity), becoming heavy at times in the north, with the chance of thunderstorms in the northwest. A severe weather warning with flash flooding[1] of a number of rivers and river valleys within the district was current. The rainfall from this weather system caused substantial runoff resulting in the saturation of catchment areas and the pooling of floodwater adjacent to the rail track at a number of locations between Broken Hill and Parkes.

At about 0545 on 3 March 2012, the crew of freight train 4PS6 travelling from Broken Hill towards Parkes reported to the Australian Rail Track Corporation (ARTC) Network Control Officer (NCO) that floodwater had overtopped the ballast at two locations between Yarrabandai and Bogan Gate. The NCO relayed this advice to the ARTC track maintenance contractor, Transfield Services Australia (Transfield) to follow-up. Track supervisors from Transfield began a series of unscheduled inspections[2] of the track, travelling west from Goobang Junction and east from Condobolin. Track supervisors from Menindee and Broken Hill also began to conduct track inspections (Figure 1).

Figure 1: Location of Roto, New South Wales

Source: Geoscience Australia Crown Copyright ©

Shortly after 0745, the Condobolin supervisor inspecting the line toward Bogan Gate reported to the NCO that rain continued to fall and floodwater had overtopped the track between Yarrabandai

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[1] Flash flooding is defined as 'flooding occurring within about 6 hours of rain, usually the result of intense local rain and characterised by rapid rises in water levels' (Bureau of Meteorology, Weather Services Handbook).

[2] Unscheduled waterway and drainage inspection carried out in response to reported flooding or heavy rain in areas prone to flooding (e.g. by drivers) to allow required actions to be determined. Source: ARTC Engineering (Track and Civil) Code of Practice Section 10 Flooding

and Bogan Gate. The supervisor advised his intention to wait for the supervisor travelling from Goobang Junction to arrive before making a final assessment of the conditions. At about this time the ARTC Train Transit Manager (TTM) joined the conversation to confirm an inspection of the track between Ivanhoe and Broken Hill should occur, as he had observed BoM radar images indicated rainfall around that area. The Condobolin supervisor then departed travelling west toward Ivanhoe, later advising the NCO that he had received reports of rainfall measurements of 25 mm and 75 mm from residents in the Roto and Ivanhoe areas respectively.

At about 1035, the Goobang Junction supervisor arrived at the flood-affected area between Yarrabandai and Bogan Gate. He advised the NCO to hold trains at Goobang Junction until midday due to rising floodwaters. Supervisors from Condobolin, Menindee and Broken Hill continued the track inspections, identifying that although rain was continuing to fall and that there was widespread pooling of rainwater runoff adjacent to the track, the under-track drainage systems appeared to be coping with the volume of water. The track supervisor from Broken Hill took the precaution of issuing a Condition Affecting the Network (CAN)[3] warning for floodwaters near Menindee.

At about 1120, the Goobang Junction supervisor advised that floodwater had receded sufficiently to allow the passage of trains under a CAN warning that restricted track speed to 40 km/h through the affected area. Train 6SP6 departed Goobang Junction at about 1330, followed later that afternoon by train 6NY3 at about 1450. The NCO provided advice of the CAN warnings in the relevant Train Order[4] issued to the crew of each train.

Following the passage of trains 6SP6 and 6NY3 through the flood-affected area between Yarrabandai and Bogan Gate, a scheduled BoM forecast (issued at about 1632) identified continuing rain, heavy at times with similar conditions expected the following day before easing. The severe weather warning for flash flooding within the Riverina District remained current.

The Goobang Junction supervisor, after continuing with track inspections, later assessed that the level of floodwater had receded sufficiently to cancel the CAN warning and update the speed restriction to 70 km/h. As trains 6SP6 and 6NY3 travelled toward Broken Hill, the Condobolin, Menindee and Broken Hill track supervisors continued to inspect the track ahead of the trains.

At about 1710, the Condobolin track supervisor had returned to Roto, reporting to the NCO that his vehicle was clear of the track and that train 6NY3 could pass. The supervisor advised that although it was still raining, the drainage pipes under the track formation were handling the flow of water satisfactorily and that it was his expectation that this situation should continue, so long as there was not a downpour within the next 8 hours.

The supervisor requested that if there was further rain, the NCO warn train crews to keep watch for signs of flooding from Condobolin onward.

The Condobolin supervisor departed Roto at about 1845 and headed towards Condobolin, clearing the track at Euabalong West at about 2108 for the passage of the next train, 7GP1. When the supervisor booked clear of the track, he advised the NCO that although there was water pooling, the condition of the track was good. The supervisor then returned to Condobolin, finishing work at around 2200. Following the inspection, two train movements passed through the Roto area, 7GP1 at around 2237 that evening followed by 6SP7 at about 0050 on the morning of the derailment.

The crews of the two preceding trains communicated no concern to the NCO related to the potential for flooding of the track between Goobang Junction and Broken Hill. Following

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3 A situation or condition that affects or has the potential to affect the safety of the ARTC Network Source: ARTC Glossary, Issue 2.0 – Rev. 0, 19 Dec 2010

4 An instruction, on the prescribed form, issued by the train controller, in train order territory to direct the movement of rail traffic Source: RISSB National Guideline Glossary of Rail Terminology 3 December 2010

discussions between the NCO and crew of train 7GP1, the NCO decided to cancel the remaining CAN warning for the Menindee area at about 0400 on 4 March 2012.

The derailment

At about 0315 on 4 March 2012, the driver and co-driver involved in the derailment commenced their shift at Goobang Junction. Due to a delay with their originally scheduled train service, they were re-rostered to work train 7SP3 to Broken Hill, departing Goobang Junction at about 0400.

Shortly after reporting the train's departure to the NCO, the driver asked where the flooding was on the track ahead. The NCO advised that most of the reports were on the previous day in the area between Euabalong West and Matakana and restrictions were in place from Yarrabandai to Bogan Gate (Figure 1). The NCO also advised that the drivers of the previous trains (7GP1 and 6SP7) had not reported anything unusual.

The driver of train 7SP3 had worked a train through Bogan Gate the previous day. He was concerned about the track condition he had experienced the previous day and as a precaution decided to maintain the train at a reduced speed of 40 km/h between Bogan Gate and the next passing loop at Yarrabandai. After passing through Yarrabandai, the driver accelerated the train to the posted track speed.

Train 7SP3 continued without incident to Condobolin where the co-driver, who was undergoing training, took over to drive the train onward under the supervision of the mentor driver (now the co-driver).

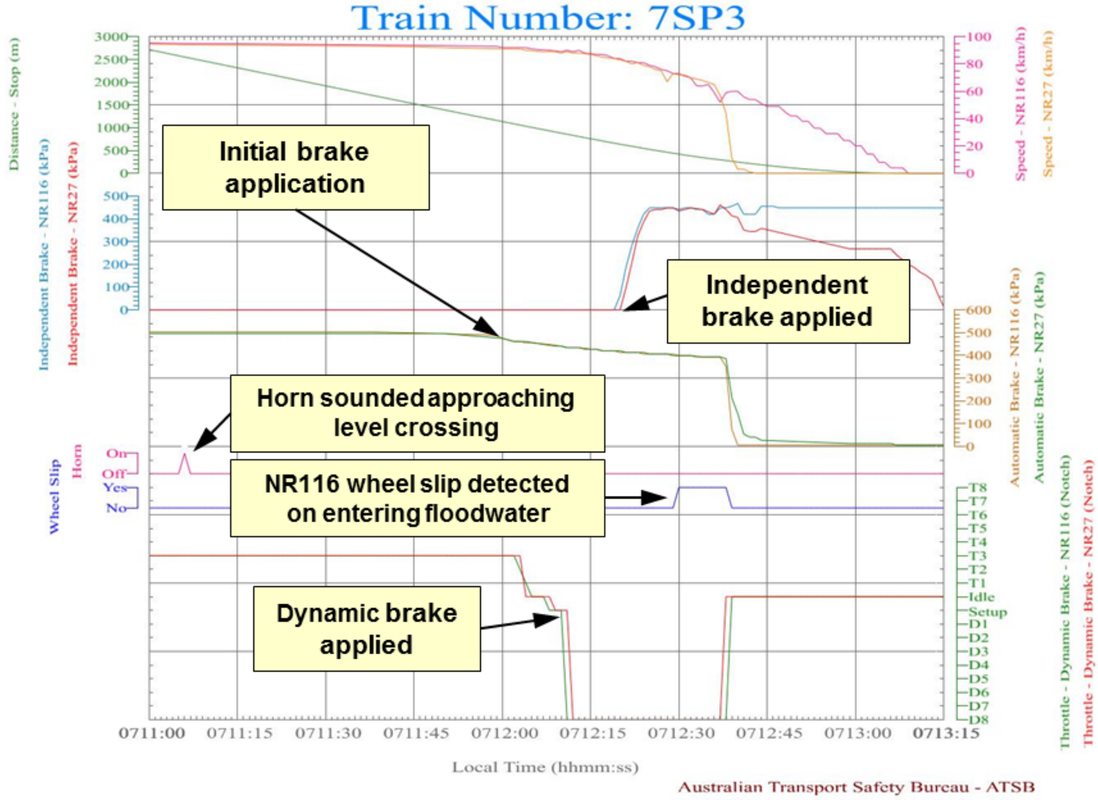
As train 7SP3 approached Roto light rain had begun to fall; the intensity increased as the train passed through Roto. At about 0711, train 7SP3 traversed the level crossing located to the west of Roto (Figure 2). The train was travelling at approximately 93 km/h when the mentor driver observed 'white water' flowing over the track ahead and instructed the trainee driver to apply the train brake. The trainee driver made a normal operating mode brake application of around 70-kpa.

Figure 2: Derailment site west of Roto

Source: Google ©

Shortly after the brake application the mentor driver intervened: he moved over to the controls and applied full dynamic braking. He followed this with a full application of the independent brake and service brake (Figure 3). At that point, the mentor driver resumed his seat and instructed the trainee driver to brace, should the train not stop before entering the water.

Figure 3: Data logger composite plot for locomotives NR116 and NR27 of train 7SP3



The train was unable to stop and as the lead locomotive (NR116) traversed the floodwater, the crew reported that the locomotive hit two distinct dips in the track that were about 25 m apart. The drivers felt a significant impact as the locomotive exited each dip, with the second being more severe and resulting in water covering the locomotive windscreen. As the train progressed through the water the lead locomotive remained on track, but the trailing locomotive, (NR27) uncoupled and collided with the rear of the lead locomotive.

The lead locomotive came to rest about 300 m past the second washaway site. After an initial assessment of the situation, the mentor driver contacted the NCO. He advised that they had passed through Roto and that train 7SP3 had encountered a washaway and had derailed.

Events post derailment

Due to the extent of floodwater and the unstable nature of the ground, the crew were only able to inspect the leading 100 m of the train (the train was 1508 m long). During the inspection, they became concerned about the rising water level and the risk of continued undermining of the formation, which they felt would further compromise to the stability of the track (Figure 4).

On returning to the lead locomotive, the crew carried out temporary repairs to the brake pipe taps damaged by the collision between the two locomotives and updated the NCO on the status of the train and track. The crew observed that the floodwaters were rising along the track and sought permission from the NCO to move NR116 to higher ground.

Figure 4: Floodwaters adjacent Roto culvert, viewed in easterly direction toward Roto

Source: Local resident

At about 0844, the NCO gave permission and the train crew moved locomotive NR116 forward approximately 1,000 m. The crew observed that the water level near the derailment site continued to rise.

At around 1016, the NCO issued a Train Order for locomotive NR116 to travel to the next location. The crew departed, arriving at Trida at about 1122, where they stabled the locomotive in the goods siding.

The crew remained at Trida until about 1536 when a Transfield road-rail vehicle[5] arrived from Broken Hill to transport the crew to Broken Hill.

Later in the day, a light locomotive[6] dispatched from Goobang Junction arrived at Roto to recover the rear portion of train 7SP3. At about 2200, PN removed the rear portion of 7SP3 from the derailment site and returned it to Goobang Junction. The derailed locomotive NR27 and seven wagons (four of which were multiple platform wagons) that had sustained damage remained at the derailment site for later recovery.

After floodwaters receded, repairs to the locomotives and remaining wagons of train 7SP3 were completed. At about 0750 on Thursday 8 March 2012, PN completed the removal of all rail vehicles from the derailment site. Transfield maintenance personnel undertook repairs to the washed out formation and damaged concrete sleepers (Figure 5). At about 1230 on Friday 9 March 2012, Transfield staff completed repairs and reopened the track.

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5 A road vehicle fitted with retractable rail guidance wheels. Source : RISSB National Guideline Glossary of Rail Terminology 3 December 2010

6 A locomotive or locomotives coupled without vehicles. Source: RISSB National Guideline Glossary of Rail Terminology 3 December 2010

Figure 5: Wash-away damage to track formation adjacent Roto culvert, viewed toward Roto (note the same perspective to Figure 4)

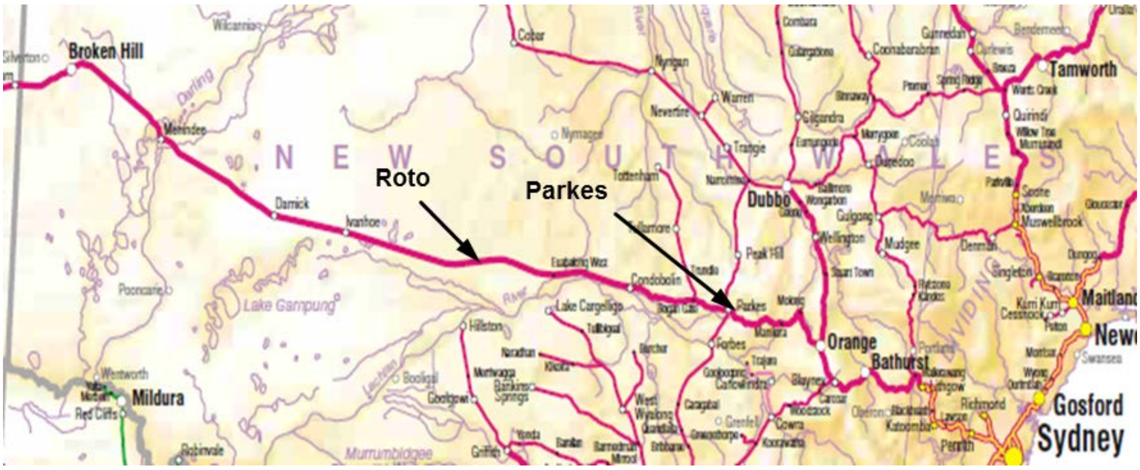
Source: ATSB

Context

The location

The derailment occurred about 2.2 km west of Roto at the 709.187 km mark[7] on the Defined Interstate Rail Network (DIRN) in New South Wales (Figure 6). Roto is located approximately 262 km west of Parkes and 418 km east of Broken Hill by rail.

Figure 6: Location of Roto, New South Wales



Source: Geoscience Australia Crown Copyright ©

Train and train crew information

Train 7SP3 was a freight service operated by Pacific National (PN) between Sydney and Perth. It consisted of two locomotives (NR116 leading and NR27 trailing) hauling 45 freight wagons of which 10 were multiple platform type. The train was 1508 m in total length and had a trailing mass of 3524.1 t.

The crew consisted of a driver and co-driver. At the time of derailment, the driver was a 'driver-in-training' with around six months experience in the rail industry. He was operating the train under the supervision of the co-driver (mentor driver) who had 36 years of experience in the rail industry.

The driver-in-training and mentor driver held appropriate competencies for the tasks being performed and had been assessed as fit for duty in accordance with the requirements of the National Standard for Health Assessment of Rail Safety Workers.

The crew of train 7SP3 on sighting fast flowing floodwaters overtopping the track formation ahead reacted reasonably in braking the train. There was no anomaly identified in the train speed, handling, rollingstock condition, or operational performance leading up to the derailment.

The consignment of train 7SP3 included dangerous goods. There was no loss of containment of these goods due to the derailment.

Environmental conditions

The closest BoM weather station to the derailment site was at Hillston (Mount View), about 20 km southwest of Roto. On the day of the occurrence Hillston weather station recorded a daily rainfall total of 114 mm. Significant rainfall had also been recorded in the areas around Ivanhoe and Hillston Airport which are located to the west and south of Roto respectively. This rainfall occurred

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7 Distance in track kilometres from a reference point located at Sydney Central Station.

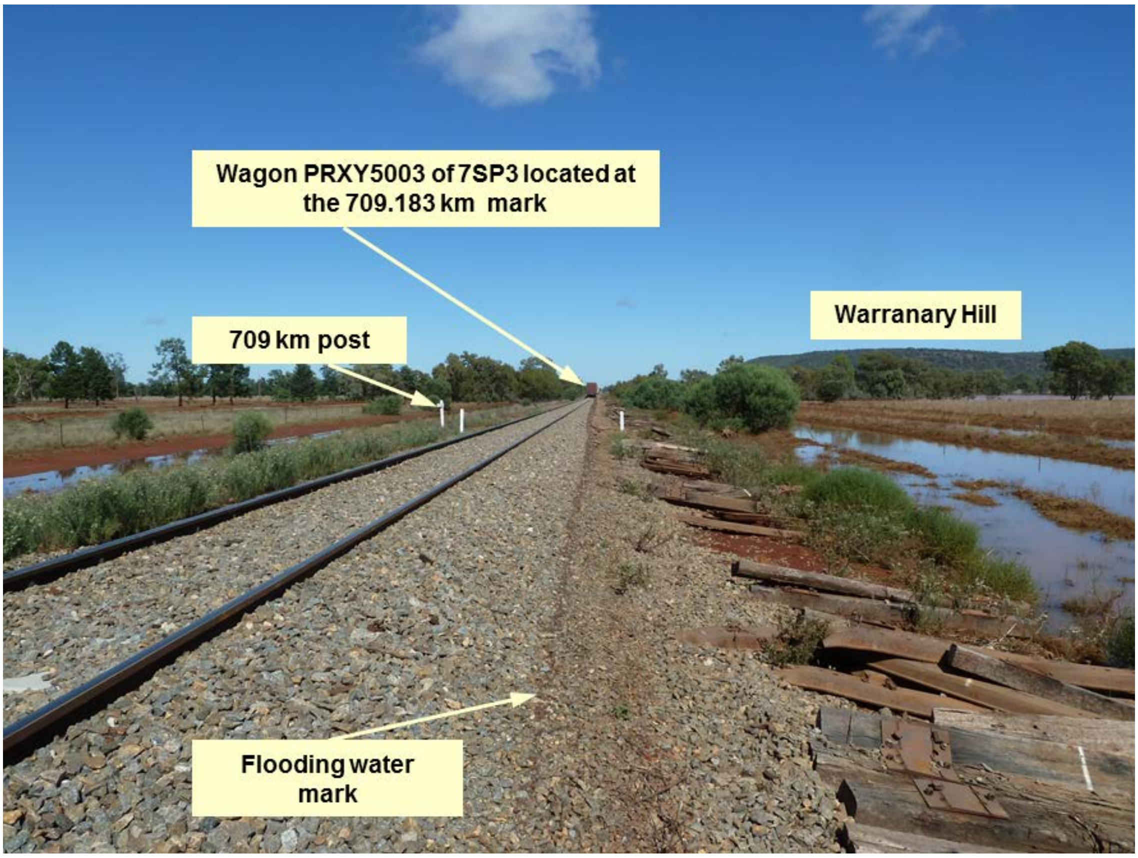
in conjunction with a broad rainband arising from a low-pressure trough that extended across NSW (Appendix A – Weather event and rainfall).

A severe weather warning for flash flooding issued by the BoM was current for the Riverina District forecast area of New South Wales, which included Roto. Post-accident analysis (Appendix A – Weather event and rainfall) suggests that the intensity of rainfall at Hillston, averaged over a 24-hour period, was equivalent to a 50-year precipitation event. A resident in the Roto area noted that the rainfall was particularly heavy on the morning of 4 March 2012 and recorded about 70 mm in a 3 to 4 hour period (a fall that would exceed a 100-year precipitation event). Based on the available information, the intensity of the rainfall in the Roto area that fell on an already saturated catchment was almost certainly well in excess of a 50-year rainfall intensity event and was the cause of flash flooding in the area.

Rainwater runoff resulted in the pooling of water against the track formation at a number of locations between Parkes and Broken Hill. The extent of flooding that occurred near the derailment site at Roto area was evident by the water debris mark on the track formation extending both east and west of the wash-away site (Figure 7).

The crew reported that light rain was still falling as train 7SP3 approached Roto at about 0710. Sunrise was at 0708 with morning civil twilight[8] occurring at 0643.

Figure 7: Flooding water mark on northern face of formation, viewed from the east of the wash-away site.



Source: ATSB

[8] Defined as the instant in the morning, when the centre of the Sun is at a depression angle of six degrees below an ideal horizon. At this time in the absence of moonlight, artificial lighting or adverse atmospheric conditions, the illumination is such that large objects may be seen but no detail is discernible. Source: Geoscience Australia

Track information

The Australian Rail Track Corporation (ARTC) manages the railway where the derailment occurred, with the movement of rail traffic controlled from the ARTC's Network Control Centre located at Mile End in South Australia. Transfield Services Australia were contracted by the ARTC to provide maintenance and inspection services for the railway infrastructure in the area of the derailment.

The standard gauge (1435 mm) track at the derailment location consisted of 53 kg/m rail fastened to concrete sleepers by resilient clips. The track formation comprised sand/clay based soil topped with a capping layer and overlaid with ballast to a nominal design ballast depth of 250 mm forming the track bed.

The track bed supported prestressed concrete sleepers spaced at about 667 mm centres. The ARTC undertook the installation of concrete sleepers between Parkes and Broken Hill under its, East/West Productivity Resleepering works project which was completed in February 2012.

Approaching the derailment site from Roto, the track was tangent[9] and the terrain undulating. The track gradient adjacent the derailment site transitioned from a falling grade of 1:597, through level, to a rising grade[10] of 1:301.

Track drainage - design

The design and construction of the track between Parkes and Broken Hill occurred prior to the ARTC leasing the interstate main line from the NSW Government on 4 September 2004. The ARTC does not have any records relating to hydrology calculations used to design the under-track drainage systems for the track section through the Roto area or of any subsequent assessment of the drainage capacity, other than routine maintenance inspections. Since taking up the lease, the ARTC has progressively transitioned infrastructure standards adopted from the previous operator into an Engineering (Track & Civil) Code of Practice (CoP). The CoP requires new waterway structures be designed in accordance with Australian Rainfall and Runoff[11] and Australian Standard AS5100.

The drainage system in the Roto area included a series of small under-track culverts installed at intervals along the track to drain the rainwater runoff from the catchment situated to the north of the railway. The culverts each consisted of a group of four 600 mm diameter corrugated metal pipes. The small under-track culvert located at the 709.187 km mark, adjacent to the derailment site, was the only culvert to sustain significant damage because of the runoff of rainwater on the morning of 4 March 2012 (Figure 8).

The CoP specifies the minimum flood opening for minor under track structures, such as the culverts at Roto, should accommodate the discharge for a 50-year return precipitation event. In this case, the intensity of rainfall in the Roto area almost certainly exceeded the minimum design criteria documented in the CoP and potentially exceeded the 100-year return precipitation event, significantly increasing the risk of flash flooding that would top the track and compromise the track structure. Consequently, the investigation focused on the management of rail safety under significant weather conditions that had the potential to exceed the designed drainage capacity of the track structure.

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9 Straight track with no applied cant. Source: RISSB National Guideline Glossary of Rail Terminology 3 December 2010.

10 A measure of the rate at which the railway is inclined (rising or falling) Gradients are signed +ve (rising) or –ve (falling) in respect of the direction of travel. Source: RISSB National Guideline Glossary of Rail Terminology 3 December 2010.

11 Australian Rainfall and Runoff (ARR) is a national guideline document for the estimation of design flood characteristics in Australia.

Figure 8: Roto Culvert, northern side view[12]

Source: Australian Rail Track Corporation Copyright ©

Track drainage - inspections

The CoP specifies the inspection and assessment arrangements applicable to drainage systems installed throughout the ARTC network. Inspections of waterways and drainage systems are categorised as scheduled or unscheduled; the latter may be in response to conditions arising from a weather event.

Areas identified as prone to flooding may additionally be declared 'special locations'. Special locations are subject to unscheduled inspections in response to defined rain events or an alarm from automatic monitoring systems that may be installed at those locations. Such inspections are undertaken to collect information on the physical condition of the waterway in flood and to monitor conditions until the risk to train operations is assessed as acceptable[13]. For areas that are not identified as special locations, unscheduled inspections may be triggered in response to automatic rainfall monitoring, reports of flooding by train drivers or heavy rains in areas prone to flooding.

In the time preceding the derailment of train 7SP3, unscheduled inspections were conducted to assess the condition of waterways and drains at various locations between Goobang Junction and Broken Hill. The inspection at Roto was undertaken at about 1845 on Saturday 3 March 2012 and had assessed the conditions as suitable for rail traffic, provided there was not a downpour in the next 8 hours. Two trains passed through Roto (the last at about 0050 on Sunday 4 March 2012) without reporting any increased flooding hazard. By the time train 7SP3 arrived at Roto (about 6 hours later), the conditions had unknowingly changed and floodwaters had topped the track resulting in a compromised track structure.

12 Picture in Figure 8 was taken prior to installation of concrete sleepers during East/West Productivity Resleepering works.

13 ARTC Engineering (Track & Civil) Code of Practice, Section 10 Flooding, Version 2.2, 08 November 2011

Other weather related occurrences

The ATSB has investigated two similar flood related weather occurrences. The first occurred near Golden Ridge[14] in Western Australia on 30 January 2009 involving the ARTC and the second at Edith River[15] in the Northern Territory on 27 December 2011 involving Genesee and Wyoming Australia (GWA).

The Golden Ridge investigation identified safety issues concerning the specification of hydrological design parameters in the CoP, the audit and assessment of the track drainage arrangements, and the timely access to reliable weather information identifying localised severe weather events that may affect the safety of the track. Although the ARTC had not identified any corrective action as a specific response to each of these safety issues, a track wash-away risk assessment was undertaken in late July 2009. The risk was assessed in relation to a hypothetical track wash-away occurring either to the east or to the west of Coonamia in South Australia[16]. The ARTC identified mitigation plans which included hydrology assessments and trialling the sourcing of specialist meteorologist services to provide advanced warning of weather events.

The ARTC initiated a limited trial of the meteorological advanced warning services for certain weather events in November 2012 with the full implementation of the service occurring in March 2013. The review of the hydrology design was completed for the track west of Broken Hill and through South Australia in June 2013. The mitigation plans were initiated and implemented after the derailment of 7SP3 at Roto, but generally focused on the track west of Broken Hill. The opportunity exists for the ARTC to carry out a similar review to the east of Broken Hill, particularly given that the ARTC does not have access to the hydrology calculations used to design the under-track drainage systems for the track section through the Roto area.

The Edith River investigation identified safety issues related to limitations in the policies, procedures and training provided to employees in managing severe weather events and ineffective warning systems in place to alert staff to the severity of a flood event. GWA, in response, initiated a review of their Extreme Weather Event Monitoring and Response Procedure and their Cyclone Response Plan to incorporate learning's from the occurrence. Awareness training packages were developed to provide operational staff, track inspectors and management guidance on the recommended responses to flooded track, storms and extreme wind events. In conjunction with the above, GWA instigated systems to detect stream flow and alert train control and train crews. Arrangements were also formalised with a number of agencies, including the BoM for the reporting and monitoring of extreme weather events.

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14 ATSB investigation number, RO-2009-003 - Derailment of Train 5PS6 near Golden Ridge WA 30 Jan 2009

15 ATSB investigation number, RO-2011-019 - Derailment of freight train 7AD1 at Edith River near Katherine NT on 27 December 2011

16 The ARTC considered that the potential consequence of a wash-away to the west of Coonamia was different to the consequence of a wash-away to the east.

Safety analysis

Introduction

Railway infrastructure is designed, constructed and maintained in accordance with applicable engineering standards to ensure serviceability in wide range of foreseeable weather conditions. Significant weather events, which produce conditions which exceed defined design parameters, increase the likelihood of degradation of the infrastructure and thereby increase the risk to the safety of rail operations.

The ability of a rail infrastructure manager to assess the risks arising from significant weather events and implement appropriate precautionary measures is therefore essential in providing a safe system for rail operations.

Development of the occurrence

On the day preceding the derailment, the ARTC initiated unscheduled inspections between Parkes and Broken Hill following reports of heavy rainfall and flooding. The track supervisor inspecting the Roto area advised the NCO that the drainage pipes were coping with the flow provided there was not another downpour in the next 8 hours. This qualification suggests that the track supervisor assessed conditions were likely to deteriorate if further heavy rain fell.

After the unscheduled inspections ended, the NCO continued to monitor the condition of the track through feedback from the train crews as they reported on progress through track sections. This feedback and the uneventful passage of train services 7GP1 and 6SP7 that passed through Roto 6 hours before the train that derailed probably created a belief that the weather system had abated and the risk of further track flooding had passed.

The weather forecast issued by the BoM, however, continued to warn of heavy rainfall and the potential for flash flooding in the district. This information, supported by radar images available from the BoM website and reports from track supervisors and train crews of widespread pooling of water in the saturated catchments adjacent the track, signalled the presence of an ongoing hazard to the railway from this weather event.

Between the passage of train 6SP7 through Roto at 0050 and the derailment of train 7SP3 at 0711, localised heavy rainfall caused significant rainwater runoff from the adjacent catchment. Information available from the BoM and local residents substantiate that the intensity of the rainfall was almost certainly in excess of a 50-year rainfall intensity event.

This resulted in property damage and scouring to an adjoining property that had not occurred with the previous falls that week (Appendix A – Weather event and rainfall) and a flash flood that overtopped the rail track adjacent to the culvert at the 709.187 km mark, causing significant scouring of the formation. The damage to the formation compromised its integrity to the extent that the track could not support the weight of a train.

Neither the NCO nor the train crew were aware of the extreme rainfall event and changed conditions that created the localised threat. This was the critical factor in the occurrence.

Safety management system

At the time of the derailment, the ARTC managed risk to safety through the implementation of its Safety Management System (SMS). A key component of the SMS is the development of procedures to address the various general engineering and operational systems safety requirements. In this case, the CoP addresses the engineering design parameters for waterways and drains as well as specifying the requirement for scheduled and unscheduled inspections of those waterways.

The CoP states that reports of heavy rain or flooding from train crews, or other sources, may trigger unscheduled inspections to assess the condition of the waterways and drains. Track supervisors determine what action is required based on their assessment of the prevailing conditions at that location.

The unscheduled inspection, while essential to identify infrastructure defects or the development of other issues observable at that time, is limited to the extent that it cannot assess risk to train operations from changed weather conditions following the inspection and prior to the passage of the next train.

After the unscheduled inspections ended, the NCO relied on the crews of trains passing through the affected area to assess the condition of infrastructure and provide feedback. In this case, there was a 6-hour period without any visual feedback of track condition, during which weather conditions resulted in flash flooding around the Roto area.

The applicable Safeworking Rules and Procedures govern the operational requirements for the movement of trains on the ARTC NSW network. These rules and procedures prescribe the actions that the NCO undertakes in response to a report from train crew or maintenance personnel of unsafe conditions. In this occurrence, the NCO issued CAN warnings in response to the advice from track supervisors undertaking the unscheduled inspections. Once the unscheduled inspections had ceased and the CAN warnings had been cancelled, the rules and procedures provided no additional guidance or instruction to the NCO in assessing and managing the continuing risk from this weather event.

There are, however, operational rules and procedures that provide guidance and instruction to the NCO about the actions or speed restrictions required to manage the movement of trains during events such as very hot weather or the triggering of an automatic rainfall monitoring warning at a special location. The ARTC operational rules and procedures provided few if any additional sources of information or guidance to the NCO or other network control staff to quantify the response and duration for managing risk during this significant weather event.

The ATSB investigation into the derailments at Golden Ridge and Edith River identified similar inadequacies in each operator’s safety management systems (the ARTC and GWA). Although the ARTC has undertaken risk assessments and implemented mitigation plans, including the provision of specialist meteorological warning services, the provision of instruction to the NCOs with respect to dealing with a significant weather events was not identified. The ARTC advised that they consider the management of weather events, subject to the specific circumstances of each event, as equivalent to managing any other condition that may affect the rail network. However, as is evident from the derailment at Roto, the absence of sufficient information, guidance, operational procedures or training to aid network control centre staff in assessing consequential hazards from a weather event, prior to dispatching trains, increases risk to operations on the railway.

Significant weather events do pose a significant operational risk and, although infrequent, the consequences of a derailment resulting from a wash away can involve injury and significant property damage. Significant weather events are a recognised hazard and risk management standards require the development and application of all reasonable and practicable measures to mitigate the effects of the associated risk. It is therefore a requirement that operators understand the nature of significant weather events, as they relate to their operations, and develop strategies that provide for the safety of the rail services operating on their network.

Findings

At approximately 0715 on 4 March 2012, freight train 7SP3 travelling from Sydney to Perth derailed after entering a washed out area of track formation where floodwaters were overtopping the rails near Roto, in New South Wales (NSW). The floodwaters developed from a high intensity rainfall event that occurred in conjunction with a period of sustained wet weather experienced in the area.

From the evidence available, the following findings are made with respect to the derailment but should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance. A safety issue is an event or condition that increases safety risk and (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

Contributing safety factors

- Widespread rainfall in the days preceding 4 March 2012 resulted in saturation of the catchment adjacent to Roto. The intensity of rainfall in the vicinity of Roto in the 6 hour period preceding the derailment of 7SP3 led to localised flash flooding.
- The design capacity of the culvert located adjacent the 709.187 km point was insufficient to discharge the runoff from the rain event that occurred during the morning of 4 March 2012. The floodwater overtopped the track, causing scouring of the track ballast and associated damage to the track formation.
- Scouring of the ballast and formation adjacent to the 709.187 km point by floodwater meant that the track could not support the weight of train 7SP3 as it passed over the affected areas. The resulting deformation in alignment of the track initiated the derailment.

Other safety factors

- **The ARTC's systems and operational procedures provided limited additional information or guidance to assist network control staff in identifying and assessing a potential threat to the serviceability of the infrastructure resulting from significant weather events. [Safety issue]**

Other key findings

- There was no anomaly identified in the train speed, handling, rollingstock condition, or operational performance preceding the derailment.
- In the lead up to the derailment of train 7SP3 there had been adequate warning of the significant weather event, the subsequent heavy rainfall and potential flood risk.
- The initial response by the ARTC to the significant weather event was generally in accordance with the organisation's policies and procedures.
- The flood event on the morning of 4 March 2012 exceeded a 50 year return rainfall event.

Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

Depending on the level of risk of the safety issue, the extent of corrective action taken by the relevant organisation, or the desirability of directing a broad safety message to the rail industry, the ATSB may issue safety recommendations or safety advisory notices as part of the final report.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

Response to significant weather events

Number:	RO-2012-002-SI-01
Issue owner:	Australian Rail Track Corporation Limited
Operation type:	Rail Transport Operator – rail infrastructure manager
Who it affects:	All rail infrastructure managers

Safety issue description:

The ARTC's systems and operational procedures provided limited additional information or guidance to assist network control staff in identifying and assessing a potential threat to the serviceability of the infrastructure resulting from significant weather events.

Proactive safety action taken by: Australian Rail Track Corporation Limited

A review of applied processes, sourcing of more timely information and trialling of remote monitoring stations at selected sites has been undertaken. The ARTC has engaged the services of a third party (March 2013) to provide an early warning network advising ARTC representatives, including the Train Transit Manager, of the likelihood of severe weather events such as high rainfall, winds and fire. The ARTC has also commenced trials of high water level monitoring equipment at two locations in South Australia with the option of further rollout if proved successful.

However, having safely managed equally significant flood events at other locations on the ARTC network by application of the existing processes, enhancement of applicable processes will be evaluated on a cost / benefit / risk exposure basis.

Action number: RO-2012-002-NSA-02

ATSB comment:

The ATSB is satisfied that the action taken by the ARTC has identified the risk posed by significant weather events and that the ARTC has emphasised the need to enhance applicable processes based on the assessment of risk exposure. The ATSB notes that the ARTC has not identified any actions to develop/improve operational procedures for implementation by network control staff when assessing response to a significant weather event.

ATSB safety recommendation to: Australian Rail Track Corporation Limited

Action number: RO-2012-002-SR-03

Action status: Released

The Australian Transport Safety Bureau recommends that the Australian Rail Track Corporation undertake further work on their systems and operational procedures that currently provide limited additional information or guidance to assist network control staff in identifying and assessing a potential threat to the serviceability of the infrastructure resulting from significant weather events.

General details

Occurrence details

Date and time:	4 March 2012 – 0715 EDT	
Occurrence category:	Accident	
Primary occurrence type:	Derailment	
Location:	Roto, New South Wales (approximately 707 track km west of Sydney)	
	Longitude: 33° 3.198' S	Latitude: 145° 26.607' E

Train details

Train operator:	Pacific National Pty Ltd	
Registration:	7SP3	
Type of operation:	Intermodal	
Persons on board:	Crew – 2	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Damage:	Minor	

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- Australian Rail Track Corporation Pty Ltd
- Bureau of Meteorology
- Pacific National Pty Ltd
- Transfield Services (Australia) Pty Ltd

References

ARTC Engineering (Track and Civil) Code of Practice, Section 10 Flooding, Version 2.2 dated 08 November 2011

ARTC Glossary, Issue 2.0 – Rev. 0, dated 19 Dec 2010

Bureau of Meteorology Monthly Weather Review New South Wales March 2012 Product code IDCKGC25R1. Prepared on 21 May 2012, ISSN 1836-3067

RISSB National Guideline Glossary of Rail Terminology, 3 December 2010

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to:

- Australian Rail Track Corporation Pty Ltd
- Pacific National Pty Ltd
- Transfield Services (Australia) Pty Ltd
- Office of the National Rail Safety Regulator
- Witnesses and individuals

Submissions were received from:

- Australian Rail Track Corporation Pty Ltd
- Pacific National Pty Ltd
- Transfield Services (Australia) Pty Ltd
- Office of the National Rail Safety Regulator
- Witnesses and individuals

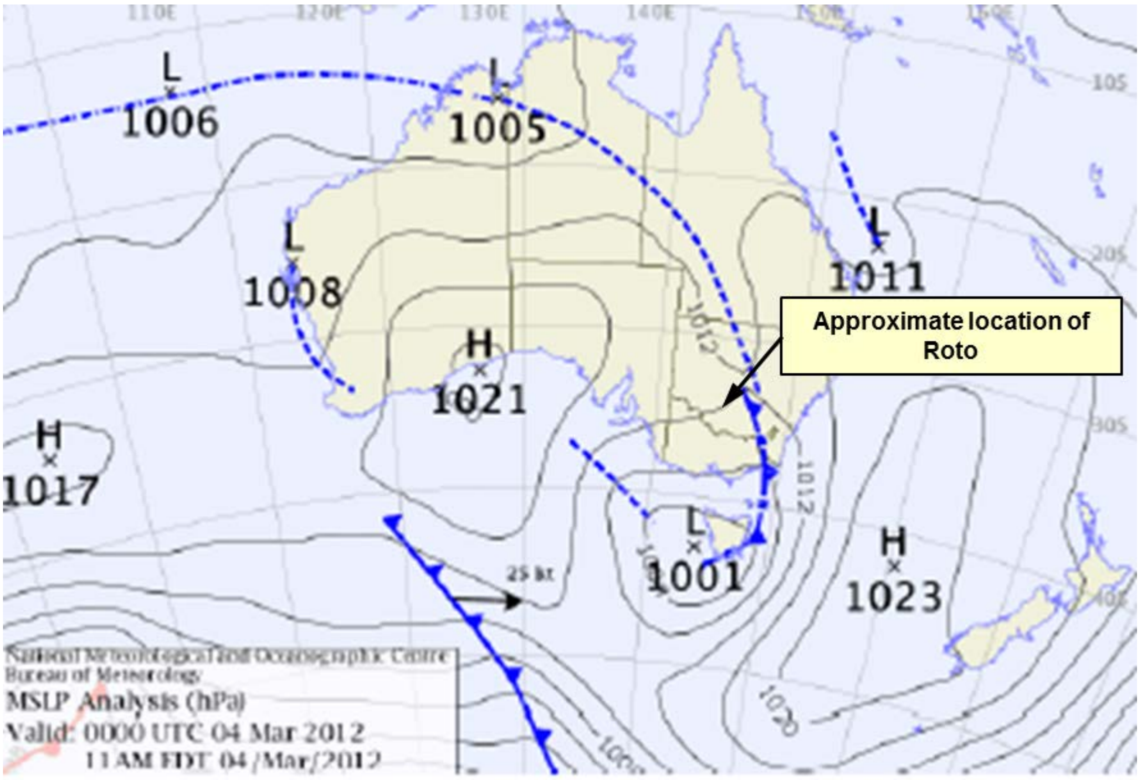
The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Appendices

Appendix A – Weather event and rainfall

The BoM Monthly Weather Review[17] recorded that NSW received a state-wide average rainfall of more than double the historical average for March 2012. This rainfall was from a slow-moving low-pressure trough that extended between northwest and southeast Australia (Figure 9). Humid air from the tropics had fed into this trough generating a sustained rainband through the western and southern part of NSW between 27 February and 4 March 2012.

Figure 9: Mean sea level pressure analysis 4 March 2012



Source: Bureau of Meteorology ©

Most of western and southern NSW recorded monthly totals three times their historical average with locations such as Ivanhoe, about 110 km to the west of Roto, receiving more than seven times the historical monthly average. Most of the significant rainfall recordings associated with this very severe rain event occurred during the first week of March. The rainfalls lead to widespread major flooding across NSW, particularly in the Lachlan and Murrumbidgee river systems respectively to the South and West of Roto.

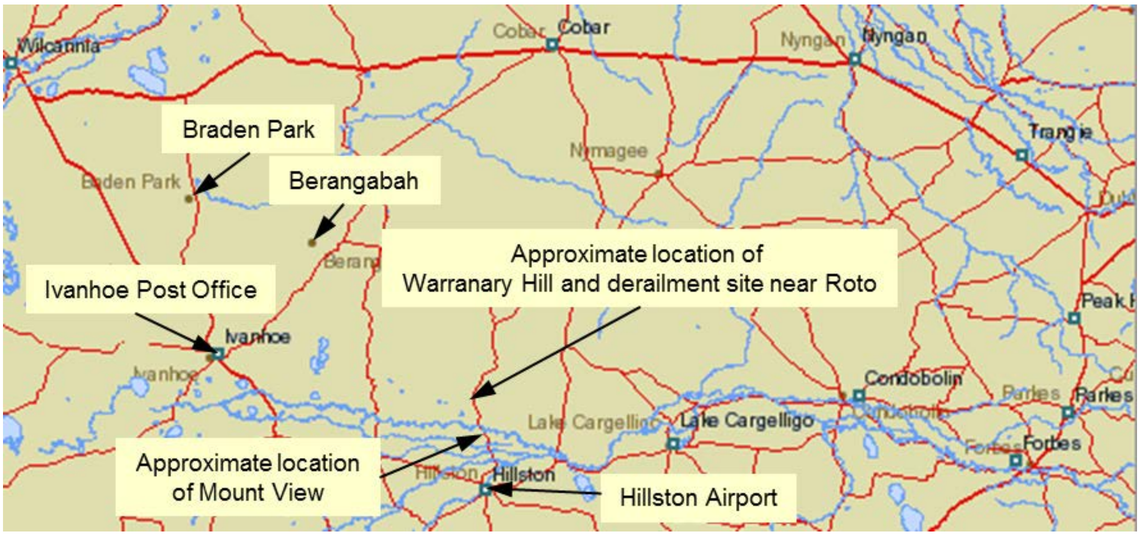
Rainfall data obtained from the BoM weather stations to the northwest and south of Roto (Figure 10) indicate significant rain fell in the week preceding the derailment. Heavy falls were recorded at each station during the 24-hour period to 0900 on 4 March 2012 (Figure 11).

The BoM site at Hillston (Mount View) situated about 20 km southwest of Roto, recorded a rainfall of 114 mm. This rainfall recording when compared to the rainfall intensity graph (mm per hour) for the Hillston area indicates that the intensity (averaged over the 24-hour period) was equivalent to

[17] Bureau of Meteorology Monthly Weather Review New South Wales March 2012 Product code IDCKGC25R1. Prepared on 21 May 2012, ISSN 1836-3067.

a 50-year event (Figure 12). If the duration of the rainfall occurred during a shorter period, the intensity would exceed a 50-year event.

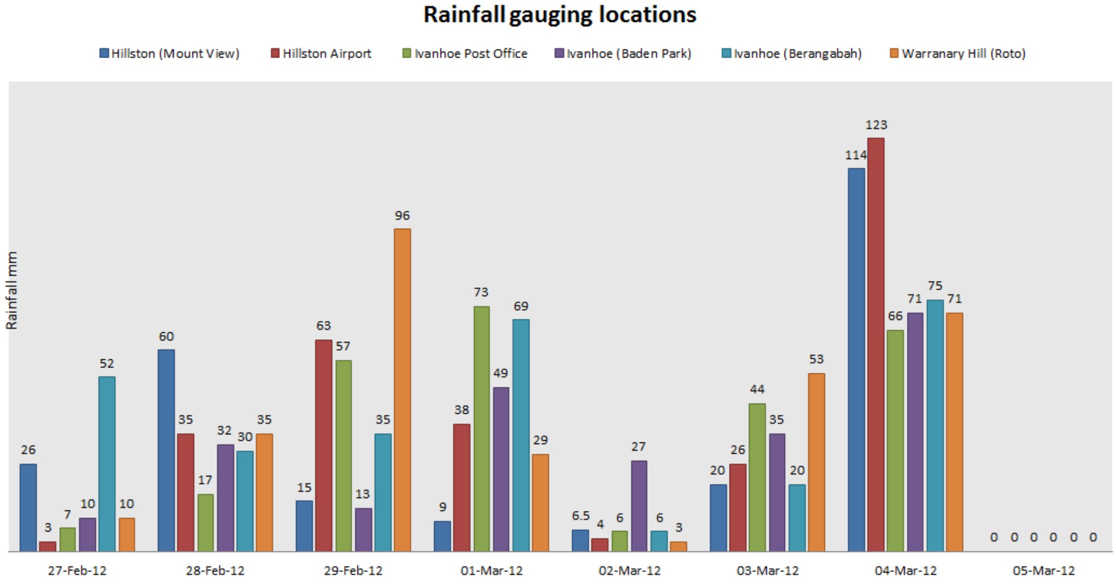
Figure 10: Bureau of Meteorology weather stations adjacent Roto



Source: Bureau of Meteorology ©

Records of rainfall obtained from a resident in the Roto area showed rainfall patterns similar to those recorded at the BoM sites during the week preceding the derailment. On the morning of 4 March 2012, the resident noted that intensity of the rainfall had been particularly heavy and the recorded fall of 71 mm had occurred within a short period of 3 to 4 hours (would exceed a 50 and potentially a 100-year rainfall intensity event based on the graph illustrated in Figure 12). This rainfall resulted in fencing being washed away at several locations and scouring in the flood-affected areas of the property that had not occurred with the previous falls that week.

Figure 11: Rainfall gauging recorded between 27 February and 5 March 2012[18]



Source: ATSB

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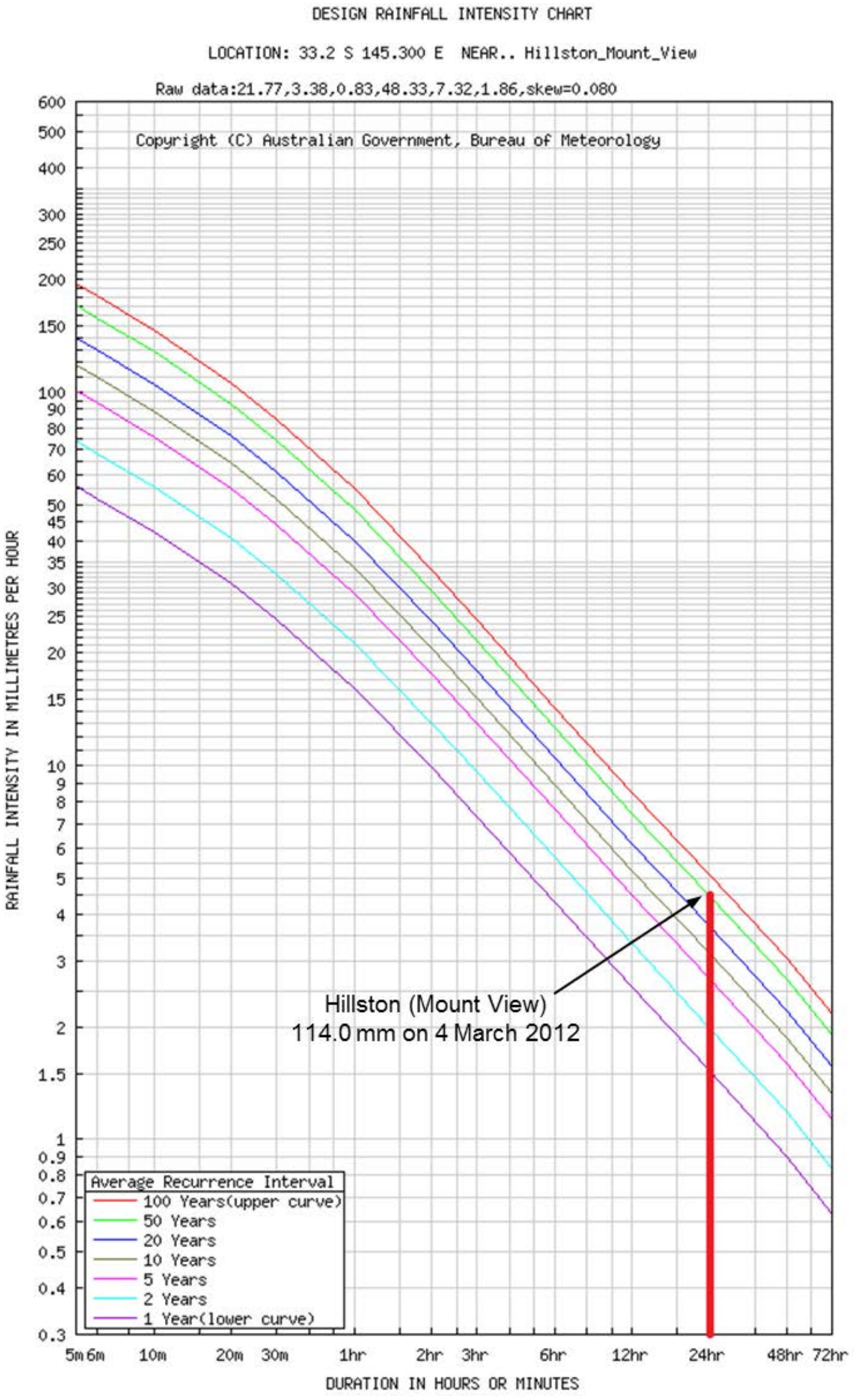
[18] Rainfall gauging obtained from Bureau of Meteorology excepting Warranary Hill (Roto), which was obtained from gauging recorded by local resident.

Figure 12: Bureau of Meteorology weather station Hillston, Mount View



Source: Bureau of Meteorology ©

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Australian Transport Safety Bureau

24 Hours 1800 020 616
Web www.atsb.gov.au
Twitter @ATSBinfo
Email atsbinfo@atsb.gov.au

Investigation

ATSB Transport Safety Report
Rail Occurrence Investigation
Derailment of train 7SP3, Roto, New South Wales, 4 March 2012

RO-2012-002
Final – 30 August 2013