RAIL SAFETY INVESTIGATION REPORT

TRACK WORKER FATALITY

BAAN BAA

22 MAY 2006
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TERMS OF REFERENCE

The Terms of Reference established by the Chief Investigator for the investigation into the circumstances surrounding the death of a railway track worker while engaged in ballast maintenance work near Baan Baa on the morning of 22 May 2006 prescribed that the purpose of the investigation was to:

- identify the factors, both primary and contributory, which caused the accident;
- identify whether the ballasting operation was being conducted according to procedures established by the Australian Rail Track Corporation for such work;
- identify whether the workers conducting the ballasting operation had been adequately trained in the use of the established procedures;
- identify whether the established procedures were appropriate for the safe conduct of ballasting operations;
- identify whether the incident might have been anticipated and assess the effectiveness of any strategies that were in place to manage the related risk/s;
- assess the effectiveness of emergency actions in response to the incident, and
- advise on any matters arising from the investigation that would enhance the safety of rail operations.
EXECUTIVE SUMMARY

The Incident

At approximately 9:00am on 22 May 2006, a track worker employed by the Rail Infrastructure Corporation (RIC) and seconded to the Australian Rail Track Corporation (ARTC) was fatally injured while participating in ballasting operations approximately 3km South of Baan Baa. The ballast train (5M23) was crewed by two Southern & Silverton Railway Pty Ltd (Silverton Rail) drivers and consisted of three locomotives and 22 ballast wagons, with a plough van at the rear (see Photo 1).

Photo 1: Ballast train 5M23 near Baan Baa

The fatally injured worker had been one of a team of three track workers who were controlling the distribution of ballast. A fourth worker operated the plough at the rear of the train, reducing the height of the ballast where necessary so that it was no higher than the rails. A fifth worker supervised the operation from the leading locomotive, while a sixth drove a support vehicle along the fire trail beside the track.

In order to maintain continuity of ballast distribution, the three track workers each rode at the front or rear of a loaded wagon to operate the ballast hopper door controls, alighting when the ballast in that wagon was depleted, and re-joining the train at a loaded wagon by means of the steps providing access to the walkway...
below the hopper door controls. In this manner the three workers commenced unloading from the front and worked their way toward the rear of the train.

The ballasting operation was continuous, with the three track workers generally being required to step off empty wagons and step onto loaded wagons while the ballast train was in motion. This involved moving to the centre of the upper walkway, stepping down onto the lower walkway, moving to the side of the wagon and using the side steps to climb down to the ballast shoulder. The configuration of the ballast wagon showing the walkways and side steps is shown in Photo 2.

![Photo 2: Ballast wagon](image)

The ballasting operation commenced at approximately 7:54am and was underway when at about 9:00am one of the three ballast wagon operators saw a colleague lying on the ballast shoulder. He alerted the rest of the crew and when they attended to the worker lying on the ballast, he was found to have a major head injury and to be deceased.

An OTSI investigator deployed to the site of the accident near Baan Baa and commenced a preliminary investigation on the day of the accident. As a result of the preliminary investigation, the Chief Investigator determined that the accident warranted formal investigation in accordance with Section 67 of the Rail Safety Act 2002 (NSW).
Findings

In relation to those matters prescribed by the Terms of Reference as the principal lines of inquiry, OTSI finds as follows:

a  Causation

i. The track worker died as a result of severe head injuries that were sustained by falling onto the ballast shoulder and being struck by a ballast hopper side door of a passing wagon.

ii. No-one witnessed the track worker’s fall so it cannot be positively determined whether he fell while getting off a moving ballast wagon, or while moving beside the track.

b  Contributory Factors

i. Stepping down from a moving rail vehicle is inherently dangerous and the danger is increased when stepping onto a loosely-packed, rough, sloping ballast shoulder and these were the prevailing conditions at the scene of the accident.

ii. At the time of the accident the ballast train was moving at a speed averaging between 9 and 10 km/h, significantly faster than the 4 to 6 km/h at which ballast is usually laid and this would have heightened the risks associated with movement onto and off the ballast wagons and movement on the ballast.

iii. The track workers sought to slow the train down but the radio that was normally available to them had been reallocated due to failure of the radio used by the plough operator. This meant that their request could not be communicated directly to, and therefore acted upon immediately by, the driver.

c  Anticipation and Management of Risk

i. Both the Work Method Statement\(^1\) and the Pre-Work Brief\(^2\) identified the dangers associated with the operation and classified the related

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\(^1\) The Work Method Statement is a document describing in detail the discrete tasks involved in a standard work activity, identifying the hazards associated with those tasks, and introducing controls to be applied in order to manage the risk.
risk as being “medium” in nature. While it is questionable whether a higher classification would have been appropriate, the documents failed to identify any means other than the exercise of care, to reduce the risk. In this regard the activity planning was deficient.

ii. The work plan specified a significantly greater amount of work than could be performed in the available time. Although this was said to be a common practice, in this case it resulted in an attempt being made to raise the tempo of the ballasting operation. As a consequence, the track workers were placed under pressure and therefore exposed to increased risk.

iii. The work plan contained no contingency provisions to be implemented in the event that communications equipment became unserviceable and there was no hand-held or other radio as a back-up to ensure continuity of radio communication in the event of an equipment malfunction. When this eventuated, no action was taken to restore communications or to compensate for the fact that the track workers did not have the means to communicate directly with the driver.

d Effectiveness of the Emergency Response

i. Emergency services responded swiftly but on arrival found the track worker to be deceased.

e Other Matters that would Enhance the Safety of Rail Operations

i. The risks associated with ballasting operations can be reduced significantly through the use of ballast wagons that can be operated by remote control, as it reduces the frequency with which track workers are required to ascend and descend ballast wagons.

ii. ARTC significantly improved its Work Method Statement (WMS) for the conduct of ballasting operations involving the use of NDFF

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2 The Pre-Work Brief is a task and safety assessment undertaken by a work team before any track work is commenced, and involves checks of the workers’ qualifications, competence and fitness for the task, identification of risks, and specification of the methods by which identified risks will be controlled.
ballast wagons in response to this incident. However, the procedure would benefit from further refinement, particularly with respect to communication and planning.

iii. This incident indicates that rail operators continue to operate locomotives in NSW that are not equipped with fully functioning data loggers. It is highly important that this be rectified both to provide operators with a useful management tool and to provide reliable data for use in the investigation of incidents that occur.

Recommendations

In order to prevent a recurrence of this type of incident, the following remedial safety actions are recommended for implementation by the organisations specified below:

a  Australian Rail Track Corporation Ltd

i. Further amend its Work Method Statement (WMS) – Unload NDFF Air Operated Ballast Wagons to:

(a) specifically identify those workers who must have a radio during ballasting operations and specifically include a requirement that all radios be tested prior to the commencement of each day’s ballasting operation;

(b) specify what constitutes a ‘normal walking speed’ and identify a speed which must not be exceeded during ballasting operations where any worker is required to walk alongside the train;

(c) specify the minimum number of workers that must be involved in a ballasting operation and define their roles and responsibilities;

(d) identify the contingencies that need to be factored into local planning and subsequently incorporated into the WMS, and referred to in safety briefings, and
(e) specify the requirement for a risk assessment to be conducted before making any changes to working arrangements, either prior to or during a ballasting operation, and specify who has the authority to make such changes.

ii. Ensure that all its employees who are required to participate in ballasting operations, included those who are seconded from RIC, and contractors it engages for the same purpose, are briefed on, understand, and fully comply with its ballasting procedures.

iii. Emphasise the importance of a proper appreciation by its work planners of the time needed to safely conduct track work.

iv. Emphasise the need to identify all of the risks associated with a specific task and the requirement to articulate specific control measures to adequately manage those risks.

v. Maintain its prohibition on workers stepping from or onto moving ballast wagons.

vi. Continue, and expedite if possible, its program to convert all ballast wagons so that they may be operated remotely.

vii. Equip all track workers with two-way radios when they are engaged in ballasting operations.

b RailCorp

i. Examine its own ballasting procedures in the light of the lessons arising from this accident.

c Southern & Silverton Railway Pty Ltd

i. Ensure that all of its locomotives comply with the legislative requirements for permanently-based radio systems and back-up radio systems.

ii. Take whatever actions are necessary to ensure that all of its locomotives are equipped with fully functioning and properly calibrated data recorders.
d The Independent Transport Safety and Reliability Regulator

i. Review the risk assessment that has underpinned the development of ARTC’s *Work Method Statement* (WMS) – *Unload NDFF Air Operated Ballast Wagons* and compare its revised requirements with those of RailCorp for the same type of activity to ensure there is a consistent approach to the planning and execution of ballasting operations within NSW.

ii. Monitor the adherence of ARTC and its employees, including contractors, to the revised procedures for ballasting operations.

iii. In light of continuing evidence that accredited rail operators are not meeting their obligations to ensure that locomotive data recorders are properly maintained and operational and are being used, accord higher priority to monitoring the condition and operation of such equipment and take appropriate enforcement action in instances where non-compliance is observed.

iv. Require all new locomotives to be equipped with automated electronic data recorders for operation in NSW.
PART 1 FACTUAL INFORMATION

Incident Synopsis

1.1 At approximately 7:40am (ESDT) on 22 May 2006, ballast train 5M23 departed Boggabri in order to lay ballast in the Boggabri to Turrawan rail section. At approximately 9:00am, one of three track workers who were controlling the distribution of ballast from the wagons saw a colleague lying on the ballast shoulder, and alerted the other crew members. On investigation, the worker lying on the ballast was found to have major head injuries and was deceased.

1.2 5M23, consisting of three locomotives, 22 ballast wagons and a plough van, was operated by Silverton Rail under contract to ARTC. The train’s crew consisted of the two Silverton Rail drivers and five track workers who were RIC employees seconded to ARTC. Three of the five track workers were designated to operate the ballast wagons, a fourth operated the plough van, while the fifth was designated as the ‘pilot’. A support vehicle, driven by another RIC employee also seconded to ARTC, travelled on a fire trail alongside the ballast train.

Incident Narrative

Before the Accident

1.3 5M23 departed Werris Creek at 4:30am on 22 May 2006 with a full load of ballast that had previously been loaded at Ardglen Quarry, and later stopped at Boggabri to pick up the five track workers. It subsequently departed Boggabri at 7:40am to perform ballasting operations at specified locations between Boggabri and Turrawan.

1.4 5M23’s timetable indicated that it had been required to depart Boggabri at 7:30am and that it was scheduled to arrive in Turrawan by 9:35am. The

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3 The pilot rides with the train drivers in order to co-ordinate the train operation with the needs of the ballasting schedule and the ballast wagon operators.
associated ballasting schedule required ballast to be unloaded and levelled at 19 locations en route and, discounting travel time between ballast drop locations, around 1.5 hours would have been available for this work.\(^4\)

1.5 At approximately 7:54am, ballast was placed along a 454 metre section of track just over 1km from the train’s earlier standing position in Boggabri. During this operation, the train travelled at a speed of approximately 4-6 km/h, a normal speed range for ballasting operations. The train then proceeded a further 7km before reaching the second location where ballast was to be placed, at around 8:35am. Ballast was then placed over a distance of around 2km over the next 25 minutes. The ballasting performed didn’t conform precisely to the work plan, with one planned drop of 600 metres being omitted and other drops differing in length from that specified in the plan.

1.6 When using manually controlled ballast wagons with pneumatic hopper door actuation, the track workers are required to ride on the ballast wagons to access controls that open and close the hopper doors. Once a wagon is emptied, the track worker alights onto the ballast shoulder and then steps onto a loaded wagon, with both movements generally occurring while the train is in motion.\(^5\)

The Accident

1.7 None of the workers saw their colleague actually fall, and their recollections of their work locations immediately prior to his fall are vague, and in some instances in conflict with other physical evidence such as the amount and location of ballast remaining in individual wagons, and the location of fresh ballast on the track. Despite careful analysis of information obtained in a number of interviews of the track workers and train crew by OTSI, ITSRR and investigating Police, it was impossible to reconcile this evidence. Under these circumstances, OTSI has relied primarily on physical evidence

\(^4\) The total distance between Boggabri and Turrawan is 32.5 km and the total distance over which ballast was to be laid therein was 7390m.

\(^5\) The usual practice is for the ballast wagon operators to work either singly or in pairs, and to start from the rear controls on the front ballast wagon and work rearwards.
obtained at the incident site, those witness accounts that are consistent with the physical evidence, and injury data provided by autopsy.

1.8 On inspection of the ballast train after the incident, the 6th wagon was found to be empty, the 7th had some ballast remaining on the right hand side, and the 8th was empty. As the deceased, (W1 in Figure 1), was reported to have been predominantly or exclusively unloading ballast on the right hand side and to have just finished unloading a wagon, the ballast remaining in the 7th wagon makes it unlikely that he was working on this wagon.

1.9 Worker 2 (W2) and Worker 3 (W3) agreed when interviewed that W3 was further towards the rear of the train than the other workers. He was therefore most likely to have been on the last empty wagon, the 8th.

1.10 As the last empty wagon before the 8th was the 6th, it is likely that this is the wagon on which W1 had just finished working, although there is another possibility canvassed later in this report.

1.11 The last stretch of fresh ballast laid on the right hand side of the train finished approximately 40 metres past the location of the body of W1.
1.12 W2 stated that immediately prior to the accident, W1 had signalled to him that the train was travelling too quickly. Shortly thereafter, W2 was seen by W3, who was distributing ballast from the 8th wagon, to be walking beside the left side of the train, the implication being that W2 had completed his work on one wagon and had climbed down onto the ballast shoulder to move to another wagon.

1.13 At about the same time as he saw W2 walking beside the train, W3, who had moved to the right side of the train, looked back towards the rear of the train and saw W1 lying on the ballast shoulder.

1.14 After seeing W1 lying on the ballast shoulder, W3 alighted from the train, which he estimates was travelling at about 7 km/h. W3 then signalled the co-driver to stop by waving his fluorescent orange vest, and walked back to where W1 was lying, observing that he had a severe head injury. By the time the train came to a stop, the body of W1 was level with the rear axle of the last ballast wagon, immediately preceding the plough van at the rear of the train. This meant that the train had travelled about 160 metres from the time W2 had first seen W1 lying on the ballast.

1.15 The driver reported that just prior to the incident he had been asked by the pilot to increase the speed of the train as they needed to be at Turrawan, a further distance of approximately 20 km, by 9:30am.6 Evidence obtained from data recorders on two of the locomotives, corroborated by witness accounts, indicates that the speed of the train was increased from an average of 6 km/h, to an average of around 9 km/h, and reached peaks of around 15 km/h.

1.16 Shortly thereafter the driver received a request from the plough operator by radio, to stop the train to allow a worker (presumably W2) who was walking alongside the train to get back onto the train. This request was significant because at normal operating speeds it would not generally have been necessary for the train to have stopped to allow the track worker to remount. The driver advised that he stopped the train and then released the

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6 As the section of track being used was single line, it was necessary for the ballast train to enter a siding at Turrawan in order to allow a scheduled passenger service to pass.
brakes in response to an “all clear” signal from the plough operator. Before the train moved he was again told to stop the train, this time by the co-driver. The co-driver’s direction was in response to having seen W3 waving his safety vest. Shortly afterwards, the driver received another radio communication from the plough operator asking that the train not be moved as one of the track workers (W1) was lying near the track and appeared to have been struck.

After the Accident

1.17 Upon being told that a worker had been struck, the pilot alighted from the leading locomotive and went towards the rear of the train. As he did so, the driver received a further radio communication from the plough operator who requested that an ambulance be called. After calling for an ambulance on his mobile phone, the driver also alighted from the locomotive and walked towards the rear of the train to reach W1. Upon doing so he felt for, but was unable to detect, a pulse. The driver then made a second call for an ambulance, and was told that one was on its way. During this call, the driver informed the emergency services telephone operator that it was his opinion that W1 was deceased.

Location of the Accident

1.18 The accident occurred at kilometrage 527.275\(^7\), approximately 2km south of Baan Baa, a small town on the Kamilaroi Highway. The single line section of track between Boggabri and Turrawan is part of the branch line between Werris Creek and Moree. When approaching the accident location from the South, the track has a down gradient varying from a maximum of 1 in 72 at a point 4km to the South, through 1 in 134 at the accident location, to substantially flat at Baan Baa. The location of Baan Baa and that of the accident are depicted in Figure 2, and Photo 3 shows the surrounding terrain.

\(^7\) All rail distances in NSW are measured from Central Station in Sydney.
Train Information

1.19 5M23 consisted of three locomotives (KL81, T387 and 602), 22 NDFF ballast wagons and an NDPF plough wagon. 5M23 was 318 metres in
length and had a gross tonnage of 1911 tonnes on departure from Boggabri.

1.20 NDFF ballast wagons are constructed of steel and are 11.86 metres in length. They have an unladen mass of 19.8 tonnes and a capacity of 54 tonnes. Ballast is loaded through an open top into a hopper that is divided laterally in the centre by a part-height structure that serves primarily to reinforce the hopper sides, but which also partially divides the hopper into two compartments, as shown in Photo 4.

![Photo 4: Internal bracing of ballast wagon](image)

1.21 Ballast is distributed onto the track from the hopper through eight pneumatically operated hopper doors, two of which are located either side of the wagon. There are also four doors in the centre of the wagon’s floor. The position of the side doors is indicated in Photo 5. The side doors are controlled in pairs and the centre doors as a single group, so that ballast is released from both the front and the rear hopper compartment of each wagon simultaneously. The doors are controlled by a ballast operator manipulating pneumatic control valves, replicated in sets of three at each corner of the wagon, as shown in Photo 6.
1.22 In order to operate the ballast controls, the operator stands on a lateral walkway, accessible only at its centre from a lower lateral walkway between access ladders on each side of the wagon. There are controls and walkways at each end of each wagon and these are depicted in Photo 6 and Photo 7 respectively.
1.23 The final wagon is a plough van, incorporating a lateral plough blade under the wagon. The plough, which is operated by a worker walking alongside the wagon, can be raised and lowered, and its angle adjusted, by means of wheels on either side of the wagon. The purpose of the plough is to ensure that the level of the newly laid ballast is not higher than the rails. The plough van and its controls are depicted in Photos 8 and 9 respectively.
Communication Equipment

1.24 The train crew had access to the following communication equipment to enable contact with Train Control and Signallers;

a. a WB 450.050 MHz portable radio handset, and
b. a mobile telephone.

1.25 On departure from Boggabri there was a radio in the locomotive, the plough operator had a WB radio handset provided by the pilot, and W1 had a WB radio handset. The plough operator’s radio had not been tested prior to departure, and at the first ballast drop, it was realised that it was not working. Consequently W1 gave his radio handset to the plough operator. There were then only two working radios available, one shared by the drivers and the pilot in the lead locomotive, and one with the plough operator.

1.26 The lead locomotive (KL81) was on lease from Chicago Freight Car Leasing Australia and was not yet equipped with a fixed radio system as now required by Rail Safety (General) Regulation 2003, issued on 31 March 2006 but not to come into effect until 1 September 2006.
Employee Information

1.27 W1 had been employed within the rail industry since 1972. His role throughout his 34 years of employment was predominantly within rail infrastructure and track maintenance. Examination of W1’s work history indicated that he was regarded as a highly experienced railway worker. W1 was seconded to ARTC in September of 2004 and continued to work in the same role and to remain in the Narrabri district under this new arrangement. His local knowledge and experience were highly regarded by his co-workers.

1.28 The drivers and the other members of the ballasting team were likewise very experienced, each having spent at least 20 years in the rail industry. The members of the ballasting team were all experienced in ballast operations, although the plough operator’s last experience on a plough van was estimated by him to have been four years ago, and the pre-work briefing he conducted on the day of the accident was the first he had been required to conduct.

Injuries

1.29 A post mortem determined that W1 sustained a fractured right collar bone, a 10cm laceration to the right elbow, and multiple compound fractures to both sides of the skull. The fractures to the left side of the skull were particularly severe, resulting in severe damage to the brain, and the cause of death was documented as “Compound fracture of the skull (multiple fractures)”.

Medical and Toxicological Information

1.30 OTSI was provided with the results of the toxicological analysis of samples obtained during the post-mortem examination of W1. These indicated the presence of:

a. a low level of Chlorpheniramine,
b. Paracetamol, at a therapeutic blood level\(^8\),

c. Pseudoephedrine, at a level moderately higher than the therapeutic blood level, and

d. Theophylline, at a level below the therapeutic blood level.

1.31 Chlorpheniramine and Pseudoephedrine are commonly combined, sometimes with Paracetamol, in medication for the relief of influenza symptoms, sinus pain and congestion. In the opinion of the pathologist who performed the autopsy, the levels at which these medications were detected was consistent with their prescribed use. Theophylline is an asthma therapy prescribed to treat severe, persistent asthma, but now in declining use.

1.32 No alcohol or illicit substance was found to be present.

1.33 Having given consideration to the known side effects of the detected medications and on the basis of advice from the pathologist and a toxicologist, OTSI formed the view that these medications had no direct bearing on the incident.

1.34 The track workers and train drivers were subject to breath analysis administered by the attending Police. OTSI noted that one of the track workers recorded a reading of .078\(^9\). Subsequent testing at Boggabri Police Station, resulting in a reading of 0.080. The limit permitted under the *Rail Safety (Drug and Alcohol Testing) Regulation 2003* for employees carrying out rail safety work is 0.02 grammes of alcohol in 210 litres of breath or 100 millilitres of blood. While the fact that this worker was operating with a blood alcohol content well above this limit is of serious concern, OTSI does not consider that this had a bearing on the circumstances of the accident.

1.35 A detailed examination of the accident scene revealed what appeared to be fresh blood on a ballast door on the right hand side of the 9\(^{th}\) ballast hopper. A sample was obtained by the Police for analysis, but this analysis was not

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\(^8\) The therapeutic blood level is that concentration of drug and/or its active metabolite(s) present in the blood (serum or plasma) following therapeutically effective dosage in humans

\(^9\) This indicates the presence of 0.078 grammes of alcohol per 210 litres of breath.
performed and unfortunately the sample was subsequently destroyed. Based on its freshness and distribution on the ballast door, OTSI is of the opinion that the blood deposit was a result of heavy contact between the ballast door and the body of the deceased track worker.

**Meteorological Information**

1.36 The train crew described the weather conditions at the time of the incident as clear and sunny. Bureau of Meteorology records for Narrabri showed an overnight minimum of 3.3°C and a temperature at 9:00am of 10.0°C. Later in the day the temperature reached a maximum of 21.5°C. The relative humidity at 9:00am was 65%, and wind speed was 4 km/h from the North East. OTSI does not consider that the weather conditions had a bearing on the circumstances of the accident.
PART 2  ANALYSIS

Causation

2.1  W1 was found, deceased and with severe and obvious head injuries, lying beside the ‘Up’ side of the railway track with his head approximately 500mm from the rail and his body down the sloping shoulder of the ballast. It was later determined that W1 had sustained multiple fractures of the skull and severe brain injuries, consistent with having been struck by a sharp, rigid object. While it is possible that W1 could have sustained head injuries during a fall while alighting from a wagon, blood was found on a ballast hopper side door rearward from the wagon on which he had last been seen. The area of the blood deposit is indicated in Photo 10. This evidence is highly significant in that had W1 been killed by a fall from a wagon, or even rendered unconscious by such a fall, the height of the lowest part of the hopper door (at least 400mm from the level of the ballast) was such that it would have passed over, and not come in contact with, his head.

![Location of strike point on hopper door](image)

**Photo 10:** Location of strike point on hopper door

2.2  As indicated at 1.9, W3 was further towards the rear of the train than the other workers. As W3 had also just finished unloading a wagon, his most likely location was on the last empty wagon, the 8th.
2.3 As the last empty wagon before the 8th was the 6th, it is likely that this is the wagon on which W1 had just finished working, and that W2, who stated that he was on the wagon in front of W1, was mistaken and was in fact on the wagon immediately behind him, the 7th.

2.4 Another possibility is that W1 was on the 7th wagon and W2 was on the 6th wagon as his statement suggested, and that for some unknown reason W1 climbed or fell from the 7th wagon before it was fully emptied.

2.5 The last stretch of fresh ballast laid on the right hand side of the train finished approximately 40 metres past the location of the body of W1. This means that if this ballast had been laid by W1, he would have then had to close the ballast doors, alight from the wagon and walk back to the location at which he was found, before being struck by the ballast door on the 9th ballast wagon. During the time taken to walk this distance, the train would have travelled approximately twice the distance he walked, as the speed of the train was approximately twice a comfortable walking pace. This scenario can be discounted, as it would have required W1 to have alighted from a location approximately 120 metres forward on the train from the 9th wagon, this being the location of the third locomotive. It is probable therefore that the last stretch of ballast was not laid by W1, but by W3.

2.6 As indicated earlier, W2 stated that immediately prior to the accident, W1 had signalled to him that the train was travelling too quickly. W2 interpreted this as a request that the train be slowed, presumably so that W1 could step down to move to another wagon. This communication from W1 to W2 rather than directly to the driver was necessary because W2 was on the same side of the train as the driver and was visible to the driver in his mirror, whereas W1 was not. Shortly thereafter, W2 was seen by W3, who was distributing ballast from the 8th wagon, to be walking beside the left side of the train, the implication being that W2 had completed his work on one wagon and had climbed down onto the ballast shoulder to move to another wagon.

2.7 At about the same time as he saw W2 walking beside the train, W3, who was now on the right side of the train, looked back towards the rear of the
train and saw W1 lying on the ballast shoulder. W3 immediately alighted from the train, which he estimates was travelling at about 7 km/h, signalled to the co-driver to stop by waving his fluorescent orange vest, and walked back to where W1 was lying, observing that he had a severe head injury. By the time the train came to a stop, the body of W1 was level with the rear axle of the last ballast wagon, immediately preceding the plough van at the rear of the train. This meant that the train had travelled about 160 metres from the time W2 had first seen W1 lying on the ballast.

2.8 Another possibility is that W1 fell to the ballast while trying to climb onto a full ballast wagon to continue his work. This is considered unlikely because he was struck by the front hopper door of the first full ballast wagon. Had he been intending to climb onto this wagon he would have done so by use of the rear ladder. It is also possible that W1 fell while trying to step onto either the 7th or the 8th wagon, perhaps to speak to a colleague or to complete the emptying of the 7th wagon.

2.9 A further possibility is that W1 fell while walking towards the rear of the train. While this possibility cannot be discounted, it is considered less likely because it would have been more difficult for his head to have come into contact with the front hopper door had he fallen downwards from a position beside the ballast wagon, as opposed to falling from a ladder which is effectively ‘in-set’ relative to the side of the wagon. Given these four possible scenarios all involved a fall, OTSI therefore focussed on what might have caused W1 to fall.

2.10 The driver reported that just prior to the incident he had been asked by the pilot to increase the speed of the train as they needed to be at Turrawan, a further distance of approximately 20km, by 9:30am\textsuperscript{10}. Evidence obtained from data recorders on two of the locomotives, corroborated by witness accounts, indicates that the speed of the train was increased from an average of 6 km/h, to an average of around 9 km/h, and reached peaks of around 15 km/h.

\textsuperscript{10} As the section of track being used was single line, it was necessary for the ballast train to enter a siding at Turrawan in order to allow a scheduled passenger service to pass.
2.11 Shortly thereafter the driver received a request from the plough operator by radio, to stop the train to allow a worker (presumably W2) who was walking alongside the train to get back onto the train. This request was significant because at normal operating speeds it would not generally have been necessary for the train to have stopped to allow the track worker to remount. The driver advised that he stopped the train and then released the brakes in response to an “all clear” signal from the plough operator. Before the train moved he was again told to stop the train, this time by the co-driver. The co-driver’s direction was in response to having seen W3 waving his safety vest. Shortly afterwards, the driver received another radio communication from the plough operator asking that the train not be moved as one of the track workers (W1) was lying near the track and appeared to have been struck.

2.12 Based on the foregoing evidence and analysis, and notwithstanding the degree of uncertainty surrounding the exact sequence of events, it is OTSI’s view that the track worker’s death was caused by his head being struck by a ballast hopper door on a ballast wagon as a consequence of falling on a rough and unstable ballast shoulder as he alighted from or walked alongside a ballast train travelling at a higher speed than was usual for such ballast operations.

**Contributory Factors**

**Local Conditions**

2.13 Alighting from and rejoining a moving rail vehicle is an inherently dangerous practice, notwithstanding the fact that it had been a standard practice for many years. OTSI noted that the ballast surface at the location of the incident sloped downwards, from a narrow shoulder, at an angle of between 22° and 28°, and that the width of the level part of the ballast from one side of the track to the other, although variable, was generally around 3 metres, similar to the 3.05 metre width of the ballast wagons. Consequently, in order to reach a position clear of the train while it was moving, a worker
alighting from a moving ballast wagon would have had to step back away from the train and onto a surface that was sloping and unstable underfoot.

**Speed**

2.14 The operating speed of ballast trains equipped with wagons that must be controlled manually is dictated by the pace at which track workers can mount and dismount wagons while they are in motion, and typically is considered to be between 4 and 6 km/h.

2.15 Each of the 5M23’s locomotives was fitted with a Hasler data recorder, designed to record time, distance, speed, brake pipe pressure, throttle position and (on the lead locomotive) vigilance response by means of stylus traces on a paper tape. When OTSI examined the tapes from the three data recorders it identified that they were not fully functional or properly calibrated. There were no brake pipe pressure or vigilance response traces and the time was incorrectly set on the leading locomotive (KL81) as is indicated in *Figures 3 and 4*. No record was available from the second locomotive (T387) as the recorder was not functioning correctly, and the tape from the third locomotive (602) had no time trace (see *Figure 5*).

2.16 There are two characteristics of Hasler data recorders that are pertinent to interpretation of the speed records from locomotives KL81 and 602. Firstly, the accuracy of the speed indication is related to the diameter of the wheels on the axle from which the speed signal is generated, resulting in an error in the indicated speed ranging from -3.5% on new wheels, to +3.5% on fully worn wheels. This error has not been accounted for in this analysis as its magnitude is not considered by OTSI to be of significance. Secondly, it is common for the speed stylus to not return to a true zero, and this is evident on both speed traces, with an indicated speed of 4 km/h on KL81 and 6 km/h on 602 when the train is stationary after the accident. That this is a failure to return to a true zero can be seen by examination of the traces where on occasions a true zero is indicated (examples being when the train came to a stand at Boggabri and after the first ballasting drop, as shown in *Figure 3*) and by comparing the speed trace with a speed calculation made from the time and distance record on the tape. It is OTSI’s opinion that the
speed recording from KL81 is the more accurate, with the recording from 602 indicating approximately 2 km/h fast.

Figure 3: Hasler tape from locomotive KL81

Figure 4: Close-up of Hasler tape from locomotive KL81
2.17 Notwithstanding that the data recordings were incomplete, OTSI was able to form a view about the manner in which 5M23 had been operated prior to the incident. Specifically, the available recordings indicate that for the first 20 minutes of the final group of ballast drops before the accident the train had averaged 6 km/h, while for the last 5 minutes this average was 9.6
km/h\textsuperscript{11}, i.e. around double the speed at which ballasting operations are normally conducted. During this final period of 5 minutes the train speed varied cyclically from a minimum of approximately 3 km/h to a maximum of approximately 13 km/h as shown in Figure 7, the speed variation being due to the train accelerating due to throttle application and the downhill slope of the track, and then being slowed by use of the independent locomotive brakes. The use of independent brakes is generally preferred by ballast train drivers as it provides good braking response, but significantly it leaves no trace on the data recorder.

![Figure 7: Comparison of speed traces for KL81 and 602](image)

2.18 The driver of 5M23 stated that his usual speed during ballasting was 4 – 6km/h, but in this instance he was operating at 8 – 10 km/h as the pilot had requested a speed increase in order to reach Turrawan by 9:30am to allow

\textsuperscript{11} The average speeds quoted are calculated from the time and distance records on the Hasler chart for KL81.
passage of a passenger service. Given that the only delay during the ballasting operation up until the time of the accident had been the loss of 10 minutes\(^1\), OTSI thought it necessary to examine the time and space considerations that underpinned the scheduling of the day’s ballasting operation.

2.19 As previously mentioned, the work plan prepared for the team identified 19 locations where ballast was to be laid and these are indicated in Figure 8.

<table>
<thead>
<tr>
<th>Ballast location(^1)</th>
<th>Start of drop</th>
<th>End of drop</th>
<th>Drop length</th>
<th>Distance between drops</th>
<th>Cumulative distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boggabri</td>
<td>515.170</td>
<td>516.680</td>
<td>0.330</td>
<td>1.180</td>
<td>1.510</td>
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<tr>
<td>Down</td>
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<td>524.250</td>
<td>0.880</td>
<td>5.200</td>
<td>5.980</td>
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<td>0.200</td>
<td>0.400</td>
<td>10.330</td>
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<tr>
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<td>526.500</td>
<td>0.600</td>
<td>0.400</td>
<td>11.330</td>
</tr>
<tr>
<td>Up, Down</td>
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<td>0.400</td>
<td>0.550</td>
<td>12.280</td>
</tr>
<tr>
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<td>0.200</td>
<td>1.900</td>
<td>15.530</td>
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<tr>
<td>Baan Baa</td>
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<td>536.450</td>
<td>0.300</td>
<td>1.850</td>
<td>21.230</td>
</tr>
<tr>
<td>Up</td>
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<td>536.900</td>
<td>0.150</td>
<td>0.300</td>
<td>21.730</td>
</tr>
<tr>
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<td>542.050</td>
<td>0.450</td>
<td>4.700</td>
<td>26.880</td>
</tr>
<tr>
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<td>542.330</td>
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<td>0.050</td>
<td>27.160</td>
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<td>0.170</td>
<td>27.680</td>
</tr>
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<td>543.900</td>
<td>0.800</td>
<td>0.250</td>
<td>28.730</td>
</tr>
<tr>
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<td>544.600</td>
<td>0.300</td>
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</tr>
<tr>
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<td>0.300</td>
<td>0.100</td>
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</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>32.430</td>
</tr>
</tbody>
</table>

**Figure 8:** Planned ballast drops

2.20 The work plan for the ballasting operation required ballast to be laid over 7.4 km of track within a total distance of 32 km. The time provided for this

\(^1\) 5M23 was scheduled to leave Boggabri at 7:30am but the driver indicated that it left at 7:40am.

\(^2\) The term “Up” refers to the left hand side of the track when looking towards Sydney Central, while “Down” refers to the left hand side of the track when looking away from Sydney Central. The measurements given for start and finish of ballast placement are distances from Sydney Central.

\(^3\) Post-incident inspection indicated that the ballast drop at 525.900 to 526.500 did not occur.
work to be performed was 90 minutes. Assuming an average train speed of 5 km/h while dropping ballast, the ballast operation required just less than 89 minutes, leaving negligible time to cover the required distances between ballast drops.

2.21 In order to satisfy the requirement for the train to be in Turrawan by 9:35am it was planned to cease ballasting operations at 9:10am. At some time before 9:00am, when it should have been clear that the work could not be completed in the remaining time, a decision was taken to increase the speed of the train in order to fit more of the planned work into the remaining time. This decision placed pressure on the crew to work at an uncomfortably fast pace as evidenced by the consequent request by a ballast operator for the train to be slowed.

Communications

2.22 The decision to speed up the ballasting operation was always going to impact most heavily upon the track workers because they were the ones who were required to step off and onto moving wagons. The limitations of the decision to speed-up were quickly made apparent when W1 indicated to W3 that the train was travelling too quickly, and again when W2 was unable to re-join the train after alighting. It is significant that the subsequent request to stop the train had to be conveyed by hand signal because the one radio available to the three track workers had been reallocated from W1 to the operator of the plough earlier in the morning. The effect of the reallocation was that none of the three workers who were the most exposed to risk had the means to communicate their requirements directly to the train driver. Had W1 had direct communication with the train driver, he may have been able to effectively communicate his concerns about 5M23’s speed before he commenced to step down from the wagon. Irrespective, OTSI has strong reservations about the fact that only one of the three track workers was ordinarily provided with a radio, given that the nature of their work meant that they were not in a position to maintain visual contact with each other or the train driver at all times.
Anticipation and Management of Risk

Policy

2.23 The manner in which ARTC requires ballasting operations using NDFF ballast wagons to be conducted is detailed in a policy document called a Work Method Statement and entitled Unload NDFF Air Operated Ballast Wagons. This WMS listed the steps involved in the operation, the hazards inherent in the task, and the controls to be applied in order to minimise the associated risk. It was issued in September 2005 with a requirement that it be read by all, and was progressively being read out in safety meetings for the benefit of some ballast workers who couldn’t read. None of those working on 5M23 on the day of the accident could recall having been specifically briefed on the WMS, but all maintained that its procedures described their normal way of working.

2.24 The WMS identified hazards associated with train movement and working on uneven surfaces. It specified that ballasting trains were to move at “walking pace” while ballast was being unloaded, and were to be stationary when the ballast plough was being locked or unlocked. It recognised by inference the need for the plough operator to walk beside the plough wagon during the placement of ballast. It also identified the key roles of Protection Officer, Ballast Ganger (the foreman of the ballast crew) and Driver and highlighted the importance of adequate radio communication and the need for those fulfilling these key roles to remain in communication at all times. Significantly the WMS made no reference to:

a. what was considered to be a normal walking pace,

b. the risks associated with workers getting off and onto moving ballast wagons, and

c. the need for back-up communications.

Task-related risk assessment and safety arrangements

2.25 OTSI’s examination of the planning documentation associated with the day’s operation and its questioning of those involved in its production, established that:
a. while the track workers, plough operator and pilot had attended a pre-working briefing, the train driver and his assistant had not;

b. the Work Site Protection Plan identified the pilot as Protection Officer, but there was no indication of the identity of the Ballast Ganger;

c. at the pre-work briefing, the hazards associated with moving on an uneven surface and climbing up onto and down from the train were identified and were classified as being “Medium”, with a low residual risk if care was taken to keep clear of the moving train and of trackside obstructions;

d. there was no reference to the fact that the ballast shoulder would be quite narrow and sloping in places, and

e. the only risk control measure identified was the need to “keep clear”, a reference to the need to be aware of trackside obstructions, particularly when alighting from a wagon.

2.26 As mentioned in paragraph 2.20, OTSI’s examination of the work plan also identified that the morning’s tasking was somewhat unrealistic. When asked to comment about this, ARTC advised that its workers always had the prerogative to vary a work plan and in fact the ballasting that did occur on the morning of 22 May 2006 did deviate from the plan, as is indicated in paragraph 1.5. Notwithstanding, at a point at which a decision should have been taken to cease ballasting, in order to reach Turrawan by 9:30am, it was decided to continue and speed-up the ballasting. A more realistic appreciation of the time that would be required to complete the amount of ballasting that was scheduled may have precluded such deviations and the subsequent decision to expedite the ballasting.

2.27 In addition to the limitations of the pre-work planning, there were two instances during the morning when some form of additional risk assessment should have occurred: when it was realised that one of the radios was unserviceable, and when the request was made by the pilot to speed-up the ballasting operation. In the first instance, a quick reference to the planning documentation would have established that the communication
arrangements require under the WMS could not be achieved with only two radios. While this did not necessarily mean that the ballasting operation could not commence, it did mean that consideration had to be given to the effect that improvised communication arrangements would have and the obvious effect was that communication would be more difficult, and the ballast operation would consequently be slowed. Had this conclusion been reached, it is unlikely that the pilot would have sought to speed up the train’s operation and even less likely that the plough operator would have agreed to the request.

2.28 OTSI also believes that it would have been appropriate to have given consideration to the need for additional safety precautions once it was decided to reallocate the track workers’ radio. This might have taken the form of slowing the ballasting operation from the outset and/or requiring the plough operator and the pilot to monitor the movement of the track workers. OTSI notes in this regard that WorkCover NSW’s Code of Practice for Moving Plant on Construction Sites, 2004 makes specific reference to the need to consider the use of spotters or safety observers to control traffic movement. While this Code was primary written to address safety needs within the building industry, OTSI notes that it is applicable in certain circumstances to activities being undertaken within the rail corridor. Irrespective, it provides valuable guidance which can be factored into the planning of track maintenance.

Adequacy of the Emergency Response

2.29 Prior to exiting the locomotive, the driver secured his train properly and called ‘000’. Records show that the NSW Ambulance Service was alerted to the accident at approximately 9:05am and the related communication had been concluded at 9:09am. They also show that an ambulance from Narrabri arrived at the scene at 9:24am. Shortly thereafter, the ambulance officers advised their Operations Centre that W1 was deceased. Some time later they transported the driver, who was visibly distressed, to Narrabri.

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15 The Driver secures the train by applying the independent brakes on the locomotives, and the train brakes, using the controls on the lead locomotive.
Hospital. Given the location and circumstances of the accident and the limited communication facilities available to the track workers and the train crew, OTSI considers the emergency to have been responded to in a very timely fashion.

Other Safety Matters

5M23’s Communication Equipment

2.30 The Special Commission of Inquiry into the Glenbrook Rail Accident (1999) recommended that all trains operating on the NSW network be able to communicate across the network. The Special Commission of Inquiry into the Waterfall Rail Accident (2005) expanded on this recommendation by further recommending that all train radio systems “be capable of receiving and transmitting emergency calls; be fitted with an emergency button that enables an emergency call from a train to have priority over other calls and that enables direct communication between the train and the network control officer responsible for the area in which the train is operating”. This recommendation was subsequently acted upon by ITSRR and new communication requirements were reflected in the Rail Safety (General) Amendment (Miscellaneous) Regulation 2006. OTSI notes that 5M23 was not yet equipped with communication equipment capable of providing a blanket emergency broadcast across the radio network in order to meet the amended regulation that was to come into effect on 1 September 2006. However, even if the locomotive had been so equipped it would have had no bearing on the consequences of the incident as in this instance the emergency response was not impeded by the lack of such equipment.

2.31 5M23’s data loggers did not satisfy the terms of Southern & Silverton’s Access Agreement as one was not functioning and neither of the other two was fully operational. That said, OTSI notes that Southern & Silverton is not alone in paying insufficient attention to the requirement that event recorders be properly maintained and calibrated. OTSI is cognisant of the fact that the Independent Transport Safety and Reliability Regulator has

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recently issued guidance relating to installation and maintenance of data loggers\textsuperscript{17}, but in the face of a continuing lack of evidence of improvement by operators, OTSI is of the view that the guidance needs to be reinforced.

**Remedial Actions**

2.32 In response to the accident, ARTC immediately suspended all ballasting operations pending the outcome of an internal investigation.\textsuperscript{18} It subsequently lifted this suspension, but not before it reviewed and redrafted the *Work Method Statement (WMS) – Unload NDIFF Air Operated Ballast Wagons*. ARTC published the revised WMS on its intranet site and emphasised the revised requirements in subsequent training. The effect of the changes are that:

a. all persons involved in a ballasting operation, including train drivers, are required to receive a pre-work briefing;

b. enhanced radio communication, including the provision of back-up radios and mobile phones, is required;

c. ballast wagon operators must remain fully within their work stations at all times while the train is moving;

d. ballast trains must be brought completely to a stand throughout ballast operations before operators alight from the train;

e. observers are required for ballast and plough operators throughout ballast operations, and

f. the speed of ballast trains is restricted to a ‘walking pace’ throughout ballast operations.

2.33 OTSI considers that ARTC’s revised WMS is improved, but would be further improved by:

a. specifically identifying those workers who must have a radio during ballasting operations and by specifically including a requirement that

\textsuperscript{17} ITSRR Guidance for Train Data Loggers, July 2007.

\textsuperscript{18} ARTC has advised OTSI that it is unable to finalise its report until the findings of the related coronial inquiry are known.
all radios be tested prior to the commencement of each day’s ballasting operation;

b. specifying what constitutes a ‘normal walking speed’ and identifying a speed which must not be exceeded during ballasting operations where any worker is required to walk alongside the train;

c. specifying the minimum number of workers that must be involved in a ballasting operation and defining their roles and responsibilities;

d. identifying the contingencies that need to be factored into local planning and subsequently incorporated into the WMS, and referred to in safety briefings; and

e. specifying who has the authority to change working arrangements prior to or during a ballasting operation, and identifying the need for a risk assessment to be made before changes are effected.

2.34 In addition to revising the WMS for ballasting operations involving the use of NDFF air operated wagons, ARTC has commenced to convert all of its NDFF ballast wagons so that they can be operated remotely.

**Summary**

2.35 Ballasting operations are conducted throughout the NSW rail network on a daily basis. While the risks associated with such operations are well known, they were not comprehensively articulated in ARTC’s related policy document. In addition, some of those risks were not given sufficient consideration during the planning and briefings that preceded the conduct of the ballasting operation within which the track worker was fatally injured. As a consequence, the amount of work that was planned for the morning exceeded that which was possible and there was no contingency identified in the plan in the event that the work fell behind schedule. When that eventuality arose, a decision was taken to speed up the operations. The effect of this decision was always going to impact most heavily on the track workers because it was they who were required to get off and onto the moving wagons.
2.36 It is highly significant that shortly after 5M23’s speed was increased from the normal ballasting speed of 4 - 6 km/h to over 9 km/h, W1 sought assistance from W2 to request, via the plough operator who had been re-allocated W1’s radio, that the train be slowed, because it appears that it was immediately following this request that W1 fell and was subsequently struck by a hopper side door on a passing wagon.
PART 3 FINDINGS

3.1 In relation to those matters prescribed by the Terms of Reference as the principal lines of inquiry, OTSI finds as follows:

a. Causation
   i. The track worker died as a result of severe head injuries that were sustained by falling onto the ballast shoulder and being struck by a ballast hopper side door of a passing wagon.
   ii. No-one witnessed the track worker’s fall so it cannot be positively determined whether he fell while getting off a moving ballast wagon, or while moving beside the track.

b. Contributory Factors
   i. Stepping down from a moving rail vehicle is inherently dangerous and the danger is increased when stepping onto a loosely-packed, rough, sloping ballast shoulder and these were the prevailing conditions at the scene of the accident.
   ii. At the time of the accident the ballast train was moving at a speed averaging between 9 and 10 km/h, significantly faster than the 4 to 6 km/h at which ballast is usually laid and this would have heightened the risks associated with movement onto and off the ballast wagons and movement on the ballast.
   iii. The track workers sought to slow the train down but the radio that was normally available to them had been reallocated due to failure of the radio used by the plough operator. This meant that their request could not be communicated directly to, and therefore acted upon immediately by, the driver.
c. Anticipation and Management of Risk

   i. Both the Work Method Statement and the Pre-Work Brief identified the dangers associated with the operation and classified the related risk as being “medium” in nature. While it is questionable as to whether a higher classification should have been determined, the documents failed to identify any means other than the exercise of care, to reduce the risk. In this regard the activity planning was deficient.

   ii. The work plan specified a significantly greater amount of work than could be performed in the available time. Although this was said to be a common practice, in this case it resulted in an attempt being made to raise the tempo of the ballasting operation. As a consequence, the track workers were placed under pressure and therefore exposed to increased risk.

   iii. The work plan contained no contingency provisions to be implemented in the event that communications equipment became unserviceable and there was no hand-held or other radio as a back-up to ensure continuity of radio communication in the event of an equipment malfunction. When this eventuated, no action was taken to restore communications or to compensate for the fact that the track workers did not have the means to communicate directly with the driver.

d. Effectiveness of the Emergency Response

   i. Emergency services responded to the scene quickly but on arrival found the track worker to be deceased.

e. Other Matters that would Enhance the Safety of Rail Operations

   i. The risks associated with ballasting operations can be reduced significantly through the use of ballast wagons that can be operated by remote control, as it reduces the
frequency with which track workers are required to ascend and descend ballast wagons.

ii. ARTC significantly improved its Work Method Statement (WMS) for the conduct of ballasting operations involving the use of NDFFF ballast wagons in response to this incident. However, the procedure would benefit from further refinement, particularly with respect to communication and planning.

iii. This incident indicates that rail operators continue to operate locomotives in NSW that are not equipped with fully functioning data loggers. It is highly important that this be rectified both to provide operators with a useful management tool and to provide reliable data for use in the investigation of incidents that occur.
PART 4 RECOMMENDATIONS

4.1 In order to prevent a recurrence of this type of accident, the following remedial safety actions are recommended for implementation by the organisations specified below.

a. Australian Rail Track Corporation Ltd.

i. Further amend its Work Method Statement (WMS) – Unload NDFF Air Operated Ballast Wagons to:

(a) specifically identify those workers who must have a radio during ballasting operations and specifically include a requirement that all radios be tested prior to the commencement of each day’s ballasting operation;

(b) specify what constitutes a ‘normal walking speed’ and identify a speed which must not be exceeded during ballasting operations where any worker is required to walk alongside the train;

(c) specify the minimum number of workers that must be involved in a ballasting operation and define their roles and responsibilities;

(d) identify the contingencies that need to be factored into local planning and subsequently incorporated into the WMS, and referred to in safety briefings, and

(e) specify the requirement for a risk assessment to be conducted before making any changes to working arrangements, either prior to or during a ballasting operation, and specify who has the authority to make such changes.

ii. Ensure that all its employees who are required to participate in ballasting operations, including those seconded from RIC, and contractors it engages for the same purpose, are briefed
on, understand, and fully comply with its ballasting procedures.

iii. Emphasise the importance of a proper appreciation by its work planners of the time needed to safely conduct track work.

iv. Emphasise the need to identify all of the risks associated with a specific task and the requirement to articulate specific control measures to adequately manage those risks.

v. Maintain its prohibition on workers stepping from or onto moving ballast wagons.

vi. Continue, and expedite if possible, its program to convert all ballast wagons so that they may be operated remotely.

vii. Equip all track workers with two-way radios when they are engaged in ballasting operations.

b. RailCorp

i. Examine its own ballasting procedures in the light of the lessons arising from this accident.

c. Southern & Silverton Railway Pty Ltd

i. Ensure that all of its locomotives comply with the legislative requirements for permanently-based radio systems and back-up radio systems.

ii. Take whatever actions are necessary to ensure that all of its locomotives are equipped with fully functioning and properly calibrated data recorders.

d. The Independent Transport Safety and Reliability Regulator

i. Review the risk assessment that has underpinned the development of ARTC’s Work Method Statement (WMS) – Unload NDFF Air Operated Ballast Wagons and compare its revised requirements with those of RailCorp for the same type
of activity to ensure there is a consistent approach to the planning and execution of ballasting operations within NSW.

ii. Monitor the adherence of ARTC and its employees, including contractors, to the revised procedures for ballasting operations.

iii. In light of continuing evidence that accredited rail operators are not meeting their obligations to ensure that data recorders are properly maintained and operational and are being used, accord higher priority to monitoring the condition and operation of such equipment and take appropriate enforcement action in instances where non-compliance is observed.

iv. Require all new locomotives to be equipped with automated electronic data recorders for operation in NSW.
Appendix 1: Sources and Submissions

Sources of Information

- Ambulance Service of New South Wales
- Bureau of Meteorology (NSW)
- Officers of the NSW Police Force
- Officers of Australian Rail Track Corporation Ltd
- Officers of the Independent Transport Safety and Reliability Regulator
- Officers of RailCorp
- Officers of Southern & Silverton Railway Pty Ltd
- Sydney West Area Health Service Division of Analytical Laboratories
- Witnesses who gave evidence on the basis of the provisions of Section 45C(3) of the *Transport Administration Act 1988 (NSW)* that they would not be identified by name in any material published by OTSI.

Submissions

Although he is not required to do so, the Chief investigator provided a briefing on the preliminary findings of the Draft Report to all Directly Involved Parties (DIPs). He subsequently forwarded a copy of the Draft Report to the DIPs to provide them with the opportunity to contribute to the compilation of the Final Report by verifying the factual information, scrutinising the analysis, findings and recommendations, and to submit recommendations for amendments to the Draft Report that they believed would enhance the accuracy, logic, integrity and resilience of the Investigation Report. The following DIPs were invited to make submissions on the Draft Report:

- Australian Rail Track Corporation Ltd
- Southern & Silverton Railway Pty Ltd
- RailCorp
- Independent Transport Safety and Reliability Regulator
Submissions were received from the following Directly Involved Parties:

- Australian Rail Track Corporation Ltd
- RailCorp
- Independent Transport Safety and Reliability Regulator

The Chief Investigator considered all representations made by DIPs and responded to the author of each of the submissions advising which of their recommended amendments would be incorporated in the Final Report, and those that would not. Where any recommended amendment was excluded, the reasons for doing so were explained.