

Investigation Report 2011-R007



**Car Strike at Knockaphunta Level Crossing (XM250),
County Mayo,
24th October 2010**

Document History

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Purpose of an investigation by the Railway Accident Investigation Unit

The Railway Accident Investigation Unit (RAIU) is a functionally independent investigation unit within the Railway Safety Commission (RSC). The purpose of an investigation by the RAIU is to improve railway safety by establishing, in so far as possible, the cause or causes of an accident or incident with a view to making recommendations for the avoidance of accidents in the future, or otherwise for the improvement of railway safety. It is not the purpose of an investigation to attribute blame or liability.

The RAIU's investigations are carried out in accordance with the Railway Safety Act 2005 and European railway safety directive 2004/49/EC.

Any enquiries about this report should be sent to:

Railway Accident Investigation Unit
2nd Floor
2 Leeson Lane
Dublin 2
Ireland

Summary

At approximately 10:50 on Sunday 24th October 2010 as the 10:15 passenger service from Athlone to Westport approached Knockaphunta Level Crossing, the train driver saw a car approaching the level crossing while the level crossing gates were open to the railway. The train driver sounded the horn and applied the emergency brake; however the train struck the car whilst it was trying to reverse away from the level crossing. There were no fatalities or injuries as a result of this accident. There was damage to the front of the car.

The immediate cause of the accident was that:

- The car stopped at the level crossing, in a position that encroached into the path of the approaching train, and then was struck by the train when attempting to reverse away from the level crossing.

The contributory factors were:

- There are no road markings or marker posts at the Level Crossing identify the decision point for users to allow them to stop clear of the railway line and make a decision to cross safely or wait;
- The level crossing gates, which provide a barrier to the railway, were open when the car driver arrived at the level crossing.

The underlying factor was:

- Iarnród Éireann has not introduced adequate measures to reduce the frequent misuse at the level crossing in relation to level crossing users leaving the gates open to the railway.

As a result of the Railway Accident Investigation Unit investigation the following new safety recommendation, relating to the occurrence, has been made:

- Iarnród Éireann should upgrade the Level Crossing to ensure that the operation of the Level Crossing is not reliant on any direct action by the level crossing user.

Two safety recommendations previously issued by the Railway Accident Investigation Unit in February and July 2008 have also been reiterated.

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1 Factual information

1.1 Relevant parties

1.1.1 Parties involved in the occurrence

Iarnród Éireann (IÉ)¹ is the *railway undertaking*² that owns and operates mainline railway services in Ireland. IÉ is also the railway *infrastructure manager*, managing the design, installation, testing, inspection, maintenance and renewal of the railway's physical assets.

The IÉ departments associated with this accident are the:

- The Intercity and Commuter Network Department – responsible for the supervision and operation of trains on the mainline, excluding the Dublin Urban Network. This includes the supervision of train drivers and the control of train movements through Centralised Traffic Control (CTC) in Dublin and regional controlling signal cabins;
- The Chief Civil Engineer's (CCE) Department – responsible for the design, inspection, maintenance and renewal of the railway's structural infrastructure, including level crossings, and the management of risks relating to the use of passive level crossings that are operated by the level crossing user.

The roles associated with this accident are the:

- Train Driver – The driver of the train involved in the accident was an IÉ employee, passed as competent to drive trains, whose last competency assessment was on the 6th May 2010;
- Car Driver – The driver of the road vehicle struck by the train. He had a full Irish driving licence. He lived locally and was a regular user of the Knockaphunta Level Crossing (which will now be referred to as the Level Crossing for the remainder of this report) as he is a member of the local rugby club, which is located 1.2 km from the Level Crossing.

1.1.2 Other relevant parties

The Railway Safety Commission (RSC) is the *national safety authority*, which is responsible for the regulatory oversight of railway safety in Ireland in accordance with the Railway Safety Act 2005 and European railway safety directive.

¹ All abbreviations are explained in the list of abbreviations section of this report.

² All terms in italics are explained in the glossary of terms section of this report.

The Road Safety Authority's (RSA) aim is to save lives and prevent injuries by reducing the number and severity of collisions on the road. Some of the ways that the RSA works to improve road safety in Ireland are by:

- Developing and implementing information and education campaigns to increase awareness of road safety and promote safer driving;
- Undertaking accident and road safety research in order to develop measures and recommendations to improve road safety;
- Producing road safety strategy documents and monitoring their implementation.

1.2 The accident

On Sunday 24th October 2010, the 10:15 passenger service from Athlone to Westport (which will now be referred to as the Train for the remainder of this report) left Athlone Station, travelling in the *Down* direction. At approximately 10:44, as the Train approached the Level Crossing the Train Driver sounded the *horn* at the *whistle board* location, approximately 430 metres (m) before the Level Crossing. See Figure 1 for location of the Level Crossing.

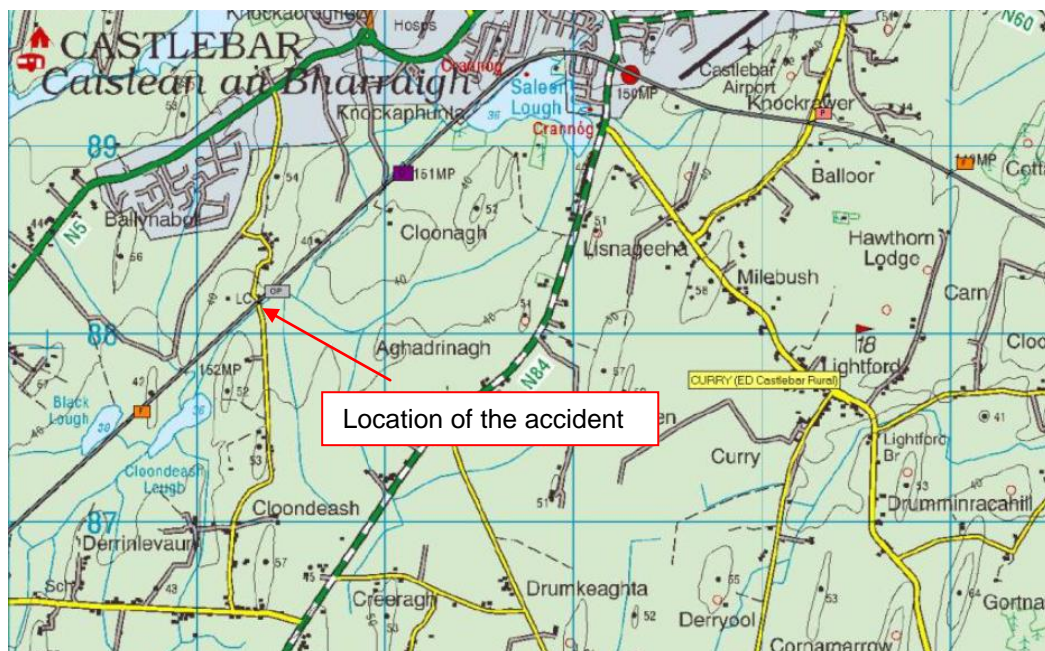


Figure 1 – Location Map (Ordnance Survey Ireland, 2003)

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As the Train continued to approach, a car travelled from the *Up* side of the Level Crossing and stopped at the Level Crossing. The Train Driver immediately re-sounded the horn and applied the emergency brake. The car then started to reverse off the Level Crossing, however, it did not clear the Level Crossing in time and was struck by the Train.

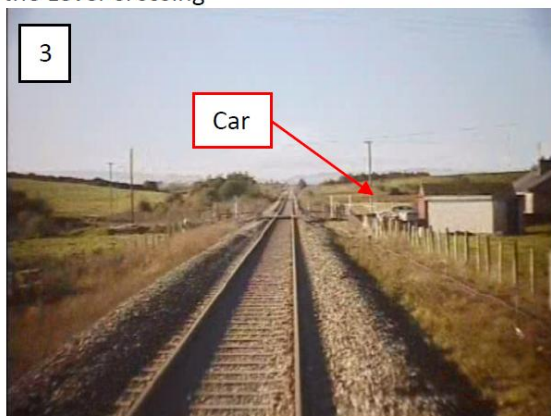
The Train's approach to the Level Crossing was recorded on the forward facing closed circuit television (CCTV) fitted to the Train. See Figure 2 for snapshots taken from the CCTV.



10:44:28.70 – Whistle board located 430 m from the Level Crossing



10:44:41.09 – Approach to Level Crossing



10:44:41.91 – First sighting of car approaching Level Crossing



10:44:43.29 – Car on Level Crossing



10:44:44.86 – Car on Level Crossing



10:44:46.26 – Car reversing off Level Crossing

Figure 2 – CCTV snapshots of the Train's approach to the Level Crossing

The Train came to a stop approximately 104 m beyond the Level Crossing. The Train Driver carried out all post accident procedures and then walked back to the Level Crossing. By the time he reached the Level Crossing, the Car Driver had driven away.

The Car Driver approached the Level Crossing with the Level Crossing gates open. He stopped the car, in a position he thought to be safe, to check for approaching trains prior to crossing the railway line. While stopped at the Level Crossing, he saw the approaching Train and realised that he was not in a safe position. He then attempted to reverse off the Level Crossing (as shown from the CCTV). However, he did not clear the Level Crossing in time and his car was struck by the Train. The Car Driver did not recall hearing any of the Train horn soundings prior to the accident, however, the windows of the car had not been lowered.

The weather at the time of the accident was dry. Met Éireann recorded a maximum temperature of 11.7 degrees Celsius, and an average wind speed of 12.7 kilometres per hour (km/h). There was good visibility at the time of the accident.

1.3 Infrastructure

1.3.1 General description

Knockaphunta Level Crossing is located on a public regional road which connects the N5 national road (Longford to Westport) to the N84 national road (Castlebar to Galway). The speed limit for this section of road is 80 km/h.

The line from Athlone to Westport is a single track *bidirectional line*. The track is plain line with *flat bottom continuously welded rail* (CWR) mounted on concrete sleepers in ballast. No factors in relation to the condition of the track were found to have contributed to the accident.

1.3.2 Knockaphunta Level Crossing

The Level Crossing is located on the Mayo Line at 151 miles 1141 yards from Broadstone Station, County Dublin. IÉ have designated the level crossing as an 'Occupational on Public Road' (OP) type crossing and is identified as asset number (no.) XM250, see Photograph 1.

OP type crossings are unattended level crossings where the level crossing gates are normally closed to the public road traffic. They require the user to open and close the level crossing gates in order to cross the railway.



Photograph 1 – Knockaphunta Level Crossing, approaching the Up side

The metal gates positioned on each side of the Level Crossing are approximately 4.3 m wide and open away from the railway. The surface of the intersection of the road with the track is covered in rubber 'Strail' units, which gives a level surface over the track. Cattle grids are installed on each side of the roadway, where it crosses the track to prevent cattle straying onto the railway line. There is concrete post and wire fencing running between the gates and the boundary hedges, see Photograph 2. There is a residential house (an old railway building) and shed positioned 15 m and 20 m, respectively, from the Up side of the Level Crossing, see Photograph 2.



Photograph 2 – Residential house and shed



Photograph 3 – View from the Up side of the level crossing

IE's technical information sheet, MW50 'Accommodation level crossings' (now referred to as MW50 for the remainder of the report), requires that for a *single track* with a 110 km/h speed limit, the *viewing distance* must be greater than 350 m, see Photograph 3 for a view from the Level Crossing. This photograph illustrates the view the Car Driver would have had of the railway line. The actual viewing distance, as recorded by the RAIU, is 582 m. Therefore there was no requirement under MW50 for a whistle board to be erected, however, there is a whistle board located approximately

430m from the Level Crossing in the Down direction, as seen in Figure 2, which was erected some years ago.

The Level Crossing is not protected by roadside traffic signals and there is no *lineside telephone* provided at the Level Crossing.

A local rugby club is located approximately 1.2 km from the Level Crossing, on the same public road as the Level Crossing is situated on, on the *Up Side* of the Level Crossing, which results in both more familiar and unfamiliar road users operating the Level Crossing.

1.3.3 Signage at the Level Crossing

IE danger and warning signage is erected on the approaches to the Level Crossing, on both sides, see Photograph 1.

An upright 'Stop' sign is present on both approaches to the Level Crossing, on the public road within the railway boundary which indicates to the road users that they must come to a full stop. In the case of this Level Crossing, the 'Stop' sign is in line with the Level Crossing gates, see Photograph 3.

In the case of this Level Crossing, once the road user opens the Level Crossing gates the road user must continue towards the *decision point*. The decision point is the position where the road user can stop their vehicle clear of the railway line and at which a decision to cross safely or wait can be made.

Apart from the 'Stop' sign, there are no other signage or road markings, such as the continuous white 'Stop' line sometimes associated with the 'Stop' sign, on the approaches to the Level Crossing.

Signage, in relation to the closure of the gates, is also present on the approaches and exits of the Level Crossing. See Photographs 4 and 5 for photographs of the signage at the Level Crossing.



Photograph 4 – Danger, warning and “keep these gates shut” signage, entering the Level Crossing



Photograph 5 – Signage in relation to the closure of the gates, exiting the Level Crossing

Upgraded signage, present at the time of the accident, was erected in June 2010, four months prior to the accident. Previous to this signage being erected, the old type warning signs had been located at the Level Crossing in accordance with MW50, see Photograph 6.



Photograph 6 – Old signage at the Level Crossing

1.3.4 Black and yellow marker posts

IE's technical information sheet, MW50 'Accommodation level crossings' (MW50), does not include any requirement for the erection of *black and yellow marker posts* at level crossings, which indicate the decision point to the user. Section 19 of IE's 'The SAFE use of Unattended Railway Level Crossings' booklet, first published in November 2006, states that "Black and yellow marker posts are being introduced at certain level crossings", and continues that "The markers are positioned at 2 metres (6 feet) from the nearest rail and on each approach to the railway line". Where these black and yellow are erected at level crossings, signage associated with how they should be used is also erected.

The RSC's level crossing guidelines for new or upgraded infrastructure, 'RSC-G-006-B, Guidelines For The Design Of Railway Infrastructure And Rolling Stock, Section 5, Level Crossings' provides:

- Guidance on the establishing of level crossing types and the conditions for suitability;
- General guidance applicable to each type of crossing;
- Specific details of signalling and crossing controls for each type of crossing;
- Guidance on carriageway aspects and crossing equipment and signs.

Section 5.8.1.2 of these guidelines, in relation to user worked crossings, states "Black and yellow marker posts may be provided to indicate the safe point (decision point) where it is safe to stop clear of the railway, while checking the view along the track."

Black and yellow marker posts are not provided at the Level Crossing.

1.3.5 Operation of the Level Crossing

The risk assessment in place at the time of the accident, updated in March 2009, recorded the daily vehicle usage (including cars, vans, buses and tractors) at the Level Crossing as 116, with an additional 20 pedestrians. An independent traffic survey, carried out after the accident, on the 7th – 8th May 2011 over a 24 hour period, recorded the daily vehicle usage, with 130 vehicles using the Level Crossing, while the pedestrian usage remained at 20. Therefore there has been an increase of 16% in the daily vehicle usage over a 21 month period.

Gates are provided at level crossings to segregate the railway from the road and these must be maintained closed across the roadway to ensure safety of level crossing users and railway users as prescribed in Part 14 (Section 13.1) of the Railway Safety Act 2005.

IEÉ provide information to level crossing users through the 'The SAFE use of Unattended Railway Level Crossings' booklet, which is available through IEÉ's website and is distributed by IEÉ to known level crossing users. It should be noted that this document is difficult to find on the website.

The booklet describes the safe method of using level crossings, including the need to obey the instructions on the signs and the requirement to always to close the gates after crossing. It also sets out the hazards associated with various types of vehicles, pedestrians and cyclists using the level crossing and the local conditions such as adverse weather or overgrown vegetation which might affect the safety of the user. Illustrated below are some of the extracts from the booklet, which are relevant to this accident. Section 3 'Knowing the railway' states:

"A train overhangs the rails by a considerable amount. Never assume that a train is only as wide as the space between the rails."

Section 7 'Using the crossing and securing the gates' states:

"It is the responsibility of the user to ensure that it is safe to cross and the railway and other users of the railway are not endangered."

"Stop clear of the railway line where you get a good view along the track in both directions. Look at the approach of trains, especially in poor visibility or at night. Watch out for the light on an approaching train. Listen for horns or the sound of an approaching train."

"Before attempting to cross, always examine the railway from the best vantage point to check for approaching trains. If the location of your crossing is such that a good view is not available, you should provide yourself with the necessary assistance to enable the maximum view to be obtained. Shut and fasten the gates immediately after using the crossing."

Section 12 'Driving cars and light vehicles (vans), including trailers, across the railway', gives some instructions to drivers, which includes:

"Open at least one window before crossing the railway"

"Turn off all radios, stereos and the like and remove personal stereo headphones. Noise may mask the sound of an approaching train. Mobile phones must not be used during the process of working the crossing"

"Use the black and yellow marker posts, where provided, when stopping. If there are no such markers stop at least 2 metres (6 feet) clear of the nearest rail."

Section 19 'Black and yellow marker posts' gives some instructions to drivers in relation to the marker posts:

"There is a requirement that every time a vehicle or machine is being driven across the level crossing, after opening both gates, it must be stopped before any part of it passes the markers. The vehicle driver, having stopped and made certain that it is safe to cross the railway line, may then move off and proceed to cross the railway."

"By stopping 2 metres (6 feet) clear of the line the vehicle will be clear of any passing train. You must always stop at the markers, with your entire vehicle, including attachments, behind them."

This booklet had been distributed to twenty-two local residents and the Secretary of the local rugby club, prior to the accident. The Car Driver was not issued with a copy of the booklet and was unaware of its existence or content, despite being a member of the local rugby club. However, it should be noted, given the number of daily Level Crossing users (approximately 130 daily vehicle users), it may be a difficult task to identify these users, especially in the case where they are one-off users

The RSC has also developed "RSC-G-012-A, Third Party Guidance on Railway Risk, Volume 3, Crossing the Railway" in relation to level crossing, which is available through the RSC's website. It should be noted however that this document is difficult to locate on the website. This document sets out the "Golden Rules for Safety at Unprotected Crossings" which include:

- Any gates or barriers should be kept closed and secured across the road except when someone wishes to cross the railway. Even if a gate is open or opened for you, you are still responsible for your own safety when crossing the railway;
- Stop, look and listen to see if a train is coming before attempting to cross;
- Get a copy of IÉ's booklet 'The SAFE Use of Unattended Railway Level Crossings' and take note of its contents.

Section 2.2 of the guidance, in relation to unprotected unmanned level crossing, provides information on the activity at level crossing, its associated hazards and amount of risk associated with this hazard, see Figure 3. This section again refers the reader to IÉ's 'The SAFE Use of Unattended Railway Level Crossings' booklet.

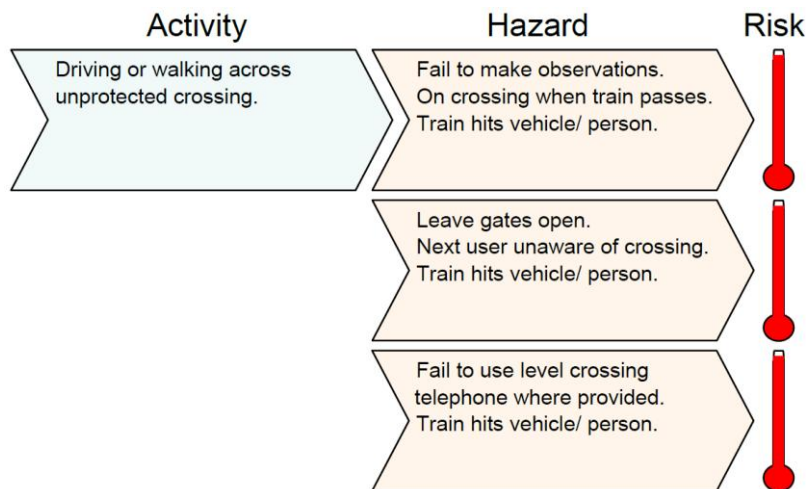


Figure 3 – Extract from the RSC's Third Party Guidance on Railway Risk in relation to unmanned level crossings

Details in relation to the operation of level crossing gates can also be found in the 'Rules of the Road' developed by the RSA, which was distributed to all households in 2007, and is available through bookstores and the RSA's website. Irish drivers are required to make themselves familiar with the contents of the 'Rules of the Road' prior to driving on Irish roads.

Section 6 (page 75), Rail/Light Rail of Rules of the Road in relation to level crossings, states the correct use of unattended level crossings as:

1. Stop clear of the railway line where you get a good view along the track in both directions;
2. Look for the approach of trains. In fog or at night, watch out for the light of an approaching train;
3. Listen for the horn or the sound of an approaching train;
4. See that both gates are open before starting to cross or wait for all barriers to go back up before moving on;
5. Close both gates after you cross;
6. Obey any other instructions signposted at the crossing.

The RSA's 'Rules of the Road' does not mention the IÉ booklet or the RSC's guidelines, however, page 198 of the booklet provides the website addresses for both organisations.

1.3.6 Misuse of the Level Crossing

IE's risk assessment at the time of the accident, identified that the Level Crossing gates are frequently left open to road traffic, and that this misuse of the Level Crossing, relative to other level crossings, was above average.

Misuse is identified in Part 14, Section 131(1) of the Railway Safety Act 2005, stating that:

“Where a person fails to shut and fasten the gate of a level crossing or passage to which this section applies, as soon as he or she or any animal or vehicle under his or her care has passed through the level crossing or passage, he or she is guilty of an offence and is liable on summary conviction in respect of every such offence to a fine not exceeding €1,000.”

Section 20.9 of IÉ's 'The SAFE use of Unattended Railway Level Crossings' booklet states:

“Always remember that you are liable to a fine in excess of €600 and/or 6 months imprisonment for failing to shut the level crossing gates.”

In the month previous to the accident, the gates were reported open to the railway by IÉ staff twenty-four times. There is no recorded number prior to this date, however, it is known to IÉ that these gates are frequently left open. It was also reported that the Level Crossing users generally do not come to a full stop when they approach the Level Crossing when the gates are open. With the speed limit of 80 km/h at the Level Crossing, cars are able to approach the Level Crossing at speed.

In 2007, four Castlebar residents were brought before the local district court on charges of failing to close the Level Crossing gates at Knockaphunta after travelling across the railway. Two of these users had been issued with IÉ's 'The SAFE use of Unattended Railway Level Crossings' booklet in 2006. The residents were not convicted by the district court for the offence.

1.4 Traction and rolling stock

The train involved was the 10:15 passenger service from Athlone to Westport, train identification A800. The service was operated by a three carriage Class 22000 *Diesel Multiple Unit* (DMU), consisting of carriages 22202, 22402 and 22302. Carriage 22202 was the leading carriage at the time of the accident. The three carriage unit is 70 m long and has a mass of 189 tonnes. The maximum allowable speed of the DMU is 160 km/h.

The *event recorder*, fitted to the leading carriage, recorded that the Train horn had been sounded at the location of the whistle board and on approach to the Level Crossing. From the event recorder and the CCTV, it can be seen that the Train Driver sounded the horn one second after seeing the car approaching the Level Crossing, and applied the emergency brake three seconds later, striking the car approximately five seconds after the application of the emergency brake. The train was travelling at 96.8 km/h when the driver applied the emergency brake, and it took twenty-three seconds to come to a stop. The train stopped 104 m beyond the Level Crossing.

No factors in relation to the condition of the Train contributed to the accident.

1.5 Signalling and communications

The single track route from Athlone to Westport is signalled using two and three aspect *colour light signals*, controlled by the Mayo Line Signaller, located in Athlone Signalling Centre. *Track Circuit Block* (TCB) regulations apply to this route.

The means of communication between the train drivers and the Mayo Line Signaller on this route is through train radio.

1.6 Operations

The Train was in Driver Only Operation, meaning that the only crew on the train is the Train Driver. The movement of trains on the Athlone to Westport line is controlled by the Mayo Line Signaller. The speed limit for the section of track at the Level Crossing was 110 km/h.

1.7 Fatalities, injuries and material damage

1.7.1 Fatalities and injuries

There were no fatalities or injuries as a result of this accident.

1.7.2 Infrastructure damage

There was no damage to the Level Crossing or any other infrastructure.

1.7.3 Traction and rolling stock damage

There was no damage to the train as a result of this accident.

1.7.4 Damage to the car

There was damage to the front of the car.

1.8 History of similar accidents and incidents

IEÉ have recorded four similar occurrences at this Level Crossing prior to this accident. Details of these accidents are summarised below:

- 23/12/67 – Four people were killed, and three were injured when the car they were travelling in drove out in front of a train;
- 24/06/98 – A timber train struck a car on the Level Crossing resulting in severe damage to car. There were no fatalities or injuries as a result of this accident;
- 11/02/04 – A car crossed the Level Crossing in front of an approaching train. There were no fatalities or injuries as a result of this incident;
- 11/06/09 – A car crossed the Level Crossing in front of an approaching train. There were no fatalities or injuries as a result of this incident.

There have been two other incidents at this Level Crossing since the accident. Details of these incidents are summarised below:

- 10/11/10 – At 18:50, a car crossed the Level Crossing while a train was approaching. The train applied the emergency brake. The train driver noted that the Level Crossing gates were open to the road as the car approached the Level Crossing. There were no fatalities or injuries as a result of this incident;
- 29/04/11 – A van crossed the Level Crossing while a train was approaching. The train applied the emergency brake. The train driver noted that the Level Crossing gates were open to the road as the van approached the Level Crossing. There were no fatalities or injuries as a result of this incident.

In addition, there have been seven recorded car strikes, excluding this accident, and 108 recorded near misses at OP type level crossings since 2002. Details of the car strikes are summarised below:

- 21/03/02 – A car was struck by a passenger train at XA099 resulting in injury to the car driver;
- 18/07/02 – A car was struck by a passenger train at XL032, the car driver was fatally injured;
- 20/12/02 – A car was struck by an empty freight train at XL083, with no resulting injuries to the car driver;
- 28/11/04 – A car was struck a train at XN152, with no resulting injuries to the car driver;
- 28/02/08 – A car was struck by a passenger train at XX032, the car driver was fatally injured;
- 31/07/08 – A car was struck by a passenger train at XN125, with no resulting injuries to the car driver;
- 02/09/10 – A tractor was struck by a train at XM096, the driver was fatally injured.

2 Analysis

2.1 Documentation on the operation of the Level Crossing

The frequency of use of the Level Crossing has increased from 116 to 130 daily vehicle users. Allowing for the fact that there may be users that use the Level Crossing multiple times a day, it is likely that the IÉ have not captured all the known users, as they have only issued 'The SAFE use of Unattended Railway Level Crossings' booklet to twenty-two known users. Despite the booklet being available to download from IÉ's website, it is difficult to find. It is therefore likely that the majority of the Level Crossing users are not in possession of IÉ's booklet.

In the case of the RSC's guidelines 'RSC-G-012-A, Third Party Guidance on Railway Risk, Volume 3, Crossing the Railway', the RSC have no policy for the issuing of these guidelines to the known Level Crossing users, and are only available to the RSC's website, with this document also being difficult to locate on the website. Therefore it is also likely that the vast majority of the Level Crossing users are not aware of the RSC's guidelines.

The document that all the Level Crossing road users are familiar with is the RSA's 'Rules of the Road', which includes a more limited amount of information in relation to the operation of level crossings. However, the document does state that users should "obey any other instructions signposted at the crossing".

All three documents mention the importance of looking and listening for approaching trains, however, IÉ's booklet is the only document that specifically requests that drivers are to "open at least one window before crossing the railway" and to "Turn off all radios, stereos and the like and remove personal stereo headphones. Noise may mask the sound of an approaching train. Mobile phones must not be used during the process of working the crossing". In the case of the accident, the Car Driver, had not lowered any windows and did not turn off the radio. Given that he had not been issued with IÉ's booklet, and this information is not provided on the signage at the Level Crossing did not listen for the train and was therefore reliant on seeing the train.

Again, all three documents make reference to the closing of the Level Crossing gates after crossing. IÉ's booklet states that a fine or imprisonment, which a user may be liable to for, is applicable if they fail to close level crossing gates; similar information is stated in the Railway Safety Act 2005.

Twenty-two known users have been identified and issued with IÉ's booklet. The Car Driver was not issued with a copy of the booklet and was unaware of its existence or content, despite being a member of the local rugby club where the Secretary of the rugby club had been issued with the booklet.

2.2 Operation of the Level Crossing

The Car Driver approached the Level Crossing with the Level Crossing gates open to road traffic. IÉ signage, in accordance with MW50, is present at the Level Crossing in relation to the operation of the Level Crossing and the closure of Level Crossing gates.

Level crossing gates provide a barrier segregating the railway from the public road and stopping cars clear of the railway prior to users of the level crossing operating the gates to cross the railway. However, in the case of this Level Crossing, where the gates are frequently left open, the Level Crossing does not have this initial barrier to stop the users of the Level Crossing to stop clear of the railway. The Level Crossing gates, when closed across the public road, also prevent the road users crossing the Level Crossing without coming to a full stop.

A 'Stop' sign is present at the Level Crossing, which users should obey, indicating to road users that they must come to a full stop. However, at this Level Crossing it is known that the Level Crossing users do not generally come to a full stop at the Level Crossing when the gates are open to the railway. To date, no measures have been introduced at the Level Crossing to encourage these Level Crossing users to come to a full stop or to close the Level Crossing gates upon using the Level Crossing.

Beyond the 'Stop' sign however there is no other signage, markers (such as the black and yellow marker posts) or road markings (such as the continuous white Stop line) to indicate the decision point for the road user. With a clear decision point absent at this Level Crossing the Car Driver miscalculated his safe stopping position, and stopped his car beyond the decision point and in a position that encroached onto the railway line, this can be seen from the CCTV in Figure 2 where the Car Driver stops and then begins reversing off the Level Crossing.

IÉ's 'The SAFE use of Unattended Railway Level Crossings' states that where the black and yellow marker posts have not been provided, the level crossing users should "stop at least 2 metres (6 feet) clear of the nearest rail." However, the Car Driver was not aware of this direction as he had not been issued with the booklet. He was also unaware that "A train overhangs the rails by a considerable amount" as this information is also only provided in the booklet. This lack user knowledge on the part of the Car Driver may have contributed to him miscalculating a safe stopping position and travelling beyond the decision point.

The only directions that the Car Driver would be familiar with are the directions provided in the RSA's 'Rules of the Road' which provides information on the safe use of level crossings. It does state that the level crossing user should "obey any other instructions signposted", however, in this case information on the decision point is not provided at the Level Crossing.

The independent traffic survey recorded, in one day, 130 vehicles and 20 pedestrians. Therefore, it is possible that there are a certain amount of unfamiliar Level Crossing users on a daily basis. There is also likely to be an increased number of unfamiliar Level Crossing users accessing the rugby club on rugby tournament match days. As a result, these Level Crossing users are reliant on IÉ's signage at the Level Crossing.

2.3 Misuse of the Level Crossing

As identified in IÉ's risk assessment for the Level Crossing, Knockaphunta Level Crossing, has a higher than average misuse rate where the Level Crossing gates are frequently left open by its users, with gates being left open to the railway twenty-four times in the month previous to the accident. This misuse continues despite being a recognised offence under the Railway Safety Act 2005.

However, given the fact that four local residents were taken to the district court in relation to the misuse of the Level Crossing and not charged with this offence, there appears to be little incentive for the Level Crossing users to close the Level Crossing gates after crossing. This is reflected by that fact that the misuse of the Level Crossing is higher than average at this Level Crossing, in comparison with other level crossings. IÉ have taken no further action in preventing the misuse at this Level Crossing.

Two near misses were reported at this Level Crossing within six months of this accident. On the 10/11/11, a car approached the Level Crossing at speed as the gates were open to the railway and attempted to cross the Level Crossing in front of an approaching train. On the 29/04/11, a van approached the Level Crossing as the gates were open to the railway and attempted to cross the Level Crossing in front of an approaching train. Of note in both instances, is the fact that the train drivers reported that the Level Crossing gates were open to the public road as the vehicles approached them.

Although the Car Driver was a familiar user of the Level Crossing, unfamiliar users at this Level Crossing should also be considered given that the Level Crossing gates are frequently left open to the railway. Consequentially unfamiliar users may approach the Level Crossing with the gates open to railway. This may result in the unfamiliar user becoming confused, as there is a conflict as the Level Crossing gates being left open where the signage states that the Level Crossing gates should be closed. As a result the unfamiliar user may drive directly through the Level Crossing, when the Level Crossing gates are open to the railway, thinking it is safe to do so and may also leave the Level Crossing gates open after crossing.

3 Conclusion

Section 2.1 of the analysis identifies the documentation available to level crossing users for the operation of the user worked level crossings, which included IÉ's 'The SAFE use of Unattended Railway Level Crossings' booklet, the RSC's guidelines 'RSC-G-006-B, Guidelines For The Design Of Railway Infrastructure and Rolling Stock, Section 5, Level Crossings' and the RSA's 'Rules of the Road'.

IÉ's booklet has been issued to twenty-two known Level Crossing users in the Knockaphunta area, resulting in the majority of the Level Crossing users not being aware of the existence of IÉ's booklet. In the case of the RSC's guidelines, these are not issued to known level crossing users, and are less likely to be known to the Level Crossing users. However, it should be noted, given the number of daily Level Crossing users (approximately 130 daily vehicle users), it may be a difficult task to identify these users, especially in the case where they are one-off users. However, these two documents provide useful information on the decision point, specifically that the decision point is 2 m from the nearest rail.

The RSA's 'Rules of the Road' does not give specific information in relation to the decision point, but does refer Level Crossing users to the instructions provided at the Level Crossing. Given that there is no information at this Level Crossing on the decision point the level crossing users, users have no information available to them on where to stop in a safe position to look for approaching trains.

All three documents give instructions on the use of the level crossing gates and the importance of closing level crossing gates.

Section 2.2 of the analysis discusses the IÉ warning signs are positioned at the Level Crossing in accordance with IÉ's standard. There is a 'Stop' sign, however, beyond this 'Stop' sign there is no decision point marked at the Level Crossing by means of a continuous white Stop line or black and yellow marker posts. Without a clear decision point there is no clear indication where road users should position their vehicle when viewing for approaching trains, and decide to cross safely or wait.

IÉ's booklet does state that where the black and yellow marker posts have not been provided, the level crossing user should "stop at least 2 metres (6 feet) clear of the nearest rail." However, given that these booklets are only issued to known users, or available through IÉ's website, and the information is not provided on the signage at the Level Crossing, the Car Driver was unaware of this information. It is also likely to be the case for other unfamiliar users of this Level Crossing.

The Car Driver had intended to stop in a safe place prior to crossing the Level Crossing, however, given that the Level Crossing gates were open when he approached the Level Crossing, in conjunction with the absence of any obvious indications for a decision point, he miscalculated his

stopping distance and position, and encroached into the pathway of the train. He was also unaware, given that he had not been issued with IÉ's booklet that the "a train overhangs the rails by a considerable amount".

Section 2.3 of the analysis discusses the analysis of the misuse of the Level Crossing at Knockaphunta, and the fact that it is higher than average when compared to other level crossings, with the Level Crossing gates frequently left open to the railway. Contributory to the continued misuse may be the fact the known Level Crossing users who misused the Level Crossing by not closing the gates after crossing, were not prosecuted and therefore there is little to deter the Level Crossing users from misusing the Level Crossing.

Unfamiliar Level Crossing users may be confused when they approach the Level Crossing with the Level Crossing gates open to public road traffic, despite the presence of signage. Therefore they may not adhere fully to all the instructions on the signage, and may not close the Level Crossing gates after operation.

There have also been two other near misses at the Level Crossing since the accident occurred, where vehicles approached the Level Crossing with the gates open to the railway and attempted to cross the Level Crossing while trains were approaching.

The *immediate cause* of the accident was that:

- The car stopped at the Level Crossing, in a position that encroached into the path of the approaching train, and then was struck by the train when attempting to reverse away from the Level Crossing.

The *contributory factors* (CoF) were:

- CoF-01 – There are no road markings or marker posts at the Level Crossing to identify the decision point for users to allow them to stop clear of the railway line and make a decision to cross safely or wait;
- CoF-02 – The level crossing gates, which provide a barrier to the railway, were open when the car driver arrived at the level crossing.

The *underlying factor* (UFs) was:

- UF-01 – IÉ have not introduced adequate measures to reduce the frequent misuse at the level crossing in relation to level crossing users leaving the gates open to the railway. The level crossing gates, which provide a barrier to the railway, were open when the car driver arrived at the Level Crossing.

4 Relevant actions already taken or in progress

4.1 Actions taken by IÉ

Since the occurrence, IÉ has advised that it has taken a number of actions aimed at improving safety at this Level Crossing, XM250. These actions have been undertaken both in response to the accident itself and in conjunction with the overall on-going strategy for the management of its level crossings across its rail network. The actions and activities undertaken are outlined below under the categories:

- Risk control;
- Communications;
- Surveys and follow up works;
- Level crossing elimination.

Additionally, IÉ has advised that it continues to manage its level crossings with dedicated ongoing programs of work associated with the infrastructure at all level crossings. Proactive attempts continue to be made in positively influencing level crossing user behaviour and use of level crossings. Improving the infrastructure and influencing behaviour continues to be an important part of the overall asset strategy for level crossings on the IÉ network.

4.1.1 Risk control at the Level Crossing

In April 2011, following close examination of the Level Crossing, a short term measure of introducing a train speed restriction of 45 mph at the Level Crossing was placed to mitigate the risks at the Level Crossing, to provide longer sighting distance and crossing times.

4.1.2 Communications

As a result of this accident, IÉ have met with representations to other stakeholders associated with the use of this Level Crossing, such as with:

- Mayo County Council – To discuss potential improvements to the Level Crossing infrastructure that interfaces between the railway and the local authority; and to discuss the provision of advance warning signage at the Level Crossing;
- A local user's representative – To listen to concerns of the regular Level Crossing users. This meeting resulted in the introduction of the speed restriction through the Level Crossing;
- RSA – To discuss issues around level crossings;
- Garda – To engage in relation to issues around level crossings.

4.1.3 Surveys and follow up works

IE conducted surveys of the Level Crossing in May and July 2011 to identify any work required as part of the ongoing maintenance of the infrastructure. Following these surveys, work arising was recorded and carried out by IE at this Level Crossing which included repairs to cattle grids, installation of gate stops and line side vegetation control works.

4.1.4 Level Crossing elimination

IE is currently progressing plans for the eventual elimination of this Level Crossing, through its closure and replacement with an *overbridge*. As part of the planning application for elimination of the Level Crossing, detailed design, surveys, flood and archaeological surveys have all been submitted to Mayo County Council and to Castlebar Urban District Council and at the time of publication of this report the outcome of this planning process is currently awaited. If planning approval is granted agreement must then be sought with the local land owners and availability of the necessary funding required prior to commencing with the works.

4.2 Actions taken by the RSA

The RSA has written to IE offering to carry out a joint safety campaign on user worked level crossings and is currently engaging with IE to improve safety at level crossings.

5 Recommendations

5.1 General description

In accordance with the Railway Safety Act 2005 (Government of Ireland, 2005a) and the European railway safety directive (European Union, 2004), recommendations are addressed to the national safety authority, the RSC. The party responsible for implementing each recommendation is identified in the recommendation.

As a result of the RAIU investigation, one new safety recommendations has been made in relation to the occurrence. A further two safety recommendations made previously by the RAIU are also being reiterated.

5.2 New recommendations relating to the occurrence

As the misuse of the Level Crossing at Knockaphunta is higher than average when compared to other Level Crossings, as there is a high frequency of the Level Crossing gates being left open to the railway; and considering the previous occurrences at this Level Crossing, including two occurrences since this accident, the RAIU make the following safety recommendation based on CoF-01, CoF-02 and UF-01:

IE should upgrade the Level Crossing to ensure that the operation of the Level Crossing is not reliant on any direct action by the level crossing user.

5.3 Reiterated recommendations

In relation to UF-01 as to the frequent misuse at the Level Crossing, with the Level Crossing gates left open to the railway the RAIU recognise that IE have attempted to reduce this misuse through communications and advertising, however the issue of misuse remains, therefore the RAIU reiterate the following safety recommendation, previously made in the RAIU's investigation report into the 'Fatality at Level Crossing XX 032 between Ballina and Manulla Junction on the 28th of February 2008:

IE must identify crossings that are regularly misused and take proactive action to manage the increased risk created by this misuse.

Although all required warning signs, including a 'Stop' sign, are positioned at the Level Crossing in accordance with IÉ's standard, there is no clear indication to the Level Crossing user on a safe position to stop and look for approaching trains, therefore the RAIU reiterate the following recommendation previously made in the RAIU's investigation report into the 'Collision between a train and a road vehicle at level crossing XN125, Cappadine, on the Ballybrophy to Killonan line 31st of July 2008', based on CoF-01:

IÉ should assess the risks relating to road users' behaviour in identifying a safe stopping position at User Worked Level Crossings and based on the outcome of this risk assessment, Iarnród Éireann should introduce measures to allow safe use of this type of level crossing.

6 Additional information

6.1 List of abbreviations and acronyms

CoF	Contributory factor
CWR	Continuous Welded Rail
DMU	Diesel Multiple Unit
km/h	kilometres per hour
m	metre
RAIU	Railway Accident Investigation Unit
RSC	Railway Safety Commission
UF	Underlying factor

6.2 Glossary of terms

*Terms with * are taken directly from Ellis' British Railway Engineering Encyclopaedia*

Black and yellow marker posts	Introduced at certain level crossings, these indicate a safe point at which to stop clear of the railway line, while checking the view along the track.
Colour light signals*	Signals which convey movement authorities to train drivers by means of coloured lights.
Continuous Welded Rail	Rails welded together to form one continuous rail that may be several kilometres long.
Córas Iompair Éireann	A statutory corporation and wholly owned by the Irish Government. CIÉ has three wholly owned subsidiary limited liability companies established under the Companies Acts, as provided for in the Transport (Reorganisation of Córas Iompair Éireann) Act 1986. Iarnród Éireann is one of these subsidiary companies.
Decision point	A point where level crossing users stop clear of the railway line and at which a decision to cross or wait can be made safely.
Diesel Multiple Unit	A train powered by diesel with the engines distributed along its length under the carriages.
Down direction	Railway line travelling towards Westport.
Down side	The left side of the track when travelling in the Down direction.
Event Recorder	A device fitted to trains to store key train parameters and driver actions.
Flat bottom Rail	A rail section having a flat base.
Horn	A compressed air warning device fitted to trains.
Infrastructure Manager	Organisation that is responsible for the establishment and maintenance of railway infrastructure, including the management of infrastructure control and safety systems.
National safety	The national body entrusted with the tasks regarding railway safety in

authority	accordance with European directive 2004/49/EC.
Lineside telephone	
Overbridge*	A bridge that allows passage over a railway.
Railway	Organisation that operates trains.
Undertaking	
Single track*	A line with a single track on which trains normally run in both directions.
Speed Restriction	A speed restriction imposed on a particular section of track, to guarantee the safe passage of trains.
Track Circuit Block	A signalling system that uses track circuits to confirm the absence of trains in order to control the movement of trains.
Up Line	Railway line travelling towards Athlone.
Up Side	The left side of the track when travelling in the Up direction.
Viewing distance	The distance from which trains must be seen in order to give adequate warning time of approaching trains.
Whistle board	An upright rectangle bearing black and yellow diagonal stripes, marking a location where a train driver is required to sound the horn, and are normally erected where the available views of the train are restricted.

6.3 References

Iarnród Éireann (1983), Maintenance of Way Technical Information Sheet MW50 Accommodation Level Crossing.

Iarnród Éireann (2006), The SAFE use of Unattended Railway Level Crossings.

Railway Safety Commission (2008), Guidelines For The Design Of Railway Infrastructure and Rolling Stock, Section 5, Level Crossings, RSC-G-006-B.

Railway Safety Commission (2008b), Third party guidance on railway risk – Volume 3: Crossing the railway, reference RSC-G-012-A.

Roads Safety Authority (2007), Rules of the Road.