LEVEL CROSSING SAFETY IMPACT ASSESSMENTS (LCSIA) FOR VEHICLE AND PEDESTRIAN CROSSINGS

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Word count: 6,235

Submission Date: 1st August 2019

ABSTRACT

While the number of deaths and injuries at level crossings in New Zealand is relatively low compared with the national road toll and injury burden, the high severity of crashes involving trains makes it a key ‘safe system’ focus. It is also alarming that the proportion of crashes involving pedestrians and cyclists at level crossings has been increasing over recent years. This in part is due to the construction of a number of cycleways and shared paths that travel alongside railway lines. In the past KiwiRail has relied primarily on the ALCAM crash estimation model to assess the increased risk of crashes at crossings due to a change in use. While ALCAM is one of the better developed level crossing models internationally, it does have its limitations when used in isolation. The ALCAM documentation specifies that other information such as incident data and the opinions of locomotive engineers should be considered in assessing risk. In practice these factors have rarely received equal importance with the ALCAM risk ratings. ALCAM also does not pick-up in sufficient detail the safety impacts created by the surrounding transport network. To better inform decision making, KiwiRail has developed a wider assessment process that includes these factors, called a Level Crossing Safety Impact Assessment (LCSIA). This new process has been found to better reflect the crash risks at level crossings under different changes in use. This paper outlines the LCSIA process and the learnings that have occurred since it was first introduced in 2016.

Keywords: Level Crossings, Railway Crossings, Pedestrian Level Crossings, Pedestrian Railway Crossings, ALCAM

INTRODUCTION

There are over 2000 public level crossings and a large number of private level crossings in New Zealand. While there are relatively few motor vehicle and pedestrian/cyclist crashes at level crossings (compared with the rest of the road network), the consequence of a crash at a level crossing is often death or a serious injury, and regularly draws media attention, especially if it involves a vulnerable road user such as school pupil or an elderly person.

In New Zealand level crossings are managed using the same "safe system" approach that is applied to other transport infrastructure. Namely, it is important to remember that humans make mistakes (but shouldn't be disproportionately punished for them) and are vulnerable to injury, requiring a focus on harm minimisation. Applying this thinking to level crossings involves considering the behavioural aspect of human interactions with level crossings and applying appropriate infrastructure (e.g. engineering, vehicle technology) or non-infrastructure (e.g. education, enforcement) treatments to each site. A shared responsibility is required to address safety, including: rail operators, road controlling authorities (Councils and NZ Transport Agency) and system users.

Since 2007, when the ALCAM (Australian Level Crossing Assessment Model) was formally adopted in New Zealand, KiwiRail has been using it to prioritise the upgrading of its existing crossings and to assess the increased risk of a change in use (e.g. significant increase in number of vehicles, pedestrians and cyclists). To mitigate the increased risk KiwiRail has required road controlling authorities (Councils and NZ Transport Agency) and other stakeholders (e.g. developers) to upgrade the impacted level crossings. However, the reliance on ALCAM has not always lead to the correct interventions. Coroners have been critical of a few decisions made by KiwiRail around level crossing safety, that may have contributed to level crossing deaths. In some cases, the ALCAM risk rating has not adequately represented the level of risk at a crossing, which may be more evident in the number of near misses (incidents) and/or the concerns raised by locomotive engineers of risky behavior at some crossings.

In addition, a number of high-profile level crossing fatalities has increased the focus on level crossing safety over the last five to ten years. In October 2016, the New Zealand Transport Accident Investigation Commission (TAIC) added "safety for pedestrians and vehicles using level crossings" to its Watchlist of pressing concerns (https://taic.org.nz/watchlist). TAIC noted that the process for assessing risk at pedestrian (and bicycle) crossings was not keeping pace with infrastructure changes and increasing patronage on metropolitan passenger trains. The increasing use of railway corridors for shared use and cycle paths has also led to an increase in pedestrians and cyclists using these corridors and the level crossings along them.

While ALCAM does have its limitations, it is still an important part of the risk assessment process. Many countries, and jurisdictions (States) within countries, use a hazard ranking tool like ALCAM to assess the level of risk at their level crossings and to manage risk across their level crossing network, at least for vehicle crossings. Sperry et al (1) contains a review of the hazard ranking tools used in 39 states within the USA. The two most common hazard ranking tools in the USA are the hazard index technique and the crash prediction formula, with the U.S DOT Accident Prediction Model being the most common (used in 19 States) ranking tool. The common factors considered in these tools are 1) highway traffic volume, 2) train volume, 3) warning device type,

4) crash history, 5) train speed, 6) number tracks, 7) highway lanes and 8) road surface. Interestingly sight distance is only assessed in 9 of the 39 States, while pedestrian volume is only considered in one State. The ALCAM vehicle model compares favorably with the USA models, and is a combination of a crash prediction model (it uses the Peabody-Dimmick Formula) and a hazard index. It contains seven of the eight factors above and the sight distance. ALCAM also contains a separate pedestrian crossing model (for pedestrian only crossings and those next to road crossings), which is a hazard index, and includes pedestrian volumes. The ALCAM model does not currently use crash data. The new process however does include crashes, near crash misses and other incident (e.g. driving through barriers) data from the IRIS incident database.

To help overcome the limitations in ALCAM, KiwiRail has developed a new assessment process called the Level Crossing Safety Impact Assessment (LCSIA). A key component of this new process is a new risk scoring system called the Level Crossing Safety Score (LCSS). In addition to the traditional ALCAM (level crossing risk model) score, the LCSS also looks at three additional data sources associated with crash risk: historical crash and incident data, safety observations made by locomotive engineers and road controlling authority (RCA) engineers, and a more detailed site safety assessment that considers the crossing and surrounding transport network and mix of users, including cyclists. In addition to a risk assessment, the LCSIA also identifies any safety issues that need to be considered at an existing site or as part of a crossing upgrade. These safety observations can be utilized in the formal safety audit process.

KiwiRail requires that an LCSIA is completed for ***all*** level crossings that are modified/ upgraded or impacted by increasing usage. Examples of increased usage include, increase in train frequencies, increase in pedestrians and cycle usage due to construction of a railway corridor cycleway or increase in vehicles due to new land-use development. A LCSIA needs to be prepared and approved prior to the construction of any planned change to level crossings or any operational changes (e.g. increase in train frequency).

This paper outlines the LCSIA process and also the lessons that have been learnt from undertaking LCSIA at over 150 pedestrian and vehicle level crossings around New Zealand. The authors of this paper were involved in preparing the LCSIA guidelines (2). This paper does include extracts from this guideline.

LCSIA CRITERIA AND ITS LINK TO NZ LEGISLATION ON RAILWAY CROSSINGS

KiwiRail has developed two criteria for use in assessing level crossing safety. The first criterion (Criterion 1) is that the Level Crossing Safety Score (LCSS) of new and modified level crossings should be ‘Low’ or ‘Medium-Low’ after opening and ten years in the future. Only at these low risk levels are the health and safety requirements as specified in the Railways Act (3) (“the Act”) deemed to be meet. The main purpose of “the Act” is to promote the safety of rail operations and to clarify the law relating to management of the railway corridor. Following recent updates, it now also incorporates aspects of the Health and Safety at Work Act (4).

When considering the safety of rail operations in the Act (3), a key concept is that of **“reasonably practicable”**, which is defined as:

In this Act, unless the context otherwise requires, reasonably practicable, in relation to a duty to ensure health and safety or to protect property, means that which is, or was, at a particular time, reasonably able to be done in relation to ensuring health and safety or the protection of property, taking into account and weighing up all relevant matters, including—

(a) the likelihood of the hazard or the risk concerned occurring; and
(b) the degree of harm or damage that might result from the hazard or risk; and
(c) what the person concerned knows, or ought reasonably to know, about—
(i) the hazard or risk; and
(ii) ways of eliminating or minimising the risk; and
(d) the availability and suitability of ways to eliminate or minimise the risk; and
(e) after assessing the extent of the risk and the available ways of eliminating or minimising the risk, the cost associated with available ways of eliminating or minimising the risk, including whether the cost is grossly disproportionate to the risk.

The Act also defines "level crossings" to include both where *"a railway line crosses a road on the same level"* or where *"the public is permitted to cross a railway line on the same level"*. The latter can therefore include crossings that are only accessible by people walking or cycling. Hence both vehicle and pedestrian/cyclist crossings are addressed by the Act.

When undertaking an LCSIA the assessor identifies what improvements are required to achieve a 'Low' and 'Medium-Low' risk score at each crossing assessed. Where half-arm barriers at vehicle crossings or automatic gates at pedestrian crossings do not achieve this low level of risk, then the recommendation is either closure or grade separation of the crossing. In many locations it is neither 'reasonably practicable' to close the crossing or grade separate, in most cases due to cost. Closure of the crossing may also deter walking and cycling trips due to the increased travel distances, which is undesirable. Hence in many situations a barrier system is reasonably practicable compared with grade separation or closure.

When Criterion 1 is not achieved then Criterion 2 needs to be meet. Criterion 2 requires that the risk score for the modified crossing is lower than the existing level crossing after opening and ten years in the future. For example, if the train frequency is increased at a crossing by 50%, then improvements should be made so that the LCSS in the after situation is lower than the existing crossing with fewer trains. Where a barrier treatment is already in place then only closure or grade separation can normally reduce the risk to the required level.

LCSIA PROCESS

The following section is a summary of the process detailed in the Level Crossing Risk Assessment Guide (2). Figure 1 shows the general process for undertaking LCSIA's at new and modified pedestrian (and cycle) and vehicle crossings. It commences with a meeting with KiwiRail to explain what is proposed and ends with an LCSIA report being submitted to KiwiRail for approval and discussion.

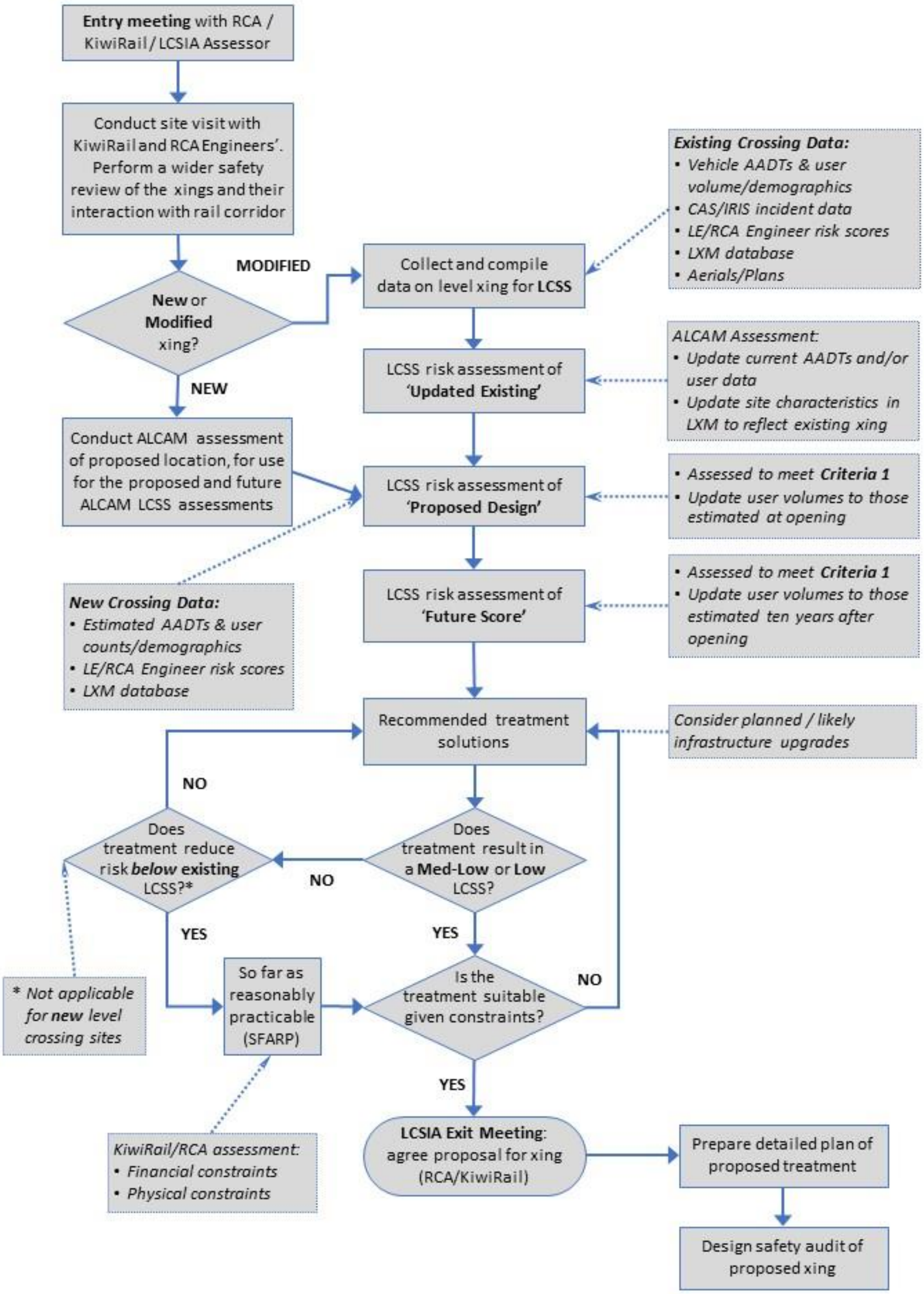

Figure 1: LCSIA Process for new and modified existing level crossings

The LCSIA report provides both the RCA and KiwiRail with an understanding of the road and rail safety risks at the site and what changes should (and could) be made to make the crossing as safe as reasonably practicable.

Risk Assessment Methodology

The elements of the LCSIA methodology include:

- Selecting the appropriate team members (including an accredited LCSIA Assessor) to undertake the assessment
- Site visit with a local roading engineer and KiwiRail representatives (must include a locomotive engineer) to understand the risks and road user behavior
- A site visit and assessment of current conditions at the level crossing (for existing crossings) and surrounding road network
- Review of the proposed 'change in use' activity to the level crossing, whether they be physical changes or changes in traffic volumes e.g. a new residential development nearby
- Complete the Site Specific Safety Score (SSSS) Assessment- looks at matters like number of cyclists and vulnerable pedestrians and proportion of distracted pedestrians
- Identify and specify any safety issues at the existing crossing (including maintenance issues) and with the proposed design / upgrade
- Calculation of the LCSS for the existing crossing conditions and the change in use (whereby the risk value of the 10 year forecast increase in users is assessed on the crossing with no upgrades employed).
- Development of a list of improvements / modifications of the proposed design to cater for the increase in users at the crossing. Undertake a LCSS assessment for the proposed design.
- Undertake a LCSS assessment for the future risk score of the crossing, based on ten year forecast increase in crossing users. Includes any necessary increased levels of controls at the crossing to cater for increase in users.
- A recommendation on the necessary changes required at the crossing in order to achieve ***Criterion 1*** or ***Criterion 2*** after opening and ten years in the future.

The following sections include more detail on these processes. An LCSIA must be led by a KiwiRail accredited assessor. For level crossings that involve a cycleway or shared paths it is also strongly recommended that a designer of walking and cycling crossings/facilities also be involved. The New Zealand "Railway Crossing Pedestrian/Cycling Guidelines" (5) provide more details on designing crossings for pedestrians and cyclists.

Existing Conditions at the level crossing

A site visit must be undertaken by an accredited assessor for each new or modified level crossing to assess the existing conditions, review proposed changes to the crossing, undertake a safety review and assess the Site Specific Safety Score. If an ALCAM assessment is not available for the crossing (i.e. there is no record in the ALCAM Level Crossing Management (LXM) database) then a separate ALCAM field survey also needs to be undertaken and a new ALCAM record produced. A local roading engineer and a locomotive engineer from KiwiRail are also normally involved in the site visit. They can raise safety concerns at the site and also provide a risk score out of 5 for each existing and proposed level crossing arrangement.

Proposed and Modified Designs at New / Upgraded Level Crossing

The LCSIA should ideally inform the design process and recommend what level and type of control devices that are required to meet ***Criterion 1*** and/or ***Criterion 2***. In many cases the applicant (i.e. the organisation or development that is increasing road user demands, increasing train demands, or making physical changes to the crossing) provides a proposed upgrade to the crossing. This proposed design can also be assessed as one of the potential upgrade options.

The LCSIA assessment team can also specify any additional protection measures that the applicant should consider to further reduce the risk at the crossing, e.g. automatic gates at a pedestrian/cyclist crossing rather than a maze with flashing lights and bells, where this is needed to achieve ***Criterion 1*** and/or ***Criterion 2***. This is called the proposed design.

Components of the Level Crossing Safety Score (LCSS)

The risk of pedestrian and motor vehicle crashes are assessed using the Level Crossing Safety Score (LCSS). The maximum score (60 points) signifies a very unsafe crossing. This score consists of the following components:

- ALCAM Score (30 points),
- Crash and incident history (10 points),
- A site-specific safety score (SSSS) (10 points), and;
- Locomotive and local roading engineers' risk assessment (10 points).

Separate assessments are undertaken for the individual vehicle and pedestrian crossings. Based on these scores, the crossing is placed into risk bands as shown in Figure 2, which correspond to a five-level risk description, ranging from HIGH to LOW

Figure 2: Level crossing safety score risk bands (2)

The following sections explain how the individual components which make up the overall LCSS are derived. The overall ranking of the crossing is based on the sum of the four components.

ALCAM (Maximum 30 points)

The ALCAM model was first released in 2000 (6) and has been modified a number of times since then based on an improved understanding of level crossing safety. The second release of the vehicle model was in 2004 and the pedestrian hazard index model was released in 2005. In 2007 New Zealand adopted the ALCAM model, which is also used in all the Australian States and Territories The most recent update in the model was in 2014. See the ALCAM in Detail (6) and ALCAM Road/Pedestrian Model Crossing Assessment Handbook (7) for more details on ALCAM.

The ALCAM risk score and associated risk bands are extracted from the LXM database, which includes scores and risk bands for all public and most private vehicle and pedestrian level crossings in Australia and in New Zealand There are five ALCAM risk bands (low, medium low, medium, medium-high and high) that are linked to the ALCAM score, with high risk crossings having the highest scores. The ALCAM scoring values for road and pedestrian crossings differ. The LCSIA guidelines (2) provide tables on how the ALCAM scores are converted to a LCSS score out of 30.

The ALCAM score is updated using the most recent vehicular, pedestrian, cyclist and train counts. Any site characteristics observed that may have changed since the initial ALCAM assessment was completed, can be used to update the site characteristics in LXM. The updated ALCAM score and risk band should then be used as the new baseline condition (Updated Existing), as all the original ALCAM assessments were undertaken more than five years ago (as far back as 2008).

ALCAM assessments can be undertaken within LXM (under proposals mode) for the Change in Use, Proposed Design and Future Score. If the future ALCAM risk score / band is expected to increase, then the SRT can assess higher levels of control to reduce the risk to an acceptable level.

Improvements to the physical control type of a level crossing site will generally have a greater impact at reducing the ALCAM risk score than other measures. For a pedestrian crossing these are usually automatic gates (including emergency egress), and flashing lights & bells. As opposed to signage, lighting or adjacent controls (i.e. adjacent road controls). For a road crossing this means the installation of half arm barriers.

Another useful output from the LXM database is the expected return period for injury and fatal crashes at each vehicle level crossings. This can be calculated for an existing and proposed crossing upgrade with and without the change in use. This is possible as the vehicle model is based on a crash prediction model (Peabody Dimmick). Validation of the crash model predictions does show that the majority of fatalities at level crossings do occur at the ‘medium-high’ and ‘high’ risk crossings. This information is normally presented for each option in the LCSIA report.

The pedestrian ALCAM model is a hazard index and so a direct relationship between pedestrian crashes and risk is not expected. However recent analysis by the authors has shown there is a fairly strong relationship between fatal pedestrian (and cycle) crashes and the ALCAM crossing score. It was found that 48% (12) and 64% (16) of the fatal pedestrian and cycle crashes in New Zealand occurred at the top 50 and 100 risk rated sites respectively. Only 8% (2 fatalities) occurred at the bottom 200 sites. Based on these findings a pseudo return period has been developed for fatal crashes at pedestrian crossings. The lowest return periods being one fatal every 20-40 years.

Crash and Incident History Analysis (Maximum 10 points)

This score is based on the number of crashes in the New Zealand CAS (crash analysis system – the nationwide road crash database) and the number of incidents reported in the KiwiRail IRIS (crash and incident) database (mainly those recorded by locomotive engineers). It can also be supplemented by other data collected locally. When there is a train vs vehicle / pedestrian fatal crash at the crossing, 10/10 points would be automatically scored.

The scoring system is weighted for certain incident types, based on severity, e.g. an injury crash scores higher than a near miss, or a crash involving a truck scores higher than a light vehicle. The IRIS data is most likely to yield more results than CAS (due to capturing incidents not involving a motor vehicle), and therefore is the stronger guide on the score for this category. Further details on how to score each element are found in the LCSIA Guidelines.

Site-Specific Safety Score (SSSS) (10 points)

This site-based score aims to analyse elements of the layout that are not well covered or missing from the ALCAM risk rating. Scoring systems are available for both urban and peri-urban road and pedestrian crossings (where speed limits are posted at 70 km/h and below) and rural road level crossings (where posted speed limits are > 70 km/h). Some of the factors considered under the SSSS include:

- Evidence of distracted pedestrians and cyclists, which is becoming a more major issue
- Grounding out which can occur when the crossing is on a hump in the road
- Large flange gaps (gap between rail and asphalt) especially at acute angle crossings
- Proportion of vulnerable users (school children) and cyclists.

It is acknowledged, that there are some subjective ratings required within the SSSS, with some scoring narratives for individual sections enabling different interpretations by different assessors. The assessor should describe the rationale for their risk ratings carefully and what information was used to establish the rating of each element. Further details on the scoring are provided within the LCSIA Guideline (2).

Locomotive and RCA Engineers' Risk Assessment (10 points)

This risk score reflects the level of death and serious injury crash risk that locomotive engineers (train drivers) and RCA engineers give to each railway crossing compared with other crossings they encounter regularly within their jurisdiction. Where possible this relative risk score should be determined by a number of different practitioners involved with the crossing. In the case of locomotive engineers this may be the opinion of several drivers that use each line. In the case of the local roading engineers, they should also consider the experience of the public (including drivers, pedestrians and cyclists), either through surveys or through an interest group representative (e.g. for motor vehicles and cyclists).

The combined opinion score of the two engineers is weighted 2:1 in favour of the locomotive engineers, as they generally have more interactions with the crossing than the local roading engineer, who may only infrequently encounter the crossing.

General Safety Review

In a similar approach to a safety audit, the LCSIA assessor identifies any safety issues at the existing crossing, in relation to the interaction of level crossing users with the rail infrastructure. The LCSIA safety review is not considered to be a replacement for formal road safety audit. The general safety review is to include all safety issues ranging from missing or damaged signs through to concerns with the layout of the level crossing and surrounding road. For example, queues of vehicles waiting to turn right into a major access or side-road that extend across the level crossing may not have been identified through the ALCAM site inspection process but have significant safety implications on the crossing.

SUMMARY OF LCSIA UNDERTAKEN TO DATE AND LESSONS LEARNT

After nearly three years of the new process (October 2016 to mid-2019), a lot has been learnt about level crossing safety and it is noted that no two level crossings are the same. In mid-2018, progress began on a second edition of the LCSIA Guidelines, which was put into practice from 2019 onwards. A number of alterations to some of the scoring procedures were changed to try an evoke movement in the LCSS values between each of the four assessment phases. By mid-2019, upwards of 200 individual crossing points have had LCSIAs conducted on them. The sites varied from quiet rural roads to busy urban pedestrian crossings. Each assessment was unique with varying characteristics and scores. This section discusses some of the key lessons learnt from undertaking these assessments.

A key element of the LCSIA assessment is the ALCAM score. An analysis undertaken for KiwiRail of over 30 level crossings in Christchurch and Wellington which identified several faults with the New Zealand ALCAM data. Therefore, the first step in any LCSIA is to check the validity of the recorded ALCAM data and correct it where possible, to produce an 'updated existing' ALCAM score. An extra benefit of the LCSIA process is that it will improve the quality of the ALCAM database (LXM) over time. KiwiRail has also taken other steps to improve the quality of the ALCAM data and to keep it up to date, including resurveying high-risk crossing across New Zealand.

An ALCAM score was not always available for all crossings, especially pedestrian crossings in peri-urban areas, even where pedestrians were already crossing the tracks. In such situations an ALCAM survey must be undertaken. The collection of ALCAM data often created delays due to the limited number of ALCAM certified practitioners. Recently this has been addressed by increasing the pool of ALCAM surveyors through new training courses.

An analysis of pedestrian data at level crossings in the ALCAM LXM database showed that pedestrian volumes were only recorded (or estimated from partial day counts) for crossings in Auckland. Everywhere else in New Zealand a default volume of 100 pedestrians and cyclists per day was adopted. Many of the Auckland volumes were out of date, i.e. four or more years old. Hence at most pedestrian crossings there is a requirement to collect the actual pedestrian and cycle volumes to improve the ALCAM database, as the ALCAM risk score is an exposure-based model, heavily reliant on the volume of users at the crossing. In addition to the counts themselves, other important information like the proportion of school children, cyclists and disabled users is collected. This additional information is used in the development of an ALCAM scores for each crossing. The preferred data collection approach recommended is at least one full day count (7am to 7pm) collected from video. Ideally traffic count data should also be updated when doing a LCSIA.

Having a video of each crossing allows the assessor to also look at the behavior of pedestrians and pick-up any distraction issues such as pedestrians using their cellphones or cyclists with headphones, which is a factor considered in the wider LCSIA. KiwiRail has a count program that is collecting additional pedestrian and cycle count data at sites where it is suspected that there are greater than 100 users per day, to help prioritise sites for treatment nationally and fill this gap in the ALCAM data. This data and counts conducted at low volumes crossings, will be used to create a range of default values for different cities and surrounding land uses, that can be applied to all crossings instead of a blanket 100 users. For example, this will see some crossings increase to 200 or 300 users per day, while others reduce down to 20 or 50 users per day.

In situations where there is a parallel or crossing cycleway, it is important to understand the origin and destination or desired line of the pedestrians and cyclist crossing the level crossing, to understand the risks at each site. For example, if there is a strong diagonal movement across the crossing then cyclists or pedestrians may choose to cross the railway line at an angle rather than at the correct closing place. This information should be obtained at the same time as pedestrian volumes data is being collected.

As already highlighted, some of the existing data in ALCAM requires updating. Information that needs updating often includes pedestrian volumes, train speeds, train numbers, vehicle AADT, passenger numbers, and carriage numbers. Train speeds in particular have a large impact on the ALCAM score and are often inaccurate in ALCAM. In some places temporary speed changes are in effect due to the need for track maintenance. However, in ALCAM the standard train speeds should be used as this reflects the ongoing risk at the crossing.

Rural road level crossings require an understanding of the road users, especially heavy vehicle types (logging/dairy) and the nearby activity. For example, nearby side roads that attract a lot of heavy vehicles could result in queuing at or over the level crossing. It is also important to consider the high-speed environment and horizontal and vertical alignments of crossings. For example, a loss of control vehicle on a crossing approach curved could potentially taking out the barrier arm components.

In urban areas it is important to be aware of nearby railway stations, reverse tracking and shunting activities that can increase risk especially of a second train coming when there are two or more tracks. Second train coming can be an issue were one train, potentially at nearby stations or in shunting yards, triggers the crossing bells, lights and barriers, and a pedestrian attempts to cross but does not see the second train approaching the crossing. KiwiRail is looking at visual and verbal warnings to alert pedestrians and motorists to another train approaching.

Our experience with developing improvement options for level crossings involving footpaths, cycleways and shared paths is that it can be challenging to fit in the necessary infrastructure. In some places mazes and automatic gates cannot be easily be fitted in within the road and rail designations and land purchase is required. Consideration also needs to be given to stacking room for the maze or automatic gates at busy cycleways. This was a key issue at one of the crossings assessed due to a nearby sideroad. There are also benefits at cycleways of having automatic gates rather than mazes as during normal operation the cyclists can travel straight through the crossing when there are automatic gates while at mazes they have to wind around the alignment at all times, even when the mazes are larger to accommodate cyclists.

Difficulties can also occur when a vehicle and pedestrian/cycle crossing have different levels of control. The most common being where the vehicle crossing has a barrier and the pedestrian crossing does not. In several situations the cyclists are required to use the vehicle crossing but we know that they may choose to use the adjacent uncontrolled pedestrian crossing to avoid the barrier when they believe they can beat the train. This is particularly common where the desire line is to cross at the pedestrian crossing on the opposite side of the road to where the cyclists would normal cross to link up with a sideroad.

Another situation where this imbalance may occur is on rural cycleways, where there is an adjoining local road that has not barrier control while the cycleway has a maze or automatic gates. In these situations it is important that a fenced-off cycleway for cyclists leads into the crossing, to funnel the cyclists to not bypass the maze or automatic gates by using the uncontrolled vehicle crossing.

The general safety assessment side of LCSIA is also important for picking up unique situations at crossings, noting that as a model, ALCAM cannot pick up all safety issues. For example, there are some driveways near an urban level crossing where drivers can exit onto the level crossing from behind the barrier arms. In such circumstances it can also be hard for the driver to see the flashing lights, and hence the only warning they get is the bells, which they may or may not hear depending on whether there is other noise in the vehicle. Ideally in these situations drivers should be banned from turning onto the crossing, or alternatively a set of flashing lights should face the exiting driver. While these matters may not always impact on the ALCAM score, they should never-the-less be addressed during an LCSIA assessment and followed up in the safety audit.

The site meeting with locomotive engineers and other KiwiRail signaling and maintenance staff has often provided many key insights into the crossing that would otherwise have gone unnoticed by the LCSIA Assessor, especially if they had travelled from out of town to conduct the assessment. It has also provided a different perspective to the crossing, where most assessments are conducted by assessors who have a road safety background and not necessarily fully knowledgeable in all things rail. This discussion has been a key facet to the success of the LCSIA process.

FINAL REMARKS/SUMMARY

The new LCSIA process has led to a step change in managing the safety of level crossings in New Zealand. It is doing this in several ways.

Firstly, it brings together not only the ALCAM risk scores but also incident and crash data from the site along with the safety opinions of locomotive and local roading engineers. The locomotive and local roading engineers have their own experience of using the crossing and also have access to the public and other professional views on the safety of the crossing. It also adds a more detailed review of several of the roadway and pedestrians/cyclist related impacts of the crossing, beyond that provided in ALCAM. Specifically looking at network impacts like traffic queuing across the line and observations of pedestrian distraction.

The LCSIA process also looks at broader safety issues that might impact on the crossing, such as marking and signage condition. The opinions of the locomotive and local roading engineers in identifying these issues is important, as they have a better understanding of how the crossing operates. A key reason for doing this assessment is to capture key issues that need to be considered as part of the safety audit process.

The LCSIA process also provides an opportunity to review and update the ALCAM data for each crossing, which in many cases may now be out of date. Of particular importance in the assessments is the pedestrian, cyclist and motor vehicle volumes that change over time, but are very important in ranking the risk of the crossing.

One area that is going to receive further attention by KiwiRail in the short to medium term are details around the trains usage of each rail line, including numbers of trains per day, length of trains and train speeds. The data for many railway lines is out of date and needs updating. When undergoing an LCSIA pay careful attention to this information and seek to update where necessary directly from KiwiRail.

‘Second train coming’ is a key issue at level crossings with two or more tracks, and especially on metro lines where train numbers are high. This issue occurs when two or more trains cross the level crossing on a single closure period, i.e. where the bells, flashing lights and barriers are activated. In many places the pedestrians and cyclists are not controlled by a barrier and may choose to cross after the first train has gone through the crossing (or when a train is waiting at a station or part of a shunting movement), and the concern is they will not see the second train that is approaching as it could be obscured by the first train. This illegal movement may in part be due to the frustration resulting from the flashing lights, bells and barriers being applied for long periods in peak periods on metro lines. In such circumstances the use of second train coming signage and verbal warnings is recommended, if automatic gates are not planned for installation.

Careful attention needs to be paid to the design of new pedestrian crossings and especially crossing of shared use paths (pedestrians and cyclists). Firstly, it can be difficult in some places to design mazes and automatic gates while keeping the crossing as close to 90 degrees as possible. When making design compromises it is important to consult the design guidance around pedestrians and cyclists at level crossings provided in KiwiRail (2017a). It is also important to make illegal movements (such as diagonal crossings and footpath riding) across the level crossing difficult through use of planting, fencing, traffic islands and hoops. This is particularly important where the shortcut movement is a lot quicker than the correct crossing movement.

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