LEVEL CROSSING PROJECT

as part of the
RAILWAY SAFETY PROGRAMME

PRESENTED BY

CONOR MCGUINNESS
SENIOR PROJECTS MANAGER
1. INTRODUCTION

- OVER 2500 CROSSINGS ON ALL LINES INCLUDING CLOSED LINES
- OVER 2000 CROSSINGS ON USED LINES
- 1600 CROSSINGS ON PASSENGER LINES
- 85% OF CROSSINGS ARE USER WORKED CROSSINGS
TYPES OF CROSSINGS

• USER WORKED – THE PERSON USING THE CROSSING HAS TO OPEN AND CLOSE THE GATES THEMSELVES EACH TIME THE CROSSING IS USED. NO RAILWAY SIGNALS LINKED TO THESE CROSSINGS.

• RAILWAY WORKED – THESE CROSSINGS ARE AUTOMATICALLY OPERATED BY THE PASSAGE OF TRAINS OR MANNED BY RAILWAY STAFF WHO OPEN AND CLOSE THE GATES FOR EACH MOVEMENT.
Field Type Crossing
Occupation Type Crossing on Public road
Crossings manned by Railway staff – C/CX/CN
Automated Crossings – Automatic Half Barrier (AHB)
Automated Crossings - 4 Barrier monitored by CCTV(CCTV)
2. DEVELOPMENT OF RISK ASSESSMENT MODEL

**National averages for crossing type**
- Average vehicle / train utilisation
- Average historic safety performance

**Crossing specific data**
- Utilisation
- Risk factors
  - condition
  - views
  - gates left open
  - train speed

**LEVEL CROSSING MODEL**

**OUTPUTS PREDICTED**
- Accident rate
- Fatality rate
- Individual risk (regular user)
• **The basis of the model is Fault Tree whose Top Event is “train - vehicle collision”, and an Event Tree showing consequences of a collision event.**

- **Risk factors: Affecting chance of user error**
  - Incentive to take risk
  - Insufficient information
  - Unable to correct error in time
  - Low familiarity with task
3. MEASUREMENT OF THE PROBLEM

- Need to look at condition and use of every crossing
- Site Visit Form developed to record similar data for each type of crossing
- All crossings visited in 1998 and data collected
**User Worked Crossings – Data collected**

- **Type of users** - familiar
- **Type of usage** - regular, seasonal
- **Condition of crossing** - views, surface, gradients
- **Types of vehicles using crossing**
- **Type of railway traffic** - speeds etc.
Railway worked crossings - Data collected

- Approach road – speed, width, view of crossing
- Crossing location - bend, close to junction
- Visibility – sun dazzle, fog
- Ability to stop
- Road usage
- Railway usage
Example of Risk Assessment Model

OP-- User Worked Crossing on Public Road
1. User Characteristics

1.1 Describe the majority of road user types at the crossing.
   - Regular / Familiar

1.2 Is there heavy seasonal use of the crossing?
   - Seasonal use

1.3 Are gates left open a known problem at the crossing?
   - Yes, Frequent
### Crossing Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Are the crossing user's views of the railwayline poor?</th>
</tr>
</thead>
</table>
| 2.1 | i) e.g. obstructions limiting view of line or views less than '11' seconds; 
      | ii) take train speed into account. |
| Up Side | Adequate |
| Down Side | Adequate |

<table>
<thead>
<tr>
<th></th>
<th>Is the crossing surface poor?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2</td>
<td>e.g. low level of fills or loose fill.</td>
</tr>
<tr>
<td>Up Side</td>
<td>Adequate</td>
</tr>
<tr>
<td>Down Side</td>
<td>Adequate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Is there a gradient across the crossing?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3</td>
<td>Potential for grounding or impeding vehicle movement.</td>
</tr>
<tr>
<td>Up Side</td>
<td>No</td>
</tr>
<tr>
<td>Down Side</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Are there additional factors which could worsen the effects of a train/vehicle collision?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4</td>
<td>e.g. embankment, complex track layout</td>
</tr>
<tr>
<td>Up Side</td>
<td>No</td>
</tr>
<tr>
<td>Down Side</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Is fog a problem at the crossing?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>Some problem</td>
</tr>
<tr>
<td>Up Side</td>
<td></td>
</tr>
<tr>
<td>Down Side</td>
<td></td>
</tr>
</tbody>
</table>
3 Road Utilisation

3.1 Estimate the total average daily road vehicle utilisation (sum of both directions).  
45.

3.2 Estimate the total average daily pedestrian utilisation (sum of both directions).  
0.

3.3 How many vehicles under 3.1 are laden buses? (O, OP and OP* only)  

3.4 Are tractors or farm machinery used on the crossing?  
Yes

3.5 Are tailbacks across the crossing a problem?  
e.g. if a road junction or turning may restrict the user’s exit from the crossing  
Up Side  
No problem  
Down Side  
No problem  

Take into account variations due to time of day and seasons.
i) Take into account variations due to time of day and seasons.
ii) Do not include crossings on foot during vehicle crossings.

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4 Railway Utilisation

4.1 Estimate the total average daily number of laden passenger trains through the crossing.

28.

4.2 Estimate the total average daily number of rail movements, other than laden passenger trains, through the crossing.

9.

4.3 Estimate the highest train speed at the level crossing.

> 50 mph

Take into account variations due to time of day and seasons.
Output from Risk Assessment Model

OP Results
<table>
<thead>
<tr>
<th></th>
<th>Scientific Format</th>
<th>Standard Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle User Fatalities (per year)</td>
<td>1.75E-03</td>
<td>0.00175</td>
</tr>
<tr>
<td>Pedestrian Fatalities (per year)</td>
<td>9.08E-05</td>
<td>0.0000908</td>
</tr>
<tr>
<td>Total Fatalities (per year)</td>
<td>1.84E-03</td>
<td>0.00184</td>
</tr>
</tbody>
</table>
## Individual Risk of Fatality

<table>
<thead>
<tr>
<th></th>
<th>Scientific Format</th>
<th>Standard Format</th>
<th>Risk 1 in ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Risk of Fatality to a Regular Vehicle User (per year)</td>
<td>5.32E-05</td>
<td>0.0000532</td>
<td>18,800</td>
</tr>
<tr>
<td>Individual Risk of Fatality to a Regular Pedestrian User (per year)</td>
<td>6.91E-07</td>
<td>0.0000007</td>
<td>1,450,000</td>
</tr>
</tbody>
</table>
### Collision Frequency

<table>
<thead>
<tr>
<th>Event Description</th>
<th>Scientific Format</th>
<th>Standard Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency of Train/Vehicle Collisions (per year)</td>
<td>4.55E-03</td>
<td>0.00455</td>
</tr>
<tr>
<td>Frequency of Laden Passenger Train/Vehicle Collisions (per year)</td>
<td>3.45E-03</td>
<td>0.00345</td>
</tr>
<tr>
<td>Severity Factor</td>
<td>Medium</td>
<td></td>
</tr>
</tbody>
</table>
Graph of Crossing Fatality Rates

- Vehicle User: 1 in 1,000,000
- Pedestrian User: 1 in 100,000
- Total: 1 in 10,000

Legend:
- Purple bar: Average for crossing type
- Blue bar: This crossing
Graph of Individual Risk of Fatality for a Regular User

- Vehicle User
- Pedestrian User

- Average for crossing type
- This Crossing

Risk of Fatality:
- 1 in 100
- 1 in 1000
- 1 in 10,000
- 1 in 100,000
- 1 in 1,000,000
- 1 in 10,000,000
- 1 in 100,000,000
4. RISK ASSESSMENT RESULTS

- Risk Acceptability criteria established in line with international norms
- Crossings to be prioritized based on results
- High Risk crossings primarily user worked.
Results of Risk Assessment programme

Crossings requiring priority investment

Crossings not requiring priority investment

Risk Acceptability Criteria

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<table>
<thead>
<tr>
<th>Either</th>
<th>Individual risk of fatality for regular users $\geq 1$ in 10,000 per annum</th>
<th>Crossing requires mitigation – &quot;BLACK AREA&quot;.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Or</td>
<td>Divisional Engineer identifies factors giving intolerable situation</td>
<td></td>
</tr>
<tr>
<td>Either</td>
<td>Individual risk of fatality for regular user $&lt; 1$ in 10,000 but $\geq 1$ in 20,000 per annum</td>
<td>Crossings requiring further evaluation - &quot;GREY AREA&quot;.</td>
</tr>
<tr>
<td>Or</td>
<td>Collision rate $\geq 1$ in 100 years</td>
<td></td>
</tr>
<tr>
<td>Or</td>
<td>Crossing is in poor maintenance condition</td>
<td></td>
</tr>
<tr>
<td>Both</td>
<td>Individual risk of fatality for a regular user $&lt; 1$ in 20,000 per annum</td>
<td>Crossing currently not requiring mitigation on risk grounds</td>
</tr>
<tr>
<td>And</td>
<td>Collision rate $&lt; 1$ in 100 years</td>
<td></td>
</tr>
</tbody>
</table>
“Black Area”

“Grey Area”

“White Area”

“Black Area”

Require mitigation on risk grounds

Evaluation Factors

• small number of users with higher than average number traverses
• cattle
• poor condition
• long crossing time compared to view time
• peaky seasonal use
• peaky daily use
• vulnerable groups
• UWC is a short cut
• crossing difficult to operate
• train speed >75mph
• hazardous goods

“White Area”

Do not currently require priority mitigation on risk grounds
Ranking the Crossings

- Priority Rating given to all ‘black’ crossings
- Priorities range from 0 to 15
- Priorities based on combination of 2 factors
- Individual risk of fatality to a regular user per annum
- Frequency of accidents per annum
## Priority Score 1 – Individual Risk

<table>
<thead>
<tr>
<th>Individual Risk of Fatality for Individual User - Range</th>
<th>Additional Factors give rise for concern</th>
<th>Priority Score 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 1 in 2,000</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>1 in 10,000 to 1 in 2000</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>1 in 20,000 to 1 in 10,000</td>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td>1 in 20,000 to 1 in 10,000</td>
<td>No</td>
<td>3</td>
</tr>
<tr>
<td>1 in 100,000 to 1 in 20,000</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Below 1 in 100,000</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>
## Priority Score 2 – Collision Frequency

<table>
<thead>
<tr>
<th>Predicted Collision Frequency – Range</th>
<th>Priority Score 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;0.01 per year</td>
<td>5</td>
</tr>
<tr>
<td>0.005 to 0.01 per year</td>
<td>4</td>
</tr>
<tr>
<td>0.001 to 0.005 per year</td>
<td>3</td>
</tr>
<tr>
<td>0.0005 to 0.001 per year</td>
<td>2</td>
</tr>
<tr>
<td>&lt;0.005 per year</td>
<td>1</td>
</tr>
</tbody>
</table>

**Priority Score** = **Priority Score 1** + **Priority Score 2**,  
Max = 15  
Score of 10 or more indicates an intolerable risk
Black Crossings by Type

» Total 608

- Field: 424
- Occupation: 131
- Attended: 41
- Automatic: 11
5. STRATEGY FOR INVESTMENT PROGRAMME

• **AIM:** To reduce risk to user at all crossings to an acceptable level

• **FOCUS ON:** Highest Risk crossings and busiest lines first

• **METHOD:** To eliminate as many crossings as possible
Additional requirements

• Close all unprotected crossings on double track lines- Dublin-Cork, Dublin-Belfast, DART

• Focus on other high speed, high traffic density lines – Portarlington-Athlone, Limerick – Limerick junction

• Avail of opportunities to close other crossings
Resources

• Project team – in house – Project Manager, engineers, technician

• Design team – external for construction works/ planning applications/site works

• Property Surveyors/negotiators

• Solicitor to draft legal agreements

• Part time financial & planning resources
6 METHODOLOGY

• All crossing closures to be reached by agreement as no compulsory powers to close crossings

• Where works involved – negotiations with users, design of works and tender phase and planning applications proceeding in parallel

• Programme needs to be flexible to substitute other crossings if progress delayed or no agreement possible
Solutions considered

- Land search to check if ownership is split
- Buy rights to crossing
- Buy cross-track property (resale)
- Provide alternative access
- Land swaps
- Protect crossing (gates, signals)
- Bridge or underpass
- Upgrade, where appropriate
Need to Follow the Paper trail

- Legal Process to be completed by user and IE and CIE Boards
- Legal Rights to be given up
- Paperwork flow to be managed
- Solicitor must be involved on both sides if land is involved
- New rights of way need to be mapped and registered
How A Crossing is Closed

- Visit Crossing User – assess needs
- Check folio in Land registry
- Reach agreement on closing crossing
- Send formal offer letter outlining terms
- User agrees terms
- Lodge planning application if required
- Fast track approval where compensation/land purchase/works below certain level
- High Cost closures must be approved by the Board
How A Crossing is Closed(2)

- Brief Solicitor on terms agreed
- Solicitor drafts closure documents & sends to Users Solicitor
- Cheque requisitioned –sent to Users Solicitor
- Solicitor checks title to land being purchased
- User signs closure documents
- If works required, works can now commence
- Crossing physically closed – money released
Time for Completion

- For Right of Way only < 2 months
- 6 months min if land involved
- 12-18 months where works are involved as land purchase and planning permission usually needed
- Up to 2 years or longer if probate has to be taken out on land
- Taking out Probate always involves payment of Tax
- Timescale is completely dependent on Users Solicitor looking at documents and contacting his client
7. EXAMPLES OF COMPLETED PROJECTS

- XC117-121 – overbridge & cattlepass
- XA21 – Land deal
- XB12 - 5 span overbridge Belfast line
- XR 7 & 9 - 2 underpasses on DART line
- XW132/4/5 - 2 underpasses & 800m access road
- XA72-3 Public road underpass
- Various others
OB236a CORK to replace 6 Field crossings
UB236b Cork line - Cattle pass at XC119
Construction of OB99a to replace XB12
Reillys Belfast line

- Location first visited in April 1999
- Survey carried out – single span designed
- Design tendered in Feb 2000 – cost €1.55m
- Scheme did not go ahead due to high cost
- Alternative Access sought – agreed in principle with 2 landowners Nov 2000
- Unable to finalise agreement for this access
Construction of OB99a to replace XB12
Reillys Belfast line (2)

- Agreement reached with different landowner for access route from old N1
- Access route rejected by landowners
- Purchase of 175 acre farm and residences rejected
- Bridge redesigned as 5 span bridge
- Scheme retendered October 2001-cost €1.46m
- Board deferred proposal Dec 2001-cheaper options sought
Construction of OB99a to replace XB12
Reillys Belfast line (3)

- Board paper prepared considering whole life cost of all options considered
- Options considered: 3 different access routes, underbridge, overbridge, farm purchase, CCTV crossing
- Acceptability of options outlined in paper
- Bridge cheapest acceptable solution based on whole life cost
- Board approved bridge proposal Feb 2002
- Main Landowners signed up 19th April 2002
Construction of OB99a to replace XB12
Belfast line – completed May 2003
Construction of OB99a Belfast line
• Construction of OB 99a Belfast line
OB99a Belfast line – XB12 Reillys in foreground
Construction of OB99a to replace XB12
Reillys Belfast line (4)

- Final clearance to go on site 4th June 2002
- Contract signed with SIAC 10th June 2002 at €1.48m (1.5% increase)
- Works commenced on site 4th July 2002
- Bridge beams over track lifted in Oct 2002
- Bridge open 19th May 2003- crossing closed
- Works complete 27th May 2003- final cost €1.645
- Project Cost €1.902m -5.9% over budget
OB99a Belfast line – Complete May 2003
**OB99a Why a 5 span bridge?**

- Poor Ground conditions
- *Embankment would have taken 6 months to settle or required ground improvement at additional cost*
- *Too much land taken up by single span embankment – user acceptance*
- *Potential Safety issue due to large volumes of fill to be drawn across crossing*
- 5 span €90k cheaper at tender than single span
XR7 & 9 Woodbrook Golf club DART line

- 2 underpasses to be constructed – one suitable for machinery (4.5m x 4.5m), one for golfers only
- Construction of 2 underpasses were o be let as one contract – actually let as 2 separate contracts
- 3 temporary crossings of Dart line to be constructed for construction traffic and to keep golf links in operation
- Overhead electrification to be dealt with – isolations required at night for certain works
XR7/9 Woodbrook Golf club DART line (2)

- Services to be exposed, protected and supported during construction – live 38 kv, ESAT. Signalling cables
- 38kv power supply switched off for some works
- 300mm gas main to be diverted for construction and redивerted post construction
- DART services to be cancelled for installation of underpasses
- Pumped drainage system to be installed
• Construction works had to be screened off from golf club
• Golf club set up liaison committee to ‘approve’ design details
• Clerk of Works appointed by Golf club to supervise works
• Extra drainage works carried out post completion to divert track drainage away from pumped system
• Construction cost €1.438m against tender of €1.014 due to splitting of contracts and accommodation works carried out by contractor
XW132/4/5 Ryans & Knockwilliam

- Construction of 2 underpasses – one for cattle, one for machinery
- Construction of 800m of access roads parallel beside railway
- Access roads linked both underpasses and 4 landowners fields
- 3 Crossings closed
- Drainage – major issue
XW137 Knockwilliam – rockbreaking for cattlepass
XW137 Knockwilliam – installation of cattlepass
XW137 Knockwilliam - fitting units together
XW132/4/5 – construction of access road beside track
XW132/4/5 Access road parallel to track
XW132/4/5 _flooding of lands at Ballyhale
Construction of UB53a at Erry - Portarlington/Athlone line

- Closure of 2 unattended public road crossings
- Largest underpass yet constructed 7.5m wide by 4.8m box
- New public road constructed to link to existing road network
- Separate access purchased for overheight vehicles
Construction of Underpass at Erry Portarlington/Athlone line October 2001
Installation of underpass at Erry Portarlington/Athlone line October 2001

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8. PROGRESS TO DATE

- 473 Crossings closed out of 2000
- 130 + land purchases, 1,060 acres purchased
- 20 - overbridges built
- 20 - underbridges built
- 38 access roads built or purchased – 3 for public road crossings
Programme costed in September 1998

Total Cost of Programme €136m

€112m to be spent in first 5 years 1999-2003

Expenditure at end of 2003 €71.8m spent

€82.9 to be spent in second 5 years 2004-2008 -€17.2 spent to end of 2005
## Crossings Closed to date - Feb 2006

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Closures</td>
<td>473</td>
</tr>
<tr>
<td>Release</td>
<td>149</td>
</tr>
<tr>
<td>Split Ownership</td>
<td>86</td>
</tr>
<tr>
<td>Land deal</td>
<td>132</td>
</tr>
<tr>
<td>Bridge</td>
<td>68</td>
</tr>
<tr>
<td>Alternative Access</td>
<td>38</td>
</tr>
</tbody>
</table>

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Solutions to date - Feb 2006

- Access Roads: 149
- Underbridges: 38
- Overbridges: 31
- Land Deals: 37
- Release: 132
- Split: 86

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High Speed /High Density routes

- Dublin/Cork: 72 closed, 40 left
- Dublin/Belfast: 8 closed, 2 left
- Portarlington/Athlone: 62 closed, 22 left
- DART lines: 2 closed, 1 unsignalled left
- Limerick/Limerick jn.: 13 closed, 38 left
Programme Risks

• User can always change mind until legal agreement signed & does.

• 3 pronged approach where works involved
  - Progress negotiations, submit planning application, develop design to tender at the same time

• Principle risk – user changes mind, effort wasted

• Be prepared to walk away if price gets too high

• Target extra crossings as many deals don’t get finished

• Land deals always take more time to complete
Underpass at XR32 Kellys Wexford line – Completed 2000
Overbridge at Bunnahinly to replace XA114/5/6
Pouring concrete to foundations Clonshanny – XA74-77 Port/Athlone
Construction of Reinforced Earth abutment at XA30-31 Port/Athlone
Bridge nearing completion at XA30-31 Port/Athlone
Overbridge at Stonepark 110 1/4 mls Sligo line
OB 347a Cork line to replace XC228
Hanlons
9. Future Strategy

- Crossings getting harder to close – deals more expensive and more complicated
- Railway Safety Act 2005 gives powers to close crossings and acquire land compulsorily
- Implementation of ‘Draft Guidelines for the Design of Railway Infrastructure...’ may limit speed through user worked crossings to 130km/hr
- Consider use of Railway Works order if reopening closed lines