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### Safety Barrier Design Standard & Relevance to the Fencing Retrofit Programme

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TII Fencing Retrofit Programme Workshop Tullamore, January 15<sup>th</sup> 2019



# Agenda...

#### **1.** VRS Design – Relevant Standards

• 03034 / 03036 / 03079

#### 2. Principles

- Forgiving Roadsides
- Hazard Mitigation
- Defined Hazards
- Hazard Ranking
- Clear Zone
- Terrain Class
- Length of Need
- **3.** VRS Risk Assessment



# **Relevant Standards...**

#### **Before We Start...**

- You won't be necessarily designing VRS for this Fencing Retrofit Programme...
- You will be assessing and referring locations which require VRS design or hazard mitigation to TII for design / implementation under other programmes...
- VRS should only be designed by those who have completed the TII VRS Designer Training Course

# **Relevant Standards...**



	Current Version	Expected 2019 Revisions
DN-REQ-03034: Safety Barriers [2015] [2019 - Design of Road Restraint Systems (Vehicle & Pedestrian)	<ul> <li>Forgiving Roadsides</li> <li>Hazards</li> <li>Clear Zone</li> <li>Terrain Classes</li> <li>Risk Assessment</li> </ul>	<ul><li>Hazards</li><li>Hazard Ranking</li><li>Operational Speeds</li></ul>
DN-REQ-03079: Guidance for Retrofitting VRS on the Single Carriageway National Road Network [2017] [2019 - Design of Road Restraint Systems for Constrained Locations (Online Improvements, Retrofitting and Urban Settings)]		<ul> <li>Clear Zones v Operational Speeds</li> <li>Risk Assessment</li> </ul>
DN-GEO-03036: Cross Sections & Headroom [2017] [2019 - Cross Sections & Headroom]	Forgiving Roadsides	<ul> <li>Forgiving Roadsides</li> <li>Hazards</li> <li>Clear Zone</li> <li>Terrain Classes</li> </ul>



#### (relevant to Fencing Retrofit)

### **Forgiving Roadsides**





# **Hazard Mitigation**

- a. Remove
- **b.** Relocate
- c. Re-design hazard (e.g. passive)
- **d. Revise** road layout or cross section to lower risk
- e. Reduce Impact Severity (e.g. breakaway features, flush profiles)
- f. Provide suitable barrier





### **Defined Hazards**



# VRS Design Principles Defined Hazards (contd)...

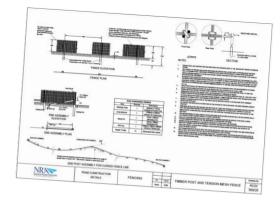


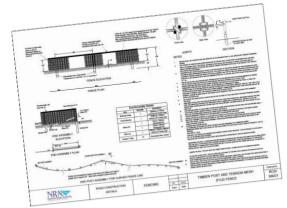
#### All fences with rails even if used as road boundary = Hazards



### Defined Hazards (contd)...

# New CC-SCD-320 & CC-SCD-321 – Timber post and strained wire mesh fence



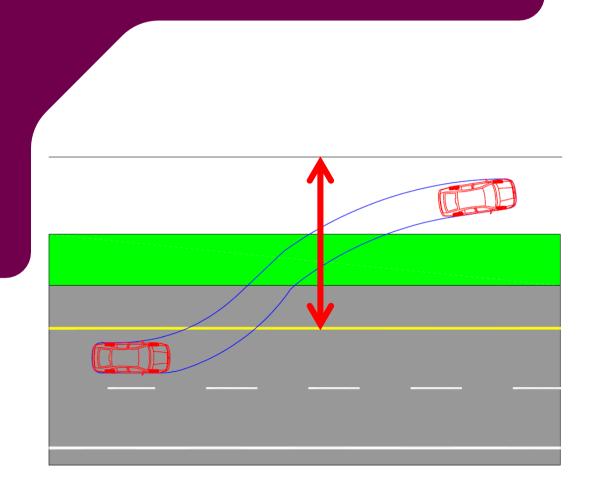




### **Hazard Ranking**

#### APPENDIX D: HAZARD RANKING

Hazard Ranking	Hazard Description			
High	<ul> <li>Lighting Columns that are not passively safe.</li> <li>Tubular Steel Signposts &gt;89mm diameter by 3.2mm thick, or equivalent strength.</li> <li>Wooden Poles or Posts with Cross Sectional Area &gt; 25,000mm<sup>2</sup> that do not have breaknoway features.</li> <li>Trees having a girth 175mm or more measured at 1m above the ground.</li> <li>Concrete posts with Cross Sectional Area &gt; 15,000mm<sup>2</sup>.</li> <li>Play grounds/Monuments and other/locations of high socio-economic value.</li> <li>Water of likely depth &gt; 0.6m.</li> <li>Bridge Pangets, Bridge Piers, Abutments, Railing Ends, Gantry Legs</li> <li>Location where emait vehicle may encroach onto road/milway which crosses</li> </ul>			
	<ul> <li>or runs parallel to read.</li> <li>Substantial fixed objects e.g. walks extending above the ground by more than 150mm with projections or recesses &gt; 100mm and sunning parallel to the mod.</li> <li>Underbridges or retaining walls &gt;0.5m high supporting the read, where a vehicle parapet or vehicle/pedestrian parapet of the required performance class is not provided.</li> <li>Buildings in danger of collapse.</li> <li>Industrial sites with potential for explosion or chemical spill.</li> <li>Reck cutting with rough face.</li> </ul>			
Medium	<ul> <li>Steep Enbankment Sippes, steeperthan 1.2 and ≥1.0m height.</li> <li>Steep Enbankment Sippes, steeperthan 1.2 and between ≥0.5m and 1.0m height.</li> <li>Enbankment Sippes between 1.2 and 1.3 (inclusive) and ≥2m height.</li> <li>Sippes to diches.</li> <li>Drainage Items such as culvert headwalls and transverse ditches that are not detailed to be traversed safely.</li> <li>Huasednoss topographical features outside the width defined in Table 4/1.</li> <li>Single cons culvert opening exceeding 1000mm measured parallel to the direction of travel.</li> <li>Culvert approximately parallel to the direction of travel.</li> <li>Steep sided cuttings or earth bunds (steeperthan 1.2) within the clear zone.</li> <li>Multiple cross culvert opening exceeding 750mm each, measured parallel to direction of travel.</li> <li>Linear V-dichen skongside the scheme.</li> <li>All fences (including timber post and rail fences) except those to RCD/300/20 <sup>3</sup>or RCD/300/21.</li> </ul>			
Low	<ul> <li>Shallow Slopes, between 13 and 1.5 gradient and ≥6m in height.</li> <li>Entbankment Slopes between 12 and 1.3 (inclusive) and between 0.5m and 2m height.</li> <li>Substantial fixed objects e.g. walls extending above the ground by more than 150mm with projections or recesses ≤ 100mm and tunning parallel to the mod.</li> </ul>			



### **Clear Zone**

- Width of traversable land to be clear of unprotected hazards
- Measured from the nearest edge of trafficked lane
- May include the road boundary and land beyond
- Influenced by speeds, horizontal curvature, and terrain profile

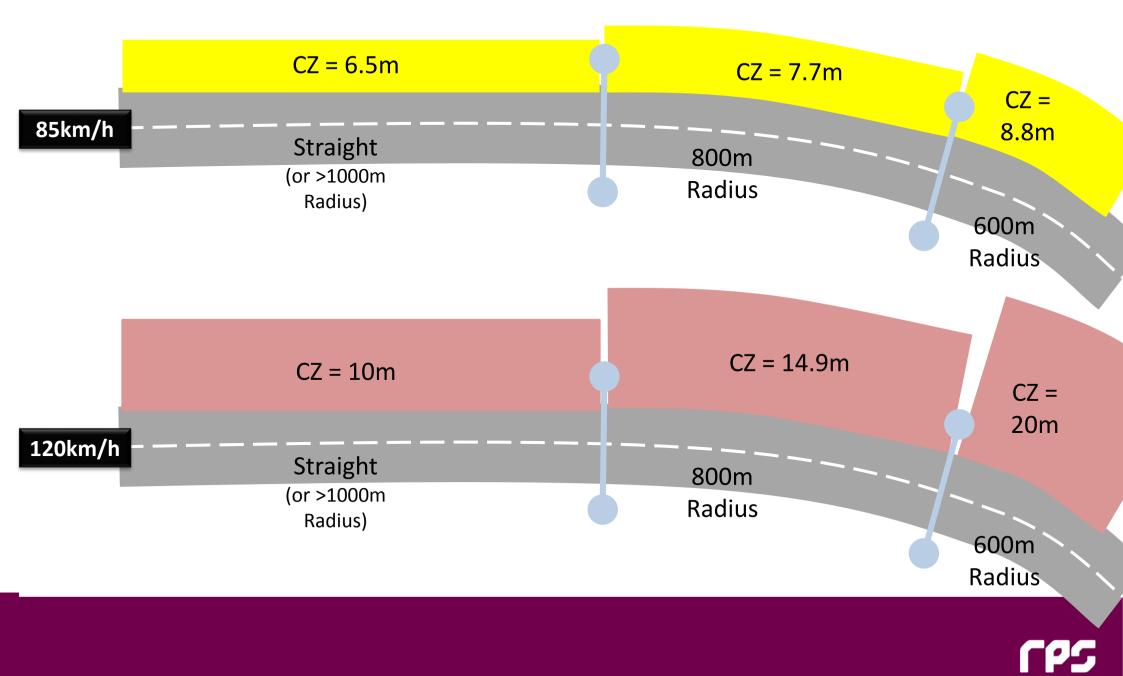
### Clear Zone (contd)...

#### DN-REQ-03034 Table 4/1 – Required Clear Zone Widths

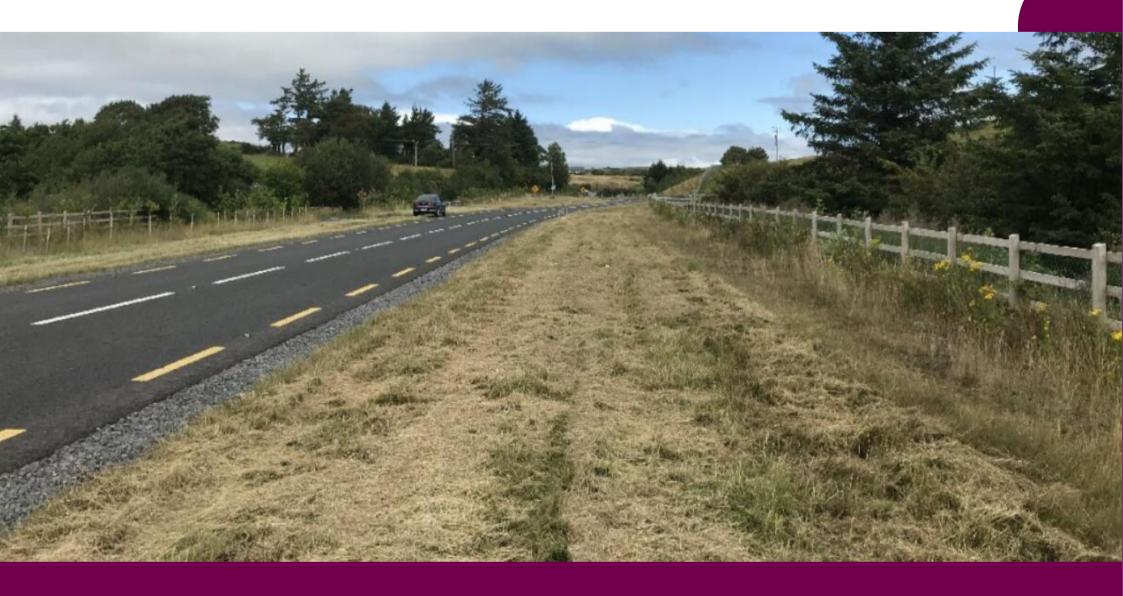
	Design Speed (km/h)			
	85	100	120	
Horizontal radius (m)	Required Width of Clear Zone (m)			
Inside of bend or Straight	6.5	8.0	10.0	
Outside of bend ≥1,000m	6.5	8.0	10.0	
" 900m	7.1	8.8	12.4	
" 800m	7.7	9.6	14.9	
" 700m	8.3	10.4	17.5	
" 600m	8.8	11.2	20.0	
" 500m	9.4	12.0		
" 400m	10.0	12.8		
" 300m	10.6			

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#### Clear Zone (contd)...

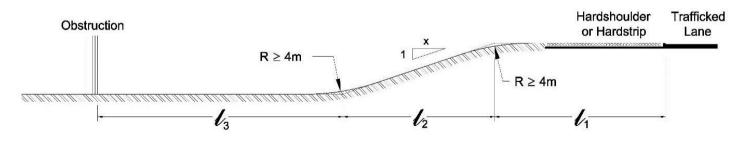


### Clear Zone (contd)...

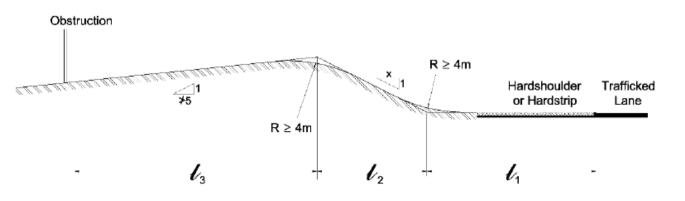




### Terrain Class (contd)...



Embankment or Falling Terrain	Terrain Class	Clear Zone Width
Slope flatter or equal to 1:5	1	$l_1 + l_2 + l_3$
Slope between 1:5 and 1:3	2	$\ell_1 + \ell_3$
Slope steeper than 1:3	3	$\ell_1$



Cutting or Rising Terrain	Terrain Class	Clear Zone Width
Slope shallower or equal to 1:2	1	$\ell_1 + \ell_2 + \ell_3$
Slope steeper than 1:2	3	$\ell_1$

### Terrain Class (contd)...

> 1:5 & ≤ 1:3

≤ **1:5** 

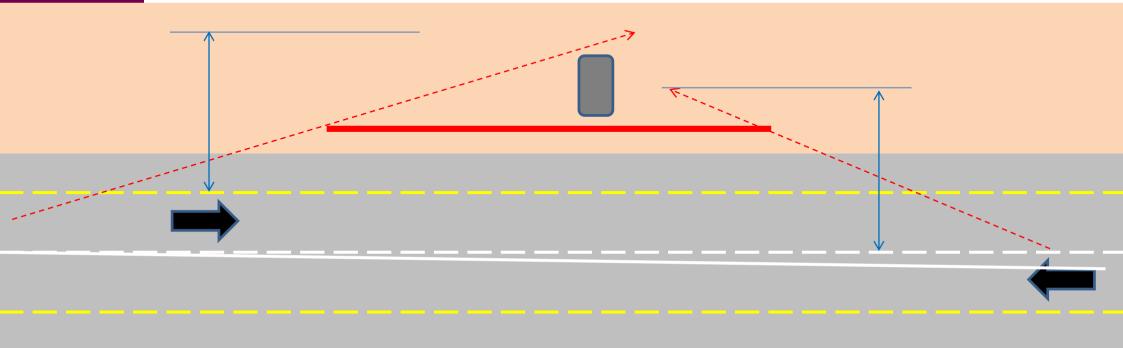


### Terrain Class (contd)...



### **Length of Need**

>> The length of a barrier which provides the full level of protection required for a particular hazard <<



# Length of Need (contd)...



# Length of Need (contd)...



## Length of Need (contd)...

A terminal is not part of a barrier's Length of Need

# VRS Design Principles Length of Need (contd)...



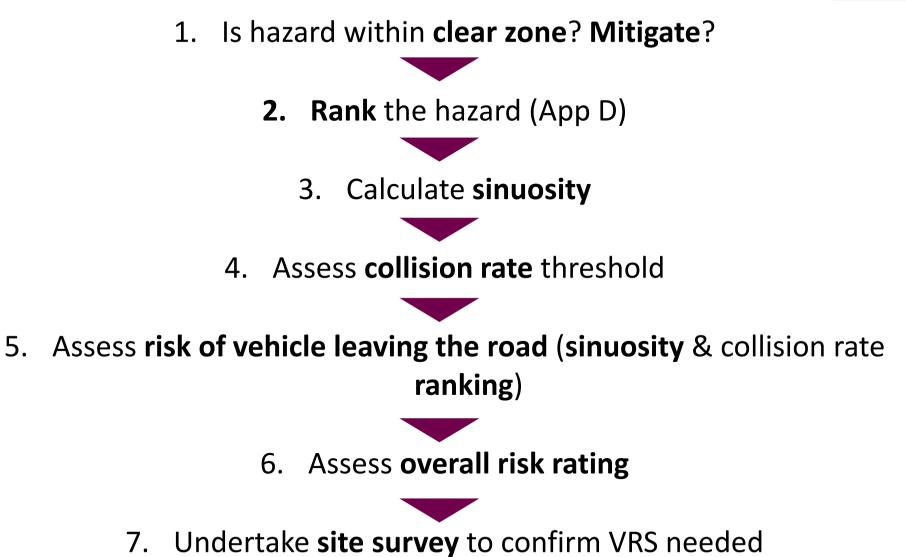


- Used by Designers to assess risk
- Involved Designers' professional judgment
- Aids decision to provide or omit VRS

donal Rood: Authority Volume 2 Section 2 sign Manual for Rood: and Bridges Part 8 AVRA 7D 10-15 (Including Amendment No. 3)	National Roads Authority Volume 2 Section 2 Design Manual for Roads and Bridges Part 8A NRA 10 1915 (Including Amandamus 156, 3)	National Randt Authority Volume 2 Section 2 Design Manual for Roads and Bridges Pert 8A NRA TO 19115 Garding Ananchanat No. 3)	National Rands Authority Volume 2 Service 2 Design Manual for Roods and Bridget (Berling) (Including Automations 78, 3)
RISKASSESSMENT PROCEDURE	$Sinuosity Index (SI) = \frac{Actual section length between A and B}{Shortest path between A and B}$	Hazard	Risk of a Vehicle Leaving the Road
eperal	Shortest pain between A ana b		8.14 The Designer shall take account of both the collision rate stanking and the samosity ranking for the section of road being examined and determine the risk of the vehicle leaving the road using the matrix
1 To assess the need for a sofety harrise on a scheme involving online readgment, a tick assessment procedure shall be undershaped by the Dasigner as described in paragraphs 3.2 to 3.17 blow. The Designer's problema languagest are segmed in the risk assessment and in the inclusion or common of human. Mich Assessment Proceedures		Cechalds within an SSS Registric the Design Speed	n Tohle 51           Rock of a Velacle         Collision Rate Reading           Loring the Road         Collision           Source Reading         H         M
2 As part of the risk assessment procedure the Desimer shall complete a risk assessment sheet at the	Figure 8/1 Sinnosity Index		H H H M
2 sets part of the first assessment procedure the Decigner shall complete a first assessment meet and the preliminary design report. This risk assessment procedure shall also be completed at the detailed design stage.	8.9 The simosity index shall be calculated by the Designer on the approach to a hazard as set out below (in all cases the minimum approach hearth to the hazard considered shall be 200m):	Figure \$/4 The Desirable Minimum SSD length shall be as per Table 1/3 of NRA TD 9 for the particular Design	M H M L L M L L
3 The Designer shall undertake the following procedure for all hazards and record it in the risk assessment sheet:	<ol> <li>Where the hazard is located within or at the end of a horizontal curve the simularity index shall be calculated by the Designer over the full length of that curve on the approach to the hazard</li> </ol>	Speed. Nearly Straight sections shall be as per Figure 7/6 of NRA TD 9.	*Where H=High, M=Medium, L=Low Table 307 Rath of a vehicle leaving the road
<ul> <li>Establish if the hazard is within the clear zone and if it can be mitigated;</li> </ul>	(see Figure 8/2).	8.10 Samonity is divided into three simonity rankings as follows:	Overall Rick Rating
<li>b) Rank the hazard as per Appendix D;</li>	Hazard	<ol> <li>Hith (H) - Simonity Index &gt; 1.02.</li> </ol>	8.15 The Decision what commare the risk of a vehicle leaving the road against the Hazard Ranking using the
<li>c) Calculate the simusity of that section of road;</li>	1	<ol> <li>High (H) - Sumoury index ≥ 1.02;</li> <li>Medium (M) = 1.004 ≤ Simonity Index ≤ 1.02;</li> </ol>	8.15 The Designer same compare the risk of a venue awaring the road against the Planto Romany using the matrix in Table 8/2 below to determine the Overall Risk Rating for the location under consideration.
<li>Assess the collision rate threshold for that section of road;</li>	×	<ol> <li>Low (L) - Simosity Index ≤ 1.004</li> </ol>	
<ul> <li>Assess the risk of a vehicle leaving the road based on simosity ranking and collision rate ranking;</li> </ul>		3) Low (L) - Jamon ay Lawre - Low	Overall Rick Rating Hazard Ranking
naming. D Access the overall risk ratius:		The Designer shall record the calculated Simosity Index and Simosity Ranking in the risk assessment	Risk of a vehicle H M L leaving the road H M L
<ul> <li>g) Undertake a site survey to confirm the need for a safety barrier.</li> </ul>	Figure 5/2	Collision Rate Ranking	H H H M L
4 The risk assessment stages described above are explained in more detail in paragraphs 8.5 to 8.17 below. anard Location and Ranking	2) Where the hazard is located on a straight or nearly straight section of road beyond a horizontal curve bot within the Deimble Minimum Stopping Sight Distance (SSD) length for the Design	8.11 The collision rate thresholds for a particular section of road shall be reviewed by the Designer using data compiled by Transport Infrastructure Ireland.	I M L L *Where H=Hish, M=Medium, L=Low
3 The Designer shall establish if the hazard is located within the clear zone in accordance with Chapter 4.	Speed of that road measured from the end of the curve, the immosivy index shall be calculated by the Designer over the full length of the curve and the straight or mearly straight section of road up to the hazard location (see figure 8.3).	Collision rates have been calculated by Transport Infrastructure leeland, and then using the methodology described in NRA HD 15, compared with historical rates and the following thresholds established:	Table 52 Overall Risk Rates Table 53 Overall Risk Rates 8.16 For each hazard location a determination shall be made as follows:
6 Where possible hazards shall be minigated as described in paragraph 3.9.	Hazard	1) Twice Above Expected Collision Rate	
7 If the hazard cannot be minimized the Desimer shall assess if the hazard ranking is high, medium or low	8	2) Above Expected Collision Rate	<ol> <li>If the overall risk rating is High, then a safety barrier shall be installed to meet the requirements of this standard or the hazard shall be minimized.</li> </ol>
record in the risk assessment sheet (Appendix D contains a non-exhaustive list of hazards to assist the Designer with the ranking).		Below Expected Collision Rate     Twice Below Expected Collision Rate	<ol> <li>If the overall sisk rating a Medium, then the Designer shall provide a safety barrier or matigate the hazard if it is within 2ms of carriageway edge.</li> </ol>
inuosity 8 The simosity of a road is defined as the actual section length between two points on a road divided by	(// "Destrable minimum SSD" length for the Design Speed	8.12 Collision Rate Thresholds can be respected from Transport Infrastructure Ireland by the Designer at <u>informery[Rim</u> and shall be assessed for the section of road under consideration. The Designer shall	If the hazard in located $\geq 2m$ from the carriageway-edge the Designer shall assess the hazard level and the risk of the vehicle leaving the road on site and determine if a safety barrier is required.
the shortest path between them (see Figure 8/1). The simulative index shall be calculated by the Designer		confirm the accuracy of the information with the client.	3) If the overall risk rating is Low, a safety barrier is not required.
as follows:	Figure 5/3 3) Consideration of the entire horizontal curve learth need not be included in the simonity index	8.13 The Designer shall assign a Collision Rate Ranking to the Collision Rate Threshold for the section of road under comideration as follows and second it in the risk assessment sheet:	Each determination shall be recorded in the risk assessment sheet along with the reason for providing or not providing the safety barrier.
	calculation where the hazard is located on a straight or nearly straight section of road beyond	<ol> <li>High (H) - Twice Above Expected Collision Rate;</li> </ol>	Site Server
	the horizontal curve and beyond the Desirable Minimum SSD length for the Design Speed of that road measured from the end of the curve. The Designer shall consider the curve length	2) Medium (M) - Above Expected Collision Rate;	
	which is a within the 200m minimum length on the approach to the hazard only (see figure $\mathbb{E}(4)$ .	3) Low (L) - Below Expected Collision Rate and Twice Below Expected Collision Rate.	8.17 A site survey shall be carried out by the Designer as part of the risk assessment procedure to confirm the need or otherwise for a safety barrier at all locations.
ovember 2015 29	November 2015 30	November 2016 31	November 2013 32







- 1. Clear zone
- 2. Rank hazard



3. Sinuosity



4. Collision Rate



5. Assess risk



6. Risk rating



#### Is it a hazard?

- Physical obstruction? List in Ch.3 of 03034
- May result in injury to occupants of errant vehicle?



#### Within Clear Zone?

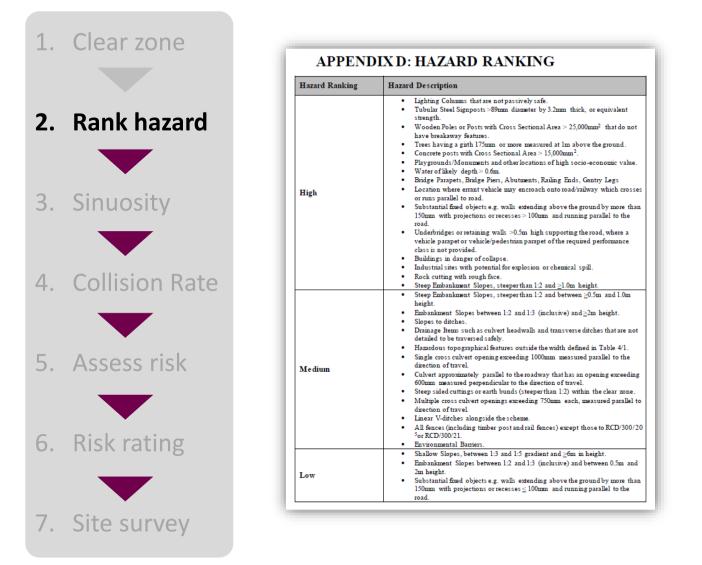
- Width to be kept clear of hazards
- Table 4/1 of 03034
- Speed, geometry

		Design Speed (km/h)		
	85	100	120	
Horizontal radius (m)	Requir	Required Width of Clear Zone (m)		
Inside of bend or Straight	6.5	8.0	10.0	
Outside of bend ≥1,000m	6.5	8.0	10.0	
" 900m	7.1	8.8	12.4	
" 800m	7.7	9.6	14.9	
" 700m	8.3	10.4	17.5	
" 600m	8.8	11.2	20.0	
" 500m	9.4	12.0		
" 400m	10.0	12.8		
" 300m	10.6			

#### Hazard Mitigation?

- Remove?
- Relocate?
- Redesign?
- Revise layout?
- Reduce impact severity?



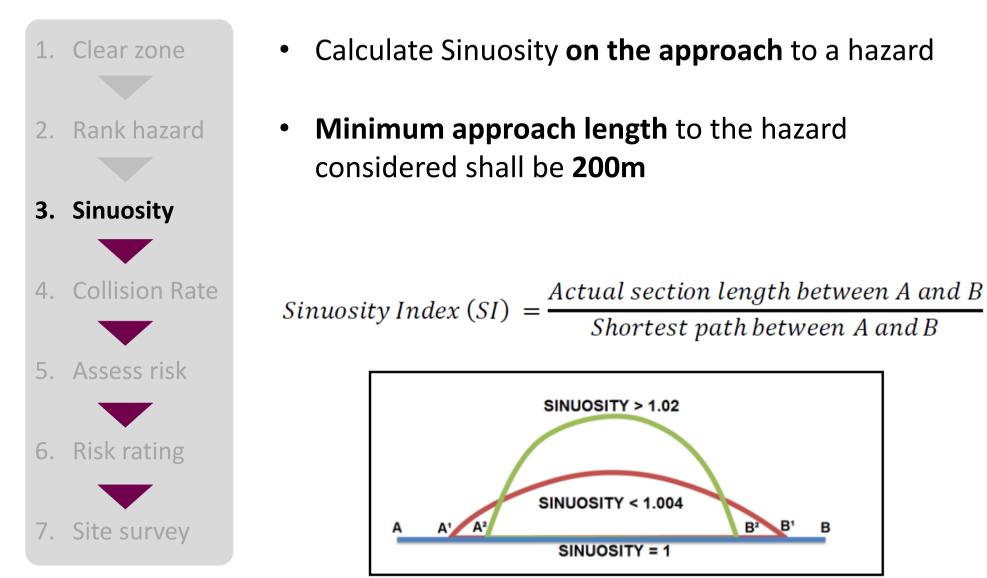


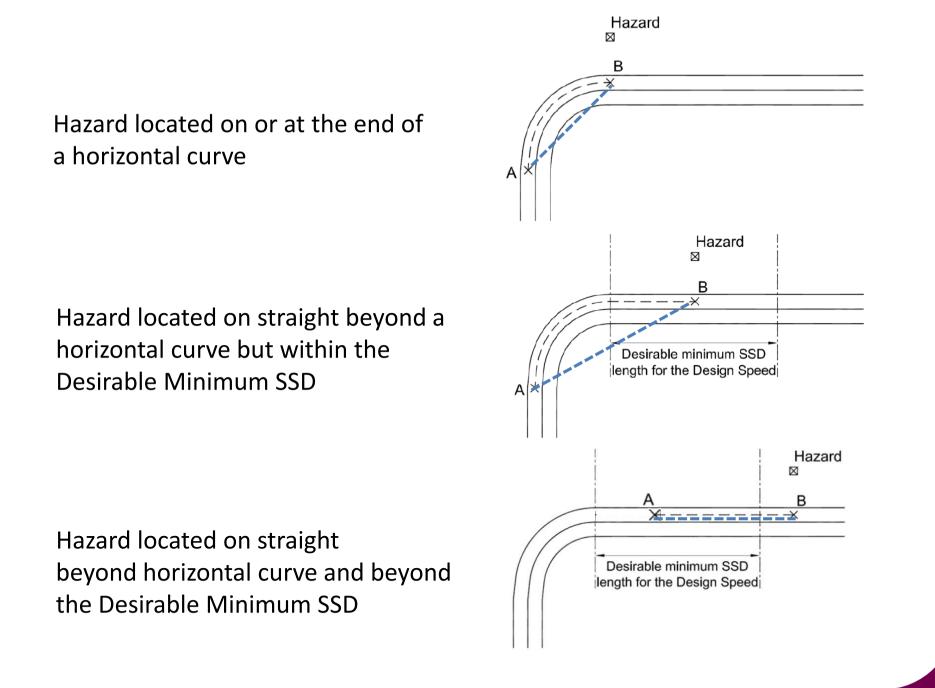
Assuming hazard cannot be mitigated...

Assess **hazard ranking** from Appendix D of 03034

as

(VH), H, M, L





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#### High (H)

Sinuosity Index > 1.02

Medium (M)

 $1.004 \le$  Sinuosity Index  $\le 1.02$ 

Low (L)

Sinuosity Index < 1.004

- 1. Clear zone
- 2. Rank hazard
- 3. Sinuosity
- 4. Collision Rate

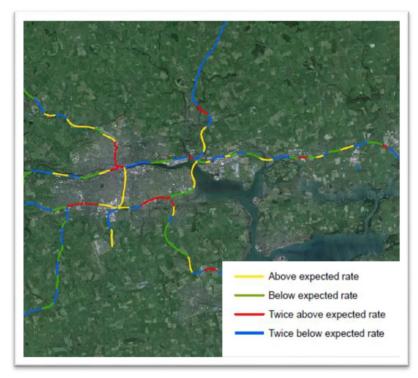


5. Assess risk



6. Risk rating



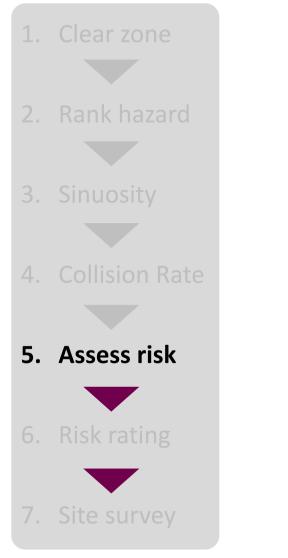


Collision Rates available from TII and data.gov.ie (KML)

- Above Expected
- Below Expected
- Twice Above
- Twice Below

Twice Above Expected Collision Rate = High (H) Above Expected Collision Rate = Medium (M)

Below & Twice Below Expected Collision Rate = Low (L)



Using both Collision Rate Ranking and Sinuosity Ranking, use matrix to determine the risk of the vehicle leaving the road...

Risk of a Vehicle Leaving the Road		<b>Collision Rate Ranking</b>		
		Н	М	L
Sinuosity Ranking	Н	Н	Н	М
	М	Н	М	L
	L	М	L	L

#### 1. Clear zone

- 2. Rank hazard
- 3. Sinuosity
- 4. Collision Rate
- 5. Assess risk
- 6. Risk rating



Using **Risk of Vehicle Leaving the Road** and **Hazard Ranking**, determine **Overall Risk Rating**...

Overall Risk Rating		Hazard Ranking		
		Н	М	L
Risk of a Vehicle Leaving the Road	Н	Н	Н	М
	М	Н	М	L
	L	М	L	L



Interpreting Overall Risk Rating...

**High** VRS required (or hazard to be mitigated).

**Medium** If hazard within 2m of c/w edge, provide VRS (or mitigate).

If hazard ≥ 2m from c/w edge, Designer to assess hazard level and risk of vehicle leaving the road on site and determine if VRS required.

**Low** VRS is not required.



- 1. Clear zone
- 2. Rank hazard
- 3. Sinuosity
- 4. Collision Rate
- 5. Assess risk
- 6. Risk rating
- 7. Site survey

Designer visits the site as part of the risk assessment procedure to confirm the need or otherwise for VRS at all hazard locations considered.





# **Thank You**

