Director of Engineering Memorandum
DEM 128/10 Revision R04
DEM TITLE: Management of Existing Vehicle Restraint Systems

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Classification

Level 1 (Title /Key Words) **:**	Vehicle Restraint Systems, Safety Barriers
Level 2 : (Directorate/Owner)**:**	Engineering
Level 3: (RSHQ or HoBU Managed Function):	Procurement Branch
Level 4 : (Work Areas)	Inventory, Inspection, Maintenance and Replacement, Repairs, Asset Management

Version 4 Updates: Incorporates changes to VRS Action Plan (Appendix 5)

1.0 Purpose

The requirements of this DEM relate to the overall management of Vehicle Restraint Systems (VRS) on the adopted road network. (The terminology VRS can be used to describe all types of vehicle safety fences, parapets and barriers).

2.0 Background

VRS are required to be specified using only performance criteria with the systems tested to meet the requirements of EN 1317. The responsibility rests with the manufacturer to ensure that the necessary testing is undertaken to certify compliance with the new European Standard.

Testing has demonstrated that many of the historic systems do not perform as originally intended, furthermore various features (for example wooden posts, poor foundations, corroded beams, welded ramp down terminals) found in older safety barriers could be hazardous to the road user in the event of a collision.

3.0 Scope

This DEM is to be read by:

- All TNI technical staff involved in the installation or management of VRS. i.e. Network Maintenance, Network Development, SRIT, TNI Design and Consultancy.
- All TNI Development Control technical staff involved in approvals of developer led schemes where VRS is to be constructed which may be adopted by TNI.
- All DBFO Companies and Consultants working on behalf of TNI.

4.0 Roles and Responsibilities

Network Services Divisions have overall responsibility for the inventory, inspection, maintenance and replacement programme for VRS in each Division.

Each Network Services Division shall be responsible for the inventory and coordinating the detailed inspection programme. TNI D&C shall generally collate the inventory data and carry out the detailed inspections and on instruction, order the repair and replacement works.

Details of all new VRS shall be submitted to the Divisional D&C contact for updating on the Structures Management System. This is applicable to Strategic Road Improvement Teams or Network Development when new sections of VRS are installed through road improvements and to Development Control on private developer led schemes.

Each TNI D&C Divisional Office has a trained advisor in the requirements of TD19 and Highways Agency Approved VRS Systems. TNI Procurement Branch can provide contact names and further advice as necessary.

TNI Procurement Branch certifies the compliance of VRS installations in accordance with DEM109/07 and for those in connection with Structures in accordance with BD2 Technical Approval.

5.0 Inventory and Inspection

The VRS inventory and detailed inspection data for each Division shall be held on the Structures Management System, which is generally updated by TNI D+C.

On behalf of the Divisional Client an inventory of all VRS shall be collated by trained inspectors (normally TNI D&C). The inventory will be based upon the template included in Appendix 4.

On behalf of the Divisional Client a detailed inspection of all VRS shall be carried out by trained inspectors (normally TNI D&C) on a rolling 5 year programme. A rolling 2 year inspection programme is required on Motorways and Trunk Road Dual Carriageways with AADT exceeding 20,000. These detailed inspections include factors such as mounting height, bolted connections, surface protective treatment and structural condition and apply to steel beam, concrete and wire rope safety fences. Refer to Appendix 1 & 2.

Inspectors must report immediately to the relevant Divisional Client, all relevant details and the priority rating of any VRS that are deemed to present a significant hazard.

The detailed inspections are in addition to the current safety inspections carried out by Network Maintenance in accordance with RSPPG_E019 which sets out TNI policy for the visual safety inspections of safety fences and timescale for the repair of damaged locations.

6.0 VRS Maintenance and Replacement Works

TD 19/06 is applied in Northern Ireland by DEM109/07 and is the standard for all proposed VRS maintenance and replacement works on roads with speeds of 50 mph or more. Further information is also provided in both documents on lower speed roads.

TD 19/06 introduces a risk-based approach to the standard for Road Restraint Systems. It does not follow the format of traditional standards in that it has two parts that must be used together:

- The written standard, TD 19/06, [DMRB 2.2.8] which contains some mandatory requirements but gives mainly advice and guidance; and
- The Road Restraint Risk Assessment Process (RRRAP) a computer based program, assists the Designer for each site/scheme to establish the need for vehicle restraint and, if so, its performance requirements.

Following collision damage if the VRS can be brought up to standard, the opportunity should be taken. When minor repair work is required or when only part of the VRS is required to be replaced due to collision damage, like for like renewal is allowed (with the exception of wooden post barrier).

7.0 Consideration of VRS during Resurfacing or Other Major Maintenance Works

TD 19/06 Paragraph 1.18 (iii) is added to as follows:
(d) resurfacing or surface dressing schemes where the works do not adversely affect the existing functionality of a VRS (with steel posts).
However the opportunity to bring a VRS up to standard should be considered, in particular on Dual Carriageways and Motorways.

TD19/06 shall apply during resurfacing schemes (excludes surface dressing) if the existing VRS located on the road has to be dismantled or is constructed with wooden posts.

If an existing VRS incorporates the welded angle beam as part of the terminal detail, this component must be replaced with a standard rolled angle beam or current standard terminal. If the VRS under consideration has wooden posts, a full VRS replacement shall be undertaken, refer to Section 6.

8.0 Prioritisation and Timescales for VRS Maintenance and Replacement

Network Services Divisions with assistance from TNI D&C, shall be responsible for coordinating the maintenance and replacement programme to ensure that VRS works, identified by the safety and detailed inspection programme, are targeted at those VRS considered as presenting the highest risk to public safety.

Existing wooden post barrier and replacement of the welded angle beam component as part of the terminal should be prioritised in each Division with a 5 year period for the replacement programmed and initiated.

Refer to Appendix 1 & 2 for summary of common defects and the prioritisation system.

Localised damage repairs or replacement of the welded angle beam shall not be carried out on barriers which are life expired.

Tensioning bolts on steel tensioned safety fences shall be checked and reset to the correct torque every 5 years, and every 2 years on Motorways and Trunk Road Dual Carriageways with AADT exceeding 20,000.

9.0 Relevant Standards

WITHDRAWN STANDARDS

TD19/85 - Safety Fences and Barriers

Interim Requirements for Road Restraint Systems (IRRRS)

CURRENT STANDARDS

BSEN1317:1998 Road Restraint Systems – Covers all specification of all current RRS

DMRB TD19/06 - Road Restraint Systems and Road Restraints Risk Assessment Process (RRRAP) Designing of RRS

BS EN 12767:2007 Passive safety of support structures for road equipment - Specifies performance requirements and defines levels in passive safety terms

DEM 79/05 Provision of Safety Barrier – Supplementary Guidance

DEM 109/07 Road Restraint Systems

10.0 Equality

No Section 75 equality issues arise from the introduction of this Memorandum as it addresses an internal procedural matter covering a technical issue.

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Appendix 1

Guide to Vehicle Restraint System Detailed Inspection and Prioritisation

Introduction

This appendix aims to provide TNI D+C and Network Maintenance with guidance on how the current backlog of repairs or replacements is to be prioritised using a consistent approach across the road network.

As barriers themselves are potential hazards, they should only be installed when necessary to shield a location /condition that could be significantly more hazardous. It is also essential to ensure that once a barrier is installed, it is maintained and repaired to ensure it functions as intended. All vehicle restraint systems installed on the adopted road network, or roads to be adopted, must be installed and maintained by Sector Scheme approved personnel.

The guidance should assist TNI in taking a reasoned and targeted approach to prioritising the repair or replacement of existing vehicle restraint systems. It is however important to acknowledge that it is not possible to predict the consequences of any particular vehicle strike given the infinite number of variables involved.

Vehicle Restraint Functionality

In order to assign condition factors to defective or damaged components it is important to understand how a vehicle restraint system works. VRS normally consist of a lead in terminal, a containment barrier formed by a post and rail/ wire system and an end terminal. Some systems will also include a transition section where barriers having different deflection characteristics meet such as at bridge parapets. In simple terms a safety barrier is designed to prevent an errant vehicle reaching a hazard by redirecting the vehicle along its line of travel with minimum adverse affect on the vehicle occupants and other vehicles. The errant vehicle should not penetrate over, through or under the restraint.

The primary mechanism enabling a barrier to redirect a vehicle is tension developed in the rail element. Any defect or defective component which reduces the tension capacity of the barrier, or any defect or obstacle which prevents or interferes with the errant vehicles path along the barrier, will affect to some degree the effectiveness of the barrier to contain and redirect.

The posts contribute to smooth redirection by limiting the amount of deflection and providing consistent stiffness along the rail to prevent pocketing. When posts become less effective, due to damage or disconnection from the rail, the rail will deflect more than its working width class.

A further critical element to the correct functioning of a barrier is the rail height. From test data it is considered that any rail less than or equal to 600mm from the top of the rail (for single rail systems) to adjacent ground level is not fully functional.

The function of a transition section is to gradually stiffen a semi-flexible beam section as it attaches to a more rigid, non-deflecting object such as a bridge parapet or concrete barrier to prevent pocketing.

Methodology

The methodology for determining the priority for repair or replacement for each barrier is to multiply the overall location factor by the overall barrier condition factor.

The Overall Location Factor is determined by taking account of the characteristics and road layout associated with each barrier (see Tables 1 to 4).

The Overall Condition Factor is determined by totalling number of condition factors in any length of barrier (see Tables 5 to 9).

The following condition factors have been assigned to defects and specific features as an indication of how each may affect the functionality of the barrier to perform.

G (good) F (fair) P (poor) H (hazardous)

Those VRS with the potential to be hazardous should initially be prioritised for repair or replacement.

Before determining any action resulting from the prioritisation it will be necessary to determine whether the barrier can be permanently removed either by eliminating the hazard it was intended to protect and/or by running a RRRAP Assessment in compliance with TD19/06.

VRS Detailed Inspection

1.0 Overall Location Factor

1.1 Road Type/AADT

If a road is not consistent with the typical AADT for its type or classification, the actual AADT figure should be used to score. If the AADT figure is not known, use the Road Category/Type.

Road Category / Type	Typical Range of Two-Way AADT	Score
Green Lane or Farm Access Road	Less than 200	0
Unclassified Road	200 to 2,000	0
Class B or C Road	2,000 to 7,000	1
Single Carriageway Class A or Trunk Road	7,000 to 20,000	2
Dual Carriageway Class A or Trunk Road	15,000 to 40,000	1.5
Motorway	Greater than 35,000	1.5

Table 1

1.2 Vehicle Speeds

Road Speed adjacent to Hazard	Plated Speed limit (mph)				
	70	60	50	40	30
Score	2	1.8	1.5	0.5	0

Table 2

1.3 Hazards

Hazards being protected to be present within 10m of carriageway

A combination of these hazards may be present and scores can be cumulative.

Hazard Type to be protected	Score[1]
River / Water Hazard	2
Embankment Drop <3m	1
Embankment Drop >3m	2
Vertical/ Almost Vertical Drop <3m	1.5
Vertical/ Almost Vertical Drop >3m	2.5
Significant Above Ground Structure	1
School / Meeting Place	2
Housing	1.5
Central Reservation	2
Other (Inspector to score)	…….

Table 3

1.4 Site Characteristics

A combination of these factors may be present and scores can be cumulative.

Site Characteristics	Score[1]
Narrow Lanes Widths	1.0
Radius with hazard on outside of bend	1.0
Barrier located close to junction or slip road	1.0
Accident History /Multiple strikes on barrier	2.0
Setback less than 0.6m	1.0
Multiple Road Furniture within setback	1.0
Hazard / Obstruction(s) within working width	1.0

Table 4

1. Maximum Score 3

Overall Location factor Total Score ___ / 10

(Sum of Elements 1.1, 1.2, 1.3, 1.4)

2.0 Barrier Condition Factor

The following condition factors have been assigned to defects and specific features as an indication of how each may affect the functionality of the barrier to perform.

G (good) F (fair) P (poor) H (hazardous)

2.1 Beam/Wire Condition

Description of Feature / Defect		Likely Condition Factor
Beam or Wires with all fixings in place, good alignment, no corrosion and within height tolerances		G
Overlap in wrong direction		F
TCB has lost tension		F
Out of Alignment but remains straight*	<300mm	F
	300mm – 450mm	P
	>450mm	H
Bolts missing (Identify locations in comments box on inspection sheet)	1 at any lap joint	F
	2 at any lap joint	P
	3 or more at any lap joint	H
Major Corrosion affecting beam thickness		H
Tensioning Bolts missing		H
Top of rail height low 500mm -600mm		P
Top of rail height low <500mm		2H
Frayed wire rope		2H
Wire rope has lost tension		3H
Rail split, torn or discontinuous		5H
Major Impact Damage in need of immediate repair		10H

Table 5

*Out of alignment is measured as the largest deviation from straight or design line between undamaged sections.

2.2 Post Condition

Description of Defect		Likely Condition Factor
Posts sound and vertical with no corrosion, fixings in place.		G
Wooden posts sound at ground level and above		F
Post /Beam connections missing		F
Posts damaged/missing at 1 location	<3	F
Post foundations loose		P
Post orientation incorrect		P
Posts damaged/missing at 1 location	>=3	H
Wooden posts rotten		5H
Major Impact Damage in need of immediate repair		10 H

Table 6

2.3 Terminals Condition

Description of Defect	Likely Condition Factor
Ramped, P1 or P4 Terminal Section free from impact and all components in place.	G
Departure Terminal with Minor Impact	F
Ramped Scroll End, Scroll Terminal	F
Fixings missing	P
Post foundations loose	P
Terminals with Minor Impact	P
Departure Terminal with Major Impact	H
Exposed Approach Full Height Anchorage Terminal	3H
Exposed Approach Full Height Fish Tail Fish Tail or No Approach Terminal	5H
Departure Ramped Welded Angle Beam	3 H
Approach Ramped Welded Angle Beam	5 H
Major Impact Damage in need of immediate repair	10 H

Table 7

2.4 Transitions Condition

Description of Defect	Likely Condition Factor
Transitions free from impact and all components in place.	G
Barriers / transition are misaligned.	F
Barrier terminates in full height anchor with no reduction in post spacing	P
Fixings missing	P
Posts foundations loose	P
Transition does not provide progressive deflection	P
Non standard or defective connection	2H
No transition /connection in place	3H
Major Impact Damage in need of immediate repair	10H

Table 8

2.5 Overall Condition Factor

Feature	H Condition Factors H[1,2]
Barrier	
Posts	
Terminals	
Transitions	
Totals[3]	

Table 9

[1]To be stated as 3H etc.
[2] Maximum 10H for Barrier, Posts, Terminals and Transitions
[3]Maximum Total to be brought forward to Section 3.0 is 10H

3.0 Priority for Repair/ Replacement

Overall Location Factor x Overall Condition Factor

Maximum Possible Score 10 x 10H = 100H

Those VRS with the potential to be hazardous should initially be prioritised for repair or replacement.

Appendix 2: Detailed Inspection Template

Barrier Identification Reference:	
Route No. :	
Route Name:	
Inspected By and Date:	

Location Factor		
Road Category / Type	**Typical Range of Two-Way AADT**	**Score A**
Green Lane or Farm Access Road	Less than 200	0
Unclassified Road	200 to 2,000	0
Class B or C Road	2,000 to 7,000	1
Single Carriageway Class A or Trunk Road	7,000 to 20,000	2
Dual Carriageway Class A or Trunk Road	15,000 to 40,000	1.5
Motorway	Greater than 35,000	1.5

Road Speed adjacent to Hazard	**Plated Speed limit (mph)**				
	70	60	50	40	30
Score B	2	1.8	1.5	0.5	0

Hazard Type to be protected	**Score C**
River / Water Hazard	2
Embankment Drop <3m	1
Embankment Drop >3m	2
Vertical/ Almost Vertical Drop <3m	1.5
Vertical/ Almost Vertical Drop >3m	2.5
Significant Above Ground Structure	1
School / Meeting Place	2
Housing	1.5
Central Reservation	2
Other (Inspector to score)	….

Site Characteristics	**Score D**
Narrow Lanes Widths	1
Radius with hazard on outside of bend	1
Barrier located close to junction or slip road	1
Accident History /Multiple strikes on barrier	2
Setback less than 0.6m	1
Multiple Road Furniture within setback	1
Hazard / Obstruction(s) within working width	1

Overall Location Factor									
Score A		**Score B**		**Score C**		**Score D**		**Total Score**	
Max 2		**Max 2**		**Max 3**		**Max 3**		**Max 10**	

Priority for Repair / Replacement						
Overall Location Factor (Max 10)			**Overall Condition Factor (Max 10H)**		**Priority (Max 100H)**	
		x		=		**H**
Comments, Location of Defects						

Beam / Wire Condition			
Description of Feature / Defect		Condition	Y or N
Beam or Wires, good condition, fixings, alignment and height		G	
Overlap in wrong direction		F	
Beam has lost tension		F	
Out of Alignment but remains straight Largest deviation from straight line between undamaged sections	<300mm	F	
	300mm – 450mm	P	
	>450mm	H	
Bolts missing (Identify locations in comments box on inspection sheet)	1 at any lap joint	F	
	2 at any lap joint	P	
	3 + at any lap joint	H	
Major Corrosion affecting beam thickness		H	
Tensioning Bolts missing		H	
Top of rail height low 500mm to 600mm		P	
Top of rail height low <500mm		2H	
Frayed wire rope		2H	
Wire rope has lost tension		3H	
Rail split, torn or discontinuous		5H	
Major Impact Damage in need of urgent repair		10H	

Post Condition		
Description of Feature / Defect	Condition	Y or N
Steel Posts sound and vertical with no corrosion, fixings in place.	G	
Wooden posts sound at ground level and above	F	
Post /Beam connections missing	F	
<3 Posts damaged / missing at 1 location	F	
Post foundations loose	P	
Post orientation incorrect	P	
>=3 Posts damaged/missing at 1 location	H	
Wooden posts rotten	5H	
Major Impact Damage in need of urgent repair	10 H	

Terminal Condition		
Description of Feature / Defect	Condition	Y or N
Ramped, P1 or P4 Terminal Section free from impact and functional	G	
Departure Terminal with Minor Impact	F	
Ramped Scroll End, Scroll Terminal	F	
Fixings missing	P	
Post foundations loose	P	
Terminals with Minor Impact	P	
Departure Terminal with Major Impact	H	
Exposed Approach Full Height Terminal	3 H	
Exposed Approach Full Height Fish Tail or No Approach Terminal	5 H	
Departure Ramped Welded Angle Beam	3 H	
Approach Ramped Welded Angle Beam	5 H	
Major Impact Damage in need of urgent repair	10 H	

Transition Condition		
Description of Feature / Defect	Condition	Y or N
Transitions free from impact and all components in place.	G	
Barriers / transition are misaligned.	F	
Barrier terminates in full height anchor with no reduction in post spacing	P	
Fixings missing	P	
Posts foundations loose	P	
Transition does not provide progressive deflection	P	
Non standard or defective connection	2H	
No transition /connection in place	3H	
Major Impact Damage in need of urgent repair	10H	

Beam / Wire		Posts		Terminal		Transition		Overall Condition Factor (Max 10H)	
	H		H		H		H		H

Appendix 3: Damage Examples

1. **Damage: Barrier no longer reasonably functional.**

Rail is bent/pushed more than 450mm out of line, and height is outside tolerances or three or more posts are broken/bent over and separated from the rail.

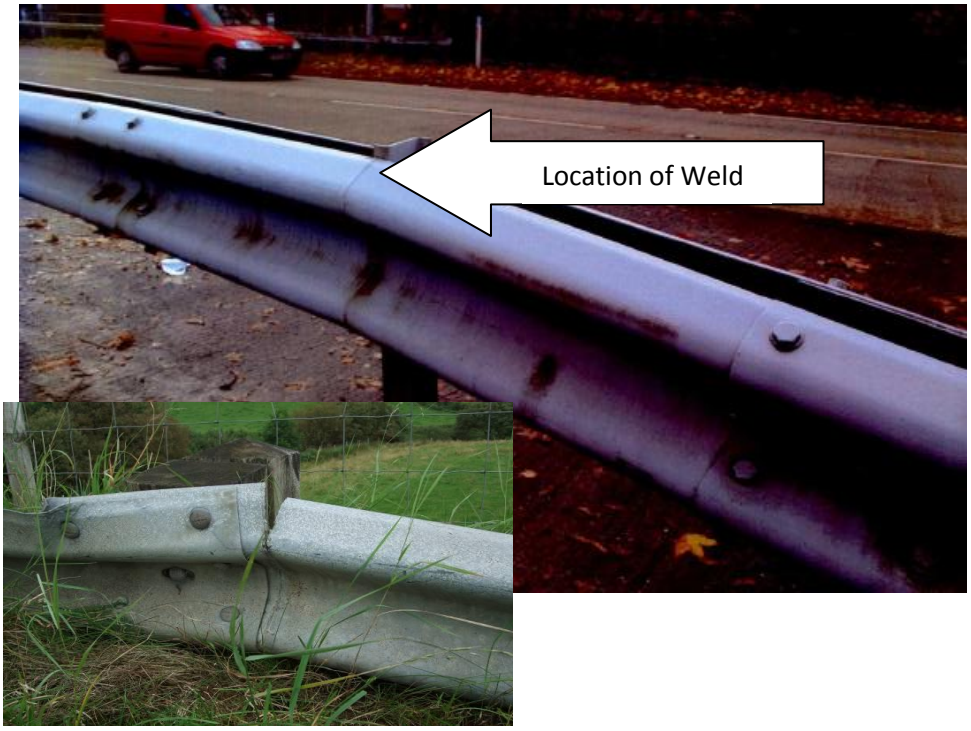
Rail element remains intact, no tears and joints remain undamaged. (Note however the posts will fall within the hazardous category.)

2. Damage: Barrier should function adequately under the majority of impacts.

Rail is bent/pushed out of line less than 300mm, rail element is intact (no tears or damaged overlaps).

Rail element is still intact, no tears and joints remain undamaged, only 2 posts damaged.

3. Hazardous Components and Layouts



Welded angle beams – Note: Weld split on

Beam is not attached to post

No connection to parapet

Barrier and parapet misaligned

Wooden post, blocked out piece missing, barrier not connected to post, top of rail low, all bolts/fixings missing.

No Approach Terminal, Rotten Wooden Posts, Hazard within working width, insufficient length of hazard protection.

Appendix 4: Inventory Template

VRS INVENTORY						
Barrier I.D. Reference:				No. of sides:		
Route No. :				Route Name:		
Section Office:						
Speed Limit:	20	30	40	50	60	70
Traffic Volume (AADT):					(If not avail, use nearest stretch)	
Data collected by:				Date:		
GIS Start Co-ordinates:	Easting:			Northing:		
GIS End Co-ordinates:	Easting:			Northing:		
Orientation:	S-N	N-S	E-W	W-E	LHS	RHS
Location:	Fway	Verge	Hard Shoulder		Central Reservation	
Containment Level:	Normal		High		Very High	
Main Hazard(s) being protected	Water Structure	Road Under Trees	Rail Under	Embankment or Drop		
			Dual Carraigeway		Other (Specify)	
Length of Barrier (including Terminals, max length 1km):						
Rail Type:	Corrugated	OBB	RHS	Wire Rope	Other (specify):	
Post Type:	Wooden	Z Post Steel	Angle Beam			
Set-Back Distance (m)			Msmt from:	Face of Kerb	Traffic Edge of White line	Back of Hardstrip/Shoulder
Height (m):			Msmt from:	Face of Kerb	Traffic Edge of White line	Back of Hardstrip/Shoulder
Lead in Terminal:	P1 Ramp	P4 Energy Absorbing		Angle Beam		Fish Tail
	Full Height Anchorage		Parapet Connection		Barrier Connection	
Departure Terminal:	P1 Ramp	P4 Energy Absorbing		Angle Beam		Fish Tail
	Full Height Anchorage		Parapet Connection		Barrier Connection	
Photographs No.	Approach					
	General					
	Departure					
Comments:						

Appendix 5: VRS Action Plan

NETWORK SERVICES BOARD **VEHICLE RESTRAINT SYSTEMS (VRS) ACTION PLAN – Issue 4: 23 March 2017**		
RECOMMENDATIONS	**RESPONSIBILITY**	**TIMESCALE/ PROGRESS**
1a. Continue survey of existing VRS stock in NI. 1b. Continue to populate the temporary VRS database until the structures management system is in place.	TNI D&CS on behalf of Divisions	**Completed** Monitor progress at Network Services Board on 6 monthly basis Report % of each Section Area complete
2a. Continue 5 year rolling programme of Detailed Inspections of VRS. 2b. Continue to record and appropriately file inspection data for future uploading to new system, until the structures management system is in place.	TNI D&CS on behalf of Divisions	**Ongoing** Monitor progress at Network Services Board on 6 monthly basis Report length of barrier inspected per year
3a. Continue ongoing programme for prioritisation and proactive replacement programme of welded angle beam VRS. 3b. Continue ongoing programme for prioritisation and proactive replacement programme of life expired VRS.	Divisions	**Complete A Routes by March 2018** Monitor progress at Network Services Board on 6 monthly basis Report no. of welded angle beam existing/ replaced. **Ongoing** Review of target for remaining life expired VRS in March 2018. Monitor progress at Network Services Board on 6 monthly basis. Report length of wooden post barrier existing/ replaced.
4. Promote the current requirements of TD19 and passive products at high risk sites	Engineering Services D&CS	**Ongoing**

Notes:

1. The Roads Service Board on 29 February 2012 requested that Divisions deal with life expired and welded beam systems on the risk based approach detailed in the DEM.
It was also confirmed that the programme of works for replacement of the welded angle beam systems is to be completed by December 2016.

2. TransportNI Management Group (formerly RSB) carried out a review on 28 November 2014 and agreed that the focus should continue on a risk based approach but with priority given to completion of the welded angle beam on A class roads by December 2016.

3. Deputy Secretary and Directors' Meeting held on 12 December 2016, noted the Director of Network Services' paper on progress against the targets set in DEM 128/10 and agreed that Target 3a be revised to extend the target date for the class A network to March 2018 – although Divisions should aim to expedite progress to complete before this date, if budgets are available.