

A83 Rest and Be Thankfull Loch Restil Vehicle Restraint System Investigation and Review



Scheme Ref: 16/NW/0901/033

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1 Introduction

In the early hours of the morning of Friday 13th January 2017, a vehicle travelling westbound on the A83 was blown off the road, coming in close proximity to the waters of Loch Restil. The accident occurred during high winds from the tail of storm “Egon” as it swept across Europe. This accident also occurred in close proximity to a previous accident where a “Lochs and Glens” coach also left the carriageway in high winds in 2015, coming to a stop near the loch.

As a result of the accident in January 2017, BEAR Scotland were commissioned by Transport Scotland to carry out a review into the location and in particular the Vehicle Restraint Systems (VRS). The aim of this report is to assess both the compliance of the existing VRS with current design standards and to provide recommendations for improvements which can be made to increase the safety of road users.

1.1 Location

The accident occurred on a single carriageway section of the A83 between The Rest and Be Thankful and Butterbridge. In this location, the carriageway runs for approximately 800m adjacent to Loch Restil, with a north-south orientation, see Figure 1 below.

Maintenance of the A83 is the responsibility of BEAR Scotland as part of its 4G NW Trunk Road maintenance contract. The carriageway is subject to the national speed limit of 60mph and carries on average 2037 vehicles per day (AADT), 9% of which is HGV usage.

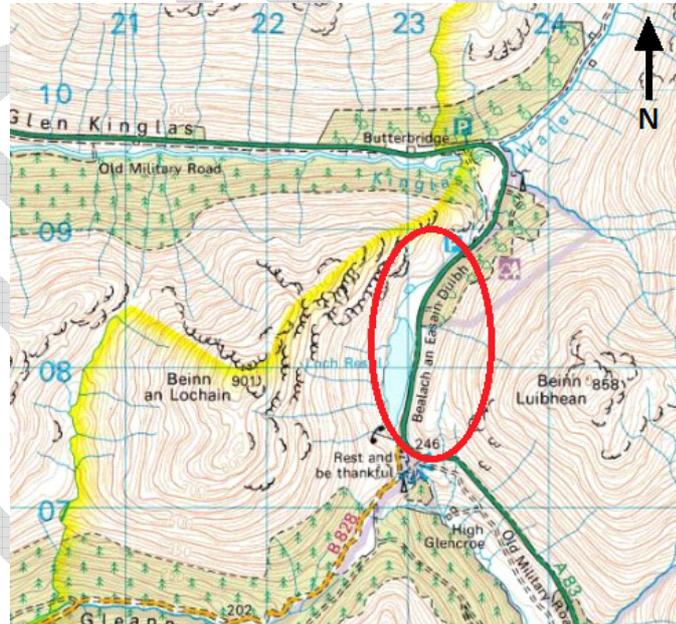


Figure 1: Location Plan

The site is situated in a highly exposed location with an elevation of approximately 248m, in the pass between Glen Croe and Glen Kinglas. This makes the site highly susceptible to strong winds. The topography of the area also results in poor mobile phone coverage which makes it difficult to seek assistance in the event of an accident. Fortunately in this instance, a BEAR Scotland gritter on a scheduled patrol passed the site soon after the accident, contacted the police via radio and offered shelter to the driver until the police arrived.

2 Investigation

2.1 Desktop Study

The initial desktop study of this site found that there are 2 sections of VRS in area. The two existing barriers are both on the nearside of the northbound (NB) carriageway. There is no VRS on the southbound (SB) carriageway. There is a Tensioned Corrugated Beam (TCB) system adjacent to the loch and an Open Box Beam (OBB) system adjacent to the stream which outfalls from Loch Restil. These are likely to have been designed to the TD19/85 VRS specification, protecting road users from the steep embankment and watercourses.

Following the Selby Rail crash in 2002, an enquiry determined that the TD19/85 standard no longer reflected the suitable protection of hazards on high-speed roads and a more risk-based analysis was needed. The timing of this change coincided with the introduction of EN1317, which is a performance based standard rather than the old product based standard which relied on the Department for Transport (DoT) promoted Non-Proprietary Safety Barrier Systems (NPSBS). The Interim Requirement for Road Restraint Systems (IRRRS) was introduced in 2002 along with the performance properties of the existing NPSBS systems. At this time a list was created which gave accepted VRS systems for use on the UK Highways network which could be used without further approval, if their performance level and deflections met the site requirements [Specification for Highway Works (SHW), Appendix SA1].

In 2006 a new design standard TD19/06 was introduced which covered all types of VRS, safety-barriers, terminals, parapets, crash cushions etc. The installation of new VRS is based on the benefit/cost calculations carried out using the Road Restraints Risk Assessment Process (RRRAP) software. This is applicable for highways of speed >50mph or >5,000 AADT.

As outlined above, the installed VRS in this section was likely to be installed under the TD19/85 standard, which relied on site inspection and engineering judgment. The information gathered during the site inspection, detailed in 2.2, will be used to assess the unprotected hazards using the RRRAP method outlined in the current standard, TD19/06.

2.2 Site Inspection

An inspection of the site was undertaken in March 2017 to gather the information required to carry out the RRRAP. A comprehensive set of record photographs was taken, a sample of which can be found in Appendix A.

Criteria

The site inspection involved walking the length of the site recording:

- The length, height, setback and available working width, type, age and condition of the VRS were recorded using the 'Safety Barrier Inspection Records' which can be viewed in Appendix B.
- Where safe to do so, the vertical and horizontal distance between the carriageway and the bottom of the embankment (in areas without VRS).
- The horizontal distance between the carriageway and the waterbody at the closest points (in areas without VRS).
- The provision of signage, whether these use passively safe posts and the condition of the signs. Sign diagram (dia.) numbers relating to the Traffic Signs Manual have been included for clarity.

Note: Any post with a diameter (\varnothing) 89mm or less, or posts which are designed to break or bend on vehicle impact are defined as passively safe and are not considered a hazard in the RRRAP.

- Anything else which may be considered a hazard was recorded to be input into the RRRAP (i.e. culverts, trees and large protruding rocks)

For the purposes of clarity, the site will be described as the following sections:

Section 1 – From Rest and Be Thankful (RABT) junction (Ch.0 to Ch.182)

Section 2 – Full length of existing NB TCB Barrier (Ch.182 – 513)

Section 3 – From small parking area to layby (Ch.513 to Ch.786)

Section 4 – From Layby to end of floodplain (Ch.786 to Ch.1246)

Section 5 – From end of floodplain to NB OBB barrier (Ch.1246 – Ch.1312)

Section 6 – Full length of existing NB OBB Barrier (Ch.1312 – Ch.1482)

See Figure 2, following, for site layout showing sections.

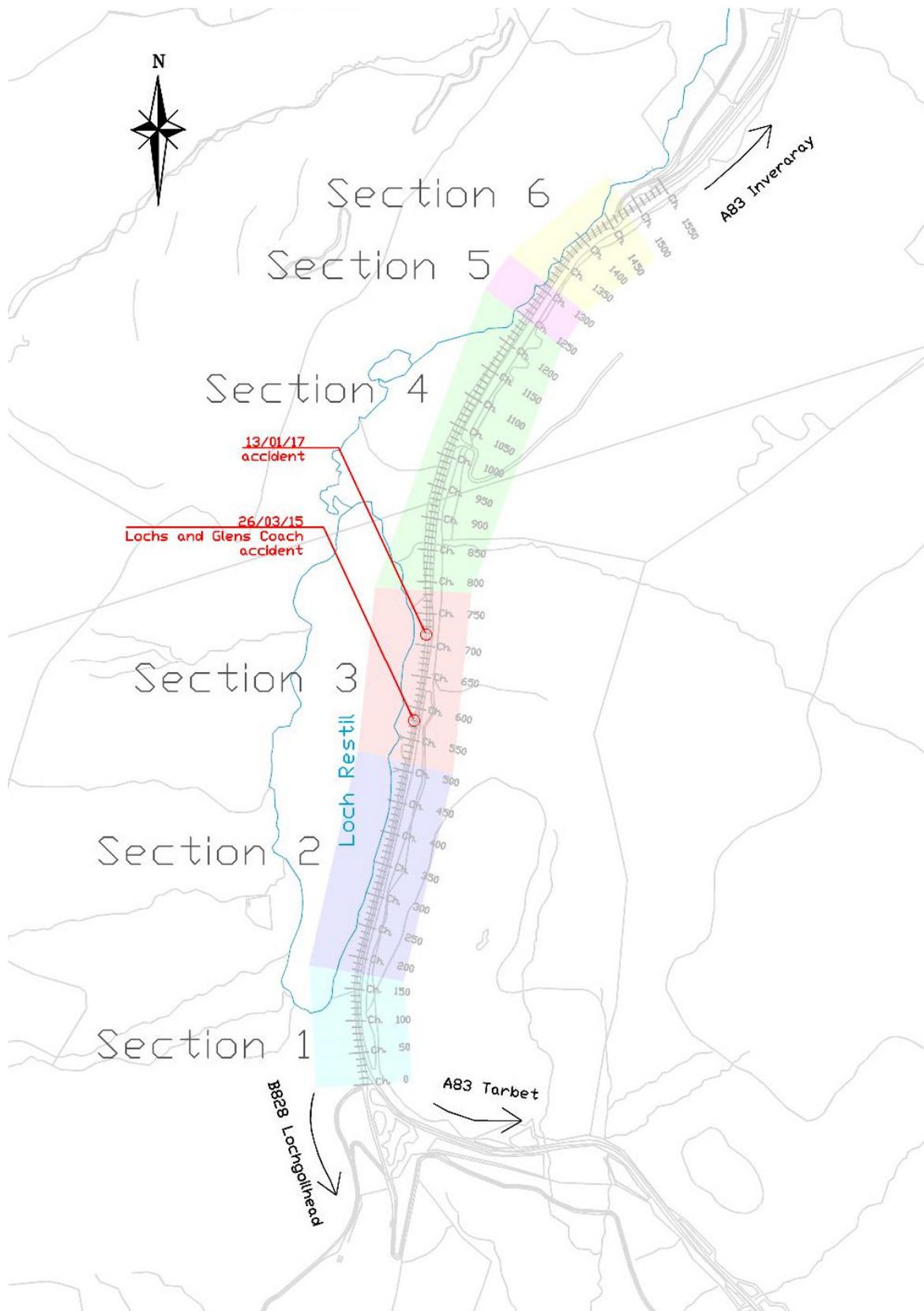


Figure 2: Site Layout

The infrastructure within each section noted during the site inspection is as follows:



Section 1 – From RABT junction to NB TCB Barrier (Ch.0 to Ch.182)

VRS

There is no VRS in this section. The verge is wide with a shallow grade. The waterbody is a significant distance from the carriageway. There is 1 tree on the verge.

Signage

There is 1no. large customised diversion route sign for use during road closures mounted on 2no. Ø140mm passively safe Jerol posts. Sign face was not visible during inspection, no defects were recorded for the posts.

2 sharp bend chevron (dia.515) signs facing south each on 2no. Ø76mm steel posts. No defects were recorded.

There is a “Risk of falling or fallen rocks” (dia. 559) sign and “For 6 miles” (dia. 570) supplementary sign on a flashing, wind and solar powered board. This is mounted on a single Ø219mm Jerol post. There is some damage to the the red border of the sign face.

There is a “Side winds” (dia. 581) sign mounted on 2no. Ø76mm steel posts. Both the sign face and poles are at the end of serviceable life. It is recommended that these are replaced.

Other

There is an SOS phone at the beginning of this section (TEL/A83/2000W). Maintenance of all SOS phones is the responsibility of Traffic Scotland. Traffic Scotland have reported that this phone was last tested on 17/03/2017 and found to be in working order.

Section 2 - Full length of existing NB TCB Barrier (Ch.182 – 513)

VRS

The site inspection confirmed that the barrier shown in Appendix A Photo 1 is a TCB system, installed to comply with N2 containment (1500kg vehicle, 70mph, 20° impact). The barrier has an adequate setback of 1200mm from the carriageway. The tensioning assembly appears to be in good condition, and the barrier appears to be tensioned sufficiently, although some of the bolts are at the ends of the slots. This is known as being 'slot bound' and results in not all beams being equally tensioned

The system is a NPSBS and would be categorised as N2W6 if installed as new under the current standard, however, the prevalence of many existing installations has meant that they are accepted as N2W5. Although the acquired rights aim to reduce the number of out of standard installations, there is only an available working width of 800mm. This is still 900mm less than 1700mm required by a W5 system in EN1317-2. Mounting height of 550mm from the carriageway is also below the standard of 610 ± 30 mm

There is corrosion to traffic face of barrier, although there are no sections where this has penetrated the full thickness or caused lamination of the material. The departure length, 8m past the hazard of the steep embankment, is less than the 30m beyond a hazard required in TD19/06.

The terminal ends are ramped P1 terminals which are no longer accepted in TD19/06 for national speed limit roads. These may overturn vehicles in the direction of the embankment and waterbody.

Manufacturing date stamping came into practise circa 1988 in line with BS5750. As there is no date stamp on the barrier it can be assumed to have been installed prior to this, which is in excess of the expected standard 20 year design life advised in TD19/06.

It is noted that this barrier is programmed to be replaced in the near future, regardless of whether or not increased protection is advised.

Signage

There are no signs present in this section.

Other

1 BT manhole in front of the barrier, this is flush with the ground and therefore does not present a hazard to motorists.

Section 3 – From small parking area to layby (Ch.513 to Ch.786)

VRS

There is no VRS in this section. The embankment behind the parking area has a steep slope which was deemed to be too steep to measure safely during the inspection. This was estimated to be at a slope of approximately 1:1 with a height of 5m. The slope adjacent to the carriageway shown in Appendix A Photo 2 and 3 is approximately 1:2 at points and there are large boulders in the verge and protruding from the embankment.

There are 2 small culverts in the embankment and the carriageway is setback 15.8m from the waterbody at the closest point (Ch.709).

Signage

There are no signs indicating that there is a parking area.

There is a “Risk of falling or fallen rocks” (dia. 559) sign and “For 1 mile” (dia. 570) supplementary sign mounted on 1no. Ø89mm steel post. The sign face is slightly dented. As it is made redundant by the previous “Falling or fallen rock” and “For 6 miles” sign combination noted less than 0.5 miles (583m) previously, it is advised that this sign is removed to prevent driver confusion.

Other

There are tyre tracks down the embankment and police tape on a post at Ch.709 which is assumed to be the location of the accident on the 13th January 2017, there is no official record of the accident location. This is also the closest point of the water to the carriageway in Section 3 at an offset of 15.8m.

The accident report from IRIS indicates that the Lochs and Glens coach accident occurred in Section 1 at Ch.76 (16512/59 Ch.400). This may be an inaccurate record or is the location where the driver initially lost control, however, photographic evidence shows that final the location of the coach was again within Section 3 at approximately Ch.580.

Section 4 – From Layby to end of floodplain (Ch.786 to Ch.1246)

VRS

There is no VRS in this section. The slope of the verge lessens to around 1:3 before becoming predominantly flat. There are 5 small culverts in this section.

Signage

There is a “Parking place” (dia. 801) sign on 2no. Ø60mm steel posts. Sign face and posts are at the end of serviceable life. Replacement of both is recommended.

There is a “Side wind” (dia. 581) sign facing traffic heading south on single Ø89mm steel post. This has been identified as a Cat.2 defect due to damage to the foundations caused by wind and will be replaced imminently.

Other

There are 2 BT manholes in the verge, flush with the ground.

Section 5 – From end of floodplain to NB OBB barrier (Ch.1246 – Ch.1312)

VRS

There is no VRS in this section. A stream which is an outfall from the loch runs almost parallel to the carriageway at a minimum offset of 6m. There is a small embankment with a steep slope heading towards the watercourse. Limited access prevented accurate measurements, however, it was estimated to be 1.5m high with a slope of 1:1.

Signage

There is a “Double bend first to right” (dia. 513) sign and “For 740yds” (dia. 570) supplementary sign on a single Ø89mm steel post. No defects were recorded.

Other

There is 1 BT manhole in the verge, flush with the ground level.

Section 6 – Full length of existing NB OBB Barrier (Ch.1312 – Ch.1482)

VRS

The site inspection confirmed barrier is an OBB system, installed to comply with N2 containment. The barrier is at an acceptable mounting height of 580mm from the carriageway and the barrier setback (PSb) is mostly adequate at 1200mm from the carriageway. This system is a NPSBS categorised as N2W5.

The working width available for this barrier is not sufficient to meet the standards set out in EN1317-2. The width from the traffic face to the water/embankment is only 800mm or less where there is limited space available as the carriageway crosses a small bridge at approximately Ch.1400. At this location a PSb of 600mm and a reduced working width of 250mm has been used. It is not known if a departure from standard was granted for this, however, the solution exhibits sound engineering sense based on TD19/85, the standard in place at the time of the design.

There is a risk of vehicles travelling north accessing the hazard from behind the approach terminal of the barrier as it does not extend 30m beyond the hazard of the steep embankment and watercourse as required in TD19/06. Likewise southbound traffic could face a similar risk if they cross over the road at the departure end although this does provide marginally better protection to the embankment and water. This risk is amplified by the sub-standard ramped P1 terminals which have the potential to flip the vehicle into the water hazard.

Although this barrier does not meet the required working width for a W5 system, this is not uncommon on the trunk road network. The barrier is generally in good condition and as such a replacement is not recommended at this time. An extension to the approach length shown in Appendix A Photo 4 is recommended with the addition of the appropriate P4 terminal. The possibility of closing the gap to another OBB barrier further north of this site should also be considered, although this may prove impractical due to the presence of public utilities.

Signage

There is 1 “Parking place” (dia. 801) sign on a single Ø76mm steel post which marks the approach to the layby in advance of Section 6. Sign face and post are at the end of serviceable life. It is recommended that both are replaced.

Other

There was no other information recorded in this section.

All sections

There are snow poles along the length of the site and verge hazard markers at several locations. Some of these are missing or damaged along the length of the site.

3 Road Restraints Risk Assessment Process

TD19/06 states that the RRRAP forms an “integral part” of the standard. The software can analyse and assess the risk posed by a hazard and determine whether a VRS system is required to minimise the risk of serious injury to road users in the event of an accident.

During the site inspection, the horizontal and vertical geometry of the embankment was measured, where safe to do so, at points where there was an obvious change of slope. The measurements were used to provide the gradient of the westbound embankment. Horizontal distances were also taken from the edge of the carriageway to the closest points of the waterbody and other potential hazards such as culverts and large protruding rocks on the verge or embankment. The traffic count information referred to in 1.1 was obtained from counter JTC08338 available on the Transport Scotland website. The speed limit for the carriageway was taken from the Integrated Roads Information System (IRIS).

All of the information gathered was entered into the RRRAP software which then calculated the risk. The VRS Summary output is shown in Table 1 below. A larger version of this table and the full collated results and the calculated risks can be found in Appendix C and D respectively.

Table 1: RRRAP VRS Summary

RRRAP version number	Issue 1.3a	Verge assessed	N/S Verge	Date of Design/ Submission	23/03/2017
Issue date	05/12/11	Section / Direction assessed		Were any of the results unexpected?	No
Road Number	A83	Location	From	To	
Road name	Loch Restil	Junction Name	N/A	N/A	
		Junction No.	N/A	N/A	
		Marker Post	N/A	N/A	
		Section Label	N/A	N/A	

ID Number	Nature of Hazard	Start chainage of hazard	End chainage of hazard	Offset of hazard from PSb	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	Barrier Containment	Barrier working width class	Parapet Containment	Barrier working width (m)	Offset of Barrier from PSb	Comments
0600.0003	Falling 1:2.5 or steeper	575.00	630.00	3.00	30.0	30.0	N2	W2		0.80	1.20	Gap from Existing <50m. Continue Barrier
0600.0006	Falling 1:2.5 or steeper	685.00	705.00	3.00	30.0	30.0	N2	W2		0.80	1.20	Gap from above <50m. Continue Barrier
8800.0003	Water > 1m Depth	786.00	1056.00	30.00								

Table 1 shows that the RRRAP recommends protection by VRS within Section 3. This is due to the slope of the embankment. Two locations from ch.575 to ch.630 and from ch.685 to ch.705 are recommended for protection. This does not include the 30m in advance and beyond the hazard of the steep sections of the embankments required under TD19/06. There is no protection required for the loch, culverts or sign posts.

In this recommendation the existing TCB barrier in Section 2 ends at ch.513 and the new section start at ch.545. TD19/06 recommends that gaps less than 50m are closed so these would be joined. When the additional 30m lengths are included, the second section overlaps with the first between ch.655 and ch.660 again these would be joined. The RRRAP recommendation is therefore to extend the existing barrier by 223m.

Whilst the RRRAP software does not consider the loch to be a hazard due to the distance from the carriageway, engineering judgment has been used to provide a design recommendation which fully protects the water hazard. This is due to the proximity of the water in both wind related accidents. As a result, the proposed design includes an additional 49m of barrier beyond the RRRAP recommendation. This covers the entire length of Section 3 with the P4 terminal in Section 4. In total this is a 272m extension to the existing TCB barrier, with a further 12m for the appropriate P4 terminal. This would protect the whole length of the carriageway which runs parallel to the east bank of Loch Restil.

4 Replacement and Improvement Recommendations

4.1 VRS Improvement Strategy Outline

Transport Scotland has a commitment to a continuing programme of replacement and renewal of sub-standard VRS on all sections of the trunk road network, bringing all systems into line with current standards. This requires considerable investment so it is important to prioritise the most at risk sites.

The TCB barrier in Section 2, adjacent to Loch Restil, has previously been identified as in need of renewal due to corrosion of the barrier. As a result a barrier replacement has been programmed for this section in the 2017/18 routine maintenance programme. It is recommended that the increase in the length of protection, specified in this report is carried out simultaneously with the replacement. A further extension south toward Rest and Be Thankful should also be investigated at this time.

The replacement system installed adjacent to the loch is likely to be a Flexbeam+ system with Trend P4 terminals or similar products which are on the list of accepted VRS systems for UK highways [SHW Appendix SA1].

The recommended extension to the barrier approach and departure lengths plus the appropriate P4 terminal upgrades to the existing OBB barrier in Section 6 are also recommended to be carried out as part of the routine maintenance scheme. Drawings showing the recommended barrier works have been included in Appendix E.

Furthermore during the routine maintenance scheme to upgrade the VRS, all signs and posts which are approaching the end of serviceable life should be replaced. Missing snow poles and verge markers should also be reinstated.

4.2 Additional Solutions

Mobile phone providers are working to improve the service in the area. EE, who have the Emergency Service Network (ESN) contract, have two proposed sites which would provide improved coverage in this location. The first at Glen Croe has just recently been given landowner approval to progress, with a full planning application being submitted imminently to Loch Lomond & The Trossachs National Park, the planning authority for this area. The second proposed site is near Butterbridge. Once live these should provide a substantial network coverage improvement. Additionally, CTIL (Vodafone/O2) have two existing mast sites in this area with pending upgrades to provide 3/4G coverage.

Under instruction from Transport Scotland, BEAR Scotland are providing a new wind gauge, which will be monitored over a 12 month period to assess whether there is a significant difference between the location at Loch Restil and Rest and Be Thankful where there is an existing wind gauge. The findings of this study may be used in future to provide variable warning signs to warn when winds are particularly strong, encouraging road users to reduce speeds. Whilst this will be beneficial, the location of the wind sensor is limited to the area behind the departure end of the existing TCB barrier at the small car parking area in Section 3. As the sensor will require solar panels to be mounted at a 5m height, the weight of this equipment and the lever action produced as a result of this mounting height is not suitable for a passively safe post. Therefore using a non-passive post will introduce a new hazard in the area which will not be fully protected by the existing barrier. The additional VRS recommendations provided in this report, however, would rectify this.

5 Conclusion and Recommendations

The outcome of this review is to recommend an increased length of protection from VRS. The recommended length of safety barrier would cover the location of both of the accident in January 2017 and the 'Lochs and Glens' coach accident of March 2015.

This conclusion has been reached through a combination of utilising the TD19/06 RRRAP software and engineering judgement. The RRRAP determined that the embankment was steep enough to merit protection. Engineering judgement was used to recommend additional protection, over the RRRAP results, based on the recurrence of accidents in a similar location during high winds. This concern was compounded by the proximity of the water to the final locations of the vehicles in both instances.

As a result of the high winds being a factor in both of the accidents, a new wind gauge will be installed near this location. This will be monitored for a 12 month trial period to determine whether additional measures need to be taken.

As the barrier adjacent to the loch is already programmed for replacement, it is advised that when a new barrier system is installed, the works include the recommendations put forward in this report. As well as the additional lengths of barrier and the upgrades to the terminals, this includes replacing worn and damaged sign faces and posts; replacing damaged verge markers and reinstating missing snow poles.

Appendix A – Site Photographs



Photo 1: Steep embankment and closer proximity of waterbody in location currently protected by TCB (looking north @ Section 2 Ch.425).



Photo 2: Minimum of 15.8m from carriageway to waterbody (looking south @ Section 3 Ch.680).



Photo 3: Minimum of 15.8m from carriageway to waterbody (looking north @ Section 3 Ch.680).



Photo 4: OBB Barrier approach length does not cover hazard (looking north @ Section 2 Ch.1285).

Appendix B – Safety Barrier Inspection Records

i) N/B Barrier 1 - Tension Corrugated Beam

Day/Date:	Wed 22/03/17		Time:	14:45		Inspector:	JK	
Route:	A83 Loch Restil		Link/Section:	16512/59		Chainage:	506 - 848	
LOCATION INFO								
CARRIAGEWAY TYPE	Single	Dual	Motorway	Slip on / off				
DIRECTION	N/B E/B			S/B (WB)				
BARRIER LOCATION	Verge	Centre	Slip (n/s)	Slip (o/s)	Roundabout			
SPEED	70		60	50	<50			
ROAD GEOMETRY	Straight	Curve H	Curve V	Junction	Other: _____			
HAZARD	Bend	Embankment	Water	Sign	Other: _____			
KERB		YES	NO	Bullnose/ 45°				
HARD STRIP		YES	NO	Width: _____				
OVERGROWN	NO	Partly	Very	Trees in WW				
VERGE BUILD UP	NO	50mm	100mm	+150mm				
PARAPET CONECTIONS	N/A	Full Height Anchor	Tranzflex	Substandard Connection				
EXISTING								
LENGTH <small>if multiple lengths of barrier</small>	330 (Barrier 1)	(Gap)	(Barrier 2)	(Gap)	(Barrier 3)	(etc.)	N>S / S>N E>W / W>E	
CLOSING GAPS	YES		NO					
TYPE	TCB	OBB	Flexbeam	Wire Rope	UCB	Other: _____		
POST	100 x 32	110 x 47	125 x 90	125 x 47	170 x 47	Other: _____		
SPACING	1.2m	1.6m	2.0m	2.4m	3.2m	Other: _____		
CONTAINMENT	N1	N2	H1	H2	H4a			
SETBACK (PSb) <small>to traffic face of barrier</small>	1.5m+	1.2m - 1.5m	1.0m - 1.2m	0.6m - 1.0m		<0.6m		
HEIGHT <small>to centre of beam from road level (if <1.5m PSb) or Verge Level (if >1.5m PSb)</small>	580mm - 640mm		Other: 550					
AGE	< 5 years	6 - 15 years	16 - 25 years	26 - 40 years		40+ Years		
FOUNDATION	Driven	Concrete	Socket			Surface Mounted		
TERMINAL	P1 (Ramp)	Fishtail	Full Height Anchor	P4	Other: _____			
BEAM CORROSION	(LOW)	1	2	3	4	5	(HIGH)	
POST CORROSION	(LOW)	1	2	3	4	5	(HIGH)	
RTC DAMAGE	Post	Beam	Terminal			None		
NEW								
SETBACK	Existing	1.2 m			RELAXATION	DEPARTURE		
NEW HAZARD	None	Sign	Post	Structure	Other: _____			
CLEARANCE TO HAZARD	1.30m + W4	1.00m - 1.29m W3	0.80m - 0.99m W2	0.60m - 0.79m W1	<0.60m W1 (DEPARTURE)			
APPROACH <small>min 30m FH past hazard</small>	OK	Extend full height _____ m			+ P4	+ P1		
DEPART <small>min 30m FH past hazard if opp. traffic can reach hazard</small>	OK	Extend full height 270 m			+ P4	+ P1		
OTHER INFORMATION:								

**4G Term Contract For The Management and Maintenance
Of The Scottish Trunk Road Network – North West Unit
Scheme Title – A83 Loch Restil Vehicle Restraint System
Investigation and Review**

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ii) N/B Barrier 2 – Open Box Beam

Day/Date:	Wed 22/03/17		Time:	13:50		Inspector:	JK	
Route:	A83 Loch Restil		Link/Section:	16512/59		Chainage:	1288 - 1458	
LOCATION INFO								
CARRIAGEWAY TYPE	Single		Dual	Motorway		Slip on / off		
DIRECTION	N/B (E/B)					S/B (W/B)		
BARRIER LOCATION	Verge		Centre	Slip (n/s)		Slip (o/s)		Roundabout
SPEED	70		60		50		<50	
ROAD GEOMETRY	Straight		Curve H		Curve V		Junction Other: _____	
HAZARD	Bend		Embankment		Water		Sign Other: _____	
KERB	YES		NO		Bullnose/ 45°			
HARD STRIP	YES		NO		Width: _____			
OVERGROWN	NO		Partly		Very		Trees in WW	
VERGE BUILD UP	NO		50mm		100mm		+150mm	
PARAPET CONNECTIONS	N/A		Full Height Anchor		Tranzflex		Substandard Connection	
EXISTING								
LENGTH	170m						N>S / S>N	
if multiple lengths of barrier	(Barrier 1)		(Gap)		(Barrier 2)		(Gap)	
CLOSING GAPS	YES		NO					
TYPE	TCB		OBB		Flexbeam		Wire Rope UCB Other: _____	
POST	100 x 32		110 x 47		125 x 90		125 x 47 170 x 47 Other: _____	
SPACING	1.2m		1.6m		2.0m		2.4m 3.2m Other: _____	
CONTAINMENT	N1		N2		H1		H2 H4a	
SETBACK (PSb) to traffic face of barrier	1.5m+		1.2m - 1.5m		1.0m - 1.2m		0.6m - 1.0m <0.6m	
HEIGHT to centre of beam from road level (if <1.5m PSb) or Verge Level (if >1.5m PSb)	580mm - 640mm		Other: _____					
AGE	< 5 years		6 - 15 years		16 - 25 years		26 - 40 years 40+ Years	
FOUNDATION	Driven		Concrete		Socket		Surface Mounted	
TERMINAL	P1 (Ramp)		Fishtail		Full Height Anchor		P4 Other: _____	
BEAM CORROSION	(LOW)		1		2 3		4 5 (HIGH)	
POST CORROSION	(LOW)		1		2 3		4 5 (HIGH)	
RTC DAMAGE	Post		Beam		Terminal		None	
NEW								
SETBACK	Existing		1.2 m		RELAXATION		DEPARTURE	
NEW HAZARD	None		Sign		Post		Structure Other: _____	
CLEARANCE TO HAZARD	1.30m +		1.00m - 1.29m		0.80m - 0.99m		0.60m - 0.79m <0.60m	
APPROACH	W4		W3		W2		W1 W1 (DEPARTURE)	
min 30m FH past hazard	OK		Extend full height		30 m		+ P4 + P1	
DEPART	OK		Extend full height		30 m		+ P4 + P1	
min 30m FH past hazard if opp. traffic can reach hazard								
OTHER INFORMATION:								



Appendix C – RRRAP VRS Summary

Road Restraint Risk Assessment Process (RRRAP) VRS Summary

RRRAP version number	Issue 1.3a
Issue date	05/12/11

Verge assessed	N/S Verge
Section / Direction assessed	

Date of Design/ Submission	23/03/2017
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Road Number	A83
Road name	Loch Restil

Location	From	To
Junction Name	N/A	N/A
Junction No.	N/A	N/A
Marker Post	N/A	N/A
Section Label	N/A	N/A

Were any of the results unexpected?	No
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ID Number	Nature of Hazard	Start chainage of hazard	End chainage of hazard	Offset of hazard from PSb	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	Barrier Containment	Barrier working width class	Parapet Containment	Barrier working width (m)	Offset of Barrier from PSb	Comments
0600.0003	Falling 1:2.5 or steeper	575.00	630.00	3.00	30.0	30.0	N2	W2		0.80	1.20	Gap from Existing <50m. Continue Barrier
0600.0006	Falling 1:2.5 or steeper	685.00	705.00	3.00	30.0	30.0	N2	W2		0.80	1.20	Gap from above <50m. Continue Barrier
8800.0003	Water > 1m Depth	786.00	1056.00	30.00								

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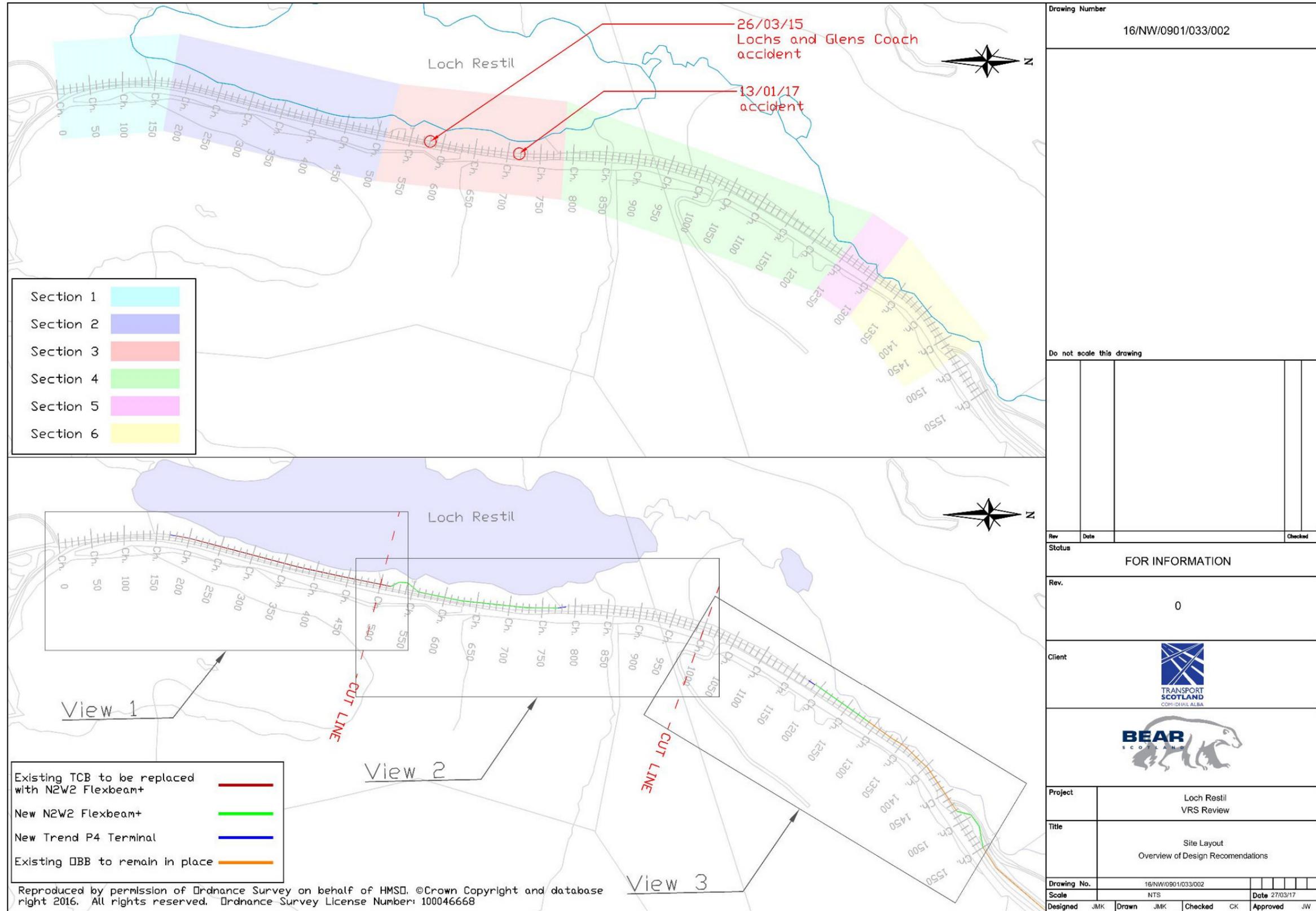
Appendix D – RRRAP Collated Hazards and Calculated Risk

Description of Feature									Description of Barrier																								
ID Number	Nature of Hazard	Start chainage of hazard	End chainage of hazard	Offset of hazard from PSb	Is risk without VRS acceptable?	What is level of risk with optimum length VRS?	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	Barrier Containment	Barrier working width class	Barrier working width (m)	Offset of Barrier from PSb	Is parapet/structure to be placed contiguously with barrier?	Parapet Containment	Output detailed results?	Cost of Option (average per year, £)	Length of hazard	Width of hazard	Aggressiveness	Other Risk Type	Total Number of people at risk	Substandard headroom over any part paved carriageway?	Substandard headroom over Verge or C/res?	Structure Carries / Parapet protecting	Designed for collision loading?	Width of adjacent Hardshoulder or Hardstrip	Width verge / Central Reserve	Overall width slope	Overall Height slope	Multiplicative factor for runoff rate	Topography Factor	Other Consequences Multiplicative factor	Angle of hazard to PSb (Degrees)
0600.0001	Falling shallower than 1:5	513.00	520.00	3.00	Yes										0.00	7.00	10.00	0.00								0.00	10.00	10.00	-1.79	0.90	1.00		
8800.0001	Water > 1m Depth	513.00	783.00	15.00	Yes										0.00	270.00	500.00	1.50							0.00	10.00	10.00	-1.79	0.90	1.00			61.87
0600.0002	Falling 1:1 or steeper	520.00	575.00	7.00	Yes										0.00	55.00	2.00	2.50							0.00	10.00	2.00	-2.00	0.90	1.00			
0600.0003	Falling 1:2.5 or steeper	575.00	630.00	3.00	No	Acceptable	11.0	9.0	N2	W2	0.80	1.20			0.00	55.00	10.00	2.00							0.00	10.00	10.00	-4.91	0.90	1.00			
0600.0004	Falling 1:5 or steeper	630.00	650.00	3.00	Yes										0.00	20.00	10.00	0.50							0.00	10.00	10.00	-3.05	0.90	1.00			
0500.0001	Culvert	633.00	648.00	8.00	Yes										0.00	15.00	2.00	1.80							0.00	10.00	10.00	-3.14	0.90	1.00			45.00
0600.0005	Falling 1:3 or steeper	650.00	685.00	3.00	Yes										0.00	35.00	10.00	0.50							0.00	10.00	10.00	-3.64	0.90	1.00			
0600.0006	Falling 1:2.5 or steeper	685.00	705.00	3.00	No	Acceptable	11.0	9.0	N2	W2	0.80	1.20			0.00	20.00	10.00	2.00							0.00	10.00	10.00	-4.53	0.90	1.00			
0600.0007	Falling 1:5 or steeper	705.00	745.00	3.00	Yes										0.00	40.00	5.00	0.50							0.00	10.00	5.00	-1.35	0.90	1.00			
8800.0002	Water > 1m Depth	709.00	979.00	15.00	Yes										0.00	270.00	500.00	1.50							0.00	10.00	5.00	-1.40	0.90	1.00			61.87
0600.0008	Falling 1:3 or steeper	745.00	765.00	3.00	Yes										0.00	20.00	5.00	0.50							0.00	10.00	5.00	-1.83	0.90	1.00			
0500.0002	Culvert	753.00	768.00	8.00	Yes										0.00	15.00	2.00	1.80							0.00	10.00	5.00	-1.75	0.90	1.00			45.00
0600.0009	Falling 1:3 or steeper	765.00	786.00	3.00	Yes										0.00	21.00	5.00	0.50							0.00	10.00	5.00	-1.64	0.90	1.00			
8800.0003	Water > 1m Depth	786.00	1056.00	30.00	Yes										0.00	270.00	500.00	1.50							0.00	10.00	5.00	-1.45	0.90	1.00			61.14

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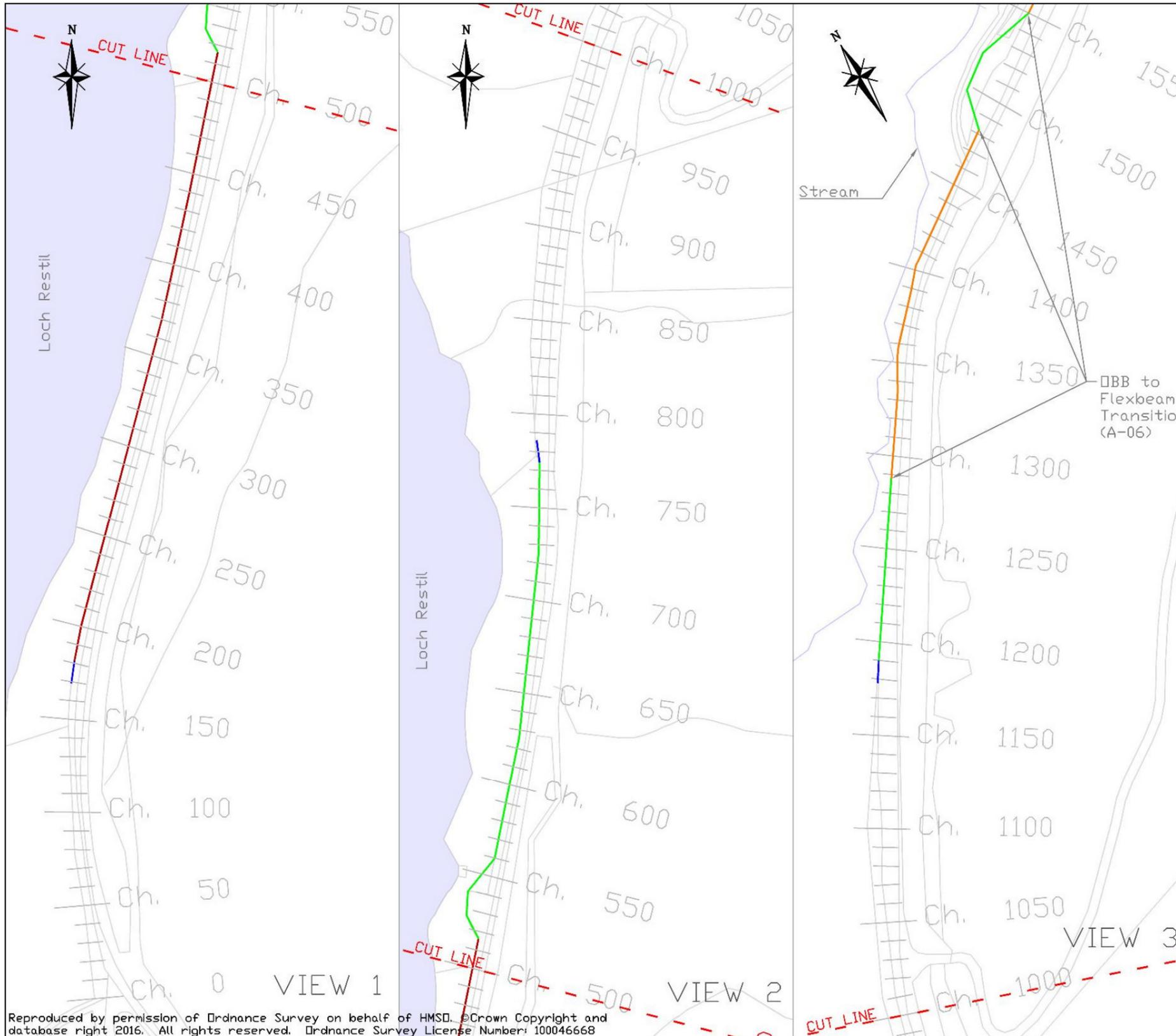
Appendix E – Proposed VRS Improvement Design



Drawing Number		16/NW/0901/033/002	
Do not scale this drawing			
Rev	Date	Checked	
Status FOR INFORMATION			
Rev. 0			
Client  			
Project		Loch Restil VRS Review	
Title		Site Layout Overview of Design Recommendations	
Drawing No.		16/NW/0901/033/002	
Scale		NTS	
Designed		Date 27/03/17	
JMK	Drawn	JMK	Checked
CK	Approved	JW	

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Drawing Number		16/NW/0901/033/003	
Existing TCB to be replaced with N2W2 Flexbeam+			
New N2W2 Flexbeam+			
New Trend P4 Terminal			
Existing OBB to remain in place			
Do not scale this drawing			
Rev	Date	Checked	
Status			
FOR INFORMATION			
Rev.			
0			
Client			
 TRANSPORT SCOTLAND CONFIDIAL ALBA			
Project		Loch Restil VRS Review	
Title		Design Recommendation	
Drawing No.	16/NW/0901/033/003		
Scale	NTS		Date 27/03/17
Designed	JMK	Drawn	JMK
Checked	CK	Approved	JW

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