

# Preventing Entry to the Strategic Road Network

Framework for Transport Related  
Technical and Engineering Advice and  
Research

4/45/12 - Lot 2: Road Transport Advice,  
Engineering Research and Consultancy

25th April 2014

Highways Agency Task Ref:	182(4/45/12)PBWSP
Project Leader:	Philippa Bloom
Name of Lead Supplier:	PBWSP
Issue: Final	Dated: 25th April 2014

Issue / revision	Final			
Remarks				
Date				
Prepared by	Graham Purvis			
Signature				
Checked by	Iain Candlish			
Signature				
Authorised by	Steve Matthews			
Signature				
Project number	70000374			
File reference				

**Issued on behalf of the PBWSP**  
**Joint venture by**  
**Graham Purvis**  
**Three White Rose Office Park**  
**Millshaw Park Lane**  
**Leeds**  
**LS11 0DL**  
**United Kingdom**

**Tel: +44 113 3956200**  
**Fax: +44(0)113 3956201**  
**[www.wspgroup.co.uk](http://www.wspgroup.co.uk)**

## Executive Summary

This study builds on the findings of a previous study undertaken in 2008 to investigate the potential systems for the closing of entry slip roads on to the Strategic Road Network. The intent of which is to provide systems which are impenetrability to the customer is to have the benefit of releasing the resources from being in attendance and managing the closure to prevent access. This will improve efficiencies by allowing the TOS or SP resources to deal with the incident or continue with day-to-day functions

The systems identified in the original study for possible implementation were used as the basis for this study and these were assessed further by undertaking a desktop study of systems currently being operated around the world. The number of systems available was increased further by the identification of systems which although not currently used on public roads could potentially be utilised.

These systems were subject to a series of evaluation considerations in order to meet the key deliverables of the take, namely:

- Prevent access to the SRN quickly
- Make closure impenetrable to customers
- Allow easy access for those authorised (e.g. emergency responders, TOS and SPs)
- Are cost effective and can be implemented
- Are acceptable to emergency responders, TOS and SPs

Four possible systems were identified as meeting the majority of the key deliverables however there remains a concern with respect to the provision of easy access to the emergency services, however it is felt that this is manageable. The four systems are:

- Manual Horizontal Swing Gate
- Manual Vertical Rising Gate
- Portable Plastic Barriers
- Trellis Barriers

Although each system has positive and negative attributes, a permanently installed system would provide a more robust and durable system. Therefore the manual horizontal swing system is the preferred system.

However it is recognised that not all slip road locations will be able to accommodate a sole design, therefore it may be more desirable to consider detailing specific criteria, such as, topography or anticipated usage, in order to determine the preferred option. This may identify that the vertical rising gate may be more suitable.

Therefore the following recommendations are made in order to take the project further:

- Identify the available funding to undertake a trial of the preferred option
- Determine the required conditions in order to determine the preferred option for each slip road
- Consultation with the Emergency Services to determine a protocol for the operating of the barriers for access
- Consider the provision of remote activated barriers on future Smart Motorway schemes. This system is additional to the systems identified above and would be technology and cost lead.

## Contents

<b>Executive Summary</b> .....	<b>2</b>
<b>1 Glossary of Frequently Used Terms</b> .....	<b>6</b>
<b>2 Introduction</b> .....	<b>7</b>
2.1 Background.....	7
2.2 Methodology .....	7
<b>3 Previous Study Reviews</b> .....	<b>8</b>
3.1 Emergency Closure of the Network (2008) - Review .....	8
3.2 Area 10 Trial Closure Review .....	9
<b>4 Research</b> .....	<b>10</b>
4.1 Emergency Closure Systems Worldwide.....	10
4.2 Traffic Officer Survey .....	11
4.3 Emergency Services.....	15
<b>5 System Evaluation</b> .....	<b>16</b>
5.1 Initial Evaluation.....	16
5.2 Secondary Evaluation .....	16
<b>6 Data Analysis</b> .....	<b>20</b>
<b>7 Cost Analysis</b> .....	<b>21</b>
7.1 Assumptions .....	21
7.2 Calculations .....	21
<b>8 Conclusion</b> .....	<b>24</b>
<b>9 Recommendations</b> .....	<b>27</b>
<b>Appendices</b> .....	<b>28</b>
<b>Appendix A: Research</b> .....	<b>29</b>
A.1 United Kingdom .....	29
A.2 Europe .....	37
A.3 United States .....	39
A.4 Australia.....	41

<b>Appendix B System Attributes .....</b>	<b>42</b>
<b>Appendix C System Evaluation .....</b>	<b>51</b>
C.1 Ease of Procurement .....	51
C.2 Cost .....	51
C.3 Operation .....	52
C.4 Infrastructure.....	53
C.5 Security.....	53
C.6 Current Use.....	53
Table 1: Closure Systems .....	10
Table 2: Initial Evaluation Rejections .....	16
Table 3: Second Evaluation Rejections .....	18
Figure 1: Second System Evaluation.....	18
Figure 2: A66 Main Carriageway .....	29
Figure 3: A66 Slip Road .....	30
Figure 4: A628 Woodhead Pass.....	30
Figure 5: M40 DBFO Plastic Barriers.....	31
Figure 6: TSRGD extract.....	31
Figure 7: Automatic Rail Crossing .....	32
Figure 8: Automatic Vertical Rising Barrier .....	32
Figure 9: Automatic Horizontal Tracked Slinging Gate.....	33
Figure 10: Automatic Horizontal Cantilever Slinging Gate .....	33
Figure 11: BarrierGuard Wheeled.....	34
Figure 12: Automatic Rising Kerb .....	34
Figure 13: Retractable Bollard.....	35
Figure 14: Water Filled Barrier .....	35
Figure 15: Intellicone.....	36
Figure 16: Heavy Duty Trellis Barrier.....	36
Figure 17: Barrier Arm in the Netherlands .....	37
Figure 18: Barrier Arm in Sweden .....	38
Figure 19: Barrier Arm in France .....	38
Figure 20: Vertical panels in Germany.....	39
Figure 21: Wisconsin ramp gate with additional panels.....	40
Figure 22: Minnesota ramp gate.....	40

---

Figure 23: Minnesota ramp gate signage.....	40
Figure 24: I-64 gates, Virginia .....	41
Figure 25: Softstop, Sydney Harbour Tunnel.....	41

## 1 Glossary of Frequently Used Terms

AMOR	Asset Maintenance and Operational Requirements
ASC	Asset Support Contract
CCTV	Close Circuit Television
COBA	Cost Benefit analysis
DBFO	Design, Build, Finance and Operate Contract
ETM	Emergency Traffic Management
HA	Highways Agency
RVP	Rendezvous Point
RCC	Regional Control Centre
SP	Area Service Provider
SRN	Strategic Road Network
TO	Traffic Officer
TOS	Traffic Officer Service
TSRGD	Traffic Signs & Roads General Directions
TTM	Temporary Traffic Management

## 2 Introduction

### 2.1 Background

It may be necessary to prevent access to the Strategic Road Network (SRN) during unplanned incidents and this will be facilitated by the closure of entry slip roads. These closures need to be implemented safely, quickly and effectively. They also need to be impenetrable to customers (road users) but allow access by Emergency Responders, the Traffic Officer Service (TOS) and area Service Providers (SP).

The establishment of such closures can require significant TOS or SP resource (location and number dependant) and further resource is required to be in attendance to manage and maintain the closure. The intention of the impenetrability to the customer is to have the benefit of releasing the resources from being in attendance and managing the closure to prevent access. This will improve efficiencies by allowing the TOS or SP resources to deal with the incident or continue with day-to-day functions. In allowing the resource to assist in dealing with the incident this will contribute in the reduction of incident clear up times; reduce congestion and improve journey time reliability supporting the CLEAR initiative, identifying issues which need to be addressed by all organisations involved in incident management.

This task was to build on the findings of a previous study, Emergency Network Closures (task ref: 538(666)) carried out by PB-WSP in 2008 for the Highways Agency Incident Management Policy Team. The original study was to identify closure methods for the main carriageway and slip roads. In order to build on the findings it was necessary to undertake a review of the previous study; identifying further methods for preventing access to the network and assessing the legal and protocol issues previously identified

The key objectives of this task were to identify methods which:

- Prevent access to the SRN quickly
- Make closure impenetrable to customers
- Allow easy access for those authorised (e.g. emergency responders, TOS and SPs)
- Are cost effective and can be implemented
- Are acceptable to emergency responders, TOS and SPs

### 2.2 Methodology

In order to determine the defined objectives, it was identified that the following should be undertaken:

- Review previous study identifying which of the methods are potentially suitable for preventing access to the SRN
- Undertake a desktop study to identify further methods currently in use both in the UK and worldwide
- Undertake an evaluation of all identified methods with respect to ease of procurement, cost, operation (deployment, maintenance, and removal), infrastructure, security and current use.
- Internet survey undertaken by the Traffic Officers to canvass opinion on the preferred method of closure.
- Provide a cost benefit analysis

## 3 Previous Study Reviews

### 3.1 Emergency Closure of the Network (2008) - Review

The study was undertaken by PB-WSP and investigated the potential methods of closing parts of the SRN safely, quickly and effectively during unplanned closures (incidents and severe weather). This included closure of both the main carriageway and slip roads.

When the study was undertaken, it was usual practice for the TOS to implement the closures and these were then enhanced by an Incident Support Unit within prescribed response timescales identified in the Network Management Manual. This document has now been replaced by the Asset Maintenance and Operational Requirements (AMOR) which describes outcomes that the SP is required to achieve, but is free to choose the methods on how the outcomes should be achieved by a risk based approach. With respect to incident management although the requirement to provide temporary traffic management is still a deliverable, the performance metric description has changed from response time to time in which to make the asset safe allowing the expeditious movement of traffic. A consequence of which is a reduction in resource and vehicle size for immediate response. The ability to implement TTM is now regarded as a secondary response operation.

The study included an investigation into the methods which are either being utilised or trialled for use both in the UK and worldwide, in addition 'blue sky ideas' were also included.

19no. concepts were identified and these were reduced through a series of evaluation stages. The outcome was that 9no. concepts were considered viable to be taken forward to an option selection process for consideration by Highways Agency (HA). These were classified into 5no. fields:

- 1 Existing methods
  - Vehicle and officer/operative
  - Traffic cones
- 2 Potential 'Quick win' method
  - Portable Barriers
- 3 Potential methods
  - Manual rising/vertical barrier arms
  - Automatic rising/vertical barrier arms
  - Manual swing barrier arms
  - Automatic swing barrier arms
- 4 Mainline closure method
  - Sologuard
- 5 Innovative method
  - Roller blind

The study was only to identify potential closure options that would be suitable. The next stage was to develop them into full operational designs and obtain formal agreement of procedures for their use.

Following the study, the options were considered by the Project Board and approval given for the development of a business case for the use of Portable Barriers to close entry slip roads including a cost benefit analysis, consideration to advance signing and procedures and protocols.

The business case was accepted and a trial undertaken within Area 10 by the then Service Provider AOne+ following approval of the required departures for the use of barricades.

### 3.2 Area 10 Trial Closure Review

The trial was undertaken between December 2010 and December 2011 following the acceptance of a business case submission developed to trial the 'quick-win' option identified in the 2008 study. A report on the trial was completed in January 2012.

The report included a cost benefit analysis using data from the business case, although correlation is difficult to ascertain and the lack of calculations within the report do not allow confirmation of the figures. The original cost benefit calculation was based on critical incident data from the SE Region and not specifically for slip road closures and therefore should not have been used.

The report identified that the barriers were only used on 7no. occasions for unplanned incidents and a further 7no. occasions within routine temporary traffic management deployments (approved for research purposes to explore the number of breaches).

The report identified that there was positive feedback from the operatives with respect to its use and effectiveness at stopping vehicles breaching the closures. The report concludes that although the cost of purchase of the equipment for the test was expected to be met by cost savings, no other cost savings had been realised. This does not follow, in that; if the cost has already been met then any further use would bring savings. The report stated that there was no investigation into the reasons for non-use suggesting that this would require detailed operational influence or observation and that it was not within the remit of the trial study. The omission of this data is critical in assessing when this system of closure would be deployed and the reason why. There is potential that the barriers were not deployed for operational reasons e.g. the barriers were not being stored near the incident location and the time taken to collect and deploy the barriers would have exceeded the incident duration. Despite the positive feedback from the operatives the report suggests a reason for their non-use was - quote - "There is a possibility that operatives prefer to attend and continually man a traditional closure than to attend to other incident management duties. At the grass roots level, it is perhaps more attractive for operatives to stay in heated vehicle cabs than to explore their best option to exit those cabs and attend to incidents, particularly where no financial incentives exist to do so". This is inappropriate and unfounded.

The report concludes that unless there is a contractual incentive for the provider to make use of the barricades equipment during unplanned incidents no further investment in equipment of this nature is recommended.

It is our feeling that the report conclusion is not viable or possible under the Asset Support Contracts (ASC). The utilisation of the barricades would potentially be a saving to the TOS and SP whilst also reducing the clearance time for the incident if the resource normally required to attend the closure assisted at the incident site or released for other duties.

## 4 Research

### 4.1 Emergency Closure Systems Worldwide

The research undertaken in the previous study has been reviewed and additional investigations undertaken on the internet to identify emergency closure systems which are in operation both within in the UK and other countries. There were a number of unusual ideas and methods which had been discarded on the basis of health and safety; unknown procurement and delivery. These were reconsidered and discounted for the same reasons. These included:

- The sprinkler – provide a wall of water similar to the Soft Stop system
- Roll of Plastic –temporary plastic fencing which can be rolled out but has handling and fixing issues
- Road Spikes – similar to the Police ‘stinger’ which could cause accident and potential insurance claim issues
- Inflatable Barrier – used extensively on speedway tracks but there could be health and safety issues with respect to inflation and would not allow emergency access
- Wire rope barrier – used in North America for security installations and it was considered there would be procurement issues and would not allow emergency access

On UK highways there are primarily only three methods which are in operation on the Strategic Road Network:

- Signs and coning to Chapter 8 of the Traffic Signs Manual (Plan SRC2)
- Snow Gates (Manual Horizontal Swing Gates) - present on 5no. routes in Scotland together with the A66 (Cumbria/Durham) and A628 Woodhead Pass in England.
- Plastic safety barriers – utilised on the M40 DBFO / Area 8

These together with other systems currently being used in the UK and internationally are summarised in Table 1 and detailed in Appendix A. In general there is little difference in the systems used in the UK or worldwide.

**Table 1: Closure Systems**

Closure Practise	UK	Europe	United States	Australia
Temporary Signs and coning (Man and Van)	✓	✓	✓	✓
Manual Horizontal Swing Gate	✓	✓	✓	✓
Manual Vertical Rising Gate	✓	✓	✓	✓
Automatic Horizontal Sliding Gate	✓	✓	✓	✓
Automatic Vertical Rising Gate	✓	✓	✓	✓
Variable Message Signing (Smart Motorway)	✓	✓	✓	✓
Portable Plastic Barriers	✓	✓	✓	✓
BarrierGuard wheeled	✓	X	✓	X
Automatic Rising kerb (Road Blocker)	✓	✓	✓	✓
Retractable ( Rising) Bollards	✓	✓	✓	✓

Closure Practise				UK	Europe	United States	Australia
Water Filled Barriers				✓	✓	✓	✓
Intellicone				✓	X	X	X
Trellis Barrier				✓	✓	✓	✓
Softstop system				X	X	X	✓
In Use	✓	Not in Use	X				

## 4.2 Traffic Officer Survey

As identified in section 3.1 the AMOR now defines the outcomes that the SP must achieve based on a risk based approach and this has resulted in the potential for delay in providing support to the TOS with respect to the implementation of Emergency Traffic Management (ETM) or Temporary Traffic Management (TTM). Although the AMOR still defines that there should still be the provision of ETM or TTM upon request, the SP is now required to consider risk when determining what immediate steps should be undertaken by them on notification of an incident, including whether they should attend. This may result in other actions being taken before an enhanced closure of the slip road will be established. It was therefore recognised that in order to remove this delay for the implementation of slip road closures in a more 'permanent' arrangement may lay with the TOS.

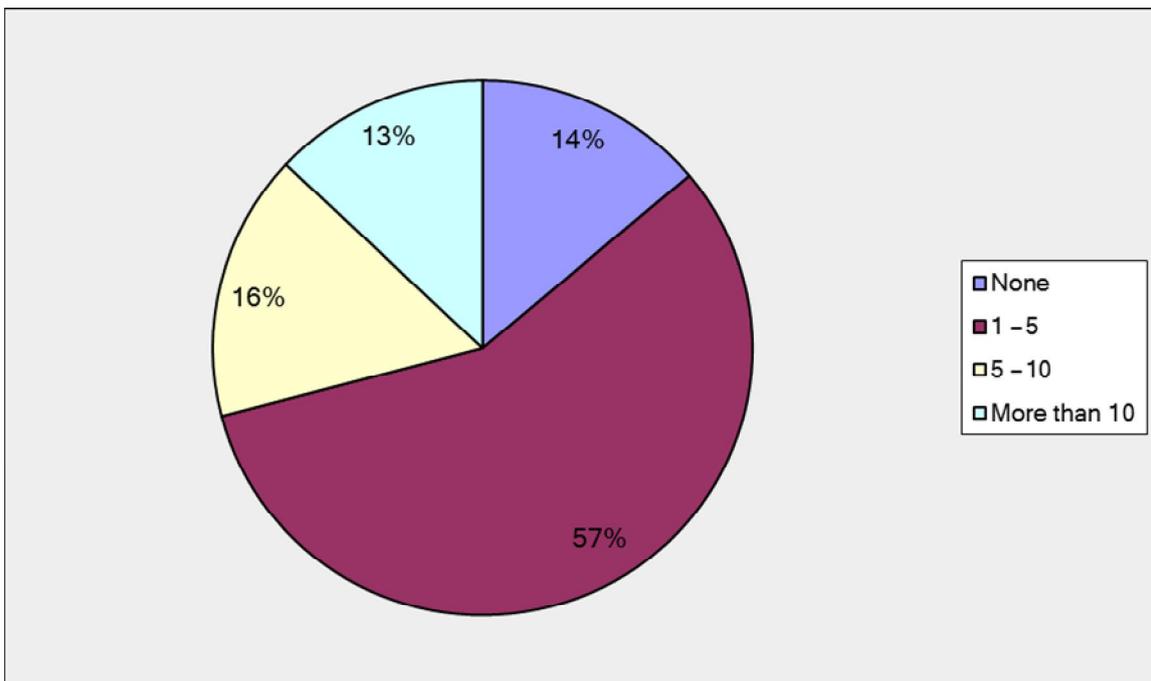
It was identified that the opinions of Traffic Officers (TO) should be sought to determine the current situation and their thoughts in providing some form of more 'permanent' arrangement. The agreed method of achieving the opinion was by an online survey that would be available to TOs. This was achieved by developing a survey on SurveyMonkey®.

Following consultation with the HA Project Manager it was established that other tasks were considering a similar approach and it was agreed that in order to prevent overburdening the TOs a combined survey would be the better method. This was led by this task and the online survey was developed on SurveyMonkey®. It was agreed to keep the questions concise and generally a multiple choice format.

There were 256 responses to the survey which represents approximately 15% of the TOS. Response details are given below:

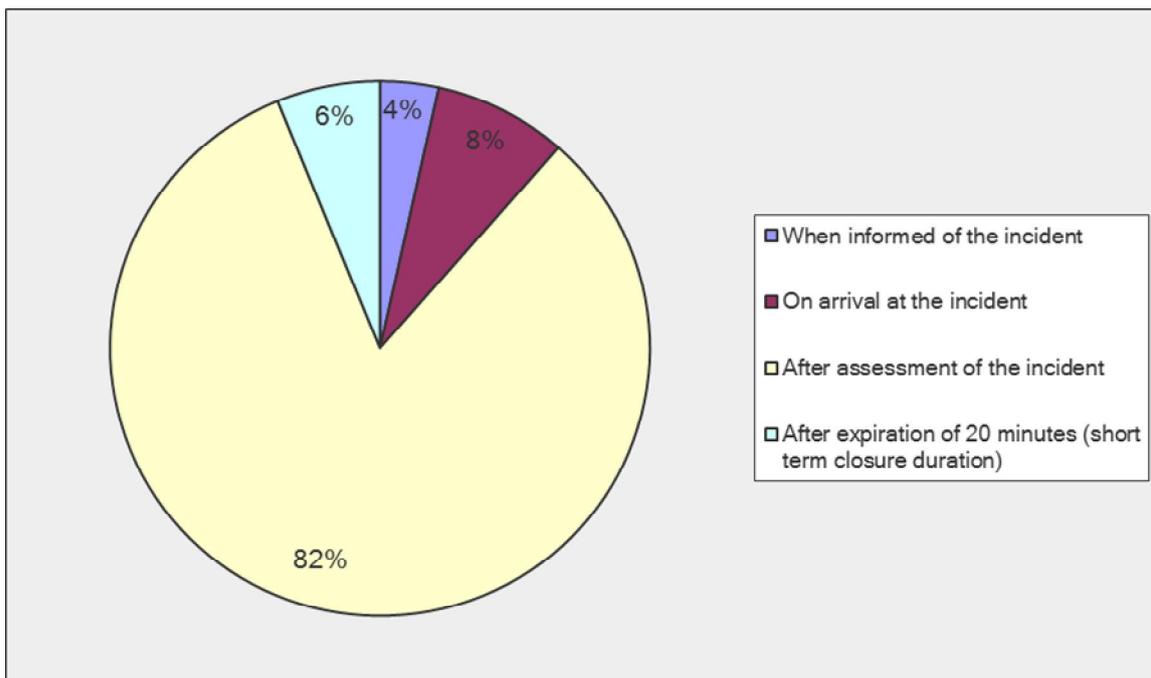
**Question 1:**

During the last six months as incident lead, how often have you provided closures, excluding short term emergency closures and NO assistance have been provided by the Area Service Provider?



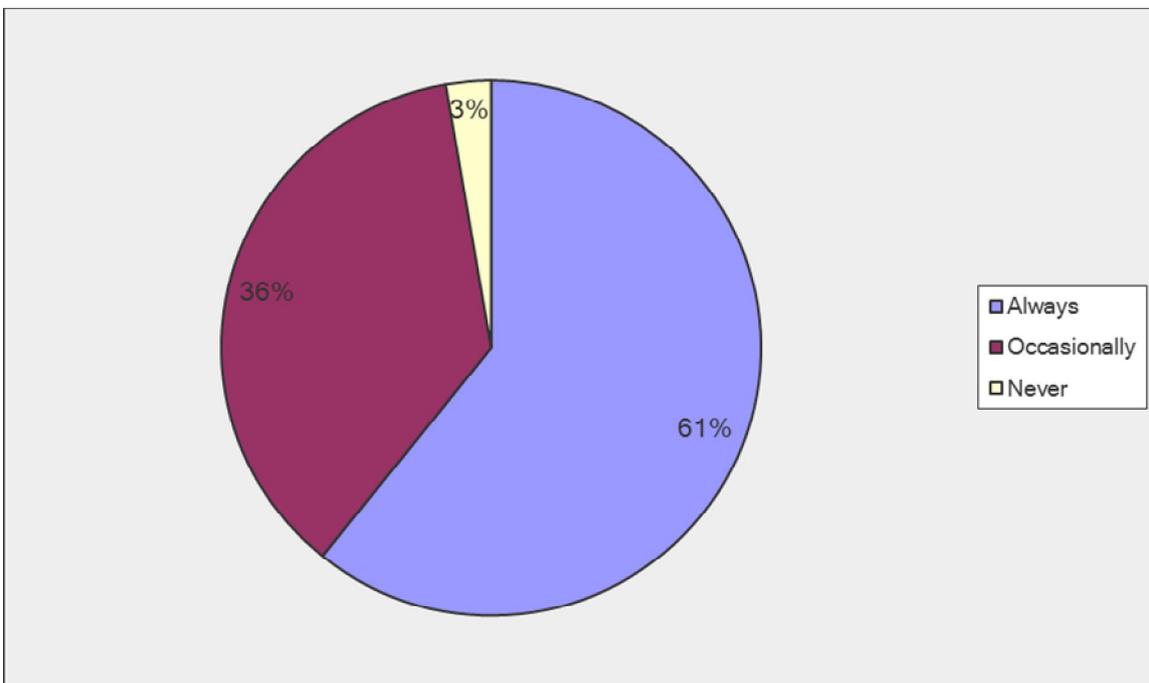
**Question 2:**

At what point during an incident do you request assistance from the Area Service Provider?



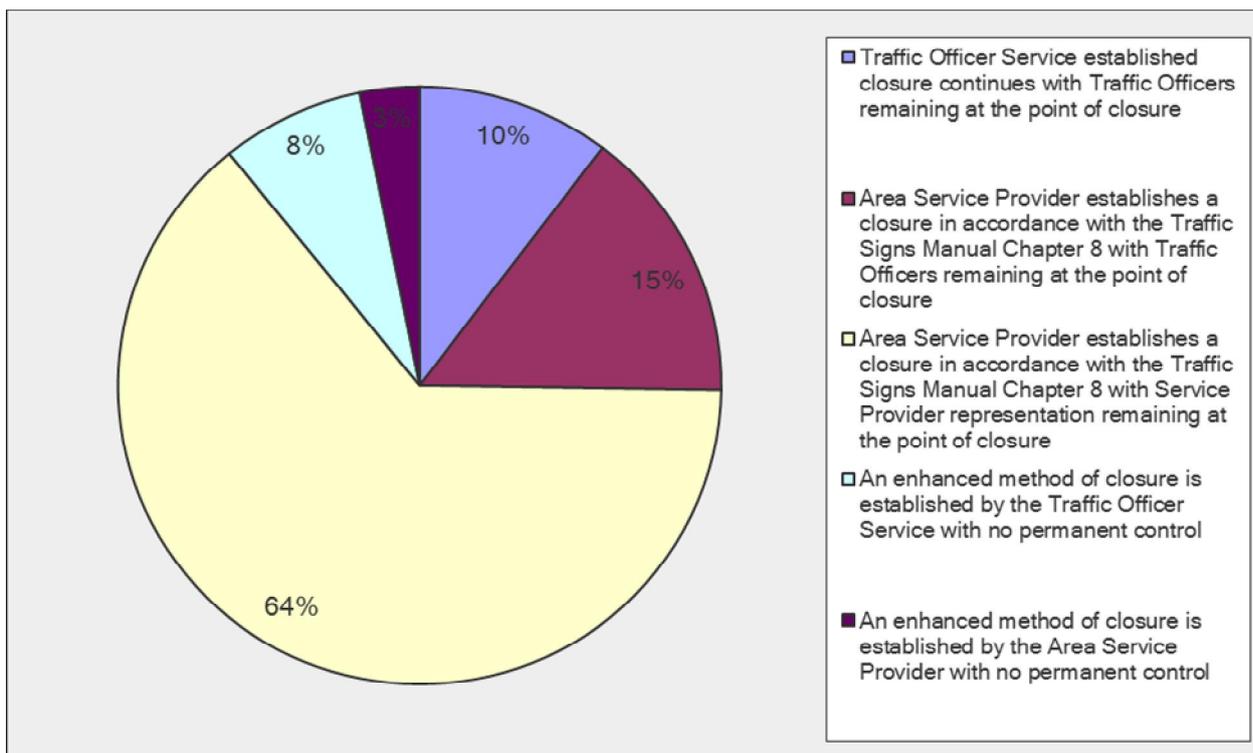
**Question 3:**

Do you normally remain at the point of the closure?



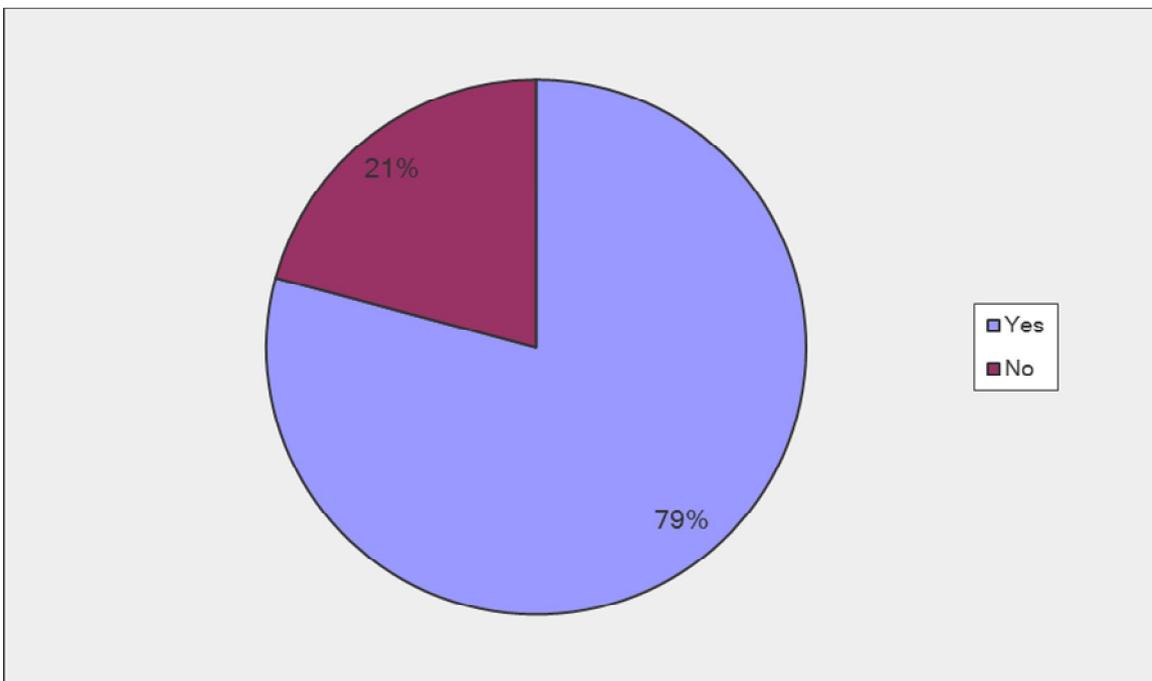
**Question 4:**

If the closure has been identified as being required for an extended period of time (in excess of 90 minutes) which in your opinion/experience is the preferred method?

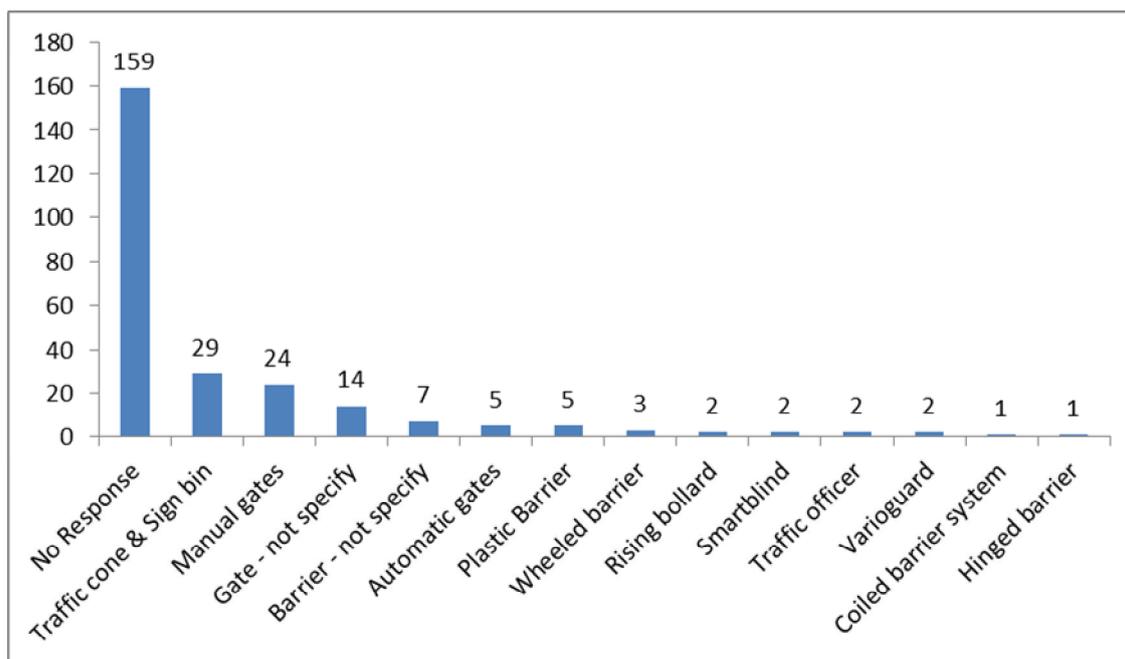


**Question 5:**

Should there be a permanent closure provision at slip roads? If yes, please state how in your opinion this can be achieved.

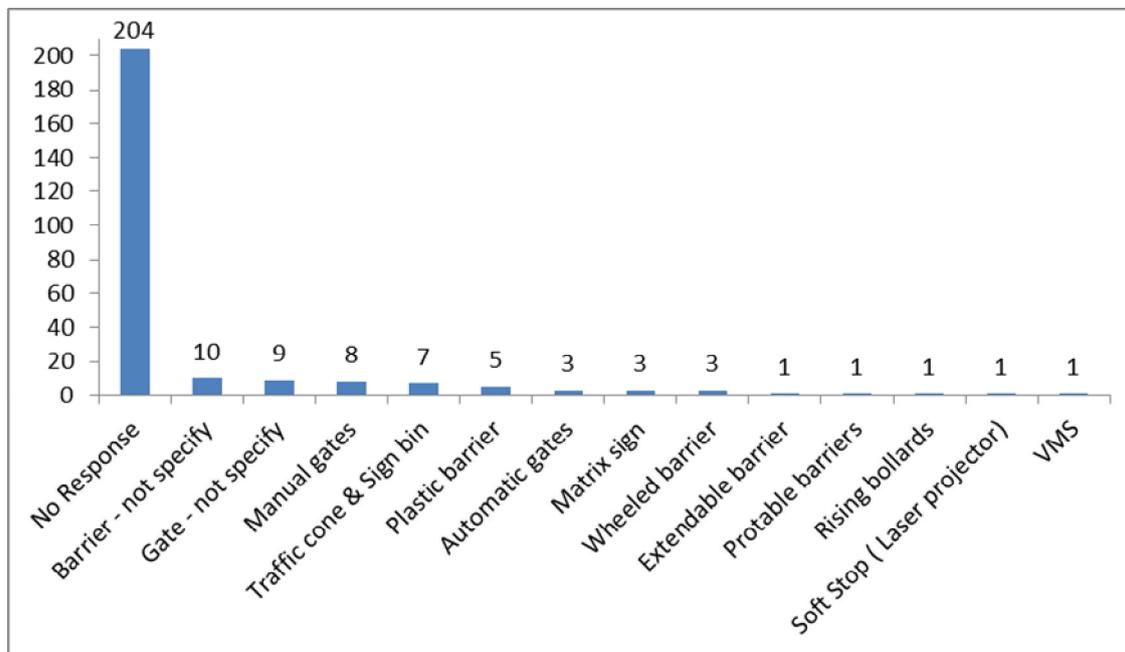


**Opinion Response**



**Question 6:**

Do you have any suggestions on any other system of closure which could be utilised?



Note: the responses have been reviewed and condensed to key suggestions for statistical purposes.

**4.3 Emergency Services**

The emergency services are concerned that unattended closures pose a delay in attending the incident. The use of manually operated system or automatically operated system will require a member of the attending team to operate the system for opening and closing thus causing a delay. Additional training will also be required to operate the system. This can only be prevented if the automatic system is operated remotely and advance notification is given to the operator or the closure is viewed by CCTV.

Consultation will be required with Emergency Service and TOS to determine a working protocol and procedure.

## 5 System Evaluation

### 5.1 Initial Evaluation

The systems identified in section 4.1, Table 1 were initially considered in terms of the basic requirements of the task:

- Closure impenetrable to customers when unattended by TOS/SP/Police
- Speed of deployment
- Easy access for authorised users

This resulted in six of the systems being discounted. These are detailed below:

**Table 2: Initial Evaluation Rejections**

System	Reason for discard
Temporary Signs and coning (Man and Van)	Existing Practice – requires TO or SP team to be present
Variable Message Signing (Smart Motorway)	Does not provide a physical barrier
Automatic Rising kerb (Road Blocker)	Access to authorised users will be difficult, extensive maintenance requirements which may affect reliability and time consuming exercise
Retractable ( Rising) Bollards	Access to authorised users will be difficult, extensive maintenance requirements which may affect reliability and time consuming exercise
Water Filled Barriers	Deployment issues and no access to authorised users
Intellicone	Same as coning and will not provide a deterrent

### 5.2 Secondary Evaluation

In order to undertake a satisfactory evaluation of the remaining systems it was necessary to consider the attributes of each system in more detail. The attributes of each system is included in Appendix B. To consider the systems against the key objectives given in section 2.1, the objectives can be represented by dividing each into a number of elements. Each element has been further sub-divided into specific criteria to be considered and a scoring matrix utilised. The elements and criteria identified are detailed below and the scoring matrix and evaluation is included in Appendix C:

- Ease of Procurement

Although the system may be common for a particular use, the supply of the equipment may not be easily available on a large scale. This should be considered as to whether this is preventative to going forward with a particular system or if this can be overcome by having more than one unique type.

#### ■ Cost

The overall cost requires considering as the initial supply cost may be high and thought a constraint; a low maintenance cost may offset this. The cost evaluation has been split into four aspects:

- System Cost
- Installation cost
- System Maintenance cost
- Decommissioning (removal from site)

#### ■ Operation

An important element in determining the system to be adopted is its actual operation. The speed in which a closure can be established; provide the prevention of access for customers whilst still allowing emergency service to access are paramount. This has been split into six aspects:

- Ease of Deployment
- Prevent Customer Access
- Authorised User Access
- Operating Mechanism
- Serviceability
- Driver Recognition

#### ■ Infrastructure

The ease with which a system can be installed into the network has a reflection on the choice. The additional infrastructure required to provide the system can be a determining factor. Six aspects have been identified:

- Ease of Installation
- Power supply
- Other services
- Communication Links
- CCTV
- Additional signing

#### ■ Security

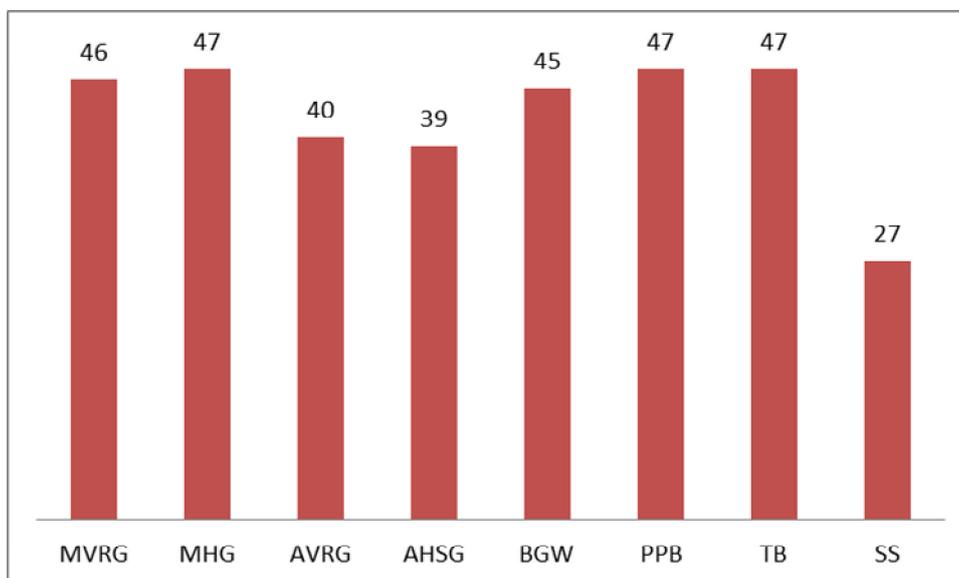
Once the system has been established it is necessary to determine how exposed the system is to abuse both when in operation and when not. Two aspects have been identified:

- Effectiveness of system
- Susceptibility to vandalism

#### ■ Current Use

Although the system is in use it may not be for this particular use or is suitable.

Following the second evaluation, the total scores for each are as follows:



**Figure 1:** Second System Evaluation

Therefore a further four systems were rejected and are detailed in Table 3.

**Table 3: Second Evaluation Rejections**

System	Reason for discard
Automatic Vertical Rising Gate	<ol style="list-style-type: none"> <li>1 Cost – initial cost for the purchase of the system and the required provision of additional infrastructure – power supply / CCTV / access system.</li> <li>2 Operation – Remote operation will require visual monitoring when activating and removing closure (CCTV). Supply of a access system (key code or swipe card) may lead to emergency service delay or abuse. Extensive maintenance requirements which may affect reliability.</li> </ol>
Automatic Horizontal Sliding Gate	<ol style="list-style-type: none"> <li>1 Cost – Initial cost for the purchase of the system and the required provision of additional infrastructure – power supply / CCTV / access system.</li> <li>2 Operation – Remote operation will require visual monitoring when activating and removing closure (CCTV). Supply of an access system (key code or swipe card) may lead to emergency service delay or abuse. Extensive maintenance requirements which may affect reliability</li> <li>3 Infrastructure – Availability of space</li> </ol>

System	Reason for discard
Softstop	1 Procurement/Cost – The system is quite unique and will be difficult to procure. The cost of providing / maintaining the system is prohibitive.  2 Infrastructure - A water supply will be necessary and this is not readily available at all slip road locations
BarrierGuard wheeled	1 Operation / Infrastructure – The minimum length of a unit (6m) necessitates either the transportation of the barriers from a stored location or retained in a storage unit at the slip road. The site constraints will prevent the provision of a storage unit.

The remaining practices to be taken forward for consideration are:

Closure System	
Manual Horizontal Swing Gate	Manual Vertical Rising Gate
Portable Plastic Barriers	Trellis Barrier

## 6 Data Analysis

In order to determine the requirement for a closure system the current situation regarding the number of closures that have been established and the duration of the closures is important. The data below has been provided by the Traffic Management Directorate Strategic Development Team.

A twelve month period (1<sup>st</sup> March 2013 – 28<sup>th</sup> February 2014) was used for the analysis and the data provided included all slip road closures as identified on the Regional Control Centre Command and Control System. The data included:

- Incident Date
- Location
- Incident Duration
- Lane impact duration
- Reason for closure

Incidents which indicated the location as 'J' or 'L' slip roads were discounted as these are exit slip roads.

The actual duration of an incident was difficult to ascertain, therefore for ease of calculation the total duration period of the incident has been used as the period of slip road closure. However there were incidents with unusually long periods (i.e. extending into weeks) and for these incidents the lane impact duration was used.

The study was specifically for emergency closures, however for comparison of potential use the total number of closures was ascertained for emergency works and all closure (i.e. including planned closures). This was because in most cases the system will be utilised for planned works.

Number of Emergency Closures	985
Total number of all closures	6001
Average Duration of an emergency closure	4.5hrs
Average Duration of all closures	6.8hrs

## 7 Cost Analysis

In order to consider the cost analysis, two assessments need to be considered:

- The anticipated time period it will take to recover the initial cost of each system based on the current method costs as a baseline.
- A Cost Benefit Analysis (COBA) assessment of the potential savings

The calculations have been completed for an individual closure.

A number of assumptions are required to develop the above

### 7.1 Assumptions

Assumption made to provide an analysis:

- Baseline condition – Man + van scenario (2 TOs/SP Operatives +vehicle, temporary cones/signs and permanent attendance)
- Market research has been used to identify the capital expenditure for equipment required for one slip road closure. This includes the initial supply of equipment, installation costs, maintenance costs and demobilisation costs. In respect to temporary closure equipment a cost has been included for the provision of a storage unit at the slip road.
- In order to keep consistency in operator costs, all closure will be established and removed by the SP.
- Number of entry slip roads nationally (Motorways only used for ease) = **748**
- The average duration of a closure is **4.5** (Emergency) / **6.8 hours** (planned) (see section 6)
- The number of closures per annum = **985 / 6001** (see section 6)
- Average number of closures per slip road per annum

Emergency only                       $985 / 748 = 1.3$

Emergency and planned       $6001 / 748 = 8.0$  (This figure appear high but reflects the national average)

### 7.2 Calculations

- Baseline Condition – 1 hour closure.

1hr Closure

2 Operatives + vehicle (per hour)	£50
Slip Road Closure materials (cones/signs) <sup>1</sup>	£20
<b>Total</b>	<b>£70</b>

The cost for each additional hour of closure will increase only by the operatives and vehicle costs.

<sup>1</sup> Costs are based on the use of existing cones/signs and are estimated on the refurbishment of cones

- Capital Expenditure for systems

### Manual Horizontal Swing Gate

System Cost	£950
Installation Cost	£790
Decommission Cost	£500
<b>Total system cost</b>	<b>£2240</b>
Annual Maintenance Cost	£500

### Manual Vertical Rising Gate

System Cost	£1000
Installation Cost	£790
Decommission Cost	£500
<b>Total system cost</b>	<b>£2290</b>
Annual Maintenance Cost	£500

### Portable Plastic Barrier

System Cost (4no. units + signs)	£600
Installation Cost	0
Decommission Cost	0
Storage Unit (unit + hardstanding)	£100
<b>Total system cost</b>	<b>£700</b>
Annual Maintenance Cost <sup>2</sup>	£300

### Trellis Barrier

System Cost (2no. units + signs)	£900
Installation Cost	0
Decommission Cost	0
Storage Unit (unit + hardstanding)	£100
<b>Total system cost</b>	<b>£1000</b>
Annual Maintenance Cost <sup>2</sup>	£450

---

<sup>2</sup> Annual Maintenance is assumed to be a complete replacement/upgrade every 2 years

■ Appraisal of Non-Monetised Benefits

All the above options will discharge TOS resources from remaining at the closure allowing them to either undertake duties relating to the incident or continue with day-to-day functions. The undertaking of incident related duties may allow the incident to be cleared quicker and therefore provide an increase in Journey Time Reliability. It is difficult to include a monetary value on this benefit and has therefore not been included in the calculations but should be noted.

■ Recovery of Total System Costs (based on the assumptions in section 7.1)

● Base Calculations

1. Number of closure required to cover Total System Cost (**A**)  
 = Total Cost of system / (Baseline cost x average duration)
2. Anticipated duration to recover cost (years)  
 = **A** / Average number of closures per slip road per annum

Calc.	Manual Horizontal Swing Gate	Manual Vertical Rising Gate	Portable Plastic Barrier	Trellis Barrier
1 Emergency	9.14	9.35	2.86	4.08
1 All	6.22	6.36	1.94	2.78
2 Emergency	7.03	7.19	2.20	3.14
2 All	0.78	0.80	0.24	0.35

These calculation are based on the assumption that a presence is retained at all closures

The table above suggests that if a permanent system was installed and used for **all** closures, based on the average number of closures in a year and each of average duration, the cost would be recovered at each slip road within one year. If the system was to be used only for emergency situations this would increase to between 7.03 and 7.19 years. There is little difference between the permanent system types

It should be noted that in some locations these may be reduced or significantly increased, therefore a consideration to usage should be deliberated system type.

## 8 Conclusion

The objective of the study was to identify a system which provides a physical barrier to prevent access to the SRN by customers during an incident that does not need to be permanently attended but remains accessible by authorised users.

A survey completed by the TOS confirmed that the majority (86%) have provided a slip road closure within the last six months and generally always remain at the closure (61%) in addition to those that occasionally stayed at the closure (36%). The consensus of opinion was there should be a permanent closure provision at slip roads (79%).

Nineteen potential systems were initially identified but five were immediately discarded as being not viable to consider for evaluation. The remaining fourteen practices were taken through two stages of evaluation.

The initial evaluation, which was impenetrability, speed of deployment and access to authorised users, discarded six systems and the second evaluation, which was ease of procurement, cost, operation, infrastructure, security and current use, a further four. Those rejected by the latter evaluation included the automatic operated systems which were discounted on cost and the provision of extensive technology. These systems could be reconsidered if the systems were included as part of the Smart Motorway implementation.

The remaining four systems are all viable and meet the majority of the key objectives although all fail to some extent with allowing easy access to authorised users and are therefore may not be acceptable to all. However, if the incident is extensive and numerous emergency responders (e.g several ambulances) are required, the closure can be identified as the Rendezvous point (RVP) and controlled access provided. The topography and current infrastructure at each slip road will also impact on the suitability of the system and therefore one system will not be suitable for all locations.

All systems have positives and negatives which have been considered to inform the final recommendation.

System	Positive	Negative
Manual Horizontal Swing Gate	<ul style="list-style-type: none"> <li>■ Robust barrier</li> <li>■ Adverse weather resistant</li> <li>■ Quick and ease of deployment/removal</li> <li>■ Easy maintenance</li> <li>■ No services required</li> <li>■ Familiar system</li> </ul>	<ul style="list-style-type: none"> <li>■ Initial system cost</li> <li>■ Procurement – manufacturing delay</li> <li>■ Requires a locking system to prevent vandalism</li> <li>■ No immediate access for emergency responders (self-entry required)</li> <li>■ Slip road gradient could be an issue</li> </ul>
Manual Vertical Rising Gate	<ul style="list-style-type: none"> <li>■ Robust barrier</li> <li>■ Quick and ease of deployment/removal</li> <li>■ Easy maintenance</li> <li>■ No service required</li> <li>■ Familiar system</li> </ul>	<ul style="list-style-type: none"> <li>■ Initial system cost</li> <li>■ Procurement – manufacturing delay</li> <li>■ Requires a locking system to prevent vandalism</li> <li>■ Potential for high wind damage when not in use</li> <li>■ No immediate access for emergency responders (self-entry required)</li> </ul>

System	Positive	Negative
Portable Plastic Barriers	<ul style="list-style-type: none"> <li>■ Initial cost</li> <li>■ Readily available</li> <li>■ Low maintenance (units replaced)</li> <li>■ No services required</li> <li>■ Familiar system</li> </ul>	<ul style="list-style-type: none"> <li>■ Slow deployment (removal from storage)</li> <li>■ More readily damaged</li> <li>■ No immediate access for emergency responders (self-entry required – longer than above gates)</li> <li>■ Susceptible to adverse weather when established (wind)</li> <li>■ Manual handling issues</li> </ul>
Trellis Barriers	<ul style="list-style-type: none"> <li>■ Initial cost</li> <li>■ Readily available</li> <li>■ Low maintenance (units replaced)</li> <li>■ No services required</li> <li>Familiar system</li> </ul>	<ul style="list-style-type: none"> <li>■ Slow deployment (removal from storage)</li> <li>■ More readily damaged</li> <li>■ No immediate access for emergency responders (self-entry required – longer than above gates)</li> <li>■ Susceptible to adverse weather when established (wind)</li> </ul> <p>Manual handling issues</p>

The siting of the barriers on the slip road will be dependent on the actual site conditions. Ideally, the system should be placed as near to the start of the slip road as possible therefore alerting drivers not to attempt to access the slip road. However, this may cause issues with the authorised users who may be required to stop on interchange roundabouts which could be high speed and therefore raise safety concerns. A safe haven could be created by placing a row of traffic cones at the end of the slip road and setting the barrier further down the slip road.

The cost analysis indicates that the temporary systems are initially identified as the more cost effective, in that they have the lower number of closures and duration period required to recover the initial costs against the cost of the baseline condition. The difference between the temporary and permanent systems is between two and threefold. However if the systems are to be used for all closures types (emergency and planned), although the difference is maintained, the duration periods are less than one year. Therefore taking into consideration speed of deployment, damage potential and ease of access for emergency responders, the permanent systems are the preferred options (see recommendations). It should be noted that the calculations are based on national figures and therefore the duration period will vary between locations. Consideration will be necessary to determine whether a national condition should be directed or the preferred system for each location will be dictated by historical closure data and topographical features.



---

## 9 Recommendations

There are potentially four systems which comply with the majority of the key deliverables and should be considered.

Although each system has positive and negative attributes, a more permanent installed system would provide a more robust and durable system. Therefore the manual horizontal swing system is the preferred system being the highest scoring in the evaluation and also the most cost beneficial..

However it is recognised that not all slip road locations will be able to accommodate a sole design, therefore it may be more desirable to consider detailing specific criteria in order to determine the preferred option. This may identify that the vertical rising gate may be more suitable.

Therefore the following recommendations are made in order to take the project further:

- Identify the available funding to undertake a trial of the preferred option
- Determine the required conditions in order to determine the preferred option for each slip road
- Consultation with the Emergency Services to determine a protocol for the operating of the barriers for access
- Consider the provision of remote activated barriers on future Smart Motorway schemes

## Appendices

## Appendix A: Research

### A.1 United Kingdom

On the UK network, the most common method slip road closures are by the establishment of a line of cones and temporary traffic signs as detailed in Chapter 8 of the Traffic Signs Manual (Plan SRC2) however other systems are in operation. Some of which were identified in the previous study ('Emergency Closure of the Network' 2008)

These include the following:

#### 6 Snow Gates (Manual Horizontal Swing Gates)

Two examples operating in England are on the A66 Cumbria/Durham Trans Pennine route and the A628 Woodhead Pass in Derbyshire. On each route two gates are provided at a two locations to prevent access to areas susceptible to extreme weather. An example of a gate on the A66 is provided in Figure 1. The gates on the A628 are of a similar construction

The A628 gates are of a similar construction as the A66 gates but rather than permanent sign plates these have been replaced by flap signs.



Figure 2: A66 Main Carriageway

The A66 also has gates on the eastbound entry slip road at Brough, these are of similar construction to the main carriageway gates (see Figure 2)

The snow gates on the A628 are of a similar construction to those on the A66 from square hollow section galvanised steel with anti-tamper hinges and padlockable. In contrast to the A66 gates the attached signs are flappable and there are no lamps. However lamps are attached when in operation (Figure 3).



**Figure 3:** A66 Slip Road



**Figure 4:** A628 Woodhead Pass

## 7 Plastic Safety Barriers

These are currently being used in Area 8 and on the M40 DBFO but only for planned works but have never been used of emergency works. They provide a physical barrier to prevent vehicles using the slip roads. Each barrier section is 2000 length x 1000mm high

The barriers have been found to be easily transportable and can be simply assembled by two operatives within 3 minutes. The simplicity of assembling the barrier system also provided a quick means of access for vehicles by simply opening the end section of the barrier as a gate.

The barriers are also highly reflective and the addition of red warning lights which communicate to a driver to 'STOP' appears to give further warning / deterrent. Additional temporary signing can be erected in front of the barrier.

The use of these barriers in Area 8 rejects the findings of the Area 10 trial and demonstrates that their use is feasible.



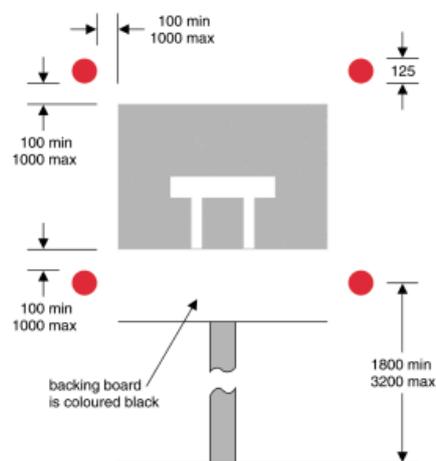
Figure 5: M40 DBFO Plastic Barriers

**8 Smart Motorway signing – Entry Slip Signals**

Although the signals do not provide a physical barrier preventing access, they are able to display light signals as prescribed by Regulation 38 of the Traffic Signs Regulations and General Directions 2002 (TSRGD).

The sign layout (right) indicates Regulation 38 and these signs could be enforced by legislation and drivers prosecuted for disregarding the sign.

Consideration could be given to the changing of the signing to Diagram 6031.1 (Red 'X') which is currently used on gantries and prohibit vehicles using the lane immediately below the signal. This would provide a more obvious visual deterrent.



6032.1  
Light signals conveying the requirement prescribed in regulation 38(a)

Item	
1	Regulations: 10(1), 10(2), 37, 38
2	Directions: 46, 50, 51, 52, 56
3	Diagrams: None
4	Permitted variants: The diagram 6008.1 symbol may be varied to the symbol shown in diagram 6006.2 or 6009.3 An identification number may be added to the backing board or post in horizontal or vertical format as appropriate

Figure 6: TSRGD extract

## 9 Automatic Vertical Rising Barriers

Used extensively at automated rail crossings to prevent vehicles crossing the track. These are used in conjunction with red warning lights and in some case CCTV.



**Figure 7:** Automatic Rail Crossing

Similar type systems are also utilised to prevent access to industrial or commercial units which can also be operated remotely and also can allow access by means of a keypad or swipe card system. In both automatic systems signage can be fixed to the barrier arms.



**Figure 8:** Automatic Vertical Rising Barrier

Other methods for preventing access have been identified in operation in the UK but not specifically for the closure of public roads. These include the following:

## 10 Automatic Horizontal Sliding Gate

Generally used to prevent access to commercial sites. There are two types of system; one utilises a ground track laid across the opening for the gates wheels to run in and secondly a cantilever sliding

gate. The cantilever system has the gate suspended on a relatively short cantilever system involving wheels set in a channel. The entire gate pivots on the cantilever wheels and operates by running back and forth on these wheels.



**Figure 9:** Automatic Horizontal Tracked Sliding Gate



**Figure 10:** Automatic Horizontal Cantilever Sliding Gate

## 11 BarrierGuard Wheeled

A lightweight barrier system that is both moveable and manoeuvrable. Individual sections are available in 6m length and have two wheel sets, each with two castors allowing stable movement and can be moved by two operatives without the need for lifting equipment. The barriers can be delivered by small vehicles from which they need to be offloaded or they can be stored on site in a purpose built secure storage building. The increase time taken to load the barriers and transport to site would be a negative influence.

Although this barrier is currently used as a means of providing protection to vulnerable structures (A14, Barrow Health and Area 13 scaffolding protection) or work areas, there is potential for other uses.



**Figure 11:** BarrierGuard Wheeled

## 12 Automatic Rising Kerb (Road Blocker)

Most commonly used in commercial and industrial parking units, although these were employed to prevent illegal access and exit from the A1(M) at Sprotbrough Depot, Doncaster (Area 12).

Generally the rising kerb is operated on site at a control cabinet with Programmable Logic Controller (PLC) controls. The barriers are to PAS 68 standard and will withstand any road vehicle. The kerb stands 1165mm high when deployed and fits flush into a non-reinforced concrete pit.

It will be necessary to install warning signs and lights in advance of the rising kerb



**Figure 12:** Automatic Rising Kerb

### 13 Retractable Bollards

A more aesthetic system than the rising kerb, but just effective is the rising bollards. These are hydraulic stainless steel bollards which can be raised or lowered and the raised height varies between 500mm and 1000mm currently used to prevent access to private roads, car parking areas and other private areas. LED lighting around its top enhances its presence. The bollards can be operated by key or remote method.



**Figure 13:** Retractable Bollard

### 14 Water Filled Barriers

Plastic barriers that are light weight in construction and can be easily moved by two men to lift and stack. The blocks are interlocking and when in position can be filled with water to provide ballast and give a solid and substantial barrier.

Lamps can be attached to provide additional prominence.

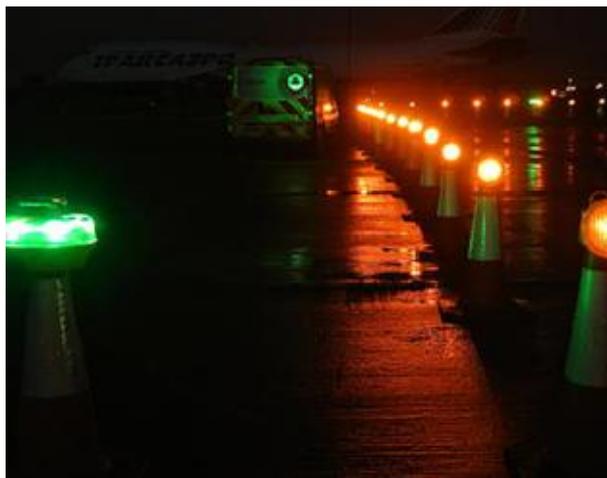


**Figure 14:** Water Filled Barrier

**15 Intellicone**

Intellicone consists of a sensor mounted on a cone which detects a combination of impact and orientation to identify a vehicle strike or malicious removal. An audiovisual alarm can be sent to a portable site alarm and/or message to a control room.

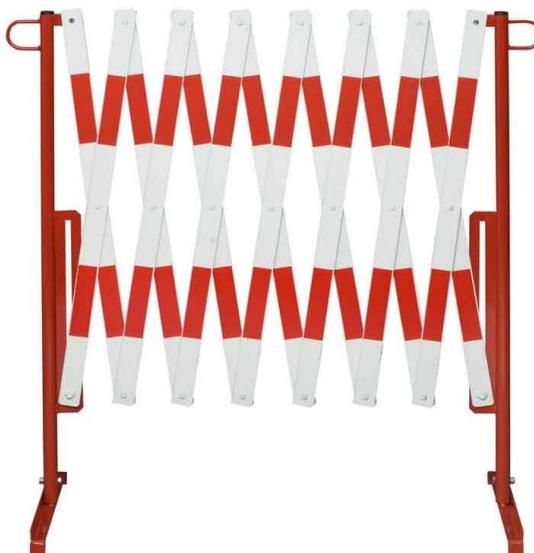
This system to be used in conjunction with Chapter 8 coning and the closure is left unattended.



**Figure 15:** Intellicone

**16 Extending Trellis Barrier**

Used primarily for the protecting excavations and preventing access to areas. The barriers fold and can be carried by one operative and extended out. A unit can be extended to 4m and 1m high. In order to close a slip road this will necessitate 2no. units. Temporary signing will also need to be provided in front of the barriers



**Figure 16:** Heavy Duty Trellis Barrier

## A.2 Europe

European countries only utilise emergency closures of their networks at critical points, typically these are at severe weather locations and are safety critical. These are primarily mountain passes, exposed locations, bridges and tunnels. The equipment being employed is generally the same as used in the UK to a greater or lesser extent. Although the equipment may be varied in design, it should be considered best practice as it allows for foreign drivers when presented with situations, they can be expected to be familiar with the familiar designs to their own countries.

These are usually in the form of:

**Permanent warning signs:** Either variable message signs or static signs and fitted with flashing warning signs which can be activated.

**Gates/barriers:** generally manually operated and fitted with at least one sign which is typically a Vienna Convention 'No entry' roundel (C1 from the convention, UK equivalent Diagram 616) and lamps (flashing or steady-burn) combined with reflective stripping to enhance its presence at night and in extreme conditions. Although these are commonly used there does not appear to be one common design or layout for these features.

**Conventional portable signs and delineation devices:** Typically roadworks signs deployed alongside a variation of cones and vertical or horizontal reflective panels of varying sizes and design. There appears little consistency between countries with respect to design of equipment, however the locality in which they are situated and the combination of equipment reduces any potential comprehension difficulties for foreign drivers.

### 17 Netherlands

Vertically operated barrier arms are usually used in the Netherlands. These can be operated manually or remotely and protected by a barrier. In some locations these are supported by a basic variable message sign.



**Figure 17:** Barrier Arm in the Netherlands

**18 Sweden**

Vertically operated barrier are used in Sweden for Road closures. It should be noted that the safety barrier arm has a large red/white board attached with flashing lamps. This allows the barrier to be more visible to approaching traffic at a greater distance.



**Figure 18:** Barrier Arm in Sweden

**19 France**

Vertically operated are typically used in France to close slip roads and tunnels. A no entry sign plate and flashing amber lights are attached to the barrier arm. Additional warning lights are positioned on the nearside verge.



**Figure 19:** Barrier Arm in France

**20 Germany**

Temporary vertical panels fixed to rubber bases are placed across the slip road to close the road. These panels are used in Germany in lieu of cones and may have lamps attached



**Figure 20:** Vertical panels in Germany

### A.3 United States

Emergency ramp (slip road) closures are implemented in the US for a number of reasons, Construction works, emergencies (accidents or weather related) and planned special occasions. They can also be established at various times of the day to help facilitate main flow to alleviate congestion. The Individual States employ similar methods of closure.

In Wisconsin, the Department of Transport are currently installing ramp gates at interstate interchanges. The ramp gates utilise a mechanical gate arm that is lowered into position to provide a physical barrier (Figure 20). The gates allow law enforcement agencies to restrict access safely and efficiently. This also reduces the need for other responders to provide traffic control measures at the on-ramp (entry slip road). They are only used for emergencies and planned special events and not construction projects or maintenance. In most cases it is the responsibility of the law enforcement agencies to deploy the ramp gates and flip down the sign adjacent to/upstream of the gate to warn drivers. The signing supports the legal basis for enforce laws relating to obeying traffic control devices (ramp gates). The gates are secured by a padlock with a state-wide combination to ensure speed and consistency. The gates are padlocked when in the down position but the state-wide combination for the lock allows emergency vehicle access. Warning lights are automatically activated when the gate is in the lowered position.

Minnesota Department of Transport operate a gate with a vertical arm with red lights (Figure 21). Static flap signs are located in advance of the gates to notify drivers (Figure 22). The system operates using Intelligent Transport System (ITS) technologies which raises and lowers the gate via wireless communication and secure website. CCTV surveillance provides real-time video. Vertical swing gates are preferred because the horizontal arms can be blocked by snow build-up during extreme conditions or overgrown by grass in summer. Under Minnesota law it is an offence for anyone trying to 'drive over, through or around any barricades and implies a \$700 fine and liable for any costs associated with any necessary rescue.



**Figure 21:** Wisconsin ramp gate with additional panels



**Figure 22:** Minnesota ramp gate



**Figure 23:** Minnesota ramp gate signage

In Virginia, gates are installed on the eastbound ramps along I-64 to aid hurricane evacuation plans. The gates re operated manually and there are two gates at each location to ensure they are completely inaccessible.



**Figure 24:** I-64 gates, Virginia

Nevada is currently going through a programme for the installation of 12no. automated gates along ramp entrances on the I-80 corridor and to update technology on previous installations. Dynamic message and flashing warning signs will be turned on prior to the gates are closed. The gates will be control from the District Office and monitored by CCTV.

#### **A.4 Australia**

At Sydney Harbour Tunnel an innovative method of access prevention called Softstop is in operation. Although the technique does not provide a physical barrier, it does give that impression. A stop sign is projected by laser onto a screen of water suggesting a physical barrier.



**Figure 25:** Softstop, Sydney Harbour Tunnel

## Appendix B System Attributes

### Manual Horizontal Swing Gate

<b>Current Use</b>	<ul style="list-style-type: none"> <li>■ A66 and A628 Snow gates</li> <li>■ Used worldwide</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>■ Easy to procure although one supplier could be an issue therefore could be graded as medium</li> </ul>
<b>Resources to Deploy</b>	<ul style="list-style-type: none"> <li>■ One operative able to deploy</li> <li>■ Additional operative could be used for look-out if heavily trafficked slip road</li> </ul>
<b>Health &amp; safety issues</b>	<ul style="list-style-type: none"> <li>■ Operative training required</li> <li>■ Operatives exposed to live traffic during deployment and re-opening procedure</li> </ul>
<b>Authorised User Access</b>	<ul style="list-style-type: none"> <li>■ Will require member of authorised user attending team to open and close.</li> <li>■ Procedure will be required</li> <li>■ Training of procedure</li> <li>■ Relatively quick access</li> </ul>
<b>Maintenance</b>	<ul style="list-style-type: none"> <li>■ Regular check and possible maintenance of opening mechanism (hinges)</li> <li>■ Locking mechanism required to prevent vandalism</li> </ul>
<b>Visibility</b>	<ul style="list-style-type: none"> <li>■ Appropriate additional sign plate and warning lamps to be incorporated into design of system</li> </ul>
<b>Environmental Impact</b>	<ul style="list-style-type: none"> <li>■ Visible system and therefore possible negative impact to customer</li> </ul>
<b>Layout</b>	<ul style="list-style-type: none"> <li>■ Longitudinal gradient (incline) may be an issue</li> <li>■ Large working space to operate closing / opening of gate (length of gate)</li> <li>■ Robust locking mechanism to deter vandalism and illegal use</li> <li>■ Possible addition of safety barrier to protect from vehicles</li> </ul>

## Manual Vertical Rising Gate

<b>Current Use</b>	<ul style="list-style-type: none"> <li>■ Used worldwide</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>■ Easy to procure although one supplier could be an issue therefore could be graded as medium</li> </ul>
<b>Resources to Deploy</b>	<ul style="list-style-type: none"> <li>■ One operative able to deploy</li> <li>■ Additional operative could be used for look-out if heavily trafficked slip road</li> </ul>
<b>Health &amp; safety issues</b>	<ul style="list-style-type: none"> <li>■ Operative training required</li> </ul>
<b>Authorised User Access</b>	<ul style="list-style-type: none"> <li>■ Will require member of authorised user attending team to open and close.</li> <li>■ Procedure will be required</li> <li>■ Training of procedure</li> <li>■ Relatively quick access</li> </ul>
<b>Maintenance</b>	<ul style="list-style-type: none"> <li>■ Regular check and possible maintenance of opening mechanism (hinges)</li> <li>■ Locking mechanism required to prevent vandalism</li> </ul>
<b>Visibility</b>	<ul style="list-style-type: none"> <li>■ Appropriate additional sign plate and warning lamps to be incorporated into design of system</li> </ul>
<b>Environmental Impact</b>	<ul style="list-style-type: none"> <li>■ Visible system and therefore possible negative impact to customer</li> </ul>
<b>Layout</b>	<ul style="list-style-type: none"> <li>■ Overhead cables could be an issue</li> <li>■ Robust locking mechanism to deter vandalism and illegal use</li> <li>■ Possible addition of safety barrier to protect from vehicles</li> </ul>

## Automatic Horizontal Sliding Gate

<b>Current Use</b>	<ul style="list-style-type: none"> <li>■ Used worldwide for access to commercial and secure units</li> <li>■ Use for access to HA Depots</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>■ The operating system / automation of the sliding gate may make this difficult to procure in number</li> </ul>
<b>Resources to Deploy</b>	<ul style="list-style-type: none"> <li>■ One operative able to deploy if mechanism on site</li> <li>■ Could be operated remotely by RCC Operator</li> <li>■ Additional operative could be used for look-out if heavily trafficked slip road</li> </ul>
<b>Health &amp; safety issues</b>	<ul style="list-style-type: none"> <li>■ Operative training required</li> <li>■ Autostop / opening system may be required</li> </ul>
<b>Authorised User Access</b>	<ul style="list-style-type: none"> <li>■ Will require member of authorised user attending team to open and close (if operated locally).</li> <li>■ Procedure will be required</li> <li>■ Training of procedure</li> <li>■ If operate remotely, procedure for contacting RCC required</li> <li>■ Time taken to access could be an issue</li> </ul>
<b>Maintenance</b>	<ul style="list-style-type: none"> <li>■ Regular check and possible maintenance of opening mechanism and motor</li> <li>■ Possibly susceptible to vandalism</li> </ul>
<b>Visibility</b>	<ul style="list-style-type: none"> <li>■ Appropriate additional sign plate and warning lamps to be incorporated into design of system</li> </ul>
<b>Environmental Impact</b>	<ul style="list-style-type: none"> <li>■ Visible system and therefore possible negative impact to customer</li> </ul>
<b>Layout</b>	<ul style="list-style-type: none"> <li>■ Power supply required</li> <li>■ Robust locking mechanism to deter vandalism and illegal use</li> <li>■ Wide verge required to facilitate sliding mechanism</li> <li>■ CCTV and warning system will be required to advise the customer</li> <li>■ Additional safety barrier required to protect sliding mechanism from errant vehicles</li> <li>■ Secure box required for operating mechanism for on-site operation</li> <li>■ Manual override of the system will be essential</li> </ul>

## Automatic Vertical Rising Gate

<b>Current Use</b>	<ul style="list-style-type: none"> <li>■ Used worldwide for access to Car parks and Business Units</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>■ The operating system / automation of the rising arm may make this difficult to procure in number</li> </ul>
<b>Resources to Deploy</b>	<ul style="list-style-type: none"> <li>■ One operative able to deploy if mechanism on site</li> <li>■ Could be operated remotely by RCC Operator</li> <li>■ Additional operative could be used for look-out if heavily trafficked slip road</li> </ul>
<b>Health &amp; safety issues</b>	<ul style="list-style-type: none"> <li>■ Operative training required</li> <li>■ Autostop / opening system may be required</li> </ul>
<b>Authorised User Access</b>	<ul style="list-style-type: none"> <li>■ Will require member of authorised user attending team to open and close (if operated locally).</li> <li>■ Procedure will be required</li> <li>■ Training of procedure</li> <li>■ If operate remotely, procedure for contacting RCC required</li> <li>■ Time taken to access could be an issue</li> </ul>
<b>Maintenance</b>	<ul style="list-style-type: none"> <li>■ Regular check and possible maintenance of opening mechanism and motor</li> <li>■ Possibly susceptible to vandalism</li> </ul>
<b>Visibility</b>	<ul style="list-style-type: none"> <li>■ Appropriate additional sign plate and warning lamps to be incorporated into design of system</li> </ul>
<b>Environmental Impact</b>	<ul style="list-style-type: none"> <li>■ Visible system and therefore possible negative impact to customer</li> </ul>
<b>Layout</b>	<ul style="list-style-type: none"> <li>■ Power supply required</li> <li>■ Robust locking mechanism to deter vandalism and illegal use</li> <li>■ CCTV and warning system will be required to advise the customer</li> <li>■ Safety barrier required to mechanism from errant vehicles</li> <li>■ Secure box required for operating mechanism for on-site operation</li> <li>■ Manual override of the system will be essential</li> </ul>

## Portable Plastic Barriers

<b>Current Use</b>	<ul style="list-style-type: none"> <li>■ Used on M40 DBFO and in Area 8 for planned closures</li> <li>■ Used worldwide for preventing access to roadwork areas and excavations</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>■ Readily available from numerous suppliers</li> </ul>
<b>Resources to Deploy</b>	<ul style="list-style-type: none"> <li>■ Ideally carried by two operatives</li> <li>■ Training programme required</li> <li>■ Additional operative could be used for look-out if heavily trafficked slip road</li> </ul>
<b>Health &amp; safety issues</b>	<ul style="list-style-type: none"> <li>■ Operative training required</li> <li>■ Manual handling issue</li> <li>■ Operatives exposed to live traffic during deployment and re-opening procedure</li> </ul>
<b>Authorised User Access</b>	<ul style="list-style-type: none"> <li>■ Will require member of authorised user attending team to open and close.</li> <li>■ Time taken to move barriers and re-set could be an issue</li> <li>■ Procedure will be required</li> <li>■ Training of procedure</li> </ul>
<b>Maintenance</b>	<ul style="list-style-type: none"> <li>■ Minimal maintenance to barriers, cheap to replace</li> </ul>
<b>Visibility</b>	<ul style="list-style-type: none"> <li>■ Appropriate additional sign plate and warning lamps to be incorporated into design of system</li> </ul>
<b>Environmental Impact</b>	<ul style="list-style-type: none"> <li>■ Visible system and therefore possible negative impact to customer</li> </ul>
<b>Layout</b>	<ul style="list-style-type: none"> <li>■ Secure storage unit required</li> </ul>

## BarrierGuard wheeled

<b>Current Use</b>	<ul style="list-style-type: none"> <li>Used in the UK for the protection of long term road works and susceptible structures</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>Currently only one supplier, therefore supply could be sporadic</li> </ul>
<b>Resources to Deploy</b>	<ul style="list-style-type: none"> <li>Easily moved by two operatives</li> <li>Training programme required</li> <li>Additional operative could be used for look-out if heavily trafficked slip road</li> </ul>
<b>Health &amp; safety issues</b>	<ul style="list-style-type: none"> <li>Operative training required</li> <li>Manual handling issue</li> <li>Operatives exposed to live traffic during deployment and re-opening procedure</li> </ul>
<b>Authorised User Access</b>	<ul style="list-style-type: none"> <li>Will require members of authorised user attending team to open and close.</li> <li>Procedure will be required</li> <li>Training of procedure</li> <li>Time taken to access could be slow</li> </ul>
<b>Maintenance</b>	<ul style="list-style-type: none"> <li>Regular checking of trolley wheels and locking mechanism</li> </ul>
<b>Visibility</b>	<ul style="list-style-type: none"> <li>Appropriate additional sign plate and warning lamps to be incorporated into design of system</li> </ul>
<b>Environmental Impact</b>	<ul style="list-style-type: none"> <li>System removed to storage therefore no visual impact</li> <li>Storage unit could have visual impact</li> </ul>
<b>Layout</b>	<ul style="list-style-type: none"> <li>Secure storage unit required</li> <li>Available space for storage unit will be an issue (length of unit – 6m)</li> </ul>

## Intellicone

<b>Current Use</b>	<ul style="list-style-type: none"> <li>■ Used in the UK as a work zone safety system</li> <li>■ Provides a warning alarm when breached</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>■ Currently only one supplier, therefore supply could be sporadic</li> </ul>
<b>Resources to Deploy</b>	<ul style="list-style-type: none"> <li>■ Easily moved by two operatives on to traffic cones</li> <li>■ Training programme required</li> <li>■ Additional operative could be used for look-out if heavily trafficked slip road</li> </ul>
<b>Health &amp; safety issues</b>	<ul style="list-style-type: none"> <li>■ Operative training required</li> <li>■ Operatives exposed to live traffic during deployment and re-opening procedure</li> </ul>
<b>Authorised User Access</b>	<ul style="list-style-type: none"> <li>■ Will require members of authorised user attending team to open and close.</li> <li>■ Procedure will be required</li> <li>■ Training of procedure</li> <li>■ Time taken to access by moving cones</li> <li>■ Resetting of system required may be time consuming</li> </ul>
<b>Maintenance</b>	<ul style="list-style-type: none"> <li>■ Regular checking of sensors and batteries</li> <li>■ Potential for vandalism and theft</li> </ul>
<b>Visibility</b>	<ul style="list-style-type: none"> <li>■ Flashing light on traffic cones</li> <li>■ Additional warning signs required</li> </ul>
<b>Environmental Impact</b>	<ul style="list-style-type: none"> <li>■ Visible system and therefore possible negative impact to customer</li> </ul>
<b>Layout</b>	<ul style="list-style-type: none"> <li>■ Secure storage unit required for cones, signs and intellicone units</li> </ul>

## Trellis Barrier

<b>Current Use</b>	<ul style="list-style-type: none"> <li>■ Used worldwide for preventing access to roadwork areas and excavations</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>■ Readily available from numerous suppliers</li> </ul>
<b>Resources to Deploy</b>	<ul style="list-style-type: none"> <li>■ Ideally carried by two operatives</li> <li>■ Training programme required</li> <li>■ Additional operative could be used for look-out if heavily trafficked slip road</li> </ul>
<b>Health &amp; safety issues</b>	<ul style="list-style-type: none"> <li>■ Operative training required</li> <li>■ Manual handling issue</li> <li>■ Operatives exposed to live traffic during deployment and re-opening procedure</li> </ul>
<b>Authorised User Access</b>	<ul style="list-style-type: none"> <li>■ Will require member of authorised user attending team to open and close.</li> <li>■ Time taken to move barriers and re-set could be an issue</li> <li>■ Procedure will be required</li> <li>■ Training of procedure</li> </ul>
<b>Maintenance</b>	<ul style="list-style-type: none"> <li>■ Minimal maintenance to barriers, cheap to replace</li> </ul>
<b>Visibility</b>	<ul style="list-style-type: none"> <li>■ Appropriate additional sign plate and warning lamps to be incorporated into design of system</li> </ul>
<b>Environmental Impact</b>	<ul style="list-style-type: none"> <li>■ Visible system and therefore possible negative impact to customer</li> </ul>
<b>Layout</b>	<ul style="list-style-type: none"> <li>■ Secure storage unit required</li> </ul>

## SoftStop

<b>Current Use</b>	<ul style="list-style-type: none"> <li>Only known use is at Sydney Harbour Tunnel in Australia</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>Only one supplier and mechanics of system suggest a difficult procurement</li> </ul>
<b>Resources to Deploy</b>	<ul style="list-style-type: none"> <li>One operative able to deploy if mechanism on site</li> <li>Could be operated remotely by RCC Operator</li> <li>Additional operative could be used for look-out if heavily trafficked slip road</li> </ul>
<b>Health &amp; safety issues</b>	<ul style="list-style-type: none"> <li>Operative training required</li> <li>'Water screen' system could lead to formation of ice during cold weather</li> <li>Operatives exposed to live traffic during deployment and re-opening procedure</li> <li>Not a physical barrier therefore customer could ignore signage and drive through</li> </ul>
<b>Authorised User Access</b>	<ul style="list-style-type: none"> <li>Not a physical barrier therefore authorised user has the ability to drive through with no delay</li> </ul>
<b>Maintenance</b>	<ul style="list-style-type: none"> <li>Regular checks on water supply and discharge facility</li> <li>Regular check on laser system</li> </ul>
<b>Visibility</b>	<ul style="list-style-type: none"> <li>Very large sign projected onto 'water screen'</li> <li>Additional lighting may be required</li> </ul>
<b>Environmental Impact</b>	<ul style="list-style-type: none"> <li>Visible system and therefore possible negative impact to customer for system framework</li> </ul>
<b>Layout</b>	<ul style="list-style-type: none"> <li>Power supply required</li> <li>Water supply required</li> <li>Robust locking mechanism to deter vandalism and illegal use</li> <li>CCTV and warning system will be required to advise the customer</li> <li>Safety barrier required to mechanism from errant vehicles</li> <li>Secure box required for operating mechanism for on-site operation</li> <li>Manual override of the system will be essential</li> </ul>

## Appendix C System Evaluation

As described in section 5, each system was assessed against a number of elements and criteria. A description of the scoring matrix is given below.

An evaluation of each system follows the descriptions:

### C.1 Ease of Procurement

The ease of procurement is based on the availability of the equipment and supply obtainability.

Criteria	Description	Scoring
Ease of Procurement	The ease in which the particular equipment will be available and its deliverability	1 – <i>supply of equipment will be difficult</i> 2 – <i>supply of equipment may be sporadic</i> 3 – <i>equipment is in ready supply or with little delay</i>

### C.2 Cost

The cost of the closure system at each slip road location has been broken down into 4no. elements to be considered. The costs are based on supplied estimates and provision at one slip road.

Criteria	Description	Scoring
System Cost	Capital cost of acquiring the closure materials	1 – >£20,000 2 – £5,000 – £20,000 3 - <£5,000
Installation Cost	Cost of installing the closure on the network	1 – >£10,000 2 – £5,000 – £10,000 3 - <£5,000
System Maintenance costs	Capital cost for maintaining the system	1 – >£2,000 2 – £1,000 – £2,000 3 - <£1,000
In operation Maintenance Cost	Cost of maintaining the closure when established during an incident	1 – >£2,000 2 – £500 – £2,000 3 - <£5,000
Decommission Cost	Cost for removing the closure when incident closed	1 – >£10,000 2 – £5,000 – £10,000 3 - <£5,000

### C.3 Operation

The operation of the method has been broken down into a number of elements which need to be considered. These are detailed below:

Criteria	Description	Scoring
Prevents Customer Access	Provides a physical barrier to the customer to prevent access	1 - No 2 - Yes
Authorised User Access	Allows authorised users to gain access through the barrier with little or no delay	1 - No 2 - Yes
Ease of Deployment	How quickly can the closure be established	1 - Slow ( <i>over 5 minutes</i> ) 2 - Medium ( <i>1 – 5 minutes</i> ) 3 - Fast ( <i>within 1 minutes</i> )
Operation Mechanism	Is the method automatic or manual	1 - Manual 2 - Automatic
Serviceability (Maintenance of equipment – not when closure in operation)	What is the frequency of maintaining the method/system when it is in use? Frequency depends upon deterioration, ease of repair and availability of spares.	1 - High maintenance ( <i>methods need checks after each establishment or difficult to repair or availability of spares may be difficult</i> ) 2 - Medium maintenance ( <i>regular maintenance checks and repair easily and availability of spares good</i> ) 3 - Low maintenance ( <i>minimal maintenance, easily repaired and spare always available</i> )
Driver Recognition	Are the drivers familiar with the type of system and the associated signing	1 - No 2 - Yes
Suitability of Location	Is the system practical for slip road locations?  Space availability Slip road gradient Overhead cables	1 - Few ( <i>only suitable for a low number of locations</i> ) 2 - Most ( <i>the majority of locations</i> ) 3 - All ( <i>all locations</i> )

## C.4 Infrastructure

Consideration should be given to the requirement for provisions within the infrastructure for the equipment.

Criteria	Description	Scoring
Ease of Installation	Can the equipment be installed without changes to the infrastructure	1 - No 2 - Yes
Power Supply	Is there a requirement for an electrical supply	1 - Yes 2 - No
Other Services	Are any other services required	1 - Yes 2 - No
Communication Links	Is there a requirement for the provision of an ERT	1 - Yes 2 - No
CCTV	Is there a requirement for CCTV	1 - Yes 2 - No
Additional Signing	Is there a requirement for additional signing	1 - Yes 2 - No

## C.5 Security

Consideration is required to the effectiveness of the system and how vulnerable the system will be to interference

Criteria	Description	Scoring
Effectiveness of the system	How difficult will the system be to breach if there are no resources remaining at the closure	1 - Easy 2 - Hard
Susceptibility to vandalism	How susceptibility is the system to vandalism when installed	1 - Easy 2 - Hard

## C.6 Current Use

Consideration should be given as to whether the system is currently in use.

Criteria	Description	Scoring
Current Use	Is the system currently in use to prevent some form of access	1 - No 2 - Yes

MANUAL VERTICAL RISING GATE			
Criteria	Description	Scoring	Comments
<b>EASE OF PROCUREMENT</b>			
Ease of Procurement	The ease in which the particular equipment will be available and its deliverability	2	Difficult for a single supplier nationally. Required quantity will necessitate a number of suppliers and supply may be sporadic
<b>COST</b>			
System Cost	Capital cost of acquiring the closure materials	2	
System Maintenance Cost	Capital cost for maintaining the system	3	
Installation Cost	Cost of installing the closure on the network	2	
In Practise Maintenance Cost	Cost of maintaining the closure when established during an incident	3	
Decommission Cost	Cost for removing the system	3	
<b>OPERATION</b>			
Prevents Customer Access	Provides a physical barrier to the customer to prevent access	1	
Authorised User Access	Allows authorised users to gain access through the barrier with little or no delay	2	Will require a team member to operate gate to allow access and re-close
Ease of Deployment	How quickly can the closure be established	3	
Operation Mechanism	Is the method automatic or manual	1	
Serviceability ( Maintenance of equipment - not when closure in operation)	What is the frequency of maintaining the method/system when it is in use. Frequency depends upon deterioration, ease of repair and availability of spares.	3	
Driver Recognition	Are the drivers familiar with the type of system and the associated signing	2	
Suitability of Location	Is the system practical for slip road locations	2	Proximity of overhead cables and other infrastructure may be an issue
<b>INFRASTRUCTURE</b>			
Ease of Installation	Can the equipment be installed without changes to the infrastructure	2	Amendment to existing safety fencing may be required
Power Supply	Is there a requirement for an electrical supply	2	
Other Services	Are any other services required	2	
Communication Links	Is there a requirement for the provision of an ERT	2	
CCTV	Is there a requirement for CCTV	2	
Additional Signing	Is there a requirement for additional signing	1	Can be fixed to barrier arm
<b>SECURITY</b>			
Effectiveness of System	How difficult will the system be to breach if there are no resources remaining at the closure	2	Dependant on locking system provision
Susceptibility to vandalism	How susceptible is the system to vandalism when installed	2	Arm will need a locking system when not in use to prevent illegal lowering of gate arm
<b>USE</b>			
Current Used	Is the system currently in use to prevent some form of access	2	Not on the SRN but used at Business locations and car parks

MANUAL HORIZONTAL SWING GATE			
Criteria	Description	Scoring	Comments
<b>EASE OF PROCUREMENT</b>			
Ease of Procurement	The ease in which the particular equipment will be available and its deliverability	2	Difficult for a single supplier nationally. Required quantity will necessitate a number of suppliers and supply may be sporadic
<b>COST</b>			
System Cost	Capital cost of acquiring the closure materials	2	
System Maintenance Cost	Capital cost for maintaining the system	3	
Installation Cost	Cost of installing the closure on the network	2	
In Practise Maintenance Cost	Cost of maintaining the closure when established during an incident	3	
Decommission Cost	Cost for removing the system	3	
<b>OPERATION</b>			
Prevents Customer Access	Provides a physical barrier to the customer to prevent access	2	
Authorised User Access	Allows authorised users to gain access through the barrier with little or no delay	2	Will require a team member to operate gate to allow access and re-close
Ease of Deployment	How quickly can the closure be established	2	
Operation Mechanism	Is the method automatic or manual	1	
Serviceability ( Maintenance of equipment - not when closure in operation)	What is the frequency of maintaining the method/system when it is in use. Frequency depends upon deterioration, ease of repair and availability of spares.	3	
Driver Recognition	Are the drivers familiar with the type of system and the associated signing	2	
Suitability of Location	Is the system practical for slip road locations	2	Slip road gradient could be an issue for length of barrier arm
<b>INFRASTRUCTURE</b>			
Ease of Installation	Can the equipment be installed without changes to the infrastructure	2	Amendment to existing safety fencing may be required
Power Supply	Is there a requirement for an electrical supply	2	
Other Services	Are any other services required	2	
Communication Links	Is there a requirement for the provision of an ERT	2	
CCTV	Is there a requirement for CCTV	2	
Additional Signing	Is there a requirement for additional signing	2	Can be fixed to barrier arm
<b>SECURITY</b>			
Effectiveness of System	How difficult will the system be to breach if there are no resources remaining at the closure	2	Dependant on locking system provision
Susceptibility to vandalism	How susceptible is the system to vandalism when installed	2	Arm will need a locking system when not in use to prevent illegal swinging of gate arm
<b>USE</b>			
Current Used	Is the system currently in use to prevent some form of access	2	Snow gates on A66 and A628

AUTOMATIC VERTICAL RISING GATE			
Criteria	Description	Scoring	Comments
<b>EASE OF PROCUREMENT</b>			
Ease of Procurement	The ease in which the particular equipment will be available and its deliverability	2	Difficult for a single supplier nationally. Required quantity will necessitate a number of suppliers and supply may be sporadic
<b>COST</b>			
System Cost	Capital cost of acquiring the closure materials	1	Provision of power supply and ancillary items
System Maintenance Cost	Capital cost for maintaining the system	2	
Installation Cost	Cost of installing the closure on the network	2	
In Practise Maintenance Cost	Cost of maintaining the closure when established during an incident	3	
Decommissioning Cost	Cost for removing the system	2	
<b>OPERATION</b>			
Prevents Customer Access	Provides a physical barrier to the customer to prevent access	2	
Authorised User Access	Allows authorised users to gain access through the barrier with little or no delay	2	Will require either a controlled means of access (control keypad / swipe card) or communication with RCC operator
Ease of Deployment	How quickly can the closure be established	2	Either deploy at site or remotely from RCC (which would increase system and installation costs)
Operation Mechanism	Is the method automatic or manual	2	
Serviceability ( Maintenance of equipment - not when closure in operation)	What is the frequency of maintaining the method/system when it is in use. Frequency depends upon deterioration, ease of repair and availability of spares.	2	
Driver Recognition	Are the drivers familiar with the type of system and the associated signing	2	
Suitability of Location	Is the system practical for slip road locations	2	Proximity of overhead cables and other infrastructure may be an issue
<b>INFRASTRUCTURE</b>			
Ease of Installation	Can the equipment be installed without changes to the infrastructure	1	Provision of additional services may be required. Amendment to existing safety fencing may be required
Power Supply	Is there a requirement for an electrical supply	1	Cost issue
Other Services	Are any other services required	2	
Communication Links	Is there a requirement for the provision of an ERT	2	
CCTV	Is there a requirement for CCTV	1	Will allow observation of location before implementation
Additional Signing	Is there a requirement for additional signing	1	Flashing warning signs/lights to alert customers of pending barrier lowering
<b>SECURITY</b>			
Effectiveness of System	How difficult will the system be to breach if there are no resources remaining at the closure	2	
Susceptibility to vandalism	How susceptible is the system to vandalism when installed	2	Possible vandalism to power supply and not the sign
<b>USE</b>			
Current Used	Is the system currently in use to prevent some form of access	2	Railway crossings and Business locations, none on the SRN

AUTOMATIC HORIZONTAL SLIDING GATE			
Criteria	Description	Scoring	Comments
<b>EASE OF PROCUREMENT</b>			
Ease of Procurement	The ease in which the particular equipment will be available and its deliverability	2	Difficult for a single supplier nationally. Required quantity will necessitate a number of suppliers and supply may be sporadic
<b>COST</b>			
System Cost	Capital cost of acquiring the closure materials	1	Provision of power supply and ancillary items
System Maintenance Cost	Capital cost for maintaining the system	2	
Installation Cost	Cost of installing the closure on the network	2	
In Practice Maintenance Cost	Cost of maintaining the closure when established during an incident	3	
Decommissioning Cost	Cost for removing the system	2	
<b>OPERATION</b>			
Prevents Customer Access	Provides a physical barrier to the customer to prevent access	2	
Authorised User Access	Allows authorised users to gain access through the barrier with little or no delay	2	Will require either a controlled means of access (control keypad / swipe card) or communication with RCC operator
Ease of Deployment	How quickly can the closure be established	2	Either deploy at site or remotely from RCC (which would increase system and installation costs)
Operation Mechanism	Is the method automatic or manual	2	
Serviceability ( Maintenance of equipment - not when closure in operation)	What is the frequency of maintaining the method/system when it is in use. Frequency depends upon deterioration, ease of repair and availability of spares.	2	
Driver Recognition	Are the drivers familiar with the type of system and the associated signing	2	
Suitability of Location	Is the system practical for slip road locations	1	The topography of the location (i.e embankment/cutting verge) and availability of space
<b>INFRASTRUCTURE</b>			
Ease of Installation	Can the equipment be installed without changes to the infrastructure	1	Installation of frames and track units
Power Supply	Is there a requirement for an electrical supply	1	
Other Services	Are any other services required	2	
Communication Links	Is there a requirement for the provision of an ERT	2	
CCTV	Is there a requirement for CCTV	1	Will allow observation of location before implementation
Additional Signing	Is there a requirement for additional signing	1	Flashing warning signs/lights to alert customers of pending gate sliding
<b>SECURITY</b>			
Effectiveness of System	How difficult will the system be to breach if there are no resources remaining at the closure	2	
Susceptibility to vandalism	How susceptible is the system to vandalism when installed	2	Possible vandalism to power supply
<b>USE</b>			
Current Used	Is the system currently in use to prevent some form of access	2	Commercial units. None on the SRN apart from HA Depot access

BARRIERGUARD WHEEL ED			
Criteria	Description	Scoring	Comments
<b>EASE OF PROCUREMENT</b>			
Ease of Procurement	The ease in which the particular equipment will be available and its deliverability	1	Only one known supplier to date.
<b>COST</b>			
System Cost	Capital cost of acquiring the closure materials	2	
System Maintenance Cost	Capital cost for maintaining the system	3	
Installation Cost	Cost of installing the closure on the network	2	
In Practice Maintenance Cost	Cost of maintaining the closure when established during an incident	3	
Decommissioning Cost	Cost for removing the system	3	
<b>OPERATION</b>			
Prevents Customer Access	Provides a physical barrier to the customer to prevent access	2	
Authorised User Access	Allows authorised users to gain access through the barrier with little or no delay	2	Will require a team member to move barrier to allow access and re-close - time consuming exercise
Ease of Deployment	How quickly can the closure be established	1	2no. Operative operation and requires removal from on site storage area or depot
Operation Mechanism	Is the method automatic or manual	1	
Serviceability ( Maintenance of equipment - not when closure in operation)	What is the frequency of maintaining the method/system when it is in use. Frequency depends upon deterioration, ease of repair and availability of spares.	3	
Driver Recognition	Are the drivers familiar with the type of system and the associated signing	2	
Suitability of Location	Is the system practical for slip road locations	2	Could be an issue on how to store equipment on site or will require to be transported to site from a depot
<b>INFRASTRUCTURE</b>			
Ease of Installation	Can the equipment be installed without changes to the infrastructure	2	
Power Supply	Is there a requirement for an electrical supply	2	
Other Services	Are any other services required	2	
Communication Links	Is there a requirement for the provision of an ERT	2	
CCTV	Is there a requirement for CCTV	2	
Additional Signing	Is there a requirement for additional signing	2	Additional signing could be fixed to barrier
<b>SECURITY</b>			
Effectiveness of System	How difficult will the system be to breach if there are no resources remaining at the closure	2	
Susceptibility to vandalism	How susceptible is the system to vandalism when installed	2	
<b>USE</b>			
Current Used	Is the system currently in use to prevent some form of access	2	Currently used to provide protection to workforce during long term works and protection to structures

PLASTIC BARRIER			
Criteria	Description	Scoring	Comments
<b>EASE OF PROCUREMENT</b>			
Ease of Procurement	The ease in which the particular equipment will be available and its deliverability	3	Readily available from numerous suppliers. An 'off-shelf' purchase
<b>COST</b>			
System Cost	Capital cost of acquiring the closure materials	3	
System Maintenance Cost	Capital cost for maintaining the system	3	
Installation Cost	Cost of installing the closure on the network	3	
In Practise Maintenance Cost	Cost of maintaining the closure when established during an incident	3	
Decommissioning Cost	Cost for removing the system	3	
<b>OPERATION</b>			
Prevents Customer Access	Provides a physical barrier to the customer to prevent access	2	There are issues with their behaviour in adverse weather conditions (wind) and could move to provide access.
Authorised User Access	Allows authorised users to gain access through the barrier with little or no delay	2	Will require a team member to move barrier to allow access and re-close
Ease of Deployment	How quickly can the closure be established	1	Equipment will need to be removed from on-site storage and carried to location. Could be a manual handling issue.
Operation Mechanism	Is the method automatic or manual	1	
Serviceability ( Maintenance of equipment - not when closure in operation)	What is the frequency of maintaining the method/system when it is in use. Frequency depends upon deterioration, ease of repair and availability of spares.	3	
Driver Recognition	Are the drivers familiar with the type of system and the associated signing	2	
Suitability of Location	Is the system practical for slip road locations	3	Slight concern regarding on-site storage location
<b>INFRASTRUCTURE</b>			
Ease of Installation	Can the equipment be installed without changes to the infrastructure	2	
Power Supply	Is there a requirement for an electrical supply	2	
Other Services	Are any other services required	2	
Communication Links	Is there a requirement for the provision of an ERT	2	
CCTV	Is there a requirement for CCTV	2	
Additional Signing	Is there a requirement for additional signing	1	Signing can be fixed to barrier or temporary signing included in on-site store
<b>SECURITY</b>			
Effectiveness of System	How difficult will the system be to breach if there are no resources remaining at the closure	1	Can be moved easily
Susceptibility to vandalism	How susceptible is the system to vandalism when installed	1	
<b>USE</b>			
Current Used	Is the system currently in use to prevent some form of access	2	Currently used on M40 BDFO and in Artea 8 to prevent access during planned works

TRELLIS BARRIER			
Criteria	Description	Scoring	Comments
<b>EASE OF PROCUREMENT</b>			
Ease of Procurement	The ease in which the particular equipment will be available and its deliverability	3	Readily available from numerous suppliers. An 'off-shelf' purchase
<b>COST</b>			
System Cost	Capital cost of acquiring the closure materials	3	
System Maintenance Cost	Capital cost for maintaining the system	3	
Installation Cost	Cost of installing the closure on the network	3	
In Practise Maintenance Cost	Cost of maintaining the closure when established during an incident	3	
Decommissioning Cost	Cost for removing the system	3	
<b>OPERATION</b>			
Prevents Customer Access	Provides a physical barrier to the customer to prevent access	2	There are issues with their behaviour in adverse weather conditions (wind) and could move to provide access.
Authorised User Access	Allows authorised users to gain access through the barrier with little or no delay	2	Will require a team member to move barrier to allow access and re-close
Ease of Deployment	How quickly can the closure be established	1	Equipment will need to be removed from on-site storage and carried to location. Could be a manual handling issue.
Operation Mechanism	Is the method automatic or manual	1	
Serviceability ( Maintenance of equipment - not when closure in operation)	What is the frequency of maintaining the method/system when it is in use. Frequency depends upon deterioration, ease of repair and availability of spares.	3	
Driver Recognition	Are the drivers familiar with the type of system and the associated signing	2	
Suitability of Location	Is the system practical for slip road locations	3	Slight concern regarding on-site storage location
<b>INFRASTRUCTURE</b>			
Ease of Installation	Can the equipment be installed without changes to the infrastructure	2	
Power Supply	Is there a requirement for an electrical supply	2	
Other Services	Are any other services required	2	
Communication Links	Is there a requirement for the provision of an ERT	2	
CCTV	Is there a requirement for CCTV	2	
Additional Signing	Is there a requirement for additional signing	1	Signing can be fixed to barrier or temporary signing included in on-site store
<b>SECURITY</b>			
Effectiveness of System	How difficult will the system be to breach if there are no resources remaining at the closure	1	Can be moved easily
Susceptibility to vandalism	How susceptible is the system to vandalism when installed	1	
<b>USE</b>			
Current Used	Is the system currently in use to prevent some form of access	2	Used on commercial sites. Not used on SRN.

<b>SoftStop</b>			
<b>Criteria</b>	<b>Description</b>	<b>Scoring</b>	<b>Comments</b>
<b>EASE OF PROCUREMENT</b>			
<b>Ease of Procurement</b>	The ease in which the particular equipment will be available and its deliverability	1	Single supplier therefore procurement will be difficult for the number required
<b>COST</b>			
<b>System Cost</b>	Capital cost of acquiring the closure materials	1	
<b>System Maintenance Cost</b>	Capital cost for maintaining the system	1	
<b>Installation Cost</b>	Cost of installing the closure on the network	1	
<b>In Practice Maintenance Cost</b>	Cost of maintaining the closure when established during an incident	1	
<b>Decommissioning Cost</b>	Cost for removing the system	1	
<b>OPERATION</b>			
<b>Prevents Customer Access</b>	Provides a physical barrier to the customer to prevent access	1	Waterscreen which can be driven through
<b>Authorised User Access</b>	Allows authorised users to gain access through the barrier with little or no delay	2	Waterscreen which can be driven through
<b>Ease of Deployment</b>	How quickly can the closure be established	2	Preferred deployment would be remote which will require coordination
<b>Operation Mechanism</b>	Is the method automatic or manual	2	
<b>Serviceability ( Maintenance of equipment - not when closure in operation)</b>	What is the frequency of maintaining the method/system when it is in use. Frequency depends upon deterioration, ease of repair and availability of spares.	1	
<b>Driver Recognition</b>	Are the drivers familiar with the type of system and the associated signing	1	
<b>Suitability of Location</b>	Is the system practical for slip road locations	1	Availability of services / remoteness of location
<b>INFRASTRUCTURE</b>			
<b>Ease of Installation</b>	Can the equipment be installed without changes to the infrastructure	1	
<b>Power Supply</b>	Is there a requirement for an electrical supply	1	
<b>Other Services</b>	Are any other services required	1	
<b>Communication Links</b>	Is there a requirement for the provision of an ERT	2	
<b>CCTV</b>	Is there a requirement for CCTV	1	
<b>Additional Signing</b>	Is there a requirement for additional signing	2	Sign is projected onto waterscreen
<b>SECURITY</b>			
<b>Effectiveness of System</b>	How difficult will the system be to breach if there are no resources remaining at the closure	1	Can be moved easily
<b>Susceptibility to vandalism</b>	How susceptible is the system to vandalism when installed	1	
<b>USE</b>			
<b>Current Used</b>	Is the system currently in use to prevent some form of access	1	Not in UK

DRAFT