SOUTHEND-ON-SEA BOROUGH COUNCIL

SOUTHEND TOWN CENTRE

HOSTILE VEHICLE MITIGATION MEASURES – VEHICLE DYNAMIC ASSESSMENT

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SUMMARY

The aim of this report is to present our assessment of vehicle approach speeds towards the identified vulnerable access points around various crowded places along the High Street in Southend Town centre, and to identify the potential impact energies in order to aid the option study and specification of Hostile Vehicle Mitigation (HVM) measures.

This report gives background information relating to the Government guidance for the protection of crowded places and provides an explanation of the rationale for the specified locations for the HVM.

This report considers the effects of topography, including corner radii, kerbs and other obstacles on the road network around the site perimeter, which may help to reduce the approach speed of a vehicle borne attack. It gives details of the speed of six different types of vehicle, as outlined in the IWA14 standard, [12]: 1.5 Tonne, 2.5Te, 3.5Te, 7.5Te, 18Te and 30Te (gross weight). The assessment allows for appropriate mitigation measures to be specified.

It is noted within the report that should tested products not be available that meet the IWA 14 test criteria, it would be acceptable to consider products tested to PAS68 [10].

Furthermore the report sets out other options available that utilise measures that have been tested against other codes of practice, such as PAS 170 (Low speed impacts with a N1G vehicle) and VADS (CPNIs own impact test standard for vehicles that may nudge or push barriers).

1. ACRONYMS

BS	British Standard
CPNI	Centre for Protection of National Infrastructure
CTPSM	Counter Terrorist Protection Security Manual
CTSA	Counter Terrorism Security Advisor
DGA	D.J. Goode & Associates Ltd.
HVM	Hostile Vehicle Mitigation
ISO	International Standards Organisation
IWA	International Workshop Agreement
kN	kiloNewton
mm	Millimetre
NaCTSO	National Counter Terrorism Security Office
PAS	Publically Available Standard
PBIED	Person Borne Improvised Explosive Device
SPF	Security Policy Framework
UK	United Kingdom
VAW	Vehicle as a Weapon
VBIED	Vehicle Borne Improvised Explosive Device

2. INTRODUCTION

2.1. Since the rise of urban terrorist attacks the Government has advised its various departments, agencies and commercial developments, where large numbers of the public will congregate, that they should protect, as far as reasonably practicable, personnel. The manual setting out ways of determining these protection measures is the Counter Terrorist Protective Security Manual (CTPSM) [4], which has now been superseded by the Security Policy Framework [3], both produced by the Cabinet Office, plus the Counter Terrorism Protective Security Advice for Commercial Centres, published by the National Counter Terrorism Security Office (NaCTSO) [6].

2.2. The recent attacks over the past five years (Nice, Berlin, Stockholm, London, Edmonton, Melbourne etc) have highlighted the use of vehicles as an attack weapon against people rather than used as a means to deploy an explosive device. Therefore, the focus of the terrorist has shift to low technology attack methods highlighting the need to offer protection to the public against this mode of attack, especially wherever large numbers of people are congregating.

2.3. We have been tasked to provide a vehicle dynamics assessment (speed of approach) for different locations around Southend Town Centre to determine the likely attack speeds that could be achieved by a variety of vehicle types at any point around the perimeter. Six main areas have been identified, these are:

1. Junction between Queensway and Victoria Avenue
2. High Street – pedestrianized area
3. Junction between Tylers Avenue and Clifftown Road
4. Junction between Alexandra Street and Heygate Avenue
5. Elmer Approach to Luker Road – close proximity to University of Essex and South Essex College of Further and Higher Education
6. The junction between Pier Hill and Royal Terrace

2.4. The areas are all currently open for vehicle access which are permitted for deliveries etc.

2.5. Throughout the High Street there are some existing bollards. However, some of them are missing and the spacing between them would permit vehicle access. Retractable bollards have also been used but they are broken and in the lowered position thereby freely allowing access to unauthorised vehicles.

2.6. This report covers the current approach routes to the sites and also considers any adjustments due to existing construction projects.

2.7. A site visit was undertaken on 10th February 2020 and a number of potential access points which can lead to high speed impacts around the perimeters were identified.

2.8. At various points around the perimeter there are some existing features which include trees, cycle stands, and walls etc. Some of these measures may be capable of being incorporated within the final scheme solution, either as they stand, or with some modification. There are also a number of non-rated products which may require replacement or may be layered to act as a deterrent.

2.9. This report covers the assessment of the areas and determines the threat posed by hostile vehicles, to allow suitable mitigation measures to be specified.

2.10. This report is produced to provide an understanding of the kinetic energy of a vehicle and is not intended to cover blast effects from an explosive device that the vehicle may be carrying.

2.11. In addition, this report is not a specification and does not cover information relating to foundations, product integration, operational requirements and procedures, speed of operation, maintenance requirements etc.

2.12. This report has been prepared based on technical information that has been obtained during the site visit, and documentation from CPNI and other Government sources. This information is referenced at the end of this report. It should be noted that some of it is Restricted in its circulation and is not generally available.

3. GOVERNMENT RECOMMENDATIONS

3.1. The Government offer advice and provide guidance to various organisations that they consider need to be aware of security concerns. This advice typically is in the form of briefings, various publications and guidance from CTSA's. For the basis of this report we have considered the following documents as being relevant to this development and provide details below of the minimum measures recommended.

3.2. Security Policy Framework (SPF), [3].

This document is intended to provide a source of counter-terrorist protective security advice and guidance. The manual covers what terrorism and counter-terrorism protective security are. It also describes a range of physical and procedural measures which may be implemented as a baseline and also those which may be implemented for different alert states. This document provides information in relation to specific threats based on building vulnerability and risk.

3.3. Counter Terrorism Protective Security Advice for Commercial Centres, produced by NaCTSO, [6].

This document has been produced to provide protective security advice to those who own, operate, manage or work in Commercial Centres, and it aids operators who are seeking to reduce the risks posed by a terrorist attack. The document covers a broad range of subject matter, from risk management to physical and electronic security. However, no reference is made to any specific threat, although it recommends communication with the local CTSA's and qualified Security / Structural Engineers.

3.4. Crowded Places Guidance – Commercial Centres, produced by NaCTSO, [8].

This document has been produced to provide protective security advice to those who own, operate, manage or work in commercial centres, and it aids operators who are seeking to reduce the risks posed by a terrorist attack. The document covers a broad range of subject matter, from risk management to physical and electronic security. Reference is made to both Vehicle Borne Improvised Explosive Device (VBIED) and Vehicle as a Weapon (VAW) style attacks however, no reference is made to any specific threat size, although it recommends communication with the local CTSA's and qualified Security / Structural Engineers.

3.5. Hostile Vehicle Mitigation Measures (HVM).

3.5.1. The UK Government has set out the minimum design guidance for HVM within Reference [1]. However, recommendations for crowded spaces or the protection of structures from vehicle borne attack is provided within the SPF, [3], and NaCTSO guide, [6].

3.5.2. Generally, the requirements for HVM within these documents, for this type of building, are as follows:

Security Policy Framework (SPF)	NaCTSO Guide
• Limit parking within proximity of building as far as possible. • Ideally maintain 25m standoff. • Control vehicle entry points and reduce speed. • Maximise standoff.	• Maintain vehicle standoff. • Robust barriers and bollards. • Non-essential vehicles kept at least 30m from buildings. • Delivery vehicle and emergency services access points identified and protected accordingly. • Perimeter provided with traffic calming measures. • Only authorised vehicles to be permitted to delivery areas and underground service areas. Vehicles to be pre-arranged and checked.

3.6. These guidance documents are generally focused on vehicles being utilised as a delivery mechanism for explosive devices, and therefore focus on maximising stand-off distances and thereby protecting building occupants.

3.7. However, since the change in attack methods CPNI have published further guidance on countering vehicle as a weapon threats, and developed a test standard VADS for determining the resistance of HVM products or other forms of street furniture against nudging and pushing attacks.

These document require consideration of deployment in relation to the crowded space, and assess the delay time rather than impact resistance. It should be noted that not all barriers that are capable of resisting a high speed impact are capable of resisting a VADS test, and therefore consideration of product vulnerabilities needs to be considered along with the different attack methods.

4. METHODOLOGY

4.1. The vulnerable area of the site, locations of surrounding landscaping and obstacles and the scope of hostile vehicle mitigation have been highlighted in the project documentation provided, and from data gathered during the site visit.

4.2. For the vulnerable locations, consideration is given to clear approach distances and corner severity. This can include road camber, gradient and traversable widths, (road, footpath, verges etc.).

4.3. From site plans and map data provided in CAD format, the various distances and corner radii to each of the designated points of impact are determined. The approaches were cross-referenced with images obtained from Google Maps™ to better understand the approach route topography.

4.4. The speed of each vehicle is based on a vast range of test data which assumes a typical weighted acceleration rate. Although variable acceleration rates have been used to simulate gear ratios, they do not precisely match any particular vehicle in terms of engine speed, engine power and torque.

4.5. From published data [1], the maximum cornering and acceleration speed is assessed based on the scaled corner radii. This can be used as the potential starting speed of the specific vehicle and, based on the straight line distance to the potential target, a final impact speed is established. In a number of cases, where the final approach is a corner, the vehicle speed is limited by this corner radius based on a set of dynamic cornering trials (if the attack vehicle travels any faster it will likely understeer and overshoot the target).

4.6. Within the published data, advantageous coefficients of friction have been used to maximise the vehicle cornering speed. This value is typical for dry asphalt road surface.

4.7. Additional factors have been assumed within the published test data such as suspension and chassis characteristics, aerodynamic drag, tyre friction and power steering system dynamics.

4.8. Upon determining the impact speed, the kinetic energy of each vehicle is then calculated to determine the maximum likely destructive capability of the vehicle groups.

4.9. The assessment assumes that the maximum cornering radii could be achieved with the use of the opposite side of the road or by driving against the flow of the traffic, on pavements or other means to maximise the impact speed. This would not be unusual when considering criminal or terrorist activity.

4.10. This above method allows us to determine the most onerous speed that the attack vehicle can achieve at the point of interest. The points of interest are then assessed with the use of differing measures and attack methods to assess the associated risk of each option provided.

5. THREAT

5.1. The threat is considered to be any reasonable sized vehicle that could deliver an explosive device or attempt to ram-raid the structure or pedestrians within a crowded environment. The IWA 14 standard identifies nine vehicle types, however for the purposes of this assessment we will only consider the UK / European vehicle types which consist of six main types of vehicle as representing those most likely to be used during an attack:

5.1.1. Small Vehicles (M1) – These are typically small vans, family cars or people carriers, in the region of 1.5Te (test weight 1.5Te). These vehicles are very common, highly manoeuvrable and accelerate quickly.

These types of vehicles normally deliver small payloads and are hard to detect, unless heavily loaded, and can easily be procured without arousing suspicion.

5.1.2. Small / Medium Vehicles (N1G) – These are typically 4 x 4 vehicles and weigh in the region of 2.5Te (test weight 2.5Te). These again are very common and can traverse rough ground easily at speed, and have some ability to climb over, at low speed, obstructions which may have been put in place to deter an attack.

These types of vehicles normally deliver a small charge, although with a heavier load it is harder to detect due to the stiffness of the suspension system as these vehicles are typically designed to carry larger loads than normal family cars.

5.1.3. Medium Vehicles (N1) – These are typically 3.5Te goods vehicles (test weight 3.5Te), usually small flat bed lorries. These are common within city environments and can be unassuming and operated covertly, particularly as they are used to transport cars, similar to vehicles used by the courier companies and vehicle recovery.

It is reasonable to expect that these vehicles would carry a medium sized payload.

5.1.4. Medium / Large Vehicles (N2A & N3C) – These are typically 7.5Te and 18Te goods vehicles (test weight 7.2Te), either large vans or small lorries. These are common within city environments and can be unassuming and operated covertly.

It is reasonable to expect that these vehicles would carry a large payload.

5.1.5. Large Vehicles (N3F) – These are typically 32Te Goods vehicles (test weight 30Te), or more, with limited manoeuvrability. These typically look out of place within the urban environment.

Due to the size of the vehicle it is reasonable to assume that they can deliver very large payloads. These vehicles have a large kinetic energy when impacting against structures, even when travelling at slow speeds.

5.2. It would be normal to expect refuse, emergency services and public carrying vehicles to approach the sites, which could also deliver a large payload.

5.3. It should also be considered that emergency service vehicles (as Trojan vehicles) may also be used to attack the sites.

5.4. Vehicle as a Weapon (VAW) style attacks should also be considered. The aim of these attacks is for the vehicle to remain drivable so as to be used as the weapon itself and not to deliver an explosive payload. These attacks are likely to be slower in nature in order to manoeuvre around or over obstacles before accelerating to cause maximum casualties. The threat vehicles for this form of attack are generally taken as the N1G and N3C size of vehicles as set out above, although when reviewing the attacks undertaken throughout the world it can be seen that all six of the UK vehicles types have been used in at least one attack.

5.5. For this form of attack, it is considered that the barrier does not need to be able to permanently stop the vehicle, but it should delay the vehicle for a set period of time to enable either a police response or create a noise that would alert the public to something abnormal occurring.

5.6. It is important, however, to ensure that both forms of vehicle borne attack are considered when reviewing a site to ensure that the sites have a degree of future proofing, as it is anticipated that the aspiration of the terrorist organisations is to develop viable devices.

6. ASSESSMENT

6.1. The assessment covers approaches to the High Street from Royal Terrace to London Road and University of Essex in Southend Town Centre. A drawing of the site in its current state is shown in Figure 1 below.

6.2. We have highlighted twenty-five (25no) current approach routes to the perimeter of the site, which are shown in Figure 1. These are considered to be the most onerous cases where the approach is either the most probable or where the impact velocity and energy would be the most destructive.

Figure 1: Southend High Street - Approach Routes

6.3. The approach routes identified in Figure 1, above are described in more detail below:

6.3.1. Approach Route 1, 2 & 3

These approach routes show the junction area between Queensway and Victoria Avenue having a final impact near Odeon Cinema.

Both routes 1 and 3 uses Queensway Road with route 1 coming from west and route 3 coming from east. Approach route 2 is straight along Victoria Avenue / A127 going past Southend Museum on the left and impacting on the junction with Queensway Road.

Figure 2: Impact point for routes 1, 2 & 3 in distance

Figure 3: Victoria Plaza Centre

6.3.2. <u>Approach Routes 4 & 5</u>

These approach routes utilise Southchurch Road, with approach route 4 coming from north and approach route 5 coming from south, both crossing Chichester Road and impacting at the same point.

Figure 4: Southchurch Road deeping

6.3.3. <u>Approach Route 6</u>

This approach route is using the one way street on Warrior Square, crossing Chichester Road hitting the soft measures that are in place and then following the route impacting High Street near Natwest Bank.

Figure 5: View along Warrior Square junction with Chichester Road

At the impact point on this route there are some bollards in place but as shown in Figure 6 below they are no longer fit for purpose.

Figure 6: Route 5 impact point showing damaged bollards

6.3.4. Approach Route 7

Approach route 7 utilises Whitegate Road and crosses Chichester Road over the pedestrian refuge island and impacting High Street near Halifax Bank.

Figure 7: View along Chichester Road at the junction with Whitegate Road

Figure 8: Route 7 impact point

Where Route 7 meets the High Street as shown in Figure 8, there are existing bollards and a cycle rack. The right hand bollard is retractable and at the time of the survey it was in the open position, thereby allowing unrestricted access to the High Street.

Figure 9: Route 7 impact point retractable bollard

6.3.5. Approach Route 8

This approach route starts on Quebec Avenue taking a left hand bend onto Baltic Avenue and then a right hand bend onto Tylers Avenue, crossing Chichester Road. There are two impact points at the High Street, as shown on Figures 11 and 12.

Figure 10: View along Tylers Avenue from the impact point

Figure 11: Route 8 impact point

Figure 12: Route 8 impact point

6.3.6. <u>Approach Route 9</u>

This approach route is straight from York Road, crossing the Junction with Chichester Road and then impacting High Street. At the impact point there is some street furniture (cycle racks and planter) blocking some of the vehicle access.

Figure 13: York Road impact point with High Street

6.3.7. <u>Approach Routes 10</u>

Approach route 10 uses Heygate Avenue taking a left on the one way street towards Alexandra St and then impacting the High Street.

Figure 14: Heygate Avenue Approach route

Figure 15: View - Heygate Avenue one way street

Figure 16: Approach route 10 impact point

Figure 17: Approach route 10 impact point rising bollard down allowing vehicle access.

6.3.8. Approach Routes 11

This approach route considers a vehicle driving through The Royal Shopping Centre for access to the High Street.

Figure 18: View along approach route 11.

Possible entrance into the Royal Shopping centre by a vehicle

Figure 19: Royal Shopping Exit into the High Street

Figure 20: Route 11 impact point

6.3.9. Approach Routes 12 & 13

Approach route 12 is direct from Pier Hill and impacting the South End of the High Street. Approach route 13 is direct from Royal Terrace Road and impacting at the same point with route 11.

Figure 21: View along Route 12 – Pier Hill – from the impact point

Figure 22: View along Route 13 – Royal Terrace – from the impact point

Figure 23: Impact point 12 & 13

6.3.10. Approach Route 14

This approach route starts on Royal Terrace taking a left turn into the Royal Mews and then a right turn impacting the High Street. Where route 14 impacts the High Street there are two bollards in place restricting vehicle access as shown in Figure 25.

Figure 24: View along Route 14

Figure 25: View from High Street towards Royal Mews

6.3.11. Approach Route 15

This approach route starts on Alexandra Street taking a right hand turn towards the car park then into Richmond Avenue prior to impacting the High Street.

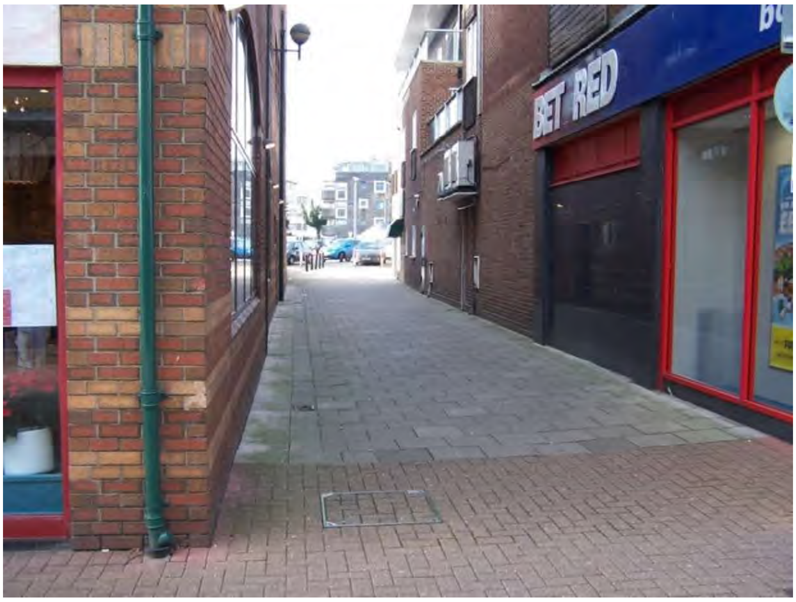

Figure 26: View from High Street impact point towards Richmond Avenue

Figure 27: Route 15 impact point into the High Street

6.3.12. Approach Route 16

Same as route 15 this route starts on Alexandra Street taking a right turn and following the road on Market Place impacting the High Street.

Figure 28: Route 16 impact point in distance.

There are some existing measures to restrict vehicular access

6.3.13. <u>Approach Route 17</u>

Approach route 17 is impacting High Street straight from Alexandra Street.

Figure 29: Alexandra Road approach route

Figure 30: Route 17 impact point.

Retractable bollard down allowing vehicular access.

6.3.14. Approach Route 18

Approach route 18 starts on Clifftown Road taking a right turn into Clarence Road and then turning left into Clarence Street impacting the High Street.

Figure 31: View along Clarence Street from the impact point

Figure 32: Route 18 impact point

6.3.15. <u>Approach Route 19</u>

This approach route starts again on Clifftown Road taking a right turn into Clarence Road then turning left into Weston Road having a final impact on the High Street.

Figure 33: View along Weston Road from impact point

Figure 34: Route 19 impact point – rising bollards down allowing vehicle access

6.3.16. <u>Approach Route 20</u>

This approach route is impacting High Street straight from Clifftown Road.

Figure 35: View along Clifftown Rd from impact point

Figure 36: Route 20 impact point

6.3.17. Approach Route 21

This approach routes starts on Napier Avenue taking a left corner onto Elmer Approach then taking a further right corner on to Luker Road near University of Essex following the open access between the buildings and having a final impact on High Street.

Figure 37: Access route 21

6.3.18. Approach Route 22

This approach route starts on College Way taking a left corner onto Queens Road, then right corner onto Elmer Avenue, then taking the Elmer Approach impacting the High Street.

Figure 38: Elmer Approach leading to High Street impact point

6.3.19. Approach Route 23

This approach route starts the same as route 22 on College Way taking a left corner into Queens Road following the route to the impact point.

Figure 39: Route 23 impact point in the distance

6.3.20. Approach Routes 24 & 25

These approach routes are straight along London Road with route 24 impacting near Santander and route 25 impacting further near Victoria Plaza.

Figure 40: Route 24 impact point is near Santander Bank

Figure 41: Route 25 Impact Point

Approach Route	Dimensions (m)								
	Corner		Approach	Corner		Approach	Corner		Approach
	Radius	Distance		Radius	Distance		Radius	Distance	
1	--	--	--	--	--	123	117	54	177
2	--	--	--	--	--	--	--	--	265
3	--	--	--	--	--	148	37	43	191
4	--	--	--	--	--	48	40	52	328
5	--	--	--	--	--	137	62	104	383
6	--	--	62	38	58	120	--	--	329
7	--	--	--	--	--	--	--	--	284
8	--	--	102	6	8	19	9	12	191
9	--	--	--	--	--	282	78	36	318
10	--	--	--	--	--	--	--	--	291
11	--	--	--	--	--	143	15	23	77
12	--	--	--	--	--	--	--	--	144
13	--	--	--	--	--	--	--	--	167
14	--	--	--	--	--	47	13	17	108
15	--	--	236	15	19	47	21	24	83
16	--	--	263	8	8	40	7	8	62
17	--	--	--	--	--	--	--	--	337
18	--	--	90	13	21	129	8	11	146
19	--	--	90	13	21	53	13	20	139
20	--	--	--	--	--	--	--	--	243
21	--	--	153	25	40	126	12	19	41
22	--	--	48	18	29	117	25	40	42
23	--	--	--	--	--	48	18	29	121
24	--	--	--	--	--	--	--	--	303
25	--	--	--	--	--	--	--	--	232

Table 1: Corner Radii and Approach Distances

6.3.21. It should be noted that although high kerb stones may offer a deterrent against smaller vehicles; other vehicles such as 4x4's, vans and lorries can easily overcome these obstacles without significant loss of speed.

6.3.22. The kinetic energy of the vehicle must be dissipated by the HVM measure as this relates to the vehicle's destructive capability. Therefore it is possible that a larger, slower vehicle will be more destructive than a smaller, faster vehicle.

6.3.23. The assessment is based on little to no traffic on the road. It can therefore be assumed that during peak periods of traffic the potential impact speeds could possibly be reduced. However, it should be considered that a determined attacker would utilise other members of the attacker cell to disrupt traffic flow to allow an attack on a particular target.

6.3.24. The tables below show the results of the assessment in terms of impact speed (mph) and kinetic energy (kJ) for each of the approaches to the site perimeter. These should be read in conjunction with the figures.

Approach route	Final Impact Velocity (mph) / Energy (kJ)											
	1.5Te		2.5Te		3.5Te		7.5Te		18Te*		30Te**	
1	56	470	46	529	43	647	36	971	29	605	29	2521
2	65	633	52	675	49	840	41	1260	33	783	33	3264
3	37	205	31	240	35	428	32	767	31	691	25	1873
4	70	734	55	756	52	946	45	1517	36	932	36	3885
5	74	821	57	812	55	1058	47	1655	38	1039	39	4559
6	70	734	56	783	52	946	45	1517	37	985	37	4104
7	67	673	53	702	50	874	43	1386	34	832	34	3465
8	58	504	47	552	44	677	36	971	29	605	29	2521
9	52	405	46	529	51	910	44	1451	36	932	36	3885
10	67	673	52	675	50	874	42	1322	35	881	35	3672
11	41	252	34	289	34	404	26	507	21	317	21	1322
12	52	405	43	462	41	588	33	816	27	524	27	2185
13	55	453	45	506	43	647	35	918	28	564	28	2350
14	48	345	39	380	37	479	30	674	24	414	24	1727
15	42	264	36	324	34	404	27	546	21	317	21	1322
16	38	216	32	256	31	336	24	432	19	260	17	1082
17	71	756	56	783	53	982	45	1517	37	985	37	4104
18	52	405	43	462	41	588	33	816	27	524	27	2185
19	52	405	42	441	40	560	32	767	26	486	26	2026
20	62	576	50	624	47	773	40	1199	32	737	32	3069
21	36	194	30	225	29	294	22	363	17	208	17	866
22	52	405	43	462	41	588	33	816	27	524	27	2185
23	48	345	40	400	38	505	31	720	24	414	24	1727
24	67	673	52	675	50	874	42	1322	35	881	35	3672
25	62	576	49	600	47	773	39	1140	32	737	32	3069

Table 2: Speed and Energy Assessment

Notes:

Values in red indicate maximum barrier design values.
* Denotes vehicle mass taken to be 7.5Te as noted in IWA14, although vehicle could carry additional mass.
** Denotes vehicle is not considered a UK threat vehicle and can be discounted unless specific threat assessments highlight this vehicle size should be considered.

6.3.25. It should be noted that the following provisions have been made within the assessment of the vehicle speed as follows:

1. All routes assume that traffic at junctions has been halted by means of deception, to allow clear runs at the target. This would be considered reasonable when considering a well-planned attack.

   Should the risk be considered a lone wolf then the approach speeds may be lower than reported in this report due to the fact that the driver would have to follow normal city traffic flow until such a time that they can back up traffic to gain maximum speed within a shorter space.

2. The speeds determined are based on current road layout and impacts against the proposed barrier lines. Measures to alter the long approach routes may assist in reducing the speed of the larger vehicles. However, this is not seen as feasible within the surrounding environment.

3. The vehicle speed of large trucks, 7.5Te, are limited to 80kph.

7. CONCLUSIONS

7.1. The tables in the previous section provides a summary of the expected, worst case, vehicle impacts at the proposed HVM line, based on the most likely attack vehicle. The results should be viewed in conjunction with the approach diagrams shown in Figure 1. These have been determined based on kinetic energy; the destructive capability of the vehicle.

7.2. It is noted that the vehicle speeds fall within the range stated in the test standards which typically limit the impact speed to 80kph.

7.3. The design of the HVM scheme should consider ways in which vehicle speed could be reduced with the use of chicanes, throttles, central reservations, and managed access control and safe/holding zones on the approach routes if possible to act as a secondary layer of protection and ensure vehicles need to make sharp turns, rather than the sweeping turns currently available. These forms of speed management systems require some driver skill and enforce a positive steering input in order to overcome.

7.4. Although consideration should be given to reducing the speed of vehicles as they approach the site, attention should be paid to the likely risks from all vehicle types when selecting products, or mitigation measures.

7.5. The results indicate that the impact from a 30Te vehicle is more onerous. However, it is generally considered that a vehicle of this type is not likely to be used as an attack vehicle in the UK. Therefore, the most onerous vehicle type is the 7.5Te (N2A) vehicle as this generates the higher impact energies.

7.6. Although consideration should be given to reducing the speed of vehicles as they approach the site, attention should be paid to the likely risks from the larger types of vehicle when compared to a 7.5Te attack vehicle.

- The availability of 7.5Te vehicle through the UK's hire company networks means that these vehicles are easily obtainable, and do not look out of place on the site road network, in particular as delivery vehicles.
- The 30Te vehicles are not very manoeuvrable, and would require a skilled driver to be able to obtain the maximum credible impact speeds the above assessment has determined.
- There are very few vehicle barrier products available that are capable of withstanding an impact from this type of vehicle as the mass of the vehicle is so great.
- These types of heavy goods vehicle (HGV) require specialist training and licenses to operate, which makes obtaining the vehicles more difficult than smaller types.
- Untrained drivers are likely to raise suspicion while driving on the public road network due to erratic driving and poor vehicle control. Although with modern gear change systems these vehicles are becoming easier to drive and poor driving should not necessarily be relied upon.

7.7. It should be noted that the test data that forms the IWA14 specification [12], for an 18Te vehicle (classified by its gross weight), was derived from a test vehicle with an unladen weight of 7500kg.

7.8. Although the base (unladen) weight of this vehicle is the same as that of the 7.5Te vehicle, they are distinctly different types of vehicle due to their rated payload capacity. The chassis design, cabin position and construction of the vehicle is such that its ride height is greater than a 7.5Te vehicle: although a protection measure (barrier or bollard) may disable the 18Te vehicle by catching and removing the axle from the vehicle body, the chassis rails, cabin and load platform may well overcome the barrier and continue to penetrate the protected zone by virtue of the vehicle's momentum.

7.9. Based on the impact predictions, HVM measures should be specified in order to ensure the maximum stand-off from the protected areas. However, the final barrier position should take into account a number of factors:

- Underground obstructions – Are there basement structures where it would not be feasible to construct VSBs over the top due to concerns regarding the structural adequacy.
- Land boundary issues – does the public footpath share a boundary with a third party and therefore requiring permission to place measures across the footpath, within 1.2m of the building line.
- Utilities – The ideal barrier position may be in a location that has a number of utilities either close to the surface or heavily congested. It may be more cost effective when considering the associated cost risk benefits that the position is amended to aid construction
- Existing Street Furniture – Can the proposed barrier line incorporate measures of existing street furniture, either by enhancement or strategic placement of street furniture locations and density to deter an attacker using a particular route.
- Archaeology.

7.10. The HVM barriers or other items of street furniture should also consider the following key issues when specifying VSB products:

- Is the system temporary or permanent?
- What is the working life of the equipment and is it suitable for the site specific environment?
- What is an acceptable timescale for barrier deployment?
- How easy is it to change the physical protection to meet changing threat levels?
- Consideration should be given to the allowable penetration distance, if any, of a vehicle which is disabled by the HVM measure. If the standoff from the protected site is limited, a tighter specification of HVM measure should be considered.
- The vehicle entry points should form a vehicle interlock with two lines of barrier.
- Will active measures be monitored?
- Depending on barrier type other less onerous vehicle types may need to be considered; i.e. a boom barrier tested to resist a N2A type vehicle may not catch the chassis of a M1 vehicle and therefore greater penetration may be likely.

8. RECOMMENDATIONS

8.1. The results indicated in Table 2, above, detail the maximum impact energies at each of the areas discussed.

8.2. An IWA14 classification is provided in Table 3 for each of the areas which is typically described as follows:

V/7200[N2A]/80/90/5

where; 'V' denotes a vehicle impact test type
'7200' denotes the test vehicle weight
'80' denotes the impact speed (in kph)
'90' is the impact angle to the front face of the bollard
'5' denotes 5m penetration

8.3. The results should be viewed in conjunction with the approach routes highlighted in Figure 1. These have been determined based on kinetic energy; the destructive capability of the vehicle.

8.4. It is proposed that the HVM solution is permanent with a mixture of passive and active (manually operated) measures. It is generally recommended that vehicle entry points provide an interlock with the use of two lines of active barrier, to ensure that the HVM line is maintained at all times. However, the active barriers will be permanently closed during day time and open out of hours and therefore no vehicle access will be permitted and as such vehicle interlocks are not considered a requirement for this project.

8.5. Pedestrian areas will need to be provided with permeable barriers; these can be formed from bollards to suit the architectural intent. It should be noted that clear spacing between these measures must be no greater than 1.2m measured at 600mm above ground level.

8.6. It may be possible to repurpose or enhance existing street furniture to form a suitable line of protection.

8.7. Where protection is required against oblique impacts (e.g. kerb-side protection on approaches that run parallel to building), the barrier classification may be reduced by resolving the impact energy into perpendicular and parallel components, this is appropriate for continuous barrier types, but not for discrete barriers such as bollards, where an impact on a single bollard will impart the full energy of the vehicle.

8.8. Based on the calculations in Section 6 above, the design impact speeds are as follows:

Ref	Location	HVM Measure	Design Impact Speeds
1	Queensway		V/7500[N3]/64/90:10
2	Victoria Avenue		V/7500[N3]/80/90:10
3	Queensway		V/7500[N3]/64/90:10
4	Southchurch Road		V/7500[N3]/80/90:10
5	Southchurch Road		V/7500[N3]/80/90:10
6	Warrior Square		V/7500[N3]/80/90:5
7	Whitegate Road		V/7500[N3]/80/90:10
8	Tylers Avenue		V/7500[N3]/64/90:5
9	York Road		V/7500[N3]/80/90:5
10	Heygate Avenue		V/7500[N3]/80/90:5
11	Queens Mall		V/7500[N2]/48/90:5
12	Pier Hill		V/7500[N3]/64/90:10
13	Royal Terrace		V/7500[N3]/64/90:10
14	Royal Mews		V/7500[N2]/64/90:5
15	Richmond Avenue		V/7500[N2]/48/90:5
16	Market Place		V/7500[N2]/48/90:5
17	Alexandra Street		V/7500[N3]/80/90:5
18	Clarence Street		V/7500[N3]/64/90:5
19	Weston Road		V/7500[N3]/64/90:5
20	Clifftown Road		V/7500[N3]/64/90:5
21	Luker Road, open access		V/7500[N2]/48/90:5
22	Elmer Approach		V/7500[N3]/64/90:5
23	Queens Road		V/7500[N3]/64/90:10
24	London Road		V/7500[N3]/80/90:5
25	London Road		V/7500[N3]/64/90:10

Table 3: Design Impact Speeds

8.9. Consideration can be given to products that have been tested to the N2A vehicle type, however it should be understood that due to the difference in impact height the penetration distance is likely to be greater if impacted by a N3C vehicle.

8.10. Please note the recommendation of a maximum 10m penetration, which will allow the vehicle to pass the line of the barrier, but will be disabled.

8.11. We have selected 10m penetration as there appears to be a suitable buffer zone prior to the main crowded areas of the town, along the High Street. This also opens up the number of products available within the market.

8.12. However, should site constraints dictate that the line of the barrier needs to be located closer to the crowded places then consideration should be given to a reduction of the penetration distance, whilst taking into account the direction of vehicle travel and therefore debris dispersal.

8.13. A penetration distance of 5m has been chosen for areas where the line of barriers will be closer buildings.

8.14. The following products would be considered suitable where a penetration distance of 5m or less is required.

Passive Measures

ATG Access	Centurian
ATG Access	SP1000
ATG Access	Shallow Mount 1200
Cova Security Gates Ltd	CSG 10850 Shallow Depth static bollard
Heald Ltd	Mantis 80 fixed
Hill and Smith	Bristorm Impeder 50 HD
Marshalls Mono Ltd	Rhinoguard 75/50 planter frame

Active Measures

ATG Access	Gem Bollard
ATG Access	Titan Rising Bollard
ATG Access	SP 1000
Avon Barrier Corporation Ltd	SB970 CR Scimitar
Eagle Automation	I-400 retractable
Frontier Pitts Ltd	Terra ATRB
Heald Ltd	HDT-1 Raptor
Perimeter Protection Germany GmbH	Elkosta Cronus SP275-1100

8.15. In addition to the above products the following products would be considered suitable where a penetration distance of 10m or less is required.

Passive Measures

ATG Access	SP200
Heald Ltd	Mantis Mk 2
Marshalls Mono Ltd	Rhinoguard 75/50
Safetyflex Barriers	Truckstopper 5
Safetyflex Barriers	Truckstopper 9

Active Measures

Calpipe Industries	PDT1200
Delta Scientific	Delta DSC720
Eagle Automation	50A Retractable Bollard
Elgoteam	BLG-05
Frontier Pitts Ltd	Rising Terra Universal Bollard
Marshalls Mono Ltd	7500/80 Rising Bollard
Perimieter Protection Germany GmbH	Bollard M50
Tescon Security	TC-RB275/1100 CR925

8.16. The above lists are not exhaustive, but give an indication to the types and amount of products that are available. The option drawings detail alternative layouts and products that we have assessed as being suitable for the differing levels of protection, and these may differ from the list above.

8.17. It should be noted that the above recommendations are based on the selection of products that meet the PAS / IWA test criteria and as such this is deemed to be the top level of protection.

It is understood that the associated costs of these elements may exclude the full deployment of this level of protection and therefore a risk assessment should consider each area and the possible use of measures to other standards such as PAS 170 or VADS.

8.18. Where tested measures are not available then further consideration should be given to layering of standard elements of street furniture to act as a deterrent. It should be noted that this may not act as a delay mechanism but may create a disturbance and as such raise an alert to something happing allowing the public to move away to safety.

8.19. In all cases the 'Do Nothing Option' should be avoided.

9. FURTHER INFORMATION REQUIRED

9.1. The information listed below will not have a significant effect on the conclusions of this report. However, they are given as items that will need to be considered should the project be taken forward to design development or construction.

9.2. No account has been taken of the existing services at this time. It is noted that there are numerous services within the proposed HVM areas identified and as such service diversions maybe required in some locations. Based on experience, programming a diversion could take up to 6 months to complete prior to works commencing on the diversion.

9.3. Information on the location of the current services routes should be requested from the utility service providers as soon as possible.

9.4. We recommend that a topographical and GPR survey of the proposed HVM areas is carried out prior to any works being undertaken to identify and locate the various services routes in these areas.

9.5. Any service clashes identified should be investigated and clarified with the use of trial holes.

9.6. In addition there may be unknown services that cannot be identified (potentially live or dead) by undertaking the above measures.

9.7. All information relating to services will need to be included within the construction health and safety file.

10. REFERENCES

[1] CPNI, *Hostile Vehicle Mitigation Guide (HVMG)*, September 2010 (RESTRICTED)

[2] CPNI, *Catalogue of Impact-Tested Vehicle Security Barriers* (RESTRICTED, continuously updated)

[3] Cabinet Office, '*Security Policy Framework*' Version 2.0, March 2009 (Restricted)

[4] Cabinet Office Security Policy Division and the Security Service; '*The Counter Terrorist Protective Security Manual*', April 2003 (Restricted)

[5] NaCTSO, '*Hostile Mitigation Guide'* (RESTRICTED)

[6] NaCTSO, '*Counter Terrorism Protective Security Advice for Commercial Centres'*

[7] Secured by Design, '*Commercial Developments V2'*, 2015

[8] NaCTSO, *'Crowded Places Guidance – Commercial Centres'*, 2017

[9] CPNI, *'Protecting Against Terrorism'*

STANDARDS

[10] PAS 68 : 2013 – Specification for Vehicle Security Barriers

[11] PAS 69 : 2013 – Guidance for the selection, installation and use of vehicle security barriers

[12] IWA 14-1 : 2014 – Vehicle Security Barriers – Part 1: Performance Requirement, vehicle impact test method and performance rating

[13] IWA 14-2 : 2014 – Vehicle Security Barriers – Part 2: Application