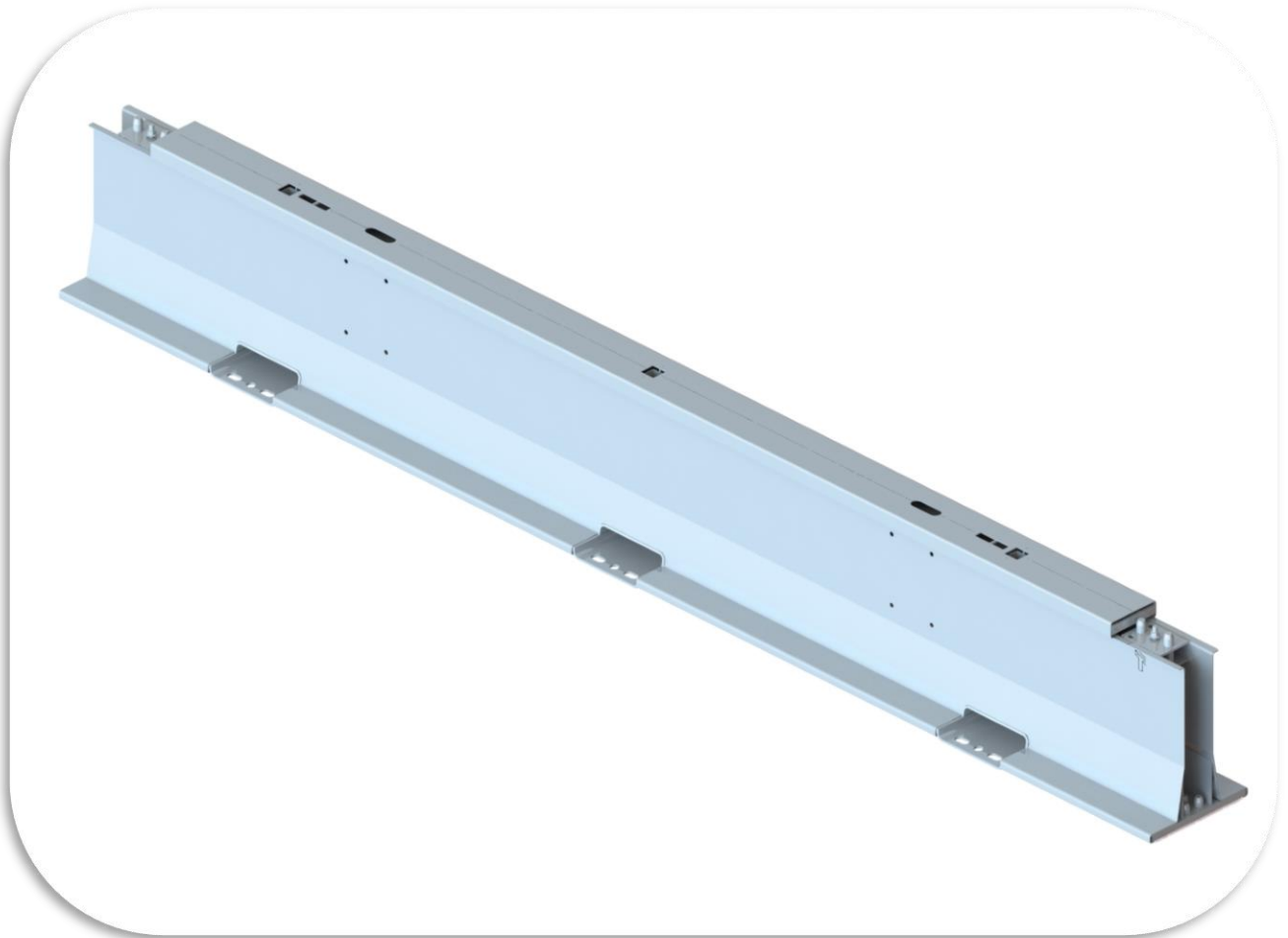




# HighwayGuard™ LDS

## Australia & New Zealand Product Manual





## Revision History

Issue	Date	Prepared by	Approved by	Reason for change
1.0	Sept 2019	O. Pulling	L. Hotchkiss	First issue.
1.1	Nov 2020	O. Pulling	A. Marsh	Absorb M added. Recycling & traceability sections added.
1.2	March 2021	O. Pulling	A. Marsh	QuadGuard M10 added.
1.3	April 2021	O. Pulling	A. Marsh	4-12 test data added.
1.4	May 2021	A. Marsh	O. Pulling	12m section & TAU M added.
1.5	August 2021	A. Marsh	O. Pulling	3-11 test data updated.
1.6	November 2022	A. Marsh	O. Pulling	ArmorBuffa added.

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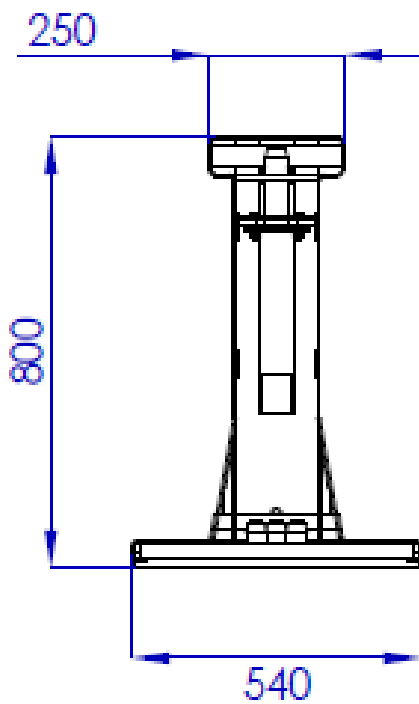
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## Introduction

HighwayGuard™ is a MASH 16 TL-3 & TL-4 compliant steel safety barrier. The 6m single barrier section, with the unique T-Connector provides quicker installation, removal and separation of barrier sections. It also offers the ability to remove sections within a run to create access gaps, replace damaged sections or alter barrier runs.

HighwayGuard™ is an anchored steel safety barrier that can be used in temporary and permanent applications.



Containment Level	Weight	Standard Barrier Length
MASH TL-3 & TL-4	99Kg per Metre	6m



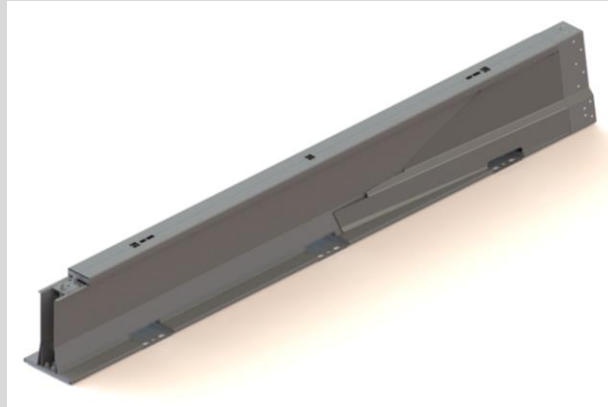
## System Components

6m Barrier	12m Barrier	End Cap	
 552kg	 1034kg	 27kg	
Standard T-Connector	2.5 Degrees T-Connector	5 Degrees T-Connector	10 Degrees T-Connector
 43kg	 60kg	 60kg	 60kg
Wheelsets	2.5 Degrees Barrier	5 Degrees Barrier	10 Degrees Barrier
 27kg	 133kg	 134kg	 136kg

Note: Weights are approximate only.



### 6m HighwayGuard™ to BG800™ Transition



614kg

## Design Considerations

It is important that HighwayGuard™ is planned/designed and installed in accordance with this manual and any approval/regulatory conditions placed upon its acceptance use in that territory.

### Delineation

Reflective delineators may be required for both permanent and temporary applications. The specification (size, shape, colour, position) can vary in accordance to meet local regulations/requirements.

### Drainage

HighwayGuard™ has a 10mm drainage gap underneath the barrier. Additional drainage provision is provided at anchor points. The water drainage per 12m section is approximately 1.15sqm.

### Pavement Types

HighwayGuard™ has been tested installed on asphalt pavement that is 150mm asphalt concrete over a granular subbase.

Alternative ground conditions may be acceptable but could require different anchor solutions.

### Install Lengths

The permissible length of the system is unlimited, but the barrier must be anchored at the end of each run and intermediately as required by the system type.

The recommended minimum length of barrier is 60m (TL-3) & 84m (TL-4) to replicate test set up. Installing with tested anchor spacing is recommended to replicate test deflections and working widths.



## Curves

The T-Connector can allow an approximate angle of up to  $0.23^\circ$  for vertical connections and  $0.77^\circ$  between barrier sections for horizontal connections. Example horizontal curves;

Method	Description	Approximate Radius (m)
1	6m Barrier Section with Standard T-Connections at maximum angle	177
2	6m Barrier Section with $2.5^\circ$ T-Connection	140
3	6m Barrier Section with $5^\circ$ T-Connection	70
4	6m Barrier Section with $10^\circ$ T-Connection	35
5	6m Barrier Section with $10^\circ$ Barrier Section and Standard T-Connection	41
6	12m Barrier Section with Standard T-Connections at maximum angle	354
7	12m Barrier Section with $2.5^\circ$ T-Connection	280
8	12m Barrier Section with $5^\circ$ T-Connection	140
9	12m Barrier Section with $10^\circ$ T-Connection	70
10	12m Barrier Section with $10^\circ$ Barrier Section and Standard T-Connection	82
11	$10^\circ$ Barrier Section with Standard T-Connection	6.6
12	$10^\circ$ Barrier Section with $10^\circ$ T-Connection	3.6



## Deflection/Clear Zone

HighwayGuard™ is designed to absorb energy when impacted. When impacted between anchors deflection occurs. No hazards or obstacles should be in the deflection area such as kerbs, work materials/equipment.

Vehicle roll should be considered with taller vehicles as these may protrude beyond the barrier deflection during impact.

## Crash Cushions/Other Connections

Crash cushions should be used when impact to either the approach or departure end of a run of HighwayGuard™ may occur.

Current Crash cushions/ Connections available;

- Highway Care BG800™ Transition (MASH Compliant)
- QuadGuard M10 (MASH Compliant)
- TAU M (MASH Compliant)
- Absorb M (MASH Compliant)
- ArmorBuffa (MASH compliant)
- QuadGuard CZ (NCHRP 350 Engineered)
- Tau II (NCHRP 350 Engineered)

An engineered connection is one that has been designed and jointly agreed by Highway Care and the crash cushion developer as acceptable for use. These may also require approval from relevant road authorities – check road authority approval for guidance on acceptable options available in your market.

## Modifications

No modifications are allowed to HighwayGuard™ components without prior approval from Highway Care.





## Crash Testing & Performance Levels

HighwayGuard™ has been tested to the MASH (2016), a brief guide showing performance levels and individual tests required is shown below for reference.

Test Standard	Performance Level	Test Reference	Vehicle Type	Impact Speed (km/h)	Impact Angle (°)	Vehicle Mass (kg)
MASH	TL-3	3-10	Light Car	100	25	1100
		3-11	Pickup	100	25	2270
		3-21	Pickup	100	25	2270
	TL-4	4-10	Light Car	100	25	1100
		4-11	Pickup	100	25	2270
		4-12	Truck	90	15	10000

System Type	Anchor Interval (m)	Test Standard	Performance Level	Dynamic Deflection (m)	Working Width (m)
HighwayGuard™ Lowest Deflection System (LDS)	12 <sup>1</sup>	MASH 16	TL-3	0.68	1.22
	24 <sup>1</sup>		TL-3	1.08	1.62
			TL-4	1.16	2.88

<sup>1</sup> LDS System has staggered anchors – refer to installation section for further detail.



## Installation

HighwayGuard™ must be installed in accordance with this manual and with the latest state road authority conditions. Where conflict arises road authority conditions take priority over this manual.

## Planning

Prior to starting an installation, it is recommended that the customer informs the installer of;

- Start/end positions and alignment requirements of each barrier run (including crash cushions)
- Curvature (horizontal and vertical) required to ensure appropriate components available
- Installation site risks identified (e.g. overhead cables, bridges, tunnels, drilling limitations)
- Traffic management measures in place to ensure appropriate and safe working space

## Tools List

(T)ool / (C)onsumable	Information
(T) Magnetic T-Bar Socket	For inserting and removing the T-Connector security nut.
(T) Drilling Equipment	Electric or air driven rock drill. Suggested drill bits are 28mm (M24 resin anchors) 400mm long.
(T) Measuring Wheel & (C) Road Marking Paint	To mark barrier position where required.
(T) 2 off 2m crow bar/wrecking bar	To assist with minor barrier re-alignment.
(T) Sledge Hammer	To hammer in anchor pins.
(T) Cranked Crow Bar	Useful for removing tight pins.
(T) Timber Blocks	To aid installation/removal on uneven ground.
(T) Wrench	With 36mm socket.
(C) Resin	Resin for M24 threaded anchor



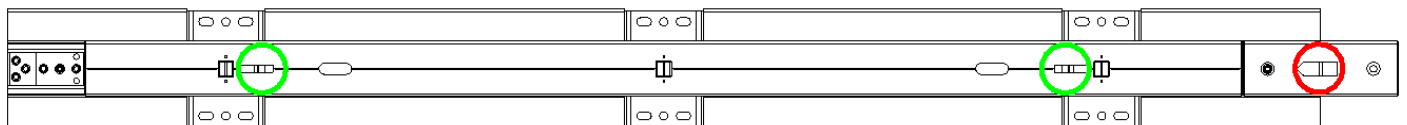
## Lifting points

### Caution

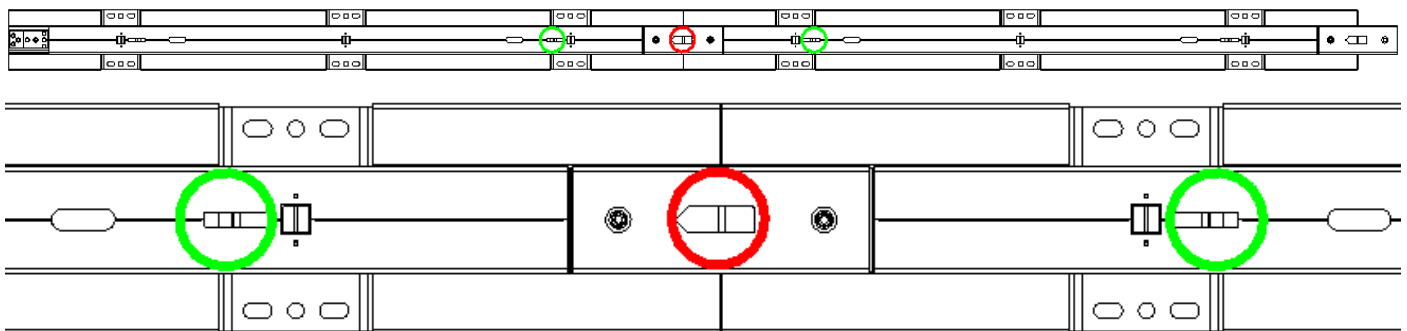
Do not use the T-Connection lifting points to lift barrier sections (highlighted by red circles). These are for lifting the T-Connection only.

Ensure lifting equipment is certified and in a safe/useable condition.

Each 6m barrier section has two designated lifting points allowing hooks to attach marked in green below.



When two 6m sections are bolted together they can be lifted as a single 12m piece using the lifting points either side of the central T-Connection.



Note: There are also lifting points on the underside of the HighwayGuard at the feet locations.

Lifting Equipment	Information
Mechanical/Pneumatic Lifting Device	Such as a lorry mounted crane or wheeled excavator. It must have suitable lifting capacity and reach to install HighwayGuard™.
Lifting Chains	Two leg assembly with a 2500kg lifting capacity, each chain is 2m long c/w hook, locking clasp and shortening clutch.
Tag Rope	Suggested 1.5 times the lifting height of the barrier.



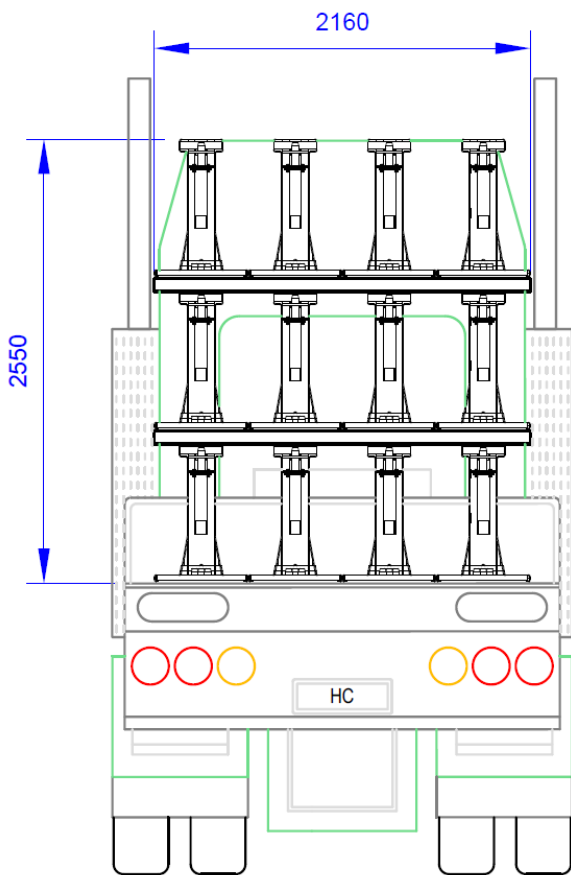
## Loading/Unloading

### Caution

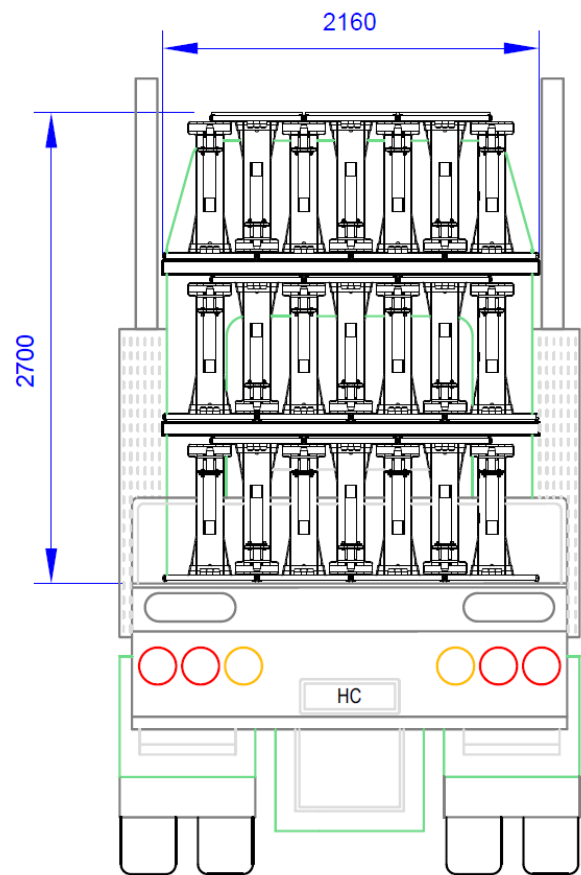
Ensure all barrier sections are secured to the truck bed with adequate ratchet straps prior to transport movements.

HighwayGuard™ can be inverted to maximise the length of barrier per load.

Check local regulations for potential weight/transport restrictions.



144m Upright



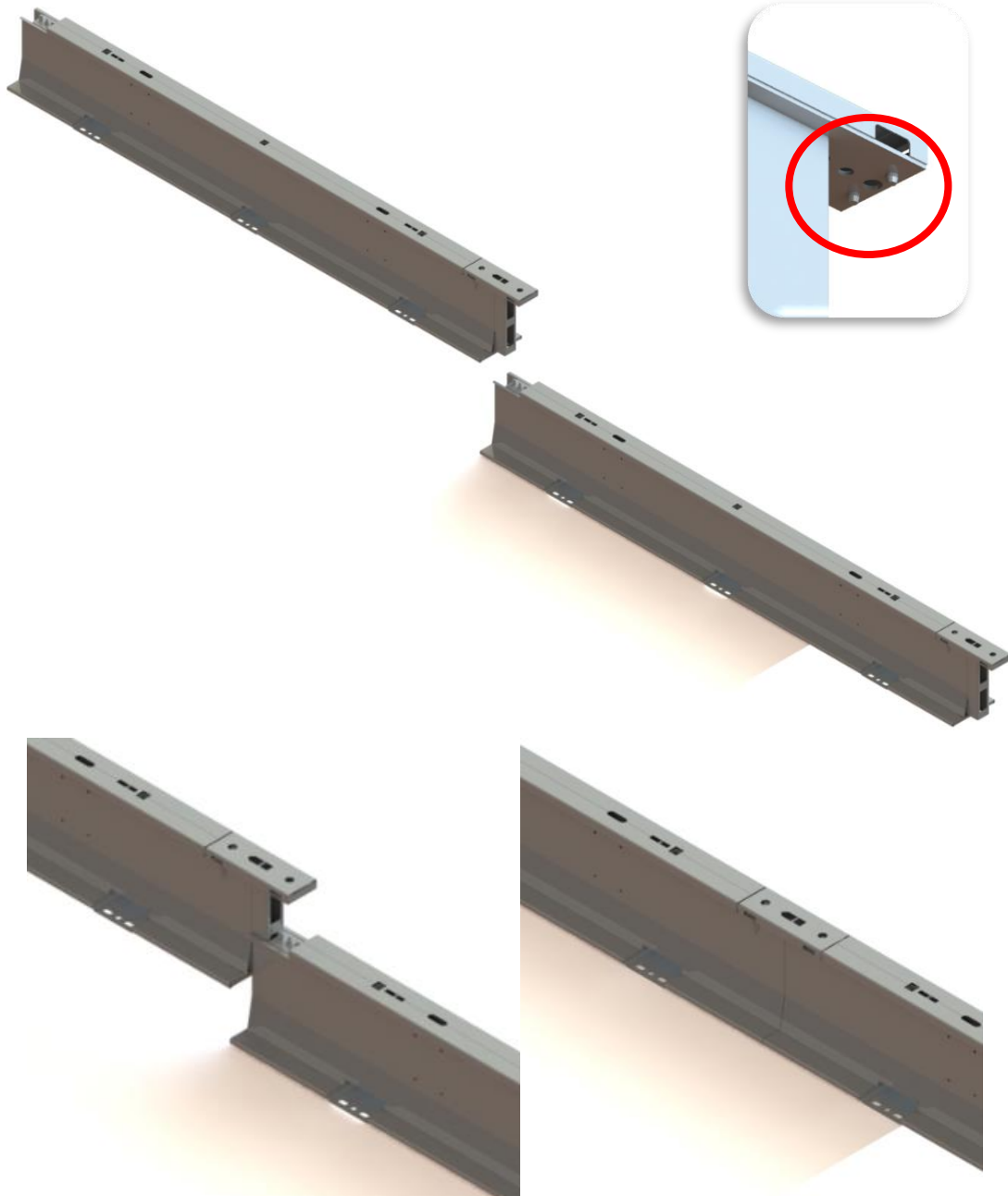
252m Inverted

When loading with the T-Connection attached to barrier sections; position these so that they will match the orientation of the install to avoid turning barrier round on site. Typically they will be at the rear of the trailer.



## Connection

Barrier sections are lowered into position with the T-Connection already attached to the end of the barrier that is being joined to the run of barrier. Ensure orientation of T-Connector allows alignment pins to be lowered onto next section.



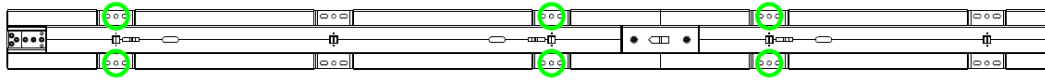
## Caution

Ensure all barrier sections being lifted have a tag line attached. Joining barrier sections presents a crush risk, ensure operator has clear view and communication ability when barriers are being aligned and connected.

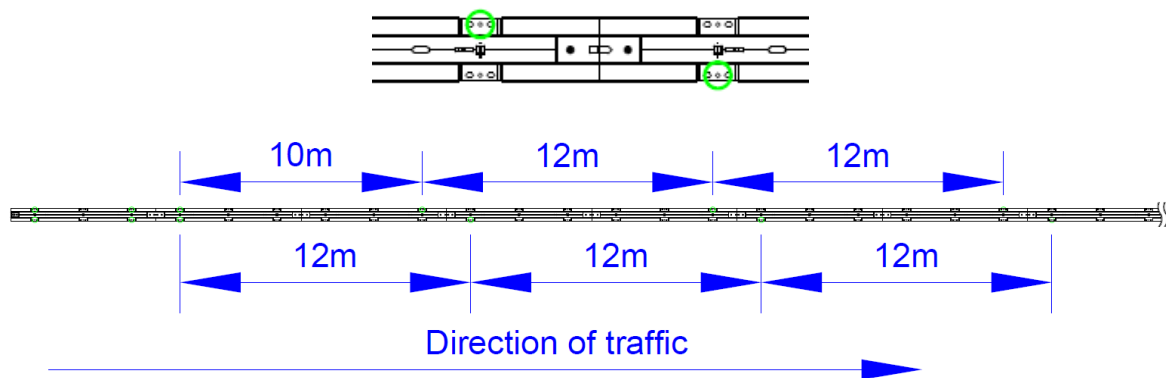


## Anchoring

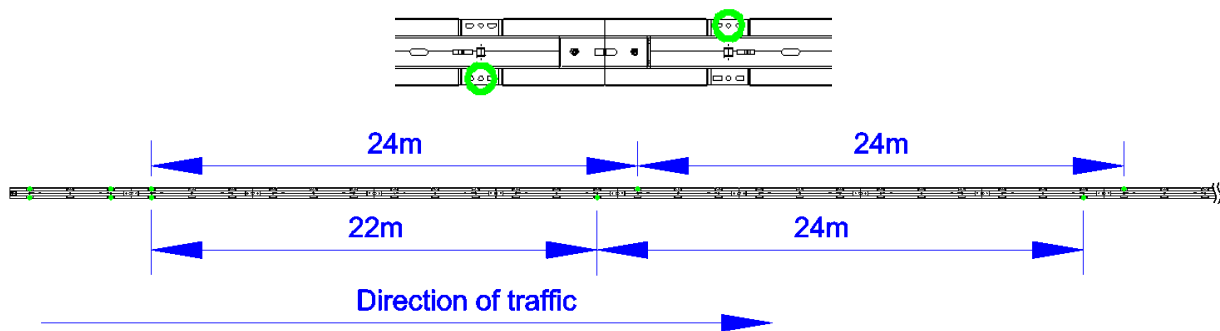
HighwayGuard™ is anchored with a minimum 6 anchor points at the first and last sections in a run of barrier. This will be in the first and last two 6m barrier sections as shown;



For the lowest TL-3 containment (see testing section) the anchors are spaced every 12m staggered over the T-Connection.



Alternatively, for TL-3 or TL-4 containment (see testing section) the anchors are spaced every 24m staggered over the T-Connection.



Crash cushions or connections/transitions should be used when impact to either the approach or departure end of a run of HighwayGuard™ may occur. Currently accepted are;

- Highway Care BG800™ Barrier Transition (MASH Compliant). See drawing HG-70-03 for anchor arrangement for this transition.
- QuadGuard M10 (MASH Compliant)
- TAU M (MASH Compliant)
- Absorb M (MASH Compliant)
- ArmorBuffa (MASH compliant)
- QuadGuard CZ Crash Cushion (NCHRP 350 Engineered).
- Tau II Crash Cushion (NCHRP 350 Engineered).



The LDS system was tested with M24 grade 8.8 resin threaded bar (28mm drill bit) with 300mm embedment for TL-3 & 400mm embedment for TL-4.

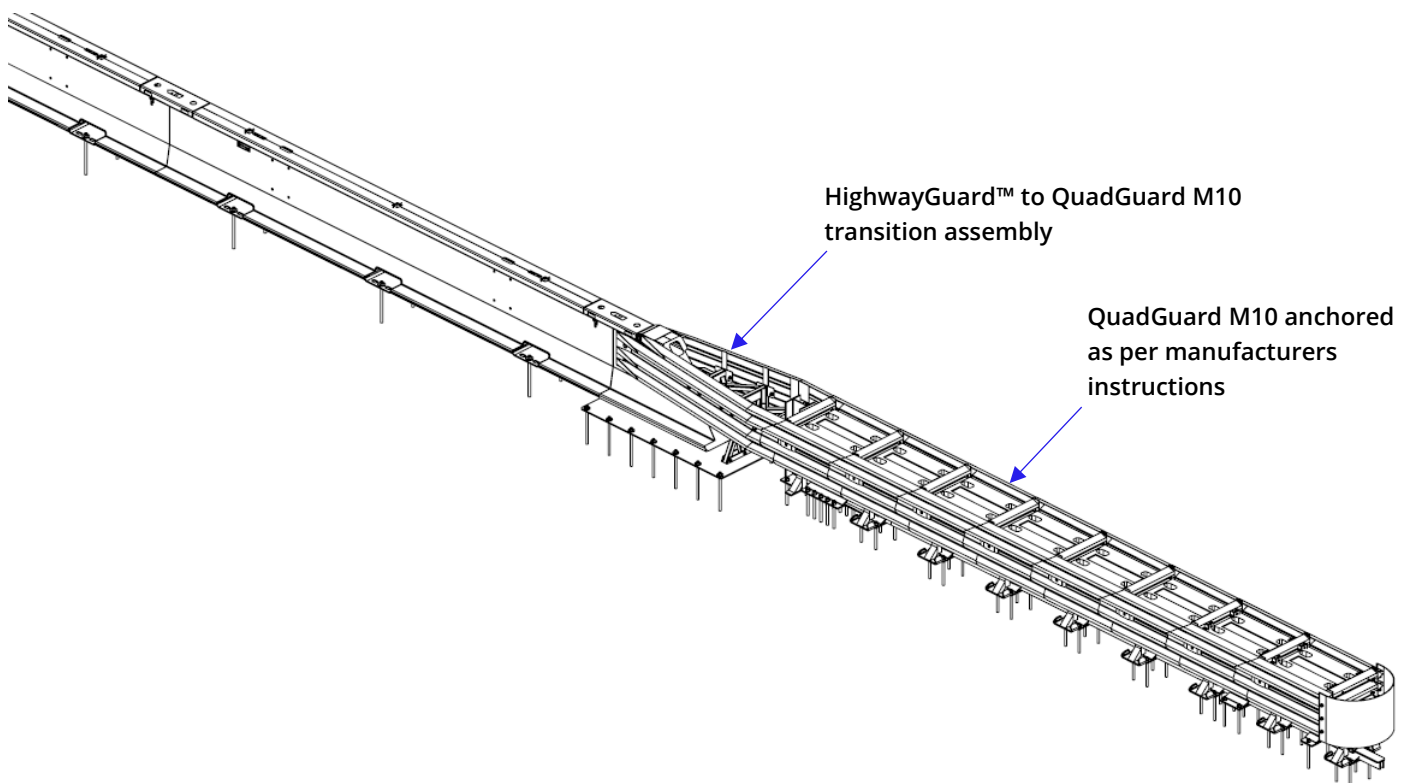
For additional anchor details and information, please refer to drawing: HG-60-12 – HighwayGuard Foundation Details.

When using crash cushions (both NCHRP 350 or MASH) the HighwayGuard™ barrier must be anchored at the start and end of runs at the following anchoring locations.



These anchors are to be M24 grade 8.8 resin threaded bar (28mm drill bit) with 400mm embedment.

In addition to the HighwayGuard™ barrier anchors above when using the QuadGuard M10 transition assembly this must also be anchored with 14 off M20 grade 8.8 resin threaded bar (24mm drill bit) with 400mm embedment as shown below (7 anchors either side of the transition assembly).





## Barrier Removal

To remove the barrier sections it is the reverse of the installation process. Namely;

- Unbolt from the ground
- Remove security nut from the side of the T connector you wish to separate
- Lift barrier section and T connector from adjoining
- If the section of barrier being removed lifts the next section, place a 50mm high block under the foot of the section being removed next to the joint to be separated and lower the barrier. It will then separate.



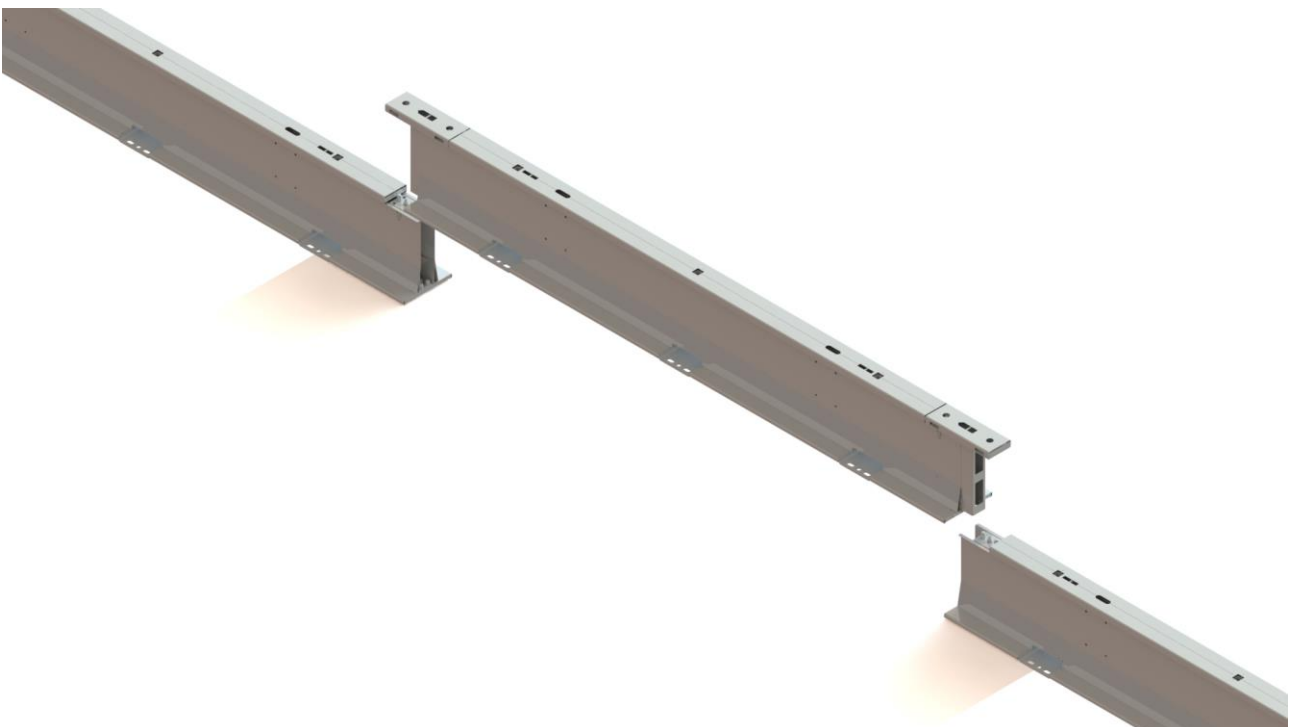
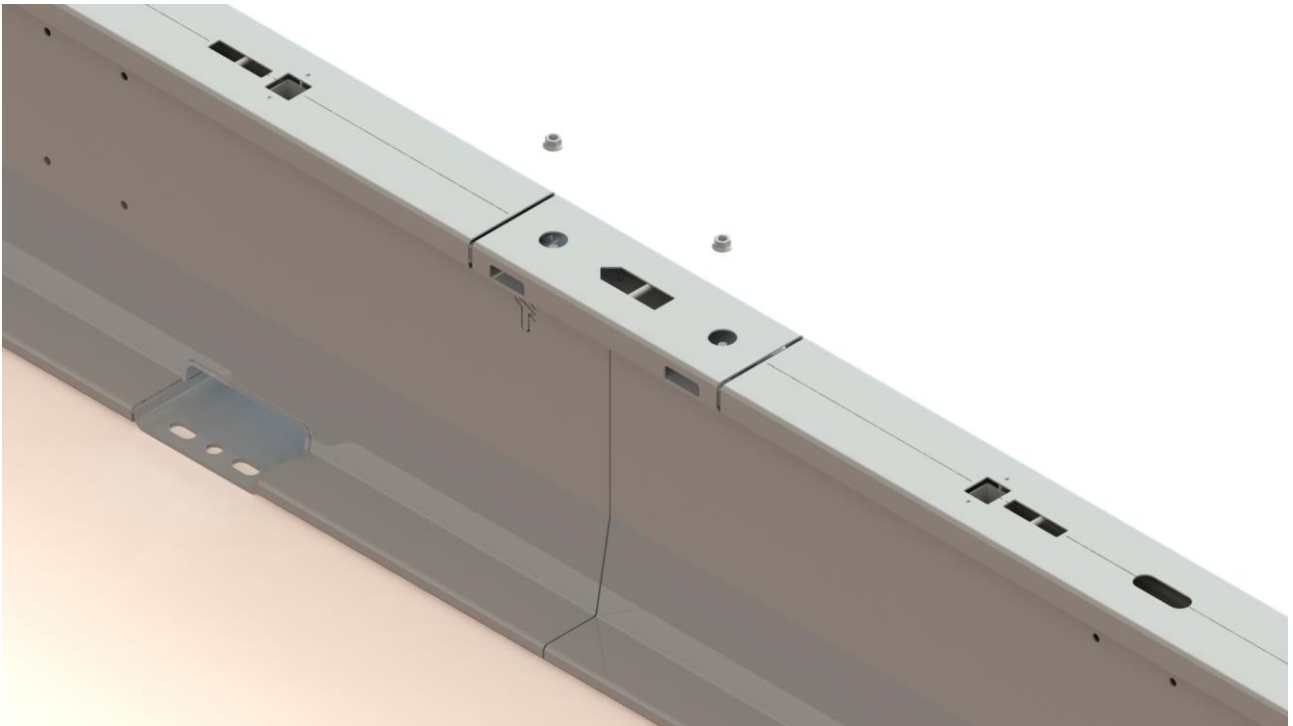




## Special Operations

### Creating Access Gap

Lift out individual sections by disconnecting the T-Connection and removing the security nut. The section can now be lifted out.





## Bridges

Where possible anchoring should take place off bridge decks. Any anchoring on bridge decks needs to be agreed in advance with the technical expert responsible for the bridge to ensure it is not damaged. If anchoring either side of a bridge deck expansion joint then this movement must be mirrored in the barrier by utilising a variable length barrier section.

## Wheelsets

These allow barrier sections to be manoeuvred without lifting machinery/equipment such as installing in tunnels or areas with overhead restrictions.

The wheelsets can be raised and lowered from the top of the barrier using a manual wrench and 24mm socket.

### Caution

Impact guns should not be used to operate the wheels.

## Pavement

HighwayGuard™ has been tested on asphalt pavement that is 150mm asphalt concrete over a granular subbase. The LDS system was tested with M24 grade 8.8 resin threaded bar (28mm drill bit) with 300mm embedment for TL-3 & 400mm embedment for TL-4.

Always ensure the resin manufacturer's installation/application instructions are adhered to.

HighwayGuard™ LDS system was tested on an asphalt pavement, anchored to the ground with threaded rod set with a chemical resin, based on trials conducted at the test facility it is recommended that the resin anchor is able to withstand a pull out force of 95kN.

Alternative ground conditions may be acceptable but might require different anchor solutions.

## Maintenance and Repair

HighwayGuard™ is generally a maintenance free barrier. It is recommended that some basic maintenance is carried out of the system every 10 years, this involves a visual check for signs of corrosion/damage both outside and inside the barrier.

For wheeled sections ensure that they are raised/lowered and maneuvered around, greasing the jacking mechanism if required on an annual basis.

Any damage to the galvanised coating should be repaired with zinc rich paint to prolong the life of the barrier.

Damage after vehicle impact will need to be assessed on a case by case basis by a competent person, typically low angle impacts will not warrant barrier replacement. Significant impacts will mean damaged sections will need to be lifted out and replaced.



## Recycling

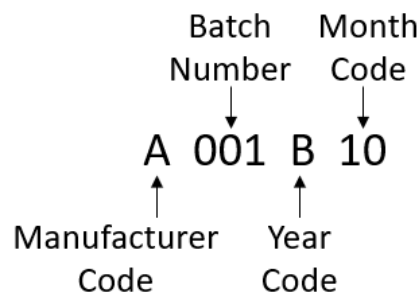
HighwayGuard™ barrier and its T-Connectors are steel manufactured and this is commonly recyclable around the world. It may be necessary to remove T-Connectors to split HighwayGuard™ assemblies into 6m barrier sections only – contact authorised recycling centres for guidance.

## Traceability

HighwayGuard™ is supplied with a small permanent sticker identifying product name and website - example below;



In addition, barrier section & T-connectors are serialised with the following format;



Contact Highway Care for further information.

## Permanent Applications

For permanent applications the following conditions apply;

- M24 threaded bar with resin is recommended for anchoring.
- After initial installation it is recommended that the site is revisited after 1 month for inspection. After this it is recommended a thorough inspection is carried out every 5 years.



## Appendix

### Frequently Asked Questions

#### 1) What type of equipment is required to install HighwayGuard™?

Suitable lifting equipment such as a Franna crane with hook lifting chains, marking and drilling equipment (e.g. Hilti or compressed air rock drill), magnetic socket. Please refer to the tools and lifting equipment section.

#### 2) What ground conditions are required to install HighwayGuard™?

HighwayGuard™ has been tested installed on asphalt pavement that is 150mm asphalt concrete over a granular subbase.

Alternative ground conditions may be acceptable but could require different anchor solutions.

#### 3) What other barriers can HighwayGuard™ attach to?

There is a tested transition to Highway Care BG800™.

#### 4) Does HighwayGuard™ require anchoring?

HighwayGuard™ is an anchored system and must always be anchored as a minimum with 6 anchors at the start and end of the barrier run if not connecting into BG800™ (when connecting to BG800™ refer to drawing HG-70-03 for anchor arrangement).

Intermediate anchoring may also be required and the frequency for the LDS system is every 12, or 24m.

#### 5) On average, how long does it take to install HighwayGuard™?

Depending on the application and circumstances at the site, experience of the workforce, equipment available, pre-assemble taken place, once the ground conditions are suitable installation of a trailer with twelve 12m assemblies can be completed in under 20 minutes.

#### 6) What testing has HighwayGuard™ been approved to?

HighwayGuard™ has been tested to the American standard MASH at TL-3. Please see the testing section for further details.

#### 7) Can HighwayGuard™ be installed in any temperature/humidity environment?

HighwayGuard™ can be installed in the majority of environments. Large temperature swings may make it desirable to use the slotted anchor points to allow barrier movement.

#### 8) What maintenance does HighwayGuard™ require?

HighwayGuard™ is a low maintenance barrier system that requires minimal maintenance. See the maintenance and permanent applications section of this manual for further details.

#### 9) What is the expected lifespan of HighwayGuard™?

HighwayGuard™ has an expected lifespan of over 20 years. This is dependent on maintenance regime and site specific environment.

#### 10) What is the smallest run of barrier and the largest available?

The permissible length of the system is unlimited but the barrier must be anchored at the end of each run and intermediately as required by the system type.



The recommended minimum length of barrier is 10 sections (60m) to replicate test set up. Installing with tested anchor spacing is recommended to replicate test deflections and working widths. There is no maximum limit but consideration for works access must be given.

**11) I need to achieve a really low deflection as I am working with limited space, what are my options?**

HighwayGuard™ Lowest Deflection System (LDS) might be the best option for this application. With the increased anchor intervals at 12m spacing deflection is reduced. Refer to crash test deflection results and it may be appropriate to risk assess the deflection figure using the calculated deflection tables in this manual.

**12) I want to install HighwayGuard™ on a bridge deck, is this possible?**

HighwayGuard™ can be installed on bridge decks in both permanent and temporary situations.

Depending on the project it may be possible to anchor either side of the bridge deck expansion joints.

Where anchoring on the bridge deck is required it may require project specific anchor details and possibly a variable length HighwayGuard™ section for the bridge expansion joint.

**13) What drainage capability does HighwayGuard™ have?**

The water drainage per 12m section is approximately 1.15sqm.

**14) How close to excavations can it be placed?**

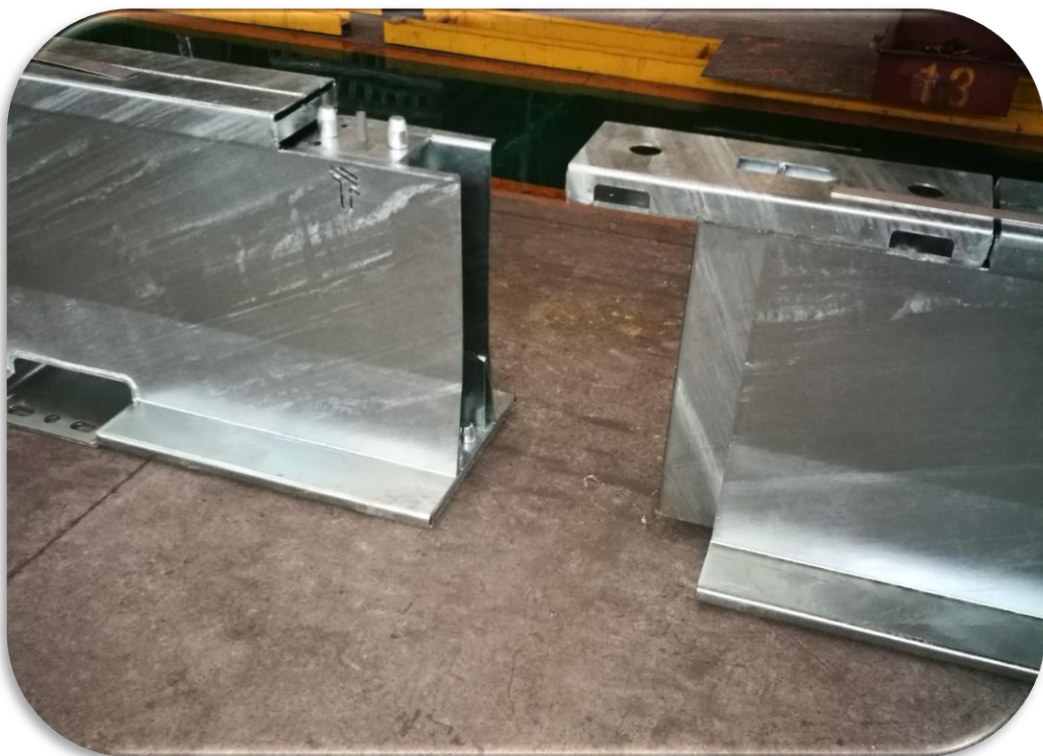
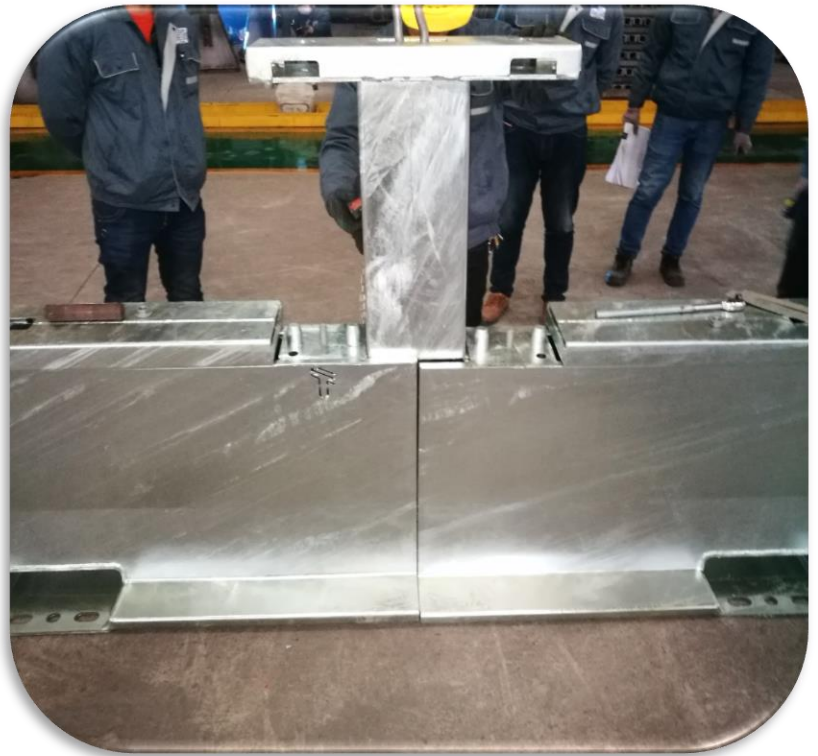
Anchors need to be a minimum of 0.68m away from excavation edge.

**15) Can access gaps be created in the middle of a long run of barrier?**

The T-Connection allows section to be removed easily from a run by crane. All that needs to be done is remove the security nut from two T-Connectors and lift the whole section vertically upwards.



**Photo Examples**





## Risk Assessments

Hazard	Scenario	Precautions to minimise the risk	Method
Injury to head	Loading and unloading barrier Manoeuvring barrier Installing barrier	Use of PPE (hard hats) Competent crane operator/banksman Operative to be vigilant	Instruction Training Training
Injury to hands	Loading and unloading barrier Manoeuvring barrier Installing barrier	Use of PPE (gloves) & correct tools Competent crane operator/banksman Operative to be vigilant	Instruction Training Training Training
Injury to feet	Loading and unloading barrier Manoeuvring barrier Installing barrier	Use of PPE (safety boots) Competent crane operator/banksman Operative to be vigilant	Instruction Training Training
Load slipping from crane	Loading and unloading barrier Manoeuvring barrier	Use certified approved slings/lift equipment Competent operative	Inspection Training
Uncontrolled Load	Loading and unloading barrier Manoeuvring Barrie	Use correct tag rope Competent operators Establish correct safety zones	Training Training Training
Slinger falling from vehicle/load	Loading and unloading barrier Manoeuvring barrier Installing barrier	Safe access and egress to vehicle and load Operative to be vigilant	Training Training
Injury from site traffic	Loading and unloading barrier Manoeuvring barrier Installing barrier	Correct site management procedures Operatives to be vigilant	Training Training
Injury from traffic	Loading and unloading barrier Manoeuvring barrier Installing barrier	Correct traffic management procedures Operatives to be vigilant	Training Training



Working on a Live Carriageway

When working on a live carriageway, a safety zone is required between the working area and the live traffic lane. It is not possible to install HighwayGuard™ unless such a safety zone is provided. It is suggested that a minimum area of not less than 0.5 metres will be required between the HighwayGuard™ and the safety zone.

Coring/Drilling for installation of anchor system

Hazard	Precautions to minimise the risk	Actions
Electrocution Damage to underground services	Before installation procedure: Inspect service plans; Use cable locating equipment and mark the position of underground apparatus. Inspect drill & drill bit	Training
Injury to eyes	Use of PPE (goggles)	Training
Injury to ears	Use of PPE (ear defenders)	Training
Dust inhalation	Use of PPE (dusk mask)	Training
Injury to skin from chemical anchor resin	Use of PPE (gloves)	Training
Injury from traffic	Correct traffic management procedures followed and operatives to be vigilant	Training

Righting Inverted Units/Inverting Units

Hazard	Precautions to minimise the risk	Actions
Load slipping	Use certified slings Use competent slinger	Inspection Training
Injury to heads	Use of PPE (hard hat)	Instruction
Injury to feet	Use of PPE (steel toe capped safety boots)	Instruction
Injury to legs	Undertake operation in safe restricted area under control of competent banksman and crane operator	Training & Instruction
Death or injury as a result of manoeuvring truck	All truck movements under control of competent banksman	Training
Injury from collision with passing traffic	Correctly installed traffic management	Training





### Installation Checklist Example

Installation Checklist				Barrier Run Information		
	Print Name	Sign Name	Date	Location;		
Installed by;				Number of runs;		
Inspected by;				Overall Length;		
				Project Number;		
HighwayGuard™				Applicable Section; Yes or No		
Is the site suitable for HighwayGuard™?				Yes	N/A	No
Are the pavement conditions suitable?				Yes	N/A	No
Are the anchors selected suitable for the pavement condition?				Yes	N/A	No
Are all the components available?				Yes	N/A	No
Are any crash cushions installed correctly?				Yes	N/A	No
Are the start and end of the barrier run installed correctly with all 6 anchors installed?				Yes	N/A	No
Are all the QuickLink security nuts installed?				Yes	N/A	No
Has any intermediate anchoring been used? If so, note the spacing here _____				Yes	N/A	No
If BG800™ transition has been used does the anchoring arrangement match how it was tested?				Yes	N/A	No
Check there are no snagging points (more than 10mm)				Yes	N/A	No
Delineators installed?				Yes	N/A	No