

# BTN 001

## Traffic Barriers for Structures

10 August 2023  
Version 2.2



### 1. Scope and Application

Bridge Technical Note (BTN) 001 – Traffic Barriers for Structures – states the Department of Transport and Planning's (DTP) requirements for different types of traffic barriers for structures. This BTN is divided into 3 parts:

- Part 1 – Traffic Barriers for Bridges
  - Barriers (Section 3)
  - Off-structure Barriers (Section 4)
  - Median Barriers (Section 5)
- Part 2 – Traffic Barriers for Culverts/Underpasses and Retaining Walls
- Part 3 – Bridge Support Protection

Bridge Technical Notes are a Code of Practice. Compliance with Bridge Technical Notes is mandatory.

BTN 001 is to be read in conjunction with DTP Standard Sections:

- Section 630 – Fabrication of Steelwork
- Section 631 – Protection Treatment of Steelwork
- Section 680 – Bonded Anchors

For the requirements on protection of noise attenuation walls, gantry and cantilever sign supports, refer to BTN 007 Noise Attenuation Walls and DTP Road Design Note (RDN) 06-13 Guidelines for the Protection of Gantry and Cantilever Sign Supports.

For further requirements of guard fence transition to concrete barriers, refer to the DTP Standard Drawings SD3951-3956 (Guard Fence to Concrete Barrier Transition).

Other than as stated in this document and relevant DTP standard sections, the provisions of AS 5100:2017 apply. Where this document differs from AS 5100:2017, its requirements override those of AS 5100:2017.

DTP was formerly known as Department of Transport (DoT) and VicRoads. DTP documents that must be complied with include all relevant DoT and VicRoads documents.

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**Bridge Technical Notes are subject to periodic review and may be superseded.**



## Document Control

This document is subject to periodic review and may be superseded. The revision date is listed in this BTN.

Note that for projects tendered prior to the revision date of this document, there are no retrospective implications of this document unless agreed otherwise with DTP.

Version	Description	Revision	Approved by
1.1	General Amendments	June 2018	Principal Bridge Engineer
2.0	New BTN combined and updated: BTN 001 – Bridge traffic barriers BTN 002 – Bridge approach barriers BTN 003 – Bridge support protection Added traffic barriers for culverts, underpasses and retaining walls.	4 Nov 2022	Chief Engineer – Roads
2.1	Updated DoT to DTP Reference to BTN 007 Noise Attenuation Walls added Updated Appendix F for sketch of bridge support protection	22 Feb 2023	Principal Engineer Structures
2.2	Updated Part 1 <ul style="list-style-type: none"><li>Section 2 to clarify the definition of bridge</li><li>Section 3.1 to clarify the requirements of barriers for bridges with SUP</li><li>Section 3.4.3 to update the shape requirements</li><li>Section 3.5.3 to specify the conditions for holding down bolts of steel posts</li></ul> Updated Part 2 Sections 2 and 4 to specify the requirements for barriers of retaining walls Updated Part 3 Sections 4 to revise the requirements for the protection of new and existing bridge supports Updated Appendix E and F to reflect the revised requirements for bridge support protection	10 Aug 2023	Senior Manager Roads Engineering



### 1. Scope and Application

BTN 001 Part 1 states DTP's requirements for the design of traffic barriers including on-structure, off-structure and median barriers for bridges (as defined in Section 2).

### 2. Definitions

<b>Bridge</b>	A structure designed to carry a road or path over an obstacle (or other open area) by spanning it. * All the requirements for traffic barriers for bridges are also applicable to the following structure types (as specified in Part 2): <ul style="list-style-type: none"> <li>• Major culvert/underpass structures with a total structure height &gt; 3 m.</li> <li>• Retaining walls located inside the Lateral extent of hazard (L<sub>A</sub>) with a height &gt; 3 m.</li> </ul>
<b>Bridge influence</b>	The effect that the presence of a bridge and the use of rigid or semi-rigid bridge barriers have on the hazard faced by road-users approaching the bridge – for example the risk of pocketing and of a vehicle impacting the end of the bridge barrier. This necessitates higher performance level roadside barriers on the bridge approaches that would not be required in the absence of the bridge.
<b>Gore</b>	The triangular area (usually surfaced and possibly linemarked) situated at the point where exit or entry ramps diverge / converge with the main carriageway.
<b>Hazard</b>	Any object or feature located between the edge of a traffic lane and the road reserve boundary, or within a median, that could cause significant personal injury to road users when impacted by an errant vehicle. This includes, but not limited to, rigid objects (e.g. a concrete bridge barrier or bridge barrier end-post), steep non-drivable batters (steeper than 6:1), vertical drops, waterways, railway, road, or high occupancy land.
<b>Lateral extent of hazard (L<sub>A</sub>)</b>	Minimum extent is given in Appendix A1 of this BTN as the Clear Zone.
<b>Performance level(s)</b>	As defined in AS 5100.1.
<b>Rigid barrier</b>	A rigid barrier is defined as a barrier designed to have no movement of the barrier system. They include continuous concrete barriers and/or steel post and rail systems on top of the concrete barriers that behave in a rigid manner, i.e. limited deflection without the need for remedial works after being impacted.
<b>Semi-rigid barrier</b>	A Semi-rigid barrier is defined as a steel post and continuous rail system.
<b>Working width</b>	The distance between the traffic face of the road safety barrier system before the impact and the maximum lateral position of any major part of the system or vehicle during and after the impact (AS 3845.1:2015).

### 3. Barriers

#### 3.1. General

Section 3 applies to all barriers on bridges except for the median barriers (refer to Section 5.1 of this Part for their applicability).

For bridges with a pedestrian/cyclist or shared user path (SUP), traffic barriers designed in accordance with this Section must be provided between the road carriageway and the pedestrian/cyclist (SUP) path as per AS5100.1. Where the posted speed is 60 kph or less and a 300 mm min high non-mountable kerb is located between the road carriageway and the pedestrian/cyclist (SUP) path, a traffic barrier may not be required subject to the approval of the DTP Chief Engineer – Roads.

## 3.2. Performance Level Selection

The barrier performance level must be determined in accordance with the process described in AS 5100.1 including Appendix A.

The selection of the performance level is based on an assessment of the risks relevant to the bridge site. Where the risk profile varies, the most critical risk must be considered to determine the barrier performance level for the whole length of the bridge.

Reference is made to the following performance levels:

- No barrier.
- Low performance level barriers.
- Regular performance level barriers.
- Medium performance level barriers.
- Special performance level barriers\*.

Where these terms are used, they have the meaning as defined in AS 5100.1.

\* The design loads and effective height criteria for Special performance level barriers must utilise the 44 t articulated van barrier performance level, as defined in AS 5100.2 Appendix A2 and A3. Special performance level barriers must be provided as per AS 5100.1 Clause 14.5.6 and Appendix A5. Site-specific justification must be based on a risk assessment, with particular emphasis on third party risk for situations.

Special performance level barriers must be adopted for bridges on freeways over passenger rail lines in metropolitan areas.

### 3.2.1. Test Levels

All barriers must be designed for the specific performance level in accordance with this BTN. For the design of barriers, no consideration must be made of test levels or the implied equivalence of test levels to performance levels that is given in Table 14.4 of AS 5100.1 unless otherwise stated in this BTN.

## 3.3. Design Loads

All barriers must be designed in accordance with the requirements of AS 5100 for the minimum design loads given in:

- (i) AS 5100.2 Table 12.2.2 for Low, Regular, and Medium performance level barriers, or
- (ii) AS 5100.2 Table A2 44 t articulated van for Special performance level barriers.

### 3.3.1. Design for Maintenance

All designs must include provisions to enable an efficient and safe replacement of a damaged barrier. The frequency and extent of repairs of the weak components must be minimised for impacts less than the design loads of appropriate performance level. Further, the replacement of barriers must not result in any damage to the deck. For all crash impacts, the design transverse and longitudinal loads must only be distributed over a maximum deck length of 9 m or 4 number of posts, whichever is less. The deflection of the steel rail due to impact must be limited to 1/180 of the distributed length as mentioned above.

To minimise the damage to the support system and the need for reconstruction which could arise from a collision, the barriers, barrier connections and supporting systems must be designed as a progressive strength system so that the barriers and connections fail prior to the failure of the supporting system.

## 3.4. Geometry

### 3.4.1. Types of Barrier System

Only semi-rigid and rigid barriers (refer to Section 2 for definitions) must be used on bridges over the entire length of the bridge.

For Medium and Special performance level barriers, rigid barriers must be adopted.

### 3.4.2. Height

Barriers must have the height appropriate to the required performance levels as described in:



- (i) AS 5100.2 Table 12.2.3 for Low, Regular, and Medium performance level barriers, or
- (ii) AS 5100.2 Table A3 44 t articulated van for Special performance level.

### 3.4.3. Shape

#### 3.4.3.1. Concrete barriers

The front profile (i.e. roadside face) of concrete barriers must have the F-shape barrier profile as illustrated in AS 5100.1 Figure 14.6.1 (A) and the drawings referred to therein. No other shape is permitted for DTP assets.

Any additional devices installed on the barriers must comply with the barrier shape requirements.

A minimum of two number 90 mm diameter conduits must be provided within the concrete barriers on both sides of the bridge as shown in Figure 3.4.3.

The parapet tail length must extend a minimum 50 mm below the top of the keeper wall of the abutment, and along the length of the bridge.

The barrier design must provide a uniform length of the concrete barrier units across the bridge where possible.

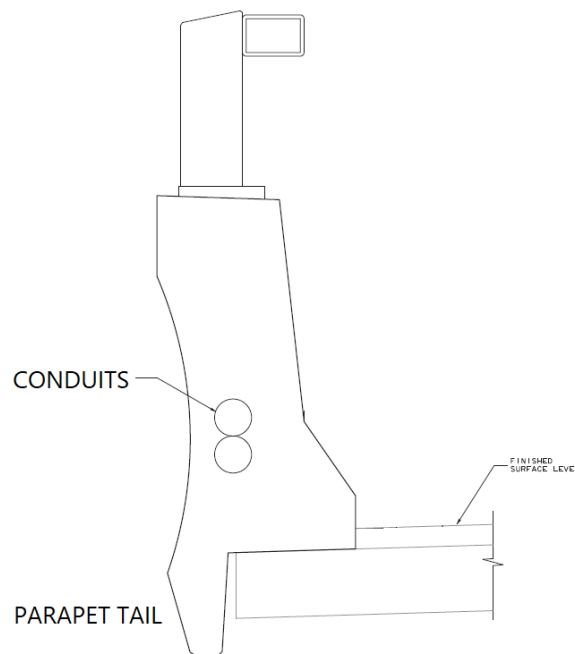


Figure 3.4.3 Standard concrete profile

#### 3.4.3.2. Steel barriers

Steel post and rail type barriers must comply with the requirements of AS 5100.1 Clause 14.6.2.

Posts for steel barriers must be either square or rectangular hollow sections complying with AS/NZS 1163; minimum grade 350 L0. The use of any other sections is not permitted.

Standard square or rectangular hollow sections must be adopted for steel posts and rail to minimise the replacement cost and repair timeframes.

#### 3.4.3.3. Steel and concrete barriers

Combined steel and concrete barriers must comprise a reinforced concrete lower section with the F-shape barrier profile with steel posts and rail(s) to provide the required overall effective height.

For new works, combined steel and concrete barriers can only be adopted for Medium and Special performance level barriers, with a minimum height of concrete section of 900 mm above the finished surface level of the adjacent traffic lane.

## 3.5. Connections and Other Details

### 3.5.1. Mounting Structures

The requirements for barrier-mounted noise attenuation walls, barrier-mounted sign structures and lighting structures, barrier-mounted protection screens and public safety barriers are provided in BTN 007, BTN 014 and BTN 035, respectively.

The exposed surface of the barrier and any barrier-mounted components must not present any safety risk to users.

### 3.5.2. Joints

Barriers of all types must incorporate provisions for expansion and contraction. Movement joints in barriers must be provided at positions that coincide with movement joints in the structure.

The gap between the precast concrete barrier units must be  $10 \text{ mm} \pm 5 \text{ mm}$  unless this is not achievable due to geometric constraints. A formed groove joint must be provided in the in-situ kerb at each barrier joint for crack control to align with the joints of the concrete barriers. The width of the groove must match the gap between the precast concrete barrier units.

Where splices in barrier rails are required, these must be fabricated by full penetration butt welding. Bolted splices are not permitted.

Bolted joints are only permitted at the movement joint locations of the structure. At movement joints, bolts must be orientated vertically to avoid becoming a snagging hazard. Cup head bolts must be used to minimise the snagging hazard.

### 3.5.3. Connections

Anchor bolts and other fixings cast into concrete must be designed to minimise any damage that might occur if the attached post or railing reaches its plastic capacity due to the effect of an impact.

Where there is enough space to remove/install the holding down bolts without removing of railings, the holding down bolts of the steel posts to the concrete barriers must be cast with the nuts embedded and bolts greased to avoid bonding with the concrete, to allow ease of removal during maintenance. Waterproofing protection must be provided to eliminate the ingress of water into the anchor system to prevent corrosion and loss of capacity of the load carrying elements over the required design life thereby compromising its structural performance.

All connections must be assembled and installed in accordance with Section 630.

#### 3.5.3.1. Bonded and mechanical anchors

Retrofitted bonded (adhesive) or mechanical bolts and fasteners must not be used on new works as holding-down bolts or to make connections between traffic barrier components where they may be subject to impact forces or the effects of impact forces. For connections to existing works only, bonded anchors may be considered for steel post and rail systems on top of the concrete barriers. The use of bonded anchors must be in accordance with the requirements of BTN 006 Bonded Anchors and Section 680.

### 3.5.4. Protective Coatings

All steel components and attachments which are not cast in concrete, must have a protective coating that meets the requirements of Section 631. Where no protective coating is specified or the steel components and/or attachments are cast in concrete, steel components must be hot dip galvanised in accordance with Section 631.

## 3.6. Retrofit/Replacement of Barriers

The required performance level for retrofitting or replacing barriers on existing structures must be assessed in accordance with the process described in AS 5100.1 including Appendix A. The bridge deck must be assessed in accordance with AS 5100.2 Clause 12.3 and strengthened, if required. The strength of existing structures and associated structural components (including barriers) must not be reduced in any way.

The design of retrofitted or replacement barriers must comply with Sections 3.1 to 3.5 of this Part and be designed such that their performance is the same as new barrier requirements.



### 3.7. Constructability and Maintainability

In addition to satisfying safety requirements, the design must be detailed to aesthetically harmonise with the structure, avoid unnecessary obstruction of the view from vehicle occupants, and preserve visibility during maintenance and inspections.

## 4. Off-structure Barriers

### 4.1. General

Section 4 covers the design of multiple performance level barrier systems for approaches and departures of the structures defined in Section 1.

The design of bridge off-structure barriers must satisfy the requirements of AS 5100.1 Clause 14.6.3.

If the bridge off-structure barrier is connected to a roadside barrier, the roadside barrier must be continuous with the bridge off-structure barrier system. A transition from the flexible roadside barrier to the more rigid bridge off-structure barrier must be provided at the junction of the two systems. The roadside barrier may overlap the end of the bridge off-structure barrier subject to appropriate allowance for its working width.

### 4.2. Performance Level

The required bridge on-structure barrier performance level must be determined in accordance with Section 3 of this Part.

The bridge off-structure barrier performance level is stepped-down incrementally in accordance with the methodology stated in Appendix A of this BTN to the point where it ends or joins the roadside barrier.

The initial section of bridge off-structure barrier adjacent to the bridge is assigned the same performance level as the bridge barrier.

### 4.3. Length of Bridge Off-structure Barrier (LOB)

The total length of bridge off-structure barrier from the end of the bridge barrier to its termination or connection to the roadside barrier is to be determined in accordance with the methodology given in Appendix A of this BTN. The methodology considers the hazards presented by the bridge and the bridge barrier (bridge influence) and the embankment geometry at the bridge approaches and includes consideration of several specific cases.

The total length of bridge off-structure barrier at each side and end of the bridge may be limited to 110 m if the calculated total length is longer.

### 4.4. Design for Strength

Bridge off-structure barriers must be designed in accordance with the requirements of Barriers (refer to Section 3 of this Part) together with AS 5100.1 and AS 5100.2 for the appropriate performance level.

To minimise the damage to the supporting system and the need for reconstruction which could arise from a collision, bridge off-structure barriers, their connections and support systems must be designed as a progressive strength system so that the barriers and connections fail prior to the failure of the supporting system.


Concrete bridge off-structure barriers and foundation systems may be designed as rigid or semi-rigid systems.

Full continuity must be provided throughout the length of the rigid or semi-rigid bridge barrier and bridge off-structure barrier systems in the lateral direction and with the foundations. In the case of steel railings, splices must be provided by full penetration butt welds.

Non-rigid roadside barriers must be designed in accordance with DTP Supplement to the Austroads Guide to Road Design (AGRD) Part 6.

### 4.5. Geometry and Appearance

The height and shape requirements stated in Section 3 of this Part must be complied with.



At junctions between barriers of different performance level, the top of the lower performance barrier must slope upwards with a maximum taper of 1 in 10 to meet the adjacent higher barrier in accordance with AS 5100.1 Clause 14.6.3. Vertical transitions are to be provided over a full length (6 m) of a precast concrete panel where the taper is less than 1 in 10.

Transitions between barrier widths must comply with the flare rates specified in the AGRD Part 6 (2022) Table 6.9.

## 4.6. Mounting of Sign Structures and Noise Attenuation Walls

Refer to Section 3.5.1 of this Part for requirements.

## 4.7. Undivided Carriageway Bridges

### Approaches

The length of bridge approach barriers on both sides (left and right) must be in accordance with Section 4.3 of this Part for:

- Approach ends for two-way traffic bridge.
- Approach end for one-way traffic bridge.

Where the road is curved, the length of the longest bridge approach barrier on either side (left or right) must be adopted for both sides.

### Departures

Undivided carriageway bridges with one-way traffic must be provided with departure barriers consistent with roadside hazards on the departure end of the bridge. The required length must be determined by consideration of the risk relative to the roadside hazards on the departure end of the bridge.

## 4.8. Divided Carriageway Bridges

The length of bridge approach barriers on both sides (left and right) must be in accordance with Sections 4.3 and 4.7 of this Part, with the following additional requirements.

### 4.8.1. Separated Bridge Decks

#### Approach Barriers

The required length of approach barriers must be determined as follows:

Distance to adjacent bridge (or width of median)  $> L_A$

The length of approach barrier is to protect  $L_A$  or 15 m whichever is greater.

Distance to adjacent bridge (or width of median)  $\leq L_A$

The length of approach barrier is to protect the distance to the traffic lanes on the adjacent bridge (or width of median).

#### Departure Barriers

The required length must be determined by consideration of the risk relative to the roadside hazards on the departure end of the bridge.

If an errant vehicle departing the bridge can impact the bridge barriers on the adjacent bridge, the off-structure barrier on the departure end of the structure must be extended to contain errant vehicles at a 15° divergence angle projected from the adjacent bridge or median side of the traffic (refer Figure B1 in Appendix B).

### 4.8.2. Combined/Single Bridge Deck

#### Approach Barriers – left side

The length of bridge approach barriers must be in accordance with Sections 4.3 and 4.8.1 of this Part.



## Approach Barriers – right (median) side and Departure barriers – both sides

The required length must be determined by consideration of risk relative to the roadside hazards on the departure end of the bridge. Refer to Section 5 of this Part for the requirements of median barriers.

### 4.9. High Risk Areas

Site-specific consideration must be given to the risk of a heavy vehicle leaving the roadway from the left-hand traffic lane (e.g. if the driver becomes incapacitated), bypassing the end of bridge off-structure barrier and failing to brake leading to encroachment into the:

- High-risk area under the bridge, particularly when this is a major roadway or railway, high use land area or deep water.
- Area beyond the Right of Way (ROW) boundary.

The risk-assessment must consider the probable stopping distance of the errant vehicle having regard to the ground surface and its likely condition in all weather conditions. For example, if the ground surface behind the barrier is a well drained flat or near flat, the probability of greater penetration is increased.

If there is a risk that an errant vehicle could bypass the bridge off-structure barrier and penetrate the high-risk area, additional provisions are required. This can be either a longer bridge off-structure barrier or a secondary barrier at the hazard or ROW boundary, or a combination of both.

#### 4.9.1. Gore Areas

The presence and geometry of gore areas can limit the length of a bridge off-structure barrier. There may be a risk of a vehicle leaving the main carriageway and encroaching onto an entry or exit ramp. Equally, vehicles on entry and exit ramps may encroach onto the main carriageway. For sites where the required length of the off-structure barrier (LOB) is curtailed by the presence of a gore area, the bridge off-structure barrier must be extended as far as possible and terminated with a proprietary attenuator at the gore area. Refer to Road Design Note 06-04 Acceptable Safety Barrier Products.

#### 4.9.2. Side Roads and Other Accesses

Special consideration must be given to side roads or access to business or private properties within the length of the bridge off-structure barrier. In these cases, the bridge off-structure barrier must be designed to safely contain errant vehicles at all probable impact angles as far as is reasonably practicable.

Barriers at openings must be curved in plan and must extend either to join a roadside barrier on the side road or to a safe termination using proprietary components in such a fashion that the hazard due to an impact with the end of the barrier is minimised.

Appropriate rigid bridge barrier systems must be extended down a freeway or major arterial entrance and exit ramps a suitable distance to protect against errant vehicles penetrating the freeway or arterial.

#### 4.9.3. End Treatments

Ends of off-structure barriers must be either:

- Designed to ensure acceptable performance on impact at the required performance level for the vehicle(s) under crashworthy consideration.
- Protected by a suitably transitioned traffic barrier and/or proprietary impact attenuation device.
- Connected to a roadside barrier.

Ends of rigid barriers that may be connected to and/or splay away from a non-rigid approach system must be suitably terminated.

End blocks, for example, must be detailed to ensure that the occupants of vehicles and others nearby are protected during an end-on impact.

The end treatment must be in accordance with the relevant sections of the DTP Supplement to the AGRD Part 6.



## 4.10. Connections

Refer to Section 3.5.3 for requirements.

## 4.11. Foundations

Bridge off-structure barriers must be provided with a foundation. The foundation must have sufficient capacity to support the design loads appropriate to the required performance level as defined in AS 5100.2 and modified by this BTN.

## 4.12. Constructability and Maintainability

The design must include provisions to enable an efficient and safe replacement of a damaged barrier.

# 5. Median Barriers

## 5.1. General

Median barriers for structures refer to the barriers that are located between the edge barriers (or parapets) and separate carriageways / ramps in the same or opposite directions and are located on the same structure with a continuous deck – i.e. no openings or vertical drop in the deck which would warrant an edge barrier (refer to Section 3 of this Part for the requirements).

## 5.2. Containment Level Selection

It is desirable that the widths of the median and the type and level of protection provided by a median barrier are consistent with the approaches to the bridge.

Where the requirements above are not practicable, the width of the median may be varied provided that the tapers applied to any changes in width are consistent with the speed environment and provide a smooth driving alignment. A risk assessment such as that detailed within AGRD Part 6 (2022) Section 6 must be undertaken to determine an appropriate level of protection.

## 5.3. Geometry and Other Details

Refer to DTP Detail Sheet – F-Shape Concrete Barrier December 2021 and relevant Standard Drawings for full details (excl. the embedment depth) for F-shape concrete barriers that must be adopted for median barriers.

All median barriers are to be precast reinforced concrete and positively connected to the bridge deck as detailed in Section 5.4.

## 5.4. Connections

The median barriers must be dowelled to the bridge deck or a foundation at 1.0 m spacing using 28 mm diameter dowels of 240 mm length (with 120 mm minimum embedment length) or equivalent (refer to Appendix C of this document for an option of the connections).

Where the total length of the connected precast concrete barriers (e.g. the length between expansion joints) is less than the minimum length requirement for the specific test level barriers, the dowels must either be:

- equivalent of total number of dowels required for the minimum length as per DTP Standard Drawing SD3902 – Concrete Barriers F-Shape Installation; or
- at a minimum spacing of 300 mm.

The dowels must be symmetrically placed on both sides of the longitudinal axis of the barrier and evenly placed along each precast concrete barrier. All precast concrete barriers must have an equivalent number of dowels depending on the length of each unit.

The bridge deck must be assessed to make sure that the connections fail prior to the failure of the deck. Where the deck does not have adequate capacity, it must be strengthened accordingly.



## 5.5. Joints

Median barriers must incorporate provisions for expansion and contraction. Movement joints in barriers must also be provided at positions that coincide with movement joints in the structure.

## 5.6. Bonded and Mechanical Anchors

Retrofitted bonded (adhesive) or mechanical bolts and fasteners must not be used on new works as holding-down bolts or to make connections between traffic barrier components where they might be subject to impact forces or the effects of impact forces. For connections to existing works only, bonded anchors may be considered. The use of bonded anchors must be in accordance with BTN 006 Bonded Anchors and Section 680.

## 5.7. Off-structure Median Barriers

A risk assessment such as that detailed within AGRD Part 6 (2022) Section 6 must be undertaken to determine an appropriate level of protection. Road safety barrier protection must be designed in accordance with AGRD Part 6 (2022), DTP corresponding supplement and Road Design Notes. The required length must be determined by consideration of risk relative to the roadside hazards on both ends of the bridge.

The roadside barrier must be continuous with the bridge-median barrier system. A transition (i.e. a bolted steel plate) from the flexible roadside barrier to the more rigid-bridge median barrier must be provided at the junction of the two systems.

## 6. Design and Proof Engineering

The design of all traffic barriers for bridges must be undertaken by an engineering consultancy that is prequalified in accordance with DTP's Prequalification for Road & Bridge Design in either the Structures – Simple (SS) or Structures - Complex (CS) category.

The traffic barrier system must be Proof Engineered by a Proof Engineer prequalified in accordance with DTP's Prequalification Scheme.



### 1. Scope and Application

BTN 001 Part 2 states the DTP's requirements for the design of traffic barriers including on-structure barriers, off-structure barriers and median barriers for culverts/underpasses and retaining walls (as defined in Section 2).

### 2. Definitions

<b>Lateral extent of hazard (L<sub>A</sub>)</b>	Minimum extent is given in Appendix A1 of this BTN as the Clear Zone.
<b>Major culverts (including underpasses)</b>	Defined as culverts and underpasses with single or multiple cells of a minimum single span or diameter $\geq 1.8$ m or have a single or combined waterway/open area $\geq 3$ m <sup>2</sup> . * The culverts and underpasses referred to in this Part are limited to the total structure height (i.e. from the culvert invert to the top of the culvert, including the link slab, etc. where applicable) is $\leq 3$ m. For culverts and underpasses with a height $> 3$ m, Part 1 of this BTN must be complied with.
<b>Minor culverts &amp; underpasses</b>	Defined as culverts and underpasses with single or multiple cells of a minimum single span or diameter $< 1.8$ m and have a single or combined waterway/open area $< 3$ m <sup>2</sup> .
<b>Retaining walls</b>	Defined as structures constructed to resist pressure from the adjoining ground or to maintain in position a mass of earth (including retaining walls, reinforced soil structures, etc.) with heights $\geq 1.5$ m with a horizontal to vertical slope of equal to or steeper than 1:2 horizontal to vertical ratio (63 degrees) (refer to Appendix D for the definition and geometry of retaining walls). * Barriers for retaining walls that are over 3 m in height and located within L <sub>A</sub> at both top and bottom of the walls, must comply with Part 1 of this BTN.
<b>Working width</b>	The distance between the traffic face of the road safety barrier system before an impact and the maximum lateral position of any major part of the system or vehicle during and after the impact (AS 3845.1:2015).

### 3. General

The requirements of barriers for major culverts/underpasses and retaining walls must follow the same principles and requirements (unless otherwise noted in this Part) as those adopted for bridge on-structure barriers and off-structure barriers (refer to Part 1 of this BTN together with AS 5100.1 and AS 5100.2) and must be determined in accordance with the process described in AS 5100.1 including Appendix A when:

- the vertical drop is  $\geq 1.5$  m; and
- the edge of the vertical drop is within L<sub>A</sub>.

In addition to the requirements stated in this Part, where the retaining walls form the approach or departure of the bridge, requirements for bridge off-structure barriers (refer to Part 1 of this BTN) must be applied.

For structures listed below:

- Minor culvert/underpass structures.
- Retaining walls with height  $< 1.5$  m.
- Major culverts/underpasses and retaining walls with vertical drop  $< 1.5$  m.
- Major culverts/underpasses and retaining walls outside L<sub>A</sub>,

a risk assessment such as that detailed within AGRD Part 6 (2022) Section 6 must be undertaken to determine an appropriate level of protection. Road safety barrier protection must be designed in accordance with AGRD Part 6 (2022), DTP corresponding supplement and Road Design Notes.

Refer to Appendix E for the Barrier Selection Flowchart and Table E1 for examples of different scenarios for the barriers over culvert/underpass structures.

Where the retaining walls form part of the bridge support (refer to Part 3 Section 2 - Definitions), the bridge support protection must be designed to comply with Part 3 of this BTN.

## 4. Barriers and Off-structure Barriers

### 4.1. Barriers on Top of Structures

The barrier performance level must be determined in accordance with the process described in AS 5100.1 including Appendix A.

For structures listed below:

- Culverts/underpass structures with a height  $\leq 3$  m.
- Retaining walls with a height  $\leq 3$  m,

the implied equivalence of test levels to performance levels that is given in AS 5100.1 Table 14.4 can be considered to determine the appropriate barriers when the clearance between the barrier and the hazard can accommodate the required working width for the chosen barrier type in accordance with AGRD Part 6 (2022). Acceptable barrier types are concrete barriers, structural steel rail and post, three-beam barriers, or guard fence (refer to RDN 06-04 Acceptable Safety Barrier Products for the list of acceptable road safety devices for each type).

For the scenarios listed below:

- Culverts/underpass structures with a height  $> 3$  m (as specified in Section 2)
- Retaining walls with a height  $> 3$  m and located within  $L_A$  at both top and bottom of the walls (as specified in Section 2).
- Where it is impractical to provide the nominated embedment or clearance for the proprietary test level barrier system,

the barriers must be designed in accordance with the requirements of Barriers in Part 1 Sections 3 and 4 of this BTN together with AS 5100.1 and AS 5100.2 for the appropriate performance level. The barriers must be provided with a foundation or connected to the structure (i.e. culvert/underpass or retaining wall) or a ground beam designed to take the appropriate loading. The foundation, connection or relevant structure must have sufficient capacity to support the design loads appropriate to the required performance level as defined in AS 5100.2 and modified by this BTN.

For culvert/underpass structures with a traffic barrier between the road carriageway and the shared user path (SUP), a rigid traffic barrier or a barrier with adequate working width to the SUP or a barrier designed in accordance with the Barriers in Part 1 of this BTN must be provided on urban freeways and major arterials with:

- a design speed greater than 80 km/h; and
- high-density pedestrian/cycling use (e.g. the culvert/underpass structure is located near a school, park, sports facility, etc. based on the risk assessment).


### 4.2. Off-structure Barriers for Retaining Walls

For retaining walls with varying height along the elevation, the appropriate off-structure barriers must be provided at locations where the vertical drop becomes less than 1.5 m and continues to reduce in height. The off-structure barriers are to follow the same principles adopted for bridge off-structure barriers for the remaining length of the retaining walls or LOB, whichever is less. Appendix D provides examples of retaining walls with approach barriers.

### 4.3. Barriers in Front (at Bottom) of Retaining Walls

For barriers in front of retaining walls, a risk assessment such as that detailed in AGRD Part 6 (2022) Section 6 must be undertaken to determine an appropriate level of protection with the following additional requirements.

- i. The barrier type and height must be such that the barrier-to-hazard clearance is greater than the barrier working width specified in AGRD Part 6 (2022) Section 6, DTP corresponding supplement and Road Design Notes.
- ii. Where retaining walls are located inside  $L_A$  along freeways:
  - Retaining walls designed to withstand a transverse collision load of 600 kN, uniformly applied over 2.4 m length at a height of 1200 mm, must be provided with a minimum of MASH Test Level 4 (TL4) reinforced concrete protection barrier.
  - Retaining walls that are not capable of withstanding the specified load must be provided with a minimum of TL5 reinforced concrete protection barrier.

- 
- Refer to DTP Detail Sheet – F-Shape Concrete Barrier Dec 2021 and relevant Standard Drawings for full details of reinforced concrete protection barriers.
  - In addition to the conditions specified in the relevant Standard Drawings, if the required barrier height exceeds the heights provided in DTP Standard Drawing SD3901, or it is not feasible to meet other conditions specified in SD3902 (such as minimum length, anchorage, etc.), the barrier must be designed to resist equivalent performance level loads as per Table 12.2.2 of AS 5100.2, applied to the top of the face of the barrier.

## 5. Median Barriers for Culverts/Underpasses

The requirements of median barriers for major culvert/underpass structures must follow the same principles and requirements (unless noted otherwise in this Part) as those adopted for bridge median barriers (refer to Part 1 Section 5 of this BTN).

Where there is adequate vertical clearance, e.g. fill or pavement material, to accommodate the embedment depth or footing of the median barrier over the structure, and adequate working width, the barrier used on the approach to a major culvert/underpass must continue across the structure where the crash risk profile is unchanged.

Where it is impractical to provide the nominated embedment depth or barrier footing, the connection to the culvert/underpass structure, ground beam or a friction slab is required to be designed to satisfy the requirements of Part 1 Section 5.4 of this BTN for F-shape concrete median barriers. The major culvert/underpass structure must be designed and constructed with the necessary capacity to accommodate barrier loadings in accordance with AS 5100.2 where the barrier is proposed to be attached to the structure. For frangible or breakaway systems that do not transfer full crash loads to the culvert/underpass structure, the structure must be designed to accommodate equivalent loadings for the specific system.



### 1. Scope and Application

BTN 001 Part 3 states DTP's requirements for the protection of supports for new and existing bridges over road, as well as other road structures that require protection.

### 2. Definitions

<b>Barrier-to-hazard clearance</b>	The minimum clearance between face of the barrier and closest face of hazard (bridge support) to the running lane.
<b>Bridge support</b>	As defined in AS 5100.2 Clause 11.
<b>Lateral extent of hazard (L<sub>A</sub>)</b>	Minimum extent is given in Appendix A1 of this BTN as the Clear Zone.
<b>Working width</b>	The distance between the traffic face of the road safety barrier system before the impact and the maximum lateral position of any major part of the system or vehicle during and after the impact ( <i>AS 3845.1:2015</i> ).
<b>Working width (for F-Shape concrete barriers)</b>	As specified in AGRD Part 6 (2022) Section 6, DTP corresponding supplement, RDN and DTP Detail Sheet – F-Shape Concrete Barrier Dec 2021.

### 3. General

#### 3.1. New Bridge Supports

Regardless of the position of bridge supports relative to the lateral extent of hazard (L<sub>A</sub>) and provision of protection barriers, the collision loads in AS 5100.2 Clause 11 must be applied for all new bridge supports except for components that are fully backed with fill/soil.

Where the abutments are located within a Reinforced Soil Structure (RSS), abutment piles or columns must be designed for collision loads distributed through the soil mass.

#### 3.2. Design for Strength

Protection barrier components must be designed and detailed in accordance with the requirements of AS 5100.5 and AS 5100.6.

#### 3.3. Foundations

Protection barriers illustrated in Appendix F must have a suitable foundation designed in accordance with AS 5100.3.

#### 3.4. End Treatment

Protection barriers must be transitioned to a roadside or median barrier, terminated with an accepted proprietary attenuation device (i.e. crash cushion), or protected by a roadside barrier, with the following conditions:

- When transitioning to a roadside or median barrier, a transition (e.g. a bolted steel plate, doweled bars, pin and loop/JJ hooks) must be provided at the junction of the two systems to effectively transfer the loading.
- Transition methods to either another barrier or crash cushion require a gradual transition in height and shape to eliminate snagging (as illustrated in Appendix F), and in accordance with AGRD Part 6 (2022) and DTP Supplement.
- When positioning a roadside barrier in front of the protection barriers, there must be sufficient clearance between the roadside barrier and the protection barriers to accommodate the required working width for the chosen barrier type in accordance with AGRD Part 6 (2022) and DTP Supplement. The length of the roadside barrier must also be determined in accordance with AGRD Part 6 (2022) and DTP Supplement.





### 3.5. Constructability and Maintainability

In the event of a collision, the design must include provisions to enable an efficient and safe replacement of damaged barrier components.

Full height concrete barriers must be adopted for bridge support protection.

## 4. Collision from Road Traffic

### 4.1. General

Further to AS 5100.1 Clause 15, the level and form of protection barriers must be as outlined in Sections 4.2 and 4.3 of this Part for new bridge supports and in Section 4.4 of this Part for existing bridge supports. Refer to Appendix E for the Bridge Support Protection Barrier Selection Flowchart.

Except where there is insufficient clearance available, bridge supports must be positioned outside  $L_A$ . The design of the protection barrier must consider relevant road design criteria, e.g., sight distance and functional aspects e.g., pedestrian/cycling access.

To prevent a vehicle from impacting the bridge support, the barrier-to-hazard clearance must be greater than the barrier working width in accordance with AGRD Part 6 (2022) and DTP Supplement to AGRD Part 6: Roadside design, safety & barriers (2022). The hazard is defined as the closest face of the support to the running lane. Whilst the protection barrier and its foundation may be integrated with the bridge support, structurally independent protection barriers are preferred.

Future widening of the road must be considered in the design of protection barriers. This will include treatment of the verge/median area and consideration of the crossfall extension to facilitate a future road widening.

Pedestrian bridge supports must not be located within the road median or separation space between carriageways / ramps, regardless of whether the traffic flows in the same or opposite directions.

Protection barriers and their connections to off-structure barriers must comply with AS 5100.1.

### 4.2. Protection of New Bridge Supports Located Outside $L_A$

Spill through abutments with a batter slope no steeper than 1.5:1 horizontal to vertical ratio must be protected by a minimum MASH Test Level 4 (TL4) barrier. RDN 06-04 Acceptable Safety Barrier Products provides a list of acceptable road safety devices. A risk assessment such as that detailed within AGRD Part 6 (2022) Section 6 must be undertaken to determine an appropriate level of protection.

All other bridge supports must be protected by a minimum MASH Test Level 5 (TL5) reinforced concrete barrier.

Refer to DTP Detail Sheet – F-Shape Concrete Barrier Dec 2021 and relevant Standard Drawings for full details and conditions.

### 4.3. Protection of New Bridge Supports Located Inside $L_A$

If site constraints do not permit the bridge supports to be positioned outside the  $L_A$ , a reinforced concrete protection barrier must be provided in accordance with this section.

The barrier height must be such that the barrier-to-hazard clearance is greater than the barrier working width specified in AGRD Part 6 (2022) Section 6, DTP corresponding supplement and Road Design Notes. The crossfall must be considered in the working widths.

- i. When the bridge support and protection barrier are integral, the integral structure must be designed for the collision loads in Section 3.1 of this Part with F-shape barrier profile.
- ii. When the bridge support and protection barrier are independent, a risk assessment such as that detailed within AGRD Part 6 (2022) Section 6 must be undertaken to determine an appropriate level of protection with the following additional requirements.
  - A minimum of TL5 reinforced concrete protection barriers must be provided.
  - Refer to DTP Detail Sheet – F-Shape Concrete Barrier Dec 2021 and relevant Standard Drawings for full details and conditions for TL5 barriers.



- In addition to the conditions specified in the relevant Standard Drawings, if the required barrier height exceeds the heights specified in DTP Standard Drawing SD3901, or it is not feasible to meet other conditions outlined in SD3902 (such as minimum length, anchorage, etc.), the barriers must be designed to resist equivalent performance level loads as per Table 12.2.2 of AS 5100.2, applied to the top of the face of the barrier.

#### 4.4. Protection of Existing Bridge Supports

For existing bridge supports, a reinforced concrete protection barrier must be provided to contain and redirect vehicles. This is required where a road widening reduces the clearance to bridge supports or when substructure modifications to bridges are being conducted.

Where the existing bridge supports can independently resist the collision load in Section 3.1 of this Part, the barrier design must be in accordance with Sections 4.2 and 4.3 of this Part.

Where the existing bridge support is not capable of independently resisting the collision load in Section 3.1 of this Part:

- Preferred Option – The bridge supports must be strengthened for the loads in Section 3.1 of this Part, and the barrier must be designed in accordance with Sections 4.2 and 4.3 of this Part.
- If the Preferred Option is not achievable due to the conditions of the existing bridge supports, the proposed reinforced concrete protection barrier must be designed to comply with all the following criteria, subject to the approval of the DTP Chief Engineer – Roads.
  - Withstand a transverse force of 1200 kN at a height of 1500 mm.
  - Withstand a longitudinal force of 2700 kN collision load at a height of 1200 mm.
  - The vehicle contact length is 2.4 m.
  - The existing bridge supports must be assessed for a reduced collision load of 350 kN and must be strengthened to this load if found to be under capacity.
  - The height of the barrier must be site specific and consider the following:
    - The capacity of the existing pier.
    - The clearance to the barrier.
    - The working width requirements.
  - The barrier height must be such that the barrier-to-hazard clearance is greater than the barrier working width specified in RDN 06-16 Barrier Design Commentary Table 4 (reproduced in this BTN as Table 4.4) with the following additional requirements.
    - The minimum barrier heights for vehicle and pedestrian/cyclist path bridges are 1500 mm and 1800 mm, respectively
    - The crossfall must be considered in the working widths.
    - A factor of safety of 1.2 as per AGRD Part 6 (2022) Clause 6.20.2 must be applied.

**Table 4.4 Working Widths for F-shape Concrete Barriers (from RDN 06-16 Table 4)**

Concrete barrier height (mm)	1500	1550	1700	1800	1900	2000	2100
<b>F-Shape profile</b>	825	815	785	765	750	735	725
<b>F-Shape profile with sway protection</b>	535	515	470	440	415	395	375

Working widths are based on the 'point of contact' method, which assumes a straight line along the barrier face (kerb reveal to top corner), extended to a height of 4.6m. These values have been rounded up. Working width is measured from the toe of the barrier.  
Sway protection is a modification to the barrier profile to reduce the amount of vehicle roll above and beyond the barrier. Refer above for additional guidance.

## Appendix A

The following steps describe the methodology for deriving the lengths of off-structure barriers at different performance levels to satisfy the requirements of this BTN and AS 5100.1 Clause 14.

### A1 Lateral Extent of Hazard ( $L_A$ )

The lateral extent of hazard ( $L_A$ ) is the Clear Zone derived from Table A1a, which considers the hazards presented by the bridge and the bridge barrier (bridge influence) and the embankment geometry at the bridge approaches.

**Table A1a: Clear Zone Distances from Edge of Through Travelled Way**  
(from Austroads Guide to Road Design Part 6 - 2010)

Design speed (km/hr)	Design ADT <sup>(3)</sup>	Clear zone width (m) <sup>(4)</sup>					
		Fill batter			Cut batter		
		6:1 to flatter	4:1 to 5:1	3:1 and steeper <sup>(2)</sup>	6:1 to flatter	4:1 to 5:1	3:1 and steeper <sup>(2)</sup>
≤60	< 750	3.0	3.0	(2)	3.0	3.0	3.0
	750 – 1500	3.5	4.5	(2)	3.5	3.5	3.5
	1501 – 6000	4.5	5.0	(2)	4.5	4.5	4.5
	>6000	5.0	5.5	(2)	5.0	5.0	5.0
70-80	< 750	3.5	4.5	(2)	3.5	3.0	3.0
	750 – 1500	5.0	6.0	(2)	5.0	4.5	3.5
	1501 – 6000	5.5	8.0	(2)	5.5	5.0	4.5
	>6000	6.5	8.5	(2)	6.5	6.0	5.0
90	< 750	4.5	5.5	(2)	3.5	3.5	3.0
	750 – 1500	5.5	7.5	(2)	5.5	5.0	3.5
	1501 – 6000	6.5	9.0	(2)	6.5	5.5	5.0
	>6000	7.5	10.0 <sup>(1)</sup>	(2)	7.5	6.5	5.5
100	< 750	5.5	7.5	(2)	5.0	4.5	3.5
	750 – 1500	7.5	10.0 <sup>(1)</sup>	(2)	6.5	5.5	4.5
	1501 – 6000	9.0	12.0 <sup>(1)</sup>	(2)	8.0	6.5	5.5
	>6000	10.0 <sup>(1)</sup>	13.5 <sup>(1)</sup>	(2)	8.5	8.0	6.5
110	< 750	6.0	8.0	(2)	5.0	5.0	3.5
	750 – 1500	8.0	11.0 <sup>(1)</sup>	(2)	6.5	6.0	5.0
	1501 – 6000	10.0 <sup>(1)</sup>	13.0 <sup>(1)</sup>	(2)	8.5	7.5	6.0
	>6000	10.5 <sup>(1)</sup>	14.0 <sup>(1)</sup>	(2)	9.0	9.0	7.5

- (1) Where a site-specific investigation indicates a high probability of continuing crashes, or such occurrences are indicated by crash history, the designer may adopt clear zone distances greater than the clear zone shown in Table A1a.
- (2) Since recovery is less likely on the unshielded, traversable 3:1 slopes, fixed objects should not be present in the vicinity of the toe of these slopes. Recovery of high-speed vehicles that encroach beyond the edge of the shoulder may be expected to occur beyond the toe of the slope. Determination of the recovery area at the toe of the slope should take into consideration available land reservation, environmental concerns, economic factors, safety needs, and crash histories. Also, the distance between the edge of the travelled lane and beginning of the 3:1 slope should influence the recovery area provided at the toe of the slope.



While the application may be limited by several factors, the fill slope parameters which may enter into determining a maximum desirable recovery are illustrated in Figure A1.

- (3) The design ADT in the table is the average daily traffic volume in both directions and all lanes, other than for divided roads where it is the total traffic in one direction.
- (4) Where the road is curved, the values in Table A1a should be adjusted by the curve correction factors in Table A1b. These curve correction factors only apply to clear zones on the outside of curves.

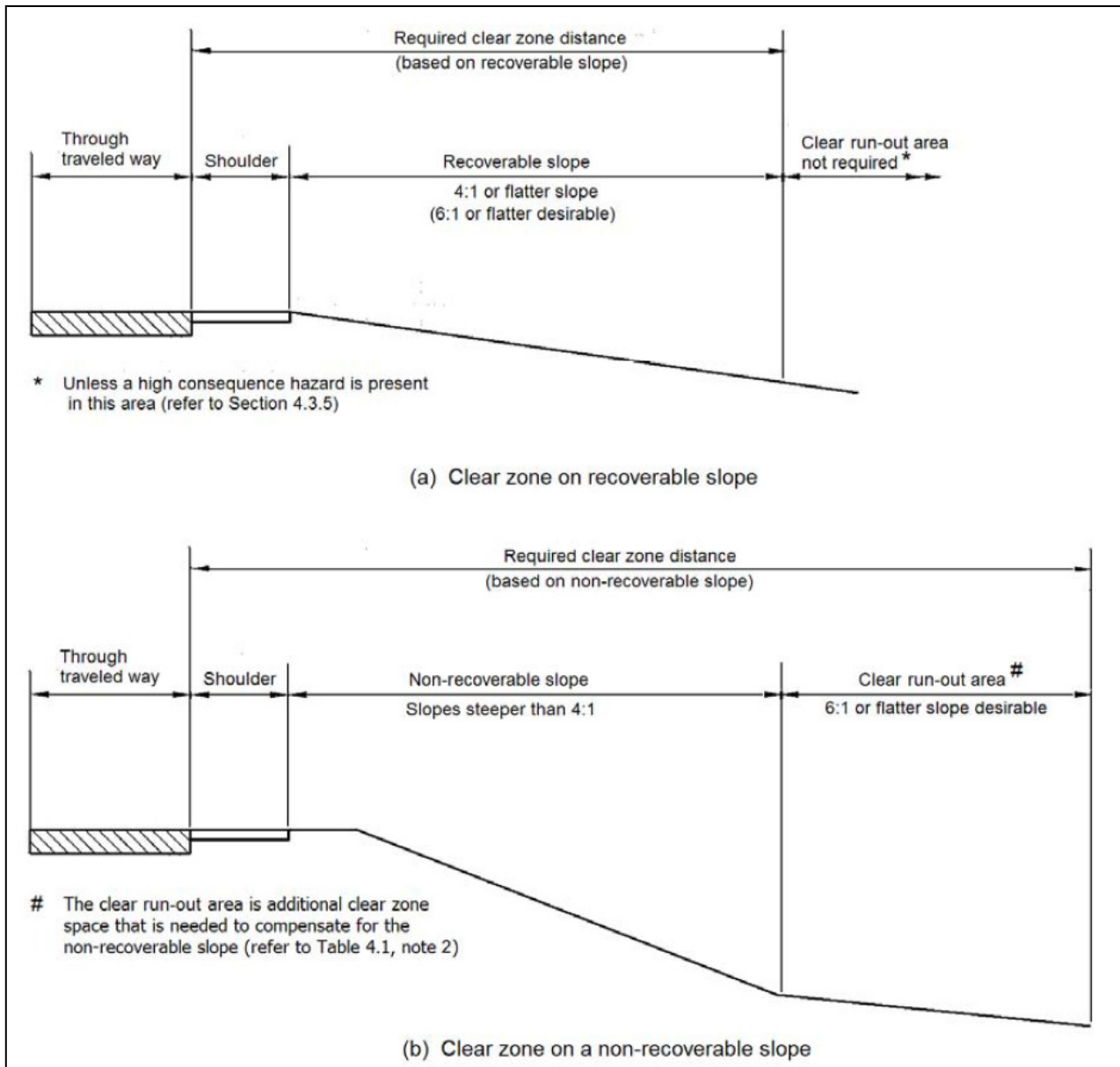
**Table A1b: Clear Zone Curve Correction Factors**  
(from *Austrroads Guide to Road Design Part 6 - 2010*)

Radius (m)	Design speed (km/h)					
	60	70	80	90	100	110
900	1.1	1.1	1.1	1.2	1.2	1.2
700	1.1	1.1	1.2	1.2	1.2	1.3
600	1.1	1.2	1.2	1.2	1.3	1.4
500	1.1	1.2	1.2	1.3	1.3	1.4
450	1.2	1.2	1.3	1.3	1.4	1.5
400	1.2	1.2	1.3	1.3	1.4	-
350	1.2	1.2	1.3	1.4	1.5	-
300	1.2	1.3	1.4	1.5	1.5	-
250	1.3	1.3	1.4	1.5	-	-
200	1.3	1.4	1.5	-	-	-
150	1.4	1.5	-	-	-	-
100	1.5	-	-	-	-	-

Source: AASHTO (2006).



Figure A1: Example of a Parallel Fill Slope Design Illustrating Clear Zone and Slopes  
(from Austroads Guide to Road Design Part 6 - 2010)



**# Note:**

- A clear run-out area at the bottom of the batter for non-recoverable slope (slopes steeper than 4:1) can be determined by subtracting the width of shoulder and verge (at the top of the batter) from the Clear Zone Width for 6:1 or flatter slope in Table A1a. The minimum width of the clear run-out area must be 3.0 m to provide for an errant car to satisfactorily come to rest. It is important that the run-out area also has a smooth surface and contains no hazardous objects or features.
- Verge is the section of the road formation that joins the shoulder with the batter.

## A2 Length of Off-structure Barrier

The length of off-structure barrier (LOB) is calculated using a 15° divergence angle from the outside edge of the traffic lane as shown in Figures B1 and B2 in Appendix B.

LOB is rounded upwards to the nearest multiple of 6 m.

## A3 Off-structure Barrier Panel Lengths

Determine the off-structure barrier performance level lengths in accordance with Table A3. The off-structure barrier performance level must be stepped-down incrementally to the point where it ends or joins the roadside barrier.

**Table A3 Off-Structure Barrier Panel Lengths**

Barrier PL on the bridge / structure	Length of special PL off-structure barrier	Length of medium PL off-structure barrier	Length of regular PL off-structure barrier	Notes
Special	LOB/3 <sup>2</sup>	LOB/3 <sup>1</sup>	LOB/3 <sup>1</sup>	<p>PL – Performance level</p> <p>1 – The length of off-structure barrier must be not less than 12 m for each performance level.</p> <p>2 – The minimum length of (special) off-structure barrier must be not less than 24 m if crossing medium to high frequency passenger rail lines or goods lines carrying noxious, flammable or large volumes freight, high volume roads, bridges over major roadways and 12 m for other cases. Minimum total length of off-structure barrier performance level provision is then equal to <math>(24 + 2 \times \text{LOB}/3)</math>.</p>
Medium		LOB/2 <sup>3</sup>	LOB/2 <sup>1</sup>	<p>3 – If the road carries more than 5 public service/tourist coaches per day, the minimum length of (medium) off-structure barrier must be not less than 24 m. Minimum total length of off-structure barrier is then equal to <math>(24 + \text{LOB}/2)</math>.</p>
Regular			LOB <sup>1</sup>	<p>4 – The foregoing panel lengths are based on multiples of 6 m.</p>

### A3.1 Orthogonal Bridges

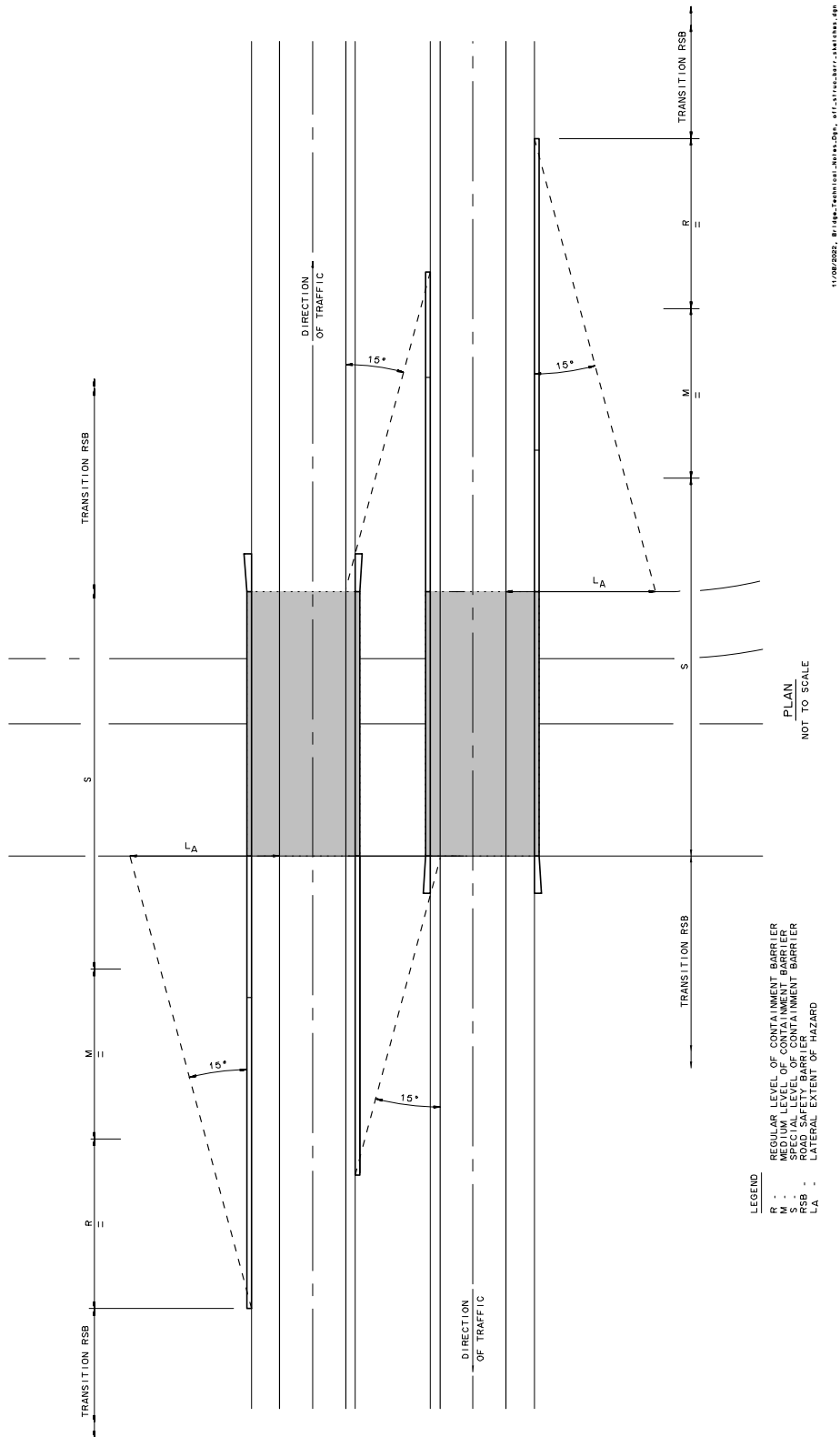
For an orthogonal bridge-crossing, the  $L_A$  is projected at right angles from the end of the bridge, which is either the end of the deck or, in an integral bridge, is defined as the exposed face of the face of abutment crosshead.

### A3.2 Skew Bridges

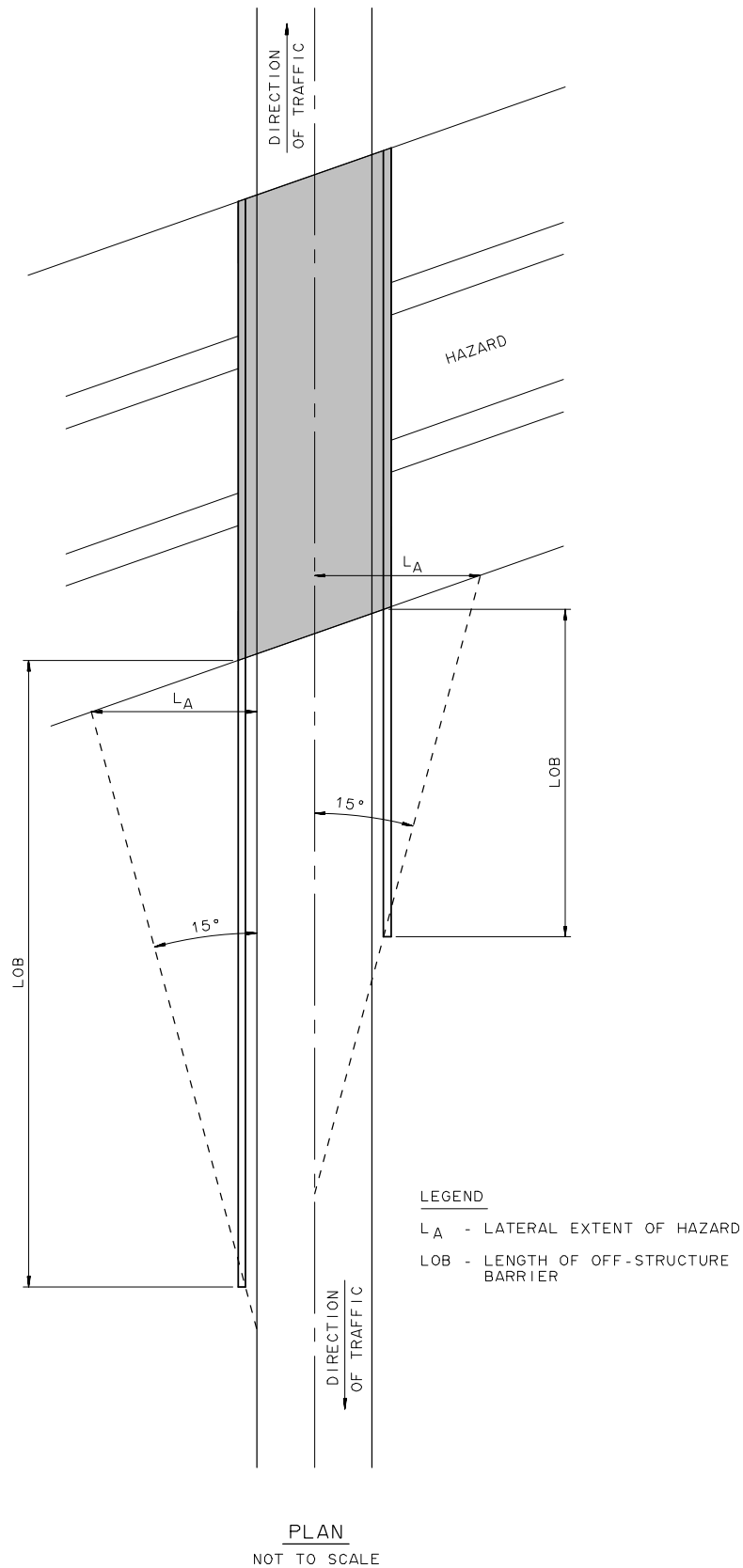
The  $L_A$  is off-set from the edge of the trafficable lane and the intersection with the hazard (Refer to Figure B2 in Appendix B which illustrates the geometry for a skew bridge).

When the ROW boundary is within the  $L_A$ , the road safety barrier beyond the minimum length of off-structure barrier required by Part 1 Section 4.3 must be designed in accordance with the Austroads Guide to Road Design (AGRD) Part 6 and DTP Supplement.

# Appendix B



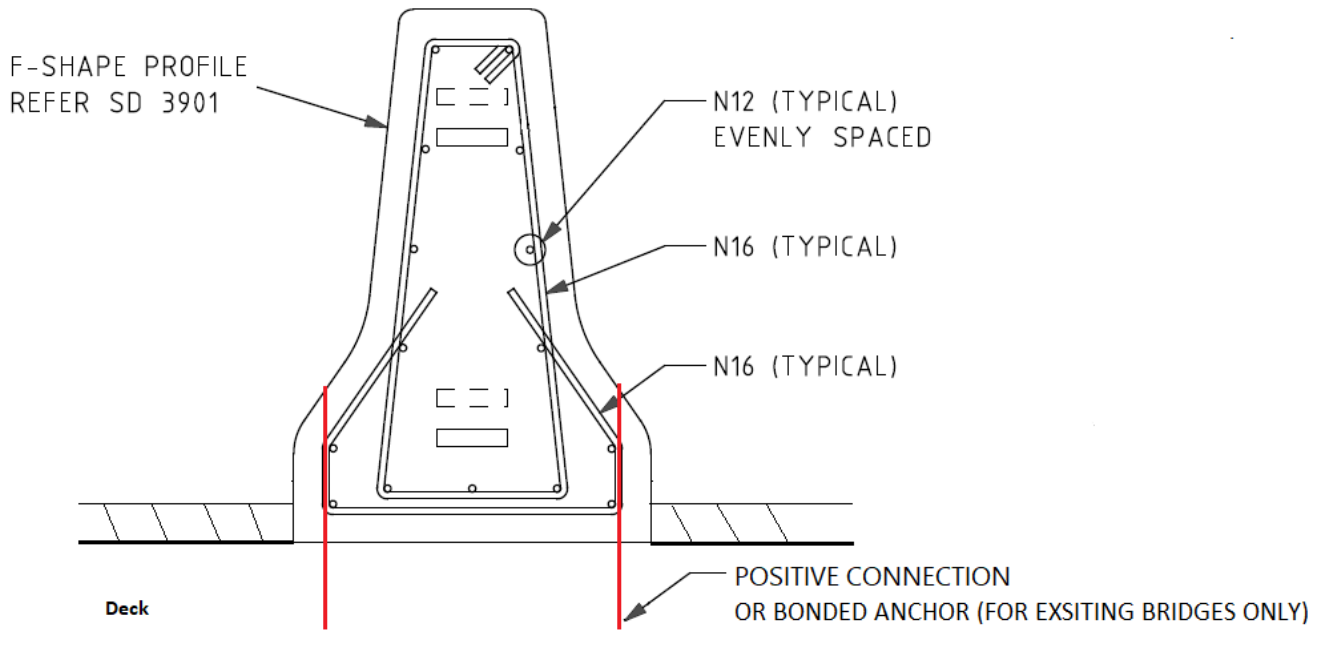
**Figure B1 - Geometry of Off-structure Barriers**



**Figure B2 - Geometry of a Skew Bridge**

## Appendix C

The following figure is an option for the connections to the bridge deck for a typical F-Shape concrete median barrier that may be considered. Noting that reinforcement shown is typical only.



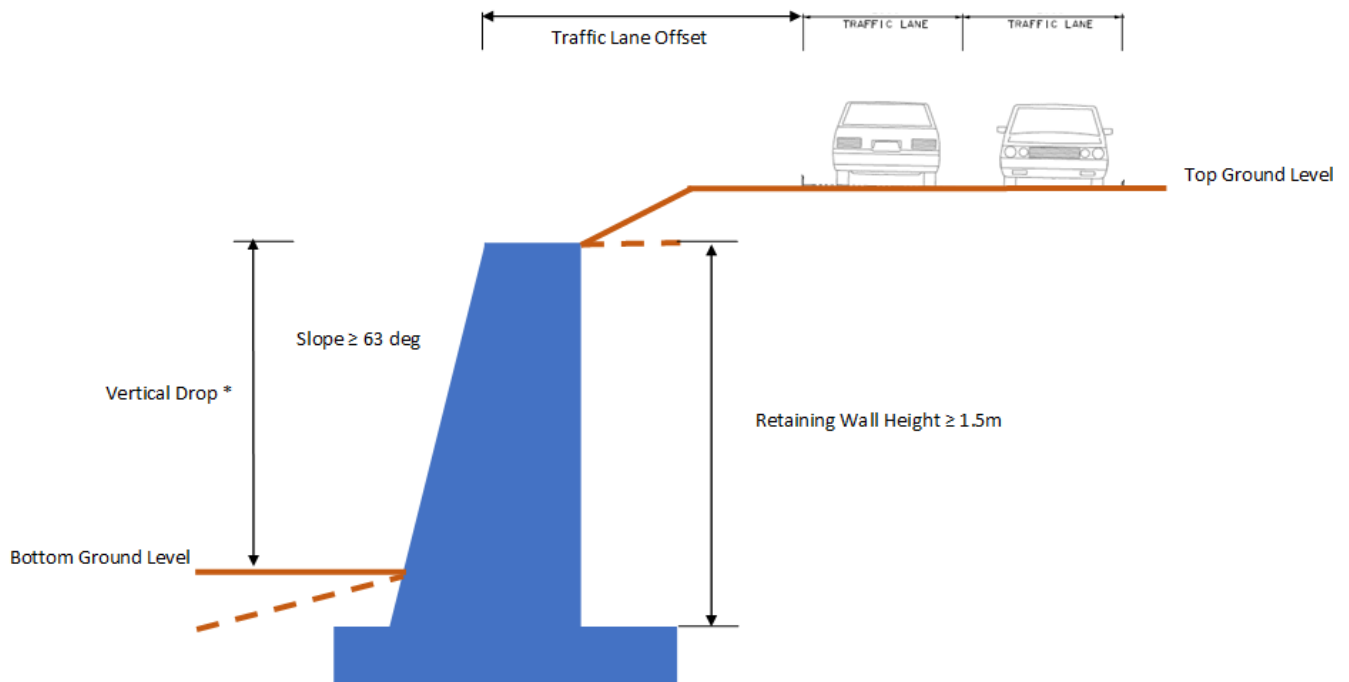
**Figure C1 - Median Barrier Connections Option**

The median barriers must be dowelled to the bridge deck or a foundation at 1.0 m spacing using 28 mm diameter dowels of 240 mm length (with 120 mm minimum embedment length) or equivalent as per Part 1 Section 5.4.

For connections to existing works only, bonded anchors may be considered. The use of bonded anchors must be in accordance with BTN 006 Bonded Anchors and Section 680.

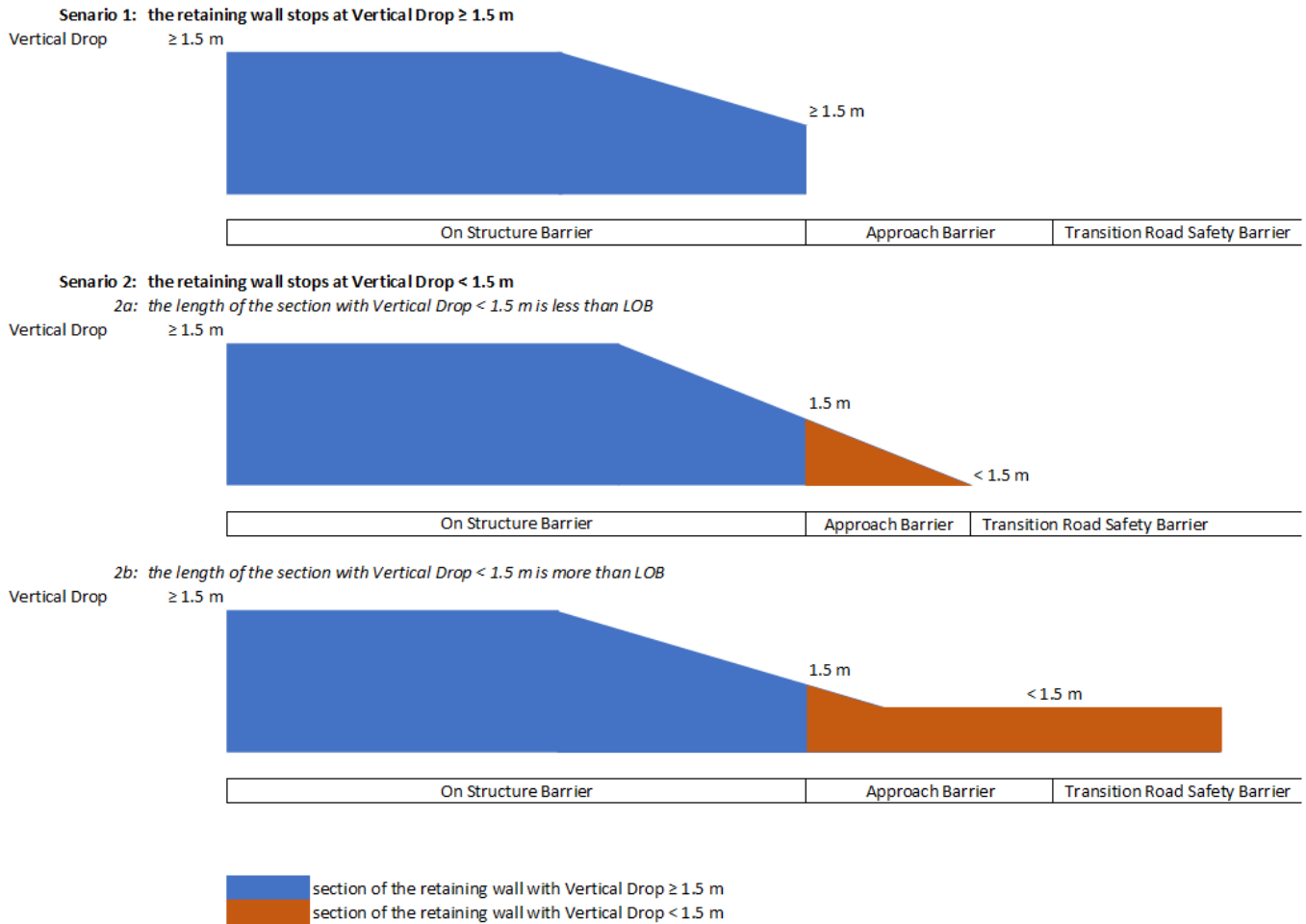


## Appendix D



\* Vertical Drop = (Retaining Wall Height) – (embedment into the ground) + (any height (top and bottom) where adjacent surface is steeper than 6:1).

**Figure D1 – Definition and Geometry of Retaining Walls (Typical)**



**Figure D2 – Examples of Barriers on Top of Retaining Walls with Approach Barriers**

# Appendix E

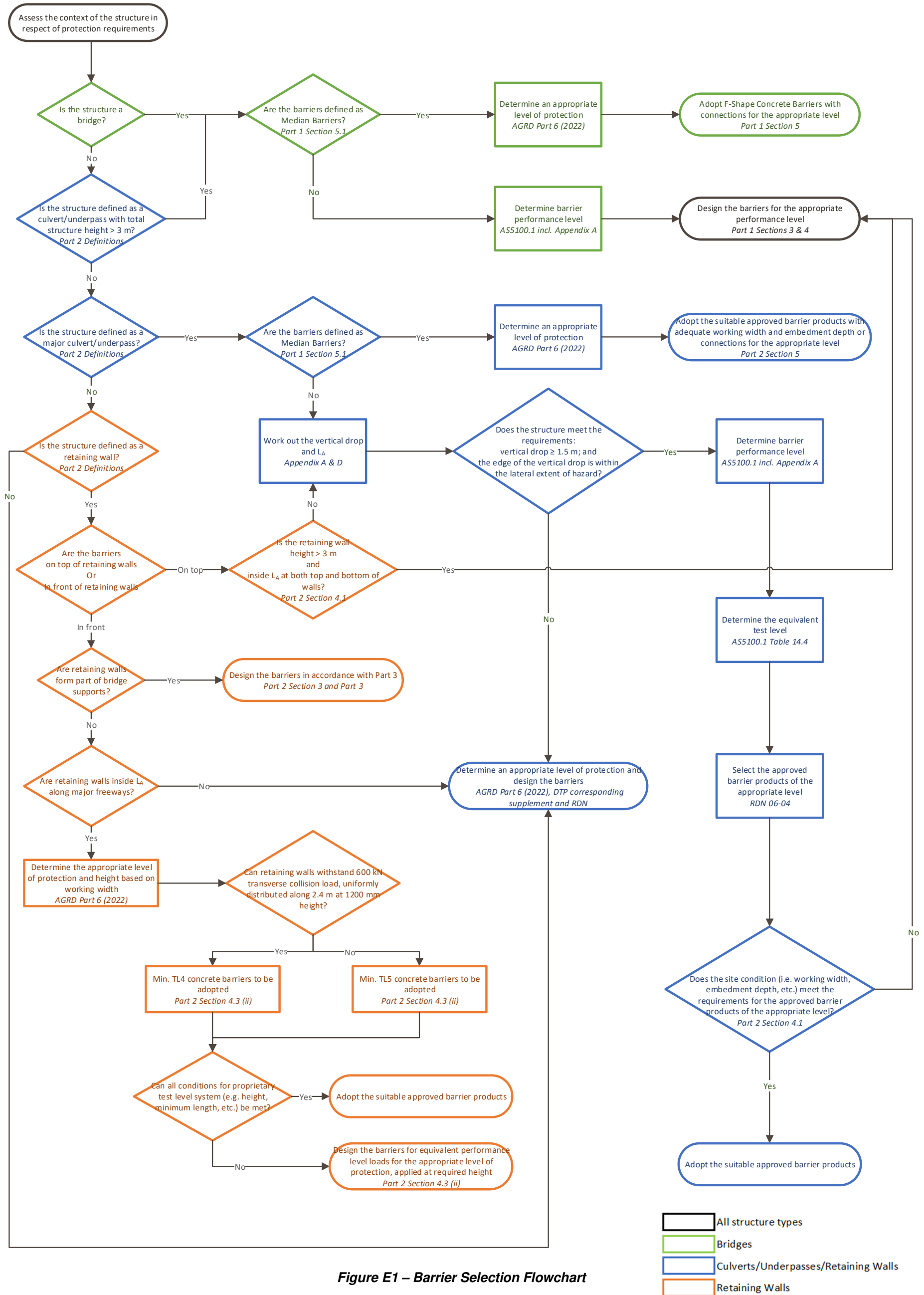


Figure E1 – Barrier Selection Flowchart



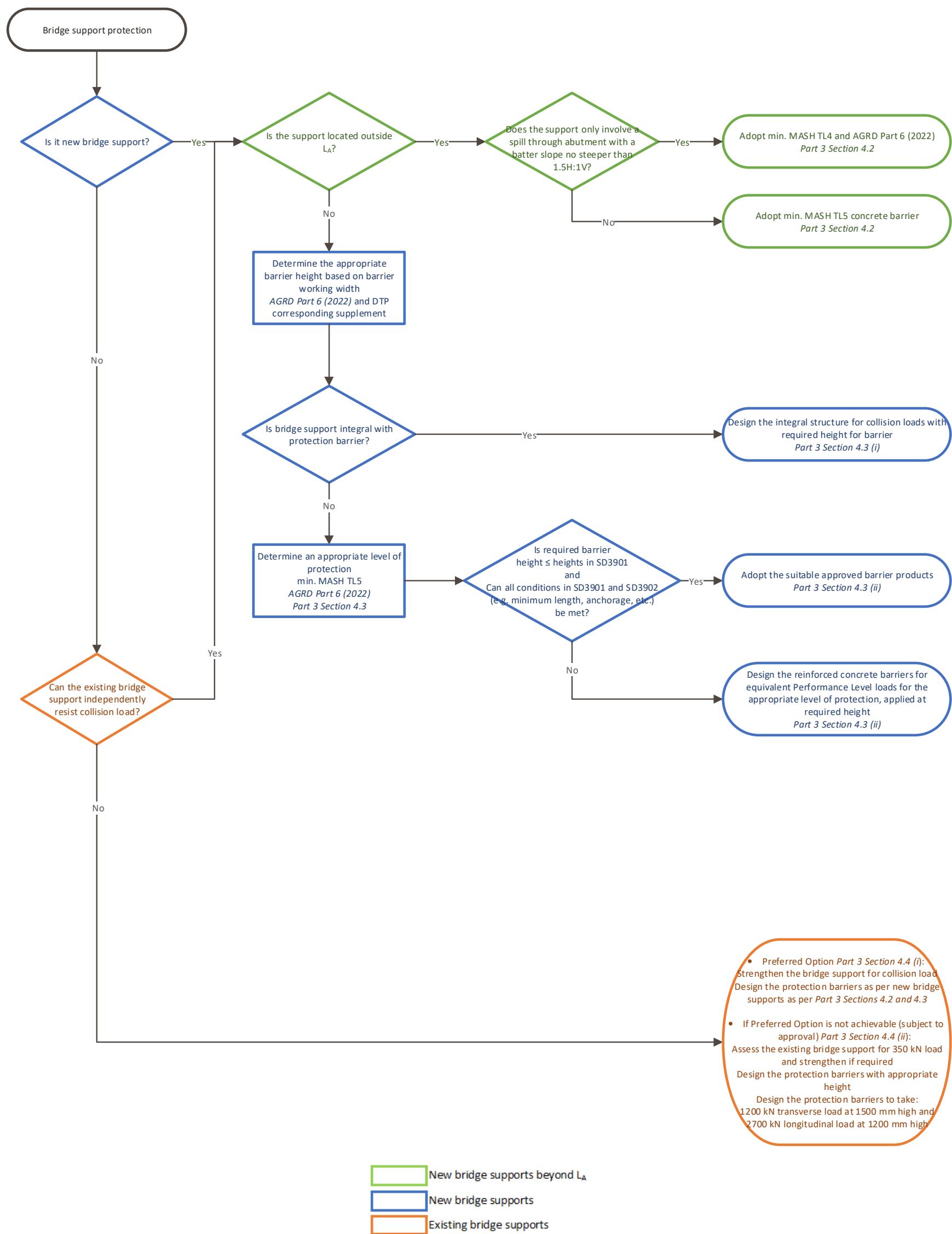
Example	No. of Cells	Cell Span (m)	Structure Height (m)	Total Area (m <sup>2</sup> )	Classified - Major/Minor Culvert or Bridge	Vertical Drop (m)	Edge of Vertical Drop Inside/Outside of L <sub>A</sub>	Barrier Requirements
<b>Selection Criteria</b>		<b>≥ 1.8 m</b>	<b>&gt; 3 m</b>	<b>≥ 3 m<sup>2</sup></b>		<b>≥ 1.5 m &amp; Inside</b>		
1	1	2	1	2	Major Culvert	1.2	Inside	AGRD Part 6
2	1	2	1	2	Major Culvert	2	Inside	BTN001 Part 2
3	1	2	1.5	3	Major Culvert	1.7	Outside	AGRD Part 6
4	1	2	3.5	7	Bridge	N/A	N/A	BTN001 Part 1
5	3	1	0.5	1.5	Minor Culvert	N/A	N/A	AGRD Part 6
6	3	1	1	3	Major Culvert	1.2	Inside	AGRD Part 6
7	3	1	1	3	Major Culvert	2	Inside	BTN001 Part 2
8	3	1	1	3	Major Culvert	2	Outside	AGRD Part 6

**Note:**

Structure height – From the culvert invert to the top of the culvert, including the link slab, etc. where applicable.

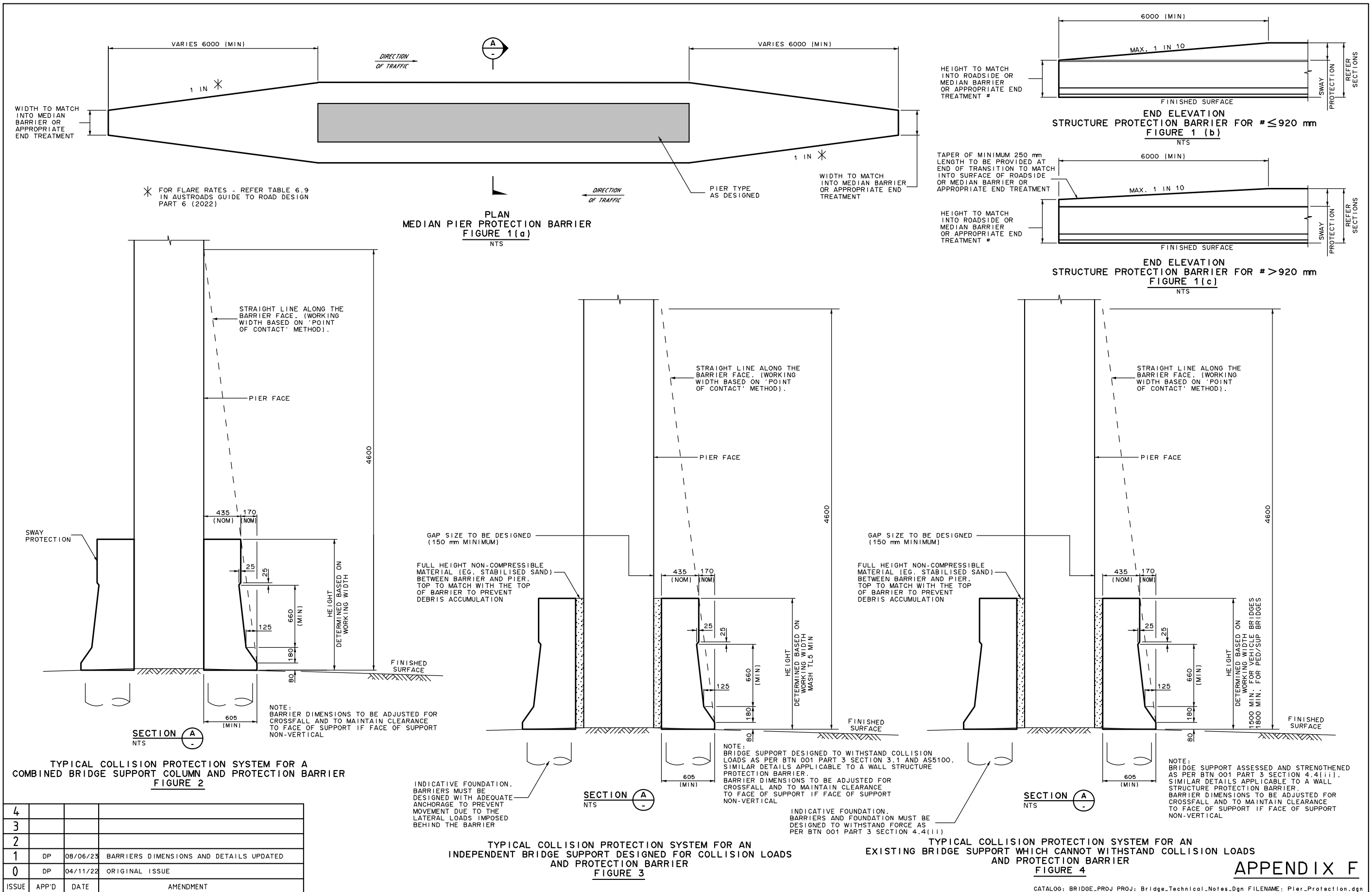
Vertical drop – Structure Height plus the fill on top where the slope is steeper than 6:1.

**Table E1 – Examples of Barrier Requirements of Culverts**



**Figure E2 – Bridge Support Protection Barrier Selection Flowchart**

# Appendix F – Protection of Bridge Supports



ISSUE	APP'D	DATE	AMENDMENT
4			
3			
2			
1	DP	08/06/23	BARRIERS DIMENSIONS AND DETAILS UPDATED
0	DP	04/11/22	ORIGINAL ISSUE

## APPENDIX F

CATALOG: BRIDGE\_PROJ PROJ: Bridge\_Technical\_Notes\_Dgn FILENAME: Pier\_Protection.dgn