Design Manual for Roads and Bridges

Drainage
Design

CD 524
Edge of pavement details

(formerly HA 39/98, HA 83/99)

Revision 0

Summary
This document provides guidance on the use of the various types of edge of pavement drainage details which are depicted in the 'B' and 'F' series of the Highway Construction Details (HCD): Manual of Contract Documents for Highway Works (MCHW3).

Application by Overseeing Organisations
Any specific requirements for Overseeing Organisations alternative or supplementary to those given in this document are given in National Application Annexes to this document.

Feedback and Enquiries
Users of this document are encouraged to raise any enquiries and/or provide feedback on the content and usage of this document to the dedicated Highways England team. The email address for all enquiries and feedback is: Standards_Enquiries@highwaysengland.co.uk

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Release notes

Version	Date	Details of amendments
0	Feb 2020	CD 524 replaces HA 39/98 and HA 83/99. This full document has been re-written to make it compliant with the new Highways England drafting rules.

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Foreword

Publishing information

This document is published by Highways England.

This document supersedes HA 39/98 and HA 83/99, which are withdrawn.

Contractual and legal considerations

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

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Introduction

Background

This document represents the combination of two former advice documents HA 39/88 Road edge details and HA 83/99, Safety aspects of road edge drainage features.

The document has rationalised any duplication between the two source documents and does not include any information in the two source documents that is not related to road edge drainage features.

The document compliments and expands on the information provided in the B and F Series of drawings in MCHW HCD Drawings [Ref 8.N].

Section 3 of the document includes requirements and advice on surface water channels. Surface water channels are described in further detail in document CD 521 [Ref 5.N]. In order to prevent duplication of information, Section 3 of this document includes several cross-references to CD 521 [Ref 5.N].

Tables summarising scenarios for use and pros and cons of the types of drainage solution available are presented in CG 501 [Ref 3.N].

Assumptions in the preparation of this document

The assumptions made in GG 101 [Ref 6.N] apply to this document.

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Abbreviations

Abbreviations

Abbreviation	Definition
CBGM	Cement bound granular mixture
VRS	Vehicle restraint systems

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Terms and definitions

Terms

Term	Definition
Channel	Narrow longitudinal strip generally near the edge of the carriageway specially constructed to collect and lead away water.
Combined drainage and kerb system	Kerb combining a closed profile hydraulic conduit with slots.
Combined surface and sub-surface drain	System of drainage that comprises a perforated, porous or open jointed carrier pipe, bedded in granular material, in a trench that is then backfilled with a granular filter material of Type A, B or C as defined in MCHW Series 500 [Ref 10.N].
Drainage channel block	Precast concrete channel unit.
Edge channel	Channel formed by the surface of the carriageway and a kerb.
Filter drain	Drain constructed using permeable materials which allow the entry of water whilst retaining the surrounding material.
Fin drain	A planar geocomposite arrangement designed to remove sub-surface moisture from beneath the pavement.
Groundwater	All water which is below the surface of the ground in the saturation zone (below the water table) and in direct contact with the ground or subsoil WFD 2015 [Ref 1.I].
Linear drainage channel	A longitudinal sub-surface closed profile hydraulic conduit with slots located in and above the conduit.
Narrow filter drain	A filter drain with a maximum trench width of 200mm where either the filter material and pipe together or the pipe alone is enclosed within a layer of geotextile.
Surface water channel	Triangular, trapezoidal or rectangular cross section channel.
Surface water	Inland waters (except groundwater), transitional waters and coastal waters WFD 2015 [Ref 1.I].

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1. Scope

Aspects covered

1.1 This document shall be used for the design of the various types of edge of pavement drainage details shown in the 'B' and 'F' Series drawings of MCHW HCD Drawings [Ref 8.N].

NOTE 1 *The 'B' Series of MCHW HCD Drawings [Ref 8.N] depict pavement edge details dealing principally with drainage aspects of highway verges and central reserves.*

NOTE 2 *Some of the drainage components shown indicatively in the 'B' Series drawings of MCHW HCD Drawings [Ref 8.N] are shown in detail in the 'F' Series drawings.*

NOTE 3 *The list of 'B' and 'F' Series drawings detailed in CG 501 [Ref 3.N] that are referred to in this document is included in Appendix A.*

NOTE 4 *MCHW HCD Drawings [Ref 8.N] supplements SHW [Ref 9.N] as does the MCHW NG [Ref 7.N]. The role of guidance for the 'B' and 'F' Series drawings of the MCHW HCD Drawings [Ref 8.N] is fulfilled by this document.*

Implementation

1.2 This document shall be implemented forthwith on all schemes involving highway drainage on the Overseeing Organisation's motorway and all-purpose trunk roads according to the implementation requirements of GG 101 [Ref 6.N].

Use of GG 101

1.3 The requirements contained in GG 101 [Ref 6.N] shall be followed in respect of activities covered by this document.

Health and safety

1.4 Unless protected from direct traffic, road edge drainage features shall be capable of withstanding the structural loading imposed on them during normal usage and the structural loading that can be imposed on them during lane closures and consequent trafficking of hard shoulders.

1.5 Road edge drainage features shall be designed to mitigate the effects on errant vehicles leaving the carriageway.

NOTE *The road edge drainage features can present a potential hazard to errant vehicles leaving the carriageway.*

1.6 The selection of road edge drainage features shall be guided by the health and safety issues associated with the maintenance needs of the features which is particularly important for central reserve drainage where difficulty of access can exacerbate maintenance interventions.

NOTE 1 *The road edge drainage feature plays a major part in road safety by removing surface water quickly.*

NOTE 2 *A suitable road edge drainage feature prevents damage to the structural foundations of the carriageway. This, in turn, reduces the requirement for maintenance.*

NOTE 3 *Maintenance on motorways and other high speed roads involves a higher than normal degree of risk, both to road users and maintenance operatives.*

NOTE 4 *Safety issues associated with rural roads differ from those associated with urban roads.*

1.7 Safety risk mitigation measures shall follow the ERIC hierarchy - eliminate, reduce, isolate and control for each identified safety risk.

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2. Combined surface and sub-surface drains

General

2.1 The edge of pavement and drainage details in MCHW HCD Drawings [Ref 8.N] shall be used as the basis of design for combined surface and sub-surface drains.

NOTE 1 The edge of pavement and drainage details included in MCHW HCD Drawings [Ref 8.N] are listed in Appendix A.

NOTE 2 Combined surface and sub-surface drains enable rapid removal of runoff from the road and verge surface.

NOTE 3 Combined surface and sub-surface drains in cuttings can manage a wide range of flows. They are particularly suited to dealing with sub-surface flows, which can vary as the water table fluctuates.

NOTE 4 As combined surface and sub-surface drains incorporate pipes with relatively large diameters they generally have an exceptionally large groundwater capacity which can extend as a cut-off below the capping layer.

NOTE 5 Combined surface and sub-surface drains are appropriate for draining roads with long lengths of zero longitudinal gradient.

NOTE 6 Combined surface and sub-surface drains with type Y surfaces as shown on drawing B15 of MCHW HCD Drawings [Ref 8.N] are more suitable for roads with flatter gradients where flow along the surface into catchpits is less assured.

NOTE 7 Combined surface and sub-surface drains with type W surfaces as shown in Drawing B15 of MCHW HCD Drawings [Ref 8.N] have a greater fall towards the centre of the drain because the reduced permeability of the thick surface layer can result in greater flows along the surface.

2.1.1 The use of surface and sub-surface drains in central reserves should be avoided in order to reduce health and safety risks during maintenance interventions.

2.1.2 Combined surface and sub-surface drains in cuttings may function as carrier drains.

NOTE Sub-surface drains are not required where combined surface and sub-surface drains in cuttings function as carrier drains.

2.2 Combined surface and sub-surface drains shall not be used in narrow verges subject to use by equestrians.

2.3 The diameter of combined surface and sub-surface drains shall be limited to 300mm to prevent the risk of saturated downstream conditions.

Upper section of combined surface and sub-surface drains

2.4 The upper section of combined surface and sub-surface drains shall be designed to mitigate the risk of stone scatter.

NOTE 1 Managing risks associated with stone scatter is described in CD 525 [Ref 2.N].

NOTE 2 The treatment options depicted in Drawing B15 of MCHW HCD Drawings [Ref 8.N] incorporate measures to reduce stone scatter.

2.4.1 Where possible, more then one type of upper section should be specified in the contract with the final choice being left to the contractor.

2.5 A lip shall be provided between the edge of carriageway and the top of the combined surface and sub-surface drain.

NOTE The purpose of the lip is to enable continuous over the edge drainage to be maintained and to reduce the effect of build up of vegetation.

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2.6 The depth of the lip between the edge of carriageway and the top of the combined surface and sub-surface drain depends on the the upper section type selected and shall be as shown in Drawing B15 of MCHW HCD Drawings [Ref 8.N].

2.6.1 Where Type 7 chambers as shown in Drawing F11 of MCHW HCD Drawings [Ref 8.N] are used to collect surface flows from combined surface and sub-surface drains, Note 7 of Drawing F11 should be amended to match the depth of the lip.

2.7 The top surface of a combined surface and sub-surface drain shall be dished to allow high flows to be channelled along the surface and into catchpits.

2.7.1 Catchpit grating levels should be calculated to suit the falls toward the centre of the drain.

Lower section of combined surface and sub-surface drains

2.8 The lower section of combined surface and sub-surface drains shall be designed as filter drains and generally in accordance with the drawings in MCHW HCD Drawings [Ref 8.N].

2.8.1 Where possible, more than one type of lower section should be specified in the contract with the final choice being left to the contractor.

NOTE *The lower section of combined surface and sub-surface drains are generally formed with Type B material.*

2.8.2 To avoid migration of fine sands and silts into the filter material, the lower section of combined surface and sub-surface drains laid in fine sands and silts should be Type J or K as shown in Drawing F2 of MCHW HCD Drawings [Ref 8.N].

2.8.3 Lightweight aggregate may be used as the filter material for combined surface and sub-surface drains Type G, H and I as shown in Drawing F2 of MCHW HCD Drawings [Ref 8.N].

2.9 To prolong the life of the combined surface and sub-surface drain, a geotextile membrane shall be placed between the upper and lower sections of the drain for drains Type G, H and I as detailed in Drawing F2 of MCHW HCD Drawings [Ref 8.N].

Asset recording

2.10 Combined surface and sub-surface drains shall be recorded as continuous assets as detailed in CD 535 [Ref 4.N].

2.10.1 The combined surface and sub-surface drain asset record should include all the attributes for continuous assets as detailed in CD 535 [Ref 4.N].

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3. Surface water channels

Profiles and dimensions

3.1 The cross-sectional profiles of surface water channels shall be triangular, trapezoidal or rectangular.

3.2 Surface water channels with rectangular cross sections shall be as described in CD 521 [Ref 5.N].

3.3 The edge of pavement and drainage details in MCHW HCD Drawings [Ref 8.N] shall be used as the basis of design for surface water water channels with triangular or trapezoidal cross sections.

NOTE *The edge of pavement and drainage details included in MCHW HCD Drawings [Ref 8.N] are listed in Appendix A.*

3.3.1 Dimension Z in Drawing B14 of MCHW HCD Drawings [Ref 8.N] should be a minimum of 200mm in order to provide a robust section capable of withstanding occasional vehicle overrun.

NOTE 1 *In rigid construction, dimension Z can be lower than 200mm where the channel and slab are slipformed together. See Type 2 as depicted in Drawing B14 of MCHW HCD Drawings [Ref 8.N].*

NOTE 2 *Depending on the pavement alternative chosen, the value of dimension Z can be increased to found it on a convenient pavement layer.*

3.3.2 Dimension Y in Drawing B14 of MCHW HCD Drawings [Ref 8.N] may be set so that flooding is avoided by allowing the water to flow onto the verge and down the embankment slope.

3.3.3 This optimum value of Y may vary with road geometry and discharge volumes for each outfall.

NOTE *For uniformity of channel cross section over the scheme, dimension Y can be set at the level required for the most vulnerable flood section.*

3.3.4 Where carriageway levels differ appreciably, the channel and central reserve profile should be modified from that shown in Drawings B6 and B7 of MCHW HCD Drawings [Ref 8.N].

Application

3.4 With rigid carriageway construction, a tie bar shall be included to limit differential movement between the channel and pavement.

3.5 A drainage path between the pavement layers that terminate above the formation level of the channel and the sub-surface drain shall be provided as shown in Drawing F21 of MCHW HCD Drawings [Ref 8.N].

3.6 Cross sectional details for surface water channels and the location of such channels relative to the position of safety fences shall be determined with due consideration to safety aspects.

NOTE 1 *Guidance on safety issues associated with the design of surface water channels is included in CD 521 [Ref 5.N].*

NOTE 2 *Surface water channels located behind a VRS are shown in Drawing B18 of MCHW HCD Drawings [Ref 8.N].*

Hydraulic design and outfalls

3.7 The hydraulic design of surface water channels shall be as detailed in CD 521 [Ref 5.N].

3.8 Surface water channel outfalls shall be as detailed in CD 521 [Ref 5.N].

Asset recording

3.9 Surface water channels shall be recorded as continuous assets as detailed in CG 501 [Ref 3.N].

3.9.1 The surface water channel asset record should include all the attributes for continuous assets as detailed in CD 535 [Ref 4.N].

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4. Drainage channel blocks

Type A and B drainage channel blocks

4.1 The edge of pavement and drainage details in MCHW HCD Drawings [Ref 8.N] shall be used as the basis of design for Type A and B drainage channel blocks.

NOTE 1 *The edge of pavement and drainage details included in MCHW HCD Drawings [Ref 8.N] are listed in Appendix A.*

NOTE 2 *Block types A and B are intended as a relatively inexpensive solution in situations where positive drainage is desirable for dealing with smaller volumes of flow and which would not justify the use of the larger surface water channel.*

4.1.1 The use of Type A and B drainage channel blocks in cuttings should only be necessary where the cutting surface has low permeability.

NOTE *Surfaces with runoff coefficients of 0.21 or greater can be considered as having low permeability.*

4.1.2 The cross falls within the central reserve as depicted in Drawing B8 of MCHW HCD Drawings [Ref 8.N] may be increased to provide additional waterway area.

4.2 The distance from the edge of the carriageway to type A and B channels in central reserves shall be 1.0 m or greater (see dimension X in Drawing B8 of MCHW HCD Drawings [Ref 8.N]).

4.3 The distance from the edge of the carriageway to type A and B channels in cuttings shall be 1.0 m or greater (see dimension W in Drawing B4 of MCHW HCD Drawings [Ref 8.N]).

4.4 Type A and B drainage channel blocks as depicted in drawings B4 and F15 of MCHW HCD Drawings [Ref 8.N] shall not be used as edge drains contiguous with hard shoulders, hardstrips, or carriageways.

4.5 Type A and B drainage channel blocks as depicted in drawings B4 and F15 of MCHW HCD Drawings [Ref 8.N] shall not be used in verges subject to frequent equestrian use.

4.6 The hydraulic capacity of the channel shall be based on a 1 in 1 year storm with flow contained within the channel cross section.

4.7 In hard shoulders and hard strips, the maximum flooding width under a 1 in 5 year storm shall be 1.5 m and 1.0 m respectively.

4.8 In central reserves, flooding shall not encroach into the offside lane under a 1 in 5 year storm.

NOTE *Where drainage channel blocks are used in central reserves the distance between outlets will be limited.*

Type C, D, E and F drainage channel blocks

4.9 The edge of pavement and drainage details in MCHW HCD Drawings [Ref 8.N] shall be used as the basis of design for Type C, D, E and F drainage channel blocks.

NOTE 1 *The edge of pavement and drainage details included in MCHW HCD Drawings [Ref 8.N] are listed in Appendix A.*

NOTE 2 *Drawing F16 of MCHW HCD Drawings [Ref 8.N] gives typical dimensions for Type E and F drainage channel blocks.*

NOTE 3 *Type E and F drainage channel blocks in combination with type C drainage channel blocks are intended as an alternative to gullies on embankments where kerbs are used. They have a distinct advantage on high embankments, avoiding the difficulty of construction of long gully connections down the embankment slope.*

NOTE 4 *Type D drainage channel blocks are articulated and are particularly suited to use on steep embankment slopes where settlement is expected.*

NOTE 5 *Type D drainage channel blocks are suitable for use as outfalls for surface water channels and for types E and F drainage channel blocks.*

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NOTE 6 *Safety aspects of rectangular channel blocks are considered in CD 521 [Ref 5.N].*

4.10 Type D drainage channel block units shall be designed with anchorage at the top and bottom and with bedding support.

Design of drainage channel block systems

4.11 The design of drainage channel block systems shall assess the likelihood of the following factors when deciding whether to use them:

1) settlement of adjacent unpaved surfaces, which could reduce their effectiveness;
2) rapid build up of silt and debris in flat areas;
3) grass cutting operations by mechanical plant.

NOTE *There are potential maintenance difficulties associated with the use of drainage channel blocks from the above factors.*

Asset recording

4.12 Drainage channel blocks shall be recorded as continuous assets as detailed in CD 535 [Ref 4.N].

4.12.1 The asset record for drainage channel blocks should include all the attributes for continuous assets as detailed in CD 535 [Ref 4.N].

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5. Kerbed edge channels

General

5.1 Kerbed edge channels draining to gullies shall be as shown in Drawing B9 of MCHW HCD Drawings [Ref 8.N] except as qualified in the advice and notes related to this clause.

5.1.1 Pipework connecting gullies to carrier pipes may pass through the sub-surface drain.

5.1.2 The use of drain type 5 in Drawing F18 as shown in MCHW HCD Drawings [Ref 8.N] may not be possible where pipework connecting gullies passes through the sub-surface drain.

NOTE 1 *The short interruption resulting from gully connection pipework that pass through of drain types 6, 7, 8 and 9 as shown in Drawing F18 of MCHW HCD Drawings [Ref 8.N] will not generally affect the performance of the filter.*

NOTE 2 *The kerbs depicted in B9 of MCHW HCD Drawings [Ref 8.N] are of the extruded type, bedded on to the carriageway surface; it is not intended to exclude the range of kerb/bedding combinations permitted in SHW [Ref 9.N].*

5.2 Kerbed edge channels draining to drainage channel blocks shall be as shown in Drawing B10 of MCHW HCD Drawings [Ref 8.N] except as qualified in the note related to this clause.

NOTE *The kerbs depicted in B10 of MCHW HCD Drawings [Ref 8.N] are of the extruded type, bedded on to the carriageway surface; it is not intended to exclude the range of kerb/bedding combinations permitted in SHW [Ref 9.N].*

5.3 Hydraulic design of kerbed edge drainage shall be in accordance with CG 501 [Ref 3.N].

5.4 Outlet spacing for kerbed edge drainage shall be in accordance with CD 526 [Ref 11.N] .

5.5 The use and placement of kerbs shall be in accordance with CD 127 [Ref 1.N].

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6. Over the edge drainage

General

6.1 The edge of pavement details in MCHW HCD Drawings [Ref 8.N] shall be used as the basis of design for over the edge drainage.

NOTE *The edge of pavement details included in MCHW HCD Drawings [Ref 8.N] are listed in Appendix A.*

6.2 Embankments shall be designed to preclude topsoil instability.

6.2.1 Use of over the edge drainage should be confined to areas where there is a low risk of topsoil instability.

NOTE *Over the edge drainage can cause soil erosion, topsoil slippage, softening of the side slopes and embankment instability.*

6.2.2 Drainage of verges and carriageway over the edge of embankments should only be used where there is an open ditch or watercourse at the base of the embankment.

6.3 Where footways abut the carriageway or on structures, over the edge drainage shall not be used.

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7. Edge of pavement drains

7.1 Edge of pavement drains shall be included on all roads except the following:

1) roads with combined surface and sub-surface drains;
2) roads comprising rigid or flexible carriageways with over the edge drainage;
3) roads with free draining sub-grade.

NOTE *The purpose of edge of pavement drainage is to provide sub-surface drainage for the pavement layers, sub-base and capping (if permeable). Sub-surface drainage ensures that the road does not fail prematurely through water-related deterioration.*

7.2 Edge of pavement drains shall be formed with fin drains or narrow filter drains.

NOTE 1 *Typical fin drain and filter drain types are included in the edge of pavement details in MCHW HCD Drawings [Ref 8.N].*

NOTE 2 *The edge of pavement details included in MCHW HCD Drawings [Ref 8.N] are listed in Appendix A.*

7.2.1 The selection of a fin drain or filter drain system to drain pavement layers of a road in cutting should be influenced by considerations of possible groundwater, drainage during construction and whether or not a longitudinal carrier drain facility is necessary to transport surface water runoff from the carriageways.

NOTE *Fin drains and narrow filter drains can be unsuitable for dealing with high groundwater flows or where a longitudinal carrier drain is necessary to transport surface water runoff from the carriageways.*

7.2.2 Edge of pavement drains under channel drainage layers should be type 10 drains as depicted in Drawing F21 of MCHW HCD Drawings [Ref 8.N] provided that their use is possible.

NOTE 1 *The purpose of the under channel drain is to intercept any water which percolates through the road surface or edge of carriageway seal into the pavement layers and sub-base.*

NOTE 2 *The under channel drainage layer depicted in Drawing F21 of MCHW HCD Drawings [Ref 8.N] is shown for use with rigid carriageways but it can also be used in conjunction with flexible carriageways.*

NOTE 3 *Where it is impractical to use the detail in Drawing F21 of MCHW HCD Drawings [Ref 8.N], proven alternative drainage methods (e.g. a layer of free draining granular material) below the channel can be used in order to to provide a pathway to the sub-surface drain.*

7.2.3 Where the sub-base comprises cement bound granular mixture (CBGM) or where cement or lime stabilisation is proposed, the drain selected should be less vulnerable to the build up of calcium based deposits.

7.3 Narrow filter drains shall always be included on the low side of carriageways on embankments.

7.3.1 Drainage design should allow as wide a range of edge of pavement drain types as possible in order to deliver the most effective solution.

7.4 Fin and narrow filter drains which form part of the permanent works shall not be used for the disposal of surface water runoff during construction.

Asset recording

7.5 Edge of pavement drains shall be recorded as continuous assets as detailed in CD 535 [Ref 4.N].

7.5.1 The edge of pavement drain asset record should include all the attributes for continuous assets as detailed in CD 535 [Ref 4.N].

NOTE *Pipework that forms part of the edge of pavement drain is not recorded as a separate asset, but is considered an integral component of the drain.*

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8. Combined drainage and kerb systems

General

8.1 The edge of pavement drawings in MCHW HCD Drawings [Ref 8.N] shall be used as the basis of design for combined drainage and kerb systems.

NOTE 1 *The edge of pavement details included in MCHW HCD Drawings [Ref 8.N] are listed in Appendix A.*

NOTE 2 *Although combined drainage and kerb systems are useful on roads with relatively flat gradients, they are prone to the build-up of sediment and debris which can impede flow into and within the system.*

NOTE 3 *Combined drainage and kerb systems are useful in urban areas where there is a high incidence of utility services because they do not need as great a depth of excavation as piped systems.*

NOTE 4 *The dual function of combined drainage and kerb systems can offer cost savings in certain circumstances.*

8.1.1 Drawing B16 of MCHW HCD Drawings [Ref 8.N] shows the feature founded on the capping layer and where a capping layer is not present, the bedding concrete may be placed on fill, existing ground or the sub-base.

8.1.2 Where the bedding concrete is placed on fill, existing ground or the sub-base, the contract documents should indicate the position of the edge of pavement drain if present.

8.2 Combined drainage and kerb features shall be designed both for accidental loading and impact.

NOTE *Combined drainage and kerb systems are, by their very nature, hollow. Consequently they can be less robust than solid kerbs equivalents of same general dimensions.*

8.3 Placement of kerbs shall be in accordance with the provisions of CD 127 [Ref 1.N].

Asset recording

8.4 Combined drainage and kerb systems shall be recorded as continuous assets as detailed in CD 535 [Ref 4.N].

8.4.1 The combined drainage and kerb system asset record should include all the attributes for continuous assets as detailed in CD 535 [Ref 4.N].

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9. Linear drainage channel systems

General

9.1 The edge of pavement details in MCHW HCD Drawings [Ref 8.N] shall be used as the basis of design for linear drainage channel systems.

NOTE 1 The edge of pavement details included in MCHW HCD Drawings [Ref 8.N] are listed in Appendix A.

NOTE 2 The linear drainage channels can be formed with proprietary precast units or with proprietary units cast in situ.

9.1.1 Drawing B17 of MCHW HCD Drawings [Ref 8.N] shows a linear drainage channel founded on the capping layer and where a capping layer is not present, the bedding concrete may be placed on fill, existing ground or the sub-base.

9.1.2 Where the bedding concrete is placed on fill, existing ground or the sub-base, the contract documents should indicate the position of the sub-surface drainage.

9.1.3 Linear drainage channel systems may be used in both verges and central reserves on motorways.

9.1.4 Linear drainage channel systems in all-purpose trunk road verges should be placed behind the vehicle restraint system (VRS).

9.1.5 Linear drainage channel systems in all-purpose trunk road central reserves should be placed behind VRS fencing or immediately in front of vertical concrete barriers.

9.1.6 The impact of maintenance should be assessed for linear drainage systems.

NOTE Linear drainage systems can increase the burden on maintenance.

9.1.7 The use of linear drainage systems in locations where frequent maintenance interventions are required should be avoided.

NOTE Linear drainage channel systems which are used on roads with relatively flat gradients are prone to the build-up of sediment and debris which can impede flow into and within the system.

9.2 Linear drainage channel systems located in motorways and all-purpose trunk roads that are not protected from direct traffic load shall be Class D400 systems as detailed in the SHW [Ref 9.N].

9.3 Linear drainage channel systems located in motorways and all-purpose trunk roads that are protected from direct traffic loading shall be Class D400 or Class C250 as detailed in the SHW [Ref 9.N].

9.4 Slotted linear drainage systems shall not be used in areas subject to pedestrian and cyclist use.

9.5 Precast channel type linear drainage systems used in areas subject to pedestrian or cyclist use shall have mesh gratings.

9.6 All linear drainage channel system gratings and covers shall be of a type that is integral with the drainage channel.

9.7 Linear drainage systems shall not be used in areas subject to trafficking by high speed heavy goods vehicles.

Asset recording

9.8 Linear drainage channel systems shall be recorded as continuous assets as detailed in CD 535 [Ref 4.N].

9.8.1 The asset records for linear drainage channel systems should include all the attributes for continuous assets as detailed in CD 535 [Ref 4.N].

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10. Normative references

The following documents, in whole or in part, are normative references for this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Ref 1.N	Highways England. CD 127, 'Cross-sections and headrooms'
Ref 2.N	Highways England. CD 525, 'Design of combined surface and sub-surface drains and management of stone scatter'
Ref 3.N	Highways England. CG 501, 'Design of highway drainage systems'
Ref 4.N	Highways England. CD 535, 'Drainage asset data and risk management'
Ref 5.N	Highways England. CD 521, 'Hydraulic design of road edge surface water channels and outlets'
Ref 6.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 7.N	Highways England. MCHW NG, 'Manual of Contract Documents for Highway Works Volume 2: Notes for Guidance on the Specification for Highway Works'
Ref 8.N	Highways England. MCHW HCD Drawings, 'Manual of Contract Documents for Highway Works Volume 3: Highway Construction Details'
Ref 9.N	Highways England. SHW, 'Manual of Contract Documents for Highway Works, Volume 1 Specification for Highway Works'
Ref 10.N	Highways England. MCHW Series 500, 'Manual of Contract Documents for Highway Works, Volume 1 Specification for Highway Works. Series 500 Drainage and service ducts.'
Ref 11.N	Highways England. CD 526, 'Spacing of road gullies'

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11. Informative references

The following documents are informative references for this document and provide supporting information.

Ref 1.I	WFD 2015, 'The Water Environment (WFD) (England and Wales) (Amendment) Regulations 2015'

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Appendix A. Highway construction details

A1 Edge of pavement details - B series

The 'B' series drawings shown in MCHW HCD Drawings [Ref 8.N] show indicative edge of pavement details pertaining to highway drainage. These drawings are indicative only and are listed in Table A.1.

Table A.1 B series drawings - Edge of pavement details

Drawing	Detail
B1	Cuttings - Combined Surface and Sub-surface Drain
B2	Cuttings - Surface Water Channel for Rigid Carriageway
B3	Cuttings - Surface Water Channel for Flexible Carriageway
B4	Cuttings - Drainage Channel Block and Drains
B5	Central Reserve - Combined Surface Water and Ground Water Filter Drain
B6	Central Reserve - Surface Water Channel for Rigid Carriageway
B7	Central Reserve - Surface Water Channel for Flexible Carriageway
B8	Central Reserve - Drainage Channel Blocks and Drains
B9	Embankments - Channels Formed by Kerbs
B10	Embankments - External Kerbs and Drainage Channel Blocks
B11	Embankments - Surface Water Channel for Rigid Carriageway
B12	Embankments - Surface Water Channel for Flexible Carriageway
B13	Embankments - Verge Drainage or Verge and Carriageway Drainage over Embankment Slope
B14	Cross Section of Surface Water Channel
B15	Cuttings and Central Reserve Combined Surface and Ground Water Filter Drains
B16	Embankments - Combined Drainage and Kerb Blocks
B17	Central Reserve Linear Drainage System with Concrete Safety Barrier
B18	Surface Water Channel Requiring Safety Barrier Protection

A2 Drainage - F series

Some of the drainage components shown in the 'B' Series drawings of are shown in detail in the 'F' Series drawings in MCHW HCD Drawings [Ref 8.N]. These drawings are indicative only and those pertinent to this document are listed in Table A.2.

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Table A.2 F series drawings - Drainage

Drawing	Detail
F2	Filter Drains - Trench and Bedding Details
F15	Drainage Channel Blocks Types A, B and C
F18	Drainage Channel Blocks Types D, E and F
F19	Edge pf Pavement Drains - Installation of Fin Drains
F20	Edge pf Pavement Drains - Installation of Narrow Filter Drains
F21	Edge of Pavement Drains - Under Channel Drainage Layers
F22	In-line Outlet Triangular S.W. Channel
F23	In-line Outlet to Trapezoidal S.W. Channel
F24	Weir Outlet to S.W. Channel

A3 Information required to be shown in the contract

Information required to be shown in the contract by virtue of the 'B' and 'F' series drawing in MCHW HCD Drawings [Ref 8.N] are detailed in Table A.3.

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Table A.3 Information required to be shown in the contract

	Drawing	Information required	Where shown in contract
I	B1, B5, B15 Combined surface and sub-surface drains	Options for top of drain (B15) & bottom of drain (F2) with schedule of permitted pipe sizes and types for filter drains.	Appendix 5/1
		Requirements where necessary for mesh, geotextile membrane, light-weight aggregate, unbound sub-base material.	Appendix 5/1
II	B2, B3, B6, B7, B11,B12, B14, B18 Surface water channels	Options for grassing, or paving for non pavement verge/central reserve	Appendix 5/3
		Dimensions T, U, V, W, X, Y, Z to Drawing B14	Appendix 5/3
		Paving details if used.	Appendix 5/3 or contract drawings
III	B9, B10 Channels formed by kerbs	Drawing shows extruded kerb.	Contract drawings
		Details of other permitted types of kerbs, e.g. B16, will require separate drawings.	Contract drawings
IV	B4, B8, B10 Drainage channel block	Options for types of channel block from F15 & F16 & grass or paving option	Appendix 5/3
		Dimensions W, X & Y.	Appendix 5/3
V	Linear drainage channels and combined channel and pipe	Offset of channel from carriageway.	Contract drawings
VI	F2 Filter drains - trench	Grading requirements for type C filter material.	Appendix 5/1
VII	F15 Drainage channel blocks	Dimensions R, L	Appendix 5/3
VIII	F18, F19, F20, F21 Fin drains, narrow filter drains and under-channel drainage layer.	Options for types of fin and narrow filter drain (F18).	Appendix 5/3
		Dimensions for height, width and pipe diameter (F18); drain slope angle & (F19); a & b (F21).	Appendix 5/4
		Requirements for surround / backfill materials & marker tape.	Appendix 5/4
IX	F22, F23, F24 Surface water channel outlets	Outlet dimensions.	Appendix 5/3

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