VOLUME 4 GEOTECHNICS AND DRAINAGE

SECTION 2 DRAINAGE

PART 4

HA 83/99

SAFETY ASPECTS OF ROAD EDGE DRAINAGE FEATURES

SUMMARY

This Advice Note gives guidance on safety aspects of road edge drainage features but contains no mandatory requirements therein. The principles outlined apply to all schemes on trunk roads, including motorways, and may also be applied generally to other new highway schemes.

INSTRUCTIONS FOR USE

This is a new document to be inserted in the manual.

1. Insert HA 83/99 into Volume 4, Section 2, Part 4 of the DMRB.

2. Archive this sheet as appropriate.

Note: A quarterly index with a full set of Volume Contents Pages is available separately from The Stationery Office Ltd.

THE HIGHWAYS AGENCY

THE SCOTTISH EXECUTIVE DEVELOPMENT DEPARTMENT

THE NATIONAL ASSEMBLY FOR WALES
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THE DEPARTMENT OF THE ENVIRONMENT FOR NORTHERN IRELAND

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Contents

1. INTRODUCTION

General

1.1 This Advice Note gives guidance on safety aspects of road edge drainage features. It relates to both all purpose trunk roads and motorways, although some parts will apply to only to the first category in so far as provision for cyclists and pedestrians is not relevant to motorways. Although the advice should be fully taken into account in the design of new schemes (see 1.9), this Advice Note contains no mandatory requirements. Careful consideration of safety implications at an early stage should minimise the number of problems identified during road safety audits as described in HD 19, Road Safety Audits (DMRB 5.2) and HA 42, Road Safety Audits (DMRB 5.2). Certain requirements of drainage systems are given in the 500 Series of Volumes 1 and 2 of the Manual of Contract Documents for Highway Works (MCHW 1 & 2). Appropriate details are given in the B and F series of drawings in Volume 3 (MCHW 3).

1.2 Safety aspects of drainage details are generally a function of the location, form and size of the detail and any associated safety barrier or safety fence provision. Road edge drainage features are primarily designed to remove surface water. Since they are usually placed along the side of the carriageway, they should not normally pose any physical hazard to road users. It is only in the event of a vehicle becoming errant that the consequential effects of a road edge drainage feature upon a vehicle become important. The advice on mitigation measures contained within this document is aimed at producing the safest solution for given situations.

1.3 This Advice Note has been prepared combining research findings reported in TRL Report PR/SE/435/98 Safety Aspects of Road Edge Drainage Features (Ref 3) TRL Report 230 Assessment of vehicle handling safety when driving into road edge water drainage channels, (Ref 5) and good engineering practice. In addition it draws together and augments safety advice given mainly in HD 33, Surface and Sub-surface Drainage Systems for Highways (DMRB 4.2), HA 39, Edge of Pavement Details (DMRB 4.2), HA 79 Edge of Pavement Details for Porous Asphalt Surface Courses (DMRB 4.2), HA 42, Road Safety Audits (DMRB 5.2) and TA 57 Roadside Features (DMRB 6.3).

1.4 Effective drainage of rainwater from road surfaces plays a major part in road safety by removing surface water quickly. In addition a suitable drainage system will minimise damage to the structural foundations of the carriageway. This, in turn, will reduce the requirement for maintenance and roadworks which tend to increase potential hazards for the road user. However, drainage features can present a potential hazard to errant vehicles leaving the carriageway. The safety aspects of such features must be considered at the design stage.

1.5 Safety problems differ on rural and urban roads, both situations need to be considered particularly in relation to the more vulnerable road users.

1.6 There is also a distinction to be made between the safety needs of new roads and those of local improvements, the design of which may be restricted if carried out within existing highway limits.

1.7 This Advice Note deals with most of the commonly used drainage details. For features which are not covered in this Advice Note, the designer should seek advice from the Overseeing Organisation.

Scope

1.8 The principles outlined in this Advice Note apply to all schemes on trunk roads including motorways. They may also be applied generally to other new highway schemes and by other highway authorities for use during the preparation, design and construction of their own comparable schemes.

Implementation

1.9 This Advice Note should be used forthwith for all schemes currently being prepared provided that, in the opinion of the Overseeing Organisation, this would not result in significant additional expense or delay progress. Design Organisations should confirm its application to particular schemes with the Overseeing Organisation.

2. PRINCIPLES

2.1 It is essential that drainage features should be efficient in removing water from the carriageway. They must also be safe and structurally adequate for normal usage and that which may occur during motorway lane closures and consequent trafficking of hard shoulders. The feature must be able to withstand accidental loading except in locations which are protected from direct traffic. The design should mitigate, as far as is reasonably possible, the effects on errant vehicles leaving the carriageway.

2.2 Maintenance on motorways and other high speed roads involves a higher than normal degree of risk, both to road users and maintenance operatives. Longevity of the system, amount of future maintenance and safety aspects of the maintenance of road edge drainage features should therefore be considered at the design stage, together with the impact that such edge features may have on safety when general maintenance work is carried out. The emphasis on central reserve drainage must be on the need for minimum maintenance owing to the difficulty of access.

2.3 It is important that the safety of all categories of road user permitted on a particular road should be considered. For all purpose trunk roads this may include drivers of motor vehicles, pedestrians, cyclists, equestrians and the disabled. Development, both existing and proposed, should be taken into account, such as the presence of schools, old people's homes and access for emergency vehicles.

2.4 The potential for safety hazards is often greatest at junctions and tie-ins. Where an improvement joins an existing road or junction, differences in the alignment can create hazards so special attention should be paid to those areas to ensure a safe transition is achieved for all features, including drainage. This applies particularly to on-line improvements, where variations in quality of alignment between new and existing sections may not be obvious to the road user.

2.5 While the behaviour of an errant vehicle and its occupants is unpredictable and deemed to be hazardous, the designer must consider carefully the safety implications of the design and should undertake all reasonable measures in order to mitigate these potential hazards. HD 33 (DMRB 4.2)

3. KERBS AND GULLIES

3.1 Kerbs and gullies have been for many years one of the commonest forms of road drainage. Kerbs may cause a hazard to errant road users, especially cyclists and motorcyclists. The degree of hazard they present appears to be acceptable in practice, primarily because they are a well established feature. Where other special kerb features are included, advice should be sought from the overseeing organisation.

3.2 Although the main functions of kerbs are to protect pedestrians and provide support for the carriageway, they are often also an essential part of a drainage system. They retain surface water at the edge of the carriageway from where it is removed through a system of gullies and pipes.

3.3 As the safety of vehicles is the main priority on high speed roads, kerbs are not recommended for general use on trunk roads in rural locations unless adjacent footways are present. They should therefore only be chosen for drainage reasons when other systems are unsuitable.

3.4 It is considered that a kerb upstand of 75mm or less (especially if battered at 45 degrees) allows an errant vehicle to mount the kerb, whereas upstands greater than this (especially if near vertical) tend to deflect an errant vehicle back into its original path (Ref 4). In rural locations it is generally safer for a high speed errant vehicle to be able to mount the kerb without overturning or causing a hazard to following vehicles. In urban situations, where the protection of pedestrians is the highest priority, it is necessary to provide kerbs of a more prominent upstand in order to prevent vehicles from mounting the footway. See 3.6. In such situations there is generally a speed restriction.

3.5 If kerbs have to be provided on trunk roads in rural areas they should normally be 75mm in height and fully battered ie splayed at 45 degrees. A vertical or near-vertical upstand should not be used in these circumstances within 300mm of a running lane.

3.6 As the safety of pedestrians is the priority in urban areas, vertical or half battered kerbs should always be provided in these locations. These normally have a 100mm to 125mm upstand.

3.7 Roundabout design to TD 16 (DMRB 6.2) deliberately sets a high deflection to deter high entry and gyratory speeds. This trades off an increase in slight accidents against a reduction in fatal/serious accidents. The use of substantial kerb upstands is one of the measures adopted to inform the driver of the deflection.

3.8 Kerbs shown in B9 and B10 of the HCD (MCHW 3) are of the extruded type, bedded on to the carriageway surface with a battered face of 2 (horizontal) to 3 (vertical). However it is not intended to exclude the range of kerbing/bedding combinations permitted in the SHW. (MCHW 1)

3.9 For the use of kerbs in relation to safety fences see TD 19, Safety Fences (DMRB 2.2) and TD 32, Wire Rope Safety Fences (DMRB 2.2). In particular, wire rope safety fences shall not be used where the height of any kerb at the edge of the adjacent paved surface exceeds 110mm. Refer to TD 32 for more detailed guidance.

3.10 The designer should base his gully spacing on an appropriate flooded width for that particular location. For example a relatively small flooded width (typically 0.5m) in the channel would normally be chosen in an urban situation to minimise nuisance and danger to cyclists and pedestrians.

3.11 Where necessary, allowance should be made for blockage of gullies by debris. The designer may obtain advice on this matter from the Overseeing Organisation. It is also important to ensure that gullies are located at low points. Potential problems may arise from consequent flooding and freezing if gully positions are not correctly and accurately determined.

3.12 Where lay-bys are constructed on kerbed carriageways any islands separating the lay-by from the carriageway should not encroach within the one metre hardstrip of the main carriageway where they could provide a hazard for cyclists.

4. SURFACE WATER CHANNELS

4.1 Surface water channels provide an economic method of drainage in new construction of rural roads. Research suggests that the channels permitted in HA 37 (DMRB 4.2) pose no greater hazard than the stone filter drain or kerb installation and in most situations are potentially less hazardous. The triangular design should be used in normal circumstances with the trapezoidal design being used where a higher than normal capacity is required. However, as deep or steep-sided surface water channels may present a hazard to errant vehicles, there are restrictions regarding their use which must be taken into account. HA 37 (DMRB 4.2).

4.2 Rectangular channels or triangular channels deeper than 150mm should be used only when a safety fence is provided in front of them. In addition, these channels should not be located in the zone behind the safety fence into which the fence may reasonably be expected to deflect on vehicle impact. Co-ordination of the layout of safety fences and surface water channels must be arranged at an early stage in design and not left to compromise at a later stage.

4.3 Geometric constraints given in HA 37 (DMRB 4.2) are designed to minimise hazard to errant vehicles. The same constraints should also be applied to channel outfall details.

4.4 The use of surface water channels should be avoided for shallow longitudinal falls if there is a risk of settlement occurring. On long slack gradients, any settlement could result in flat spots or even reverse falls, with consequent safety problems related to flooding and freezing.

4.5 The degree of security against flooding varies and should be dealt with on a case-by-case basis. Also, although a certain amount of flooding may be tolerated in the hardshoulder and verge hardstrip, in central reserves it is important to prevent water encroaching on to the right hand lane or from overflowing on to the opposite carriageway. Advice is given in HA 37 (DMRB 4.2).

5. DRAINAGE CHANNEL BLOCKS

5.1 Drainage channel blocks Types A and B (as shown in Drawing F15-HCD (MCHW 3)) are intended for use 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 channels. The surcharged levels for drainage channel blocks should comply with the criteria given for surface water channels.

5.2 Drainage channel blocks Types A and B should be installed parallel to the road and not less than one metre from the edge of the carriageway. They are not permitted as edge drains contiguous with hard shoulders, hardstrips, or carriageways. They should also be avoided in verges subject to frequent equestrian use.

5.3 Type C drainage channel blocks are intended for use instead of gullies or grips and to provide drainage across embankments through appropriate gaps in the kerb line. Blocks D, E and F are intended to take run-off down an embankment slope to a toe ditch.

6. LINEAR DRAINAGE CHANNEL SYSTEMS

6.1 Linear drainage channels are described in Clauses 517 (MCHW 1) and NG 517 (MCHW 2). As with other drainage features they should not be installed in locations where they will be subject to heavy trafficking by high speed Heavy Goods Vehicles. In exceptional circumstances they may be used in trafficked situations, such as crossovers or nosings. Those systems meeting the requirements of Class D (as given in Clause 517) will resist occasional overrun by all vehicles permitted on trunk roads including motorways. All gratings and covers must be of a type that is integral with the drainage channel. Class C channels shall only be installed in locations which are protected from direct traffic loading (eg behind safety fencing).

6.2 Not all the slot dimensions permitted in MCHW 1 may suitable on safety grounds where they may be accessible by vulnerable road users. The designer should refer to Clause NG 517 (MCHW 2) and Clause 6.17 of HD 33 (DMRB 4.2). In addition, where linear drainage channel systems are considered for areas accessible by vulnerable road users, the advice of the Overseeing Organisation should be sought.

6.3 Linear drainage channel systems may be used adjacent to vertical concrete barriers as shown in Drawing B 17, MCHW 3. Slot widths shall generally be as given in Clause 517 with the exception given for motorways in Note 9 of Drawing B17. On motorways a wider range of slot dimensions is permitted as pedestrians and cyclists are prohibited. However the designer should be aware of possible emergency situations.

6.4 When used on shallow gradients linear drainage channels may be prone to maintenance difficulties. The consequent potential hazards associated with a possible high level of maintenance should therefore be considered.

7. COMBINED DRAINAGE AND KERB SYSTEMS

7.1 Combined drainage and kerb systems are described in Clause 516 (MCHW 1) and NG 516 (MCHW 2). They are useful where kerbs are necessary at locations of little or no longitudinal gradient. They are particularly useful at roundabouts where there is little fall and in urban areas where there is a high incidence of public utility services because they do not need as great a depth of excavation as a typical piped system.

7.2 Where drainage and kerb systems may be subject to vehicle over-run care should be taken to ensure that the system is designed both for accidental loading and impact. Because combined drainage and kerb systems are by their nature hollow, they may not be as robust as solid kerbs of the same general dimensions.

7.3 As described in Chapter 3, kerbs for combined drainage and kerb units shall normally be 75mm high and fully battered in rural locations. For urban locations refer to advice in Chapter 3 or seek advice from the Overseeing Organisation.

8. COMBINED SURFACE AND GROUNDWATER FILTER DRAINS

8.1 Combined filter drains are not advocated for general use in new construction but they may be useful in cutting situations requiring appreciable ground water removal or where roads have long lengths of zero longitudinal gradient. They may also be used in reconstruction work where the best option is replacing like for like. One of the main reasons for the move away from these drains is the problem of stone scatter and it should be noted that standard details do not permit type B filter material at the surface. Where the stone filter media can be replaced with an alternative that is not prone to scatter, see 8.4, then use may be permitted.

8.2 Where combined filter drains are used, care should be taken to minimise potential stone scatter problems. Stone scatter presents a safety hazard especially when a hard shoulder is used as a running lane in contraflow. Stone scatter from central reserve drains presents an even greater safety hazard.

8.3 Various methods are available to reduce stone scatter; and some of the standard methods are shown in Drawing B15 of the HCD (MCHW 3). These include the use of topsoil over the drain (possibly with a geotextile separator), the use of sub-base or the use of lightweight aggregates. In addition HA 79/97 shows the option of a bitumen-bound aggregate as a topping or spraying the top surface of exposed filter material with bitumen.

8.4 A relatively recent technique is that of using bitumen-bound shredded tyres at the surface. Research has indicated that motorists or cyclists can cross such a surface more readily than a typical kerb. Guidance on the use of bonded shredded tyres as an alternative filter topping may be sought from the Overseeing Organisation. Consideration should be given to using different colour binders where it is necessary to differentiate the drain surface from the road surface.

8.5 Where the degree of porosity is significantly reduced by the introduction of a less permeable material in the top layer, it is necessary that a slight dishing should be provided in the top surface of the drain to allow water to be channelled along the surface and into catchpits during heavy rainfall. Drawings B1, B5, B15, MCHW 3.

8.6 The emphasis on central reserve drainage must be on minimum maintenance due to difficulty of access. The use of filter drains is not suitable in this location as the filter media requires cleaning and replacement over a period of time, and presents a safety hazard from stone scatter to fast moving vehicles.

8.7 As filter drains have a gravel (or other unbound) surface, their use should be avoided in narrow verges subject to use by equestrians.

8.8 The use of crushed rock in filter drains, being more angular, is likely to be less hazardous than rounded gravel.

9. OVER THE EDGE DRAINAGE

9.1 Advice on the use of over the edge drainage is given in HA 39 (DMRB 4.2). For new construction the level of the grass verge should be set at or slightly below carriageway level to minimise the effect from the build-up of grass kerbs B15 HCD MCHW 3.

9.2 Where the verge is higher than carriageway level there will probably be a need for grips to be cut through the verge. As a general rule the grips should be fairly wide and shallow sided . This will extend the period before they need recutting or cleaning and will minimise the difficulty for motorists to pull onto them in an emergency.

10. SPECIAL CONSIDERATIONS

Porous Asphalt

10.1 Porous asphalt has a number of advantages over conventional materials in that it can reduce traffic noise, spray and glare. However, it has the disadvantage that the most efficient method of water removal requires an open, free face at the edge of the carriageway. This typically takes the form of a 50mm step down, which may have undesirable safety implications for some road users. Advice on possible alternative edge details is given in HA 79 (DMRB 4.2).

10.2 Where porous asphalt is used in conjunction with surface water channels, the vertical distance between the top of the porous asphalt layer and the invert of the channel should not exceed 150mm. Allowing for the 50mm drop to base course level, the maximum depth of a surface water channel in these circumstances is therefore reduced from 150mm to 100mm.

10.3 Because it is not easily seen, a step down off the edge of the carriageway is more likely to be hazardous to many road users than a similar step up. This is particularly true for pedestrians and riders of two wheel vehicles.

10.4 The use of porous asphalt with free edges with over the edge drainage or a kerbed channel or a surface water channel are not suitable for use on roads frequented by pedestrians or cyclists because of safety hazards. Safety considerations are therefore especially important when porous asphalt in used in urban areas.

10.5 External kerbed channels and surface water channels which involve a step down should not be used immediately adjacent to the edge of the carriageway without a hardstrip or hardshoulder, other than alongside the central reserve. Where a step down is unavoidable the provision of raised rib markings would provide some protection for vulnerable road users.

10.6 Porous asphalt surfaces must be continued across the hard strip and not discontinued at the edge of the carriageway, as this practice might create a step which may be dangerous to cyclists.

10.7 The installation of loops into porous asphalt road surfaces requires a modified loop slot profile and the use of a porous backfill in order to retain porosity of the road surface. A suitable slot profile together with material and installation specifications is contained in MCHW 1 Clause 1540: Specification for the installation of detector loops on motorways and all purpose trunk roads.

Cyclists

10.8 As cycling is being actively encouraged as a means of transport, it is a matter of increasing importance that the safety of cyclists should be considered in the design of improvements, especially in urban areas. Guidance is given in TA 67 (DMRB 5.2) and TA 57 (DMRB 6.3).

10.9 The hard strips alongside all purpose roads are not intended to serve as cycle lanes, but it is recognised that they are used by cyclists, as a safety measure, to gain separation from passing traffic. In the absence of alternative provision this is unavoidable, but good maintenance of the hard strip then takes on greater importance. As cyclists are more adversely affected than motor vehicles by glass or other debris, it is important to maintain regular sweeping of edge strips which are used by cyclists.

10.10 The presence of cyclists within the hard strip locally reduces the value of this safety feature. Also, raised rib markings adjacent to the hard strip may cause difficulties for cyclists entering or leaving the marginal strip near junctions.

10.11 Research has indicated that cyclists and motorcyclists are better able to negotiate surface water channels of the geometry permitted by HA 37 (DMRB 4.2) than some common features such as gravel drains and kerbs.

Chamber Covers and Gully Gratings

10.12 Chamber covers and gully gratings should not normally be sited in carriageways. By virtue of their need to be removable, their presence in a carriageway is a potential hazard, especially in trunk road situations. Where this is unavoidable they should be kept clear of the wheel tracks in the running lanes to avoid repeated wheel loadings. BS EN 124 (Ref 8) requires covers in these locations to be of a certain weight or incorporate a security feature. Designers will also need to be cognisant of the possibility that under certain temporary traffic conditions the hard shoulder is used as a running lane.

10.13 For all trunk roads chamber covers and gully gratings should meet the requirements of Class D400 of BS EN 124. Where, exceptionally, covers have to be located in areas subjected to large numbers of high speed heavy goods vehicles covers may have to be upgraded to Class E600 (BS EN 124). Advice may be sought from the Overseeing Organisation.

10.14 Safety problems may arise from relatively minor problems with manhole covers and chambers in that maintenance or repair will require roadworks and lane closures which will, in turn, create a higher risk situation on the highway.

10.15 Before permitting trafficking, care must be taken to ensure that all reinstated framework is flush with the paved surface and securely bedded using suitable bedding materials, eg quick setting mortar. Advice on suitable bedding materials may be obtained from the Overseeing Organisation.

10.16 Gully gratings and grids should have slots at angles that will not affect the passage of cyclists and should be set in accordance with Clause 508 (MCHW 1). Grids and gratings should also be avoided at cyclist crossing points.

Road Markings

10.17 It is essential that road markings do not restrict the drainage from the carriageway surface. Even a thin film of standing water can be particularly dangerous in the winter when it may freeze. The markings may project up to 6mm above the adjacent surface although the ribs of raised rib markings may be higher. Chapter 5 of the Traffic Signs Manual requires gaps of between 100 – 150mm in the longitudinal thermoplastic marking every 36 metres where the longitudinal gradient is less than 1 in 150, to reduce the obstruction of surface water flow. (Drawing P1012.2 and IAN 1/90).

10.18 Where a kerb exists a clear space of 225mm should generally be maintained between markings and the kerbed edge of the road. This will allow water to flow freely and help ensure that the markings do not become unnecessarily dirty.

11. REFERENCES AND BIBLIOGRAPHY

1. Manual of Contract Documents for Highway Works (MCHW)

Specification for Highway Works (SHW) (MCHW 1)

Notes for Guidance on the Specification for Highway Works (NGSHW) (MCHW 2)

Highway Construction Details (HCD) (MCHW 3)

2. Design Manual for Roads and Bridges (DMRB) (The Stationery Office)

HD 19 Road Safety Audits (DMRB 5.2)

HD 33 Surface and Sub-surface Drainage Systems for Highways (DMRB 4.2)

HA 37 Hydraulic Design of Road Edge Surface Water Channels (DMRB 4.2)

HA 39 Edge of Pavement Details (DMRB 4.2)

HA 42 Road Safety Audits (DMRB 5.2)

HA 78 Design of Outfalls for Surface Water Channels (DMRB 4.2)

HA 79 Edge of Pavement Details for Porous Asphalt Surface Courses (DMRB 4.2)

TD 16 Geometric Design of Roundabouts (DMRB 6.2)

TD 19 Safety Fences (DMRB 2.2)

TD 32 Wire Rope Safety Fences (DMRB 2.2)

TA 57 Roadside Features (DMRB 6.3)

TA 67 Providing for Cyclists (DMRB 5.2)

TA 69 The location and layout of lay-bys (DMRB 6.3)

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6. CR2 Contractor Report 2. The drainage capacity of BS road gullies and a method for estimating their spacing.

7. CR76 Contractor Report 76. Methods for the removal of surface water from trunk roads.

8. BS EN 124:1994. Gully tops and manhole tops for vehicular and pedestrian areas - Design requirements, type testing, marking, quality control.

12. ENQUIRIES

All technical enquiries or comments on this Advice Note should be sent in writing as appropriate to:

Traffic, Safety and Envrionment Divisional Director
Highways Agency
St Christopher House
Southwark Street
London
SE1 0TE

G CLARKE
Traffic, Safety and Environmental
Divisional Director

The Chief Road Engineer
The Scottish Executive Development Department
National Roads Directorate
Victoria Quay
Edinburgh EH6 6QQ

J HOWISON
Chief Road Engineer

Head of Network Management Division
The National Assembly for Wales
Cynulliad Cenedlaethol Cymru
Crown Buildings
Cathays Park
Cardiff CF1 3NQ

R J SHAW
Head of Network Management Division

Assistant Technical Director
Department of the Environment for
Northern Ireland
Roads Service
Clarence Court
10-18 Adelaide Street
Belfast BT2 8GB

D O'HAGAN
Assistant Technical Director