Design Manual for Roads and Bridges

Drainage
Design

CD 535
Drainage asset data and risk management

(formerly HD 43/04, IAN 147/12)

Version 1.1.0

Summary
This document defines the requirements for recording of inventory and condition of drainage assets, and the management of flooding, pollution and cross-asset risks related to drainage.

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 National Highways team. The email address for all enquiries and feedback is: Standards_Enquiries@highwaysengland.co.uk

This is a controlled document.

Contents

Latest release notes

Document code	Version number	Date of publication of relevant change	Changes made to	Type of change
CD 535	1.**1**.0	October 2021	Core document, England NAA	Incremental change to requirements

Minor updates to reflect changes in scope of CS 551. Minor updates to include a small number of additional asset types or attributes. Minor updates to operational reporting requirements to reflect changing business practice. Minor clarifications of wording.

Previous versions

Document code	Version number	Date of publication of relevant change	Changes made to	Type of change
CD 535	1	January 2020		
CD 535	0	June 2019		

Foreword

Publishing information

This document is published by National Highways.

This document supersedes HD 43/04 and IAN 147/12 which are withdrawn.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.

Introduction

Background

This document defines the requirements for recording of inventory and condition of drainage assets, and the management of flooding, pollution and cross-asset risks related to drainage.

Prior to this document, HD 43 set out the requirements for recording of drainage asset inventory information. This was updated and supplemented by IAN 147, which set out advice for recording of inventory and condition data for all types of drainage assets, and provided guidance for capturing this data through surveys and digitisation of records.

This document formalises these requirements, and incorporates other drainage asset management instructions and guidance that have been published more recently.

National Application Annexes to this document provide further details of the scope and format of data, and drainage asset management procedures specific to the Overseeing Organisation.

Assumptions made in the preparation of the document

The assumptions made in GG 101 [Ref 3.N] apply to this document.

Abbreviations

Abbreviation	Definition
DDMS	Drainage data management system
EqIA	Equality impact assessment
GIS	Geographical information system
GPS	Global positioning system
LiDAR	Light detection and ranging
VRS	Vehicle restraint system

Terms and definitions

In addition to the terms defined in the table below, drainage asset types are defined and described in greater detail in Appendix A

Term	Definition
Acute pollution	Incidence of pollution that occurs suddenly. NOTE: A spillage event as a result of an accidental discharge from a vehicle is a potential cause of an acute pollution incident.
Asset condition	A measure of the current health of an asset, that indicates its ability to perform as designed and its likelihood of failure. NOTE: Condition is considered in terms of serviceability (service condition) and structural integrity (structural condition).
Asset condition survey	Field surveys that assess the condition of all drainage assets in an area at the asset level, without detailed recording of defects. NOTE: Where the assets have not been previously recorded the survey also captures the asset inventory, connectivity and flow direction between assets.
Asset inventory information	Data and information concerning the physical, permanent characteristics of one or more assets. NOTE 1: Asset inventory includes details of each asset type, their component parts, information about their permanent characteristics such as materials and dimensions, and how the assets connect together to form a drainage system. NOTE 2: To satisfy connectivity requirements, some records in the asset inventory can comprise network modelling items.
Asset inventory survey	Quick field surveys that either identify the location of priority drainage assets or confirm the validity of existing inventory records. NOTE: The surveys are selective and are unlikely to survey 100 % of the assets in an area.
Basin	A depression in the ground that temporarily detains storm water flows. NOTE: The water can be directed to a surface water outfall, or it can percolate through to groundwater.
Chronic pollution	Incidence of pollution that occurs over a long period of time, not from an individual incident. NOTE: Long-term run-off from the carriageway can cause chronic pollution.
Continuous asset	Asset such as a pipe, ditch or channel that is represented as a linear feature in GIS. NOTE: The GIS geometry represents the asset's centre-line, and does not reflect its width.

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Detailed defect survey	Detailed field surveys to record all condition defects in the inspected drainage assets. NOTE 1: For pipework and chambers, this involves internal CCTV survey. For non-pipework assets, it involves detailed inspection, possibly with selective excavation of some buried assets. NOTE 2: Where the asset inventory has not previously been recorded, or has not been recorded in detail, then the detailed inventory is also captured. NOTE 3: The survey can focus on particular assets in an area of known performance problems, or can survey all the drainage assets in the area, in which case the survey also records how the assets connect together and flow directions.
Diffuse pollution	Incidence of pollution involving pollutants from several sources, over a long period of time, rather than from an individual incident. NOTE: Individually, the pollutants involved can have no significant impact on water quality, but at a catchment scale and/or in combination can become significant.
Drainage asset	An individual component within a drainage system, such as a gully, pipe, ditch or pond.
Drainage data management system	Overseeing Organisation's primary database for managing information concerning drainage assets and flooding.
Drainage highway catchment	A group of all the drainage systems and the adjacent land they drain, between two geographical high points of the highway network. NOTE 1: Both carriageways of a dual carriageway are considered part of the same catchment, but risks can be assessed separately for each carriageway. NOTE 2: A drainage highway catchment can include one or more drainage systems.
Drainage system	A group of drainage assets that are directly or indirectly connected to each other, within a single drainage highway catchment. NOTE: Each individual drainage asset is part of only one drainage system.
Flood / flooding	The accumulation or passage of water at the ground surface where it is not normally experienced.
Flood event	A single incidence of flooding on or within 200m of a carriageway, at a particular location and time.
Flooding hotspot	An extent of carriageway at risk of repeated flooding.
Mitigation	An action or procedure that is designed and implemented to reduce a risk to an acceptable level. NOTE 1: A mitigation does not necessarily eliminate a risk entirely. NOTE 2: Acceptability criteria for the level of residual risk can be defined on a case-by-case basis.

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Network modelling item	An asset inventory record that takes the place of one or more physical point asset or continuous asset records to satisfy drainage network connectivity requirements. NOTE: Example usages are where there is either no physical asset, where the detailed arrangement of the physical assets are not yet known, or where flow direction is generalised in a region asset.
Point asset	Asset such as a chamber that is represented as a point in GIS. NOTE 1: The dimensions or physical shape of the asset are not represented in the GIS geometry, but only as data attributes. NOTE 2: Some assets of a linear physical shape such as weirs are represented as point assets because the overall flow direction is across their width, rather than along their length.
Pollution	The presence or introduction of a substance that can have an adverse impact on the environment, over a short or long period, regardless of cause and whether this is accidental or deliberate. NOTE: Pollution can affect environmental factors such as air quality, noise, water quality, visual impacts, etc; only water quality impacts are within the scope of this document.
Pollution incident	An incidence of pollution at a specific location, either on an acute or chronic basis.
Pond	A depression in the ground with a permanent water body.
Priority asset register	Flooding or pollution risk assessment information for priority assets, recorded in the DDMS in addition to the asset's inventory and condition information.
Priority asset	An outfall or soakaway that presents a risk of pollution, or a culvert that presents a risk of flooding.
Region asset	Asset such as a pond or basin that is represented as a closed polygon in GIS. NOTE: The GIS geometry reflects its physical boundary.
Repeated flooding	The occurrence of at least two flood events within a rolling five-year period, along the same extent of carriageway.
Service condition	The performance of an asset and severity of the defects that affect its serviceability, independent of its structural condition. NOTE: Service defects are addressed by maintenance of the asset such as cleansing or vegetation clearance.
Spillage event	A single spillage on the carriageway or within the highway boundary, at a particular location and time. NOTE: A spillage event does not necessarily result in the occurrence of a pollution incident.
Structural condition	The condition of the fabric of the asset and the severity of defects that affect its integrity. NOTE: Structural defects are addressed by repairing or replacing the asset.

1. Scope

Aspects covered

1.1 The requirements and advice contained within this document shall apply to all matters concerning recording of inventory and condition of drainage assets, and the management of priority drainage assets and flooding.

Implementation

1.2 This document shall be implemented forthwith on all schemes involving recording of inventory and condition of the drainage asset, and the management of priority drainage assets and flooding, on the Overseeing Organisations' motorway and all-purpose trunk roads according to the implementation requirements of GG 101 [Ref 3.N].

Use of GG 101

1.3 The requirements contained in GG 101 [Ref 3.N] shall be followed in respect of activities covered by this document.

2. Asset inventory data

2.1 All drainage assets shall be recorded in the Overseeing Organisation's drainage data management system (DDMS).

NOTE 1 *Overseeing Organisation-specific information on the DDMS including data dictionary, format and validation requirements is provided in the National Application Annexes.*

NOTE 2 *Drainage inventory data can be obtained from various sources including:*

1) asset inventory and condition field surveys;

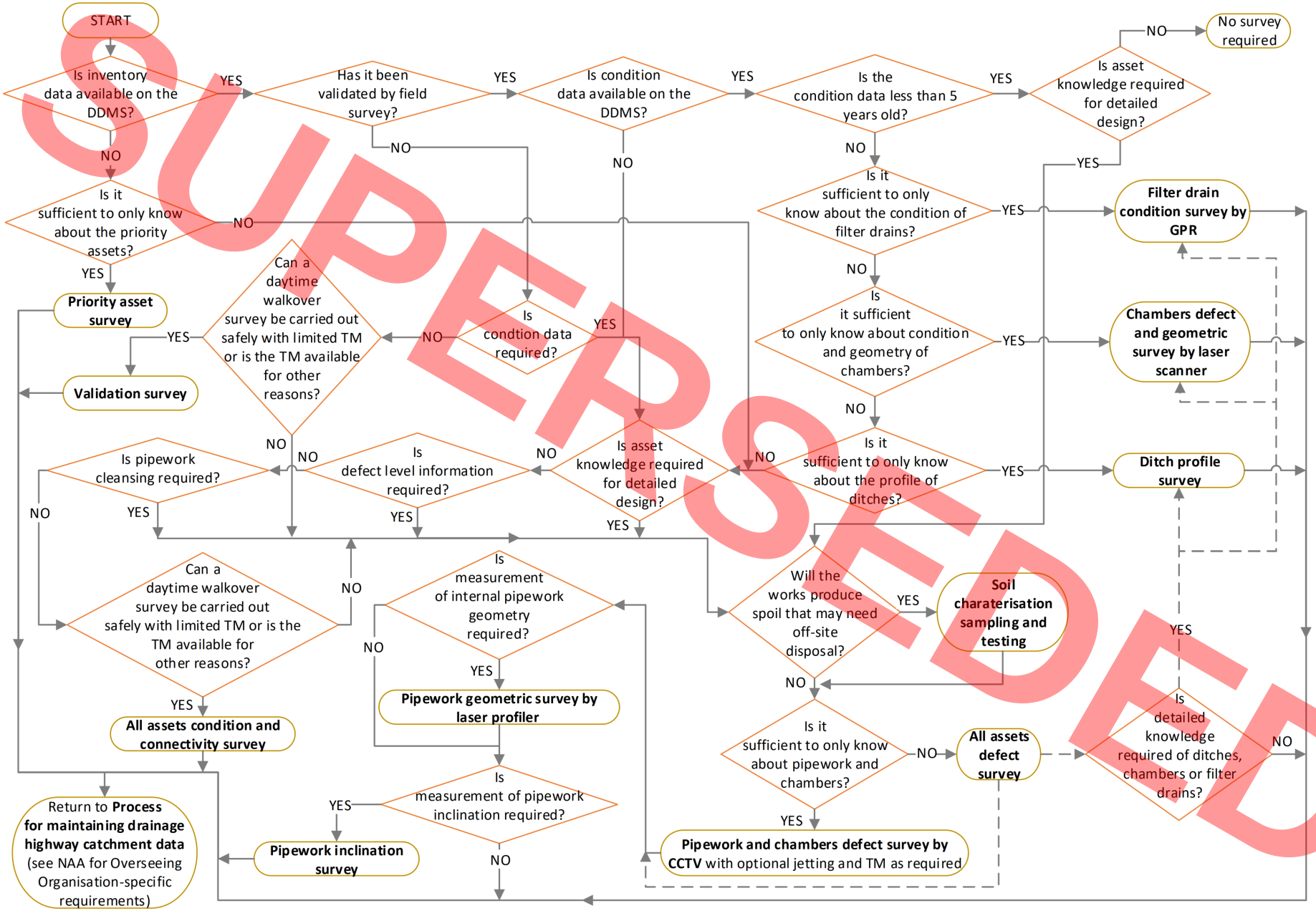
2) existing information in non-primary databases;

3) processing of as-built drainage drawings;

4) processing of remote sensing data such as LiDAR or photography.

2.2 Where the required asset data is to be obtained from a field survey, the decision tree shown in Figure 2.2 shall be followed to determine the most appropriate survey method to capture the information.

Figure 2.2 Drainage survey methodology decision tree



2.3 Drainage asset field surveys shall be carried out in accordance with the detailed requirements given in CS 551 [Ref 2.N].

2.4 Where traffic management is required to safely undertake a field survey, this shall be in accordance with TSM Chapter 8 [Ref 4.N].

2.5 Each physical drainage asset shall be recorded only once in the DDMS.

NOTE 1 Where an asset already recorded in the DDMS is resurveyed, the existing record is updated rather than adding a new record.

NOTE 2 Where the condition of an asset has been surveyed more than once and the DDMS permits records for multiple surveys to be held, then these are all related to the same single asset inventory record, and the most recent condition information is indicated.

2.6 Each drainage asset recorded in the DDMS shall be assigned to one drainage highway catchment.

2.7 Where asset inventory data is not derived from a field survey, the inventory records shall be marked as "unvalidated" until they have been validated by a field survey.

2.7.1 A field validation survey may cover a representative sample of point assets to determine the overall reliability of the records used to derive the data.

2.7.2 In addition to validation surveys, the inventory data may be validated during any other type of field survey, such as an asset condition survey.

2.8 As-built drawings, record status reports and signed design certificates shall be provided in accordance with the requirements of the National Application Annexes.

Asset type

2.9 Each drainage asset shall have its asset type identified and recorded.

NOTE 1 A brief definition of each asset type is provided in Appendix A.

NOTE 2 Drainage asset type codes, and further detailed descriptions of asset types are provided in the National Application Annexes.

2.10 At the location where drainage discharges to a third party system, watercourse, the sea, or otherwise leaves the responsibility of the Overseeing Organisation, an outfall shall be recorded.

NOTE 1 Outfalls can occur at a physical asset, such as an outlet from a pipe, or at a location where there is no physical asset such as a point along a ditch.

NOTE 2 Requirements for the precedence of asset types, where more than one type asset type is applicable, are given in this sub-section.

2.11 At the location where drainage discharges to the ground, a soakaway chamber, soakaway borehole, soakaway trench or infiltration basin shall be recorded.

2.12 Where a drainage asset has more than one function and could be classified as one of several types, its asset type shall be identified in the following descending order of precedence:

1) soakaways, outfalls and culverts;
2) any other asset types apart from standalone flow control devices and network modelling items;
3) standalone flow control devices; and,
4) network modelling items.

NOTE 1 Where an asset such as an outlet or standalone flow control device is located at an outfall location, its asset type is recorded as an outfall.

NOTE 2 Where there is no physical asset at the location of an outfall, its asset type is recorded as an outfall.

NOTE 3 Where an asset such as an outlet has a flow control device, but is not at an outfall location, its asset type is recorded as an outlet. The nature of the flow control is recorded as part of the inventory information.

NOTE 4 *Where a flow control device is not associated with another asset type, and is not at an outfall location, its asset type is recorded as a standalone flow control device. The nature of the flow control is recorded as part of the inventory information.*

NOTE 5 *Further guidance for specific asset types is provided in Appendix A.*

2.13 Drainage assets shall be recorded as a point, continuous or region asset as shown in Table 2.13, depending on their asset type.

Table 2.13 High level grouping of drainage asset types

Asset group	Geometry	Asset types
Chambers	point	manhole, catchpit, inspection chamber, rodding eye, bifurcation or storm overflow, lamphole, soakaway chamber, soakaway borehole, gully, instrumented gully, other special chamber
Inlets and outlets	point	outfall, inlet, outlet, grip inlet
Pipes	continuous	pipework, gravity drain, rising main, culvert, syphon, land drainage
Filter drains	continuous	counterfort drain, combined surface and sub-surface filter drain, filter drain, narrow filter drain, fin drain, soakaway trench
Ditches and channels	continuous	ditch, grip, grassed surface water channel or swale, surface water channel, drainage channel block, edge channel, combined kerb and drainage channel, combined pipe and channel drain, linear drainage channel, "over the edge" drainage
Ponds	region	detention basin, retention pond, sedimentation pond, infiltration basin, pollution containment pond or tank, wetlands, reed bed treatment system, pond (undifferentiated)
Ancillaries	point	standalone flow control device, interceptor, oil separator, pumping station, vortex separator
	continuous	linear cellular storage system
	region	reservoir pavement
Network modelling items	point	ghost node, phantom node, region node, connector node
	continuous	phantom connector, region connector

Asset location

2.14 The location of all drainage assets shall be recorded using the national grid, datum and transformation according to the requirements of the Overseeing Organisation.

NOTE *Overseeing Organisation specific requirements on asset location are provided in the National Application Annexes.*

2.15 Where the level of an asset is recorded, this shall be to the datum determined by the Overseeing Organisation.

2.16 Asset location shall be recorded to the minimum accuracy and stated to the precision given in Table 2.16 below, depending on the survey type.

Table 2.16 Asset location accuracy

Survey type(s)	Horizontal accuracy	Horizontal precision	Vertical accuracy	Vertical precision
Inventory surveys	+/- 5 metres	1 metre	not surveyed	n/a
Condition surveys	+/- 1 metre	1 metre	not surveyed	n/a
Detailed defect surveys	+/- 100 mm	0.1 metre	+/- 25 mm absolute levels +/- 10 mm relative levels within same asset	0.01 metre

NOTE *Where a measurement of relatively low accuracy is stated to a high precision, such as a GPS receiver that outputs a location at a centimetre-level of precision but is only accurate to within +/-1 metre, stating the full precision can give a misleading impression of the accuracy of the measurement.*

2.16.1 For herringbone drains, the full geometric layout should be recorded as several connected continuous assets, each classified as a counterfort drain.

Asset referencing

2.17 Each drainage asset shall be assigned a permanent asset reference that is unique across the entire Overseeing Organisation's drainage asset base.

NOTE 1 *The permanent asset reference can be assigned by the Overseeing Organisation's DDMS, when the asset is first recorded.*

NOTE 2 *A region asset and its associated region node are considered to be the same asset, and have the same asset reference.*

2.17.1 Assets may be assigned a local asset reference, which is:

1) unique within a drainage catchment, except for a region asset and its associated region node;
2) alphanumeric, containing at least one letter, such that the reference cannot be interpreted by computer software as a numeric, date or time value; and,
3) in a format that does not visually resemble the unique, national asset reference.

NOTE 1 *Overseeing Organisation-specific requirements in the relevant National Application Annex define if a local asset reference is optional or mandatory information.*

NOTE 2 *Computer software can modify and reformat numeric, date and time values, or text strings that it can interpret as such, either during data production or subsequently. This leads to incorrect asset references and can break connectivity between assets. For example:*

1) values such as "001" can be modified, in this case to "1";

2) *values such as "10/02" or "10-2" can be interpreted as dates, modified and variably formatted, in this case to 10th February or 2nd October of the current year;*

3) *values such as "10:2" or "10:02" can be interpreted as times, modified and variably formatted, in this case to "10:02:00";*

4) *values such as "1E3" can be interpreted as numeric and modified, in this case to "1000" or "1,000".*

2.18 Asset references, whether manually or system assigned, shall not contain space characters.

2.18.1 The underscore character may be used in asset references instead of a space.

2.19 Asset references, whether manually or system assigned, shall be retained during all subsequent updates of the asset record.

2.20 Where a copy of an asset record is also held in a non-prime system, the record in that system shall include the asset reference(s) in the DDMS.

Connectivity and flow direction

Point assets

2.21 Each point asset shall be connected to at least one continuous asset.

Continuous assets

2.22 Each continuous asset shall have one associated point asset located at each of its ends.

2.22.1 A single point asset may have any number of continuous assets connecting with them.

2.23 The flow direction of all continuous assets shall be indicated by recording one of the associated point assets as the upstream asset and the other as the downstream asset.

NOTE *A single point asset can be the upstream point asset of one or more continuous assets, and the downstream point asset of one or more other continuous assets.*

2.24 The flow direction shall be recorded as the drainage system was designed, and as it would function under conditions within design criteria.

NOTE *Flow direction can be temporarily reversed in some drainage assets under surcharge or other exceptional conditions.*

2.25 The certainty of the connectivity and flow direction shall be recorded in the inventory information for all continuous assets.

2.26 Continuous assets shall be split into two separately recorded assets where a significant change in the asset occurs, such as a watershed, significant change in dimensions, materials or lining, or where there is an intermediate flow control device.

NOTE *Where there is no physical asset at the location of a significant change, a ghost node is recorded, and is the upstream or downstream asset as appropriate of the two continuous assets.*

Additional requirements for continuous assets with intermediate connections

2.27 Where a continuous asset has one or more incoming assets connecting part way along it, the continuous asset shall not be split into multiple assets.

2.28 Where a continuous asset has one or more incoming assets connecting part way along it, the point asset at the farthest upstream end of the continuous asset shall be recorded as the upstream asset.

NOTE *An example scenario of a continuous asset with intermediate incoming assets is provided in Appendix A.*

2.29 Where a continuous asset has one or more outgoing assets connecting part way along it, the continuous asset shall be split into multiple assets.

NOTE *An example scenario of a continuous asset with intermediate outgoing assets, is where inlets are located along a channel.*

Region assets

2.30 Each region asset shall have one associated region node point asset located at its geometric centroid that is used to define connectivity.

2.30.1 Where the geometric centroid lies outside the perimeter of the region asset, the region node location should instead be defined within the perimeter.

NOTE *The geometric centroid only lies outside the perimeter of a region asset where it is of a highly irregular shape.*

2.31 The association between the region node and region asset shall be defined by assigning the same asset reference to both.

NOTE 1 *The only scenario when it is acceptable to have two asset records with the same asset reference within a single catchment, is a region asset and its associated region node.*

NOTE 2 *Where local asset references are assigned, these are also the same for the region asset and associated region node.*

2.32 Each region asset shall be connected to the rest of the drainage network at its associated region node, by at least one region connector to represent inwards flow and, with the exception of infiltration basins, one region connector to represent outwards flow.

NOTE *Infiltration basins discharge to the ground over their full extent rather than at a specific point.*

2.33 Region connectors shall connect the region node at one end, and a point asset at the location of the inflow or outflow as applicable at the other.

2.33.1 Where there is no physical asset at the inflow or outflow location, the point asset type should be assigned as a ghost node.

NOTE 1 *To satisfy connectivity requirements of continuous assets, the region connector is connected to the region node point asset, as a proxy for the associated region asset.*

NOTE 2 *An example usage of region assets, region nodes and region connectors is provided in Appendix A.*

NOTE 3 *The inflow or outflow point is normally located on the perimeter of the region asset, but can be located within it to accurately record the inflow or outflow location.*

Use of phantom nodes and phantom connectors

2.34 Where the nature of the drainage asset is not known beyond a point along a continuous asset, a phantom node point asset shall be recorded at that location.

2.35 Where the nature of the drainage asset between two point assets is not known but connectivity between them is expected, a phantom connector continuous asset shall be recorded between the two point assets.

2.35.1 A single phantom connector may represent either a single physical continuous drainage asset or multiple drainage assets of various types.

NOTE *The point assets at each end of a phantom connector have their actual asset type recorded, and are not recorded as phantom nodes.*

3. Asset condition data

3.1 Where the condition of an asset is to be recorded, the asset shall also have its inventory recorded in accordance with Section 2.

3.2 The condition of drainage assets shall be assessed separately in terms of structural condition and service condition.

3.3 Asset condition shall be assessed either at an asset level, or by recording separate structural and service defects (defect level) which are then aggregated to asset level.

NOTE 1 Either condition assessment approach is intended to result in the same condition grades, with the asset level approach being quicker, and the defect level approach providing additional detail and accuracy.

NOTE 2 Selection of the approach to condition assessment depends on the survey methodology used.

Asset-level condition assessment

3.4 Where condition is assessed at asset level, structural condition and service condition shall be graded in accordance with the criteria in Table 3.4, except where the Overseeing Organisation provides more prescriptive data.

Table 3.4 Structural and service grade definitions

Grade	Structural condition	Service condition
1	No defects	Clear
2	Superficial defects	Superficial deposits with no loss of performance
3	Minor defects	Performance slightly reduced
4	Major defects	Performance severely reduced
5	Not fit for purpose	Blocked or unsafe condition
9	Assessment attempted but not possible	Assessment attempted but not possible
0	Assessment not attempted	Assessment not attempted

NOTE 1 Where assessment of an asset's condition was attempted but not possible, e.g. visibility or access obstructed by extensive vegetation, the condition grade(s) that could not be assessed are recorded as 9.

NOTE 2 Where the service condition of an asset could not be assessed due to a structural defect, such as a seized cover, the structural grade is assessed if possible and recorded as 1 to 5, and a service grade of 9 is recorded.

NOTE 3 Where assessment of an asset's condition was intended but not possible due to practicalities such as a lack of suitable traffic management, the condition grade(s) that could not be assessed are recorded as 0.

Defect-level condition assessment

3.5 Where asset condition is assessed at defect level, the structural grade and service grade shall be determined in accordance with the criteria in Table 3.5a and Table 3.5b.

Table 3.5a Structural and service grade calculation method

Asset class	Structural grade	Service grade
Point	Peak structural score	Peak service score
Continu-ous	Peak structural score	Worst grade defined by peak service score or mean service score
Region	Peak structural score	Peak service score

Table 3.5b Structural and service grade definitions

Structural condition		Service condition		
Peak structural score range	Structural grade	Peak service score range (to 1 decimal place)	Mean service score range (to 1 decimal place)	Service grade
<10	1	<1.0	<0.5	1
10 to 39	2	1.0 to 1.9	0.5 to 0.9	2
40 to 79	3	2.0 to 4.9	1.0 to 2.4	3
80 to 164	4	5.0 to 9.9	2.5 to 4.9	4
165	5	≥10.0	≥5.0	5
Unable to assess	9	Unable to assess	Unable to assess	9
Not attempted	0	Not attempted	Not attempted	0

3.5.1 Where the DDMS provides functions to determine defect scores and/or calculate the resultant structural grade and service grade, these scores and grades should not be manually calculated.

3.5.2 Where a defect level assessment is carried out on an asset but no structural defects are found, an appropriate observation to indicate the asset is free from structural defects should be recorded.

3.5.3 Where a defect level assessment is carried out on an asset but no service defects are found, an appropriate observation to indicate the asset is free from service defects should be recorded.

3.5.4 A single drainage asset may have any number of structural and/or service defects recorded.

3.5.5 Where a defect level assessment is carried out on an asset, other non-defect observations related to the inspection, such as the location of any abandonment, or detailed inventory aspects such as alignment deviations may be recorded.

NOTE 1 Overseeing Organisation-specific detailed defect coding and scoring criteria are provided in the National Application Annexes.

NOTE 2 For continuous assets, the mean service score is defined as the sum of all service defect level scores, divided by the length of the asset in metres.

NOTE 3 Any manual calculations can be overridden by the DDMS, to ensure consistency of scoring and grading.

NOTE 4 Non-defect observations are not scored and do not affect the structural or service condition grades.

NOTE 5 Where there are no structural defects in an asset, its structural grade is 1.

NOTE 6 Where there are no service defects in an asset, its service grade is 1.

4. Managing flood risk

General requirements

4.1 The drainage asset shall be managed to minimise the current and future predicted impacts of flooding on the network's assets, users, workers and third parties.

4.2 In addition to the drainage asset inventory and condition data, registers of priority culverts, flood events and flooding hotspots shall be maintained.

NOTE *Assessment and mitigation procedures, risk assessment criteria, and information recording requirements for culverts, flood events and flooding hotspots are given in the National Application Annexes.*

Recording flood data

4.3 Information and data about flooding shall be recorded in the Overseeing Organisation's DDMS for flooding data.

NOTE *Overseeing Organisation-specific information on DDMS including data dictionary, format and validation requirements is provided in the National Application Annexes.*

4.4 Where flooding is potentially related to a culvert, the flooding risk due to the culvert shall be assessed and recorded in the DDMS priority asset register for culverts.

Flood events

4.5 As soon as a flood is notified actions shall be commenced to mitigate any impacts.

4.5.1 The flood event and arising mitigation actions should be logged within the operational management system within 24 hours.

4.6 The flood shall be assessed to determine whether it is a reportable flood event.

NOTE *Overseeing Organisation-specific definitions of a reportable flood event are provided in the National Application Annexes.*

4.7 All flood events reported to the Overseeing Organisation or its agents, that are either on the road network or within 200 metres of it, shall be entered into the DDMS, within 7 days of the report.

NOTE 1 *Floods can be reported by members of the public, emergency services, Overseeing Organisation personnel or their agents.*

NOTE 2 *Where a reported flood event is further than 200 metres from the network, it is not necessary to enter this into the DDMS.*

4.8 Within the initial 7-day period of the flood event being reported, the following information shall be recorded in the DDMS:

1) location of the approximate centre of the flood using the national grid and transformation according to the requirements of the Overseeing Organisation;
2) date and time the flood was initially reported; and,
3) whether the flood is affecting the carriageway and/or adjacent third party property.

4.8.1 Where additional information about the flood is confirmed within the initial 7-day period, this should be entered into the DDMS.

NOTE 1 *Overseeing Organisation-specific requirements on flood event location are provided in the National Application Annexes.*

NOTE 2 *Not all information regarding a flood event is likely to be known within 7 days, such as causes and identification of further required actions.*

4.9 All information regarding a flood event shall be recorded in the DDMS within 28 days of the flood event's occurrence.

NOTE *Overseeing Organisation-specific requirements on the information to be recorded about flood events is provided in the National Application Annexes.*

Flooding hotspots

4.10 Where an extent of carriageway is at risk of repeated flooding, the risk shall be assessed and recorded on the DDMS.

NOTE *The minimum extent of a flooding hotspot is typically delimited by adjacent junctions, or the extent of carriageway that a diversion route avoids, around the specific flooding location(s).*

4.10.1 Each carriageway of a dual carriageway may be treated as separate extents, for separate flood risk assessment.

4.10.2 Flooding hotspot extents may be based on drainage catchment extents.

4.10.3 A flooding hotspot may be identified where a single high-impact flood event has occurred.

4.11 Where the DDMS does not automatically identify potential flooding hotspot locations, they shall be manually identified based on flood event records.

NOTE *Overseeing Organisation-specific requirements and criteria for defining flooding hotspots are provided in the National Application Annexes.*

5. Managing risks to water quality

General requirements

5.1 The drainage asset must be managed in accordance with the European Community Directive 2000/60/EC [Ref 1.N] to:

1) prevent the deterioration of the status of all types of surface water and groundwater bodies; and,
2) support the protection, enhancement and restoration of all bodies of surface water and groundwater.

NOTE *Pollution of water bodies can occur either due to:*

1) short-term incidents at a specific location that cause acute pollution, such as accidental spills from vehicles; or,
2) carriageway run-off over a longer period of time or wider geographical area, causing chronic or diffuse pollution.

Outfalls and soakaways

5.2 In addition to the drainage asset inventory and condition data, registers of priority outfalls and priority soakaways shall be maintained.

NOTE *Assessment and mitigation procedures, risk assessment criteria, and information recording requirements for soakaways and outfalls are given in the National Application Annexes.*

Recording spillage data

5.3 All spillage events on the highway network shall be recorded on the DDMS with the following information, within 24 hours of the spillage's occurrence:

1) location of the approximate centre of the spillage using the national grid and transformation according to the requirements of the Overseeing Organisation;
2) date and time the spillage was initially reported;
3) whether the spill is affecting the carriageway and/or adjacent third party property.

NOTE *Overseeing Organisation-specific requirements on spillage event location are provided in the National Application Annexes.*

5.4 All information regarding a spillage event shall be recorded in the DDMS, within 28 days of the spillage event's occurrence.

NOTE *Further information required to be entered regarding each spillage event is detailed in the relevant National Application Annex.*

6. Managing cross-asset risks

6.1 A cross-asset approach shall be taken to managing the risks caused by, and to, the drainage asset.

6.2 When determining the overall level of risk that a drainage asset causes, the drainage-related condition of associated non-drainage assets shall be assessed, in addition to the condition of the drainage asset itself.

6.2.1 Best practice advice in CIRIA C714 [Ref 1.I] should be followed when implementing processes for managing the cross-asset risks related to drainage.

NOTE 1 *As an example of assessment using non-drainage assets, the presence of hydrophilic vegetation on an earthwork can indicate underperforming or insufficient drainage, even if the condition of the drainage asset itself is good.*

NOTE 2 *Inadequate carriageway drainage resulting in slow removal of water from the pavement can lead to premature failure of the pavement surface or formation layers, as well as the risks associated with flooding.*

6.3 Where improvement or remedial works are required on non-drainage assets, and these are partly or wholly as a result of poor condition or insufficient drainage, these works shall include measures to address the future cross-asset risk due to the drainage assets.

6.4 Works carried out to non-drainage assets shall be designed and implemented such that they do not cause an adverse impact to the drainage asset.

NOTE *Potential adverse impacts to drainage assets due to work on other assets can include, for example:*

1) *physical damage to drainage assets, for example, as a result of excavations or installation of other assets such as VRS;*
2) *changes to run-off characteristics such that existing drainage is unsuitable or of insufficient capacity; or,*
3) *release of foreign materials into the drainage system, above normal background amounts, which might result in blockages, reduced capacity or risks to water quality.*

6.5 Works carried out to drainage assets shall be designed and implemented such that they do not cause an adverse impact on other assets.

7. 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	2000/60/EC, 'Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy'
Ref 2.N	National Highways. CS 551, 'Drainage surveys'
Ref 3.N	National Highways. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 4.N	TSO. TSM Chapter 8, 'Traffic Signs Manual Chapter 8 - Traffic Safety Measures and Signs for Road Works and Temporary Situations'

8. Informative references

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

Ref 1.I	CIRIA. Spink T, Duncan I, Lawrance A, Todd A.. CIRIA C714, 'Transport infrastructure drainage: condition appraisal and remedial treatment'

Appendix A. Drainage asset types

A1 Asset type descriptions

Example photographs of assets are provided where appropriate.

A1.1 Point assets

Tables A.1 to A.4 define each type of point drainage asset. Some point asset types may also have attributes that describe additional inventory features, detailed in Table A.5.

Table A.1 Point assets - chambers

Asset type	Synonyms	Location	Construction	Function	Drainage database representation	Example photographs
Manhole		In pipe runs generally off the carriageway at intervals, at pipe junctions or at changes in pipe diameter	Chamber with solid base with formed channel	Access to pipes for inspection and cleaning	Point asset with connectivity	**Manhole** 
Catchpit	Sediment trap	In pipe runs generally off the carriageway at intervals, at pipe junctions or at changes in pipe diameter	Chamber with unbenched base set below the invert level of the outgoing pipe	Retains sediment to reduce the volume of solid material moving downstream, and provides access for cleaning	Point asset with connectivity	**Catchpit** 
Inspection chamber		In pipe runs generally off the carriageway	Small non-entry chamber	Inspection access to small diameter pipes or ancillary equipment	Point asset with connectivity	**Inspection chamber** 

Table A.1 Point assets - chambers (continued)

Asset type	Synonyms	Location	Construction	Function	Drainage database representation	Example photographs
Rodding eye		In pipe runs generally off the carriageway	Small non-entry access to pipe in one direction only	Limited access for pipe cleaning by manual rodding techniques	Point asset with connectivity	**Rodding eye** 
Bifurcation or storm overflow		In pipe runs generally off the carriageway, more often as an attribute of an attenuation feature	Chamber with two or more outgoing pipes	Splits water flow and/or relieves storm surcharge	Point asset with connectivity	**Bifurcation or storm overflow** 
Lamphole		In pipe runs generally off the carriageway. Primarily found on combined sewerage systems rather than highway drainage.	Narrow non-entry chamber, shaft or vertical pipe	Inspection access	Point asset with connectivity	**Lamphole** 

Table A.1 Point assets - chambers (continued)

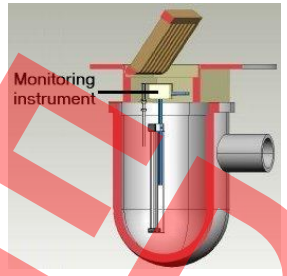
Asset type	Synonyms	Location	Construction	Function	Drainage database representation	Example photographs
Soakaway chamber		At the downstream end of the highway drainage system where it discharges into the ground.	Chamber with perforated base and/or sides	Storage and infiltration to the ground of surface water	Point asset with upstream connectivity. Included within priority soakaways register	
Soakaway borehole	Borehole also known as "well"	At the downstream end of the highway drainage system where it discharges into the ground.	Chamber with perforated borehole or shaft in its base	Storage and infiltration to the ground of surface water	Point asset with upstream connectivity. Included within priority soakaways register	
Gully	Kerb inlet	At the edge of the carriageway	Small chamber usually with a surface grating in the edge of the pavement. Can have a sediment sump. Can have an integral water odour trap. Primarily used in conjunction with kerbs	Intercepts carriageway run-off and conveys it to a continuous drainage asset. Can trap sediment. Can prevent odours escaping from the downstream piped system.	Point asset with downstream connectivity (see Figure A.3)	**Gully** 
Instrumented gully		At the edge of the carriageway	A gully that includes instrumentation to measure the water and/or silt level.	Instrumentation provides early warning of flooding and/or blockage.	Point asset with downstream connectivity (see Figure A.3)	**Instrumented gully** 
Other special chamber		Not specific. Generally off the carriageway	Chamber of unspecified use	Access or containing non-standard equipment	Point asset with connectivity	

Table A.2 Point assets - inlets and outlets

Asset type	Synonyms	Location	Construction	Function	Drainage database representation	Example photographs
Outfall		At the downstream end of the highway drainage system where it discharges into a third party drainage system, such as a watercourse, tidal waters or a sewer (see Section A2.1.1 for details)	Might or might not be a physical asset. Can be an outlet or standalone flow control device	Demarcates the ownership boundary between the Overseeing Organisation's highway drainage network and a third party drainage system	Point asset with upstream connectivity. Included within priority outfall register (see Figure A.1)	**Outfall** 
Inlet		The point at which water flows from an open surface continuous asset (such as a ditch) or region asset, to a sub-surface continuous asset (such as pipework or a culvert)	Can have various physical characteristics including flow controls, headwall, trash screen, etc.	Controls surface waters and protects adjacent infrastructure. Demarcates change from surface to sub-surface flow	Point asset with connectivity (see Figure A.1)	**Inlet** 
Outlet		The point at which water flows from a sub-surface continuous asset (such as pipework or a culvert) to an open surface continuous asset (such as a ditch) or region asset	Can have various physical characteristics including flow controls, headwall etc.	Controls surface waters and protects adjacent infrastructure. Demarcates change from sub-surface to surface flow	Point asset with connectivity. Included within priority outfall register only if it is also an outfall (see Figure A.1)	**Outlet** 

Table A.2 Point assets - inlets and outlets (continued)

Asset type	Synonyms	Location	Construction	Function	Drainage database representation	Example photographs
Grip inlet	Piped grip	At the edge of the carriageway	Inlet at the upstream end of a piped grip, non-piped grip or informal over the edge drainage	Leads surface water away from the carriageway across the verge.	Point asset with downstream connectivity	**Grip inlet**

Table A.3 Point assets - ancillaries

Asset type	Synonyms	Location	Construction	Function	Drainage database representation	Example photographs
Standalone flow control device		In point assets on pipe runs, in ditches or channels, or at the inlet or outlet to a region asset, remote from the carriageway	Can have various physical characteristics	Regulates flow rate down-stream	Point asset with connectivity (see Figure A.7) Where the flow control is part of another point asset type, the asset is recorded as that other asset type, and the nature of the flow control is recorded as an inventory attribute of the asset (see Table A.5).	See Table A.5
Interceptor		In pipe runs, ditches or channels off the carriageway	A chamber or tank	Traps sediment	Point asset with connectivity	
Oil separator	Oil/petrol interceptor	In pipe runs, ditches or channels off the carriageway	A chamber or tank. Can be designed as either a bypass or full retention separator, treating part or all of the inflow.	Pollution control device that traps fuel and oil.	Point asset with connectivity	**Oil separator** 

Table A.3 Point assets - ancillaries (continued)

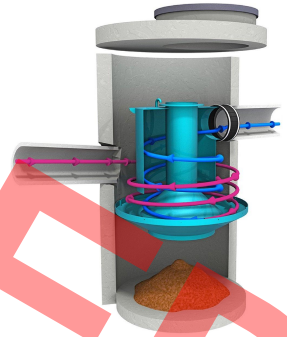
Asset type	Synonyms	Location	Construction	Function	Drainage database representation	Example photographs
Pumping station		In pipe runs off the carriageway	A chamber or other structure containing pumps that can be submersible (wet well) or there can be a separate structure for the motors (dry well). Can include mechanical and electrical equipment such as valves, floats or control switch gear.	Pumped removal of surface water	Point asset with connectivity. With supplementary details of the contained equipment	**Pumping station** 
Vortex separator		In pipe runs off the carriageway	Installed within a chamber or as a standalone device. Runoff is directed into a vortex flow that separates and traps sediment and other solid material.	Separates sediment and other solids from liquid	Point asset with connectivity	**Vortex separator** 

Table A.4 Point assets - network modelling

Asset type	Location	Function	Drainage database representation
Ghost node	Connects adjacent continuous assets where there is no physical point asset.	Allows definition of connectivity	Point item with connectivity
Phantom node	Upstream or downstream end point of a known drainage system	Indicates limit of knowledge of the drainage system	Point item with either upstream or downstream connectivity
Region node	Point item located at the geometric centroid of a region asset	Allows definition of connectivity to a region asset	Point item with connectivity (see Figure A.7)
Connector node	Point item representing an incoming intermediate connection to a continuous asset	Allows definition of connectivity to a continuous asset without segmenting the continuous asset	Point item with connectivity (see Figures A.2 and A.3)

Table A.5 Point assets - inventory attributes

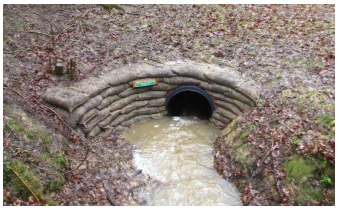
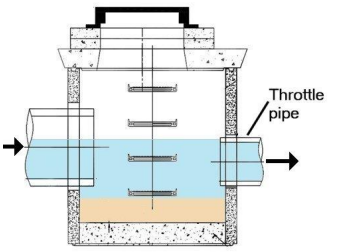
Attribute type	Applicable asset types	Description	Example photographs
Headwall	Outfall, outlet, inlet	Structure at the start or end point of a piped outfall, outlet or inlet to retain and stabilise an earth bank and minimise erosion risk.	**Headwall** 
Step irons	Manhole, catchpit, bifurcation or storm overflow, soakaway chamber, other special chamber, interceptor, oil separator, pumping station, vortex separator	Preformed steps, usually galvanised steel, cast into a structure wall to provide a means of access.	**Step irons** 
Throttle pipe	Manhole, catchpit, bifurcation or storm overflow, other special chamber	A pipe of smaller diameter than that of the free-flowing hydraulic pipe that is positioned to restrict the flow that will pass downstream.	**Throttle pipe** 

Table A.5 Point assets - inventory attributes (continued)

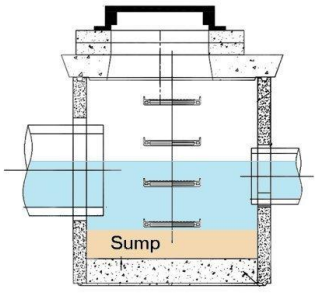
Attribute type	Applicable asset types	Description	Example photographs
Guardrail	Outfall, outlet, inlet, standalone flow control device	A safety feature comprising a rail, or rails, forming a barrier around an opening or vertical drop.	**Guardrail** 
Safety chain	Manhole, catchpit, bifurcation or storm overflow, other special chamber	A chain across the outgoing pipe from a chamber that is attached to the chamber benching or walls, as a safety feature to reduce the risk of an operative being swept into the pipeline by the flow.	**Safety chain** 
Safety bar	Manhole, catchpit, bifurcation or storm overflow, other special chamber	A bar positioned across handrails in a manhole to prevent direct access to the invert or, less commonly, in place of a safety chain across an outgoing pipe.	
Sump	Catchpit	A volume within a structure positioned below the incoming and/or outgoing pipes usually to detain settleable materials or water.	**Sump** 

Table A.5 Point assets - inventory attributes (continued)

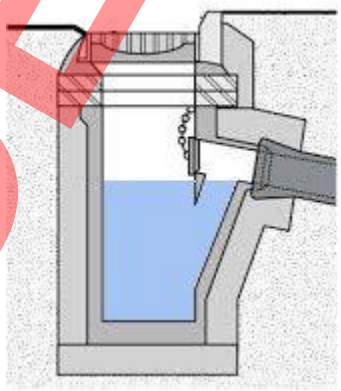
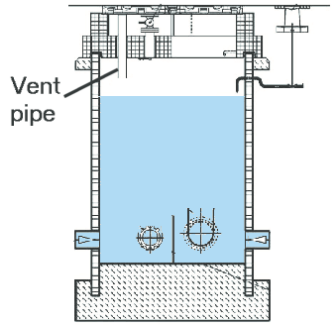
Attribute type	Applicable asset types	Description	Example photographs
Trapped gully	Gully, instrumented gully	A gully with an enclosed vertical riser connecting the horizontal outlet pipe, the latter will have a removable bung to enable rodding. The base of the riser is below the water level in the gully pot preventing the escape of odours.	**Trapped gully** 
Ventil-ation pipe	Manhole, catchpit, bifurcation or storm overflow, soakaway chamber, other special chamber, interceptor, oil separator, pumping station, vortex separator	A vertical pipe that enables the escape of gases and prevents the build-up of air pressure in a structure due to flows surcharging above the pipe level.	**Ventilation pipe** 
Flap valve	Outfall	A plate hung over the end of an outfall pipe that is pushed open by the outgoing flow but is pushed closed, should the water level beyond the pipe rise, to prevent backflow up the outfall pipe.	**Flap valve** 

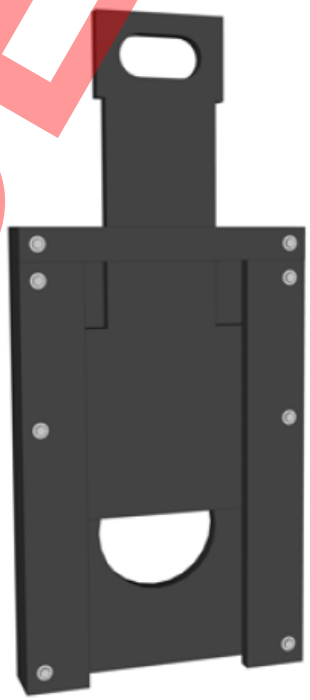
Table A.5 Point assets - inventory attributes (continued)

Attribute type	Applicable asset types	Description	Example photographs
Orifice plate	Outfall, outlet, manhole, catchpit, bifurcation or storm overflow, other special chamber	A plate placed over an outgoing pipe that has an opening smaller than the diameter of the pipe thereby restricting the flow rate downstream of the orifice.	**Orifice plate** 
Sluice gate	Standalone flow control device	A gate of metal (cast iron) or timber that is set in grooves in the channel sides and moves vertically to either open or close for control of flows within the channel.	**Sluice gate** 
Weir	Standalone flow control device	A low height dam positioned in a channel or ditch to control the overtopping water flow rate, sometimes positioned at the side of a channel to allow high water levels to overflow.	**Weir** 
Screen/ grill	Outfall, outlet, inlet	Usually positioned over a headwall to provide security and/or retain floatable debris reducing the risk of blockage downstream.	**Screen/ grill** 

Table A.5 Point assets - inventory attributes (continued)

Attribute type	Applicable asset types	Description	Example photographs
Penstock	Outfall, outlet, inlet, manhole, catchpit, bifurcation or storm overflow, other special chamber, standalone flow control device	Similar to a sluice gate, a penstock controls the flow of water into a pipe (on-seating) or out of a pipe (off-seating) and is usually positioned inside a chamber or on a headwall.	**Penstock** 
Flume	Standalone flow control device	A hydraulically designed restriction in the width of a channel to increase the flow velocity under free-flowing conditions.	**Flume** 
Baffle	Standalone flow control device	A plate, or set of plates, or solid obstacles positioned within a channel to regulate the flow of water.	**Baffle** 
Hanging wall	Standalone flow control device	A baffle plate suspended above a channel bed and immersed in the flow to regulate the flow and/or detain floatable debris.	**Hanging wall** 

Table A.5 Point assets - inventory attributes (continued)

Attribute type	Applicable asset types	Description	Example photographs
Hand-stop	Outfall, outlet, inlet, standalone flow control device	Similar to a small sluice gate that slides vertically in grooves of the channel sides and operated by hand to stem the flow of water.	**Handstop** 

A1.2 Continuous assets

Tables A.6 to A.10 define each type of continuous drainage asset

Table A.6 Continuous assets - ditches and channels

Asset type	Synonyms	Location and layout	Construction	Function	Drainage database representation	Example photographs
Ditch		Usually parallel to carriageway in the verge or remote associated with the earthwork	Open trench, normally with battered side slopes. Lined or unlined	Intercepts and conveys surface water runoff from the carriageway, earthworks and/or adjacent land	Continuous asset with flow direction and connectivity	**Ditch** 
Grip		Perpendicular to carriageway across verge and/or associated earthwork	Shallow open trench	Conveys carriageway runoff across the verge and/or earthwork, usually to a ditch	Continuous asset with flow direction and connectivity. Grip inlet recorded as upstream point asset	**Grip** 
Grassed surface water channel or swale		Surface water channels are adjacent to the carriageway. Swales are separated by a section of verge.	Shallow grassed open channels. Swales are wider and deeper than grassed surface water channels.	Intercepts and conveys carriageway runoff. Provides storage and flow attenuation.	Continuous asset with flow direction and connectivity	**Grassed surface water channel or swale** 

Table A.6 Continuous assets - ditches and channels (continued)

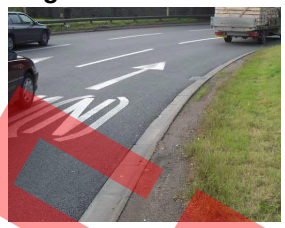
Asset type	Synonyms	Location and layout	Construction	Function	Drainage database representation	Example photographs
Surface water channel		Near the edge of the carriageway	Concrete, trapezoidal or V-section, shallow (<125 mm depth) open channel	Intercepts and conveys carriageway runoff.	Continuous asset with flow direction and connectivity	**Surface water channel** 
Drainage channel block		Near the edge of the carriageway	Narrow open channel formed of precast concrete units, often interlocking	Intercepts and conveys carriageway runoff.	Continuous asset with flow direction and connectivity	**Drainage channel block** 
Edge channel		At the edge of the carriageway where it meets the kerb	Narrow open channel	Intercepts and conveys carriageway runoff.	Continuous asset with flow direction and connectivity	**Edge channel** 
Combined kerb and drainage channel	Beany block	In the kerb at the edge of the carriageway	Precast concrete or metal kerb units with inlets to an enclosed internal drainage channel	Intercepts and conveys carriageway runoff.	Continuous asset with flow direction and connectivity	**Combined kerb and drainage channel** 

Table A.6 Continuous assets - ditches and channels (continued)

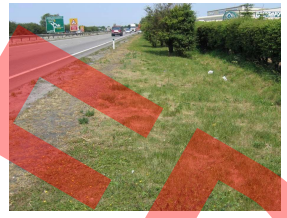
Asset type	Synonyms	Location and layout	Construction	Function	Drainage database representation	Example photographs
Combined pipe and channel drain	Slot drain	Near the edge of the carriageway	Open concrete channel with an integral enclosed drainage channel or pipe below it. The two parts are hydraulically connected via intermittent slots.	Intercepts and conveys carriageway runoff.	Continuous asset with flow direction and connectivity	**Combined pipe and channel drain** 
Linear drainage channel		At the edge of the carriageway	Enclosed, U-shaped concrete channel with an integral grating along the top	Intercepts and conveys carriageway runoff.	Continuous asset with flow direction and connectivity	**Linear drainage channel** 
"Over the edge" drainage		At the side of the carriageway	No physical asset except where used in conjunction with a grip inlet	Water flows off the edge of the carriageway, across the verge and/or earthwork, usually to a ditch	Connectivity attribute on the grip inlet provides connectivity and flow direction to the receiving ditch	**Over the edge drain** 

Table A.7 Continuous assets - filter drains

Asset type	Synonyms	Location and layout	Filter medium	Geotextile wrap	Pipe	Function	Drainage database representation	Example photographs
Counterfort drain	Slope drain	Face of earth-works. Oblique or perpendicular to carriageway. Deep. Maybe herring-bone	Gravel. Surface can or cannot be exposed	Maybe	Maybe without. Maybe perforated	Drains mainly subsurface water and reinforces slope. Can also drain surface water.	Combined filter and pipe single asset. Multiple connected assets if herringbone. With flow direction and connectivity	**Counterfort drain** 
Combined surface and subsurface filter drain	Filter drain, French drain	Side of carriageway	Graded crushed rock, or gravel. Surface exposed.	Maybe	Perforated or porous	Drains surface and subsurface water	Combined filter and pipe single asset. With flow direction and connectivity	**Combined surface and sub-surface filter drain** 
Filter drain		Side of carriageway	Graded crushed rock, or gravel. Surface exposed.	Maybe	Maybe without. Maybe with non-perforated.	Drains surface and subsurface water	Single asset for filter. Separate asset for non-perforated pipe. With flow direction and connectivity	**Filter drain** 
Narrow filter drain		Side of carriageway	Graded crushed rock, or gravel. Surface not exposed	Maybe Maybe integral with pipe	Perforated or porous	Drains subsurface water	Combined filter and pipe single asset. With flow direction and connectivity	**Narrow filter drain** 

Table A.7 Continuous assets - filter drains (continued)

Asset type	Synonyms	Location and layout	Filter medium	Geotextile wrap	Pipe	Function	Drainage database representation	Example photographs
Fin drain		Side of carriageway	Expanded plastic. Surface not exposed	Integral	Maybe without. Maybe perforated or porous	Drains subsurface water	Combined filter and pipe single asset. With flow direction and connectivity	
Soakaway trench		At the downstream end of the highway drainage system where it discharges into the ground.	Graded crushed rock or gravel. Surface not exposed	Maybe	Maybe without. Maybe perforated or porous	Storage and infiltration to the ground of surface water	Combined filter and pipe single asset. With upstream connectivity. Included within priority soakaways register	

Table A.8 Continuous assets - pipes

Asset type	Synonyms	Location and layout	Diameter	Pipe construction	Function	Drainage database representation	Example photographs
Pipework		Not specific	≤900 mm	Sealed, perforated, porous or butt jointed	Non-specific. Collects and/or conveys surface and/or subsurface water	Continuous asset with flow direction and connectivity. Where possible pipes should be identified as one of the more specific types.	
Gravity drain	Carrier drain	Not specific	≤900 mm	Sealed	Conveys surface water under gravity	Continuous asset with flow direction and connectivity	
Rising main		Not specific	≤900 mm	Sealed	Conveys surface water under pressure	Continuous asset with flow direction and connectivity	
Culvert (managed as a drainage asset)		Usually crossing below carriageway	≥450 mm to ≤900 mm	Large diameter pipe	Conveys surface water course or ditch drain under the carriageway	Continuous asset with flow direction and connectivity. Included within priority culverts register.	
Culvert (managed as a structure asset)		Usually crossing below carriageway	>900 mm	Large diameter pipe, rectangular box or other structure	Conveys surface water course or ditch drain under the carriageway	Continuous asset with flow direction and connectivity. Included within priority culverts register.	**Culvert** 
Syphon	Inverted syphon	Usually crossing below carriageway	≤900 mm	Sealed	Conveys surface water under the carriageway at a level below the connected pipework	Continuous asset with flow direction and connectivity	

Table A.8 Continuous assets - pipes (continued)

Asset type	Synonyms	Location and layout	Diameter	Pipe construction	Function	Drainage database representation	Example photographs
Land drainage		Remote from carriageway	≤900 mm, but usually ≤150 mm	Perforated, porous or butt jointed	Collects subsurface water	Continuous asset with flow direction and connectivity	

Table A.9 Continuous assets - ancillaries

Asset type	Location and layout	Filter medium	Geotextile wrap	Pipe	Function	Drainage database representation
Linear cellular storage system	Usually towards the downstream end of the highway drainage system where it discharges into the ground or is upstream of a flow control device.	Modular prefabricated units. Surface not exposed	Generally	Maybe without. Maybe perforated or porous	Storage and infiltration to the ground of surface water	Combined filter and pipe single asset. With upstream connectivity. Included within priority soakaways register

Table A.10 Continuous assets - network modelling

Asset type	Location	Function	Drainage database representation
Phantom connector	Connects two point assets where the physical connection is unknown	Allows definition of connectivity whilst indicating the limit of knowledge of the drainage system	Continuous item with flow direction and connectivity (see Figure A.6)
Region connector	Connects the region node at the centre of a region asset to either the inflow or outflow point	Defines the connectivity and flow through a region asset	Continuous item with flow direction and connectivity (see Figure A.7)

A1.3 Region assets

Tables A.11 to A.12 define each type of region drainage asset.

Table A.11 Region assets - ponds

Asset type	Synonyms	Location and layout	Construction	Function	Drainage database representation	Example photographs
Detention basin	Detention pond, dry pond, balancing pond	Remote from carriageway	Basin, intended to be dry for extended periods. Can have an impermeable liner.	Temporary storm water storage and attenuation of downstream flow. Does not allow infiltration.	Region asset with central region node and region connectors to define connectivity and flow through the asset	**Detention basin**  **Detention basin** 
Retention pond	Wet pond, balancing pond	Remote from carriageway	Pond that generally retains some water at all times.	Prolonged storm water storage, allowing controlled release downstream. Can have a treatment function.	Region asset with central region node and region connectors to define connectivity and flow through the asset.	**Retention pond** 
Sedimentation pond	Balancing pond	Remote from carriageway	Pond, usually with an impermeable base.	Settlement of sediment prior to downstream discharge. Will also have an attenuation function.	Region asset with central region node and region connectors to define connectivity and flow through the asset	**Sedimentation pond** 

Table A.11 Region assets - ponds (continued)

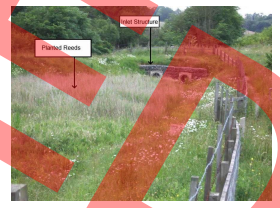
Asset type	Synonyms	Location and layout	Construction	Function	Drainage database representation	Example photographs
Infiltration basin	Infiltration / soakaway lagoon, infiltration / soakaway pond	Remote from carriageway	Basin with permeable base, often with a granular filter layer	Storm water storage with infiltration to groundwater	Region asset with central region node and region connectors to define connectivity and flow through the asset. Included within priority soakaways register. Can have an exceedance overflow.	**Infiltration basin**  **Infiltration basin** 
Pollution containment pond or tank	Balancing pond	Remote from carriageway immediately upstream of outfall	Pond or tank with a minimum 20 m^3 volume and shut-off mechanism	Containment of potentially polluting liquid spills	Region asset with central region node and region connectors to define connectivity and flow through the asset	**Pollution containment pond or tank** 
Wetlands	Reed-beds, balancing pond, vegetated treatment system	Remote from carriageway	Predominantly saturated area supporting aquatic and/or semi-aquatic life such as reed swamps, marshes or bogs	Treatment and attenuation of potentially polluting run-off	Region asset with central region node and region connectors to define connectivity and flow through the asset	**Wetlands** 

Table A.11 Region assets - ponds (continued)

Asset type	Synonyms	Location and layout	Construction	Function	Drainage database representation	Example photographs
Reed bed treatment system		Remote from carriageway	Shallow pond or wide ditch with variety of reed types	Treatment and attenuation of potentially polluting run-off	Region asset with central region node and region connectors to define connectivity and flow through the asset	
Pond (undifferen-tiated)	Balancing pond	Remote from carriageway	Not specific or unknown	Not specific or unknown, or can perform a combination of functions	Region asset with central region node and region connectors to define connectivity and flow through the asset	(Photo not appropriate due to generic nature of asset type.)

Table A.12 Region assets - ancillaries

Asset type	Synonyms	Location and layout	Construction	Function	Drainage database representation	Example photographs
Reservoir pavement		Under the carriageway pavement	Porous subbase constructed of aggregate or prefabricated units. Fed by either a pervious surface pavement or surface runoff diverted via gullies, edge drains and pipes	Provides storage and attenuation of storm waters	Region asset with central region node and region connectors to define connectivity and flow through the asset	

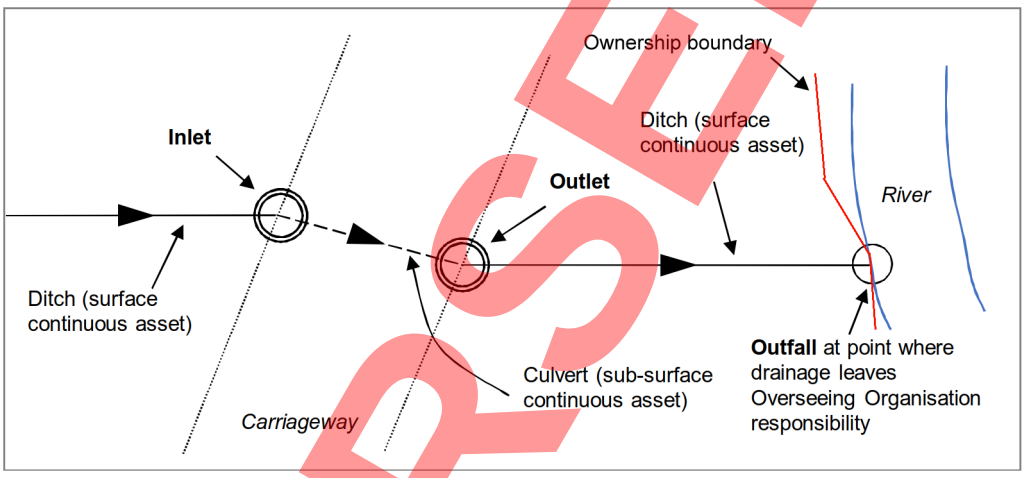
A2 Asset example usages

A2.1 Point assets - inlets and outlets

A2.1.1 Outfalls, inlets and outlets

Figure A.1 shows an example usage of an inlet, outlet and outfall. A ditch flowing into a culvert, to pass underneath a road, would have an inlet at the upstream end of the culvert. As the culvert emerges from beneath the road into another ditch, it would have an outlet. The ditch discharges into a third party river and in this case does not have a physical structure. The ownership boundary (and the limit of the Overseeing Organisation's responsibility) coincides with the river bank and this defines the outfall location.

Figure A.1 Example use of inlets, outlets and outfalls



Points to note:

1) If the ownership boundary had been midway between the carriageway and the river, then the outfall would be at that location, not where the ditch physically discharges into the river.
2) The outfall has the potential to pollute third party waters and is therefore a priority asset and is included within the priority outfall register.
3) If the connection between the culvert and the river had been piped, instead of a ditch, then the outfall would also have been an outlet. Outlets are only priority assets where they are also outfalls, in which case they would be included within the priority outfall register.
4) Indicative highway ownership boundaries, and hence potential outfall locations, may be found in mapping data sets available at www.gov.uk. Definitive ownership boundary information is available from HM Land Registry www.gov.uk/government/organisations/land-registry
5) Where the ownership boundary is along a watercourse, under riparian law, the boundary would be the centreline of the watercourse channel, although the discharge point into the third party waters would be on the river bank.

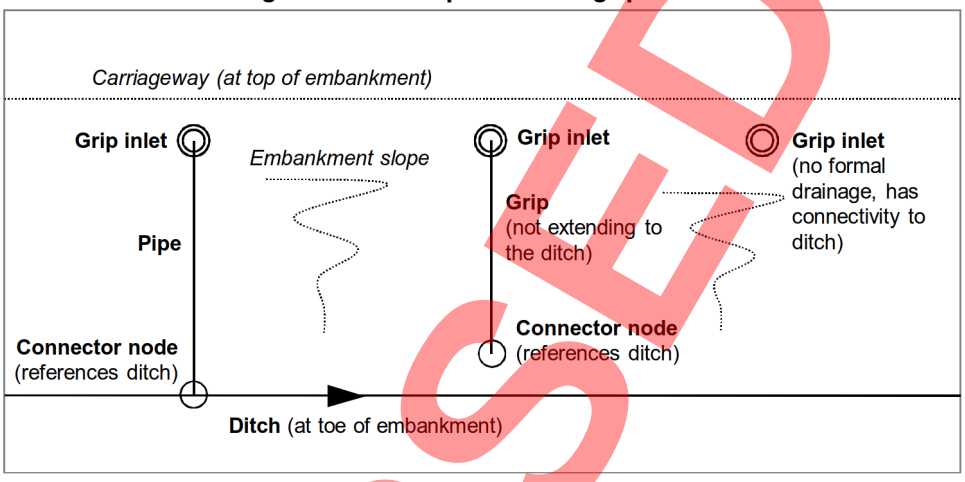
A2.1.2 Grip inlets

Figure A.2 shows three examples of grip inlets, located along the crest of an embankment, each of which allows drainage to be conveyed to the ditch at the toe of the embankment. The ditch is a single asset that extends beyond the limits of the figure:

1) The first grip inlet is at the upstream end of a "piped grip", which is recorded as a pipework asset or gravity drain. The downstream end of the pipe connects part way along the ditch, and therefore has a connector node that references the ditch. (See example use of connector nodes, below.)

2) The second grip inlet is at the upstream end of a non-piped grip, which is recorded as a grip. In this case, the grip does not extend all of the way to the ditch, but it has been established that drainage will flow informally into the ditch, part way along it. The downstream end of the grip therefore has a connector node that references the ditch. (See example use of connector nodes, below.)
3) The third grip inlet has no formal drainage downstream of it, and the drainage would therefore flow informally down the embankment and into the ditch, part way along it. Therefore the grip inlet references that it is connected to the ditch, similar to a connector node. (See example use of connector nodes, below.)

Figure A.2 Example uses of grip inlets



A2.2 Drainage network modelling items

A2.2.1 Ghost nodes

A ghost node is a network modelling point item used to complete a drainage network by representing a node that has no physical manifestation. The ghost node allows connectivity between assets to be defined, by satisfying the requirement that all continuous assets have an upstream and downstream point.

Example uses of ghost nodes include:

1) the ends of ditches or other continuous assets where there is no physical point asset;
2) a point where the nature of a ditch or other continuous asset significantly changes, such as a watershed where the flow direction changes, but there is no other physical point asset. The ditch in this case would be split into two assets, connected by the ghost node;
3) at the connection between two surface assets such as a ditch and a pond, where there is no physical asset such as a flow control device; and,
4) at the connections between sections of a herringbone drain, where there is no physical asset.

A2.2.2 Connector nodes

A connector node is a network modelling point item representing an incoming intermediate connection to a continuous asset. A connector node is located at the downstream end of the incoming asset. Because it is at an intermediate location along the outgoing continuous asset, it is neither the upstream nor downstream point asset of this continuous asset. The connector node has a connectivity reference to associate it to the continuous asset that is downstream of it.

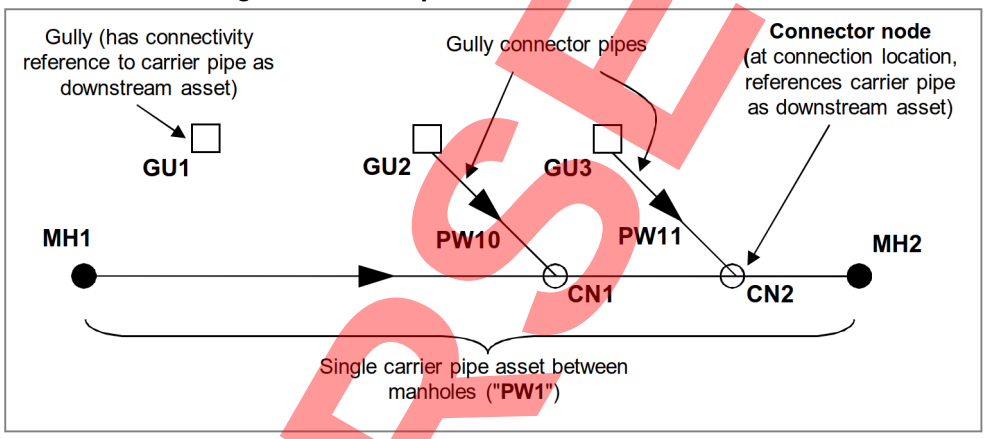
The connector node would normally be geographically located on its downstream continuous asset, but need not be in all cases. Similarly, point assets where the path of connection is unknown (e.g. an unknown gully connector) or informal (e.g. a grip inlet with no formal downstream drainage) can refer to a downstream continuous asset, into which they would connect at an intermediate point.

Figure A.3 shows an example use of connector nodes. The example given above for grip inlets, also shows example uses.

In the example below, there are three gullies ("GU1", "GU2" and "GU3") that are known to connect with a single carrier pipe ("PW1"), at intermediate points along it. The carrier pipe has a manhole at its upstream ("MH1") and downstream ends ("MH2"). The gullies are connected as follows:

1) The connection between gully GU1 and the carrier pipe is unknown, as the gully connector and/or connection has not been identified. GU1 therefore has a connectivity reference to the carrier pipe as its downstream asset. No continuous asset is directly connected to GU1.
2) GU2 is known to connect to the carrier pipe via a gully connector pipe "PW10", at a connection located at the connector node "CN1". CN1 has a connectivity reference to the carrier pipe as its downstream asset. The gully connector pipe PW10 has GU2 as its upstream asset, and CN1 as its downstream asset.
3) GU3 is similar to GU2, connected to the carrier pipe via a gully connector pipe "PW11" and connector node "CN2". CN2 has a connectivity reference to the carrier pipe as its downstream asset. The gully connector pipe PW11 has GU3 as its upstream asset, and CN2 as its downstream asset.

Figure A.3 Example use of connector nodes



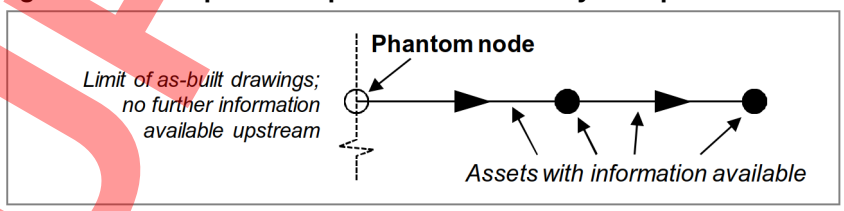
A2.2.3 Phantom nodes

A phantom node is a network modelling point item that provides an upstream or downstream end point of a drainage system, when the nature of the drainage system beyond the phantom node is unknown, because either there are no as-built drawings or it has not been surveyed.

Once information is available, phantom nodes should be replaced with the correct asset information.

Figure A.4 shows an example use of a phantom node, when deriving asset data from incomplete drawings. The dashed line indicates the limit of available information.

Figure A.4 Example incomplete asset inventory with phantom node



A2.2.4 Phantom connectors

A phantom connector is a network modelling continuous item that represents a connection between two known point assets in which the route of the continuous connection between them is unknown, but there is some degree of certainty that the two are connected. A phantom connector can be used if an area of an as-built drawing is obscured, or where a below ground pipework survey has not been carried out but the pipework route can be established with some degree of certainty, for example by dye tracing.

A single phantom connector can represent several assets in reality. This is distinct from other types of continuous asset with uncertain connectivity, where the nature of the item is otherwise known.

Once information is available, phantom connectors should be replaced with the correct asset information.

Figure A.5 and Figure A.6 show an example usage of a phantom connector where part of the source information is unavailable, but connectivity is expected.

Figure A.5 Example incomplete asset inventory due to missing information

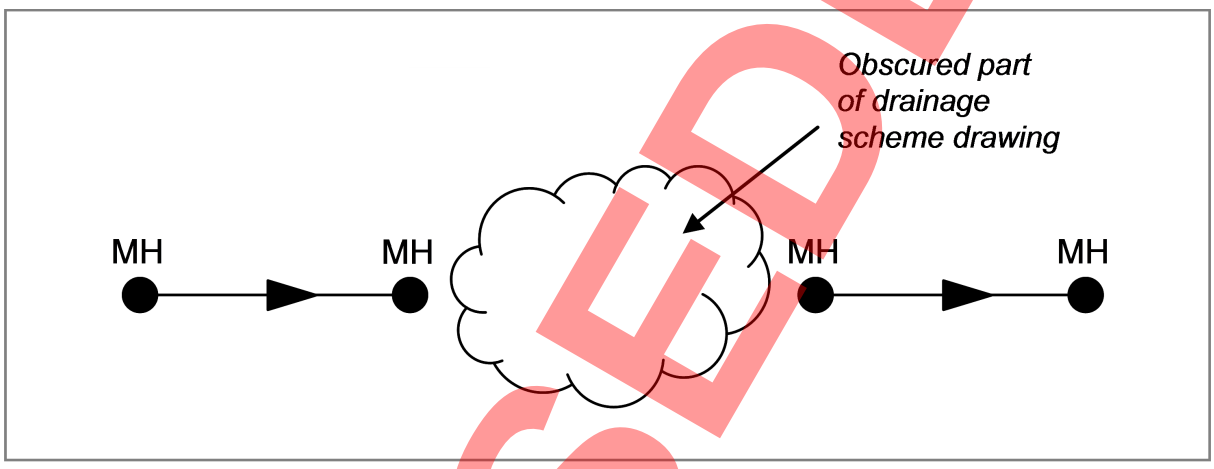
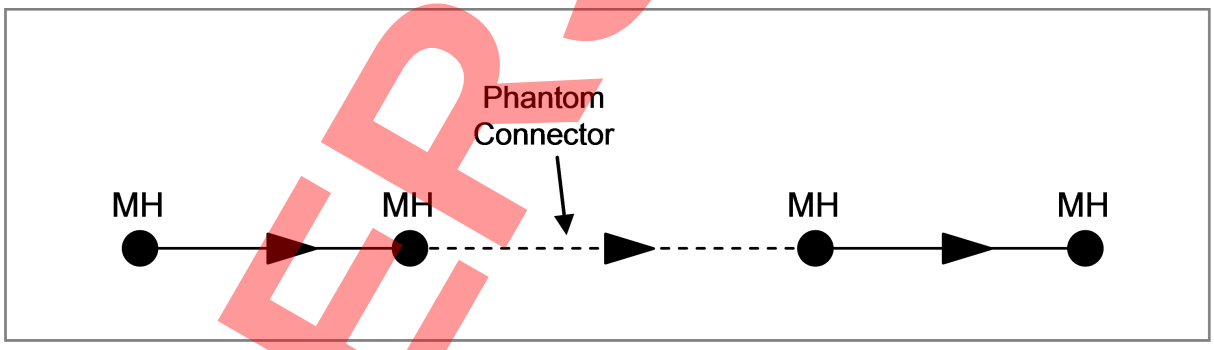


Figure A.6 Example incomplete asset inventory with phantom connector



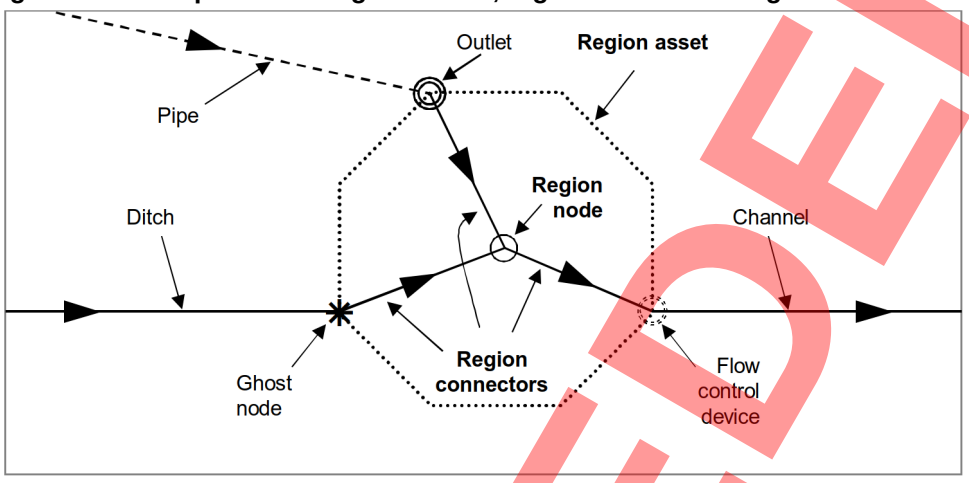
A2.2.5 Region connectors and region nodes

A region connector is a network modelling continuous item that represents the flow of drainage through a region asset such as a pond. It connects the associated region node at the centre of the region asset to either an inflow or outflow point, which is normally on the perimeter of the pond but can be within it.

Each region asset should normally have at least one region connector for the inflow and, with the exception of infiltration basins that solely drain to the ground, one for the outflow.

An example arrangement of a region node, region asset and region connectors is shown in Figure A.7. The region asset has two incoming continuous assets: a pipe and a ditch; and one outgoing continuous asset: a channel. Where the pipe ends at the pond, there is an outlet because the drainage system is changing from sub-surface to open. There is no physical asset where the ditch enters the pond, but to satisfy connectivity requirements, there needs to be a point asset at the end of the ditch, so this will be a ghost node. Where the pond flows into the channel there is a weir, which is represented by a flow control device point asset. Region connectors join the region node to each point where a continuous asset enters or leaves the region asset.

Figure A.7 Example use of region nodes, region assets and region connectors



Drainage
Design

CD 535
England National Application Annex to CD 535 Drainage asset data and risk management

(formerly HD 43/04)

Version 0.1.0

Summary
This National Application Annex sets out the National Highways-specific requirements for recording of inventory and condition of drainage assets, and the management of flooding, pollution and cross-asset risks related to drainage.

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 National Highways team. The email address for all enquiries and feedback is: Standards_Enquiries@highwaysengland.co.uk

This is a controlled document.

Contents

Latest release notes

Document code	Version number	Date of publication of relevant change	Changes made to	Type of change
CD 535	0.**1**.0	October 2021	England NAA	Incremental change to requirements

Removal of the RACI. Minor updates to operational reporting requirements to reflect changing business practice. Addition of guidance on flooding definitions to reflect current business practice, including new photographic appendix. Template for England NAA updated as previous version was on incorrect template and did not include the prefix 'E' before clauses. Revision 1 (January 2020) Revision to update references only. Revision 0 (June 2019) England National Application Annex to CD 535.

Previous versions

Document code	Version number	Date of publication of relevant change	Changes made to	Type of change

Foreword

Publishing information

This document is published by National Highways.

This document supersedes HD 43/04, which is 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.

Introduction

Background

This document gives the National Highways-specific requirements for recording of inventory and condition of drainage assets, and the management of flooding, pollution and cross-asset risks related to drainage.

In addition it sets out general requirements for the management of drainage assets, and for provision of information to support reporting of performance metrics and measures by National Highways.

Assumptions made in the preparation of the document

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

Mutual Recognition

Where there is a requirement in this document for compliance with any part of a "British Standard" or other technical specification, that requirement may be met by compliance with the Mutual Recognition clause in GG 101 [Ref 6.N].

Abbreviations

Abbreviations

Abbreviation	Definition
AADT	Annual average daily traffic
ADMM	Asset data management manual ADMM [Ref 1.N]
AMP	Asset management plan
ASC	Asset support contract
CFMP	Catchment flood management plan
DBFO	Design, build, finance, operate
DDMS	Drainage data management system
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
EA	Environment Agency
EngTech	Engineering Technician (qualification)
EQS	Environmental Quality Standard
F&WM (Act)	Flood and Water Management (Act) [Ref F&WM 2010 c.29 [Ref 5.N]
FSI	Flood severity index
HADDMS	Highways Agency (now National Highways) drainage data management system
HEWRAT	Highways England (National Highways) water risk assessment tool
HRS	Hazard ranking score
IDB	Internal drainage board
LLFA	Lead local flood authority
MoU	Memorandum of understanding
MP	Major Projects (National Highways directorate)
OD	(National Highways) Operations Directorate
OMM	Operational metrics manual
OS	Ordnance Survey
PI	Performance indicator
RBMP	River basement management plan
S58	Section 58
SHE	Safety, health and environment
SP	Service provider
SPR	Source-pathway-receptor
SWP	Severe weather plan
VM	Value management

Terms and definitions

Terms

Term	Definition
Active management	Procedures to manage the flooding or pollution risk of a drainage asset or drainage system, without carrying out renewals or improvements to assets. NOTE: Active management can include measures such as prioritised scheduled maintenance (such as gully cleaning) or an increased frequency of inspections.
Baseline risk	Flooding or pollution risk level assigned to priority assets during an offline bulk process, usually carried out centrally and nationally by National Highways, to determine expected risk. NOTE: The baseline risk is verified during the risk assessment process, comprising desk and/or field studies.
Drainage data management system (DDMS)	National Highways' primary database for managing information concerning drainage assets and flooding.
Drainage liaison engineer	Person responsible for all drainage surveys, maintenance and renewals within an operational area, and is the key point of contact for all drainage related matters.
Environmental quality standard	Assessment of the annual average concentration of soluble pollutants for outfalls, compared with published environmental quality standards given in DMRB LA 113 [Ref 9.N]. NOTE: This assessment is facilitated through HEWRAT.
Flood champion	Person responsible for integration and coordination of flood risk management within an operational area. NOTE: This person can also be the operational area's drainage liaison engineer.
Flood severity index	Numeric, quantitative assessment of the severity of a flood event's impacts. NOTE: The current detailed definition of the flood severity index can be downloaded from the DDMS.
Lead local flood authority	Unitary authority or county council that has responsibility for developing, maintaining and applying a strategy for local flood risk management in their area and for maintaining a register of flood risk assets. NOTE: Also has lead responsibility for managing the risk of flooding from surface water, groundwater and ordinary watercourses.
Operational area	Geographical and organisational area within which assets are managed by National Highways or its supply chain.
OSGB36	An ordnance survey datum representing the OS National Grid reference system.

Terms (continued)

Term	Definition
OSGM15	An ordnance survey geodetic transformation model to convert a level between global height models and ordnance datum Newlyn. NOTE: OSGM15 supersedes the OSGM02 transformation.
OSTN15	An ordnance survey geodetic transformation model to convert a location between global coordinate systems and OS National Grid (OSGB36). NOTE: OSTN15 supersedes the OSTN02 transformation.
Sediment pollution risk	Assessment of sediment-bound pollutants in highway runoff. NOTE: This assessment is facilitated through HEWRAT.
Soluble pollution risk	Assessment of short-lived, higher concentration discharges of soluble pollutants. NOTE: This assessment is facilitated through HEWRAT.
Spillage risk	Assessment determined for soakaways and outfalls from the applicable method set out in LA 113 [Ref 9.N]. NOTE: This assessment is facilitated through HEWRAT.

E/1. General requirements

Roles and responsibilities

E/1.1 Each operational area shall nominate a suitably qualified and experienced person or persons to carry out each of the following functions:

1) drainage liaison engineer responsible for all matters related to the management of the drainage asset; and,
2) flood champion responsible for all matters related to the management of flooding risk.

NOTE *"Suitably qualified and experienced" means a minimum of EngTech or equivalent, and a minimum of five years' experience of managing highway drainage assets.*

E/1.1.1 The functions of the drainage liaison engineer and flood champion may be carried out by persons with alternative role titles.

E/1.1.2 The functions of the drainage liaison engineer and flood champion may be carried out by the same person.

E/1.2 Those carrying out the functions of drainage liaison engineer and/or flood champion shall be subject to acceptance by National Highways, if not employed by National Highways.

Performance measures and metrics

E/1.3 Information shall be recorded on the drainage data management system (DDMS) to enable National Highways to accurately report against the performance metrics defined in the Operational Metrics Manual. OMM [Ref 7.N]

NOTE 1 *The metrics defined in the Operational Metrics Manual OMM [Ref 7.N] are reviewed periodically and subject to change.*

NOTE 2 *National Highways defines additional drainage and flooding performance measures and metrics for internal reporting and monitoring purposes.*

E/1.4 Where information on the DDMS requires clarification or further evidence to support a reported measure or metric, a response to a request for this information shall be provided within seven days.

NOTE *For example, a metric based on the number of flooding mitigations can require further evidence of the work that has taken place, or of the active management processes implemented, in order for the mitigation to be counted in the metric.*

E/2. Asset inventory and condition data

E/2.1 Drainage asset inventory and condition data shall be recorded in accordance with the requirements of the Asset Data Management Manual ADMM [Ref 1.N].

NOTE 1 The asset data management manual includes:

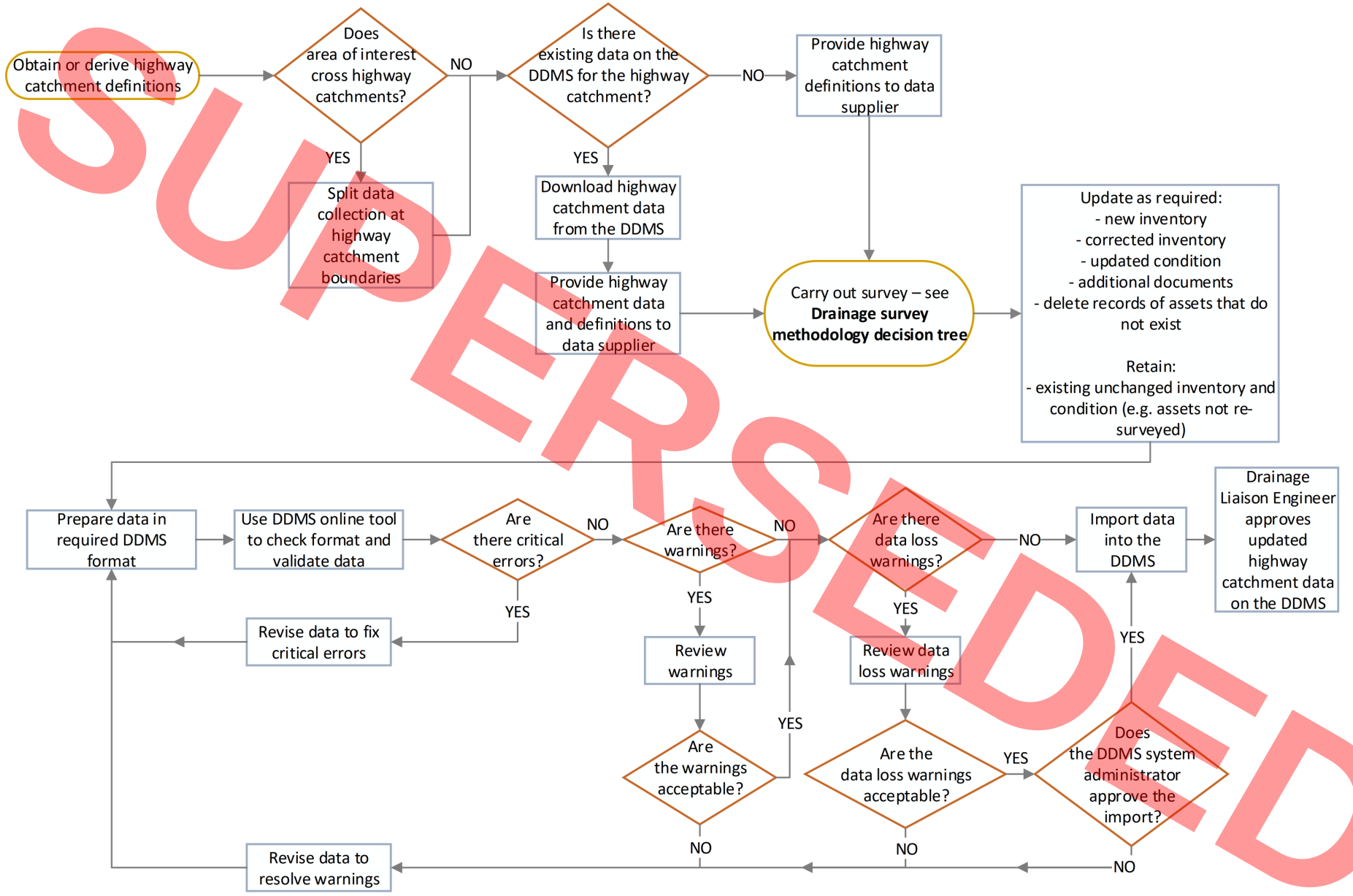
1) *detailed definition of asset types, including example photographs and synonyms;*
2) *data dictionary definition such as the list of inventory and condition data fields, inventory codes (such as for material and shape) and condition observation codes;*
3) *units of measurement;*
4) *condition defect scoring criteria;*
5) *mandatory data population requirements;*
6) *data format specification;*
7) *acceptable formats for attached documents and files;*
8) *data validation criteria; and,*
9) *data submission process.*

NOTE 2 Template files, example files and further guidance can be downloaded from the DDMS.

E/2.2 Survey data shall be supplied in the formats required in CS 551 [Ref 4.N] for upload to the DDMS within 30 days of completion of the site works.

E/2.3 The process described in Figure E/2.3 shall be followed for maintaining the asset data for each drainage highway catchment.

Figure E/2.3 Process for maintaining drainage highway catchment data



E/2.4 The location of all drainage assets shall be recorded to OSGB36 datum, using the OSTN15 transformation model.

E/2.4.1 Further advice on coordinate systems and transformation models may be obtained from the Ordnance Survey.

E/2.5 Where the level of an asset is recorded, this shall be to Ordnance Datum Newlyn, using the OSGM15 transformation model.

E/2.6 Where asset condition is assessed at asset-level, this shall be in accordance with the criteria set out in CS 551 [Ref 4.N].

NOTE *CS 551 [Ref 4.N] includes:*

1) requirements for various survey types:

a) validation surveys;
b) priority asset surveys;
c) filter drain condition surveys by GPR;
d) all assets condition and connectivity surveys;
e) pipework and chambers defect surveys by CCTV; and,
f) pipework geometric surveys by laser profiler.

2) drainage condition grade quick assessment procedure:

a) methodology;
b) definition of asset type groups;
c) list of excluded asset types; and,
d) criteria for visual assessment of structural and service condition grades.

E/2.7 As-built drawings, record status reports and signed design certificates shall be acquired and uploaded to the DDMS in accordance with the ADMM [Ref 1.N].

E/3. Managing flooding and pollution risk

General requirements

E/3.1 Flood risk related to highway drainage assets must be managed in accordance with National Highways' role as an English risk management authority under the Flood and Water Management Act F&WM 2010 c.29 [Ref 5.N].

E/3.2 Where applicable, flood risk related to region assets must be managed in accordance with the Reservoirs Act 1975 (Reservoirs Act c.23 [Ref 8.N]).

E/3.3 The relevant lead local flood authority and other flood risk management authorities must be co-operated with on matters related to flood risk management, under the requirements of the Flood and Water Management Act 2010 F&WM 2010 c.29 [Ref 5.N].

E/3.4 Data regarding all aspects of flooding and water quality described in this section, shall be recorded on the DDMS in accordance with the requirements of the ADMM [Ref 1.N].

E/3.5 Priority assets and flooding hotspots shall have their flooding or pollution risk level assessed and, if necessary, mitigated in the following order:

1) initial data capture;
2) risk assessment; and,
3) mitigation design and implementation.

Initial data capture

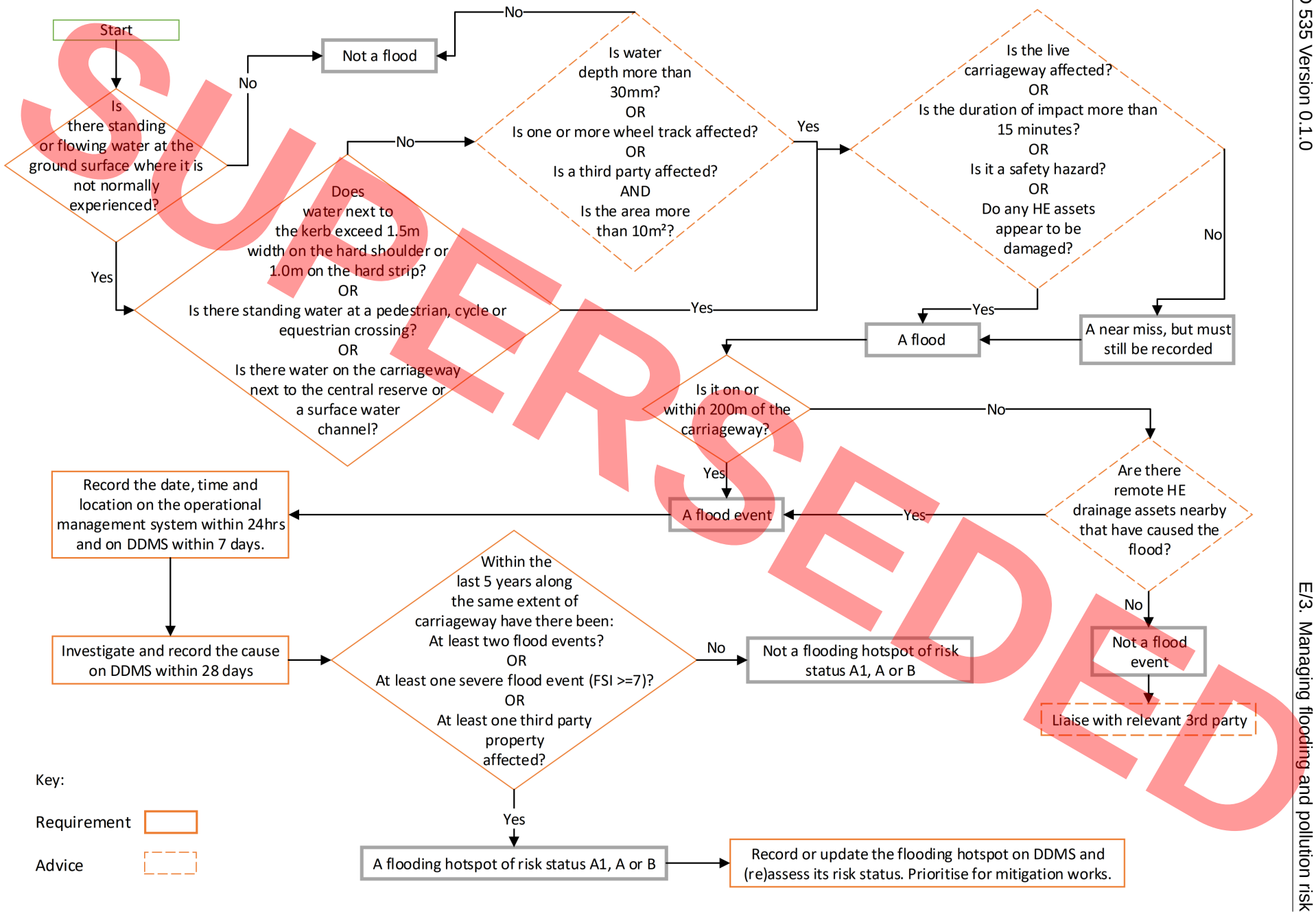
Priority assets

E/3.6 Soakaways, outfalls and culverts shall be recorded as part of the asset inventory and condition data, in accordance with Section 2.

Flood events

E/3.7 A flood, a reportable flood event and a flooding hotspot shall be defined as set out in the flow chart in Figure E/3.7.

Figure E/3.7 Flooding definitions



NOTE *Factors such as whether the live carriageway is affected, the duration of impact, the safety impact or whether any other National Highways assets are being damaged do not come into the definition of a flood event. Such matters are considered in the assessment of the impact when reporting a flood event on the DDMS. The flood is a "near miss" if the live carriageway is not impacted, but it is still recorded as a flood event on the DDMS.*

E/3.8 The following design requirements shall be taken as defining a flood:

1) any standing or flowing water that extends beyond the CD 526 [Ref 10.N] requirements of:
   a) 1.5m from the kerb for the hard shoulder; or,
   b) 1.0m from the kerb for the hard strip;
2) any standing water at pedestrian, cycle or equestrian crossings contrary to the requirements of CD 526 [Ref 10.N];
3) any surcharge of water onto the carriageway adjacent to the central reserve contrary to the requirements of CG 501 [Ref 2.N]; or,
4) any surcharge of water into the running lane from adjacent surface water channels contrary to the requirements of CG 501 [Ref 2.N].

E/3.8.1 The following may be used to distinguish between a flood and a puddle:

1) water depth estimated to be more than 30 mm; or
2) one or more wheel tracks affected irrespective of water depth; or
3) third party land or property affected; and,
4) flood area estimated to be 10 m^2 or more.

NOTE *Photographic examples of what is and what is not defined as a flood are given in Appendix E/A.*

E/3.9 A flood that is located on or within 200m of the carriageway shall be recorded on the DDMS as a flood event.

NOTE *Where third party flooding is located more than 200m from the carriageway that is related to a remote National Highways drainage asset (such as an outfall or soakaway) the flood is recorded as a flood event on the DDMS by recording the location on the linear drainage asset that leads to the remote drainage asset at just under 200m from the carriageway, and adding a note in the flood description to describe and coordinate the actual flood location.*

E/3.10 The location of all flood events shall be recorded to OSGB36 datum, using the OSTN15 transformation model.

NOTE *Where the location of the flood event is recorded as a relative location, such as a marker post chainage, this is in addition to the location as OS coordinates.*

E/3.11 The severity of flood events shall be quantified in accordance with the flood severity index (FSI) definition, which can be downloaded from the DDMS.

NOTE 1 *The DDMS automatically calculates the flood severity index from the information entered for each flood event.*

NOTE 2 *A flood receives an FSI score even if the carriageway is not affected.*

NOTE 3 *A flood receives an FSI score even if the duration of impact is less than 15 minutes.*

NOTE 4 *The only way that a flood can receive an FSI of 0 is if it cannot be snapped to the HAPMS network on the DDMS as it is more than 200m from the carriageway, and is therefore not classed as a flood event.*

E/3.12 The nature of any impacts of a flood event on third parties or other assets shall be assessed and recorded on the DDMS.

E/3.13 The flood event and arising mitigation actions shall be logged within the operational management system within 24 hours as detailed in the ADMM [Ref 1.N].

E/3.14 All flood events that are either on the road network or within 200 metres of it, shall be entered into the DDMS within 7 days as detailed in the ADMM [Ref 1.N].

E/3.15 Flood event records shall be completed, reviewed and set to closed status on the DDMS within 28 days of the flood event's occurrence as detailed in the ADMM [Ref 1.N].

Spillage events

E/3.16 The location of all spillage events shall be recorded to OSGB36 datum, using the OSTN15 transformation model.

NOTE *Where the location of the spillage event is recorded as a relative location, such as a marker post chainage, this is in addition to the location as OS coordinates.*

E/3.17 The severity of spillage events shall be quantified in accordance with the spill severity index definition, which can be downloaded from the DDMS.

NOTE *The DDMS automatically calculates the spill severity Index from the information entered for each spillage event.*

E/3.18 The nature of any impacts of a spillage event on the environment, third parties or other assets shall be assessed and recorded on the DDMS.

E/3.19 Where the Environment Agency was notified of or attended a spillage event, or took any enforcement action, the nature of this shall be recorded against the spillage event record in the DDMS.

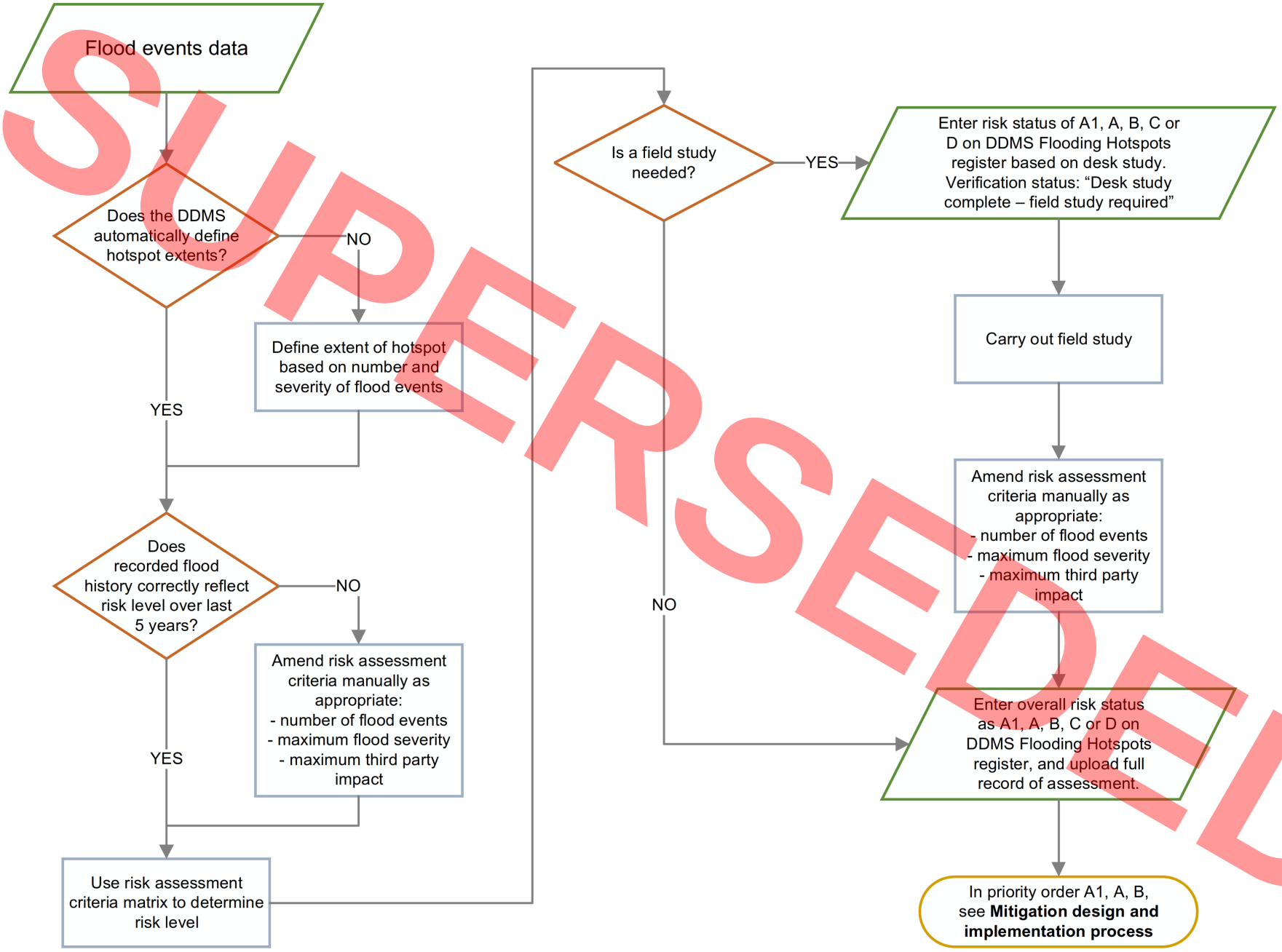
E/3.20 Spillage event records shall be completed, reviewed and set to closed status on the DDMS by the drainage liaison engineer, within 28 days of the spillage event's occurrence.

Risk assessment

Flooding hotspots

E/3.21 Flooding hotspots shall have their location defined and flooding risk assessed in accordance with the process in Figure E/3.21.

Figure E/3.21 Process for defining and assessing risk of flooding hotspots



NOTE *Further detailed guidance on the flooding hotspot assessment process can be downloaded from the DDMS.*

E/3.22 Flooding hotspots shall have their risk assessed against the criteria in Figure E/3.22.

Figure E/3.22 Flooding hotspot risk assessment criteria matrix

	Overall flooding hotspot risk status (Defined by the most severe of that determined by the carriageway impacts or third party impacts)			
	Number of floods within the hotspot in the last 5 years			
	>5	2 to 5	1	0
Most severe carriageway flooding impact (highest Flood Severity Index)				
7 to 10	A1 (Highest)	A (Very High)	B (High)	N/A
5 to 6	A (Very High)	B (High)	C (Moderate)	N/A
0 to 4	B (High)	C (Moderate)	D (Low)	N/A
No history of flooding	N/A	N/A	N/A	D (Low)
Most severe third party impact				
Residential or critical infrastructure	A (Very High)	A (Very High)	A (Very High)	N/A
Commercial	B (High)	B (High)	B (High)	N/A
Agricultural	C (Moderate)	C (Moderate)	C (Moderate)	N/A
None	D (Low)	D (Low)	D (Low)	D (Low)

NOTE *The flood severity index of the flood events is rounded to the nearest whole number, before applying the matrix in Figure E/3.22.*

E/3.23 Where flooding hotspots have a baseline risk recorded on the DDMS, the highest risk level hotspots shall be assessed first.

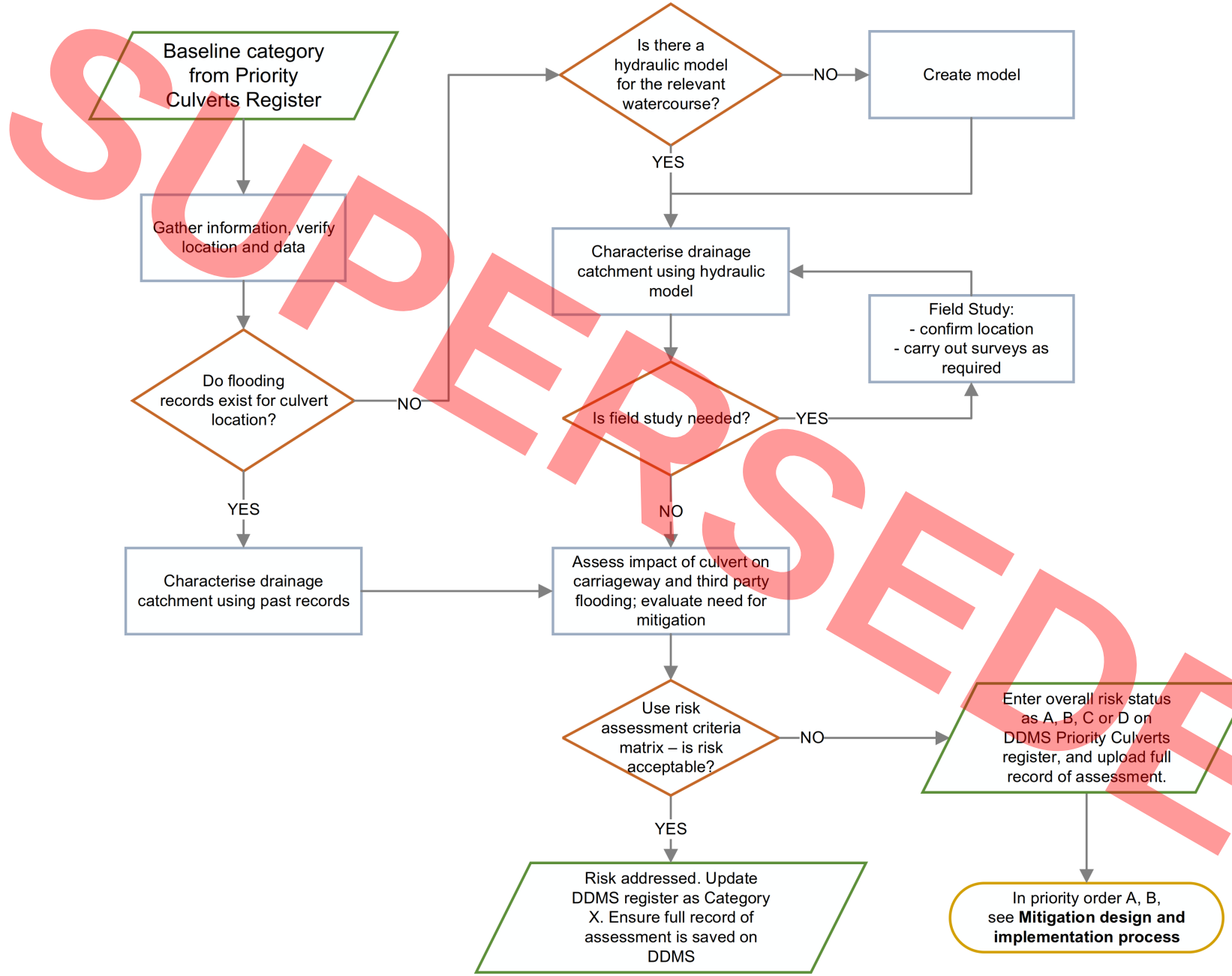
E/3.24 Where flooding hotspots do not have a baseline risk recorded on the DDMS, hotspots in locations known to be susceptible to severe, repeated flooding shall be assessed first.

E/3.25 The results of the desk study and any field assessment shall be recorded on the DDMS in the flooding hotspots register.

Culverts

E/3.26 Culverts shall have their flooding risk assessed in accordance with the process in Figure E/3.26.

Figure E/3.26 Process for assessing flood risk of culverts



NOTE *Further detailed guidance on the culverts assessment process can be downloaded from the DDMS.*

E/3.27 Culverts shall have their flooding risk assessed against the criteria in Figure E/3.27, being the worst of either the carriageway or third party flooding impacts.

Figure E/3.27 Culvert flood risk assessment criteria matrix

	Overall culvert flood risk status (Defined by the most severe of that determined by the carriageway impacts or third party impacts)			
	Number of floods related to the culvert in the last 10 years			
	>5	2 to 5	1	0
Most severe carriageway flooding impact (highest Flood Severity Index)				
7 to 10	A (Very High)	A (Very High)	B (High)	N/A
3 to 6	A (Very High)	B (High)	C (Moderate)	N/A
0 to 2	B (High)	C (Moderate)	D (Low)	N/A
No history of flooding	N/A	N/A	N/A	D (Low)
Most severe third party impact				
Residential or critical infrastructure	A (Very High)	A (Very High)	B (High)	N/A
Commercial	A (Very High)	B (High)	C (Moderate)	N/A
Agricultural	B (High)	C (Moderate)	D (Low)	N/A
None	D (Low)	D (Low)	D (Low)	D (Low)

NOTE *The flood severity index of the flood events is rounded to the nearest whole number, before applying the matrix in Figure E/3.27.*

E/3.28 Where culverts have a baseline risk recorded on the DDMS, the highest risk level assets shall be assessed first.

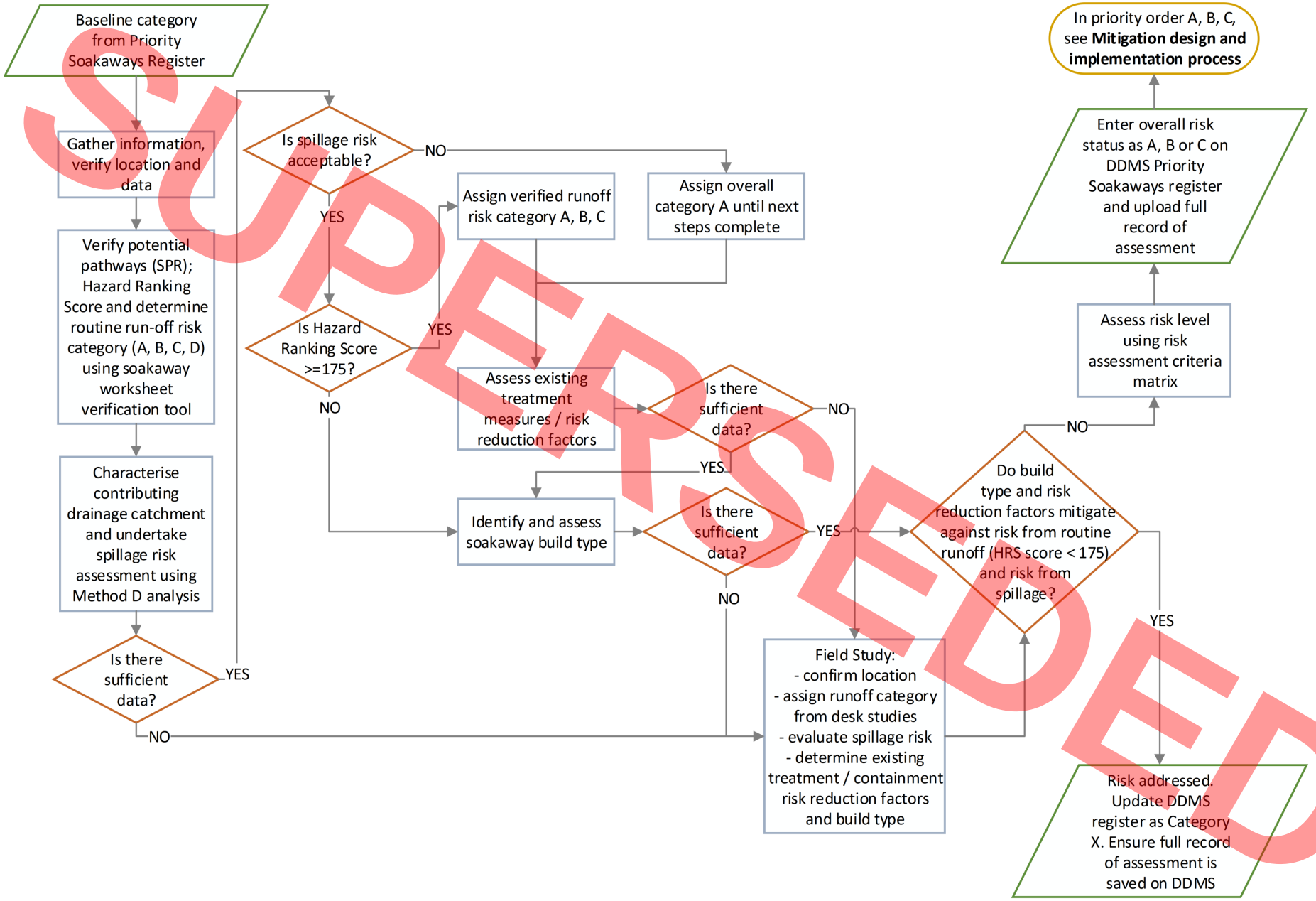
E/3.29 Where culverts do not have a baseline risk recorded on the DDMS, culverts in locations known to be susceptible to flooding shall be assessed first.

E/3.30 The results of the desk study and any field assessment shall be recorded on the DDMS in the priority culverts register.

Soakaways

E/3.31 Soakaways shall have their pollution risk assessed in accordance with the process in Figure E/3.31.

Figure E/3.31 Process for assessing pollution risk of soakaways



NOTE *Further detailed guidance on the soakaways assessment process can be downloaded from the DDMS.*

E/3.32 Soakaways shall have their risk assessed against the criteria in Figure E/3.32.

Figure E/3.32 Soakaway pollution risk assessment criteria matrix

		Overall soakaway risk status			
		Routine runoff risk category			
		A	B	C	D
Spillage risk	Fail	A (Very High)			
	Pass	A (Very High)	B (High)	C (Moderate)	X (Risk Addressed)

E/3.33 Where soakaways have a baseline risk recorded on the DDMS, the highest risk level assets shall be assessed first.

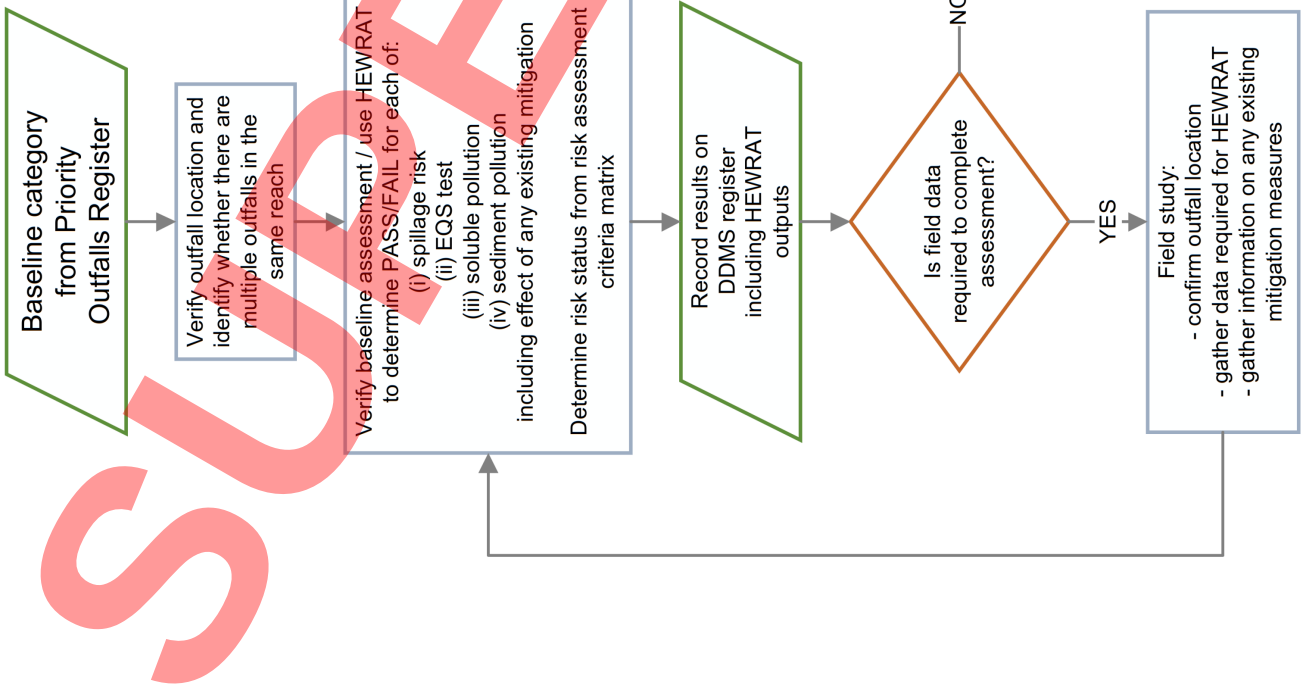
E/3.34 Where soakaways do not have a baseline risk recorded on the DDMS, soakaways in locations known to be susceptible to pollution shall be assessed first.

E/3.35 The results of the desk study and any field assessment shall be recorded on the DDMS in the priority soakaways register.

Outfalls

E/3.36 Outfalls shall have their pollution risk assessed in accordance with the process in Figure E/3.36.

Figure E/3.36 Process for assessing pollution risk of outfalls



NOTE 1 *Further detailed guidance on the outfalls assessment process can be downloaded from the DDMS.*

NOTE 2 *HEWRAT can be downloaded from the DDMS.*

E/3.37 Outfalls shall have their risk assessed against the criteria in Figure E/3.37.

Figure E/3.37 Outfall pollution risk assessment criteria matrix

Risk criterion	Risk criterion assessment outcome					
Spillage Risk	Fail	(any)	Pass			
EQS	(any)	Fail	Pass			
Soluble pollution	(any)	(any)	Fail	Fail	Pass	Pass
Sediment pollution	(any)	(any)	Fail	Pass	Fail	Pass
Overall outfall risk status	A (Very High)	A (Very High)	B (High)	C (Moderate)	C (Moderate)	X (Risk Addressed)

E/3.38 Where outfalls have a baseline risk recorded on the DDMS, the highest risk level assets shall be assessed first.

E/3.39 Where outfalls do not have a baseline risk recorded on the DDMS, outfalls in locations known to be susceptible to pollution shall be assessed first.

E/3.40 The results of the desk study and any field assessment shall be recorded on the DDMS in the priority outfalls register.

Mitigation design and implementation

E/3.41 Priority assets and flooding hotspots shall be mitigated in priority order based on their overall risk status, following risk assessment.

E/3.41.1 Priority assets and flooding hotspots should be considered for mitigation if their overall risk status following risk assessment is as follows:

1) flooding hotspots of risk status A1, A or B;
2) priority culverts of risk status A or B;
3) priority soakaways of risk status A, B or C; and,
4) priority outfalls of risk status A, B or C.

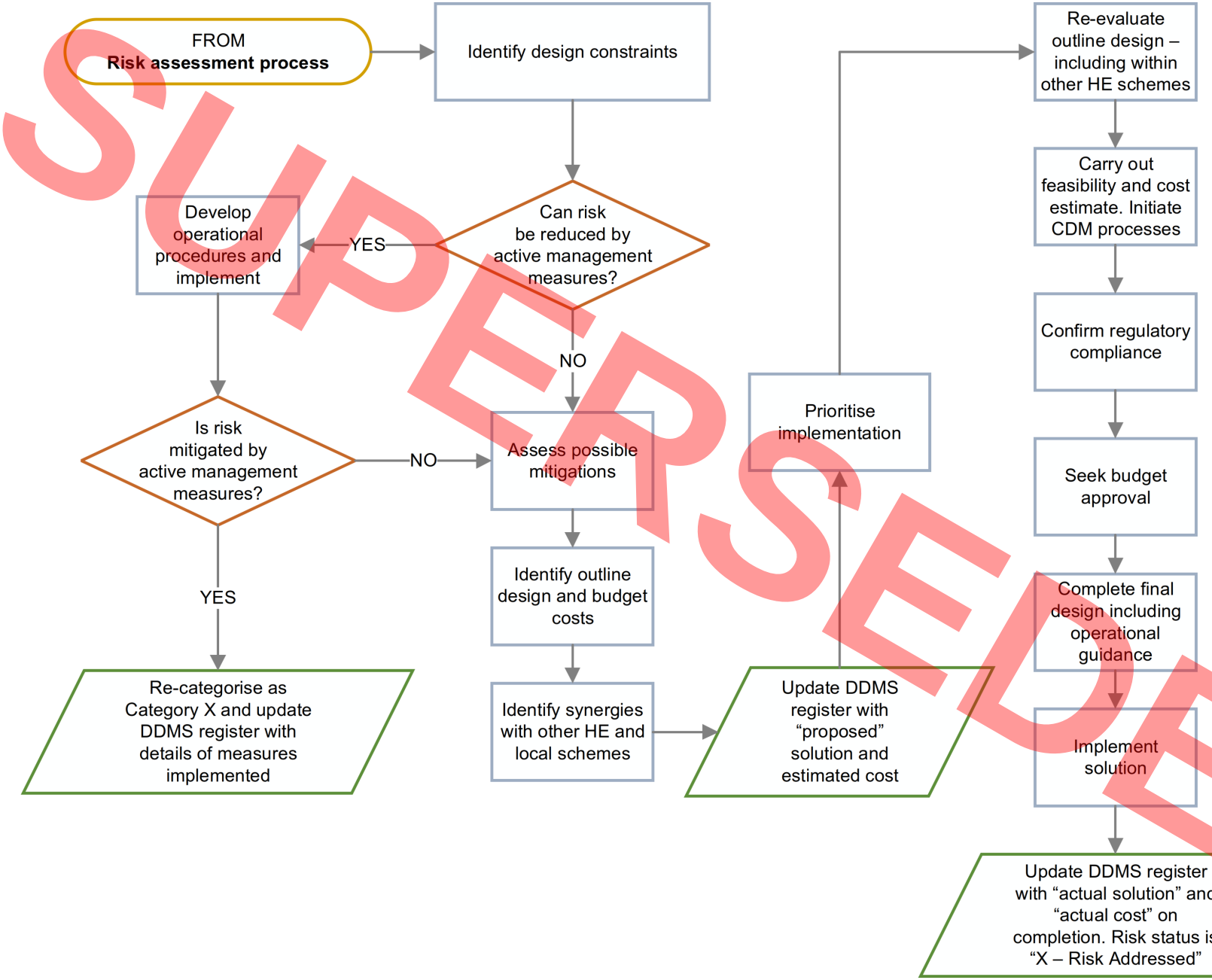
E/3.41.2 Where a lower risk priority asset or hotspot could be mitigated sooner than higher risk assets or hotspots, and where this would not delay mitigation of the higher risk locations, the lower risk asset or hotspot may be mitigated earlier.

E/3.42 Mitigations of priority assets and flooding hotspots shall be designed and implemented such that the risk status is reduced as follows, when reassessed against the applicable risk level criteria given in this section:

1) flooding hotspots and priority culverts to a risk status of C or D (based on expected reduction in future flooding); and,
2) priority soakaways and outfalls to a risk status of D.

E/3.43 Where assessment and prioritisation of risk indicates that a priority asset or flooding hotspot requires mitigation, the mitigation shall be designed and approved in accordance with the process in Figure E/3.43.

Figure E/3.43 Process for design and approval of priority asset and flooding hotspot mitigations



NOTE *Further detailed guidance on the mitigation design and implementation process can be downloaded from the DDMS.*

E/3.44 Mitigations shall be designed in accordance with the requirements and guidance contained in the related documents referenced in CG 501 [Ref 2.N] and that stated in LA 113 [Ref 9.N] and CD 529 [Ref 3.N].

E/3.45 Details of the mitigation shall be recorded on the DDMS, by updating the asset inventory data and relevant priority asset register in accordance with the ADMM [Ref 1.N].

E/3.46 Where the mitigation is implemented by active management, the following shall be recorded on the DDMS, in the relevant priority asset register:

1) details of the risk management processes to be implemented, including their frequency; and,
2) ongoing records to demonstrate that the processes are being carried out.

NOTE *Active management measures can include, but are not limited to, processes such as automated or manual monitoring, or a more regular, pro-active maintenance regime, to prevent future flooding or pollution at the location.*

E/3.47 Where active management processes have been implemented, these shall remain in place unless a further assessment demonstrates that the risk level has been reduced to a sufficient level where mitigations would not otherwise be required, and remains at that level without those processes.

E/4. 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. ADMM, 'Asset Data Management Manual'
Ref 2.N	Highways England. CG 501, 'Design of highway drainage systems'
Ref 3.N	Highways England. CD 529, 'Design of outfall and culvert details'
Ref 4.N	Highways England. CS 551, 'Drainage surveys'
Ref 5.N	The National Archives. legislation.gov.uk UK Public General Acts. F&WM 2010 c.29, 'Flood and Water Management Act 2010'
Ref 6.N	National Highways. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 7.N	Highways England. OMM, 'Operational Metrics Manual'
Ref 8.N	The National Archives. Legislation.gov.uk. Reservoirs Act c.23, 'Reservoirs Act 1975 and various Reservoirs Act (Amendment) Regulations'
Ref 9.N	Highways England. LA 113, 'Road drainage and the water environment'
Ref 10.N	Highways England. CD 526, 'Spacing of road gullies'

Appendix E/A. Photographic guide to flood definition

The following photographs illustrate what should or should not be described as a flood.

Table E/A.1 Examples of floods

Description	Example
Standing water across lanes 1 and 2. A flood and a flood event.	
Flowing water less than 30 mm deep in fast lane adjacent to central reservation. A flood and a flood event.	
Flowing and standing water across the verge and hard shoulder, more than 1.5 m wide. A flood and a flood event.	

Table E/A.1 Examples of floods (continued)

Flowing water in neighbouring garden within 200 m of the carriageway. A flood and a flood event.	
Standing water in adjacent field, on verge and carriageway. A flood and a flood event.	
Standing water in adjacent field within 200 m of the carriageway. A flood and a flood event.	
Standing water at the edge of the carriageway locally over one wheel track. Area more than 10 m^2. A flood and a flood event.	

Table E/A.1 Examples of floods (continued)

Standing water on the hard shoulder, locally more than 1.5 m wide and more than 10 m^2. A flood and a flood event.	
Water flowing across carriageway. Less than 30 mm deep. Two lanes and slip road affected. A flood and a flood event.	
Standing water on footway more than 10 m^2. A flood and a flood event.	
Standing water in turning lane adjacent of central reservation. A flood and a flood event.	

Table E/A.1 Examples of floods (continued)

Flowing water across carriageway. Less than 30 mm deep, more than 10 m^2 in area. A flood and a flood event.	
Standing water on hard strip, more than 1.0 m wide. 10 m^2 criteria does not apply. A flood and a flood event.	
Surcharging gully, water depth more than 30 mm and wheel track affected. Less than 10 m^2. But engineering judgement says that this is a flood and a flood event due to its location at a junction.	

Table E/A.2 Examples that are not floods

Description	Example
Standing water less than 30 mm deep, not covering a wheel track and less than 10 m^2. A puddle, not a flood.	
Standing water more than 10 m^2, but within surface water channel within hard strip, not impacting on running lanes. Not a flood.	
Standing water in hard strip. One wheel track (just) impacted. Less than 10 m^2. A puddle, not a flood.	
Standing water at edge of carriageway not impacting on wheel track. Less than 30 mm deep and less than 10 m^2. A puddle, not a flood.	

Department for Infrastructure
An Roinn Bonneagair

Drainage
Design

CD 535
Northern Ireland National Application Annex to CD 535 Drainage asset data and risk management

(formerly HD 43/04)

Version 0.0.1

Summary
This National Application Annex contains the Department for Infrastructure, Northern Ireland specific requirements related to drainage asset data and risk management.

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 team in the Department for Infrastructure, Northern Ireland. The email address for all enquiries and feedback is: dcu@infrastructure-ni.gov.uk

This is a controlled document.

Contents

Latest release notes

Document code	Version number	Date of publication of relevant change	Changes made to	Type of change
CD 535	0.0.**1**	October 2021	Northern Ireland NAA	Incremental change to notes and editorial updates

Department for Infrastructure, Northern Ireland NAA to CD 535.

Previous versions

Document code	Version number	Date of publication of relevant change	Changes made to	Type of change
CD 535	0	June 2019		

Foreword

Publishing information

This document is published by National Highways on behalf of Department for Infrastructure, Northern Ireland.

This document supersedes HD 43/04, which is 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.

Introduction

Background

This National Application Annex contains the Department for Infrastructure, Northern Ireland-specific requirements for drainage asset data and risk management.

NI/1. Applicability of CD 535

NI/1.1 The requirements of CD 535 shall not apply in Northern Ireland.

NOTE *Whilst the general principles of CD 535 are endorsed, this document is not regarded as mandatory for use in Northern Ireland.*

NI/1.2 The Department for Infrastructure, Northern Ireland shall be contacted for current requirements related to drainage asset data and risk management.

NI/1.2.1 Procedures in CD 535 related to drainage asset data and risk management may be outlined within Department for Infrastructure, Northern Ireland contracts as relevant.

NI/1.2.2 Reference may be made to maintenance instructions/manuals in Department for Infrastructure, Northern Ireland contracts as relevant.

Drainage
Design

CD 535
Scotland National Application Annex to CD 535 Drainage asset data and risk management

(formerly HD 43/04)

Revision 0

Summary
Please contact Transport Scotland for the application of CD 535. The email address is: TSStandardsBranch@transport.gov.scot

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 Transport Scotland team. The email address for all enquiries and feedback is: TSStandardsBranch@transport.gov.scot

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Contents

Release notes

Version	Date	Details of amendments
0	Jun 2019	Scotland National Application Annex to CD 535.

Llywodraeth Cymru
Welsh Government

Drainage
Design

CD 535
Wales National Application Annex to CD 535
Drainage asset data and risk management

(formerly HD 43/03)

Revision 0

Summary
Please contact Welsh Government for the application of CD 535. The email address is: Standards_Feedback_and_Enquiries@gov.wales.

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 Welsh Government team. The email address for all enquiries and feedback is: Standards_Feedback_and_Enquiries@gov.wales

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