national highways

Lower Thames Crossing

6.3 Environmental Statement Appendices
Appendix 14.6 - Flood Risk Assessment - Part 7

APFP Regulation 5(2)(a) and (5)(2)(e)

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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Lower Thames Crossing

Appendix 14.6 - Flood Risk Assessment - Part 7

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1 Introduction

1.1 Context

1.1.1 This document forms Part 7 of the Flood Risk Assessment (the FRA) for the A122 Lower Thames Crossing (the Project).

1.1.2 The FRA forms Appendix 14.6 of the Environmental Statement (Application Document 6.3).

1.2 Form of assessment

1.2.1 The FRA is presented in nine principal parts and one affiliated part. These parts and a brief description of their contents are detailed in Plate 1.1.

1.2.2 For the purposes of the FRA, the Project has been divided into five discrete catchments. These catchments are listed Table 1.1 and are shown on Drawing 00100.

Table 1.1 FRA catchments

Catchment	Title
EFR-1	South of River Thames
EFR-2	North Portal to Chadwell St Mary
EFR-3	A13 junction
EFR-4	Ockendon Link
EFR-5	North Section

1.2.3 All drawings referenced in this document can be found in Part 9 of the FRA.

1.2.4 The key points raised in this document are presented in ‘Text boxes’.

1.3 Basis of assessment

1.3.1 The FRA is based on the design as presented in the Development Consent Order (DCO) application.

1.3.2 The FRA includes an assessment of flood risk for both the construction phase and operational phase of the Project.

1.4 Design Principles

1.4.1 The Design Principles (Application Document 7.5) are embedded measures that have been developed through an iterative design process. The Design Principles are secured by Requirement 3 of Schedule 2 of the DCO.

1.4.2 Elements of the surface water drainage strategy that would be secured through the Design Principles are identified in this document. Design Principles relevant to the surface water drainage strategy are identified by an alpha-numerical reference code, for example, SX.X or LSP.XX.

1.5 Register of Environmental Actions and Commitments

1.5.1 Good practice and essential mitigation are included in the Register of Environmental Actions and Commitments (REAC), which forms part of Appendix 2.2: Code of Construction Practice (Application Document 6.3).

1.5.2 Each action and commitment in the REAC has a unique alpha-numerical reference code.

1.5.3 Where appropriate, the REAC reference codes for secured commitments and actions have been cross-referenced in this document. For example, the code for a Road Drainage and Water Environment commitment would be [RDWE0XX].

1.6 Surface water drainage

1.6.1 This part of the FRA considers existing and proposed surface water drainage provisions across the Project and water quality issues.

1.6.2 This part also details the greenfield runoff rates used to inform the surface water drainage design. The sections of this part are detailed in Plate 1.2 along with a brief description of their contents.

1.6.3 Assessments that review the impact that the highway drainage design would have on the water environment comprise the following:

a. Appendix 14.3 Operational Surface Water Drainage Pollution Risk Assessment (Application Document 6.3)

b. Appendix 14.5 Hydrogeological Risk Assessment, Annex 13, Annex 14 and Annex 15 (Application Document 6.3)

Plate 1.1 Form of the FRA

Principal parts

Part	Description
Part 1: Introduction	This part sets out the objectives of the FRA and describes the methodology used in its development. It also includes a list of stakeholders and the glossary for the FRA.
Part 2: Planning policy	This part summarises the national, regional and local legislation that is directly or indirectly related to flood risk.
Part 3: Environmental setting	This part provides descriptive information about the existing environmental conditions within the Order Limits.
Part 4: Hydraulic assessment – Mardyke	This part describes the hydraulic modelling undertaken to analyse flooding scenarios in the River Mardyke catchment.
Part 5: Hydraulic assessment – West Tilbury Main	This part describes the hydraulic modelling undertaken to analyse flooding scenarios in Tilbury Marshes. It also describes the hydraulic breach modelling undertaken to analyse tidal flood risk.
Part 6: Flood risk	The probability and potential consequences of flooding from all sources are considered in this part, along with a matrix of mitigation measures.
Part 7: Surface water drainage	**This part reviews the existing surface water drainage provisions and sets out the highway drainage strategy.**
Part 8: Technical summary	This part includes a technical summary of the FRA and sets out conclusions that would be used to inform the design.
Part 9: Drawings	All drawings that support the FRA are included in this part.

Affiliated part

Part	Description
Part 10: Watercourse crossings and diversions	This part details the watercourse crossings and diversions that would be required to construct and operate the Project. This part also details hydraulic structures in watercourses.

Plate 1.2 Form of Part 7 of the FRA

Section	Description
Section 1: Introduction	This section sets out the context of the document and details the form of the assessment.
Section 2: South of the River Thames Catchment EFR-1	This section describes the existing surface water drainage provisions in Catchment EFR-1. This section also sets out the design basis and design strategy that would be adopted for the catchment and outlines the surface water drainage provisions that would be included in the catchment. Flood risk associated with surface water drainage and water quality for Catchment EFR-1 are also dealt with in this section.
Section 3: North Portal to Chadwell St Mary, A13 junction and Ockendon Link Catchments EFR-2 to EFR-4	This section describes the existing surface water drainage provisions in Catchments EFR-2, EFR-3 and EFR-4. This section also sets out the design basis and design strategy that would be adopted for these catchments and outlines the surface water drainage provisions that would be included in the catchments. Flood risk associated with surface water drainage and water quality for Catchments EFR-2, EFR-3 and EFR-4 are also dealt with in this section.
Section 4: North Section Catchment EFR-5	This section describes the existing surface water drainage provisions in Catchment EFR-5. This section also sets out the design basis and design strategy that would be adopted for the catchment and outlines the surface water drainage provisions that would be included in the catchment. Flood risk associated with surface water drainage and water quality for Catchment EFR-5 are also dealt with in this section.
Section 5: Greenfield runoff	This section sets out the methodologies used to calculate greenfield runoff rates.
Section 6: Summary	A summary of the contents of this part of the FRA are presented in this section.
Section 7: References	

2 South of River Thames (EFR-1)

2.1 Existing surface water drainage

General

2.1.1 Existing provisions for the collection of highway runoff along the A2/M2 corridor comprise a combination of the following:

a. Concrete surface water channels

b. Kerbed edge channels

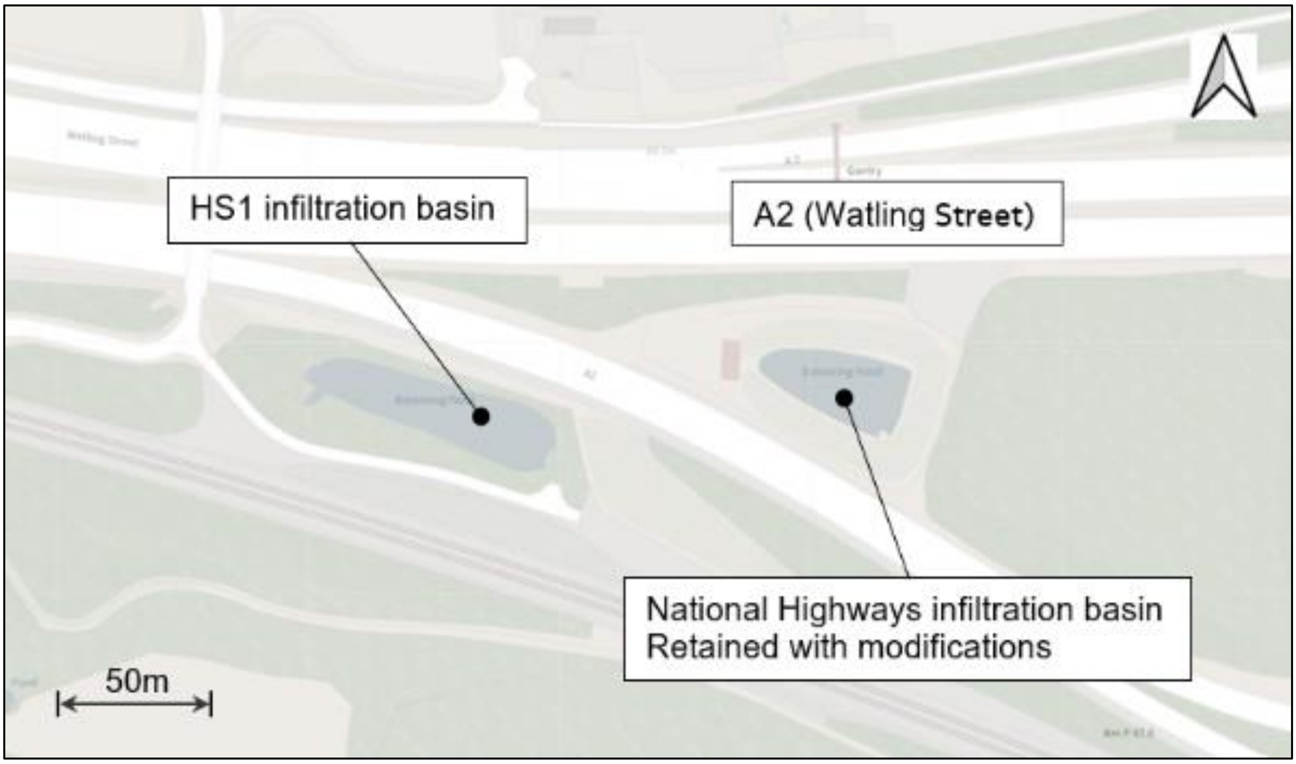
c. Combined drainage and kerb systems

2.1.2 The section of the A2/M2 corridor that would be reconfigured to accommodate the Project is supported by five infiltration basins. Details of these basins are provided below.

Existing drainage at Park Pale interchange

2.1.3 There are two infiltration basins in the south-west quadrant of the Park Pale interchange (A2/M2 junction). One of these basins is a High Speed 1 (HS1) asset and the other is a National Highways asset (see Plate 2.1).

Plate 2.1 Infiltration basins at Park Pale interchange



2.1.4 The National Highways infiltration basin receives flows from the highway drainage networks extending eastwards and westwards from the junction.

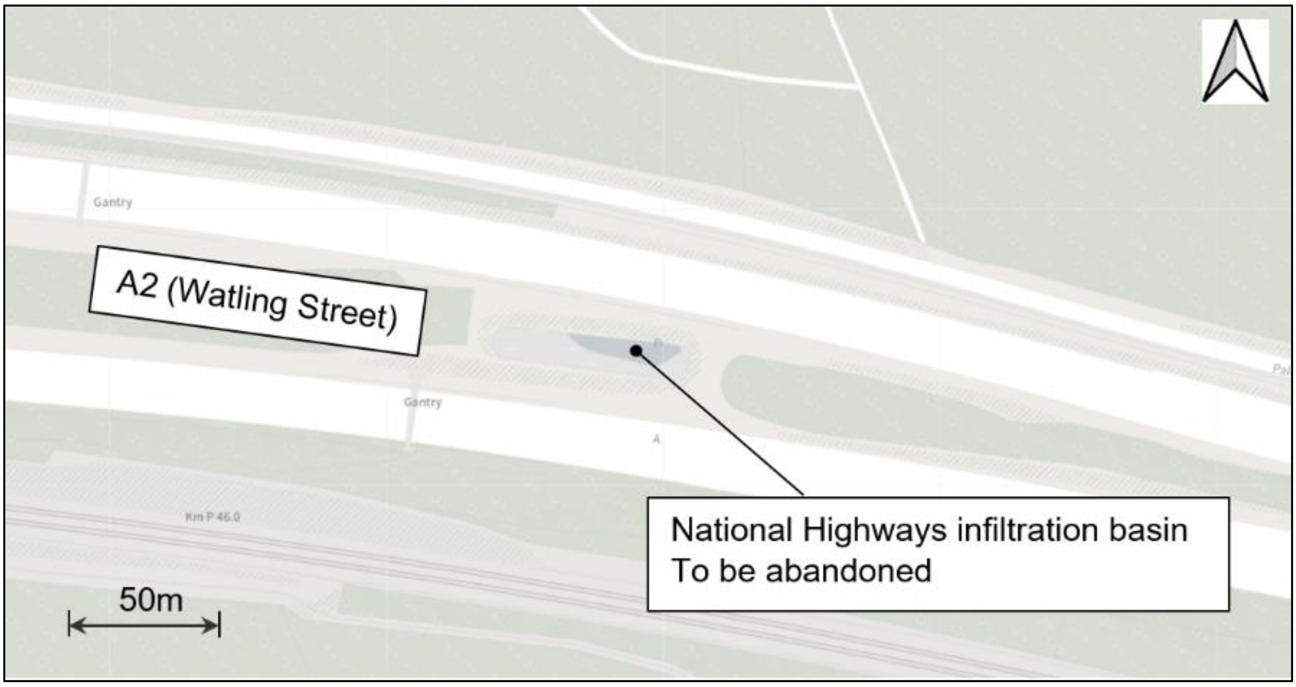
2.1.5 As-built data shows that the National Highways basin has a petrol/oil interceptor on its inlet pipe and that the basin has a 150mm diameter overflow pipe discharging into a drainage network flowing eastwards.

2.1.6 The design outflow rates and infiltration capacity for this basin are not known.

Existing drainage at the Cobham junction

2.1.7 Going westwards from the Park Pale interchange, the existing drainage for the A2 outfalls to an infiltration basin located within the central reserve, immediately to the east of Cobham junction (see Plate 2.2).

Plate 2.2 Infiltration basin near Cobham junction



2.1.8 The infiltration capacity of this basin is not known.

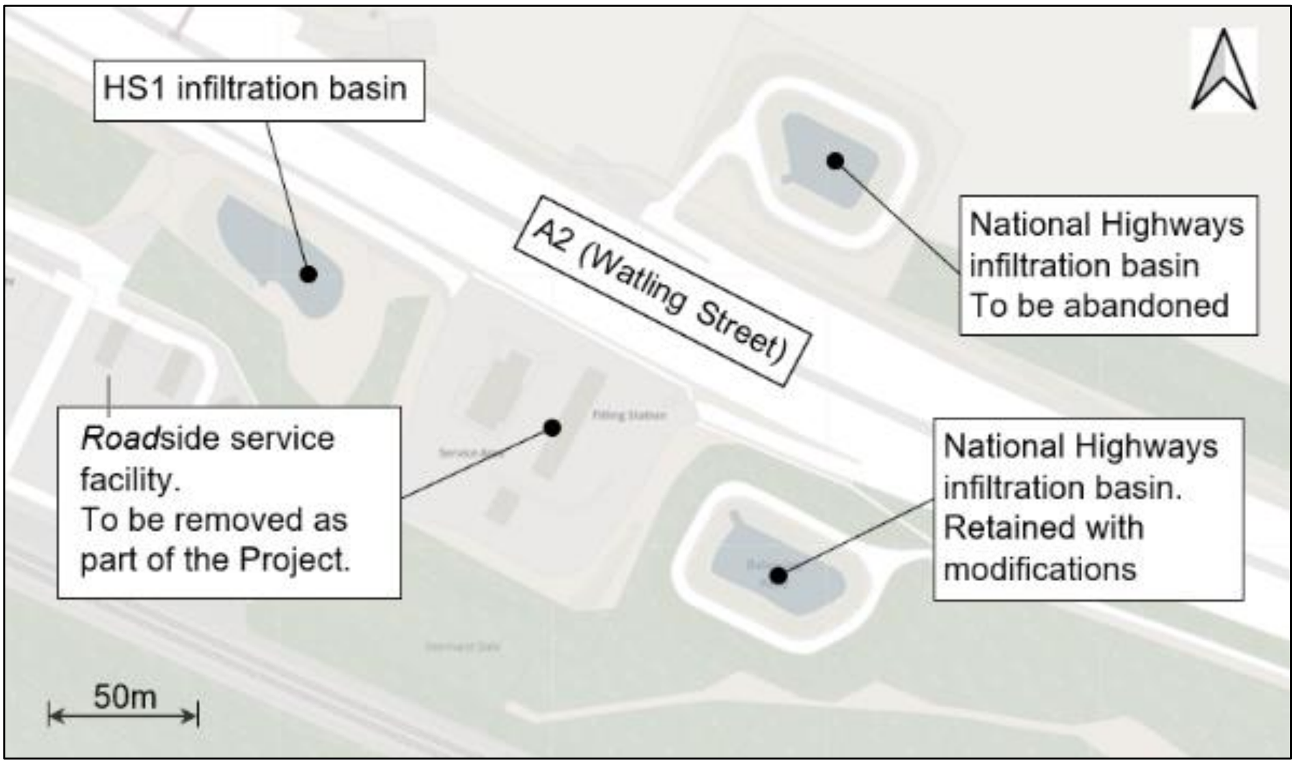
2.1.9 There are no records of pollution control devices and no details of likely design outflow rates.

2.1.10 The inaccessibility of this basin presents a safety hazard for maintenance personnel.

Existing drainage at the A2 roadside service facility

2.1.11 Three existing infiltration basins are sited around the roadside service facility on the A2. Two of these serve the A2 and the third serves HS1. These infiltration basins are shown in Plate 2.3.

Plate 2.3 Infiltration basins at M2/A2/Lower Thames Crossing junction



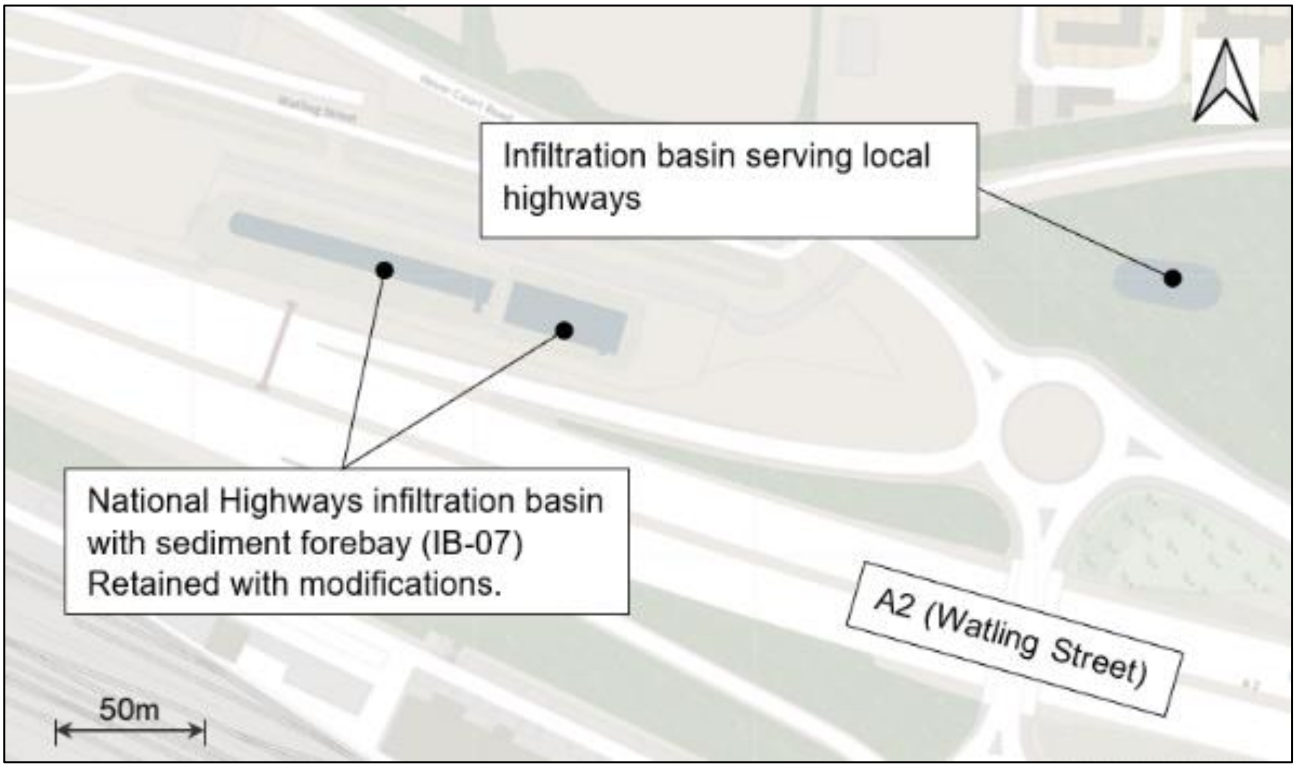
2.1.12 As-built data shows both National Highways basins have a bypass-type oil separator on their inlet pipework. A penstock chamber is also provided downstream of the separators to enable the drainage network to be shut off in the event of an accidental spillage.

2.1.13 The design outflow rate and infiltration capacity of these basins are not known.

Existing drainage at Marling Cross junction

2.1.14 A further existing infiltration basin serving the A2 lies at the western extent of the proposed A2 reconfiguration (see Plate 2.4); this basin incorporates a sediment forebay. A second basin, located to the east of the A2 basin, serves the local road network and is not associated with the A2 drainage network.

Plate 2.4 Infiltration basin at Marling Cross junction



Text box 2.1 Catchment EFR-1 – Existing drainage provisions

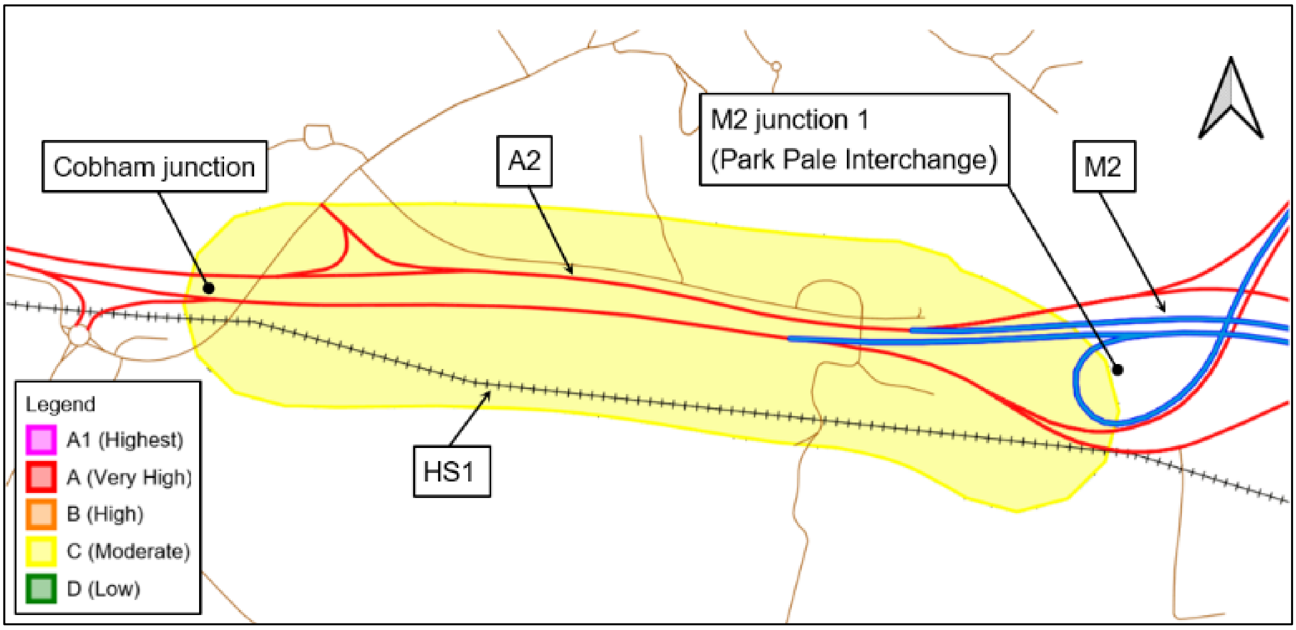
Surface water runoff along the A2/M2 corridor is captured by a combination of concrete surface water channels, kerbed edge channels and combined drainage and kerb systems. All surface water runoff is directed to infiltration basins for disposal.

2.2 Highways Agency Drainage Data Management System

2.2.1 Highways Agency Drainage Data Management System (HADDMS) indicates that there is one flood risk hotspot along the A2/M2 corridor[1]. The hotspot encompasses the western part M2 junction 1 (Park Pale interchange), and extends westward, along both carriageways, to Cobham junction. See Plate 2.5.

[1] A flooding hotspot is an extent of carriageway at risk of repeated flooding.

Plate 2.5 Hotspot overall status[2]



2.2.2 HADDMS reports that there have been numerous flooding events along the A2/M2 corridor[3]. HADDMS reports the severity of flooding events on a sliding scale of 1 (low) to 10 (high), with one special category 'High Impact Floods' for the highest severity. The majority of the events along the A2/M2 are very low severity events (severity: 0 to 2). In addition, two moderate-severity events (severity: 5 to 6) and one high-severity event (severity: 7 to 8) have been reported.

2.2.3 HADDMS also reports that there have been numerous flooding events along the A2/M2 slip roads and side roads. These were very low severity events (severity:0 to 2) or low severity events (severity: 3 to 4).

2.2.4 The new drainage provisions under the Project would encompass the location of all reported flood events so any legacy issues associated with these events would be eliminated. Furthermore, the new drainage provisions would extend across the full length of the flood hotspot.

2.3 Drainage design basis

Design basis statement

2.3.1 For surface water drainage purposes, Catchment EFR-1 would comprise the Project road and any other paved and/or unpaved area that falls towards it.

2.3.2 The drainage system for Catchment EFR-1 would be designed to rapidly remove surface water from the carriageway.

2.3.3 The drainage design would consider ease of access for planned maintenance interventions.

2.3.4 The drainage design for the Project road would comply with the relevant provisions of Design Manual for Roads and Bridges (DMRB). The drainage

[2] Main image from HADDMS (Highways England) (accessed September 2022)
[3] A flood event is defined as a single incidence of flooding on or within 200m of a carriageway.

design for local highways would comply with the requirements of the Lead Local Flood Authority (LLFA) (Kent County Council). Any drainage-related requirements of the Environment Agency would be complied with where applicable.

2.3.5 Pumping stations in surface water drainage networks would only be used where gravity drainage networks and/or soakaways (infiltration features) are not viable.

Key assumptions

2.3.6 It has been assumed that the rate of infiltration through the underlying chalk formation is adequate for efficient disposal of runoff. Further details about infiltration rates in Catchment EFR-1 can be found in Appendix 14.5: Hydrogeological Risk Assessment (Application Document 6.3) of the ES.

Key constraints

2.3.7 The surface water drainage design for Catchment EFR-1 would be developed with due regard to the following key environmental constraints:

a. Underlying geology and surface topography

b. Sites designated for nature, conservation and biodiversity

c. Flood risk

d. Groundwater source protection zones

Climate change

2.3.8 For the design of carriageway drainage, climate change allowances would be applied in accordance with the provisions of DMRB CG 501 (National Highways, 2022). This standard states that climate change would be accommodated by applying a 20% uplift in peak rainfall intensity. The standard also requires that a sensitivity test based on a 40% uplift in peak rainfall intensity is also undertaken.

2.3.9 For the remaining elements of the drainage design, climate change would normally be calculated in accordance with the Environment Agency's guidance on climate change for flood risk assessments (Environment Agency 2022). When the drainage design for the Project was undertaken the guidance stipulated that to accommodate climate change, a 20% uplift was to be applied to peak rainfall intensity and that a sensitivity test for a 40% uplift was undertaken. However, since the design was undertaken, the guidance has been updated with higher uplifts on peak rainfall intensity. As the revised guidance was published after the drainage design was undertaken, the Environment Agency verbally agreed at meeting held on 4th May 2022 that a 5% departure on peak rainfall intensities was acceptable[4]. With this departure taken into account, the 20% and 40% uplift on peak rainfall intensity are deemed to be accepted for drainage design.

2.3.10 Further details on climate change allowances for drainage design are presented in Annex A.

[4] The departure on peak rainfall intensity is recorded in Application Document 5.4.1.1, Statement of Common Ground between National Highways and the Environment Agency.

Text box 2.2 Catchment EFR-1 – Drainage design basis

The proposed drainage system in Catchment EFR-1 allows for:

- Rapid removal of water from the carriageway.
- Ease of access for maintenance personnel.
- The effects of climate change.
- Due regard to environmental constraints.
- The requirements of the DMRB, the Environment Agency and the LLFA.

Climate change allowances for carriageways design would comprise a 20% uplift in peak rainfall intensity and a sensitivity check for a 40% uplift.

Climate change allowances for other parts of the drainage system would also comprise a 20% uplift in peak rainfall intensity and a sensitivity check for a 40% uplift.

2.4 Drainage design strategy

Overarching strategy

2.4.1 The proposed drainage strategy would be based on the use of gravity drainage networks that outfall to infiltration basins. This strategy is secured by the Design Principle LPS.29 (Application Document 7.5).

2.4.2 The only exception to the above would be the network for the catchment that includes the South Portal ramp. As a gravity discharge from the base of the ramp to an appropriate receptor is not viable, this network would incorporate a pumping station and rising main.

2.4.3 Conveyance of runoff would be by means of drainage ditches and pipes. Drainage ditches would be used wherever practicable. This strategy is secured by Design Principle LPS.28 (Application Document 7.5).

Sustainable Drainage Systems

2.4.4 The use of sustainable drainage systems (SuDS) would be adopted wherever appropriate. This requirement is secured by Design Principle LPS.17 (Application Document 7.5).

2.4.5 The underlying chalk formation in Catchment EFR-1 is suitable for SuDS features incorporating infiltration techniques; the use of such features would therefore be prioritised in Catchment EFR-1.

Surface water collection and conveyance

2.4.6 Collection of runoff from new highways would be by means of one of the edge of pavement details specified in DMRB 524 (Highways England, 2021a). Typically, runoff would be collected by concrete surface water channels when the highway is on an embankment and by combined surface and sub-surface drains when the highway is in cutting.

2.4.7 Collected water would be conveyed to infiltration basins via gravity drainage networks. Drainage networks would be routed along highway verges wherever possible and practicable.

Disposal of highway runoff

2.4.8 It is proposed that soakaways (infiltration basins) would be used for disposal of all highway runoff in Catchment EFR-1.

2.4.9 Under the hierarchy of runoff disposal options, discharge to ground by means of infiltration is preferable to discharge to a watercourse. However, due to the volume of runoff generated by the Project, the use of watercourses for disposal of runoff was investigated. The only watercourses in the vicinity of Catchment EFR-1 is the network of watercourses to the north of the South Portal. However, this network was deemed to be unsuitable for long-term discharge of highway runoff as it lies in the South Thames Estuary and Marshes Site of Special Scientific Interest and the Thames Estuary and Marshes Ramsar site.

Infiltration basins

2.4.10 New infiltration basins would be designed as vegetated drainage systems in accordance with the provisions of DMRB CD 532 (Highways England, 2021b). [RDWE034]

2.4.11 Existing infiltration basins would be remodelled in accordance with the provisions of DMRB CD 532 (Highways England, 2021b) and modified as required to meet the needs of the Project. [RDWE034]

2.4.12 Subject to any space constraints, infiltration basins would incorporate a sediment forebay with sufficient capacity to accommodate the first flush.[5] The forebay would be lined with an impermeable membrane to reduce the risk of compromising groundwater quality by confining potentially contaminated runoff. [RDWE034]

2.4.13 Where practicable, local topography would be used to integrate infiltration basins with the surrounding landscape. This requirement is secured by Design Principle LPS.17 (Application Document 7.5).

2.4.14 Where space constraints preclude the use of a sediment forebay, a pollution control device would be included immediately upstream of any basin inlet. Typically, vortex separators would be used for pollution control. [RDWE034]

2.4.15 The infiltration capacity of the basins would be enhanced by incorporating infiltration trenches across their inverts.

2.4.16 Infiltration basins serving the junction between the Project road and the A2 would be located within central islands where practicable. This requirement is secured by Design Principle S2.08 (Application Document 7.5).

2.4.17 The location of proposed infiltration basins is shown on Drawing 00197.

[5] The first flush is the runoff from the first part of a rainfall event. This usually is the most polluted runoff, especially when there is intense rainfall after long dry periods during which pollutants can accumulate on the road.

Text box 2.3 Catchment EFR-1 – Drainage design strategy

The proposed drainage strategy for Catchment EFR-1 would generally be based on the use of gravity drainage networks that outfall to infiltration basins. SuDS in Catchment EFR-1 would include extensive use of infiltration basins for the disposal of highway runoff. Typically, runoff from new highways would be collected by concrete surface water channels when the highway is on an embankment and by combined surface and sub-surface drains when the highway is in cutting. All new infiltration basins would be designed as vegetated drainage systems in accordance with the provisions of DMRB CD 532. Where retained, existing infiltration basins will be modified to suit the needs of the Project and would be remodelled as vegetated drainage systems in accordance with the provisions of DMRB CD 532. Basins would include a lined sediment forebay where possible; where not possible (e.g. due to space constraints), a vortex separator (or other appropriate pollution control device) would be incorporated upstream of the basin. Penstocks (or other appropriate flow control device) would be incorporated immediately upstream of all infiltration basin inlets so that flow to the basin could be shut off in the event of an accidental spillage.

2.5 Drainage design

General

2.5.1 The highway drainage in Catchment EFR-1 would be divided into nine drainage catchments, each of which would discharge to an infiltration basin.

2.5.2 The principal elements of proposed drainage provisions in Catchment EFR-1 would be as detailed below and outlined on Drawing 00197.

Catchment discharging to infiltration basin IB-01

2.5.3 The catchment draining to IB-01 would include elements of Park Pale interchange and parts of the A2.

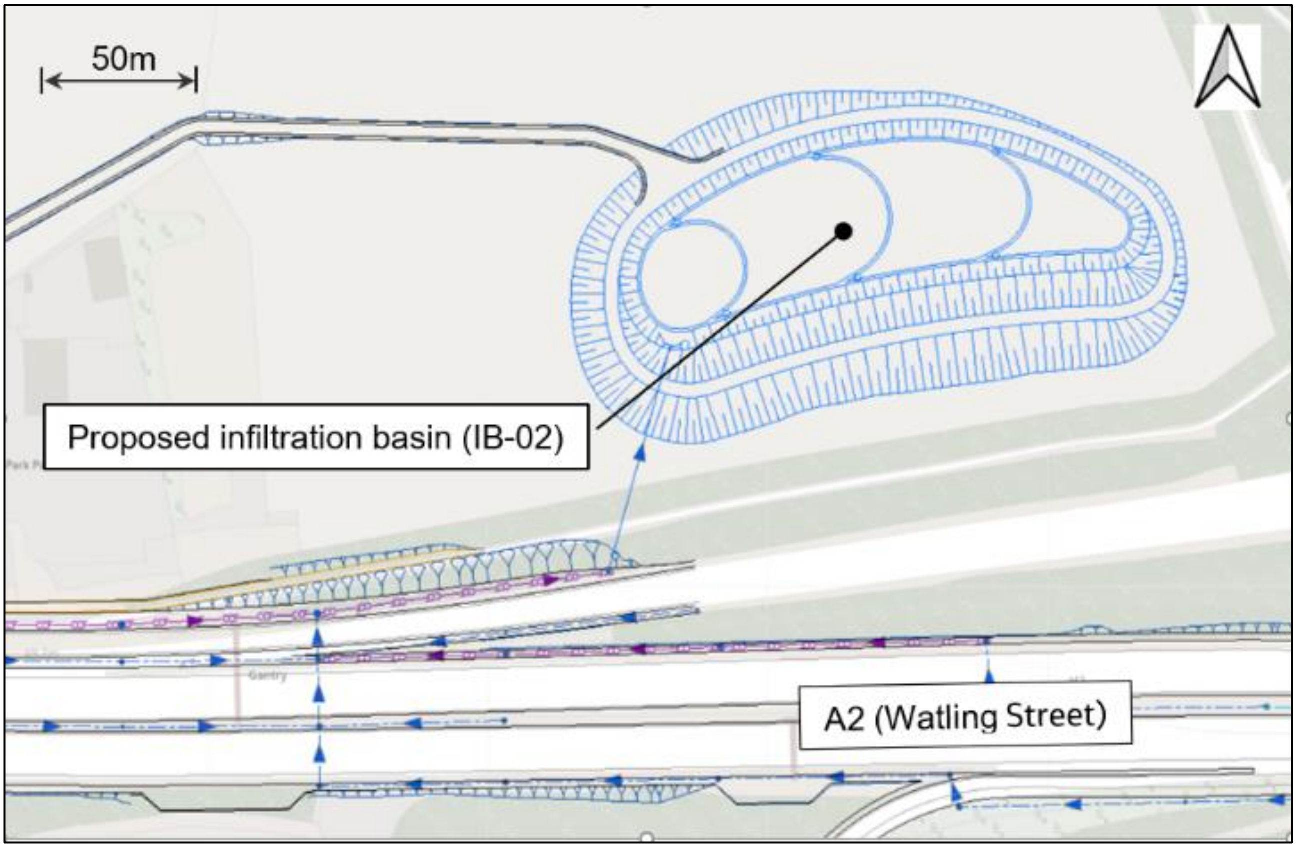
2.5.4 IB-01 is an existing infiltration basin which is located in the south west quadrant of Park Pale interchange (see Plate 2.1). The footprint of the basin would remain unchanged, but it would it be subject to major refurbishment with new pollution control and flow control measures added.

Catchment discharging to infiltration basin IB-02

2.5.5 The catchment discharging to IB-02 would comprise the section of highway between Park Pale interchange and the junction between the Project road and the A2. This would include elements of the A2, M2 and Park Pale interchange and Cobham junction. The basin in the central reserve that currently serves Cobham junction would be lost under a reconfigured part of the A2.

2.5.6 IB-02 would be a new infiltration basin located to the north of the A2, near Park Pale interchange (see Plate 2.6).

Plate 2.6 Infiltration basin IB-02



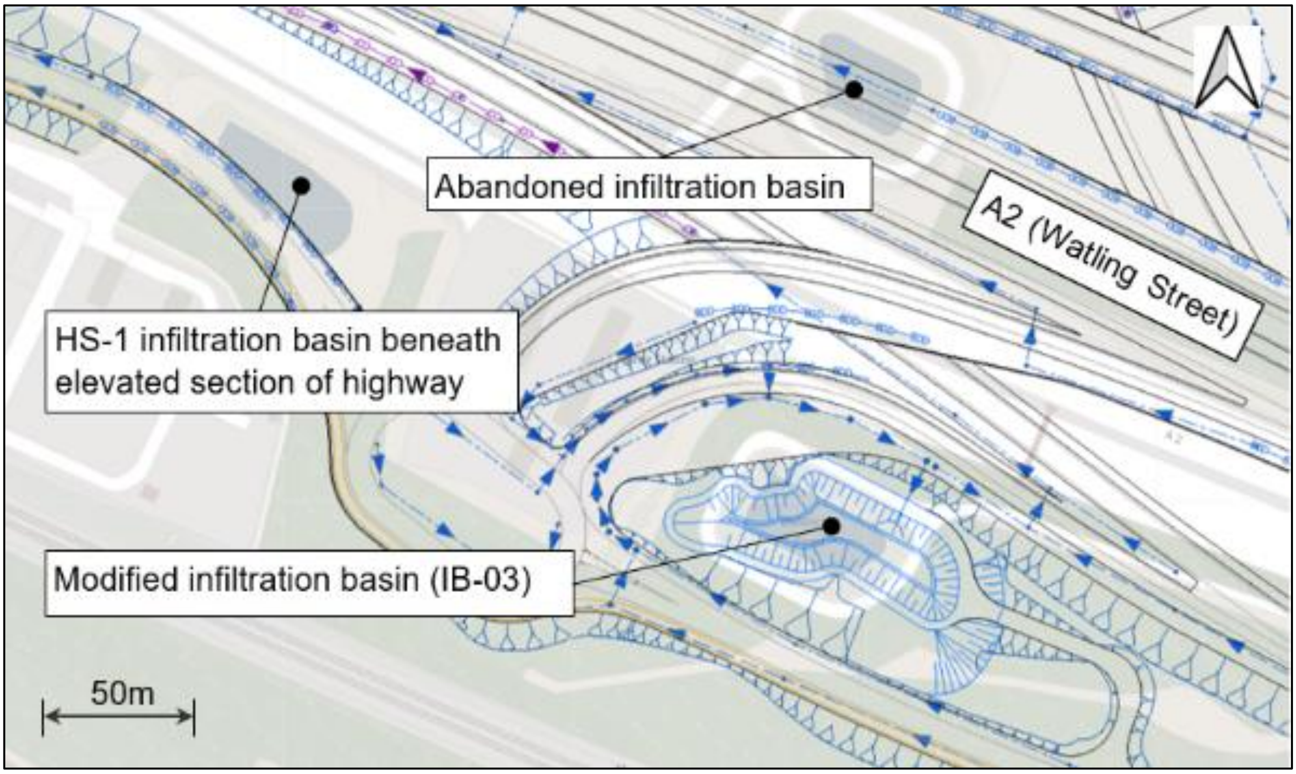
Catchment discharging to infiltration basin IB-03

2.5.7 The catchment discharging to IB-03 would serve local connector roads between the A2 and HS1.

2.5.8 IB-03 is an existing infiltration basin that would be modified to meet the needs of the Project. It is located to the south of the A2, near the proposed junction between the A2 and the Project road (see Plate 2.7).

2.5.9 The remodelled infiltration basin shown in Plate 2.7 has been superimposed over the outline of the existing basin.

Plate 2.7 Infiltration basin IB-03

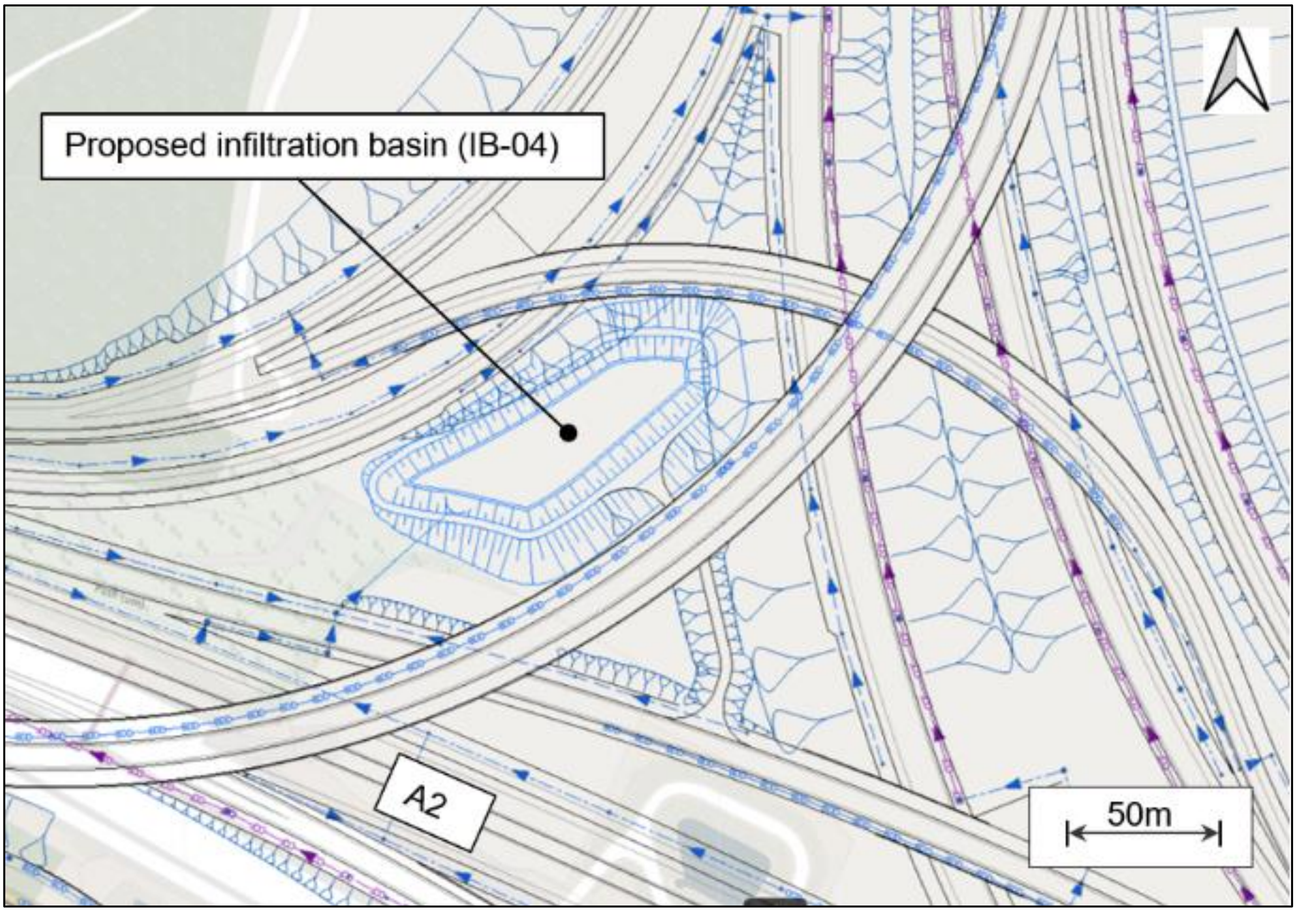


Catchment discharging to infiltration basin IB-04

2.5.10 The catchment discharging to IB-04 would include the A2 where it passes through the junction with the Project road and parts of the A2 to the west of the junction.

2.5.11 IB-04 would be a new infiltration basin located within the junction between the A2 and the Project road (see Plate 2.8).

Plate 2.8 Infiltration basin IB-04

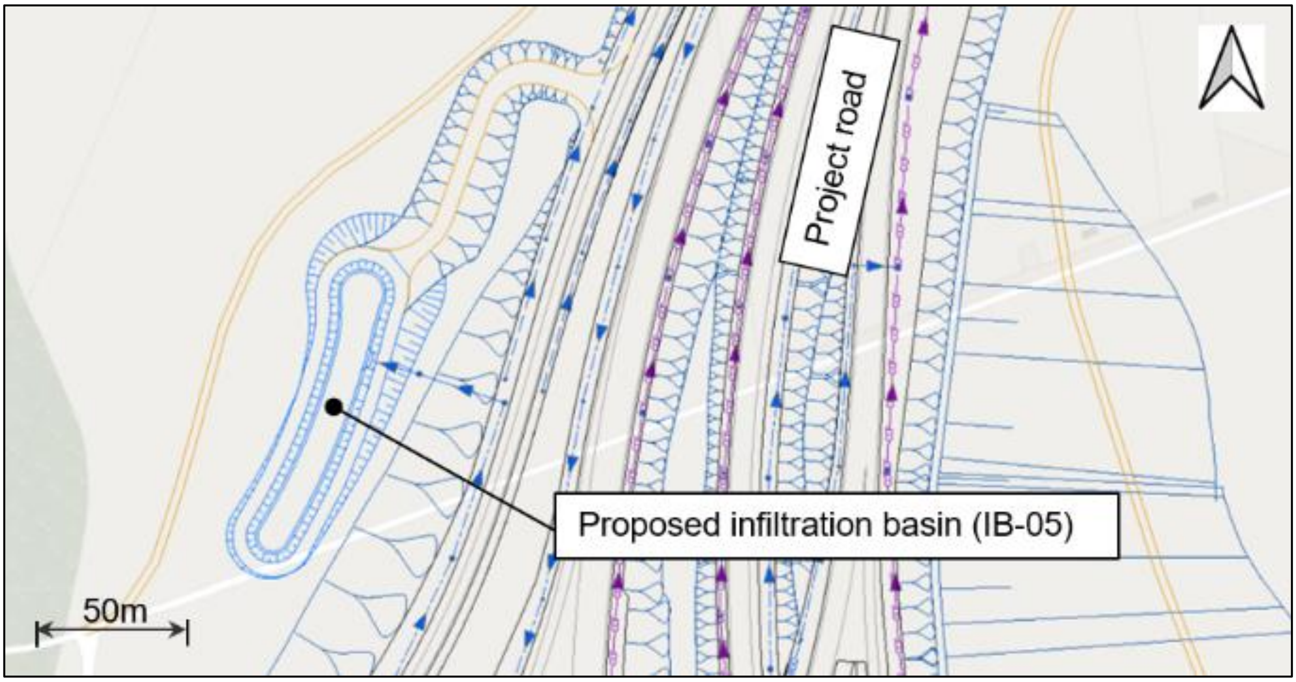


Catchment discharging to infiltration basin IB-05

2.5.12 The catchment discharging to IB-05 would comprise parts of the A2 to the west of the junction with the Project road, the slip road from the eastbound carriageway of the A2 to the northbound carriageway of the Project road, and an elevated interchange road.

2.5.13 IB-05 would be a new infiltration basin, located to the north west of the junction between the A2 and the Project road (see Plate 2.9).

Plate 2.9 Infiltration basin IB-5

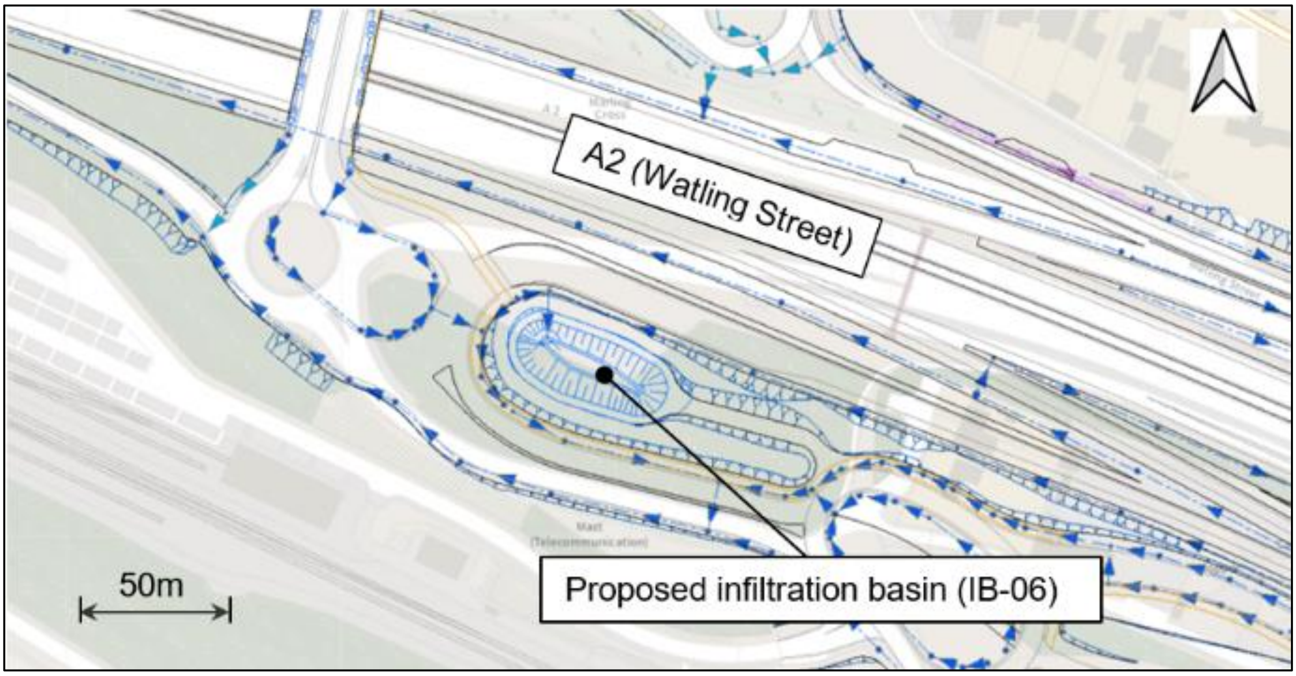


Catchment discharging to infiltration basin IB-06

2.5.14 The catchment discharging to IB-06 would comprise the westbound A2 off-slip at Marling Cross junction and local connector roads.

2.5.15 IB-06 would be a new infiltration basin, located to the west of the junction between the A2 and the Project road (see Plate 2.10).

Plate 2.10 Infiltration basin IB-06



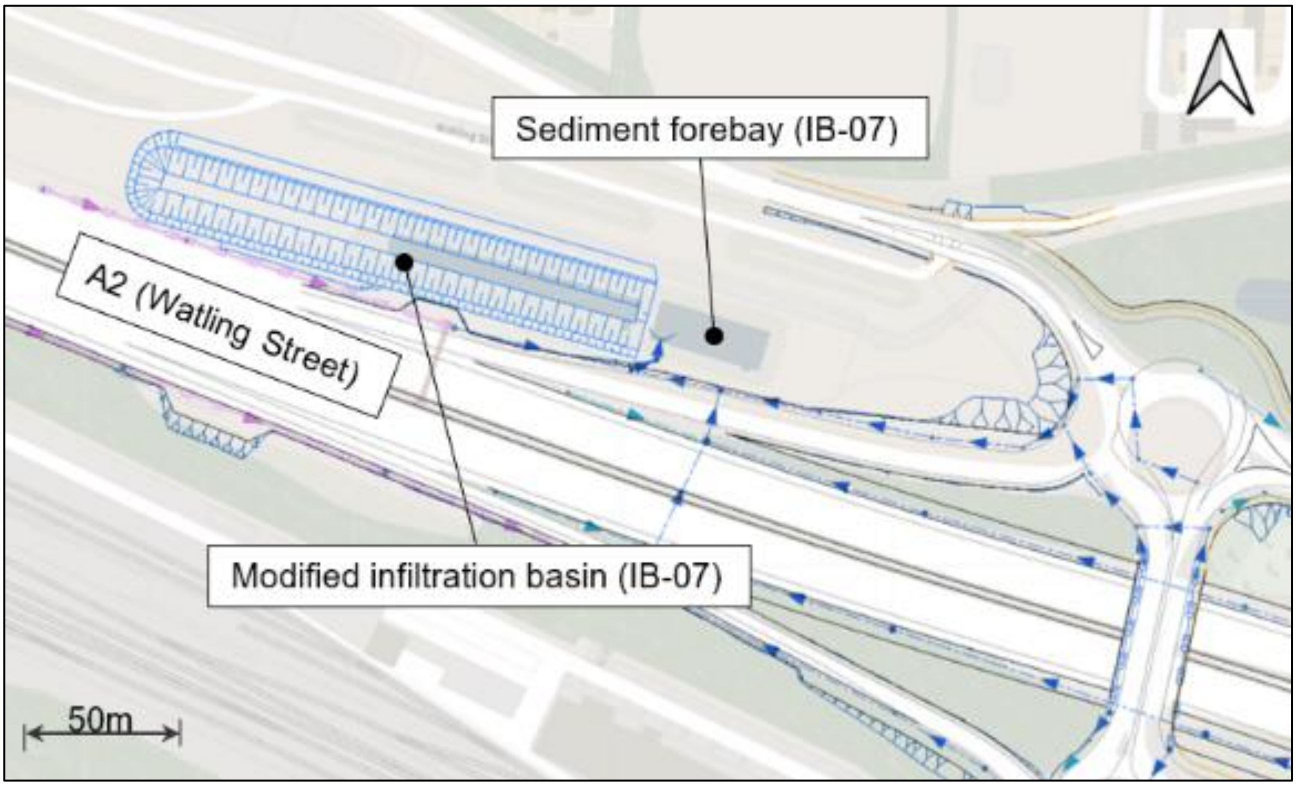
Catchment discharging to infiltration basin IB-07

2.5.16 The catchment discharging to IB-07 comprises parts of the A2, the A2 westbound off-slip and eastbound on-slip at Marling Cross junction, and local connector roads.

2.5.17 IB-07 is an existing infiltration basin with a sediment forebay. It is located to the north of the A2, at the western extent of the Project (see Plate 2.11). The basin and forebay would be modified to meet the needs of the Project.

2.5.18 The remodelled infiltration basin shown in Plate 2.11 has been superimposed over the outline of the existing basin.

Plate 2.11 Infiltration basin IB-07



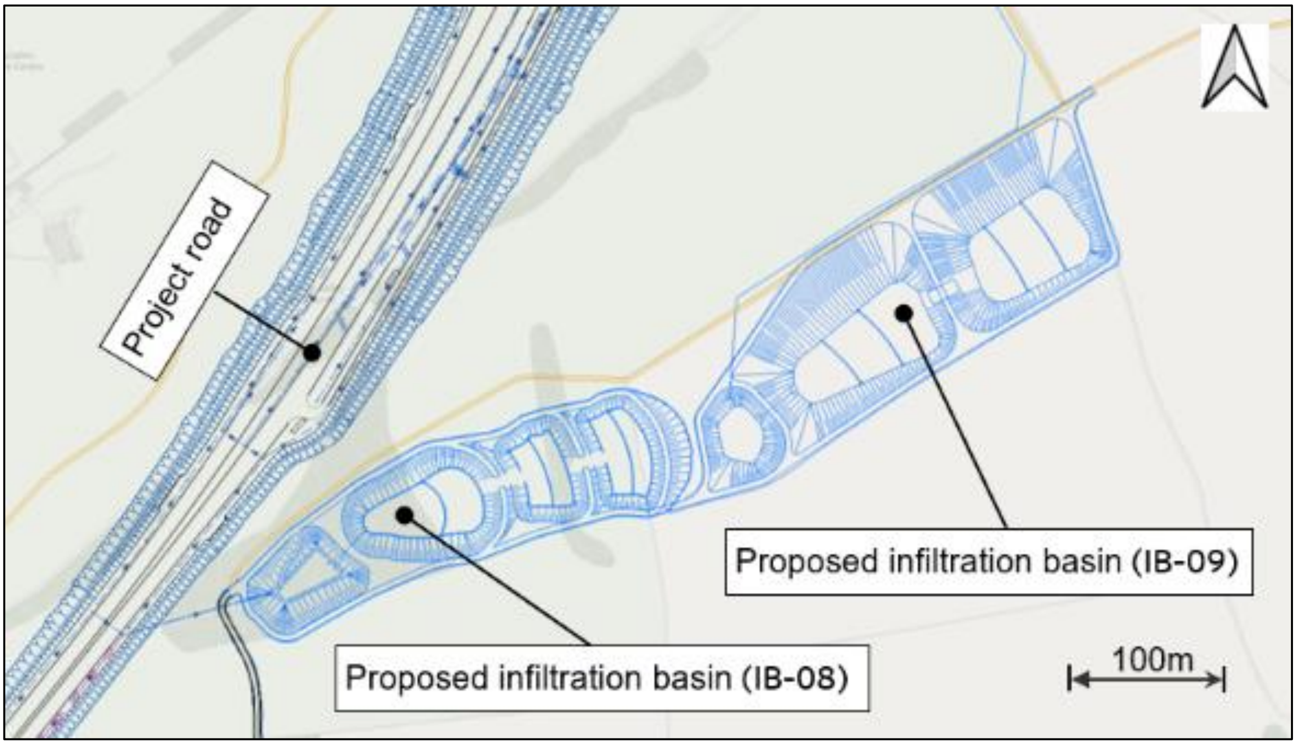
Catchment discharging to infiltration basin IB-08

2.5.19 The catchment discharging to IB-08 would comprise parts of the junction between the A2 and the Project road and the section of the Project road between the junction and the head of the South Portal ramp.

2.5.20 IB-08 is a new basin that would comprise a lined sediment forebay and three small, connected cascading infiltration basins. It would be located to the east of the Project road at the head of the South Portal ramp (see Plate 2.12).

2.5.21 The first infiltration basin would be utilised after each rainfall event with the second and third only being used during more severe storm events. Over time, this mode of operation is likely to lead to a fall in infiltration efficiency of the first two basins. To account for this, the design would apply a different infiltration rate to each basin. The first two basins would be designed using low (inhibited) infiltration rates that would reflect the loss in efficiency over time. The third basin would be designed using a higher (uninhibited) infiltration rate that would reflect ongoing efficiency.

Plate 2.12 Infiltration basins IB-08 and IB-09



Catchment discharging to infiltration basin IB-09

2.5.22 The catchment discharging to IB-09 would comprise a steep ramp in a deep cutting running down towards the South Portal.

2.5.23 IB-09 is a new basin that would comprise a lined sediment forebay and two small, connected cascading infiltration basins. It would be located to the south-east of the South Portal (see Plate 2.12).

2.5.24 A large pumping station would be incorporated into the South Portal structure to pump highway runoff to the basin.

2.5.25 The first basin would be used after each rainfall event with the second only being used during more severe storm events. Over time, this mode of operation would lead to a fall in infiltration rate of the first basin. To account for this, the design would apply a different infiltration rate to each basin. The first basin would be designed using a low (inhibited) infiltration rate that would reflect the loss in efficiency over time. The second basin would be designed using a higher (uninhibited) infiltration rate that would reflect ongoing efficiency.

Summary

2.5.26 A summary of the infiltration basins proposed for Catchment EFR-1 is presented in Table 2.1.

Table 2.1 Catchment EFR-1 – Summary of infiltration basins

Basin ref.	Model ref. (1)	Status	Pollution control(2)	Flow control(3)
IB-01	EXPOS01-001	Existing (modified)	LSF	✓
IB-02	POS01-001	Proposed	LSF	✓
IB-03	EXPOS02-005	Existing (modified)	PCD	✓
IB-04	POS02-004	Proposed	LCD	✓
IB-05	POS02-002	Proposed	LSF	✓
IB-06	POS02-001	Proposed	PCD	✓
IB-07	EXPOS02-001	Existing (modified)	LSF	✓
IB-08	POS02-003	Proposed (cascaded basin)	LSF	✓
IB-09	POS04-001	Proposed (cascaded basin)	LSF	✓

Legend
LSF Lined sediment forebay
PCD Pollution control device (vortex separator or other appropriate pollution control device) (See also paragraph 2.7.2)

Notes:
The model references are given to the basins in the hydraulic models prepared for the drainage design, and are included here for information and for cross-referencing with documents that only use model references to denote the basins.
Where included, sediment forebays would be lined.
Penstocks (or other appropriate flow control device) would be used for isolating basins in the event of a spillage.

Text box 2.4 Catchment EFR-1 – Drainage design

The highway drainage in Catchment EFR-1 would be divided into nine drainage catchments, each of which would discharge to an infiltration basin. One of the drainage catchments would require a pumping station and rising main.

The catchments would comprise both new and existing carriageway surfaces.

Three existing infiltration basins would be retained with modifications, and six new infiltration basins would be constructed.

2.6 Flood risk and drainage

Introduction

2.6.1 Flood risks directly associated with the drainage strategy for Catchment EFR-1 are outlined below. Details of other flood risks are presented in Part 6 of the FRA.

Maintenance

2.6.2 Maintenance of the drainage system is required to ensure its effective operation. Failure to maintain the drainage system increases the risk that the system could be overwhelmed, and this could result in flooding of the carriageway.

2.6.3 Drainage infrastructure and treatment systems would be maintained and inspected in accordance with DMRB GM 701 (Highways England, 2020a) and DMRB GS 801 (Highways England, 2020b) to ensure that the highway drainage system is fully operational. [RDWE012]

Perched groundwater

2.6.4 Although there is currently no recorded evidence of groundwater flooding in Catchment EFR-1, where permeable or partly permeable strata overlie less permeable strata there is potential for perched groundwater to occur.

2.6.5 If perched water is intercepted (e.g. by cuttings or by local topographic changes), there is potential for groundwater to emerge locally.

2.6.6 On account of their highly localised nature, identification of all occurrences of perched groundwater is difficult.

2.6.7 If perched groundwater is encountered in cuttings, it would most likely occur as localised seepages only.

2.6.8 This risk could be mitigated by provision of drainage networks incorporating an appropriate edge of pavement detail, such as combined surface and sub-surface drains (DMRB CD 524, Highways England, 2021a).

Groundwater mounding

2.6.9 The use of infiltration systems would enhance groundwater recharge locally, due to providing a more direct flow pathway, with a commensurate increase in local groundwater level. This can lead to potential groundwater mounding and an increased risk of local groundwater flooding both in the immediate vicinity of the infiltration system and further downgradient. A detailed assessment of groundwater mounding is presented in Appendix 14.5: Hydrogeological Risk Assessment (Application Document 6.3). This assessment demonstrates that the proposed infiltration basins would not result in mounding that would reach ground surface.

Text box 2.5 Catchment EFR-1 – Flood risk and drainage

A planned maintenance programme would be established to ensure that the drainage system operates effectively.

Perched water may be encountered in cuttings. If perched groundwater is encountered, it would most likely occur as localised seepages only.
This risk could be mitigated by provision of drainage networks incorporating an appropriate edge of pavement detail, such as combined surface and sub-surface drains.

Modelling studies have demonstrated that groundwater mounding, due to locally enhanced groundwater recharge from the proposed infiltration basins, would not lead to groundwater flooding.

2.7 Pollution control and water quality

Pollution control

2.7.1 Vegetated infiltration basins provide an effective pollution control measure for highway runoff, for example, providing settlement for sediments and treatment of dissolved metals.

2.7.2 In addition to the pollution control measures outlined in paragraphs 2.4.12 and 2.4.13, networks with infiltration basins would include a method to isolate a harmful spillage before it reaches a basin, regardless of whether designated containment provision is made. Isolation (flow control) would be included upstream of each pond inlet, typically in the form of a penstock. [RDWE034]

Water quality

2.7.3 A hydrogeological risk assessment informed by water quality modelling has been undertaken to investigate the likely impacts that highway runoff from the Project would have on the water quality of the network of watercourses to the north of the South Portal and other relevant receptors.

2.7.4 The hydrogeological risk assessment and its findings are described in Appendix 14.5 (Application Document 6.3) of the ES.

Text box 2.6 Water quality

Runoff from the Project road would be treated to a level that is acceptable for disposal to ground.

An assessment of the likely impacts that highway runoff from the Project would have on the water quality of the network of watercourses to the north of Catchment EFR-1 is detailed in Appendix 14.5 of the ES (Application Document 6.3).

3 North Portal to Ockendon Link (EFR-2 to EFR-4)

3.1 Introduction

3.1.1 As Catchments EFR-2, EFR-3 and EFR-4 share a common drainage strategy, they have been grouped together for reporting purposes.

3.2 Existing surface water drainage

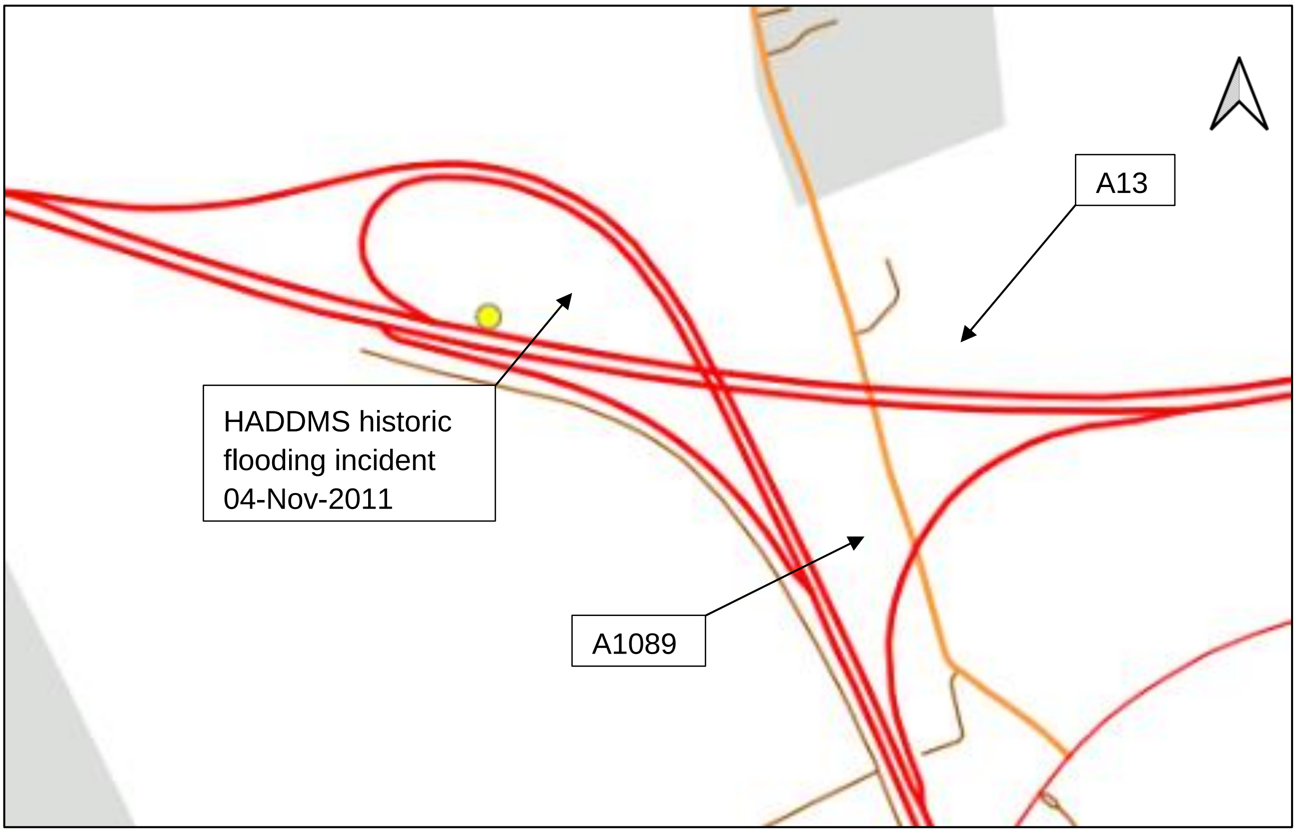
3.2.1 The part of the Project in Catchments EFR-2 and EFR-4 is all new development. There are no junctions with existing roads, and by extension, no existing drainage networks to connect to and/or impact.

3.2.2 In Catchment EFR-3, there are existing drainage provisions across the junction between the A13 and A1089. This junction would be remodelled to incorporate the Project road.

3.2.3 HADDMS records indicate that the existing drainage provisions on the A13 at the point where it would cross over the Project road comprise edge channels with gullies and collector drains.

3.2.4 HADDMS records indicate one historic flooding incident near the new A13 junction (see Plate 3.1). The HADDMS Flood Incident Details indicate that this was not a high impact incident.

Plate 3.1 A13/A1089 junction



3.2.5 HADDMS does not show the outfall of the A13/A1089 junction drainage network but records from Thurrock Council indicate that the runoff is discharged to a watercourse approximately 1.5km to the east of the current junction (close to the junction between the A13 and A1014).

Text box 3.1 Catchment EFR-2, EFR-3 and EFR-4 – Existing drainage

There are no existing drainage networks in Catchments EFR-2 and EFR-4.

Existing highway drainage in Catchment EFR-3 comprises the drainage for the junction between the A13 and the A1089.

3.3 Drainage design basis

Design basis statement

3.3.1 The surface water drainage catchments in EFR-2, EFR-3 and EFR-4 would comprise the Project road and any other paved and/or unpaved area that falls towards it.

3.3.2 The drainage system for Catchments EFR-2, EFR-3 and EFR-4 would be designed to rapidly remove surface water from the carriageway.

3.3.3 The proposed drainage design would consider ease of access for planned maintenance interventions.

3.3.4 The drainage design for the Project road would comply with the relevant provisions of DMRB. The drainage design for local highways would comply with the requirements of the LLFA (Thurrock Council). Any drainage-related requirements of the Environment Agency would be complied with where applicable.

3.3.5 Pumping stations in surface water drainage networks would only be used where gravity drainage networks and/or soakaways (infiltration features) are not viable.

Key assumptions

3.3.6 There are several historic landfill sites close to Catchments EFR-2 and EFR-4. It is assumed that no specific treatment facilities are required to treat contaminated groundwater picked up by the highway drainage network (e.g. via combined surface and sub-surface drains).

3.3.7 It is assumed the revised drainage networks would continue to discharge to existing outfalls where appropriate.

3.3.8 It is assumed that infiltration features can be used to serve small sections of highway that cannot readily connect to a watercourse, pond, basin and/or drainage network. Further details about the performance of drainage facilities that would incorporate infiltration techniques can be found in Appendix 14.5: Hydrogeological Risk Assessment (Application Document 6.3) of the ES.

Key constraints

3.3.9 The drainage system would be developed with due regard to the following key constraints:

a. Underlying geology and surface topography

b. Watercourses

c. Flood risk

d. Aquifers and groundwater

e. Designated nature conservation sites

Climate change

3.3.10 Climate change allowances for drainage design in Catchment EFR-2, EFR-3 and EFR-4 would be as described in paragraphs 2.3.8 to 2.3.10.

Text box 3.2 Catchment EFR-2, EFR-3 and EFR-4 – Drainage design basis

The proposed drainage system in Catchments EFR-2, EFR-3 and EFR-4 would allow for the following:

- Rapid removal of water from the carriageway
- Ease of access for maintenance personnel
- The effects of climate change
- Due regard to environmental constraints
- The requirements of the DMRB, the Environment Agency and LLFA

The proposed drainage system in Catchments EFR-2, EFR-3 and EFR-4 would assume the following:

- There is no cross-contamination of highway runoff by leachate from the historic landfills.
- Infiltration features (swales and basins) can be used to serve small sections of highway located within the A13 junction that cannot readily be connected to a watercourse or another drainage network.

Climate change allowances for carriageways design would comprise a 20% uplift in peak rainfall intensity and a sensitivity check for a 40% uplift.

Climate change allowances for other parts of the drainage system would also comprise a 20% uplift in peak rainfall intensity and a sensitivity check for a 40% uplift.

3.4 Drainage design strategy

Overarching strategy

3.4.1 The proposed drainage strategy would primarily be based on the use of gravity drainage networks that outfall to retention ponds prior to discharge to watercourses. This strategy is secured by the Design Principle LPS.30 (Application Document 7.5).

3.4.2 Exceptions to the above include a network that drains to a detention basin (Catchment EFR-2), a network that drains to an infiltration basin (Catchment EFR-3) and a network that incorporates a pumping station and rising main (Catchment EFR-2). This strategy is secured by the Design Principle LPS.30 (Application Document 7.5).

3.4.3 Conveyance of runoff would be by means of drainage ditches, pipes and culverts. Drainage ditches would be used wherever practicable. This strategy is secured by Design Principle LPS.28 (Application Document 7.5).

3.4.4 Drainage systems incorporating retention ponds or detention basins would include treatment measures for highway runoff designed to meet the requirements specified for each outfall to surface watercourses identified in ES Appendix 14.3, Operational Surface Water Drainage Pollution Risk Assessment. [RDWE025]

SuDS

3.4.5 The use of sustainable drainage systems (SuDS) would be adopted wherever appropriate. This requirement is secured by Design Principle LPF.17 (Application Document 7.5).

3.4.6 Where ground conditions are favourable, SuDS components employing infiltration techniques would be considered. Such techniques provide water quality benefits and avoid additional flow to watercourses.

3.4.7 The underlying chalk formation in Catchment EFR-3 is suitable for SuDS components using infiltration techniques. They would generally be used for small, isolated catchments that cannot be readily connected to one of the main drainage networks. SuDS components suitable for use in Catchment EFR-3 include the following:

a. Infiltration basins

b. Swales (these would be used as detention features rather than conveyance features)

3.4.8 The use of SuDS components using infiltration techniques would not be considered in Catchments EFR-2 and EFR-4 due to one, or a combination, of the following:

a. Unfavourable ground conditions

b. Presence of landfills along the route

c. Potential for high groundwater

3.4.9 SuDS components in Catchments EFR-2 and EFR-4 would include retention ponds, an infiltration basin and a detention basin. The retention ponds and detention basin would incorporate pollution control measures to protect downstream water bodies, and flow control measures to attenuate discharge of runoff to watercourses.

3.4.10 Notwithstanding Section 3.4.8, Catchment EFR-4 would incorporate swales to accommodate runoff from small drainage catchments that cannot readily be drained to a watercourse or connected to another drainage network. These swales would operate as infiltration features rather than for conveyance of runoff.

Surface water collection and conveyance

3.4.11 Collection of runoff from new highways would be by means of one of the edge of pavement details specified in DMRB CG 524 (Highways England, 2021a). Typically, runoff would be collected by concrete surface water channels when the highway is on an embankment and by combined surface and sub-surface drains when the highway is in cutting.

3.4.12 Drainage networks would be routed along highway verges wherever possible and practicable.

Retention ponds

3.4.13 Retention ponds would be designed as vegetated drainage systems in accordance with the provisions of DMRB CD 532 (Highways England, 2021b). [RDWE035]

3.4.14 Retention ponds would incorporate a lined sediment forebay with sufficient capacity to accommodate the first flush. [RDWE035]

3.4.15 In accordance with DMRB CD 532, pond capacities and discharge rates would be agreed in consultation with the local land drainage authority[6]. Attenuation would be by means of a small diameter pipe, vortex controls, orifice plates or a combination thereof. [RDWE035]

3.4.16 Where practicable, local topography would be used to integrate retention ponds with the surrounding landscape. This condition is secured by Design Principle LPS.17 (Application Document 7.5).

3.4.17 The location of retention ponds and their respective outfalls is shown on Drawing 000198.

Infiltration basins

3.4.18 There would be one infiltration basin in Catchment EFR-3. The drainage design strategy for this basin would follow the strategy for infiltration basins in Section 2.3.

Detention basins

3.4.19 Detention basins would be designed in accordance with the provisions of DMRB CD 532 (Highways England, 2021b). [RDWE048]

3.4.20 A pollution control device (e.g. vortex grit separator) would be incorporated immediately upstream of all basin inlets.

3.4.21 Basin capacities and discharge rates would be agreed in consultation with the local land drainage authority. Attenuation would be by means of a small diameter pipe, vortex controls, orifice plates or a combination thereof. [RDWE048]

3.4.22 The location of the detention basin and its outfall is shown on Drawing 000198.

[6] The land drainage authority is organisation with a role in respect of land drainage and flooding. For the Project, this role would be undertaken by the LLFA.

Text box 3.3 Catchments EFR-2, EFR-3 & EFR-4 – Drainage design strategy

The highway drainage networks for Catchments EFR-2, EFR-3 and EFR-4 would generally comprise networks that gravitate to retention ponds, an infiltration basin or a detention basin.

SuDS in Catchment EFR-3 would include features using infiltration techniques (infiltration basins and swales).

SuDS in Catchments EFR-2 and EFR-4 would comprise the use of retention ponds with pollution control and flow control measures, an infiltration basin and a detention basin. Swales would be used in small drainage catchments where runoff cannot be drained to a watercourse or connected to another drainage network.

Typically, runoff from new highways would be collected by concrete surface water channels when the highway is on an embankment and by combined surface and sub-surface drains when the highway is in cutting.

Retention ponds, detention basins and infiltration basins would be designed as vegetated drainage systems in accordance with the provisions of DMRB CD 532. Larger retention ponds would incorporate a lined sediment forebay.

The local land drainage authority would be consulted about capacities and discharge rates for retention ponds and detention basins.

3.5 Drainage design

General

3.5.1 There would be five drainage catchments in EFR-2, two drainage catchments in EFR-4 and two drainage catchments that span EFR-3 and EFR-4.

3.5.2 The principal elements of proposed drainage provisions in Catchments EFR-2, EFR-3 and EFR-4 would be as outlined in Drawing 00198.

3.5.3 The surface water drainage design for each drainage catchment would be as outlined below.

Catchment discharging to retention pond RP-01 and RP-02

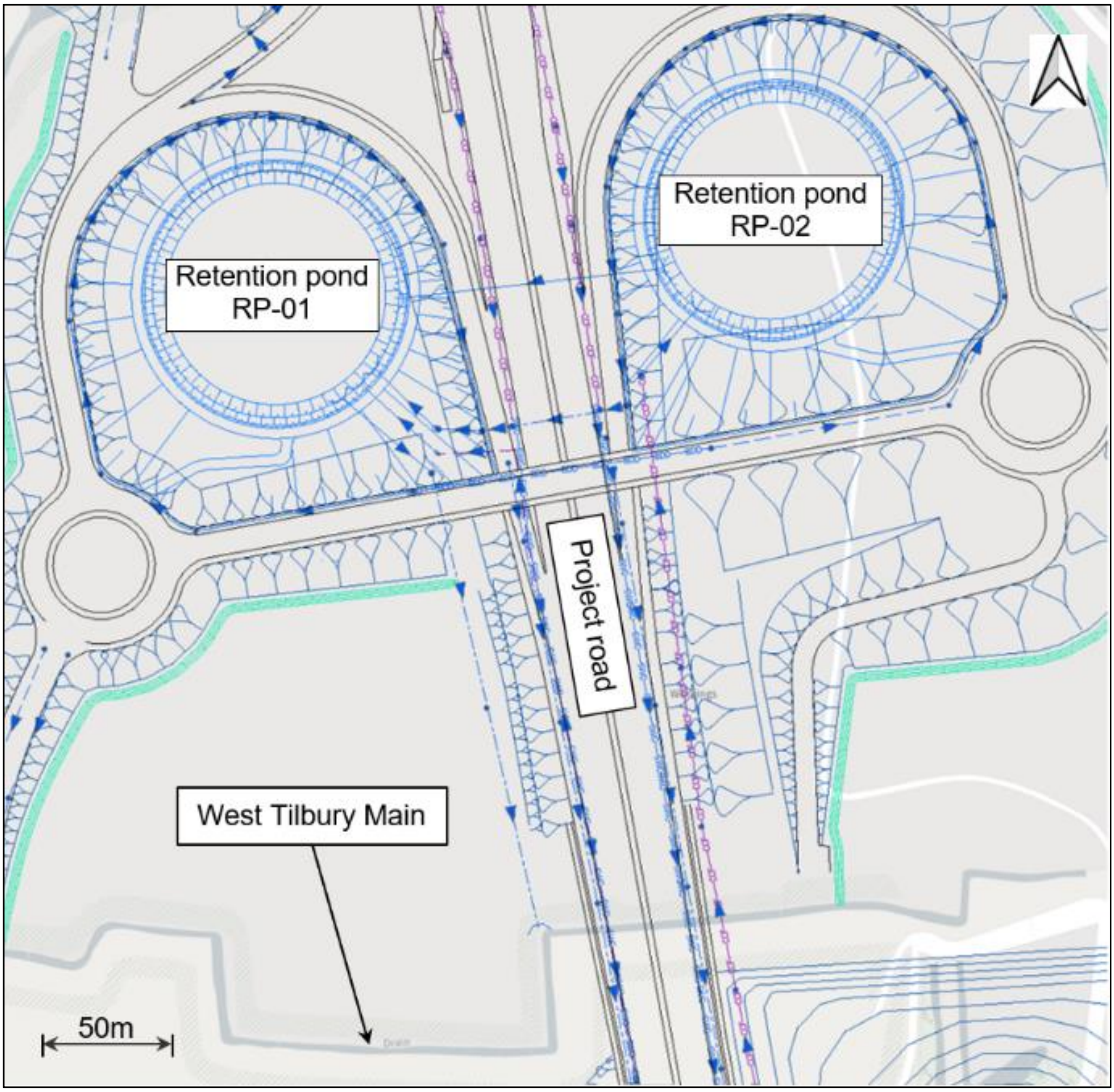
3.5.4 The catchment for RP-01 and RP-02 would comprise the new carriageway from the foot of the North Portal ramp up to a high point over the Tilbury Loop railway line.

3.5.5 RP-01 and RP-02 would be new retention ponds and would be located either side of the Project road, near the top of the North Portal ramp (see Plate 3.2).

3.5.6 Runoff that cannot gravitate to the retention ponds will be collected at the foot of the North Portal ramp and pumped up to RP-01.

3.5.7 RP-02 would flow into RP-01 via a 900mm diameter piped culvert. The outlet of RP-01 would be set above the design flood level. This would enable flows from the pond to be discharged to West Tilbury Main when the outfall is operating in surcharged conditions.

Plate 3.2 Retention ponds RP-01 and RP-02



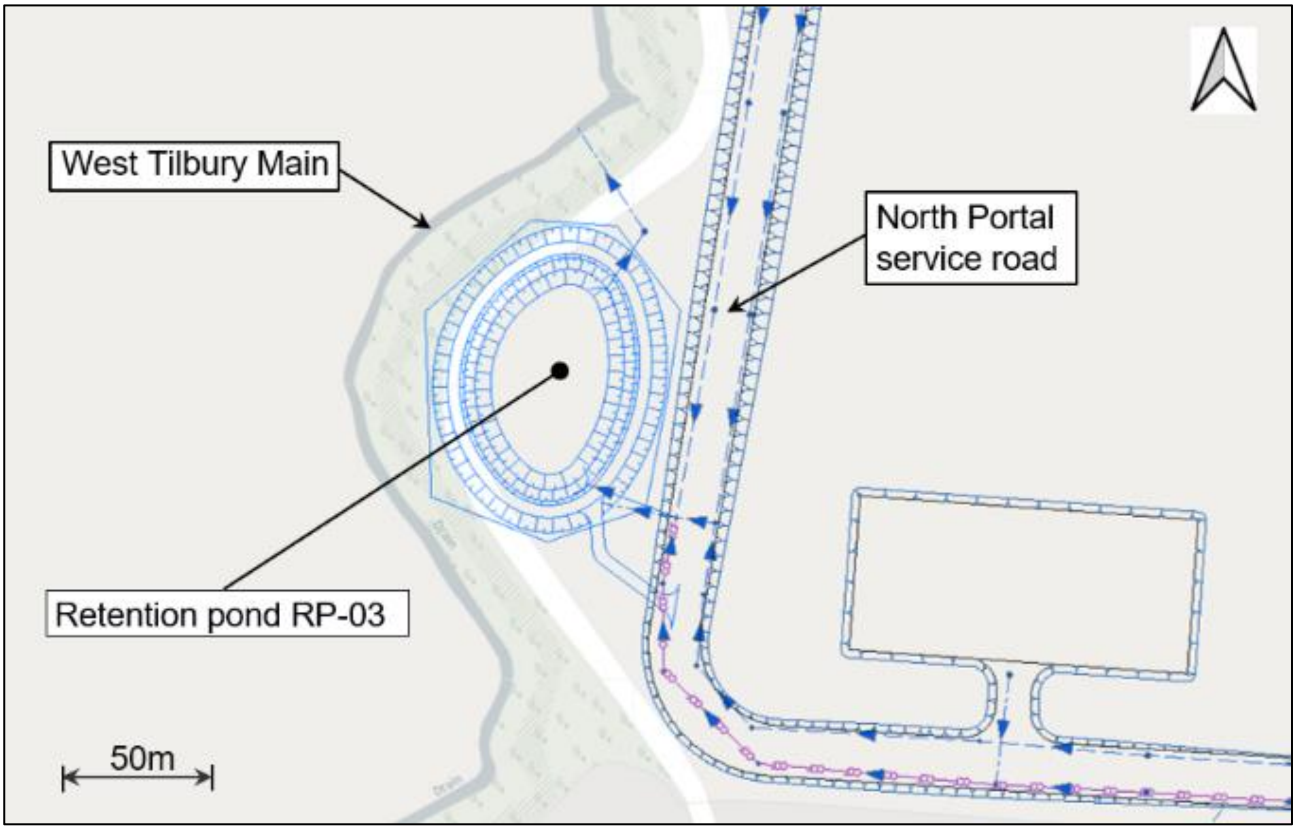
Catchment discharging to retention pond RP-03

3.5.8 The catchment for RP-03 would comprise part of the North Portal service road.

3.5.9 RP-03 would be a new, small retention pond located to the west of the North Portal service road (see Plate 3.3).

3.5.10 The outlet of RP-03 would be set above the design flood level. This would enable flows from the pond to be discharged to West Tilbury Main when the outfall is under surge conditions.

Plate 3.3 Retention pond RP-03



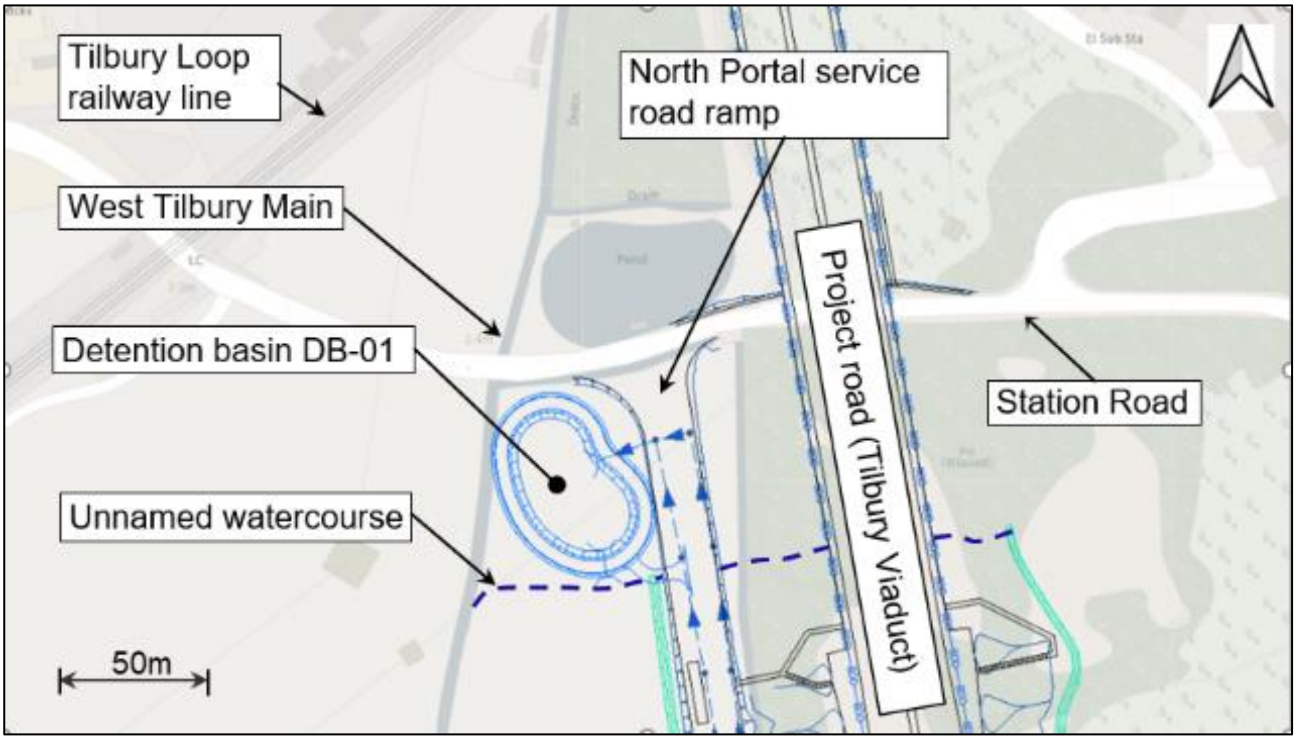
Catchments discharging to detention basin DB-01

3.5.11 The catchment for DB-01 would comprise part of the North Portal service road.

3.5.12 DB-01 would be a small, dry basin that would serve the section of the North Portal service road that ramps down to Station Road. It would be located to the west of the Project road, near the southern extent of Tilbury viaduct and would discharge to an unnamed watercourse that discharges to West Tilbury Main (see Plate 3.4).

3.5.13 Ground levels at the point where the service road would tie into Station Road are below the design flood level. It therefore follows that DB-01 would need to lie below the design flood level. The area around the service road tie-in point is low-lying and is susceptible to fluvial flooding. During a severe storm event, flood levels along the unnamed watercourse (West Tilbury Main tributary) may rise leading to inundation of the basin. Under such conditions, the area around the basin would also be inundated. If the area around the basin is inundated the ‘loss’ of the basin will have zero net effect on local flooding (ie flood levels at the basin would simply match the surrounding flood level). As proportionate protective measures would not be able to prevent inundation, it is proposed that the basin would be undefended and allowed to fill and empty as flood levels in the area rise and fall.

Plate 3.4 Detention basin DB-01



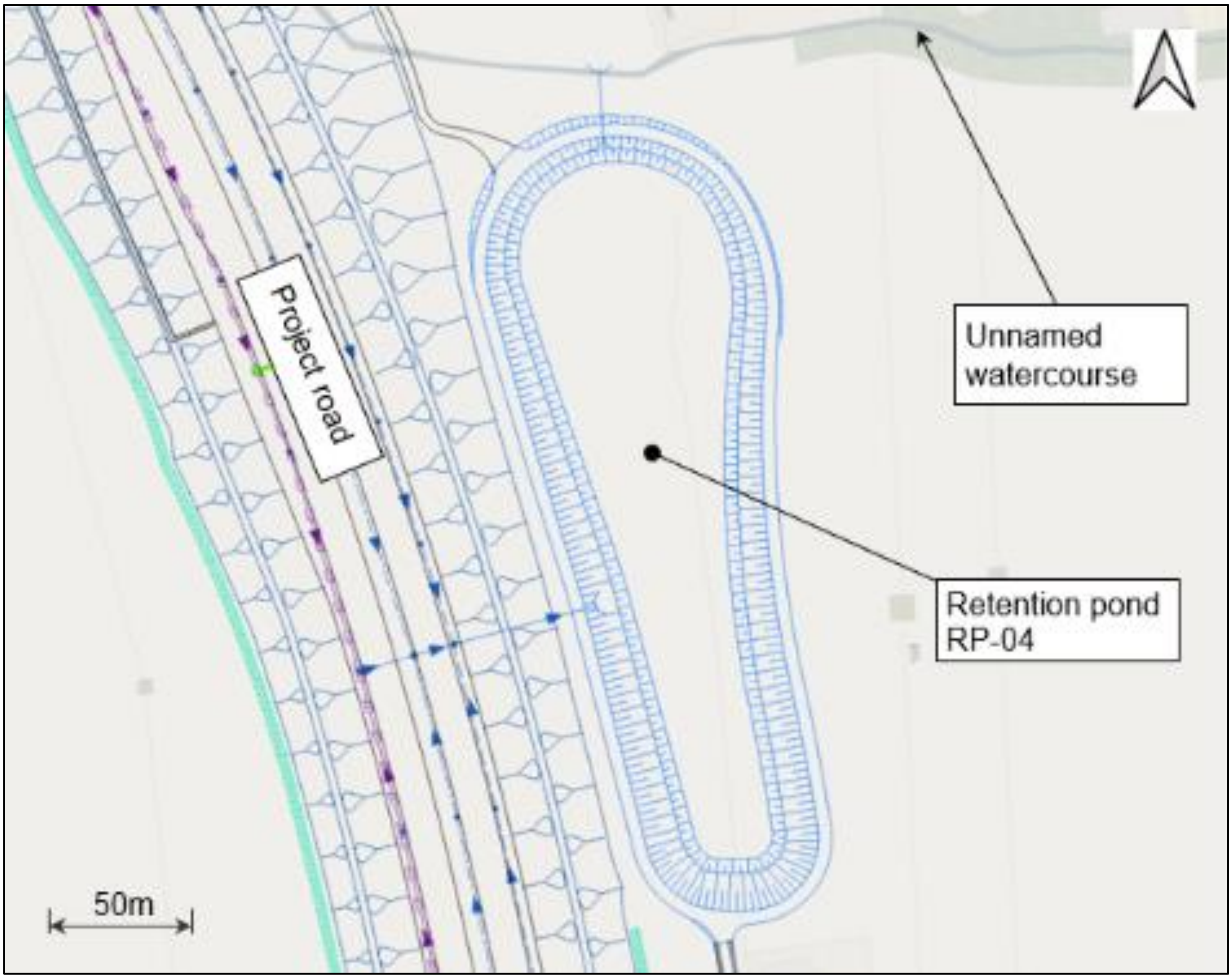
Catchment discharging to retention pond RP-04

3.5.14 This drainage catchment would comprise the new carriageway between the high point over the railway line and the junction between the Project road, the A13 and the A1089. The low point is toward the middle of the catchment, where the Project road crosses Gobions Sewer.

3.5.15 RP-04 would be a new retention pond located to the east of the Project road, near Linford, and would discharge to Gobions Sewer (see Plate 3.5).

3.5.16 RP-04 is situated within a groundwater Source Protection Zone 1. The entire pond would include an impermeable lining in order to prevent seepage of drainage discharges into the ground to safeguard potable groundwater quality. [RDWE032]

Plate 3.5 Retention pond RP-04



Catchment discharging to retention ponds RP-05 and RP-06

3.5.17 The drainage catchment for RP-04 and RP-05 would comprise the junction between the Project road, the A13 and the A1089. The catchment would extend northwards to Orsett Fen Sewer and eastwards to the existing junction between the A13, A128 and A1013 (Orsett Cock).

3.5.18 The preferred method of disposal of highway runoff would be via deep trunk mains running north along the verges of the Project road from low points to retention ponds and eventually discharging to Orsett Fen Sewer. This solution would enable the junction to be drained by gravity but would result in a section of pipeline at a depth of more than 7.5m over a length of approximately 500m.

3.5.19 RP-05 and RP-06 would be new retention ponds. The ponds would be located on opposite sides of the Project road and to the west of the proposed junction. The rationale for having two ponds, rather than a single large one, is to avoid encroachment into areas of valued farmland and to facilitate maintenance (see Plate 3.6).

Plate 3.6 Retention ponds RP-05 and RP-06

3.5.20 Retention ponds RP-05 and RP-06 would be served by separate drainage networks which both flow westwards from the proposed junction, along each verge of the Project road.

3.5.21 The size of the total catchment draining to RP-05 and RP-06 would be very large. A proportion of the catchment area would not naturally flow into the receiving watercourse (Orsett Fen Sewer). This issue was discussed with the Environment Agency and it was agreed that the outflow from the ponds would be limited to the greenfield runoff from that part of the catchment that could reasonably be estimated as naturally draining to Orsett Fen Sewer.

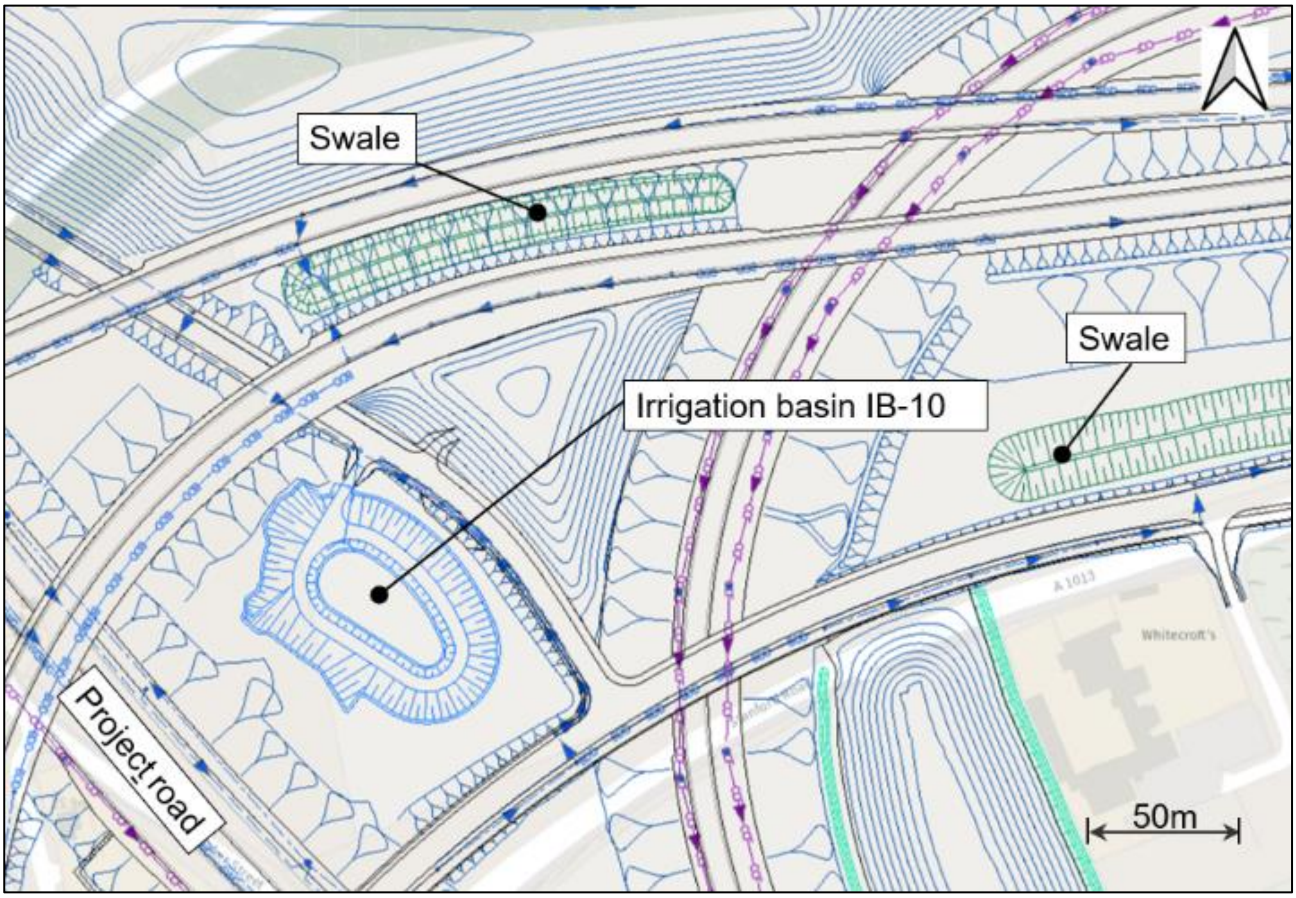
Catchment discharging to infiltration basin IB-10

3.5.22 This catchment cannot readily be connected to the networks draining to retention ponds RP-05 and RP-06.

3.5.23 IB-10 would be a new infiltration basin, located within the proposed junction between the A13, A1089 and the Project road (see Plate 3.7). The basin would incorporate a vortex separator (or other appropriate pollution control device) immediately upstream of the inlet.

3.5.24 In addition to IB-10, there are a number of swales located within the proposed junction. These swales serve parts of the junction that cannot readily be drained to IB-10, RP-05 or RP-06. These swales would operate as infiltration features rather than for conveyance of runoff.

Plate 3.7 Infiltration basin IB-10



Catchment discharging to retention pond RP-07

3.5.25 The limits of this small catchment would be the apexes of the two viaducts across the Mardyke floodplain.

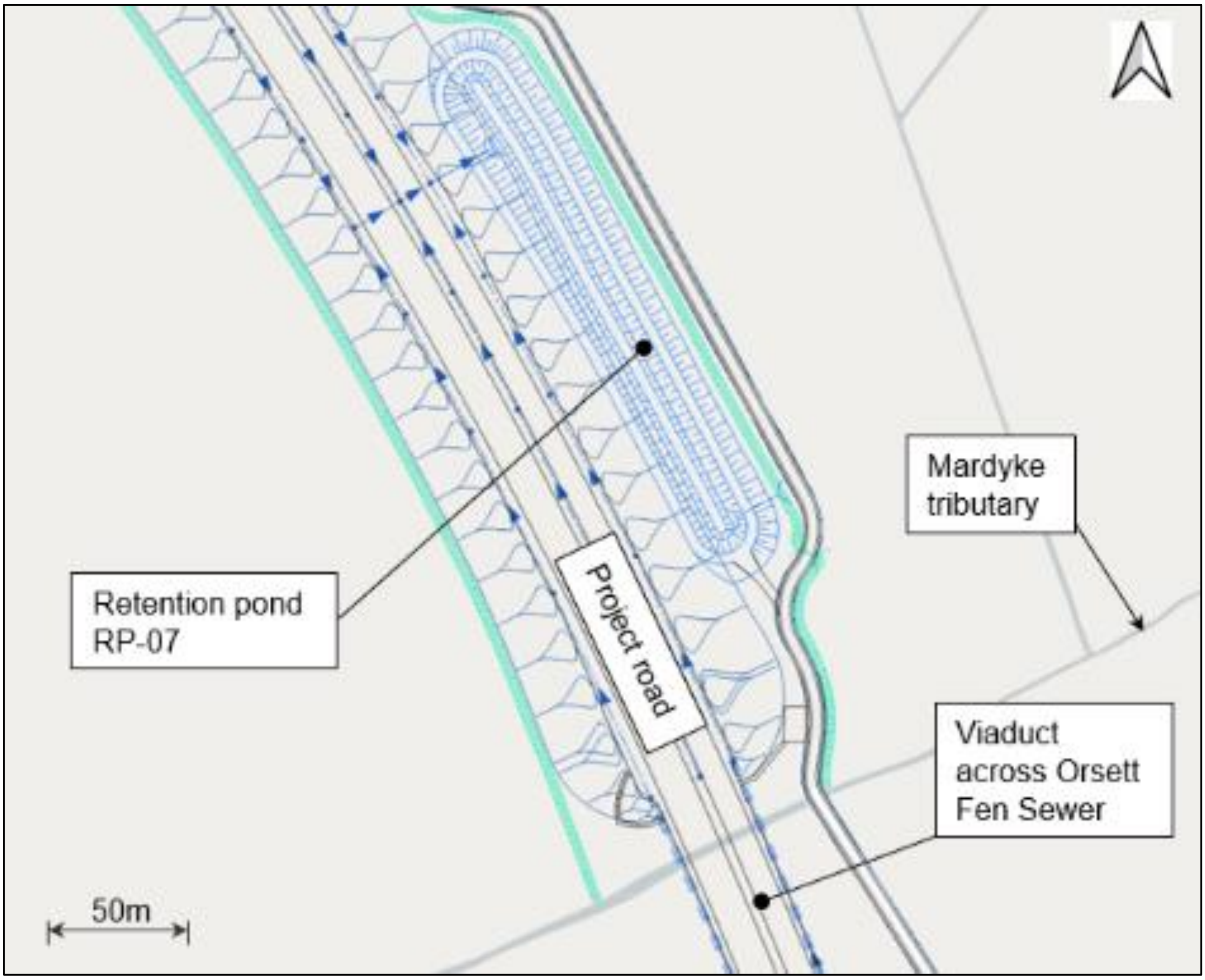
3.5.26 The drainage network would be installed in the verges, flowing from the apex of each viaduct back to the retention pond.

3.5.27 RP-07 would be a new retention pond located to the north of the viaduct that crosses Orsett Fen Sewer and an unnamed watercourse (see Plate 3.8).

3.5.28 RP-07 would be formed at an elevated level by extending the Project road embankment. The invert level of the pond outlet would be higher than the design flood level.

3.5.29 The pond would outfall into an unnamed ordinary watercourse (a tributary of the Mardyke). As the invert level of the pond outlet would lie above the design flood level, flows from the pond would be able to be discharged to the watercourse when the outfall is operating in surcharged conditions.

Plate 3.8 Retention pond RP-07



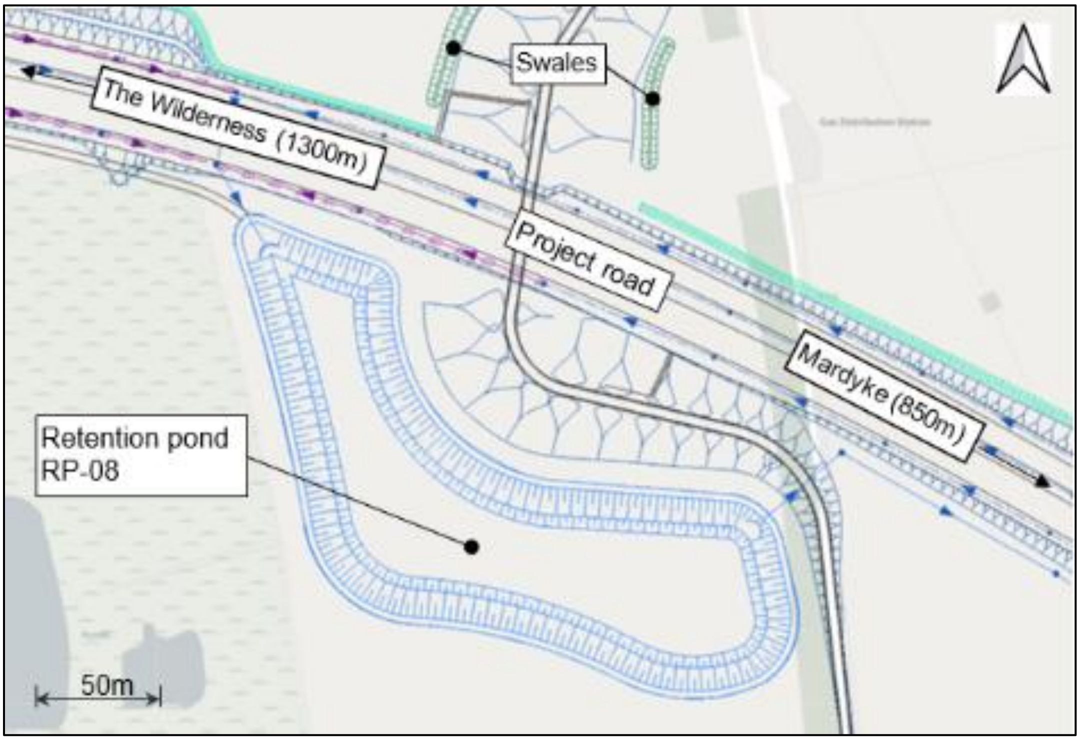
Catchment discharging to retention pond RP-08

3.5.30 This catchment extends from the apex of the viaduct crossing the Mardyke to the point where the Project road starts to diverge to form the junction with the M25.

3.5.31 The catchment includes sections of new highway on embankments and in cuttings and drains to RP-08, which is located between the Wilderness and the Mardyke (see Plate 3.9).

3.5.32 The invert level of the RB-08 is lower than the invert level of the watercourses in its immediate vicinity. For disposal of the highway runoff, a deep drainage network would be provided running along the base of the Project road embankment and eventually discharging into the Mardyke (which is at a lower elevation than the watercourses closer to the pond).

Plate 3.9 Retention pond RP-08



Summary

3.5.33 A summary of the retention ponds, detention basins and infiltration basins proposed for Catchments EFR-2, EFR-3 and EFR-4 is presented in Table 3.1.

Table 3.1 Catchments EFR-2, EFR-3 and EFR-4 - Summary of ponds and basins

Pond ref.	Model ref (1)	Discharge location	Pollution control(2)(3)	Flow control	
				Attenuate(4)	Isolate(5)(6)
RP-01	POS08-001	West Tilbury Main	LSF	✓	✓
RP-02	POS08-002	Pond PR-01	LSF	✓	✓
RP-03	POS08-003	West Tilbury Main	PCD	✓	✓
DB-01	POS09-001	West Tilbury Main	PCD	✓	✓
RP-04	POS10-01	Gobions Sewer	FL(7)	✓	✓
RP-05	POS11-001	Orsett Fen Sewer	LSF	✓	✓
RP-06	POS11-002	Orsett Fen Sewer	LSF	✓	✓
IB-10	POS11-003	To ground	PCD	N/A	✓
RP-07	POS12-001	Unnamed OWC(8)	LSF	✓	✓
RP-08	POS12-002	Mardyke	LSF	✓	✓

Legend
LSF Lined sediment forebay
PCD Pollution control device
FL Fully lined
Notes:
The model reference is the reference given to this facility in the hydraulic modelling prepared for the design. It is included here for information and for cross-referencing with the models and other parts of the ES.
Where included, sediment forebays would be lined.
Vortex separators (or other appropriate pollution control devices) would be included immediately upstream of the pond/basin.
Flow control is required to regulate discharge to watercourses.
Penstocks (or other appropriate flow control device) would be used for isolating retention pond and detention basin networks in the event of a spillage see also 3.7.2 and 3.7.3).
Penstocks (or other appropriate flow control device) would be used for isolating the infiltration basin in the event of a spillage (see also 3.7.1).
Pond RP-04 lies in a groundwater source protection zone. To safeguard the groundwater source, the pond would be fully lined. [RDWE032]

Text box 3.4 Catchments EFR-2, EFR-3 and EFR-4 – Drainage design

A total of eight new retention ponds, one detention basin and one infiltration basin would be included in the Project to serve the drainage networks for Catchments EFR-2, EFR-3 and EFR-4.

There would be five drainage catchments in EFR-2 and each drainage catchment would have its own retention pond or detention basin. Three of the ponds and the detention basin would discharge to West Tilbury Main. The fourth pond would discharge to a network of watercourses that outfall to the River Thames to the north of Coalhouse Fort.

Two drainage catchments would span across EFR-3 and EFR-4. The ponds associated with these drainage catchments would both lie in EFR-4 and discharge to Orsett Fen Sewer.

Two drainage catchments would lie fully within EFR-4. The drainage ponds associated with these catchments would drain to the Mardyke and an unnamed ordinary watercourse that is a tributary of the Mardyke.

An area in the centre of the new proposed junction between the Project road, A13 and A1089 that cannot be connected to a watercourse would be drained to an infiltration basin.

3.6 Flood risk and drainage

Introduction

3.6.1 Flood risks directly associated with the drainage strategy for Catchments EFR 2, EFR-3 and EFR-4 are outlined below. Details of other flood risks are presented in Part 6 of the FRA (Appendix 14.6, Application Document 6.3).

Maintenance

3.6.2 Maintenance of a drainage system is required to ensure its effective operation. Failure to maintain a drainage system increases the risk that the system could be overwhelmed, and this could result in flooding in the carriageway.

3.6.3 Drainage infrastructure and treatment systems would be maintained and inspected in accordance with DMRB GM 701 (Highways England, 2020a) and DMRB GS 801 (Highways England, 2020b) to ensure that the highway drainage system is kept in full working order. [RDWE012]

Perched groundwater

3.6.4 Where permeable or partly permeable strata overlie less permeable strata there is potential for perched water to occur. If perched water is intercepted (e.g. by cuttings or by local topographic change), there is potential for groundwater to emerge locally.

3.6.5 On account of their highly localised nature, identification of all occurrences of perched groundwater is difficult.

3.6.6 If perched groundwater is encountered in cuttings, it would most likely occur as localised seepages only.

3.6.7 This risk could be mitigated by provision of drainage networks incorporating an appropriate edge of pavement detail, such as combined surface and sub-surface drains (DMRB CD 524, Highways England, 2021a).

Groundwater mounding

3.6.8 Due to a more direct flow pathway, the use of an infiltration system for IB-10 would enhance groundwater recharge locally, with a commensurate increase in local groundwater level. This could lead to potential groundwater level mounding and an increased risk of local groundwater flooding both in the immediate vicinity of the infiltration system and further downgradient. A detailed assessment of groundwater mounding is presented in Appendix 14.5: Hydrogeological Risk Assessment (Application Document 6.3). This assessment demonstrates that the proposed infiltration basin would not result in mounding that would reach ground surface.

Reservoirs

3.6.9 It is a requirement to notify the Environment Agency if a reservoir with the potential to hold 25,000m^3 or more of water above ground level is to be built, brought back into use or altered (Department for Environment, Food and Rural Affairs, and Environment Agency, 2014). Any such reservoir would impose a flood risk in the event of failure or breach. Although some of the proposed retention ponds would have the potential to hold more than 25,000m^3, most of the storage would be below ground level.

Text box 3.5 Catchments EFR-2, EFR-3 & EFR-4 – Flood risk and drainage

A planned maintenance programme would be established to ensure that the drainage system operates effectively.

Perched water may be encountered in cuttings. If perched groundwater is encountered, it would most likely occur as localised seepages only. This risk could be mitigated by provision of a drainage system incorporating an appropriate edge of pavement detail, such as combined surface and sub-surface drains.

Groundwater mounding due to locally enhanced groundwater recharge from the proposed infiltration basin is unlikely to result in flooding.

Large retention ponds need to be regarded as reservoirs if their above-ground capacities exceed 25,000m^3. In such cases, flood risk due to a breach of a retention structure would need to be considered. Although some of the retention ponds have large storage capacities, they would not present a flood risk as the majority of their respective capacities are below ground.

3.7 Pollution control and water quality

Pollution control

3.7.1 Retention ponds, detention basins and infiltration basins provide an effective pollution control measure for highway runoff, for example, providing for settlement of suspended sediments and treatment of dissolved metals.

3.7.2 In addition to the pollution control measures outlined in paragraph 3.4.14, a flow control device would be included between retention pond outlets and receiving watercourses. This flow control device would be used to protect the watercourse in the event of an accidental spillage and would be included regardless of whether designated containment provision is made in the pond design. Typically, penstocks would be used for flow control. [RDWE035]

3.7.3 In addition to the pollution control measures outlined in paragraph 3.4.20, a flow control device would be included between detention basin outlet and receiving watercourses. This flow control device would be used to protect the watercourse in the event of an accidental spillage and would be included regardless of whether designated containment provision is made in the basin design. Typically, penstocks would be used for flow control. [RDWE035]

3.7.4 In addition to the pollution control measures outlined in paragraphs 2.4.12 and 2.4.13, the network with an infiltration basin would include a method to isolate an accidental spillage before it reaches the basin, regardless of whether designated containment provision is made. Isolation (flow control) would be included upstream of each pond inlet, typically in the form of a penstock. [RDWE034]

Water quality

3.7.5 An assessment has been undertaken to determine the pollution risks to surface water bodies that would receive discharges of highway drainage from the Project. The assessment considers pollution risks from the following:

a. Routine runoff

b. Accidental spillages

3.7.6 The assessment has been undertaken in accordance with the methodologies set out in the DMRB LA 113 (Highways England, 2020c). These methods have been implemented using the Highways England Water Risk Assessment Tool (HEWRAT) and the Water Framework Directive[7] UK Technical Advisory Group Metals-Bioavailability Assessment Tool (M-BAT).

3.7.7 Measures embedded in the drainage design to treat and attenuate runoff prior to discharge have been factored into the routine runoff pollution assessment. The results of assessment demonstrated that the embedded treatment measures would safeguard the water quality of receiving watercourses.

3.7.8 The accidental spillage risk assessment concluded that when treatment measures are taken into account, the calculated probability of a spillage causing a serious pollution incident would be below the thresholds set in the assessment criteria.

3.7.9 Full details of the assessment are provided in the Operational Surface Water Drainage Pollution Risk Assessment (Appendix 14.3, Application Document 6.3) of the ES.

Text box 3.6 Catchments EFR-2, EFR-3 and EFR-4 – Surface water quality

Runoff from the Project road would be treated to a level that is acceptable for disposal to open water bodies.

Water quality assessments have been undertaken to investigate likely impacts that highway runoff from the Project would have on the water quality of receiving watercourses.

The assessment has been undertaken in accordance with the methodologies set out in DMRB LA 113 (Highways England, 2020c) and concluded that pollution risk from routine runoff and from accidental spillages does not cause an undue risk to the water environment.

[7] The Water Framework Directive 2000/60/EC is an EU directive which commits European Union member states to achieve good qualitative and quantitative status of all water bodies.

4 North Section (EFR-5)

4.1 Existing surface water drainage

General

4.1.1 Several existing drainage catchments on the M25 would be affected by the Project. For reporting purposes, catchments that discharge to the same location have been separated as follows:

a. Existing catchments discharging to the West Mardyke
b. Existing catchment discharging to a West Mardyke tributary
c. Existing catchments at M25 junction 29
d. Existing catchment north of M25 junction 29

4.1.2 Details of these catchments are outlined below.

Existing catchments discharging to the West Mardyke

4.1.3 The networks for these two existing drainage catchments discharge to the West Mardyke at points to the east of the M25 but from opposite banks. Each network incorporates a retention pond (see Plate 4.1 and Plate 4.2).

Plate 4.1 Existing retention pond discharging to the West Mardyke (1 of 2)

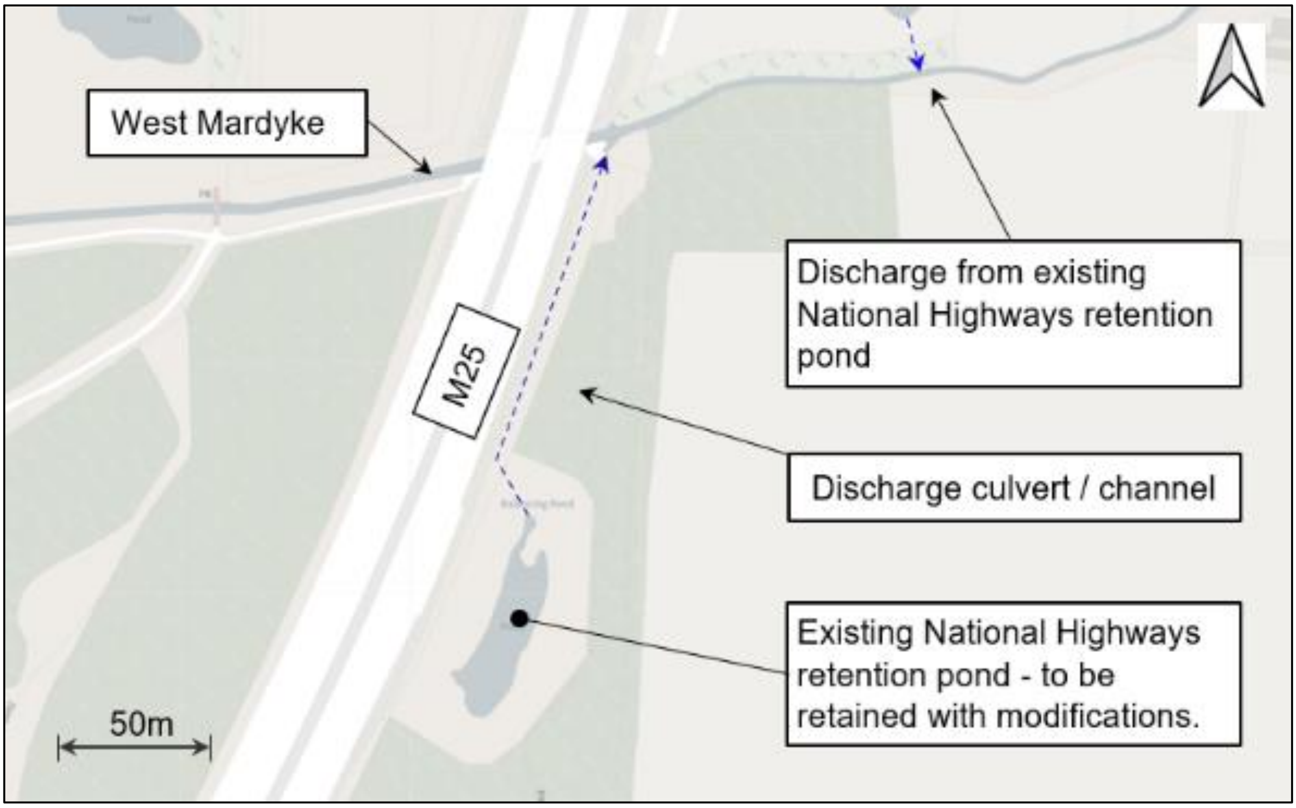
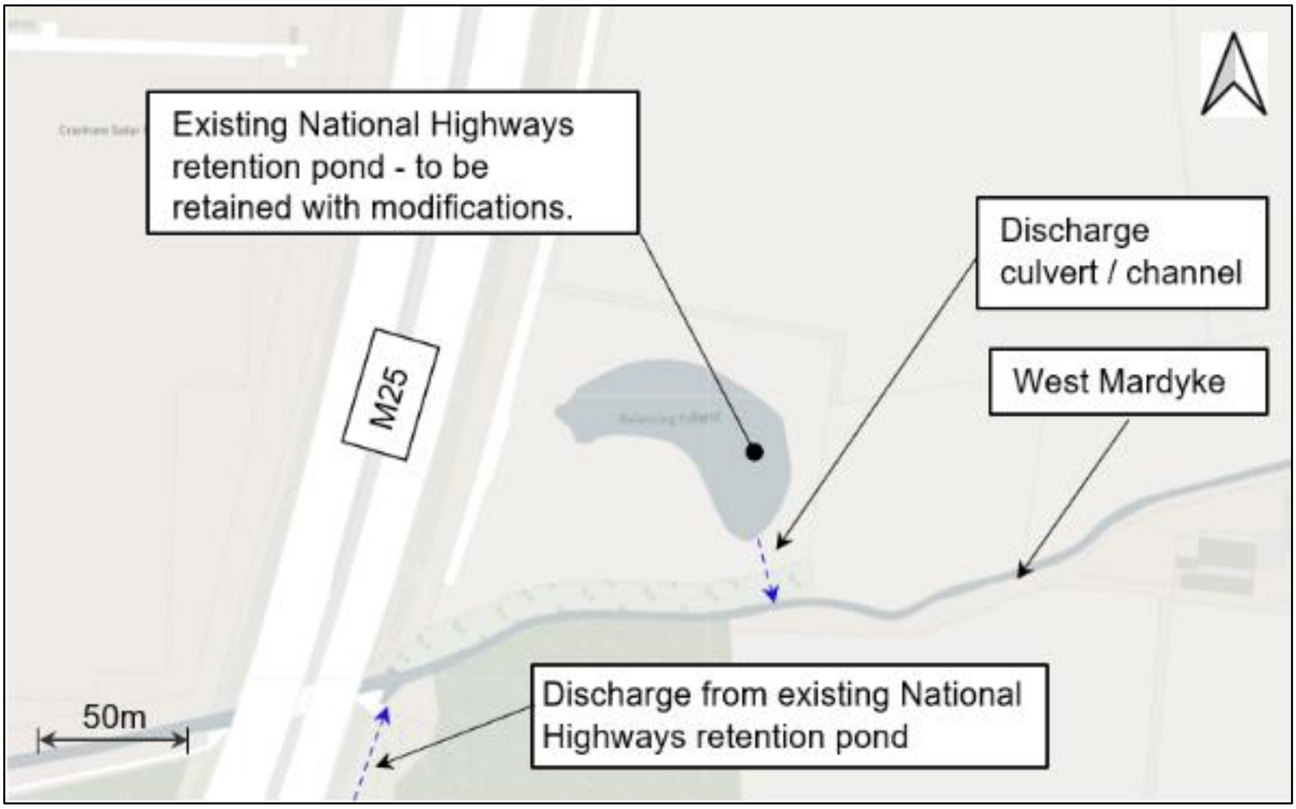


Plate 4.2 Existing retention pond discharging to the West Mardyke (2 of 2)



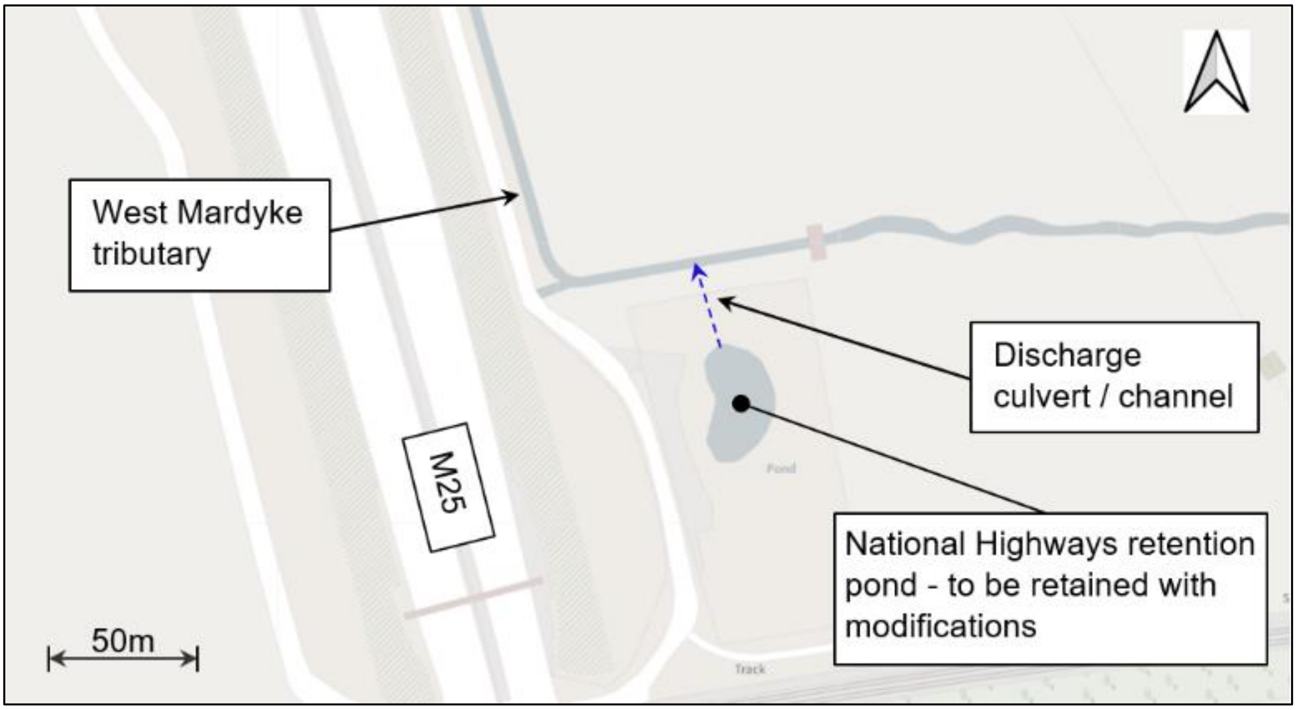
4.1.4 The drainage network to the south of the West Mardyke includes four orifice plates for flow control; three orifice plates are located within the network and the fourth is on the outfall pipe.

4.1.5 The drainage network to the north of the West Mardyke does not include any flow control measures.

Existing catchment discharging to a West Mardyke tributary

4.1.6 The network for this existing drainage catchment discharges to a retention pond and then onward to a watercourse that is a tributary of the West Mardyke (see Plate 4.3).

Plate 4.3 Existing pond discharging to West Mardyke tributary



4.1.7 The network does not include any flow control measures.

Existing catchments at M25 junction 29

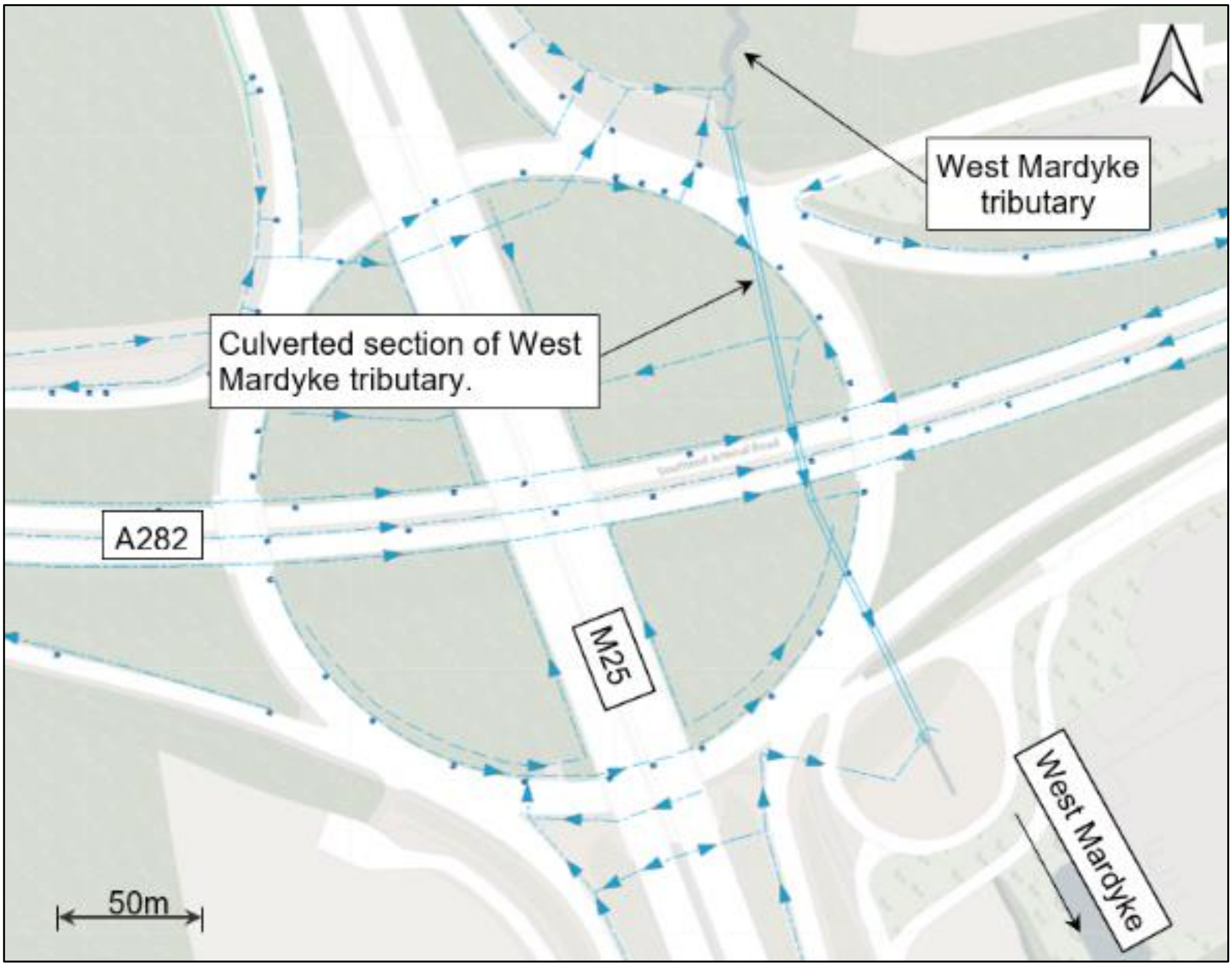
4.1.8 The A127 is connected to the M25 at junction 29.

4.1.9 There is a watercourse running north to south that crosses M25 junction 29. This watercourse, which eventually discharges to the West Mardyke, is in culvert where it crosses the junction.

4.1.10 Several minor networks serving M25 junction 29 and the A127 drain directly into the watercourse or into the culverted section of the watercourse. Elements of these networks serve parts of the M25 that would fall within the Order Limits (see Plate 4.4).

4.1.11 The networks around M25 junction 29 do not incorporate any flow control measures.

Plate 4.4 M25 junction 29

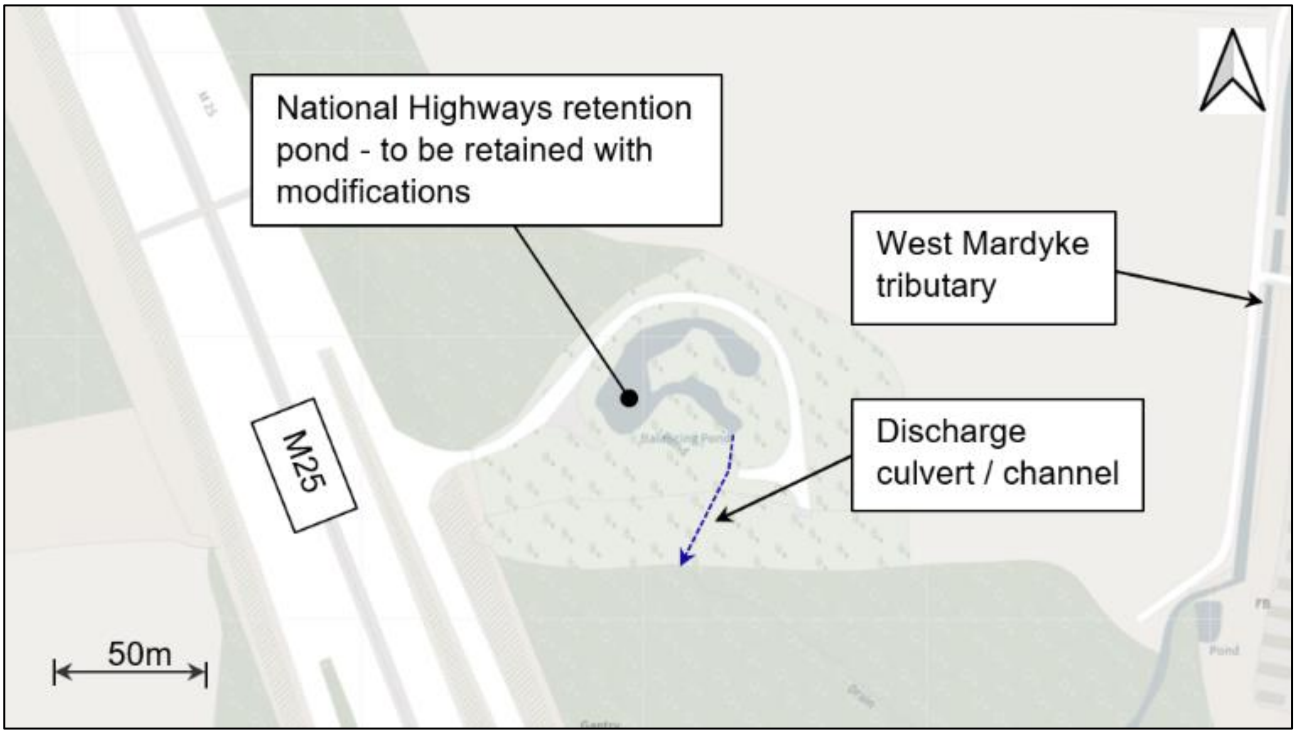


Existing catchment north of M25 junction 29

4.1.12 The network for this existing drainage catchment discharges to a retention pond and then onward to a drain that eventually discharges to a tributary of the West Mardyke (see Plate 4.5).

4.1.13 The network does not incorporate any flow control measures.

Plate 4.5 Existing pond discharging to West Mardyke tributary



Text box 4.1 Catchment EFR-5 – Existing drainage provisions

Several existing drainage catchments along the M25 would be affected by the Project. These catchments drain to retention ponds and discharge to either the West Mardyke or unnamed watercourses.

4.2 Drainage design basis

Design basis statement

4.2.1 For surface water drainage purposes, Catchment EFR-5 would comprise the Project road, widened sections of the M25, new and reconfigured slip roads, and the paved and/or unpaved areas that fall towards them.

4.2.2 The drainage systems for Catchment EFR-5 would be designed to rapidly remove water from the carriageway.

4.2.3 The proposed drainage design would consider ease of access for planned maintenance interventions.

4.2.4 The drainage design for the Project road would comply with the relevant provisions of DMRB. The drainage design for local highways would comply with the requirements of the London Borough of Havering. Any drainage-related requirements of the Environment Agency would be complied with where applicable.

Key assumptions

4.2.5 The existing motorway retention ponds in EFR-5 lie in the London Borough of Havering but flows discharged from them flow into Thurrock via the West Mardyke. Following discussions with Essex County Council in 2019, it was agreed that discharge rates from these existing retention ponds would be reduced by at least 50%[8]. [RDWE035]

4.2.6 A Design Build Finance Operate (DBFO) widening scheme on the M25 was completed in 2010 and it has been assumed that all existing drainage retained as part of that scheme was assessed at the time of the scheme and any faults rectified. The DMRB states that the drainage assets have a design life of 60 years and hence it has been assumed that the existing drainage networks along the M25 are in good condition.

Key constraints

4.2.7 The surface water drainage design would be developed with due regard to the following key constraints:

a. Watercourses

b. Flood risk

c. Groundwater

d. Underlying geology and surface topography

Climate change

4.2.8 Climate change allowances for drainage design in Catchment EFR-5 would be as described in paragraphs 2.3.8 to 2.3.10.

Text box 4.2 Catchment EFR-5 – Drainage design basis

The proposed drainage system in Catchment EFR-5 would allow for the following:

- Rapid removal of water from the carriageway
- Ease of access for maintenance personnel
- The effects of climate change
- Due regard to environmental constraints
- The requirements of the DMRB, the Environment Agency and LLFA.

It is assumed that all existing drainage retained as part of the DBFO widening scheme (2010) was assessed at the time of the scheme and any faults rectified.

Further to discussions with Essex County Council (2019), discharge rates from the existing motorway networks that discharge to watercourses that flow through Thurrock would be reduced by at least 50%.

Climate change allowances for carriageways design would comprise a 20% uplift in peak rainfall intensity and a sensitivity check for a 40% uplift.

Climate change allowances for other parts of the drainage system would also comprise a 20% uplift in peak rainfall intensity and a sensitivity check for a 40% uplift.

[8] Essex County Council is acting as LLFA on behalf of Thurrock Council.

4.3 Drainage design strategy

Overarching strategy

4.3.1 The proposed drainage strategy would primarily be based on the use of gravity drainage networks that outfall to retention ponds prior to discharge to watercourses. This strategy is secured in the Design Principles (Application Document 7.5).

4.3.2 The exception to the above is the proposed drainage strategy for M25 junction 29, which would be based on the use of gravity drainage networks that discharge directly to watercourses.

4.3.3 The surface water drainage system along this section of the M25 would be a combination of existing drainage networks (where it is feasible to retain and/or upgrade them) and new drainage networks.

4.3.4 Conveyance of runoff would be by means of drainage ditches, pipes and culverts. Drainage ditches would be used wherever practicable. This strategy is secured in the Design Principles (Application Document 7.5).

4.3.5 Drainage systems incorporating retention ponds or detention basins would include treatment measures for highway runoff designed to meet the requirements specified for each outfall to surface watercourses identified in ES Appendix 14.3, Operational Surface Water Drainage Pollution Risk Assessment. [RDWE025]

SuDS

4.3.6 The use of SuDS would be adopted wherever appropriate. This requirement is secured by Design Principle LPS.17 (Application Document 7.5).

4.3.7 SuDS components in Catchment EFR-5 would include retention ponds with pollution control measures to protect downstream water bodies and flow control measures to attenuate discharge of runoff to watercourses.

4.3.8 The use of SuDS components using infiltration techniques would not be considered in Catchment EFR-5 due to unfavourable ground conditions and the potential for high groundwater.

Surface water collection and conveyance

4.3.9 Most of the existing road edge drainage collection infrastructure would require replacement due to the revised carriageway width.

4.3.10 Collection of runoff from new highways would be by means of one of the edge of pavement details specified in DMRB CD 524 (Highways England, 2021a). Typically, runoff would be collected by concrete surface water channels when the highway is on an embankment and by combined surface and sub-surface drains when the highway is in cutting.

4.3.11 Piped drainage networks would be routed along highway verges wherever possible and practicable.

Retention ponds

4.3.12 New retention ponds would be designed in accordance with the provisions of DMRB CD 532 (Highways England, 2021b). [RDWE035]

4.3.13 Existing ponds would be remodelled as vegetated drainage systems in accordance with the provisions of DMRB CD 532 (Highways England, 2021b) and modified as required to meet the needs of the Project. [RDWE035]

4.3.14 Retention ponds would incorporate a lined sediment forebay with sufficient capacity to accommodate the first flush. [RDWE035]

4.3.15 Where practicable, local topography would be used to integrate retention ponds with the surrounding landscape. This condition is secured by Design Principle LPS.17 (Application Document 7.5).

4.3.16 In accordance with DMRB CD 532, pond discharge rates and capacities would be agreed in consultation with the local land drainage authority[9]. Attenuation would be by means of a small diameter pipe, vortex controls, orifice plates or a combination thereof. Attenuation would be by means of a small diameter pipe, vortex controls, orifice plates or a combination thereof. [RDWE035]

4.3.17 The location of retention ponds and their respective outfalls are shown on Drawing 00199.

Networks without retention ponds

4.3.18 The drainage provisions in the vicinity of M25 junction 29 comprise a number of small drainage networks that do not incorporate any flow control measures (i.e. simply networks that drain directly to a watercourse).

4.3.19 These networks would be extended and enhanced to meet the drainage requirements of the Project. A detailed description of the proposed extensions and enhancements is provided in Section 4.4.

Text box 4.3 Catchment EFR-5 – Drainage design strategy

> The proposed surface water drainage system in EFR-5 would be a combination of existing drainage networks (where it is feasible to retain and/or upgrade them) and new drainage networks.
>
> Collection and disposal of surface water runoff from highways in Catchment EFR-5 would be by positive drainage networks that drain directly to watercourses or retention ponds before eventual discharge to a watercourse.
>
> Typically, runoff from new highways would be collected by concrete surface water channels when the highway is on an embankment and by combined surface and sub-surface drains when the highway is in cutting.
>
> SuDS in Catchment EFR-5 would be limited to the use of retention ponds with pollution control and flow control measures.
>
> The local land drainage authority would be consulted about capacities and discharge rates for retention ponds.

[9] The land drainage authority is an organisation with a role in respect of land drainage and flooding. For the Project, this role would be undertaken by the LLFA.

New retention ponds would be designed as vegetated drainage systems and existing retention ponds would be remodelled as vegetated drainage systems.

The existing networks around M25 junction 29 would generally be retained. Adjustments would be made to these networks as required to meet the drainage needs of the Project in line with the current DMRB standards.

4.4 Drainage design

General

4.4.1 In addition to the existing catchments described in Section 4.1, two new catchments would be established to serve new sections of highway. These new catchments would comprise one that discharges to the West Mardyke and one that discharges to a drainage ditch.

4.4.2 The principal elements of the proposed drainage provisions in Catchment EFR-5 would be as outlined on Drawing 00199.

4.4.3 The surface water drainage design for each drainage catchment would be as outlined below.

New catchments

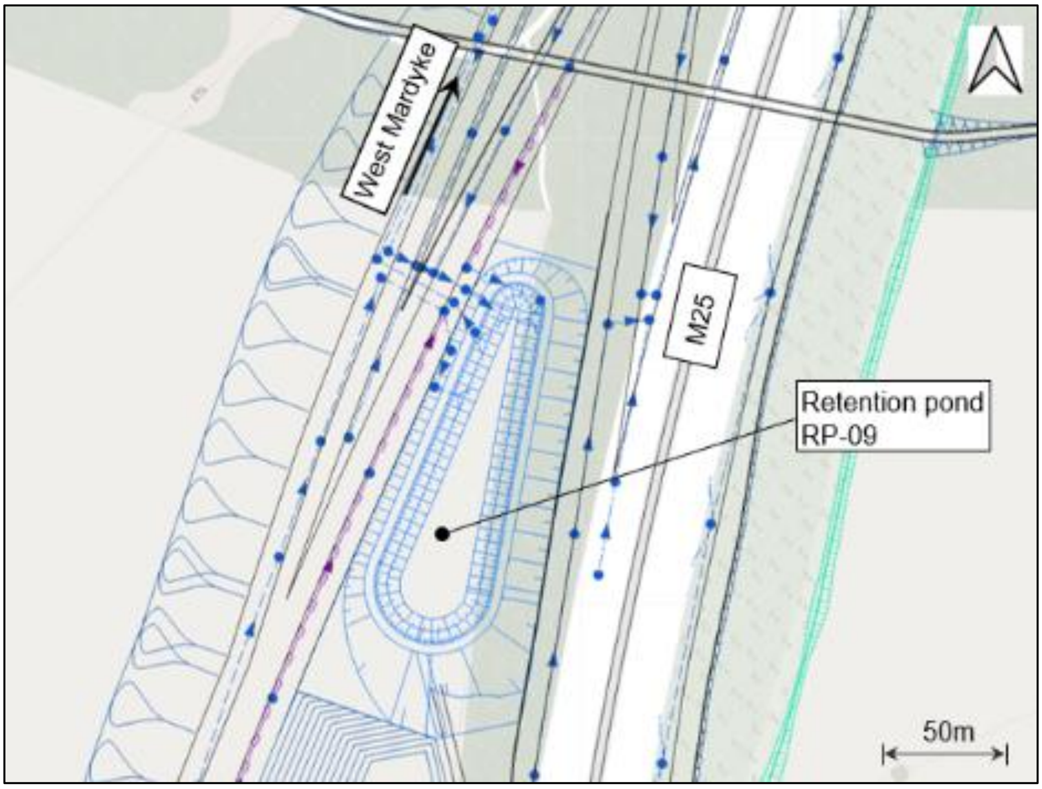
New catchment discharging to the West Mardyke

4.4.4 A new catchment would be established to drain the northbound merge from the Project road to the M25.

4.4.5 A new drainage network and retention pond (RP-08) would be implemented to accommodate flows from this catchment (see Plate 4.6). The pond would be designed in accordance with the provisions of DMRB CD 532 (Highways England, 2021b). [RDWE035]

4.4.6 The pond would discharge to the West Mardyke, which is the nearest available watercourse.

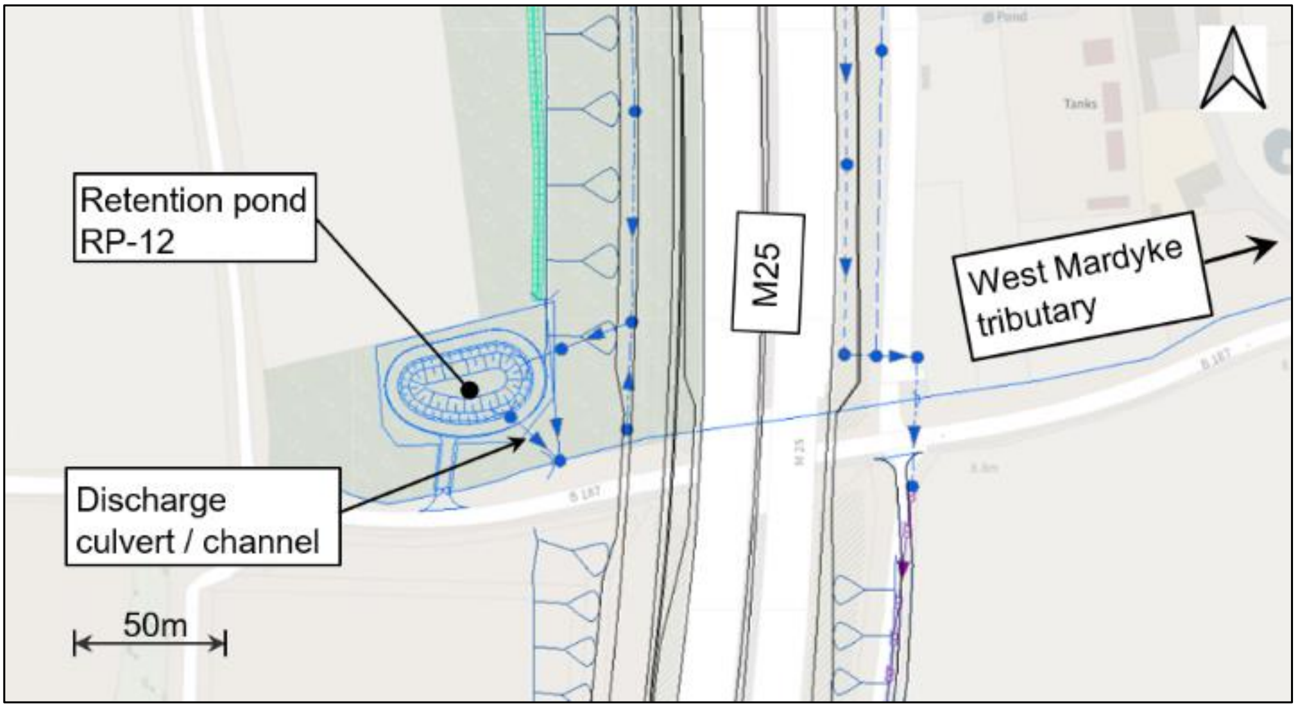
Plate 4.6 Retention pond PR-09



New catchment discharging road drainage ditch

4.4.7 A new distributor road is proposed between junctions 28 and 29 of the M25. Part of this new road cannot readily be incorporated into an existing M25 drainage network. A new catchment would be provided for this section of road. The catchment would drain to a new retention pond (RP-12) and then be discharged to a local watercourse via a new outfall (see Plate 4.7).

Plate 4.7 Retention pond RP-12



Existing catchments with retention ponds

4.4.8 The ponds serving existing catchments would be remodelled as vegetated drainage systems in accordance with the provisions of DMRB CD 532 (Highways England, 2021b) and modified as required to meet the needs of the Project. [RDWE035]

4.4.9 The capacity of the existing ponds would be increased to allow for the changes in their catchments and the reduced rate of discharge (see Para 4.2.6).

4.4.10 Existing pond outfall locations would be retained.

4.4.11 The remodelled retention ponds would be as shown in Plate 4.8 to Plate 4.11.

4.4.12 In Plate 4.8 to Plate 4.11, the remodelled retention ponds have been superimposed over the existing ponds.

Plate 4.8 Retention pond PR-10

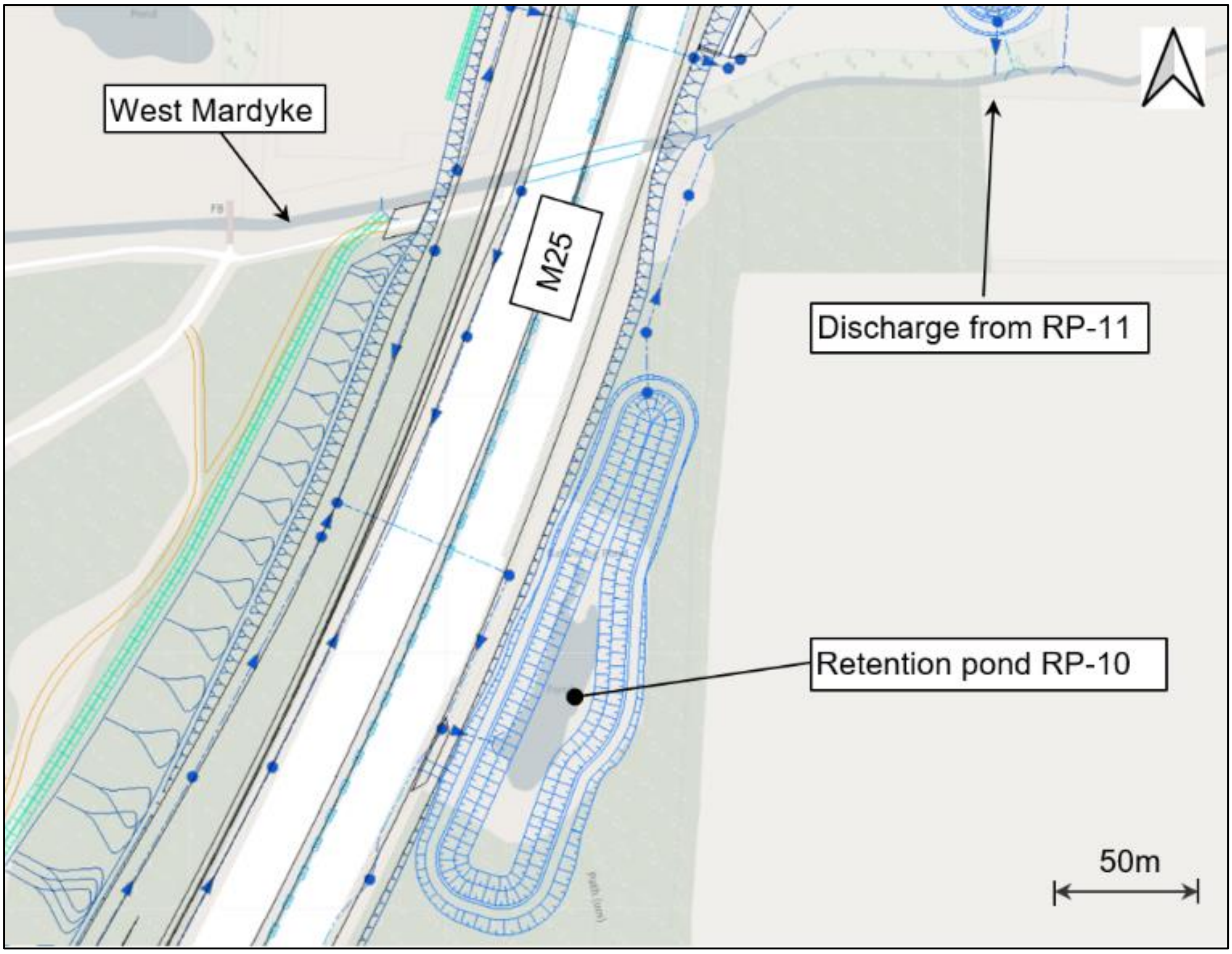


Plate 4.9 Retention pond RP-11

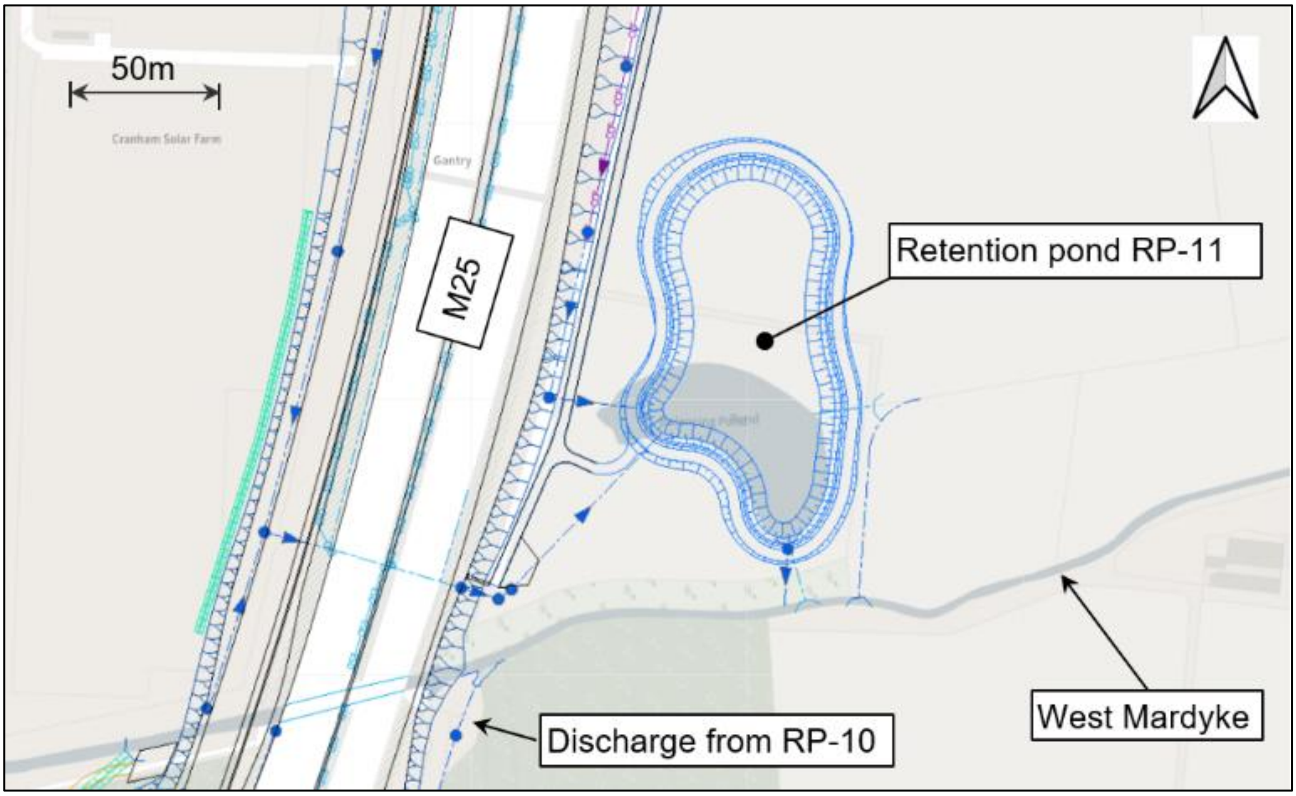


Plate 4.10 Retention pond RP-13

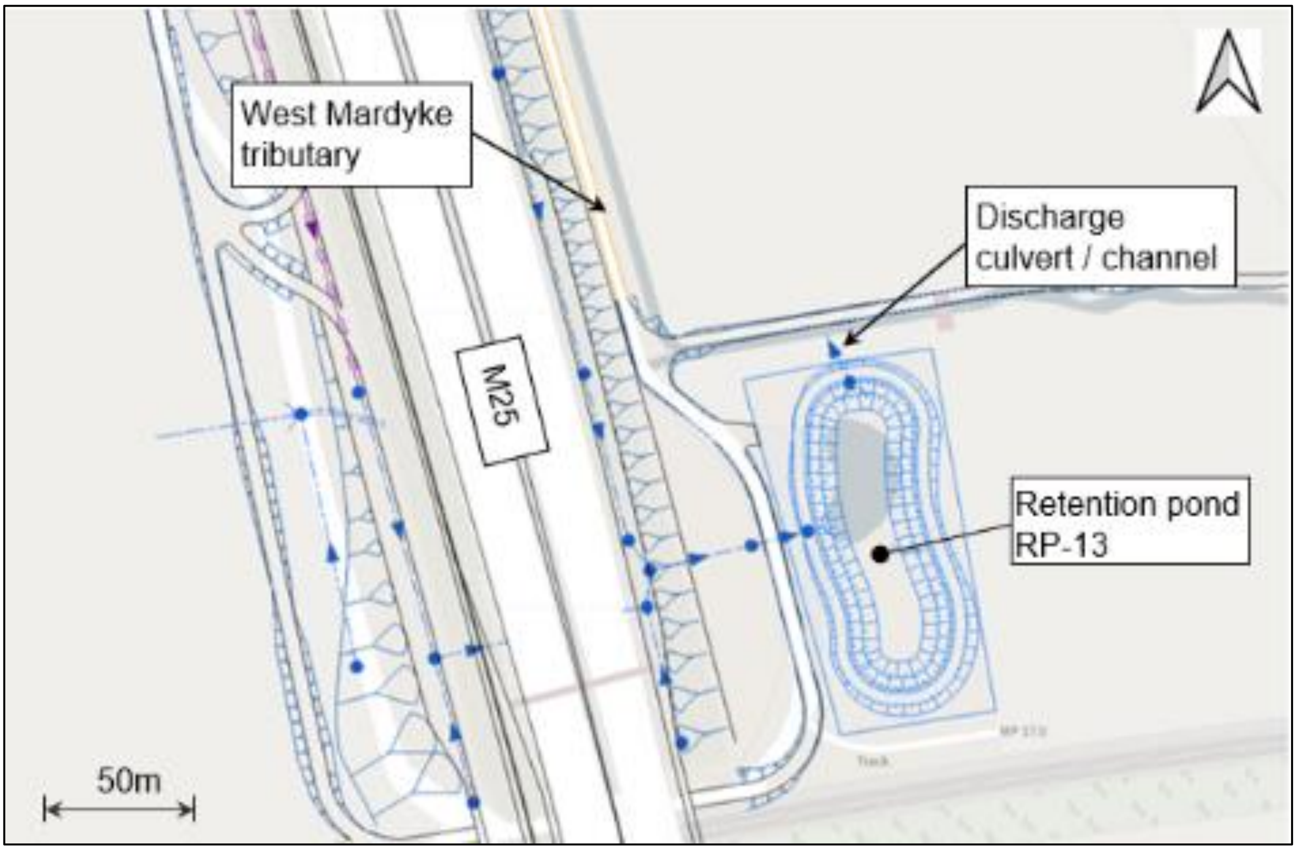
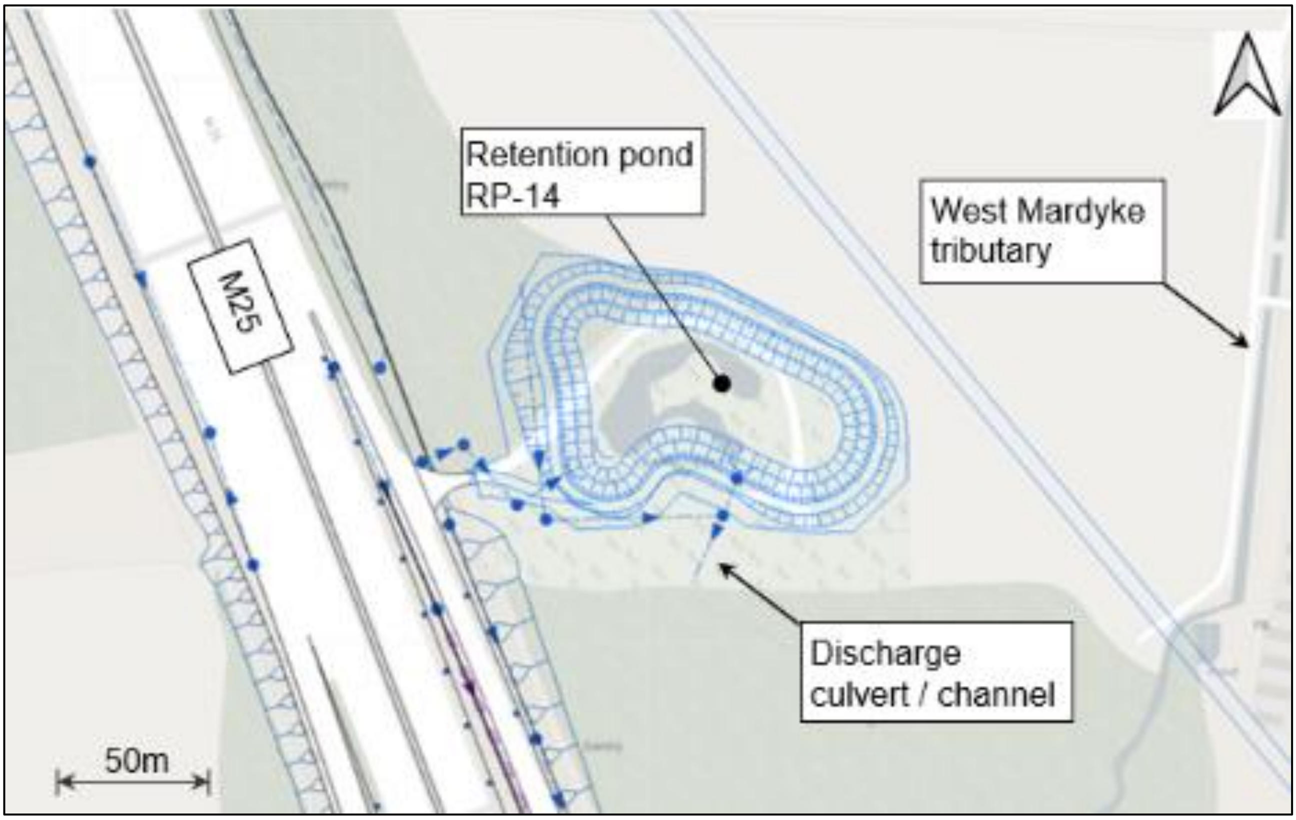


Plate 4.11 Retention pond RP-14



Changes to junction 29 existing drainage

4.4.13 Drainage provisions in the vicinity of M25 junction 29 comprise a number of small networks that discharge freely into the watercourse running north to south across the junction.

4.4.14 Development in the vicinity of M25 junction 29 would include provision of new paved areas. To drain these areas, some of these drainage networks would need to be extended. It is also possible that new networks would need to be established if the new paved areas cannot reasonably be incorporated within one of the existing networks.

4.4.15 To avoid the need for complex flow control measures within the extended networks around M25 junction 29, they would continue to discharge freely into the watercourse so far as is practicable, and the existing outfalls would be retained. Similarly, any new networks would also discharge freely into the watercourse.

4.4.16 The new paved areas served by the extended and new drainage networks would result in a net increase in the peak runoff rate. As flow control measures would not be incorporated in these networks, alternative measures would be needed to offset the increased peak runoff rate.

4.4.17 The net increase in peak runoff rate would be partially offset by incorporating some simple attenuation measures. Storage for the attenuation would be provided by incorporating oversized pipes in the new and extended networks, and flow control would be accomplished by incorporating throttling pipework downstream of the storage.

4.4.18 Any residual offsetting required to reduce the net peak runoff rate would be achieved by reducing the discharge rates from the retention ponds either side of the junction.

4.4.19 Discharge rates from the retention ponds would be further reduced to accommodate a reduction on the net discharge rate from the existing networks as required by the LLFA (see Section 4.2).

Summary

4.4.20 The modifications that would be undertaken at each existing retention pond in Catchment EFR-5 are summarised in Table 4.1 along with their retained discharge location.

Table 4.1 Catchment EFR-5 – Summary of existing retention ponds

Pond	Model ref(1)	Discharge location	Capacity increase	Pollution control(2)	Flow control	
					Attenuate(3)	Isolate(4)
RP-10	POS13-001	West Mardyke	✓	LSF	✓	✓
RP-11	POS14-001	West Mardyke	✓	LSF	✓	✓
RP-13	POS14-003	Mardyke tributary	✓	LSF	✓	✓
RP-14	POS14-005	Mardyke tributary	✓	LSF	✓	✓

Legend
LSF – Lined sediment forebay
A summary of the new retention ponds proposed for Catchment EFR-5 is presented in Table 4.2.

Notes:
The model reference is the reference given to this facility in the hydraulic modelling prepared for the design. It is included here for information and for cross referencing with the models and other parts of the ES.
Where included, sediment forebays would be lined.
Flow control is required to regulate discharge to watercourses.

4.4.21 Penstocks (or other appropriate flow control device) would be used for isolating the retention pond networks in the event of an accidental spillage.

Table 4.2 Catchment EFR-5 – Summary of proposed retention ponds

Pond	Model ref(1)	Discharge location	Capacity increase	Pollution control(2)	Flow control	
					Attenuate(3)	Isolate(4)
RP-09	POS13-002	West Mardyke	N/A	LSF	✓	✓
RP-12	POS14-002	Drainage ditch	N/A	LSF	✓	✓

Legend
LSF – Lined sediment forebay

Notes:
The model reference is the reference given to this facility in the hydraulic modelling prepared for the design. It is included here for information and for cross referencing with the models and other parts of the ES.
Where included, sediment forebays would be lined.
Vortex separators (or other appropriate pollution control devices) would be included immediately upstream of the pond/basin.

4.4.22 Penstocks (or other appropriate flow control device) would be used for isolating the basins in the event of a spillage (see paragraph 4.6.2).

Text box 4.4 Catchment EFR-5 – Drainage design

For catchment EFR-5, four existing retention ponds would be retained, and two new retention ponds would be constructed.

Existing ponds would also be modified to suit the needs of the Project.

To accommodate a reduction in rate of discharge, the four existing retention ponds would be enlarged. The reduced flow would afford flood mitigation to areas downstream of the ponds.

Existing networks around junction 29 of the M25 would be augmented to accommodate any increase in catchment areas resulting from the Project.

4.5 Flood risk and drainage

Introduction

4.5.1 Flood risks directly associated with the drainage strategy for Catchment EFR-5 are outlined below. Details of other flood risks are presented in Part 6 of the FRA.

Maintenance

4.5.2 Maintenance of a drainage system is required to ensure its effective operation. Failure to maintain a drainage system increases the risk that the system could be overwhelmed, and this could result in flooding in the carriageway.

4.5.3 Drainage infrastructure and treatment systems would be maintained and inspected in accordance with DMRB GM 701 (Highways England, 2020a) and DMRB GS 801 (Highways England, 2020b) to ensure that the highway drainage system is kept in full working order. [RDWE012]

Perched groundwater

4.5.4 Where permeable or partly permeable strata overlie less permeable strata there is potential for perched water to occur. If perched water is intercepted (e.g. by cuttings or by local topographic change), there is potential for groundwater to emerge locally.

4.5.5 On account of their highly localised nature, identification of all occurrences of perched groundwater is difficult. If perched groundwater is encountered in cuttings, it would most likely occur as localised seepages only.

4.5.6 This risk could be mitigated by provision of drainage networks incorporating an appropriate edge of pavement detail, such as combined surface and sub-surface drains (DMRB CD 524, Highways England, 2021a).

Text box 4.5 Catchment EFR-5 – Flood risk and drainage

A planned maintenance programme would be established to ensure that the drainage system operates effectively.

Perched water may be encountered in cuttings. If perched groundwater is encountered, it would most likely occur as localised seepages only. This risk could be mitigated by provision of drainage networks incorporating an appropriate edge of pavement detail, such as combined surface and sub-surface drains.

4.6 Pollution control and water quality

Pollution control

4.6.1 Retention ponds provide an effective pollution control measure for highway runoff, provide for settlement of suspended sediments and treatment of dissolved metals.

4.6.2 In addition to the pollution control measures outlined in paragraph 4.3.14, a flow control device would be included between retention pond outlets and receiving watercourses. This flow control device would be used to protect the watercourse in the event of an accidental spillage and would be included regardless of whether designated containment provision is made. Typically, penstocks would be used for flow control. [RDWE035]

Water quality

4.6.3 An assessment has been undertaken to determine the pollution risks to surface water bodies that would receive discharges of highway drainage from the Project. The assessment considers pollution risks from the following:

a. Routine runoff

b. Accidental spillages

4.6.4 The assessment has been undertaken in accordance with the methodologies set out in the DMRB LA 113 (Highways England, 2020c). These methods have been implemented using the Highways England Water Risk Assessment Tool (HEWRAT) and the Water Framework Directive UK Technical Advisory Group Metals-Bioavailability Assessment Tool (M-BAT).

4.6.5 Measures embedded in the drainage design to treat and attenuate runoff prior to discharge have been factored into the routine runoff pollution assessment. The results of assessment demonstrated that the embedded treatment measures would safeguard the water quality of receiving watercourses.

4.6.6 The accidental spillage risk assessment concluded that when treatment measures are taken into account, the calculated probability of a spillage causing a serious pollution incident would be below the thresholds set in the assessment criteria.

4.6.7 Full details of the assessment are provided in the Operational Surface Water Drainage Pollution Risk Assessment (ES Appendix 14.3, Application Document 6.3).

Text box 4.6 Catchment EFR-5 – Surface water quality

Runoff from the Project road would be treated to a level that is acceptable for disposal by discharge to a surface water bodies.

Water quality assessments have been undertaken to investigate likely impacts that highway runoff from the Project would have on the water quality of receiving watercourses.

The assessment has been undertaken in accordance with the methodologies set out in DMRB LA 113 (Highways England, 2020c) and concluded pollution risk from routine runoff and from accidental spillages would not cause an undue risk to the water environment.

5 Greenfield runoff rate

5.1 Introduction

5.1.1 The greenfield runoff rate for a site is used to define the allowable rate of discharge from a development without increasing downstream flood risk.

5.1.2 Greenfield runoff rates inform the drainage design and facilitate the design of flow attenuation facilities. This section details the methodology used to calculate the greenfield runoff rate.

5.2 Assessment of greenfield runoff rates

Methodology

5.2.1 There are several methods that can be used to estimate greenfield runoff rate. DMRB CD 522 (Highways England, 2020d) recommends calculation of flood flows for road design would be by one of the following:

a. Flood Estimation Handbook (FEH)

b. Institute of Hydrology Report 124 (IH124)

5.2.2 The FEH is published by the Centre for Ecology and Hydrology (2008) and details the statistical method and the Revitalised Flood Hydrograph (ReFH2) method. The FEH is the industry standard method for flood estimation.

5.2.3 The FEH statistical method is based on the analysis of all available suitable flood flow records from gauging stations throughout the UK. The method comprises the estimation of an index flood and a growth curve that can be applied to the index flood.

5.2.4 The ReFH2 design hydrograph method is the most up-to-date version of the FEH's rainfall-runoff approach to flood estimation. The ReFH2 is a software-based method in which design storm estimates are routed through a catchment, resulting in estimated peak flow and runoff volume.

5.2.5 IH124 is a document that was issued in 1994 by the Institute of Hydrology. It is an extension of the Flood Studies Report (FSR) work aimed at providing a better estimate of peak runoff flow rates for small catchments than had been previously developed.

5.2.6 Report SC030219, Rainfall runoff management for urban developments, is a joint publication by the Department for Environment, Food and Rural Affairs, and Environment Agency (2013). This report notes that all the methods detailed above are valid and acceptable. The report acknowledges that the FEH methods often provide better estimates of peak flow than IH124, but unlike IH124, they require proprietary data. The report adds that none of the methods can be assumed to provide the correct value. Table 1 of Report SC030219 summarises the methods to be used for calculation of greenfield runoff peak flow rates. The table notes that for developments of up to 50ha (0.5km^2) the IH124 method and the FEH statistical method are appropriate. For sites with areas greater than 50ha, Table 1 of Report SC030219 notes that all three methods detailed above are appropriate.

5.2.7 As none of the highway catchments exceed 50ha, the IH124 method and the FEH statistical method would be used to calculate greenfield runoff rates.

Allowances

5.2.8 There are two conditions where the greenfield runoff rate is not applied to define the limiting discharge rates. These are as follows:

c. The minimum value of Q_{BAR}[10] for a site would be set 1l/s/ha. Low values of Q_{BAR} are seen as being an unreasonable requirement as they result in generating very large storage requirements.

d. A practicable minimum limit on the discharge rate from a flow control device is often a compromise between attenuating to a satisfactorily low flow rate while keeping the risk of blockage to an acceptable level. For the Project, the minimum flow rate from a flow control device would be set at 1l/s.

Greenfield runoff rates by highway catchment

5.2.9 The FEH statistical method and the IH124 method, are set out in Annex B.

5.2.10 Greenfield runoff rates for each drainage catchment, as calculated by the FEH statistical method and the IH124 method, are presented in Annex D.

Text box 5.1 Calculation of greenfield runoff rate

> The greenfield runoff values derived by established methods should be regarded as approximate. The primary objective of using an agreed method is to provide a consistent approach and a reasonable estimate on which to base design.
>
> DMRB CD 522 (Highways England, 2020d) recommends calculations of flood flows for road design should be by the Flood Estimation Handbook (FEH) method or the Institute of Hydrology Report 124 (IH124) method.

[10] Q_{BAR} is the peak rate of flow from a catchment for the mean annual flood (a return period of approximately 1:2.3 years)

6 Summary

6.1 Highway drainage strategy

6.1.1 To the south of the River Thames, the highway drainage strategy for the operational phase of the Project would primarily be based on the use of gravity drainage networks that outfall to infiltration basins.

6.1.2 To the north of the River Thames, the highway drainage strategy for the operational phase of the Project would primarily be based on the use of gravity drainage networks that outfall to retention ponds prior to discharge to watercourses.

6.1.3 The exceptions to the above comprise the networks that drain the tunnel portal ramps, each of which would include a pumping station. Also, there is one infiltration pond and one detention basin to the north of the River Thames.

6.2 Design standards

6.2.1 The principal design standards that would be used to develop the highway drainage would comprise the following:

a. DMRB CG 501 Design of highway drainage systems (National Highways, 2022).

b. DMRB CD 532 - Vegetated drainage systems for highway runoff. (Highways England, 2021b).

6.2.2 A full list of all the standards, guidance and legislation that would be used to inform design development is included in Section 7.

6.3 Sustainable Drainage Systems (SuDS)

6.3.1 SuDS have been incorporated into the preliminary design where possible and practicable. A summary of the SuDS features that would be included in the highway drainage design is presented in Table 6.1.

Table 6.1 Summary of SuDS features

SuDS feature	Flood Catchment				
	EFR-1	EFR-2	EFR-3	FRR-4	EFR-5
Infiltration basin	✓		✓		
Retention pond		✓	✓	✓	✓
Detention basin		✓			
Swale			✓	✓	
Flow attenuation		✓	✓	✓	✓

6.4 Retention basins

6.4.1 Retention ponds included in the project are summarised in Table 6.2.

Table 6.2 Summary of retention ponds

Pond ref.	Model ref.(1)	Status(2)	Flood catchment	Discharge location	Pollution control(3)	Flow control	
						Attenuate(4)	Isolate(5)
RP-01	POS08-001	New	EFR-2	West Tilbury Main	LSF	✓	✓
RP-02	POS08-002	New	EFR-2	Pond PR-01	LSF	✓	✓
RP-03	POS08-003	New	EFR-2	West Tilbury Main	LSF	✓	✓
RP-04	POS10-01	New	EFR-2	Unnamed OWC	FL	✓	✓
RP-05	POS11-001	New	EFR-4	Orsett Fen Sewer	LSF	✓	✓
RP-06	POS11-002	New	EFR-4	Orsett Fen Sewer	LSF	✓	✓
RP-07	POS12-001	New	EFR-4	Unnamed OWC	LSF	✓	✓
RP-08	POS12-002	New	EFR-4	Mardyke	LSF	✓	✓
RP-09	POS13-002	Existing	EFR-5	West Mardyke	LSF	✓	✓
RP-10	POS13-001	Existing	EFR-5	West Mardyke	LSF	✓	✓
RP-11	POS14-001	Existing	EFR-5	West Mardyke	LSF	✓	✓
RP-12	POS14-002	New	EFR-5	Unnamed OWC	LSF	✓	✓
RP-13	POS14-003	Existing	EFR-5	Unnamed OWC	LSF	✓	✓
RP-14	POS14-005	New	EFR-5	Unnamed OWC	LSF	✓	✓

Legend
LSF Lined sediment forebay
FL Fully lined

Notes:
The model reference is the reference given to this facility in the hydraulic modelling prepared for the design. It is included here for information and for cross referencing with the models and other parts of the ES.
Where included, sediment forebays would be lined.
Discharge from retention ponds would be attenuated in accordance with the requirements of the Environment Agency (main rivers) or appropriate LLFA for ordinary watercourses.

6.5 Infiltration basins

6.5.1 The highway drainage network would include 10 infiltration basins, of which three are existing and seven would be new. A summary of existing and proposed infiltration basins is presented in Table 6.3.

Table 6.3 Summary of infiltration basins

Pond	Model ref.(1)	Flood catchment	Status	Pollution control(2)	Isolation provision(3)
IB-01	POS08-001	EFR-1	Existing (modified)	LSF	✓
IB-02	POS08-002	EFR-1	Proposed	LSF	✓
IB-03	POS08-003	EFR-1	Existing (modified)	PCD	✓
IB-04	POS10-01	EFR-1	Proposed	LCD	✓
IB-05	POS11-001	EFR-1	Proposed	LSF	✓
IB-06	POS11-002	EFR-1	Proposed	PCD	✓
IB-07	POS12-001	EFR-1	Existing (modified)	LSF	✓
IB-08	POS12-002	EFR-1	Proposed (cascaded basin)	LSF	✓
IB-09	POS04-001	EFR-1	Proposed (cascaded basin)	LSF	✓
IB-10	POS11-003	EFR-3	Proposed	PCD	✓

Legend
LSF Lined sediment forebay
PCD Pollution control device

Notes:
The model references are the reference given to the basins in the hydraulic models prepared for the drainage design. It is included here for information and for cross-referencing with documents that only use model references to denote the basins.
Where included, sediment forebays would be lined.
Penstocks (or other appropriate flow control device) would be used for isolating basins in the event of a spillage.

6.6 Greenfield runoff

6.6.1 DMRB CD 522 (Highways England 2020d) recommends calculations of flood flows for road design should be by the FEH method or the IH124 method.

6.6.2 The greenfield runoff values derived by the FEH or IF124 methods should be regarded as approximate. The primary objective of using an agreed method is to provide a consistent approach and a reasonable estimate on which to base design.

6.7 REAC and Design Principles

6.7.1 The REAC entries applicable to the drainage strategy are summarised in Table 6.4.

Table 6.4 REAC entries for the drainage strategy

REAC	Name
RDWE012	Operational drainage maintenance
RDWE025	Operational drainage design (treatment train)
RDWE032	Potable groundwater protection
RDWE034	Operational drainage (infiltration basins)
RDWE035	Operational drainage (retention ponds)
RDWE048	Operational drainage (detention basins)

6.7.2 The Design Principles (Application Document 7.5) that apply to the drainage strategy are summarised in Table 6.5.

Table 6.5 Design Principles for the drainage strategy

Design Principle	Name
Para 1.2.12	Highway drainage
LPS.17	Pond and basin integration
S2.08	A2 junction infiltration basins
TBC	Use of SuDS
TBC	Conveyance of runoff

References

Centre for Ecology and Hydrology (2008). Flood Estimation Handbook.

Centre for Ecology and Hydrology (2020). Flood Estimation Handbook Web Service. Accessed December 2021. https://fehweb.ceh.ac.uk/

Department for Environment, Food and Rural Affairs, and Environment Agency (2013). Delivering benefits through evidence: Rainfall runoff management for developments. Report SC030219. Accessed September 2020. https://www.gov.uk/government/publications/rainfall-runoff-management-for-developments

Department for Environment, Food and Rural Affairs, and Environment Agency (2014). Guidance - Reservoirs: owner and operator requirements. Accessed December 2021. https://www.gov.uk/guidance/reservoirs-owner-and-operator-requirements

Environment Agency (2022). Guidance - Flood risk assessments: climate change allowances. https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Highways England, HADDMS - Drainage Data Management System. Accessed September 2022

Greater London Authority, The London Plan, March 2021. https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf

Highways England (2020a). Design Manual for Roads and Bridges, GM 701 - Asset delivery asset maintenance requirements. March 2020. https://www.standardsforhighways.co.uk/dmrb/

Highways England (2020b). Design Manual for Roads and Bridges, GS 801 - Asset delivery asset inspection requirements. March 2020. https://www.standardsforhighways.co.uk/dmrb/

Highways England (2020c). Design Manual for Roads and Bridges, LA 113 - Road drainage and the water environment. March 2020. https://www.standardsforhighways.co.uk/dmrb/

Highways England (2020d). Design Manual for Roads and Bridges, CG 522 - Drainage of runoff from natural catchments. March 2020. https://www.standardsforhighways.co.uk/dmrb/

Highways England (2021a). Design Manual for Roads and Bridges, CD 524 - Edge of pavement details. November 2021. https://www.standardsforhighways.co.uk/dmrb/

Highways England (2021b). Design Manual for Roads and Bridges, CD 532 - Vegetated drainage systems for highway runoff. November 2021. https://www.standardsforhighways.co.uk/dmrb/

National Highways (2022). Design Manual for Roads and Bridges, CG 501 - Design of highway drainage systems. Version 2.1.0. Accessed August 2022. https://www.standardsforhighways.co.uk/dmrb/

HR Wallingford (2020). UK SuDS website. Accessed September 2020. https://www.uksuds.com/

Institute of Hydrology (1983). Review of Regional Growth Curves. Flood Studies Supplementary Report No.14. Wallingford: Institute of Hydrology.

Institute of Hydrology (1994). Report No. 124, Flood estimation for small catchments (IH124). June 1994. http://nora.nerc.ac.uk/id/eprint/7367/1/IH_124.pdf

Institute of Hydrology (1995). Report No. 126, Hydrology of soil types: a hydrologically based classification of the soils of the United Kingdom. November 1995. http://nora.nerc.ac.uk/id/eprint/7369/1/IH_126.pdf

London Borough of Havering (2008). Core Strategies and Development Control Policies - Development Plan Document. https://www.havering.gov.uk/download/downloads/id/1632/core_strategy_development_control.pdf

Natural Environment Research Council (NERC) (1975), Flood Studies Report.

Annexes

Annex A Climate change allowances

A.1 Carriageway drainage

A.1.1 Climate change allowances for carriageway design are calculated in accordance with the provisions of DMRB CG 501 (2022).

A.1.2 This standard stipulates that a 20% uplift is applied to peak rainfall intensity and that a sensitivity test is undertaken with a 40% uplift applied to peak rainfall intensity.

A.1.3 These uplifts are based on the understanding that some short duration flooding on highways is acceptable. They are not supposed to replicate the Environment Agency’s guidance on climate change allowances for flood risk assessments (Environment Agency, 2022).

A.2 Other elements of the drainage design

A.2.1 Peak rainfall intensity allowances for other elements of the drainage design are based on management catchments. The Project lies across the Medway Management Catchment and the South Essex Management Catchment. Table A.1 shows anticipated changes in rainfall intensity by management catchment (Environment Agency, 2022).

Table A.1 Peak rainfall allowances by catchment

Epoch	Allowance for 1% AEP event			
	South Essex		Medway	
	Central	Upper end	Central	Upper end
2050s epoch (2022 and 2060)	20%	45%	20%	45%
2070s epoch (2061 and 2125)	25%	40%	20%	40%

Note: These peak rainfall allowances are for small catchments (less than 5km^2).

A.2.2 The Environment Agency’s guidance on climate change allowances (Environment Agency, 2022) notes that the method of application of peak rainfall intensities depends upon the lifetime of the development.

A.2.3 The Project is planned to become operational in 2030 and have a minimum lifetime of 100 years (i.e., up to at least 2130). The guidance stipulates that for developments with a lifetime beyond 2100, flood risk assessments should assess the upper end allowances for both the 1% and 3.3% AEP events for the 2070s epoch (2061 to 2125).

A.2.4 The guidance goes on to state that development shall be designed so that for the upper end allowance in the 1% AEP event:

a. There is no increase in flood risk elsewhere.

b. The development will be safe from surface water flooding.

A.2.5 Notwithstanding the above, the Environment Agency’s guidance notes that in some locations, the allowance for the 2050s epoch is higher than that for the 2070s epoch. The guidance states that where this is the case, and development has a lifetime beyond 2061, the higher of the two allowances should be adopted.

A.2.6 As the latest version of the guidance on climate change allowance was published after the drainage design for the Project was undertaken, the Environment Agency permitted a departure on peak rainfall allowances. Peak rainfall allowances by catchment for other elements of the drainage are presented in Table A.2.

Table A.2 Peak rainfall allowances by catchment for the Project

Epoch	Allowance for 1% AEP event			
	South Essex		Medway	
	Central	Upper end	Central	Upper end
2070s epoch (2061 and 2125)	20%	40%	20%	40%

Note: These peak rainfall allowances are for small catchments (less than 5km^2).

Annex B Greenfield runoff rate

B.1 FEH statistical method

Introduction

B.1.1 The FEH statistical method produces a value for the index flood (Q_{MED}) which is the median of the set of annual maximum flow peaks and is equivalent to approximately the 1 in 2-year flow rate. Calculating the flows from different return period events comprises four stages:

a. Determine Q_{MED}

b. Derive an appropriate growth curve

c. Evaluate the full flood frequency curve

d. Convert Q_{MED} to Q_{BAR}

Determine Q_{MED}

B.1.2 The index flood can be computed from relevant observed flows or can be calculated using the correlation formula below. In the absence of observed flows, the correlation formula would be used to calculate the index flood.

Equation A1
$Q_{MED} = 8.3062 \times AREA^{0.8510} \times 0.1536^{(1000/SAAR)} \times FARL^{3.4451} \times 0.0460^{(BFIHOST \times BFIHOST)}$

Where:

Q_{MED}	Median annual flow rate; the two-year event
FARL	Measurement of water bodies in the catchment
AREA	Area of the catchment (km^2)
SAAR	Standard average annual rainfall
BFIHOST	Base flow index

B.1.3 The value for standard average annual rainfall (SAAR) is available from the Flood Studies Report (FSR) or from the Centre for Ecology and Hydrology's (2020) FEH Web Service. The average rainfall is based on data for the period 1941–1970. For further information on the FEH Web Service, refer to Annex C.

B.1.4 FARL is an index of flood attenuation by reservoirs and lakes. This figure is obtained from the FEH Web Service.

B.1.5 BFIHOST is derived using the Hydrology of Soil Types (HOST) classification. The HOST classification is a hydrogeological classification of soils of the United Kingdom (Institute of Hydrology, 1995). This figure is also obtained from the FEH Web Service.

B.1.6 If the catchment is less than 50ha, the nearest hydrologically comparable catchment of 50ha or greater should be used to calculate the runoff and then factored down by the ratio of the site size to the catchment area.

Derive an appropriate growth curve

B.1.7 The preferred technique for derivation of a growth curve when using FEH statistical method depends upon whether the site is gauged or ungauged. For gauged sites, the flood growth curve is derived by applying flood frequency analysis techniques on actual data. For ungauged sites, the growth curve is calculated using proprietary software which analyses pooled data from several hydrologically similar catchments.

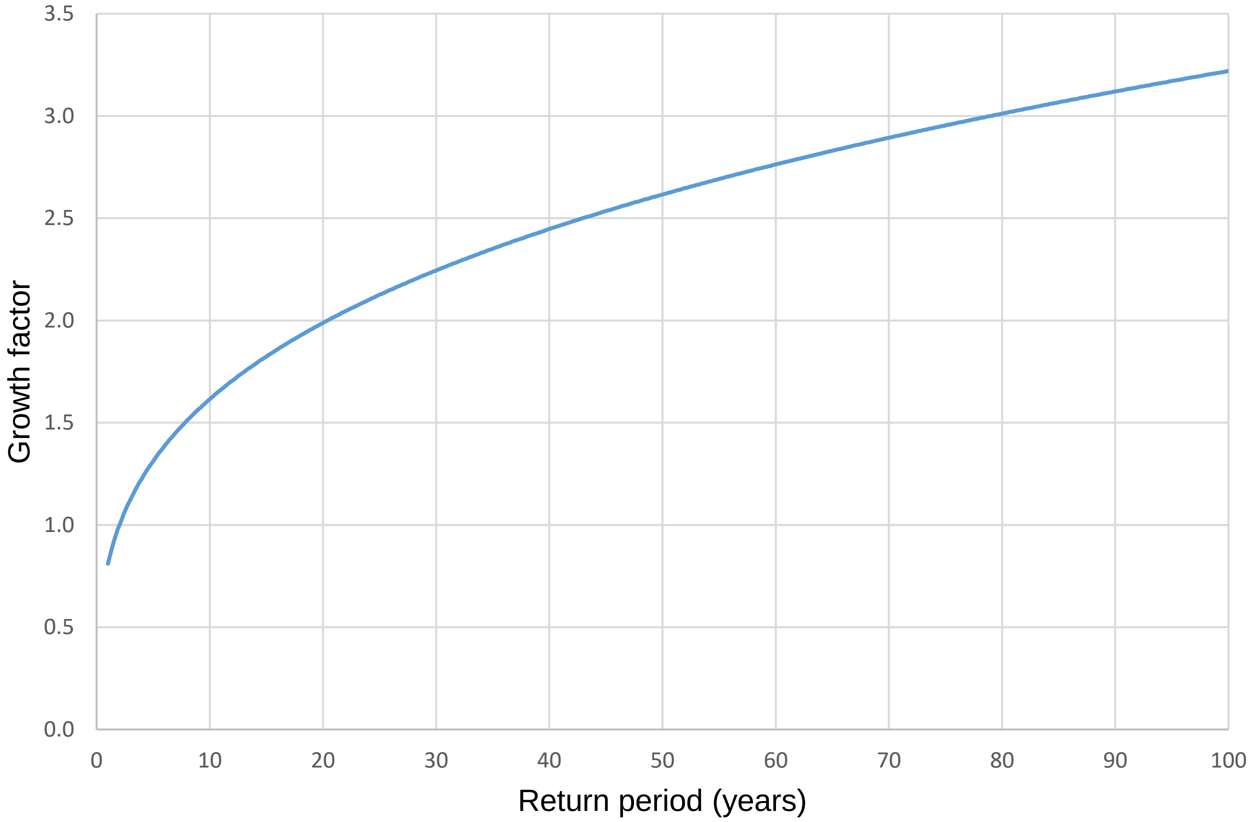
B.1.8 As actual data for the site and appropriate proprietary software are not available to the Project, the regionally derived FSR growth curve published by NERC (1977 and 1993) has been used to approximate an appropriate growth curve.

B.1.9 The UK was divided into 10 hydrological regions by the FSR. The growth curves are defined by the hydrological region into which the development falls. The part of the development to the south of the River Thames lies in Hydrological Region 7 and the area to the north of the Thames lies in Hydrological Region 6. The growth curves for these two regions are the same. The growth factors for Regions 6/7 are shown in Table B.1. These factors have been used to generate the growth factor curve shown in Plate B.1.

Table B.1 Growth curve

Hydrological region	Return period (years)								
	1	2	5	10	25	30	50	100	500
Region 6/7	0.85	0.88	1.28	1.62	2.14	2.40	2.62	3.19	4.49

Plate B.1 Growth factor curve



Evaluate the full flood frequency curve

B.1.10 Peak flow rates for each return period are estimated by multiplying Q_{MED} by the relevant growth factor curve.

Convert Q_{MED} to Q_{BAR}

B.1.11 Flood Studies Supplementary Report No. 14 (FSSR 14) (Institute of Hydrology, 1983) can be used to convert Q_{MED} to Q_{BAR}. Conversion factors are also available from HR Wallingford's (2020) web-based Greenfield Runoff Rate Estimation Tool.

B.2 Institute of Hydrology Report 124 Method

Introduction

B.2.1 The IH124 method was developed for characterising the flood response in small catchments (areas not exceeding 25km^2). Calculating the flows from different return period events comprises three stages:

a. Estimate Q_{BAR}

b. Select appropriate growth curve

c. Evaluate the full flood frequency curve

Estimate Q_{BAR}

B.2.2 Q_{BAR} is estimated using the following equation:

Equation B2
$Q_{BAR} = 0.00108\ AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$

Where:

Q_{BAR} Mean annual flow rate for an event with a return of 2.3 years (l/s)

AREA Area of the catchment (km^2)

SAAR Standard average annual rainfall (mm)

SOIL Soil Index

B.2.3 SOIL indices (1 to 5) are defined in the Flood Studies Report (Natural Environment Research Council (NERC), 1975). The index describes the maximum runoff potential and was derived by a consideration of soil permeability and topographic slope.

B.2.4 The value for standard annual rainfall (SAAR) is available from the Flood Studies Report (FSR) or from the Centre for Ecology and Hydrology's (2020) FEH Web Service. The average rainfall is based on data for the period 1941-1970. For further information on the FEH Web Service, refer to Annex C.

Select an appropriate growth curve

B.2.5 Q_{BAR} can be factored for the regional growth curve to obtain the peak flow estimates for required return periods.

B.2.6 The recommended growth curves for the IH124 method are the regionally derived FSR growth curve published by NERC (1977 and 1993).

B.2.7 The UK was divided into 10 hydrological regions by the FSR. The growth curves are defined by the hydrological region into which the development falls. The part of the development to the south of the River Thames lies in Hydrological Region 7 and the area to the north of the Thames lies in Hydrological Region 6. The growth curve for these two regions is the same. The growth factors for Regions 6/7 are shown in Table B.1. These factors have been used to generate the growth factor curve shown in Plate B.1.

Evaluate the full flood frequency curve

B.2.8 Peak flow rates for each return period are estimated by multiplying Q_{BAR} by the relevant growth factor curve.

Annex C FEH Web Service

C.1.1 The Centre for Ecology and Hydrology (2020) FEH Web Service provides the data and rainfall model outputs that are at the core of the flood frequency estimation procedures set out in the Flood Estimation Handbook (FEH) (Centre for Ecology and Hydrology, 2008). This service provides catchment data (depicters) for numerous sites across the UK.

C.1.2 The catchment sites through which the highway is routed have been identified and appropriate depicters extracted (SAAR, FARL and BFIHOST).

C.1.3 Some of the catchments overlap and there are some gaps for areas that do not fall within a suitable catchment (e.g. catchments that include large urbanised areas and are thus not representative of the development area). Where gaps occur, depicters have been interpolated using adjacent or topographically similar catchments. Where catchments overlap, the smaller or most topographically representative catchment has been used to define the depicters.

Annex D Greenfield runoff rates

D.1.1 Greenfield runoff rates for each drainage catchment, as calculated by the FEH statistical method and the IH124 method, are presented below in HE540039-CJV-EFR-GEN-CALC-ENV-0300.

LOWER THAMES CROSSING

Calculation	HE540039-CJV-EFR-GEN-CALC-ENV-0300	Version	1.0
		Serial	CALC-001
Subject:	Greenfield Runoff Rates	Prepared by	ICF
		Prepared by	26-Aug-22
Sub-subject:	Title Sheet	Checked by	-
		Date	-

STATUS	
Preliminary	✓
Tender	
Final	
Construction	
Other (state)	

LEVEL OF VERIFICATION	
Self-check by originator	
Self-check by originator and approval	✓
Check and approval	
Detailed check and approval	
External check and internal approval	

CONTENTS

(yellow)	Manual input
(white)	No input required

Version	Status	Description	Approved by	Date
1.0	Preliminary	DCO Application	MW	21-Oct-22
			-	-
			-	-
			-	-
			-	-
			-	-
			-	-
			-	-

LOWER THAMES CROSSING

Calculation	HE540039-CJV-EFR-GEN-CALC-ENV-0300	Version	1.0
		Serial	CALC-002
Subject:	Greenfield Runoff Rates	Prepared by	ICF
		Date	26-Aug-22
Sub-subject:	FEH Statistical Method	Checked by	-
		Date	-

Objectives

1 Assessment of greenfield runoff rates using FEH Statistical Method

2 Comparison of the results with UK SuDS online tool and MicroDrainage Software

3 Assessment of greenfield runoff rates by storm event

Notes

These calculations should be used in conjunction with Drawing HE540039-CJV-EFR-SZP_DCZZZZZZZZ-DR-LF-00190 to 00192

Formula

QMED = 8.3062 x (0.01 x AREA)^0.8510 x 0.1536^(1000/SAAR) x FARL^3.4451 x 0.0460^(BFIHOST x BFIHOST)

Where:

QMED	Median annual flow rate; the 1:2 year event (m^3/s)	
FARL	Measurement of water bodies in the catchment.	FEH website (acquired purchase)
AREA	Area of the catchment (ha).	
SAAR	Standard average annual rainfall (mm)	FEH website (acquired purchase)
BFIHOST	Base flow index	FEH website (acquired purchase)

$QMED_{RURLA}$ to $QBAR_{RURAL}$ conversion factor 1.136 HR Wallingford - Greenfield Runoff Rate Estimation

A Table of runoff rates by FEH catchment is given in Table CALC-001-1

LOWER THAMES CROSSING

Calculation	HE540039-CJV-EFR-GEN-CALC-ENV-0300	Version	1.0
		Serial	CALC-002
Subject:	Greenfield Runoff Rates	Prepared by	ICF
		Date	26-Aug-22
Sub-subject:	FEH Statistical Method	Checked by	-
		Date	-

Table CALC-002-1: Greenfield Runoff Rates - FAH Method

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)
FEH Catchment	AREA	SAAR6190	SOIL	FARL	BIFHOST	$QMED_{RURAL}$	$QBAR_{RURAL}$	AREA	$QMED_{RURAL}$	$QBAR_{RURAL}$
	(ha)	(mm)				(l/s)	(l/s)	(ha)	(l/s)	(l/s)
01	50	638	0.30	1.000	0.822	30.50	34.64	50	30.50	34.64
02	50	628	0.10	1.000	0.764	38.63	43.89	50	38.63	43.89
03	50	621	0.10	0.914	0.791	24.08	27.35	50	24.08	27.35
04	50	606	0.10	1.000	0.862	21.22	24.11	50	21.22	24.11
05	50	572	0.37	1.000	0.896	14.69	16.69	50	14.69	16.69
06	50	568	0.37	1.000	0.897	14.28	16.22	50	14.28	16.22
07	50	545	0.30	1.000	0.833	17.47	19.85	50	17.47	19.85
08	50	543	0.30	1.000	0.862	14.83	16.84	50	14.83	16.84
09	50	546	0.47	1.000	0.882	13.57	15.42	50	13.57	15.42
10	50	546	0.47	1.000	0.867	14.71	16.71	50	14.71	16.71
11	50	551	0.47	1.000	0.377	99.17	112.66	50	99.17	112.66
12	50	544	0.47	1.000	0.423	84.75	96.28	50	84.75	96.28
13	50	545	0.47	1.000	0.427	84.40	95.88	50	84.40	95.88
14	50	551	0.47	0.959	0.593	45.04	51.16	50	45.04	51.16
15	50	558	0.47	1.000	0.437	89.04	101.15	50	89.04	101.15
16	50	589	0.47	1.000	0.210	167.00	189.72	50	167.00	189.72
17	50	564	0.47	0.990	0.266	129.07	146.62	50	129.07	146.62

Notes

(a) The minimum value for AREA in column (B) is 50 ha (this cell will be calculated automatically).

(b) The value of AREA in column (I) is the actual area of the catchment.

(c) For actual areas under 50ha, the value of $QBAR_{RURAL}$ and $QMED_{RURAL}$ are calculated on a linear regression basis.

(d) The min value of $QBAR_{RURAL}$ is 1 l/s (adjusted automatically)

(e) The min value of $QBAR_{RURAL}$ per ha is 1 l/s/ha

Growth Factors

Hydrological Zones	North of Thames	Zone 6	Defra - Report SC030219
	South of Thames	Zone 7	Defra - Report SC030219

	Growth Factors		
AEP	100%	20%	1%
Growth curve factor - Zone	0.85	1.28	3.19

CIRIA report C753 SuDS Manual - Table 24.2

Growth Curves for Zones 6 and 7 are the same.

Table CALC-002-1: Greenfield Runoff Rates with Growth Factored - FEH Method

(A)	(B)	(C)	(D)	(E	(F)	(G)	(H)	(I)
FEH Catchment	AREA	$QBAR_{RURAL}$	AED 100%	AED 20%	AED 1%	AED 100%	AED 20%	AED 1%
	(ha)	(l/s)	(l/s)	(l/s)	(l/s)	(l/s/ha)	(l/s/ha)	(l/s/ha)
01	50	34.64	29.45	44.34	110.51	0.59	0.89	2.21
02	50	43.89	37.30	56.17	139.99	0.75	1.12	2.80
03	50	27.35	23.25	35.01	87.26	0.47	0.70	1.75
04	50	24.11	20.49	30.86	76.91	0.41	0.62	1.54
05	50	16.69	14.19	21.36	53.24	0.28	0.43	1.06
06	50	16.22	13.79	20.76	51.74	0.28	0.42	1.03
07	50	19.85	16.87	25.40	63.31	0.34	0.51	1.27
08	50	16.84	14.32	21.56	53.73	0.29	0.43	1.07
09	50	15.42	13.10	19.73	49.18	0.26	0.39	0.98
10	50	16.71	14.21	21.39	53.32	0.28	0.43	1.07
11	50	112.66	95.76	144.20	359.37	1.92	2.88	7.19
12	50	96.28	81.84	123.24	307.14	1.64	2.46	6.14
13	50	95.88	81.50	122.73	305.86	1.63	2.45	6.12
14	50	51.16	43.49	65.49	163.20	0.87	1.31	3.26
15	50	101.15	85.98	129.47	322.67	1.72	2.59	6.45
16	50	189.72	161.26	242.84	605.19	3.23	4.86	12.10
17	50	146.62	124.63	187.67	467.72	2.49	3.75	9.35

LOWER THAMES CROSSING

Calculation	HE540039-CJV-EFR-GEN-CALC-ENV-0300	Version	1.0
		Serial	CALC-003
Subject:	Greenfield Runoff Rates	Prepared by	ICF
		Date	26-Aug-22
Sub-subject:	IH124 Method	Checked by	-
		Date	-

Objectives

1 Assessment of greenfield runoff rates using IH 124 Method
2 Comparison of the results with UK SuDS online tool and MicroDrainage Software
3 Assessment of greenfield runoff rates by storm event

Notes

These calculations should be used in conjunction with Drawing HE540039-CJV-EFR-SZP_DCZZZZZZZZ-DR-LF-00190 to 00192

Formula

$QBAR_{RURAL}$ = 0.00108 AREA^0.89 x SAAR^1.17 x SOIL^2.17

Where:

QBAR(rural)	Mean annual flood for an event with a return of 2.3 years (m^3/s)	
AREA	Area of the catchment (ha)	
SAAR	Standard annual rainfall (mm)	FEH website (acquired purchase)
SOIL	Soil Index	FEH website (acquired purchase)

$QMED_{RURLA}$ to $QBAR_{RURAL}$ conversion factor 1.136 HR Wallingford - Greenfield Runoff Rate Estimation

A Table of runoff rates by FEH catchment is given in Table CALC-001-1

Table CALC-003-1: Greenfield Runoff Rates - IH124 Method

(A) FEH Catchment	(B) AREA (ha)	(C) SAAR6190 (mm)	(D) SOIL	(E) $QBAR_{RURAL}$ (l/s)	(F) AREA (ha)	(G) $QBAR_{RURAL}$ (l/s)
01	50	638	0.30	81.75	50	81.75
02	50	628	0.10	7.40	50	7.40
03	50	621	0.10	7.30	50	7.30
04	50	606	0.10	7.10	50	7.10
05	50	572	0.37	113.41	50	113.41
06	50	568	0.37	112.48	50	112.48
07	50	545	0.30	67.99	50	67.99
08	50	543	0.30	67.70	50	67.70
09	50	546	0.47	180.50	50	180.50
10	50	546	0.47	180.50	50	180.50
11	50	551	0.47	182.43	50	182.43
12	50	544	0.47	179.73	50	179.73
13	50	545	0.47	180.11	50	180.11
14	50	551	0.47	182.43	50	182.43
15	50	558	0.47	185.15	50	185.15
16	50	589	0.47	197.24	50	197.24
17	50	564	0.47	187.48	50	187.48

Notes

(a) The minimum value for AREA in column (B) is 50 ha

(b) The value of AREA in column (F) is the actual area

(c) For actual areas under 50ha, the value of $QBAR_{RURAL}$ is calculated on a linear regression basis.

(d) If the actual area is more than 50ha, the actual area of the would be entered columns (B) and (G)

(e) The min value of $QBAR_{RURAL}$ is 5l/s

(f) The min value of $QBAR_{RURAL}$ per ha is 1 l/s/ha

(g) Appropriate depicters of SAAR have been extracted from the Flood Estimation Handbook (FEH) web service, supported by the Centre for Ecology and Hydrology (CEH).

LOWER THAMES CROSSING

Calculation	HE540039-CJV-EFR-GEN-CALC-ENV-0300	Version	1.0
		Serial	CALC-003
Subject:	Greenfield Runoff Rates	Prepared by	ICF
		Date	26-Aug-22
Sub-subject:	IH124 Method	Checked by	-
		Date	-

Growth Factors

Hydrological Zones	North of Thames	Zone 6	Defra - Report SC030219
	South of Thames	Zone 7	Defra - Report SC030219

	Growth Factors		
AEP	100%	0.20	0.010
Growth curve factor - Zone	0.85	1.28	3.19

CIRIA report C753 SuDS Manual - Table 24.2

Growth Curves for Zones 6 and 7 are the same.

Table CALC-003-1: Greenfield Runoff Rates with Growth Factored - IH124 Method

(A)	(B)	(C)	(D)	(E	(F)	(G)	(H)	(I)
FEF Catchment	AREA	$QBAR_{RURAL}$	AED 100%	AED 20%	AED 1%	AED 100%	AED 20%	AED 1%
	(ha)	(l/s)	(l/s)	(l/s)	(l/s)	(l/s/ha)	(l/s)	(l/s)
01	50	81.75	69.49	104.64	260.79	1.39	2.09	5.22
02	50	7.40	6.29	9.47	23.60	0.13	0.19	0.47
03	50	7.30	6.21	9.35	23.29	0.12	0.19	0.47
04	50	7.10	6.03	9.08	22.64	0.12	0.18	0.45
05	50	113.41	96.40	145.17	361.78	1.93	2.90	7.24
06	50	112.48	95.61	143.98	358.83	1.91	2.88	7.18
07	50	67.99	57.79	87.03	216.89	1.16	1.74	4.34
08	50	67.70	57.54	86.65	215.96	1.15	1.73	4.32
09	50	180.50	153.42	231.04	575.79	3.07	4.62	11.52
10	50	180.50	153.42	231.04	575.79	3.07	4.62	11.52
11	50	182.43	155.07	233.52	581.97	3.10	4.67	11.64
12	50	179.73	152.77	230.05	573.32	3.06	4.60	11.47
13	50	180.11	153.10	230.54	574.56	3.06	4.61	11.49
14	50	182.43	155.07	233.52	581.97	3.10	4.67	11.64
15	50	185.15	157.38	236.99	590.63	3.15	4.74	11.81
16	50	197.24	167.65	252.47	629.19	3.35	5.05	12.58
17	50	187.48	159.36	239.97	598.06	3.19	4.80	11.96

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