

Drainage Strategy and Maintenance Statement

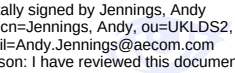
Brookleigh (Northern Arc)
Reserved Matters Application

Homes England

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Table of Contents

1.	Introduction.....	1
1.1	Background and Context	1
1.2	Document Purpose	1
1.3	Site Location	1
1.4	Proposed Development	2
2.	Design Criteria	3
2.1	Surface Water Drainage Strategy	3
3.	Site Context.....	4
3.1	Site Description.....	4
3.2	Topography	4
3.3	Geology	4
3.4	Hydrology and Hydrogeology.....	4
3.5	Existing Drainage.....	5
4.	Surface Water	7
4.1	Site Constraints	7
4.2	Proposed Surface Water Runoff Rates	7
4.3	Surface Water Volume	8
4.4	SuDS Strategy	9
4.5	Surface Water Quality	11
5.	Schedule of Maintenance.....	16
5.1	Introduction	16
5.2	Attenuation Tanks	16
5.3	Attenuation Basins	17
5.4	Filter Drains	18
5.5	Bioretention Areas	19
5.6	Proprietary Treatment System	19
5.7	Gullies and Catchpits.....	20
5.8	Flow Control Devices.....	21
	Appendix A – Proposed Development Layout.....	22
	Appendix B – Topographic Survey Data	23
	Appendix C – Proposed Drainage Layouts	24

Figures

Figure 1 - Planning Boundary and Drainage Networks	1
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Tables

Table 1. Greenfield runoff rates	6
Table 2. Network 4.3 Pollution and Mitigation Indices	13
Table 3. Network 4.8 Pollution and Mitigation Indices	13
Table 4. Network 5.6 Pollution and Mitigation Indices	15
Table 5. Network 9.7 Pollution and Mitigation Indices	15
Table 6. Operation and maintenance requirements for attenuation tanks	16
Table 7. Operation and maintenance requirements for infiltration basins	17
Table 8. Operation and maintenance requirements for filter drains	18
Table 9. Operation and maintenance requirements for bioretention systems.....	19

Table 10. Operation and maintenance requirements for proprietary treatment systems	20
Table 11. Operation and maintenance requirements for gullies and catchpits.....	20
Table 12. Operation and maintenance requirements for flow control devices	21

1. Introduction

1.1 Background and Context

- 1.1.1 AECOM Ltd. (AECOM) has been commissioned by Homes England to prepare and submit a Reserved Matters application for the Central Section highway of the Brookleigh (previously “Northern Arc”) development, following the previously approved outline planning permission granted for the wider development (outline application reference DM/21/3279).
- 1.1.2 The Outline Planning Application (OPA) was submitted to Mid Sussex District Council (MSDC), accompanied by an Environmental Statement, in December 2018 and planning permission was granted by MSDC in October 2019.

1.2 Document Purpose

- 1.2.1 This document has been produced to support the Reserved Matters application and sets out the main principles of the Drainage Strategy for the Central Section of the Brookleigh development spine road.
- 1.2.2 The Flood Risk Assessment (FRA) previously produced by AECOM for the whole development was approved under the OPA (DM/21/3279) and will therefore form the basis of this document.

1.3 Site Location

- 1.3.1 Figure 1 below shows the extent of the Central Section boundary for consideration within this Reserved Matters planning submission (in red), along with the location of the four drainage networks that are the focus of this report.

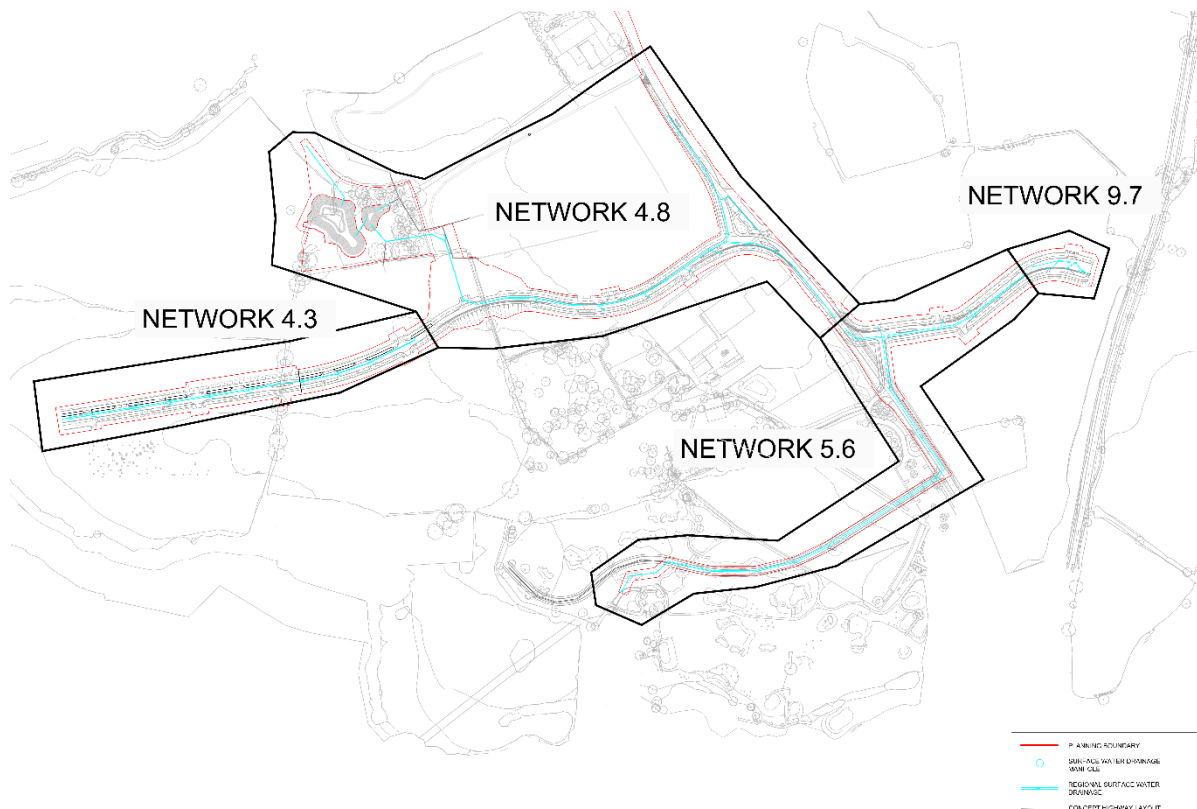


Figure 1 - Planning Boundary and Drainage Networks

- 1.3.2 The centre of the site is at National Grid Reference 530131E, 120814N, and the nearest postcode is RH15 8RE.

- 1.3.3 MSDC is the Local Planning Authority (LPA) for this site.

1.4 Proposed Development

- 1.4.1 The layout of the proposed development is provided in Appendix A.
- 1.4.2 Further details of the proposed development are contained within the AECOM Northern Arc, Burgess Hill Masterplan document, September 2018, submitted with the outline planning application.

2. Design Criteria

2.1 Surface Water Drainage Strategy

- 2.1.1 The surface water drainage system has been designed to meet the requirements outlined in the National Planning Policy Framework (NPPF) and the technical standards set out in the Sewerage Sector Guidance approved documents and CIRIA SuDS Manual 2015.
- 2.1.2 The existing site is predominantly greenfield, with the exception of existing highways which are served by existing highway drainage systems. The main land uses are agriculture and woodland. There are currently no Southern Water sewers serving the site.
- 2.1.3 Runoff from the majority of the existing site drains towards the River Adur (East), which traverses the south of the site, and the Copyhold Stream, which traverses the north of the site. Runoff from the Lowlands Farm area in the far east of the site drains towards the World's End Stream, which is a tributary of the River Adur.
- 2.1.4 The Building Regulations 2010 Approved Document H, Drainage and Waste Disposal (2015 Edition) has been issued by the Secretary of State for the purpose of providing practical guidance with respect to the requirements of Schedule 1 and Schedule 7 of the Building Regulations 2010 for England and Wales. This, along with MSDC's SFRA requires that surface water runoff be discharged according to the following discharge hierarchy:
1. Discharge by infiltration to the ground;
 2. Discharge to surface water bodies;
 3. Discharge to a surface water sewer, highway drain or another drainage system;
 4. Discharge to a combined sewer.
- 2.1.5 West Sussex County Council (WSCC) is the Lead Local Flood Authority (LLFA) for this site and the surrounding area and, as a statutory consultee, requires a site-specific drainage strategy to demonstrate that the proposed surface water drainage scheme complies with their policies, including that of sustainable drainage. Regular communication with WSCC has been an ongoing part of the development of the drainage strategy and design thus far, in order to ensure the design adheres to their policies.
- 2.1.6 Meetings have also been held with MSDC representatives to discuss the overall drainage strategy principles, in their role as the planning authority.
- 2.1.7 As defined in the AECOM Regional Surface Water Drainage Masterplan, the wider Brookleigh site was assessed and split into a number of drainage areas based on the existing site topography and estimated surface water runoff from the developments proposed in each area. Each drainage area was then sub-divided into drainage networks, each of which was designed to serve one or more individual development plots.
- 2.1.8 For the Central Section site, four of these drainage networks are required in order for the highway to be provided with sufficient surface water drainage. These are known as Network 4.3, Network 4.8, Network 5.6 and Network 9.7, and will cover the entire Central Section highway.

3. Site Context

3.1 Site Description

- 3.1.1 The Central Section site covers an area of 7.21 hectares in total, with the current land use predominantly being farmland and woodland, while also covering part of the existing B2036 Cuckfield Road within the site boundary, and as such is considered to be a greenfield site.
- 3.1.2 Located to the west and east of the site are the sites for the Western Bridge and Link Road (WBLR) and Eastern Bridge and Link Road (EBLR) respectively, which are a part of the wider Brookleigh (Northern Arc) development.

3.2 Topography

- 3.2.1 Several topographical surveys of the site have been undertaken for both the wider Brookleigh development, as well as for the Central Section site itself. The most recent topographic survey data which has been used for all elements of the current design is contained within Appendix B.

3.3 Geology

- 3.3.1 Based on a review of published geological maps and British Geological Survey (BGS) Viewer, the majority of the Site is directly underlain by Weald Clay Formation. This formation is characterised by dark grey mudstones with subordinate siltstones, sandstones, and includes clay ironstones. Clay ironstones are shown as elongated outcrops in the southern and eastern part of the Site.
- 3.3.2 In the eastern part of the Site, the geology is affected by the Burgess Hill Fault with the near surface geology becoming the Horsham Stone Member together with Weald Clay Formation. Horsham Stone Member is characterised by sandstone.
- 3.3.3 The Weald Clay Formation is expected to be over 100m thick in the western part of the Site, whilst the thickness is reduced east of the Burgess Hill Fault (which runs roughly along Isaac Lane). Precise thickness of the Weald Clay Formation in the eastern part of the Site is not shown in the published geological maps.
- 3.3.4 Superficial deposits are generally shown as absent within the study area, with the exception of elongated outcrops of Alluvium over the Weald Clay Formation, associated with River Adur East and Copyhold Stream, and localised outcrops of River Terrace Deposits, shown at the north-eastern edge of the Site.
- 3.3.5 The deeper geology comprises Upper Tunbridge Well Sand, which outcrops 250m north-east of the Site. This formation is characterised by sandstone and siltstone.

3.4 Hydrology and Hydrogeology

- 3.4.1 A review of the 'Magic' maps indicates that the majority of the Site overlies the Weald Clay unproductive strata. These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow. The significant thickness of Weald Clay (>100m according to the published geological maps, in the western part of the Site, will limit the vertical migration of groundwater. In the eastern part of the Site, the thickness of the Weald Clay is shown to be reduced.
- 3.4.2 Secondary A Aquifers, associated with the Alluvium and the River Terrace Deposits, intercept the Site along the rivers floodplain (Alluvium) and at the northern edge of the site (RTD). Secondary A Aquifers are defined by the EA as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.
- 3.4.3 Secondary A Aquifers are also associated with the Horsham Stone member, which outcrops in the eastern part of the Site and with the Upper Tunbridge Well Sand, which is at depth beneath the Weald Clay and outcrops 250m north-east of the Site.

- 3.4.4 BGS records show shallow groundwater to have been encountered on-site at between 1.80m and 5.50m bgl within the fissured Weald Clay.
- 3.4.5 The Envirocheck Report® indicates that there are no licensed groundwater abstractions located within 1km of the Site.
- 3.4.6 In addition, the Envirocheck® Report indicates there are ten registered Environmental Permits, (previously known as discharge consents) on Site; these are related to sewage discharge directly to tributaries of the River Adur East. There are also twenty registered discharge consents within 250m of the Site; these are related to sewage discharge, site drainage and trade discharges directly to River Adur east and tributaries.
- 3.4.7 Review of the 'Magic' maps indicates that the Site is not located within a Groundwater Source Protection Zone (SPZ) for the protection of potable water supply abstractions.
- 3.4.8 The Site is identified as not lying within a Surface Water or Groundwater Safeguard Zone. Drinking water safeguard zones are designated areas in which the use of certain substances must be carefully managed to prevent the pollution of raw water sources that are used to provide drinking water.
- 3.4.9 The main watercourse in the study area is the River Adur East, which cuts through the Site in a southwestern direction in the eastern part of the Site, then runs along the southern boundary before bisecting the western portion of the Site in a north-western direction. Copyhold Stream bounds the Site to the north, west of Cuckfield Road.
- 3.4.10 Both rivers are likely to be in hydraulic continuity with groundwater within the superficial deposits of the Alluvium beneath the Site.
- 3.4.11 The Envirocheck® Report indicates that in 2009, the River Adur East was designated with a Biological Quality of 'Fairly Good' to 'Very Good' and Chemical Quality of 'Fair' to 'Good'. The Environment Agency live database gives a range of 'Bad' to 'Good' for the River Adur East at Goddards Green in 2016.
- 3.4.12 The Site and the surrounding area include a number of streams, drains and ponds, mostly occupying former clay pits.
- 3.4.13 The Envirocheck® Report indicates that there are no licensed surface water abstractions located within 1km of the Site. The closest surface water abstraction is approximately 1,745m west of the Site and relates to agriculture water use.
- 3.4.14 The EA Flood Maps indicate that the majority of the Site lies in Flood Zone 1. Flood zones refer to the probability of river and sea flooding (Flood Zone 1 has less than 1% probability of flooding from rivers), ignoring the presence of defences. Along the Copyhold Stream, the Site lies in Flood Zone 2 (Flood Zone 2 has between 1% and 0.1% probability of flooding from rivers). Along the River Adur East (and drains) in the northern portion of the Site, an area of the Site lies in a Flood Zone 3 (Flood Zone 3 has 1% or greater probability of flooding from rivers). The Site area is shown not to benefit from flood defences associated with the above-mentioned rivers.

3.5 Existing Drainage

- 3.5.1 The existing site is predominantly greenfield, with the exception of the existing Cuckfield Road highway which is served by existing highway drainage systems. The main land uses are agriculture and woodland and there are currently no Southern Water sewers serving the site.
- 3.5.2 Runoff from the majority of the existing site drains towards the River Adur (East), which traverses the south of the Site, and the Copyhold Stream, which traverses the north of the Site.
- 3.5.3 The Greenfield runoff rates for the site were calculated in preparation for the Outline Planning Application using the ReFH2 method, and are shown in Table 1. Greenfield runoff rates

Table 1. Greenfield runoff rates

Return Period	Greenfield Runoff Rate (l/s/ha)
1 in 1 year	7.06
Q_{bar}	7.9
1 in 30 years	15.4
1 in 100 years	19.7
1 in 100 years + 40% Climate Change Allowance	27.6

4. Surface Water

4.1 Site Constraints

- 4.1.1 The main design constraints identified in the four required surface water networks at this stage are as follows:
- The Weald Clay assumed to underlie the vast majority of the site is of very low permeability, and therefore unsuitable for infiltration drainage.
 - Multiple existing hedgerows that some of the drainage will need to pass through, with suitability to support bat foraging;
 - Existing ancient and semi-natural woodland in a number of locations around the site, including Six Acre Shaw, which comprises category A trees;
 - Potential crossings with other drainage networks required during later phases of the wider development;
 - Various existing utilities within the site including an intermediate pressure gas main which will be partly diverted;
 - A large part of the network intended to serve the Secondary Road (East) sub catchment is to be constructed in advance of the secondary road;
 - The network serving the Northern Arc avenue Central Section to the west of Cuckfield Road is to be constructed along the alignment of the secondary road adjacent to the Central Neighbourhood Centre in advance of the construction of the secondary road;
 - Existing Cuckfield Road infrastructure will require continuation or be otherwise integrated into the Central Section;
 - WBLR and EBLR interaction including proposed bridge and embankments;
 - Within the proposed local park there is an existing GCN pond and category A, B and C trees. A GCN licence will be required for works conducted in the vicinity of the existing pond;
 - Some development parcels due to be constructed at a later phase depend on the drainage infrastructure for the Central Section which will be constructed prior to the detailed design of the development parcels.

4.2 Proposed Surface Water Runoff Rates

- 4.2.1 The National Planning Policy Framework (NPPF) requires that new development should not increase flood risk outside the Site. In the context of surface water drainage, this effectively means that surface water runoff from the Proposed Development should not exceed the greenfield runoff rates and volumes already generated. This is typically achieved by restricting the rate of surface water discharge from the development at a controlled rate equating to the 1-year greenfield runoff rate (Q_1) for events up to a 1-year return period (100% Annual Exceedance Probability (AEP)), and the mean annual flood, Q_{bar} for events up to a 100-year return period + 40% rainfall intensity climate change allowance.
- 4.2.2 As outlined in section 3.5, the surface water catchments were assessed, and greenfield runoff rates calculated in order to determine suitable proposed discharge rates for each network serving the Central Section.
- 4.2.3 The area of impermeable surfacing will increase from the current greenfield condition as a result of the Proposed Development. Restriction of runoff from the site will therefore be restricted to 7.9 l/s/ha of impermeable area for flows into the drainage networks from the areas contributed by the development of the Central Section.
- 4.2.4 The maximum allowable discharge rates calculated in accordance with Section 4.2.3 for each surface water drainage network serving the Central Section (i.e. Phase 1) are as follows:

Up to a 100% AEP storm event (equivalent to Q_1):

Network 4.3: 5.33 l/s

Network 4.8: 10.13 l/s (Phase 1)

Network 5.6: 3.65 l/s

Network 9.7: 1.36 l/s*

10% AEP to 1% AEP + 40% Climate Change Allowance (equivalent to Q_{bar}):

Network 4.3: 5.96 l/s

Network 4.8: 11.33 l/s

Network 5.6: 4.09 l/s

Network 9.7: 1.52 l/s*

- * Due to concerns that a flow rate this low could potentially contribute to blockages in the flow control device, a higher flow rate restriction of 2.6 l/s has been agreed and implemented into the design for Network 9.7.

- 4.2.5 Due to the proposed phasing of the Site, the maximum allowable discharge rate for Network 4.8 increases with future phases as the development of plots connecting into the network takes place. The rates shown in Section 4.2.4 are for Phase 1 only. The drainage infrastructure for Network 4.8 has been sized so that connections for Phases 2 to 4 can connect into the network without the requirement to increase capacity, subject to the discharge restrictions at each connection as shown on drawings 60610807-ACM-04-XX-DR-DR-700145 to 700148 along with estimated attenuation storage requirements. The allowable discharge rates for future phases for Network 4.8 are as follows:

Phase 2:

Up to a 100% AEP storm event (equivalent to Q_1): 35.26 l/s

10% AEP to 1% AEP + 40% Climate Change Allowance (equivalent to Q_{bar}): 39.45 l/s

Phase 4:

Up to a 100% AEP storm event (equivalent to Q_1): 44.90 l/s

10% AEP to 1% AEP + 40% Climate Change Allowance (equivalent to Q_{bar}): 50.24 l/s

Future phases are beyond the scope of the current central section Reserved Matters application. The discharge rates provided in this section are for information only.

- 4.2.6 The maximum allowable discharge rate for Network 5.6 also increases with future phases as the development of the secondary road connecting into the network takes place. The rates shown in Section 4.2.4 are for Phase 1 only. The drainage infrastructure for Network 5.6 has been sized so that connections for Phase 3 can connect into the network without the requirement to increase capacity. The allowable discharge rates for future phases for Network 5.6 are as follows:

Phase 3:

Up to a 100% AEP storm event (equivalent to Q_1): 8.17 l/s

10% AEP to 1% AEP + 40% Climate Change Allowance (equivalent to Q_{bar}): 9.14 l/s

Future phases are beyond the scope of the current central section Reserved Matters application. The discharge rates provided in this section are for information only.

4.3 Surface Water Volume

- 4.3.1 To restrict the rate of surface water discharge from the Proposed Development to a controlled rate equating to Q_{bar} , attenuation storage is necessary to balance the difference between runoff and

discharge. Surface water attenuation storage locations have been identified, fragmented and distributed across the site according to site constraints including development plot layouts, topography, ecology and arboriculture. Attenuation for the Northern Arc avenue Central Section shall be provided through SuDS features, including ponds and tree pits, and online storage in the form of oversized pipes beneath the carriageway.

- 4.3.2 Surface water storage volumes for the Phase 1 highway in Network 4.3 has been calculated to approximately 1061 m³ when limited to Q_{bar} as above. Runoff will be restricted and attenuated through oversized pipes and tree pits for all storm events up to and including the 1% AEP + 40%CC return period storm event. This equates to approximately 1405 m³/ha.
- 4.3.3 Surface water storage volumes for Network 4.8 has been calculated to approximately 9642 m³, including the highway, contributing areas from future development phases, and SuDS including pond, detention basin and tree pits. Approximately 3683 m³ of this storage volume is to be constructed as part of the Phase 1 highway works, including 2537 m³ within the pond and detention basin, with the remaining storage to be constructed in future phases which will require flow control measures to restrict discharge from the development plots connecting into the constructed Phase 1 network. This equates to approximately 1516m³/ha including future phases.
- 4.3.4 Surface water storage volumes for Network 5.6 has been calculated to approximately 1218m³ when limited to Q_{bar} as above, and accounts for the Phase 1 highway works, existing section of Cuckfield Road, and future secondary road that will be provided by others. Approximately 1120m³ of this storage is to be constructed as part of the Phase 1 highway works. Runoff will be restricted and attenuated through oversized pipes and tree pits for all storm events up to and including the 1% AEP + 40%CC return period storm event. This equates to approximately 1052m³/ha including future phases.
- 4.3.5 Surface water storage volumes for the Phase 1 highway in Network 9.7 has been calculated to approximately 195m³ when limited to the restricted discharge rate of 2.6 l/s. The restricted flow will be attenuated through the use of oversized pipes and tree pits for all storm events up to and including the 1% AEP + 40%CC return period storm event. This equates to approximately 1016m³/ha.
- 4.3.6 Storage has been designed to provide attenuation volumes for 1 in 100-year return period events plus a 40% climate change allowance. While allowance has been given for climate change, no allowance has been considered for urban creep in this case, as the Central Section is almost entirely made up of new carriageway and any associated infrastructure.

4.4 SuDS Strategy

- 4.4.1 The surface water drainage strategy aims to maximise the use of sustainable drainage features to aid in the control and storage of surface water runoff, prior to its release into various watercourses.
- 4.4.2 Drawings included in Appendix C show the proposed drainage layouts and the inclusion of various SuDS features where conditions and space allow, including tree pits and attenuation ponds.

4.4.3 4.3 Drainage Approach

Network 4.3 solely serves the western end of the Central Section of Northern Arc avenue. The network outfalls to the WBLR surface drainage system, to use the space available at the outfall efficiently and maximise the attenuation storage volume available for the WBLR. There is little remaining space available for off-highway attenuation of flows to serve Network 4.3. Instead, runoff from the footpaths along both sides of the Central Section is directed over the surface directly into bioretention areas in the verges. Runoff from the carriageway is directed to gullies which then feed into the bioretention areas. The bioretention areas will include trees and other vegetation, as directed by the Landscape Architect, and will improve water quality as described in Section 4.5 and provide some additional attenuation volume. The majority of the attenuation volume is provided through oversized pipes located within the carriageway. Hydro-Brake flow controls are placed at intermittent manholes along the drainage run, to hold the water back so that it can be released slowly at Q_{bar} -equivalent rates at the outfall to the WBLR system.

4.4.4 4.8 Drainage Approach

The section of Northern Arc avenue located within Drainage Network 4.8 also drains to bioretention areas in the verges. However due to the lower occurrence of verges in this section of Northern Arc avenue, some parts of the carriageway will bypass the bioretention areas, instead feeding directly into the main drain under the highway. As in Network 4.3, attenuation volume is provided through oversized pipes located within the carriageway, and Hydro-Brake flow controls are placed at intermittent manholes along the drainage run. Running from East to West along the highway, the drainage network then turns north along the approximate alignment of the proposed secondary road next to the proposed Central Neighbourhood Centre location, and then westwards via an oil interceptor, and feeds into a series of two attenuation basins. The first is a detention basin which will be predominantly dry, only filling during storm events. Gabion baskets will be placed downstream of the inlets across the detention basin, creating sediment forebays to trap sediment in an easily accessible area and enabling it to be cleared more easily. The second attenuation basin is a pond, with the outlet level set to ensure a permanent depth of water. The pond is designed to be suitable as habitat for Great-Crested Newts. It also features an aquatic bench to ensure higher variation in depths across the pond to enable a greater variety of vegetation to be grown, in line with the recommendations of CIRIA C753. A hydro-brake controls discharge from the pond. The outfall of Network 4.8 is subject to restricted construction techniques to protect the Ancient Woodland in which it is located. Please refer to 60610807-ACM-04-XX-DR-DR-700345 to 700348. There are three connection points along Network 4.8 which enable the connection of future developable areas. Refer to 60610807-ACM-04-XX-DR-DR-700145 to 700148 for details.

4.4.5 5.6 Drainage Approach

Network 5.6 serves a portion of the eastern section of Northern Arc avenue, and existing section of Cuckfield Road, and will also serve a future secondary road which will not be constructed as part of the Central Section package. The majority of the section of Northern Arc avenue served by this network drains to bio-retention areas in the verges, with the rest feeding directly into the main highway drain. Due to insufficient space within the highway boundary to provide centralised attenuation volumes, attenuation is instead provided through the use of oversized pipes within the main highway network, with some additional attenuation also provided by the bio-retention areas within Northern Arc avenue. These bio-retention areas pickup runoff directly from the adjacent footway areas, as well as from some portions of the carriageway itself via road gullies. The bioretention areas will include trees and other vegetation as directed by the Landscape Architect and will improve water quality as described in Section 4.5. There are five Hydro-Brake flow controls situated throughout the system to ensure maximum utilisation of the oversized pipe storage during storm events, and to help maintain the outfall flow rate to the Q_{bar} equivalent rate at the outfall to the existing watercourse. Prior to the outfall, a by-pass fuel/oil separator is also provided to help remove contaminants from the water and ensure a minimum level of water quality.

4.4.6 9.7 Drainage Approach

Network 9.7 is a relatively small network in comparison to the other three and consists solely of a short section of the eastern end of Northern Arc avenue, immediately adjacent to the EBLR site. Similarly to the other networks, it contains some bio-retention areas within the verges which are utilised for both attenuation volume storage and improving water quality within the system. Again, there is little space available to provide a centralised large volume of attenuation storage such as a tank or pond, and therefore the required volumes are provided through oversized pipes within the network. This network outfalls directly into the EBLR surface water drainage network at a restricted flow rate of 2.6l/s, for which two Hydro-Brake flow controls are provided in manholes at different points along the main network branch.

4.4.7 Pond Design

All of the proposed regional SuDS features presented in this Regional Surface Water Masterplan are to be located in open spaces, which are identified in the Open Space Transfer Plan. These open spaces are to be adopted by Mid Sussex District Council (MSDC). It is understood that the regional SuDS features contained within the adopted open spaces shall also be adopted by MSDC, subject to the terms of the S106 agreement. The design of Pond 12 has been informed by CIRIA C753 The SuDS Manual. A length to width ratio of 3:1 maximises the flow path and encourages plug flow. Side slopes of 1 in 4 (compared to the minimum 1 in 3) improve ease of access out of the pond for anyone who may find themselves in it. A minimum 3.5m wide access strip is provided around the perimeter of

the pond, enabling a long-reach excavator (assumed 20m horizontal working range) to reach all parts of the pond. The ground surface around the pond is no steeper than 1 in 12 for a minimum width of 3.5m, enabling maintenance equipment access and precluding the requirement for fencing. An aquatic bench has been provided 300mm below the permanent water level to encourage the establishment of marginal vegetation growth. This would improve the biodiversity of the pond habitat and enhance the quality treatment benefit. The aquatic bench is 2m wide and gently sloped at a grade of 1 in 200. The maximum combined depth of the pond does not exceed 2.5m, while a maximum permanent water depth of 1m means the pond is suitable to support a great-crested newt population. A minimum freeboard of 300mm has been applied in line with the recommendations of CIRIA C753, with an overflow provided to maintain this maximum level.

4.4.8 Detention Basin Design

The design approach for detention basin Pond 13 has been largely the same as for Pond 12. However no permanent body of water, bar a small pool at the outlet, is provided. This means that there is no aquatic bench requirement or any slope variation greater than 1 in 100 below the permanent water level. The maximum depth of water is 1.5m. 1m high gabion basket porous weirs are to be placed across the detention basin downstream of each outfall to create a sediment forebay to reduce the velocity of and disperse incoming flows across the basin and settle out and trap sediment behind for enhanced water treatment and easier maintenance. A minimum freeboard of 300mm has been applied in line with the recommendations of CIRIA C753, with an overflow provided to maintain this maximum level.

4.4.9 Tree Pit Design

The design of the tree pit standard detail has been developed in conjunction with the AECOM landscape team to integrate the requirements of both disciplines. A minimum 1m depth of soil is included to support tree root growth beneath the surface. This acts as a filter medium for the filtration of runoff entering the tree pits. In terms of drainage performance, the tree pits have been designed in accordance with the requirements for Bioretention Areas in CIRIA C753 The SuDS Manual. Runoff from the footpath enters the tree pit at surface level, while runoff from the carriageway is collected via standard roadside gullies and enters the tree pit via a perforated pipe below the level of the rootball. The gullies will act to trap sediment in the first instance and must be emptied in accordance with the maintenance statement in order to continue operating efficiently. Runoff will filter through the soil and be collected in the drainage layer at the base of the tree pit, ultimately entering the perforated drainage pipe and outfalling to the downstream catchpit and connecting to the main drain. The upstream and downstream catchpits also provide access to inspect the system for any blockages. To ensure minimum orifice size requirements in the highway drainage system are not overstepped, no flow control acts on the tree pits to 'back up' water into them, however they do provide some level of attenuation as runoff filters through. This also ensures that the tree pits do not become waterlogged which could damage the trees. An overflow pipe has also been provided at a level 250mm above the invert of the inlet pipe. This enables exceedance flows to pass downstream through the drainage network should the percolation capacity of the filter medium be exceeded, thereby preventing waterlogging.

4.5 Surface Water Quality

- 4.5.1 The SuDS aspects of the surface water drainage design have been incorporated with the intention to also benefit the surface water quality and have been designed in accordance with the CIRIA SuDS Manual C753 guidance.
- 4.5.2 Treatment train – CIRIA C753. In accordance with CIRIA C753, the networks have been designed to create a treatment system using the principles of a SuDS management train. Utilising different SuDS in series along the network targets a range of pollutants, improving water quality and acting as a buffer for accidental spills and intermittent high pollutant loads.
- 4.5.3 Tree pits collect and attenuate runoff from the footpaths which are sloped towards them, while highway runoff is collected through gullies which drain to the subsoil of the tree pit. The tree roots and soils filter

- out pollutants from the runoff directly, including metals, pesticides and organic compounds, nitrogen, phosphorus and hydrocarbons.
- 4.5.4 Filter drains are utilised in a single location – along the retained section of Cuckfield Road used for access to the college. Filter drains can help reduce pollutant levels in runoff by filtering out fine sediments and other pollutants, but to prevent clogging and failure the drain is offset from the highway edge by a minimum 0.5m from the access road edge, to allow for a surface filter strip to trap silt before flows enter the drain.
 - 4.5.5 There is one detention basin serving the Central Section which is located within Network 4.8. They treat the runoff via gravitational settling of particulate pollutants. The detention basin features a sediment forebay formed by the inclusion of gabion basket berms formed across the detention basin downstream of each inlet. The forebay is intended to improve the water quality performance and reduce long-term maintenance requirements.
 - 4.5.6 There is one pond serving the Central Section which is located within Network 4.8. Ponds treat incoming runoff through settling and biological uptake. The primary pollutant removal mechanism is the settling of silts and suspended sediments.
 - 4.5.7 While it is recognised that no treatment of surface water runoff occurs within road gullies, they provide a valuable means of capturing silt and sediment from runoff before it enters other SuDS features, as acknowledged in CIRIA C753.
 - 4.5.8 The performance of each SuDS component and its contribution to the SuDS treatment train has been calculate in accordance with the Simple Index Approach described in CIRIA C753 Section 26.7.1. The calculated hazard and mitigation indices for each network can be seen in Tables 2 to 5.
 - 4.5.9 Pollution hazard indices were calculated based on CIRIA C753 Table 26.2. The Central Section is judged to be a road which falls under the medium pollution hazard level, as it is neither a low traffic road nor a trunk road / motorway.
 - 4.5.10 Network 4.8 features connection points for future secondary road, residential and commercial developments, and the network has therefore been assessed under the assumption that these connections will be made. Residential plots were judged to fall under the low pollution hazard level in accordance with CIRIA C753 Table 26.2, while commercial plots and schools were deemed to have a medium hazard level.
 - 4.5.11 Each discrete treatment train has been assessed individually according to the hazard level and mitigation provided., however one feature may serve multiple treatment trains.
 - 4.5.12 All mitigation indices have been assessed for the critical 1 in 1 year flood event in line with CIRIA C753 guidance.
 - 4.5.13 Oil interceptors have been sized based on the critical flood event stated in 4.5.12. Mitigation indices are as stated on the manufacturer's website for a SPEL Stormceptor Class 1 by-pass separator.
 - 4.5.14 The tree pits act as a bioretention system for water quality purposes in accordance with CIRIA C753. Runoff from the pavement is directed onto the surface of the tree pit while gullies feed runoff from the carriageway into the subsoil. The CIRIA guidance states that bioretention systems provide effective treatment through the removal of sediments by filtration through surface vegetation and groundcover, the removal of fine particulates by infiltration through the underlying filter medium layers, and the removal of dissolved pollutants by sorption to the filter medium. Equation 18.1 of CIRIA C753 gives a surface area of filter bed required for a given bioretention area. The critical tree pit across the Central Section in terms of ratio of tree pit area to assigned impermeable area was assessed using Equation 18.1. 50% of the lowest of the recommended permeability values for the filter media was used for the purposes of the check, to allow for initial clogging rates (which tend to repair as the plant community establishes itself and rooting depth increases). Surface water volumes for the maximum design flood (1 in 100 year + 40% climate change) rather than the critical flood for water quality, as flows for this design storm pass through the systems. A maximum drain down time of 24 hours was specified in line with the requirements of trees recommended in the guidance. The resultant minimum surface area of filter bed was less than 60% of that provided area in the critical tree pit. It is therefore judged that the mitigation indices specified in CIRIA C753 Table 26.3 for Bioretention Areas are used.

- 4.5.15 Mitigation indices for Pond 12 in Network 4.8 has been assessed in accordance with CIRIA C753. The volume of the permanent pool is compared to the treatment volume calculated for 15mm of rainfall depth falling over the contributed catchment. In this case the permanent water volume in P12 is 53% of the required treatment volume. A factor of 0.53 has therefore been applied to each of this mitigation indices.
- 4.5.16 Due to the multiple inlets for detention basin P13 and the flow control on the outlet which restricts flow in the critical 1 in 1 year storm event which raises the water level, it is not considered practical to use the Manning's equation to calculate the residence time as recommended in CIRIA C753 in order to assess treatment performance. This has instead been calculated by dividing the volume of water in the pond (m³) by the discharge rate out of the basin (m³/s) for the critical event. The velocity of flow through the pond has however been calculated using Manning's equation. Gabion basket porous weirs are placed across the basin downstream of each outlet, to further reduce the velocity and disperse flows across the basin, and create a sediment forebay. This will also enable easier maintenance by collecting sediment in more definite locations. The sediment forebays consist of a minimum of 10% of the detention basin area. Given that the velocity calculated for the critical event is below the limiting velocity of 0.3m/s as recommended in CIRIA C753, and that the depth of flow is raised above the recommended 0.1m due to the flow restriction as opposed to the flow rate passing through the basin, the residence time has been used to calculate the factor to apply to the mitigation indices. A residence time of 5 minutes for the basin is compared to the desired residence time of 9 minutes for the basin, giving a factor of 0.599.
- 4.5.17 Table 3 shows that further mitigation measures are required in the future commercial developments that will connect into Drainage Network 4.8. Development of these measures is outside of the scope of these works.

Table 2. Network 4.3 Pollution and Mitigation Indices

Location	Pollution Hazard Level	Mitigation Process	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Primary Road Pollution Hazard Indices	Medium	-	0.7	0.6	0.7
Primary Road (with tree pits) Mitigation Indices	-	Tree Pit (Bioretention System)	0.8	0.8	0.8
	-	Oil Interceptor	0.8	0.6	0.9
	-	Total	0.8+(0.8/2) = 1.2	0.8 + (0.6/2) = 1.1	0.8 + (0.9/2) = 1.25

Source: In accordance with CIRIA C753 The SuDS Manual

Table 3. Network 4.8 Pollution and Mitigation Indices

Location	Pollution Hazard Level	Mitigation Process	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Central Section Pollution Hazard Indices	Medium	-	0.7	0.6	0.7
Central Section Pollution Mitigation Indices		Oil Interceptor	0.8	0.6	0.9
		Detention Basin	0.42	0.42	0.5
		Pond	0.4	0.4	0.29
		Total	0.8 + (0.42/2) + (0.4/2) = 1.21	0.6 + (0.42/2) + (0.37/2) = 1.01	0.9 + (0.5/2) + (0.29/2) = 1.29
Central Section (with Tree Pits) Pollution Mitigation Indices		Tree Pits	0.8	0.8	0.8
		Oil Interceptor	0.8	0.6	0.9
		Detention Basin	0.42	0.42	0.5

Location	Pollution Hazard Level	Mitigation Process	Total Suspended Solids (TSS)	Metals	Hydrocarbons
		Pond	0.4	0.4	0.29
		Total	$0.8 + (0.8/2) + (0.42/2) + (0.4/2) = 1.61$	$0.8 + (0.6/2) + (0.42/2) + (0.4/2) = 1.51$	$0.8 + (0.9/2) + (0.5/2) + (0.29/2) = 1.65$
Residential Pollution Hazard Indices	Low	-	0.5	0.4	0.4
Residential Pollution Mitigation Indices		Detention Basin	0.42	0.42	0.5
		Pond	0.4	0.4	0.29
		Total	$0.42 + (0.4/2) = 0.62$	$0.42 + (0.4/2) = 0.62$	$0.5 + (0.29/2) = 0.65$
Commercial Pollution Hazard Indices	Medium	-	0.7	0.6	0.7
Commercial Pollution Mitigation Indices		Detention Basin	0.42	0.42	0.5
		Pond	0.4	0.4	0.29
		Total	$0.42 + (0.4/2) = 0.62$	$0.42 + (0.4/2) = 0.62$	$0.5 + (0.29/2) = 0.65$

Source: In accordance with CIRIA C753 The SuDS Manual

Table 4. Network 5.6 Pollution and Mitigation Indices

Location	Pollution Hazard Level	Mitigation Process	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Primary Road Pollution Hazard Indices	Medium	-	0.7	0.6	0.7
Primary Road (with tree pits) Mitigation Indices	-	Tree Pit (Bioretention System)	0.8	0.8	0.8
	-	Oil Interceptor	0.8	0.6	0.9
	-	Total	0.8+(0.8/2) = 1.2	0.8 + (0.6/2) = 1.1	0.8 + (0.9/2) = 1.25

Source: In accordance with CIRIA C753 The SuDS Manual

Table 5. Network 9.7 Pollution and Mitigation Indices

Location	Pollution Hazard Level	Mitigation Process	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Primary Road Pollution Hazard Indices	Medium	-	0.7	0.6	0.7
Primary Road (with tree pits) Mitigation Indices	-	Tree Pit (Bioretention System)	0.8	0.8	0.8
	-	Oil Interceptor	0.8	0.6	0.9
	-	Total	0.8+(0.8/2) = 1.2	0.8 + (0.6/2) = 1.1	0.8 + (0.9/2) = 1.25

Source: In accordance with CIRIA C753 The SuDS Manual

5. Schedule of Maintenance

5.1 Introduction

5.1.1 CIRIA C753 The SuDS Manual defines maintenance activities as the following:

1. Regular maintenance (including inspections); carried out to a frequent predictable schedule.
2. Occasional maintenance; periodic but on a much less frequent and predictable basis than regular maintenance.
3. Remedial maintenance; intermittent tasks that may be required to rectify faults.

Suitable maintenance of the surface water drainage system including SuDS is essential to ensure the ongoing performance of the system and its capability to respond to rainfall events as designed.

5.1.2 The surface water drainage systems are to be offered for adoption subject to formal agreement with the respective authority. Drainage infrastructure serving exclusive highway infrastructure will be offered for adoption to the Highway Authority. SuDS features and drainage infrastructure in open space will be offered for adoption to MSDC. Future drainage infrastructure to and within the development plots not under the scope of the Central Section but for which connection points have been designed are intended to be adopted by Southern Water. Defined boundaries at changes of intended adoption authority are shown on the following AECOM Drainage Layout drawings:

- 60610807-ACM-04-XX-DR-DR-700145-700148

5.1.3 Responsibility for maintenance of any drainage network elements during construction will rest with the Principal Contractor, who must fulfil any maintenance requirements as outlined below up until the date of the site handover.

5.1.4 A sitewide maintenance statement and schedule has been produced by AECOM to cover the maintenance period prior to adoption by the relevant statutory undertaker, and while still under ownership of the client, Homes England. Refer to document reference 60610807-ACM-CS-XX-OM-HW-0001 for further information.

5.2 Attenuation Tanks

5.2.1 Attenuation tanks are usually buried structures, designed to store rainfall in order to mimic the behaviour of existing surface water runoff from their respective catchments. For the Central Section they take the form of oversized concrete pipes.

5.2.2 The inflow and outflow of water are critical to their function, and the tank structure itself should be kept free of debris, gradual build-up of silt, and should be inspected for defects.

5.2.3 The following table has been informed by the CIRIA C753 guideline with regards to scheduling of maintenance operations, actions, and their frequency and should be used as a non-exhaustive guide. Reference should also be made to the manufacturer's operation and maintenance manual if applicable.

Table 6. Operation and maintenance requirements for attenuation tanks

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. Consult the adopting authority and if required take remedial action.	After each and every storm event for 3 months following construction and then monthly.

Maintenance Schedule	Required Action	Typical Frequency
	Remove debris from the catchment surface (where it may cause risks to performance).	Weekly during construction or as required. Minimum monthly.
	Remove sediment from pre-treatment structures.	Bi-annually (2x per year), or as required.
Remedial actions	Repair / rehabilitate inlets and outlets, including flow controls.	As required
Monitoring	Inspect / check all inlets / outlets to check they are in good condition.	Bi-annually
	Survey inside of tank/pipe for sediment build-up and remove if necessary	Prior to adoption or 1 year after completion of construction, whatever comes first. Additional internal surveys are recommended if the outlet suffers recurring silt build-up that indicates the tank/pipe may be holding silt.

Source: CIRIA C753 SuDS Manual

5.3 Attenuation Basins

- 5.3.1 Attenuation basins are vegetated open surface basins designed to store water and, in the case of the Central Section features, discharge to the receiving downstream network via a control structure.
- 5.3.2 Vegetation provides both amenity benefit and filtration of pollutants and is therefore equally important to the hydraulic function of the basin.
- 5.3.3 The following table has been informed by CIRIA C753 with regards to scheduling of maintenance operations, actions and their frequency and should be used as a non-exhaustive guide. Reference should also be made to the manufacturer's operation and maintenance manual for any inlet structures or valves.

Table 7. Operation and maintenance requirements for infiltration basins

Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Remove litter, debris and trash	Monthly
	Cut grass – for landscaped areas and access routes	Monthly (during growing season) or as required by the adoption authority
	Cut grass – meadow grass in and around basin (above permanent water line)	Half yearly: spring (before nesting season) and autumn
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
Occasional maintenance	Reseed areas of poor vegetation growth	Bi-annually, or as required
	Prune and trim trees and remove cuttings	As required
	Remove sediment from pre-treatment system when 20% full.	Observe sediment levels monthly and remove sediment as required and immediately prior to adoption.

Maintenance Schedule	Required Action	Typical Frequency
Remedial actions	Repair erosion or other damage by reseeding or returfing	As required
	Realign scour protection if required	As required
	Repair or rehabilitate inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required
Monitoring	Inspect inlets, outlets and overflow for blockages and clear if required	After each and every storm event for 3 months following construction and then monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and pre-treatment systems for silt accumulation; establish appropriate silt removal frequencies	Monthly

Source: CIRIA C753

5.4 Filter Drains

- 5.4.1 Filter drains or trenches are shallow excavations filled with rubble or stone that create subsurface storage of stormwater runoff. These trenches can be used to filter and convey surface water towards downstream SuDS components. They can be used independently or as part of a swale or other channel.
- 5.4.2 The following table has been informed by CIRIA C753 with regards to scheduling of maintenance operations, actions and their frequency and should be used as a non-exhaustive guide.

Table 8. Operation and maintenance requirements for filter drains

Maintenance schedule	Required Action	Typical Frequency
Regular maintenance	Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices	Monthly (or as required)
	Inspect filter drain surface, inlet/outlet pipework and control systems for blockage, clogging, standing water and structural damage	Monthly
	Inspect pre-treatment systems, inlets and perforated pipework for silt accumulation, and establish appropriate silt removal frequencies	Six monthly and immediately prior to adoption
	Remove sediment from pre-treatment devices	Six monthly, or as required
Occasional maintenance	Remove or control tree roots where they are encroaching on the sides of the filter drain, using recommended methods (e.g. NJUG, 2007 or BS 3998:2010)	As required

Maintenance schedule	Required Action	Typical Frequency
Remedial actions	Clear perforated pipework of blockages	As required

Source: CIRIA C753

5.5 Bioretention Areas

- 5.5.1 Bioretention systems can include tree pits, planters and rain gardens and use engineered soils to store and treat runoff from frequent rainfall events. There are often overflow pipes for heavier rainfall events.
- 5.5.2 A schedule setting out the maintenance operations, actions and frequency is included below. Please also refer to the manufacturer's operation and maintenance manual for any proprietary systems.

Table 9. Operation and maintenance requirements for bioretention systems

Maintenance schedule	Required Action	Typical Frequency
Regular inspections	Inspect filtration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain to determine if maintenance is necessary.	Quarterly
	Check operation of underdrains by inspection of flows after rain	Annually
	Assess plants for disease infection, poor growth, invasive species etc and replace as necessary	Quarterly
	Inspect inlets and outlets for blockage	Quarterly
Regular maintenance	Remove litter, surface debris and weeds	Quarterly (or more frequently for tidiness or aesthetic reasons)
	Replace any plants, to maintain planting density	As required
	Remove sediment, litter and debris build-up from around inlets or from forebays	Quarterly to bi-annually
Occasional maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required	As required
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch	As required
Remedial actions	Remove and replace filter medium and vegetation above	As required but likely to be > 20 years

Source: CIRIA C753

5.6 Proprietary Treatment System

- 5.6.1 Proprietary treatment systems can include but are not limited to vortex separators and oil interceptors.
- 5.6.2 Such systems are designed to perform important cleansing functions and protect downstream systems from pollution. Therefore, regular inspection and maintenance is critical.

- 5.6.3 Such systems may include telemetry systems or alarms to warn of inoperability or a need for maintenance.
- 5.6.4 The following table has been informed by CIRIA C753 with regards to scheduling of maintenance operations, actions and their frequency and should be used as a non-exhaustive guide.

Table 10. Operation and maintenance requirements for proprietary treatment systems

Maintenance schedule	Required Action	Typical Frequency
Routine maintenance	Remove litter and debris and inspect for sediment, oil and grease accumulation	Inspect after each storm event for the first three months following construction and then six monthly or as deemed appropriate
	Change the filter media	As recommended by the manufacturer
	Remove sediment, oil grease and floatables	As necessary – indicated by system inspections or immediately following a spill
Remedial actions	Replace malfunctioning parts or structures	As recommended by the manufacturer
Monitoring	Inspect for evidence of poor operation	Inspect after each storm event for the first three months following construction and then six monthly or as deemed appropriate
	Inspect filter media and establish appropriate replacement frequencies	Six monthly
	Inspect sediment accumulation rates and establish appropriate removal frequencies	Monthly during first half year of operation, then every six months

Source: CIRIA C753

5.7 Gullies and Catchpits

- 5.7.1 Gullies and catchpits are intended to collect surface runoff and convey it to the underground piped network. They are typically constructed with a sump to collect and retain some sediment, debris and light oils washed into the system from the upstream catchment.
- 5.7.2 To continue to provide a benefit to the system and reduce the likelihood/occurrence of clogging in downstream features, they must be regularly inspected and emptied.
- 5.7.3 The following table has been informed by BS EN 752 with regards to scheduling of maintenance operations, actions and their frequency and should be used as a non-exhaustive guide.

Table 11. Operation and maintenance requirements for gullies and catchpits

Maintenance schedule	Required Action	Typical Frequency
Routine maintenance	Remove litter and debris and inspect for sediment, oil and grease accumulation	Inspect after each storm event for the first three months following construction and then six monthly or as deemed appropriate
	Remove sediment, oil, grease and floatables	As necessary – indicated by system inspections or immediately following a spill

Maintenance schedule	Required Action	Typical Frequency
Remedial actions	Replace malfunctioning parts or structures	As recommended by the manufacturer.
Monitoring	Inspect for evidence of poor operation	Inspection after each storm event for the first three months following construction and then six monthly or as deemed appropriate
	Inspect sediment accumulation rates and establish appropriate removal frequencies	Monthly during first half year of operation, then every six months.

Source: BS EN 752

5.8 Flow Control Devices

- 5.8.1 Flow control devices may include manhole chambers fitted with vortex flow controls or orifice plates, or orifice plates fitted to headwalls or weir walls.
- 5.8.2 The purpose of flow control devices is to restrict the rate of discharge to a predefined rate, and their performance can be impacted if they become blocked or become damaged.
- 5.8.3 An indicative schedule providing general maintenance operations, actions and frequency is included below and should be used as a non-exhaustive guide. Please also refer to the manufacturer's operation and maintenance manual for any proprietary devices.

Table 12. Operation and maintenance requirements for flow control devices

Maintenance schedule	Required Action	Typical Frequency
Routine maintenance Remedial actions	Remove litter and debris and inspect for sediment, oil and grease accumulation	Inspect after each storm event for the first 3 months following construction and then monthly or as deemed appropriate.
	Remove sediment, oil, grease and floatables	Inspect after each storm event for the first 3 months following construction and then monthly or as deemed appropriate
	Replace malfunctioning parts or structures	Inspect monthly, and replace as required.
Monitoring	Inspect for evidence of poor operation	Six monthly
	Check the operation of bypass facilities	Six monthly
Monitoring Routine maintenance	Inspect sediment accumulation rates and establish appropriate removal frequencies	Inspect after each storm event for the first 3 months following construction and then monthly or as deemed appropriate.
	Remove litter and debris and inspect for sediment, oil and grease accumulation	Inspect after each storm event for the first 3 months following construction and then monthly or as deemed appropriate.

Appendix A – Proposed Development Layout

Appendix B – Topographic Survey Data

Appendix C – Proposed Drainage Layouts

