

Growing Baldock

Environmental Statement Addendum
Volume 2: Figures & Appendices

Chapter 10: Hydrology and Flooding
Appendix 10.1 Drainage Strategy



Growing Baldock Drainage Strategy Report

May 2026

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E	05.05.2026	Reg 25 Submission
D	24.09.2025	Final Planning Issue
C	12.09.2025	Final draft
B	22.08.2025	Updated draft
A	15.07.2025	Draft issue for comment
Revision	Date	Status
Prepared by:		Mike Duff
Checked by:		David Purcell
Approved by:		David Purcell

1 Introduction

AKT II have been commissioned to undertake a foul and surface water drainage strategy on behalf of their Client, Urban & Civic, in support of an Outline Planning Application for up to 3,200 homes, up to 16ha of employment, waste and leisure infrastructure, mixed use local centre, up to 1 secondary school, up to 2 x primary schools, up to 1 SEND school, health hub, green infrastructure (including parks, formal sports provision, play, habitat areas, informal open space and structural planting), internal street network, access junctions and railway crossing, public transport infrastructure, pedestrian/cycle network (including PRow diversions, active travel routes, mobility hubs and crossing of the railway), utilities and drainage infrastructure (including diversions of existing and provision of new infrastructure, pumping stations, sustainable drainage, primary substations, rising main/strategic sewer and renewable energy infrastructure), ground remodelling/earthworks and any necessary demolitions.

The site area is approximately 217 hectares and consists of farmland as existing, which will be developed to form a mix of residential and employment land plots as proposed.

The site is located on the eastern edge of Baldock at Bygrave Common and Clothall Common and the Northings and Eastings for the development land are 525580, 234692 respectively.

This report is intended to cover only the outline aspects of drainage design and provide the guidelines and parameters for the detailed design at later /more advanced stages of the project.

This report has been prepared in accordance with the guidance contained in the National Policy Framework (NPPF) and the accompanying Planning Practice guidance and a more detailed explanation of the requirements nationally and locally are laid out in Section 4 of this report.

The following drainage report and strategy will need to be agreed with the Lead Local Flood Authority (LLFA) to obtain planning approval and satisfy the relevant consultees (the local Water Authority and the Environment Agency, where relevant)



Figure 1.1 Site photo



Figure 1.2 Site photo

2 Executive Summary

SITE INFORMATION	
National Grid Reference	525580 E, 234692 N
Site Area	Approximately 217 ha
Geology	Superficial geology across the area of the site to the north of the railway line consists mainly of alluvial deposits of sand and silt with veins of Clay with Flints Formation and Lowestoft Formation. In addition there is a small area of Glaciofluvial Deposits (Mid Pleistocene - Sand And Gravel) in the south western corner. The area is underlain by bedrock compromising mainly of West Melbury Marly Chalk Formation. In addition there are small areas of the chalk formations, Totternhoe Stone Member and Zig Zag Formation.
Hydrogeology	The Environment Agency’s superficial aquifer designation map indicates that the site is underlain by a Secondary A or Secondary (undifferentiated) Aquifer. The Bedrock Aquifer map indicates the bedrock underlying the site is classified as a Principal Aquifer. The site is located partially within an Environment Agency SPZ designated Zone II - Outer Protection Zone and partially in a Zone III - Total Catchment. Groundwater has not been encountered in the site-specific ground investigations nor in the ongoing monitoring.
Hydrology	The nearest water features are the Ivel Springs and the River Ivel to the west of the site.
SURFACE WATER DRAINAGE DESIGN	
Conceptual scheme design	Surface water will be disposed of through infiltration wherever possible and follow the disposal hierarchy. The residential plots are proposed to discharge to individual soakaways. In areas of medium density chalk a 5m clearance zone from building foundations will be adopted. In the areas noted as low density a 10 m clearance will be adopted which may mean soakaways cannot be located within individual residential plots in certain instances. In these cases, the soakaways will be located in nearby areas of communal car parking or open space. The general road and footpath network and the Employment Land buildings will be drained to infiltration basins through a combination of swales, bio-retention areas and piped networks. The Employment Land car park areas will be constructed as permeable paving and discharge via infiltration. The sitewide drainage design has been sized to accommodate the 1 in 100 year + 40% climate change event without any flooding occurring to properties. Runoff from higher pollution risk areas such as industrial land uses will be suitably treated before being discharged to the ground.
FOUL WATER DRAINAGE DESIGN	
Conceptual scheme design	Foul water for Plot BA2 will be disposed of by gravity to the public sewer in Laxton Gardens as advised by Anglian Water. Occupation beyond this phase is subject to implementation of an Anglian Water reinforcement (rising main upgrade / direct pumped main to Letchworth Wastewater Treatment Works) to be agreed with Anglian Water.

3 The Site

3.1 Site Location

The site is located to the north and east of the historic market town of Baldock, within the administrative area of North Hertfordshire. The development site is located to the immediate north-east of Baldock town centre and Baldock railway station.

The site comprises a series of parcels of predominantly agricultural land immediately adjoining the urban area:

- The northernmost, and largest component of the site (BA1) lies to the east of North Road and Baldock town centre to the south. The southern boundary is defined by the railway line and the eastern and northern edge by existing field boundaries and public rights of way. Bygrave / Ashwell Road runs broadly east-west through this part of the site, from North Road to the village of Bygrave to the north east.
- A narrow strip of land between the railway to the north and Royston Road to the south, forms the central portion of the Growing Baldock development area (BA10). This area incorporates a number of both small businesses and private homes.
- The remaining portion of the Growing Baldock site (incorporating BA3, the Urban Open Land and BA2) wraps around the eastern side of the settlement, bound to the west by existing development area and to the east by the A505. Clothall Road dissects this part of the site, as it runs north-west towards the town centre. The OPA site also incorporates part of the Walls Field Scheduled Monument, to the south east of Hartsfield School and a small parcel of land west of North Road, adjacent to the Ivel Springs Nature Reserve.

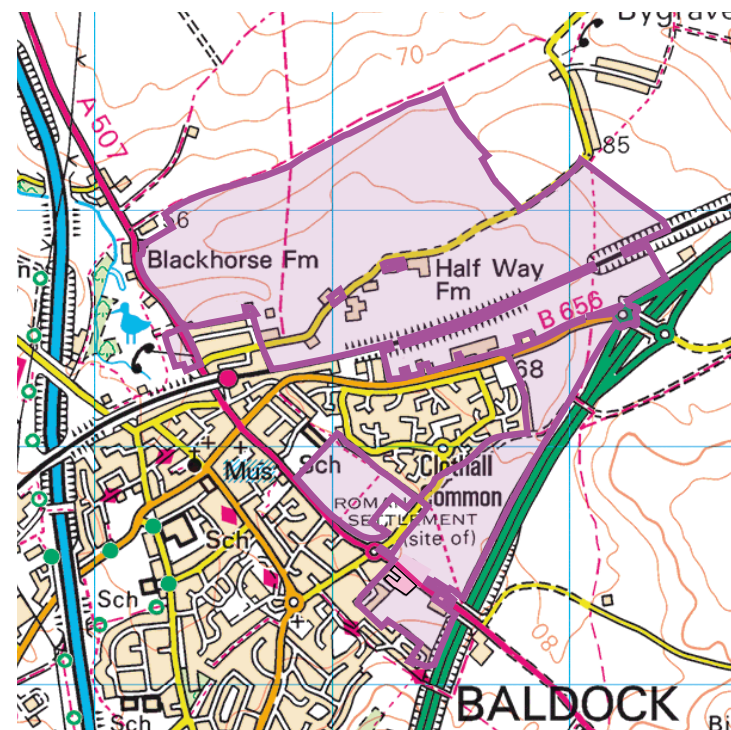


Figure 3.1 Site Location (StreetMap)



Figure 3.2 Local Plan Allocation Sites



Figure 3.3 Site Location (Google Maps)

3.2 Site Description

The majority of the site is given over to agricultural tenancies and is therefore rural in character, with field boundaries defined by hedgerows / trees of varying age and quality. There are no watercourses or water bodies present on site. A network of public rights of way and bridleways traverse the site.

The Outline Planning boundary occupies an area of approximately 220 ha.

3.2.1 Topography

The southern area generally falls from south to north from a high point of approximately 90.00 m AOD at the south western corner to 72.00 m AOD at Clothall Road and approximately 68.00 m AOD at Royston Road.

The central area between Royston Road and the railway line generally falls from east to west from a high point of 77.00 m AOD at the eastern boundary down to 66.00 m AOD next to the commercial premises.

The northern area also falls east to west from a high point of 80.00 m AOD at the eastern boundary to 57.00 m AOD at North Road.

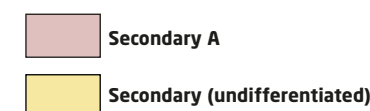


Figure 3.4 BGS Combined Geology Map

3.2.2 Geology

Superficial geology across the area of the site to the north of the railway line consists mainly of alluvial deposits of sand and silt with veins of Clay with Flints Formation and Lowestoft Formation. In addition there is a small area of Glaciofluvial Deposits (Mid Pleistocene - Sand And Gravel) in the south western corner.

The area is underlain by bedrock comprising mainly of West Melbury Marly Chalk Formation. In addition there are small areas of the chalk formations, Totternhoe Stone Member and Zig Zag Formation.

Superficial geology across the area of the site to the south of the railway line comprises alluvial deposits of sand and silt with veins of head deposits of clay, silt, sand and gravel.

The area is underlain by bedrock comprising Holywell Nodular Chalk formation and New Pit Chalk formation.

A proportion of the southern area to the immediate south of the B656 comprises made ground as a result of the spoil which was generated during the construction of the A505.

The superficial drift expected beneath the site is classified as a Secondary A or Secondary (undifferentiated) Aquifer (Figure 3.4).

The bedrock beneath the site is classified as a Principal Aquifer, as per the Bedrock Aquifer map (Figure 3.5). Unproductive Strata are deposits with low permeability that have negligible significance for water supply or river base flow.

The southern side of the site where the bedrock consists of Harwich Formation, is designated as a Secondary A Aquifer.

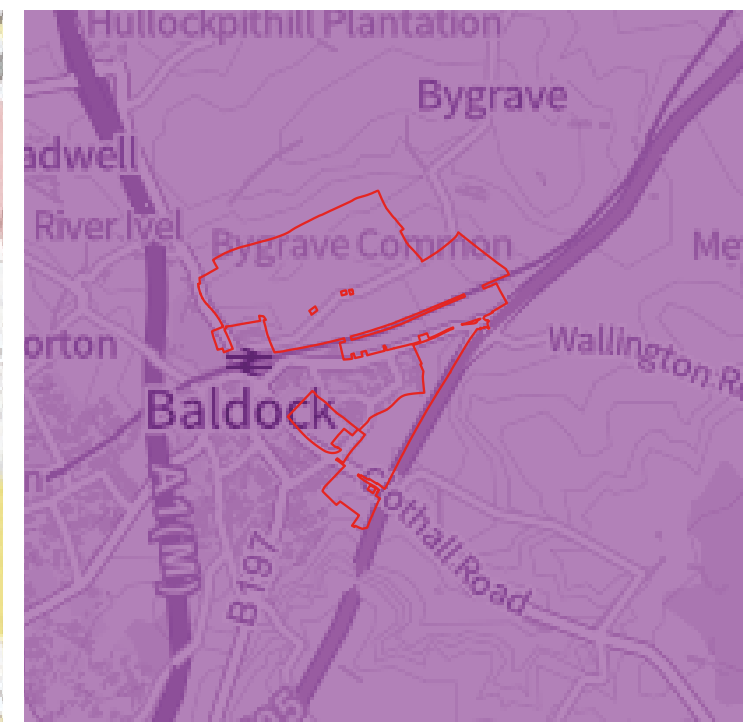


Figure 3.5 Bedrock Aquifer Map

3.2.3 Groundwater

An initial site investigation was carried out on the northern part of the site in November 2017 in which groundwater was not encountered. However, this investigation covered only a limited area of the overall site and there may be significant variations in groundwater both across the site and seasonally.

Further site investigation works were undertaken on the northern part of the site from November 2023 through to May 2024. In Parcel BA1 groundwater was noted in 3 trial pits:

- TP-096 - 3.00m BGL
- TP-097 - 2.00m BGL
- TP-098 - 2.70m BGL

Groundwater was also encountered in one Window Sample and at depth in 6no. rotary boreholes along the northern edge of the railway line. These depths are tabulated below:

	16/11/23	22/11/23	07/12/23	09/01/24	25/01/24	07/02/24	20/02/24	05/03/24	14/05/24	19/05/24	21/05/24	05/06/24
WS-37	-	-	-	-	-	-	-	-	2.00m BGL	2.27m BGL	2.05m BGL	2.11m BGL
Ro-R1-01	NGWR	-	14.12m BGL	11.65m BGL	10.72m BGL	10.79m BGL	10.23m BGL	8.85m BGL				
Ro-R1-02	NGWR	-	15.29m BGL	13.00m BGL	11.92m BGL	12.05m BGL	11.53m BGL	10.00m BGL				
Ro-R2/R3-01	-	NGWR	7.88m BGL	6.50m BGL	6.18m BGL	6.08m BGL	5.78m BGL	4.95m BGL				
Ro-R2/R3-02	-	NGWR	8.15m BGL	7.32m BGL	5.95m BGL	6.29m BGL	5.98m BGL	5.06m BGL				
Ro-R5-R1	NGWR	-	9.10m BGL	6.94m BGL	6.40m BGL	6.42m BGL	6.23m BGL	5.65m BGL				
Ro-R5-R2	NGWR	-	10.61m BGL	7.28m BGL	6.73m BGL	6.82m BGL	6.08m BGL	4.95m BGL				

No groundwater was noted in any of the investigations carried out in Parcels BA2 or BA3.

In Parcel B10, groundwater was noted at depth in 6no. rotary boreholes along the southern edge of the railway line. These depths are tabulated below:

	Original	07/12/23	09/01/24	25/01/24	07/02/24	20/02/24	05/03/24
Ro-R1-03	NGWR	14.39m BGL	12.13m BGL	11.20m BGL	11.26m BGL	10.70m BGL	10.70m BGL
Ro-R1-04	NGWR	14.56m BGL	11.91m BGL	10.92m BGL	10.99m BGL	10.49m BGL	10.49m BGL
Ro-R2/R3-03	NGWR	8.92m BGL	6.97m BGL	7.06m BGL	7.11m BGL	6.90m BGL	6.90m BGL
Ro-R2/R3-04	NGWR	9.35m BGL	7.28m BGL	7.42m BGL	7.55m BGL	7.26m BGL	7.26m BGL
Ro-R5-R03	NGWR	9.76m BGL	7.60m BGL	7.13m BGL	7.22m BGL	6.71m BGL	6.71m BGL
Ro-R5-R04	NGWR	9.68m BGL	7.43m BGL	7.02m BGL	7.12m BGL	6.53m BGL	6.53m BGL

3.2.4 Infiltration Testing

An initial site investigation was carried out on the northern part of the site in November 2017 which included BRE 365 infiltration tests. The results are summarised below:

	Test Depth	Infiltration Rate
ST1	1.45 m	1.46 x 10 ⁻⁵ m/s
ST2	1.40 m	1.35 x 10 ⁻⁵ m/s
ST3	1.70 m	1.27 x 10 ⁻⁵ m/s
ST4	1.40 m	1.47 x 10 ⁻⁵ m/s
ST5	1.40 m	1.39 x 10 ⁻⁵ m/s
ST6	1.40 m	2.02 x 10 ⁻⁵ m/s

Subsequent testing was undertaken by Shadbolt Environmental between November 2023 and May 2024 which yielded similar porosity values (tabulated below):

	Test Depth	Infiltration Rate
TP-010	1.30 m	1.78 x 10 ⁻⁵ m/s
TP-022	1.60 m	1.85 x 10 ⁻⁵ m/s
TP-031	1.40 m	5.85 x 10 ⁻⁵ m/s
TP-039	1.20 m	4.27 x 10 ⁻⁵ m/s
TP-045	1.30 m	9.98 x 10 ⁻⁵ m/s
TP-048	1.30 m	5.22 x 10 ⁻⁵ m/s
TP-055	1.40 m	8.41 x 10 ⁻⁶ m/s
TP-068	1.30 m	1.43 x 10 ⁻⁵ m/s
TP-094	1.65 m	1.42 x 10 ⁻⁴ m/s
TP-105	1.60 m	2.27 x 10 ⁻⁵ m/s
TP-127	1.50 m	2.84 x 10 ⁻⁵ m/s
TP-131	1.30 m	8.17 x 10 ⁻⁶ m/s
TP-137	1.90 m	2.40 x 10 ⁻⁴ m/s
TP-139	1.50 m	1.12 x 10 ⁻⁴ m/s
TP-149	1.65 m	5.34 x 10 ⁻⁶ m/s
TP-161	1.05 m	2.97 x 10 ⁻⁶ m/s
TP-176	1.10 m	9.31 x 10 ⁻⁶ m/s
TP-191	1.70 m	9.23 x 10 ⁻⁵ m/s
TP-203	1.40 m	1.71 x 10 ⁻⁵ m/s
SA-01	1.20 m	2.36 x 10 ⁻⁵ m/s
SA-02	1.40 m	3.48 x 10 ⁻⁵ m/s

The infiltration test locations are shown in Figure 3.6 for reference and details of the tests are contained in Appendix G.

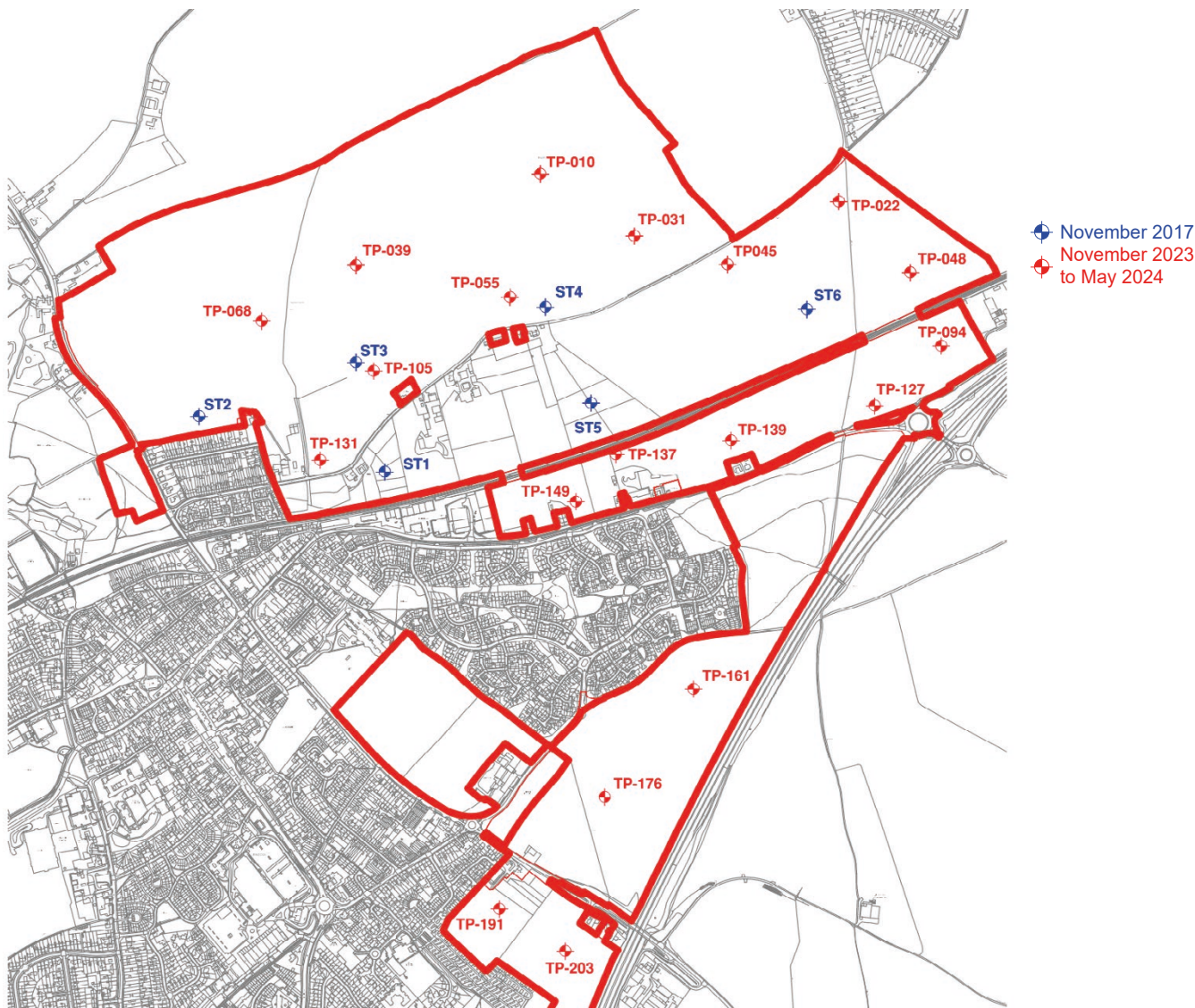


Figure 3.6 Infiltration test locations

3.2.5 Source Protection zones

The site is located partially within a Zone II - Outer Protection Zone and partially in Zone III - Total Catchment (Figure 3.7)

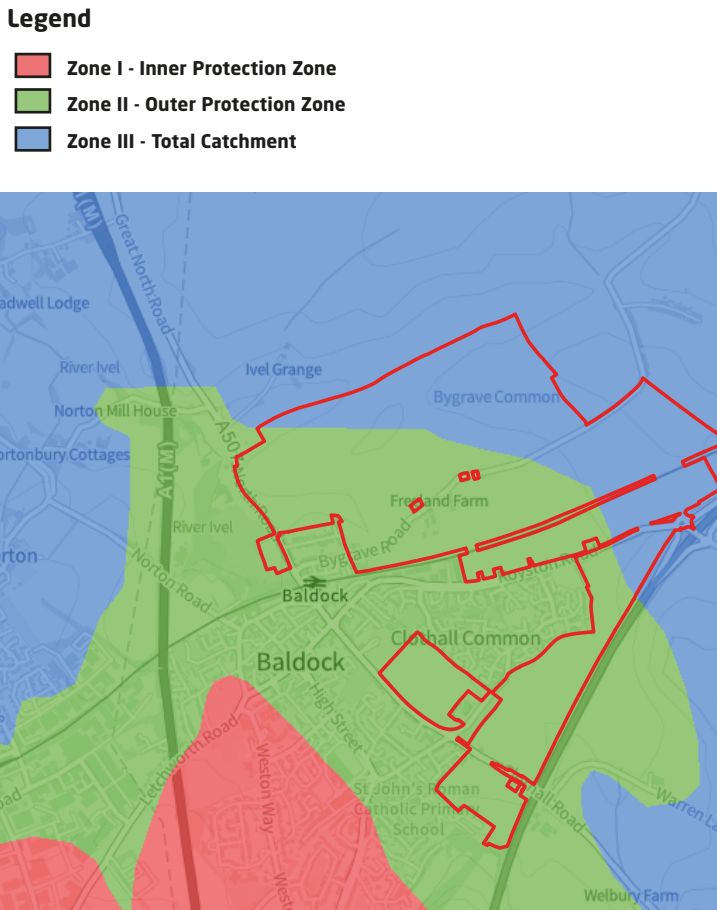


Figure 3.7 Source Protection Zone Map

4 Design Standards

4.1 National Standards

The following guides and current British Standards will be used for the design of the drainage elements on this project:

- BS EN 752:2017 Drain and Sewer Systems Outside Buildings. Sewer System Management
- BS EN 12056 Gravity Drainage Systems Inside Buildings: Part 2
- Building Regulations 2010 Part H1 – Foul Water Drainage (2015 Edition)
- Building Regulations 2010 Part H2 – Wastewater Treatment Systems and Cesspools (2015 Edition)
- Building Regulations 2010 Part H3 – Rainwater Drainage (2015 Edition)
- Building Regulations 2010 Part H4 – Building Over Sewers (2015 Edition)
- Building Regulations 2010 Part H5 – Separate Systems of Drainage (2015 Edition)
- Building Regulations 2010 Part H6 – Solid Waste Storage (2015 Edition)
- Environment Agency “Control of Runoff from New Developments Interim Regional Guidance”
- National Planning Policy Framework Planning Practice Guidance



Figure 4.1 HCC Local Flood Risk Management Strategy

4.2 National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) superseded Planning Policy Statement 25 “Development and Flood Risk” (PPS 25) although the requirements and goals remain essentially the same:

- The susceptibility of land to flooding is a material planning consideration;
- The Environment Agency has the lead role in providing advice on flood issues, at a strategic level and in relation to planning applications;
- Planning decisions should apply the precautionary principle to the issue of flood risk, using a risk-based search sequence to avoid inappropriate development on undeveloped and undefended flood plains etc;
- Developers should fund flood defences and warning measures required because of the development;
- Planning policies and decisions should recognise that the consideration of flood risk and its management needs to be applied on a whole-catchment basis and not only be restricted to flood plains.

With regard to the NPPF, those proposing particular developments are responsible for:

- Providing an assessment of whether any proposed development is likely to be affected by flooding and whether it will increase flood risk elsewhere and the measures proposed to deal with these effects and risks and;
- Satisfying the local planning authority that any flood risk to the development or additional risk arising from the proposal will be successfully managed with the minimum environmental effect thus ensuring the safe development and secure future occupancy of the site.

After this has been addressed, it is then the local planning authority’s responsibility (advised as necessary by the Environment Agency on fluvial and tidal flood risk, and the Lead Local Flood Authority (LLFA) on surface water flood risk) to determine an application for planning permission after taking into account all material considerations, including the issue of flood risk and how it might be managed or mitigated. Local planning authorities are required to adopt a risk-based approach to proposals for development in flood risk areas.

4.3 Local Standards and Guidance

The Local Standards and guidance for the management of surface water drainage has been summarised by the LLFA in their document “LLFA Summary Guidance for developers” updated in August 2021. The purpose of this guide is to assist developers in the design of surface water drainage systems and to support the Local Planning Authorities in considering drainage proposals. This should be read alongside Hertfordshire County Council’s Local Flood Risk Management Strategy (LFRMS) adopted in February 2019.

They key design criteria from these documents are as follows:

LLFA Summary Guidance for Developers

1. Runoff rates

Peak discharge rates from site will not increase as a result of the proposed development, up to a 1 in 100 chance in any year including an allowance for climate change storm event. We expect all applicants to achieve greenfield runoff rates for greenfield development sites to reduce the impact of the development on the surface water drainage infrastructure

2. Storage volumes

Storage volumes for all events up to a 1 in 100 chance in any year including an allowance for climate change storm event will be provided on site utilising above ground storage where practicable. The site will not flood from surface water up to a 1 in 100 chance in any year including an allowance for climate change event, *OR* surface water flooding will be safely contained on site up to this event, ensuring that surface water runoff will not increase flood risk to the development or third parties. There should be no flooding within the site for up to and including the 1 in 30 chance in any year rainfall event.

3. Sustainable drainage techniques

Sustainable Drainage Systems (SuDS) such as green roofs, attenuation basins, ponds, swales and permeable pavements will be used. The SuDS hierarchy should be followed as you design the site. The methods at the top of the hierarchy are preferred because they are beneficial in terms of sustainability, water quality and biodiversity. The hierarchy should be used in descending order, with any obstacles to the use of SuDS methods clearly justified.

4. Residual Risk

The residual risk of flooding can be managed and contained safely on site should any drainage features fail (e.g., pumps, flow controls or Hydro-Brakes) *OR* during an extreme storm event.

5. Climate change allowances

Guidance on climate change allowances can be found within the National Planning Policy Framework Technical Guidance and Climate Change allowance note for Hertfordshire.

6. Infiltration rates

Infiltration rates should be worked out in accordance with BRE Digest 365 for shallow infiltration.

HCC Local Flood Risk Management Strategy (LFRMS)

Policy 13: Discharge hierarchy for SuDS

Proposals for SuDS must follow the discharge hierarchy as set out in the non-statutory technical standards for sustainable drainage systems. The discharge hierarchy should be appropriately assessed and the selected discharge point for proposed SuDS must be justified.

Policy 14: Runoff rates for greenfield sites

For greenfield sites, the peak runoff rate from the development for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must not exceed the peak greenfield runoff rate from the whole site for the same event.

Policy 16: Flooding on and from development sites

Flooding must not occur on any part of the site for a 1 in 30 year rainfall event except in areas that are designed to hold and convey water. During a 1 in 100 year plus climate change rainfall event no flooding should occur in any part of a building (including a basement); utility plant susceptible to water (e.g. pumping station or electrical sub-station) or on neighbouring sites.

Policy 17: Development sites along natural flow routes and in existing flood risk areas

Where a development alters the natural flow route and/or is located in an area with existing flooding issues or a high risk of potential flooding; proposals must demonstrate the management of any existing and predicted overland flows entering the site from adjacent areas for all rainfall events up to and including 1 in 100 year plus climate change event.

Policy 18: SuDS to be designed at or near the surface

Proposals must demonstrate that the SuDS have been designed at or near the surface in line with the SuDS hierarchy. Underground attenuation features will only be acceptable where it is proven that alternate surface based methods are not appropriate or feasible. The design of the drainage system must account for the likely impacts of climate change and changes in impermeable area over the design life of the development.

Policy 19: During construction arrangements

There should be appropriate arrangements for surface water drainage during the construction phase of a development site. A construction management plan to address all surface water runoff and any flooding issues during the construction stage should be submitted at detailed design stage.

Policy 20: SuDS to have a design life compatible with the development and to include a management and maintenance plan

Drainage components should have a design life compatible with the development. Design should be based on actual site levels, ensuring that the construction of any other infrastructure and services does not compromise the final construction of the SuDS. Proposals for SuDS must include a management and maintenance plan for the lifetime of the development which shall include arrangements for adoption and any other arrangements to secure the operation of the scheme throughout its lifetime.

Policy 21: SuDS to have wider benefits

In accordance with relevant local plan policies and guidance, proposals for SuDS must maximise wider benefits as appropriate.

5 Surface water drainage

5.1 Existing scheme

The available Anglian Water record plans indicate that the there are no public surface water sewers in the vicinity of the site area located to the north of the railway line. There are houses located on Larkins Close, Salisbury Road and Bygrave Road which suggests that the properties in this area must drain by some form of infiltration.

The record plans indicate that the closest public surface water sewers to the southern area of the site are:

- A 375 mm dia. surface water sewer in Wallington Road adjacent to Parcel DEV14.
- A 150 / 225 mm dia. surface water sewer in Walnut Avenue / Laxton Gardens adjacent to Parcel DEV15.
- A 450 / 675 mm dia. surface water sewer in Clothall Road which the above 225 and 375 mm dia. sewers connect into.
- A number of 225 mm dia surface water sewers serving the housing to the south and east of Yeomanry Drive (Barley Rise, Chauncy Gardens, Merchants Walk, Aleyn Way and Orwell View).

Extracts from the record plans are shown in Figures 5.1 and 5.2 for reference and the full plans are contained in Appendix F.

It is assumed that the development parcels are not currently connected to the public surface water drainage network.

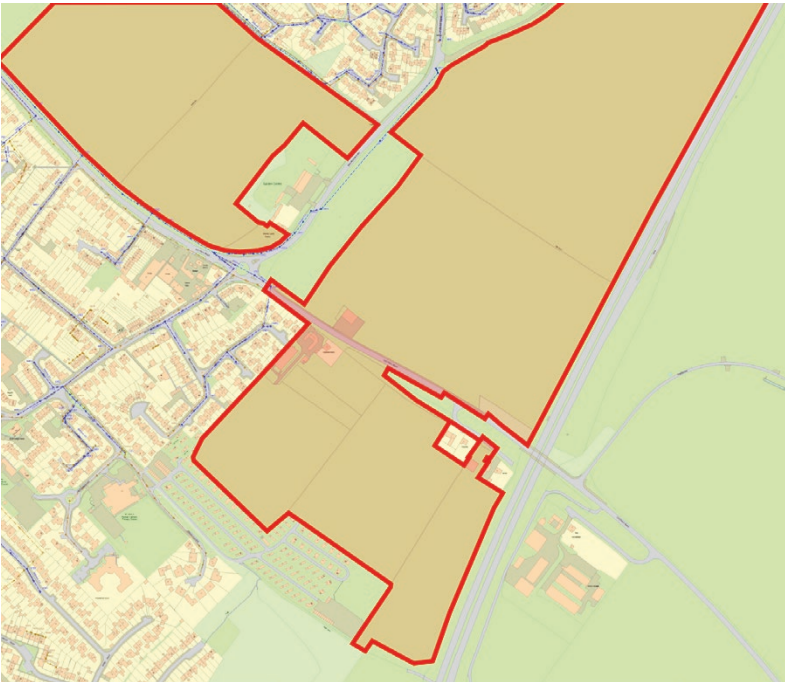


Figure 5.1 Anglian Water Sewer Record

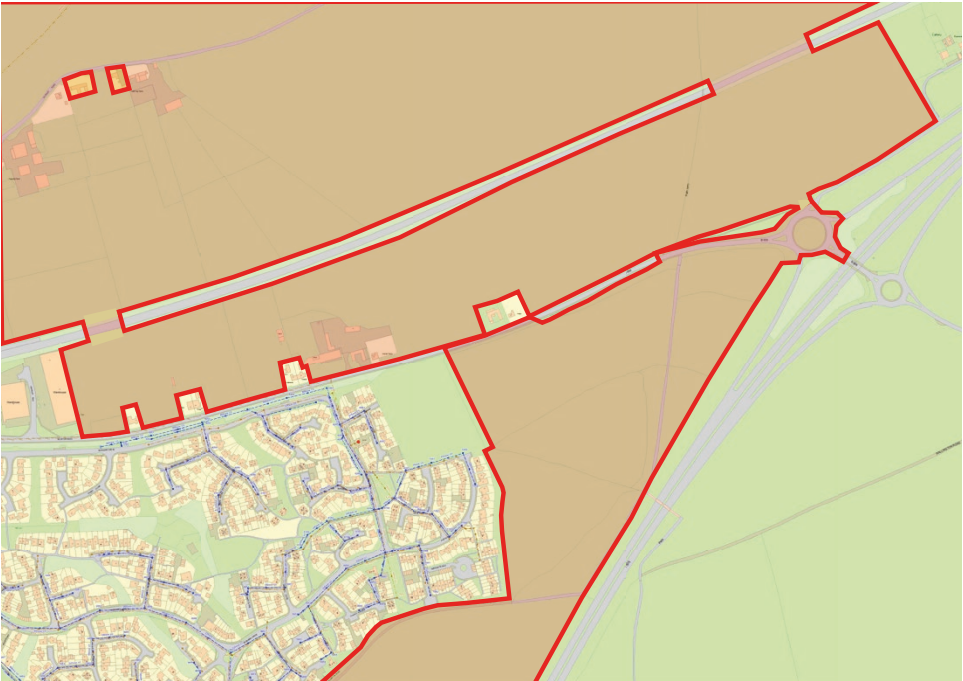


Figure 5.2 Anglian Water Sewer Record

5.1.1 Site Characteristics

- Site Location: GB 524400 234600 TL 24400 34600
- FEH Version: 2022
- SAAR = 589mm
- CWI = 84.580
- SPRHOST = 5.24
- URBEXT2000 = 0.0431
- Areal Reduction Factor = 1.00
- BFIHOST = 0.953
- FARL = 1.000

Detailed calculations are contained in Appendix B for reference. The discharge rates and volumes are summarised below:

Catchment	Indicative Developable Area	Q _{med}	Q ₁	Q ₁₀	Q ₃₀	Q ₁₀₀	Greenfield Runoff volume
Reso1	40,700 m ²	1.78 l/s	1.55 l/s	2.93 l/s	4.35 l/s	6.32 l/s	20 m ³
Reso2	9,500 m ²	0.51 l/s	0.45 l/s	0.85 l/s	1.26 l/s	1.83 l/s	5 m ³
Reso3	2,000 m ²	0.14 l/s	0.12 l/s	0.23 l/s	0.33 l/s	0.49 l/s	1 m ³
Reso4	36,300 m ²	1.61 l/s	1.40 l/s	2.66 l/s	3.95 l/s	5.74 l/s	18 m ³
Reso5	53,300 m ²	2.23 l/s	1.94 l/s	3.69 l/s	5.47 l/s	7.95 l/s	26 m ³
Reso6	27,100 m ²	1.26 l/s	1.09 l/s	2.07 l/s	3.08 l/s	4.47 l/s	14 m ³
Reso7	2,500 m ²	0.17 l/s	0.14 l/s	0.27 l/s	0.41 l/s	0.59 l/s	1 m ³
Reso8	168,500 m ²	5.95 l/s	5.18 l/s	9.82 l/s	14.58 l/s	21.18 l/s	82 m ³
Reso9	25,600 m ²	1.20 l/s	1.04 l/s	1.98 l/s	2.93 l/s	4.26 l/s	13 m ³
Res10	1,100 m ²	0.08 l/s	0.07 l/s	0.14 l/s	0.20 l/s	0.29 l/s	1 m ³
Res11	1,200 m ²	0.09 l/s	0.08 l/s	0.15 l/s	0.22 l/s	0.32 l/s	1 m ³
Res12	68,400 m ²	2.76 l/s	2.40 l/s	4.56 l/s	6.77 l/s	9.84 l/s	34 m ³
Res13	189,600 m ²	6.58 l/s	5.72 l/s	10.85 l/s	16.12 l/s	23.42 l/s	92 m ³
Res14	50,300 m ²	2.13 l/s	1.85 l/s	3.51 l/s	5.21 l/s	7.57 l/s	25 m ³
Res15	2,300 m ²	0.15 l/s	0.13 l/s	0.25 l/s	0.38 l/s	0.55 l/s	1 m ³
Res16	69,600 m ²	2.80 l/s	2.44 l/s	4.63 l/s	6.87 l/s	9.98 l/s	34 m ³
Residential Total	748,000 m ²	29.44 l/s	25.61 l/s	48.57 l/s	72.13 l/s	104.80 l/s	334 m ³
EMPo1	5,500 m ²	0.30 l/s	0.26 l/s	0.50 l/s	0.74 l/s	1.07 l/s	3 m ³
EMPo2	16,400 m ²	0.80 l/s	0.70 l/s	1.32 l/s	1.96 l/s	2.85 l/s	63 m ³
EMPo3	60,640 m ²	2.50 l/s	2.18 l/s	4.13 l/s	6.13 l/s	8.90 l/s	30 m ³
Employment Land Total	154,000 m ²	6.50 l/s	5.66 l/s	10.73 l/s	15.68 l/s	23.14 l/s	96 m ³
LCo1	11,600 m ²	0.61 l/s	0.53 l/s	1.01 l/s	1.50 l/s	2.17 l/s	6 m ³
LCo2	7,600 m ²	0.43 l/s	0.37 l/s	0.70 l/s	1.04 l/s	1.52 l/s	4 m ³
LCo3	5,000 m ²	0.30 l/s	0.26 l/s	0.49 l/s	0.73 l/s	1.06 l/s	3 m ³
LCo4	8,800 m ²	0.48 l/s	0.42 l/s	0.80 l/s	1.18 l/s	1.72 l/s	5 m ³
LCo5	7,100 m ²	0.40 l/s	0.35 l/s	0.66 l/s	0.98 l/s	1.43 l/s	4 m ³
LCo6	5,400 m ²	0.32 l/s	0.28 l/s	0.53 l/s	0.78 l/s	1.13 l/s	3 m ³
Local Centre Total	45,500 m ²	2.54 l/s	2.21 l/s	4.19 l/s	6.22 l/s	9.03 l/s	25 m ³
Eduo1	22,200 m ²	1.06 l/s	0.92 l/s	1.75 l/s	2.60 l/s	3.77 l/s	11 m ³
Eduo2	20,100 m ²	0.97 l/s	0.85 l/s	1.61 l/s	2.39 l/s	3.47 l/s	10 m ³
Fle01	105,000 m ²	3.98 l/s	3.46 l/s	6.56 l/s	9.75 l/s	14.16 l/s	51 m ³
Total	1,136,740 m ²	45.59 l/s	39.66 l/s	75.22 l/s	111.69 l/s	162.29 l/s	527 m ³

5.2 Proposed scheme

The philosophy for the proposed SUDS strategy is to dispose of surface water by infiltration wherever possible. The proposals include:

- Individual soakaways to the residential plots
- Permeable paving to driveways and residential parking areas
- Infiltration basins to collect runoff from residential parcel roads and footpaths
- Permeable paving to employment land car parking areas
- Infiltration basins to collect runoff from employment land buildings, roads and pavements
- Swales and bio-retention areas to partially convey runoff from roads and footpaths to the infiltration basins along with traditional piped systems

The proposed drainage strategy drawings are contained in Appendix D for reference.

The SuDS selection process undertaken is outlined in detail in Appendix C and the proposed SuDS devices are summarised in Figure 5.3 below.

Range	Total potential change anticipated for 2010-2039	Total potential change anticipated for 2040-2059	Total potential change anticipated for 2060-2115
Upper end	10%	20%	40%
Central	5%	10%	20%

Figure 5.4 Peak rainfall intensity climate change allowance

Element	Management stage	Water quantity	Water quality	Amenity & biodiversity	To be considered in scheme
Rainwater harvesting	Prevention	✓	✗	✗	✓
Green / brown / blue roof	Source control	✓	✓	✓	✓
Raingardens	Source control	✓	✓	✓	✓
Bio-retention	Source control	✓	✓	✓	✓
Permeable surfacing	Source control	✓	✓	✗	✓
Swales	Source control	✓	✓	✓	✓
Detention basin / ponds	Source control	✓	✓	✓	✓
Discharge to tidal river / dock / canals	Site control	✓	✗	✗	✓
Storage tanks / Geocellular storage	Site control	✓	✗	✗	✓
Oversized piping	Site control	✓	✗	✗	✗
Design for exceedance	Site control	✓	✗	✗	✓

Figure 5.3 Summary of proposed SuDS devices

5.2.1 Design criteria and modelling results

The estimated impermeable areas for the proposed development have been based on the following assumptions:

- Employment Land building area - 50% of the Gross Developable Area
- Employment Land on-site car parks - 10% of the Gross Developable Area
- Highways / hardstanding - 15% of the Gross Developable Area
- Residential - 100 m² per dwelling plus a 10% allowance for Urban Creep
- Local Centre hardstanding area - 75% of the Gross Developable Area
- Education parcels hardstanding area - 30% of the Gross Developable Area
- Flexible parcel hardstanding area - 20% of the Gross Developable Area

The rainfall parameters have been based on the following values:

- Site Location: GB 524400 234600 TL 24400 34600
- FEH Version: 2022
- Standard Annual Average Rainfall (SAAR) = 589 mm
- Volumetric runoff coefficient C_v (summer) = 1.0
- Volumetric runoff coefficient C_v (winter) = 1.0
- Climate change allowance = 40% ("Upper Limit" of the DEFRA guidance (refer to Figure 5.4 below)
- CWI = 84.580
- SPRHOST = 5.24
- URBEXT2000 = 0.0431
- Areal Reduction Factor = 1.00
- BFIHOST = 0.953
- FARL = 1.000

The InfoDrainage results demonstrate that all water is contained within the proposed drainage system for every event up to and including the 1 in 100 year plus 40% climate change allowance event.

Detailed calculations for the proposed run off rates and discharge volumes are contained in Appendix B for reference and are summarised below.

Residential Plots

Catchment	Indicative No. of Dwellings	Soakaway Dimensions	Void Ratio	Soakaway Volume	Total House Soakaway Volume
Reso1	175	3.4 x 3.4 x 2.2m	30%	7.63 m³	1,335 m³
Reso2	40	3.4 x 3.4 x 2.2m	30%	7.63 m³	305 m³
Reso3	10	3.4 x 3.4 x 2.2m	30%	7.63 m³	76 m³
Reso4	155	3.4 x 3.4 x 2.2m	30%	7.63 m³	1,183 m³
Reso5	230	3.1 x 3.1 x 2.0m	30%	5.77 m³	1,326 m³
Reso6	120	3.3 x 3.3 x 2.1m	30%	6.86 m³	823 m³
Reso7	12	3.2 x 3.2 x 2.7m	30%	8.29 m³	100 m³
Reso8	730	3.4 x 3.4 x 2.1m	30%	7.28 m³	5,316 m³
Reso9	115	3.4 x 3.4 x 2.2m	30%	7.63 m³	877 m³
Res10	5	3.2 x 3.2 x 2.7m	30%	8.29 m³	41 m³
Res11	5	3.2 x 3.2 x 2.7m	30%	8.29 m³	41 m³
Res12	300	3.4 x 3.4 x 2.2m	30%	7.63 m³	2,289 m³
Res13	821	3.4 x 3.4 x 2.2m	30%	7.63 m³	6,264 m³
Res14	220	2.7 x 2.7 x 2.0m	30%	4.37 m³	962 m³
Res15	10	2.6 x 2.6 x 2.0m	30%	4.06 m³	41 m³
Res16	252	2.7 x 2.7 x 2.0m	30%	4.37 m³	1,102 m³
3,200					22,083 m³

Employment Land Car Park Areas

Plot	Car Park Hardstanding	Required Depth (m)
Empo1	630 m²	0.450
Empo2	12,900 m²	0.450
Empo3	2,630 m²	0.450

Main Infiltration Basins

Basin	Design Depth	Design Volume
1	1.00	5,763 m³
2	1.00	9,025 m³
3	1.00	6,910 m³
4	1.00	713 m³
5	1.20	4,365 m³
6	1.20	4,419 m³
7	1.00	3,804 m³
8	1.00	598 m³



Figure 5.5 Infiltration basin locations

5.2.2 Water quality

SuDS features will be designed in accordance with the guidance contained in CIRIA C753 - The SuDS Manual. In particular, for water quality, Chapters 4 and 26 will be adhered to. As infiltration is proposed as a main source of surface water disposal the following requirements will need to be observed:

- The discharge of clean roof water to the ground is acceptable provided that (a) all roof water downpipes are sealed against pollutants entering the system from polluted surface runoff, effluent disposal or other forms of discharge and (b) gross sediments and silts are removed upstream of the infiltration component.
- There should be a minimum depth of 1 m of unsaturated aquifer material between the base of any infiltration system and the maximum likely groundwater level (taking account of potential shifts in groundwater level resulting from extended periods of wet weather). Evidence from groundwater records may demonstrate the maximum groundwater levels, but where there is any uncertainty, appropriate groundwater monitoring should be undertaken to demonstrate levels across the site. Ground investigation should establish the typical maximum upper level of the saturated layer of an unconfined aquifer. "Typical" in this context would be a representative winter water table level, based on hydrogeological records and/or expert opinion and discounting extremes in weather or artificial suppression by engineering techniques such as pumping.

- The method of discharge should not create new pathways for pollutants to groundwater or mobilise contaminants already in the ground (EA, 2013).
- For contaminated land sites, the site investigation report should be used to identify any residual hotspots where pollutants are still likely to be present, and these areas should be located on the site plan. Any infiltration through contaminated soils could potentially mobilise or remobilise pollutants, alter remedial measures undertaken on site and cause pollution of groundwater. Guidance on an appropriate approach for this should be sought from the environmental regulator. A discharge that disturbs land that subsequently causes a release of pollutants to groundwater may potentially require an environmental permit, or alter liabilities under Part 11a of the Environmental Protection Act 1990.

In addition to these requirements, Table 4.3 of The SuDS Manual which has been reproduced in Figure 5.6 below will also be followed to prevent any risk to the local groundwater and surrounding area.

An initial assessment has been undertaken of the likely treatment trains which shows that in all cases, the level of treatment is appropriate for the type of area being drained. These calculations are contained in Appendix B, page 93 for reference.

Land use	Pollution hazard level	Requirements for discharge to surface waters, including coasts and estuaries	Requirements for discharge to groundwater
Residential roofs	Very low	Removal of gross solids and sediments only	
Individual property driveways, roofs (excluding residential), residential car parks, low traffic roads (e.g. cul de sacs, home zones, general access roads), nonresidential car parking with infrequent change (e.g. schools, offices)	Low	Simple index approach <i>Note: extra measures may be required for discharges to protected resource</i>	
Commercial yard and delivery areas, nonresidential car parking with frequent change (e.g. hospitals, retail), all roads except low traffic roads and trunk roads/motorways	Medium	Simple index approach <i>Note: extra measures may be required for discharges to protected resources</i>	Simple index approach <i>Note: extra measures may be required for discharges to protected resources</i> In England and Wales, Risk Screening must be undertaken first to determine whether consultation with the environmental regulator is required.
Trunk roads and motorways	High	Follow the guidance and risk assessment process set out in HA (2009)	
Sites with heavy pollution (e.g. haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured, industrial sites	High	Discharges may require an environmental licence or permit. Obtain pre-permitting advice from the environmental regulator. Risk assessment is likely to be required.	

Figure 5.6 Minimum water quality management requirements for discharges to receiving surface waters and groundwater

5.2.3 Exceedance Flows

In the unlikely event that the capacity of the surface water system is exceeded, water will leave the site via overland flow.

For the land north of the railway line the exceedance route for any overland flow generated by the site will follow the route of the existing Winterborne from east to west. These flows will end up in Infiltration Basins 1, 2 and 3 at the western end of the site.

For the land between the railway line and Royston Road the flows will also generally travel east to west and south to north to be intercepted by Infiltration Basins 5 and 6. The very western end would flow toward, and be contained by, the railway embankment as is the case in the existing situation.

To the south of Royston Road, overland flow in the eastern half of Plot BA3 will flow north east towards Infiltration Basin 7. The western half will flow north west towards Wallington Road and will be controlled by the soft landscaping proposed in this area. Overland flow within Plot BA2 will flow northwards and be intercepted by Infiltration Basin 8.

These routes are shown in Figure 5.7 below.

No exceedance flows will enter the site from external sources as the construction of the A505 has cut off any potential flow route from the south.

In addition, the proposed drainage strategy results in the potential for an exceedance event and the exceedance volumes generated by the site being greatly reduced.



Figure 5.7 Exceedance flow routes

5.3 River Ivel

The River Ivel is a chalk stream which runs to the west of the proposed development (Figure 5.7). The underlying bedrock in the Baldock area is chalk which acts as an aquifer storing large quantities of groundwater. Where the bedrock hits the surface, springs form and give rise to chalk streams (Figure 5.8). The Ivel Springs are located to the north and west of the site between Norton Road to the west, North Road to the east and the railway line to the south.

As the streams rely on groundwater to feed them they are therefore susceptible to seasonal fluctuations and over-abstraction. It is understood that the River Ivel suffers from the current water abstraction rate and often runs dry. At present, the site is mainly greenfield farmland and so there is currently an element of infiltration to the subsoil charging the aquifer but there is also a significant amount of rainfall being absorbed by the planting and so “lost”.

The proposed surface water drainage for the Baldock scheme will be designed in line with the guidance and recommendations contained in The SuDS Manual (CIRIA C753) but will also consider the most appropriate SuDS measures in the context of the River Ivel and the chalk aquifer. Two main techniques would have an impact on these:

- Rainwater harvesting would **directly reuse** surface water runoff to help satisfy some of the development’s non-potable water demand, reducing the required water supply from public water mains which, in turn, could reduce the amount of abstraction required to be undertaken by the Water Authority.
- Infiltration would recharge the aquifer which would, in turn, help to feed the Ivel Springs and ease the effects of abstraction by providing more direct inflow.

A suitable balance will need to be struck between these two approaches. Although rainwater harvesting can reduce water demand it does not provide any direct amenity or habitat benefit. Rainwater harvesting systems also require overflows as they are designed to cater for lower intensity storm events. Also, by covering large areas of the land with hardstanding and then harvesting the water, this would remove a significant recharge source to the underlying aquifer.

Infiltration provides more tangible amenity and habitat benefits by feeding into the River Ivel and its eco-system. This approach would also ensure more rainfall is available for **indirect reuse** through the abstraction process. The topography of the site suggests that the plots to the south near Clothall Road would have the biggest infiltration and recharge impact as groundwater flows north from here toward Ivel Springs. Disposing of all surface water by infiltration techniques ensures a “no worse” scenario as a minimum in terms of aquifer recharge and may actually increase the recharge due to the reduction in losses due to absorption by farmland planting.

Affinity Water have future plans for reducing water abstraction from the River Ivel and securing other sources which will potentially impact the choice of SuDS techniques depending on the timing of the AW works and the development of the masterplan site as both will be undertaken over a number of years.

Also, the new development foul sewerage network will be designed in accordance with the current standards and legislation and pumping stations will be sized to have sufficient storage capacity to ensure that there is no risk to the groundwater aquifer from overflows or spillages.



Figure 5.8 River Ivel / Ivel Springs Location Plan

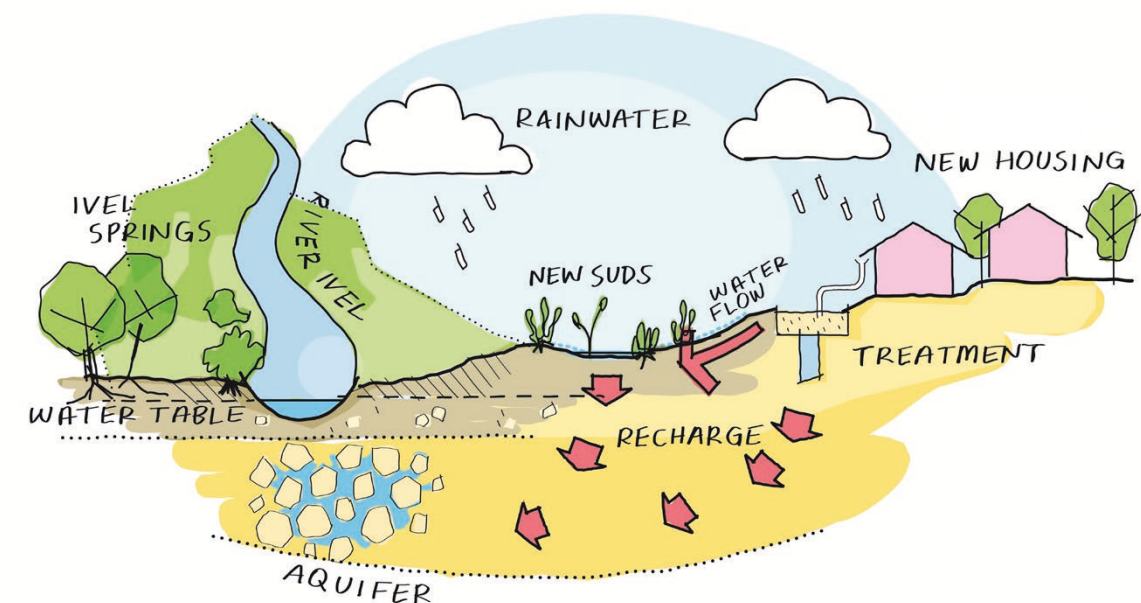


Figure 5.9 Indicative watercycle

6 Foul water drainage

6.1 Existing scheme

The Anglian Water record drawings show public foul sewers adjacent to the northern part of the site serving the properties in Salisbury Road, Bygrave Road and North Road along with a foul rising main crossing the site from north-east to south-west which discharges into the gravity foul sewer in Bygrave Road. This main will have an easement associated with it which would constrain the proposed plot layouts in the vicinity of it. Alternatively, a diversion could be sought to either remove from the site completely or to relocate it to a more favourable route through the site.

To the south, there are foul sewers serving the properties on Walnut Avenue and Laxton Gardens, Barley Rise, Chauncey Gardens and Merchants Walk and Aleyn Way and Orwell View.

It is understood that these sewers eventually discharge to the Baldock-Norton Road pumping station before being pumped to Letchworth Wastewater Treatment Plant which is located off Stotford Road.

However, as the existing site is greenfield there are currently no foul water flows discharged from the site.

An extract from the record plans is shown in Figures 5.1 and 5.2 for reference.

6.2 Proposed scheme

A pre-development enquiry has been lodged with Anglian Water to ascertain the potential to connect to the existing public foul water network. Their response is contained in Appendix E for reference.

Anglian Water have confirmed that, at present, their modelling confirms that there is sufficient capacity within Letchworth Wastewater Treatment Plant (LWRC) to accommodate the development.

However, the modelling also confirms that there is insufficient capacity within the existing Baldock-Norton Road pumping station for all the additional flows from the new development and therefore, mitigation measures will be required to allow the whole development to connect.

Prior advice has been received that there is capacity within the existing network to allow an initial phase of homes to connect without the need for any mitigations being put in place. Anglian Water have advised that connection should be made to manhole MH1403 which is located at Laxton Gardens (refer to Figures 6.1 and 6.2 below). This connection will therefore be used by plot BA2 (or DEV15). Urban&Civic is continuing to work with Anglian Water to confirm the availability of initial capacity.

Anglian Water have confirmed that an alternative foul water drainage strategy will need to be considered for the remaining plots which are outlined below.

The original 2017 planning application (17/01344/1SCP) proposed to connect directly to an existing manhole located within the compound of the Baldock-Norton Road pumping station which Anglian Water confirmed had insufficient capacity and provided a list of alternative mitigation measures:

1. Providing 723 m³ of additional storage within the pumping station compound.
2. A possible alternative to providing additional storage at Norton Road pumping station is to increase pass-forward flow capacity. It is estimated that the flow would need to increase by 20l/s, which would require an upgrade of the power supply to the pumping station and upsizing the rising main.
3. Subject to formation levels on the development, it may be possible to incorporate on-line storage within the development site drainage.
4. A pumped conveyance direct to Letchworth WRC. The configuration and position of the inlet indicates that a direct connection at a rate of 37.7l/s can be made without significant detriment to the WRC process and upstream sewerage. Therefore no mitigation would be required for a direct connection to the WRC.

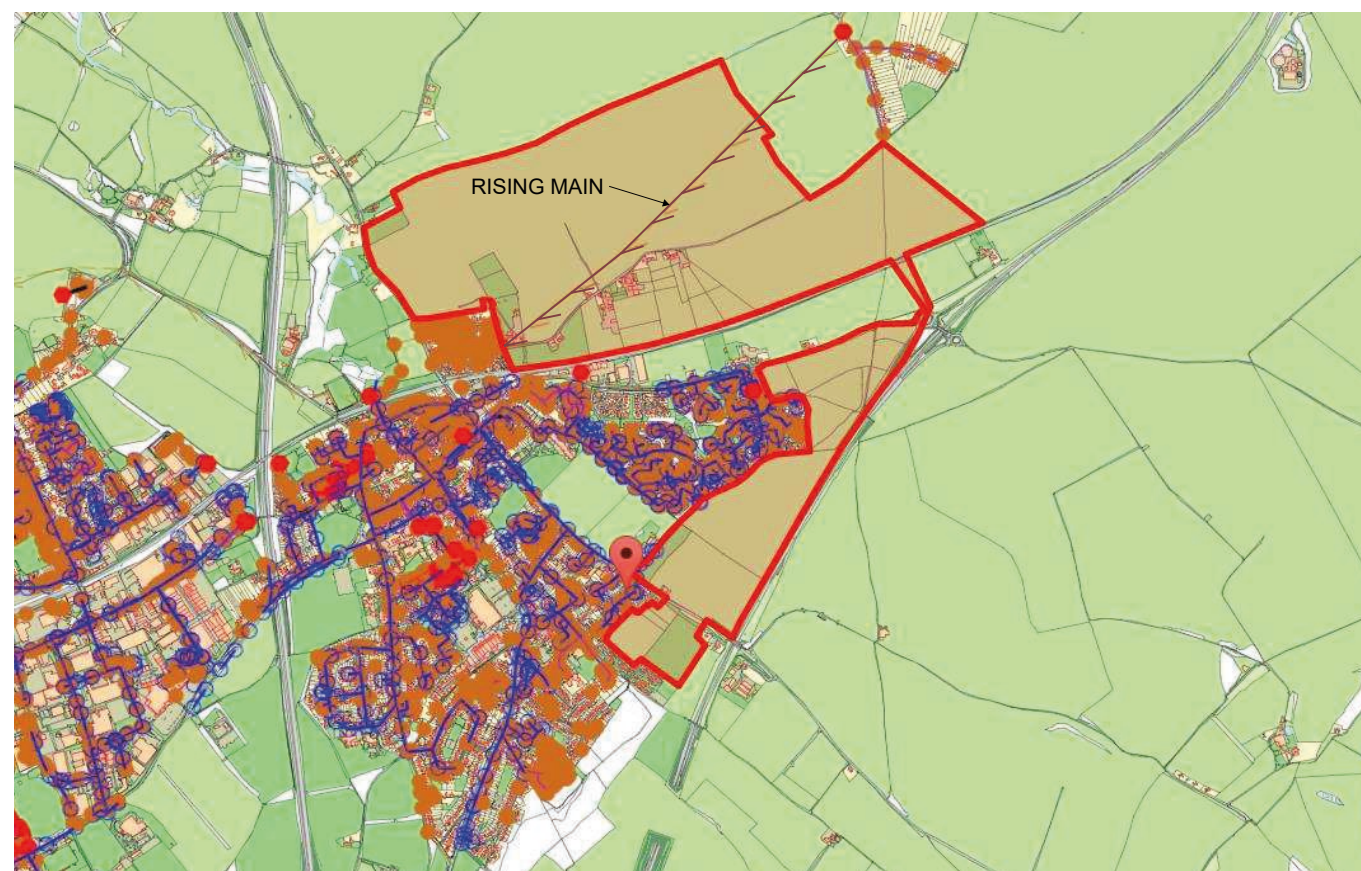


Figure 6.1 Proposed connection points

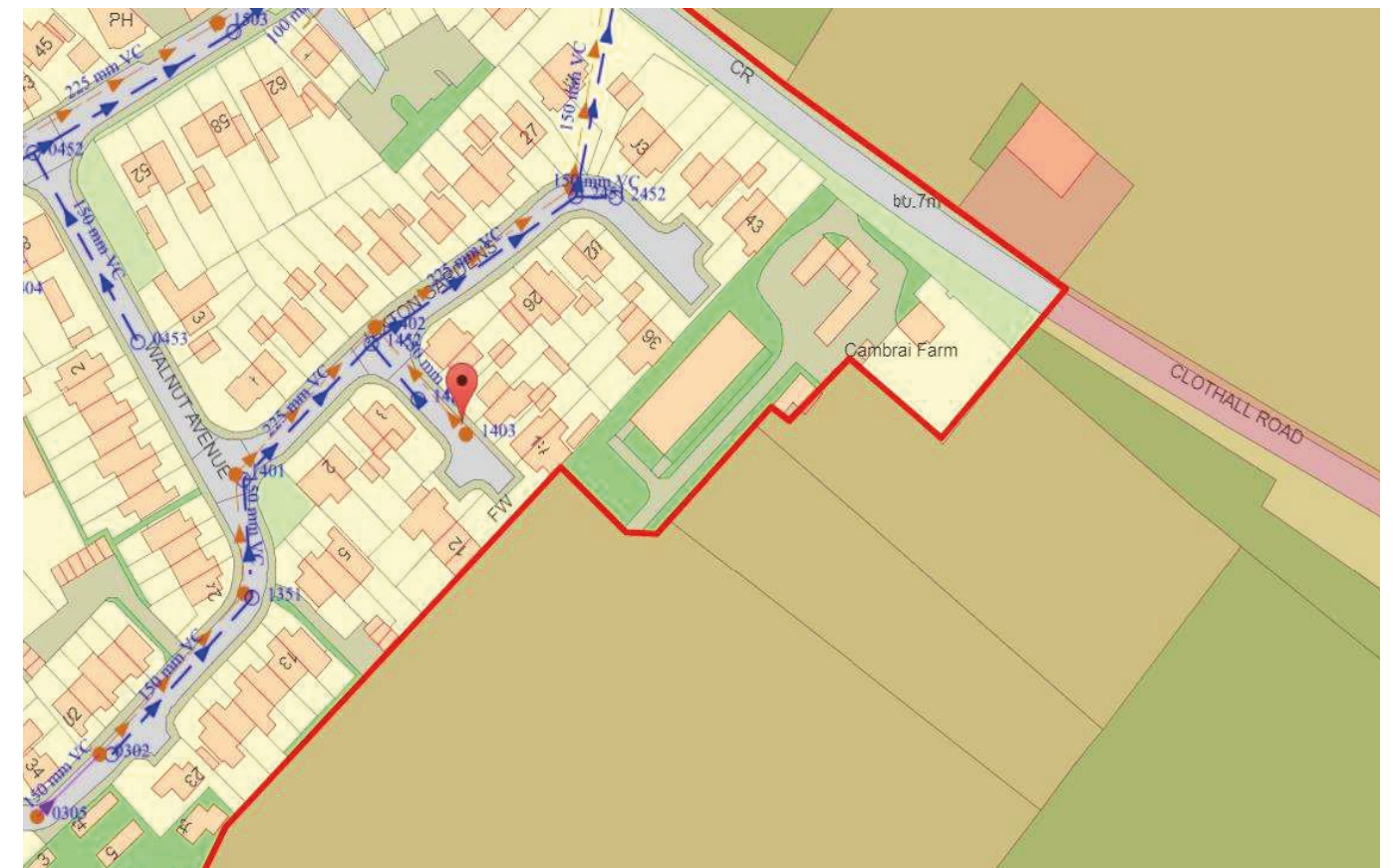


Figure 6.2 Proposed connection points

The proposed approach is a variation on the “pumped conveyance direct to Letchworth WRC” alternative option that Anglian Water put forward. This would give more freedom to the layout of the sewers in the northern site as there is no reliance on a gravity connection to the Baldock-Norton Road pumping station and the new pumping station can be positioned to suit the proposed layout and contouring.

It is proposed that the remaining plots on the southern site are to be pumped across the railway to the northern site and then pumped onward to LWRC along with the flows from the northern plots. The rising main will discharge to an existing 600mm dia. Anglian Water foul water sewer at a point just to the south east of LWRC. This will require an additional level of co-ordination to be undertaken in the phasing and planning of the northern plots and the pumping station.

Based on the Anglian Water response to the original Pre-application Enquiry, the pumped conveyance to Letchworth WRC will need to be undertaken within the first phase of development beyond the first 200 homes. These works will be carried out directly by Anglian Water under a Section 98 Agreement and this process is being progressed by the applicant.

The most suitable location for the main pumping station on the northern site is in the west or north west corner as this is the lowest point of the site and also the closest point to Letchworth WRC and so this appears to be the most suitable location without taking phasing into account. Locating the pumping station at the low point will allow the northern site to drain to it by gravity without the sewers becoming excessively deep.

For the south site there are two options:

- 1. Pump the foul flows across the railway and then provide a gravity sewer to the northern pumping station
- 2. Pump the foul flows directly to the northern pumping station

Option 1 has the advantages of limiting the length of rising main, reducing the pump sizes required and allowing the gravity sewer to double up as a gravity sewer for the northern site. However, it relies on the layout of the northern site to be designed in sufficient detail that the pipes can be correctly sized and the route can be constructed without later needing to be diverted to accommodate late layout changes.

Option 2 can be developed relatively freely of any knowledge of the northern site layout but increases the length of the rising main and would require larger pump sets.

Also, the construction and layout of the northern pumping station will need to be carefully considered as there will be significantly less flow passing through the station in the early phases compared to the fully developed scheme. This will impact rising main sizes and the number and size of pumps. The routing of the rising main through third party land will also need to be reviewed although Anglian Water have given an indicative route which will need to be developed and adjusted to suit the constraints encountered.

Calculations for the estimated foul water discharge for each plot are contained in Appendix B and the results have been summarised below:

Plot	Peak Discharge (litres/day)	Peak Discharge (litres/sec)
Reso1	700,000	8.10
Reso2	160,000	1.85
Reso3	40,000	0.46
Reso4	620,000	7.18
Reso5	920,000	10.65
Reso6	480,000	5.56
Reso7	48,000	0.56
Reso8	2,920,000	33.80
Reso9	460,000	5.32
Res10	20,000	0.23
Res11	20,000	0.23
Res12	1,200,000	13.89
Res13	3,284,000	38.01
Res14	880,000	10.19
Res15	40,000	0.46
Res16	1,008,000	11.67
Empo1	95,895	2.29
Empo2	2,238,434	53.25
Empo3	400,568	8.97
Local Centre (LCo1 to LCo6)	288,075	5.68
Eduo1	56,700	1.97
Eduo2	56,700	1.97
Fleo1	226,800	7.88
Total	16,163,171	230.16

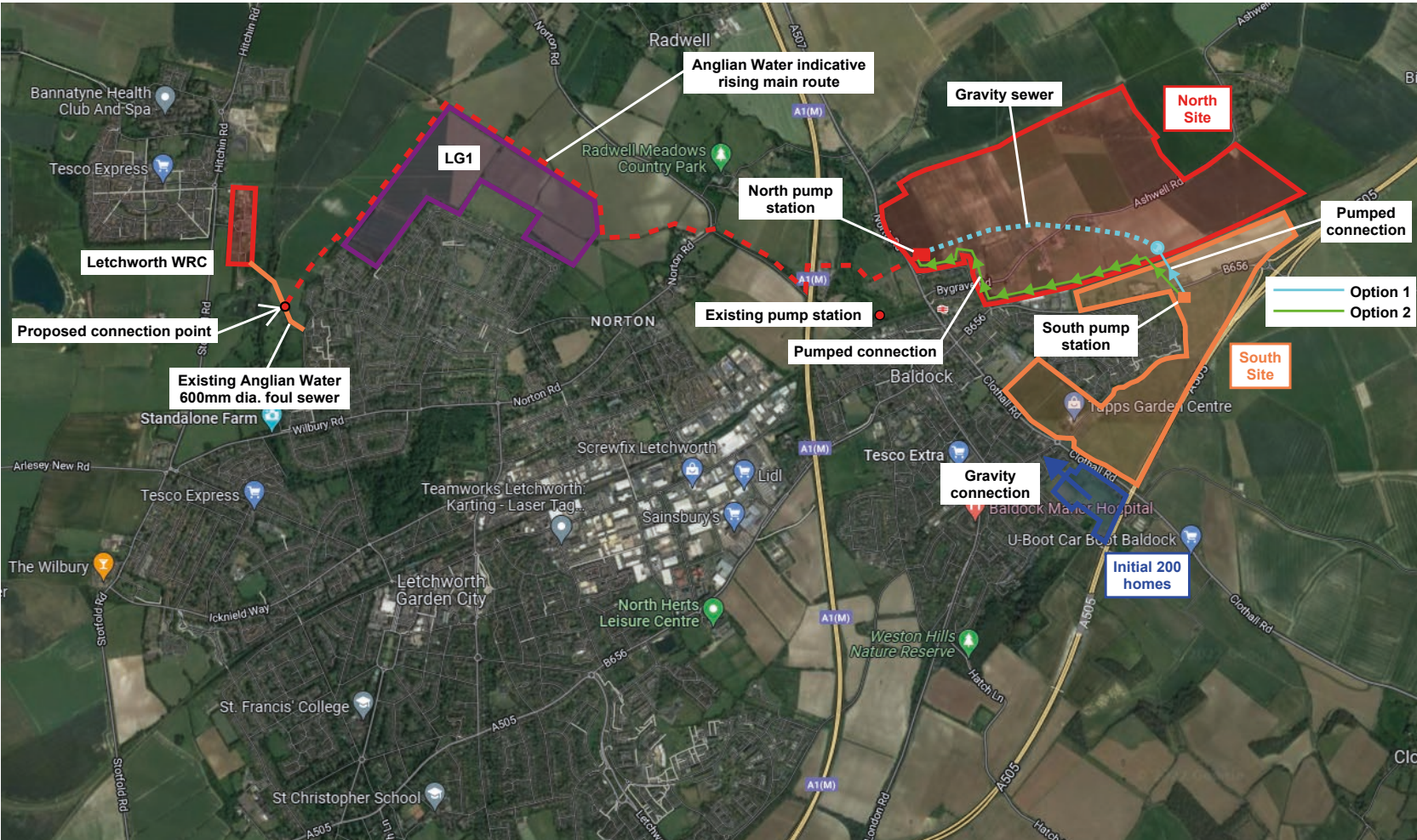


Figure 6.3 Proposed connection points

7 Summary

The table below and Figure 7.1 summarise the foul and surface water requirements to enable each of the parcels identified to be developed.

The surface water requirements have been based on the assumed build out programme:

- 1. Reso1, Reso2, Reso3 and Res o4
- 2. Reso5, Reso6, Reso8, Reso9 LCo1, LCo2, LCo3, LCo4 and Eduo1
- 3. Reso7, Res10, Res11, Res12, Res 13, LCo5 and LCo6

If Parcels Reso7, Res10, Res11 and Res12 were to be brought forward before Parcels Reso8 and Reso9,it is likely that Basin 2 would have sufficient capacity to accommodate these parcels but would require abortive work to drain them to Basin 2 before cutting them back to connect to Basin3 in the final layout. This will require further consideration at detailed design stage.

Parcel	Foul Water requirement	Surface Water requirement
Reso1	Construction of connection to Letchworth WRC	Construction of Basin 1
Reso2	Construction of connection to Letchworth WRC	Construction of Basin 1
Reso3	Construction of connection to Letchworth WRC	Construction of Basin 1
Reso4	Construction of connection to Letchworth WRC	Construction of Basin 1
Reso5	Construction of connection to Letchworth WRC	Construction of Basin 2
Reso6	Construction of connection to Letchworth WRC	Construction of Basin 2
Reso7	Construction of connection to Letchworth WRC	Construction of Basin 3
Reso8	Construction of connection to Letchworth WRC	Construction of Basin 2
Reso9	Construction of connection to Letchworth WRC	Construction of Basin 2
Res10	Construction of connection to Letchworth WRC	Construction of Basin 3
Res11	Construction of connection to Letchworth WRC	Construction of Basin 3
Res12	Construction of connection to Letchworth WRC	Construction of Basin 3
Res13	Construction of connection to Letchworth WRC	Construction of Basin 3
Res14	Construction of connection to Letchworth WRC	Construction of Basin 4
Res15	Construction of connection to Letchworth WRC	Construction of Basin 5
Res16	Gravity connection to MH1403 in Laxton Gdns	Construction of Basin 8
EMPo1	Construction of connection to Letchworth WRC	Construction of Basin 5
EMPo2	Construction of connection to Letchworth WRC	Construction of Basins 5 & 6
EMPo3	Construction of connection to Letchworth WRC	Construction of Basin 6
LCo1	Construction of connection to Letchworth WRC	Construction of Basin 2
LCo2	Construction of connection to Letchworth WRC	Construction of Basin 2
LCo3	Construction of connection to Letchworth WRC	Construction of Basin 2
LCo4	Construction of connection to Letchworth WRC	Construction of Basin 2
LCo5	Construction of connection to Letchworth WRC	Construction of Basin 3
LCo6	Construction of connection to Letchworth WRC	Construction of Basin 3
Eduo1	Construction of connection to Letchworth WRC	Construction of Basin 2
Eduo2	Construction of connection to Letchworth WRC	Construction of Basin 4
Fle01	Construction of connection to Letchworth WRC	Construction of Basin 7



Figure 7.1 Infiltration basin and connection point locations

8 Flood risk assessment requirements

The Environment Agency's Indicative Floodplain Map (see Figure 7.1) shows that the site lies in Zone 1 – an area with a low probability of flooding. However, as the site is greater than 1 ha in area, a Flood Risk Assessment is required in accordance with the National Planning Policy Framework.

AKT II have undertaken a site specific flood risk assessment for the redevelopment and the main findings of this assessment are summarised below:

- In accordance with the National Planning Policy Framework, we would categorise the site as lying entirely within Flood Zone 1 - an area assessed as having a less than 1 in 1000 annual probability of river or sea and river flooding (<0.1%).
- In accordance with the NPPF, all proposed land uses are acceptable within Flood Zone 1 and therefore the site passes the Sequential Test.
- The site has been assessed as being at **very low risk** of flooding from rivers or tidal sources.
- The site has been assessed as being at **very low risk** from surcharging sewers.
- The site has been assessed as being at **very low risk** from groundwater sources.
- The site has been assessed as being at **very low risk** from artificial sources.
- The site has been assessed as generally being at **very low risk** from surface water flooding. Mitigation measures are proposed for the areas noted as being susceptible to overland flow / surface flooding and these should be implemented as part of the drainage strategy.
- The proposed redevelopment has an acceptable flood risk within the terms and requirements of the National Planning Policy Framework.

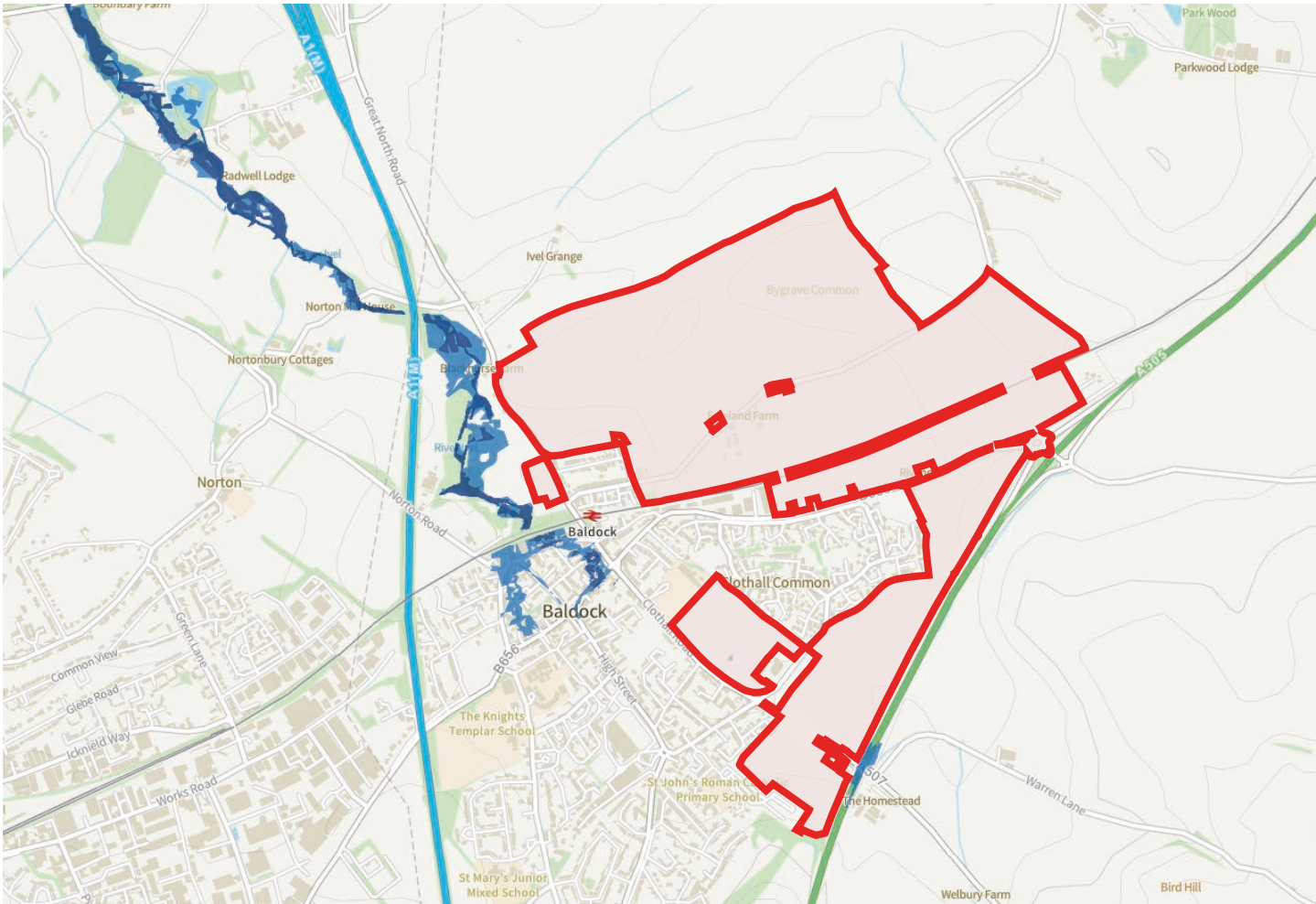


Figure 8.1 Environment Agency indicative flood map

9 Maintenance and operation

Before cleaning, final testing and immediately before handover the Contractor will:

- Lift covers to manholes, inspection chambers and access points. Remove mortar droppings, debris and loose wrappings.
- Thoroughly flush pipelines with water to remove silt and check for blockages. Rod pipelines between access points if there is any indication that they may be obstructed.
- Carry out a CCTV of the pipework to ensure that it is free of silt and blockages.

The End User shall then follow the “Waste Management, The Duty of Care – A Code of Practice (Revised 1996)” and shall ensure that their waste does not escape from their control and is transferred only to a registered waste carrier to be sent for recycling or disposal at a suitably licensed facility.

All waste arising from the maintenance of the drains and sewers shall be handled, stored and disposed of correctly to avoid pollution. Waste may be designated as hazardous / special waste and, as such, the End User shall ensure that they comply with the Hazardous Waste (England and Wales) Regulations 2005.

Reference shall be made to CIRIA publication C753 - The SuDS Manual by the Contractor and the End User. A suitable maintenance schedule must be developed, maintained, followed and updated as required to reflect observed performance. The following items are highlighted for guidance.

9.1 General drainage

The below ground drainage network has been designed in accordance with the requirements of the Building Regulations whilst acknowledging the need to limit the number of inspection chambers within “front of house” areas. To this end, all main runs have rodding eyes, manholes or inspection chambers at the head of the run and at all changes of direction to provide access to rod or jet the main pipework.

Where possible, connections from stacks or gullies have been made directly to these manholes or inspection chambers to allow the connection to be rodded or jetted from the downstream end. Where this is not possible, each stack has been detailed to have an access hatch provided just above floor level (see Figure 8.1) to allow the connection to be rodded or jetted from the upstream end. Similarly, the gullies have a rodding access provided within their body allowing the pipework to be rodded or jetted from the gully downstream.

Gullies and channels have been specified with silt buckets and silt trap manholes have been provided upstream of all tanks and infiltration structures to prevent the ingress of silts into the drainage network and impairing the performance of the system.

Maintenance schedule	Required action	Recorded frequency
Regular maintenance	Inspect and identify areas that are not operating correctly. If required, take remedial action.	Monthly for the first three months then six-monthly
	Remove sediment from pre-treatment structures (e.g. gullies, channels, silt traps).	Six-monthly or as required
Occasional maintenance	Debris removal from catchment surface where this may cause risks to performance.	Monthly
Remedial actions	Repair / rehabilitation of inlets, outlets, overflows and vents.	As required
Monitoring	Inspect all manholes, inspection chambers, inlets, outlets, overflows and vents to ensure they are in good condition and operating as designed.	Annually and after large storms

9.2 Pumped systems

Pumps have been designed as duplex units operating on a duty / standby based on hours run, pump failure and high / high water level. A suitable BMS interface shall be provided monitoring each pump system for the following status points:

- Pump 1 running / Pump 2 running - These statuses shall be provided to the BMS in the form of a volt free contact that is closed when the pump is running.
- Pump 1 failed / Pump 2 failed - These statuses shall be provided to the BMS in the form of a volt free contact that is closed when the pump has deemed to have failed, i.e. failed to run when requested. This shall cause a latched general alarm on the BMS.
- High water level - This status shall be provided to the BMS in the form of a volt free contact that is closed when a high water level is breached. The level shall set at a level that is higher than the normal pump control level switch. This shall cause a latched general alarm on the BMS.
- High / High water level - This status shall be provided to the BMS in the form of a volt free contact that is closed when a high / high water level is breached. The level shall set at a level that is higher than the high water level switch. This shall cause a critical latched alarm on the BMS.
- System not in automatic / not available - This status shall be provided to the BMS in the form of a volt free contact that is open (failsafe) when the system is not available to operate. This shall operate should any event occur that could prevent the system from operating, such as power loss to the control panel, hand / off / auto switches not in Auto, isolators opened. This shall cause a critical latched alarm on the BMS.

The BMS shall be capable of raising the following alarms:

- Excessive Pump Running Alarm - The BMS shall monitor the running status of each pump. Should any pump run for longer than 20 minutes, a general alarm shall be raised on the BMS.
- Excessive Pump Starts Alarm - The BMS shall calculate from the running status the number of starts per hour. Should the number of starts per hour exceed 4, a general alarm shall be raised on the BMS.

A control panel local to each pump station shall be provided to monitor the same status points and alarms as defined for the BMS Interface above.

9.3 Petrol separators

The separator shall be provided with a robust device to provide visual and audible warning to an appropriate location when the level of oil reaches 90 % of the oil storage volume under static liquid level conditions. Appropriate maintenance shall then be carried out.

Maintenance schedule	Required action	Recorded frequency
Regular maintenance	Follow the manufacturer's recommended guidelines.	As manufacturer's recommendations
	Remove sediment / oil from separator.	Six-monthly or as manufacturer's recommendations
	Service all electrical equipment.	As manufacturer's recommendations
	Inspect integrity of separator and all mechanical parts.	Six-monthly or as manufacturer's recommendations

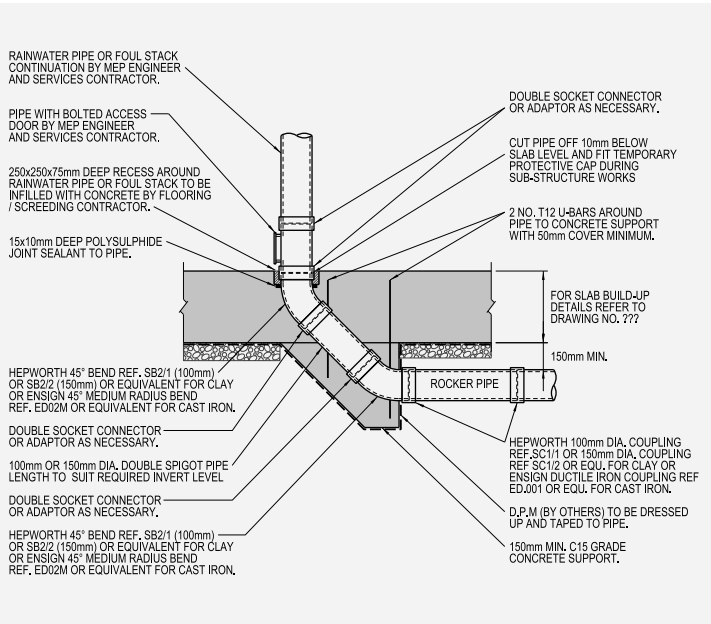


Figure 9.1 Rodding /jetting access detail

9.4 Rainwater Harvesting

Any property with a rainwater harvesting system installed should be provided with appropriate information as to what equipment has been installed, its purpose, its operation and maintenance requirements, the actions needed to address any potential failure and the expected performance of the system. Information on the options for external maintenance support should also be provided.

Most systems require periodic checking and maintenance to ensure troublefree and reliable operation. There are wide differences in the extent of maintenance required for different systems, and manufacturers’ guidelines should always be followed. The table of actions below is not exhaustive and some actions may not always be required.

Maintenance requirements are largely dependent on the runoff source and the runoff use (and thus treatment processes provided). This will range from weekly input through to rare intervention. Routine inspection of the filter system at quarterly annual intervals is advised, even if they do not appear to need specific intervention. Pumps need very little attention, but their design life is generally regarded as only being 10 years. Where automatic provision of potable water occurs (if and when rainwater is either not available or the system has failed), it is useful to have sensor warnings relayed in such a manner as to inform the user of the current status of the system.

Tanks should be accessible for internal inspection, and the cover should preferably be lockable.

The maintenance responsibility for a rainwater harvesting system is usually with the owner of the property, but any communal systems require the participating community to be informed of the system, as detailed, but also be provided with information of who the organisation is that is maintaining the system and any financial commitments and any legally binding maintenance agreement.

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspection of the tank for debris and sediment buildup, inlets/outlets/ withdrawal devices, overflow areas, pumps, filters	Annually (and following poor performance)
	Cleaning of tank, inlets, outlets, gutters, withdrawal devices and roof drain filters of silts and other debris	Annually (and following poor performance)
Occasional maintenance	Cleaning and/or replacement of any filters	Three monthly (or as required)
Remedial actions	Repair of overflow erosion damage or damage to tank	As required
	Pump repairs	As required

9.5 Green Roofs

Intensive green roofs are likely to require regular inspection and maintenance. Grassed areas may require mowing weekly or fortnightly, plant beds may require weeding on a weekly or fortnightly basis during the growing season, and wildflower meadows may require annual mowing with the cuttings removed.

Extensive green roofs should normally only require biannual or annual visits to remove litter, check fire breaks and drains and, in some cases, remove unwanted invasive plants. The most maintenance is generally required during the establishment stage (12 to 15 months), and this should usually be made the responsibility of the green roof provider. Maintenance contractors with specialist training should be used, where possible.

All maintenance actions carried out at roof level must be in full compliance with the appropriate health and safety regulations, and particularly those specifically dealing with working at height. Training and guidance information on operating and maintaining the roof should be provided to all property owners and tenants. Safety fastenings will be required for personnel working on the roof. Specific maintenance needs of the green roof should be monitored and maintenance schedules adjusted to suit requirements.

The table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

Maintenance schedule	Required action	Typical frequency
Regular inspections	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources	Annually and after severe storms
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system	Annually and after severe storms
	Inspect underside of roof for evidence of leakage	Annually and after severe storms
Regular maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth	Six monthly and annually or as required
	During establishment (ie year one), replace dead plants as required	Monthly (but usually responsibility of manufacturer)
	Post establishment, replace dead plants as required (where > 5% of coverage)	Annually (in autumn)
	Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow grasses, prune shrubs and manage other planting (if appropriate) as required – clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled	As required
	If drain inlet has settled, cracked or moved, investigate and repair as appropriate	As required

9.6 Soakaway systems

During the construction stage it is essential that construction sediment is prevented from entering the infiltration system and the Contractor shall provide adequate protection to prevent this.

The design of soakaways, infiltration trenches and blankets should include monitoring points where the water level in the system can be observed or measured. This can either be via an inspection well or inspection cover (where the attenuation storage space is a void). For larger installations the inspection access should provide a clear view of the infiltration surface (even if the storage zone is filled). For small, filled soakaways, a 50 mm perforated pipe is adequate.

The useful life and effective operation of an infiltration component is related to the frequency of maintenance and the risk of sediment being introduced into the system.

An easement should be considered where multiple properties discharge to a single soakaway, to ensure longterm access for maintenance purposes.

Maintenance will usually be carried out manually, although a suction tanker can be used for sediment/debris removal for large systems. If maintenance is not undertaken for long periods, deposits can become hardpacked and require considerable effort to remove.

Replacement of the aggregate or geocellular units will be necessary if the system becomes blocked with silt. Effective monitoring will give information on changes in infiltration rate and provide a warning of potential failure in the long term.

Roads and/or parking areas draining to infiltration components should be regularly swept to prevent silt being washed off the surface which will minimise the need for maintenance.

Maintenance responsibility should be placed with an appropriate organisation.

The table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect for sediment and debris in pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	Annually
	Cleaning of gutters and any filters on downpipes	Annually (or as required based on inspections)
	Trimming any roots that may be causing blockages	Annually (or as required)
Occasional maintenance	Remove sediment and debris from pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	As required, based on inspections
Remedial actions	Reconstruct soakaway and/or replace or clean void fill, if performance deteriorates or failure occurs	As required
	Replacement of clogged geotextile (will require reconstruction of soakaway)	As required
Monitoring	Inspect silt traps and note rate of sediment accumulation	Monthly in the first year and then annually
	Check soakaway to ensure emptying is occurring	Annually

9.7 Infiltration basins

During the construction stage it is essential that construction sediment is prevented from entering the infiltration system and the Contractor shall provide adequate protection to prevent this.

Regular inspection and maintenance is important for the effective operation of infiltration basins as designed. Maintenance responsibility for an infiltration basin and its surrounding area should be placed with a responsible organisation.

Regular mowing in and around infiltration basins is only required along maintenance access routes, amenity areas (eg footpaths), across embankments and across the main storage area. The remaining areas can be managed as “meadow” or other appropriate vegetation, unless additional management is required for landscaping purposes. Grass cutting may need to accommodate specific sward mixes and specialist seed or turf supplier recommendations. Deeprooting vegetation can maintain infiltration rates and minimise the need for remedial maintenance. All vegetation management activities should take account of the need to maximise biosecurity and prevent the spread of invasive species.

Adequate access should be provided to the infiltration basin for inspection and maintenance, including for appropriate equipment and vehicles such as mowing equipment. The table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

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
	Cut grass - meadow grass in and around basin	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	Annually, or as required
	Prune and trim trees and remove cuttings	As required
	Remove sediment from pre-treatment system when 50% full	As required
Remedial actions	Repair erosion or other damage by reseedling or re- turfing	As required
	Realign the rip-rap	As required
	Repair or rehabilitate inlets, outlets and overflows	As required
	Rehabilitate infiltration surface using scarifying and spiking techniques if performance deteriorates	As required
	Relevel uneven surfaces and reinstate design levels	As required
Monitoring	Inspect inlets, outlets and overflows for blockages, and clear if required	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	Half yearly
	Inspect infiltration surfaces for compaction and ponding	Monthly

9.8 Attenuation tanks

By aligning AquaCell Plus units end-to-end,full length viewing channels have been created within the base of the attenuation tank allowing for CCTV inspection if required. CCTV inspection of the tank is recommended at six-monthly intervals and after every major storm. Should the CCTV reveal a build up of silt in the base of the tank these channels also allow for jetting of the tank structure to clear the system.

Silt traps prior to inlet pipework should be routinely inspected and cleaned out to minimise debris reaching the tank. It is important to prevent construction silt from entering the AquaCell structure.

The table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Remedial actions		
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

9.9 Filter Strips

Filter strips will require regular maintenance to ensure continuing operation to design performance standards, and all designers should provide detailed specifications and frequencies for the required maintenance activities along with likely machinery requirements and typical annual costs - within the Maintenance Plan.

Maintenance of filter strips is relatively straightforward for landscape contractors and typically there should only be a small amount of extra work (if any) required for a filter strip over and above what is necessary for standard public open space. However, regular inspection and maintenance is important for the effective operation of filter strips as designed. Maintenance responsibility for a filter strip should always be placed with an appropriate organisation. If filter strips are implemented within private property, owners should be educated on their routine maintenance needs, and should understand the long-term Maintenance Plan and any legally binding maintenance agreement.

Access for maintenance vehicles should always be available. However, this is not usually a constraint due to the likely location of the filter strip adjacent to impermeable areas. Litter and debris removal should be undertaken as part of general landscape maintenance for the site and before any other SuDS management task. All litter should be removed from site.

The major maintenance requirement for filter strips is mowing. This should ideally retain grass lengths of 75-150 mm across the main “treatment” surface to assist in filtering pollutants and retaining sediments and to reduce the risk of flattening during runoff events. However, longer vegetation lengths, where appropriate, are not considered to pose a significant risk to functionality.

Grass clippings should be disposed of either off site or outside the area of the filter strip to remove nutrients and pollutants. All vegetation management activities should take account of the need to maximise biosecurity and prevent the spread of invasive species.

Any damage due to sediment removal or erosion should be repaired and immediately reseeded or planted.

The table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass - to retain grass height within specified design range	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect filter strip surface to identify evidence of erosion, poor vegetation growth, compaction, ponding, sedimentation and contamination (eg oils)	Monthly (at start, then half yearly)
	Check flow spreader and filter strip surface for even gradients	Monthly (at start, then half yearly)
	Inspect gravel flow spreader upstream of filter strip for clogging	Monthly (at start, then half yearly)
	Inspect silt accumulation rates and establish appropriate removal frequencies	Monthly (at start, then half yearly)
Occasional maintenance	Reseed areas of poor vegetation growth; alter plant types to better suit conditions, if required	As required or if bare soil is exposed over > 10% of the filter strip area.
Remedial actions	Repair erosion or other damage by re-turfing or reseedling	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

9.10 Filter Drains

Filter drains will require regular maintenance to ensure continuing operation to design performance standards, and all designers should provide detailed specifications and frequencies for the required maintenance activities along with likely machinery requirements and typical annual costs – within the Maintenance Plan. The treatment performance of filter drains is dependent on maintenance, and robust management plans will be required to ensure that maintenance is carried out in the long term.

Regular inspection and maintenance is important for the effective operation of filter drains as designed. Maintenance responsibility for a filter drain should always be placed with an appropriate organisation. Adequate access should always be provided to the filter drain for inspection and maintenance. If filter drains are implemented within private property, owners should be educated on their routine maintenance needs, and should understand the long-term Maintenance Plan and any legally binding maintenance agreement.

Litter (including leaf litter) and debris removal should be undertaken as part of general landscape maintenance for the site and before any other SuDS management task. All litter should be removed from site.

The table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

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 blockages, 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
	Remove sediment from pre-treatment devices	Six monthly, or as required
Occasional maintenance	Remove or control tree roots where they are encroaching the sides of the filter drain, using recommended methods (eg NJUG, 2007 or BS 3998:2010)	As required
	At locations with high pollution loads, remove surface geotextile and replace, and wash or replace overlying filter medium	Five yearly, or as required
	Clear perforated pipework of blockages	As required

9.11 Swales

Swales will require regular maintenance to ensure continuing operation to design performance standards. The treatment performance of swales is dependent on maintenance, and robust management plans will be required to ensure maintenance is carried out in the long term.

Maintenance of swales is relatively straightforward for landscape contractors, and typically there should only be a small amount of extra work (if any) required for a swale over and above what is necessary for standard public open space. However, regular inspection and maintenance are important for the effective operation of swales as designed. Maintenance responsibility for a swale should always be placed with an appropriate organisation. If swales are implemented within private property, owners should be educated on their routine maintenance needs, and should understand the longterm Maintenance Plan and any legally binding maintenance agreement.

Adequate access should be provided to all swale areas for inspection and maintenance, including for appropriate equipment and vehicles. Litter and debris removal should be undertaken as part of general landscape maintenance for the site and before any other SuDS management task. All litter should be removed from site.

The major maintenance requirement for dry swales is mowing. Mowing should ideally retain grass lengths of 75-150 mm across the main “treatment” surface, to assist in filtering pollutants and retaining sediments and to reduce the risk of flattening during runoff events. However, longer vegetation lengths, where appropriate, are not considered to pose a significant risk to functionality.

Grass clippings should be disposed of either off site or outside the area of the swale, to remove nutrients and pollutants. For wet swales, mowing of wetland vegetation is not required. However, harvesting of very dense vegetation may be desirable in the autumn after plant dieback, to prevent the discharge of excess organic material into receiving waters. All vegetation management activities should take account of the need to maximise biosecurity and prevent the spread of invasive species.

Occasionally sediment will need to be removed (eg once deposits exceed 25 mm in depth), although this can be minimised by ensuring that upstream areas are stabilised and by incorporating effective pre-treatment devices. Available evidence from monitoring studies indicates that small distributed infiltration practices such as swales do not contaminate underlying soils, even after more than 10 years of operation (TRCA, 2008). Sediments excavated from a swale that receives runoff from residential or standard road and roof areas are generally not toxic or hazardous material and can therefore be safely disposed of by either land application or landfilling. However, consultation should take place with the environmental regulator to confirm appropriate protocols. Sediment testing may be required before sediment excavation to determine its classification and appropriate disposal methods. For runoff from busy streets with high vehicle traffic, sediment testing will be essential. Any damage due to sediment removal or erosion should be repaired and immediately reseeded or planted.

The table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48 hours	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Remedial actions	Repair erosion or other damage by re-turfing or reseedling	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

9.12 Bioretention Systems

Bioretention systems will require regular maintenance to ensure continuing operation to design performance standards, and all designers should provide detailed specifications and frequencies for the required maintenance activities along with likely machinery requirements and typical annual costs - within the Maintenance Plan. The treatment performance of bioretention systems is dependent on maintenance, and robust management plans will be required to ensure that maintenance is carried out in the long term. Different designs will have different operation and maintenance requirements, but this section gives some generic guidance. Ease of access for maintenance and inspection is essential.

The main cause of failure of bioretention systems is clogging of the surface, which is easily visible. Underdrains and drainage layers are beneath the ground, and malfunctioning is not so easy to detect and therefore could potentially be ignored. However, the results of any malfunction are likely to cause surface ponding. The clogging of the surface or drainage layers can cause poor outflow water quality due to water bypassing the filter medium to the overflow more frequently than allowed for. During the first few months after installation, the system should be visually inspected after rainfall events, and the amount of deposition measured, to give the operator an idea of the expected rate of sediment deposition. After this initial period, systems should be inspected each quarter, to verify the appropriate level of maintenance.

Adequate access should be provided for all bioretention areas for inspection and maintenance, including for the appropriate equipment and vehicles.

Litter picking should be frequent, as rubbish is detrimental to the visual appearance of bioretention systems. Frequent street sweeping in the catchment area will increase the time interval between cleaning out forebays or the filter surface and will reduce the loading of fine suspended solids that can potentially clog the filter medium.

All vegetation management activities should take account of the need to maximise biosecurity and prevent the spread of invasive species.

Maintenance responsibility for all systems should be placed with an appropriate organisation, and Maintenance Plans and schedules should be developed during the design phase. The most intensive maintenance is required during the establishment period. Herbicides, pesticides and fertilizers should not be used on bioretention systems. This is because these pollutants will wash through the system quite easily.

Sediments excavated from pretreatment devices that receive runoff from residential or standard road and roof areas are generally not toxic or hazardous material and can therefore be safely disposed of by either land application or landfilling. However, consultation should take place with the environmental regulator to confirm appropriate protocols. Sediment testing may be required before sediment excavation, to determine its classification and appropriate disposal methods. For industrial site runoff, sediment testing will be essential. In the majority of cases, it will be acceptable to distribute the sediment on site, if there is an appropriate safe and acceptable location to do so. Proper disposal of sediment and debris removed must be ensured, and the environmental regulator should be approached for advice where there are any doubts concerning disposal options.

The table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

Maintenance schedule	Required action	Typical frequency
Regular inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain (if appropriate) 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 and 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 biannually
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

9.13 Pervious Pavements

Regular inspection and maintenance is important for the effective operation of pervious pavements. Maintenance responsibility for a pervious pavement and its surrounding area should be placed with an appropriate responsible organisation. Before handing over the pavement to the client, it should be inspected for clogging, litter, weeds and water ponding, and all failures should be rectified. After handover, the pavement should be inspected regularly, preferably during and after heavy rainfall to check effective operation and to identify any areas of ponding.

Pervious pavements need to be regularly cleaned of silt and other sediments to preserve their infiltration capacity. Extensive experience suggests that sweeping once per year should be sufficient to maintain an acceptable infiltration rate on most sites. However, in some instances, more or less sweeping may be required and the frequency should be adjusted to suit sitespecific circumstances and should be informed by inspection reports.

A brush and suction cleaner (which can be a lorrymounted device or a smaller precinct sweeper) should be used for regular sweeping. Care should be taken in adjusting vacuuming equipment to avoid removal of jointing material. Any lost material should be replaced. It is also possible to clean the surface using lightweight rotating brush cleaners combined with power spraying using hot water.

If the surface has clogged then a more specialist sweeper with water jetting and oscillating and rotating brushes may be required, especially for porous asphalt surfaces, to restore the surface infiltration rate to an acceptable level. The specialist equipment should be adjusted so that it does not strip binder from the aggregate in the asphalt.

The likely design life of grass reinforcement will be dictated by trafficking and is likely to be about 20 years if designed correctly. For concrete block permeable paving the design life should be no different from standard paving, assuming that an effective maintenance regime is in place to minimise risks of infiltration clogging. Porous asphalt will lose strength and begin to fatigue due to oxidation of the binder. This is likely to occur slightly faster in porous asphalt than normal asphalt, so the design life will be reduced slightly. Porous concrete should have a similar design life to a normal concrete slab.

The reconstruction of failed areas of concrete block pavement should be less costly and disruptive than the rehabilitation of continuous concrete or asphalt porous surfaces due to the reduced area that is likely to be affected. Materials removed from the voids or the layers below the surface may contain heavy metals and hydrocarbons and may need to be disposed of as controlled waste. Sediment testing should be carried out before disposal to confirm its classification and appropriate disposal methods.

Many of the specific maintenance activities for pervious pavements can be undertaken as part of a general site cleaning contract (many car parks or roads are swept to remove litter and for visual reasons to keep them tidy) and therefore, if litter management is already required at site, this should have marginal cost implications.

Generally, pervious pavements require less frequent gritting in winter to prevent ice formation. There is also less risk of ice formation after snow melt, as the melt water drains directly into the underlying subbase and does not have chance to refreeze. A slight frost may occur more frequently on the surface of pervious pavements compared to adjacent impermeable surfaces, but this is only likely to last for a few hours. It does not happen in all installations and, if necessary, this can be dealt with by application of salt. It is not likely to pose a hazard to vehicle movements.

The table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer’s recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

9.14 Detention Basins

Detention basins will require ongoing regular maintenance to ensure continuing operation to design performance standards, and all designers should provide detailed specifications and frequencies for the required maintenance activities along with likely machinery requirements and typical annual costs – within the Maintenance Plan. The treatment performance of bioretention systems is dependent on maintenance, and robust management plans will be required to ensure maintenance is carried out in the long term. Different designs will have different operation and maintenance requirements, but this section gives some generic guidance.

Maintenance of detention basins is relatively straightforward for landscape contractors, and typically there should only be a small amount of extra work (if any) required for a SuDS detention basin over and above what is necessary for standard public open space.

Maintenance responsibility for a basin should always be placed with an appropriate organisation. Adequate access should be provided to all detention basin areas for inspection and maintenance, including for appropriate equipment and vehicles. Litter and debris removal should be undertaken as part of general landscape maintenance for the site and before any other SuDS management task. All litter should be removed from site.

The major maintenance requirement for detention basins is usually mowing. Regular mowing in and around detention basins is only required along maintenance access routes, amenity areas (eg footpaths), across any embankment and across the main storage area. The remaining areas can be managed as “meadow”, unless additional management is required for landscape/amenity/recreational or aesthetic reasons.

Mowing should ideally retain grass lengths of 75-150 mm across the main “treatment” surface to assist in filtering pollutants and retaining sediments and to reduce the risk of flattening during runoff events. Shorter lengths may be required when recreational facilities form part of the basin, but in this case the basin will be dealing with exceedance flows only and not treatment. Grass clippings should be disposed of off-site or outside the detention basin area to remove nutrients and pollutants. Where a detention basin has a small permanent pool at the outlet, its submerged and emergent aquatic vegetation should be managed as for ponds or wetlands. Plant management, to achieve the desired habitat effect, should be clearly specified in a maintenance schedule. All vegetation management activities should take account of the need to maximise biosecurity and prevent the spread of invasive species.

Occasionally sediment will need to be removed (eg once deposits exceed 25 mm in depth). Sediments excavated from a detention basin that receives runoff from residential or standard road and roof areas are generally not toxic or hazardous and can therefore be safely disposed of by either land application or landfilling. However, consultation should take place with the environmental regulator to confirm appropriate protocols. Sediment testing may be required before sediment excavation to determine its classification and appropriate disposal methods. For runoff from busy streets with high vehicle traffic, sediment testing will be essential. In the majority of cases, it will be acceptable to distribute the sediment on-site if there is an appropriate safe and acceptable location to do so. Further detail on waste management is provided in Chapter 32. Any damage due to sediment removal or erosion and scour resulting from major events should be repaired and immediately reseeded or planted.

Many of the specific maintenance activities for detention basins can be undertaken as part of a general landscape management contract and therefore, if landscape management is already required at site, should have marginal cost implications. If basins are implemented within private property, owners should be educated on their routine maintenance needs, and should understand the longterm Maintenance Plan and any legally binding maintenance agreement.

The table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season), or as required
	Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required
	Check any penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlet and forebay	Annually (or as required)
Occasional maintenance	Manage wetland plants in outlet pool – where provided	Annually (as set out in Chapter 23)
	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
Remedial actions	Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)
	Repair erosion or other damage by reseedling or re-turfing	As required
	Realignment of rip-rap	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
Remedial actions	Relevel uneven surfaces and reinstate design levels	As required

9.15 Ponds and Wetlands

Ponds and wetlands will require regular maintenance to ensure continuing operation to design performance standards, and all designers should provide detailed specifications and frequencies for the required maintenance activities, along with likely machinery requirements and typical annual costs – within the Maintenance Plan. The treatment performance of ponds and wetlands is dependent on maintenance, and robust management plans will be required to ensure maintenance is carried out in the long term. Different designs will have different operation and maintenance requirements, but this section gives some generic guidance.

Maintenance of ponds is relatively straightforward for landscape contractors, and typically there should only be a small amount of extra work required for a SuDS pond or wetland feature over and above what is necessary for standard public open space.

Regular inspection and maintenance is important for the effective operation of ponds as designed. Maintenance responsibility for a pond and its surrounding area should always be placed with a responsible organisation. Litter and debris removal should be undertaken as part of general landscape maintenance for the site and before any other SuDS management task. All litter should be removed from site.

Any invasive maintenance work such as silt or vegetation removal is only required intermittently, but it should be planned to be sympathetic to the requirements of wildlife in a pond. Care should be taken to avoid disturbance to nesting birds during the breeding season and habitats of target species (eg great crested newt and water voles) at critical times. The window for carrying out maintenance to achieve this is usually towards the end of the growing season (typically September/October), although this will vary with species). Invasive silt and vegetation removal should only be carried out to limited areas at any one time (25–30% of the pond area on one occasion each year to minimise the impact on biodiversity. Plant management, to achieve particular desired habitat effects, should be clearly specified in a maintenance schedule.

Site vegetation should be trimmed as necessary to keep the pond free of leaves and to maintain the aesthetic appearance of the site. Slope areas that have become bare should be re-vegetated and any eroded areas should be regraded before replanting.

Maintenance access (or “easement”) should be provided to the pond from a public or private road. An assessment should be made at the planning stage regarding the maintenance and associated access requirements. Ideally, access should be at least 3.5 m wide, have a maximum cross fall of 1 in 7, and be sufficiently robust to withstand maintenance equipment and vehicles. However, temporary access routes for infrequent operations could be considered where permanent routes are not appropriate. The access should extend to any forebay, safety and aquatic benches, inlet and outlet infrastructure. Consideration should be given as to whether maintenance vehicles will need to turn around. Wherever possible SuDS ponds and wetlands should be designed so that special machinery is not required to undertake maintenance.

The table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass – public areas	Monthly (during growing season)
	Cut the meadow grass	Half yearly (spring, before nesting season, and autumn)
	Inspect marginal and bankside vegetation and remove nuisance plants (for first 3 years)	Monthly (at start, then as required)
	Inspect inlets, outlets, banksides, structures, pipework etc for evidence of blockage and/or physical damage	Monthly
	Inspect water body for signs of poor water quality	Monthly (May – October)
	Inspect silt accumulation rates in any forebay and in main body of the pond and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
	Check any mechanical devices, eg penstocks	Half yearly
	Hand cut submerged and emergent aquatic plants (at minimum of 0.1 m above pond base; include max 25% of pond surface)	Annually
	Remove 25% of bank vegetation from water’s edge to a minimum of 1 m above water level	Annually
	Tidy all dead growth (scrub clearance) before start of growing season (Note: tree maintenance is usually part of overall landscape management contract)	Annually
	Remove sediment from any forebay.	Every 1–5 years, or as required
Occasional maintenance	Remove sediment and planting from one quadrant of the main body of ponds without sediment forebays.	Every 5 years, or as required
	Remove sediment from the main body of big ponds when pool volume is reduced by 20%	With effective pre-treatment, this will only be required rarely, eg every 25–50 years
Remedial actions	Repair erosion or other damage	As required
	Replant, where necessary	As required
	Aerate pond when signs of eutrophication are detected	As required
	Realign rip-rap or repair other damage	As required
	Repair / rehabilitate inlets, outlets and overflows.	As required