

Flood Risk Assessment & Outline Drainage Strategy

Housing Development

Flosh Meadows

Cleator

Washington Homes

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GLOSSARY OF TERMS

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
BGL	Below Ground Level
BGS	British Geological Society
CC	Climate Change
CCC	Cumberland County Council
DSM	Digital Surface Model
DTM	Digital Terrain Model
EA	Environment Agency
FEH	Flood Estimation Handbook
FFL	Finished Floor Level
FRA	Flood Risk Assessment
GIS	Geographical Information System
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
NPPF	National Planning Policy Framework
OS	Ordnance Survey
RGP	RG Parkins & Partners Ltd
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage System
UU	United Utilities

1. INTRODUCTION

1.1 BACKGROUND

This report has been prepared by R. G. Parkins & Partners Ltd (RGP) for Washington Homes Ltd in support of their proposals for a residential development comprising 51 no. dwellings with associated access roads, driveways and landscaped areas for a site located at Flish, Cleator.

The site was previously split into three areas as follows:

- The Meadows SR12 – comprising 21 dwellings located in the southern portion
- Mid Meadows SR12A – comprising 19 dwellings located in the north-west portion
- Top Meadows – comprising 7 dwellings located in the north-east portion

The development site has previously been approved at Planning via a number of separate Planning Applications as listed below.

- 4/17/2214/001 – Outline Planning for the erection of 7 dwellings [Top Meadows]
- 4/17/2391/001 – Outline Planning for the erection on 19 dwellings [Mid Meadows SR12A]
- 4/20/2218/0R1 – Reserved Matters Application for 14/17/2214/001 [Top Meadows]
- 4/21/2554/0R1 – Reserved Matters Application for 14/17/2391/001 [Mid Meadows SR12A]
- 4/22/2092/001 – Hybrid Application for 21 self-build dwellings [The Meadows SR12]

A previous flood risk assessment was completed by Coast Consulting Engineers in 2022 and subsequent detailed drainage strategies completed in 2023. The drainage proposals were eventually approved by the LPA and LLFA, subject to standard Planning conditions.

RGP has been appointed to undertake a Flood Risk Assessment and drainage strategy for the full development site in accordance with the National Planning Policy Framework ^[1] (NPPF) to support a new detailed planning application that fulfils the requirements of the Local Planning Authority, Lead Local Flood Authority, Environment Agency and the Sewerage Undertaker.

The following study assesses flood risk to the site and proposed development and demonstrates the proposed development will not adversely affect flood risk elsewhere.

1.2 PLANNING POLICY

The NPPF ^[1] and its Planning Practice Guidance ^[2] states “a site-specific flood risk assessment should be provided for all development in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk

assessment as being at increased flood risk in the future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.”

1.3 THE DEVELOPMENT IN THE CONTEXT OF PLANNING POLICY

Owing to the size of the development, it is classed as major development (over 1 ha) in accordance with The Town and Country Planning Order 2015 ^[3].

The area covered by the application is approximately 3.394 ha (hectares) and by reference to the Environment Agency Flood Map, the site lies entirely in Flood Zones 1.

Table 2 of the NPPF’s Planning Practice Guidance ^[2] classifies each development into a vulnerability class, depending on the type of development, as outlined in Table 1.1.

The site is to be developed for dwellings; and is classified as ‘more vulnerable’. ‘More Vulnerable’ development classes are deemed acceptable in terms of flood risk within Flood Zones 1, 2 and 3a but are not acceptable within Flood Zone 3b.

Table 1.1 Vulnerability Classification

Vulnerability Classification	Development
Essential Infrastructure	Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. Essential utility infrastructure, which must be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. Wind turbines.
Highly Vulnerable	Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operation during flooding. Emergency dispersal points. Basement dwellings. Caravans, mobile homes, and park homes intended for permanent residential use. Installations requiring hazardous substances consent.
More Vulnerable	Hospitals. Residential institutions such as residential care homes, children's homes, prisons and hostels. Buildings used for dwelling houses , student halls of residence, drinking establishments, nightclubs, and hotels. Non-residential uses for health services, nurseries, and education establishments. Landfill and sites used for waste management facilities for hazardous waste. Sites used for holiday or short let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	Police, ambulance, and fire stations which are NOT required to be operational during flooding. Buildings used for shops; financial, professional, and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distributions; non-residential institutions not included in the 'more vulnerable' class; and assemble and leisure. Land and buildings used for agriculture and forestry. Waste treatment (except landfill & hazardous waste facilities). Minerals working & processing (except for sand & gravel working). Water treatment works which do not need to remain operational during times of flood. Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.
Water-Compatible Development	Flood control infrastructure. Water transmission infrastructure & pumping stations. Sewage transmission infrastructure & pumping stations. Sand & gravel working. Docks, marinas, and wharves. Navigation facilities. Ministry of Defence installations. Ship building, repairing & dismantling, dockside fish processing & refrigeration & compatible activities requiring a waterside location. Water based recreation (excluding sleeping accommodation). Lifeguard and coastguard stations. Amenity open space, nature conservation & biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. Essential ancillary sleeping or residential accommodation for staff required by uses in this category subject to a specific warning & evacuation plan.

2. SITE CHARACTERISATION

2.1 SITE LOCATION

The site is located adjacent to the A5086 and to the North of Cleator at National Grid Co Ordinates 301760E 514090N as indicated in Figure 2.1 below.

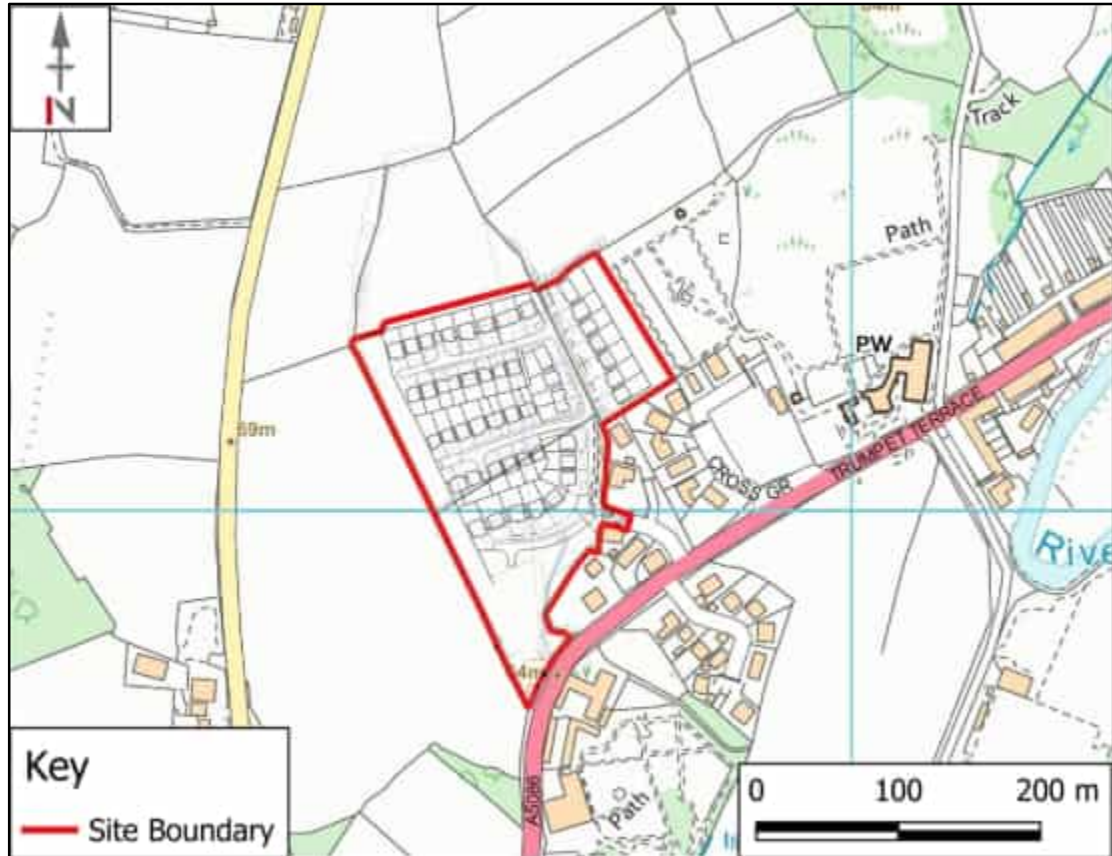


Figure 2.1 Site Location

2.2 SITE DESCRIPTION

The total site area is 3.394 ha (33,942 m²) and includes the proposed swale and land drainage diversion system that runs along the northern and western boundaries. The area associated with the new housing and associated infrastructure is 2.85 ha (28,500 m²) i.e. the developable area.

The site is accessed from the A5086 public highway along its southern boundary and is bounded by Floss Meadows to the southeast, with agricultural land surrounding the remainder of the site.

Topography across the site generally falls in a southerly direction, with ground levels ranging from approximately 70.0 mAOD along the northern and eastern boundaries to approximately 63.0 mAOD at the southern extent of the site. A topographical survey indicates an overall level difference of approximately 7.0 m across the site (Figure 2.2).

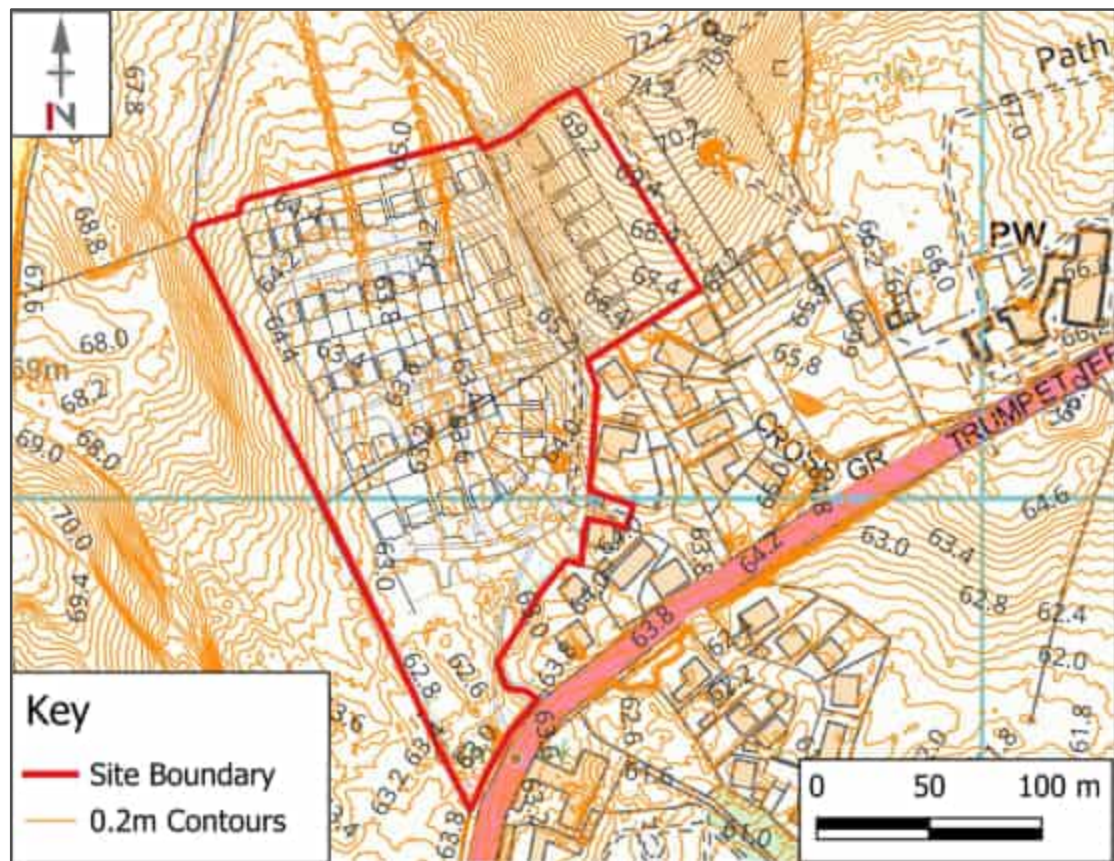


Figure 2.2 Site Topography

2.3 GEOLOGY & HYDROGEOLOGY

British Geological Survey (BGS) ^[4] mapping indicates the site is underlain by the geological sequences outlined in Table 2.1. The DEFRA Magic Map Application ^[5] indicates the nearest Groundwater Source Protection Zone is a Zone 3 'Total Catchment' which is situated approximately 2.2 km south-west of the site.

Table 2.1 Site Geological Summary

Geological Unit	Classification	Description	Aquifer Classification
Soil (South)	Soilscape 18	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	N/A
Soil (North)	Soilscape 6	Freely draining slightly acid loamy soils	N/A
Drift	Glaciofluvial deposits, Devensian	Glaz, sand and gravel	Summary: Secondary A
Solid	Frizington Limestone Formation	Limestone	Summary: Principal

A Phase 1 Desk Top Study Report was completed by Geoenvironmental Engineering Ltd (GEO) in 2014^[6] and confirmed that the site is at moderate risk to geohazards primarily due to the variable nature of the drift deposits and potential issues with shallow groundwater.

2.4 HYDROLOGY

The River Keekle is located approximately c.450m west of the proposed development site, on the opposite side of Cleator Gate Road and across third-party land. The River Ehen is located approximately c.400m southeast of the proposed development site, on the opposite side of the A5086 road and across third-party land. The River Keekle and the River Ehen are both classified as a 'main river' and are therefore regulated by the Environment Agency.

2.5 EXISTING PUBLIC SEWERS

United Utilities sewer records indicate the presence of an existing 300mm diameter combined sewer located within the A5086 immediately south of the site. The records also show a 375mm combined sewer running within the site boundary in the south-west corner. There are also separate foul and surface water sewers located in Floss Meadows, both 150mm dia., that discharge directly into the existing combined sewer system. A copy of the UU sewer records is included in Appendix A for reference.

2.6 EXISTING CULVERTED WATERCOURSE

Within the south-west corner of the site is an existing open water channel that discharges into a stone culvert that runs below the A5086 in a south-easterly direction for c. 165m before out falling into an open watercourse on the other side of a boundary wall. This watercourse ultimately discharges into the River Ehen further to the south. Photographic records of the watercourse (open and culverted sections) are included in Appendix B for reference and a plan showing the existing drainage infrastructure is included in Appendix C.

The history and nature of the existing watercourse (open and culverted) was extensively discussed between Coast Consulting Engineers and the LLFA as part of the previous Planning Applications (see list included in Section 1.1) and whether the upstream stone culverts were part of an historical mill race serving downstream industrial mills. It was ultimately agreed that the downstream culvert would present the best overall discharge point for attenuated surface water from any future housing development. RGP have reviewed the historical information and previous Planning consultation and agree with this approach.

2.7 GROUND INVESTIGATION

A detailed Phase 2 Ground Investigation was undertaken by GEO Environmental Engineering in June and July 2018^[7]. The investigation comprised:

- 9 no. dynamic (windowless) sampling boreholes to depths between approximately 1.5 m and 3.85 m below ground level (bgl);
- 23 no. mechanically excavated trial pits to depths between approximately 1.3 m and 3.6 m bgl;

- 7 no. Dynamic Probe Super Heavy (DPSH) tests to depths between approximately 2.6 m and 7.5 m bgl;
- 13 no. Dynamic Cone Penetrometer (DCP) tests;
- In-situ Standard Penetration Testing (SPT);
- Hand Shear Vane (HSV) testing;
- Ground gas and groundwater monitoring;
- Chemical and geotechnical laboratory testing of selected soil samples; and
- A Level 1 Generic Quantitative Risk Assessment (GQRA).

Full details of the Ground Investigation are provided within GEO Environmental Engineering's Phase 2 Ground Investigation Report ^[7].

2.7.1 NATURAL DRIFT DEPOSITS

The investigation identified a thin layer of topsoil and locally reworked made ground across the site, generally extending to depths of between 0.2 m and 0.5 m bgl. Beneath this, the site is underlain by variable natural drift deposits, generally consistent with alluvial soils, with glacial deposits encountered at depth in some locations.

An area of deep alluvial deposits was identified within the central and western parts of the site and locally within the northern part. These deposits comprise peat, soft to very soft clay and silty sand, extending generally to depths between 2.3 m and 2.6 m bgl and locally to approximately 4.3 m bgl. Elsewhere, the site is underlain by firm to stiff sandy gravelly clay, gravelly sand, and medium dense to dense sands and gravels with occasional cobbles and boulders. Stiff to very stiff glacial clay (glacial till) was encountered locally from depths of approximately 2.0 m to 2.6 m bgl.

2.7.2 SOLID (BEDROCK) GEOLOGY

Bedrock was not encountered during the investigation.

2.7.3 GROUNDWATER

Groundwater strikes were encountered sporadically across the central and southern parts of the site at depths between approximately 1.5 m and 2.9 m bgl, whilst exploratory holes within the northern part of the site were recorded as dry on completion. Groundwater is considered likely to be perched within the drift deposits rather than representing a continuous groundwater table. Subsequent groundwater monitoring undertaken between July and October 2018 identified groundwater levels ranging between approximately 1.2 m and 3.33 m bgl following periods of wetter weather.

2.7.4 GEOTECHNICAL CONSTRAINTS

The investigation identified several geotechnical constraints across the site. Areas of peat and soft to very soft alluvial clay are present within the central and western parts of the site and are not

considered suitable founding strata. Dynamic probing and Hand Shear Vane testing confirmed the presence of very low-strength soils within these areas. Occasional cobbles and boulders were also encountered across the site, particularly within the granular deposits and northern part of the development area.

2.7.5 CONTAMINATION RISK

Chemical and geo-environmental testing identified no visual or olfactory evidence of significant contamination during the field investigation. No asbestos was detected within the samples tested and soil contaminant concentrations were below the relevant assessment criteria for a residential development with plant uptake. Accordingly, remediation is not considered necessary for the proposed residential end use.

2.7.6 GROUND GAS ASSESSMENT

Ground gas monitoring recorded elevated carbon dioxide concentrations, although no methane was detected during the monitoring period. Based on the monitoring results, the site was classified as Characteristic Situation 2 (CS2) / Amber 1 in accordance with current guidance, indicating that basic ground gas protection measures will be required as part of the development. The site is also located within a Radon Affected Area and full radon protection measures are recommended.

2.7.7 INFILTRATION TESTING

Infiltration testing indicated that the underlying ground conditions are unsuitable for the implementation of an infiltration-based Sustainable Drainage System (SuDS). The presence of alluvial deposits, including peat and soft alluvial clays, together with perched groundwater within the drift deposits and relatively shallow monitored groundwater levels, would constrain infiltration performance. Consequently, an attenuation-based surface water drainage strategy is considered to represent the most appropriate and feasible means of managing surface water runoff from the proposed development.

3. ASSESSMENT OF FLOOD RISK

3.1 BACKGROUND

The following risk assessment has been carried out in accordance with the National Planning Policy Framework ^[1] and its Planning Practice Guidance ^[2] on Flood Risk. The broad aim of the guidance is to reduce the number of people and properties within the natural and built environment at risk of flooding. To achieve this aim, planning authorities are required to ensure that flood risk is properly assessed during the initial planning stages.

Responsibility for this assessment lies with the developers and they must demonstrate:

- Whether the proposed development is likely to be affected by flooding.
- Whether the proposed development will increase flood risk in other parts of the hydrological catchment.
- That the measures proposed to deal with any flood risk are sustainable.

The developer must prove to the Local Planning Authority and the Environment Agency that the existing flood risk or the flood risk associated with the proposed development can be satisfactorily managed.

3.2 FLOOD RISK TERMINOLOGY

Flood risk considers both the probability and consequence of flooding.

Flood events are often described in terms of their probability of recurrence or probability of occurring in any one year. The threshold between a medium flood and a large flood is often regarded as the 1 in 100-year event. This is an event which statistical analysis suggests will occur on average once every hundred years. However, this does not mean that such an event will not occur more than once every hundred years. Table 3.1 shows the event return periods expressed in years and annual exceedance probabilities as a fraction and a percentage.

For example, a 1 in 100-year event has a 1% probability of occurring in any one year, i.e. a 1 in 100 probability. A 1000-year event has a 0.1% probability of occurring in any one year, i.e. a 1 in 1000 probability.

Table 3.1 Flood Return Periods & Exceedance Probabilities

Return Period (years)	Annual Exceedance Probability (AEP)	
	Fraction	Percentage
2	0.5	50%
10	0.1	10%
25	0.04	4%
50	0.02	2%
100	0.01	1%
200	0.005	0.5%
500	0.002	0.2%
1000	0.001	0.1%

3.3 DATA COLLECTION

The following information was referred to for the Flood Risk Assessment:

- Environment Agency Flood Map for Planning covering the site and adjacent area
- Environment Agency Surface Water Flood Risk Map
- Environment Agency Reservoir Flood Risk Map
- Environment Agency Historic Flood Map
- United Utilities sewer records
- Development layout plan
- Topographic survey

3.4 ENVIRONMENT AGENCY FLOOD MAP FOR PLANNING

Figure 3.1 is an extract from the EA's Flood Map for Planning ^[8]. This map identifies the extent of Flood Zones 2 and 3. Flood Zone 3 (darker blue) is the area that could be affected by flooding up to and including a river flow rate with an annual exceedance probability of 1% or an area that could be affected by flooding from the sea with an annual exceedance probability of 0.5%. Flood Zone 2 (lighter blue) is the area that would be affected by more extreme events with an AEP of 0.1%. Areas which are not coloured are Flood Zone 1, i.e. areas where flooding is highly unlikely. The Flood Map for Planning (Figure 3.1) shows that the site is located entirely within Flood Zone 1. It is considered that the site is not at risk of tidal or fluvial flooding.

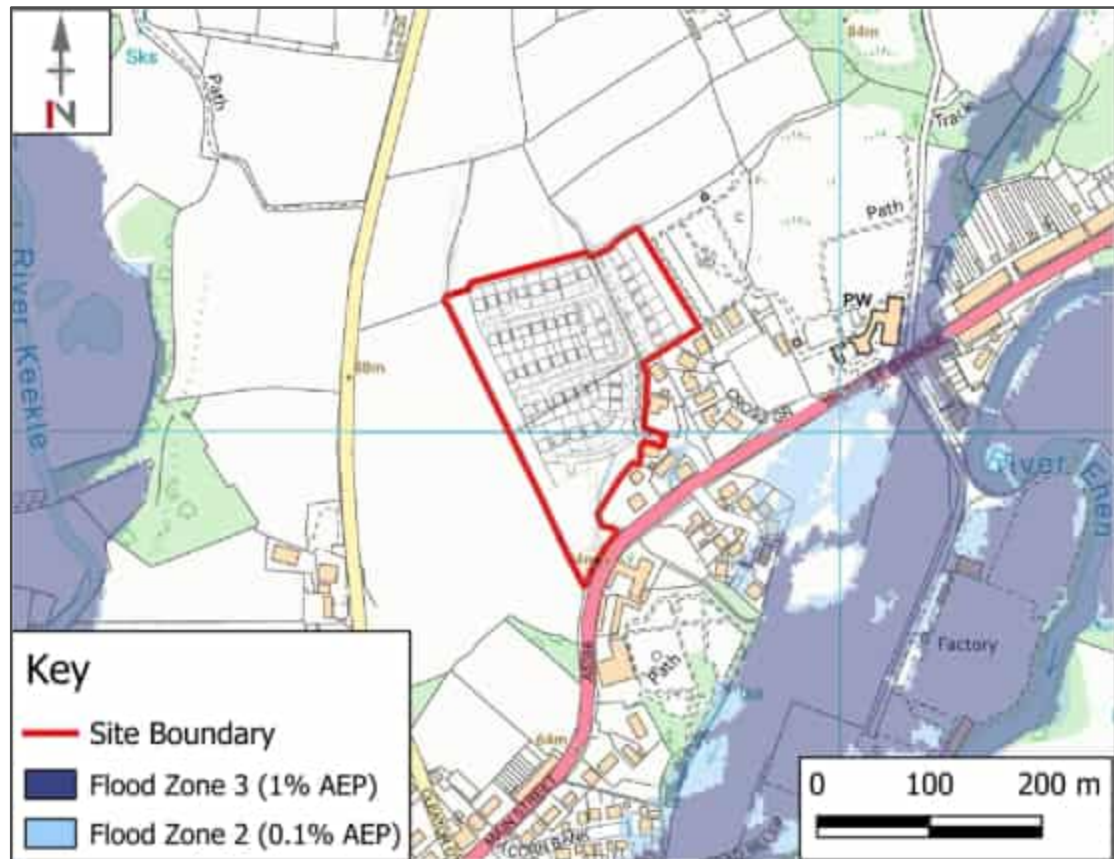


Figure 3.1 Environment Agency Flood Map for Planning

3.5 SURFACE WATER FLOOD RISK

Surface water flooding is that which results from extreme rainfall rather than overflowing rivers. This type of flooding typically occurs when extreme rainfall causes water to run down slopes and collect in depressions in the landscape or where runoff is focussed into an area where drainage is insufficient. It can also cause erosion resulting in the partial or complete blockage of drains or culverts.

Figure 3.2 shows an extract from the EA surface water flood risk map ^[8]. This has four risk classifications from very low probability (<0.1% AEP) to high probability (>3.3% AEP). The EA's map shows that the northern half of the site is largely unaffected by surface water flooding, with only isolated, narrow flow paths present. Surface water appears to follow natural low points through the site, with the greatest accumulation occurring at the southern end where overland flow converges.

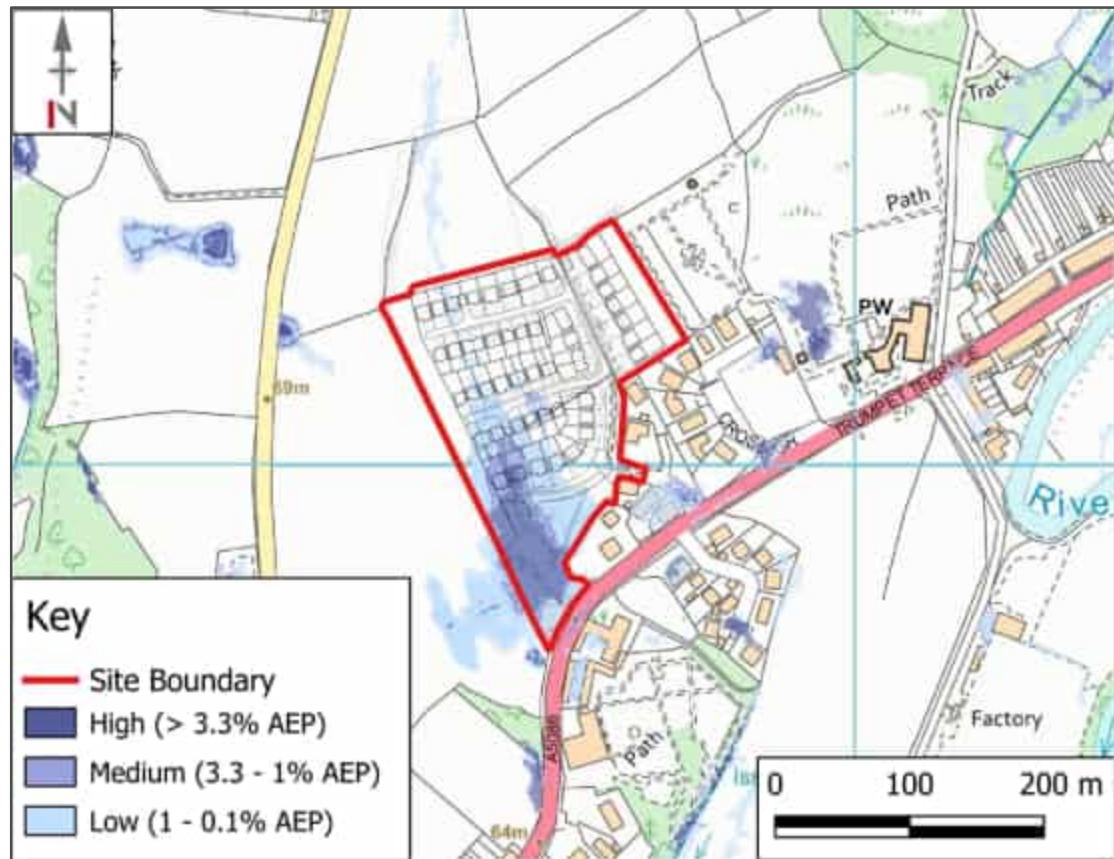


Figure 3.2 Environment Agency Surface Water Flood Map

Projections of future climate change indicate that more frequent short-duration, high intensity rainfall events are likely to occur over the next few decades in the UK. These future changes will have implications for surface water flooding. This will lead to increased and new risks of flooding within the lifetime of planned developments. As such, the EA have provided a surface water flood risk map which accounts for the impacts due to climate change (Figure 3.3)

The future climate change mapping indicates a modest increase in the extent of surface water flooding, principally along existing overland flow paths. No significant new areas of flooding are predicted within the site.

The Surface Water Flood Risk Mapping is indicative, and the EA states the mapping should not be used at property level. It also states:

"If the Content is displayed in map form to others, we recommend it should not be used with base mapping more detailed than 1:10,000 as the data is open to misinterpretation if used as a more detailed scale. Because of the way they have been produced and the fact that they are indicative, the maps are not appropriate to act as the sole evidence for any specific planning or regulatory decision or assessment of risk in relation to flooding at any scale without further supporting studies or evidence".

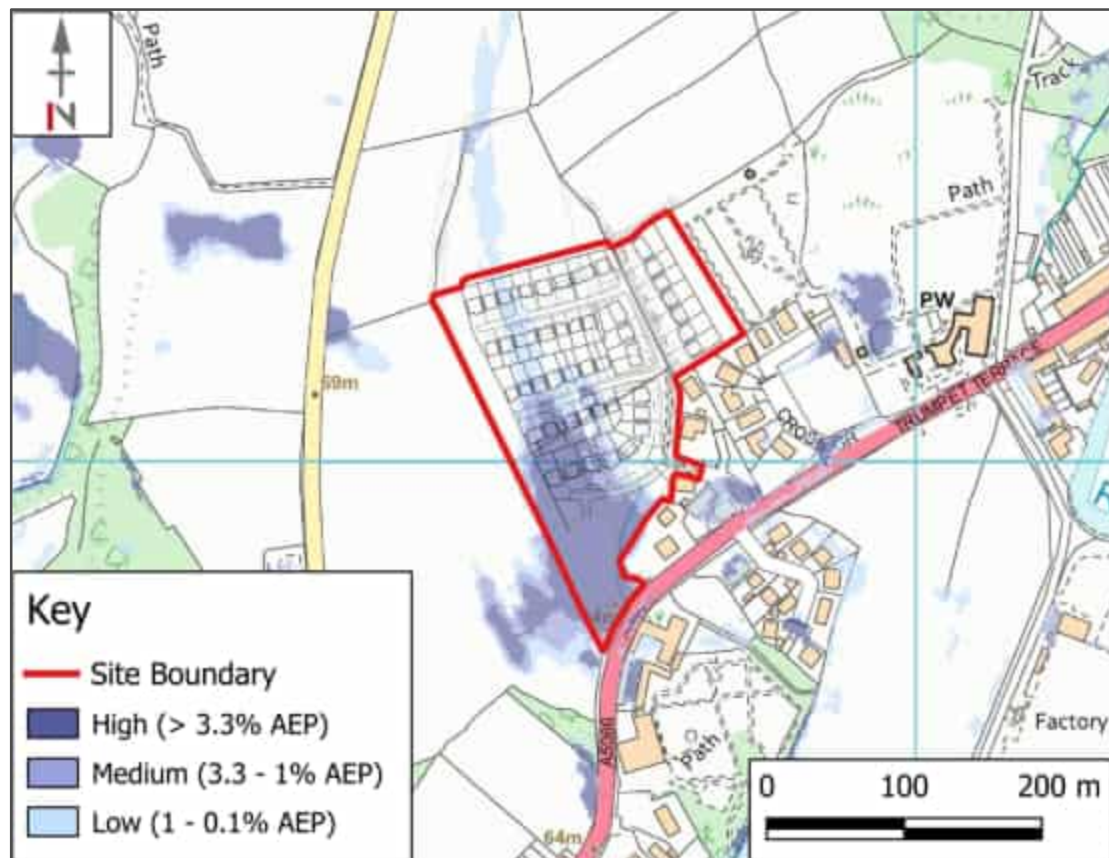


Figure 3.3 Environment Agency Surface Water Flood Map with Climate Change allowances

RGP have assessed the LiDAR data for the land to the north which confirms that the land typically falls from north to south, as indicated by the apparent flow path on the surface water flood map to the north. However, the LiDAR does not accurately represent field boundaries, ditches, hedgerows, mature trees or other surface features that would intercept, store or restrict overland flow from the north. Likewise, the surface water flood map does not include the downstream culverted watercourse that runs below the A5086 towards the River Ehen as there is no obvious flow path shown on the flood map below the road that would connect the north to the south side of the public highway. It is therefore concluded that the latest EA flood map provides a significant over-prediction on the actual likelihood of surface water flooding in this location.

RGP have recently raised these concerns with the EA on several sites throughout Cumbria, as the latest surface water flood modelling is clearly incorrect and inaccurate and does not take into account important historical drainage infrastructure or surface features. Whilst the EA have acknowledged these apparent errors in their modelling, they have confirmed that there are currently no plans to update the models or improve the accuracy of the flood map outputs.

3.6 MITIGATION OF SURFACE WATER FLOOD RISK

Whilst RGP have concluded that the latest EA surface water flood maps significantly over-predict the likelihood and extent of flooding in the south-west corner of the development site, it is accepted that under an extreme storm event, the local topography could result in overland flow entering the development site from the north, potentially flooding new properties located along the northern

boundary. To mitigate this risk, it is proposed that a new drainage swale/ditch is constructed along the northern boundary to intercept and convey overland flows towards and down the western boundary, with ultimate discharge into the open watercourse via a new 450mm dia. culvert pipe. These proposals are discussed in greater detail in Section 4.9.

3.7 GROUNDWATER FLOOD RISK

Groundwater flooding occurs when groundwater levels rise above the ground surface and is most associated with low-lying areas underlain by permeable soils or geological deposits.

There is no known history of groundwater flooding affecting the site and the proposed development does not include any below-ground accommodation. Accordingly, the risk of groundwater flooding to the proposed development is low.

A Phase 2 Ground Investigation undertaken by GEO Environmental Engineering identified variable ground conditions across the site. The site is generally underlain by alluvial deposits over glacial materials, with areas of peat, soft clay and loose silty sand encountered within the central and western parts of the site. Groundwater was encountered intermittently across the southern and central parts of the site at depths between approximately 1.5 m and 2.9 m below ground level, indicating the presence of shallow and potentially perched groundwater in parts of the site.

Although groundwater was encountered during the investigation, monitoring and site observations indicate that groundwater is localised within the drift deposits rather than representing a continuous groundwater table. The proposed development will not significantly alter groundwater flow paths and finished floor levels will be set above surrounding ground levels. On this basis, the risk of groundwater flooding to the proposed development is low.

The presence of shallow groundwater and locally low permeability alluvial deposits has, however, informed the drainage strategy and supports the conclusion that infiltration-based SuDS are unsuitable for the disposal of surface water runoff.

3.8 FLOODING FROM RESERVOIRS, CANALS OR OTHER ARTIFICIAL SOURCES

There are no reservoirs, canals or other artificial sources within the vicinity of the proposed development site.

3.9 FLOODING FROM SEWERS

United Utilities records identify a 300 mm diameter combined sewer within the A5086 to the south of the site and a 375mm diameter combined sewer running through the south-western corner of the development site. As these sewers lie outside the development area, south of the proposed new detention basin and there is no evidence of historical sewer flooding affecting the site, the risk of sewer flooding is deemed to be low.

3.10 HISTORIC FLOODING

The Environment Agency has not provided any historic information on flooding occurring at the proposed development site.

4. SURFACE WATER DRAINAGE STRATEGY & OUTLINE DESIGN

4.1 INTRODUCTION

The principal aim of the surface water drainage strategy and design is to avoid, reduce and delay the discharge of rainfall to public sewers and watercourses in order to protect watercourses and reduce the risk of localised flooding, pollution and other environmental damage.

In order to satisfy these criteria this surface water runoff assessment and drainage design has been undertaken in accordance with the following reports and guidance documents:

- SuDS Manual, CIRIA Report C753, 2015 ^[9]
- Code of Practice for Surface Water Management, BS8582:2013, November 2013 ^[10]
- Rainfall Runoff Management for Developments, Defra/EA, SC030219, October 2013 ^[11]
- Designing for Exceedance in Urban Drainage – Good Practice, CIRIA Report C635, 2006 ^[12]
- Flood Estimation Handbook (FEH) ^[13]
- Flood Studies Report (FSR), Volume 1, Hydrological Studies, 1993 ^[14]
- Flood Studies Supplementary Report No 14 (FSSR14), Review of Regional Growth Curves, 1983 ^[15]
- Flood Estimation for Small Catchments, Marshall & Bayliss, Institute of Hydrology, Report No. 124 (IoH 124), 1994 ^[16]
- Department for Environment, Food and Rural Affairs, National Standards for Sustainable Drainage Systems (SuDS), July 2025 ^[17]

The drainage assessment and outline design are based on the latest site layout plan provided by Green Swallow Architects. Any alterations to the site plan resulting in changes to impermeable areas will require the drainage strategy to be revisited.

4.2 SURFACE WATER DISPOSAL

Surface water disposal has been considered in line with the hierarchy outlined in the SuDS Manual. The approach considers infiltration drainage in preference to disposal to watercourse, in preference to discharge to sewer.

Cumberland Council as Lead Local Flood Authority prefer design in accordance with the Cumbria Design Guide which identifies the following hierarchy of techniques to be used:

- **Prevention:** Prevention of runoff by good site design and the reduction of impermeable areas.
- **Source Control:** Dealing with water where and when it falls (e.g. permeable paving).
- **Site Control:** Management of water in the local area (e.g. swales, detention basins).
- **Regional Control:** Management of runoff from sites (e.g. balancing ponds, wetlands).

4.2.1 COLLECTED FOR NON-POTABLE USE

The national standards for SuDS were updated in July 2025 ^[17], placing “collected for non-potable use” (i.e. rainwater harvesting) as the highest priority, above “infiltrated to ground.” Rainwater harvesting (RWH) involves collecting and storing rainwater (typically from roof areas) for reuse in non-potable applications such as irrigation, toilet flushing, and laundry. While it can reduce reliance on mains water and lower water bills, RWH systems are generally expensive to install, often requiring large underground tanks and pumped distribution systems.

Most commercially available RWH systems provide minimal additional storage for attenuation, meaning they offer limited benefit in terms of SuDS performance. In Cumbria, tanks are also likely to be full at the onset of a storm, and without an automated drawdown mechanism to create pre-event capacity, they cannot function as effective attenuation features. For RWH to contribute meaningfully to SuDS, it must be paired with a consistent, frequent non-potable demand that keeps the tank sufficiently empty to accommodate new rainfall. Where water use is low or intermittent, the system cannot reliably provide attenuation.

Given the nature of the housing development, the budget constraints, and the limited attenuation benefit offered by RWH, it is concluded that RWH is not a suitable option for this site. Additionally, the Environment Agency does not classify Cleator as a “seriously water-stressed” area, so the use of RWH is not considered necessary or appropriate in this context.

4.2.2 DISCHARGE TO GROUND

As discussed in Section 2.6, the Phase 2 Ground Investigation identified variable ground conditions across the site, including areas of peat, soft alluvial clay and shallow groundwater.

It is concluded that infiltration-based SuDS will not be a suitable method for the disposal of surface water.

4.2.3 DISPOSAL TO A WATERCOURSE

As RWH and infiltration has been discounted, discharge to a watercourse has been considered, as per the previously LLFA approved drainage strategy presented by Coast Consulting Engineers in 2023 for the previous Planning Applications. RGP have reviewed all the available data and have concluded that this approach is acceptable and is preferable to discharge into the existing public combined sewer system.

4.3 PRE-APPLICATION CONSULTATIONS WITH LLFA

Due to the previous Planning history concerning the development site, complexity of the existing drainage infrastructure and the latest surface water flood maps, RGP arranged a consultation with Cumberland Council Lead Local Flood Authority officers on 1st May 2026. The following items were discussed and agreed in principle:

- It was acknowledged and agreed that the existing upstream stone culverts that run through the site were unlikely to be historic mill races and should be dealt with as culverted ordinary watercourses.

- It was agreed that development site runoff should be attenuated to Greenfield QBAR and that the most practical form of storage should comprised a detention basin, located in the south-west corner of the site. Discharge into the existing open section of ordinary watercourse was the optimum solution.
- Discharge of surface water into the UU combined sewer network would not be acceptable.
- Runoff contribution from gardens and POS should be included within the drainage design.
- An interception/conveyance swale located along the northern boundary was considered the most practical solution to deal with both overland flow and diverted flows from the existing stone culverts. It was agreed that this land drainage system would then run down the western boundary and discharge into the existing open watercourse and not the detention basin.

4.4 PRE-DEVELOPMENT RUNOFF ASSESSMENT

The pre-development Greenfield runoff assessment has been undertaken in accordance with the latest Flood Estimation Handbook (FEH) Statistical Method^[13], updated in 2025, which introduced significant changes to hydrological analysis in the UK, focusing on better representing current catchment conditions through updated datasets and recalibrated models. This impacts how greenfield runoff rates (the baseline flow from undeveloped land used in SuDS design) are calculated. The updated calculation has been undertaken using the Greenfield runoff rate estimation tool provided by HR Wallingford (www.uknuts.com).

The assessment is based on the total developable area only and does not include the land associated with the proposed swale and land drainage system located along the northern and western boundaries. This provides a total area of c. 2.85 ha to be used for the pre-development Greenfield runoff assessment. A copy of the calculations is presented in Appendix D and summarised below in Table 4.1.

Table 4.1 Pre-Development Greenfield Runoff Rates

Rate of Runoff (l/s)	
Event	Greenfield
Q1	15.6
QBAR	18.0
Q10	24.8
Q30	30.6
Q100	37.4
Q200	42.6

The proposed discharge rate matching the equivalent Greenfield QBAR runoff of 18.0 l/s and will therefore be used as the max. attenuated rate of discharge in the surface water drainage design.

4.5 SURFACE WATER DRAINAGE DESIGN PARAMETERS

The surface water drainage system has been designed on the following basis using the modified rational method and a generated rainfall profile.

4.5.1 CLIMATE CHANGE

Projections of future climate change indicate that more frequent short-duration, high intensity rainfall and more frequent periods of long-duration rainfall are likely to occur over the next few decades in the UK. These future changes will have implications for river flooding and for local flash flooding. These factors will lead to increased and new risks of flooding within the lifetime of planned developments.

The EA have provided a peak rainfall online map showing the anticipated changes in peak rainfall intensity across the UK. Climate change allowances are now provided on a catchment-by-catchment basis. The site falls within the Southwest Lakes catchment. Table 4.2 outlines the EA guidance for this catchment, for the anticipated design life of the proposed development.

Table 4.2 Southwest Lakes Management Catchment Peak Rainfall Allowances (1.0% AEP)

South West Lakes (1.0% AEP)	Central Allowance (%)	Upper End Allowance (%)
2050s	30	45
2070s	35	50

In line with current guidance and for conservative design, a 50% allowance shall be used within this assessment.

4.5.2 URBAN CREEP

BS 8582:2013^[10] outlines best practice regarding Urban Creep. Although not a statutory requirement, future increase in impermeable area due to extensions and introduction of impervious positively drained areas has been considered. An uplift of 10% on impermeable areas associated with plots only has been applied to the contributing area used for surface water drainage design.

4.5.3 PERCENTAGE IMPERMEABILITY (PIMP)

The percentage impermeability (PIMP) for all impermeable areas is modelled as 100%. The entirety of the impermeable areas is to be positively drained.

4.5.4 VOLUMETRIC RUNOFF COEFFICIENT (CV)

The volumetric runoff coefficient describes the volume of surface water which runs off an impermeable surface following losses due to infiltration, depression storage, initial wetting and evaporation. The coefficient is dimensionless. Default industry standard volumetric runoff coefficients are 0.75 for summer and 0.84 for winter.

A runoff coefficient of 1.0 has been used in the surface water drainage design. This is higher than the default industry standards and provides a further factor of safety within the hydraulic design.

4.5.5 RAINFALL MODEL

The calculations use the REFH2 unit hydrograph methodology in line with best practice as outlined in the SuDS Manual^[9]. The calculations use the most up to date available catchment descriptors (2022) provided by the Centre for Ecology and Hydrology Flood Estimation Handbook web service.

4.5.6 CONTRIBUTION OF RUNOFF FROM PERMEABLE AREAS

Post-development, the runoff contribution from permeable/undrained gardens and landscaped areas that fall towards driveways/roads and potentially contribute to a new drainage system must be assessed to ensure the drainage network is designed appropriately.

Runoff coefficients for permeable surfaces vary significantly with soil type, slope gradient, planting type, antecedent moisture, infiltration capacity, local depressions, and wider site conditions. There is no industry-wide consensus on values, with typical coefficients for gardens and landscaping ranging from 0.1 to 0.5. Applying a coefficient of 1.0 would be inappropriate, as it would disregard the natural interception, attenuation and storage benefits that permeable areas provide during extreme rainfall events. To establish a more representative value, it is proposed that the Base Flow Index (BFI), derived from the UK Hydrology of Soil Types (HOST) classification within the FEH Web Service, is used as an inverse proxy for surface runoff intensity from permeable/undrained areas. A higher BFI indicates greater catchment storage and slower, lower-intensity runoff. Accordingly, the runoff coefficient decreases as BFI increases, and vice versa.

On this basis, 30% of the permeable areas that falls towards potential intercepting drainage components could contribute to the drainage network and as such have been included within the catchment area draining into the new surface water drainage system. This includes all front and rear gardens serving the dwellings and some areas of landscaping/POS located adjacent to proposed areas of positively drained hardstanding.

The catchment assessment is further complicated by the requirement to apply a 10% uplift to all roof areas to account for Urban Creep. Extensions, widened driveways, and enlarged patios typically encroach into garden areas, reducing the effective permeable area within each property's curtilage. This reduction has been incorporated into the revised calculations, and the corresponding overall drained areas contributing to the drainage network have been included in Table 4.5 for reference.

4.6 ASSESSMENT OF SITE AREAS & CATCHMENT PLAN

To support the exploration of options for site drainage, the spatial extent of different types of proposed land cover on the site have been measured. Table 4.3 shows the measured proposed land cover areas. Note that the +10% urban creep contribution is included in these calculations for all impermeable areas associated with the plots (roofs, footpaths, patios and driveways). A drawing summarising these land cover areas is included in Appendix D for reference.

Table 4.3 Land Cover Areas

Land Cover Type	Area		Percentage of total site area
	m ²	Ha	
Dwelling roofs	5,056.1	0.506	15%
Footpaths & patios	2,359.1	0.236	7%
Driveways & car parking	2,561.2	0.256	8%
Front & rear gardens	8,876.4	0.888	26%
Adopted highways & footways	4,107.4	0.411	12%
Land drainage & diversion swale	5,270.0	0.527	16%
Remaining landscaping / POS /BNG	5,712.0	0.571	17%
Total	33,942.0	3.394	100%

To develop the detailed drainage design, only certain surfaces and areas will be positively drained into the surface water network. Positively drained areas include roof areas, patio /paved areas, car parking, access roads and footways. Front and rear gardens will have a permeable surface and will have no positive drainage system. However, as discussed in Section 4.5.6 runoff from some of these permeable areas may potentially contribute to the drainage network. As such, a runoff contribution of 30% has been factored into the catchment calculations for gardens and landscaping that may runoff into the drainage network.

The proposed interception/conveyance swale that runs along the northern and western boundaries will not contribute to the new surface water drainage system and is therefore not included within the catchment.

On this basis the total drained catchment area contributing to the new private surface water drainage system and SuDS detention basin has been calculated and is summarised in Table 4.4. The total catchment area is represented in the Surface Water Drainage Catchment Plan included in Appendix D.

Table 4.4 Summary of total catchment areas contributing to the surface water drainage system

Land Cover	Area		Percentage of total site area
	m ²	Ha	
Total area contributing	18,861.4	1.886	56%
Total area not contributing	15,080.6	1.508	44%
Total	33,942.0	3.394	100%

4.7 CONSIDERATION OF ALTERNATIVE SUDS COMPONENTS

Permeable paving, rain gardens, soakaways and other infiltration-based SuDS components have been considered. However, infiltration testing and the ground investigation identified low permeability soils and perched groundwater, making these techniques unsuitable for the site. Green roofs and rainwater harvesting systems have been considered but discounted owing to maintenance requirements, practicality constraints associated with a conventional residential development and their limited contribution to the overall drainage strategy.

Enhanced treatment and attenuation will instead be provided by the proposed detention basin as discussed below.

4.8 SURFACE WATER DRAINAGE DESIGN

The proposed surface water drainage network serving the development has been modelled using Causeway FLOW and the output files area included in Appendix E for reference.

The drainage design has been sized to store a future 1% AEP event of critical duration without any flooding. Future climate change (50%) and urban creep (10% uplift) and potential permeable area contributions (30%) is accounted for within the calculations.

It is proposed that all site runoff will drain via traditional below-ground gravity drainage through a network of pipes and chambers into a SuDS detention basin located in the natural low point of the site in the south-west corner.

The new detention basin will be formed as permanent feature in an area designated as open space and will be designed to incorporate shallow, grassed slopes to provide important amenity and biodiversity benefits to the development. The basin will be 1.2m deep and will provide a total attenuation storage of 1,727m³ to the top of crest level.

New access roads and car parking areas will be constructed using conventional surfacing in the form of asphalt or block paving. The access roads will be drained via a series of highway gullies into the proposed surface water drainage network.

Roof water, driveway and road runoff will connect directly into the surface water pipe network upstream of the detention basin, with inspection and manhole chambers utilised to route the new pipework to suit the proposed development layout and allow for future inspection and maintenance. Proposed ground levels will fall consistently to the west and south in order to enable gravity connections to the drainage system.

A silt trap manhole (ref: S19) will be located upstream of the detention basin which will provide surface water treatment and access for maintenance. Silt traps isolate silt and other particles by encouraging settlement into sumps, preventing ingress into SuDS components.

A flow control chamber (ref: S22) with a proprietary flow control device will restrict discharge from the attenuation basin to a max. rate of 18 l/s equalling the pre-development greenfield QBAR rate. Final discharge will be into the existing open section of ordinary watercourse. A summary of the detention basin design is provided below in Table 4.5.

Table 4.5 Detention Basin critical event storm water storage depths

Discharge Rate (l/s)	Catchment Area (m ²)	Storage Volume to TWL (m ³)	Max Water Depth TWL (m)	Freeboard (m)	Remaining volume (m ³)
18.0	18,860	1556.2	1.121	0.079	170.80

Note: TWL - Top Water Level for the Q100 + 50%CC event

4.9 SWALE & LAND DRAINAGE DIVERSION SYSTEM

As discussed in Section 3.6 it is proposed that a new 3.5m wide by 500mm deep drainage swale/ditch is constructed along the northern boundary to intercept and convey overland flows towards and down the western boundary, with discharge into the open watercourse via a new 450mm dia. culvert pipe. A raised 500mm high bund will be provided at the top of the southern edge of the swale to provide enhanced protection to the new dwellings located along the northern boundary and reduce the risk of surface water entering the development during periods of heavy rainfall.

The new swale will also provide the discharge point for the diversion of the existing stone culverts that run through the development site from the north. The stone culverts will be re-aligned to ensure flows are directed at 45 degrees into the swale channel with stone rip-rap provided for enhanced erosion protection.

The swale channel will be formed at an adequate gradient to ensure self-cleansing velocity and will include several 400mm high earth check dams with a 150mm dia. pipe laid through the base. The check dams will be spaced at c. 25m and will ensure the swale provides temporary storage and controlled conveyance of runoff, prior to discharge into the existing downstream watercourse.

The swale system will be finished with topsoil, grass seeding and suitable planting to provide water quality, biodiversity and amenity benefits in accordance with SuDS principles.

For full details of the swale arrangement refer to the relevant drawings included in Appendix C.

4.10 OTHER BENEFITS OF DEVELOPMENT

The development site in its current form is sparse vegetation, underlain by relatively impermeable soil, which provides little in the way of natural flood defence or attenuation to overland flows and stormwater runoff. The land in its current form also lacks any meaningful biodiversity or amenity value and provides limited benefits to the surrounding community.

The proposed development site will tie into the existing topography via careful design. Slopes, gardens and open space areas will be carefully landscaped using a variety of plants, shrubs and trees, providing a net gain in biodiversity and enhanced storage/protection against overland flows.

As such the existing hydraulic regime of the site will be modified whereby overland and subsurface flows will be intercepted, attenuated, and re-directed by above and below ground structures, positive drainage and service trenches and the risk of downstream flooding would not be increased.

4.11 DESIGNING FOR LOCAL DRAINAGE SYSTEM FAILURE

In accordance with the general principles discussed in CIRIA Report C635 – Designing for Exceedance in Urban Drainage ^[12] the proposed surface water drainage, where practical, has been designed to ensure there is no increased risk of flooding on the site or elsewhere as a result of extreme rainfall, lack of maintenance, blockages or other causes. These measures are discussed below.

4.11.1 BLOCKAGE & EXCEEDANCE

Based on the existing topography and proposed highway and finished floor levels, overland flows will follow the designed site gradients and drainage corridors indicated on the drainage strategy drawings.

In the unlikely event of exceedance or blockage of the drainage network, including pipes, gullies, manholes, silt traps or flow control structures, surface water would emerge from the lowest points within the drainage system and follow the proposed ground levels towards the detention basin and associated surface water management features.

Exceedance flows will be managed on site as far as practicable through the drainage network and detention basin. During rainfall events exceeding the design standard, runoff may temporarily surcharge within the drainage system before safely overflowing along designated exceedance routes. The detention basin has been designed to provide additional attenuation storage and freeboard capacity during such events.

It is proposed that the crest of the basin is locally lowered by 100mm along the southern extent, and as such, in the unlikely event that the basin water level overtops the crest, exceedance flows would be directed towards the topographical low spot in the south-west corner and into the existing open watercourse.

Any exceedance flows from the land drainage swale would continue to follow the natural and proposed site gradients towards the southern part of the site and would not adversely affect the proposed dwellings.

A plan indicating the flood flow routes is included in Appendix C and demonstrates that no new dwelling would be at risk of flooding.

4.11.2 SURFACE STORAGE & EXTERNAL LEVELS

The proposed site levels have been designed to provide additional surface water storage and safe conveyance of exceedance flows should the SuDS features or upstream drainage network become blocked or exceed capacity. Where appropriate, kerb upstands of approximately 25-100 mm will be provided to direct surface water runoff along the highway network and towards drainage features, reducing the risk of uncontrolled flow routes and directing runoff away from proposed dwellings.

4.11.3 BUILDING LAYOUT & DETAIL

The finished floor levels to the new dwellings have been designed and situated to ensure that they are not at risk of flooding from overland flow. Finished floor levels will typically be set 150mm above external paved areas (whilst providing level access where needed). External footpaths typically fall away from the thresholds, ensuring that any flood water runs away from, rather than towards the dwellings.

4.11.4 DRAINAGE CONTINGENCY

The sustainable drainage system has been designed to attenuate a 100-year design storm including a 50% allowance for climate change, with no flooding. The drainage system will also provide capacity for lower probability (greater design storm events) which are not critical duration. In addition, an approx. 80mm freeboard is proposed in the detention basin above the Q100+CC event resulting in an overall basin capacity volumetric of 1,727m³ which will provide a significant amount of additional storage contingency (c. 170.8m³) should it ever be required and exceedance would be highly unlikely as a result.

4.12 SURFACE WATER QUALITY

The treatment of surface water is not a statutory requirement. Water quality remains a material consideration but there are no prescriptive standards to be imposed in terms of treatment train management. In the absence of a design standard, the SuDS manual has been used which outlines best practice.

Pollutants such as suspended solids, heavy metals and organic pollutants may be present in surface water runoff, the quantity and composition of the runoff is highly dependent upon site use. For housing developments, the pollutant load is very low. The SuDS Manual^[9] outlines best practice with regards to treatment of surface water by SuDS components prior to discharge to the environment. SuDS components can be effective in reducing the amount of pollutants within the surface water discharged and therefore environmental impact of the development. SuDS components may be installed in series to form a treatment train to treat the runoff.

The simple index approach as outlined in the SuDS Manual^[9] has been used to assess the pollution hazard indices and proposed treatment mitigation. For the entirety of the site the categories of runoff including roof areas, residential parking, and access road, and the treatment is proposed by the detention basin. Tables 4.6 to 4.8 summarise the pollution hazard and mitigation indices for each type of runoff.

Table 4.6 Pollution Hazard & Mitigation Indices-Roof Areas

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.2	0.2	0.05
Pollution Mitigation	0.5	0.5	0.6
Treatment Suitability	Adequate	Adequate	Adequate

Table 4.7 Pollution Hazard & Mitigation Indices-Drive Areas

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.5	0.6
Treatment Suitability	Adequate	Adequate	Adequate

Table 4.8 Pollution Hazard & Mitigation Indices-Road Areas

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation	0.5	0.5	0.6
Treatment Suitability	Adequate	Adequate	Adequate

4.13 OPERATIONS & MAINTENANCE RESPONSIBILITY

A ‘*SuDS Operations & Maintenance Plan*’ has been prepared by RGP detailing the requirements for future maintenance of the SuDS components and has been submitted in support of the Planning Application. The SuDS detention basin and associated upstream/downstream surface water sewer pipes will be offered for adoption under a S104 agreement to the adoption authority.

The land drainage swale and diversion culvert will remain private and will be maintained by a third-party Management Company.

4.14 CONSTRUCTION & VALIDATION OF SUSTAINABLE DRAINAGE SYSTEMS

Construction of the SuDS detention basin, associated below ground drainage and interception/conveyance swale is a critical element to the long-term performance of the systems. As such, a ‘*SuDS Construction Management Plan*’ has been prepared by RGP and has been submitted in support of the Planning Application. During construction, it is recommended that the construction works are inspected by a suitably qualified Civil Engineer to validate that the SuDS have been constructed in accordance with the design and specification.

5. FOUL WATER DRAINAGE STRATEGY

As discussed in Section 2.5, United Utilities sewer records indicate the presence of an existing 300mm & 375mm diameter combined sewers to the south of the development site. There is also a 150mm dia. foul water sewer located in Floss Meadows.

It is proposed that foul water runoff from the development will be collected via a conventional gravity foul water drainage network and discharged to the existing United Utilities sewer network, subject to the agreement of United Utilities.

No surface water runoff from the development will be permitted to enter either the combined or foul water drainage system. Surface water will be managed separately in accordance with the surface water drainage strategy outlined in Section 4, thereby reducing the risk of surcharge and flooding within the public sewer network during periods of heavy rainfall.

A pre-development wastewater enquiry will be submitted to United Utilities to confirm the acceptability of the proposed foul water connections.

Foul water discharge calculations have been undertaken in accordance with the Design and Construction Guidance^[18] for foul and surface water sewers. The estimated peak foul flow rate for the development is shown in Table 5.1.

Table 5.1 Peak Foul Flow Rates

Sewage Sector Design and Construction Guidance Clause B3.1	
Peak Load based on number of dwellings 51 units @ 4000 (l/day)	204,000
Total Foul Flow Rate from Sites (l/s)	2.36

The estimated peak wastewater flow from the development is 1.62 litres/second.

The indicative foul water drainage layout is included on the drainage plan included in Appendix C.

6. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are made:

- The proposed development comprises 51 dwellings with associated roads, driveways and landscaped areas on a site extending to approximately 3.394 ha.
- The site lies entirely within Flood Zone 1 and is therefore considered to be at low risk of fluvial flooding.
- Review of Environment Agency mapping indicates the site is at low risk from groundwater, reservoir and sewer flooding.
- Surface water flood mapping identifies overland flow paths within the site, primarily following existing topography towards the southern boundary. A significant area of surface water flooding is predicted to occur in the south-west corner. Closer scrutiny of the flood map demonstrates that the existing known culverted watercourse that runs below the public highway has not been accurately represented in the flood modelling, resulting in a significant over-prediction of the surface water flooding.
- Ground investigation and infiltration testing have confirmed that infiltration-based drainage systems are not suitable due to the presence of alluvial deposits, low permeability soils and shallow groundwater.
- Surface water runoff from the proposed development will be conveyed via a conventional gravity drainage network to a proposed SuDS detention basin located within the southern part of the site.
- The drainage system has been designed to restrict discharge to the equivalent greenfield QBAR runoff rate of 18.0 l/s, ensuring the development does not increase flood risk elsewhere.
- The proposed drainage system has been designed to accommodate the 1% AEP rainfall event with an additional 50% climate change allowance, without flooding occurring within the drainage system.
- A land drainage diversion swale is proposed along the northern and western boundaries of the site to intercept and convey overland surface water runoff towards the existing open watercourse in the south-west corner. The swale will also intercept and convey flows from the existing stone culverts that run through the development site.
- Surface water quality treatment will be provided through the proposed SuDS detention basin, with pollutant mitigation indices demonstrating adequate treatment in accordance with CIRIA SuDS Manual guidance.
- Foul water from the development will discharge to the existing United Utilities combined and foul water sewer network, subject to the agreement of United Utilities.
- The estimated peak foul water discharge from the development is 2.36 l/s.
- Finished floor levels, proposed site levels and exceedance flow routes have been designed to minimise flood risk to the proposed dwellings.

- A separate SuDS Operations and Maintenance Plan has been prepared by RGP detailing future maintenance requirements of all sustainable drainage systems.
- A separate SuDS Construction Management Plan has been prepared by RGP detailing suitable measures that should be implemented during the construction phase to ensure that runoff is adequately managed to reduce both on-site and off-site flood risk and that proposed SuDS components are protected from damage.
- It is therefore concluded that the proposed development can be developed safely and sustainably, without increasing flood risk on-site or elsewhere, and is compliant with the requirements of the NPPF, Planning Practice Guidance and Cumberland Council drainage policy.

7. REFERENCES

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- [12] CIRIA, Designing for Exceedance in Urban Drainage – Good Practice, Report C635, London, 2006.
- [13] Centre for Ecology and Hydrology, Flood Estimation Handbook, Vols. 1 – 5 & FEH CD-ROM 3, 2009.
- [14] Institute of Hydrology, Flood Studies Report, Volume 1, Hydrological Studies, 1993.
- [15] Institute of Hydrology, Flood Studies Supplementary Report No 14 – Review of Regional Growth Curves, August 1983.
- [16] Marshall & Bayliss, 1994. Flood Estimation for Small Catchments, Report No. 124 (IoH 124), Institute of Hydrology.
- [17] Department for Environment, Food and Rural Affairs, National Standards for Sustainable Drainage Systems (SuDS), July 2025
- [18] Water UK, Design and Construction Guidance for Foul & Surface Water Sewers Offered for Adoption Under the Code for Adoption Agreements for Water and Sewage Companies Operating Wholly or Mainly in England, Approved Version 10, October 2019

APPENDIX A

UU SEWER RECORD



**United Utilities Maps
for SafeDig**

Date : 25/03/2026 11:43:39

Centre X: 301854

Centre Y: 513886

Scale : 1250

UserName: RGP4RK1NS

**Extract from maps of United Utilities'
Underground Assets**

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. The actual positions may be different from those shown on the plan and private service pipes may be shown by a blue broken line. United Utilities Water will not accept liability for any damage caused by the actual position being different from those shown.

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APPENDIX B

PHOTOGRAPHS OF CULVERTS & WATERCOURSE



Photo B1 – Section of open watercourse in south-west corner of site looking downstream



Photo B2 – Section of open watercourse in south-west corner of site looking upstream



Photo B3 – Section of central culverted watercourse upstream of open section



Photo B4 – Eastern culverted watercourse looking upstream from existing fenceline



Photo B5 – Western culverted watercourse looking upstream from existing fenceline



Photo B6 – downstream outfall position of culverted watercourse c. 165m to south-east of site

APPENDIX C

RGP DRAWINGS



Existing Drainage Key

Existing Combined Water Public Sewer

Existing Foul Water Public Sewer

Existing Surface Water Public Sewer

Land Drainage

Rev	Description	Date	Revised by	Checked by	Approved
Issue Purpose: Planning					
Do not scale from this drawing					

R G PARKINS

Kendal | 01539 729393 Lancaster | 01524 32548

Client: Washington Homes

Project: Flosch Meadows, Cleator

Drawing Title: Existing Drainage Plan

Scale @ A1: 1:500

First Issue: 29/09/26

Office of Origin: Kendal

Drawn by: SR

Checked by: TM

Approved: TM

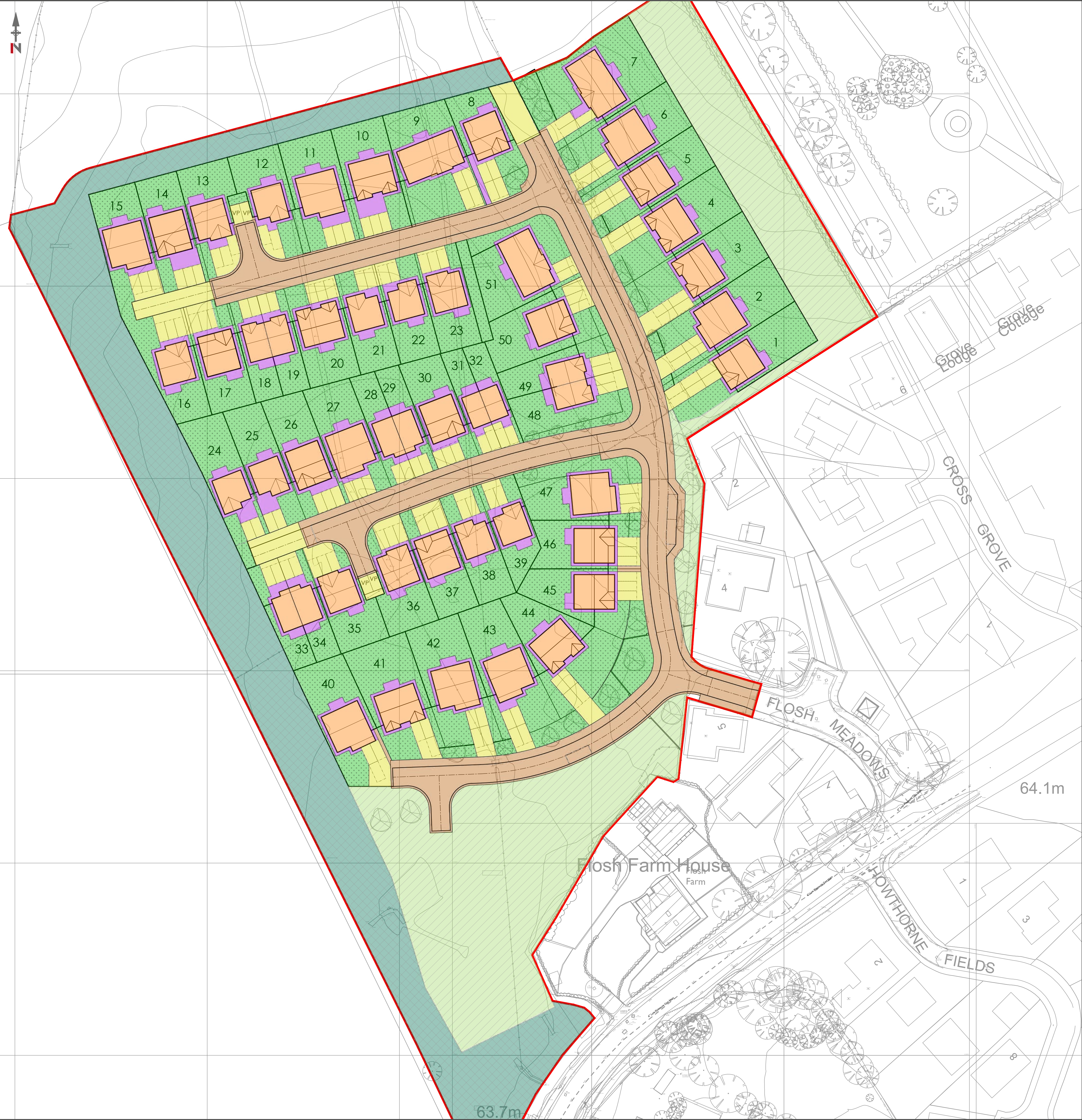
Project No: 2026-0032

Drawing No: 40

Rev:

BIM No:





KEY		
Dwelling roofs		= 0.506 Ha
Footpaths & patios		= 0.236 Ha
Driveways		= 0.256 Ha
Front & rear gardens		= 0.888 Ha
Adopted highways & footways		= 0.411 Ha
Land drainage diversion & swale		= 0.527 Ha
Remaining landscaping/ POS / BNG		= 0.571 Ha
TOTAL AREA		= 3.394 Ha

Rev	Description	Date	Revised by	Checked by	Approved
Issue Purpose: Planning					
Do not scale from this drawing					

R G PARKINS

Kendal | 01539 729393 Lancaster | 01524 32548

Client: Washington Homes

Project: Flos Meadows, Cleator

Drawing Title: Surface Water Drainage Catchment Plan

Scale @ A1: 1:500

First Issue: 29/09/26

Office of Origin: Kendal

Drawn by: SR

Checked by: TM

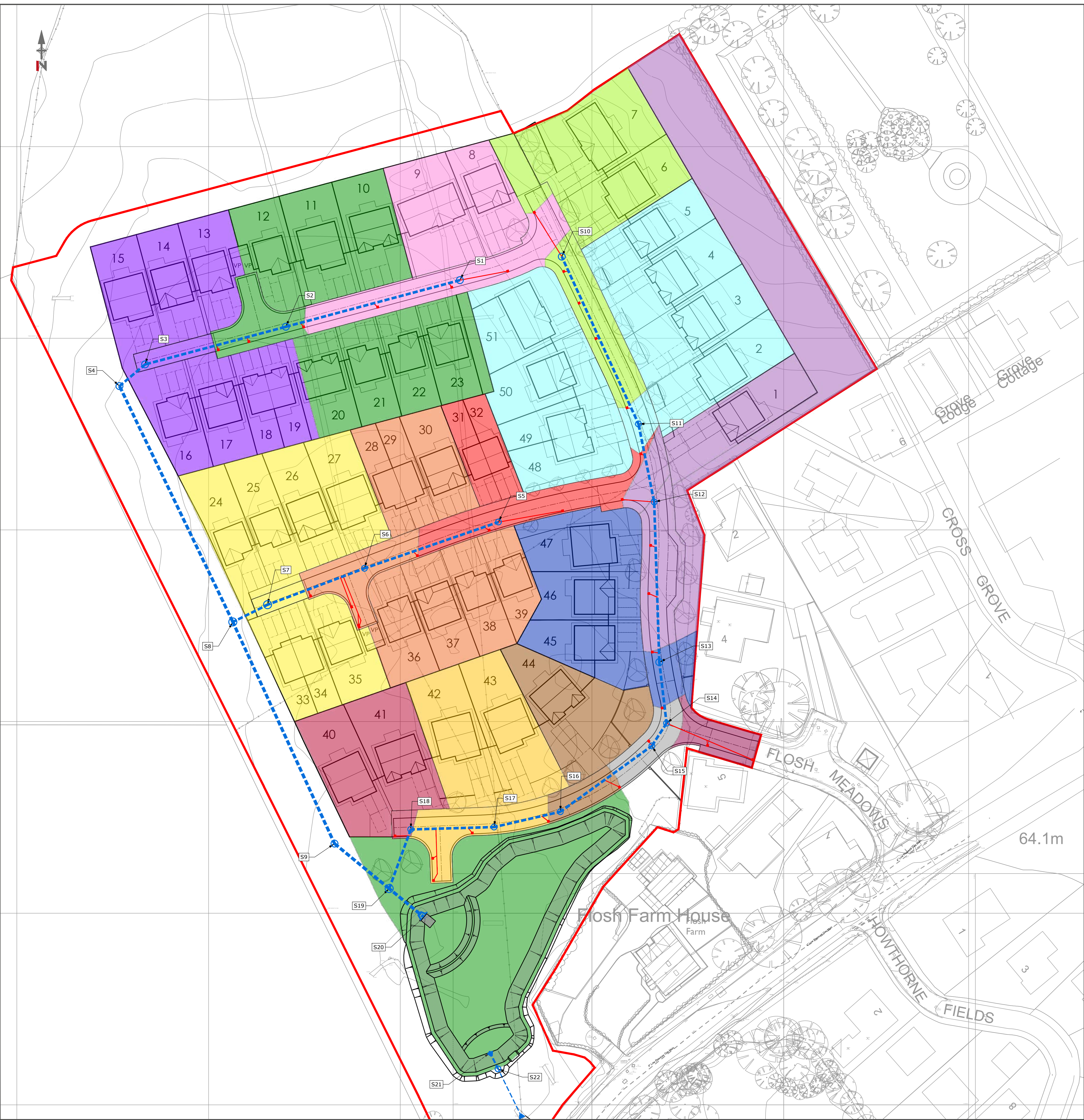
Approved: TM

Project No: 2026-0032

Drawing No: 42

Rev:

BIM No:



KEY		
S1		= 0.120 Ha
S2		= 0.113 Ha
S3		= 0.205 Ha
S4		= 0.000 Ha
S5		= 0.070 Ha
S6		= 0.170 Ha
S7		= 0.156 Ha
S8		= 0.000 Ha
S9		= 0.000 Ha
S10		= 0.125 Ha
S11		= 0.231 Ha
S12		= 0.141 Ha
S13		= 0.086 Ha
S14		= 0.016 Ha
S15		= 0.019 Ha
S16		= 0.048 Ha
S17		= 0.101 Ha
S18		= 0.087 Ha
S19		= 0.000 Ha
S20		= 0.000 Ha
S21		= 0.200 Ha
S22		= 0.000 Ha
TOTAL		= 1.886 Ha

Notes:
1. Impermeable catchment areas include +10% Urban Creep to all roof areas of the dwellings.
2. Contributing permeable areas have been assessed based on anticipated garden slope direction.
3. Run-off percentage for permeable areas (SPR) is estimated from base flow index derived using the UK Hydrology of Soil Types (HOST) classification from FEH web service <https://fehweb.ceh.ac.uk/>.

Rev	Description	Date	Revised by	Checked by	Approved
Issue Purpose: Planning					
Do not scale from this drawing					

R G PARKINS
Kendal | 01539 729393 Lancaster | 01524 32548

Client: **Washington Homes**
Project: **Flosch Meadows, Cleator**
Drawing Title: **Surface Water Drainage Catchment Plan**

Scale @ A1: 1:500	First Issue: 29/09/26	Office of Origin: Kendal
Drawn by: SR	Checked by: TM	Approved: TM
Project No: 2026-0032	Drawing No: 43	Rev:
BIM No:		



Rev	Description	Date	Revised by	Checked by	Approved
Issue Purpose: Planning					
Do not scale from this drawing					

R G PARKINS
Kendal | 01539 729393 Lancaster | 01524 32548

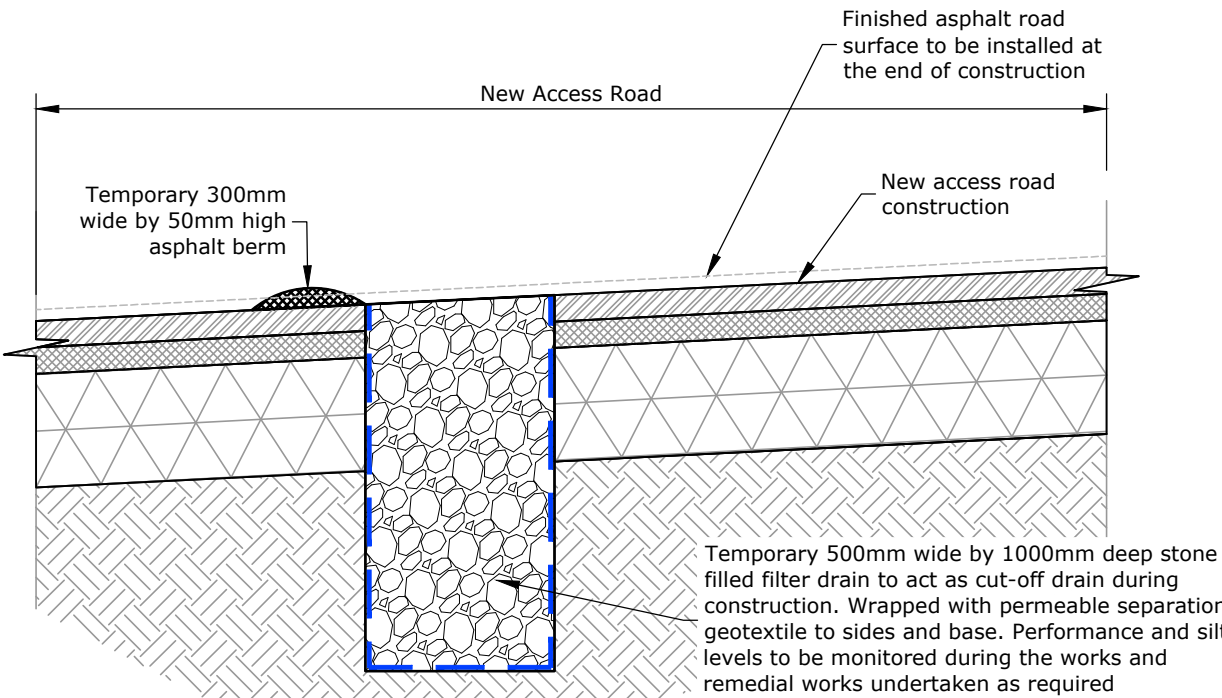
Client: Washington Homes
Project: Flos Meadows, Cleator
Drawing Title: Surface Water Drainage Exceedance Plan

Scale @ A1: 1:500	First Issue: 29/09/26	Office of Origin: Kendal
Drawn by: SR	Checked by: TM	Approved: TM
Project No: 2026-0032	Drawing No: 44	Rev:
BIM No:		

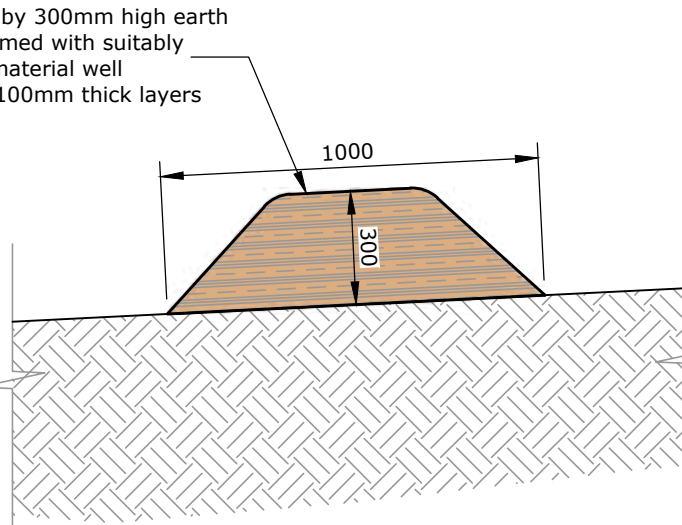


General

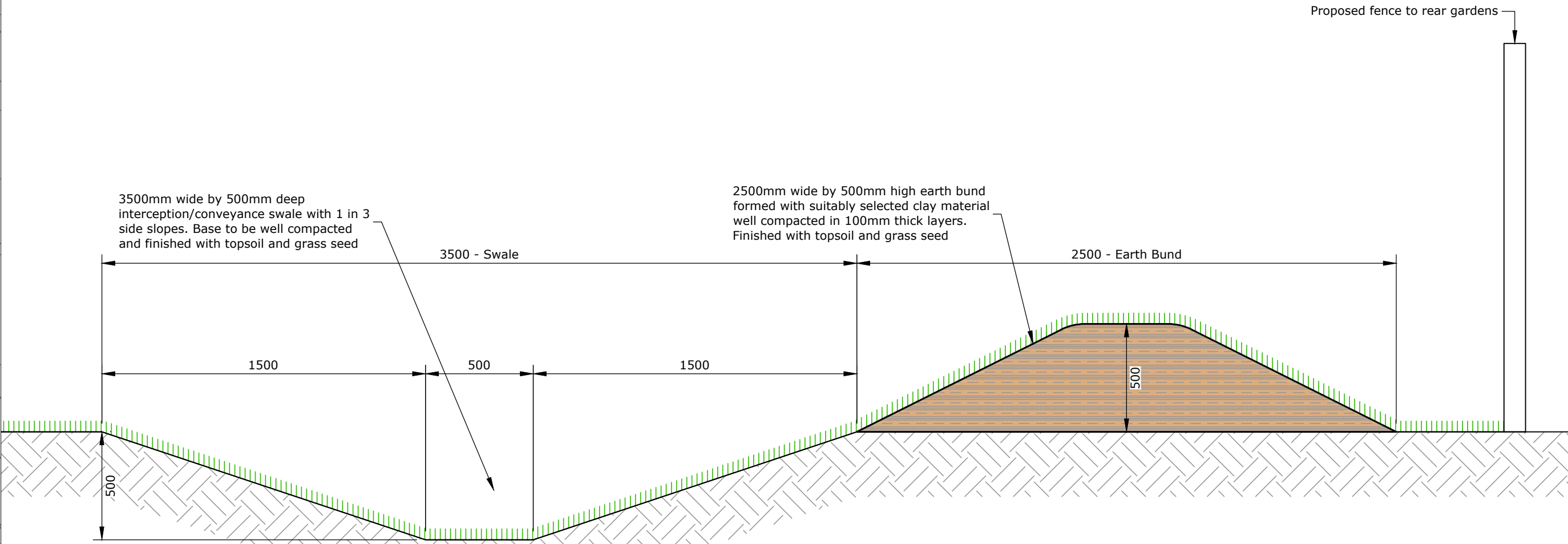
1. This drawing should not be scaled - use figured dimensions only. If in doubt, ask.
2. All dimensions are in millimetres unless stated otherwise.
3. This drawing is to be read in conjunction with all relevant Architects drawings as well as all other drawings by RG Parkins (refer to RG Parkins drawing register).
4. The Contractor is responsible for verifying all dimensions on site prior to commencing works
5. Any specified proprietary products are to be installed in strict accordance with manufacturers guidelines. No specified product should be substituted without gaining approval from RG Parkins.



Section A-A
Temporary Filter Drain & Berm
at Site Entrance
Scale 1:20



Section B-B
Earth Bund Along Southern Boundary
Scale 1:20



Section C-C
Permanent Swale and Earth
Bund Along Northern Boundary
Scale 1:20

Rev	Description	Date	Revised by	Checked by	Approved
Issue Purpose: Planning					
Do not scale from this drawing					

R G PARKINS
Kendal | 01539 729393 | Lancaster | 01524 32548

Client: Washington Homes
Project: Floss Meadows, Cleator
Drawing Title: Proposed Works to Manage Runoff During Construction

Scale @ A1: 1:500	First Issue: 29/09/26	Office of Origin: Kendal
Drawn by: SR	Checked by: TM	Approved: TM
Project No: 2026-0032	Drawing No: 45	Rev:
BIM No:		

APPENDIX D

PREDEVELOPMENT GREENFIELD CALCULATIONS

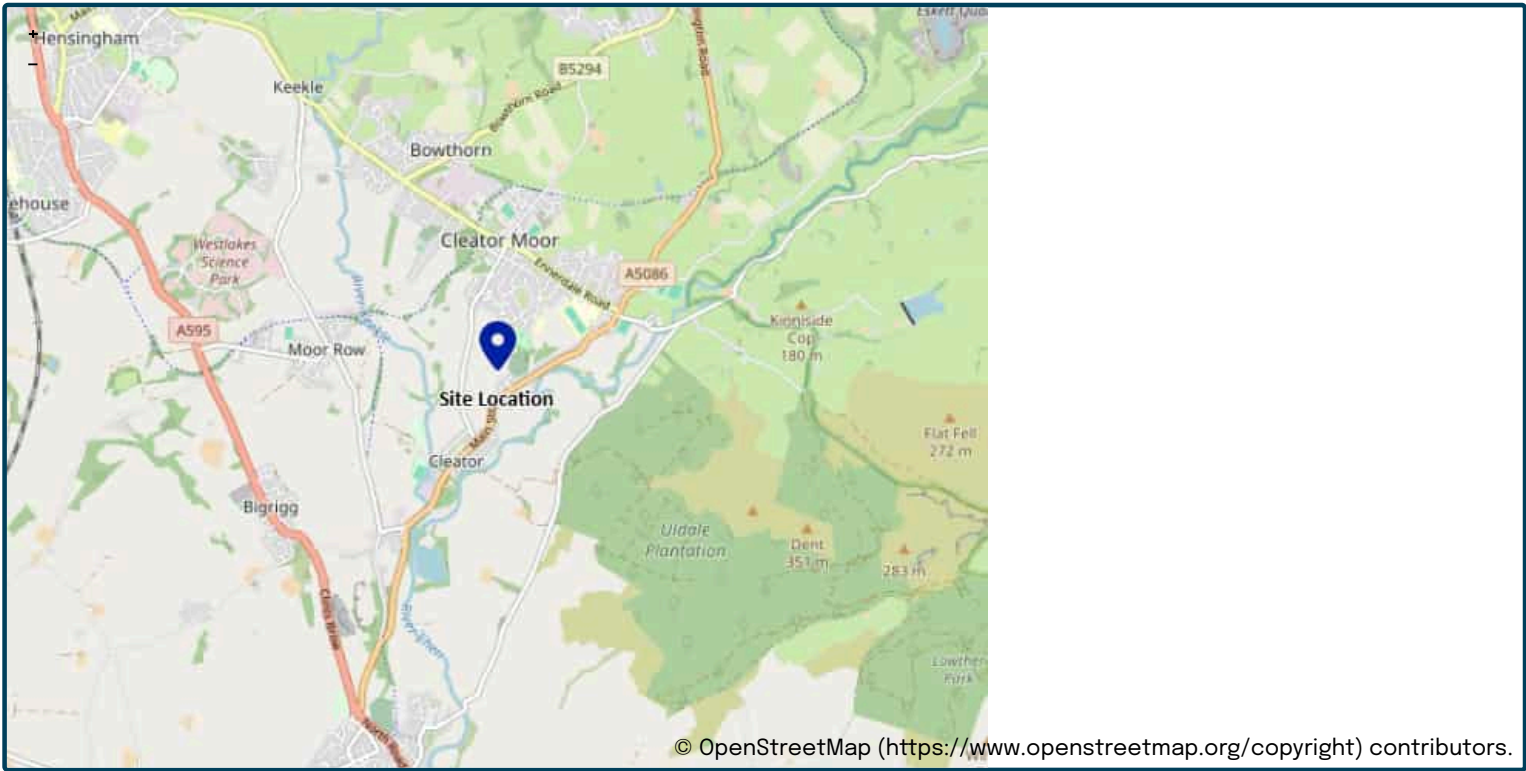
This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance “Rainfall runoff management for developments”, SC030219 (2013), the SuDS Manual C753 (CIRIA, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Project details

Date	23/07/2026
Calculated by	Troy Melhuish
Reference	K2026-0032
Model version	2.2.3

Location

Site name	Flosh Meadows
Site location	Cleator



Site easting (British National Grid)	301830
Site northing (British National Grid)	513985

Site details

Total site area (ha)	2.85
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Greenfield runoff

Method

Method	FEH statistical (2025)
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FEH statistical (2025)

	<u>My value</u>	<u>Map value</u>
SAAR9120 (mm)	1364 mm	
BFIHOST19scaled	0.613	
QMed-QBar conversion	1.075	1.075
QMed (l/s)	16.7 l/s	
QBar (FEH statistical 2025) (l/s)	18 l/s	

Growth curve factors

	<u>My value</u>	<u>Map value</u>
Hydrological region	10	10
1 year growth factor	0.87	
2 year growth factor	0.93	
10 year growth factor	1.38	
30 year growth factor	1.7	
100 year growth factor	2.08	
200 year growth factor	2.37	

Results

Method	FEH statistical (2025)
Flow rate 1 year (l/s)	15.6 l/s
Flow rate 2 year (l/s)	16.7 l/s
Flow rate 10 years (l/s)	24.8 l/s
Flow rate 30 years (l/s)	30.6 l/s
Flow rate 100 years (l/s)	37.4 l/s
Flow rate 200 years (l/s)	42.6 l/s

Please note runoff estimation is subject to significant uncertainty. Results are therefore normally reported to only 1 decimal place. Where 2 decimal places are provided, this does not indicate accuracy to this level, it has been adopted to prevent ‘zero’ figures from being reported. Outputs less than 0.01 l/s are reported as 0.01 l/s.

Disclaimer

This report was produced using the Greenfield runoff rate estimation tool (2.2.3) developed by HR Wallingford and available at uksuds.com (<https://www.uksuds.com/>). The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at uksuds.com/terms-conditions (<https://www.uksuds.com/terms-conditions>). The outputs from this tool have been used to estimate Greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, Centre for Ecology and Hydrology, Wallingford Hydrosolutions or any other organisation for the use of these data in the design or operational characteristics of any drainage scheme.

APPENDIX E

SURFACE WATER DRAINAGE DESIGN CALCULATIONS

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	1.000	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
S1	0.120	5.00	64.978	1800	301765.556	514115.163	2.092
S2	0.113	5.00	64.502	1800	301720.154	514103.009	1.734
S3	0.205	5.00	64.249	1800	301683.450	514093.183	1.576
S4	0.000		64.452	2100	301676.772	514087.522	1.946
S5	0.070	5.00	64.190	1800	301775.615	514052.055	1.524
S6	0.170	5.00	63.828	1800	301740.659	514039.981	1.254
S7	0.156	5.00	63.559	1800	301715.396	514030.494	1.052
S8	0.000	5.00	63.700	2100	301706.331	514025.980	1.365
S9	0.000		63.520	2100	301732.847	513968.161	1.358
S10	0.125	5.00	66.094	1800	301792.131	514121.293	3.277
S11	0.231	5.00	65.592	1800	301812.127	514077.656	2.895
S12	0.141	5.00	64.989	1800	301816.225	514057.295	2.344
S13	0.086	5.00	64.551	1800	301817.564	514015.497	2.011
S14	0.016	5.00	64.444	1800	301819.451	513999.575	1.944
S15	0.019	5.00	64.392	1800	301815.625	513993.654	1.910
S16	0.048	5.00	64.192	1800	301791.760	513976.479	1.784
S17	0.101	5.00	64.071	1800	301774.465	513972.476	1.707
S18	0.087	5.00	63.934	1800	301752.736	513971.855	1.624
S19	0.000		63.220	2100	301747.113	513956.420	1.104
S20	0.000		63.200	20	301756.158	513948.976	1.160
S21	0.200	5.00	63.200	20	301773.372	513913.709	1.200
S22	0.000		63.200	1500	301775.513	513909.374	1.220
S23			63.100	20	301781.749	513896.681	1.170

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	S1	S2	47.001	0.600	62.886	62.768	0.118	400.0	600	5.65	50.0
1.001	S2	S3	37.996	0.600	62.768	62.673	0.095	400.0	600	6.17	50.0
1.002	S3	S4	8.755	0.600	62.673	62.651	0.022	400.0	600	6.29	50.0
1.003	S4	S8	68.273	0.600	62.506	62.335	0.171	400.0	750	7.11	50.0
2.000	S5	S6	36.982	0.600	62.666	62.574	0.092	400.0	600	5.51	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
1.000	1.211	342.4	21.7	1.492	1.134	0.120	0.0
1.001	1.211	342.4	42.1	1.134	0.976	0.233	0.0
1.002	1.211	342.4	79.1	0.976	1.201	0.438	0.0
1.003	1.393	615.3	79.1	1.196	0.615	0.438	0.0
2.000	1.211	342.4	12.6	0.924	0.654	0.070	0.0

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
2.001	S6	S7	26.986	0.600	62.574	62.507	0.067	400.0	600	5.88	50.0
2.002	S7	S8	10.127	0.600	62.507	62.482	0.025	400.0	600	6.02	50.0
1.004	S8	S9	63.609	0.600	62.335	62.176	0.159	400.0	750	7.87	50.0
1.005	S9	S19	18.476	0.600	62.162	62.116	0.046	400.0	750	8.09	50.0
3.000	S10	S11	48.000	0.600	62.817	62.697	0.120	400.0	600	5.66	50.0
3.001	S11	S12	20.769	0.600	62.697	62.645	0.052	400.0	600	5.95	50.0
3.002	S12	S13	41.819	0.600	62.645	62.540	0.105	398.3	600	6.52	50.0
3.003	S13	S14	16.033	0.600	62.540	62.500	0.040	400.8	600	6.74	50.0
3.004	S14	S15	7.050	0.600	62.500	62.482	0.018	391.6	600	6.84	50.0
3.005	S15	S16	29.403	0.600	62.482	62.408	0.074	397.3	600	7.24	50.0
3.006	S16	S17	17.752	0.600	62.408	62.364	0.044	403.5	600	7.49	50.0
3.007	S17	S18	21.738	0.600	62.364	62.310	0.054	402.6	600	7.79	50.0
3.008	S18	S19	16.427	0.600	62.310	62.269	0.041	400.0	600	8.01	50.0
1.006	S19	S20	11.714	0.600	62.116	62.087	0.029	400.0	750	8.23	50.0
4.000	S21	S22	4.835	0.600	62.000	61.980	0.020	241.7	450	5.06	50.0
4.001	S22	S23	14.142	0.600	61.980	61.930	0.050	282.8	225	5.37	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
2.001	1.211	342.4	43.4	0.654	0.452	0.240	0.0
2.002	1.211	342.4	71.6	0.452	0.618	0.396	0.0
1.004	1.393	615.3	150.7	0.615	0.594	0.834	0.0
1.005	1.393	615.3	150.7	0.608	0.354	0.834	0.0
3.000	1.211	342.4	22.6	2.677	2.295	0.125	0.0
3.001	1.211	342.4	64.3	2.295	1.744	0.356	0.0
3.002	1.214	343.2	89.8	1.744	1.411	0.497	0.0
3.003	1.210	342.1	105.3	1.411	1.344	0.583	0.0
3.004	1.224	346.1	108.2	1.344	1.310	0.599	0.0
3.005	1.215	343.6	111.7	1.310	1.184	0.618	0.0
3.006	1.206	340.9	120.3	1.184	1.107	0.666	0.0
3.007	1.207	341.3	138.6	1.107	1.024	0.767	0.0
3.008	1.211	342.4	154.3	1.024	0.351	0.854	0.0
1.006	1.393	615.3	305.0	0.354	0.363	1.688	0.0
4.000	1.303	207.2	36.1	0.750	0.770	0.200	0.0
4.001	0.772	30.7	36.1	0.995	0.945	0.200	0.0

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	47.001	400.0	600	Circular_Default Sewer Type	64.978	62.886	1.492	64.502	62.768	1.134
1.001	37.996	400.0	600	Circular_Default Sewer Type	64.502	62.768	1.134	64.249	62.673	0.976
1.002	8.755	400.0	600	Circular_Default Sewer Type	64.249	62.673	0.976	64.452	62.651	1.201
1.003	68.273	400.0	750	Circular_Default Sewer Type	64.452	62.506	1.196	63.700	62.335	0.615

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	S1	1800	Manhole	Adoptable	S2	1800	Manhole	Adoptable
1.001	S2	1800	Manhole	Adoptable	S3	1800	Manhole	Adoptable
1.002	S3	1800	Manhole	Adoptable	S4	2100	Manhole	Adoptable
1.003	S4	2100	Manhole	Adoptable	S8	2100	Manhole	Adoptable

Pipeline Schedule

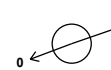
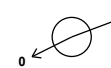
Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
2.000	36.982	400.0	600	Circular_Default Sewer Type	64.190	62.666	0.924	63.828	62.574	0.654
2.001	26.986	400.0	600	Circular_Default Sewer Type	63.828	62.574	0.654	63.559	62.507	0.452
2.002	10.127	400.0	600	Circular_Default Sewer Type	63.559	62.507	0.452	63.700	62.482	0.618
1.004	63.609	400.0	750	Circular_Default Sewer Type	63.700	62.335	0.615	63.520	62.176	0.594
1.005	18.476	400.0	750	Circular_Default Sewer Type	63.520	62.162	0.608	63.220	62.116	0.354
3.000	48.000	400.0	600	Circular_Default Sewer Type	66.094	62.817	2.677	65.592	62.697	2.295
3.001	20.769	400.0	600	Circular_Default Sewer Type	65.592	62.697	2.295	64.989	62.645	1.744
3.002	41.819	398.3	600	Circular_Default Sewer Type	64.989	62.645	1.744	64.551	62.540	1.411
3.003	16.033	400.8	600	Circular_Default Sewer Type	64.551	62.540	1.411	64.444	62.500	1.344
3.004	7.050	391.6	600	Circular_Default Sewer Type	64.444	62.500	1.344	64.392	62.482	1.310
3.005	29.403	397.3	600	Circular_Default Sewer Type	64.392	62.482	1.310	64.192	62.408	1.184
3.006	17.752	403.5	600	Circular_Default Sewer Type	64.192	62.408	1.184	64.071	62.364	1.107
3.007	21.738	402.6	600	Circular_Default Sewer Type	64.071	62.364	1.107	63.934	62.310	1.024
3.008	16.427	400.0	600	Circular_Default Sewer Type	63.934	62.310	1.024	63.220	62.269	0.351
1.006	11.714	400.0	750	Circular_Default Sewer Type	63.220	62.116	0.354	63.200	62.087	0.363
4.000	4.835	241.7	450	Circular_Default Sewer Type	63.200	62.000	0.750	63.200	61.980	0.770
4.001	14.142	282.8	225	Circular_Default Sewer Type	63.200	61.980	0.995	63.100	61.930	0.945

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
2.000	S5	1800	Manhole	Adoptable	S6	1800	Manhole	Adoptable
2.001	S6	1800	Manhole	Adoptable	S7	1800	Manhole	Adoptable
2.002	S7	1800	Manhole	Adoptable	S8	2100	Manhole	Adoptable
1.004	S8	2100	Manhole	Adoptable	S9	2100	Manhole	Adoptable
1.005	S9	2100	Manhole	Adoptable	S19	2100	Manhole	Adoptable
3.000	S10	1800	Manhole	Adoptable	S11	1800	Manhole	Adoptable
3.001	S11	1800	Manhole	Adoptable	S12	1800	Manhole	Adoptable
3.002	S12	1800	Manhole	Adoptable	S13	1800	Manhole	Adoptable
3.003	S13	1800	Manhole	Adoptable	S14	1800	Manhole	Adoptable
3.004	S14	1800	Manhole	Adoptable	S15	1800	Manhole	Adoptable
3.005	S15	1800	Manhole	Adoptable	S16	1800	Manhole	Adoptable
3.006	S16	1800	Manhole	Adoptable	S17	1800	Manhole	Adoptable
3.007	S17	1800	Manhole	Adoptable	S18	1800	Manhole	Adoptable
3.008	S18	1800	Manhole	Adoptable	S19	2100	Manhole	Adoptable
1.006	S19	2100	Manhole	Adoptable	S20	20	Junction	
4.000	S21	20	Junction		S22	1500	Manhole	Adoptable
4.001	S22	1500	Manhole	Adoptable	S23	20	Junction	

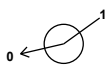
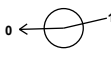
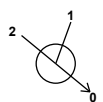
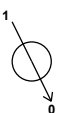
Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
S1	301765.556	514115.163	64.978	2.092	1800	0				
						0	1.000	62.886	600	
S2	301720.154	514103.009	64.502	1.734	1800	0 1	1	1.000	62.768	600
						0	1.001	62.768	600	

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
S3	301683.450	514093.183	64.249	1.576	1800	 1	1.001	62.673	600	
						 0	1.002	62.673	600	
S4	301676.772	514087.522	64.452	1.946	2100	 1	1.002	62.651	600	
						 0	1.003	62.506	750	
S5	301775.615	514052.055	64.190	1.524	1800	 0	2.000	62.666	600	
S6	301740.659	514039.981	63.828	1.254	1800	 1	2.000	62.574	600	
						 0	2.001	62.574	600	
S7	301715.396	514030.494	63.559	1.052	1800	 1	2.001	62.507	600	
						 0	2.002	62.507	600	
S8	301706.331	514025.980	63.700	1.365	2100	 2	2.002	62.482	600	
						 2	1.003	62.335	750	
						 0	1.004	62.335	750	
S9	301732.847	513968.161	63.520	1.358	2100	 1	1	1.004	62.176	750
						 0	1.005	62.162	750	
S10	301792.131	514121.293	66.094	3.277	1800	 0	0	3.000	62.817	600
S11	301812.127	514077.656	65.592	2.895	1800	 1	1	3.000	62.697	600
						 0	3.001	62.697	600	
S12	301816.225	514057.295	64.989	2.344	1800	 1	1	3.001	62.645	600
						 0	3.002	62.645	600	
S13	301817.564	514015.497	64.551	2.011	1800	 1	1	3.002	62.540	600
						 0	3.003	62.540	600	
S14	301819.451	513999.575	64.444	1.944	1800	 1	1	3.003	62.500	600
						 0	3.004	62.500	600	
S15	301815.625	513993.654	64.392	1.910	1800	 1	1	3.004	62.482	600
						 0	3.005	62.482	600	

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
S16	301791.760	513976.479	64.192	1.784	1800		1	3.005	62.408	600
							0	3.006	62.408	600
S17	301774.465	513972.476	64.071	1.707	1800		1	3.006	62.364	600
							0	3.007	62.364	600
S18	301752.736	513971.855	63.934	1.624	1800		1	3.007	62.310	600
							0	3.008	62.310	600
S19	301747.113	513956.420	63.220	1.104	2100		1	3.008	62.269	600
							2	1.005	62.116	750
							0	1.006	62.116	750
S20	301756.158	513948.976	63.200	1.160	20		1	1.006	62.087	750
S21	301773.372	513913.709	63.200	1.200	20		0	4.000	62.000	450
S22	301775.513	513909.374	63.200	1.220	1500		1	4.000	61.980	450
							0	4.001	61.980	225
S23	301781.749	513896.681	63.100	1.170	20		1	4.001	61.930	225

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Detailed	Starting Level (m)
Rainfall Events	Singular	Skip Steady State	✓	Check Discharge Rate(s) x
Summer CV	1.000	Drain Down Time (mins)	240	Check Discharge Volume x
Winter CV	1.000	Additional Storage (m³/ha)	20.0	

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
100	50	0	0

Node S22 Online StormBrake™ Control

Flap Valve	x	Design Flow (l/s)	18.0
Replaces Downstream Link	x	Product Code	FPM-SB1-01200-01800-1100
Invert Level (m)	61.980	Min Outlet Diameter (m)	0.225
Design Depth (m)	1.200	Min Node Diameter (mm)	1200

Node S21 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	40.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	62.000	Main Channel Slope (1:X)	1000.0
Safety Factor	2.0	Time to half empty (mins)		Main Channel n	0.030

Inlets

S20

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1118.5	0.0	0.400	1328.8	0.0	0.800	1549.0	0.0	1.200	1779.3	0.0
0.100	1169.9	0.0	0.500	1382.9	0.0	0.900	1605.6	0.0			
0.200	1222.3	0.0	0.600	1437.7	0.0	1.000	1662.8	0.0			
0.300	1275.2	0.0	0.700	1493.1	0.0	1.100	1720.6	0.0			

Results for 100 year +50% CC Critical Storm Duration. Lowest mass balance: 99.89%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1	11	63.150	0.264	84.7	0.9730	0.0000	OK
15 minute summer	S2	11	63.135	0.367	156.5	1.4120	0.0000	OK
960 minute winter	S3	900	63.121	0.448	25.2	2.3033	0.0000	OK
960 minute winter	S4	900	63.121	0.615	25.2	2.1289	0.0000	OK
960 minute winter	S5	900	63.121	0.455	4.0	1.5743	0.0000	OK
960 minute winter	S6	900	63.121	0.547	13.8	2.8729	0.0000	OK
960 minute winter	S7	900	63.121	0.614	22.2	3.3809	0.0000	SURCHARGED
960 minute winter	S8	900	63.121	0.786	45.0	2.7213	0.0000	SURCHARGED
960 minute winter	S9	900	63.121	0.959	42.3	3.3205	0.0000	SURCHARGED
30 minute summer	S10	19	63.685	0.868	86.0	2.8712	0.0000	SURCHARGED
30 minute summer	S11	19	63.705	1.008	227.0	4.1724	0.0000	SURCHARGED
30 minute summer	S12	19	63.677	1.032	300.9	3.8668	0.0000	SURCHARGED
30 minute summer	S13	19	63.558	1.018	358.2	3.4626	0.0000	SURCHARGED
30 minute summer	S14	19	63.471	0.971	360.1	2.6299	0.0000	SURCHARGED
30 minute summer	S15	19	63.410	0.928	364.6	2.5454	0.0000	SURCHARGED
30 minute summer	S16	19	63.281	0.873	390.4	2.6916	0.0000	SURCHARGED
30 minute summer	S17	19	63.175	0.811	452.2	3.0243	0.0000	SURCHARGED
960 minute winter	S18	900	63.121	0.811	45.7	2.9311	0.0000	SURCHARGED
960 minute winter	S19	900	63.121	1.005	85.3	3.4798	0.0000	FLOOD RISK
960 minute winter	S20	900	63.121	1.081	84.4	0.0000	0.0000	OK
960 minute winter	S21	900	63.121	1.121	57.0	3.7347	0.0000	FLOOD RISK
960 minute winter	S22	900	63.120	1.140	18.1	2.0148	0.0000	FLOOD RISK
30 minute summer	S23	120	62.041	0.111	18.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S1	1.000	S2	80.4	0.667	0.235	7.0423	
15 minute summer	S2	1.001	S3	155.5	0.808	0.454	7.4824	
960 minute winter	S3	1.002	S4	25.2	0.750	0.074	2.0229	
960 minute winter	S4	1.003	S8	23.8	0.508	0.039	28.2073	
960 minute winter	S5	2.000	S6	4.0	0.254	0.012	9.2182	
960 minute winter	S6	2.001	S7	13.4	0.473	0.039	7.4361	
960 minute winter	S7	2.002	S8	21.6	0.708	0.063	2.8525	
960 minute winter	S8	1.004	S9	42.3	0.643	0.069	27.9956	
960 minute winter	S9	1.005	S19	40.5	0.416	0.066	8.1317	
30 minute summer	S10	3.000	S11	76.4	0.440	0.223	13.5205	
30 minute summer	S11	3.001	S12	212.6	0.781	0.621	5.8502	
30 minute summer	S12	3.002	S13	304.4	1.081	0.887	11.7795	
30 minute summer	S13	3.003	S14	350.2	1.243	1.024	4.5161	
30 minute summer	S14	3.004	S15	352.7	1.252	1.019	1.9858	
30 minute summer	S15	3.005	S16	366.3	1.300	1.066	8.2822	
30 minute summer	S16	3.006	S17	395.1	1.403	1.159	5.0003	
30 minute summer	S17	3.007	S18	456.1	1.619	1.336	6.1231	
960 minute winter	S18	3.008	S19	45.0	0.801	0.131	4.6271	
960 minute winter	S19	1.006	S20	84.4	0.714	0.137	5.1556	
960 minute winter	S20	Flow through Pond	S21	45.5	0.037	0.002	1556.1719	
960 minute winter	S21	4.000	S22	18.1	0.198	0.087	0.7661	
960 minute winter	S22	4.001	S23	18.0	0.860	0.586	0.2958	978.4