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Land West of Herne Bay: Flood Risk Assessment and Outline Drainage Strategy

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Land West of Herne Bay: Flood Risk Assessment and Outline Drainage Strategy

Client

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1. Introduction

Aqua Terra Consultants Ltd (Aqua Terra) was instructed by Fairfax Land Ventures Ltd (the Client) to provide a Flood Risk Assessment (FRA) and Outline Drainage Strategy (ODS) to support a residential led development on a parcel of land west of Herne Bay Road, Sturry, Kent, (the Site).

1.1. Background

The FRA is to support an outline planning application with all matters reserved except for access for up to 127 dwellings, landscaping, open space, SuDS, and associated works with access from Herne Bay Road and retained pedestrian access from Sweechgate.

1.2. Scope

The scope of the FRA and ODS is as follows:

- Preparation of a FRA, written in line with the National Planning Policy Framework (NPPF) and supporting Planning Practice Guidance (PPG), to satisfy the Environment Agency (EA) and the Lead Local Flood Authority (LLFA, Kent County Council) that potential flood risks from all sources to and from the proposed development have been considered and that the proposed development is appropriate, as defined in the NPPF;
- Acquisition and review of modelled flood extents and levels for current and future climate scenarios from the EA;
- Where required, consideration of appropriate site-specific flood risk mitigation measures and provision of recommendations for a strategy for managing and mitigating potential flood risk posed on the Site;
- Review national, regional and local guidance and policies on surface water management;
- Estimate surface water runoff and preliminary attenuation storage requirements;
- Assessment of potential surface water runoff destinations;
- An appraisal of potentially feasible SuDS features for the Site; and,
- Provide a SuDS strategy for managing surface water runoff from the proposed development

1.3. Data sources

The main sources of data utilised in this assessment are summarised below:

- The proposed development plans as provided by the Client;
- LiDAR Digital Terrain Model (DTM) data obtained through data.gov.uk (DeFRA, 2020-22) ;
- EA flood risk data (Environment Agency, 2025);
- Soilsmap soil mapping (Cranfield Soil and AgriFood Institute, 2025);
- British Geological Survey (BGS) mapping (British Geological Society, 2025) ;
- Kent Local Flood Risk Management Strategy 2024 - 2034 (Kent County Council, 2024)
- Kent County Council – Preliminary Flood Risk Assessment (Kent County Council, 2011);
- Kent County Council – The Kent design guide, making it happen – sustainability (drainage systems);
- Canterbury City Council – Strategic Flood Risk Assessment (Herrington Consulting, 2024); and,
- Water. People. Places. A guide for master planning sustainable drainage into developments. Prepared by the Lead Local Flood Authorities of the South East of England (AECOM, 2013)

1.4. Limitations

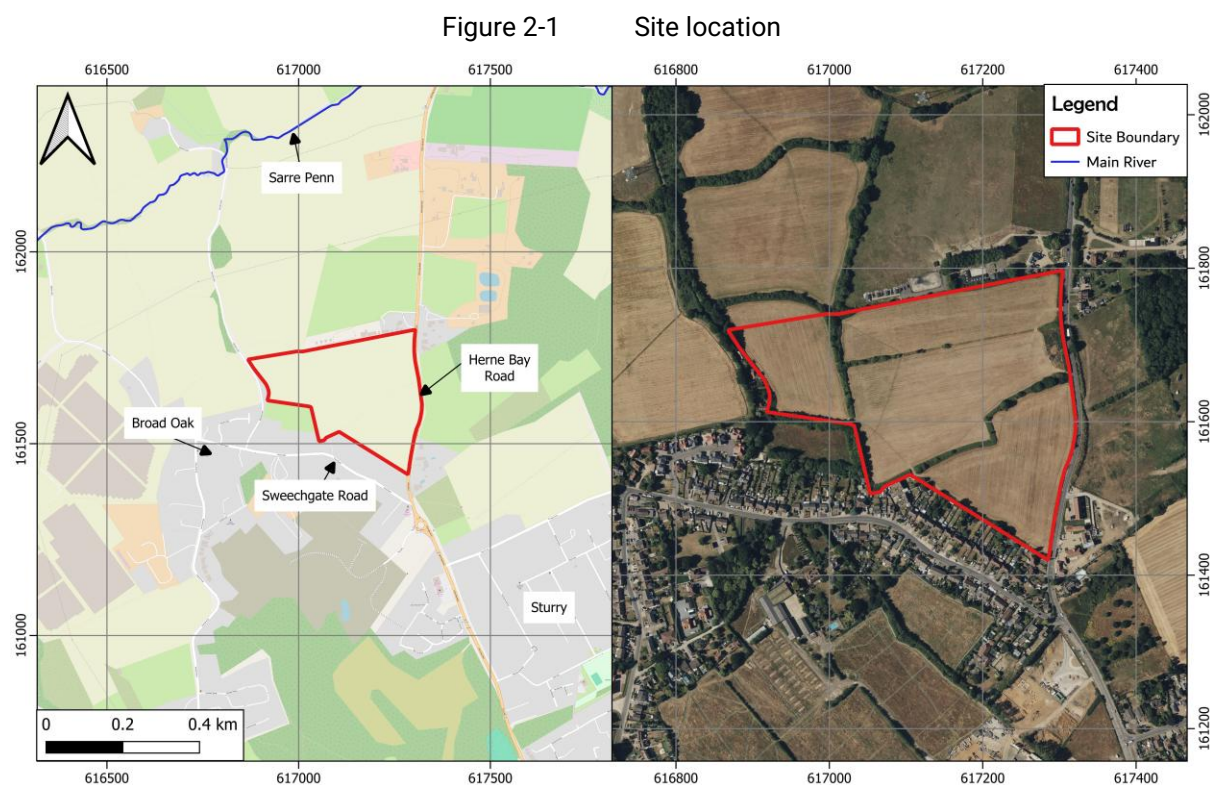
This report is written strictly for the benefit of the Client and bound by the conditions presented in Appendix A.

2. Site setting

2.1. Site location and description

The Site is located on the outskirts of Sturry as shown in Figure 2-1, to the west of Herne Bay Road. The Ordnance Survey Grid Reference for the approximate centre of the Site is TR 17133 61615.

The Site currently comprises pastoral agricultural land divided into fields with hedges. The Sarre Penn (a Main River) lies to the north of the Site. The overall area proposed to be developed is approximately 9.7Ha.



Contains Open Street Map data © OpenStreetMap and Bing Aerial imagery © Microsoft

2.2. Topography and current drainage arrangements

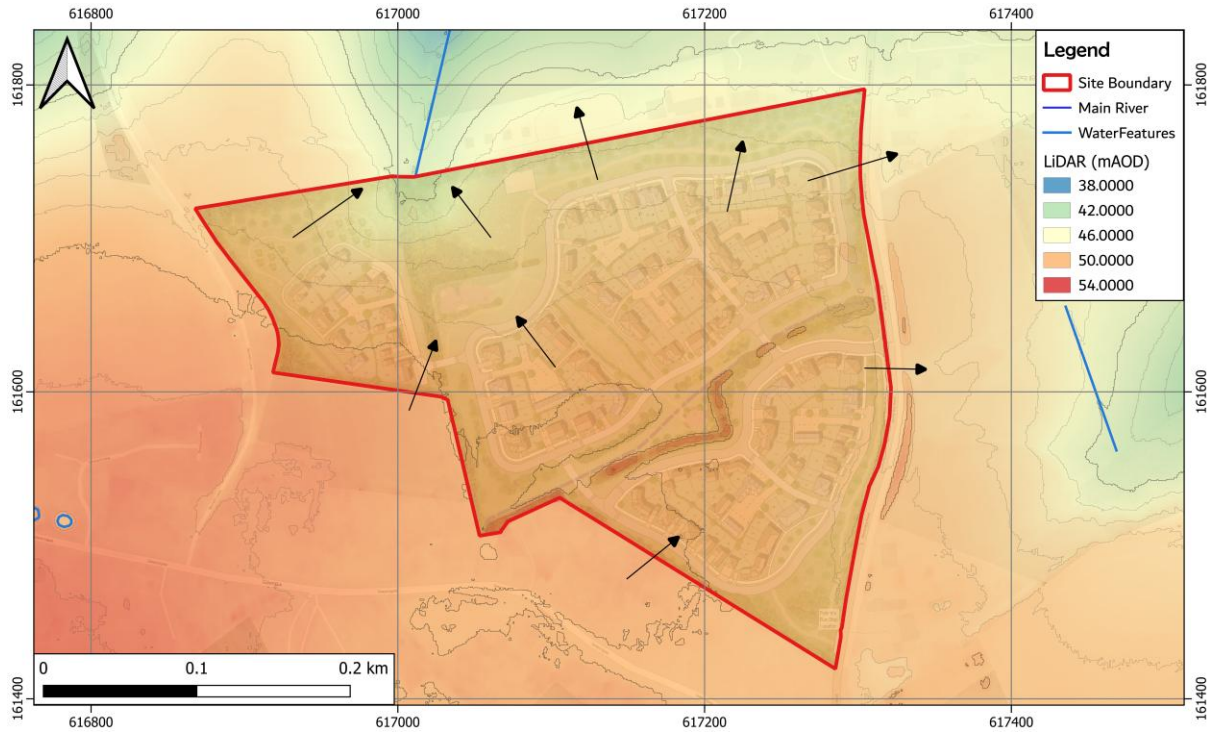
Figure 2-2 presents LiDAR topographical data and inferred current runoff directions data overlain by the proposed development plans. The Site is situated on an interfluvium between two river valleys. Ground elevations in the area around the Site slope generally northwards. The southern part of the Site itself slopes in a more easterly direction.

The ground elevation at the Site falls from approximately 52m above Ordnance Datum (m aOD) in the southwest to a minimum of approximately 48.93m aOD in the northeast. Topographic survey for the Site has been undertaken by Marvin & Partners in April 2024 and is provided in Appendix B.

At present, the Site does not have a formal drainage system and surface water runoff will either infiltrate or flow overland with the topography. A northwards flowing drain (which leads to Sarre Penn watercourse) located at the northern boundary is thought to receive much of the Site runoff with Herne Bay Road also receiving some runoff from the southernmost area. Sewer plans from Southern

Water (see Appendix C) indicate that a foul rising main runs along Herne Bay Road to the east of the Site.

Figure 2-2 Existing ground elevations from LiDAR data



2.3. Geology and hydrogeology

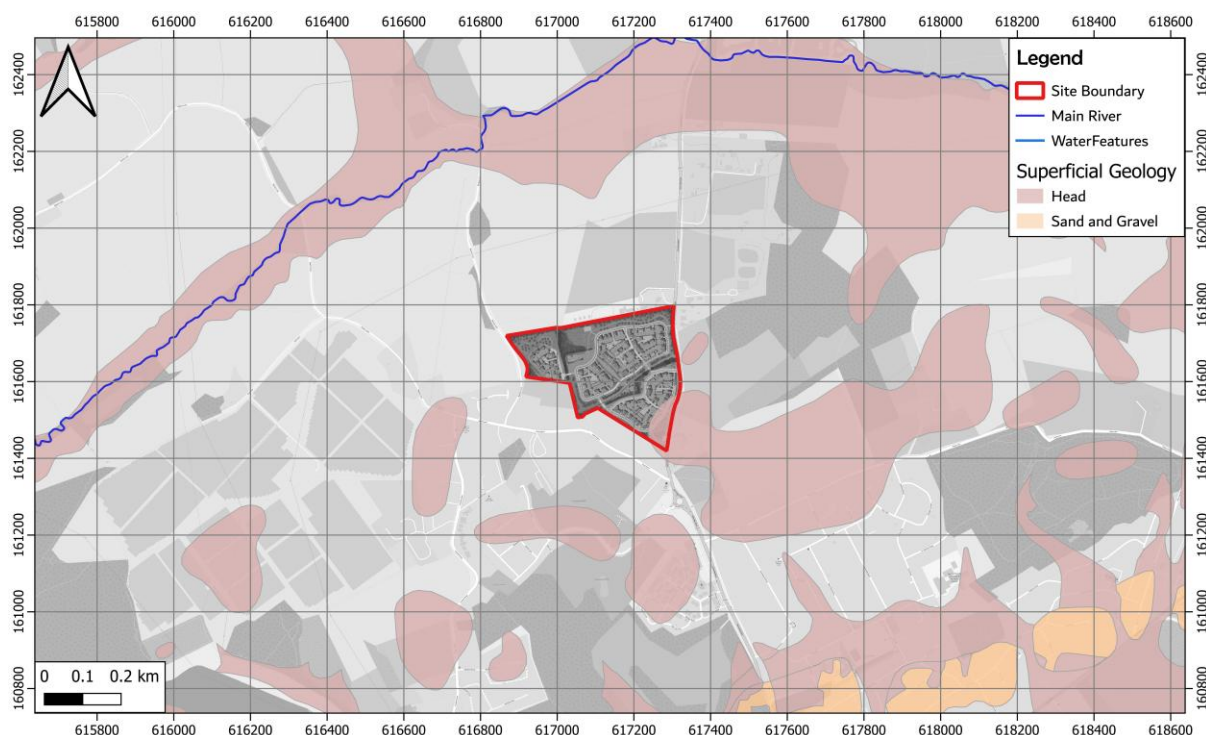
2.3.1. Published soils and geology

A review of Soilsapes and British Geological Survey (BGS) 1:50,000 scale mapping indicates the geological sequence underlying the Site is as follows:

- Soils: Slowly permeable, seasonally wet, slightly acid but base-rich loamy and clayey soils.
- Superficial deposits (see Figure 2-3): Head Deposits (gravel, sand, silt and clay) across the southernmost extent of the Site, with superficial deposits absent across the remainder of the Site.
- Solid geology: London Clay Formation (to a depth of c. 30 m according to nearby BGS borehole logs)

Given the nature of the bedrock, a clayey matrix to the Head deposits may be expected. A borehole located 600m south-west of the Site indicates that the London Clay formation extends to a depth of c. 30m and is underlain by Thanet Sand and at depth the White Chalk.

Figure 2-3 Superficial deposits



2.3.2. Hydrogeology

The Head Deposits are classified by the EA as a Secondary A aquifer, and the London Clay Formation is not classified as an Aquifer. The Head Deposits are classified as having 'Low' vulnerability. The Site is not within a source protection zone (SPZ).

2.4. Hydrology

The nearest key surface water feature is the Sarre Penn which lies 500m north of the Site. However, there is a drain following a shallow valley which starts within the Site's northern boundary and drains towards the Sarre Penn.

The Site falls within the Sarre Penn and River Wantsum Water Body. The water body achieved Moderate ecological status in 2022 and Failed Chemical in 2019 (although did not require assessment for chemical in 2022). There is low confidence on achieving the objective of Good ecological status by 2027 due to the significant adverse impact on current uses of the land that the required changes would have.

Hydrological descriptors for the Site are provided in Table 2-1.

Table 2-1 Hydrological point descriptors

Descriptor	Value
NGR	TR 17133 61615
BFIHOST19	0.327
PROPWET	0.21
SAAR6190	625 mm

3. Proposed Development

The Proposed Development comprises up to 127 dwellings with associated landscaping, open space, SuDS and works with access from Herne Bay Road and retained pedestrian access from Sweechgate. An illustrative masterplan of the proposed development has been supplied to Aqua Terra and is presented in Figure 3-1. More detailed plans are provided in Appendix D.

Figure 3-1 Illustrative masterplan



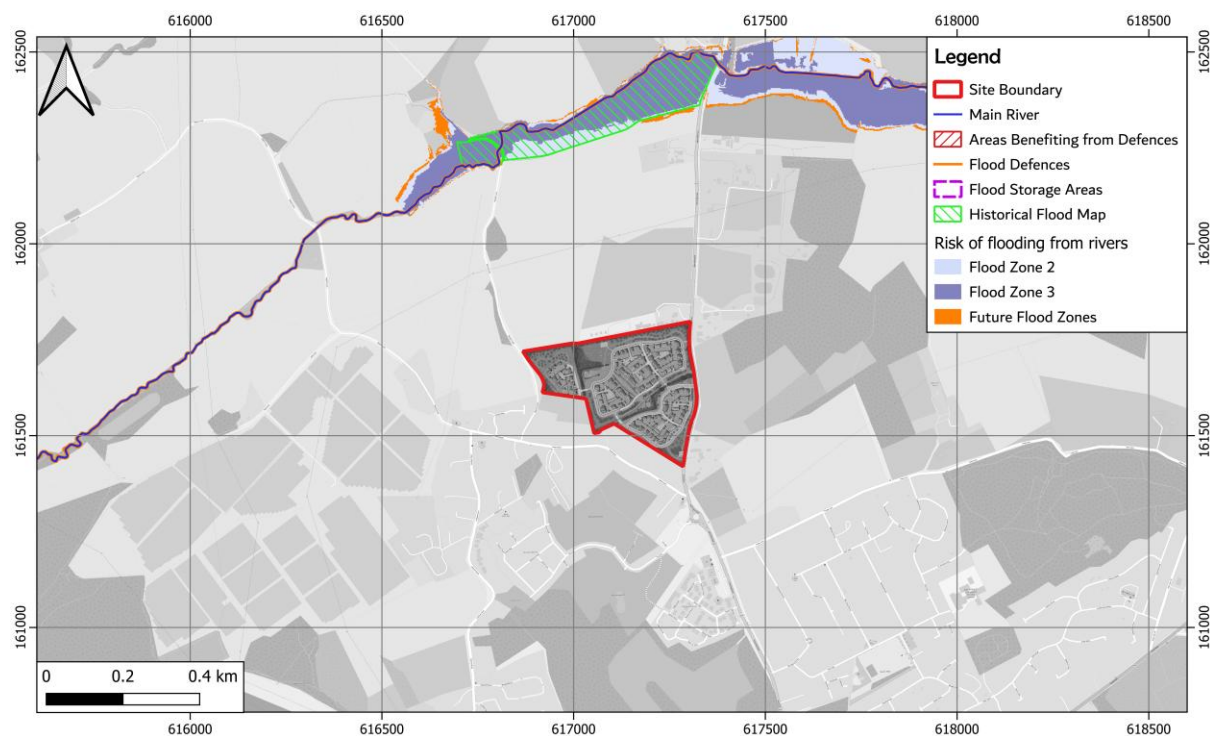
Source: Paul Hewett (December 2025)

4. Flood risk to the proposed development

4.1. Fluvial and tidal

The EA's Flood Map for Planning (see Figure 4-1) indicates that the Sarre Penn floodplain extends to the north of the Site, however not over the Site, and the Site is entirely within Flood Zone 1. The same remains true when the climate change is considered. The Site is therefore considered to be at very low risk of fluvial flooding both now and in the future.

Figure 4-1 Risk of Flooding from Rivers and Sea



4.2. Surface water

Surface water (pluvial) flooding is usually associated with extreme rainfall events but may also occur when rain falls on land that is already saturated or has a low permeability. Rainfall that is unable to infiltrate into the ground generates overland flow which can lead to flooding or 'ponding' in localised topographical depressions before the runoff is able to enter local drainage systems and watercourses.

The EA's Risk of Flooding from Surface Water (RoFSW) flood map, updated in February 2025 to account for climate change, is shown in Figure 4-2. Several areas at risk of surface water flooding are within the Site boundary. These include:

- The beginnings of a surface water flow path along the northern boundary of the Site which flows away from the Site towards Sarre Penn
- An area of ponding running west to east across a portion of the Site. This area is located on an elevated portion of the Site and does not appear to form a flow path. The proposed layout has been designed to avoid this area with built development limited to an access road crossing the area of ponding. Flood depth data (Figure 4-3) indicates that there is a low risk

of flood depths exceeding 0.2m (but very low/ negligible risk of exceeding 0.3m), and velocities are less than 0.25 m/s.

- A high risk flow path along the eastern boundary of the Site, which extends onto proposed residential roads, although not onto individual dwelling plots. Flood depths along the road are less than 0.2m and velocities under 0.25 m/s.
- The main access to the Site is within an area of low flood risk with depths less than 0.2m. Velocities along Herne Bay Road have a medium to low risk of exceeding 0.25m/s in the immediate vicinity of the access to the Site, however are shallow in depth (<0.2m) with lower flood risk to the north along Herne Bay Road than southwards towards Sturry.

Figure 4-2 Risk of Flooding from Surface Water

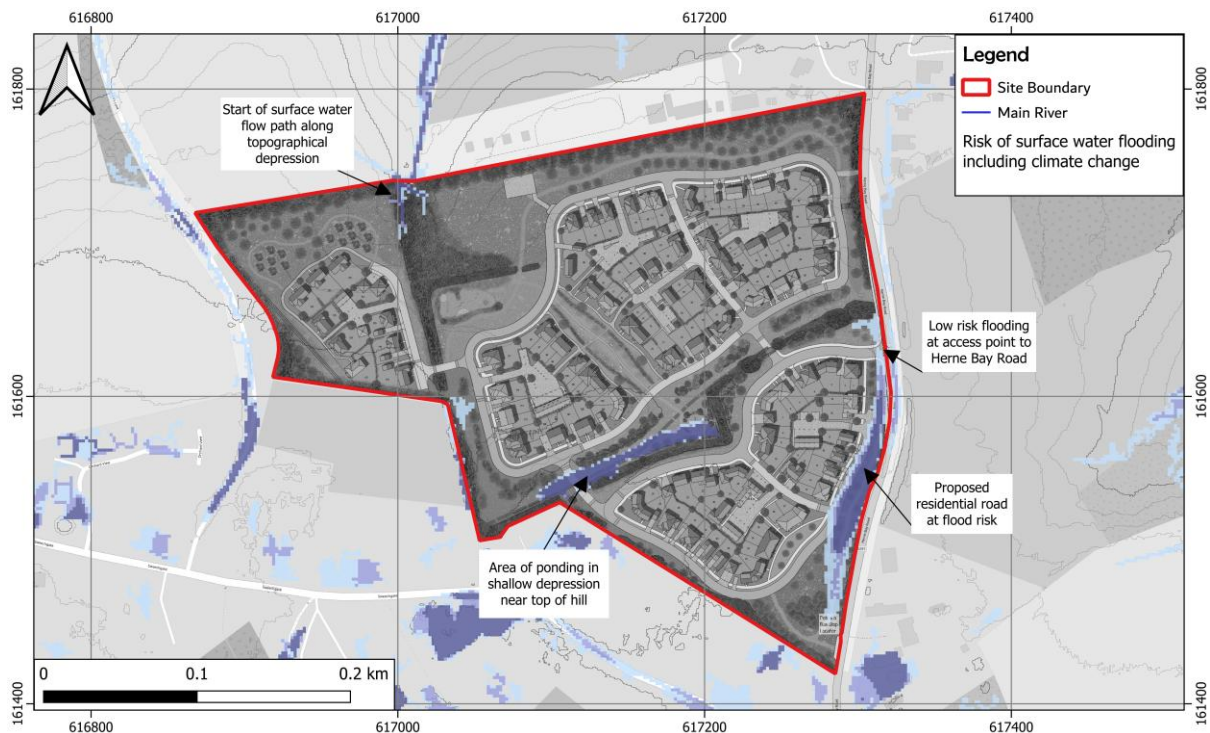
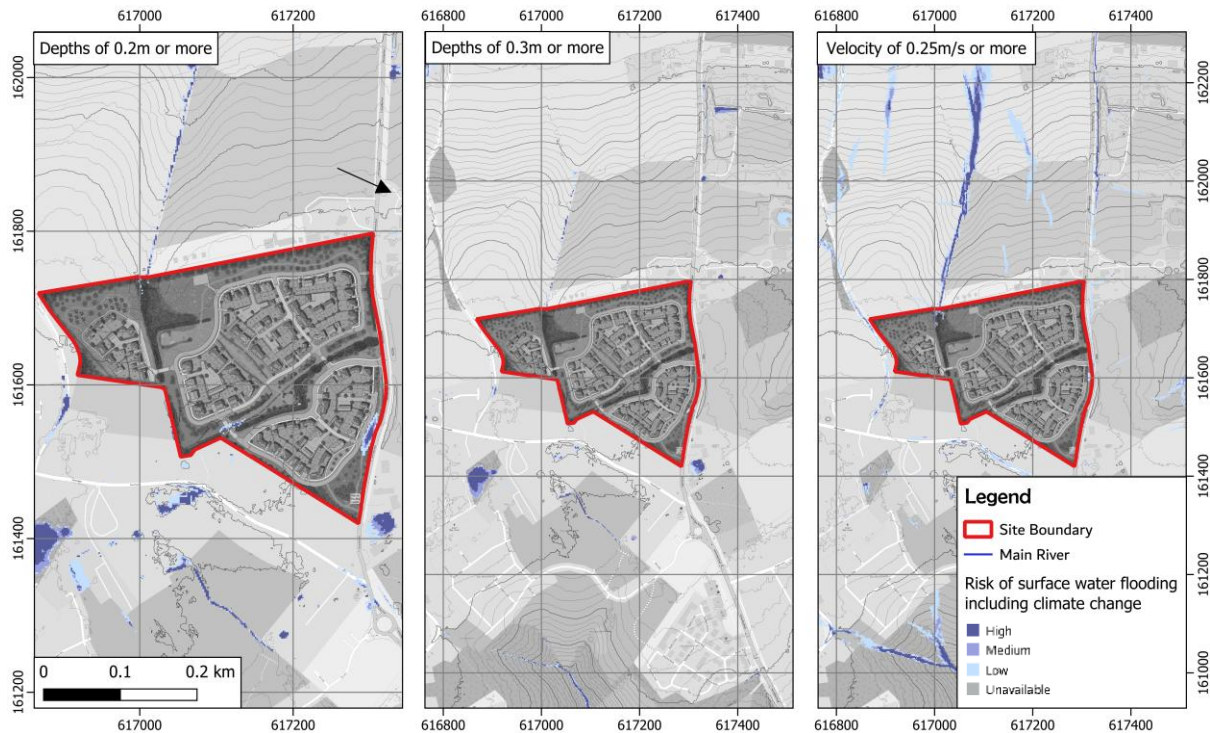


Figure 4-3 Surface Water Flood Risk (Depths > 0.2 and 0.3m and Velocity > 0.25m/s)



4.3. Groundwater

Groundwater flooding occurs when the water table rises above the surface elevation (or the floor of sub-surface structures).

The Kent Preliminary Flood Risk Assessment report provides a coarse resolution map depicting groundwater flood risk across the county. This shows the area near the Site to be at Negligible risk. This is supported by the elevated location of the Site compared to the Stour valley to the south and Sarre Penn to the north.

The Canterbury City Council Strategic Flood Risk Assessment also suggests that the Site is at low risk of flooding as it is not located within the Stour Valley (High risk) or sandstone areas to the south and east of the River Stour (Medium Risk).

4.4. Sewer flooding

Sewer flooding can occur during periods of intense rainfall and /or if a sewer becomes blocked with debris. The Kent Preliminary Risk Assessment does not provide any details of sewer flooding records, and no sewer network currently serve the Site. The Canterbury City Council Strategic Flood Risk Assessment includes an assessment of sewer flooding, however no specific mention is made of Sturry suggesting that reports of sewer flooding in the area are low – it is therefore considered that risk of sewer flooding on the Site is low.

4.5. Catastrophic failures

This section considers catastrophic failures of water bearing infrastructure in the area of interest. The data.gov.uk datasets suggest no risk of catastrophic flooding from reservoir failure within the proposed area for development.

4.6. Historical flooding

There are no recorded flood outlines for the area, although the EA historical flood map does indicate some past flooding of Sarre Penn (see Figure 4-1).

5. Flood Risk Mitigation Measures

5.1. Sequential test

The NPPF states that:

The sequential test should be used in areas known to be at risk now or in the future from any form of flooding, except in situations where a site-specific flood risk assessment demonstrates that no built development within the site boundary, including access or escape routes, land raising or other potentially vulnerable elements, would be located on an area that would be at risk of flooding from any source, now and in the future (having regard to potential changes in flood risk).

The proposed area for built development lies entirely within Fluvial Flood Zone 1 (low probability) now and in the future. The sequential approach has been applied to the layout of the Site by locating the most vulnerable elements (dwellings) outside of the surface water flood risk areas. Whilst some less vulnerable elements (such as residential roads) are within the surface water flood risk areas, the depths and velocities at these locations are low even during the extreme 0.1% AEP event (< 0.2m deep in all but one location which is under 0.3m and < 0.25m/s).

Herrington Consulting undertook a Level 2 Strategic flood Risk assessment for Canterbury City Council in 2022, which applied the Sequential test to 61 Sites within the Canterbury City Council region. Whilst the Proposed Development was not included within those 61 Sites, in line with the approach taken within that sequential test, 4% of the Site has been assessed to be at Low (or greater) risk of surface water flooding. This places the Site within the second group of assessed sites – defined as ‘Sites within Flood Zone 1 where ≤ 10% of the site is at risk of surface water flooding’.

The Level 2 SFRA states that:

“CC has provided details of 61 sites. Out of these sites, 6 sites have been identified to be situated in Flood Zone 1 and at ‘very low’ risk of flooding from surface water. An additional 25 sites have been identified in Flood Zone 1 where less than 10% of the site is shown to be at risk of flooding from surface water. Consequently, it is concluded that these sites can meet the requirements of the Sequential test and as a result, the Exception Test is not required”

It is therefore considered, given that the Site falls into the same category as that detailed above, the Site meets the requirements of the Sequential test, and no Exception Test is required.

To meet the PPG requirements, the proposed development will be considered appropriate in this location provided the following conditions are met:

- Remains safe in times of flooding whilst taking climate change into account;
- Does not result in a net loss of floodplain storage;
- Does not impede existing water flow pathways; and,
- Does not increase the volume and rate of surface water runoff leaving a site over its intended design lifetime.

5.2. Remain safe in times of flooding

During the design 1% AEP flood event, accounting for climate change – the only portions of the built development that are at flood risk are the residential road along the eastern boundary of the Site, and the link road linking the southern parcel to the central parcel. Depths of flooding in both locations are less than 0.2m and velocities <0.25m/s and flood hazard is < 0.75 representing ‘very low hazard’. Access to the Site from Herne Bay Road is flood free if heading northwards away from Sturry.

During the extreme 0.1% AEP flood event, accounting for climate change, flood hazard on the Site remains ‘very low’ with flood depths less than 0.3m and velocities < 0.25m/s. Access to the Site

during this event from Herne Bay Road is at flood risk with depths less than 0.2m and very low hazard.

Flood free pedestrian access is maintained during all events for the dwellings that front onto the road along the eastern boundary that is at flood risk, and a secondary flood free link road connects the southern parcel to the central parcel.

It is therefore considered that the Site will remain safe in times of flooding (including the extreme flood event), with flood free pedestrian access available to all dwellings, and 'very low hazard' vehicular access available to all dwellings.

5.3. No net loss of floodplain storage or impediment to flow paths

The proposed development will not result in a net loss of floodplain storage, or impede existing water flow pathways based on the very low risk from fluvial, tidal and surface water flooding.

It is not proposed to substantially change ground elevations along the eastern road boundary or the link road which are within the surface water flood extents. The link road will be constructed so as to allow surface water to pond over the road surface resulting in no loss of storage. Velocities are minimal (<0.25 m/s for all events) as the area at risk of flooding is not a well-defined flow path.

5.4. No increase in volume and rate of surface water runoff

The following stipulations are provided in the EA guidance for managing rainfall runoff:

- Stormwater runoff rates and volumes discharged from urban developments should approximate to the Site greenfield response over a range of storm frequencies of occurrence (return periods).
- Runoff for extreme events should be managed on-Site. This requires:
 - The peak rate of stormwater run-off to be limited.
 - The volume of run-off to be limited.
- The pollution load to receiving waters from stormwater runoff to be minimised.
- The assessment of overland flows and temporary flood storage across the Site.

Section 6 describes the drainage strategy for the Site, which is designed in such a way as to prevent an increase in runoff rates from the Site under a range of design storm scenarios. This includes suitable allowances for future increases in rainfall intensity caused by climate change.

Due to the impermeable ground conditions (based on London Clay bedrock) it has not been possible to limit the volume of run-off to greenfield volumes, however in line with the National standards for sustainable drainage systems (SuDS) runoff rates will be limited to the 50% AEP greenfield runoff rate (or 3 l/s/ha, whichever is greater) for all events up to and including the design event (1% AEP with 45% Climate change).

The Drainage Strategy also assesses measures for ensuring pollution load to receiving water courses from stormwater runoff are minimised and an assessment of overland flows and temporary flood storage across the Site.

6. Drainage Strategy

The NPPF stipulates that all new developments must be “safe, without increasing flood risk elsewhere”. The National Standards for Sustainable Drainage Systems (HM Government, 2025) expand on these principles by setting a clear hierarchy for runoff destinations and defining seven technical standards covering runoff control, management of everyday and extreme rainfall, water quality, amenity, biodiversity and consideration of structural design, construction and long-term maintenance.

The proposed drainage design is described under Section 6.1 with subsequent sections covering each of the 7 standards that are required to be demonstrated for all SuDS schemes. Appendix E provides a plan of the proposed drainage scheme.

6.1. Proposed Drainage Design

A SuDS Strategy has been drafted and includes at source controls through porous paving acting as attenuation storage along the low traffic roads and communal parking areas. The southern and eastern catchments then drain via a stepped swale running along the eastern and northern boundaries to a larger detention basin in the north west of the Site. The central and western catchments each drain to smaller basins which then outflow to the larger attenuation basin. The larger attenuation basin will discharge at the 50% AEP greenfield runoff rate for all storm events up to the design event to a drain located on the northern boundary of the Site which flows northwards towards the Sarre Penn.

The swales and drainage basins will for the most part remain dry and will be incorporated into landscaping proposals for ‘play on the way’ features and open mown areas for informal recreational purposes.

6.1.1. Assessment of catchment areas

The Site has been split into catchments (see Figure 6-1) based on topography and the layout of the development. The positively drained area for each sub-catchment has been calculated as follows:

Positively drained area = Public adoptable areas (such as roads, footpaths) +
 1.1* Private non-adoptable areas (roofs, driveways and paths) +
 Footprint of key Suds features (such as detention basins) +
 0.3*Remaining greenfield area (excluding large open public areas) +

This ensures that urban creep (at 10%) is accounted for in non-adoptable impermeable areas, and an allowance for greenfield runoff that may be intercepted by the drainage network. Figure 6-2 shows the proposed adoptable and non-adoptable areas on Site, along with proposed permeable paving (located only on adoptable areas). Some minor paths have been assumed to be constructed with permeable surfacing and have not been further included within the drainage assessment.

Roads that are risk of surface water flooding have not been assumed to be constructed of porous paving, as any potential storage could be flooded by runoff from off-site.

Appendix F provides details of how the positively drained area has been calculated for each catchment. ReFH2 hydrographs representing the greenfield areas have been applied to each catchment upstream of respective key SuDS features.

The total positively drained area for the Site is 5.05 ha

Figure 6-1 Urban catchments

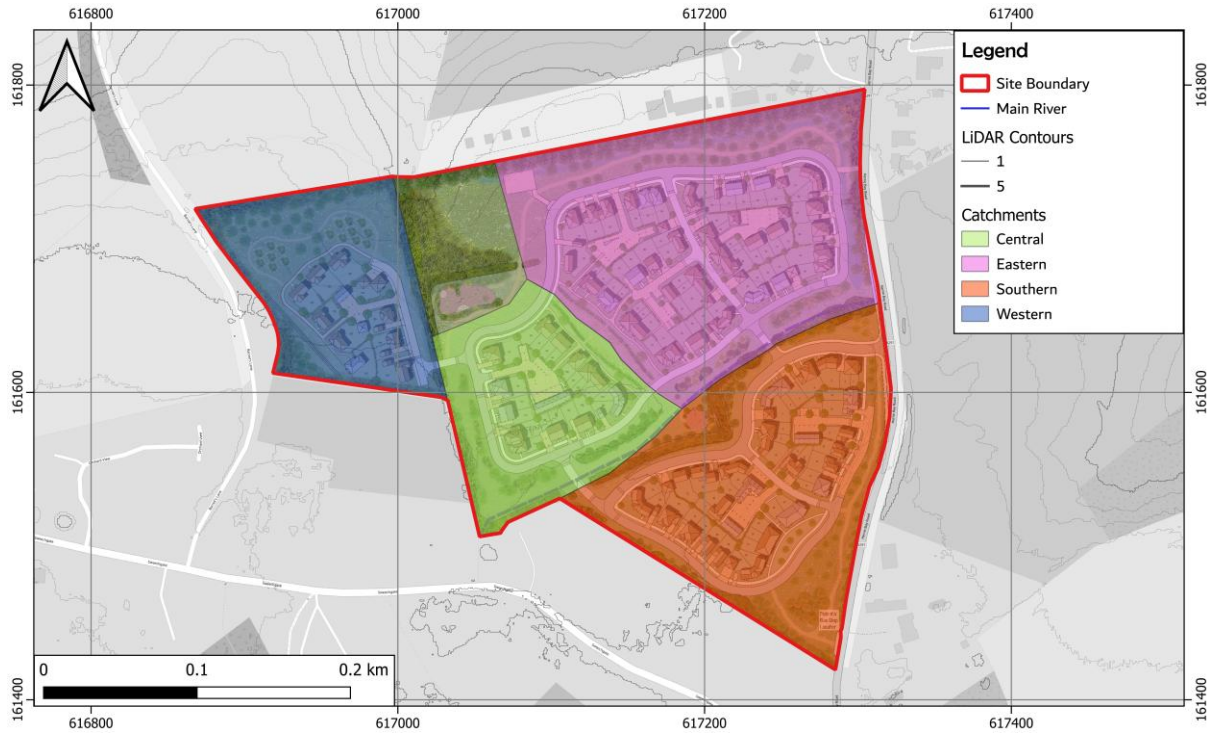


Figure 6-2 Adoptable and non-adoptable areas on Site



6.1.2. Proposed storage and control elements

Porous paving has been proposed for low traffic roads and communal parking areas (as indicated in Figure 6-4). Areas of porous paving have been assumed to have a 35% porosity and a depth of 0.6m. Orifices have been used as flow controls on the porous paving areas to limit flow rates passing onto downstream detention basins. At this stage in the design, porous paving areas have been amalgamated and therefore the orifice dimensions presented in the hydraulic calculations may not be representative of what will be required when areas of porous paving are sub-divided to enable stepped storage areas accounting for the slope of the Site. As part of the detailed design orifices smaller than 0.05m in diameters must be robustly protected from blockage risk as per the National SuDS Standards. It is proposed that the porous paving could be left un-lined to allow any potential infiltration to occur. Infiltration is however likely to be limited due to the London Clay underlying the Site and no infiltration has been assumed within the calculations.

The stepped swale along the eastern boundary of the Site has 1:4 side slopes, a depth of 0.8m and top width of 9m. The swale will include low flow orifices and overflow weirs to maximise attenuation potential whilst ensuring the swale can drain affectively following an event.

The swale along the northern boundary has 1:4 side slopes, a depth of 1.2m and an average width of 15m. It is anticipated that a low flow channel will be meandered into the swale to provide additional interest. This will be further designed during detailed design.

The individual basins for the western and central catchments are 1.5m deep with 1:3 side slopes. They are controlled by orifices which discharge to the larger attenuation basin in the north of the Site.

The attenuation basin in the north of the Site receives discharge from the western and central basins and the swale along the eastern boundary. The basin has a depth of 2m and 1:3 side slopes. Outflow from the basin is controlled by Hydrobrake (or similar) to limit discharge to the 50% AEP greenfield runoff rate. Some additional re-profiling will be required upslope of the basin to lower ground levels to the top of basin level. On the downslope of the basin a raised embankment to retain the flow will be required.

As the layout plans for the Site progress, the required storage could be distributed over additional features such as rain gardens or tree pits adjacent to the larger roads to comprise a "SuDS train" within the Site.

Figure 6-3 details the location and key properties of SuDS features. A detailed assessment of outfall invert levels has been undertaken in Section 6.2.3. Details of the modelled scheme in the form of a Causeway Flow report are provided in Appendix G.

Figure 6-3 Properties of key SuDS features



6.1.3. Performance calculation parameters

Causeway Flow has been used to model the proposed drainage design using a source control approach – therefore not all details have been provided but rather the model has been used to confirm that the overall storage provision on Site is sufficient.

For each sub-catchment four inflows have been considered:

1. Rainfall landing directly on porous paving areas, and an equal contribution from neighbouring impermeable surfaces (such as residential roofs). This is routed to the swale / detention basins via a porous paving storage unit.
2. Rainfall landing on remaining impermeable surfaces that have not been assumed to be able to be routed via a porous paving storage unit. This is routed direct to the swale / detention basin
3. Rainfall landing directly on swale / detention basin
4. A ReFH2 hydrograph routed direct to the swale / detention basin representing runoff from 30% of the permeable surfaces within the catchment.

The assumption that each porous paving area can accept up to an equal contribution from adjacent impermeable surfaces is considered acceptable at the outline drainage stage.

Key model parameters are as follows:

- Model run for the 50%, 3.3% and 100% AEP events with a 40% and 45% allowance for climate change for the 3.3% and 100% AEP events respectively, representing the upper end peak rainfall climate change allowance for the Stour Management Catchment
- FEH22 rainfall profiles used, with full range of storm durations from 15 minutes to 4,320 minutes
- Volumetric runoff coefficient set to 1 for both winter and summer storms to represent capture of all runoff from impermeable surfaces

- No infiltration has been assumed for any of the SuDS features

The results from the modelling are presented under the relevant standards, with a detailed output report from Causeway Flow presented in Appendix G.

6.1.4. Feasibility of design

Whilst the performance calculations undertaken provide a simplified representation of the proposed drainage system, in particular with reference to the exclusion of the piped network and relevant invert / cover levels, slopes across the Site are sufficient that a gravity fed system should be possible across the Site and no pumping has been proposed. Figure 6-4 details likely cover levels along proposed drainage routes based on topography, and proposed invert levels for basins and outfalls to demonstrate that the design is feasible. Further assessment of the proposed outfall locations is presented in Section 6.2.3.

Figure 6-4 Proposed cover levels and basin invert / outfall levels



6.2. Standard 1: Runoff Destinations

Surface water runoff must be disposed of according to a hierarchy of destinations as follows:

- Priority 1: collected for non-potable use
- Priority 2: Infiltrated to ground
- Priority 3: Discharged to an above ground surface water body
- Priority 4: Discharged to a surface water sewer, or another piped surface water drainage system
- Priority 5: Discharged to a combined sewer

The suitability of each of these options is discussed below.

6.2.1. Water re-use

Water re-use (i.e. the use of water butts or more sophisticated tank systems to capture rainwater for re-use) could be implemented at the Site. These sites collect water from clean surfaces (such as rooftops) for (generally non-potable) use on Site.

Rainwater harvesting is particularly useful at Sites with a low infiltration potential and limited space for attenuation features. It also has wider sustainability benefits with regards to lowering the water supply demand. It is anticipated that water re-use will be incorporated as part of the detailed drainage design however they have not been included in the outline strategy to ensure the system has sufficient capacity. Rainwater harvesting will also be necessary to ensure everyday rainfall is managed – this is further discussed in Section 6.3.

6.2.2. Infiltration to ground

The entire of the Site is underlain by London Clay, and therefore whilst infiltration testing has not been undertaken at the Site it is highly unlikely that infiltration would be a viable runoff destination.

SuDS features will be left un-lined to maximise any limited infiltration potential on the Site however the current assessment has assumed no infiltration in order to ensure that storage features are suitably sized.

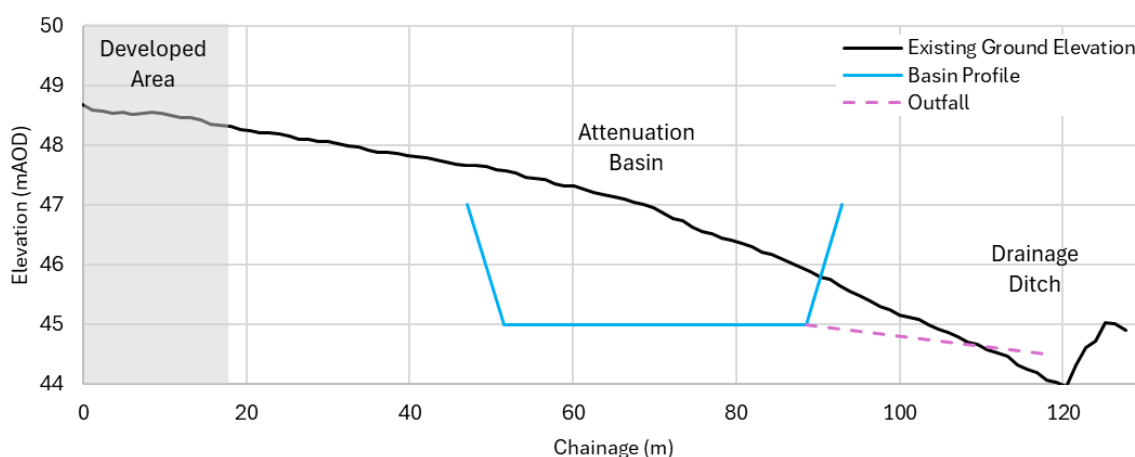
6.2.3. Discharge to surface water body

Discharge of runoff at restricted rates to the drain located along the northern boundary of the Site is a feasible destination for surface runoff from the Site. A condition survey of the stream should be undertaken to confirm that water can freely flow within the stream without obstruction.

Figure 6-5 provides a cross-section profile through the main attenuation basin to demonstrate that the proposed elevations for the basin will allow discharge to the drain, and it is unlikely that surcharging of the outfall will result in significant reduction in outflow from the basin as the natural bank level of the ditch is similar to the invert level of the basin. Therefore levels at the outfall are unlikely to rise significantly above the invert level of the basin.

Any connection to the drain may require Ordinary Watercourse Consent.

Figure 6-5 Cross-section profile through attenuation basin



6.2.4. Discharge to surface water drains and/or combined drain

Given the likely feasibility of discharging to a surface water body, this option would unlikely be used in this instance.

6.3. Standard 2: Management of everyday rainfall

Drainage schemes should ensure that at least the first 5mm of rainfall for the majority of rainfall events does not result in runoff from the site to surface waters or piped drainage systems. Runoff from positively drained surfaces, for at least 5mm of rainfall must either be collected for use, infiltrated into the ground, or else captured, conveyed and stored within SuDS features where these features will naturally absorb or retain runoff and therefore not discharge off the Site.

Due to infiltration not being possible / extremely limited on Site, managing the first 5mm of rainfall through infiltration alone is not possible.

The National SuDS standards state that compliance with standard 2 can be assumed for unlined permeable surfaces, for all soil types, which drain an adjacent impermeable area if the additional impermeable area is no greater than the permeable area. This is a constraint that has been used within the drainage design and therefore all flow draining via the porous paving features is deemed to be compliant.

Swales with a longitudinal gradient of less than 1:100 with at least 500mm of suitable base material, and detention basins are suitable for interception for impermeable areas up to 5 times the base of the vegetated surface area receiving the runoff, whether lined or unlined. Therefore the swales around the eastern and northern boundaries and the detention basins will contribute to managing everyday rainfall.

Table 6-1 summarises the assessment of management of everyday rainfall for the remaining surfaces that do not drain to porous paving. The swales have been assumed to serve the southern catchment and the main detention basin the eastern catchment (as flow from the eastern catchment may not reside for long enough within the swale before discharging to the detention basin). This demonstrates that the proposed features are sufficient for managing every day rainfall, however the detailed design should ensure that the detention basins do not include specific provisions for routing low flows directly to the outlet.

Table 6-1 Management of everyday rainfall

Catchment	Impermeable surfaces not draining to porous paving (m ²)	Detention basin surface area (at base level) (m ²)	Swale vegetated area (m ²)	5 x Detention Basin and swale area (m ²)	Residual 'non-compliant' surface area
Southern	3047	N/A	1340 ¹	6700	None
Eastern	2542	1075	N/A	5375	None
Central	400	100	N/A	500	None
Western	533	150	N/A	750	None

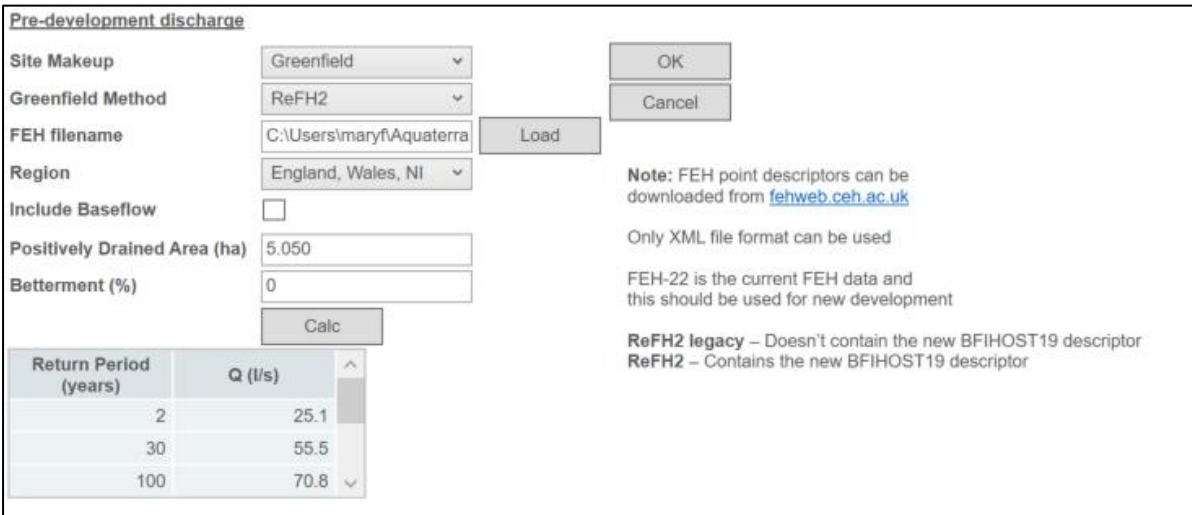
¹ 4 swale sections along the eastern boundary each with length 25m and bottom width 2.6m, and two swale sections along the northern boundary each with length 100m and bottom width 5.4m.

6.4. Standard 3: Management of extreme rainfall and flooding

6.4.1. Greenfield runoff rates and volumes

The total positively drained area for the Site is 5.05 ha. The ReFH2 method (Using FEH22 rainfall model) has been utilised to estimate the greenfield runoff rates for the Site (see Figure 6-6).

Figure 6-6 Greenfield Runoff Rates



Pre-development discharge

Site Makeup: Greenfield (dropdown) [OK] [Cancel]

Greenfield Method: ReFH2 (dropdown)

FEH filename: C:\Users\maryf\Aquaterra [Load]

Region: England, Wales, NI (dropdown)

Include Baseflow: ☐

Positively Drained Area (ha): 5.050

Betterment (%): 0 [Calc]

Note: FEH point descriptors can be downloaded from fehweb.ceh.ac.uk

Only XML file format can be used

FEH-22 is the current FEH data and this should be used for new development

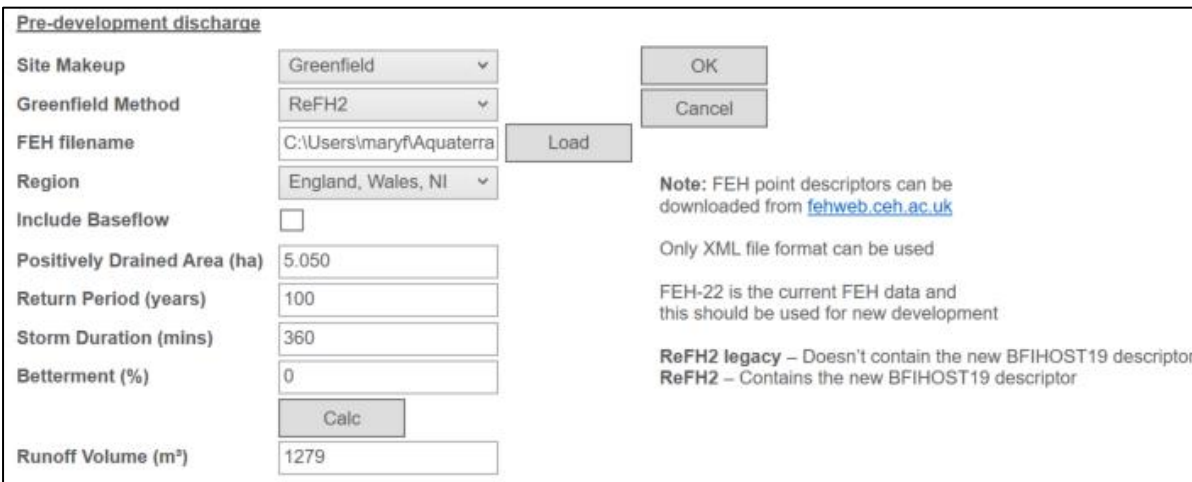
ReFH2 legacy – Doesn't contain the new BFIHOST19 descriptor
ReFH2 – Contains the new BFIHOST19 descriptor

Return Period (years)	Q (l/s)
2	25.1
30	55.5
100	70.8

Due to infiltration not being feasible on the Site, the volume of runoff discharged from the proposed development for the 1% AEP, 6 hour rainfall event will be greater than the volume of greenfield runoff for the same rainfall event. Therefore the peak allowable discharge rate from the development for all events up to and including the 1% AEP with Climate change is the 50% AEP greenfield runoff rate (25.1 l/s) based on the National Standards for SuDS.

The Greenfield runoff volume for the Site for the 1% AEP, 6 hour storm duration event has also been calculated and is presented in Figure 6-7.

Figure 6-7 Greenfield Runoff Volume



Pre-development discharge

Site Makeup: Greenfield (dropdown) [OK] [Cancel]

Greenfield Method: ReFH2 (dropdown)

FEH filename: C:\Users\maryf\Aquaterra [Load]

Region: England, Wales, NI (dropdown)

Include Baseflow: ☐

Positively Drained Area (ha): 5.050

Return Period (years): 100

Storm Duration (mins): 360

Betterment (%): 0 [Calc]

Note: FEH point descriptors can be downloaded from fehweb.ceh.ac.uk

Only XML file format can be used

FEH-22 is the current FEH data and this should be used for new development

ReFH2 legacy – Doesn't contain the new BFIHOST19 descriptor
ReFH2 – Contains the new BFIHOST19 descriptor

Runoff Volume (m³): 1279

6.4.2. Performance assessment

The principal SuDS features have been modelled using Causeway Flow software to ensure there is sufficient storage volume within the system and discharge rates can be limited to the 50% AEP greenfield runoff rates.

Table 6-2 and Table 6-3 summarise the model results at the SuDS features for the 3.3% AEP +40% and 1% AEP + 45% scenarios. This confirms that, based on the parameters described above, the proposed drainage scheme will be able to attenuate and discharge runoff to greenfield runoff rates for both scenarios.

Detailed model outputs are provided in Appendix F. It should be noted that the model aims to only replicate the key storage features within the proposed scheme.

Table 6-2 Summary of 1 in 30 year + 40% climate change model results

Feature name	Critical storm	Peak water depth (m aOD)	Peak outflow (l/s)	Flood Risk Status
Southern Porous Paving (S PP)	360 Min: Summer	0.425	11.9	Surcharged
Eastern Porous Paving (E PP)	240 Min: Winter	0.913	13.9	Surcharged
Central Porous Paving (C PP)	240 Min: Winter	0.819	6.6	Surcharged
Western Porous Paving (W PP)	180 Min: Winter	0.672	4.2	Surcharged
Eastern Swale (Swale 4)	720 Min: Summer	0.974	43.9	OK
Northern Swale (Swale 6)	2880 Min: Summer	0.941	35.7	Flood Risk
Central Basin	960 Min: Summer	0.993	8.0	Surcharged
Western Basin	720 Min: Winter	0.811	6.1	Surcharged
Attenuation Basin	2880 Min: Summer	0.805	25.0	Surcharged
Total Discharge			25.0	

Table 6-3 Summary of 1 in 100 year + 45% climate change model results

Feature name	Critical storm	Peak water depth (m aOD)	Peak outflow (l/s)	Flood Risk Status
Southern Porous Paving (S PP)	960 Min: Summer	0.973	19.1	Flood Risk
Eastern Porous Paving (E PP)	960 Min: Summer	1.090	15.3	Surcharged
Central Porous Paving (C PP)	960 Min: Summer	1.012	7.4	Surcharged
Western Porous Paving (W PP)	960 Min: Summer	0.813	4.6	Surcharged

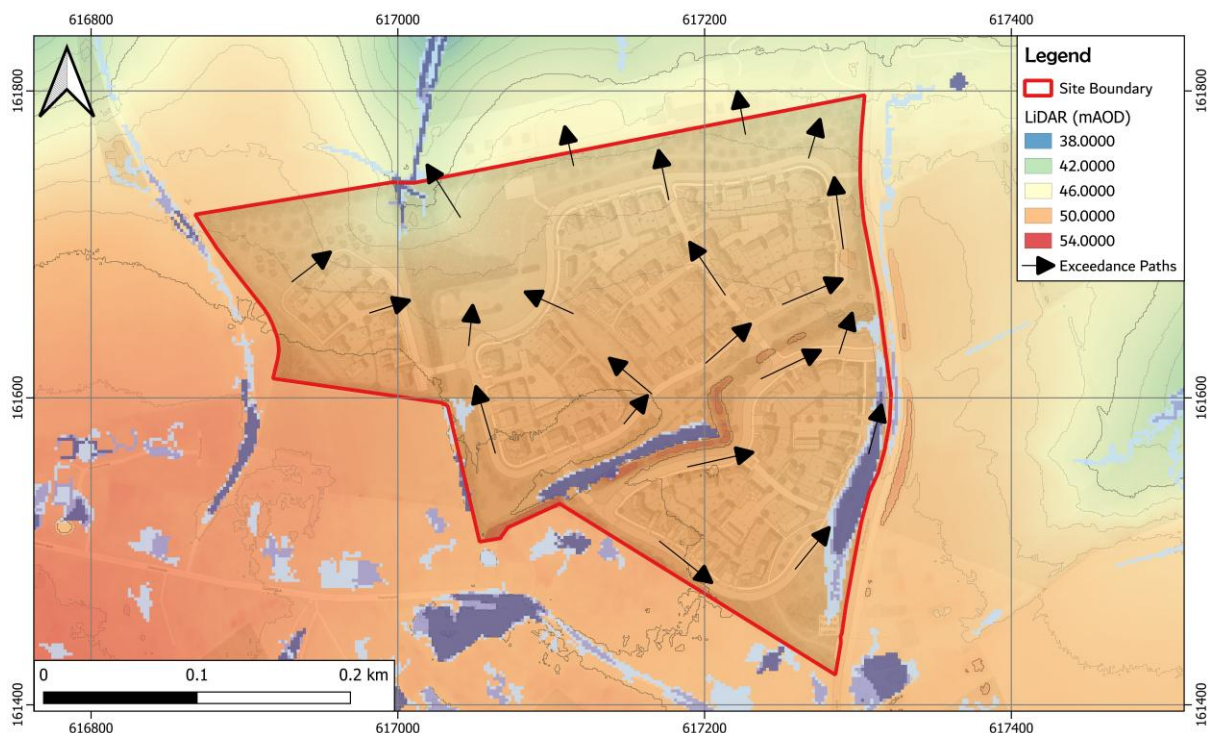
Feature name	Critical storm	Peak water depth (m aOD)	Peak outflow (l/s)	Flood Risk Status
Eastern Swale (Swale 4)	2880 Min: Summer	1.085	40.0	OK
Northern Swale (Swale 6)	2880 Min: Summer	1.185	82.7	Flood Risk
Central Basin	1440 Min: Summer	1.467	9.8	Flood Risk
Western Basin	2160 Min: Summer	1.342	7.2	Flood Risk
Attenuation Basin	2880 Min: Summer	1.984	25.0	Flood Risk
Total Discharge			25.0	

6.4.3. Exceedance flow paths

Whilst the strategy has aimed to ensure no flooding during the extreme 1 in 100 year + 45% climate change scenario, there is always a residual risk that flooding may occur for example due to more extreme events or blockage of structures. Under these conditions, exceedance flows will be designed to follow the existing preferential surface water flow paths towards the north of the Site, via the road network. Raised kerbs or bunds will be created along roads to direct flows where required. Flow will be directed away from the main access roads, and where already on the road, directed towards the nearest downslope green space to ensure that safe access is maintained for emergency services.

Very high level exceedance flow directions are illustrated in Figure 6-8 based on topographic data. A more detailed analysis of exceedance flows will be undertaken during as part of the detailed drainage strategy.

Figure 6-8 Exceedance flow routes



6.5. Standard 4: Water Quality

SuDS techniques can be used to effectively manage the quality of surface water flowing across a site. Different methods can be used to intercept pollutants and allow them to degrade or be stored in-situ without impacting the quality of water further downstream. Frequent and short duration rainfall events are those that are most loaded with potential contaminants (silts, fines, heavy metals and various organic and inorganic contaminants). Therefore, the first 5mm to 10mm of rainfall (i.e. the 'first flush') should be adequately treated using SuDS.

The proposed development will primarily consist of residential dwellings, low traffic roads and driveways. The CIRIA SuDS manual categorises runoff from residential dwellings as presenting a very low water quality hazard and runoff from low usage roads and residential driveways as presenting a low hazard rating (see Table 6-4).

Table 6-4 Water quality hazard ratings (CIRIA, 2015)

Land use	Hazard level
Residential roof drainage	Very low
Residential, amenity uses including low usage car parking spaces and roads, other roof drainage . Non-residential car parking with infrequent change (<e.g. schools, offices, i.e. < 300 traffic movements/day)	Low
Commercial uses including car parking spaces and roads (e.g. hospitals, retail, excluding low usage roads, trunk roads and motorways)	Medium
Sites with heavy pollution (e.g. haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemical and fuels (other than domestic fuel oil) are delivered, handled, stored used or manufactured, industrial sites	High
Trunk roads and motorways	High

The CIRIA SuDS manual (CIRIA, 2015) advocates a qualitative approach to designing a SuDS scheme for a site with a low hazard rating. This should provide adequate controls on pollutants contained in runoff water.

As the proposed development is predominantly residential in nature with a low hazard rating, hazard indices of 0.5 for Total Suspended Solids (TSS), 0.4 for Metals and 0.4 for Hydrocarbons are considered applicable.

The measures detailed in Table 6-5 are examples which are suitable for inclusion in a drainage strategy for a residential development to mitigate a potential increase in pollutant load within on-site and off-site runoff – note text in bold are measures included in this SuDS Strategy. Removal indices are included for each feature type relative to the specific pollutant.

Table 6-5 Mitigation indices for SuDS components

Component type	TSS	Metals	Hydrocarbons
Filter drain	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Permeable paving	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond	0.7	0.7	0.5

The inclusion of detention basins within the SuDS strategy for the Site will provide adequate treatment to mitigate the low hazard associated with runoff from the development provided all runoff flows through a detention basin (as per the outline strategy), and most runoff will pass additionally pass through either permeable paving and/or pass via the proposed swales.

Sediment traps (i.e. sumps within the inspection chambers of the final manhole upstream of each feature) will be used to facilitate the maintenance of these SuDS features and reduce the build-up of potentially polluted material.

6.6. Standard 5 & 6: Amenity and Biodiversity

SuDS schemes present opportunities to enhance habitat for wildlife on-site and this often improves the biodiversity of the surrounding areas. Ponds, constructed wetlands and other surface water features are landscape assets that have amenity value and improve the aesthetics of a site more than conventional drainage systems.

The use of swales and grassed detention basins will enhance the biodiversity and amenity value of the Site post-development. Ecological diversity should be enhanced by the use of native planting within/around each feature. There is also potential to incorporate 'Play on the Way' features into the Swale which runs alongside a pedestrian path. The detailed drainage strategy will provide further details on how planting and natural play areas will be incorporated into the drainage design to maximise the amenity and biodiversity potential.

6.7. Standard 7: Design of drainage for construction, operation, maintenance, decommissioning and structural integrity

The Construction (Design and Management) Regulations 2015 include requirements for designers to take account of the health and safety risks associated with the construction, operation and maintenance and decommissioning of the drainage system to minimise these risk as far as reasonably practicable.

SuDS features should be built and operated in accordance with guidance outlined in the CiRIA SuDS Manual.

The drainage design can be delivered as a gravity fed system which reduces the reliance on mechanical systems and the cost of operation.

6.7.1. Maintenance Schedules

Inspection and long-term maintenance of SuDS components ensure efficient operation and prevents failure. Management of the surface water drainage system will be undertaken by a Management Company.

This section outlines the maintenance and management schedules for the proposed drainage system. The schedules have been formulated in line with guidelines contained within the CIRIA SuDS Manual (CIRIA, 2015). There are three categories of maintenance activities referred to in this report, although not all are required for each SuDS feature:

- **Regular maintenance** – tasks which are required to be undertaken on a weekly or monthly basis, or as required.
- **Occasional maintenance** – tasks which are required to be undertaken periodically, typically at intervals of three months or more.
- **Remedial maintenance** – tasks which are not required on a regular basis but are done when necessary.

This section is intended to give an overview of the operation and maintenance for the range of drainage features included within the surface water drainage strategy and in relation to typical/standard details only.

Maintenance schedules for the proposed SuDS components are provided in the following tables. These schedules are not exhaustive and should be reassessed at regular intervals to determine if any additional maintenance requirements are required to preserve the performance and condition of the drainage system.

Table 6-6 Maintenance for pipes and manholes

Maintenance schedule	Required action	Frequency
Regular maintenance	Remove any accumulation of silt, sediment, leaves and debris etc	Monthly, or as required
	Inspect for evidence of poor operation	Monthly (during the first year), then half yearly
Occasional maintenance	High pressure water jet removal of silt build-up and avoid blockages, particularly at bends or changes in direction	Six monthly, or as required
	Remove or control tree roots where they are encroaching pipe runs, using recommended methods	As required
Remedial actions	Clear pipework and gully grates of blockages	As required
	Replace any damaged or failed pipes, gullies or manholes	As required

Table 6-7 Maintenance for pervious pavements

Maintenance schedule	Required action	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 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	As required

Maintenance schedule	Required action	Frequency
	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	
	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

Table 6-8 Maintenance for swales

Maintenance schedule	Required action	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 as 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

Maintenance schedule	Required action	Frequency
Remedial actions	Repair erosion or other damage by re-turfing or reseed	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 stripe	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

Table 6-9 Maintenance for detention basins

Maintenance schedule	Required action	Frequency
Regular maintenance	Remove any accumulation of silt, sediment, leaves and debris etc	Monthly, or as required
	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), or 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
	Check any penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
Occasional maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from outlets, forebays and main basin when required	Every 5 years, or as required
Remedial actions	Repair erosion or other damage by reseed or re-turfing	As required
	Realignment of rip-rap	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required

Table 6-10 Maintenance for control devices

Maintenance schedule	Required action	Frequency
Regular maintenance	Inspect/check pipework to ensure that the flow control is in good condition and operating as designed	Monthly
	Inspect for evidence of poor operation	Monthly, or as required
Occasional maintenance	High pressure water jet removal of silt build-up	Six monthly, or as required
Remedial actions	Clear pipework of blockages	As required
	Replace the flow control if it becomes damaged	As required

6.8. Further SuDS considerations

The detailed design strategy should include:

- Consideration of rainwater harvesting options to promote re-use of water.
- Additional small scale feature such as property level swales and tree pits / rain gardens within communal parking areas to form a SuDS train and provide additional amenity and biodiversity benefits
- Assessment of individual porous paving areas, and respective additional contributing areas, with stepped sub-base to ensure minimal slope across each area.
- Means of ensuring that small orifices (< 0.05 diameter) are robustly protected from blockage.

7. Foul Drainage

Foul water from the proposed development will be managed through a private treatment plant which treats the effluent and discharges to the drain located along the northern boundary of the Site.

The plant has been designed to remove the need to connect foul water to the main drainage sewers which would create an increase in nutrients (phosphate) and thereby to pose a potential risk to the water environment along the River Stour and at the Stodmarsh Lakes (Special Protection Area (SPA), Ramsar site, Special Area of Conservation (SAC) and a Site of Special Scientific Interest (SSSI)).

British Water Flows & Loads Criteria were used to size the treatment plant as summarised below:

127 units = 635 population + 20% contingency

Total assumed (worst case) population of 800, factored down by 0.8 as per British Water Flows & Loads Criteria = **640**

Using the above a private plant was sized as follows:

Population equivalent	Flow (per head)	Flow (total)	BOD (per head)	BOD (total)	Ammonia (per head)	Ammonia (total)
640	150	96,000	60	38,400	8	5,120

The quality of the final treated has been calculated as follows:

Effluent Quality	
BOD	20mg/l
Total suspended solids	30mg/l
Ammonia	20mg/l
Phosphate	1-2mg/l
Nitrate	18mg/l

If required, a connection to the public foul sewerage network is possible but this would likely require an assessment of nutrients and suitable off-set provided in terms of credits.

To support this alternative, a capacity check is underway with Southern Water the statutory undertaker responsible for foul water drainage services.

Sewer Asset plans from Southern Water (see Appendix C) indicate that there is a foul rising main along Herne Bay Road, and a manhole (3701) located to the north-east of the Site to which it should be possible to discharge under gravity for the majority of the Site.

A formal S106 application will be required to be completed and approved by Southern Water prior to a connection being made. No surface water will be discharged into the foul sewer network.

8. Conclusions

The Proposed Development for up to 127 dwellings on a parcel of land west of Herne Bay, lies within an area of overall low flood risk. The Site is not at risk of fluvial or tidal flooding now or in the future. Risk of flooding from groundwater, sewers and catastrophic flooding is also very low. There is some risk of surface water flooding of the Site, extending over 4% of the total Site area.

The proposed development is classified as 'More Vulnerable' with regards to flood risk, and all dwellings are located outside of areas of surface water flooding. Where surface water flooding is present on the Site extending over low traffic roads, hazard levels are 'very low' for all events including the extreme 0.1% AEP with climate change. Dry pedestrian access can be had to all dwellings at all times.

The Site will remain safe from flooding through the implementation of SuDS to ensure no increase in runoff rates from the Site.

A drainage strategy has been prepared for the Site which proposed discharge to a ditch along the northern boundary of the Site which drains to Sarre Penn further to the north. Attenuation is provided on Site via porous paving on low traffic roads, a swale along the eastern and northern boundaries of the Site, and several attenuation basins in the north of the Site. Discharge at the 50% AEP greenfield runoff rate is proposed for all events up to the design 1% AEP with climate change event.

Performance calculations to assess the storage requirements have demonstrated that the design can limit discharge to the 50% AEP greenfield runoff rate for both the 3.33% and 1% AEP events with climate change. The Site is not expected to require significant land raising / lowering to accommodate a gravity driven drainage system as there is a suitable gradient over the Site.

The detailed design will consider the use of rain water harvesting to maximise re-use of water and minimise runoff. The detailed design will also explore the potential to incorporate 'Play on the Way' features into the Swale which runs alongside a pedestrian path.

A foul drainage capacity check is underway with Southern Water and there is a foul sewer manhole to the north-east of the Site to which the majority of the Site should be able to discharge to under gravity.

9. References

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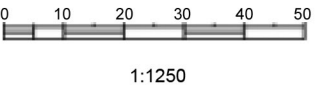
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WARNING: BAC pipes are constructed of Bonded Asbestos Cement.

WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement.

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Heme Bay Road	





— Prow CB69

Fairfax

FAIRFAX LAND VENTURES LTD

project:

LAND WEST OF:

HERNE BAY ROAD
STURRY

title:

ILLUSTRATIVE MASTER PLAN

date: Dec '25

scale: 1:1250 @ A1

drawing number:
2504/PL.08

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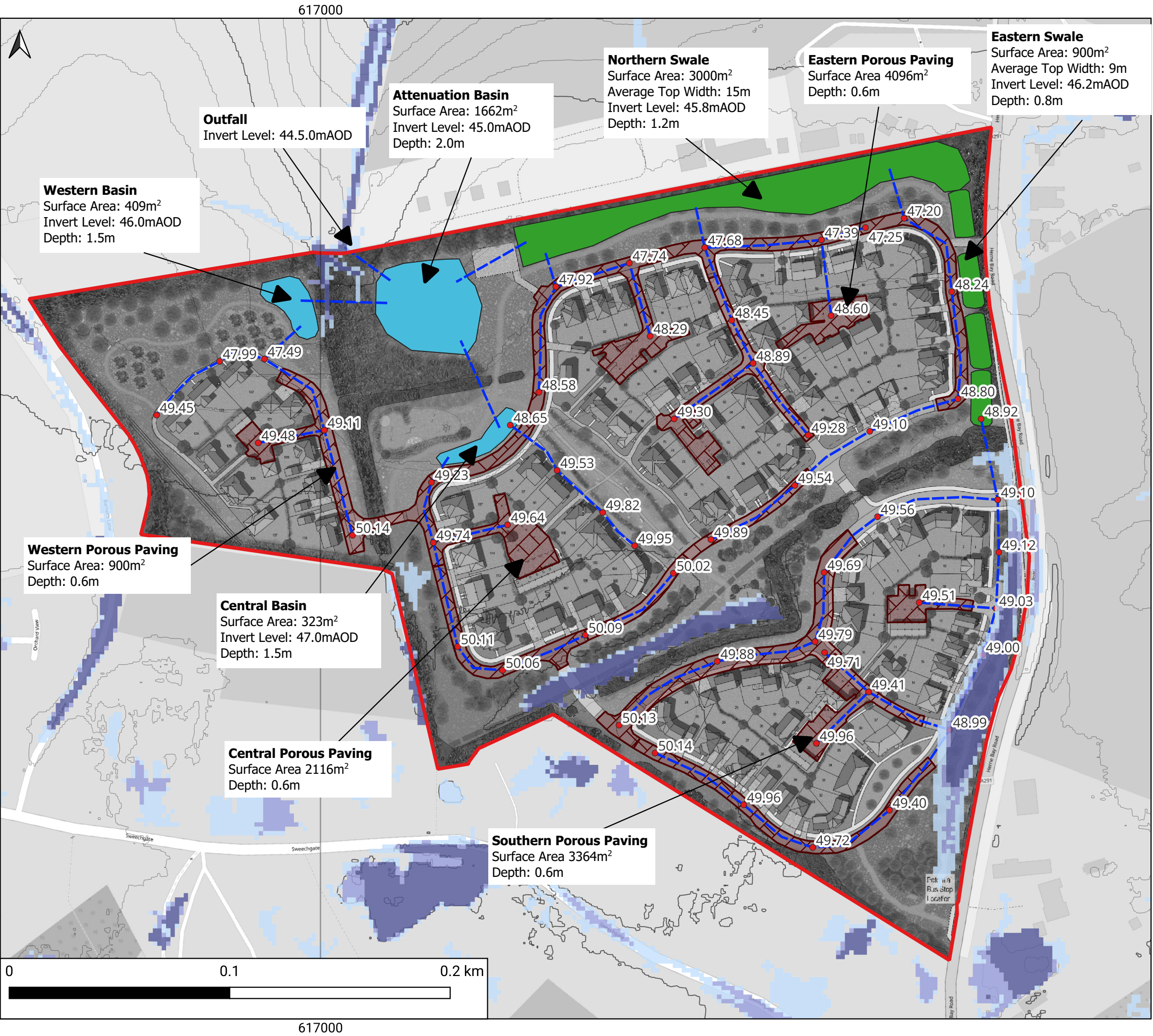
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Land West of Herne Bay: Outline
Drainage Study

P24038_R1_D01: Drainage Scheme

Legend

Site Boundary

LiDAR Contours

1
5

Risk of surface water flooding
(inc climate change)

High
Medium
Low
Unavailable

SuDS Features

Porous Paving

SuDS Basin

Swale

Indicative Pipe Network

Indicative Cover Levels

Table F-1: Catchment area calculations (all areas in hectares)

Catchment	Total Area	Impermeable (non-adoptable area – roofs, driveways)	Impermeable (adoptable areas – roads, pavements, communal parking)	Increase for urban creep (10% of non-adoptable areas)	SuDS footprint (basins and swales)	Total impermeable area	Remaining permeable area	30% estimate of permeable area to drain to network	Total positively drained area
	A	B	C	D = B*0.1	E	F = B+C+D+E	G= A-F	H = G*0.3	I = F + H
Western	1.43	0.14	0.10	0.01	0.04	0.29	1.15	0.34	0.63
Southern	2.60	0.39	0.55	0.04	0.00	0.98	1.62	0.49	1.47
Central	1.51	0.19	0.27	0.02	0.03	0.51	0.51	0.30	0.81
Eastern	3.32	0.50	0.54	0.05	0.31	1.41	1.41	0.57	1.98
Additional SuDS Basins					0.16				0.16
Total									5.05

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)
11.000	20.942	41.9	225	1 Default	47.000	45.000	1.775	45.000	44.500	0.275
9.000	39.747	29.4	150	1 Default	48.500	47.000	1.350	47.000	45.650	1.200
12.000	10.050	50.2	225	1 Default	47.000	45.800	0.975	47.000	45.600	1.175
10.000	30.438	87.0	150	1 Default	47.500	46.000	1.350	47.000	45.650	1.200

Link	US Node	Node Type	DS Node	Node Type
11.000	Attenuation Basin	Junction	Outfall	Junction
9.000	C Basin	Junction	C Basin DS	Junction
12.000	Swale 6	Junction	Swale 6 DS	Junction
10.000	W Basin	Junction	W Basin DS	Junction

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Node Type	Connections	Link	IL (m)	Dia (mm)	Link Type
S PP	617214.088	161532.100	49.500	1.000	Junction					
						0	1.000	48.500	225	1 Default
S Additional Imp	617246.479	161533.450	49.500	1.000	Junction					
						0	2.000	48.500	225	1 Default
S DS	617300.318	161669.723	49.000	1.300	Junction		1	2.000	48.000	225 1 Default
						2	1.000	48.000	225	1 Default
E PP	617169.888	161677.185	49.000	1.500	Junction					
						0	4.000	47.500	300	1 Default
C PP	617093.972	161599.244	50.000	1.425	Junction					
						0	8.000	48.575	300	1 Default
W PP	616950.238	161649.518	49.500	1.350	Junction					
						0	5.000	48.150	225	1 Default
W Additional Imp	616985.665	161644.712	49.500	1.350	Junction					
						0	6.000	48.150	150	1 Default
C Additional Imp	617126.363	161600.210	49.500	0.850	Junction					
						0	7.000	48.650	150	1 Default
E Additional Imp	617199.580	161680.559	49.500	1.425	Junction					
						0	3.000	48.075	225	1 Default

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Node Type	Connections	Link	IL (m)	Dia (mm)	Link Type
E DS	617150.280	161750.806	47.000	1.200	Junction		1	4.000	46.000	300 1 Default
							2	3.000	46.000	225 1 Default
C DS	617082.681	161649.115	48.500	1.500	Junction		1	8.000	47.500	300 1 Default
							2	7.000	47.500	150 1 Default
W DS	616982.153	161710.348	47.500	1.500	Junction		1	6.000	46.500	150 1 Default
							2	5.000	46.500	225 1 Default
Attenuation Basin	617030.014	161732.683	47.000	2.000	Junction		0	11.000	45.000	225 1 Default
Outfall	617011.426	161742.330	45.000	0.500	Junction		1	11.000	44.500	225 1 Default
Swale 4	617283.640	161776.959	47.200	1.300	Junction					
Swale 1	617298.030	161690.950	48.500	1.300	Junction					
Swale 2	617294.557	161716.753	48.000	1.300	Junction					
Swale 3	617290.091	161749.172	47.500	1.300	Junction					
Swale 5	617163.653	161765.857	47.100	1.300	Junction					
Swale 6	617073.861	161741.366	47.000	1.200	Junction		0	12.000	45.800	225 1 Default
C Basin	617081.705	161669.859	48.500	1.500	Junction		0	9.000	47.000	150 1 Default
C Basin DS	617055.460	161699.709	47.000	2.000	Junction		1	9.000	45.650	150 1 Default

Node Swale 5 Pond Storage Structure

Invert Level (m)45.900

Time to half empty (mins)

Analyse flow through structurex

Inlets

Swale 4

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	540.0	1.200	1500.0

Node Swale 6 Pond Storage Structure

Invert Level (m)45.800

Time to half empty (mins)

Analyse flow through structurex

Inlets

Swale 5E DS

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	540.0	1.200	1500.0

Node Swale 1 Pond Storage Structure

Invert Level (m)47.700

Time to half empty (mins)1126

Analyse flow through structurex

Inlets

S DS

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	65.0	0.800	225.0

Node Swale 2 Pond Storage Structure

Invert Level (m)47.200

Time to half empty (mins)

Analyse flow through structurex

Inlets

Swale 1

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	65.0	0.800	225.0

Node Swale 3 Pond Storage Structure

Invert Level (m)46.700

Time to half empty (mins)

Analyse flow through structurex

Inlets

Swale 2

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	65.0	0.800	225.0

Node Swale 4 Pond Storage Structure

Invert Level (m) 46.200 | Time to half empty (mins) | Analyse flow through structure x

Inlets
Swale 3

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	65.0	0.800	225.0

Node C Basin Pond Storage Structure

Invert Level (m) 47.000 | Time to half empty (mins) 1050 | Analyse flow through structure x

Inlets
C DS

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	100.0	1.500	323.1

Node W Basin Pond Storage Structure

Invert Level (m) 46.000 | Time to half empty (mins) | Analyse flow through structure x

Inlets
W DS

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	150.0	1.500	409.0

Other (defaults)

Entry Loss (manhole) 0.250 | Exit Loss (manhole) 0.250 | Entry Loss (junction) 0.000 | Exit Loss (junction) 0.000 | Apply Recommended Losses x | Flood Risk (m) 0.300

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.56%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute summer	S PP	240	48.704	0.204	31.0	93.1871	0.0000	OK
15 minute summer	S Additional Imp	12	48.764	0.264	49.3	1.5862	0.0000	SURCHARGED
480 minute summer	S DS	296	48.352	0.652	19.3	0.0000	0.0000	OK
240 minute summer	E PP	160	48.173	0.673	48.6	78.9679	0.0000	SURCHARGED
240 minute summer	C PP	164	49.154	0.579	25.5	44.2894	0.0000	SURCHARGED
180 minute summer	W PP	120	48.610	0.460	12.5	15.0173	0.0000	SURCHARGED
15 minute summer	W Additional Imp	11	48.205	0.055	8.2	0.0405	0.0000	OK
15 minute summer	C Additional Imp	11	48.703	0.053	6.6	0.0501	0.0000	OK
15 minute summer	E Additional Imp	11	48.186	0.111	41.0	0.3895	0.0000	OK
4320 minute winter	E DS	3180	46.249	0.449	6.1	0.0000	0.0000	OK
480 minute summer	C DS	488	47.501	0.501	8.6	0.0000	0.0000	OK
360 minute summer	W DS	336	46.328	0.328	7.1	0.0000	0.0000	OK
960 minute summer	Attenuation Basin	870	45.182	0.182	10.7	204.2288	0.0000	OK
960 minute summer	Outfall	870	44.555	0.055	10.6	0.0000	0.0000	OK
2160 minute summer	Swale 4	2580	46.784	0.884	6.8	72.4023	0.0000	OK
480 minute summer	Swale 1	296	48.335	1.135	16.2	83.6771	0.0000	OK
720 minute summer	Swale 2	495	47.827	1.127	15.9	80.4296	0.0000	OK
720 minute summer	Swale 3	630	47.317	1.117	12.2	78.6640	0.0000	OK
4320 minute summer	Swale 5	4560	46.427	0.627	4.2	397.0886	0.0000	OK
4320 minute winter	Swale 6	3180	46.246	0.446	4.9	322.9666	0.0000	SURCHARGED
480 minute summer	C Basin	488	47.492	0.492	6.8	68.2146	0.0000	SURCHARGED
960 minute summer	C Basin DS	870	45.186	0.186	5.5	0.0000	0.0000	OK
960 minute summer	Swale 6 DS	870	45.186	0.186	3.3	0.0000	0.0000	OK
360 minute summer	W Basin	336	46.323	0.323	5.5	58.1429	0.0000	SURCHARGED
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
360 minute summer	S PP	1.000	S DS	7.4	0.569	0.259	4.2094	
15 minute summer	S Additional Imp	2.000	S DS	35.0	0.951	1.161	5.0786	
240 minute summer	E PP	4.000	E DS	11.8	1.324	0.076	1.9331	
240 minute summer	C PP	8.000	C DS	5.5	1.079	0.034	0.2619	
180 minute summer	W PP	5.000	W DS	3.4	1.017	0.042	0.2308	
15 minute summer	W Additional Imp	6.000	W DS	8.0	1.383	0.284	0.3811	
15 minute summer	C Additional Imp	7.000	C DS	6.4	1.141	0.271	0.3671	
15 minute summer	E Additional Imp	3.000	E DS	40.2	2.058	0.495	1.6754	
960 minute summer	Attenuation Basin	11.000	Outfall	10.6	1.418	0.132	0.1567	669.8
4320 minute winter	Swale 6	12.000	Swale 6 DS	3.4	0.947	0.046	0.0356	
4320 minute winter	Swale 6	Weir	Attenuation Basin	0.0				0.0
480 minute summer	C Basin	9.000	C Basin DS	5.6	1.391	0.169	0.1590	
360 minute summer	W Basin	10.000	W Basin DS	3.7	0.841	0.194	0.1340	

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.56%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute summer	W Basin DS	870	45.186	0.186	3.5	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)
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Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 99.03%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute summer	S PP	272	48.925	0.425	86.1	317.6353	0.0000	SURCHARGED
15 minute summer	S Additional Imp	10	49.500	1.000	171.1	21.2507	0.0000	FLOOD RISK
180 minute summer	S DS	104	48.440	0.740	67.8	0.0000	0.0000	OK
240 minute winter	E PP	228	48.413	0.913	92.3	360.2017	0.0000	SURCHARGED
240 minute winter	C PP	232	49.394	0.819	48.3	197.0762	0.0000	SURCHARGED
180 minute winter	W PP	168	48.822	0.672	25.3	72.6057	0.0000	SURCHARGED
15 minute summer	W Additional Imp	10	48.269	0.119	28.5	0.0885	0.0000	OK
15 minute summer	C Additional Imp	11	48.766	0.116	22.8	0.1088	0.0000	OK
15 minute summer	E Additional Imp	10	49.500	1.425	142.7	7.9922	0.0000	FLOOD RISK
2880 minute summer	E DS	1860	46.753	0.953	26.4	0.0000	0.0000	OK
960 minute summer	C DS	870	48.004	1.004	14.8	0.0000	0.0000	OK
720 minute summer	W DS	690	46.820	0.820	14.6	0.0000	0.0000	OK
2880 minute summer	Attenuation Basin	2460	45.805	0.805	33.1	967.6437	0.0000	SURCHARGED
1440 minute summer	Outfall	1650	44.586	0.086	25.0	0.0000	0.0000	OK
720 minute summer	Swale 4	420	46.874	0.974	43.9	89.5899	0.0000	OK
180 minute summer	Swale 1	104	48.403	1.203	66.8	99.5112	0.0000	OK
360 minute summer	Swale 2	208	47.888	1.188	56.2	92.4641	0.0000	OK
480 minute summer	Swale 3	280	47.380	1.180	50.2	90.9316	0.0000	OK
2880 minute summer	Swale 5	1860	46.841	1.041	29.6	864.7438	0.0000	OK
2880 minute summer	Swale 6	1860	46.741	0.941	35.7	872.2977	0.0000	FLOOD RISK
960 minute summer	C Basin	870	47.993	0.993	11.1	174.3862	0.0000	SURCHARGED
2880 minute summer	C Basin DS	2460	45.812	0.812	7.7	0.0000	0.0000	OK
2880 minute summer	Swale 6 DS	2460	45.811	0.811	6.5	0.0000	0.0000	OK
720 minute summer	W Basin	705	46.811	0.811	10.3	180.0390	0.0000	SURCHARGED
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
360 minute summer	S PP	1.000	S DS	11.9	0.578	0.416	4.6112	
15 minute summer	S Additional Imp	2.000	S DS	84.5	2.125	2.803	5.8274	
240 minute winter	E PP	4.000	E DS	13.9	1.340	0.089	3.0643	
240 minute winter	C PP	8.000	C DS	6.6	1.135	0.041	1.9440	
180 minute winter	W PP	5.000	W DS	4.2	1.081	0.052	0.7061	
15 minute summer	W Additional Imp	6.000	W DS	28.1	1.817	0.994	1.0612	
15 minute summer	C Additional Imp	7.000	C DS	22.3	1.528	0.944	0.9560	
15 minute summer	E Additional Imp	3.000	E DS	114.8	2.887	1.416	3.4127	
2880 minute summer	Attenuation Basin	11.000	Outfall	25.0	1.807	0.311	0.2902	3521.4
2880 minute summer	Swale 6	12.000	Swale 6 DS	5.0	1.063	0.067	0.2176	
2880 minute summer	Swale 6	Weir	Attenuation Basin	30.6				1093.4
960 minute summer	C Basin	9.000	C Basin DS	8.0	1.543	0.244	0.2072	
720 minute summer	W Basin	10.000	W Basin DS	6.1	0.966	0.320	0.1920	

Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 99.03%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
2880 minute summer	W Basin DS	2460	45.810	0.810	6.5	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)
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Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 99.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute summer	S PP	615	49.473	0.973	63.0	502.2003	0.0000	FLOOD RISK
15 minute summer	S Additional Imp	9	49.500	1.000	223.3	33.9656	0.0000	FLOOD RISK
120 minute summer	S DS	74	48.475	0.775	95.4	0.0000	0.0000	OK
960 minute summer	E PP	660	48.590	1.090	77.9	579.4984	0.0000	SURCHARGED
960 minute summer	C PP	675	49.587	1.012	40.8	320.3058	0.0000	SURCHARGED
960 minute summer	W PP	630	48.963	0.813	17.6	111.1784	0.0000	SURCHARGED
15 minute summer	W Additional Imp	11	48.947	0.797	37.2	0.5903	0.0000	SURCHARGED
15 minute summer	C Additional Imp	11	49.137	0.487	29.8	0.4584	0.0000	SURCHARGED
15 minute summer	E Additional Imp	9	49.500	1.425	186.0	14.8551	0.0000	FLOOD RISK
2880 minute summer	E DS	2880	46.991	1.191	38.7	0.0000	0.0000	OK
1440 minute summer	C DS	1230	48.481	1.481	20.5	0.0000	0.0000	OK
2160 minute summer	W DS	1980	47.351	1.351	17.2	0.0000	0.0000	OK
2880 minute summer	Attenuation Basin	2880	46.984	1.984	82.8	2720.0040	0.0000	FLOOD RISK
480 minute winter	Outfall	1264	44.586	0.086	25.0	0.0000	0.0000	OK
2880 minute summer	Swale 4	2880	46.985	1.085	40.0	112.9958	0.0000	OK
120 minute summer	Swale 1	74	48.431	1.231	93.0	106.1828	0.0000	OK
240 minute summer	Swale 2	140	47.917	1.217	83.6	98.5216	0.0000	OK
360 minute summer	Swale 3	208	47.410	1.209	76.1	96.9167	0.0000	OK
2880 minute summer	Swale 5	2880	46.985	1.185	44.6	1059.2610	0.0000	OK
2880 minute summer	Swale 6	2880	46.985	1.185	82.7	1208.4180	0.0000	FLOOD RISK
1440 minute summer	C Basin	1230	48.467	1.467	14.9	309.5322	0.0000	FLOOD RISK
2880 minute summer	C Basin DS	2880	46.993	1.993	19.6	0.0000	0.0000	OK
2880 minute summer	Swale 6 DS	2940	46.984	1.984	19.5	0.0000	0.0000	OK
2160 minute summer	W Basin	1980	47.342	1.342	12.5	359.3459	0.0000	FLOOD RISK
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
960 minute summer	S PP	1.000	S DS	19.1	0.558	0.669	5.2059	
15 minute summer	S Additional Imp	2.000	S DS	105.4	2.649	3.494	5.8274	
960 minute summer	E PP	4.000	E DS	15.3	1.268	0.098	3.0903	
960 minute summer	C PP	8.000	C DS	7.4	1.083	0.046	1.9608	
960 minute summer	W PP	5.000	W DS	4.6	1.050	0.057	1.5082	
15 minute summer	W Additional Imp	6.000	W DS	33.0	1.874	1.168	1.1525	
15 minute summer	C Additional Imp	7.000	C DS	26.6	1.512	1.129	1.1393	
15 minute summer	E Additional Imp	3.000	E DS	139.2	3.501	1.717	3.4114	
2880 minute summer	Attenuation Basin	11.000	Outfall	25.0	1.807	0.310	0.2899	4619.9
2880 minute summer	Swale 6	12.000	Swale 6 DS	5.1	1.069	0.069	0.3997	
2880 minute summer	Swale 6	Weir	Attenuation Basin	78.0				3401.7
1440 minute summer	C Basin	9.000	C Basin DS	9.8	1.607	0.299	0.4697	
2160 minute summer	W Basin	10.000	W Basin DS	7.2	0.998	0.378	0.5359	

Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 99.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
2880 minute summer	W Basin DS	2880	46.990	1.990	19.5	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)
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