BROOKBANKS

10709 Brooklands Farm, Whitstable

Technical Note 7 Rev 2: Review of Flooding and Drainage and Potential Mitigation

3rd June 2024

Document Status

Rev	Issue Status	Prepared / Date	Checked / Date	Approved / Date
0	Draft	KM 17.05.24	AMa 30.05.24	RB 30.05.23
1	Draft	AMa 31.05.24	AMa 31.05.24	RB 31.05.23
2	Final	AMa 03.06.24	AMa 03.06.24	RB 03.06.23

1 Introduction

1.1 Brookbanks is appointed by Hallam Land Management Ltd to consider a range of technical issues in relation to a proposed development at Brooklands Farm, Whitstable, hereafter referred to as "the Site", with the red line boundary presented as **Figure 1-1.** The Site is approximately 79.13ha in size.

1.2 This Technical Note reviews the current flood risk across the Site, and surrounding Whitstable, from all causes, and determines its cause. The Note will further determine any potential mitigation proposals that the Site can implement as part of the proposed development to help reduce the impact of flooding in Whitstable downstream of the Site after development by improving and mitigating surface water and foul drainage.

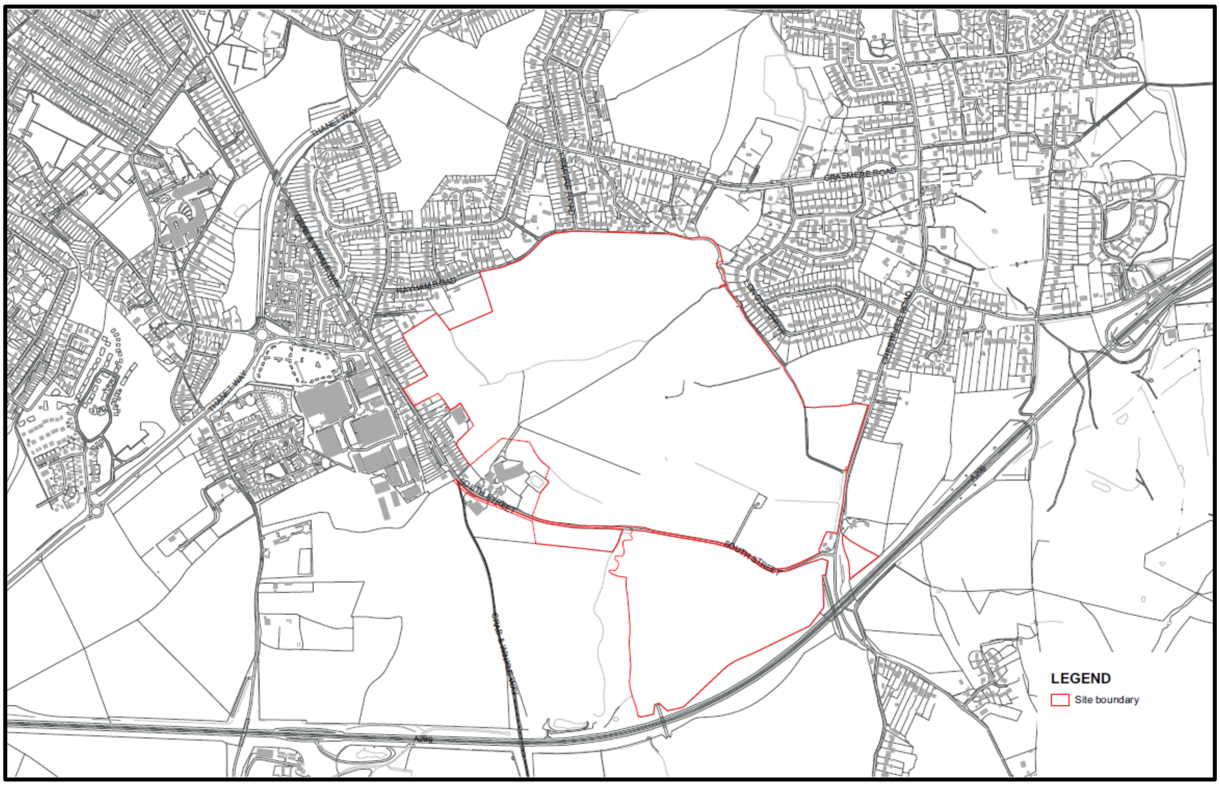


Figure 1-1: Brooklands Farm, Whitstable, Red Line Boundary

2 Existing Flooding

Surface Water Flooding

2.1 Overland surface water flow mechanisms result from the inability of unpaved ground to infiltrate rainfall, or due to inadequacies of drainage systems in paved areas, to accommodate flow directed to gullies, drainage downpipes or similar. In minor cases, local ponding may occur. In more extreme events, flows accumulate and may be conveyed across land following the topography.

2.2 **Figure 2-1** illustrates the Environment Agency's (EA) Long Term Flood Risk Mapping of surface water flooding across Whitstable, which ranges from very low risk to high risk. The high risk areas are located along existing drainage networks, depressions within open spaces, and north of Whitstable Station along the High Street and Cromwell Road. There is also shown to be a low risk of surface water flooding along residential roads.

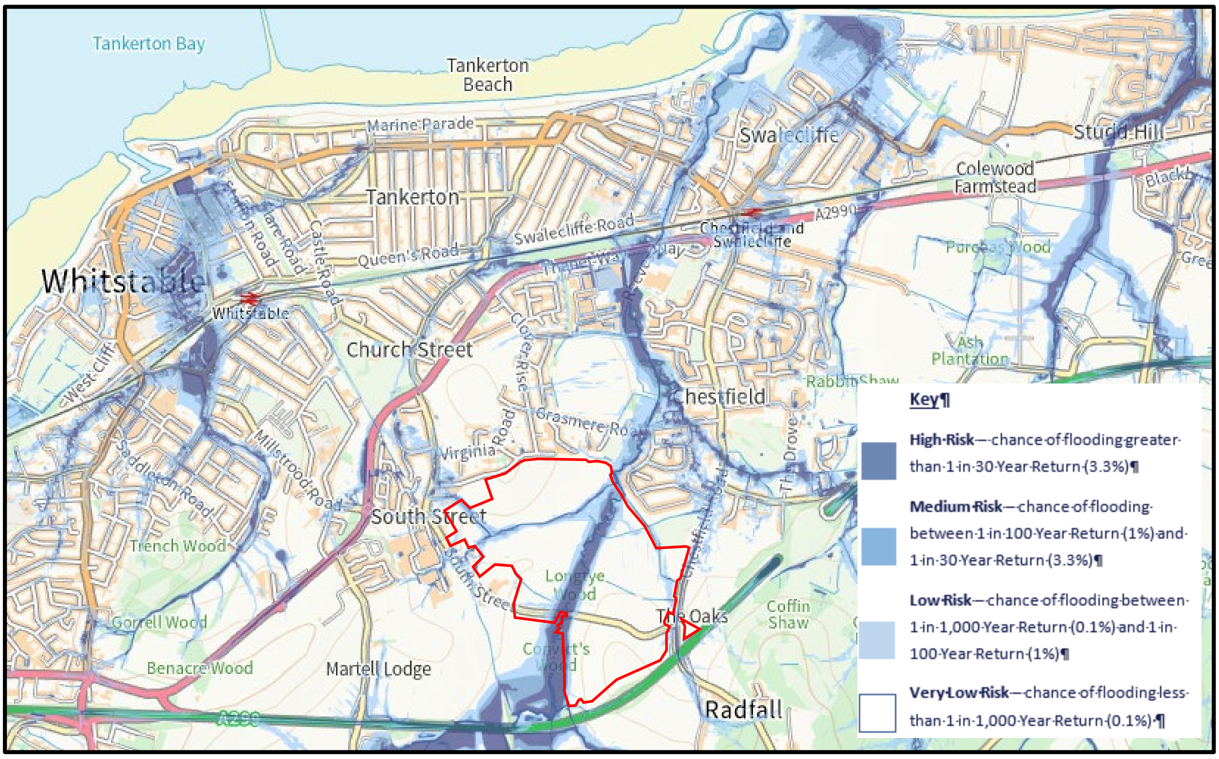


Figure 2-1: EA Long Term Flood Risk Maps – Flood risk from Surface Water (Gov.UK website)

Fluvial Flooding

2.3 The EA Flood Map for Planning provides the predicted Flood Zones of Main Rivers and the Sea across England. The mapping covers three Flood Zones, as follows:

- Flood Zone 1 – Low probability of flooding (land having less than a 1 in 1,000 annual probability).
- Flood Zone 2 – Medium risk (land having between a 1 in 100 and 1 in 1,000 annual probability).
- Flood Zone 3 – High risk (land with a 1 in 100 or greater annual probability).

2.4 For Whitstable, the EA mapping (**Figure 2-2**) illustrates that the main sources of flooding are from both the sea and Main Rivers.

2.5 The land in the town centre is at greatest risk from coastal flooding, from the Thames Estuary, since it is relatively low lying. It does have flood protection measures in place, as shown in **Figure 2-2**, with, according to the South East Coastal Group, the primary defence being a large shingle beach maintained by timber groynes, which acts to dissipate wave energy, reducing overtopping and preventing damage to the seawall, which protects the town from flooding. Improvement works were undertaken in 2006 by replacing several sections of the hardwood timber groynes and introducing 70,000m^3 shingle. The berm was designed to be 6m high with a slope of 1 in 7 slope to the foreshore. The South East Coastal Group report that these improvements have been very successful, as the beach monitoring of three times per year, undertaken via the Regional Coastal Monitoring Programme, shows little beach material moves out of Whitstable through longshore drift.

2.6 For Main Rivers, two are present, the Swalecliffe Brook (and tributary passing through Chestfield) and Gorrell Stream (flows north through Duncan Down draining into the main harbour), to the east and west of Whitstable, respectively. For both watercourses, land immediately adjacent are in either Flood Zone 2 or 3. As can be seen from **Figure 2-2**, Swalecliffe Brook passes through the centre of the Site, whilst Gorrell Stream at its closest is c.850m to the west and does not impact the Site.

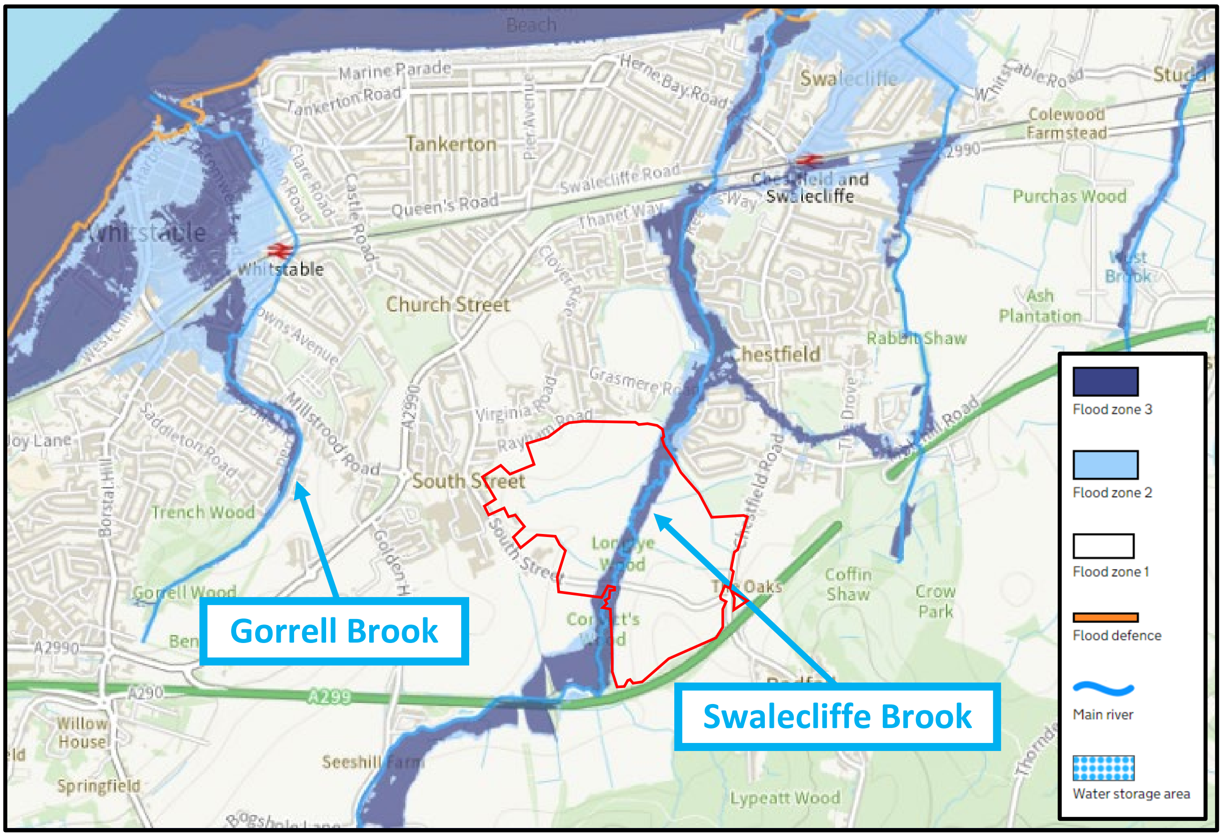


Figure 2-2: EA Flood Map for Planning, 2024

2.7 The existing flood model for Whitstable has been obtained from the EA in order to review the flooding from the Swalecliffe Brook in storm event periods other than the 1 in 100 year illustrated on the EA mapping. This provides more detailed knowledge into the frequency and volume of flooding along the Swalecliffe Brook.

2.8 The modelled results for the 1 in 5 and 1 in 20-year fluvial storm events illustrate that the Swalecliffe Brook is prone to frequent fluvial flooding, with significant volumes. The extent of the flooding from the Swalecliffe Brook are provided in **Figure 2-3** and **2-4**. As can be seen from this, during heavy rainfall and storm events, flood waters flow downhill before eventually finding its way into the existing storm and combined sewer network.

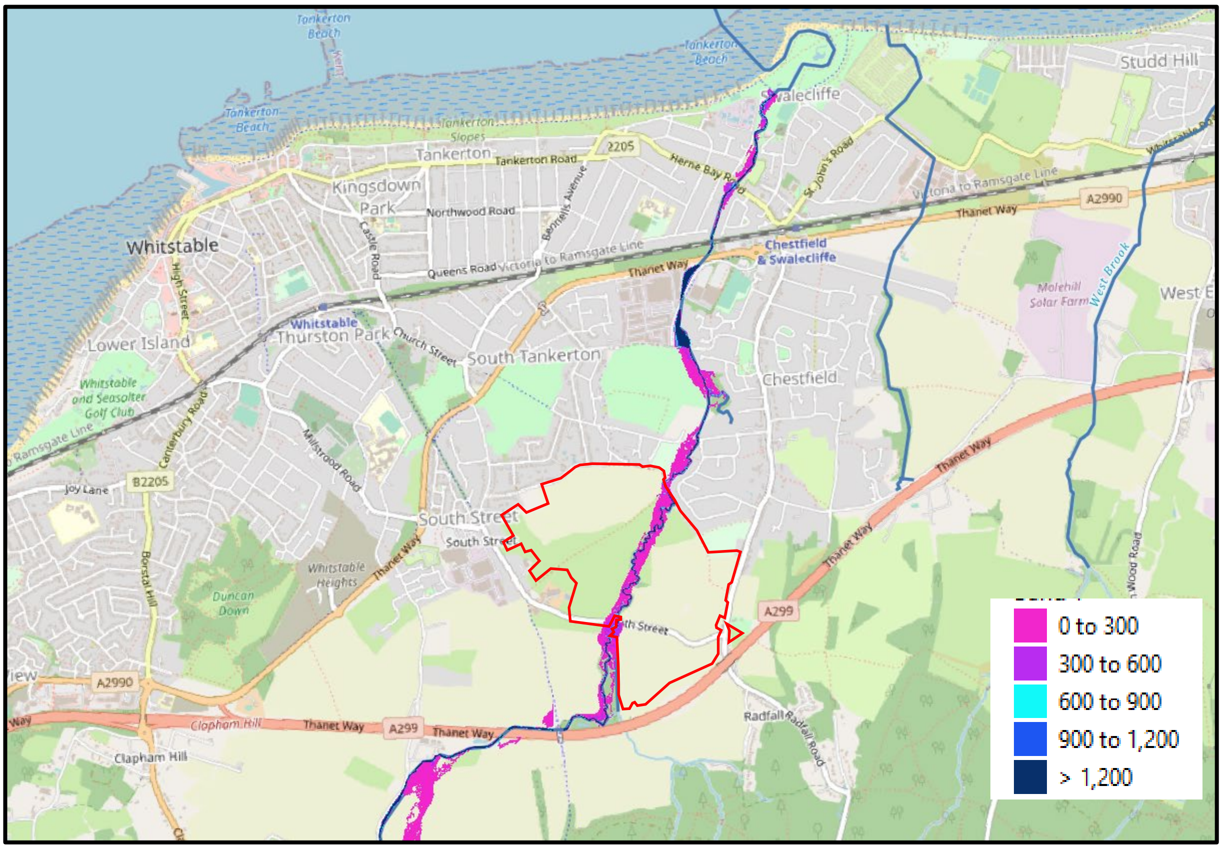


Figure 2-3: EA Flood Model, 1 in 5 year

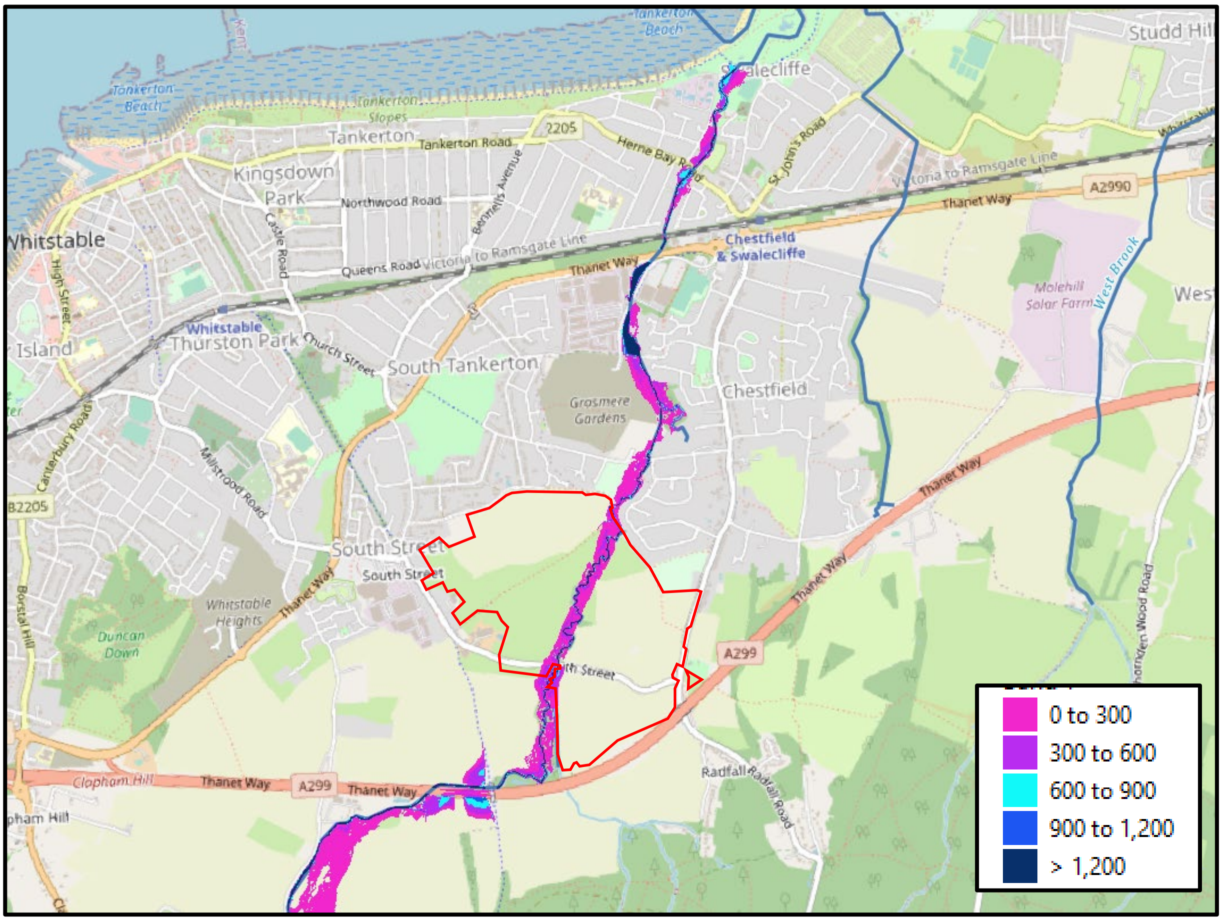


Figure 2-4: EA Flood Model, 1 in 20 year

Sewer Flooding

2.9 Flooding may also occur from sewers, especially where combined sewers are common, which are where collected surface waters enter the same sewer as foul water.

2.10 Therefore, Southern Water (the local water and sewerage water company) have been approached and have confirmed that the sewer flooding across Whitstable comes from storm water and combined sewers across the region becoming overwhelmed with surface water runoff and fluvial flooding as illustrated in **Figures 2-1 to 2-4**.

2.11 Southern Water confirmed the sewer network around Tankerton and Swalecliffe was built c.150 years ago and are not designed to accommodate modern day flows. In addition, the highways drainage around Whitstable consists of road gullies which are connected to the surface water and combined sewer network. These gullies provide another way in which flood water can enter the sewer network. Southern Water upgrades are occurring to improve this situation, see Section 3 for further information.

2.12 With ongoing development, urban creep, and climate change, the extent and volume of both surface water and fluvial flooding is on the rise.

3 Southern Water's Assessment

3.1 Southern Water produced the Swalecliffe Pathfinder, Whitstable Catchment Technical Report (July 2022), reviewing the Swalecliffe Wastewater Treatment Works and the extent of sewer flooding across Whitstable.

3.2 The report determined that the area's most at risk of sewer flooding are those closest to the coast, where there are no surface water sewers currently in operation (**Figure 3-1**) as per the Whitstable Catchment Technical report (July 2022). Southern Water's primary aim is to manage surface water, ensuring water drains safely away from homes and public open green spaces.

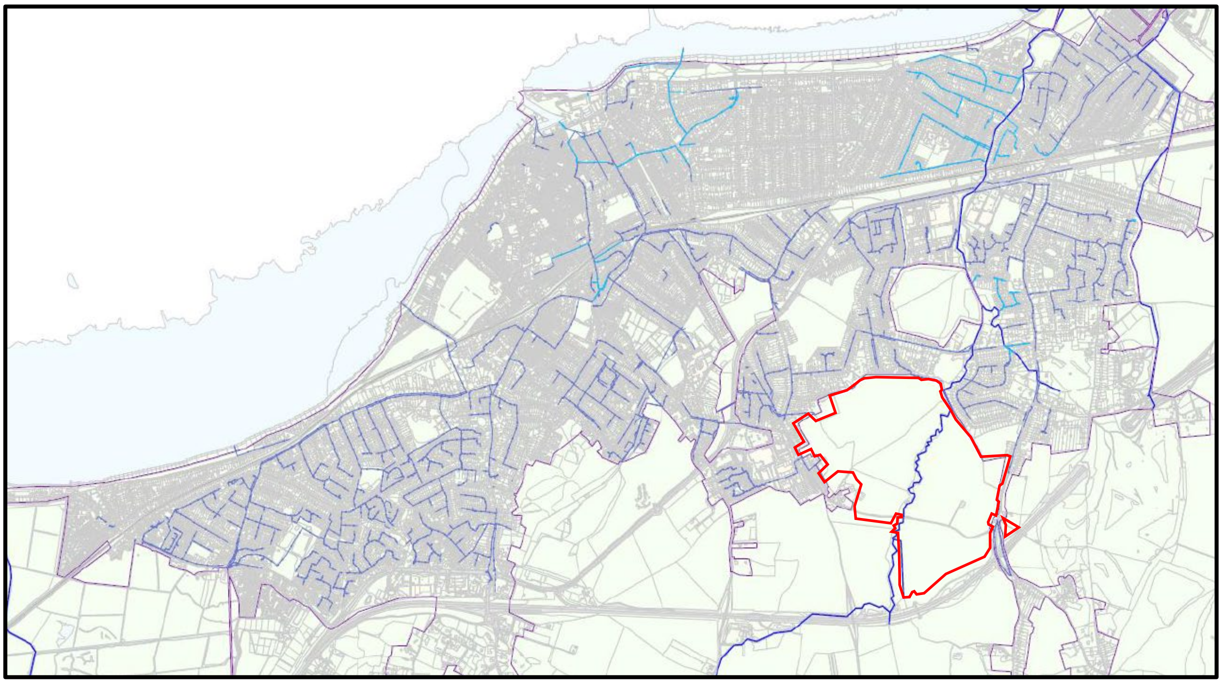


Figure 3-1: Current Surface Water System in Whitstable, Swalecliffe Pathfinder Technical Report July 2022

3.3 Southern Water's three main types of interventions to reduce the risk of flooding and storm overflow use are:

1. Upstream source control (removing and slowing the flow of rainwater).
    - Rainwater Harvesting.
    - Permeable Paving.
    - Green Roofs.
    - Bioretention -Tree Pits and Planters.
    - Rain Gardens.
    - Swales.
2. System optimisation (making better use of the existing infrastructure).
    - Improvements in storage tank use and control.
    - Improvements in pumping station use and control.
    - Better data availability.
3. Infrastructure enhancements (building larger infrastructure).
    - Larger sewers & pumping stations.
    - Larger storm tanks and treatment works.

Ongoing Southern Water Works

3.4 The three main mitigation proposals that Southern Water are currently implementing are:

1. Upgrade works at Swalecliffe Waste Water Treatment Works (WwTW) to reduce the amount of times discharge of untreated effluent to the sea occurs.
2. Identifying works within Whitstable town where sewers can be repaired, bypassed, or improved to reduce the amount of surface water coming into the foul network.
3. Working with the council on public buildings and residential units to install Sustainable Drainage (SuDS), in order to reduce the volume and speed at which surface water enters the sewer system. As the majority of Whitstable has a clay geology, the option to utilise infiltration SuDS are not viable and, therefore, Southern Water are focusing on constructing SuDS and discharging more surface water into the watercourses instead of the sewer network.

3.5 Southern Water have already begun their upgrade works at Swalecliffe WwTW and are providing mitigation within the Tankerton and Swalecliffe areas.

3.6 Local mitigation measures include providing smart water butts in houses within the Tankerton area to reduce the amount of runoff from individual dwellings. Theses water butts are designed to open or close a valve prior to rainfall to make capacity for the incoming storm. These systems take information from the weather forecast to calculate how much water needs to be released.

3.7 **Figure 3-2** illustrates the location of other ongoing SuDS schemes, which includes living walls and rain gardens at Whitstable Library and Bioretention at Cornwallis Circle Recreation Ground.

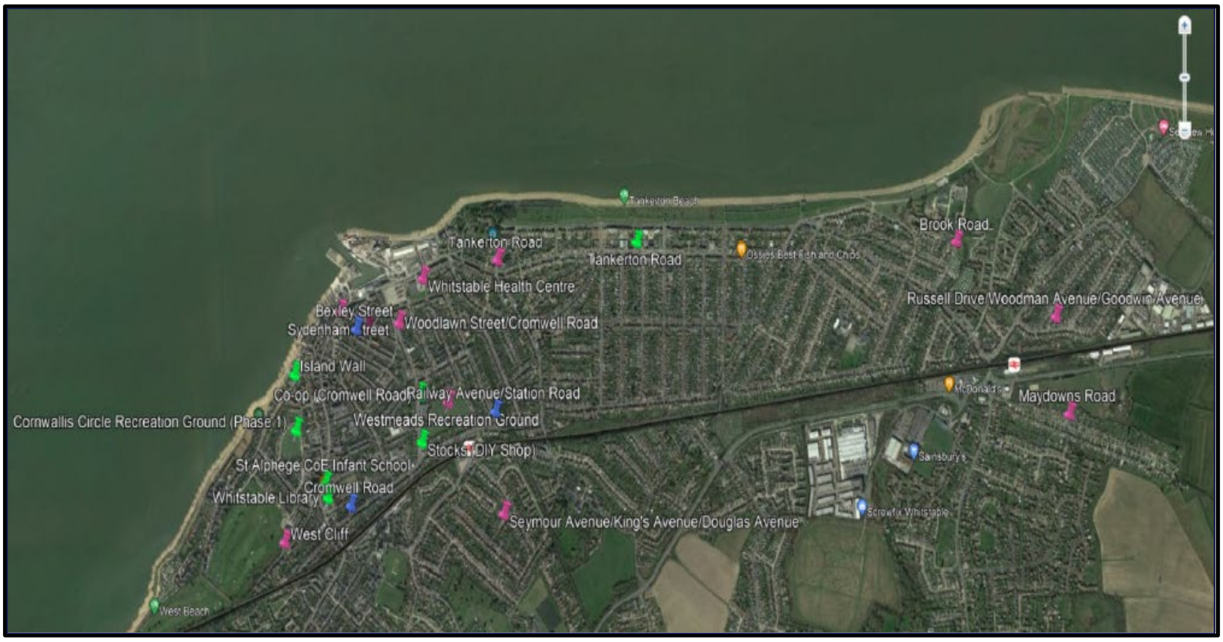


Figure 3-2: Southern Water – Location of SuDS Schemes

Southern Water Meeting

3.8 A meeting with Jonathan Yates at Southern Water (Programme Delivery Lead for the East) was held on the 19th April 2023 to discuss the proposed development at Whitstable, along with solutions which are being assessed across the wider area. Southern Water shared a PowerPoint presentation, which identified how they are looking to address issues in the network. This PowerPoint is provided within **Appendix A**, with details of the meeting and PowerPoint provided below.

3.9 Southern Water confirmed that a Clean Rivers and Seas Task Force has been set up to deliver at least six pathfinder projects over the next two years.

3.10 Southern Water are looking to work in partnership with developers to ensure that flooding is therefore reduced. Southern Water are looking to promote simple actions such as water butts or recycling rainwater to assist with their goals.

3.11 Specifically, for the Swalecliffe area, Southern Water confirmed that they are working to reduce 74 hectares of hard surfaces, along with separating the surface water and sewer network. Via hotspot mapping, Southern Water are aware of where to target these solutions.

3.12 Within the meeting, Southern Water did confirm that they have acknowledged that new foul water sources are not causing the major problem, and that it is a surface water storm and combined sewer issue in the older parts of town due the sewers not being larger enough to deal with the combined flows. They are addressing this through three main methods:

1. Works at the treatment works to reduce the number of times the discharge to sea of untreated effluent has to be used.
2. Identifying works within the town where sewers can be repaired, bypassed, or improved to reduce the amount of surface water entering the foul network.
3. Working with the local council on public buildings and residential units to install SuDS to reduce the speed at which surface water enters the system in the first instance.

3.13 Southern Water outlined that as the Site is at the top of their system and the Site will be applying SuDS / discharging our surface water to the watercourse, they believe the Site should not have an impact and will undertake site-specific modelling to confirm if this is the case. It has been offered that the Site could look to assist further with measures which include;

1. Improved SUDS over and above the Site's requirement (in planning terms) to restrict storm water in shorter term events from entering the stream and therefore helping to relieve pressure downstream.
2. Designing the foul drainage with onsite storage, via either restricted pipes or pumping to deliver a constant rate of foul flow to take out peak and troughs during storm events.
3. Pumping could have telemetry that can be designed to store during storm events, preventing the foul water from flowing into the system downstream during storm events.
4. Diverting foul flow from Radfall through the proposed development site and baffling similar for foul flows within our site.

3.14 Southern Water were receptive to all the points outlined above, and it was agreed that proposals for the Site would work on developing some plans to highlight what could be implemented to assist Southern Water. It was discussed that a further meeting would take place to discuss the proposals further and hopefully secure Southern Water's support for any future submission.

4 Modelling Results

4.1 **Appendix B** presents supporting information on the hydrology and hydrological modelling undertaken to generate the results discussed in this and the next Section.

Baseline Scenario

4.2 The baseline scenario represent the 'As Existing' or 'Current Day' conditions of the watercourse network, and shows the current surface water flood risk at Whitstable development area.

4.3 **Figure 4-1** show the Baseline (current day) scenario, for a 1 in100yr (Right) compared with the Risk of Flooding of Surface Water (RoFSW) 1 in 100yr (Left). When compared the modelling results versus the EA risk of flooding of surface water regions (shown in **Figures 2-3** and **2-4) it** shows strong similitudes, which show that the modelling methodology is reliable and robust. In addition, due to the finer gird size of the modelling (1m) than that used by the EA, new surface water flow routes are identified on smaller tributaries of the Swalecliffe Brook (within the western part of the Site) as well as overland flows elsewhere (for example, fields in the east of the Site, and along existing public highways/in residential areas off site). The on-site flows need to be considered for any development.

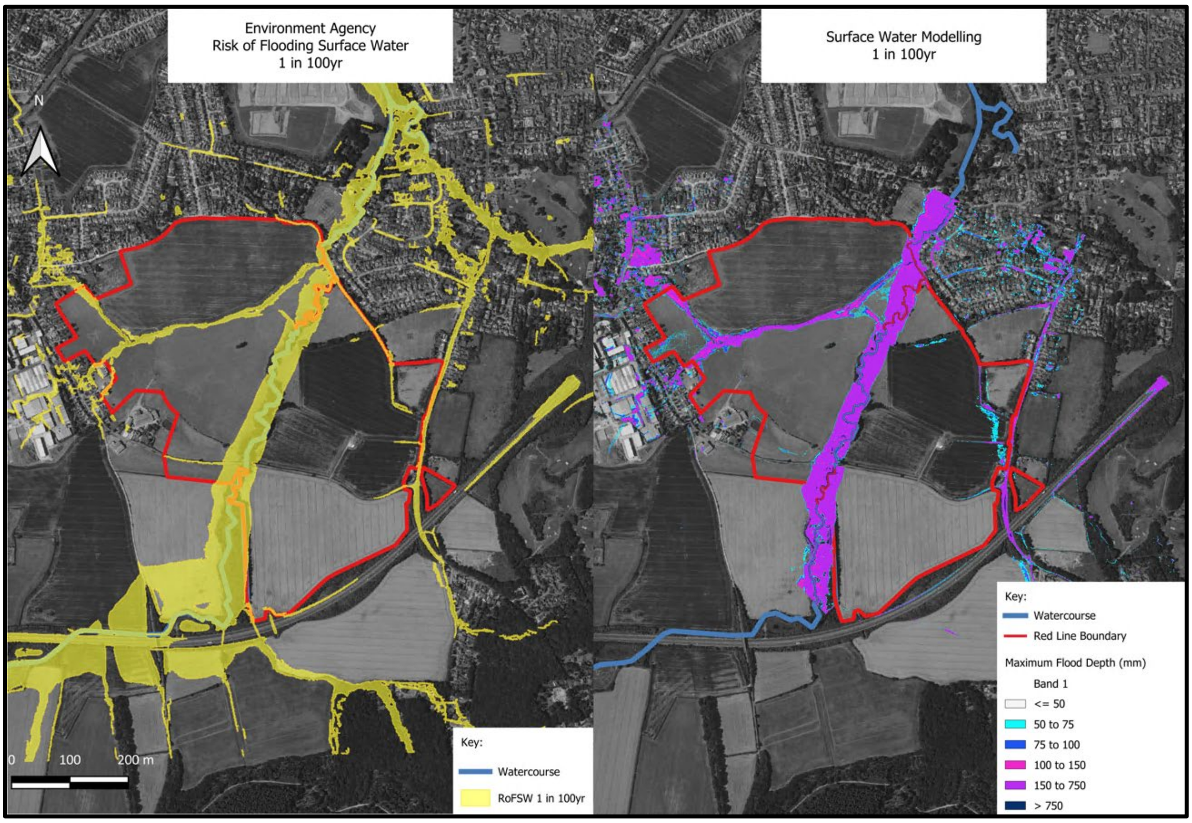


Figure 4-1: Baseline scenario 1 in100yr vs RoFSW 1 in 100yr

4.4 **Figure 4-2** show the Baseline (current day) scenario, for a 1 in100yr+55%CC event, 30min rainfall duration-West catchment. **Figure 4-3** show the Baseline (current day) scenario, for a 1 in100yr+55%CC event, 30min rainfall duration-East catchment.

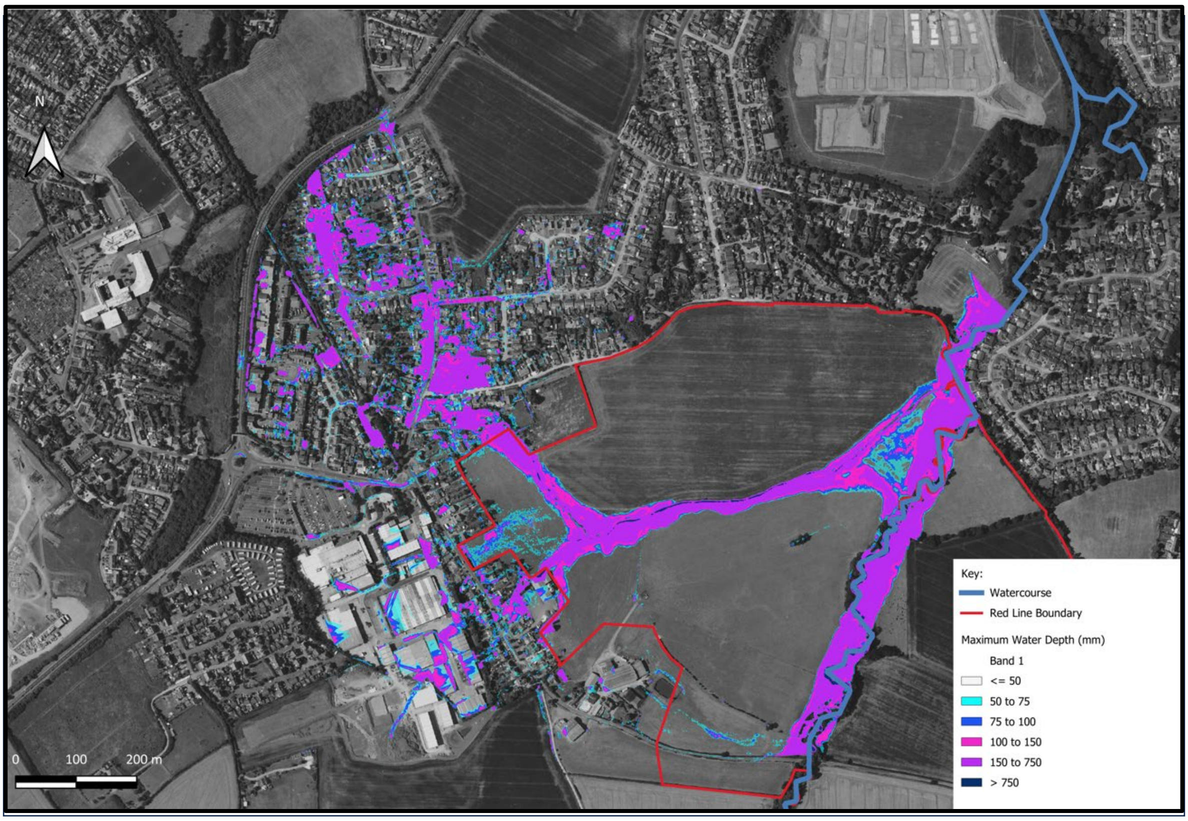


Figure 4-2: Baseline scenario 1 in100yr+55%CC-West catchment

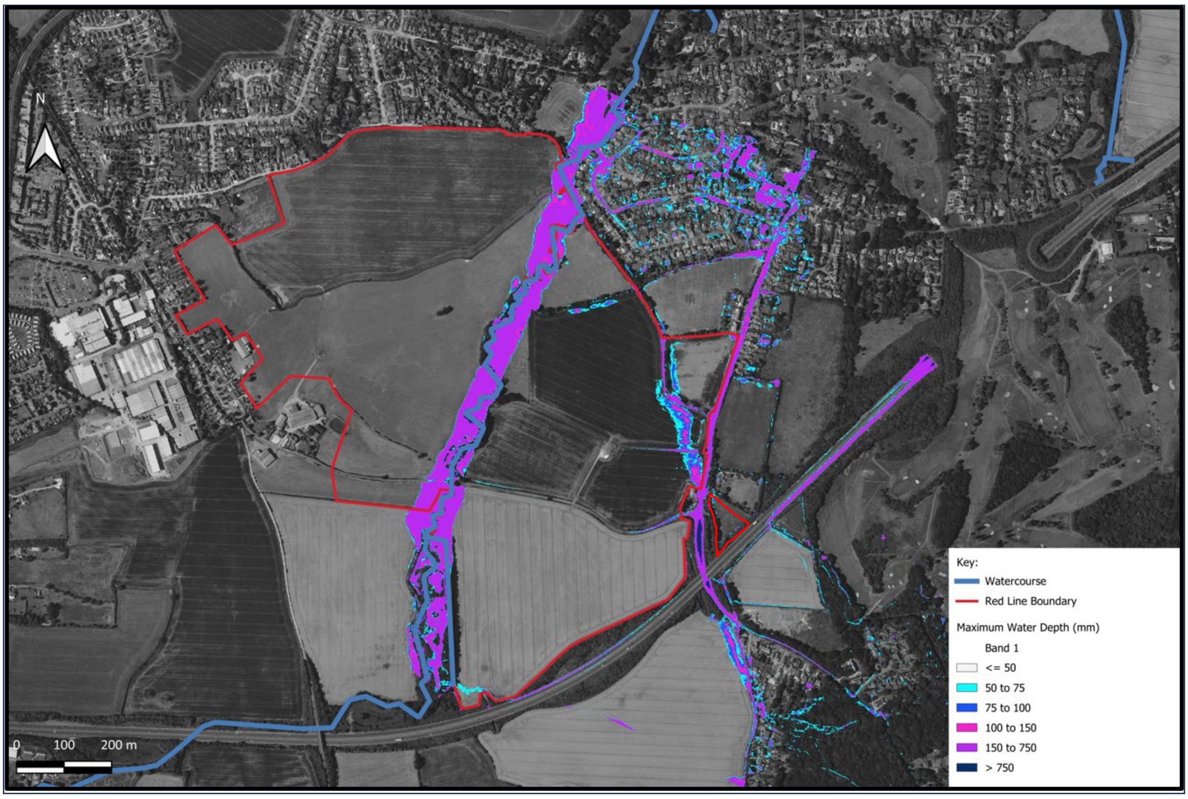


Figure 4-3: Baseline scenario 1 in100yr+55%CC-East catchment

4.5 **Figure 4-1** shows the comparison between the Risk of Flooding of Surface Water (RoFSW) and the modelled baseline (current day) scenario. It can be noted that strong similitudes between both, whilst the modelling scenario also shows additional flow paths as it is used a more refined DTM (1m), which identifies ground levels more accurately.

4.6 The West catchment modelling (**Figure 4-2**) has identified that some accumulation occurs at the urban region in the north-west and that there is an increase in flood depths, as the flooding waters flow in an easterly direction towards the Swalecliffe Brook through the central ditch, and, in certain regions, overtopping parts of it. However, the proposed development area to the north and south of the ditch remains flood free.

4.7 The East catchment modelling (**Figure 4-3**) has identified that flooding waters from off-site mostly flow along the Chestfield Road in a northerly direction, whilst some of water flow is diverted in a north easterly direction following land at lower levels and existing ditches. Flood water accumulates close to Radfall Cottage on Chestfield Road. Almost the entirety of the proposed development land between Chestfield Road and Swalecliffe Brook remain flood free.

5 On Site Mitigation

5.1 As discussed previously, the Site is located to the south of Whitstable, upstream of the areas at risk of sewer flooding, and encompasses the Swalecliffe Brook.

5.2 The current storm water / surface water falling on the Site from off-site is uncontrolled and enters the Swalecliffe Brook unopposed. Therefore, there is opportunity within the Site to mitigate and reduce the risk of fluvial flooding by restricting this rate of run-off across the Site, which will assist both surface and sewer flooding within Whitstable.

5.3 The following sections discuss measures that the Site can offer to help mitigate surface water runoff and assist with downstream flooding, are:

- Sustainable drainage (SuDS).
- Foul drainage.

Sustainable Drainage (SuDS)

5.4 By incorporating onsite SuDS, storm water flow will be restricted before being discharged into the Swalecliffe Brook. Because of this the SuDS can be designed over and above policy requirement in order to reduce flows and relieve pressure in the Swalecliffe Brook downstream.

5.5 SuDS are about minimising the effect of the built environment on the natural water cycle, and the fundamental purpose of a SuDS solution is to enable a developed site to handle rainfall and surface water runoff as if it were still a greenfield site. To achieve this, SuDS will be designed to mimic natural drainage by managing surface water runoff as close to the source and the surface as possible, rather than overwhelming stormwater drains and risking flooding.

5.6 The Four Pillars of SuDS Design will be used as a guide for all SuDS at the Site to ensure they are multifunctional:

1. Quantity – Store sufficient water as if it were a greenfield site and accounting for climate change.
2. Quality – To facilitate an improvement in water quality, by mitigating any contaminants.
3. Amenity – To improve local amenity, by facilitating recreation and meeting places that are well designed.
4. Biodiversity – Create habitats and improve biodiversity.

5.7 It is a recognised industry standard, set out in The SuDS Manual (CIRIA Report C753, 2015), that all designed SuDS should restrict storm water discharge to QBAR (the mean annual flood event) for all storm events up to and including the 1 in 100 year plus climate change storm event. In order to provide a further betterment on the rate storm water leaves the Site the development has the ability to restrict storm water discharge to the 1 in 1 year storm event, reducing the Sites discharge rate by 0.58 l/s/ha.

5.8 Based off the latest parameters plan, **Figure 5-1** illustrates the location of the proposed main detention basins across the Site. The basins shown are currently designed to accommodate all storm water for the 1 in 100 year plus 55% climate change storm event while discharging to the 1 in 1 year runoff rate. However, as previously mentioned, holistic incorporation of other SuDS features will be used across the Site.

5.9 The designed SuDS network for the Site, could be designed to attenuate and discharge to QBAR, where surface water would require an approximate attenuation volume of 25,722m^3 across 10 basins.

Figure 5-1: Indicative Main SuDS Locations

5.10 Across the Site there is additional opportunity to increase the storage by reducing the discharge rates in the basins and incorporating 'at source' SuDS. These include smart water butts within residential gardens, rainwater harvesting systems, rain gardens, swales, bioretention systems including tree pits, porous paving.

Component Types	Description	Collection Mechanism	Design Criteria					
			Water Quantity			Water Quality	Amenity	Biodiversity
			Peak Runoff Rate	Runoff Volumes				
				Small Events	Large Events			
Rainwater Harvesting Systems	Systems that collect runoff from the roof of a building or other paved surface for use	P		●	●		●	
Green Roofs	Planted soil layers on the roof of buildings that slow and store runoff	S	○	●		●	●	●
Filter Strips	Grass strips that promote sedimentation and filtration as runoff is conveyed over the surface	L		●		●	○	○
Filter Drains	Shallow stone filled trenches that provide attenuation, conveyance, and treatment of runoff	L	●	○		●	○	○
Swales	Vegetated channels (sometimes planted) used to convey and treat runoff	L	●	●	●	●	●	●
Bioretention Systems	Shallow landscaped depressions that allow runoff to pond temporarily on the surface, before filtering through vegetation and underlying soils	P	●	●	●	●	●	●
Trees	Trees within soil-filled tree pots, tree planters or structural soils used to collect, store, and treat runoff	P	●	●		●	●	●
Pervious Pavements	Structural paving through which runoff can soak and subsequently be stored in the sub-base beneath, and/or allowed to infiltrate into the ground below	S	●	●	●	●	○	○

* Key
P – Point (collected where rainfall lands), L – Lateral (rainfall runoff collected in a drain or channel), S – Surface (collected where rainfall lands over a surface)
● Likely Valuable Contribution ○ Some Potential Contribution to Delivery of Design Criterion

Table 5-1: CIRIA Guidance as an extract from Table 7.1 (SuDS Component Delivery of Design Criteria)

5.11 Due to the clay bedrock geology which underlies the entire Site it is unlikely that infiltration would be a viable means of discharging surface water and, therefore, this has not been included within the additional SuDS options. As a result, all discharge will be to Swalecliffe Brook.

5.12 **Table 5-1** (an extract of Table 7.1 from the CIRIA SuDS Manual C753) outlines the benefits that the additional SuDS options have.

5.13 Depending on the additional type of SuDS utilised, storm water flow has the opportunity to reduce the discharge rate to less than the 1 in 1 year storm event or remove surface water from entering the Swalecliffe Brook altogether.

Foul Drainage

5.14 Due to the fall of the Site any foul drainage would be able to connect into the existing sewer network via gravity.

5.15 However, in order to reduce the foul water flow into the existing network the Site has the opportunity to provide pumping stations, as indicatively located in **Figure 5-3** along the northern boundary, to store and reduce flows leaving the Site, thereby, reducing the pressure within the existing network.

Figure 5-2: Indicative Locations of Foul Water Pumping Stations

5.16 The pumping stations would also be able to prevent any flows leaving the Site for a designated timeframe, possibly for up to 48 hours (to be agreed during planning), during a storm event and then only release flows once any risk of flooding or surcharging within the network has passed.

6 Development Scenario with Mitigation

Development

6.1 As identified from the Section 6 flow paths in both sections of the development area (West and East) are well defined, the west region accumulates at the central ditch flowing downstream towards Swalecliffe Brook, the proposed development is planning to divert the ditch further south, which will increase the flow conveyance and volume capacity of retention. As well as location of SuDS features and flood storage areas next to the watercourse.

6.2 The East catchment also show that most of the surface flow convey at Chestfield Road direction north, with some overflow diverting at Radfall Cottage direction Northeast. Therefore, the proposal for this region is to enhance the ditch parallel to the road increasing its conveyance and flood capacity.

6.3 **Figure 6-1** shows the indicative Concept Plan with the proposed development layout.

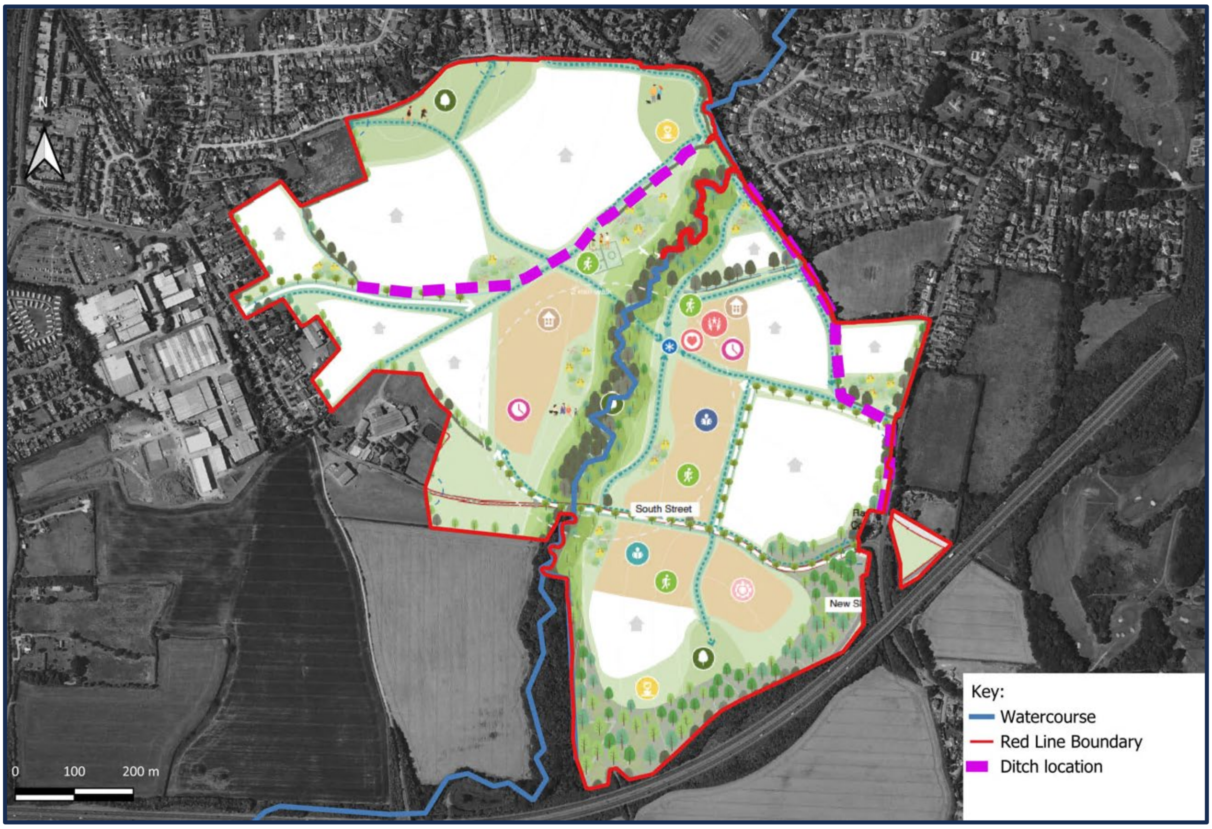


Figure 6-1: Indicative Concept Plan showing the proposed development layout

Development results

6.4 The development with mitigation scenario it is an indicative set of results for what will occur when the proposed development is in place. Therefore, there still some room for improvements and further work will refine the issues and identify such improvements as an iterative process. However, the mitigation (with proposed development) scenario identifies the issue and defines a possible solution and the possible impacts and, therefore, establish the first set of results and possible solution of the surface water flooding for the proposed development area and their effects downstream.

6.5 Ground levels for the diverted watercourses are expected to change to represent more accurately the final mitigation solution and to show the betterment that provides to the scheme as a whole.

6.6 **Figure 6-2** show the mitigation (with proposed development) scenario 1 in 100yr +55%CC West.

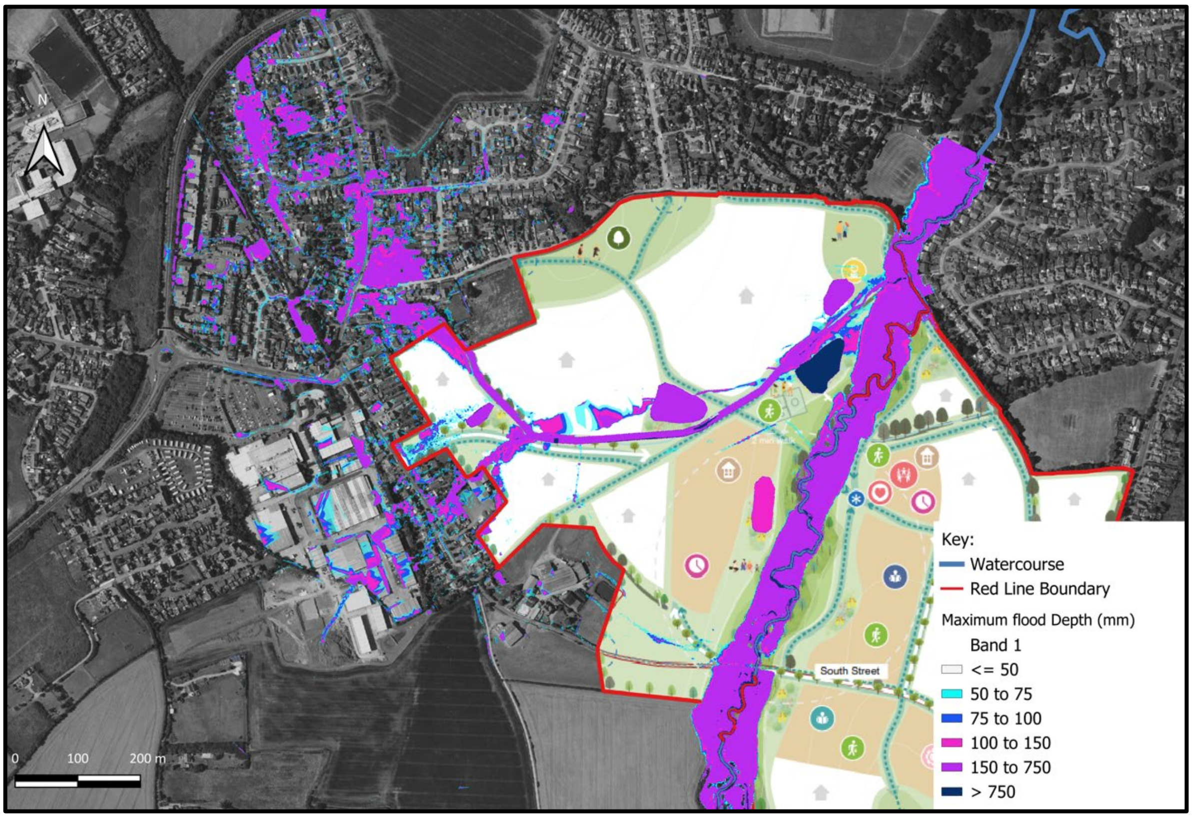


Figure 6-2: Mitigation scenario 1 in 100yr +55%CC-West

6.7 Central ditch hydrographs Baseline (current day) vs Mitigation (with proposed development) – Upstream and Downstream sections **Figure 6-3**.

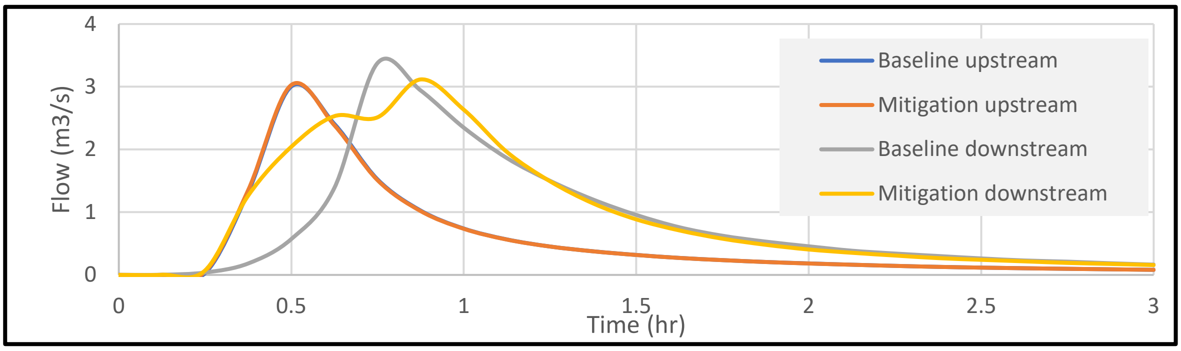


Figure 6-3: Central ditch peak hydrographs, upstream and downstream comparison

6.8 The proposed development with mitigation demonstrate that for the east and west development areas the residential and employment areas will remain flood free.

6.9 The proposed development with mitigation scenario east and west show that the proposal can bring betterment and has an positive impact in the reduction of flood risk.

6.10 **Figure 6-4** show the mitigation (with proposed development) scenario 1 in 100yr +55%CC East.

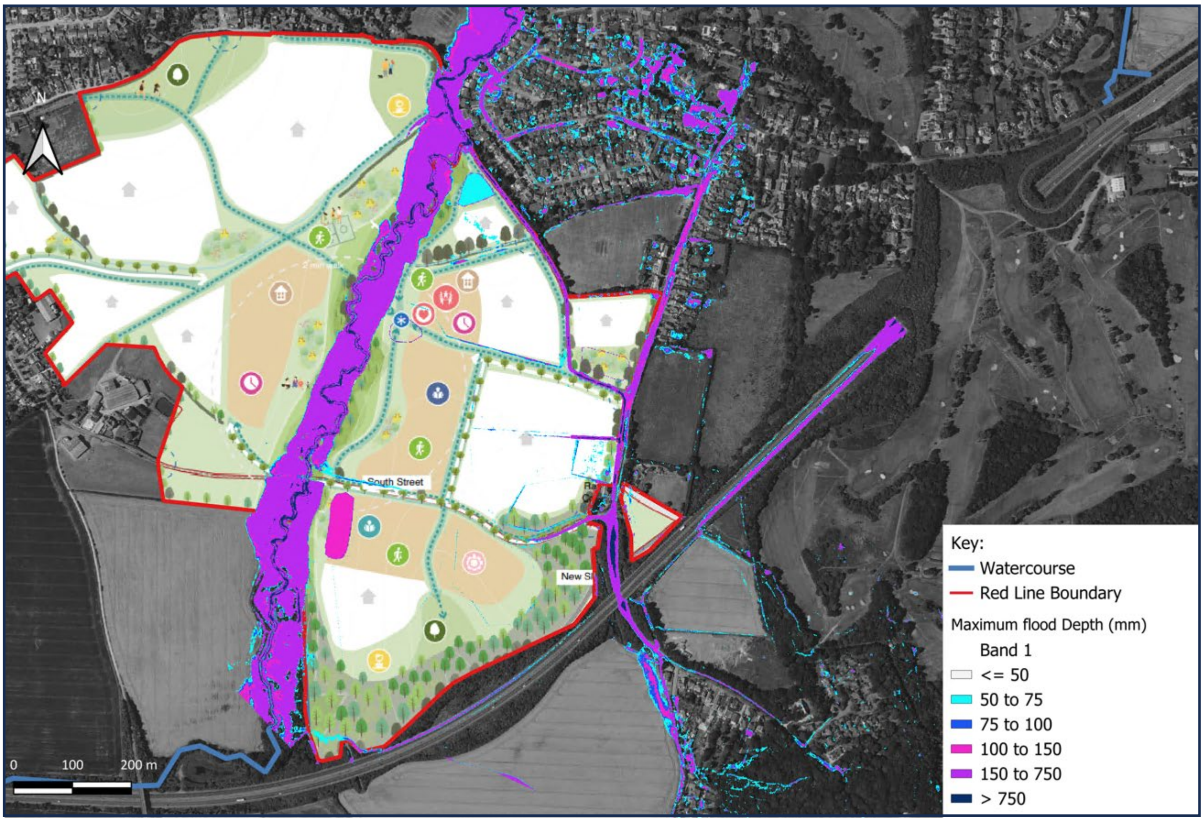


Figure 6-4: Mitigation scenario 1 in 100yr +55%CC-East

7 Summary

7.1 Whitstable is impacted by both surface water and fluvial flooding on a regular basis, which causes the existing sewer network to be become overwhelmed. This then causes storm water to back up within the network and flood residential areas not affected by the initial flooding events.

7.2 In addition, Southern Water has identified that sewer flooding occurs. After undertaking a catchment wide assessment of Whitstable to understand the causes of flooding and outline interventions to help reduce and mitigate the risk of sewer flooding. These interventions range from catchment wide modelling, upgrades to the WwTW and inclusion of at source control measures.

7.3 Preliminary hydrological modelling has shown how SuDS and realignment of the western ditch can both assist mitigate baseline (current day) flooding identified. By doing this with multifunctional spaces and incorporating the SuDS design ethos of the Four Pillars alongside the quantity of water that can be stored, water quality improvements can occur, as well as providing well designed spaces for amenity and biodiversity net gain, as help mitigate the flood risk within Whitstable by restricting both fluvial and storm volumes and flow rates discharging into the Swalecliffe Brook.

7.4 Possible sewer flooding reduction can also occur by instead of using the possible gravity discharge of foul (which wouldn't have any surface waters discharging to it), it is proposed that pumping stations are used, which will be able to restrict and even prevent the flow of foul when local sewers downstream are at capacity.

7.5 The proposed development at the Site can significantly assist in decreasing both surface water and sewer flooding downstream. Further details and designs will be developed as the Site progresses through the planning system, to be defined at Outline and Reserved Matters stages.

Appendix A – Southern Water's Clean Rivers and Seas Task Force Presentation

Clean Rivers and Seas Task Force

Tankerton Sailing Club March 2023

WATER for LIFE

from Southern Water

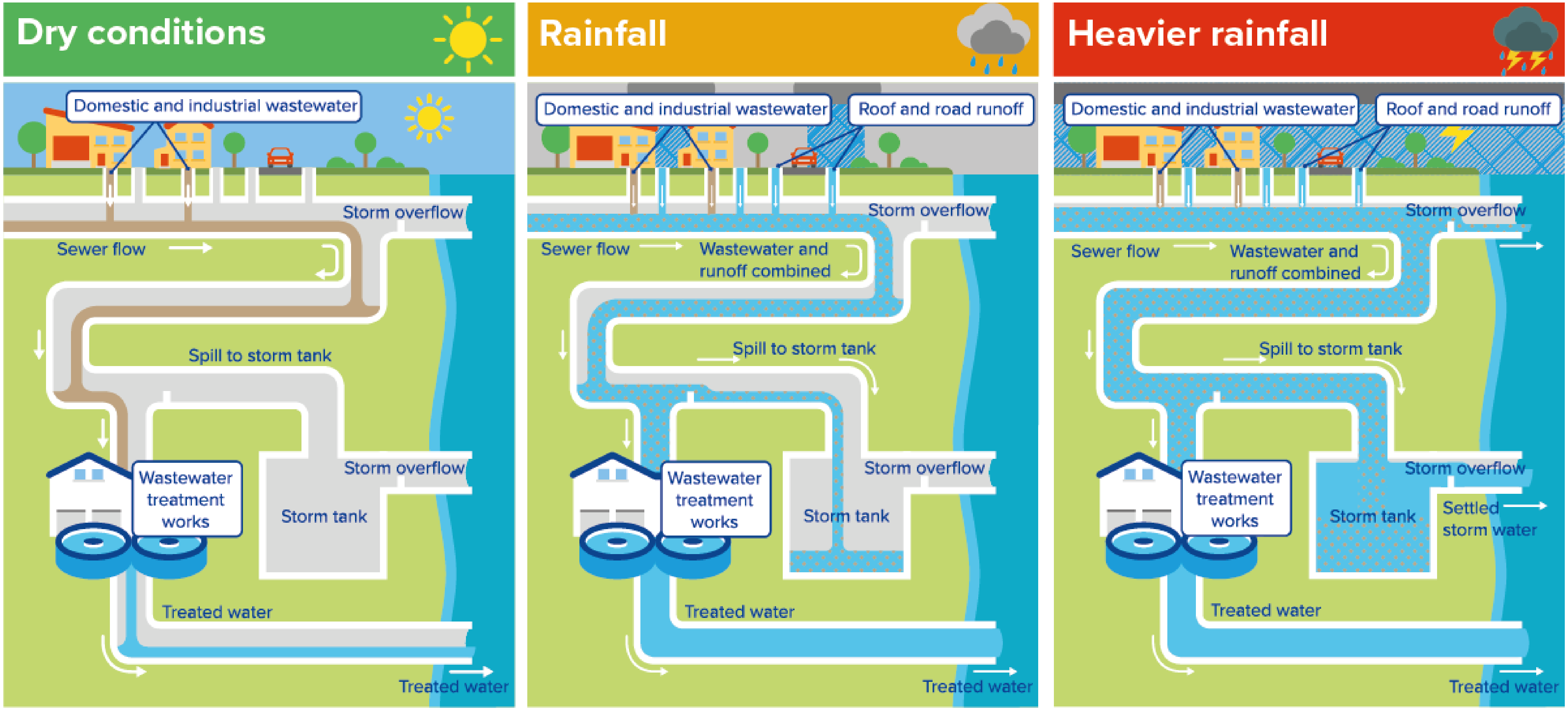
Clean Rivers and Seas Task Force

- We agree the use of overflows is no longer acceptable.
- The task force is responsible for delivering at least six pathfinder projects over the next two years. The task force will seek to establish strong partnerships to ensure their success.
- In parallel, we will build and deliver a regional plan to reduce storm releases between now and 2030.
- Weblink - [Storm Overflows (southernwater.co.uk)]

WATER for LIFE

from Southern Water

What are storm overflows?



There are broadly 3 main types of intervention to reduce flooding and storm overflow use:

1. **Source control** (removing and slowing the flow of rain water)
   Rainwater harvesting, Permeable paving, Green roofs, Soakaways (includes tree pits), Rain garden (swales), Planters

2. **Optimisation of existing infrastructure**
   Optimisation, tweaking of connected systems and interface, Different mechanical and electrical equipment (e.g. pumps), Improvements in pumping station and storm tank use and control, Smart network control with increased digitalisation

3. **Build bigger infrastructure** (building larger pipes, pumping stations, etc.)
   Wetlands treatment (Groundwater), Sewer lining/sealing (Groundwater), Larger sewers, Large storm tanks, Large treatment works

Exhausting the first two options through pathfinder approach

WATER for LIFE from Southern Water

What might the solutions look like?

Working in partnership

- We want to work in **collaboration** with a range of partners at all levels and across industries to achieve this.
- We also want to promote the simple actions that everyone can do to help such as installing water butts to recycle rain water or reducing the amount of pavement in gardens.

WATER for LIFE from Southern Water

Our task force is exploring ways to reduce storm overflows via our pathfinder projects

The Clean Rivers and Seas Task Force is a dedicated team that is working to significantly reduce the use of storm overflows by 2030. **It is delivering six pathfinder projects over the next two years.**

Pan Parishes

- Sealing private pipework with an innovative chemical called Tubogel, as well as sealing the public sewer network to reduce groundwater infiltration.
- Exploring the creation of a local wetland.

Swalecliffe

- Working to reduce Swalecliffe's 74 hectares of hard surfaces.
- Separating the surface water and sewer network.
- Hotspot mapping shows us where to target solutions.

Margate

- Finding opportunities to increase surface water drainage with local councils. For example, reducing the amount of hard surfaces across Margate.
- Looking at opportunities to separate the surface water and sewer network and improve drainage.

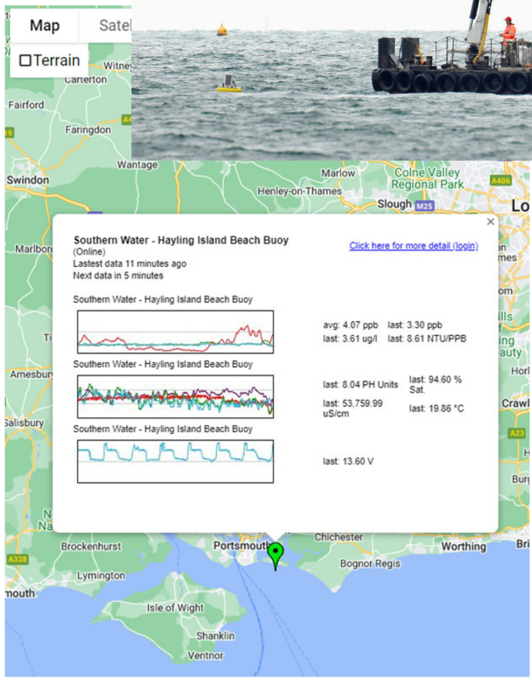
Sandown

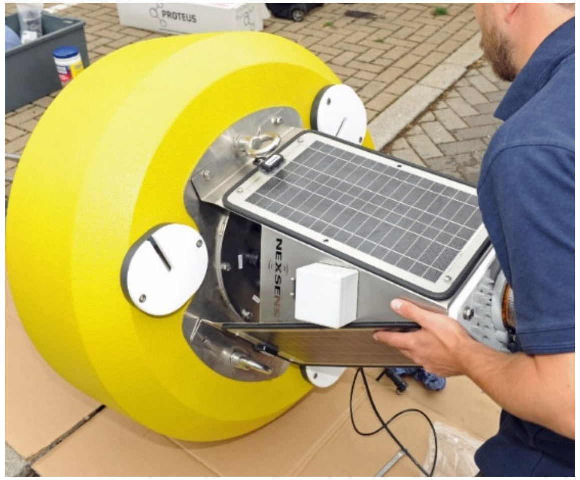
- Enhancing wastewater pumping station control, surface water removal and storage solutions.
- Trialling slow-drain water butts in Havenstreet.

Deal

- Installing smart or passive water butts or rain planters.
- Working with the local councils and highways to introduce roadside verges, parks and gardens and more green spaces.
- Engaging with schools.
- Surveying surface water connections.
- Introducing rainfall monitors and tracking the flow of surface water.
- Improving our Golf Road pumping station.
- Increasing our storm tank capacity.

Water quality testing buoys





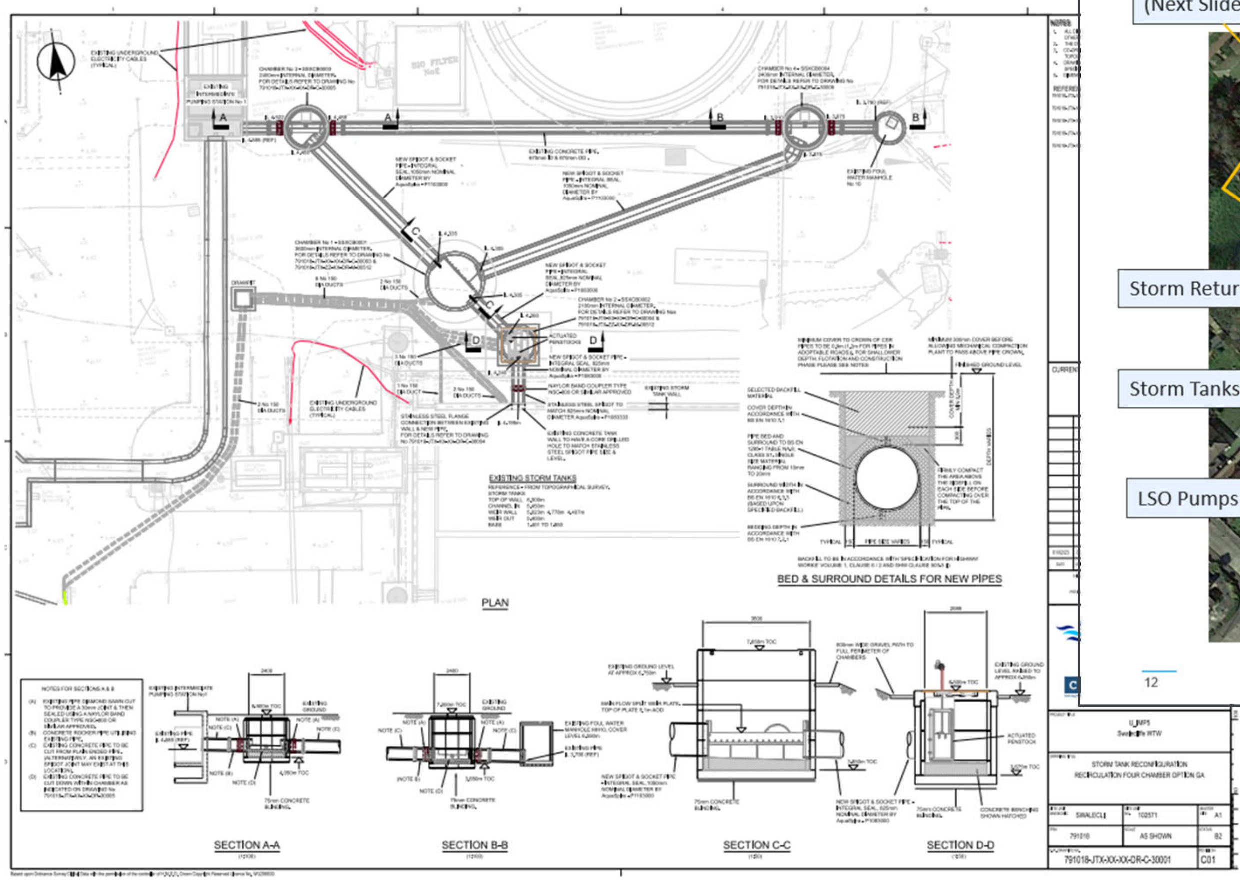
- Southern Water wants to improve water quality understanding
- Two water quality testing buoys were launched into the sea in the summer 2022 – one off Tankerton shore and one off Hayling Island
- These are 12-month pilots
- Data will be publicly available online once calibration is complete

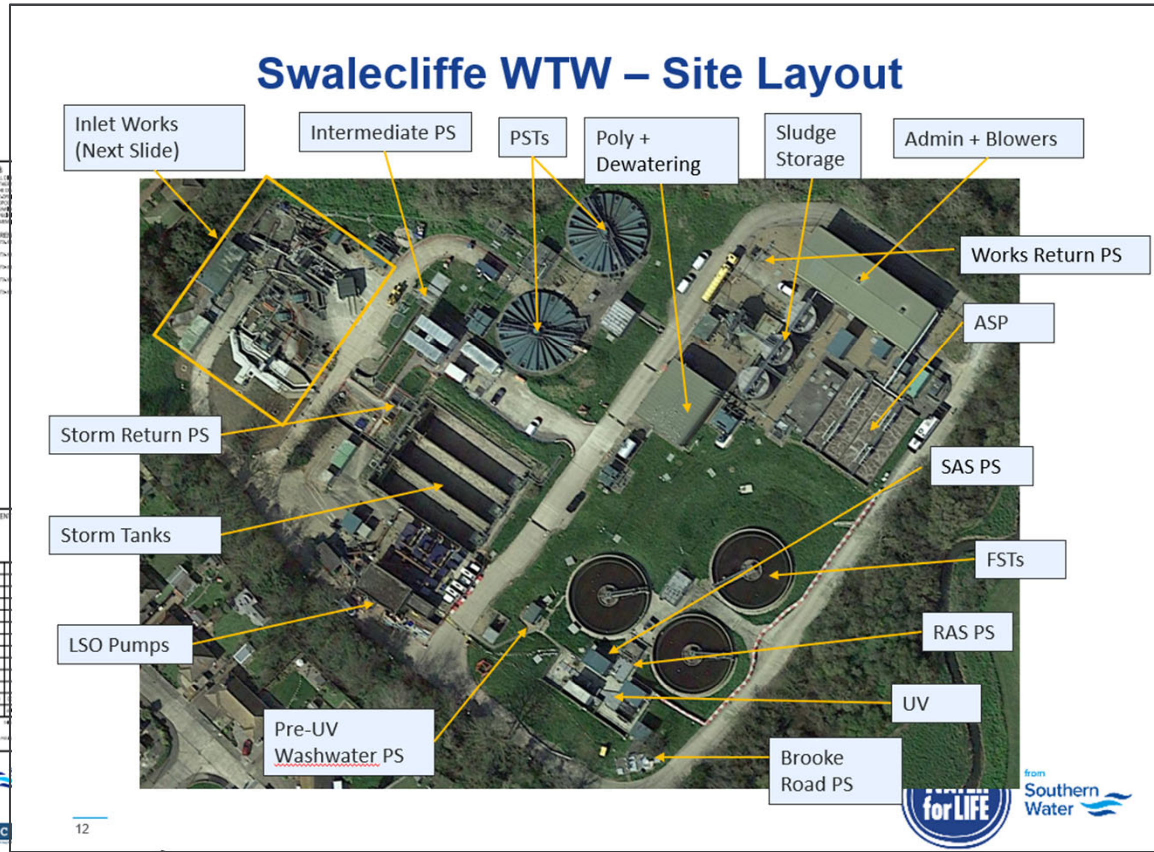
from Southern Water

Whitstable (Swalecliffe Catchment)

Pathfinder Activity

Swalecliffe Treatment Works





Swalecliffe Catchment – Pathfinder Activity

Interventions

1. Optimisation

2. Misconnections

3. SuDS Schemes

4. Planters & Water Butts

5. Modelling

Aim:

To understand the existing combined system and utilise its full potential to achieve maximum benefit.

Station Road WPS:

- ‘Health Check’ carried out by Afeco
- Analysis currently being carried out to understand system and determine potential opportunities

Centaur System:

- Trialling innovative system to utilise spare capacity in the Diamond Road sub-catchment

Swalecliffe Catchment – Pathfinder Activity

Interventions

1. Optimisation
2. **Misconnections**
3. SuDS Schemes
4. Planters & Water Butts
5. Modelling

21 potential opportunities identified via GIS analysis

Aim:

To investigate locations where surface water pipes connect into the combined system to identify opportunities for re-connection.

15 of these are genuine opportunities

			Grid Ref.	CSO Sub-Catchment	Pipe Dia. (mm)	Node Type	Genuine Opportunity?	Priority
		d	TR 1166 1705	Diamond Road Whitstable CEO	?	CSO	N	N/A
		ad	TR 1166 6803	Northwood Road Whitstable No 2 CSO	300	CSO	N	N/A
		d	TR 1165 081D	Diamond Road Whitstable CEO	750	Dummy Manhole	Y	H
4	1569808	Westmeads Road	TR 1166 350D	Diamond Road Whitstable CEO	100	Dummy Manhole	Y	H
5	1564956	Northwood Road	TR 1166 5853	Northwood Road Whitstable No 1 CSO	300	Manhole	?	L
6	1569312	Salton Road	TR 1166 4506	Diamond Road Whitstable CEO	100	Manhole	Y	H
7	1566236	Kingsdown Park	TR 1167 8051	Northwood Road Whitstable No 2 CSO	225	Manhole	Y	M
8	1569841	Albert Street	TR 1066 6709	Diamond Road Whitstable CEO	150	Manhole	Y	L
9	1569860	St Peter's Road	TR 1066 8904	Diamond Road Whitstable CEO	225	Manhole	Y	H
10	1569756	Off Clare Road	TR 1166 4502	Diamond Road Whitstable CEO	225	Manhole	Y	M
11	1570543	Bayview Road	TR 1065 6101	Diamond Road Whitstable CEO	?	Manhole	Y	L
12	1570545	B2205	TR 1065 5003	Diamond Road Whitstable CEO	?	Manhole	Y	M
13	1690386	Cornwallis Circle	TR 1066 5403	Diamond Road Whitstable CEO	225	Manhole	N	N/A
14	603283960	Aurelie Way	TR 1165 8110	Diamond Road Whitstable CEO	50	Manhole	Y	L
15	1564854	Tower Parade	TR 1167 1051	Diamond Road Whitstable CEO	175	Manhole	Y	M
16	1570941	Beresford Road	TR 1066 9303	Diamond Road Whitstable CEO	225	Manhole	Y	M
17	1575237	Wheatley Road	TR 1166 1502	Diamond Road Whitstable CEO	225	Manhole	Y	M
18	44797014	Off Kendal Meadow	TR 1466 045P	Swalecliffe CSO/Swalecliffe SSO	300	Pumping Station	N	N/A
19	1573347	Off Westgate Terrace	TR 1166 090P	Diamond Road Whitstable CEO	1050	Pumping Station	N	N/A
20	1569360	Railway Avenue	TR 1166 1402	Diamond Road Whitstable CEO	225	Manhole	Y	H
21	1569823	Woodlawn Street	TR 1066 7802	Diamond Road Whitstable CEO	225	Manhole	Y	H

Next Steps:

- Confirm impermeable area contribution
- Arrange for further surveys where required
- Further investigation into possible re-connection points (e.g. rivers, surface water pipes, water butts)
- Refine prioritised list of opportunities based on outputs from analysis above

WATER for LIFE

from Southern Water

Swalecliffe Catchment – Pathfinder Activity

Interventions

1. Optimisation

2. Misconnections

3. SuDS Schemes

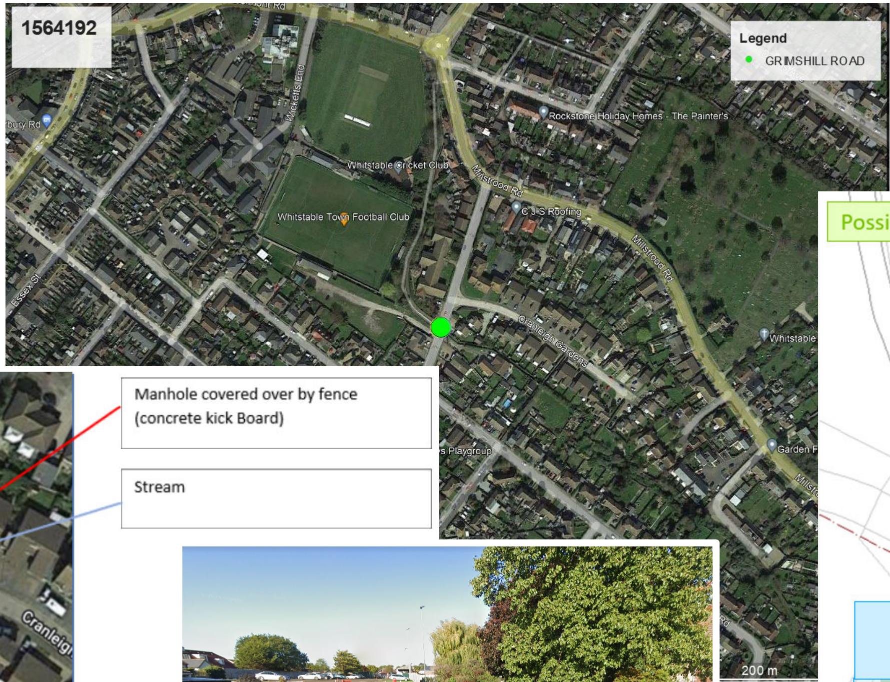
4. Planters & Water Butts

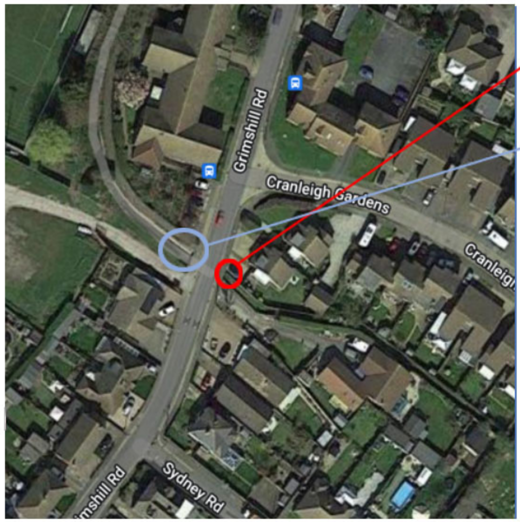
5. Modelling

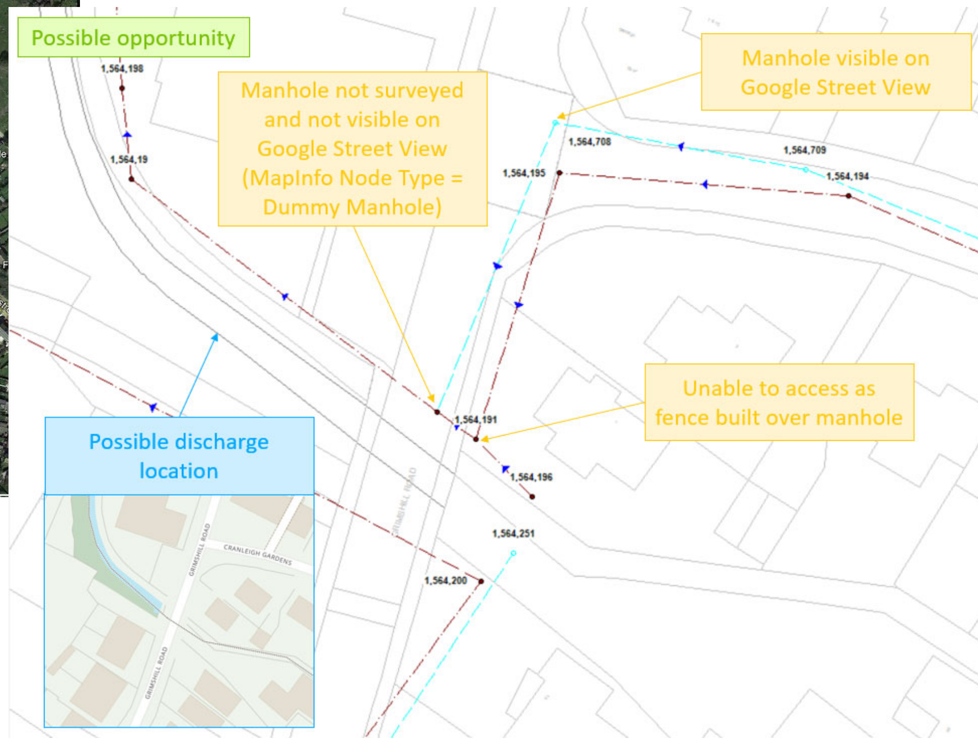
Example – Grimshill Road:

Survey results:

- Unsuccessful – property fence blocking access to manhole cover
- Nearby stream (Gorrel Stream) running along driveway near to blocked manhole





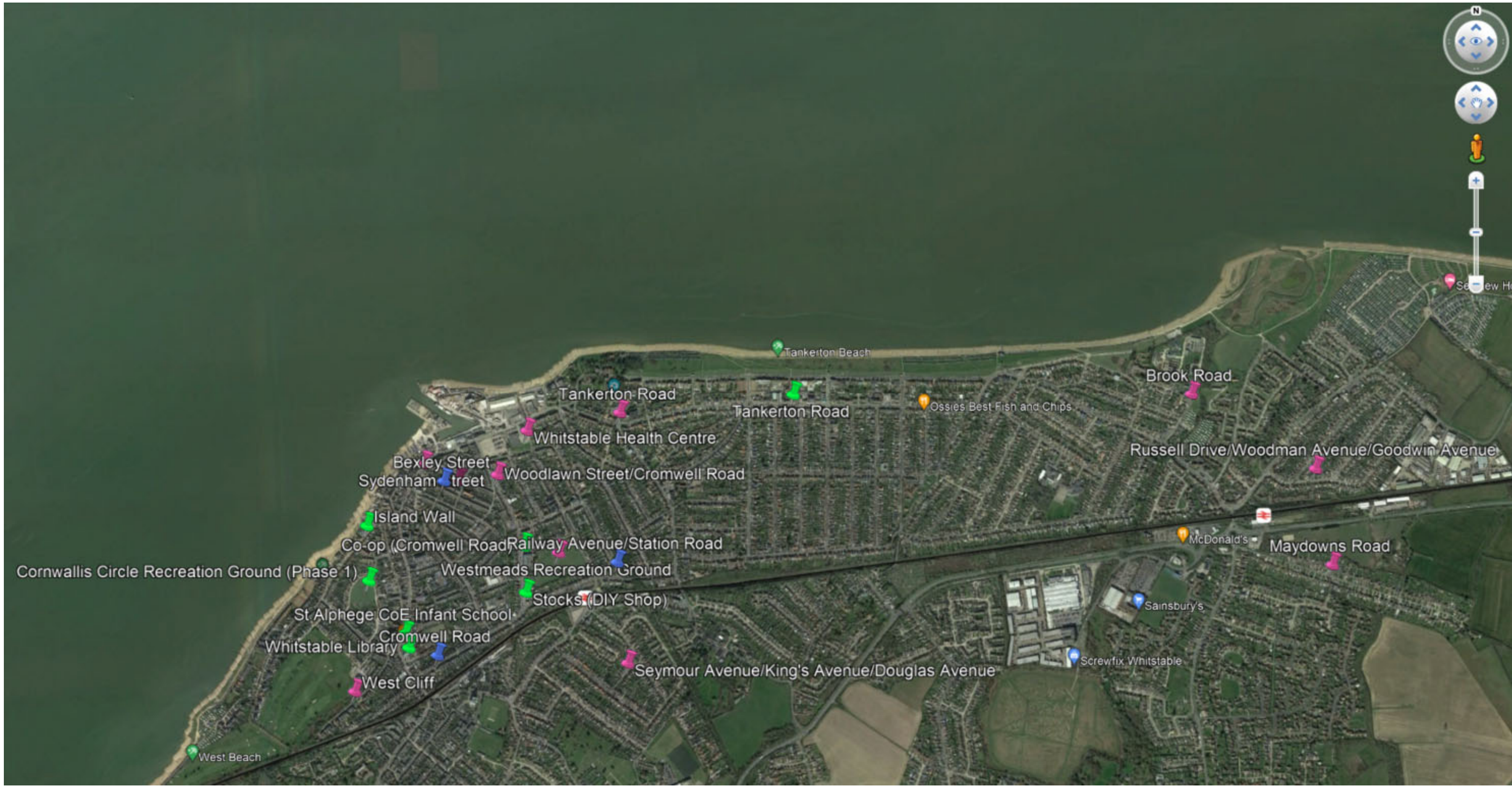


Swalecliffe Catchment – Pathfinder Activity

Interventions

1. Optimisation
2. Misconnections
3. **SuDS Schemes**
4. Planters & Water Butts
5. Modelling

Locations of SuDS Schemes:



Swalecliffe Catchment – Pathfinder Activity

Interventions

1. Optimisation
2. Misconnections
3. **SuDS Schemes**
4. Planters & Water Butts
5. Modelling

Whitstable Library

LIVING WALL - framework for climbing plants, to incorporate existing library sign.

SuDS planter takes water from downpipe/library roof

Existing gullies - water diverted into raingardens or tree pits.

Existing road falls towards SE side (away from edge with library forecourt) - potential to collect SW from road gullies and feed into SUDs?

Raingarden with amended drainage connection - diverts surface water run-off into SuDs with overflow back to existing below ground drainage.

Grey to Green scheme, Sheffield

White Hart Lane (Bob Bray Associates)

Southern edge - potential for raingardens along edge with road (NB maintain access for vehicles stopping here?).

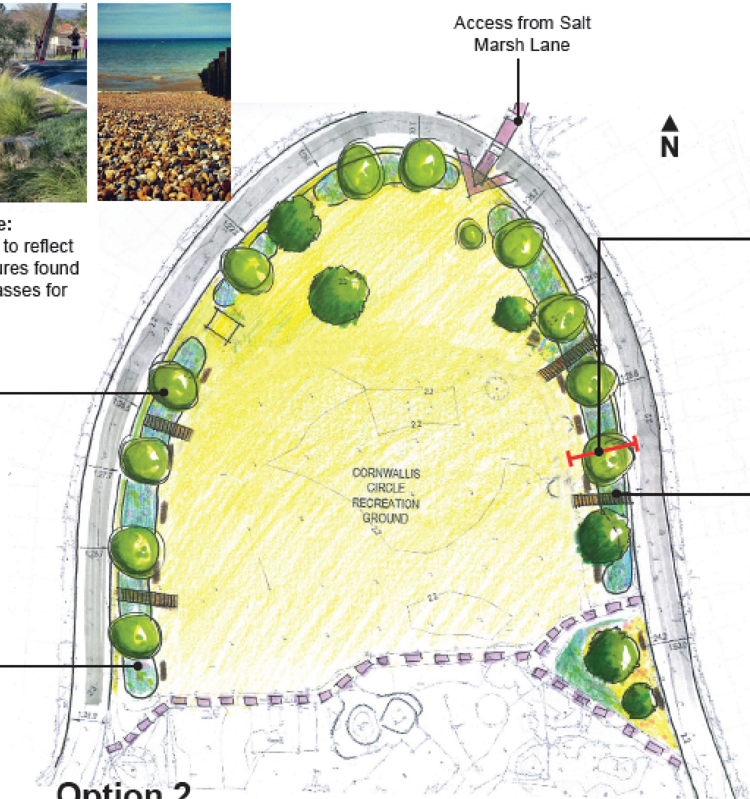
Swalecliffe Catchment – Pathfinder Activity

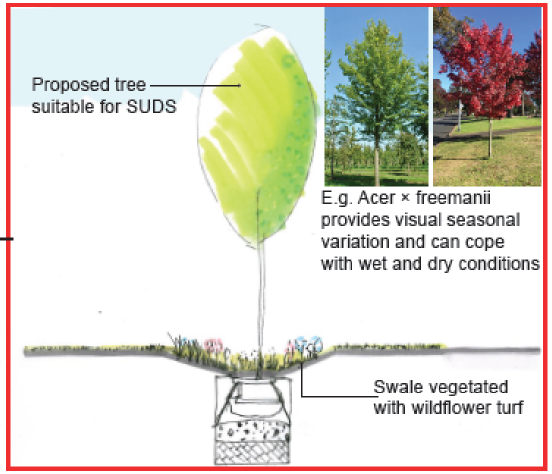
Interventions

1. Optimisation
2. Misconnections
3. **SuDS Schemes**
4. Planters & Water Butts
5. Modelling

Cornwallis Circle Recreation Ground

Ornamental planting with gravel / boulder base:
Boulders and gravel to line the base of the swale, to reflect the coastal location and mirror materials and textures found on the nearby beach. Planted with ornamental grasses for year-round structure and visual interest





Design for ecology
Use of flowering perennials within swales will attract pollinating insects with further opportunity to provide 'bug hotel' shelters areas using logs and other organic materials.

Option 2

- Perimeter swales with tree planting
- Rain garden / wild wet meadow
- Open space retained with connecting board walks / bridges

Amenity use
Timber board bridges span the swales linking to the central open space to improve permeability and access to the park from the east and west. These would create new permanent connections and would affect existing balustrade fencing

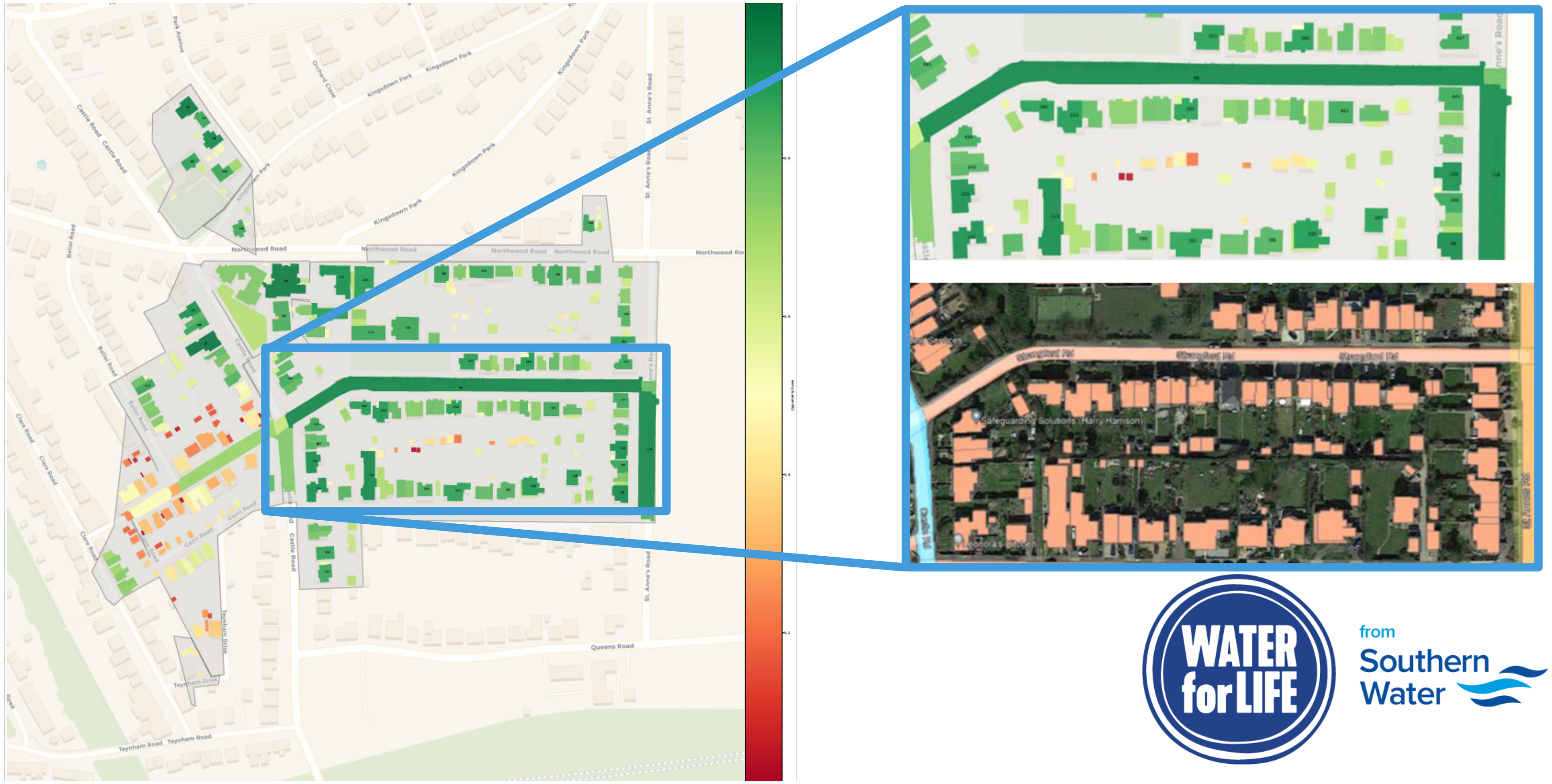
Swalecliffe Catchment – Pathfinder Activity

Interventions

1. Optimisation
2. Misconnections
3. SuDS Schemes
4. **Planters & Water Butts**
5. Modelling

Aim:

To target specific areas of the catchment for planter and water butt install to achieve maximum impact in reducing surface water run-off, based on a GIS analysis of impermeable area contribution.



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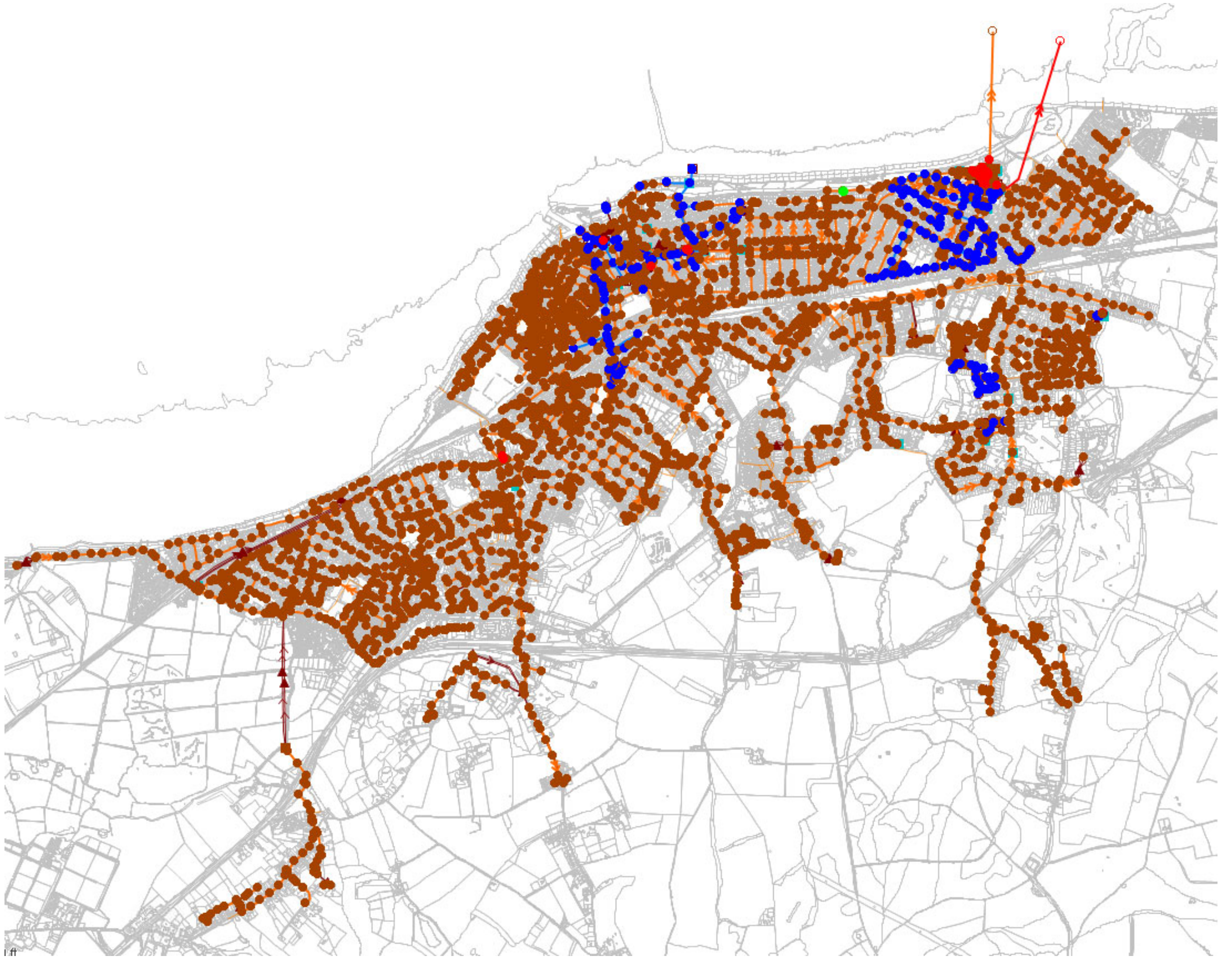
Swalecliffe Catchment – Pathfinder Activity

Interventions
1. Optimisation
2. Misconnections
3. SuDS Schemes
4. Planters & Water Butts
5. Modelling



Aim:

To model all Pathfinder activities in the Swalecliffe catchment, so that we can measure progress and plan future work.

Other slides

Swalecliffe Catchment – Pathfinder Activity

Interventions

1. Optimisation
2. Misconnections
3. **SuDS Schemes**
4. Planters & Water Butts
5. Modelling

Aim:

To implement nature-based solutions to slow or remove surface water run-off entering the combined system.

Location	Status	Design Lead Company	Reason for Status	SuDs Type	CSO	Estimated Contributing Impermeable Area (Ha)
Co-op (Cromwell Road)	Active	Groundwork		SuDS – Planters & Water Butts	Diamond Road Whitstable CEO	0.105
Cornwallis Circle Recreation Ground (Phase 1)	Active	Stantec		Large SuDS – Green Parks	Diamond Road Whitstable CEO	0.4
Island Wall	Active	Groundwork		SuDS – Planters & Water Butts	Diamond Road Whitstable CEO	0.0479
St Alphege CoE Infant School	On Hold	Groundwork	Connectivity surveys inconclusive	SuDS – Planters & Water Butts	Diamond Road Whitstable CEO	0.0086
Stocks (DIY Shop)	Active	Groundwork		SuDS – Planters & Water Butts	Diamond Road Whitstable CEO	0.0417
Tankerton Road	Active	Groundwork		SuDS – Planters & Water Butts	Northwood Road Whitstable No 2 CSO	0.315
Whitstable Library	Active	Groundwork		SuDS - Living Walls	Diamond Road Whitstable CEO	0.0087
Cromwell Road	Active	Groundwork		SuDS - Highways	Diamond Road Whitstable CEO	0.8001
Railway Avenue/Station Road	Active	Groundwork		SuDS - Highways	Diamond Road Whitstable CEO	0.4213
Bexley Street	Active	Groundwork		SuDS - Highways	Diamond Road Whitstable CEO	0.5206
Westmeads Recreation Ground	On Hold	Stantec	Waiting on connectivity	Large SuDS – Green Parks	Swalecliffe CSO/ Swalecliffe SSO	0.8461
Woodlawn Street/Sydenham Street/ Albert Street	Active	Groundwork		SuDS – Planters & Water Butts	Diamond Road Whitstable CEO	0.63
Seymour Avenue/King's Avenue/ Douglas Avenue	On Hold	Stantec	Waiting on connectivity	SuDS - Highways	Diamond Road Whitstable CEO	0.8962
Tankerton Road	On Hold	Stantec	Waiting on connectivity	SuDS - Highways	Swalecliffe CSO/ Swalecliffe SSO	0.4887
Maydowns Road	On Hold	Stantec	Waiting on connectivity	SuDS - Highways	Swalecliffe CSO/ Swalecliffe SSO	0.5385
Russell Drive/Woodman Avenue/ Goodwin Avenue	On Hold	Stantec	Waiting on connectivity	SuDS - Highways	Swalecliffe CSO/ Swalecliffe SSO	0.9089
Brook Road	On Hold	Stantec	Waiting on connectivity	SuDS - Highways	Swalecliffe CSO/ Swalecliffe SSO	0.2467
West Cliff	On Hold	Stantec	Waiting on connectivity	SuDS - Highways	Swalecliffe CSO/ Swalecliffe SSO	0.2759
Sydenham Street	On Hold	Groundwork	Waiting on connectivity	SuDS - Highways	Diamond Road Whitstable CEO	TBC
Woodlawn Street/Cromwell Road	On Hold	Groundwork	Waiting on connectivity	SuDS - Highways	Diamond Road Whitstable CEO	TBC
Whitstable Health Centre	On Hold	Groundwork	Waiting on connectivity	Large SuDS – Roofs & Car Parks	Swalecliffe CSO/ Swalecliffe SSO	TBC
Cornwallis Circle Recreation Ground (Phase 2)	Not Started	Stantec	Waiting for Phase 1 to progress	Large SuDS - Green Parks	Diamond Road Whitstable CEO	0.85

Appendix B – Supporting Hydrology and Hydrological Modelling Information

This Appendix presents more information on the hydrology and hydrological modelling undertaken to generate the results discussed in the main text.

Hydrology

The EA flood model has been obtained, as shown within **Figure 2-3** and **2-4,** which considers only the fluvial (river water) element of the entire catchment that flows within Swalecliffe Brook, so covers a substantial amount of land both up and down stream of the Site.

To represent the pluvial element (surface water), Brookbanks has acquired Flood Estimation Handbook (FEH) Catchment Descriptors (CD) for the catchment where the development lies within.

The topography across the Site falls gently from high points of approximately c.35m Above Ordnance Datum AOD along the southern boundary, at the A299, c.33m AOD on the western boundary, and c.26m AOD on the eastern boundary, falling to an overall low point of c.11m AOD along the Swalecliffe Brook at the northern boundary.

The wider catchment the EA uses has been analysed and compared with the FEH CDs and, based on topographic contours, has been updated to determine the sub-catchments that drains towards the development area, those catchments are illustrated in **Figure A-1**.

To determine the design storm there are many equations to calculate, with the time of concentration the most commonly used are Kirpich (1940) and Soil Conservation Service (SCS)(1972). Using the formulas the concentration time for the catchments are 24 and 27 minutes (min) and, therefore, a design storm of 30min has been deemed to be the most adequate to the site (East and West catchments).

The FEH rainfall modelling includes the Duration Depth Frequency curves (DDF), such curves represent the amount of rainfall (mm) falling related with the frequency of the event (commonly known as return period) and the duration of the event.

Two FEH datasets have been used, as follows:

- FEH13 rainfall DDF model was based on an analysis of over 170,000 station-years of data from daily rain gauges throughout the UK, together with about 17,000 station-years of hourly data.
- FEH22 rainfall model is the FEH’s latest UK-wide statistical model for rainfall depth-duration-frequency (DDF) estimation.

The main difference between FEH13 and FEH22 is the data and methods used to estimate flood frequency. FEH22 uses the latest data and improved methods for estimating flood frequency, including better representation of extreme rainfall events. However, both have been used, as although the FE22 is more up to date, the FEH13 data will show more conservatively modelled data.

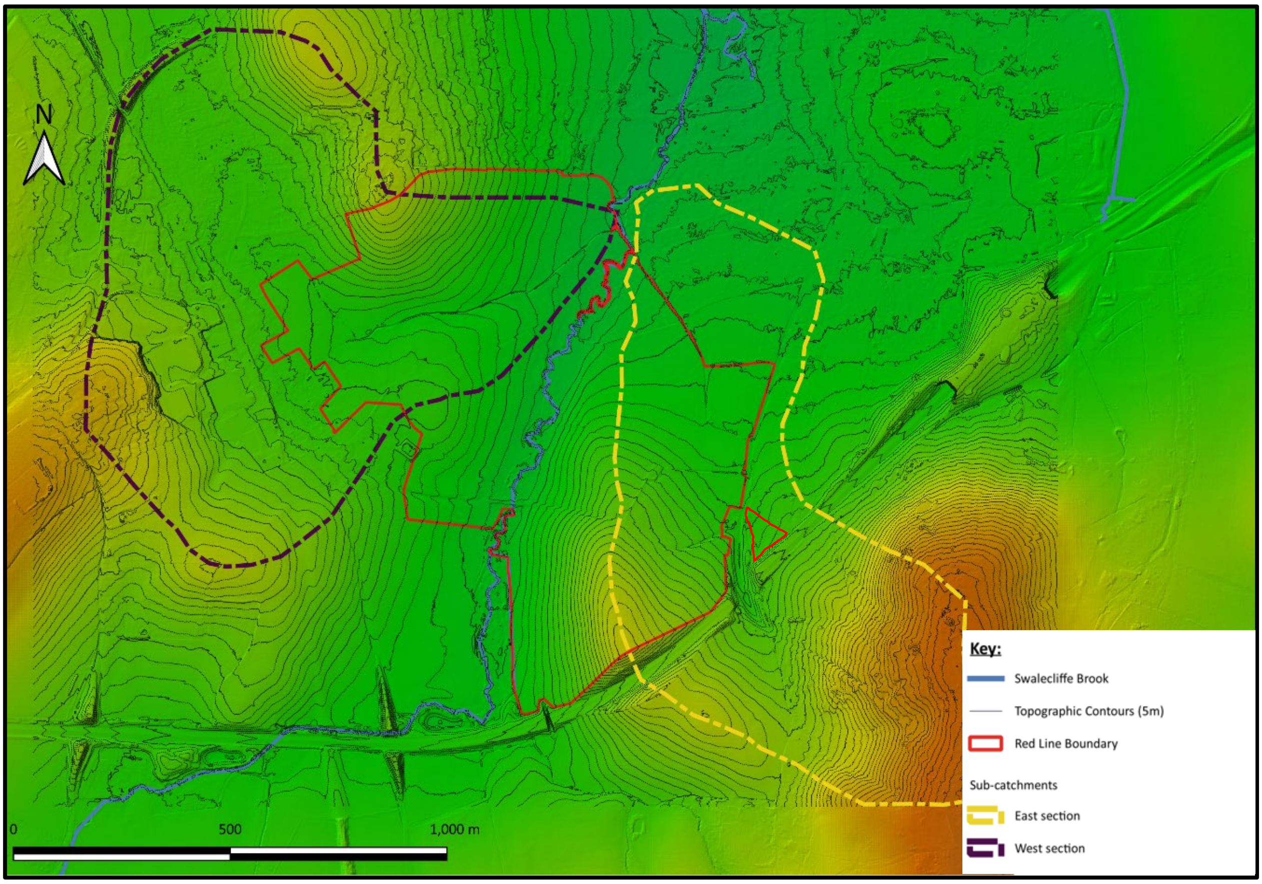


Figure A-1: Development area – Sub-catchments

Figure A-2 shows the DDF curves for 30min duration, 1 in 100yr event calculated with the FEH13 and FEH22 database.

Table A-1 below show the calculation for 1 in 100yr and 1 in 1000yr rainfall event for the FEH13 and FEH22 database.

Table A-1 Rainfall data DDF, FEH13 & FEH22

Duration	Event	FEH13	FEH22
30 min	100yr	32.8	28.8
30 min	1000yr	52.7	44.8

For the purpose of this report the FEH13 has been selected as it is considered most conservative scenario for the design rainfall.

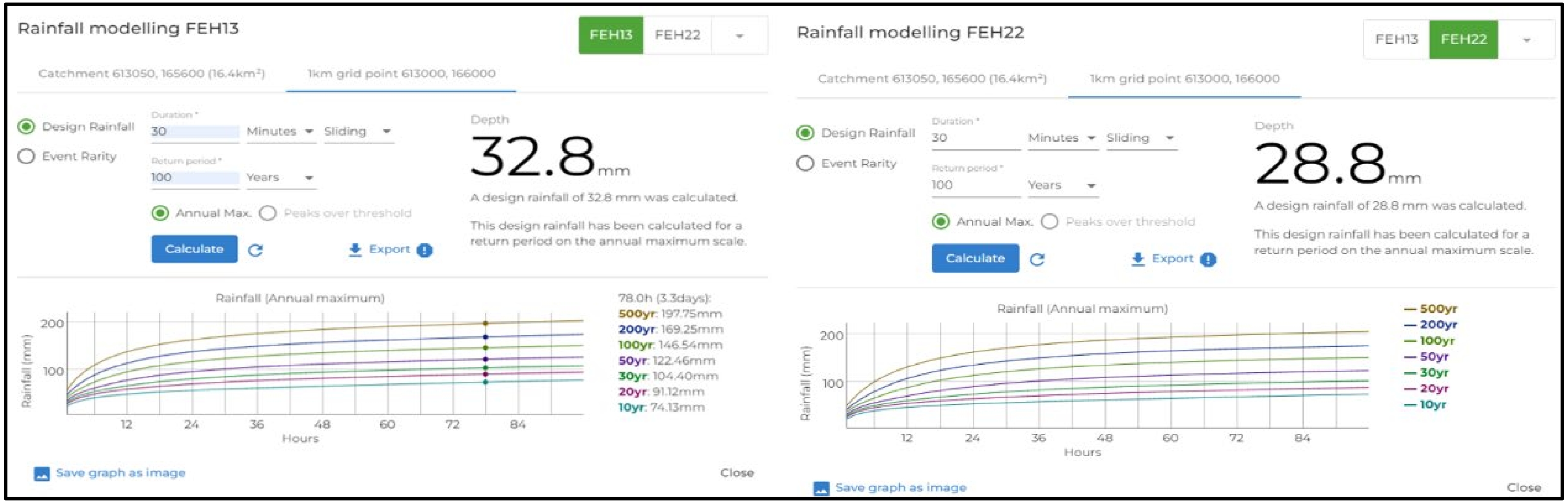


Figure A-2: Duration Depth Frequency curves – 1 in 100yr, FEH portal

The construction of the hyetographs, which represent the amount of rainfall as time progresses, is shown in **Figure A-3**.

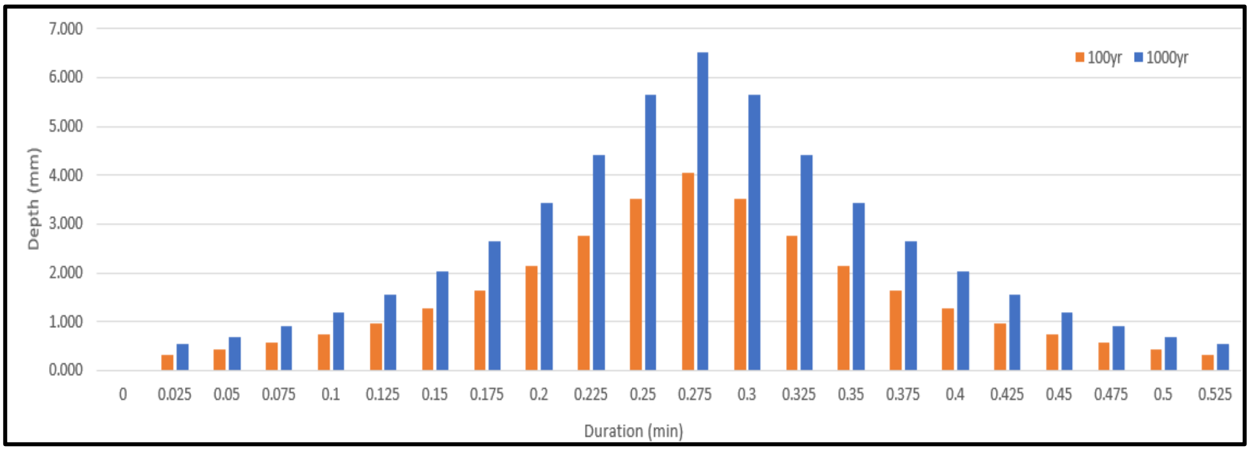


Figure A-3: Design Storm Hyetographs 1 in 100yr and 1 in 1000yr

Hydrological Modelling

Tuflow has been used as the hydrological modelling software since it has the capability to model direct rainfall approach within a delimited 2D active domain. Tuflow version 2023-03-AB has been used for this model.

1D domain

Tuflow has the capacity to model the Swalecliffe Brook watercourse as a 1D domain. However, for the purpose of this report the initial water levels (IWL) of the water course has been determined with the EA model maximum water levels and the 1 in 100yr maximum water levels has been used as initial condition for the watercourse.

It is also possible to include within the 1D domain the urban network as drainage/sewer network including manholes, gullies, underground storage, pumping etc. due to the limited information none of this elements are included within the surface water modelling. Therefore all the elements are modelled entirely within the 2D domain.

2D domain

As stated above, the Swalecliffe Brook was modelled within the 2D domain as initial water level, using the maximum level from the EA model.

As well the rainfall area was defined by the sub-catchment previously calculated in Section 4. The rainfall area was sub-divided in greenfield area and urban area and the losses calculated approximately 70% of the pluvial will become effective rainfall and for the greenfield ~25%. The calculated with the Base Flow Index using the Hydrology of Soil Types (BFIHOST) for the specific catchment.

Note, the above figures do not sum to 100%, and are not meant to. Rather for urban areas the remaining 30% and for greenfield the remaining 75% is infiltration, evapotranspiration, and used by plants, etc. Hence, for modelling work, only the rainfall that turns into surface water flows needs to be considered.

The direct rainfall was located within the 2D with the feature 2d_rf, the design was in comma separated values (.csv) format as boundary condition data base (bc_dbase). These database includes the hyetograph (design rainfall) for the following events:

- 1 in 100yr.
- 1 in 100yr +38%CC; Central estimate.
- 1 in 100yr +55%CC; Higher estimate.
- 1 in 1000yr.

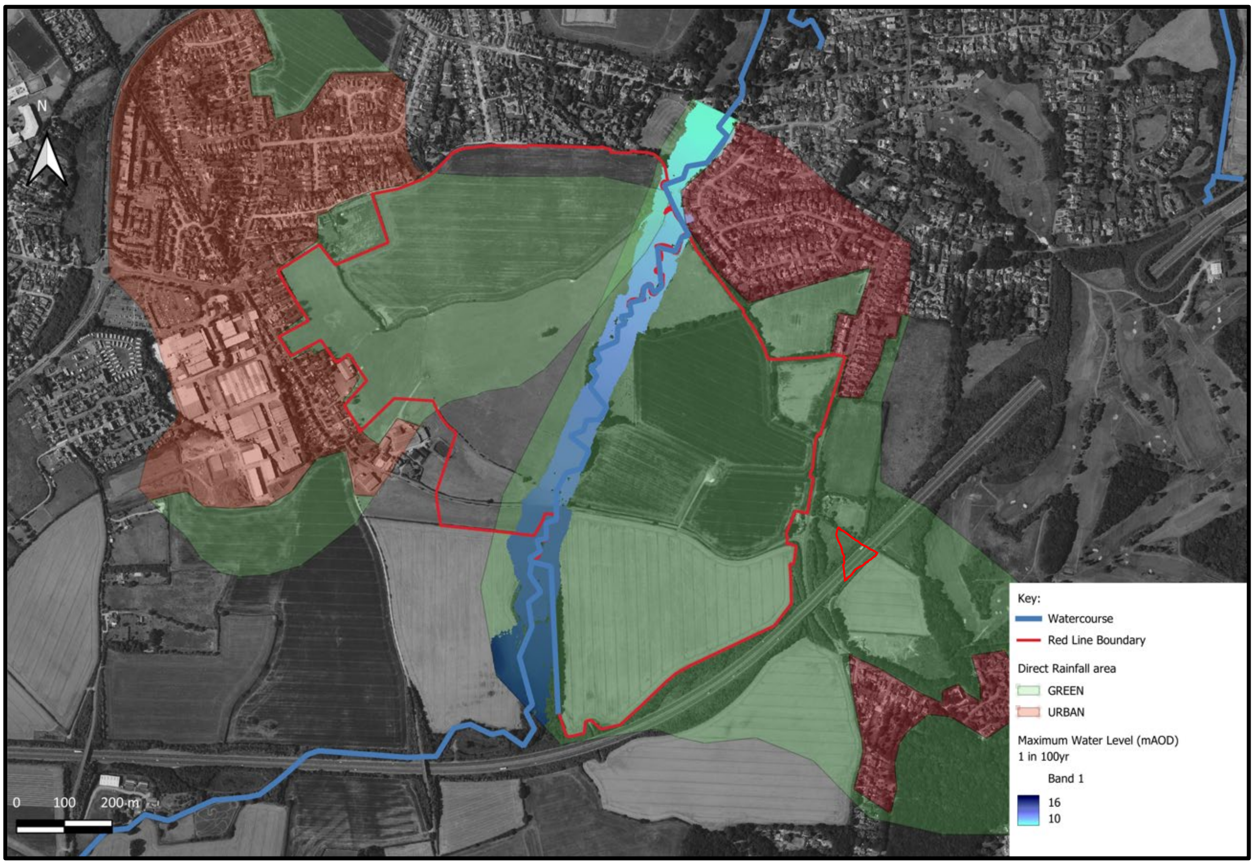


Figure A-4 illustrates the rainfall region for the modelling.

The 1m composite (2022) Digital Terrain Model (DTM) LiDAR has been used to define the ground model within the 2D domain. A cell size of 1m has been used in order to achieve enough accuracy of the rainfall model.

The downstream boundary condition was located at the Swalecliffe Brook with a slope of 1% based on the values of the EA model.

Additionally at the 2D domain the roughness materials have been determined with the OS mapping and the Land Cover map 2019 (LANDIS) determined the land-use classification.

Manning's roughness values within the Tuflow Materials File (.tmf) has been set with general surface of 0.07, trees 0.10, water 0.025, roads 0.015 and buildings with a high roughness of 0.30.

The model has been split into the West and East rainfall regions, as shown in **Figure A-1.**