Swalecliffe Pathfinder

Whitstable Catchment

Technical Report

July 2022

from Southern Water

Contents

Table of Figures

Table of Tables

Document History

Revision	Purpose	Originated	Reviewed	Authorised	Date
V1.0	Draft Issue for Comments	PMG	RMcT	NM	16/5/2022
V2.0	Final Issue	PMG	RMcT	NM	21/7/2022

Executive Summary

The Whitstable catchment, which is linked to Swalecliffe Wastewater Treatment Works (WwTW), was specifically chosen as a pathfinder catchment because, whilst approximately half the catchment of Whitstable is a separated sewer system, there is still significant excess water in the network, resulting in numerous permitted storm overflow discharges. This catchment was selected so that, by using a holistic catchment approach to managing flows, we can identify options to reduce the storm loading on the treatment works and reduce pollution incidents.

Approximately half of the sewers serving Whitstable are separate foul and surface water pipes, the other half are combined sewers. Houses are protected from flooding of the combined system using 7 storm overflows. These storm overflows, previously called combined sewer overflows (CSOs), act like a relief valve during periods of heavy rain. They release flows into the environment to avoid sewage flooding in the catchment.

Having surface water from rainfall mix with the sewage creates a number of issues including: an increased risk of flooding, contamination of rainwater that could be fed straight back into the environment and increased costs of pumping and treating diluted sewage, as well as the impact of overflow spills into the environment.

However managing surface water is a complex, shared problem, as it means making sure that water drains effectively from homes and gardens, roads, fields, businesses and public spaces.

Southern Water has set up a Task Force with several aims, the key one being to significantly reduce the use of storm overflows by 2030. To investigate how this can be achieved, a number of pathfinder projects have been set up and the Whitstable catchment is one of those. These pathfinders have a staged approach as follows:

Stage 0 – study and surveys
Stage 1 – no regret interventions and trials
Stage 2 – more complex interventions and large scale pilots
Stage 3 – larger scale investments to deliver the outcome

The interventions identified are likely to be a mix of types of innovative and traditional solutions such as:

- Upstream source control (removing and slowing the flow of rainwater)
- System optimisation (making better use of the existing infrastructure)
- Infrastructure enhancements (build new or larger infrastructure)

The mechanism that these interventions will be delivered by is also likely to be innovative, with Southern Water working in partnership with Kent County Council, local council projects and community groups to provide solutions that provide multiple benefits.

Within Whitstable we believe the key opportunities will be around the front end of the treatment works, including controlling the flow pumped to the works better and managing the storm flows at the works. Also, due to the large number of wastewater pumping stations (WPS) in the catchment, we are investigating how we can optimise the control of these pumping stations to smooth out the flow and avoid overwhelming the system. Finally, where there are combined sewers within the catchment or surface water sewers directly connecting into the foul system, we will look at options to install sustainable urban drainage systems. For all these interventions, further survey work and modelling will be required, to confirm if other potential interventions will provide the benefit required. We will continue to identify and, where appropriate, enact these interventions whilst we collate the results of the rest of the surveys.

This report is only the start of the journey towards a sustainable drainage system in Whitstable. We will work as partners to investigate and better understand the existing drainage systems, to identify and deliver opportunities for improvement, and plan together for the sustainable growth of the town of Whitstable.

What we ask of our partners and the community is to continue to support that journey, with photos and data, ideas and enthusiasm. So that together we can agree how decisions can be made, now and in the future, for our mutual benefit.

1.0 Introduction and Document Purpose

This report is an output of a Stage 0 study for the Whitstable (Swalecliffe) catchment. The Swalecliffe catchment was specifically chosen as a pathfinder catchment because, whilst approximately half the catchment of Swalecliffe is a separated sewer system, there is still significant excess water in the network, resulting in numerous permitted storm overflow discharges. We will use a holistic approach to understand the root cause and better manage water flows, identifying options to reduce peak loading onto the treatment works and other parts of the network. We will also be investigating if there are other causes of additional flow into the wastewater sewers.

2.0 The Problem

2.1 The Management of Surface Water

Managing surface water is about making sure that water drains safely from homes and gardens, roads, fields, businesses and public spaces. Good surface water management is about making sure that rain can drain effectively straight through our environment, using a combination of natural and manmade drainage networks.

Sometimes rainwater falling on impermeable surfaces such as roofs and roads can be contaminated by surface contaminants; it can also get into the sewer system and be contaminated by foul sewage. This contaminated water needs to be pumped & treated and if the volume overwhelms the downstream assets, then sometimes diluted sewage has to be discharged into rivers and the sea via a storm overflow (see Section 4 for more details). Storm overflows, previously known as combined sewer overflows (CSOs), are a relief valve for the drainage system to prevent the devastating impact of sewer flooding.

Water companies have a critical part to play in improving surface water management.

3.0 Particulars about Whitstable Drainage

3.1 Location and Local Government Services

Whitstable is a seaside town on the north coast of Kent in south-east England. The town is 5 miles north of Canterbury and 2 miles west of Herne Bay. The local services for Whitstable are provided by Canterbury City Council (CCC). Kent County Council (KCC) is responsible for more strategic services such as education, libraries, main roads, social services, trading standards and transport.

3.2 Geography & Topography

The Swalecliffe catchment lies in Kent, between Herne Bay and Faversham. It includes the principal settlements of Whitstable and Chestfield, with the remaining population in smaller towns and villages such as Seasalter and Yorkletts (see Figure 1).

The catchment is bisected by a rail line which crosses from east to west through Seasalter, Whitstable and Swalecliffe. Two rivers, Swalecliffe Brook and Gorrell Stream, cross the catchment from south to north along with a number of smaller watercourses.

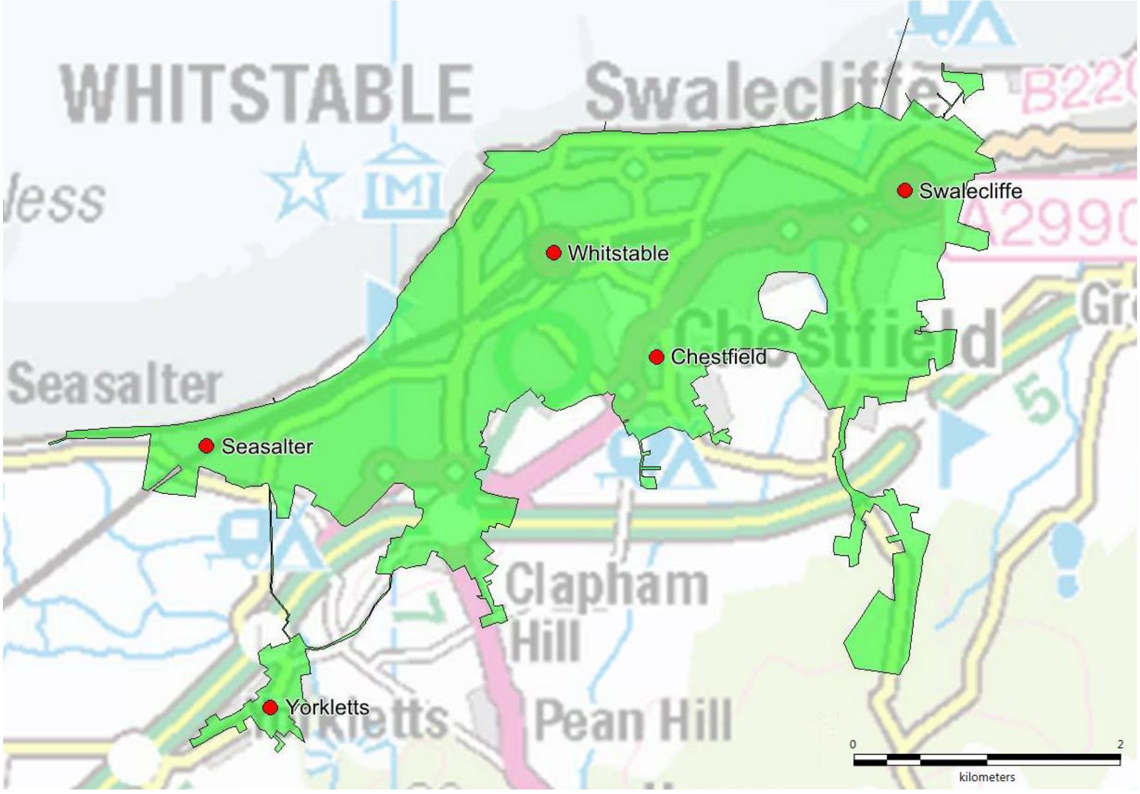

Figure 1 – Whitstable Catchment[1]

The topography of the catchment is moderate-to-steep, as shown in Figure 2 and Figure 3 (higher areas in brown, lowers areas down to sea level in blue), with the highest point at 70m AOD and the lowest point approximately at sea level.

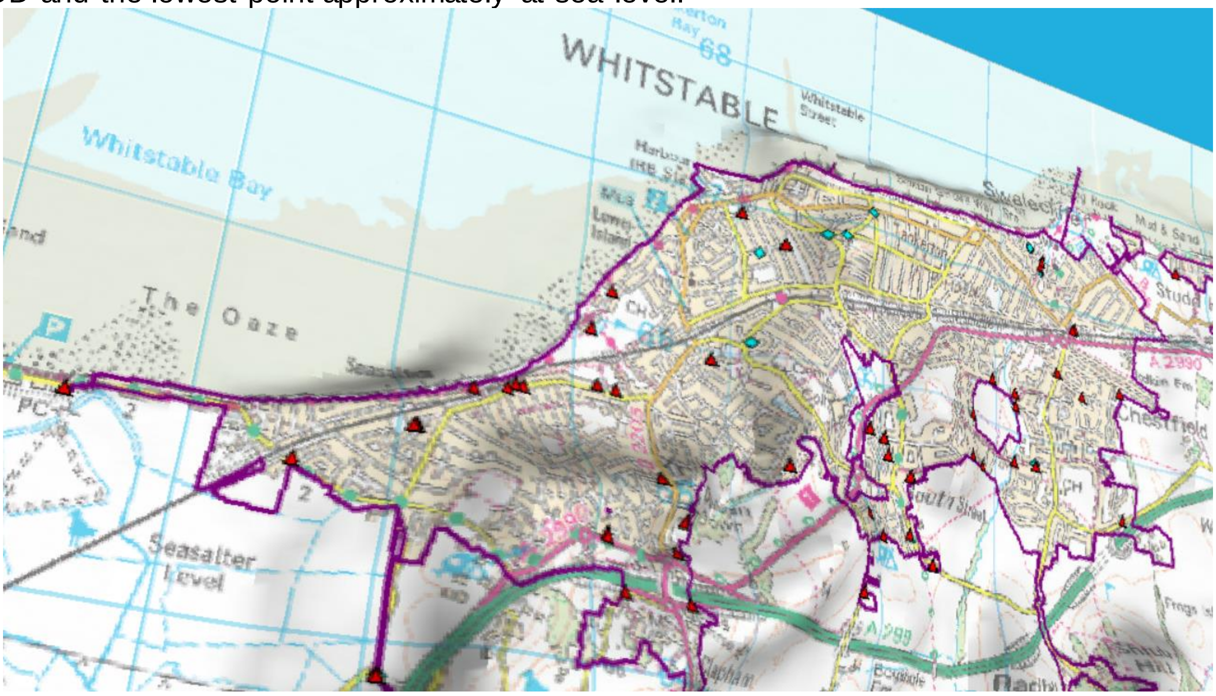

Figure 2 – Whitstable Catchment Topography OS Mapping[2]

[1] Southern Water Drainage Area Plan 2019
[2] Southern Water Asset Miner OS copyright

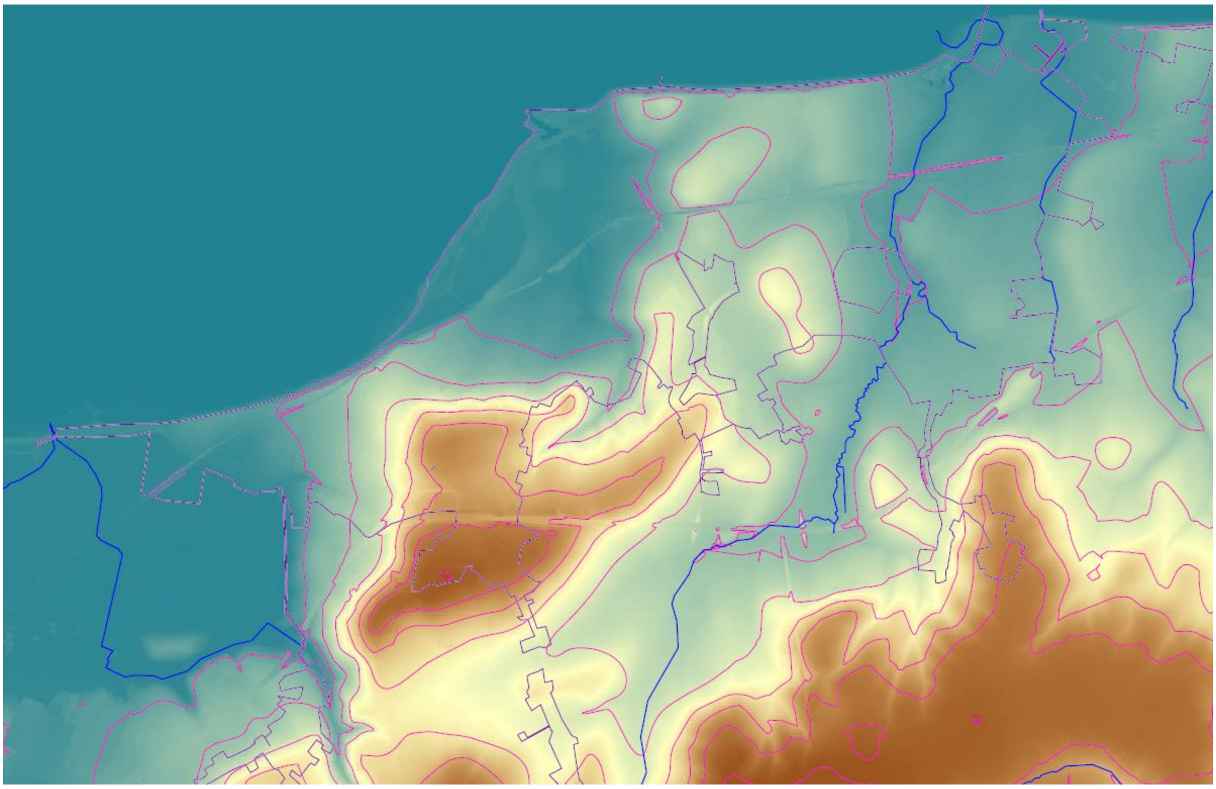

Figure 3 – Whitstable Topography EA LiDAR[3]

3.3 Geology

For the most part (90%), the Whitstable catchment is underlain by a solid geology of London Clay, which outcrops at ground level and is shown as uncoloured on Figure 4. London Clay has low permeability, so is therefore expected to be unsuitable for use as soakaway drainage.

Head Deposits (red on Figure 4) - comprising mainly Clay and Silt, and in this area is expected to be derived from the London Clay. Head deposits are poorly sorted and poorly stratified, formed by hillwash and soil creep, with fine material expected to dominate, meaning low permeability. It occurs as a narrow linear band of deposit aligned north/south on the east side only of the catchment, for example near Chestfield and South Street.

Alluvium (yellow on Figure 4) - there is alluvium in the west side of the study area (Seasalter and Yorkletts) and under Whitstable town centre. A soft to firm unconsolidated, compressible silty clay, but which can contain layers of silt, sand, peat and basal gravel. Soakage is expected to be variable, generally slow, although in some locations quicker when sand/gravel is present.

[3] 2020 2m DTM LIDAR Composite model, Environment Agency

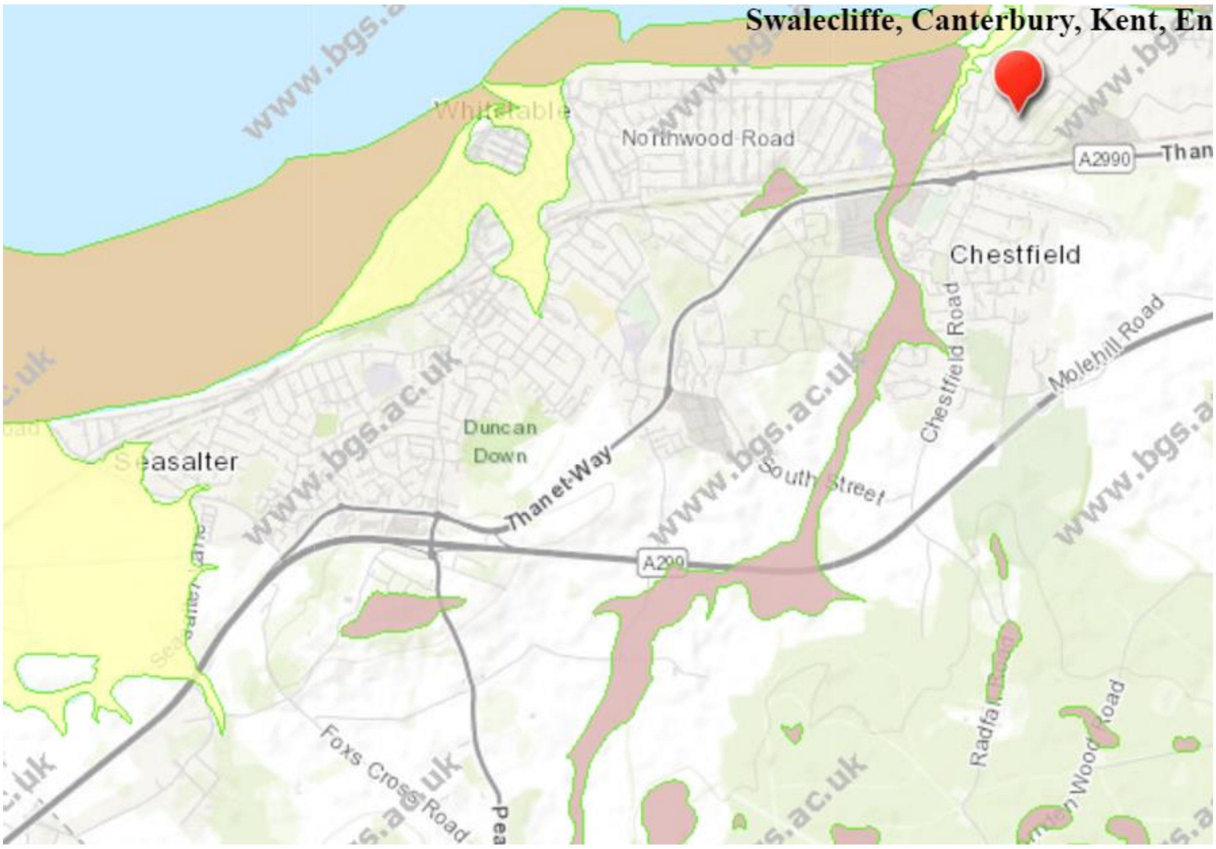

Figure 4 – Geology of Whitstable[4]

3.4 Southern Water Drainage System

Drainage systems can be made up of single pipe systems (combined) and two pipe systems (foul and surface water). Appendix B provides some background information on how drainage systems have developed and in particular the contribution that legacy housing (houses where the roof drainage and sewage drainage combine) makes to the surface water management.

The drainage system within Whitstable consists predominantly of separate sewers (foul or surface water) although there are some combined sewers.

3.5 The Combined Sewerage System

We have a network model of the existing foul and combined sewer system of Whitstable, which we use to run different rainfall scenarios to understand the impacts on the system. As the catchment changes this model must be updated, calibrated and verified. Figure 5 shows the current extent of the model.

4 www.bgs.ac.uk

Figure 5 – Foul/combined sewer system in the Whitstable catchment (red)[5]

There is a programme to install 210 additional level monitors in the catchment which will begin in Whitstable soon. This will also give us more 'real-time' data of water levels in the sewers.

A wider survey is being commissioned for some elements of the foul/combined system across Whitstable to enable to the foul/combined network model to be improved. This will support decision making around other potential large interventions (see Section 6).

3.6 Catchment Pumping Stations

Within the Swalecliffe catchment in Whitstable there are 52 pumping stations: 11 pump surface water (SWP) and 41 pump foul sewage (WPS) (see Figure 6).

Site Title	Place	Type
PRIMROSE WAY CHESTFIELD SWP	CHESTFIELD	SWP
ST JOHNS ROAD CHESTFIELD SWP	CHESTFIELD	SWP
THE RIDINGS CHESTFIELD SWP	CHESTFIELD	SWP
KENDAL MEADOW CHESTFIELD SWP	CHESTFIELD	SWP
ASHLEY DRIVE SEASALTER SWP	SEASALTER	SWP
GORREL WHITSTABLE SWP	WHITSTABLE	SWP
HARTY FERRY VIEW WHITSTABLE SWP	WHITSTABLE	SWP
WICKETTS END BELMONT ROAD SWP	WHITSTABLE	SWP
77 JOY LANE WHITSTABLE SWP	WHITSTABLE	SWP
AURELIE WAY WHITSTABLE SWP	WHITSTABLE	SWP
GLENSIDE SPIRE AVENUE SWP	YORKLETTS	SWP
GRASMERE ROAD CHESTFIELD NO 1 WPS	CHESTFIELD	WPS
GRASMERE ROAD CHESTFIELD NO 2 WPS	CHESTFIELD	WPS

[5] Southern Water Asset Miner System

ST JOHNS ROAD CHESTFIELD WPS	CHESTFIELD	WPS
THE RIDINGS CHESTFIELD WPS	CHESTFIELD	WPS
PRIMROSE WAY CHESTFIELD WPS	CHESTFIELD	WPS
LAXTON WAY CHESTFIELD WPS	CHESTFIELD	WPS
RADFALL RIDE CHESTFIELD WPS	CHESTFIELD	WPS
BIRKDALE CLOSE CHESTFIELD WPS	CHESTFIELD	WPS
KENDAL MEADOW CHESTFIELD WPS	CHESTFIELD	WPS
CLAPHAM HILL WPS	CLAPHAM HILL	WPS
WALDEN CAMP SEASALTER WPS	SEASALTER	WPS
WHITEBRIDGE FARM SEASALTER WPS	SEASALTER	WPS
ASHLEY DRIVE SEASALTER WPS	SEASALTER	WPS
LUCERNE ROAD SEASALTER WPS	SEASALTER	WPS
GOLDEN HILL NO.2 WPS	SEASALTER	WPS
BROOK ROAD SWALECLIFFE NEW WPS	SWALECLIFFE	WPS
SOUTH STREET WHITSTABLE WPS	WHITSTABLE	WPS
SPIRE AVENUE WHITSTABLE WPS	WHITSTABLE	WPS
RICHMOND ROAD WHITSTABLE WPS	WHITSTABLE	WPS
STATION ROAD WHITSTABLE WPS	WHITSTABLE	WPS
SOUTH VIEW ROAD WHITSTABLE WPS	WHITSTABLE	WPS
BROOKLANDS FARM WHITSTABLE WPS	WHITSTABLE	WPS
WRAIK HILL WHITSTABLE WPS	WHITSTABLE	WPS
ADMIRALTY WALK WHITSTABLE WPS	WHITSTABLE	WPS
GOLDEN HILL WHITSTABLE WPS	WHITSTABLE	WPS
JOHN WILSON BUSINESS PARK WPS	WHITSTABLE	WPS
DANIELS COURT WHITSTABLE WPS	WHITSTABLE	WPS
WELLINGTON STREET WHITSTABLE WPS	WHITSTABLE	WPS
BLACKBERRY WAY WHITSTABLE WPS	WHITSTABLE	WPS
HARTY FERRY VIEW WHITSTABLE WPS	WHITSTABLE	WPS
7 BENACRE ROAD WHITSTABLE WPS	WHITSTABLE	WPS
64 MARTINDOWN ROAD WHITSTABLE WPS	WHITSTABLE	WPS
5 SAXON SHORE ISLAND WALL WPS	WHITSTABLE	WPS
ST ANDREWS CLOSE WHITSTABLE WPS	WHITSTABLE	WPS
OLYMPIA WAY WHITSTABLE WPS	WHITSTABLE	WPS
77 JOY LANE WHITSTABLE WPS	WHITSTABLE	WPS
74 & 76 SOUTH STREET WHITSTABLE WPS	WHITSTABLE	WPS
AURELIE WAY WHITSTABLE WPS	WHITSTABLE	WPS
DARGATE ROAD YORKLETTS WPS	YORKLETTS	WPS
GLEN WALK YORKLETTS WPS	YORKLETTS	WPS
THANET WAY SOUTH SERVICES YORKLETTS WPS	YORKLETTS	WPS

Table 1: Wastewater Pumping Stations in the Swalecliffe Catchments[6]

[6] Southern Water Asset Miner System

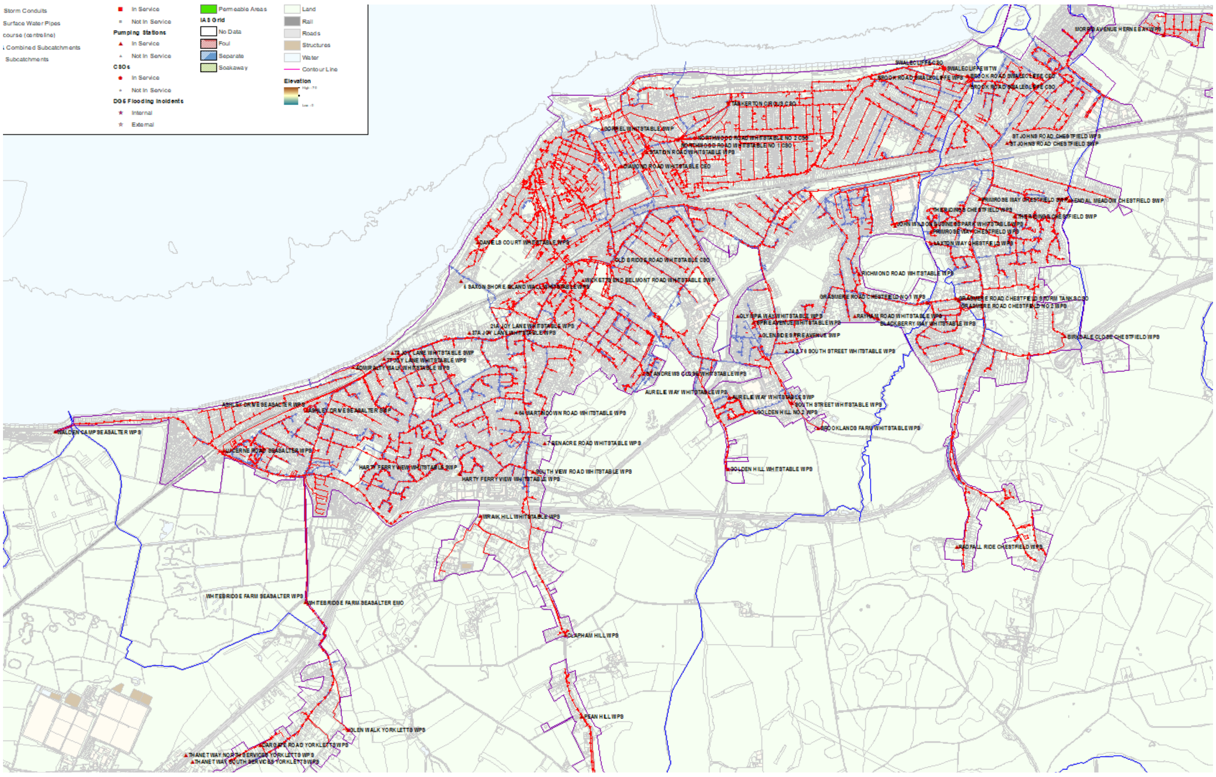

Figure 6 – Location of Pumping Stations within the Swalecliffe catchment[7]

3.7 Swalecliffe WwTW

The foul sewage from the Whitstable catchment is transferred to Swalecliffe WwTW by gravity and pumping stations. This is why the catchment of Whitstable is often referred to as Swalecliffe.

Swalecliffe WwTW is located within the boundaries of the Swalecliffe Brook river catchment. It serves a population equivalent of 37,500 of Whitstable and Swalecliffe. Flows up to 205l/s are fully treated, with grit and screening removal, followed by Primary and Secondary treatment through an activated sludge process:

- Primary treatment - consisting of three sedimentation tanks
- Secondary treatment (first stage) - consisting of five activated sludge lanes
- Secondary treatment (second stage) - consisting of two final settlement tanks

All treated flows are then subjected to UV treatment before being released into the English Channel, close to Swalecliffe Brook delta, either via gravity or pumping depending on the tidal conditions.

Flows in excess of 205l/s and below 760l/s are fully screened before being passed to the long sea outfall.

Flows in excess of 760/ls are fully screened before being passed to storm tanks for storage. These flows are returned to the treatment process when the flow rate reduces. In the event of the capacity of the storm tanks being fully utilised, the overflow passes down an alternative outfall to the English Channel.

[7] Southern Water Asset Miner System

3.8 Whitstable (Swalecliffe) Storm Overflows

Storm overflows are a relief valve for the system to prevent the devastating impact of sewer flooding. See Section 4.0 for more information.

There are 7 sewer overflows within the Swalecliffe WwTW catchment including 1 emergency overflow. The contributing areas of each are shown in Figure 7.

	Overflow	Type	Releases in 2020[8]
1	Swalecliffe (WwTW) CSO	Combined Sewer Overflow	89
2	Tankerton Circus CSO	Combined Sewer Overflow	15
3	Diamond Road Whitstable CEO	Combined Sewer/Emergency Overflow	16
4	Northwood Road Whitstable No 1 CSO	Combined Sewer Overflow	11
5	Swalecliffe SSO	Combined Sewer Overflow	5
6	Northwood Road Whitstable No 2 CSO	Combined Sewer Overflow	3
	Brook Road Swalecliffe CEO *	Combined Sewer/Emergency Overflow	2
7	Grasmere Road Chesterfield Storm Tanks CSO	Combined Sewer Overflow	2

*now sealed

Table 2: List of Storm and Emergency Overflows within the Swalecliffe WwTW catchment

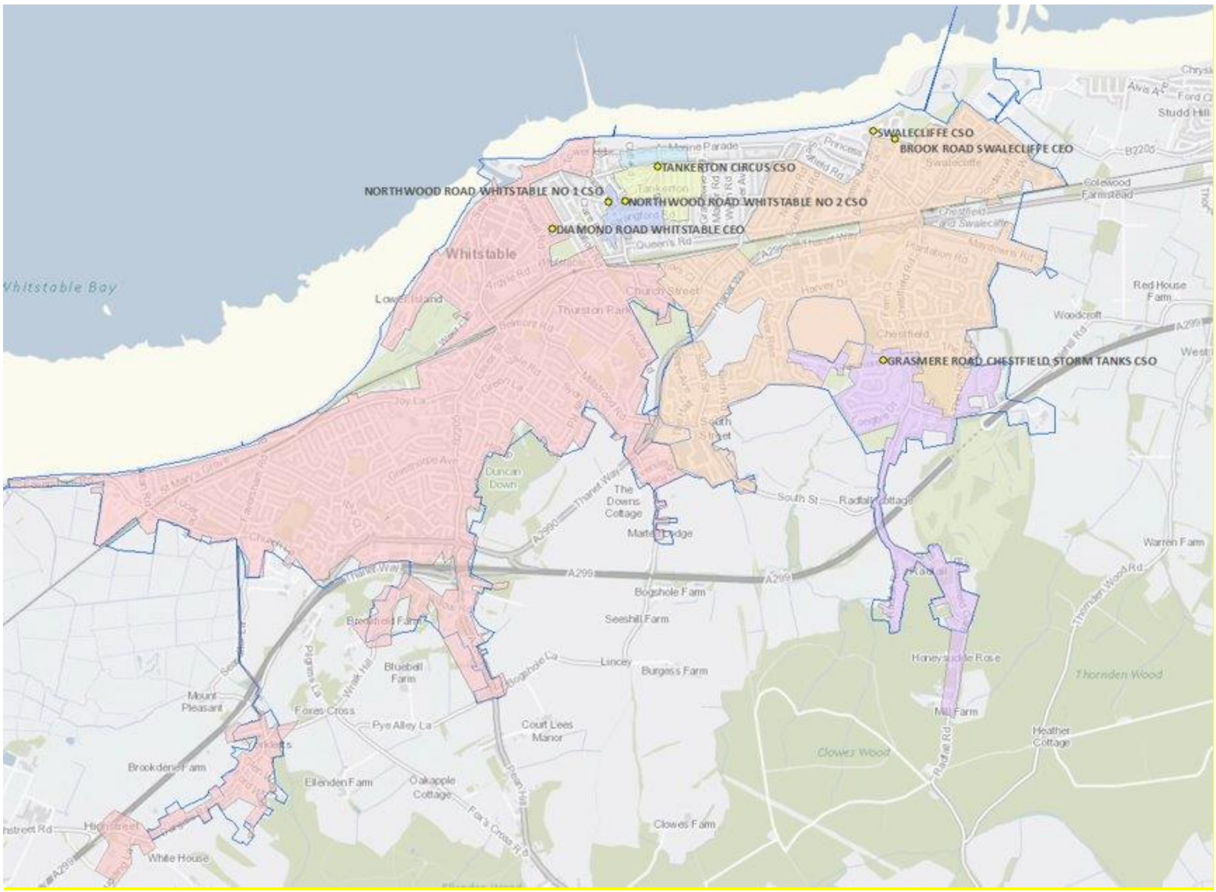

Figure 7 – Drainage catchment areas of the Swalecliffe Storm Overflows[9]

[8] https://www.southernwater.co.uk/our-performance/flow-and-spill-reporting

[9] Southern Water Asset Miner System

3.9 The Surface Water System

Figure 8 below shows the current surface water sewers in the Southern Water network model. These surface water sewers discharge to local ditches and also to the sea.

Figure 8 – Current mapping of Surface water system in Whitstable[10]

Figure 8 also shows that only some sections of the surface water system are currently included in the network model (shown in light blue), while some sections need more investigation (shown in dark blue). We are commissioning a flow, connectivity and manhole survey that will enable the surface water model to be expanded. The flow survey will be used to calibrate this model.

Building up a model of the surface water system will allow us to understand the interaction between the various sewer systems within the Swalecliffe catchment more clearly. In addition, a better understanding of the surface water system will help to highlight opportunities to disconnect roads and roofs from the combined system, and therefore reduce the volume of water passing to the storm overflows and Swalecliffe WwTW.

3.10 The Highway Drainage System

Highway drainage generally consists of road gullies connected to the surface water and combined sewer systems. For Whitstable, the highway drainage/public surface water sewers are owned and maintained by KCC as the Highway Authority.

KCC Highways Department have provided us with mapping information for the road gullies across the Whitstable Catchment (Figure 9). We will be working with KCC to understand how the gullies connect to the combined and surface water sewers.

We will use this information to work with KCC to identify future opportunities to disconnect highway drainage from the combined system as the project progresses through the stages. See Section 4.4 for further details.

[10] Southern Water Asset Miner System

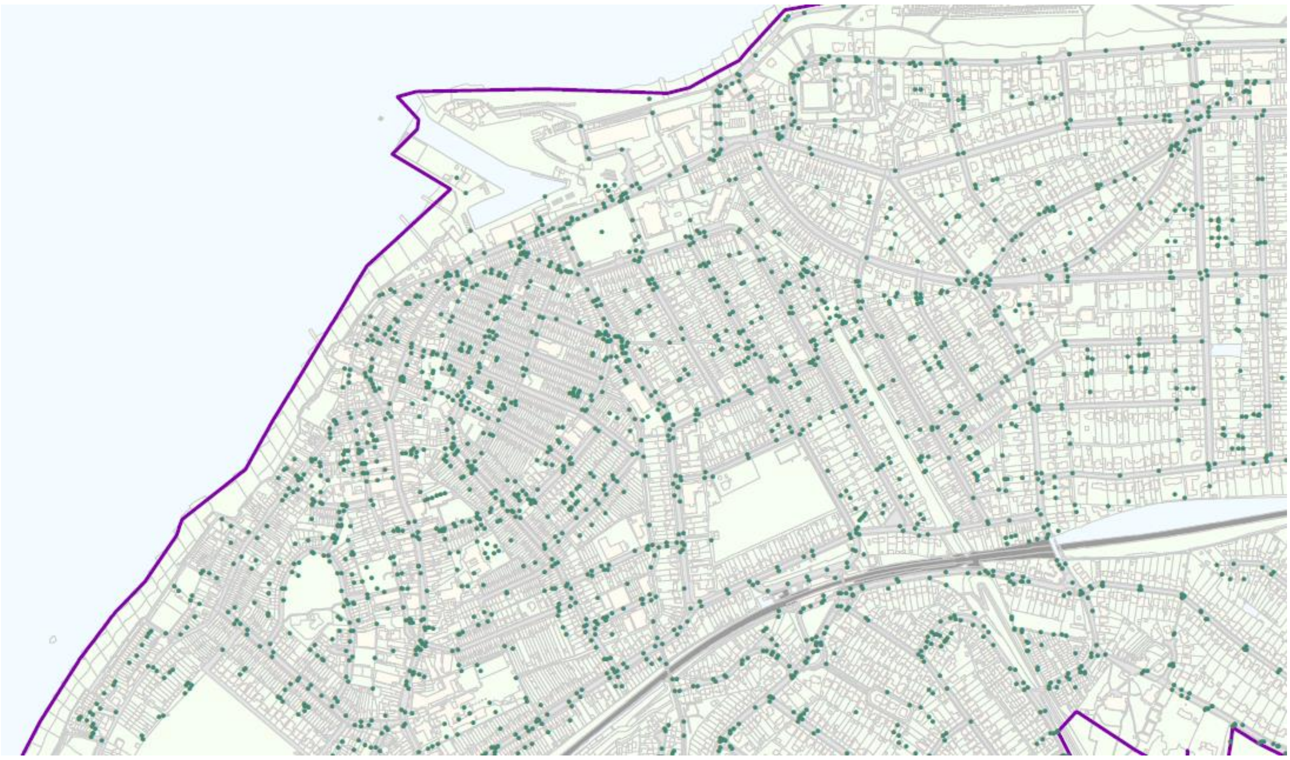

Figure 9 – Excerpt of mapping showing highway gullies across the Whitstable catchment[11]

3.11 River and Coastal System and Flooding

The main river draining the catchment is the Swalecliffe Brook. This river runs from south to north and discharges to the sea in the area close to the WwTW. Gorrell Stream is another water body that crosses the catchment, south to north, and drains to the sea, it is mainly culverted throughout the built up area. Figure 10 shows the Main Rivers within the catchment.

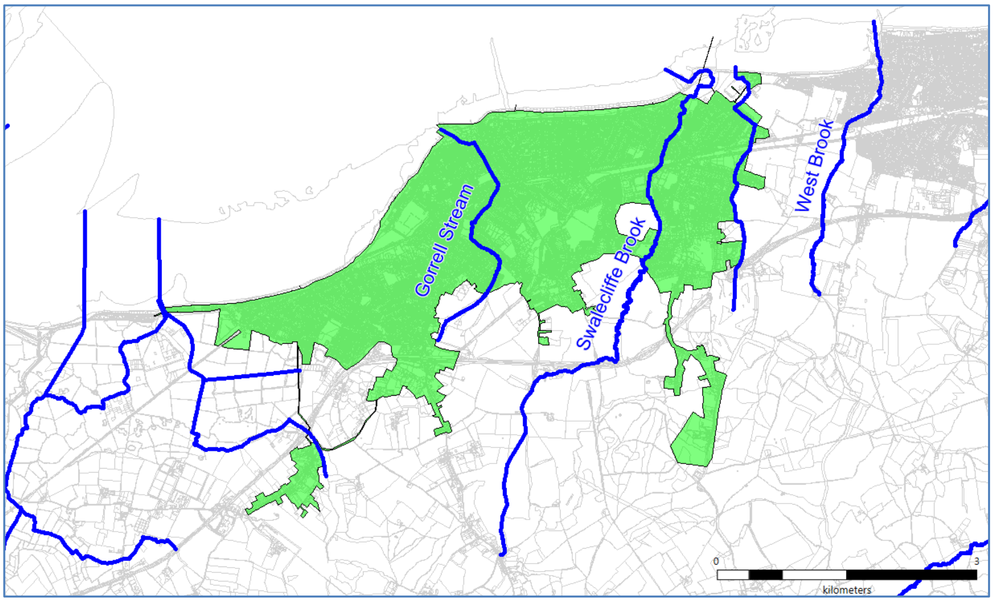

Figure 10 – Main Rivers within the Swalecliffe drainage catchment[12]

[11] KCC highways department, 2021
[12] Southern Water Drainage Area Plan 2019

The northern edges of Whitstable are in a range of very low-risk to high-risk zones for river and coastal flooding, particularly along the watercourses of the Gorrell Stream and the Swalecliffe Brook (see Figure 11).

Figure 11 – Environment Agency River and Coastal Flood Map[13]

3.12 Surface Water Flooding

Flooding from surface water is typically associated with natural overland flow paths and local depressions in topography where surface water runoff can accumulate during or following heavy rainfall events. The Environment Agency's map is shown in Figure 12.

13 Your long term flood risk assessment - GOV.UK (check-long-term-flood-risk.service.gov.uk)

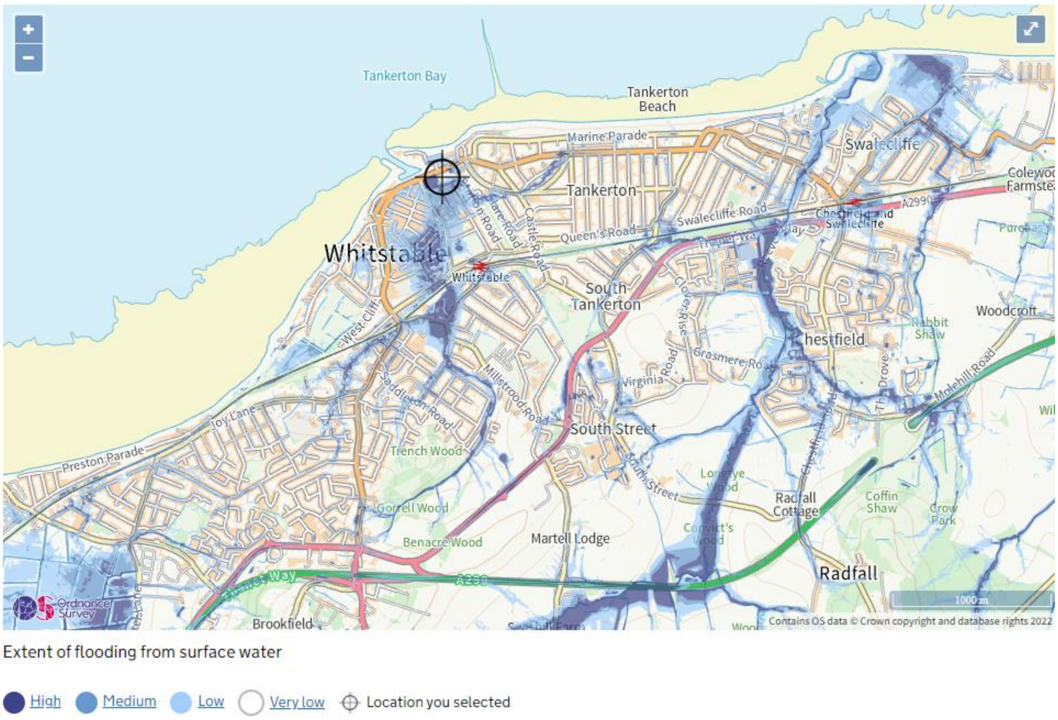

Figure 12 – Extract from the Environment Agency's Flood Risk from Surface Water map[14]

[14] Your long term flood risk assessment - GOV.UK (check-long-term-flood-risk.service.gov.uk)

3.13 Simplified Whitstable Schematic Layout

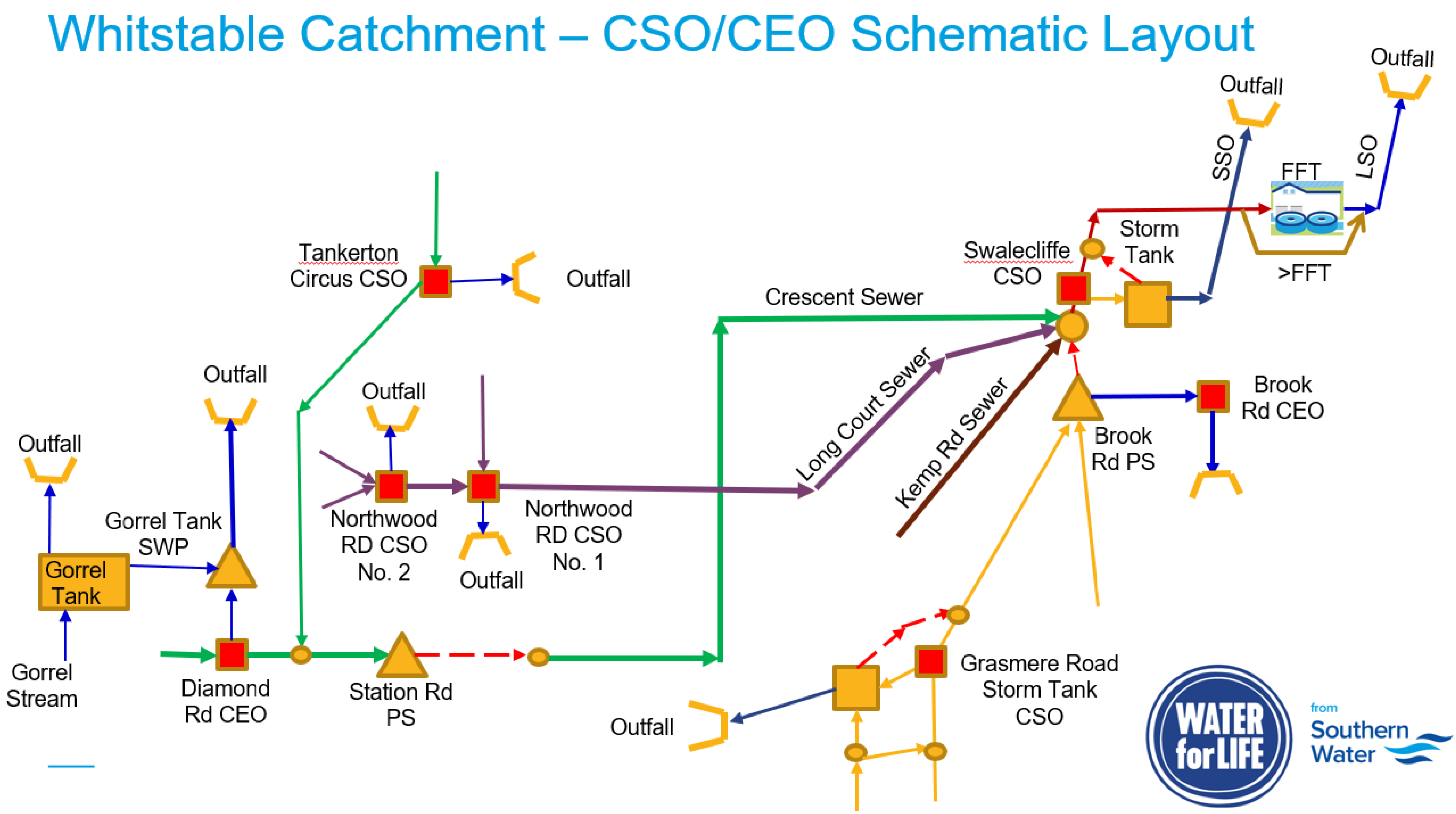

Figure 13 – Indicative layout of the Storm Overflows in the Swalecliffe WwTW catchment

4.0 Why Change is Required and what we are doing

4.1 Why Change is Required

This section describes why we need to make a change now. It is to everyone's benefit if rainwater can be channelled safely back into the ground or environment at a local catchment level rather than being pumped, treated and discharged to rivers or the sea.

Flooding

Unmanaged surface water, especially after extreme events, can cause uncontrolled flooding which is unacceptable. Section 3.0 begins to describe the various drainage pathways for surface water and how they are interconnected. To solve this problem we need a different approach to surface water management.

Urban creep

"The country's built environment is constantly changing and "urban creep" – home extensions, conservatories and paving over front gardens for parking – can all add to the amount of water going into our sewers and drains. Green space that would absorb rainwater is covered over by concrete and tarmac that will not. In fact, studies show that "urban creep" results in a larger increase in predicted flooding than new housing, because it adds more rainwater to these systems"[15].

Climate change

Figure 14 describes the state of the UK climate in 2020.

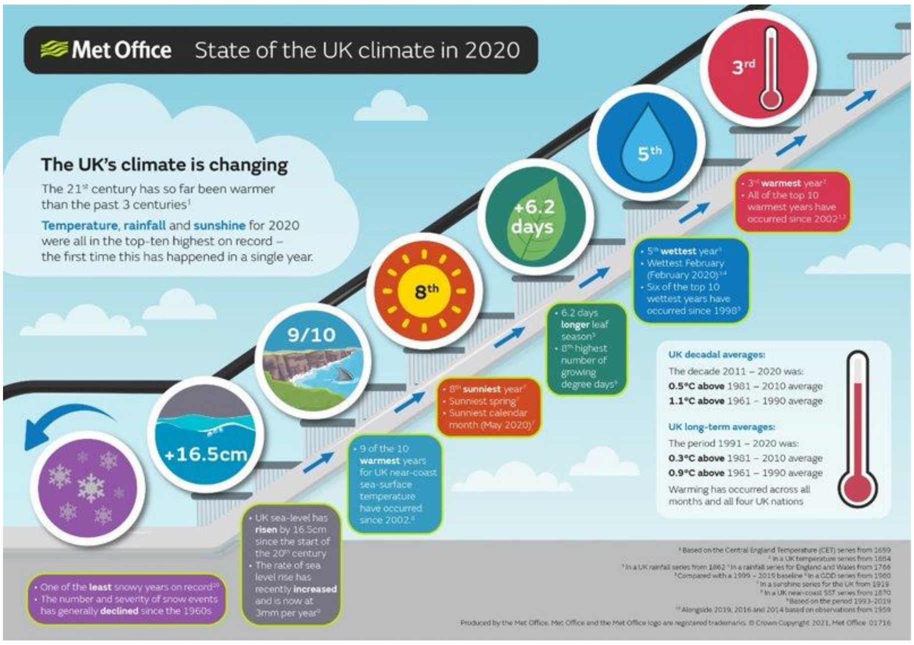

Figure 14 – Climate change drivers[16]

[15] 21st Century Drainage Programme – the context, Water UK
[16] Met office, 2020

"More people, bigger towns and cities and the effects of climate change will mean a greater demand for water when it is hot and dry, and fewer green spaces to absorb rainwater when it is wet and more unpredictable weather"[17]. As global temperatures rise, the number of extreme rainfall days is expected to increase with increased intensity, meaning that short duration storms may exceed the capacity of the surface water and combined systems and risk a higher frequency of flooding.

Figure 15 shows the Met Office classification of rainfall intensity in mm/hr, which has been matched, for these purposes, to an appropriate type of storm to aid understanding.

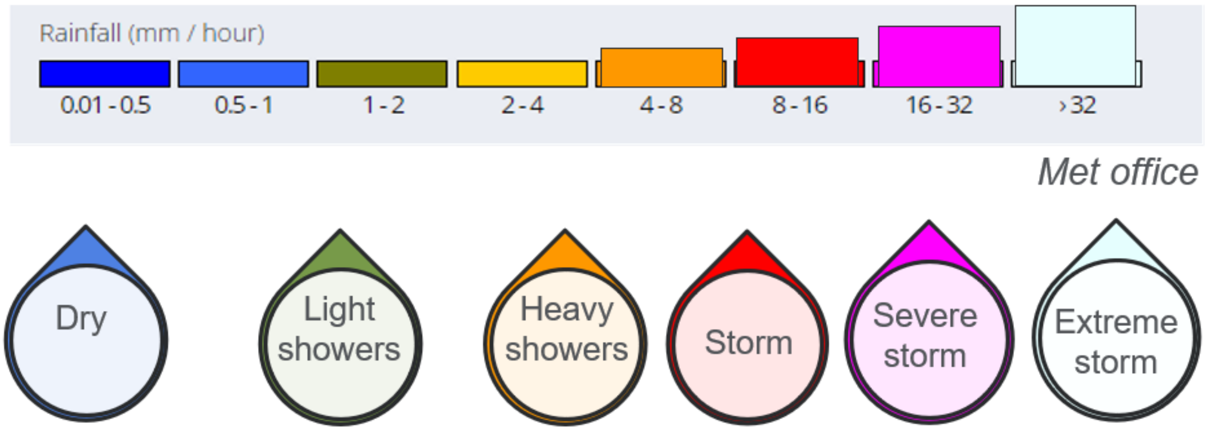

Figure 15 – Rainfall intensity/storm size diagram

As the South East is already water-stressed, it may be particularly susceptible to the impacts of climate change. Water resources are already scarce, and rising temperatures will reduce them further, leading to more frequent droughts[18].

Greenhouse gases and energy use

Water industry operations require large amounts of energy for treating drinking water, processing wastewater, and pumping large volumes around an extensive network. Wastewater treatment processes use about half of the total operational energy across the water sector. Greenhouse gas emissions from the operational side of the water industry are around 0.7% of UK emissions (Ofwat, 2010). In 2011-12, companies reported that they emitted the equivalent of about 4 million tonnes of carbon dioxide[8]. It is therefore very important that the impact on carbon emissions is carefully considered, and holistic catchment solutions are likely to drive the most sustainable solutions.

Storm overflows to rivers and the sea

Storm overflows are a relief valve for the system to prevent the devastating impact of sewer flooding. However we cannot just block them up as this could cause flooding (see Figure 16).

[17] 21st Century Drainage Programme – the context, Water UK
[18] Southern Water climate change adaptation, 2021

Figure 16 – Why do we need Storm Overflows?

4.2 The Southern Water Storm Overflow Taskforce

Southern Water have set up a storm overflow taskforce. There are 4 streams to the taskforce:

1. The pathfinder projects.
2. Developing a regional plan to significantly reduce the use of storm releases by 2030.
3. Complaints & Engagement – create and communicate a common narrative.
4. Beachbuoy and transparency.

4.3 The Pathfinder Projects

The first workstream of the task force are the pathfinder catchment projects. The pathfinder projects have been set up to develop and trial a better, more collaborative approach to surface water management.

The initial 5 pathfinder catchments are:

- Deal, Kent
- Margate, Kent
- Swalecliffe, Kent
- Sandown, Isle of Wight
- Seven Parishes (Pan Parish) near Andover, Hampshire

4.4 Swalecliffe Pathfinder Objective

A published study with intervention options to deliver a significant reduction in spills frequency from a 2020 baseline through partnership approaches.

Demonstrate the principles at scale and reduce the measured storm flows in sub-catchments.

4.5 A Staged Approach

We are undertaking a staged approach to the pathfinder project which allows us to identify and deliver some low risk interventions and pilot schemes quickly; whilst we undertake further modelling to provide confidence and ensure we understand and manage risk for larger interventions.

Learning from the pathfinders will also feed into the Southern Water 5 yearly funding request process.

The staged approach is described below:

Stage	Description
Stage 0	Initial surveys and study with identification of early 'no regrets' low risk interventions and any additional surveys and modelling requirements
Stage 1	No regret interventions and small trials (SWS and partner organisations)
Stage 2	More complex interventions and scaled pilots (SWS and partner organisations)
Stage 3	Larger scale investments to achieve pathfinder outcomes (SWS and partner organisations) • Model updates • Large Scale interventions

Table 3: Description of pathfinder staged approach

Appendix C shows how additionally the data that we want to capture around the catchment will be combined to provide a holistic view for storm water management. This is an ongoing process. Early small interventions with low risk of unintended consequences can be enacted quickly. As we gain a more detailed understanding of the catchment, our understanding of the risks associated with a larger scale, more complex intervention improves, which provides confidence in a successful outcome.

5.0 Potential Solutions and Wider Benefits

As mentioned in Section 4.0, floods and storm overflow spills are caused by rainwater overwhelming the sewer system. The key to reducing these risks is either by reducing the volume of rainwater getting into the sewer or increasing the sewer's ability to cope with it. To that end we have split this into 3 main types of intervention to reduce the risk of flooding and storm overflow use:

- Upstream source control (removing and slowing the flow of rainwater)
- System optimisation (making better use of the existing infrastructure)
- Infrastructure enhancements (build larger infrastructure)

5.1 Upstream Source Control - Removing and Slowing the Flow of Rainwater

Types of solution

- Rainwater harvesting

Water butts can be retrofitted easily to existing downpipes, they hold back the peak run off from roofs and adjust the amount of water drained to the drainage system, provided they are regularly emptied. They also provide rainwater for domestic garden use.

- Permeable paving

Impermeable footpaths, driveways, car parks and parking bays can be converted to a surface which allows water to soak into porous ground or, where the ground is less porous, into a gravel filled base which slows the flow into the drainage system or into the ground.

- Green roofs

Green roofs are generally made up of a shallow layer of material planted with low-growing, stress-tolerant grasses, mosses and sedum. These lightweight systems require little maintenance. They not only attenuate run off i.e. 'slow the flow' but have other benefits such as providing insulation in winter and cooling in summer by absorbing heat from the sun.

- Bioretention - tree pits

Bioretention areas/tree pits are designed to collect, attenuate and or infiltrate runoff by providing both storage volume and infiltration area within the underlying structure. The soils around the trees can also be used to filter out pollutants from runoff directly. These are particularly useful in urban roads and pavements to help manage surface water from highways.

- Bioretention - planters

Planters are typically raised above ground features or repurposing of existing raised areas to attenuate run off, or 'slow the flow'. Above ground planters can be easily retrofitted to accept diverted flows from downpipes where there is space.

- Rain garden (swales)

These are vegetated channels which are used to convey, treat and infiltrate surface water; and disconnect conventional roofs and paved areas from the combined and surface water drainage. Swales can be retrofitted into existing systems by re-purposing existing landscaped or grassed areas to contain swale features.

Natural and social capital impact

Southern Water defines natural capital as the element of nature that provides value to society. Social capital is defined as Southern Water's relationships and others' trust in the business. In addition to the drainage benefits that the above solutions provide, they also give many other benefits, some of which are listed below.

Water resource and water quality benefits

- Water butts can reduce the volume of mains water used for gardening.

- Infiltration supports aquifer recharge and can improve raw water quality by filtering water through the soil.
- 'Slow the flow' measures intercept flows containing sediment and other pollutants washed from fields, roads, etc. and can improve water quality by trapping these in situ.

Urban environment benefits

- Planted vegetation can contribute to a reduction in the urban heat island effect by providing shade and reducing local temperatures. Green roofs can reduce the need to heat and cool buildings.
- Vegetation helps to absorb carbon and helps to remove pollutants from the air resulting in improved public health and reduced costs associated with treating health issues (e.g. asthma).
- Removing rainwater from the system avoids the carbon costs of pumping effluent across catchments and to wastewater treatment works. Chemical carbon costs associated with treating this diluted sewage are also reduced.

Natural environment and wellbeing benefits

- Vegetation can provide habitats for pollinators and other wildlife.
- Vegetation can sequester carbon.
- Green spaces improve the aesthetics of local communities and enable people to connect more with nature.

5.2 System Optimisation – Making Better Use of Existing Infrastructure

If we cannot remove or slow the flow of water before it gets into the system then we would look at our existing infrastructure, pumps, storage tanks and instrumentation to enable us to control the system better i.e. smart network control with increased digitalisation.

Types of solution

Improvements in storage tank use and control

By being able to adjust how a storage tank fills and releases there is more flexibility to manage the variable types of storms that could hit a catchment e.g. intense short summer storms after a period of dry weather or prolonged winter rainstorms.

Improvements in pumping station use and control

Optimising the use of pumping stations across the catchment can also mean we utilise the catchment storage better, reduce wear, and improve resilience of the assets. This can also result in reduced energy and hence carbon use.

Better data availability

Level monitoring in the catchment and at storage tanks and flow meters on pumping stations means that more data is available to identify issues proactively, plan maintenance, optimise the system and design solutions.

Natural and social capital impact

Whilst system optimisation may require some additional instrumentation, it enables us to make full use of existing assets as well as potentially providing energy and carbon benefits.

Optimisation of existing assets also avoids the disruption caused by large construction projects. More data can also aid real time reporting to the public, enabling trust with local communities and impacted groups such as recreational bathers.

5.3 Infrastructure Enhancements – Build Larger Infrastructure

In some instances we may not be able to remove enough surface water or optimise a system sufficiently to avoid constructing new assets. These may be:

Types of solution

- Larger sewers & pumping stations – to transfer the rainwater and/or diluted sewage more quickly away from an affected area.
- Larger storm tanks – to store more of the volume of rain during storms.
- Large treatment works – to treat the rainwater and/or diluted sewage before it is discharged back to the environment.

Natural and social capital impact

- There will be high carbon costs (embedded and emissions) associated with the construction and operation of these new assets.
- There is the potential for the direct loss of vegetation and habitat during construction which could lead to the loss of a range of ecosystem services (e.g. biodiversity, air quality, health and wellbeing etc.).
- There will be disruption to the local community whilst these assets are being constructed (traffic, noise, air quality impacts etc.).

6.0 What are the Next Steps for the Swalecliffe (Whitstable) Catchment?

There are many interventions that could be considered for the Swalecliffe catchment. Whilst its underlying geology means that sustainable drainage systems may be limited for direct infiltration to the ground, this may not be the case in all locations and there are other opportunities to slow the flow.

This section sets out the additional investigations that we intend to do with our partners in the Swalecliffe catchment but also some of the trials and early interventions that we would like to construct. These investigations & pilots will further influence our understanding of the issues, risks, impacts and benefits of various solutions.

Some actions are no regret and can be implemented immediately, some will require design and procurement time, and others will need to be trialed and/or modelled to ensure that the impacts are well understood. Southern Water along, with its partners, will log and monitor these interventions, applying them as per the staged approach described in Section 4.4.

The sections below list some of the interventions that have been completed, are in progress or will be considered and modelled to assess their impact. This list is not exhaustive, and we intend to continuously evolve it as the pathfinder project progresses.

6.1 Upstream Source Control - Removing and Slowing the Flow of Rainwater

The current network model for the foul/combined system for Swalecliffe WwTW indicates that across the total catchment there is only about 75 hectares of impermeable area that drains into the combined system. This plus the existence of a surface water system may mean that removing impermeable areas may not be the main solution to the issues of storm overflow spills in the Swalecliffe catchment.

Section 3.0 also noted that the ground conditions within Whitstable are not ideal for infiltration directly to the ground. However, the solutions described below can still be utilised as they also slow the flow of rainwater getting into the system.

Whitstable Combined Sewer Network Model

The Geographical Information Systems (GIS) data and network model have historically been updated separately. New surveys ensure that both records are updated together, however this has not been done historically. An exercise to identify where data is missing and prioritise collection (depending on flooding/storm overflow discharge benefit) will be undertaken.

Whitstable Surface Water Model

Historically surface water models have only been produced for a small number of specific projects. Southern Water are building a network model of the surface water network in Swalecliffe, along with flow monitoring within the surface water system. This will allow us to identify if there are areas with spare capacity where we can disconnect impermeable area from the combined sewer system.

Impermeable area removal

We are using GIS to identify large roofs (red) and other large impermeable areas that may connect into the combined system. We will then work with the owners to identify if these are connected and what the opportunities are to divert the flow or slow it before it connects to the system, using some of the measures identified in Section 5.0.

Particular areas that we would like to focus on are around the existing storm overflows where there is limited existing surface water systems (see Figure 17).

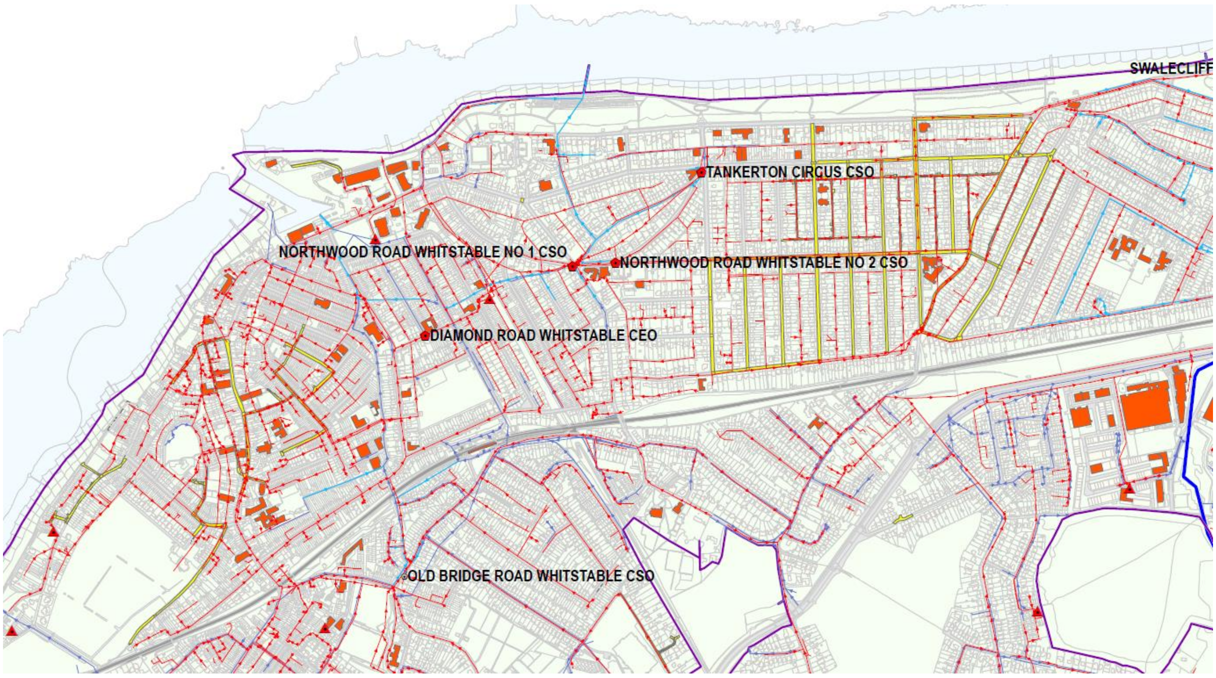

Figure 17 – Pathfinder focus area in Whitstable catchment[19]

Highway drainage disconnection

We will continue to work with KCC to identify areas of highway drainage that could be disconnected from the combined sewer and connected to the surface water system or an infiltration solution (sustainable urban drainage type).

Surface water connections into the combined system

In some locations a separate surface water drainage system has been directly connected into the combined system. We are using GIS to identify these locations and investigate if there are alternative locations to discharge e.g. infiltrate to ground, a separate surface water pipe or a nearby water course.

Domestic solutions to slow the flow and remove impermeable area.

We are looking to identify pilot areas for various domestic solutions within the catchment to assess the benefit, adoption and maintenance requirements, including:

- Smart water butts
- Raised planters
- Property level rain gardens
- Soakaways
- Porous paving

[19] KCC highways department, 2021

6.2 System Optimisation – Making Better Use of Existing Infrastructure

Improvements in storm tank use and control at Swalecliffe WwTW – Stage 2

One of the storm overflows that spills frequently is at the WwTW. We are reviewing flow and performance data from the WwTW site to characterise the spill events. These investigations will look to see if changes to the site operation can reduce or remove this high spill frequency. It is noted already that the high spill frequency is made up of a significant percentage of short duration spills, so smoothing out these events will be the early focus. Once the situation is understood, investigations to reduce these spills is likely to focus on:

- Site specific controls - look to optimise existing site controls to ensure the works maximises the capacity to treat flows to the high standards
- System optimisation - study and optimise the sewer network and remote pumping stations to improve system performance

Swalecliffe WwTW flow permit arrangement – Stage 3

The current flow arrangement of the Swalecliffe WwTW is compliant with its EA permit. However, we believe there are opportunities to work with the Environment Agency to improve the use of existing assets within the works. This could potentially improve the utilisation of the storm tanks and mean better treated flows would be discharged through the short sea outfall with less frequency.

The re-negotiation of a WwTW permit would be subject to extensive liaison, design and modelling and therefore would be a long term project.

Improvements in pumping station use and control

As per Section 3.0, there are 41 WPS within the catchment. We are undertaking a programme where we review the control and output of the key WPS to understand if any optimisation of pumping station control can be used to reduce the frequency that the system is overwhelmed and spills via the storm overflows.

6.3 Infrastructure Enhancements – Build Larger Infrastructure

Within this Asset Management Period, 2020 - 2025, there a number of schemes being constructed within Swalecliffe WwTW. These are not pathfinder projects but are part of Southern Water's capital delivery programme. These works are required by the Environment Agency as part of the Water Industry National Environment Programme. A brief description of the schemes and their benefits is given below for information only.

Flow to Full Treatment

The design of a scheme has started that will increase the flow through the WwTW. This will mean that more flow will receive full treatment (all stages of settlement & biological treatment) before the treated effluent is discharged via the long sea outfall.

Short Sea Outfall

The design of a scheme has started that will replace the short sea outfall which is at the end of its design life. The new outfall will also have increased capacity and its size and position will have been modelled to minimise the impact on the local area.

Brook Road CSO – complete

Brook Road Combined Sewer Overflow has recently been blocked to trial its replacement with a pumped system to the WwTW. A review of the success and the resilience of the pumping solution will be done.

Stage	Description	Types of Intervention	Timescales
Stage 0	Initial surveys and study with identification of early 'no regrets' low risk interventions and any additional surveys and modelling requirements	• Surface Water network survey • Swalecliffe WwTW short spills analysis	• Spring 2022 • Spring 2022
Stage 1	No regret interventions and small trials (SWS and partner organisations)	• Brook Road WPS - VSDs • Catchment WPS analysis • Understand impact of infiltration	• Summer/Autumn 2022 • Summer/Autumn 2022 • Summer/Autumn 2022
Stage 2	More complex interventions and scaled pilots (SWS and partner organisations)	• Trial SuDs opportunities • Catchment WPS optimisation trials • Optimisation of Swalecliffe WwTW • SW connection removal (easy)	• Autumn 2022 • 2023 onwards • 2023 onwards • 2023 onwards
Stage 3	Larger scale investments to achieve pathfinder outcomes (SWS and partner organisations) • Model updates • Large Scale interventions	• Surface Water model build • Transfer of impermeable area from combined sewer to surface water sewer • Trials at Swalecliffe WwTW (TBC) • SW connection removal (complex)	• 2023 onwards • 2024 onwards • 2024 onwards • 2024 onwards
Other Southern Water Projects and Studies	Swalecliffe WwTW (see section 6.3) Swalecliffe catchment	• FFT increase • SSO replacement • Urban Pollution Management (UPM) Study • Bathing Waters Study • Shellfish Study	• 2025 • September 2024 • Initial Study 2022 • Initial Study 2022 • Initial Study 2022

Table 4: Draft interventions for Stage 0-3 in Swalecliffe catchment

7.0 Partnership and Community Working – What can you do to Help?

As shown in Section 3.0, "water companies are not solely responsible for stormwater management; they are one of many organisations involved in ensuring communities stay protected. The change in the weather is testing all sectors of UK society, and we are all moving towards changes in population and in weather conditions that we have never before had to plan for"[20].

To achieve what is needed, utilities, councils and communities need to work together to achieve mutual benefits. Southern Water have committed to doing this by engaging with our partner organisations and the community to solve the problems.

So what can the community do?

7.1 Support Further Investigations for Whitstable

We are interested in time and date stamped photos and videos to help us understand how the Whitstable catchment reacts to rainfall. With time and date stamped evidence, and a clear location, we can match this information with other information to better understand how the whole system interacts. This includes:

- Photos and videos of overland flow.
- Photos and videos of flooded areas.
- Photos and videos of the level of the surface water ditches.
- Reporting blocked highway gullies to KCC.

7.2 Protect the Pumping Stations, Foul and Combined Sewers

Fat, oil and grease[21]

Fat, oil and grease often ends up being washed down the kitchen sink. Over time, they harden to a concrete-like material and restrict the flow of wastewater in the pipes or even block them. These blockages can cause wastewater to back-up through toilets and sinks into homes and businesses, or escape through manholes into streets and rivers

Unflushables[22]

Items such as wipes, nappies and cotton buds are the scourge of our sewers - they create blockages, cause flooding in homes and damage the environment. Every year in England and Wales water companies deal with over 300,000 blockages – thousands of which see people's homes and belongings ruined by sewer flooding. Wastewater companies are still spending around £90 million each year clearing blockages nationwide, while damage to the environment by the plastics used in unflushable items has become a real focus.

[20] 21st Century Drainage Programme – the context, Water UK
[21] Fat, oil and grease (southernwater.co.uk)
[22] The Unflushables (southernwater.co.uk)

Our sewers are only designed to take away the three Ps – pee, poo and paper.

In the kitchen, follow our top tips to avoid fat, oil and grease building up in the sewer.

- Use containers – butter tubs, yoghurt pots or jam jars can all be used to collect cooled fat and oil – then just put them in the bin
- Clear your plates – scrape any leftover food or grease and fat residue from plates, pans or cooking utensils into the bin before washing up
- Bag it and bin it – put a bin in your bathroom for anything that isn't pee, poo or paper. Perhaps use scented nappy sacks or dog poo bags (degradable if you can) to throw away any nappies, sanitary items or condoms.
- Compost your food waste – collect uncooked fruit and vegetable peelings for use as compost in your garden.
- Strain the pain – a simple sink or drain strainer can stop food and hair getting down the pipes.

7.3 Protect Surface Water and Combined Sewer Capacity – Existing Developments

You can help release capacity in the existing sewer systems by using less water, removing surface water connections and slowing the flow

Households

- Install water butts and planters on your property that take the rainwater from your roof and either slow its connection to the sewers or ideally divert it to a soakaway.
- Could you convert your paved, impermeable driveways into permeable surfaces?
- Try to ensure that existing impermeable surfaces drain to a permeable surface rather than the road or the sewers.
- If possible, disconnect existing drainage from the combined and surface water sewerage systems.
- Report blocked highway gullies and drains asap to KCC.
- Report blocked sewers to Southern Water.

Target 100[23]

Population growth, climate change, increased urbanisation and environmental protection mean we all need to change how we understand and value water. Target 100 is a commitment by Southern Water to its customers to support them to reduce personal consumption to an average of 100 litres each per day by 2040; while we reduce leakage by 15% by 2025 and 40% by 2040. As well as making sure there is enough water to go round, households could cut their bills, and less water used mean less water going into the foul and combined sewers, creating more capacity.

Community, businesses, developers & partnerships

Engage with SWS, KCC, CCC and other partners to identify areas for surface water removal, ownership and maintenance. As described in Section 5.0 there are multiple benefits that can be achieved for the whole community.

[23] Target 100, together let's hit target 100. (southernwater.co.uk)

7.4 Protect Surface Water and Combined Sewer Capacity – Future Developments

Households

- If you extend your house or create additional roof areas (urban creep) if possible, make sure these drain to a soakaway or surface water system or consider green roofs.
- If developing your drive or garden, could you install permeable paving rather than connect to the surface water system or drain to the highway system.
- Avoid misconnections - misconnections can happen during work to extend or improve a house, when a new house is built or simply when a new appliance is plumbed in. If any of your plumbing drains to a surface water sewer, the wastewater will pollute local watercourses. Similarly if clean water drains are misconnected, they can overload the foul sewer and lead to flooding. It's the homeowner's responsibility to ensure there are no misconnections at their property. If you're unsure what to do, you can go to ConnectRight or contact Southern Water directly. Alternatively, for a list of plumbers in your area, visit the WaterSafe website.[24]

Community, businesses, developers & partnerships

- Ensure new developments are sustainable i.e. they are not connected to the combined sewer. Where possible, also avoid connection to the surface water system to allow rainwater to infiltrate to the water table, increasing the water availability for rivers and streams for biodiversity and for extraction for drinking water.

8.0 Future Sustainable Growth

Southern Water are looking to work with our drainage and surface water management partners, including CCC and KCC, at how surface water management can be better considered and incorporated into the sustainable growth plans for Whitstable. These conversations could include areas such as:

- More detailed consultation on specific proposals, including small scale developments
- Support to encourage more use of sustainable urban drainage schemes and nature based solutions, including upstream 'slowing the flow' type measures.
- Ensuring that post construction, the installations comply with the requirements.
- Collaboration to make policies more aligned with sustainable drainage and climate change requirements.

9.0 Conclusions

The Swalecliffe drainage system is a predominantly separate sewer system and therefore there may be limited opportunities to reduce storm overflow spills by removing or slowing the flow from impermeable areas. However there are areas with combined sewers, and we will be focusing on these for this type of solution.

[24] Bad plumbing and pollution (southernwater.co.uk)

We are also looking at the WwTW carefully in conjunction with the existing programme of works to see if we can adjust how the inlet to the works is controlled and review how assets are used, to as a minimum reduce the number of short duration spills.

We have identified a number of locations where surface water sewers may be connected directly into the combined system, and we will be investigating alternative locations to discharge this rainwater.

The final key area of work within the Swalecliffe catchment is to review if better management of the control of the WPS in the catchment could reduce the number of storm overflow spills.

There may be other areas of opportunity within the catchment, and we will continue to work with our partners, and we look forward to engaging with the community, to identify opportunities that may also provide multiple benefits to the region, such as water resources, water quality, green space and biodiversity benefits.

Appendix A – Whitstable (Swalecliffe) Technical Group

Southern Water have set up a Technical Group with prospective partners so that we can discuss some of the opportunities to manage surface water and rainfall better in the Whitstable (Swalecliffe) catchment.

- Max Tant, KCC – Lead Local Flood Authority
- Earl Bourner, KCC Highways
- Matthew Young, Canterbury County Council
- Nick Mills, Southern Water
- Rob McTaggart, Southern Water
- Penny Green, Southern Water

Appendix B – How does Urban Drainage Work?

B.1 The Development of the Urban Drainage System

Victorian drainage – single pipe solution

The modern built sewerage network began to appear in the mid-19th century. Overcrowded cities had no means to control the disposal of wastewater. Rivers were overloaded and public health was under threat. Over the next 70 – 100 years, thousands of kilometres of sewers were laid. These combined sewers, as we know them today not only took wastewater from homes but also rainfall runoff from paved and roofed area.

Roofs and paved areas (urbanisation) and the provision of artificial drainage, or sewer systems, has a twofold effect on the natural drainage process. Firstly, it reduces infiltration thereby increasing the volume of run-off. Secondly, artificial surfaces, pipes and channels convey run-off more rapidly, making drainage areas more responsive to short duration/high intensity storms. This two-fold effect significantly changes the rates of run-off, by a factor of 10 or more when compared to a natural drainage system.

In addition to the intensification of peak flow, the single pipe system mixes untreated wastewater and surface water runoff. Conveyance capacity and disposal capacity at wastewater pumping stations and treatment works has traditionally been limited such that during heavy rainfall (to protect life and property) storm overflows operate to discharge a mixture of 'clean' surface runoff and screened untreated or partly treated wastewater (see Figure 18).

Early 20th Century drainage - two pipe solution

With the advent of modern sewers and cleaner streets, it became feasible to separately drain the two flows (wastewater and surface water). Between the first and second World Wars the building of new combined systems declined in favour of the new separate systems. The roofs and paved area were drained by a surface water system and the wastewater was drained by a foul water system. These foul water systems from new developments would typically connect to their older combined systems for conveyance and disposal at wastewater treatment works. Surface water systems would discharge direct to receiving waters (water courses, estuaries and coastal waters). Although separate systems removed the need to install new overflows, the rapid collection and conveyance of rainwater away from where it fell continues to cause problems, particularly in intense storms.

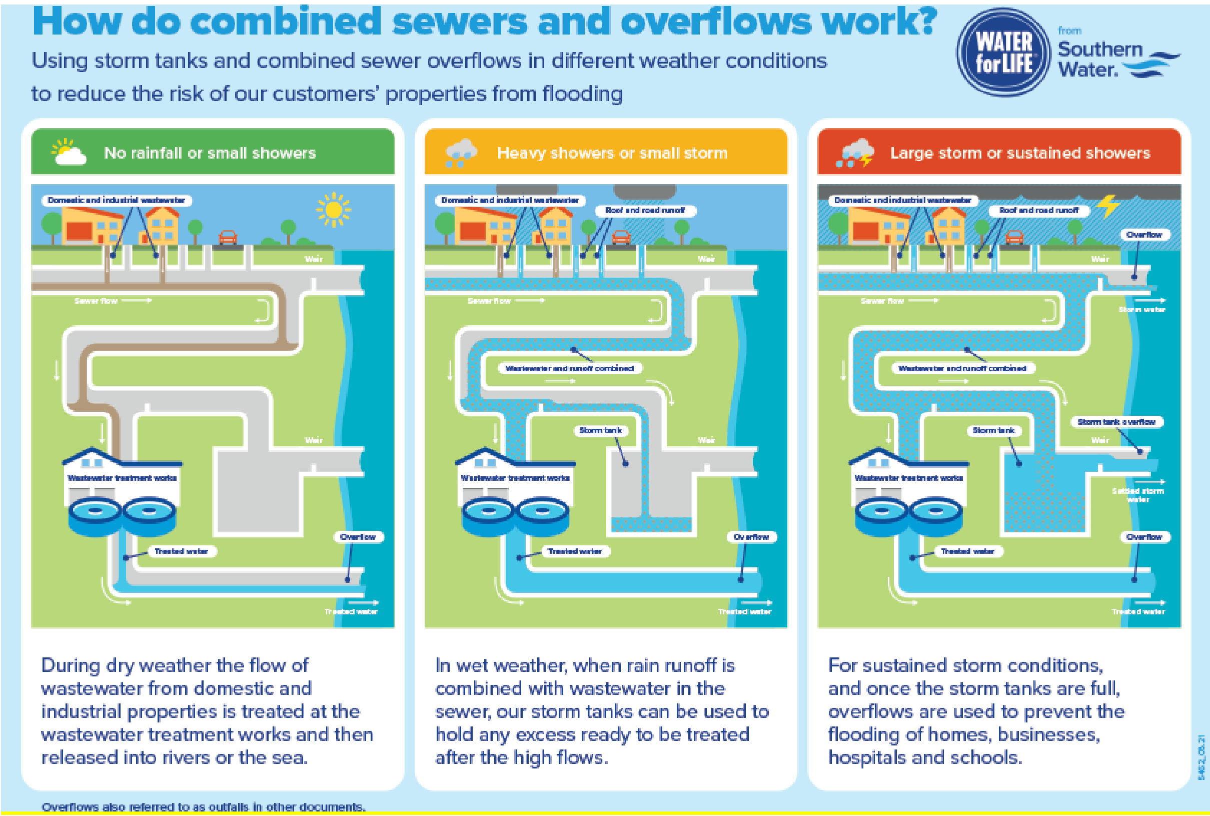

Figure 18 – How combined sewers and overflows work

Late 20th Century drainage – sustainable drainage

In the last 30 years, planning regulation has changed and there is now a requirement to reduce peak runoff rate from urbanized areas. Flows from new developments are restricted to 'greenfield' runoff i.e. a rate equivalent to that of a green field and are typically built with a Sustainable Urban Drainage System (SuDs). These systems closely mimic a natural drainage system.

Retrofitting sustainable drainage

Homes and paved areas drained by combined sewers can be retrofitted with a range of SuDS features which either 'slow the flow' or fully disconnect the surface water flow from the combined sewer system. Both methods reduce the intensity of the peak flows to a more consistent level and mimic natural drainage systems.

Sustainable drainage systems can also reduce flooding in the catchment, increase infiltration to replenish ground water systems and restore capacity in the network. They also reduce pressure on the downstream assets and therefore increase the asset life of existing infrastructure. This also results in storm overflows operating less often, with more flow being treated at wastewater treatment works before discharge to the environment.

B.2 The Contribution of Legacy Housing

Legacy housing is houses that are connected to the combined system. As you can see from Figure 19, only 13% of the water that falls on a home with sustainable drainage will drain to the sewer, therefore significantly reducing the contribution to, pressure on and risk to the downstream assets.

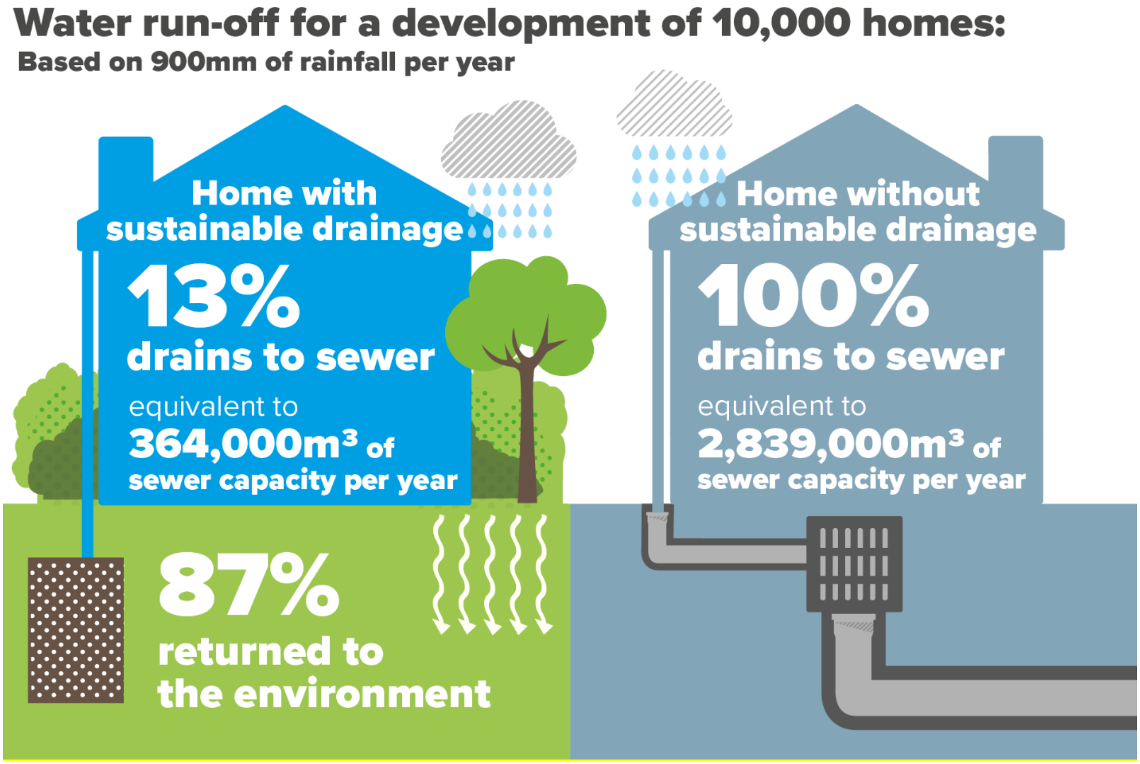

Figure 19 – The impact of legacy drainage systems

B.3 Highway Drainage System

Road or highway drainage i.e. road gullies, also connect to surface water systems. Often this is the same surface water system that takes roof drainage into the single pipe/combined system described in Appendix B.

When rain falls on the impermeable highway areas this can contribute to rapid increases in flow to the drainage system and overwhelm it. In particularly intense storms and/or if gullies are blocked, then overland flow can occur. This overland flow can cause flooding or allow rainwater to enter combined sewers which are not always designed for these extreme flows.

B.4 Internal Drainage Board

Across England there are a number of Internal Drainage Boards who work in partnership with local councils, the Environment Agency and other local partners to reduce the risk of flooding to agricultural, residential and industrial land, and are overseen by the Department for the Environment, Food and Rural Affairs. They carry out an annual programme of maintenance works to ensure water levels are kept at an appropriate and safe level.

Appendix C – Building a Holistic View of a Catchment for Storm Water Management

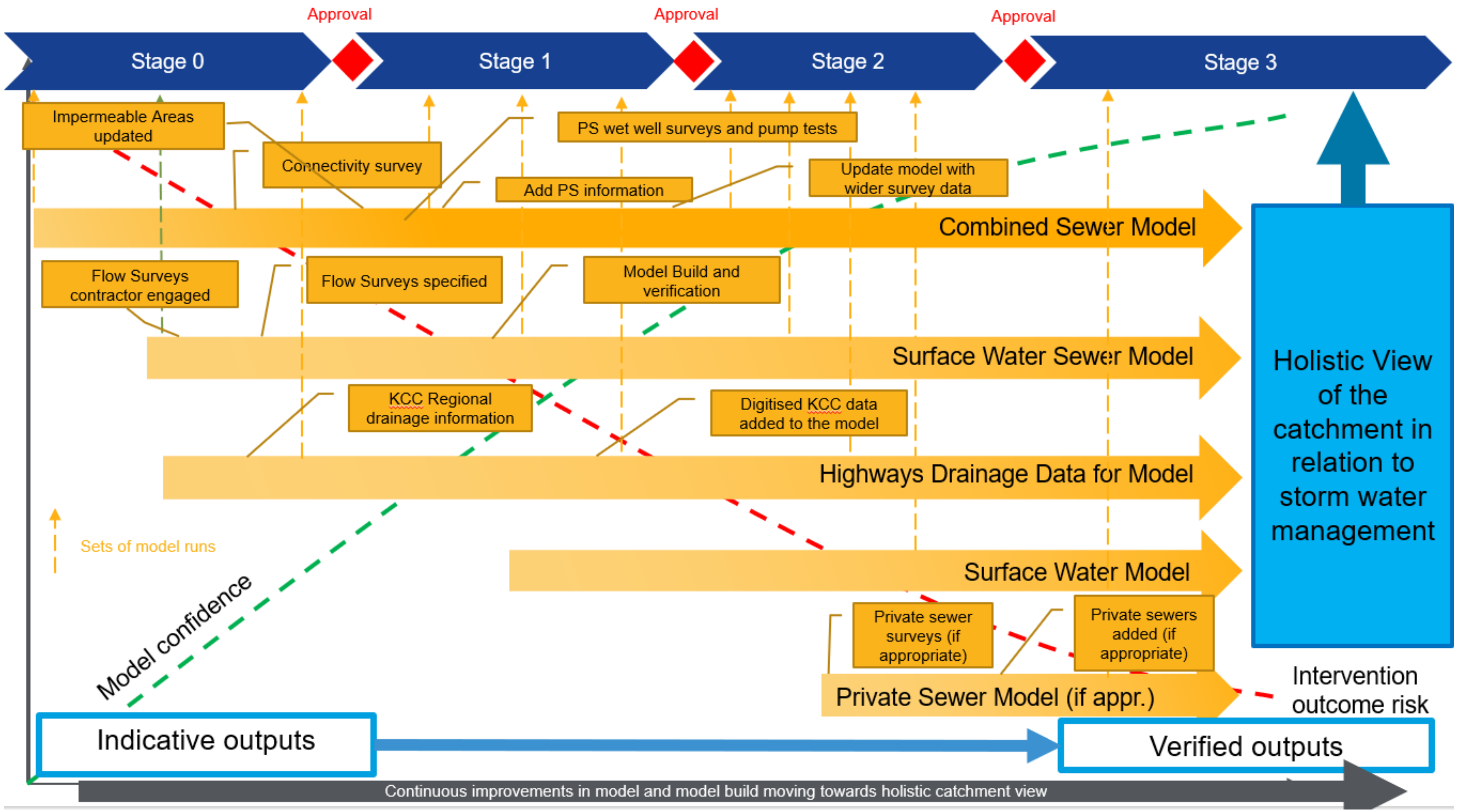

Figure 20 - Building a holistic view of a catchment

Glossary

Catchment	An area that is drained by a complex sewerage system comprising a network of pipes, wastewater pumping stations, and wastewater treatment works.
CCTV	Closed Circuit Television Video sewer inspection refers to the process of using a camera to see inside pipelines, sewer lines or drains.
Combined Sewers	A system that conveys both foul and surface water.
Storm Overflow	A traditional storm overflow which will have a condition for pass forward flow, an Event Duration Monitor (EDM), a screen and possibly storage volume.
DEFRA	Department for the Environment, Food and Rural Affairs
Dry weather flow	Dry weather flow is the flow of wastewater in a sewer system during dry weather that presents with minimal infiltration.
Dry weather flow pumps	These are pumps whose size is calculated to pump an agreed volume of flow forward to the WwTW. This flow rate is agreed with the EA.
Emergency Overflow	Typically, on a pumping station or WwTW and only used if the site has suffered a power or mechanical failure. For example, Diamond Road WPS has an emergency overflow.
EDM	Event Duration Monitor
FFT	Flow to Full Treatment
FOG	Fat, oil and grease
Foul Sewer	A sewer that is expected to carry predominately foul sewage from toilets, sinks, baths and appliances from a domestic property. The foul sewer also carries wastewater industrial and commercial properties.
GIS	Geographic Information Systems (GIS) are most often associated with mapping and provides geographic information through maps or databases. GIS combines hardware, software and data to provide visual geographic information. Also known in Southern Water as the sewer record.
Hydro-Brake®	This is a device that controls the flow coming out of a tank. Under regular conditions, water passes through the Hydro-Brake® unrestricted and continues downstream at normal levels. At times of high flow e.g. during a rainstorm, the structure's internal geometry harnesses the natural energy of the flow. This holds back the water, releasing it at a controlled rate.
IDB	Internal Drainage Board
Intervention	An action or project being undertaken in order to provide a solution/benefit for the catchment issue e.g. flood risk or number of storm overflow discharges.

KCC	Kent County Council
LSO	Long Sea Outfall
Main River	Main rivers are usually larger rivers and streams. The Environment Agency designates these and carries out maintenance, improvement or construction work on main rivers to manage flood risk.
Natural capital	Southern Water defines natural capital as the element of nature that provides value to society.
Network model	A software model representing the piped drainage system through which different rainfall scenarios can be run to understand the impact on storage capacity, water levels and pumping station capacity.
No regret intervention	Where it has been agreed through Governance that intervention will provide a benefit with negligible risk of a negative outcome.
Ofwat	The Water Services Regulation Authority
Rainfall scenario	Different types of storms that can be used in a network model. These storms may vary in length or intensity.
Social capital	Social capital is defined as Southern Water's relationships and others' trust in the business.
SWS	Southern Water Services
SSO	Short Sea Outfall
Storm Overflow	Where a combined sewer discharges a diluted but untreated mix of wastewater and rainwater into a water body during rainfall. The term is synonymous, for the purposes of this document, with the terms, combined sewer overflow, intermittent discharge and storm tank overflow.
SuDs	Sustainable Urban Drainage Systems
Unflushables	Items which should be disposed of in the bin, not the toilet.
WPS	Wastewater pumping station
WwTW	Wastewater treatment works