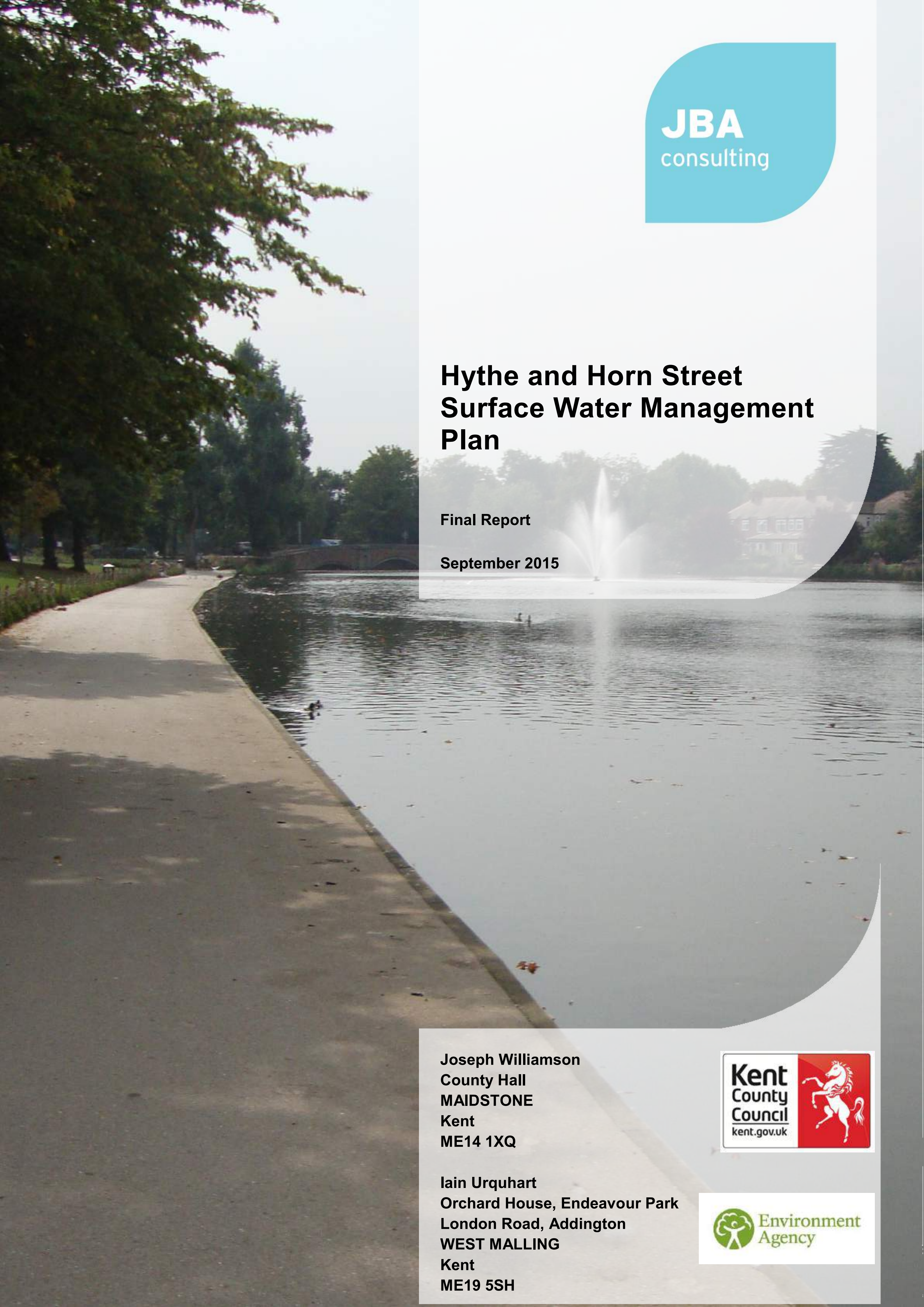

Hythe and Horn Street Surface Water Management Plan

Final Report

September 2015

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
Draft v1.0	-	Joseph Williamson (Kent County Council, Iain Urquhart (Environment Agency)
Draft v1.1	Updates to damage calculations	
Draft Final v1.2	Updates to Action Plan	Joseph Williamson (Kent County Council, Iain Urquhart (Environment Agency)
Final Report v3	Minor Ammendments	Joseph Williamson (Kent County Council, Iain Urquhart (Environment Agency)

Contract

This report describes work commissioned by Kent County Council and the Environment Agency by an email dated 16th October 2014. Kent County Council and the Environment Agency's representatives for the contract were Joseph Williamson and Iain Urquhart respectively. Jodie Hall, Elizabeth Gorton and Ian Ringer of JBA Consulting carried out this work.

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Purpose

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Acknowledgements

We would like to acknowledge and thank Kent County Council, Shepway District Council, the Environment Agency and Southern Water for all their assistance during this project.

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Abbreviations and Glossary of Terms

Term	Definition
CIL	Community Infrastructure Levy
CIRIA	Construction Industry Research and Information Association
Defra	Department for Environment, Food & Rural Affairs
Drainage Area (DA)	Are defined for the purposes of this study using FMfSW (1 in 200 year (deep)), historic flooding records and policy areas as defined by Kent County Council
DTM	Digital Terrain Model
EA	Environment Agency
EU	European Union
FAG	Flood Action Group. Groups of residents concerned about flooding in their area.
FDGiA	Flood Defence Grant in Aid
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG (Welsh Assembly Government).
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Floods and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
FMfSW	Flood Map for Surface Water. It has subsequently been replaced by the uFMfSW.
IDB	Internal Drainage Board
InfoWorks CS	Hydraulic and hydrologic modelling software produced by Innovyze. Used for modelling drainage systems.
InfoWorks ICM	Hydraulic and hydrologic modelling software produced by Innovyze. Capable of modelling integrated drainage systems including rivers, surface runoff, sewers and highway drainage.
JBA	Jeremy Benn Associates
KCC	Kent County Council
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
NPPF	National Planning Policy Framework
NRD	National Receptor Dataset – a collection of risk receptors produced by the Environment Agency
Ordinary Watercourse	All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.
PAR	Project Appraisal Report
Pathway	The mechanism or method flood waters are directed to a location/ receptor.
PFRA	Preliminary Flood Risk Assessment
Receptor	The area at risk from receiving flood water
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment
SHLAA	Strategic Housing Land Availability Assessment - The Strategic Housing Land Availability Assessment (SHLAA) is a technical piece of evidence to support

Term	Definition
	the Core Strategy and Sites & Policies Development Plan Documents (DPDs). Its purpose is to demonstrate that there is a supply of housing land in the District which is suitable and deliverable.
Source	Source of flooding i.e. heavy rainfall
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS	Sustainable Drainage Systems - Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques
Surface water flooding	Flooding as a result of surface water runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing what is known as pluvial flooding.
SW	Southern Water
SWMP	Surface Water Management Plan - The SWMP plan should outline the preferred surface water management strategy and identify the actions, timescales and responsibilities of each partner. It is the principal output from the SWMP study.
uFMfSW	Updated Flood Map for Surface Water. An update of the Environment Agency's previous national scale surface water flood map (FMfSW) with local information and knowledge on surface water from LLFA's.

1 Introduction

1.1 What is a Surface Water Management Plan

A Surface Water Management Plan (SWMP) is a study to understand the flood risk that arises from local flooding, defined by the Flood and Water Management Act 2010 as flooding from surface runoff, groundwater, and ordinary watercourses[1].

SWMPs are led by a partnership of flood risk management authorities who each have risk management role for flooding. , These may include the County Council, District Council, sewerage undertaker and other relevant authorities.

The purpose of a SWMP is to identify the local flood risk issues, what options there may be to prevent them (or the damage they cause) and a responsible authority to oversee the delivery of each identified option which is presented in an Action Plan agreed by the partners.

1.2 Previous studies

The Stage 2 SWMP follows on from the Folkestone and Hythe Stage 1 SWMP, which provided data gathering and a preliminary risk assessment for the whole of the Folkestone and Hythe. Kent County Council (KCC) in partnership with the Environment Agency (EA), Shepway District Council (SDC) and Southern Water (SW) undertook the Stage 1 SWMP as part of KCC's remit for strategic oversight of local flood risk management in Kent, conferred on them by the Flood and Water Management Act 2010. The Stage 1 SWMP was completed in November 2012.

The Stage 1 SWMP identified that Hythe would benefit from a more detailed study to understand the interaction between the various drainage systems - the Seabrook Stream, Saltwood and Mill Leese, Brockhill Stream, Royal Military Canal, sewerage system, highway drains and other drainage systems. KCC has commissioned the Hythe and Horne Street Stage 2 SWMP to investigate the flood risk across the study area shown Figure 1-1 for the Stage 2 SWMP.

1.3 SWMP drivers

The preparation of a SWMP was driven in response to the following considerations:

- The need to build on the understanding of high risk areas highlighted in the Stage 1 SWMP
- The requirement to investigate options for longer term solutions and accompanying sources of funding. This includes options such as removing surface water from the combined system and increasing storage capacity in the wider catchment.
- The need for a long term strategy for all the agencies involved in the water management within Hythe and Horn Street to manage the local flood risk.

1.4 SWMP objectives

The Hythe and Horn Street SWMP has the following objectives:

- To establish a local partnership as a steering group to work collaboratively to understand the causes and how to mitigate flooding;
- To collate and map out historical flood events for all local flood risk sources;
- To develop an understanding of flooding within Hythe through the development of a computer model. The computer model will be used to:
  - identify causes of the flooding and flow routes;
  - determine areas at risk of flooding;
  - estimate the economic impact of flooding to the town;
  - test 'options' to determine the most effective way of tacking the problem.
- Communicate with other local partners on the findings of the SWMP.
- Outline a plan to manage identified risks, including who is responsible for the action, timescales and costs.

[1] All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.

1.5 SWMP Production

JBA and partners have worked together to produce the SWMP by:

- Sharing information: the partners share information they hold on flooding, drainage systems and the catchment, including maps, computer models, river flow and rainfall data and local knowledge.
- Communication: Meetings, presentations and site visits are used to share knowledge, understand the roles and responsibilities of each organisation, review technical work and develop options to manage the flood risk.
- Transparency: Consultation with wider internal partners will be used to gather information and opinion on flood risk within Hythe and present the findings of the SWMP.

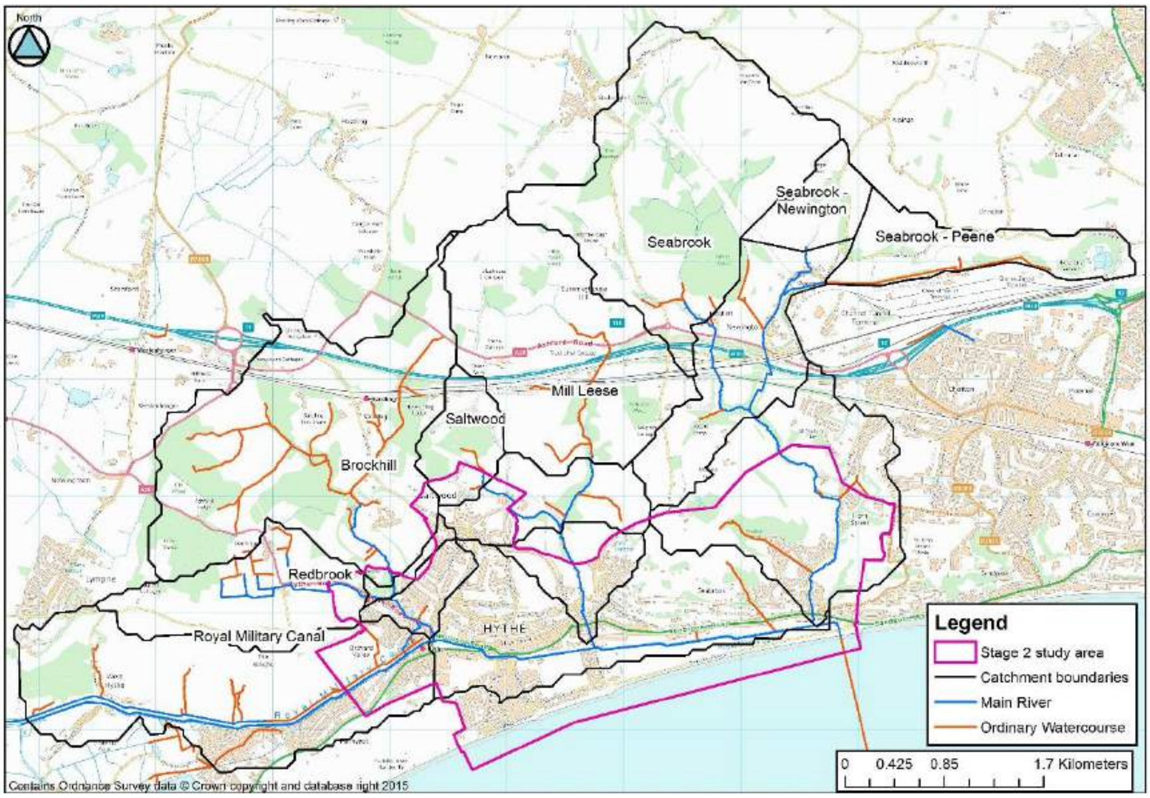
1.6 Study area

The study area includes the built areas of Hythe to the west and Horn Street to the east as shown in pink in Figure 1-1. There are three main rivers in the study area, the Brockhill Stream, the Saltwood and Mill Leese Stream and the Seabrook Stream. The streams drain largely rural catchments along the hills to the north of the Hythe flowing southwards through the built up area and discharging into the sea via the Royal Military Canal.

The study area is a mix of both urban and rural areas. The main urban areas of Hythe and Seabrook are located in the flatter lower catchment bounded to the south by the coastline. There are also settlements in the middle catchment including Horn Street and Saltwood. The upper catchment is largely rural, the streams consist of drains or ditches which run through farmland and a number of areas of woodland.

The topography of Hythe and Horn Street is steep and the streets around the town are generally narrow, steep and with little permeable areas. These slopes encourage runoff as water moves on the surface under gravity quicker than the rate of infiltration. A map of the LIDAR is shown in Appendix B, Map 1.

Figure 1-1: SWMP study area



1.7 Planning Context

It is important to consider how the SWMP integrates with local planning guidance in order that it can be aligned where surface water management is either already considered or can be delivered in conjunction with other relevant policies to provide multiple benefits.

The Shepway District Council Core Strategy published in 2013 covers the Hythe and Horn Street SWMP study area and sets out the planning principles for this area. Several of its policies notably Seabrook Valley (SS7), and Hythe (CSD7) contain sections which are relevant in the context of the SWMP in addition to more specific water management issues.

The Core Policies for Planning contained in the Core Strategy Delivery, section 5 of the report make specific mention to Water and Coastal Environmental Management in Shepway in sub section 5.65 (in relation to SuDS) where it states:

'Developers should strive to reduce the risk of flooding from surface water and foul water and its contribution to fluvial flooding, reducing the amount of water discharged to foul water drainage. The Flooding and Water Management Act (2010) requires developers to consider Sustainable Urban Drainage Systems (SUDS), and this should include provisions in proposals to confirm long-term management arrangements for features. In all instances developers should aim to reduce the rate of water runoff from sites'

Water resources management in sub section 5.69 may also allow for multiple benefits where demand management measures complement a reduction in surface runoff:

'This will complement the demand management measures being undertaken in the district for all users, and support wider environmental management in the district (including CSD4). Encouraging the more efficient use of water through rainwater harvesting or its re-use as 'grey water' relieves pressure on water resources but also potentially decreases discharges. These opportunities can all, in turn, contribute to the mitigation measures against climate change'

In addition to the more general polices there are several location specific ones of interest.

1.7.1 Policy SS7: Spatial Strategy for Shorncliffe Garrison, Folkestone

The Shorncliffe Garrison complex is allocated for a predominantly residential development of around 1,000 dwellings to 2026 (up to 1,200 by 2031) and an improved military establishment, together with a hub of new community facilities, associated enhancements to sports and green infrastructure. Development of this site has the potential to contribute to managing surface water as the policy states that planning permission will also only be granted where:

e. *The proposal incorporates high-quality green infrastructure at the design stage, with sports and public open space usable for active recreation retained in line with national policy, and improved changing facilities provided at 'The Stadium'.*

f. *Land at Seabrook Valley is released from military use for public and natural open space purposes, and a management strategy is in place to enhance biodiversity and to increase accessibility to the countryside where appropriate. Development proposals shall include an appropriate recreational access strategy to ensure additional impacts to Natura 2000 site(s) are acceptably mitigated against, in accordance with policy CSD4*

A.1.1 Policy CSD7: Hythe Strategy page - 98

This policy sets out that Hythe should develop as the high-quality residential, business, service, retail and tourist centre for central Hythe in line with the vision in paragraph 3.16. New development should respect the historic character of the town and the established grain of the settlement in line with the place-shaping principles set out in policy SS3.

The policy states that development should contribute to the priorities for investment in the town particularly relevant in the context of having the potential to manage surface water and provide multiple benefits are:

e. *Investing in strategic flood defences to protect residents and the Hythe Ranges.*

f. *Delivering public realm improvements in the High Street and town centre:*

i. Improving the setting of historic buildings and the Royal Military Canal,

ii. Increasing the ability of shoppers, visitors and residents to access and circulate along the main retail frontage

1.8 Using this report

The report is broken into 5 distinct sections with additional technical information provided in the appendices. Table 1-1 below displays the information contained within each section of the report.

Table 1-1: Report Layout

Section	Description of contents
1. Introduction	Defines the objectives of the SWMP and describes the background of the study area.
2. Partnership and Communications	Summary of the key partners and the consultation and engagement that accompanied the development of the SWMP.
3. Risk Assessment	Outlines the process followed to assess flood risk, and identifies the risk at hotspots within the study area.
4. Options	Describes the assessment of options to manage and reduce flood risk.
5. SWMP Action Plan	Provides details of the catchment wide and the location specific Action Plan and potential funding opportunities.

1.9 Partnership Approach

Surface water management cannot be undertaken by a single authority, organisation or partner; key organisations and decision-makers must work together to plan and act to manage surface water across Hythe and Horn Street. Many organisations have rights and responsibilities for management of surface water. Although this study was commissioned by Kent County Council, key partners have been consulted with at regular stages of the study. Working in partnership encourages co-operation between different agencies and enables all parties to make informed decisions and agree the most cost effective way of managing surface water flood risk across Folkestone and Hythe over the long term. The partnership process is also designed to encourage the development of innovative solutions and practices and improve understanding of surface water flooding.

2 Risk Assessment

2.1 Level of assessment

The Folkestone Level 1 SWMP[2] highlighted the catchments of the Seabrook, Brockhill and Mill Lease Streams as being areas of both significant historic and modelled flood risk from various sources. In line with the DEFRA guidance[3] a **detailed assessment** has been commissioned for the Stage 2 SWMP. This level of assessment aims to provide a more detailed understanding of the causes and consequences of surface water flooding, and to test the benefits and costs of potential mitigation measures. This will be achieved through modelling the performance of surface and sub-surface drainage systems, the modelling results and detailed analyses have then been used to prepare an action plan.

The risk assessment carried out used the Source > Pathway > Receptor approach:

- **Sources** refers to the sources of flooding - in this case flooding from pluvial (intense rainfall), sewers and watercourses has been quantified using a hydraulic model
- **Pathways** of flooding are how the flood waters get from the source to the receptor. In this study, overland pathways from all modelled sources have been considered using the 2-dimensional model described in section 2.2.
- **Receptors** refer to anything which can be impacted by flooding, including people, households, community facilities, infrastructure and land. This is discussed further in section 2.2.

Further technical details of the risk assessment method are provided in Appendix D.

2.2 Modelling the catchment

An integrated modelling approach was taken, which incorporated the Seabrook, Mill Leese and Brockhill Streams and their tributaries, and Southern Water, foul, combined and surface water drainage systems. Highways drainage information was not available at the inception of the study and no private sewerage was included (due to lack of records), therefore they have not been modelled.

A detailed integrated modelling approach for Hythe and Horn Street was justified by the requirement of the study to assess the flood risk from a variety of sources and to test a range of flood risk management measures. The modelling needed to consider the capacity of the local drainage system, the capacity of both open and culverted channels and runoff from both rural and urban areas.

InfoWorks ICM was chosen as the most appropriate modelling software as it can represent direct rainfall and overland flows, river networks and sewer networks simultaneously within one modelling platform. Most importantly, it also accounts for the interactions between these systems.

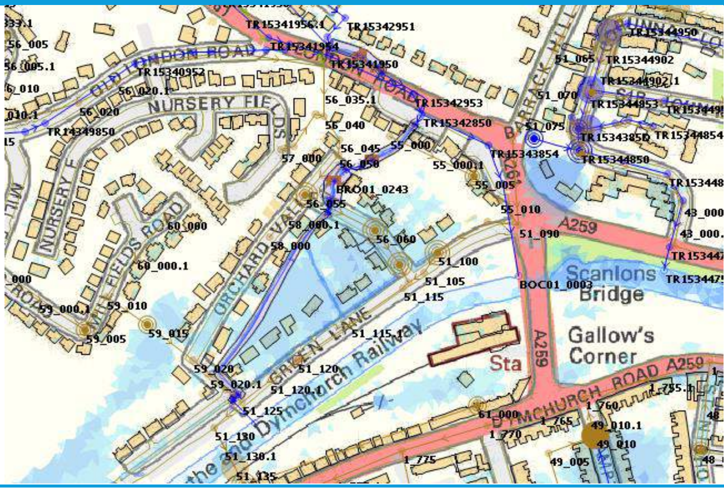
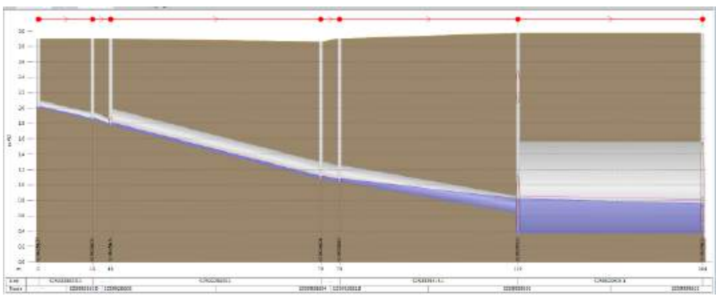
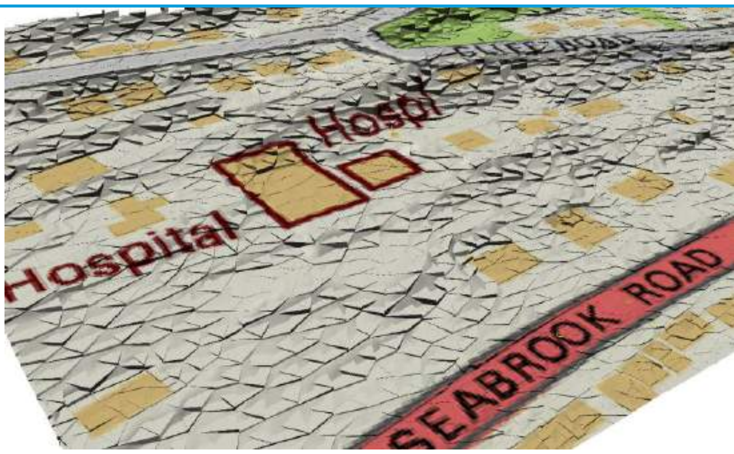
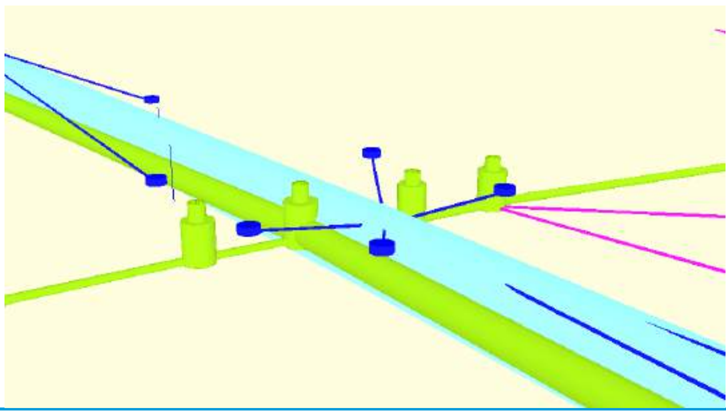
Full technical details are provided in the Model Operation Manual in Appendix D.

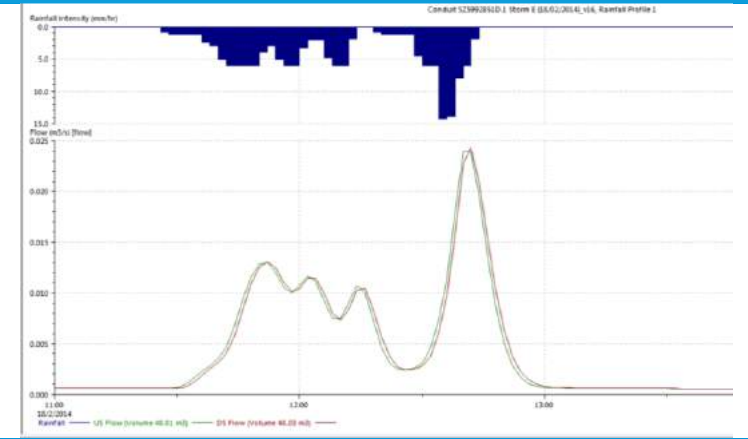
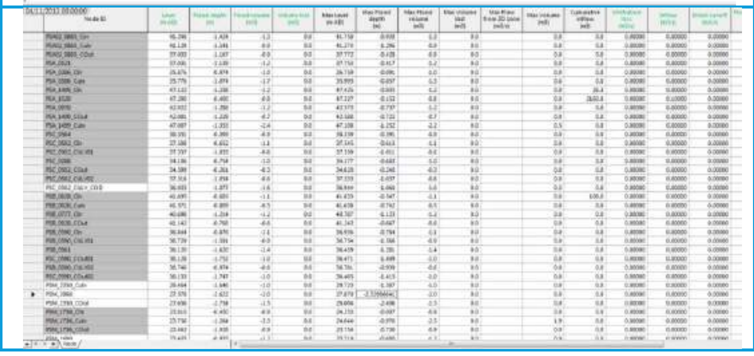
The model provides results in a variety of formats and provides a powerful tool for understanding and communicating flood risk within the study area. The range of results formats are displayed in Table 2-1.

[2] Folkestone & Hythe Surface Water Management Plan – Stage 1 (Kent County Council, 2012)

[3] Surface Water Management Plan Technical Guidance (DEFRA, March 2010)

Table 2-1: Model results formats

Results format / Description	Appearance	Export formats
Map / plan view. **R**esults from the 2D model including depth, velocity and hazard (a combination of depth and velocity which indicates the danger to people due by flooding) can be displayed.		GIS (SHP, TAB)
Long-section. These show a section along part of the drainage network (rivers and pipes), with the water level shown. They are useful for identifying pinch-points (restrictions) within the system and how they impact on upstream flooding.		BMP, WMF
3D plan view. Adds the vertical dimension to the map / plan view, allowing the influence of catchment topography on flooding to be better understood.		BMP
3D node view. Allows the connectivity below ground to be viewed. Particularly useful to understand complex structures such as the pumping stations or storage tanks.		BMP

Results format / Description	Appearance	Export formats
Graphs. Enable better understanding of the catchment hydraulics e.g. depth vs. velocity, and viewing results at different locations.		BMP, WMF
Tabular views and exports. Enable results to be exported to spreadsheets etc. for further analysis.		CSV

2.3 Assessing the risk

The model was tested using a range of design rainfall events ranging from the 1 in 5 up to the 1 in 1000 year return periods. After mapping the modelled results to show the predicted depth, velocity and hazard to people, the next step was to estimate the receptors at risk of flooding at different return periods. This involved a detailed count of properties at risk as well as an assessment of the damage costs based on depth and the area of the property flooded.

Receptors are the people, buildings, infrastructure or areas of land impacted adversely by flooding. The principal source of information on receptors used for this study was the National Receptor Database (NRD) maintained and supplied by the EA. This is a geographically referenced database of all homes, public buildings and services, commercial premises, above-ground utility services and environmentally designated areas. Housing units are classified by their lowest level (basement, ground floor, first floor etc.) to assist the quantification of risk to people and property. Map 6 shows the key receptors in Hythe and Horn Street.

Further information on the risk assessment method is provided in Appendix F.

2.4 Validating the risk assessment

A number of approaches have been taken to validate the risk assessment which are discussed in the following sections.

2.4.1 Project partner meetings

The progress and option meeting involved a presentation of the model build and the initial results to all the project partners. The results for the main areas at risk (Orchard Valley, Spring Lane, Mill Road, Blackhouse Hill and Seabrook) following the initial model runs were discussed enabling additional feedback about the flood history at each location to be captured. The principle feedback from this meeting was that:

- The modelled results broadly appeared to represent the flooding occurring in known flood hotspots well.
- The historical flooding reported in the Stage 1 SWMP along North Road is not shown in the results, however it is thought this is linked to piped drainage issues in this area

2.4.2 Comparison with historic flood events

Appendix C shows a comparison of historic flooding and modelled risk for hotspots across the modelled area. The historic flooding evidence available is insufficient to undertake full modelling of the historic events however it provides a good evidence for the assessment of the modelling outputs.

A summary of the results of the comparison of the reported historic flooding and modelled flood risk are summarised below in Table 2-2. The location of the historic flooding is shown in Map 5 of Appendix B.

Table 2-2: Summary of model performance against historic flooding

Location	Model performance	Conclusion
Orchard Valley	The model predicts surcharge from combined sewers on Orchard Valley. Ponding occurs in the low lying areas and on roads. Green Lane is not predicted to flood for all return periods ran (including 1 in 1000 year event).	At Orchard Valley, predicted flooding is mostly consistent with historical flood records in the area. On Green Lane, historical surface water flooding is not represented in the modelled results. On London Road, the uFMfSW flooding is more extensive than the modelled flooding.
St Hilda's Road	The model predicts surface water flooding and surcharge from the combined system.	This is consistent with historical flood records in the area.
Mill Road and Station Road	The model predicts surface water flooding on Mill Road. Flooding from Mill Leese occurs due to exceeded capacity in the river at >1 in 30 year event.	The prediction of fluvial and surface water flooding is consistent with the historical flood records for the area and the uFMfSW.
Cannongate Road	The model predicts some surcharge from combined sewers and some runoff from Sene Valley Golf Course.	Prediction by model is consistent with uFMfSW, however most of the flooding appears to derive from surface water as opposed to from surcharging sewers as detailed in the historic records.
Spring Lane	The model predicts surface water flooding derived from the north and south of Spring Lane. The water is shown to flow down Spring Lane into the Seabrook Stream.	On the historical records for the area, flooding on the south of Spring Lane is shown as fluvial flooding. The model predicts this as surface water. The pathway on the uFMfSW from Quarry Walk to Seabrook Stream is not predicted in the model.
Seabrook	The model predicts surface water flooding in the low lying areas south of the A259. Surcharging of the combined sewers is predicted.	The predicted extent is not as extensive as the uFMfSW with less sewer flooding.
High Street	The model simulates surface water flooding derived from the upper catchment. Sewer surcharging is also simulated at the junction at Mount Street.	Flooding from the combined sewer network is consistent with historic flooding. The results are consistent with the uFMfSW.

2.5 Results

Flood risk mapping has been produced for the 1 in 2, 5, 10, 20, 30, 50, 75, 100, 250 and 1000 year rainfall events and the 1 in 100 year plus climate change event (see Appendix B). The maps show the depth of flooding and the hazard to people rating, which uses a combination of depth and velocity flow to assess health and safety hazards to people.

2.5.1 Orchard Valley

Sources

Historic flooding records show sewer flooding at >16 properties in this area. The model indicates the main source of flooding is surcharge from the combined network and surface water flooding.

Pathways

The surface water flooding in Orchard Valley is caused by surface runoff from the north-east and north-west. London Road acts as a significant flow path. Surface water is simulated to flow down Barrack Hill and Corunna Close to pond in the area east of the A259.

Receptors

Principally residential properties but ponding also occurs on a main road (A261). Two electricity substations are at risk.

Frequency and severity

Due to its low lying position, Orchard Valley has surface water flooding problems in as frequent as the 1 in 2 year event although sewer surcharging does not occur until the 1 in 5 year event.

2.5.2 St Hilda's Road, Hythe

Sources

The model **predicts** flooding in the low lying areas around St Hilda's Road, mainly in the gardens and on the road. The model shows this is largely surface water with combined sewer surcharge along West Hill Road. This is consistent with the historic flooding events.

Pathways

Surcharging from **the** combined system on Leonards Road and surrounding roads along with surface water runoff causes localised flooding. Some ponding of surface water occurs due to **the** flat topography.

Receptors

Residential properties.

Frequency and severity

Small areas of surface water ponding are predicted as frequently as the 1 in 2 year event although water is not simulated to enter properties until the 1 in 10 year event.

2.5.3 Mill Road and Station Road, Hythe

Sources

The model simulates out of bank flow from the Mill Leese Stream due to insufficient culvert capacity downstream at higher return periods (1 in 50 year event and above).

Pathways

Blackhouse Hill is shown as a flow route in the uFMfSW and the modelled results. Water is also simulated by the current modelling to flow down Station Road.

Receptors

Principally residential properties with ponding also occurring on the main road. There is an electricity substation at risk.

Frequency and severity

Surface water flooding impacts the area from the 1 in 2 year event causing ponding on Mill Road and to properties. Fluvial flooding occurs in the 1 in 50 year event and above. Surface water flooding is simulated to contribute to the flooding issues in the Mill Road area from the 1 in 2 year event. The model results reflect the uFMfSW; however the known historical flooding incidents do not support this modelled risk.

2.5.4 Cannongate Road

Sources

Surface water runs off Sene Valley Golf Course, some surcharging of combined sewer system occurs due to capacity exceedance.

Pathways

Runoff from Sene Valley Golf Course flows down Cannongate Road, Blackhouse Hill, Sene Park and Farmer Close. Although the surface water primarily flows east to west, when it meets Cannongate Road, it flows south down the road.

Receptors

Residential properties with 2 electricity substations at risk.

Frequency and severity

Surface water flooding of properties occurs frequently, the modelled risk shows flooding in the 1 in 2 year event.

2.5.5 Spring Lane

Sources

Surface water from hillsides to the north and south of Spring Lane

Pathways

Surface water from Paraker Wood floods properties to the north of Spring Lane and flows down the road to Seabrook Stream. Model shows ponding against houses and in the road caused due to flow path from top of Spring Lane. This represents the uFMfSW well.

Receptors

Residential properties.

Frequency and severity

Surface water flooding of properties occurs frequently, and modelled risk shows flooding in the 1 in 2 year event.

2.5.6 Seabrook

Sources

The model shows a surface water flow path running down Horn Street after overtopping the bank at the Seabrook Court culvert entrance. This flow path is consistent with the uFMfSW.

Predicted flooding around Sea Road is consistent with the uFMfSW, however at Seabrook Gardens and Victoria Grove less flooding is represented on the modelled results which is also inconsistent with the historic flooding.

Some properties around Seabrook Court are modelled to flood. This is consistent with historic flooding records.

Pathways

Flooding occurs as a result of surface water, some of which travels from Whitenbrook Wood. Manhole surcharge occurs from the combined network at locations where the hydraulic gradient flattens.

Receptors

Principally residential properties with some small commercial properties and a school at risk. There are electricity substations at risk. The main road is also affected.

Frequency and severity

Ponding and surcharging from the sewer network occurs from low return periods.

2.5.7 High Street

Sources

The model indicates flooding in this area is largely caused by surface water from the hillside and runoff from large impermeable areas. There is an unknown source of flooding in the area in the historical records which shows as sewer flooding of up to 5 properties in this area.

Pathways

Surface water flows from both the east and the west on the High Street, meeting at the lowest point and flowing through a commercial area onto Prospect Road. Roads generally act as flow paths although water also flows around properties.

Receptors

Principally residential properties with ponding also occurring on a main road (A259) in larger events. Historical flooding has affected the local businesses. An electricity substation is at risk.

Frequency and severity

Surface water flooding on High Street is frequent, which is consistent with the historic flooding evidence available. Surcharging starts to occur in the 1 in 5 year event.

2.6 Flood risk metrics

The results of the modelling in conjunction with the historical flooding data identify surface water flooding hotspots as outlined in Section 2.4.2 and discussed further in Appendix B. An assessment has been made of the identified hotspots with damages to receptors assessed using the methodology in the 2010 Multi-Coloured handbook[4], with damage calculations based on the data in the 2013 update to the Multi-Coloured Manual. Further details of the damage cost appraisal is included in Appendix D.

A summary of the estimated damages for the study area as a whole for a range of return periods is shown in Table 2-3 and Table 2-4 below. It should be noted that the property counts shown below include all properties that are affected by flooding that runs across the land surface, but does not include properties that may be affected by internal flooding from the sewer network.

Table 2-3: Summary of Flood Damages to a depth of 0.1m

Return Period	Area Flooded / m^2	Number of Properties flooded to a depth of 0.1m	Mean damages / £
1 in 2	71,840	579	11,315,000
1 in 5	115,604	895	15,419,000
1 in 10	157,379	1133	19,242,000
1 in 20	208,631	1273	23,534,500
1 in 30	247,202	1498	25,871,500
1 in 50	306,733	1768	31,307,000
1 in 75	353,022	2007	34,630,500
1 in 100	386,492	2125	37,308,000
1 in 100cc	465,709	2366	43,248,000
1 in 250	499,151	2442	45,139,000
1 in 1000	720,967	3051	59,837,000

Table 2-4: Summary of Flood Damages to a depth of 0.1m

Return Period	Area Flooded / m^2	Number of Properties flooded to a depth of 0.1m	Mean damages / £
1 in 2	599,816	4426	26,704,500
1 in 5	768,912	4837	30,780,000
1 in 10	909,221	5118	33,821,500
1 in 20	1,063,865	5390	37,331,000
1 in 30	1,159,729	5534	39,872,500
1 in 50	1,302,243	5715	43,274,500
1 in 75	1,417,516	5863	45,820,500
1 in 100	1,500,181	5954	47,712,000
1 in 100cc	1,701,723	6149	51,952,500
1 in 250	1,791,243	6225	53,469,500
1 in 1000	2,292,135	6561	64,413,500

[4] Penning-Rowsell E, Priest S, Parker D, Morris J, Tunstall S, Viavattene C, Chatterton J, and Owen D (2013) Flood and Coastal Erosion Risk Management: Manual for Economic Appraisal (Multi-Coloured Manual). Flood Hazard Research Centre, London

Table 2-5 presents a summary of the flood damages for the hotspots identified above for the 1 in 100 year storm.

Table 2-5: Summary of Flood Damages for 1 in 100 year storm

Location	Area Flooded / m^2	Number of Properties flooded to a depth of 0.1m	Mean damages / £
Orchard Valley	11399	42	4,712,500
High Street	23046	270	9,593,000
Spring Lane	2400	32	559,500
Mill Road and Blackhouse Hill	10050	102	1,953,500
Seabrook	25229	110	2,073,000

2.7 Water quality assessment

2.7.1 Coastal and bathing waters

Hythe and Sandgate have designated bathing waters, which plays an important role in the tourism economy of the area. Treatment at Hythe sewage treatment works was installed in 2001. This improved quality within Hythe Bay, which stretches from Folkestone down to the headland of Dungeness[5]. Hythe's bathing water has met the EA's "higher" standard[6] since 1994, whereas Sandgate has only met the standard since 2008. This failure was due to a faulty wastewater pumping station which discharged untreated sewage into the Royal Military Canal. The fault was subsequently rectified. Seabrook CSO discharges into the RMC just before the outfall onto the beach. Discharges occur when heavy rainfall overwhelms the sewerage system and causes diluted sewage to overflow.[7].

2.7.2 Surface waters

The Seabrook Stream has been assessed as having Good Status in the Environment Agency's Water Framework Directive assessment of surface waters[8]. The Mill Leese and Brockhill Streams have not been assessed. A map showing the WFD overall status of the rivers is shown in Appendix B, Map 3.

2.7.3 Conclusions

No significant water quality issues have been identified in the study area, however and future measures to manage surface water flood risk must ensure that the current coastal and surface water quality does not deteriorate and, wherever feasible, to ensure that surface water management measures contribute to improving water quality.

[5] Environment Agency (2015) http://environment.data.gov.uk/bwq/explorer/info.html?site=ukj4208-13500

[6] Bathing water quality compliance classification for use during transition to the Revised Bathing Water Directive - rBWD (2006/7/EC) For annual assessments, "Higher" means that the bathing water meets the criteria for the stricter guideline standards of the cBWD Directive (76/0160/EEC). Sample limits used are: "Higher" EC: ≤100; IE: ≤100. "Minimum" EC: ≤2000 "Fail" EC: >2000 EC = Escherichia coli, IE = Intestinal enterococci. All numeric limits are cfu/100ml

[7] Environment Agency (2015) http://environment.data.gov.uk/bwq/explorer/info.html?site=ukj4208-13400

[8] Environment Agency (2015) http://data.gov.uk/dataset/wfd-surface-water-classification-status-and-objectives

3 Options

3.1 Objectives

The options assessment process identifies, shortlists and assesses measures for mitigating surface water flooding within Hythe and Horn Street providing a framework for the agreement of preferred options.

Options are tested by adjusting the model to reflect the changes they deliver, comparing damages both with and without it. An assessment of the cost of implementing the option are made as well as the economic benefits of the reduction in damages. This is used to make an assessment of the cost effectiveness of the option, assessed as a cost-benefit ratio.

Many assumptions have to be made about the measures that are delivered, how much they cost and any maintenance they require etc. Short-listed option will require much further assessment before it can be delivered to refine these assumptions.

The preferred options have then been carried forward to the SWMP Action Plan.

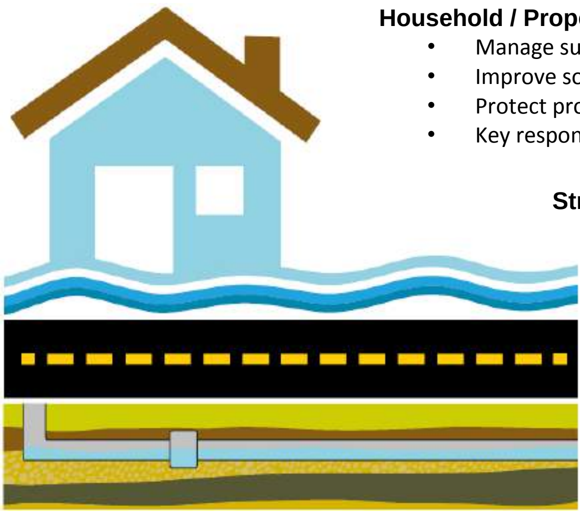
3.2 Options meeting

The options workshop reviewed flood risk at all of the hotspots identified during stage 1, to identify where and what type of solutions the stage 2 SWMP should consider. The partnership agreed priority locations for the stage 2 SWMP assessment which are outlined in the following sections.

3.3 Options assessment concept

The options assessment for Hythe and Horn Street was based around the concept of a tiered approach for improving surface water management. This included property level (recognising that a large proportion of impermeable surfaces are private roofs and driveways), street level (seeking to slow runoff from roads), town level (putting in place planning polices and making the most of new developments) and below ground (recognising the need to improve sewerage system performance). This approach is illustrated in Figure 3-1 and the options described in the following sections.

Figure 3-1: The tiered approach to options assessment



3.4 Property Level

3.4.1 Option 1 - Property Level Protection

Option 1 accepts that even with mitigation options there may be a residual risk from surface water flooding. Property Level Protection (PLP) may be the best solution to protect a home or business against specific surface water issues in certain locations, such as High Street. Feasibility issues at High Street limit the available options of PLP, as the current level of access to shops is required to be maintained.

The critical duration of the catchment is around 3 hours and there is currently no flood warning system for surface water flood risk, therefore limited time would be available to install temporary flood mitigation measures so it may be necessary to consider more permanent solutions.

PLP measures can be categorised as flood resistant measures, which form a barrier to flood water to keep it out of the property, or flood resilience measures such as replacing carpets with waterproof tiling and raising electricity sockets in order to reduce the impact of any floodwater that does enter the property and aid in the recovery process. It is suggested that resilience measures would be most suitable in this location

Homes and business owners would be responsible for PLP with the support of SDC.

Modelling

No additional modelling has been undertaken for this option.

3.4.2 Option 2 - Management of surface water at property level

Option 2 considers the additional benefit that could be attained by the application of SuDS retrofit measures in the Spring Lane and High Street areas. At both locations measures considered included the replacement of all impermeable road and pavements in the area with permeable surfaces.

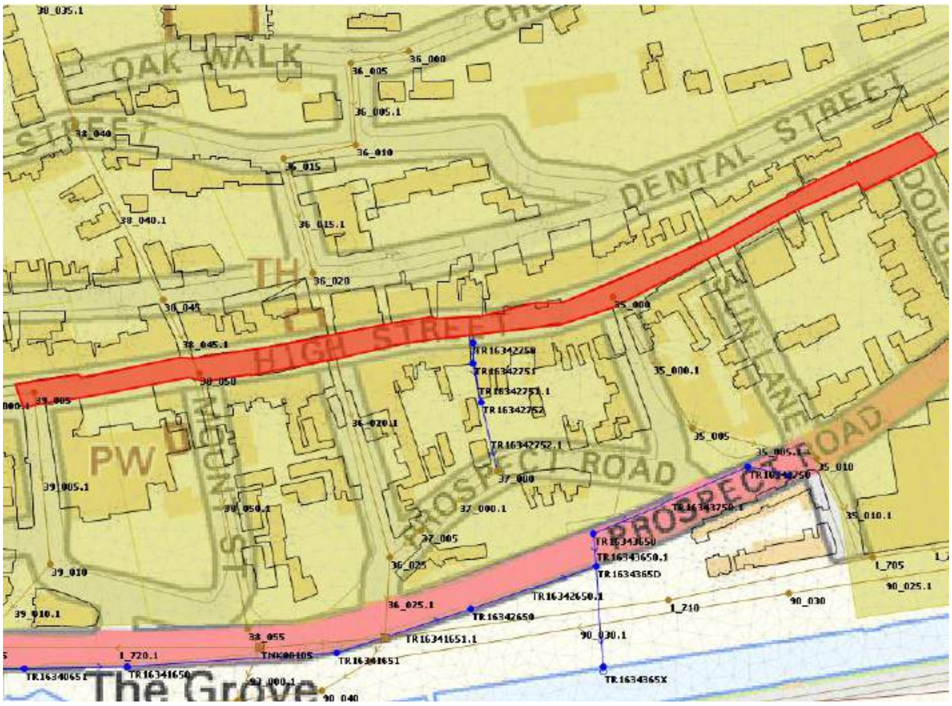
These measures represents a scenario in which SDC and residents work together to address flood risk.

Modelling

Modelling has been undertaken using infiltration zones to represent permeable parking. An Infiltration Loss Coefficient of 200mm/h with a Fixed Runoff Coefficient of 0.3 and infiltration type set to ConstInf were set up within the model. At Spring Lane, permeable parking was modelled on a single side of the road in locations which would mimic normal parking areas. Mesh zones have been used to lower the parking area by 0.15m and porous walls set to 0.3m height have been added at regular intervals with the aim of trapping flow for infiltration (Figure 3-2). At High Street, the same parameters were used for the infiltration zone, shown selected in Figure 3-3.

Figure 3-2: Schematic of permeable parking retrofit modelling at Spring Lane

Figure 3-3: Schematic of permeable parking retrofit modelling at High Street



3.5 Street Level

3.5.1 Option 3 - Surface Water Separation

Option 3 considers the impact of separating or removing surface water from the drainage system.

At Orchard Valley, the option tests whether surcharging sewers in the upstream catchment are causing flooding in the Orchard Valley estate, and whether by separating surface water from the combined network the flooding can be reduced.

At Seabrook, the option considers the impact of removal of roof runoff from the network. This could be represented by the creation of a surface water system, or by the removal of permeable surface runoff areas from the network through the application of SuDS retrofit measures (for example green roofs or rain gardens). The use of rain gardens provides additional benefits in terms of enhancing the appearance of the streetscape and improvements in biodiversity. Engagement with residents would be required to assess their opinion of the impact on the streetscape. A recent retrofit of rain gardens has been undertaken in Nottingham. The CIRIA website contains a case study including photographs of the installed rain gardens and information on resident feedback[9].

Modelling

Modelling has been undertaken to test the effects of surface water removal from the combined network at Orchard Valley. The scenario tests removal of all permeable areas from the combined network routing of this runoff either into the existing surface water network along Old London Road, or directly draining it to the Mill Fields Road area into the RMC via a new surface water network using conventional or SuDS drainage. Should the drainage of the Mill Fields area be taken forward further investigation will be required to identify the best route for the new drainage

The existing foul network and subcatchments are shown in Figure 3-4. The permeable area has been removed from these subcatchments and added to both new (highlighted in Figure 3-4) and existing surface water subcatchments. All contributing area from foul subcatchments within the area has been removed and applied to the surface water system.

The Seabrook scenario tests removal of roof area from the foul network around Seabrook. It does not include creation of any new surface water drainage, but assumes that the roof drainage managed using SuDS techniques. As the specific roof runoff area has not been included in the existing Southern Water model, it has been assumed that 25% of the permeable area in the subcatchments highlighted in red in Figure 3-5 has been removed to represent this loss of roof area.

[9] CIRIA (2014) http://www.susdrain.org/case-studies/case_studies/nottingham_green_streets_retrofit_rain_garden_project.html

Figure 3-4: Schematic of Surface Water Separation at Orchard Valley

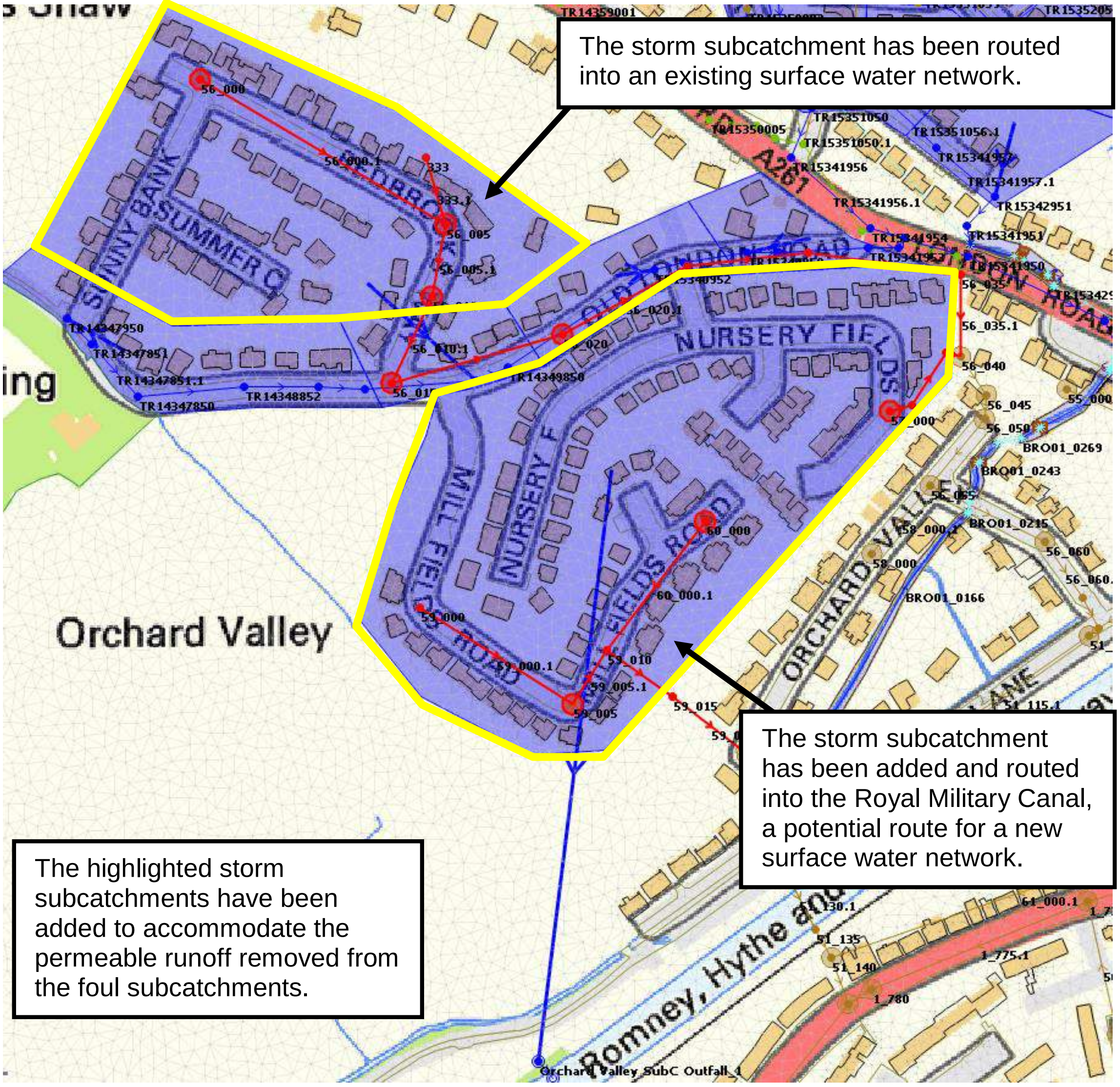
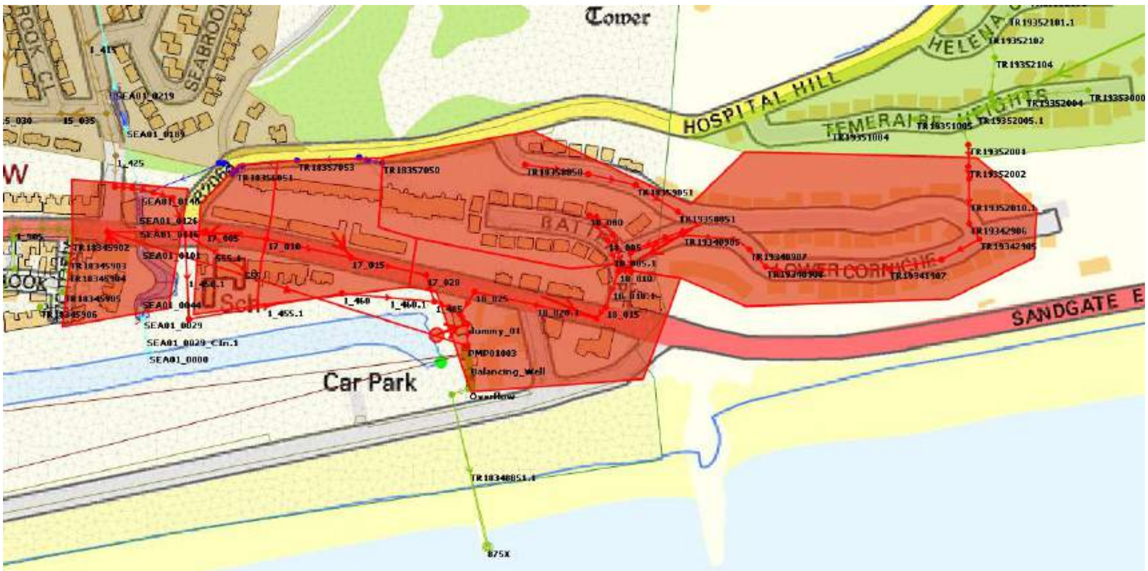


Figure 3-5: Option testing at Seabrook removed roof runoff from the foul network



3.5.2 Option 4 - Flow Diversion

Option 4 diverts overland flows away from houses in the Sene Park and Blackhouse Hill **area where** there is **the** potential to reduce the number of properties affected by surface water flooding **through altering flow routes.** At High Street, flow paths could be altered by use of speed bumps or through temporary measures during storm events.

Modelling

Porous walls with a height of 0.3m have been added to alter flow routes around Sene Park and Blackhouse Hill (Figure 3-6). They have been added in areas where surface water flooding is problematic and the impacts of flow diversion will be assessed. Scenarios at High Street have not been modelled.

Figure 3-6: Schematisation of flow diversion bunds at Sene Park

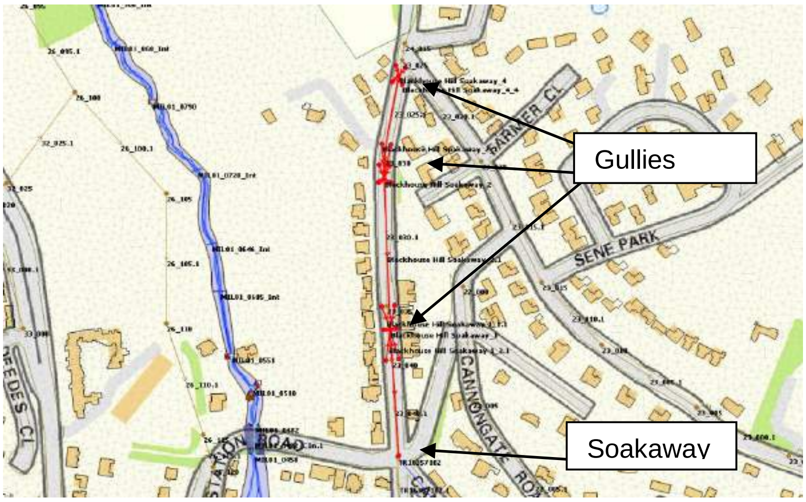
3.5.3 Option 5 - Gullies to Soakaway

Option 5 assesses the potential impact of retro-fitting a soakaway at Blackhouse Hill, with connecting gullies. It is intended to reduce surface water flooding by intercepting the flow path of surface water along Blackhouse Hill and drain it to soakaway.

Modelling

Gully nodes have been set up to capture flow in the areas with highest flood depths. The nodes have been set as Gully 2D with a head discharge table set up for an urban highway. They all drain downstream to a soakaway located at the junction of Station Road and Blackhouse Hill. The soakaway dimensions are 20m^2 base area and 5m deep. The infiltration rate is 100mm per hour. Although the gullies are not represented in the model as they would in reality, the scenario is testing the capacity of such a system to affect flows in the area.

Figure 3-7: Schematisation of soakaways at Blackhouse Hill



3.5.4 Option 6 - Flood Storage Areas

Option 6 assesses the potential to create flood storage areas within the catchment offers an option opportunity on Seabrook Stream where flow could be throttled and retained within the flood plain with the aim of increasing river capacity downstream.

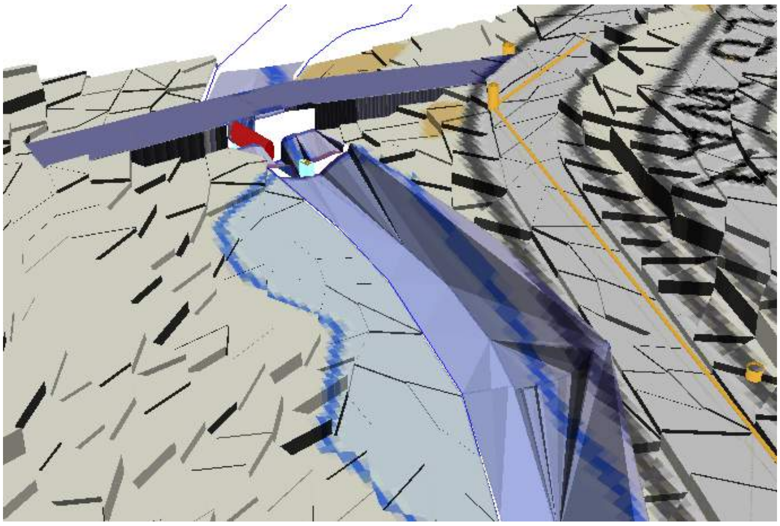
Modelling

Two scenarios were modelled, one utilising storage at Fish Farm only, and **a second** scenario utilising storage at two locations on Seabrook Stream; Casebourne Farm and Fish Farm.

The Fish Farm scenario was modelled by adding an orifice in place of the existing footbridge to throttle the flow to 2.5m3/s, whilst adding a mesh zone to allow more flood water to be stored to a level of 17mAD without overtopping the structure (Figure 3-8). The flow was limited to 2.5m^3/s with the intention of creating capacity in the culverted reach of the stream close to the outlet into the RMC.

The second scenario which also utilised storage at Casebourne Farm involved throttling the flow in the same way and using a mesh zone to contain the 2D flow. **This time the f**low at Casebourne Farm was throttled to 2.5m^3/s, **while the** Fish Farm was throttled to 1.8m^3/s to test the possible effects of providing additional capacity in the system downstream.

Figure 3-8: Schematisation of flood storage at Fish Farm



3.6 Below ground

3.6.1 Option 7 - Upgrade pipes

Option 7 tests the potential to upsize the culverted watercourse which runs between Mill Road, under Twiss Road and outfalls under Earlsfield Road. This would allow increased capacity and reduce the out of bank flow around Mill Road.

Modelling

Pipe diameter was increased from 1200mm to 1500mm for the selected conduits (Figure 3-9). Manhole roofs have been increased in height accordingly to match with the pipe soffit.

Figure 3-9: Upsized pipe at Mill Road

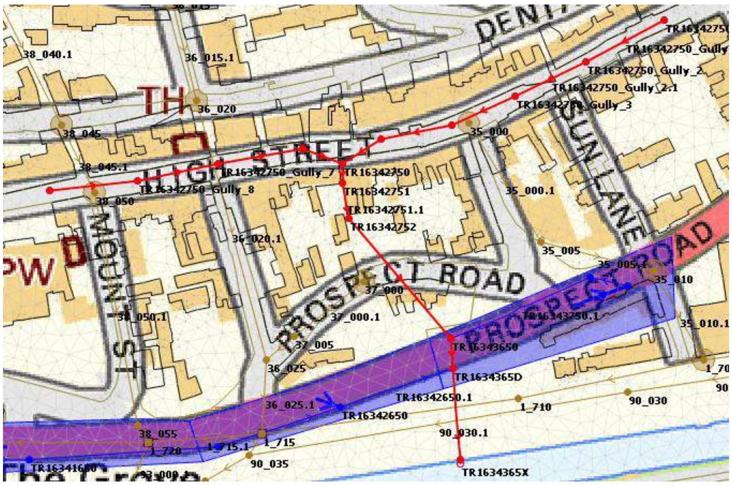
3.6.2 Option 8 - Extend Surface Water System

Option 8 investigates the potential to extend the surface water sewer network at the High Street, and alter the connection (which currently links to the foul network) to join the existing surface water network at Prospect Road. New Surface Water gullies pick up flow on High Street and the pipes from Prospect Road to the outfall at the RMC would be upsized to allow for a larger capacity. In addition to reducing surface water flood risk on High Street, this would alleviate current pressure within the combined system from the current runoff from the limited High Street system.

Modelling

The existing surface water drainage which connects to the combined system on Prospect Road has been rerouted into the existing surface water system which outfalls directly into the canal (Figure 3-10). The nodes have been set as flood type Gully 2D with a head discharge table set up for an urban highway. The connection has been upsized to 450mm from 250mm / 300mm to account for the increase in flow.

Figure 3-10: Surface Water System at High Street



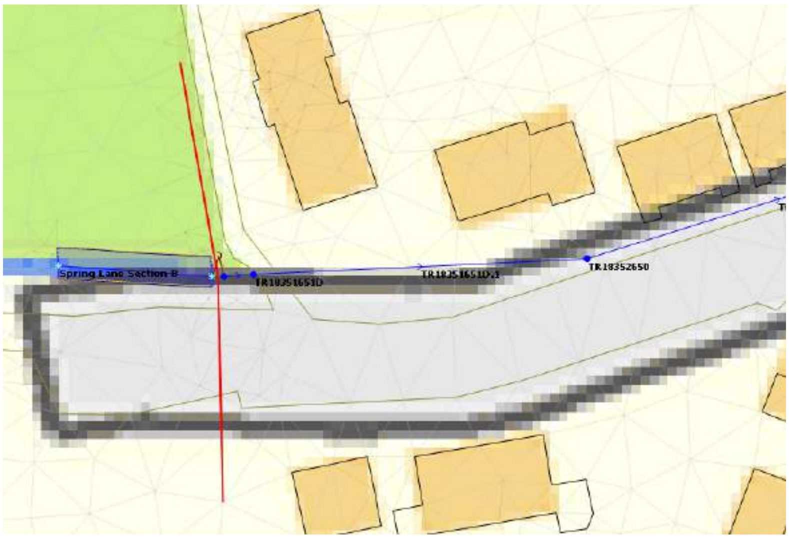
3.6.3 Option 9 - Improve Culvert Inlet Structure

Option 9 tests the effect of removing overland flooding resulting from surcharge of the inlet to the Spring Lane Culvert. At present there is an overland flow path that affects a number of properties and this option aims to eliminate this.

Modelling

A porous wall was digitised to prevent any fluvial flow overtopping the culvert inlet structure therefore assessing the significance of fluvial flows on flood risk along Spring Lane. A positive impact on depth reduction would indicate that fluvial flooding is a contributing factor to flood risk on Spring Lane, and that improving the inlet structure may be a potential option to reduce risk from this source (Figure 3-11).

Figure 3-11: Porous wall to test potential of impact of improving inlet structure



3.7 Catchment scale and non-structural measures

3.7.1 Pumping

The St Hilda's road area is located in the southern corner of Hythe between the RMC and the sea. It is a low lying area with high density housing and therefore there is little scope for above ground mitigation options. Below ground options are limited due to the existing pressures on the local drainage network.

Further investigation is require to understand the precise nature of flooding in this location. Is the network vulnerable to high intensity or longer duration events, is infiltration a problem (which can often be an issue in low lying areas) to identify a strategy for surface water removal.

Modelling

No additional modelling has been undertaken for this option as part of the SWMP as it was recognised that the Range Road pump station is a terminal WPS pumping to West Hythe WTW which controls flow under consent. Surface water separation and/or flow control at source is therefore the only feasible solution once the flooding mechanism is more accurately determined.

3.7.2 Surface water disconnection measures

The catchment offers a limited number of potential opportunities to disconnect surface water drainage from large roofed and paved areas discharging to the sewerage system or watercourses. They fall into two categories:

- The potential to disconnect surface water sewers connected to the combined sewer system. These are areas of the catchment where development has installed separate sewers, but these then join together to discharge to the combined sewer system.

  These areas are limited within Hythe and Horn Street however there are some areas of surface water (and combined) system at the east of the catchment at Seabrook which eventually drain into the combined sewer which runs along Battery Point. Disconnecting these is unlikely to have a significant impact downstream given how small the areas are.
- The second category is potential to disconnect large roofs and car parks within the catchment to limit the discharge from these surfaces. These surfaces are limited in the main flood risk hot spots and therefore these would be opportunities best considered during redevelopment or refurbishment.

3.7.3 Spatial planning measures

It has been noted that no Strategic Housing Land Availability Assessment (SHLAA) has been carried out to consider sites which may be potentially selected for development. However Appendix 6, of the Shepway District Council Strategic Flood Risk Assessment (SFRA)[10] highlights

[10] Shepway District Council Strategic Flood Risk Assessment - Final (June 2009)

proposed development sites and details site appraisals. The following are measures specific to spatial planning which could offer benefit to flood risk management in the longer term.

Recommendation: Restrict runoff from brownfield sites

The SDC SFRA specifies that the run-off rates and volumes from brownfield sites should not be increased from their current values:

"To ensure that flood risk is not increased within the District any new development will need to be designed such that the peak rate and volume of surface water runoff from the site is not increased above the existing surface water runoff rate."… "Developers are, however, strongly encouraged to reduce runoff rates from previously-developed sites as much as is reasonably practicable."

"For sites less than 1 hectare, surface water flows associated with the 100 year event (including an appropriate allowance for climate change), should preferably be contained within the site at designated temporary storage locations, either located above or below ground."

"*In line with PPS25, for development within Zones 2 or 3 and for sites greater than 1 hectare, a surface water management strategy will also need to be incorporated within the site-specific FRA. The requirements for this are set out in Section 10.4 of the SFRA.2*

The specifications within the SDC SFRA are in line with the Defra non-statutory technical standards for sustainable drainage systems[11], which recommend attenuation of surface water flows from brownfield sites but do not impose this where it is not reasonably practical.

Recommendation: Presumption against culverting

The Flood and Water Management Act 2010 amended the Land Drainage Act 1991 so that flood risk from ordinary watercourses is now considered and managed at the local level. Works that are likely to alter or impact the flow or storage of water, or the erection of a culvert requires consent from the Drainage Board. Although the SDC policy does not currently discourage culverting of watercourses, it is recommended that discouragement against culverting would apply within the existing urban areas as well as to new developments. Wherever possible, existing watercourses and drainage channels should remain above-ground, offering risk management authorities' benefits in terms of maintenance, future upgrading, increased biodiversity and pollution prevention. The CIRIA Culvert Design and Operation Guide[12] provides guidance in this area. The policy would need to be managed and applied by SDC and EA when reviewing planning applications and Land Drainage consents.

Recommendation: Raise awareness and enforcement of paving front gardens

Much of Hythe and Horn Street has experienced the loss of front gardens to hard standing parking. Incremental increases of impermeable areas (known as 'urban creep') have been demonstrated to increase the risk of flooding. As this is a difficult area to enforce the preferred approach is to raise a greater awareness of the issue within Hythe and Horn Street and provide guidance to households and contractors. Further policy and guidance in this area to consider:

- Raise public awareness of the restrictions on paving of front gardens amongst residents and contractors
- Education on the issue of household drainage and misconnections and developments carried out under permitted development rights
- Advice with the respect to drainage of small developments
- Identify how Development Control can implement this policy without creating large amounts of additional activity

Recommendation: Drainage of new developments / SuDS

The Shepway District Council SFRA recognises the need for discharge patterns from new developments to reflect the discharge pattern of the undeveloped greenfield site. It states that, "*new development should incorporate the principles of SuDS in its drainage design wherever practically achievable."* and, "*if the site is a greenfield site then the strategy will need to*

[11] Defra (2015) Non-statutory technical standards for sustainable drainage systems. Accessed online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf on 06/05/2015

[12] Balkham, M, Fosbeary, C, Kitchen, A, Rickard, C. (2010) Culvert design and operation guide (C689), CIRIA,

demonstrate that the maximum rate of surface water runoff from the site is controlled such that it does not exceed the pre-developed greenfield runoff rate."

This policy is broadly in line with the 2015 Defra on-statutory technical standards for sustainable drainage systems. In addition, NPPF recommends *"using opportunities offered by new development to reduce the causes and impacts of flooding."* Therefore development upstream of areas of existing risk could be required to reduce runoff (compared to the current situation) in order to reduce downstream flood risk, or contribute in other ways to managing that risk.

3.8 Assessment of options

The modelled options have been assessed by comparing the number of properties affected by flooding and the total mean flood damages. Where the options are location specific the results have been assessed for the areas that they are expected to influence. The tables below show the change in modelled surface water flood risk for the options.

Table 3-1: Change in modelled flood damages for options at Spring Lane

Option		Return Period	Number of Properties flooded to a depth of 0.1m	Change in Number of Properties flooded to a depth of 0.1m	Change in Mean damages / £
9	Culvert Inlet Structure Improvement	5 year	23	0	-500
		30 year	29	1	-7,000
		100 year	29	-3	-32,500
2	Permeable Parking	5 year	20	-3	-59,000
		30 year	28	0	-9,500
		100 year	32	0	-12,500

Results of the culvert inlet structure improvement scenario show benefits to the mean damages and number of properties flooded for the 100 year event. This suggests that further investigation into the efficiency of the structure at Spring Lane should take place.

There is significant reduction in mean damages for the 5 year return period, this is due to the reduction in the number of properties flooded. In the higher order events, the damages are reduced as the depth of flooding is reduced in spite of the fact that the number of properties remains the same.

Table 3-2: Change in modelled flood damages for options at High Street

Option		Return Period	Number of Properties flooded to a depth of 0.1m	Change in Number of Properties flooded to a depth of 0.1m	Change in Mean damages / £
8	Surface Water Drainage	5 year	111	-2	-28000
		30 year	189	-17	-241000
		100 year	254	-16	-308000
2	Permeable Parking	5 year	109	-4	-43500
		30 year	205	-1	-41500
		100 year	270	0	-37000

Options for reduction of flood risk at High Street give extremely positive results. A change in mean damages of over £200,000 is shown for the 30 year and 100 year scenario with the installation of a surface water system. The results also show that flood risk could be greatly reduced or eliminated for up to 17 properties.

The permeable parking scenario shows that the greatest reduction is seen in the more frequent events. As High Street regularly floods at low return periods, this option may prove ideal.

Table 3-3: Change in modelled flood damages for options at Orchard Valley

Option		Return Period	Number of Properties flooded to a depth of 0.1m	Change in Number of Properties flooded to a depth of 0.1m	Change in Mean damages / £
3	Surface Water Separation	5 year	12	-7	-161500
		30 year	20	-7	-152500
		100 year	28	-14	-233000
7	London Road Culvert	5 year	19	0	0
		30 year	27	0	-1000

	Upsize	100 year	42	0	-22000

Results for the surface water separation scenario show a reduction in the amount of properties at risk from flooding.

An increase in capacity of the culvert at London Road is shown to have negligible benefits and therefore this option should not be explored further.

Table 3-4: Change in modelled flood damages for options at Seabrook

Option		Return Period	Number of Properties flooded to a depth of 0.1m	Change in Number of Properties flooded to a depth of 0.1m	Change in Mean damages / £
3	Surface Water Separation	5 year	48	0	0
		30 year	82	0	0
		100 year	110	0	0
6	FSA at Fish Farm	5 year	47	-1	-40,000
		30 year	83	+1	104,500
		100 year	111	+1	36,500
6	FSAs at Casebourne and Fish Farm	5 year	47	-1	-40,000
		30 year	82	0	74,500
		100 year	111	+1	38,000

The surface water separation scenario at Seabrook is shown to have no impact in Seabrook.

The flood storage scenario results are mixed, however are expected to have a positive impact on flood risk therefore it is recommended these scenarios are investigated further.

Table 3-5: Change in modelled flood damages for options at Mill Leese and Blackhouse Hill

Option		Return Period	Number of Properties flooded to a depth of 0.1m	Change in Number of Properties flooded to a depth of 0.1m	Change in Mean damages / £
5	Gullies to Soakaway	5 year	41	4	+64,000
		30 year	57	1	+33,000
		100 year	105	3	+91,500
7	Culvert Upsize	5 year	37	0	0
		30 year	53	-3	-46,500
		100 year	71	-31	-387,500
4	Flow Management	5 year	36	-1	-50,000
		30 year	57	1	-37,500
		100 year	102	0	+4,500

Culvert upsize at Mill Lease shows a significant change in mean damages and property count.

The gullies to soakaway option shows an increase in the amount of properties flooded and mean damages and therefore can be discounted.

Flow management at Sene Park is unsuccessful due to the steepness of the land.

An initial economic appraisal of the options has not been made of the cost-benefit of the options assessed and this should be completed following any additional investigation into the options that may be taken forward.

3.9 Stakeholder input to options assessment

The views of the internal and external stakeholders on the potential solutions were gathered at the partnership options meeting.

The options meeting was held during the initial stages of options testing using the integrated model. The meeting was intended to update the partners on progress, facilitate discussion around the initial model outputs and the implications for the areas of concern, and gain views from all attending. Outcomes from this meeting were used to inform the draft Action Plan.

In addition to appointed project consultants from JBA Consulting, representatives of the following partners were present at the meeting:

- Kent County Council
- Southern Water

- Shepway District Council
- Environment Agency

All partners were also invited to review the draft final report and therefore had a second opportunity to comment on the options assessment.

4 SWMP Action Plan

4.1 Introduction

The Stage 1 SWMP identified a range of recommended actions for the reduction of flood risk across the Folkestone and Hythe SWMP area. The Action Plan collates all information undertaken and collated as part of this SWMP study and:

- Outlines the actions required and where and how they should be undertaken;
- Sets out which partner or stakeholder is responsible for implementing the actions and who will support them;
- Provides indicative costs; and
- Identifies priorities.

This section restates the generic actions agreed at Stage 1 and identifies new actions for the study area identified by this stage 2 SWMP.

4.2 Catchment wide Action Plan

Table 4-1 describes the catchment wide actions to be applied throughout the study area of Hythe and Horn Street.

Key: Stage 1 action remaining, new action identified at Stage 2

Table 4-1: Catchment wide Action Plan

Ref	Applicable Drainage Areas	Action/Option (What?)	Priority Actions (How?)	Lead Action Owner	Supporting Action Owner(s)*	Priority (When?) **	Indicative Relative Cost
1	All Drainage Areas	Maintain regular communications within the SWMP partnership and monitor the progress of actions	Initially a quarterly meeting or teleconference	KCC	EA, SW, SDC	Short - Long Term	Low
2	All drainage areas	Raise awareness within the LLFA regarding the current policy for surface water management, specifically SuDS within the evidence documents (e.g. SDC SFRA) Ensure surface water flood risks identified at planning: Ensure SWMP findings are available to users of the SFRA. This could take the form of an addendum etc	1. Ensure new developments do not increase the risk of surcharge of sewer network within their catchment.	EA, SDC & SW	KCC	Long Term	Low
			2. Stakeholder engagement to inform the public about the benefits of rainwater reuse and recycling and SuDS retrofitting	KCC, EA, SDC,	SW	Long term	Low
			3. Amend SFRA or prepare addendum note	SDC		Short Term	
3	All drainage areas	Raise awareness within the LLFA regarding the current policy for surface water management, specifically SuDS within the evidence base documents – such as the Shepway District Council SFRA. Raise awareness of urban creep through: 1. Raise public awareness on paving of front gardens. 2. Drainage advice for small developments 3. Education on the issue of household drainage. 4. Identify how Development Control can implement policy without creating additional activity.	1. Ensure new developments incorporate SuDS in accordance with : the NPPF, Local Plan Policy U7 on Sustainable Urban Drainage Systems SDC SFRA (Section 13) Requirements of the Defra non-statutory technical standards for sustainable drainage systems and relevant LLFA guidance.	SDC,	EA, KCC	Long Term	Low
4	All Drainage areas	Raise public awareness of surface water issues. Increase level of public reporting to inform targeted maintenance schedule of flooding hotspots	Online surface water awareness pilot, leaflet drop and development of online reporting of blocked drains	KCC	EA	Quick Win	Low
5	All Drainage areas	Maintain regular (quarterly) communications with residents and other stakeholders through KCC website, mailshot, drop-in meetings.	Agree a long term communications plan.	KCC	EA	Short - Medium Term	Low
6	All Drainage areas	Implement runoff reduction measures in combination with demand management measures such as rainwater harvesting etc.	Planning Control through Core Strategy	SDC	KCC	Long Term	

Location Specific Action Plan

Table 4-2 describes those actions identified at stage 1 which have been completed or progressed by this stage 2 SWMP, and new actions arising from this study:

Stage 1 action completed Stage 1 action progressed Stage 1 action remaining new action identified at stage 2

Table 4-2: Location specific actions

Area of benefit	Location of action	Action/Option	Benefits	Next Steps	Action Owner	Supporter(s)	Priority*	Indicative Cost (£)
Orchard Valley	Orchard Valley	Surface water disconnection from the combined system	Potential for reducing flood risk.	On-site review of potential for SuDS retrofit	SW	KCC	Medium Term	
	Pennypot	Investigate the potential for removal of throttle of the foul system (from Orchard Valley).	To reduce flood risk at Orchard Valley by allowing the culvert to work at full capacity.	Review purpose of throttle and any adverse impacts of removal	SW		Medium Term	
Seabrook	Horn Street	Fluvial storage options at Casebourne Farm and Fish Farm.	Potential to reduce fluvial fllood risk and create additional capacity for surface water runoff	Environment Agency feasibility study	EA	KCC	Medium / Long Term	
	Spring Lane	Local improvements to improve management of surface/groundwater at top end. Surface water removal from combined sewerage	Reduced risk from surface / groundwater flooding Reducing flooding from combined sewers	Combined SW / KCC feasibility study	SW / KCC	KCC Highways	Medium / Long Term	
	Seabrook Valley	Flood Risk sensitive land management in the Seabrook valley as part of the	Potential for reducing runoff or attenuating rapid runoff in the Seabrook catchment	SDC to ensure this is understood and incorporated into future development planning of Shorncliffe Garrison development SS7	SDC	KCC	Long Term	
High Street	High Street	Investigate potential of a surface water system on the High Street, and connection to upsized existing surface water system	Reduction in flood risk to High Street properties	Investigate feasibility	SW	KCC	Medium Term	
	High Street	Investigate feasibility of SUDS on High Street - particularly permeable paving of parking bays.	Reduction in flood risk to High Street properties and improvement to water quality.	On-site review of potential for SuDS retrofit	KCC	SW	Long Term	
	High Street	Investigate PLP measures as an action on properties affected along High Street	Reduce the impact of flooding on households and businesses by providing	On-site review of potential for PLP options	Property owners	KCC	Medium Term	

			resistance and resilience to flooding					
	High Street (western end)	Using section 106 funding to provide betterment	Routing of flows / upgrading of drainage system	Investigate feasibility	KCC	SDC	Medium Term	
Mill Road	Mill Road	Upsize culvert running between river reaches.	Potential to reduce flood risk on Mill Road and East Street.	Investigate feasibility	EA / SDC / KCC	-	Medium Term	
Cannongate Road/ Sene Park/ Cliff Close	PLP	Investigate PLP measures as an action on properties affected along High Street	Reduce the impact of flooding on households and businesses by providing resistance and resilience to flooding	On-site review of potential for PLP options	Property owners	KCC	Medium Term	
Spring Lane	Spring Lane	Remove blockage from Spring Lane Culvert identified in CCTV survey	Reinstate full capacity of culvert	Reduce the increased flood risk caused by blockage	SDC	KCC	Short Term	
St Hilda's Road	St Hilda's Road	Further investigations	Great understanding of the flooding mechanisms	Determine and understand the events which lead flooding allowing solutions to be developed.	SW	KCC	Short Term	
	St Hilda's Road	Pump station upgrade	Reduction in flood frequency and severity	Feasibility study	SW	KCC	Medium Term	

***Priority: Quick win = within 12 months. Short Term = up to 2 years. Medium Term = up to 5 years. Long Term = open ended/indefinite.**

4.3 Timeframe and responsibilities

The project partners have reviewed and commented upon the actions during the Internal Stakeholder workshop and in their review of the draft final report.

High priority actions identified in the 'Action Plan' are likely to be those addressed first. However, this report can only consider relative priorities within Hythe and Horn Street. Some partner organisations, Southern Water and Kent County Council have flood risk management responsibilities beyond the geographic scope of this study, and therefore the priority of actions within Hythe and Horn Street will have to be assessed against actions in other areas. Kent County Council is currently undertaking a number of stage 1 and stage 2 SWMPs in a number of other settlements across the county.

It is recommended that an annual review of the High and Medium Priority actions is undertaken. This will allow for forward financial planning in line with external partners and internal budget allocations. Low priority actions should be reviewed on a three-year cycle.

4.4 Sources of funding

Funding for local flood risk management may come from a wide range of sources. In Hythe and Horn Street these may include:

- Defra (Flood Defence Grant in Aid)
- Kent County Council (highways)
- Southern Water
- Network Rail
- Industrial estate owners and businesses
- New developments (directly through the developer or through CIL)
- Local communities
- Shepway District Council
- Romney Marshes Area Internal Drainage Board
- River Stour Internal Drainage Board

It is likely that schemes in Shepway will not have sufficiently strong cost-benefit ratios to attract 100% funding from Defra Flood Defence Grant in Aid (FDGiA), and would therefore require a portfolio of funding to be developed from various sources, including funding sources available for delivering other objectives such as improvements to highways, public open spaces and bio-diversity.

4.5 Ongoing monitoring

The partnership established as part of the SWMP process should continue beyond the completion of the SWMP in order to discuss the implementation of the actions and review opportunities and legislation changes.

The SWMP Action Plan should be reviewed and updated once every six years as a minimum in line with the Defra SWMP guidance. However there may be circumstances that initiate a review and/or update of the action plan in the interim period, for example:

- Occurrence of a surface water flood event;
- Additional data or modelling becoming available, which may alter the understanding of flood risk within the study area;
- Investment decision by partner(s) is different to the preferred option within the action plan, which may require a revision of the action plan, and;
- Additional (major) development or other changes in the catchment which may affect the surface water flood risk.

The action plan should act as a live document that is updated and amended on a regular basis. As a minimum the action plan should be agreed in the Kent County Council Local Flood Risk Management Strategy, although individual partners may wish to review their actions more regularly.

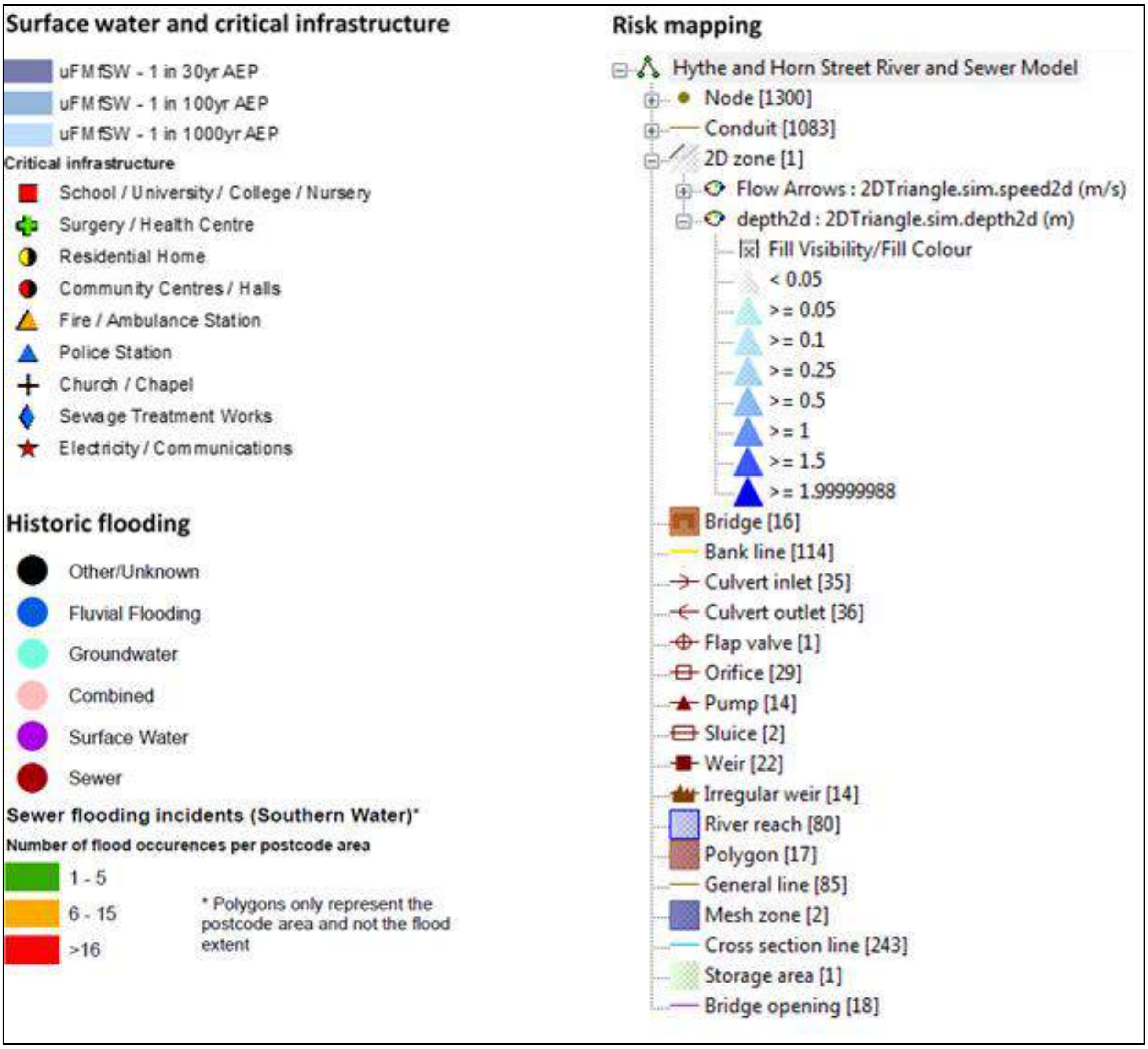
Appendices

B Maps

Map	Title
1	Study area and topography
2	Watercourses and drainage systems
3	Water Framework Directive and Pollution Incidents
4	Land use and development
5	Historic flooding
6	Flooding receptors
7	Fluvial Flood Zones
8	Updated Flood Maps for Surface Water
9	Modelled Watercourses and Drainage
10	Damage Calculation Receptor Areas
11	Model results - Depth - 1 in 30 AEP 2015, 180 minute storm duration
12	Model results - Depth - 1 in 100 AEP 2015, 180 minute storm duration
13	Model results - Depth - 1 in 100 AEP plus Climate Change, 180 minute storm duration
14	Model results - Hazard - 1 in 30 AEP 2015, 180 minute storm duration
15	Model results - Hazard - 1 in 100 AEP 2015, 180 minute storm duration
16	Model results - Hazard - 1 in 100 AEP plus Climate Change, 180 minute storm duration

C Flood risk assessment

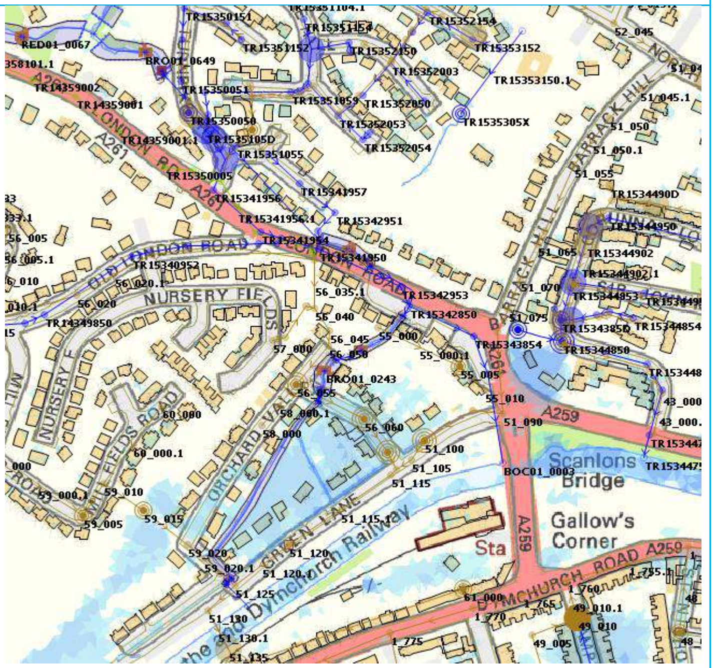
C.1 Key to maps



C.2 Orchard Valley

uFMfSW and critical infrastructure

SWMP model results (M100-180)



Historic flooding

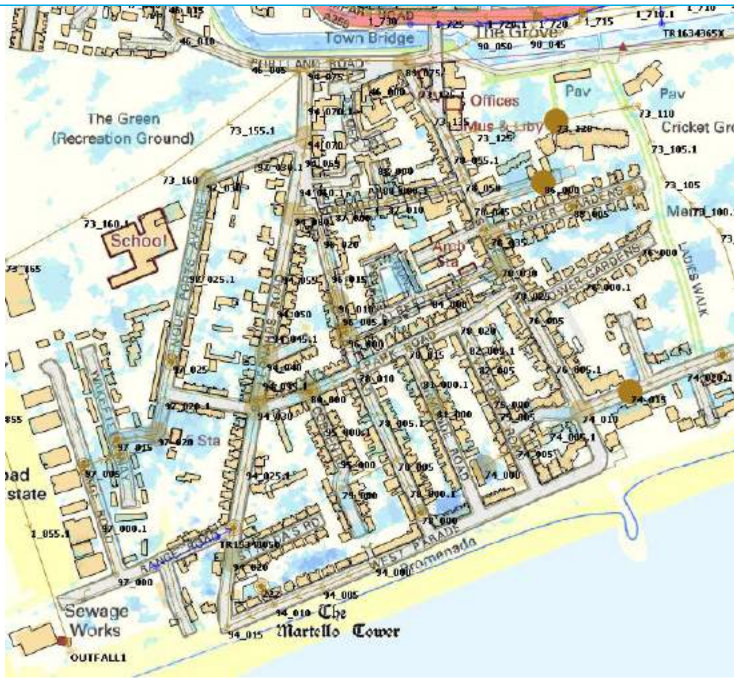
Model performance:	The model shows the combined network on Orchard Valley surcharging and ponding in the low lying areas. Orchard Valley is flooded, however Green Lane does not flood. Not all the flooding is contained within the roads. Further significant surface water ponding is modelled East of the A621. The uFMfSW shows a large amount of flooding in this region and flow paths are also shown down Barrack Hill and Corunna Close. The modelled results are consistent with the high number of historic flood events located in the area.
Assessment of flood mechanisms and risk:	The main source of flooding at Orchard Valley is from surcharging combined sewers and surface water ponding up to 0.8m deep. The flooding south of Corunna Close is a result of surface water flowing down Brockhill Road, over land and down Corunna Close.

C.3 St Hilda's Road, Hythe

uFMfSW and critical infrastructure

Historic flooding

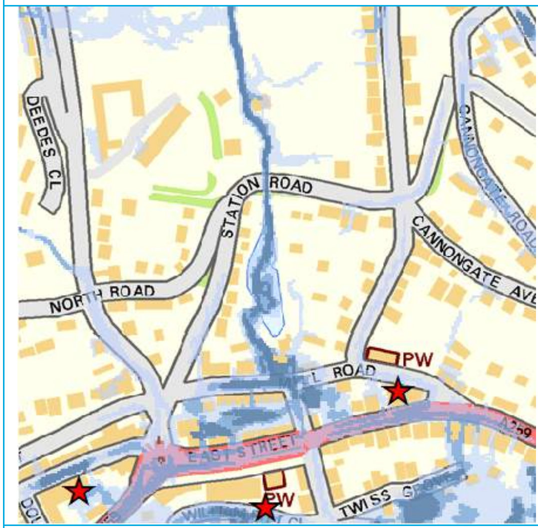
SWMP model results (M100-180)



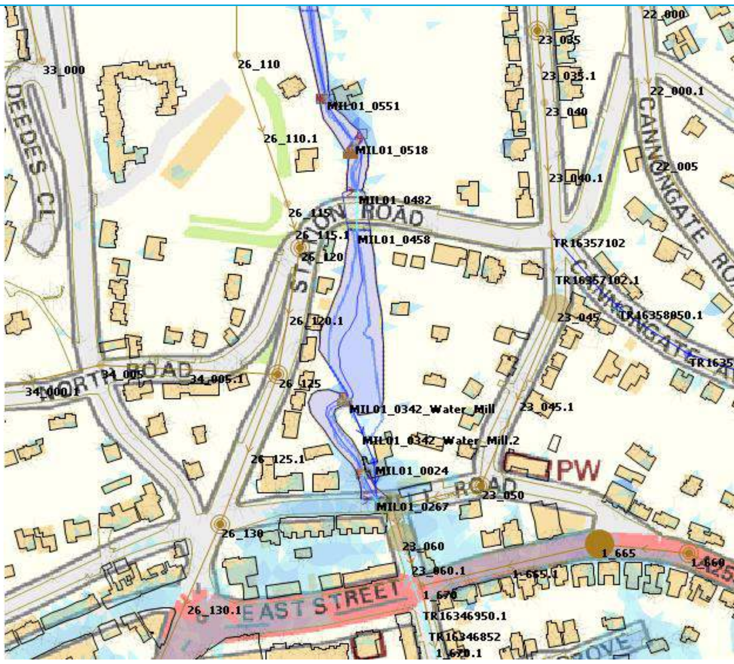
Model performance:	The model is simulating flooding in the low lying areas around St Hilda's Road, mainly in the gardens and on the road. The model shows combined sewer surcharge along St Leonards Road with surface water flooding flowing from the east to the west of St Hilda's Road. This is consistent with the historic flooding events.
Assessment of flood mechanisms and risk:	Surcharging from combined system on Leonards Road and surrounding roads along with surface water runoff causes localised flooding. Ponding occurs due to flat topography in the area.

C.4 Mill Road and Station Road, Hythe

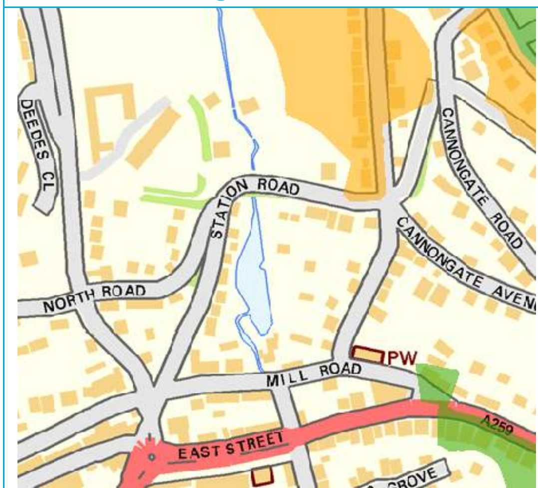
uFMfSW and critical infrastructure



SWMP model results (M100-180)



Historic flooding



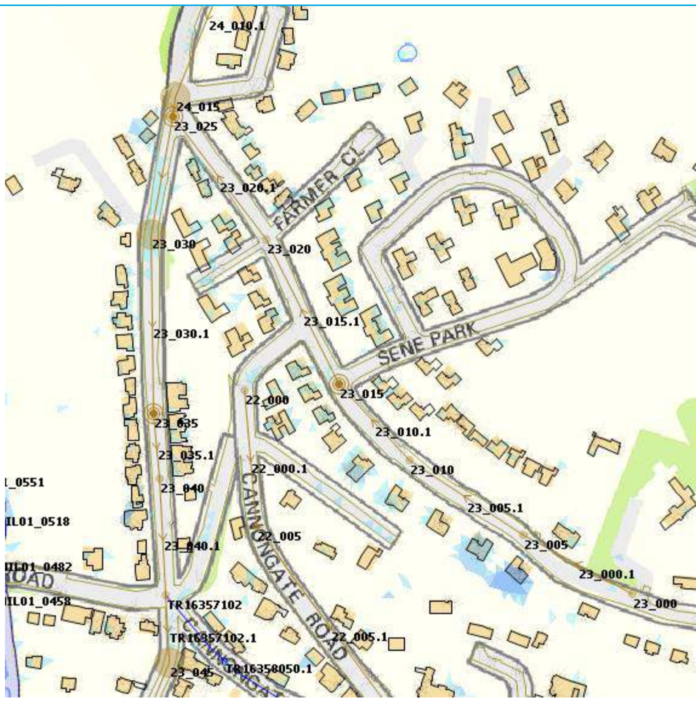
Model performance:	The model is simulating out of bank flow from the Mill Leese Stream due to insufficient culvert capacity downstream. Surface water flooding is simulated to contribute to the flooding issues in the Mill Road area. The model results reflect the uFMfSW but the known historical flooding incidents do not support this flooding.
Assessment of flood mechanisms and risk:	Blackhouse Hill is shown as a flow route in the uFMfSW and the modelled results. Flood depth on Mill Road is simulated up to 0.5m and is shown to affect properties on Mill Road and East Street.

C.5 Cannongate Road, Hythe

uFMfSW and critical infrastructure

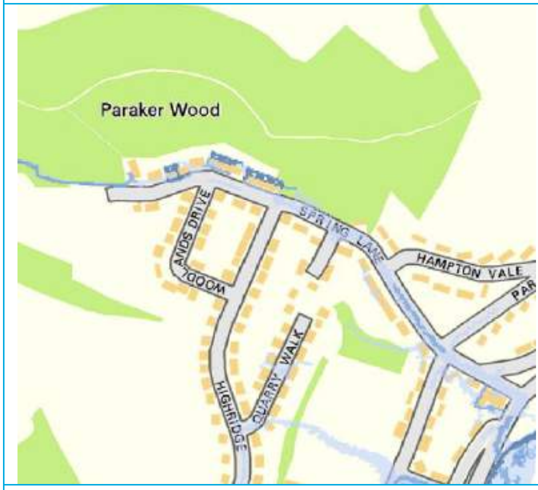
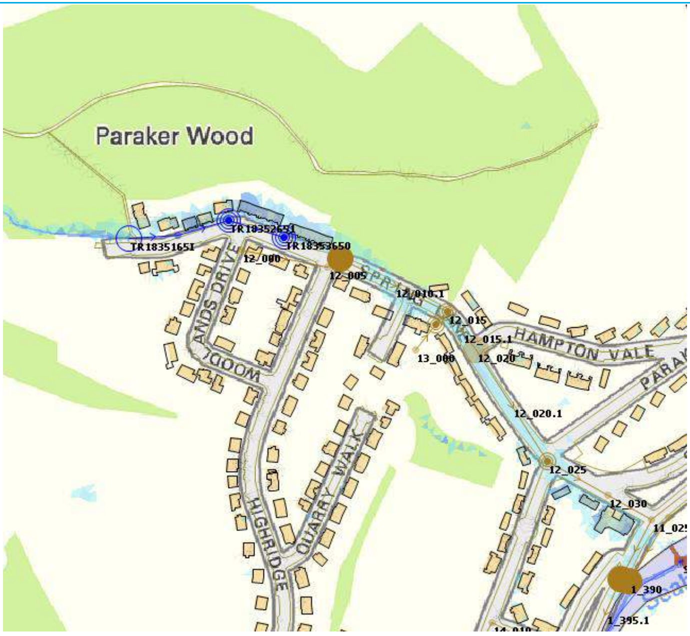
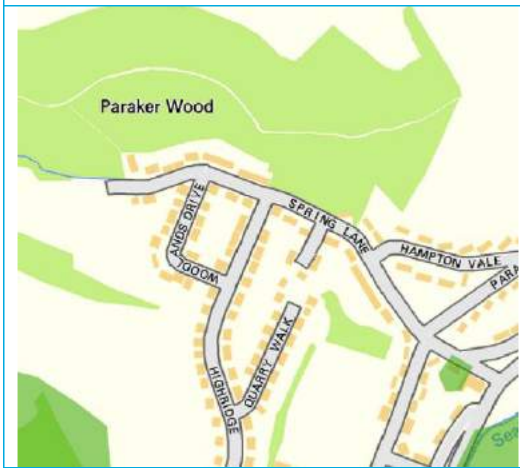
Historic flooding

SWMP model results (M100-180)



Model performance:	A flow path running south to north is identified within the model results and uFMfSW. Ponding occurs in some locations and this is consistent between modelled results and uFMfSW. Surcharging of combined sewer system due to capacity exceedance. There are historical records of sewer flooding within this area.
Assessment of flood mechanisms and risk:	Mainly surface water flooding from Sene Valley Golf Course flowing down Cannongate Road and Blackhouse Hill.

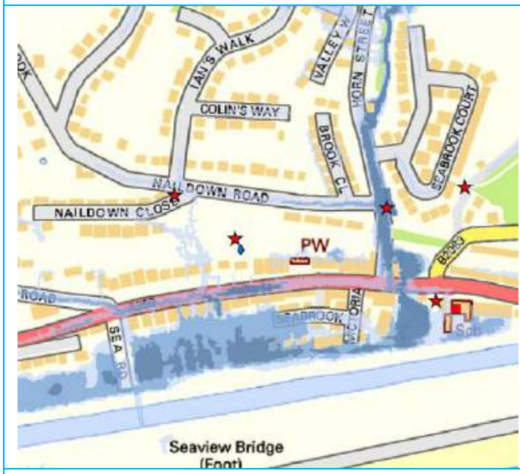
C.6 Spring Lane, Horn Street

uFMfSW and critical infrastructure	SWMP model results (M100-180)
	
Historic flooding	
	

Model performance:	Model shows ponding against houses and in the road caused due to flow path from top of Spring Lane. This represents the uFMfSW well. The flow route from Quarry Walk to Ian's Walk is not represented in the modelled results however is in the uFMfSW.
Assessment of flood mechanisms and risk:	Surface water from Paraker Wood floods properties at the north of Spring Lane and flows down the road to Seabrook Stream where it causes flooding to properties at the south of Spring Lane.

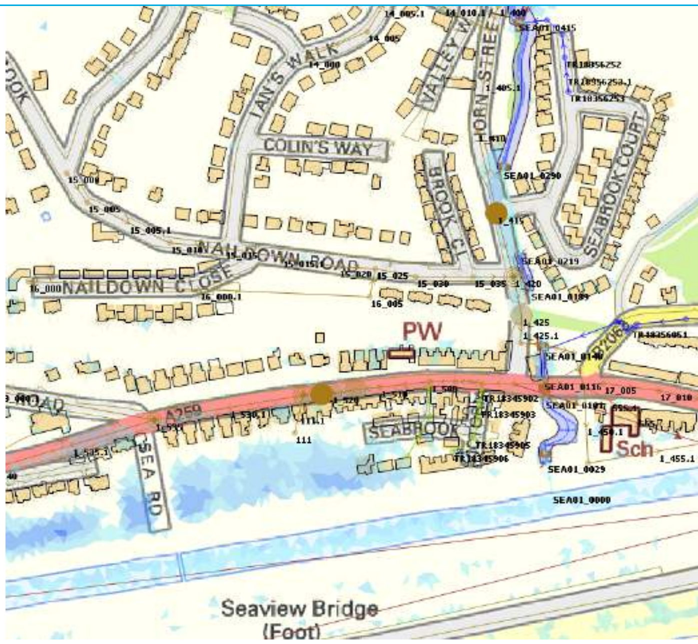
C.7 Seabrook

uFMfSW and critical infrastructure



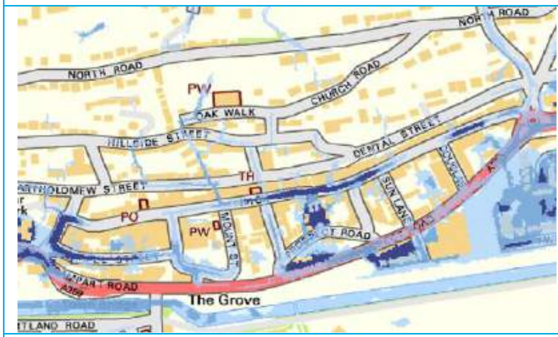
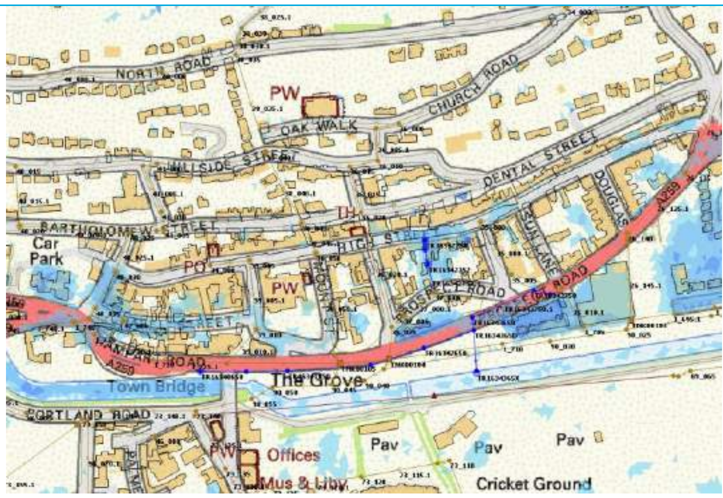
Historic flooding

SWMP model results (M100-180)



Model performance:	The model shows a surface water flow path which runs down Horn Street after overtopping the bank at the culvert running under Seabrook Court entrance. This flow path is consistent with the uFMfSW. Flooding around Sea Road is consistent with the uFMfSW, however at Seabrook Gardens and Victoria Grove less flooding is represented on the modelled results which is also inconsistent with the historic flooding. Some properties around Seabrook Court are modelled to flood. This is consistent with historic flooding records.
Assessment of flood mechanisms and risk:	Flooding is a results of surface water, some of which travels from Whitenbrook Wood. Manhole surcharging occurs from the combined network at locations where the hydraulic gradient flattens.

C.8 High Street

uFMfSW and critical infrastructure	SWMP model results (M100-180)
	
Historic flooding	
	

Model performance:	The model shows surface water flow paths which run off from the hillside to the north and from the surrounding impermeable areas. This water flows downhill ponding in the low points along the High Street. Flooding along the high street is consistent with the uFMfSW although slightly lower flood depths are modelled Flooding in the centre of the High Street is consistent with the reported historical flooding evidence recorded as from unknown sources.
Assessment of flood mechanisms and risk:	Flooding occurs as a result of intense rainfall, steep topography and impermeable surfaces High Street, meeting at the lowest point and flowing through a commercial area onto Prospect Road. Roads generally act as flow paths although water also flows around properties.

D Model Operation Manual

E Economic Appraisal

E.1 Approach

The 2010 Multi Coloured Manual provides standard flood depth/direct damage datasets for a range of property types, both residential and commercial. This standard depth/damage data for direct and indirect damages has been utilised in this study to assess the potential damages that could occur under each of the options. Flood depths within each property have been provided by the 2D hydraulic modelling results.

A mean, minimum and maximum flood depth is derived by JBA's in-house FRISM tool based on the range of flood depths within the building footprint. The mean flood damages have been presented in this analysis.

A key assumption with the flood damage calculations is that bare earth ground levels are assumed for the flood damage calculations. Flood depth thresholds of 0.01 and 0.1m have been tested to represent flood levels that may be able to enter properties. This is a significant assumption; the site visit confirmed that where some properties are below the road levels this is generally not unreasonable, but there are properties with lower and higher thresholds.

The following assumptions, presented in Table D-1 were used to generate direct flood damage estimates.

Table D-1: Direct flood damage assumptions

Data type	Data and any assumptions used
Depth Damage data	Standard 2013 Multi-Coloured Manual used.
Flood depths	Mean flood depths for each property extracted for the 2, 5, 10, 20, 30, 75, 100, 100cc, 250 and 1000 year return periods.
Threshold level	No building threshold values used – depth thresholds of 0.01 and 0.1m have been tested to assess the impact of flood depth
Residential property types	Defined by property types (Detached, Semi-Detached, Terraced, Flat, Bungalow).
Upper floor flats	Due to the nature of the residential properties in the study area, with the majority of properties being single dwellings the upper floor flats have been retained in the NRD; however the damages have been excluded in the FRISM software.
Non-residential property types	MCM property types defined using national receptor dataset.
Property areas	Defined by OS MasterMap data.
Capping of property damages	Property market values have not been used for capping.
Flood duration	Assumed to be less than 12 hours.
Updating of MCM damage data	Updated from 2013 damage data

Data errors and inconsistencies

The approach to estimation of flood damages relies on the input of 2D modelling and the overlay of property boundaries to define average depths at each property. Filtered LIDAR data has been used in the model build and this forms the basis of the flood depths within each property boundary. In some locations, due to the filtering process and the averaging of flood depths within large property boundaries, flood depths are not always consistent (i.e. they do not increase with increasing return periods). A more thorough analysis using property threshold levels would help to correct these inconsistencies in the future.

Indirect damages

The multi coloured manual provides guidance on the assessment of indirect damages. It recommends that a value equal to 5.6% of the direct property damages is used to represent emergency costs. These include the response and recovery costs incurred by organisations such as the emergency services, local authorities and the Environment Agency.

Guidance and standard costs are also provided in the multi coloured manual for the assessment of additional costs incurred by property owners as a result of flooding. These include rental costs for alternative accommodation, additional heating and electricity costs required to dry out a flooded property. These have not been included in the analysis at this stage.

Intangibles

Current guidance indicates that the value of avoiding health impacts of fluvial flooding is of the order of £200 per year per household. This value is equivalent to the reduction in damages associated with moving from a do-nothing option to an option with an annual flood probability of 1% (100 year standard). A risk reduction matrix has been used to calculate the value of benefits for different pre-scheme standards and designed scheme protection standards.

E.2 Damages calculation methodology

E.2.1 Summary

Property counts and damage estimates have been calculated using FRISM, JBA's in-house flood metrics software.

E.2.2 Flooding Data

The FRISM calculation was run for the following return periods; 2, 5, 10, 20, 30, 50, 75, 100, 100cc, 250 and 1000 year. These results were annualised assuming a first flood with a return period of 1 year to obtain average annual damages.

All the return periods were queried for depths greater than 0.1m. The depth threshold was used to generate a flood outline from the model depth grid. The outline was then used for property counts. Damages were only calculated for properties which were within the flood outline.

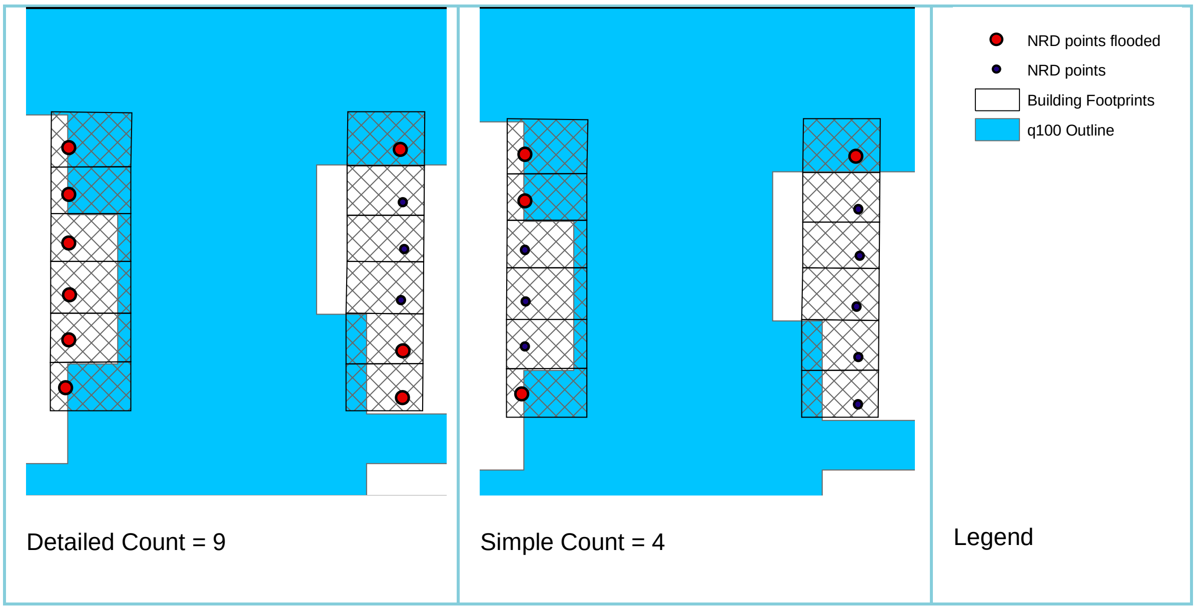
E.2.3 Receptor Data

The receptor datasets used for the calculations were the NRD property point's layer together with Master Map building polygons. The full NRD data was used in the assessment of damages. This includes some receptor points that were retained, but did not have a building footprint in Master Map. These receptors include features such as public telephones and electricity sub stations and have been retained to ensure that the value of lost services is included in the damage counts.

E.2.4 Property counts

Property counts were undertaken using the detailed counting method. This method utilises the Master Map building footprints in conjunction with the NRD property points. A property point is counted as flooded if its corresponding building footprint is within the flood outline, even if the property point itself may not fall within the flood outline, this is illustrated in Figure D-1. Where the additional points without footprints have been retained a single depth value is taken at the point in question.

Figure D-1: Counting method



E.2.5 Depths

Each flooded property point is attributed with a min, max and mean depth value these values correspond to the minimum, maximum and mean value of the depth grid within the property footprint. If the property footprint contains less than half a depth grid cell then it will not receive any depth values, although the property will count as flooded.

E.2.6 Damages

Each flooded property point is attributed with a min, max and mean damage value these values correspond to the damage value for the minimum, maximum and mean depth within the property footprint.

The damage value is in pounds and is worked out by obtaining a unit damage value (£/m2) using the depth damage curves from the Multi Coloured Manual 2013 (Flood Hazards Research Centre 2013). The unit damage value depends on the depth at the property and the property type. This damage value is then multiplied by the value in the floorarea field of the NRD to obtain an absolute damage value.

Damages have not been calculated for properties whose floorlevel is 'pU'. These are potential uppers which are generally upper floors in flats, however properties with a floor level of 'pU' have been included within the property counts. This is because the damage occurred by an upper floor flat is likely to be null however the residents of the property will still be affected by the flooding.

E.2.7 Reporting Units

Properly counts and damages were summarised on a reporting unit level. The reporting units used for this study were the areas outlined in the Stage 1 SWMP and Section 2.4.2 of this report. For each model scenario each reporting units is attributed with a count according to the number of each receptor type flooded within the reporting unit. The max, min and mean depth of individual receptors within the reporting unit is also recorded as well as the max, min and mean damage of individual receptors. Damages are also summed within each reporting unit. There are 3 damages sums for each reporting unit as the minimum, maximum, and mean damage of each individual receptor is summed giving a min, max and mean sum. Table D-5 defines the fieldnames used in the reporting unit feature classes and the excel spreadsheet.

Table D-3: FRISM Field definitions

Field Name Prefix	Field Name Suffix	Definition
Area Flooded		
nrd_ppl_Full.shp	Detailed Count	Property Count within the reporting unit according to the metric definition
nrd_ppl_Full.shp	Detailed Count Depth Min	The minimum depth at an individual property within the reporting unit
nrd_ppl_Full.shp	Detailed Count Depth Mean	The mean depth at an individual property within the reporting unit
nrd_ppl_Full.shp	Detailed Count Depth Max	The maximum depth at an individual property within the reporting unit
nrd_ppl_Full.shp	Detailed Count Damage Min	The minimum damages at an individual property within the reporting unit
nrd_ppl_Full.shp	Detailed Count Damage Mean	The mean damages at an individual property within the reporting unit
nrd_ppl_Full.shp	Detailed Count Damage Max	The maximum damages at an individual property within the reporting unit
nrd_ppl_Full.shp	Detailed Count Damage Min Sum	The sum of minimum damages at an individual property within the reporting unit
nrd_ppl_Full.shp	Detailed Count Damage Mean Sum	The sum of mean damages at an individual property within the reporting unit
nrd_ppl_Full.shp	Detailed Count Damage Max Sum	The sum of maximum damages at an individual property within the reporting unit

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