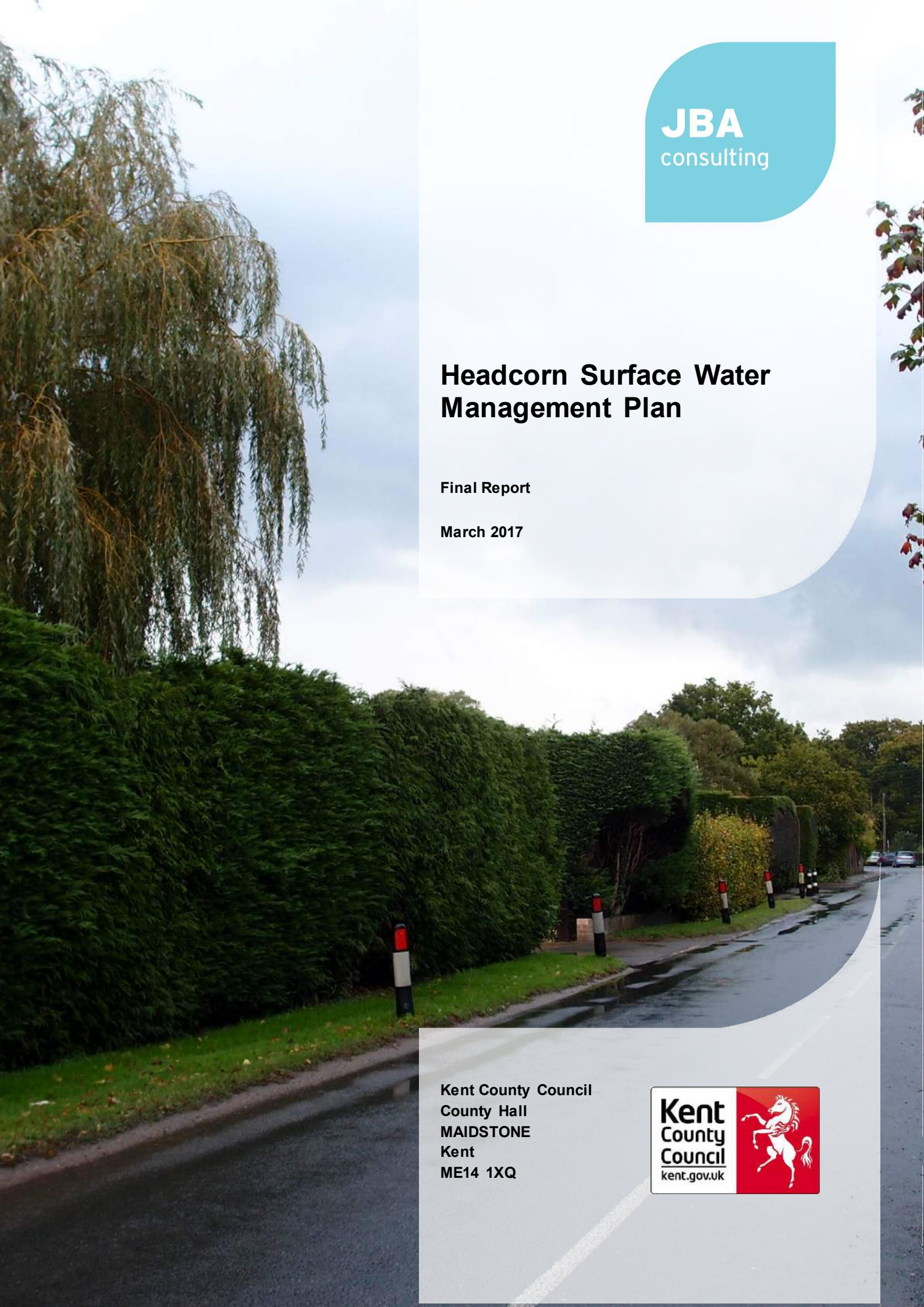

Headcorn Surface Water Management Plan

Final Report

March 2017

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
V1 August 2016	N/A	Max Tant
V2 October 2016	Address comments from MT	Headcorn SWMP project partners
V3 March 2017	Address comments from project partners	Max Tant

Contract

This report describes work commissioned by Max Tant, on behalf of Kent County Council. Kent County Council's representative for the contract was Max Tant. Jennifer Hill and Christopher Matthias of JBA Consulting carried out this work.

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Technical Director

Purpose

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Acknowledgements

JBA would like to thank Kent County Council, Maidstone Borough Council, Headcorn Parish Council, Southern Water, the Environment Agency and the Medway IDB for their contributions throughout the project.

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Executive Summary

A Stage 1 Surface Water Management Plan (SWMP) for Maidstone was commissioned after the Preliminary Flood Risk Assessment (PFRA) for Kent found that Maidstone was the settlement most at risk of surface water flooding settlement in the county. The Stage 1 SWMP for the Maidstone District found a history of flooding in the village of Headcorn. Common sources of flooding were found to be sewer flooding from the foul network and surface water flooding following heavy rain.

This SWMP, focussing specifically on Headcorn, was commissioned in 2014 as a detailed assessment of local flood risk, following Defra (2010) guidance. The aim of this study was to provide a detailed understanding of the causes and consequences of surface water flooding and to test the benefits and costs of mitigation measures.

Understanding the causes of surface water flooding was achieved by;

- updating the flood history to include recent incidents and understanding the source and pathway of the flooding; and
- creating an integrated model of flood risk and analysing the results to understand the flood mechanisms.

Understanding the consequence of the flooding was achieved by;

- understanding the receptor of recorded flood incidents;
- counting the dwellings and critical infrastructure predicted to flood; and
- calculating the economic damages of predicted flooding to dwellings and critical infrastructure.

Hotspots were defined as areas with repeated flood history or predicted risk from the Integrated Urban Drainage Model and the updated Flood Map for Surface Water. The hotspot areas in Headcorn were: Moat Road, School Stream (particularly Uptons, Headcorn Primary School and Mill Bank), Station Road and The Chantry.

At each hotspot, a long list of potential flood risk mitigation measures was drawn up. The feasibility of these options was assessed on a site visit and against known restrictions to develop a short list of options. The effectiveness of each option was tested in the hydraulic model. These included and attenuation basin on the School Stream and drainage ditches at Station Road.

The revised cost of flooding was then calculated using the options model results and the Multi-coloured Manual of flooding damage curves. The benefit of the option was then contrasted with the estimated cost of construction using Cost-Benefit Analysis. None of the options were found to be cost beneficial. Therefore, KCC would not be able to secure funding for these proposed schemes via the Flood Grant in Aid process. As a result, ways to manage the flood risk without implementing schemes was considered. It is proposed that a rain gauge is installed in the School Stream catchment which will automatically update the village flood wardens when heavy rain occurs. This will provide them with warning to be prepared for a flood event on the School Stream. The should be considered in conjunction with Property Level Protection so properties, and particularly the school are more resilient to flooding.

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Abbreviations

AEP ..... Annual Exceedance Probability

CCTV ..... Close Circuit Television

CEP ..... Communication and Engagement Plan

DA ..... Drainage Area

DFGiA ..... Defra Flood Grant in Aid

DTM ..... Digital Terrain Model

IDB ..... Internal Drainage Board

IUD ..... Integrated Urban Drainage

JBA ..... Jeremy Benn Associates

KCC ..... Kent County Council

LLFA ..... Lead Local Flood Authority

MBC ..... Maidstone Borough Council

mAOD ..... metres Above Ordnance Datum

NPPF ..... National Planning Policy Framework

NRD ..... National Receptors Database

RMA ..... Risk Management Authority

SFRA ..... Strategic Flood Risk Assessment

SHLAA ..... Strategic Housing Land Availability Assessment

SuDS ..... Sustainable Drainage Systems

SWMP ..... Surface Water Management Plan

uFMfSW ..... updated Flood Map for Surface Water

1 Introduction

This surface water management plan (SWMP) has been undertaken to explore the local flood risks in the Parish of Headcorn. It has been prepared by a partnership of Kent County Council, the Environment Agency, Maidstone Borough Council, Upper Medway Internal Drainage Board (IDB), Southern Water and Headcorn Parish Council.

1.1 What is a Surface Water Management Plan

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

SWMPs are led by a partnership of flood risk management authorities who have responsibilities for aspects of local flooding, including the County Council, Local Authority, Sewerage Undertaker and other relevant authorities.

The purpose of a SWMP is to identify what the local flood risk issues are, what options there may be to prevent them or the damage they cause and who should take these options forward. This is presented in an Action Plan that the partners agree.

Kent County Council (KCC) often takes a two stage approach to SWMPs. Initially, a Stage 1 SWMP is undertaken which collects all the available flood risk and flood history data in the catchment. Where this process identifies a flood prone area a Stage 2 SWMP can be required to make a more detailed assessment of flood risk and focus the resulting action plan of flood mitigation measures.

1.2 Stage 1 SWMP: key findings

Kent County Council in partnership with the Environment Agency, Maidstone Borough Council, Upper Medway Internal Drainage Board (IDB) and Southern Water prepared the Stage 1 Maidstone SWMP to investigate the local flood risks to the Maidstone borough, published in 2014.

The Maidstone SWMP study area was subdivided into Drainage Areas to allow more in depth analysis. A list of all the drainage areas in the Maidstone SWMP is available in Table 1-1.

Table 1-1 Maidstone Stage 1 SWMP Drainage Areas (DA)

Drainage Area	Location
DA01	Maidstone Rural North
DA02	Maidstone Rural Mid
DA03	Maidstone Rural West
DA04	Maidstone Rural East

The area of the Headcorn Surface Water Management Plan falls within DA04, Maidstone Rural East. The Stage 1 SWMP stated that there were numerous flooding issues identified in Headcorn including fluvial flooding from the School Stream, foul sewer flooding and surface water flooding caused by blocked drainage. Therefore, one of the actions resulting from the Stage 1 SWMP was to complete an integrated catchment model of Headcorn.

1.3 Detailed SWMP: drivers

The preparation the detailed SWMP for Headcorn was driven in response to the following primary considerations:

- The need to manage local flood risk as a consequence of assessments performed under the Flood Risk Regulations, 2009 or the Flood and Water Management Act 2010;
- The need to inform spatial planning and development control, develop a strategy for flood risk management, and provide evidence that future new development can be implemented and local flood risk safely managed; and
- The need to build on the understanding of high risk areas highlighted within the Stage 1 SWMP and to develop feasible options for improving local flood risk within known hot spot areas.

1.4 Study objectives

The objectives of the Headcorn SWMP as set out in the scope of work were:

1. The establishment of a local partnership as a steering group;
2. The collation and mapping of a comprehensive flood history for all relevant local flood risk sources which may include collecting data from residents of Headcorn;
3. The preparation of source pathway receptor models for all the risks and sources that are identified;
4. The preparation of a hydrodynamic flood model;
5. The predicted flooding, including depth, velocity and hazard to people from the 1 in 2, 5, 20, 30, 75, 100, 100 +CC and 1000 events;
6. Determine the areas at risk of flooding;
7. Identification of the causes of flooding and/or constraints to drainage;
8. Estimate the economic impact of flooding to the Headcorn and to assess mitigation options for the flood risk identified;
9. Identify potential mitigation options for the flood risks identified;
10. Identification of opportunities to deliver flood risk management benefits through local planning documents, including neighbourhood plans;
11. Set out a clear plan for further work that may be necessary to manage or better understand the risks identified.

1.5 Study area

The Headcorn SWMP focuses on the village of Headcorn within the Maidstone Borough. The study area includes the entire parish and is shown in Figure 1-1 and spans north to Hearnden Green and south to Wick Hill.

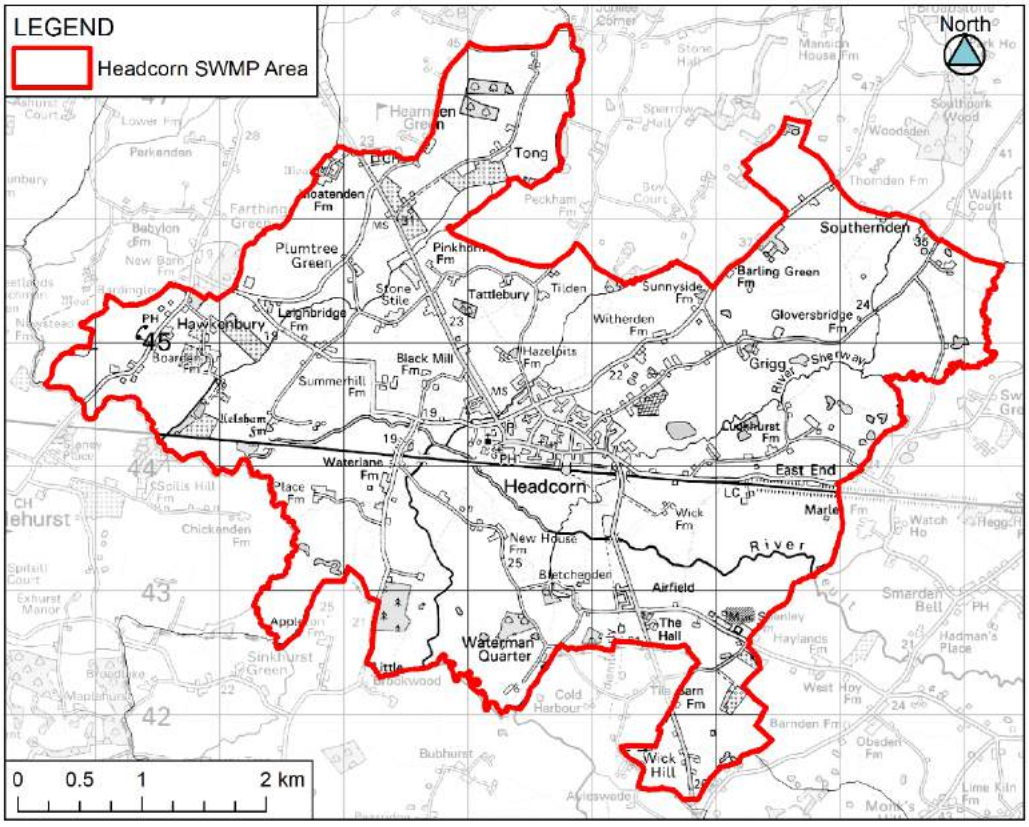

Figure 1-1 Headcorn SWMP study area

2 Partnership and Communications

2.1 Partnership approach

Surface water cannot be managed by a single authority, organisation or partner; all the key organisations and decision-makers must work together to plan and act to manage surface water across Headcorn. Many organisations have rights and responsibilities for management of surface water. Although Kent County Council commissioned this project, the key partners have been consulted at appropriate stages in 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 Headcorn in 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.

2.1.1 Key partners

Partners are defined as organisations with responsibility for the decision or actions that need to be taken to manage surface water flooding. The key partners involved in this project are listed in Table 2-1.

Table 2-1 Partners involved in the Headcorn SWMP

Partner Organisation	Representative(s)
Kent County Council (Flood Risk Management)	Max Tant Joe Williamson
Kent County Council (Highways)	Adam Murdin
Maidstone Borough Council (Drainage) Maidstone Borough Council (Planning)	Bill Axel Chris Berry
Southern Water Utilities Ltd	Mike Tomlinson
Environment Agency	Peter Waring
Medway Internal Drainage Board	Michael Watson
Headcorn Parish Council	Lyn Selby

The project partners have supplied the data to inform this SWMP and have been attributed as action owners in the SWMP action plan. Headcorn Parish Council have been involved throughout the preparation of this SWMP. The Parish Council have supported the production of the SWMP by passing on their detailed local knowledge of flood incidents that have occurred in Headcorn and explaining the impact of flooding on the community.

In addition to the above, the Maidstone Borough Council (MBC) Planning department was also involved in the SWMP. As the authority responsible for setting local planning policy, it sets the development strategy for the area which will have a direct impact on how surface water is managed in new developments and redevelopments in the study area.

2.2 The Communication and Engagement Plan

A Communications and Engagement Plan (CEP) was developed and maintained to;

- Illustrate internally and externally the importance of communicating honestly and transparently with our delivery partners, stakeholders and communities;
- Support the project team in spending time and resources wisely, informing and involving the right people about the right things, at the right time; and
- Act as an overarching umbrella plan which ensures co-ordination between stakeholder engagement activities, media communications, internal/external communications, external funding and stakeholder support, other consultations.

2.3 Partnership meetings

Meetings have been held at key points throughout the project to consult the project partners and incorporate the knowledge of local issues.

The first project steering group focused on knowledge capture. The recorded flood incident data provided by the partners was presented and early identification of flooding hotspots were discussed. The project partners also shared information on their assets which could impact flood risk and any proposed schemes. During this meeting, it was identified which drainage systems would be included in the model and what information would be required to support this which identified additional data requests and where bespoke survey was required.

Key outcomes from the first steering group meeting were:

- Flash flooding from the School Stream was a high priority for residents in Headcorn
- Flooding from foul sewage has occurred on Moat Road
- Planned survey of the highway drainage assets by KCC for inclusion in the model
- Survey drawings of highway bridges over School Stream and the River Sherway were available from KCC highways so survey was not required.

The second project steering group meeting focused on review of the draft model results. The hydrological analysis and model build process were explained and the draft outputs shared with the partners as animations and maximum depth results. Key outcomes from the second steering group meeting were:

- Modelled flood extents on School Stream near the Uptons and Brooklands under-estimated observed extents
- Flood extent on School Stream at the Scout Hut match observed
- Foul sewer exceedance was predicted which matches observations
- Maintenance of fluvial assets is critical to managing flood risk in Headcorn.

The third and final project steering group meeting focused on review of the options modelling, cost benefits analysis and discussed the way forward for Headcorn. Key outcomes from the third steering group meeting were:

- Surface water is not predicted to flood into the foul sewerage system on Moat Road
- The cost estimates appeared to underestimate the cost of construction based on experience in Kent, leading to the application of 'optimism bias' which is reasonable for a schemes at this outline stage
- A number of flood alleviation measures were tested which are affective at storing or channelling water but do not significantly reduce the total flood damages predicted. Therefore, the cost far outweighs the benefit.
- KCC would support HPC in installing a weather gauge in the School Stream catchment to inform their own flood warning system.

In addition to full partnership meetings, two meetings have been undertaken between JBA, KCC and Southern Water.

3 Risk Assessment

The risk assessment chapter of this report outlines the approach taken to assess the flood risk and summarises the results of the assessment.

3.1 Levels of assessment

The Maidstone Stage 1 SWMP highlighted the drainage area covering Headcorn as having a significant history of flooding, particularly on the highways. Therefore, in line with the Defra guidance[1], a detailed assessment has been undertaken for this SWMP. This level of assessment aims to provide a detailed understanding of the causes and consequences of surface water flooding, and to test the benefits and costs of mitigation measures. This will be achieved through the modelling of surface and sub-surface drainage systems. The results of the detailed analyses have then been used to prepare an action plan.

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

- Source - the origin of flood water
- Pathway - a route or means by which a receptor can be affected by flooding
- Receptor - something that can be adversely affected by flooding

Having applied the Source-Pathway-Receptor model it is possible mitigate the flood risk by addressing the source (often very difficult), block or alter the pathway and even remove the receptor e.g. steer development away.

3.2 Catchment characteristics

Both the natural and built environment impacts the risk of flooding from local sources. This section characterises the catchment including the fluvial network, geology and drainage network from urban areas.

3.2.1 Physical features

The SWMP study area contains a number of watercourses, the River Beult lies tot eh south of the village and is classified as a main river. The village of Headcorn is bound by two tributaries to the River Beult; the School Stream to the north which is classified as Main River from Ulcombe Road and the River Sherway to the south which is an IDB drain.

In addition to Main Rivers, there are a large number of Ordinary Watercourses within the wider parish, draining towards the River Beult. Some of these Ordinary Watercourses are within the Upper Medway IDB district. The IDB adopt and maintain some ordinary watercourses in their district. Other ordinary watercourses are the responsibility of riparian owners. Of note is the IDB drain, the Hammer Stream, which carries a significant flow and meets the River Beult near the confluence with the School Stream.

The watercourses within the Headcorn SWMP study area have been highlighted Figure 3-1. Main Rivers are shown in dark blue whereas the Ordinary Watercourses are in light blue and IDB drains are light and dark blue hatched.

[1] Defra (2010) Surface Water Management Plan Technical Guidance. Defra: London

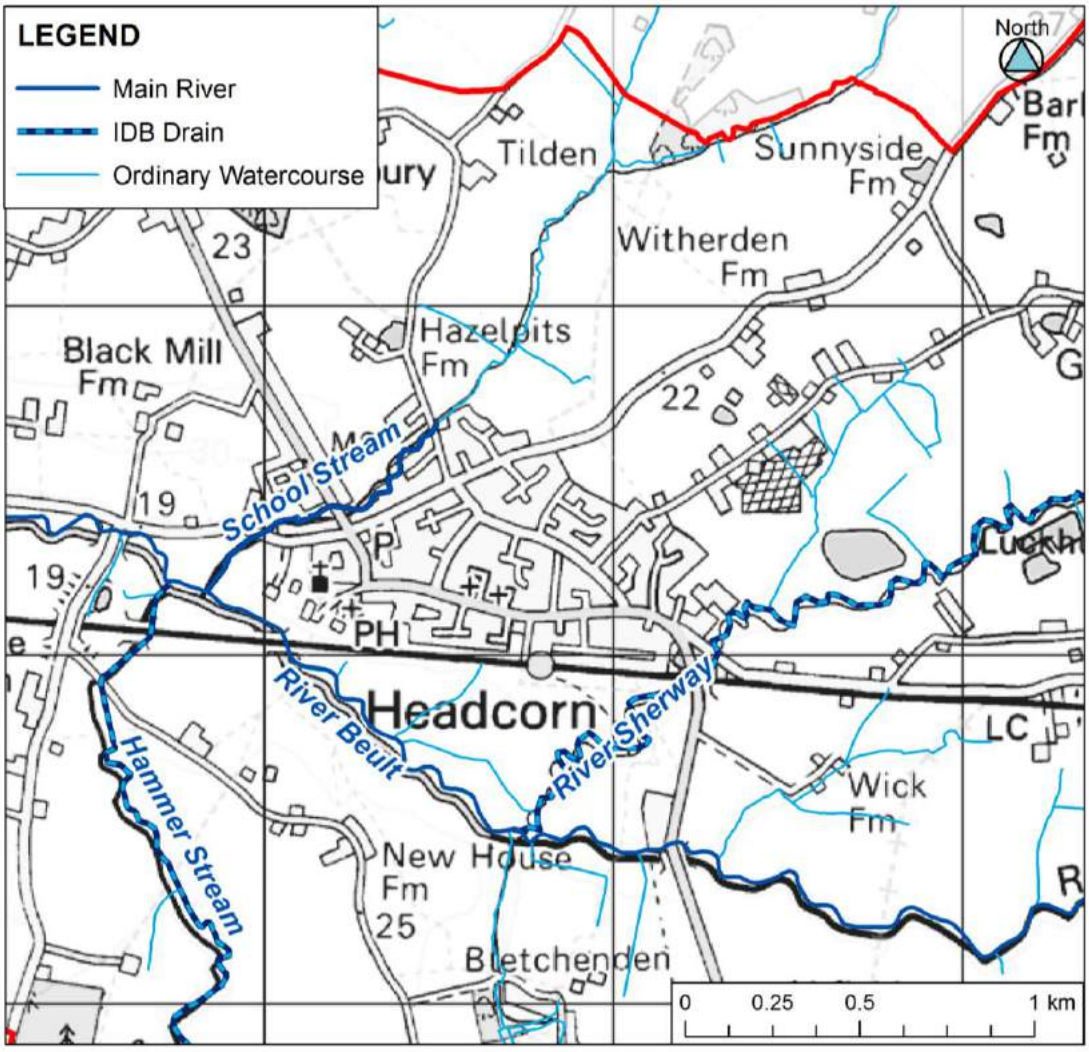

Figure 3-1 Headcorn watercourses

Headcorn is predominately underlain by the Weald Clay formation which is spatially variable containing predominantly clays, mudstones and siltstones with intermittent limestones. Periodic flood events throughout geological time have facilitated the deposition of alluvium and river terrace superficial deposits, which overlay a proportion of the SWMP study area, particularly following the River Beult and Hammer Stream. The distribution of bed rock and superficial deposits, in reference to the study area, is shown in Figure 3-2.

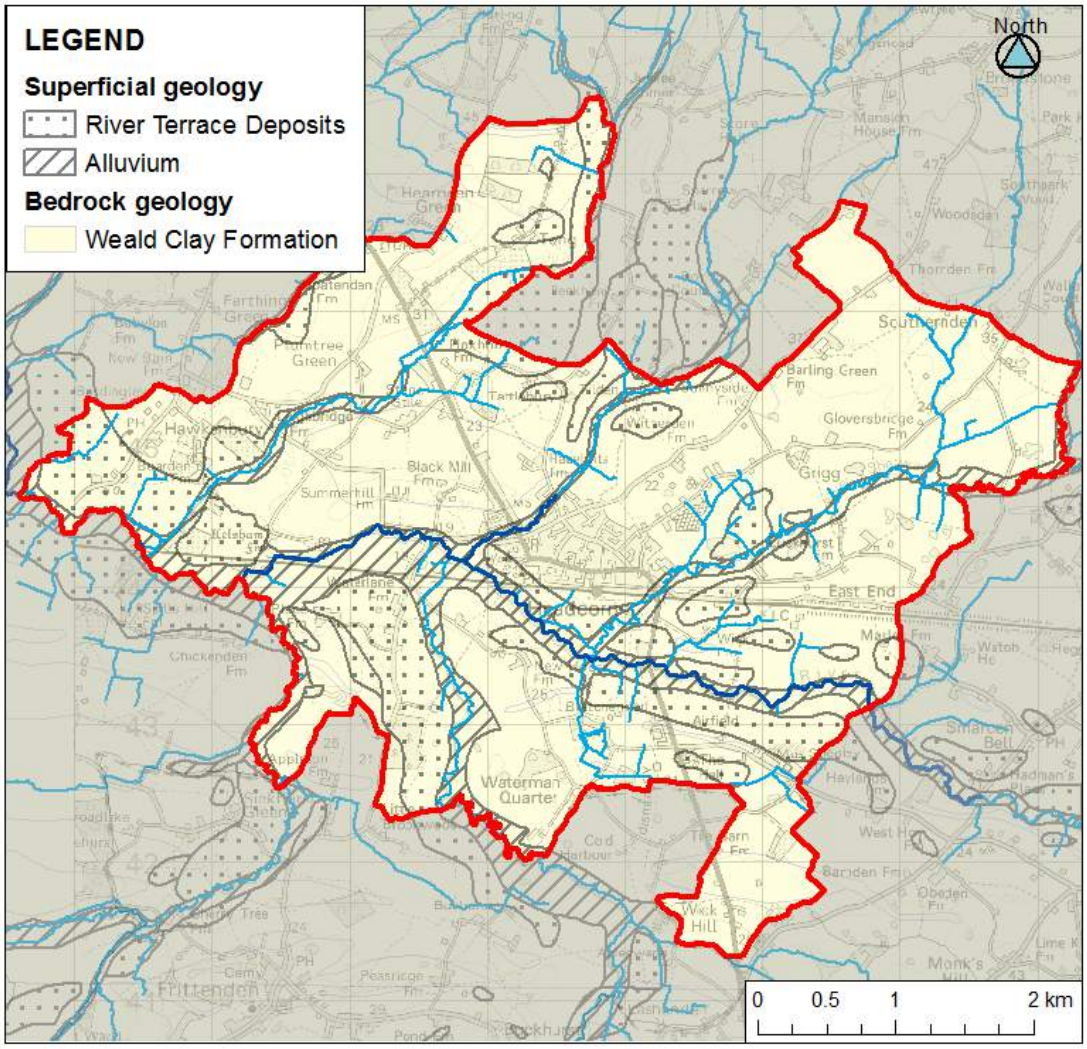

Figure 3-2: Geology in the Parish of Headcorn

Clays are typically low in permeability due to their fine grain size. The impermeable bedrock geology is more likely to lead to the generation of surface water runoff, which can be result in pluvial ponding in topographic depressions. However, fractures or cavities in the geology can act as a conduit for groundwater and allow surface water to rapidly infiltrate in some areas.

The superficial geology has more capacity to accept and store surface water runoff as this tends to be less compressed. However, as the infiltration to the bedrock geology below is impeded, there is potential for increasing groundwater flood risk locally.

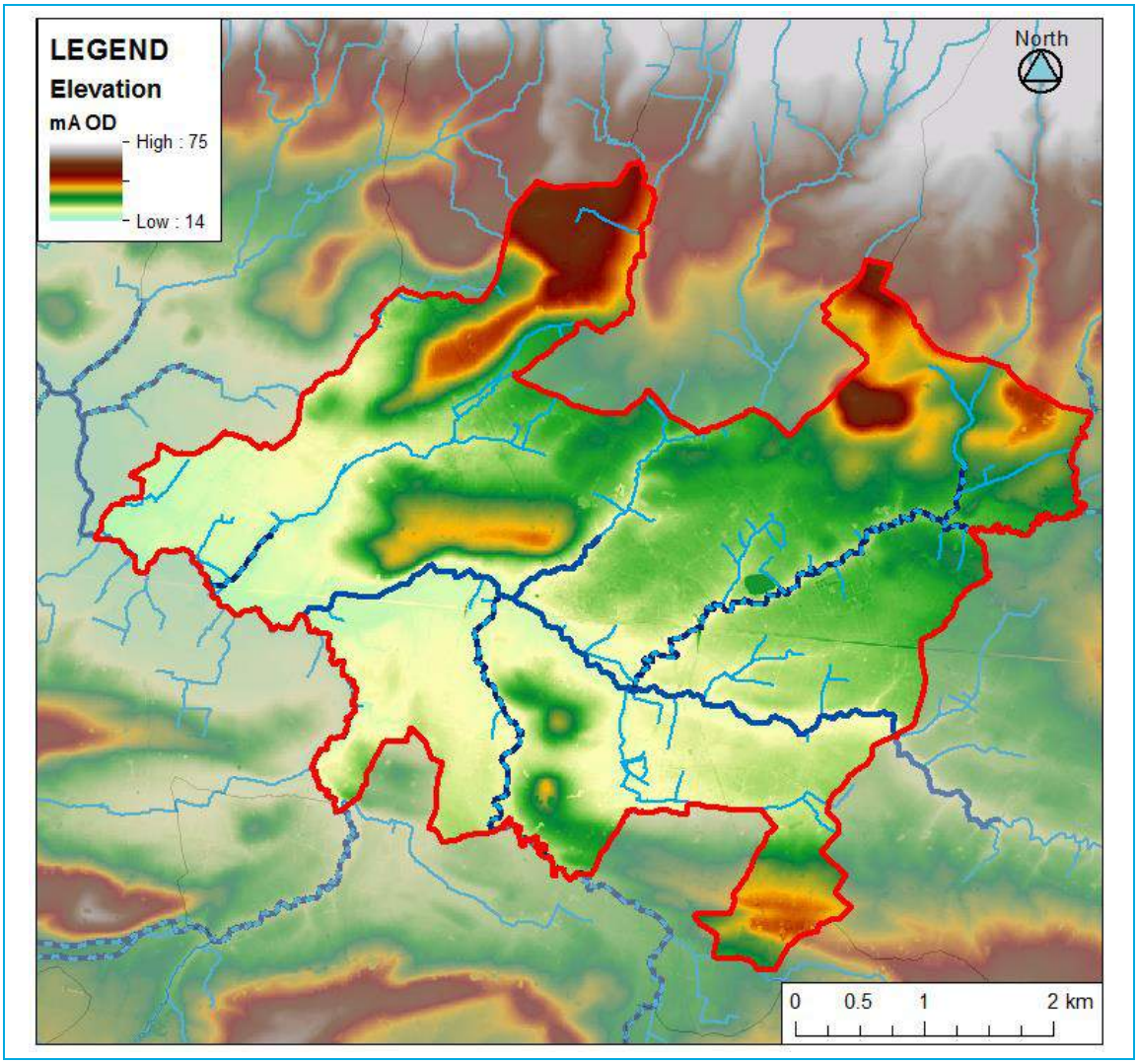

Figure 3-3: Topography in the Parish of Headcorn

The topography of the parish is generally flat and low lying in the natural basin of the River Beult. However, there are some areas of locally higher topography around Black Mill Farm and New House Farm. A gently sloping topography is not likely to generate a rapid runoff response and instead is more likely to lead to areas of pluvial ponding. Due to the impermeable geology, it is likely that the duration of any surface water ponding could be extended.

3.2.2 Land use

Historic mapping shows a number of ponds within the Parish of Headcorn. Some of these ponds remain today, but others have been infilled or developed over. Development has occurred at the Burdens, Chaplin Drive, New Road and Oaks Lane and infilling has occurred at Orchard Glade, Knights Way and the High Street. No historic watercourses were identified from old maps which are not shown on current day mapping.

Headcorn village is defined as a Rural Service Centre in Maidstone Borough Council's Core Strategy[2] as it includes facilities and infrastructure used by the surrounding rural communities. The land use is predominately low density residential in the village and agricultural in the parish as a whole. There is a stretch of commercial properties along the High Street and Station Road and some industrial land to the east of the village near the River Sherway.

The current land use and potential future growth areas are shown which includes aerial photography as it clearly demonstrates predominately rural land use in the parish. The urban areas are generally to drained by sewerage, whereas the natural areas are either naturally via infiltration or to the network of drainage ditches.

[2] Maidstone Core Strategy 2011

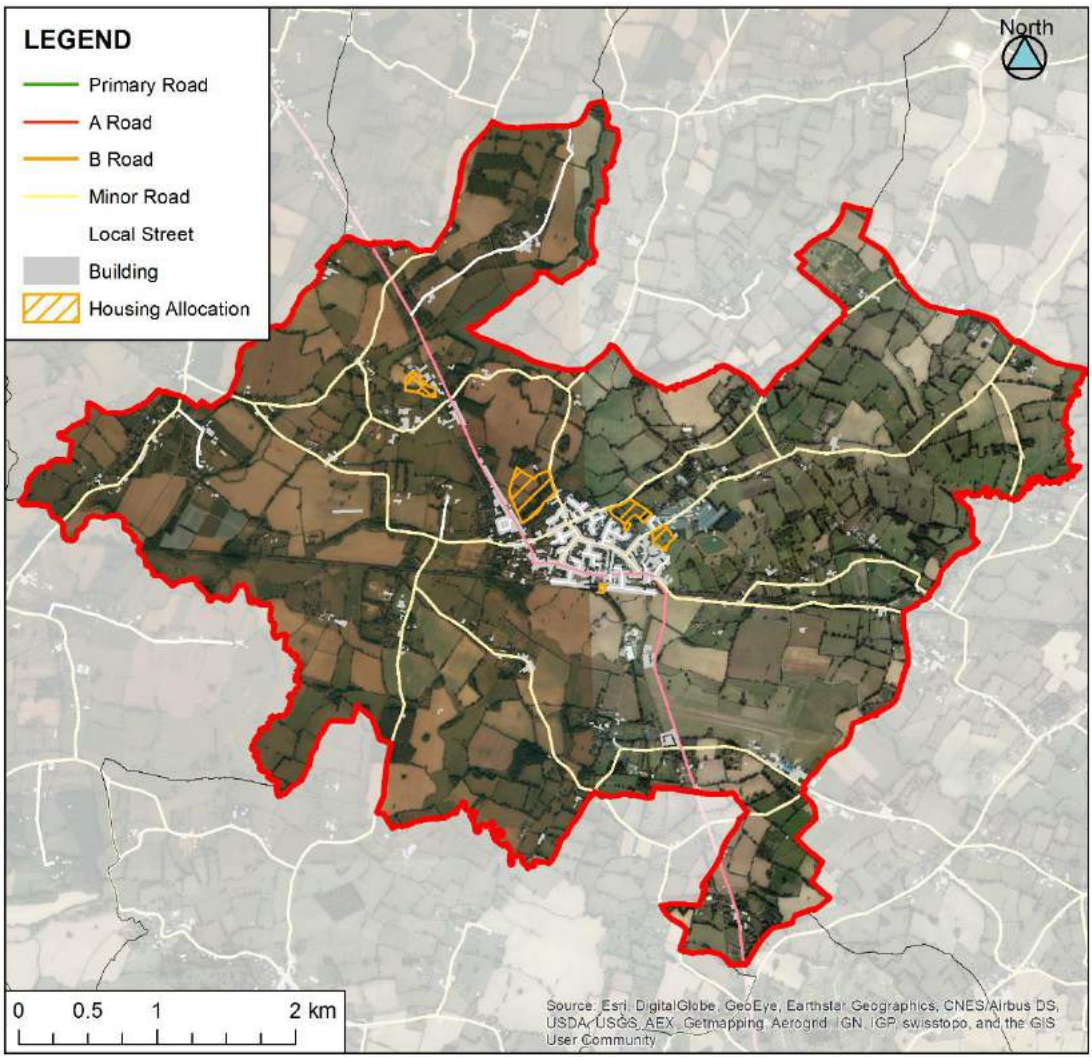

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Figure 3-4: Land use in the Parish of Headcorn

3.2.3 Urban drainage

The sewerage system in Headcorn is largely foul only. An Impermeable Area Survey (IAS) for Headcorn has been undertaken by Southern Water. This indicates that surface water from a large number of properties in Headcorn drain to soakaway. Exceptions to this are on Moat Road, High Street and Ulcombe Road, where surface water drains to the foul system and Oak Farm Gardens, Thatch Barn Road and Sharp's Field which are newer developments and have a separate surface water drainage system.,

There is a considerable highway drainage network in Headcorn as there are few surface water sewers available to discharge to. The highway drainage system is operated by KCC highways. Sections of this drainage network have been surveyed to inform this study including Orchard Glade, Grigg Lane, Knaves Acre, Chaplin Drive and Kings Road. Elsewhere, it has been assumed that the highway gullies drain to a Southern Water surface water sewer when one is available. Otherwise the highways drain to soakaway. This assumption was, where possible, tested and verified when on site. Given the local geology, it is somewhat surprising that there are significant numbers of soakaways in the catchment. This could indicate that the geology is relatively permeable, or could point to soakaways with insufficient soakage potential as being a source of surface water flooding.

The assets shown on Figure 3-5 have been divided into foul (brown) and surface water (blue) sewers and highway drainage (black).

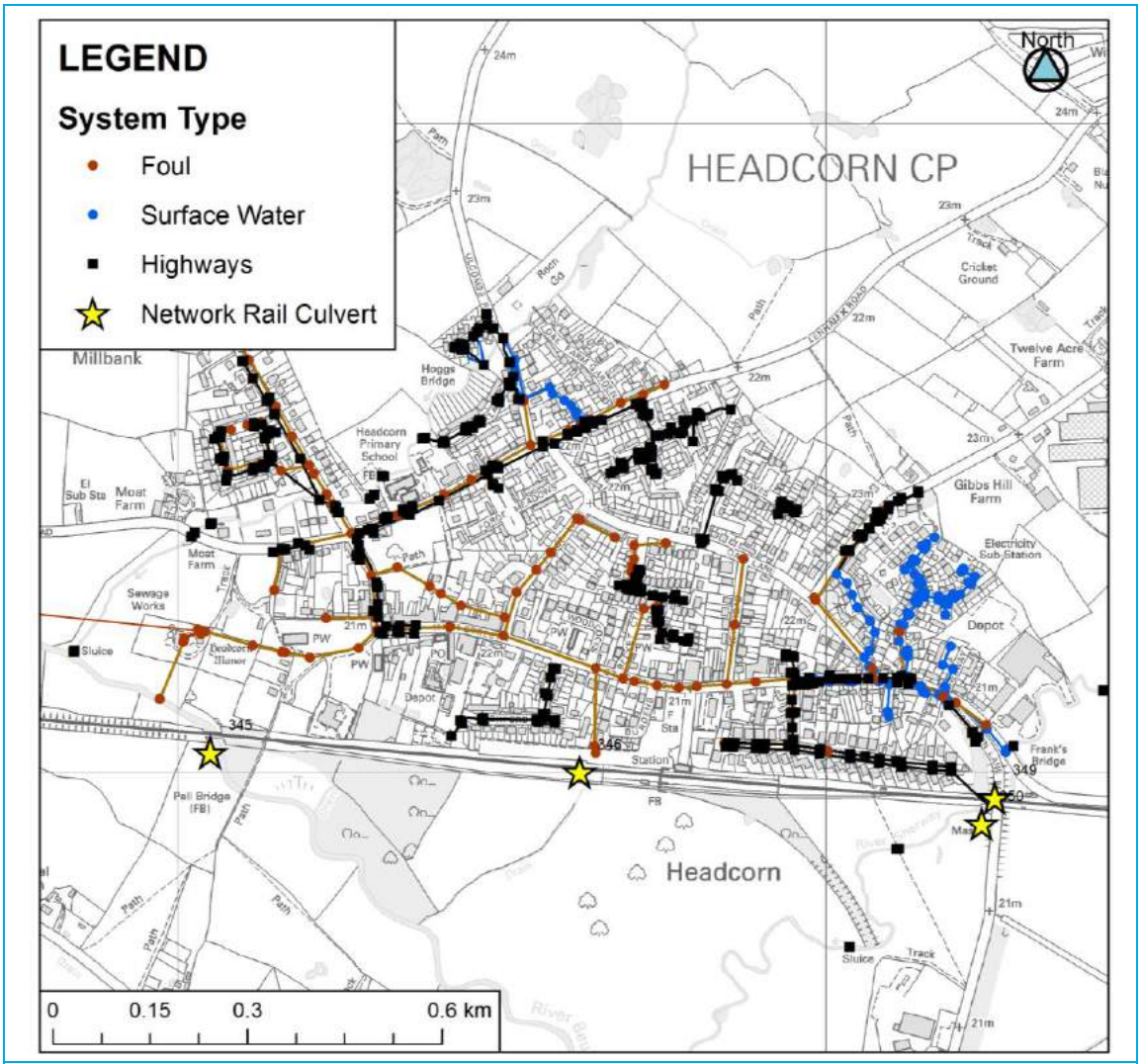


Figure 3-5 Headcorn urban drainage network

The Tonbridge to Ashford railway line runs through the parish, south of the village of Headcorn. The railway is on a raised embankment which largely divides Headcorn from the River Beult floodplain. From the inspection records provided by Network Rail, five railway culverts conveying watercourses have been identified. The inspection records also summarise the culvert condition at last survey. The last surveys concluded that the Main River culverts are in fair condition. However, the minor drainage culverts are said to be blocked due to sedimentation or vegetation. The survey report recommended clearance of the barrel and approaching ditches. In addition, residents of Headcorn have identified an additional railway culvert south of the High Street which has not been identified in Figure 3-5.

3.3 Flood history

Flood incident data provided geographical information on where flooding had been recorded. The data provided by the partners was standardised using the Source-Pathway-Receptor model.

3.3.1 Source-Pathway-Receptor model

The Source-Pathway-Receptor model is a concept that can provide an understanding of all sources of flood hazard. It is particularly useful in this context as it can be used to generalise the data gathered from numerous sources.

- Source - the origin of flood water
- Pathway - a route or means by which a receptor can be affected by flooding

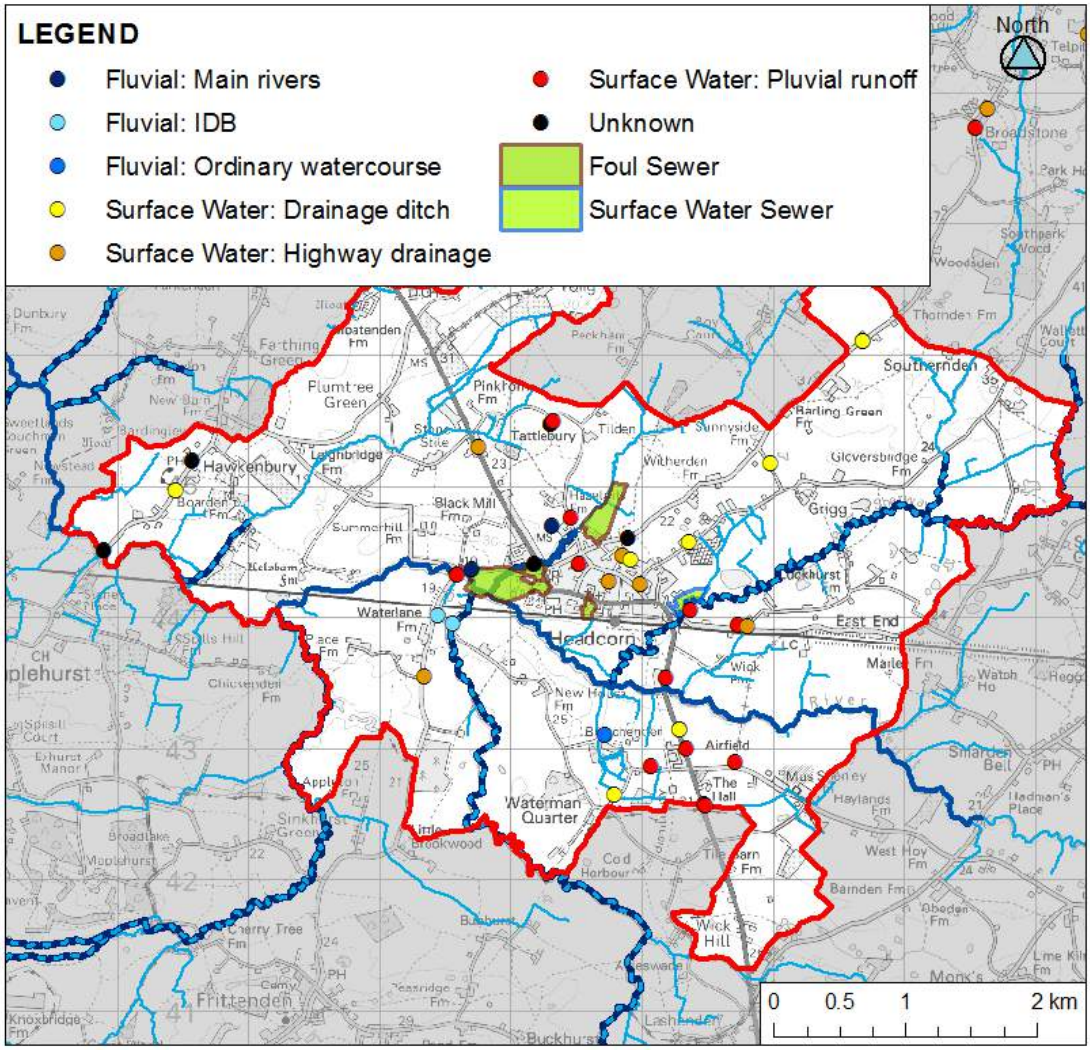
- Receptor - something that can be adversely affected by flooding

Having applied the Source-Pathway-Receptor model it is possible to mitigate the flood risk by addressing the source (often very difficult), block or alter the pathway and even remove the receptor e.g. steer development away.

3.3.2 Historic sources of flooding

The recorded flood history in Headcorn indicates that the main flood mechanisms operating within the town are; foul sewer exceedance, surface water flooding due to blocked highway drainage or ditches and fluvial flooding from School Stream.

The Stage 1 SWMP for Maidstone collated data on incidents of historical flooding from each Risk Management Authority. During the Headcorn SWMP, these flood incident records have been updated to 2014. A summary of flood incident source and location is shown in Figure 3-6.



Southern Water provided their flood history record for use in this project. To protect their customer's confidentiality, this information was only available to a seven-digit postcode.

Figure 3-6 Flood history from local sources in Headcorn

There have been flood incidents reported across the Headcorn parish. Flooding has been repeatedly reported in Headcorn village, at the Waterman Quarter and near Waterlane Farm. Fluvial flooding from Ordinary Watercourses has been reported from Hammer Stream and Main River flooding has been reported on School Stream (flood incidents reported from the River Beult have not been included in Figure 3-6).

Within Headcorn village, the most common causes of flooding are hydraulic overload from foul sewers and surface water runoff due to blocked drainage.

Most of the surface water flood incidents related to infrastructure in Headcorn were isolated incidents, with the highest frequency of flooding two incidents at any one location. Therefore, it is likely that the infrastructure has subsequently been cleaned or replaced in most cases.

The sewer flooding incidents recorded have occurred in the School Stream fluvial corridor. Therefore, there was potential that these flood mechanisms could be integrated. This was investigated as part of the SWMP and no evidence of fluvial or surface water inundation of the foul sewerage system was identified. It is likely that the system designed to be foul only is now also conveying surface water runoff. This will be due to direct connections from properties to the foul sewer network. This is because the original soakaways are not likely to be effective in the impermeable area.

3.3.3 Patterns that lead to flooding

Analysis of past events was undertaken to understand the patterns that lead to flooding in Headcorn. A full report is available in Appendix B. Flooding from surface water and foul sewers has coincided with high water levels on the River Beult, including winter 2012 and winter 2013. This suggest that flooding from local sources is exacerbated when drainage is limited by high fluvial levels.

In addition to this, flooding can occur in Headcorn independently of high water levels on the Beult. For example, in Autumn 2000 to flash flooding on the School Stream impacted a number of properties in Headcorn. The peak of this fluvial event had passed before the River Beult had responded to the same rainfall event.

3.4 Predicted flood risk

This section discusses surface water flood risk mapping from both the national dataset and the local modelling undertaken as part of this study.

3.4.1 Updated Flood Map for Surface Water (uFMfSW)

National surface water flood risk mapping, known as the uFMfSW exists for England and Wales and has been published by the Environment Agency. The uFMfSW for a 1 in 30, 1 in 100 and 1 in 1000-year rainfall events in the Headcorn area is shown in Figure 3-7.

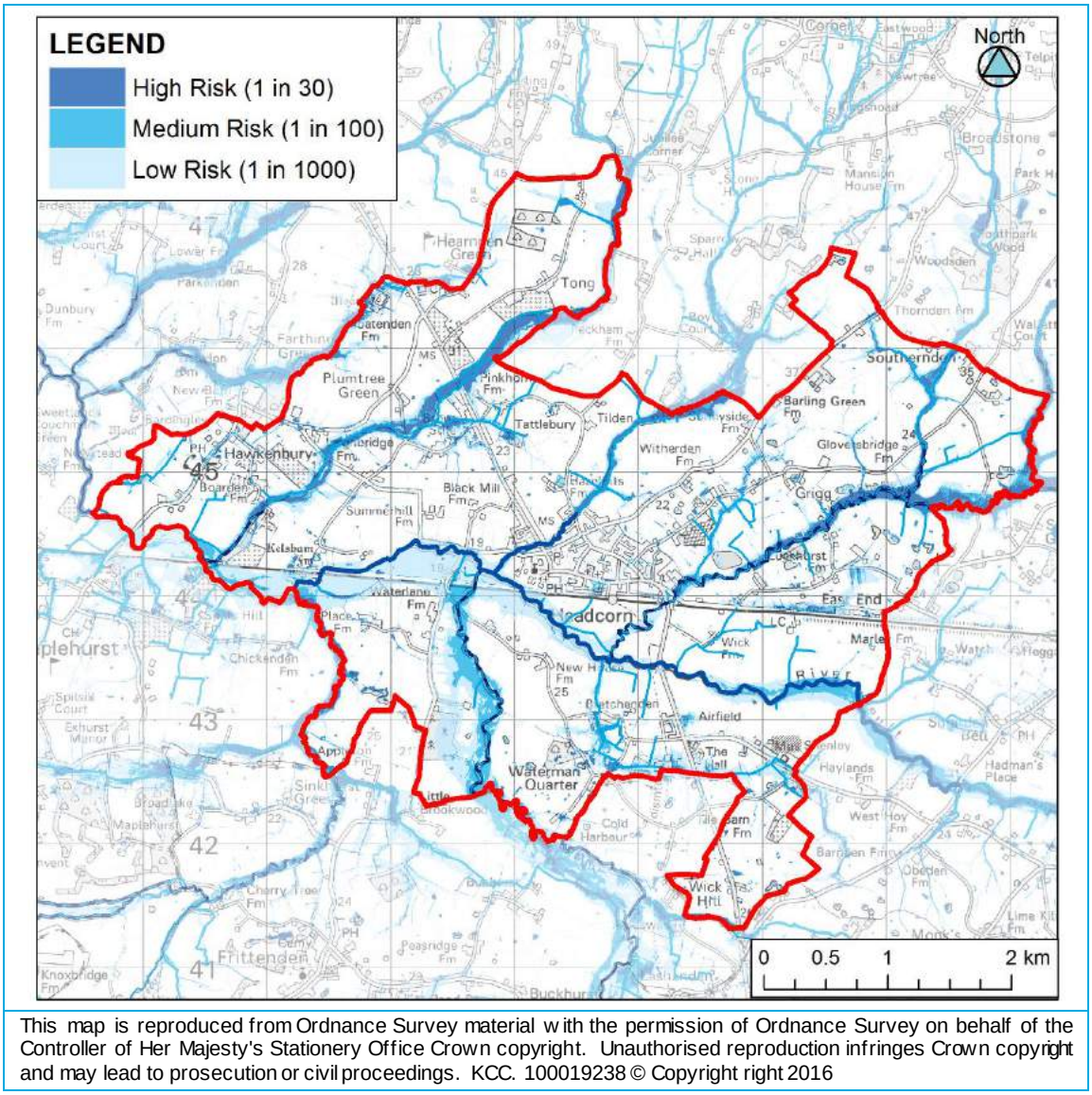


Figure 3-7 High, medium and low surface water flood risk in Headcorn according to the uFMfSW

The uFMfSW predicts surface water flood risk to be concentrated along the fluvial corridors with high surface water flood risk predicted along the River Sherway, the upper reaches of School Stream the ordinary watercourse between Tattlebury and Hawkenbury and around the Waterman Quarter.

Within the village of Headcorn, the medium surface water flood risk area shows a dry valley which runs through the village centre which intercepts Station Road and the Burdens. This is impounded but the railway line causing local ponding. The low risk extent picks up surface water along most highways within the village, particularly Griggs Lane, Oak Land and Kings Road.

3.4.2 Integrated Urban Drainage Model (IUDM)

An integrated modelling approach was developed as part of this study which represents all drainage systems and overland flows. The IUD model represents overland flow, public urban drainage network (highways, sewerage and railway culverts) and watercourses. Each of the model elements is dynamically linked to allow the exchange of flows.

Hydraulic Model Inflows

A full technical report describing the hydrological assessment is available in Appendix B. This section provides an overview of the hydrology and the outputs.

There have been two hydrological methods applied to the IUDM; both direct rainfall and point inflows. Flow hydrographs and rainfall hyetographs were calculated for the following Annual

Exceedance Probability (AEP) events; 50%, 10%, 5%, 3.33%, 2%, 1.33%, 1% and 0.1%. The effects of climate change were considered for the 1% AEP event. For this event, flow and rainfall intensity was increased by 20%.

The direct inflows were calculated using the FEH Statistical method which was appropriate because the catchments are fairly small, impermeable and mostly rural. Peak flows were derived for the School Stream and the River Sherway at the upstream and downstream of the study area. The upstream inflows were applied to the upstream of the model extent. There were no lateral inflows used because direct rainfall allowed for a distributed inflow throughout the modelled length. The downstream flow estimates were used as check flows to test that the modelled flows at the downstream extent matched with the flows calculated in the hydrology.

Hydraulic Model Build

A full technical report describing the IUD model is available in Appendix D. This section provides an overview of the IUD model and outputs.

Overland flow has been modelled across the parish of Headcorn. A digital terrain model (DTM), consisting of high resolution Lidar data has been used to inform the bare-earth topography of the catchment. Some surface features such as buildings, roads and wooded areas have also been represented as these have a direct impact on overland flow paths and velocities.

The drainage systems modelled include Southern Water's surface water sewers, Kent County Councils Highway drainage and Network Rail culverts. The Southern Water foul sewer network has been imported from an existing Southern Water model. The surface water sewers model has been built from Southern Water asset data. The highway drainage model has been built from survey data collected for this study and supplemented with existing asset data. Southern Water's foul sewer model has been verified against a short term flow survey, The performance of the surface water model has been tested against historic incidents, but no verification against flow survey has been completed.

Two watercourses have been modelled in detail in Headcorn, the River Sherway and the School Stream as they were both considered to pose a flood risk to people and property in Headcorn. The River Beult has not been modelled explicitly, but interactions with the Sherway and School Stream have been considered by applying a water level representative of the River Beult at the downstream extent of the watercourse models. The water level remains constant throughout the simulation at the peak level for a 20% AEP event on the River Beult. This water level represents out of bank conditions, and was used because it was the smallest return period available from existing modelling of the River Medway catchment.

The River Sherway and School Stream are marked with a blue line in Figure 3-8. A 1D representation of watercourses is the best way to estimate both channel capacity and in channel velocity. The 1D river model has also been connected to a 2D flood plain model at the banks of the watercourses. This allows the exceedance flows to be routed under gravity over land.

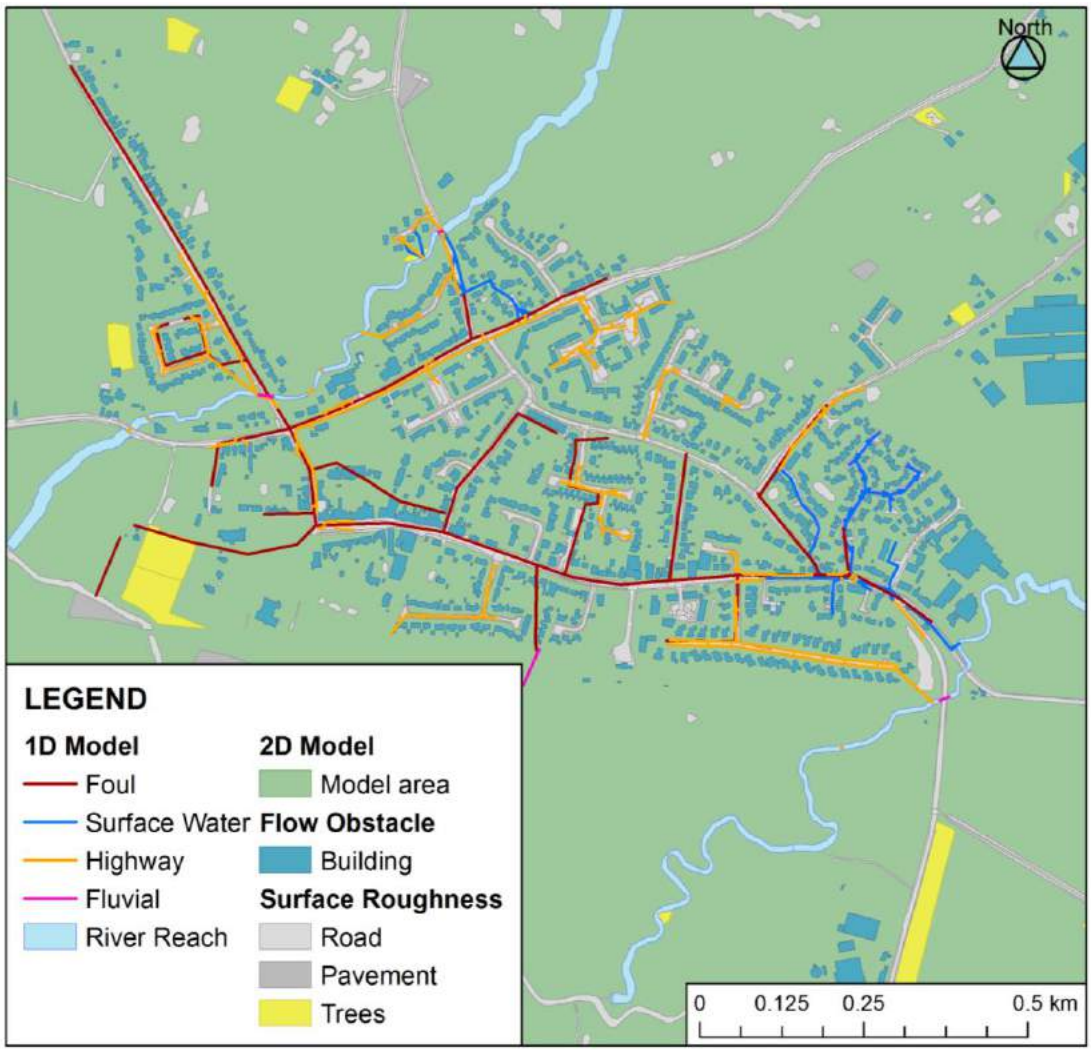


Figure 3-8: Headcorn IUDM schematic

Model results

The results of the model are presented in Appendix E for the 1 in 2, 10, 20, 30, 75, 100, 100 +CC and 1000-year rainfall events. The maps show depth of flooding and the hazard to people rating, which uses a combination of depth and velocity of flow to assess health and safety hazards to people.

3.5 Flood risk metrics

Metrics have been used to quantify the impact of flooding at each modelled return period. Metrics consider a count of properties predicted to be at risk and an estimate of damages due to flooding based on the Multi-Coloured Manual[3].

3.5.1 Property counts

Property counts were based on the results from the IUDM as this was considered the best representation of flood risk in the catchment. The analysis was undertaken using Frism, a JBA GIS-based tool for analysing flood impact and damages. A detailed count was undertaken which 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 does not fall within the flood outline.

[3] Middlesex University (2013) Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal.

The total number of properties counted at each return period is shown in Table 3-1.

Table 3-1: Baseline property count at each Annual Exceedance Probability (AEP) event

Flood Event Return Interval	Residential Properties Flooded	Non Residential Properties Flooded	Total
50% AEP event	28	18	46
10% AEP event	46	35	81
5% AEP event	74	63	137
3.33% AEP event	93	83	176
2% AEP event	107	111	218
1.33% AEP event	124	123	247
1% AEP event	140	132	272
0.1% AEP event	243	221	464

The model results show that an increasing number of properties are flooded at each return period, as would be expected. The results suggest relatively few properties are at risk in a 50 % AEP event but this rises steadily to over 200 properties from the 2% EP event and greater. The extreme flood of 0.1% AEP is predicted to impact 464 properties in the Headcorn parish. The number of residential and non-residential properties predicted to be at risk is fairly equal for each return period, despite there being more residential properties in Headcorn. This is due to the situation of non-residential premises in areas of higher risk such as adjacent to the River Sherway and School Stream.

In the wider parish the land use is largely rural and as such there are few receptors at risk of flooding. However, there is some flood risk predicted to properties at Hawkenbury.

3.5.2 Damage calculations

Internal flooding of properties has an economic impact. The majority of financial cost is due to the damage incurred to the property (direct damages) but there are also secondary costs such as the emergency response (indirect damages) and the impact to health (intangible damages).

The damage calculation includes all of these costs. The Multi-Coloured Manual (MCM) 2013 provides a methodology for calculating damages, as well as cost versus flood depth curve which has informed this assessment.

A property threshold level of 0.15 metres has been assumed. This means that if a property is intersected by a flood depth less than 0.15m, it has been assumed that no direct damage will be incurred as the flood water could not access the property.

The damages curve for each of the properties was adjusted to account for inflation. This was done by using the monthly variation of the Customer Price Index (CPI) which was inputted at 132.6. The CPI uses the prices of a representative sample to statistically estimate the variation in the real property value whilst accounting for the changes in the rate of inflation.

The economic damages estimated for the baseline scenario for each Annual Exceedance Probability (AEP) is shown in Table 3-2.

Table 3-2: Baseline damage calculation at each Annual Exceedance Probability (AEP) event to the nearest £k

Flood Event Return Interval	Residential (£)	Commercial (£)	Total Damage (£)
50% AEP event	295,000	282,000	577,000
10% AEP event	453,000	622,000	1,075,000
5% AEP event	643,000	1,001,000	1,644,000
3.33% AEP event	793,000	1,340,000	2,132,000
2% AEP event	964,000	1,785,000	2,749,000

Flood Event Return Interval	Residential (£)	Commercial (£)	Total Damage (£)
1.33% AEP event	1,093,000	2,019,000	3,113,000
1% AEP event	1,197,000	2,157,000	3,353,000
0.1% AEP event	2,465,000	3,485,000	5,950,000

The potential damages from flooding increase at each AEP event in line with the increased number of properties at risk. The non-residential damages are often higher than the residential damages, despite fewer properties being at risk. This is due to the calculation considering the floor plan of a building which can be large in the case of the warehouse buildings near the River Sherway. As a result, the potential damages to the building and contents is high. The total damages in Headcorn for a 1% AEP event is £3,353,000.

3.6 Flooding hotspots

A flooding hotspot is an area identified as prone to flooding according to local knowledge, flood history or flood risk mapping. These include Moat Road, the School Stream (particularly around Headcorn Primary School and Hogg's Bridge), Station Road and the River Sherway around Franks Bridge.

3.6.1 School Stream catchment

The School Stream is a flashy watercourse with a number of potential receptors along its course. Areas of interest within the catchment are Moat Road, Headcorn Primary School and the area around Hoggs Bridge as described below.

Moat Road

The foul sewerage on Moat Road is reported to flood regularly, impacting highways and residential curtilage but no internal flooding has been reported. There is a vented manhole cover on Moat Road which is the point of exceedance. There is a bio-hazard and water quality risk associated with this regular flooding. Moat Road is shown in Figure 3-9.

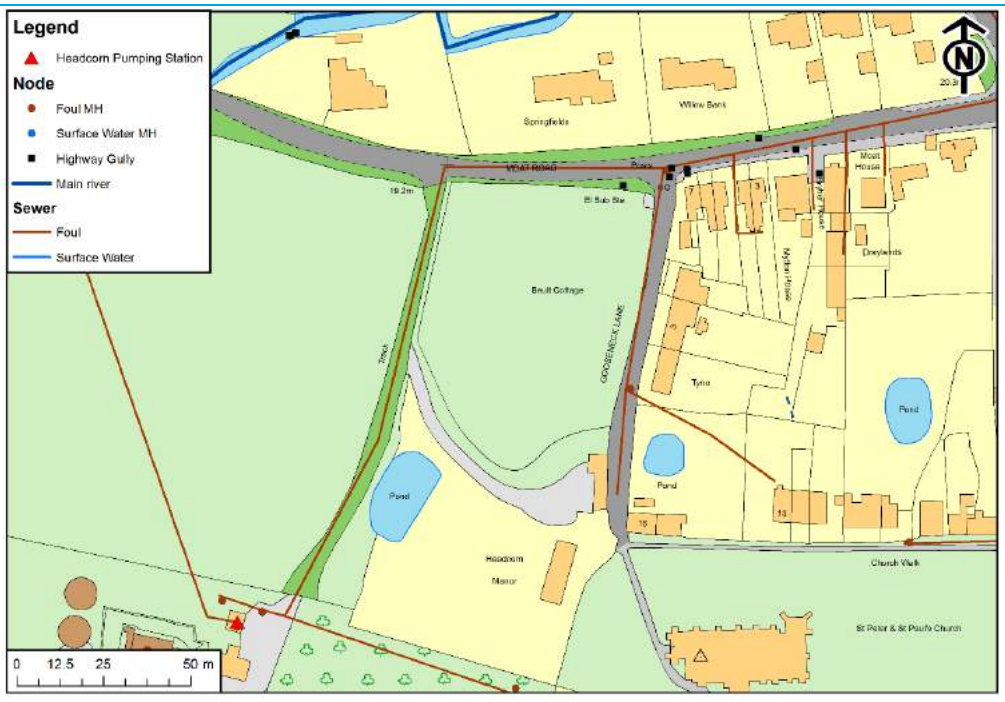


Figure 3-9: Moat Road, Headcorn

The key drainage assets on Moat Road are listed in Table 3-3.

Table 3-3: Drainage assets on Moat Road

Asset	Owner	Comments
Foul sewerage	Southern Water	The sewer drains northwards under gravity from Gooseneck Lane onto Moat Road from where it continues to North Street before discharging to Headcorn Pumping Station. One of the manhole covers on Moat Road is vented (as shown below).  As a result, when the sewer surcharges, exceedance occurs at this point.
Highway drainage	Kent County Council	There are few highway gullies on Moat Road. During the site visit, some shallow water ponding was observed at the kerb side.

The IUD model does not predict any fluvial or surface water inundation of the foul sewerage. Therefore, it is concluded that unplanned flows in this system are due to direct connections of surface water drainage. The catchment area upstream of this point is relatively small as the network drains less than 20 dwellings. As a result, identifying the source of any misconnections, surface water ingress or infiltration may be possible. In addition, the sewerage is hydraulically inefficient as it flows away from the Headcorn pumping station and is 500 metres longer than a direct route southward. However, a direct route may not be achievable due to land ownership and other constraints.

The modelling has not highlighted Moat Road as an area of high surface water risk. However, there was shallow ponding observed during the site visit which could be better managed with a more effective highway drainage system. There are narrow highway verges along Moat Road which could be an opportunity for retrofit highway SuDS such as swales and rain gardens.

Headcorn Primary School

Headcorn Primary School has reported internal flooding on one occasion and flooding of the school grounds on more than one occasion. Internal flooding was reported in 2000 when a flash flooding event coincided with partial blockage of the bridge downstream of the school site. Headcorn Primary School and the surrounding area is shown in Figure 3-10.

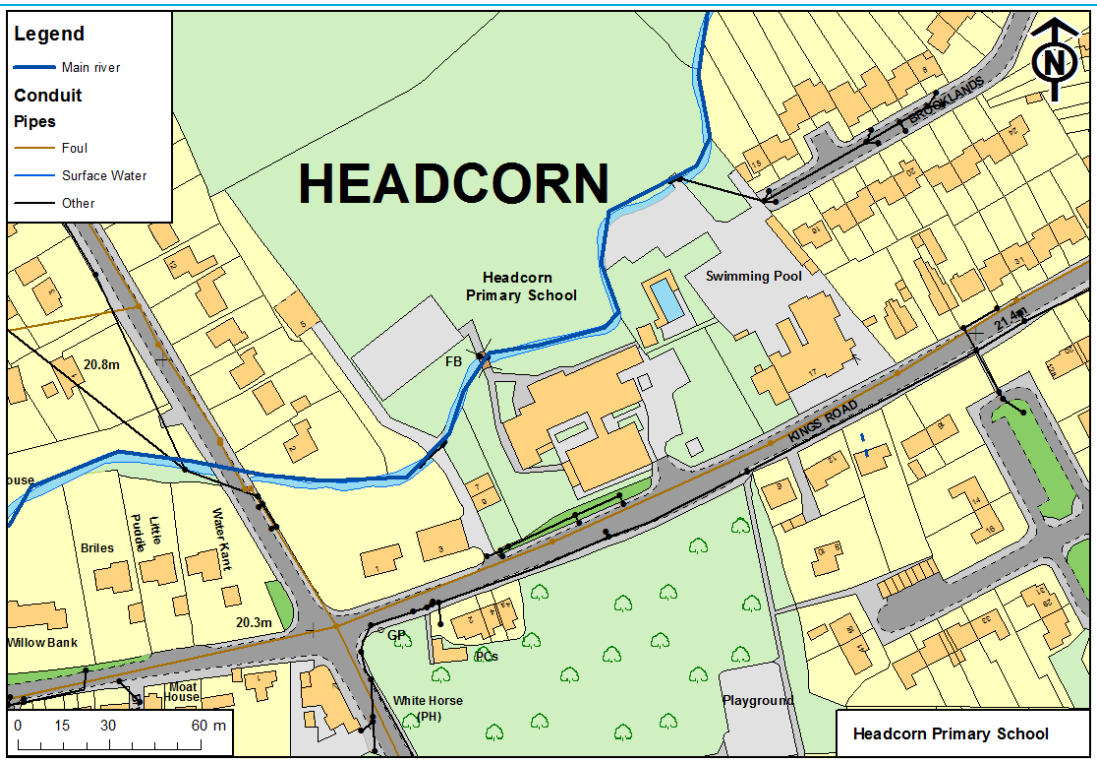


Figure 3-10: Headcorn Primary School, Headcorn

The critical drainage asset at Headcorn Primary School is the School Stream which flows east to west through the school grounds.

The internal flooding event highlights the importance of maintenance on key structures. This is supported by the IUD model results which show the school building is not at risk of fluvial flooding during a 1% AEP event, unless there is a partial blockage on the bridge under North Street. There are opportunities on the school site to manage fluvial exceedance flows, but the priority should be to maintain full capacity at the downstream structures.

The IUD model results show the school building is at risk of surface water flooding. However, this is local pluvial ponding within in reality is likely to be managed by the drainage at the school site.

Hoggs Bridge

The Hoggs Bridge is the Ulcombe Road crossing on the School Stream. Significant fluvial flooding has been observed in the area, particularly in 2000 and the winter of 2013-2014. Upstream of the Hoggs Bridge the Recreation Ground has been observed to high depths, which was said to almost reach the Scout Hut. Downstream of the Hoggs Bridge, the Uptons is reported to be vulnerable to flooding as is the gardens of Brooklands. The Hoggs Bridge and surrounding area is shown in Figure 3-11.

Figure 3-11: Hoggs Bridge on the School Stream, Headcorn

Within the Hoggs Bridge hotspot there are a number of drainage assets. The key assets are listed in Table 3-4.

Table 3-4: Drainage assets at Hoggs Bridge

Asset	Maintainer	Comments
Sewerage	Southern Water	The Uptons is a relatively new development and as such has a separate surface water and foul sewerage network. The surface water sewers discharge to School Stream. There are two foul sewage pumping stations; Oak Farm Garden and Ulcombe Road. The Ulcombe Road pumping station is at high risk of river flooding..
Highway drainage	Kent County Council	Highway drains discharge to the surface water sewerage on the Uptons and Ulcombe Road.
School Stream	Environment Agency and riparian owners	Upstream of Hoggs Bridge the School Stream is classified as ordinary watercourse. Downstream of the Hoggs Bridge the School Stream is classified as Main River.

The IUD model results show the recreation ground acts as a natural flood storage area and this is predicted to flood to within 5 metres of the Scout Hut. The 10% AEP event is impounded in the Recreation Ground by the Ulcombe Road. However, in the 5% AEP event this storage is exceeded, the road is overtopped and fluvial flood risk starts to threaten the Uptons at a 3.33%

AEP event and larger. Flood Risk to the gardens of Brooklands is first predicted in a 10 % AEP event, but no damage to properties is predicted even in the 0.1% AEP event.

3.6.2 Station Road

Figure 3-12: Station Road, Headcorn

Within the Station Road hotspot there are a number of drainage assets. The key assets are listed in Table 3-4.

Table 3-5: Drainage assets at Station Road

Asset	Maintainer	Comments
Sewerage	Southern Water	A foul only system drains Station Road.
Private Soakaways	Land owner	The IAS for Headcorn shows one property Station Road confirmed to drain to soakaway and the others are assumed to drain to soakaway, including the station car park. The Burdens was not mapped at the time of survey.
Highway drainage	Kent County Council	There are a number of highway drains on Station Road and the Burdens. These were not surveyed during the project because parked cars made them difficult to access.
Railway culvert	Network Rail	The last available survey concluded that this culvert was blocked and was in need of de-sedimentation and vegetation clearance.

The IUD model results show pluvial ponding predicted on Station Road from the 55 AEP event. A flow path is predicted down New Road and onto Station Road before continuing down Burdens toward the railway culvert. There is no formal channel upstream of the railway culvert (although

there is a drainage ditch downstream of the railway) so surface water ponds against the railway embankment before passing.

Surface water flooding has been recorded to the station car park where the discharge of the draining is limited by the soakaway draining into an impermeable soil. There is an opportunity to manage exceedance and route exceedance flows under the railway to the exiting drainage ditch. However, this us dependant on the clearance of the existing railway culvert.

3.6.3 Franks Bridge

The Franks Bridge crosses the River Sherway and is the upstream extent of three river crossings within 100 m. These river crossings are the act as a flow constriction causing fluvial exceedance of the River Sherway upstream of this point. The receptor is generally farm land but there are some commercial buildings predicted to be at risk which are classified as Less Vulnerable to flooding.

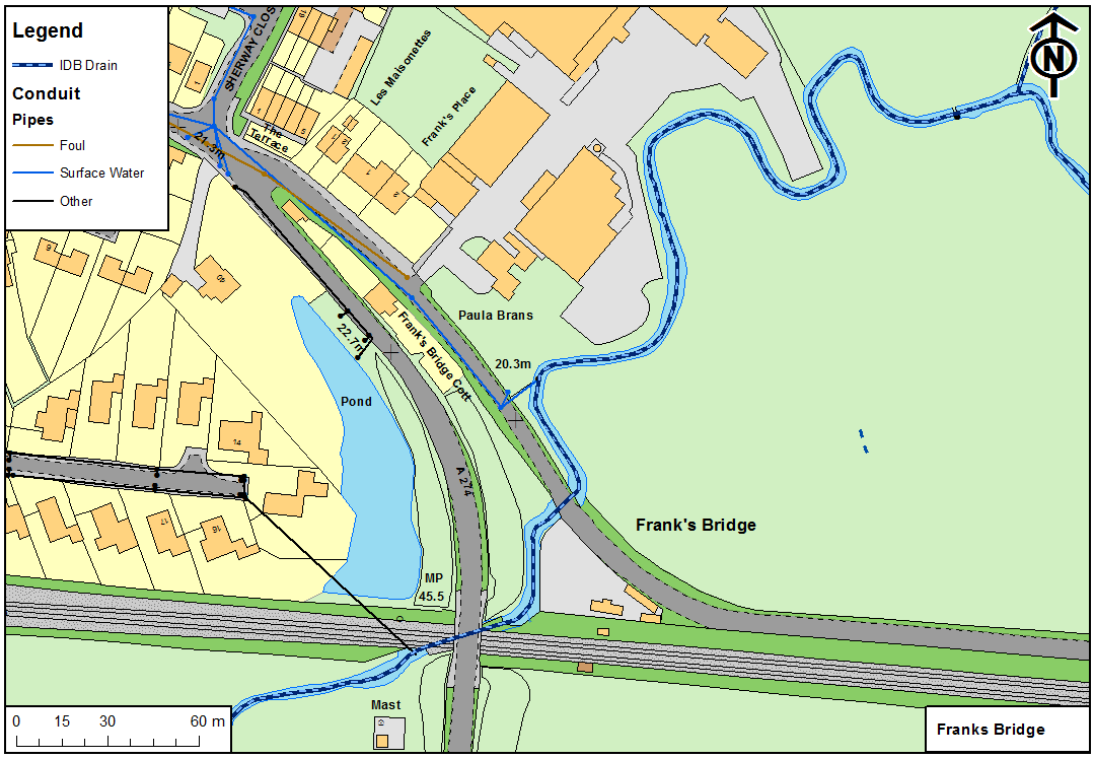


Figure 3-13: Franks Bridge on the River Sherway, Headcorn

Within the Franks Bridge hotspot there are a number of drainage assets. The key assets are listed in Table 3-4.

Table 3-6: Drainage assets at Station Road

Asset	Maintainer	Comments
River Sherway	Upper Medway IDB	The River Sherway is classified as an IDB watercourse.
Franks Bridge	Kent County Council	Franks Bridge is the Smarden Road crossing over the River Sherway.
Railway culvert	Network Rail	The last available survey report found this culvert to be in good condition for passing fluvial flows.

The IUD model predicts some fluvial flood risk to the industrial buildings on Smarden Road from a 5% AEP event. The predicted risk to this site then remains fairly consistent event in a 0.1% AEP

event. The A274, Biddenden Lane, is not predicted to be at fluvial flood risk, even in a 0.1 AEP event. However, the Smarden Road is shown to become inundated in a 2% AEP event and greater. The flood extent from the River Sherway intersect lower vulnerability receptors such as agricultural land, highways and industrial units.

The pond on Orchard Glade is a collection area for surface water runoff as it becomes impounded by the raised A274 and the railway embankment. Properties in Orchard Glade are predicted to be at risk from the 5% AEP event, but the risk is largely to gardens.

3.7 Validation of the risk assessment

A variety of approaches have been taken to validate this risk assessment, as outlined in the following sections.

3.7.1 Model verification against hydrometric data

To verify sewer flow models Water Companies, undertake in pipe flow and level surveys accompanied by a network of rain gauges. These are often temporary and remain in the ground long enough to record three storms of sufficient depth and intensity with which to verify the model against. This detailed verification process compensates for not being aware of the condition of the piped network or the exact contributing areas. The parameters can be adjusted to produce results that represent what occurred in the catchment. However, short-term flow surveys are expensive and therefore are prioritised towards key assets; which for a water company are rarely surface water sewerage networks. As a result, there is no in pipe flow data to verify this model against.

Therefore, the verification has focussed on matching the predicted surface water flow paths and pooling areas with the reports of flooding.

3.7.2 Model review meeting

The baseline model results were presented to the project steering group for their approval based on local knowledge of flood mechanisms as discussed in Section 3.7. This meeting found that the fluvial flood extent at the downstream of Hoggs Bridge under estimated that which was observed. Upstream of the bridge, it was a good match with flood extents in the recreation ground almost reaching the Scout Hut. This led to testing of runoff rates to check whether the flow contribution from intervening areas was accurate and checking of the bridge representation to check it was not restricting too much flow. The bridge survey drawing provided by KCC highways is a hand sketch and not as accurate at the survey specified for this project. However, the measurements in the model reflect the survey so no changes were made. The sewer exceedance predicted at Moat Road match with the reported incidents.

3.7.3 Historic events

Southern Water records flood events from sewers. The data they have provided for this project is a count of flooding incidents within a seven-digit postcode. The data has been supplied in this format to respect their customer's confidentially. Therefore, its uses for model validation are limited, as we do not know if the flooding was from a foul or surface water sewer and where the incident occurred exactly.

Kent County Council highways keep a log of flooding incidents. This highlights stretches of road that have had flooding and occasionally, points data of where the flooding has occurred. This more precise data is more useful for model validation. As a result, this data set has been the primary source of information for model validation. Further discussion of historic flooding datasets can be found in section 3.3.2.

Locations where surface water flooding has been reported have been well represented by the IUD model, with Ulcombe Road, Grigg Lane, Chaplin Drive and Oak Lane all predicted to be at some risk. However, flood risk is predicted to the Burdens which has not been reported. Flooding from surface water when drainage was blocked has been reported on Knaves Acre is not predicted by the IUD model. In the model as it is assumed that all assets are free of obstruction, therefore it is possible the surface water flooding at these locations could have been avoided if the drainage network was running clear.

4 Development

Maidstone Borough Council are in the process of revising their Local Plan which will set the framework for development in the Borough. The draft Local Plan defines Headcorn as a rural service centre[4] and the policy for Headcorn includes development of 423 new residential dwellings over six sites and further 5,500m^2 employment floor space is allocated.

Surface water flooding is exacerbated by urbanisation when natural, permeable land uses are replaced with impermeable surfaces. However, the impact can be mitigated if KCC and Maidstone Borough Council guidance on the management of surface water is followed in the design of new developments. The guidance recommends the use of sustainable drainage systems (SuDS) which mimic natural systems and reduce surface water runoff and pollution. National Planning Policy Framework (NPPF) recommends that where possible development should be an opportunity to reduce flood risk. Developers are not required to solve existing flooding problems off their site, though they are encouraged to provide betterment through NPPF, and appropriate management of runoff at a development site could reduce flood risk elsewhere. If this is supported by local planning policies it is more likely to be delivered by developers.

This section examines the location of allocated development sites in relation to known hotspots and considers how development could change flood risk in Headcorn.

4.1 Ulcombe Road

The Ulcombe Road site is the largest housing allocation in Headcorn and accounts for 220 of the 423 dwellings allocated in the village. The area allocated is illustrated in Figure 4-1.

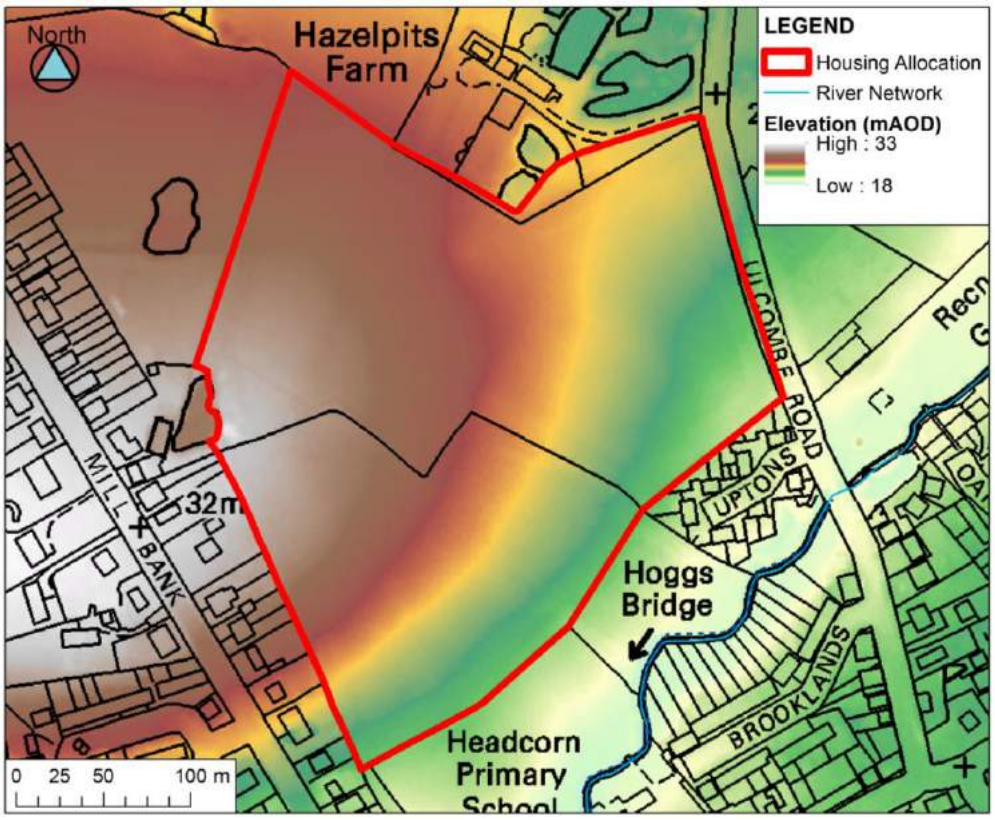


Figure 4-1: Ulcombe Road development site

[4] http://services.maidstone.gov.uk/docs/February%202016%20Regulation%2019%20Draft%20Local%20Plan.pdf

This site is potentially the most sensitive to flood risk of all the housing allocations in Headcorn. It is located adjacent to Headcorn Primary School and the Uptons within the School Stream catchment. The site slopes steeply away from School Stream and as a result is very unlikely to be at risk from fluvial flooding. In addition, in the currently greenfield conditions the site is predicted to be at very low risk of surface water flooding. However, development of this site has the potential to increase flood risk on the School Stream, if surface water is not managed appropriately.

The School Stream is recognised to respond rapidly to rainfall and peak before the River Beult. A drainage strategy for this site should consider attention of runoff to allow the peak on the School Stream to pass but then discharge of the attenuation before the peak of the River Beult raises otherwise drainage will be impeded. Any opportunities to reduce runoff below greenfield rate should be sought here to help manage fluvial flood risk from School Stream.

Foul drainage from this site is likely to connect to the existing Southern Water sewerage system upstream of Moat Road (although not on the same branch as the Moat Road). Therefore, the available capacity for additional flows should be considered via a Capacity Check[5] undertaken by Southern Water. If required, mitigation measures should be installed.

4.2 Lenham Road

The land north of Lenham Road has been allocated for development of 48 dwellings. The area allocated is illustrated in Figure 4-2.

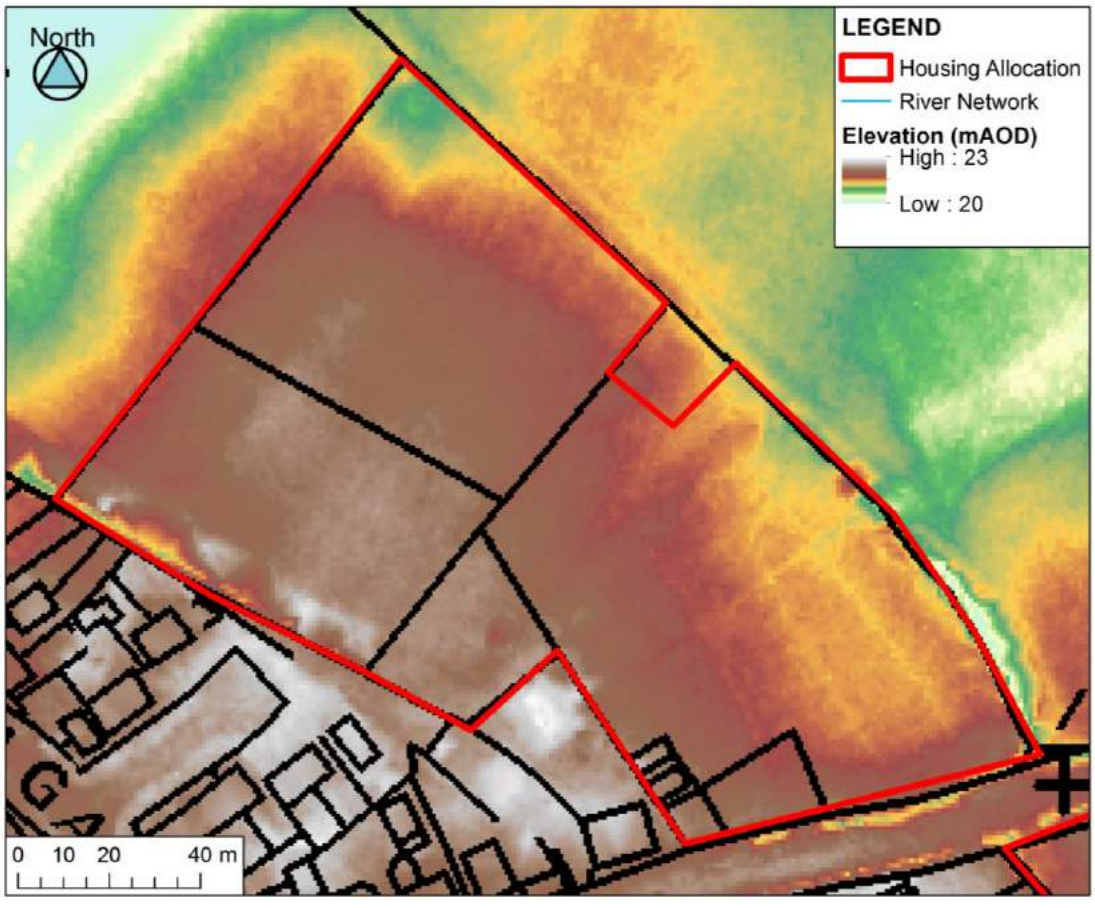


Figure 4-2: Lenham Road development site

The Lenham Road development also lies within the School Stream catchment. The site is upstream of Ulcombe Road, therefore increased runoff from the site could impact flood risk at all of the three hotspot locations identified in the School Stream catchment.

[5] https://www.southernwater.co.uk/capacity-check-sewer

The model results show the site itself is unlikely to be at risk of fluvial flooding but surface water flooding could occur in local depressions. The master plan for the site should consider the local surface water flood risk and steer development away from the highest risk areas. The surface water drainage strategy for the site should investigate opportunities to reduce flood risk below greenfield rate to help manage fluvial flood risk on the School Stream.

Foul drainage from this site is likely to connect to the existing Southern Water sewerage system upstream of Moat Road (although not on the same branch as the Moat Road). Therefore, the available capacity for additional flows should be considered via a Capacity Check[6] undertaken by Southern Water. If required, mitigation measures should be installed.

4.3 Old School Nursery

The Old School Nursery is allocated for development of nine dwellings. It includes re-develop of a brownfield site. The area allocated is illustrated in Figure 4-3.

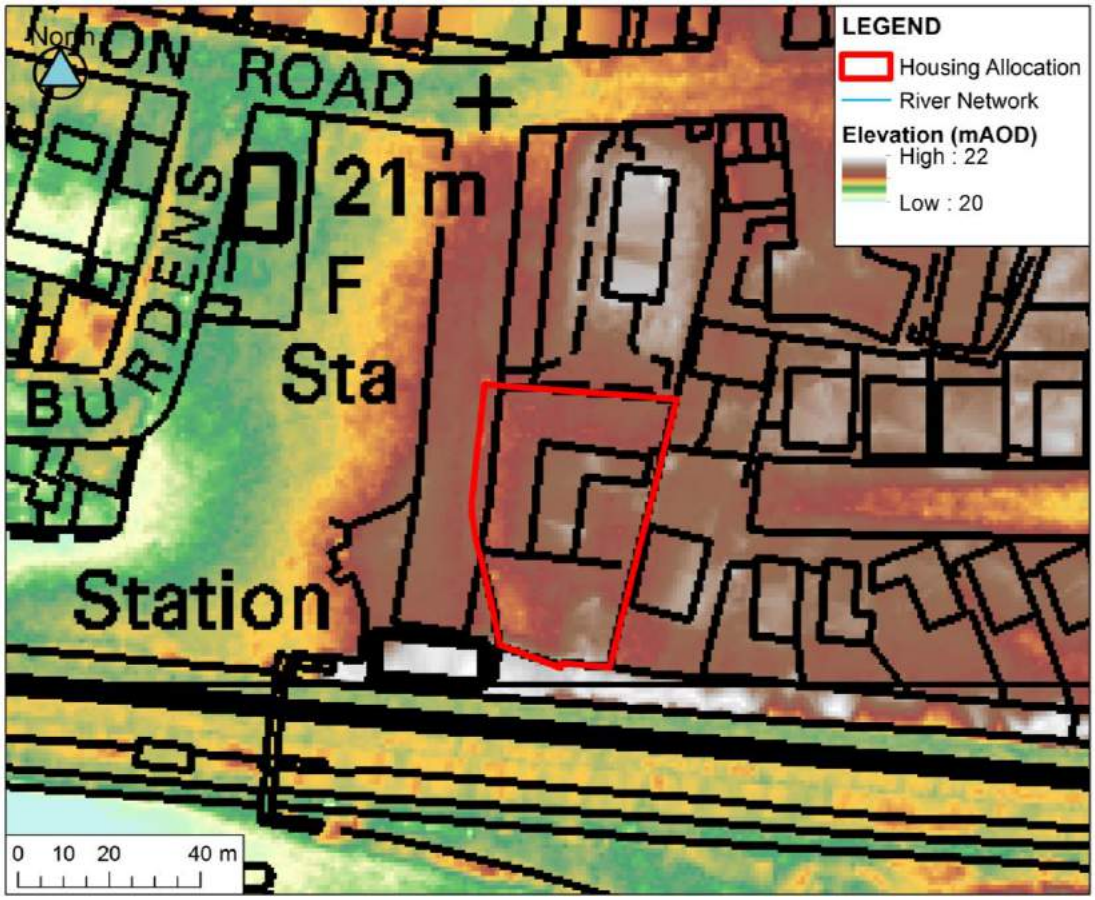


Figure 4-3: Old School Nursery Site

The Old School Nursery site is adjacent the Station Road hotspot. The IUD model predicts that some areas of the site are at risk of surface water flooding, and this should be considered during the master planning, allowing more vulnerable land uses to be steered away from areas at the greatest risk.

Local examples at the Station has demonstrated that soakaways are not effective in this area and any drainage strategy including SuDS techniques depended on infiltration should be accompanied by a soakaway test to demonstrate evidence that this method would be effective at the Old School Nursery site. Surface water sewerage from this site could continue west towards the railway culvert or east, down Orchard Glade towards the River Sherway. Both areas have been highlighted as flooding hotspots so reducing the runoff from the site to greenfield rate would benefit

[6] https://www.southernwater.co.uk/capacity-check-sewer

local flood risk. In addition, if the drainage strategy discharges to the railway culvert behind Burdens, the condition of this asset should be assessed.

4.4 Grigg Lane

The land south of Grigg Lane has been allocated for development of 55 dwellings. The area allocated is illustrated in Figure 4-4.

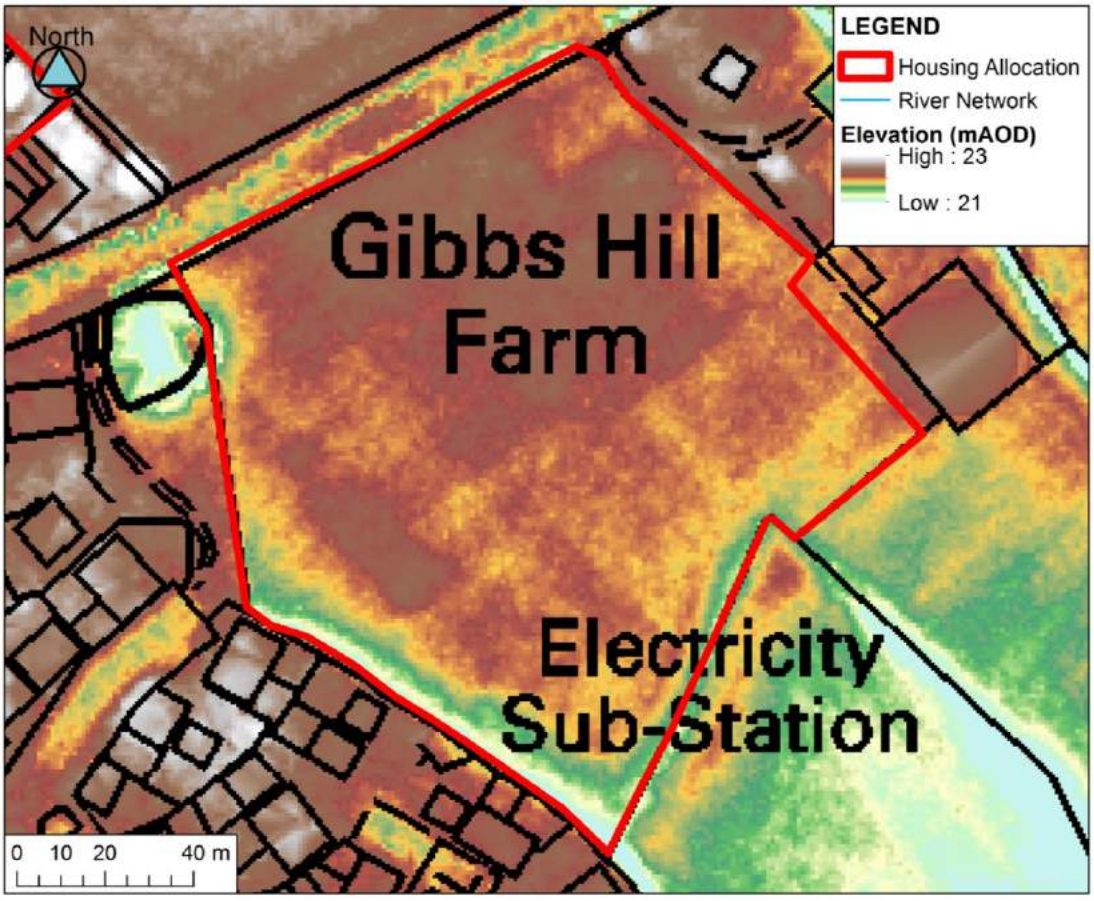


Figure 4-4: Griggs Lane, Headcorn

The Griggs Lane development lies within the River Sherway catchment. The IUD model results predict surface water flood risk along Griggs Lane to the north and within the field drains to the west and the south which drain to the River Sherway. The master planning of the site should be designed sequentially, to allow more vulnerable land uses to be steered away from areas at the greatest risk.

The River Sherway is a lower priority to the School Stream as the receptors at risk are generally lower vulnerability to flooding. However, effective management of surface water is still important at this site as is located upstream of the Frank's Bridge. Therefore, the drainage strategy should identify any opportunities to reduced runoff below greenfield to help manage fluvial flood risk.

5 Options

A full list of potential options to mitigate flood risk in Headcorn can be found in Appendix F. This includes indicative costs and benefits of each measure, as well as examples where these measures are being successfully used in Headcorn.

5.1 Objectives

The objective of the options assessment process was to identify, shortlist and assess a suite of measures (individual actions or procedures to manage current and future surface water flood risk, or to meet other SWMP objectives) for mitigating surface water flooding and agree preferred options (a single measure or combinations of measures) across the study area. The preferred options are then included in the Action Plan.

5.2 Options appraisal

The options appraisal first looked at opportunity and needs in the Headcorn Parish. It was agreed during the options workshop that the areas in greatest need of intervention were the flooding hotspots and these were the focus of the options assessment. The opportunities considered current land use and planned activities. A preliminary 'long list' of options was developed which considered multiple methods to manage the flood risk. The options were then whittled down to a short list which were considered the most effective and feasible. These were then tested in the hydraulic model.

5.2.1 Opportunities

Locations have been identified where there may be opportunities to manage surface water by retrofitting SuDS (such as large flat roofs and open green spaces), store fluvial exceedance such as open spaces or agricultural land, or where work is already planned by Risk Management Authorities and efficiencies could be realised by combining programmes.

There are currently no planned schemes in Headcorn. However, this SWMP has aligned with preparation of the Southern Water Drainage Area Plan which has allowed for effective sharing of information and survey data (for example KCC's gully survey).

As discussed in Section 4, the proposed developments could be an opportunity to manage flood risk in Headcorn and the surrounding area. Intelligent use of SuDS should enable surface water to be managed at the site and avoid increasing runoff elsewhere. Suitable drainage strategies should be prepared by the developer, noting the potential constraints listed above.

Opportunities to retrofit SuDS in Headcorn considered current green spaces and limitations such as narrow footpaths, buried services or need for parking. Areas suitable for SuDS retrofit include the Burdens, Station Car Park, Headcorn Primary School and Moat Road.

5.2.2 Needs

The area of greatest need for flood management from local sources in Headcorn have been identified as:

- The School Stream catchment at Headcorn Primary School and around Ulcombe Road (moat Road was not included as the IUD model demonstrated flooding from the found system was not caused by surface water inundation and therefore beyond the scope of the SWMP)
- The Station Road/ Burgens area
- The River Sherway catchment at The Chantry

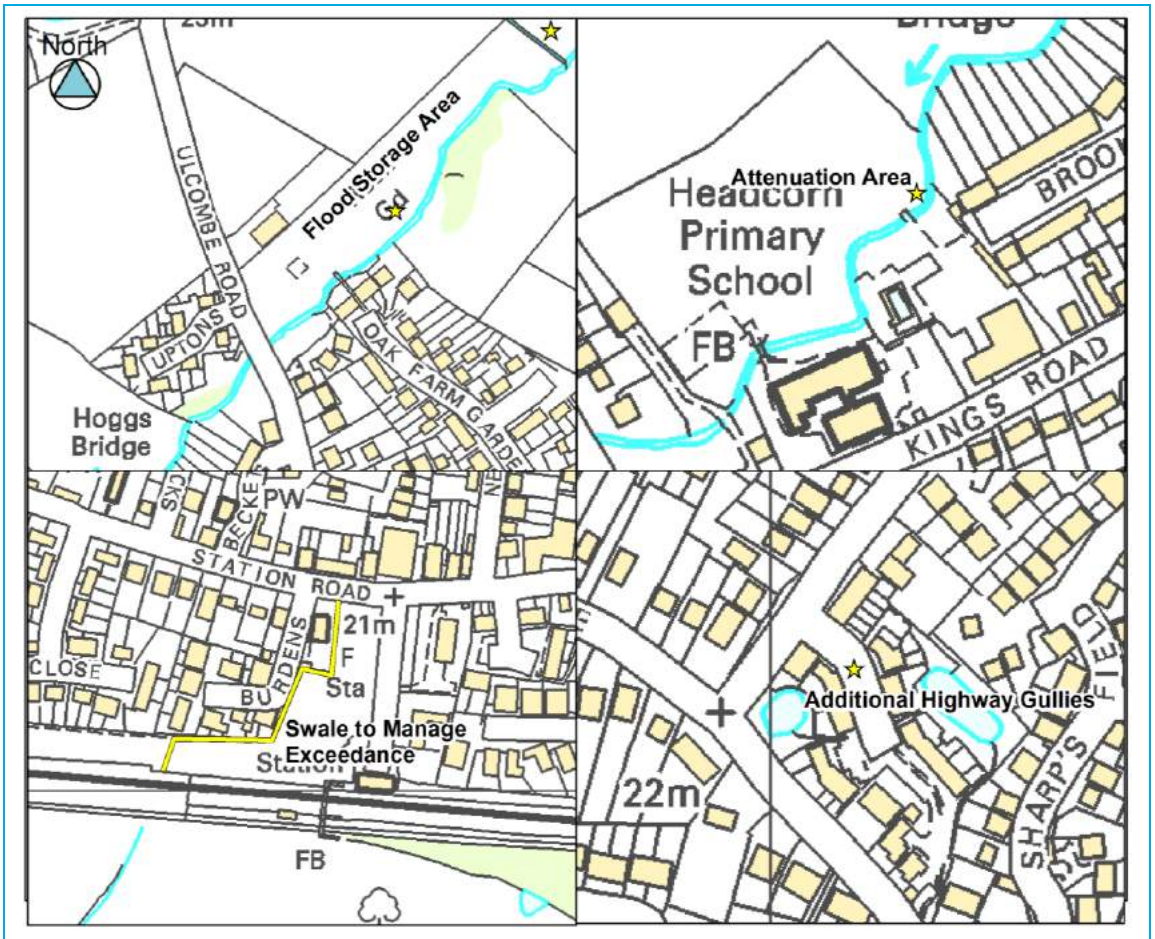
5.2.3 Short list of options

The short listed options have been summarised in and displayed in Table 5-1.

Table 5-1: Shortlisted options for Headcorn

Hotspot	Option	Purpose
The School Stream (upstream of Ulcombe Road and Headcorn Primary School)	Flood storage area	Store exceedance flows, preventing flooding of downstream receptors
The School Stream at Headcorn Primary School	Attenuation area	Store exceedance flows, preventing flooding of school buildings
The Burdens	Swale	Channel surface water runoff from Station Road around receptors and connect to existing railway culvert.
The Chantry	Highway gullies	Provide more drainage from the surface to the underlying surface water sewer.

Figure 5-1: Plan of shortlisted options for Headcorn



The options were then tested and refined in the hydraulic model. The performance of each model was tested against the baseline model.

5.2.4 Results

The attenuation area at the recreation ground was effective as it held fluvial flows upstream of Ulcombe Road and reduced the fluvial flood extent at Uptons, behind Brooklands, at the School site. However, as the baseline IUD model results predicted a low risk to properties, the predicted flood damages in this area were relatively low. In addition, the damages predominately occurred as a result of local surface water ponding, rather than fluvial flooding. As a result, the flood storage area does not result in substantial reduction of damages predicted by the model. Therefore, the costs of construction far outweigh the flood alleviation benefits at a ratio of 330:1. Therefore this option is not cost beneficial and would not be able to access funding via traditional Flood Grant in Aid[7] mechanisms.

The swale to manage exceedance at the Burdens was an effective measure to channel exceedance from Station Road. However, it did not prevent localised pluvial ponding which is predicted at topographic depressions within the Burdens. In reality, the private drainage may manage this surface water flood risk, but this level of detail has not been included in the model. As damages were predicted in both the baseline and the option model, the damages where not sufficiently reduced to outweigh the cost of a scheme. The scheme was estimated to cost five times greater than the predicted flood risk benefits. Delivery of this option would have to include co-operation from the neighbouring land owner (train station car park) and may include some land take. Therefore, this option may not be practical. In the Station Road/ Burdens area a more appropriate intervention is the maintenance of existing assets as it has been identified that the railway culvert was partially blocked and most of the properties drain to private soakaways. However, as the swale is an effective option, it should not be discounted if surface water flooding continues to be an issue here after all assets are operating at full capacity.

On the Chantry, local surface water inundation of highways is predicted but the IUD model results suggest there is available capacity in the urban drainage system (highway drains and Southern Water surface water sewerage). Therefore, an option was test with an increased number of highway gullies to permit better connectivity. The model results showed that the increased drainage did reduce the maximum extent of highway flooding in the Chantry. However, direct damages to highways as a result of surface water flooding are expected to be low, especially as this type of flooding is short duration. As a result, highways are not a receptor included in the damage calculation which only included buildings. Therefore, the costs of his scheme outweigh the benefits at a ratio of 2:1. Therefore, this option is not cost effective. It is noted that there are two ponds within The Chantry and Sharp's Field development. It is understood that local surface water drainage is discharged to these ponds but this is not shown on any asset maps. A sensible next step for the Chantry is mapping of the drainage assets, to allow for an improved model representation.

As none of the cost benefit ratios were sufficiently strong, it is not recommended that any options tested are progressed to design stage at this time. However, opportunities to improve local resilience have also been explored. KCC have agreed to support Headcorn Parish Council (HPC) with the siting and installation of weather gauge in the School Stream catchment. This gauge will record rainfall rather than fluvial flows but is intended to give early warning of a flash flooding event. The device should include telemetry to provide HPC with automatic notifications of heavy rainfall which could lead to flooding. This will enable the communities at risk to be prepared including where applicable, fitting Property Level Protection.

[7] https://www.gov.uk/government/collections/flood-and-coastal-defence-funding-for-risk-management-authorities

6 SWMP Action Plan

6.1 Introduction

The SWMP identified a range of recommended actions for the reduction of flood risk across the Headcorn 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 relevant generic actions agreed at Stage 1 and identifies new actions for the study area identified by this SWMP.

6.2 Generic Action Plan

Some of the actions derived during this SWMP are applicable to the whole SWMP area of Headcorn. Actions to mitigate these issues are listed in the generic action plan.

Table 6-1: Generic action plan for Headcorn

Reference	Action	Action owner	Priority
GAP01	*Maintain the partnership* The ongoing partnership will discuss the implementation of the proposed actions, review opportunities for operational efficiency and to review any legislative changes.	All	High
GAP02	*Sustainable development* It is recommended that the planning authority incorporate the findings of this SWMP, thereby raise issues to developers through its local plan to allow for pre-emptive flood risk reduction during the planning process. For example, capacity of the foul drainage system is particularly important in Headcorn and should be considered at planning stage. In addition, the majority of properties in Headcorn are suspected to drain to soakaway. Due to the impermeable geology and high water table, it is likely that soakage would be significantly impeded and therefore soakaways are not appropriate. Future development should not necessarily follow this precedent and utilise local soakage testing to ensure infiltration is an affective technique at the site.	MBC, SW and HPC	High
GAP03	*Asset maintenance* Optimise the routine asset inspection and maintenance to prevent flooding occurring as a result of malfunctioning highway drainage or sewerage.	Network Rail/ KCC highways/ Southern Water	High
CAP04	*Community resilience* KCC and the EA offer flood warden training and guidance on community resilience. Headcorn have one flood warden but there is an opportunity to train	HPC, EA KCC	High

Reference	Action	Action owner	Priority
	more wardens to share the responsibility or specialise in different areas within the parish.		

6.3 Location specific Action Plan

Table 6-2 describes the action plan for specific locations. The site specific action plan phases work, to provide a step by step guide for implementation. Some of the later actions will only be required if earlier actions do not resolve the flooding issue. Ongoing monitoring of flood incidents is essential to assess the impact of these actions.

Table 6-2: Site specific actions for Headcorn

Ref	Area of benefit	Problem	Action	Benefits	Action Owner	Supporter	Priority	Indicative Cost
HEAD 01	Moat Road	Foul sewer flooding regularly impacts roads and residential curtilage. Investigation has shown the sewer network is not at risk of SW or fluvial inundation	1. Undertake a Drainage Area Plan to quantify the risk and investigate options to alleviate risk. Include a survey to identify where surface water connections are made to foul drainage. 2. Consider options for rerouting connections to the pumping station. 3. Consider SuDS on Moat Road to convey surface water away from sewerage infrastructure	Water quality and public health	SW SW KCC	SW	High	High
HEAD 02	School Stream (Headcorn Primary School, Uptons, Mill Bank)	Flashy fluvial flooding from the School Stream, the discharge of which can be impeded by a high River Beult. Receptors include the school and residential properties.	1. Install a rain gauge in the catchment to provide warning of potentially high flows to residents 2. Improve resilience of the School and residential properties at risk using Property Level Protection 3. Develop an emergency response plan in the catchment to inform residents and install PLP	Improve preparedness and resilience of the community	HPC	KCC	High	Mid
HEAD 03	School Stream (Headcorn Primary School)	Flooding of the primary school occurred when the Mill Bank road bridge was partially blocked. Model testing has shown a number of properties would vulnerable to flooding if this structure is blocked.	1. Maintain full conveyance through regular asset inspection and clearance. HPC to alert EA if blockage occurs 2. If blockage remains an issue consider the installation of a debris screen	Maintain conveyance through bridge structure	EA	HPC	High	Mid

Ref	Area of benefit	Problem	Action	Benefits	Action Owner	Supporter	Priority	Indicative Cost
HEAD 04	Station Road	Surface water flooding impact the station car park and Station Road. There is also risk to properties. Flow eventually routes south through a railway culvert which has previously been blocked.	1. Improve drainage at the station car park – there may be a soakaway which requires cleansing 2. Consider managing exceedance in a ditch system along Burdens 3. Continue to maintain the railway culvert to maximize conveyance	Maximise existing drainage and divert flows away from vulnerable receptors	1. NR 2. KCC Highways 3. NR	KCC	Low	Low
HEAD 05	The Chantry	Surface water flows down Grigg Lane onto the Chantry towards Wheeler Street. An existing surface water drainage system including ponds is not well mapped.	1. Map surface water drainage assets to understand how the ponds interact. 2. Identify opportunities to store more surface water runoff in the existing ponds	Maximise existing drainage assets to manage surface water flood risk	KCC Highways	SW KCC	Low	Low

** Indicative Cost: Low = Up to 50k, Mid = 50-150k, High = 150-250k or 250+k*

EA: Environment Agency	*KCC: Kent County Council*	*KCC Highways: Kent County Council Highways*	*MBC: Maidstone Borough Council*	*HPC: Headcorn Parish Council*	*NR: Network Rail*	*SW: Southern Water*

6.4 Review timeframe and responsibilities

High priority actions identified in the 'Action Plan' are likely to be those addressed first. However, this report can only consider relative priorities within Headcorn. Some partner organisations, including the Environment Agency, 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 Headcorn will have to be assessed against actions in other areas. Kent County Council is currently undertaking SWMPs in a number of other settlements across the county and delivering existing Action Plans.

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.

6.5 Sources of funding

Funding for local flood risk management may come from a wide range of sources. In Headcorn these may include:

- Defra (Flood Defence Grant in Aid)
- Kent County Council (highways)
- Southern Water
- Industrial estate owners and businesses
- New developments (directly through the developer or through CIL)
- Local communities
- Maidstone District Council

6.6 Ongoing monitoring

The partnership arrangements established as part of the SWMP process should continue beyond the completion of the SWMP in order to discuss the implementation of the proposed actions, review opportunities for operational efficiency and to review any legislative changes.

The SWMP Action Plan should be reviewed and updated once every six years as a minimum, but there may be circumstances which might trigger a review and/or an update of the Action Plan in the interim, for example:

- Occurrence of a surface water flood event;
- Additional data or modelling becoming available, which may alter the understanding of risk within the study area;
- Outcome of investment decisions by partners is different to the preferred option, which may require a revision to 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, and as a minimum this should be as agreed in the Local Flood Risk Management Strategy for Kent, although individual partners may wish to review their actions more regularly.

Appendices

A Appendix A - Watercourse Map

B Appendix B - Patterns the Lead to Flooding

C Appendix C - FEH Calculation Record

D Appendix D - Model Operation Manual

E Appendix E - Model Results

F Appendix F - Cost Benefit Analysis

Offices at

Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Haywards Heath
Limerick
Newcastle upon Tyne
Newport
Saltaire
Skipton
Tadcaster
Thirsk
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