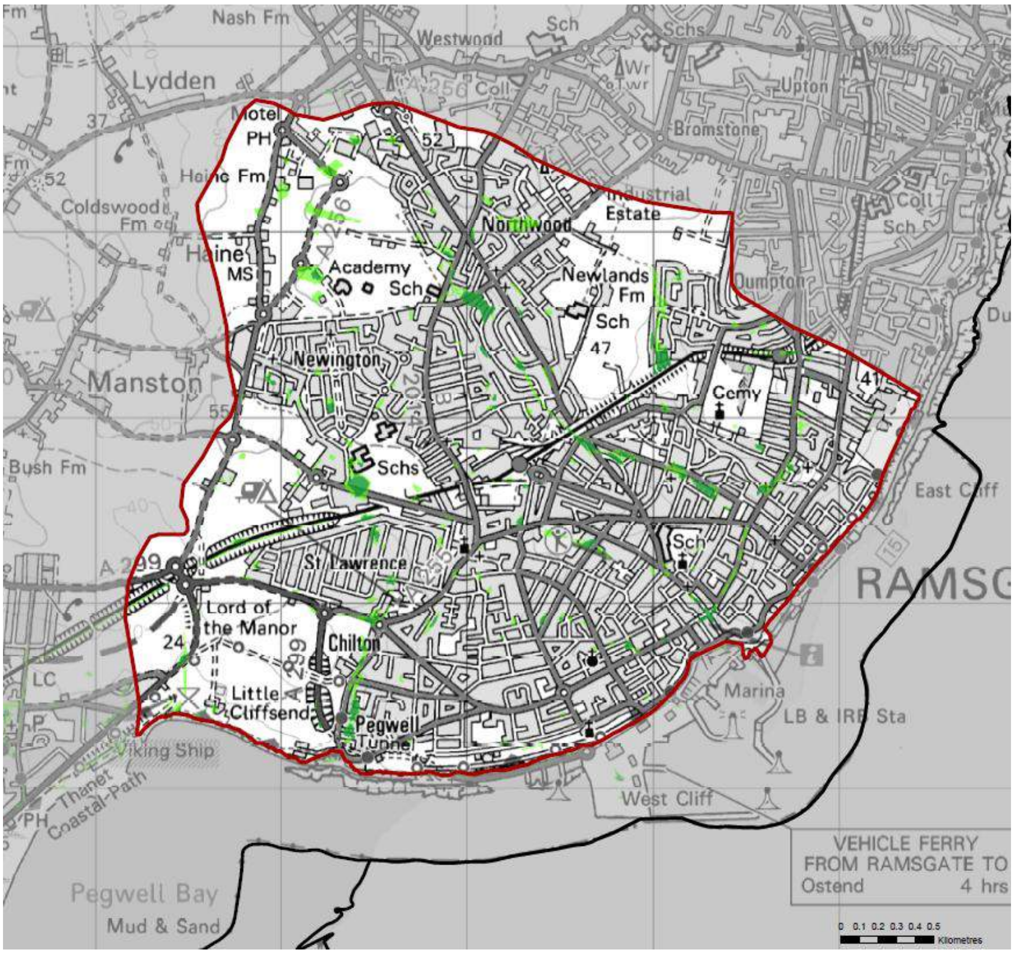
CAPITA

Ramsgate
Surface Water Management Plan
Stage 2



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RELATED DOCUMENTS

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	Kent Preliminary Flood Risk Assessment	Kent County Council	2011	-
	Thanet District Strategic Flood Risk Assessment	Entec	2009	03
	River Stour Catchment Flood Management Plan	Environment Agency	2008	-
	Thanet Stage 1 Surface Water Management Plan	JBA Consulting	2013	02

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Acknowledgements

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- Environment Agency
- Southern Water
- British Geological Survey
- Kent Highways
- Thanet District Council

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1 Introduction

Capita Property and infrastructure (Capita) has been commissioned by Kent County Council (KCC) to prepare a Surface Water Management Plan (SWMP) for the town of Ramsgate, within the Thanet District Council administrative area.

The Thanet Stage 1 Surface Water Management Plan (2013) undertaken on behalf of KCC highlighted surface water flood risk within Ramsgate and recommended production of a detailed SWMP for the town. The Thanet SWMP attributed previous surface water flooding incidents primarily to heavy rainfall and blocked or overloaded drains and gullies. Combined sewage surcharge has been identified as a particular issue at Ramsgate Harbour.

As it has previously been identified that the Ramsgate area is susceptible to surface water flooding, this SWMP will provide a basis for more effective management of surface water and surface water flood risk. This SWMP for Ramsgate has been commissioned to confirm any significant local flood risks and what further work may be required in the future.

1.1 What is a Surface Water Management Plan?

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

This SWMP study has been commissioned by KCC, the Lead Local Flood Authority (LLFA, in partnership with key local stakeholders responsible for surface water management and drainage in the Ramsgate area including Thanet District Council, (TDC), Southern Water (SW) and the Environment Agency (EA).

The purpose of a SWMP is to identify what the local flood risk issues are, what damage may be caused, what options there may be to prevent them and who should take these options forward. This is presented in an action plan which lists the partners who are responsible for taking the various options forward. The action plan, which will be reviewed periodically, is agreed by all project partners to tackle the flood risks that are identified.

1.2 Objectives

The objectives of the SWMP are to:

- Develop a thorough understanding of surface water flood risk in and around the study area, taking into account the implications of climate change, population and demographic change and increasing urbanisation in and around Ramsgate town
- Identify, define and prioritise Opportunity Areas, including further definition of existing local flood risk zones and mapping new areas of potential flood risk
- Make recommendations for holistic and integrated management of surface water management which improve emergency and land use planning, and support better flood risk and drainage infrastructure investments
- Establish and consolidate partnerships between key stakeholders to facilitate a collaborative culture, promoting openness and sharing of data, skills, resource and learning, and encouraging improved coordination and collaborative working
- Engage with stakeholders to raise awareness of surface water flooding, identify flood risks and assets, and agree mitigation measures and actions
- Deliver outputs to enable practical improvements or change where partners and stakeholders take ownership of their flood risk and commit to delivering and maintaining the recommended measures and actions

1.3 Study Area

The study area comprises the town of Ramsgate in Thanet District within Kent County. Thanet District Council (TDC) is a second tier local authority and KCC is the upper tier local authority responsible for delivering the LLFA requirements of the FWMA in the Ramsgate area.

Ramsgate covers an area of 12.13km^2 and is located on the coast of the north-eastern tip of Kent County. Ramsgate is made up of a shallow valley between hills with peaks of 50-60mAOD. Two chalk cliffs, East Cliff and West Cliff, comprise the shoreline in the area, with regions of sandy beach. The Royal Harbour Marina is prominent in the region and lies between East Cliff and West Cliff. There are no watercourses in the study area.

The spatial extent of the study area within this SWMP is focussed on the urban areas of Ramsgate and is approximately 9.5 km^2. The study area is shown in Figure 1-1. Figure 1-2 provides an overview of the land uses within the study area.

The study area falls within the River Stour catchment; however the River Stour and its tributaries lie outside of the study area and the River Stour discharges to the English Channel south west of Ramsgate. No watercourses were identified in the study area.

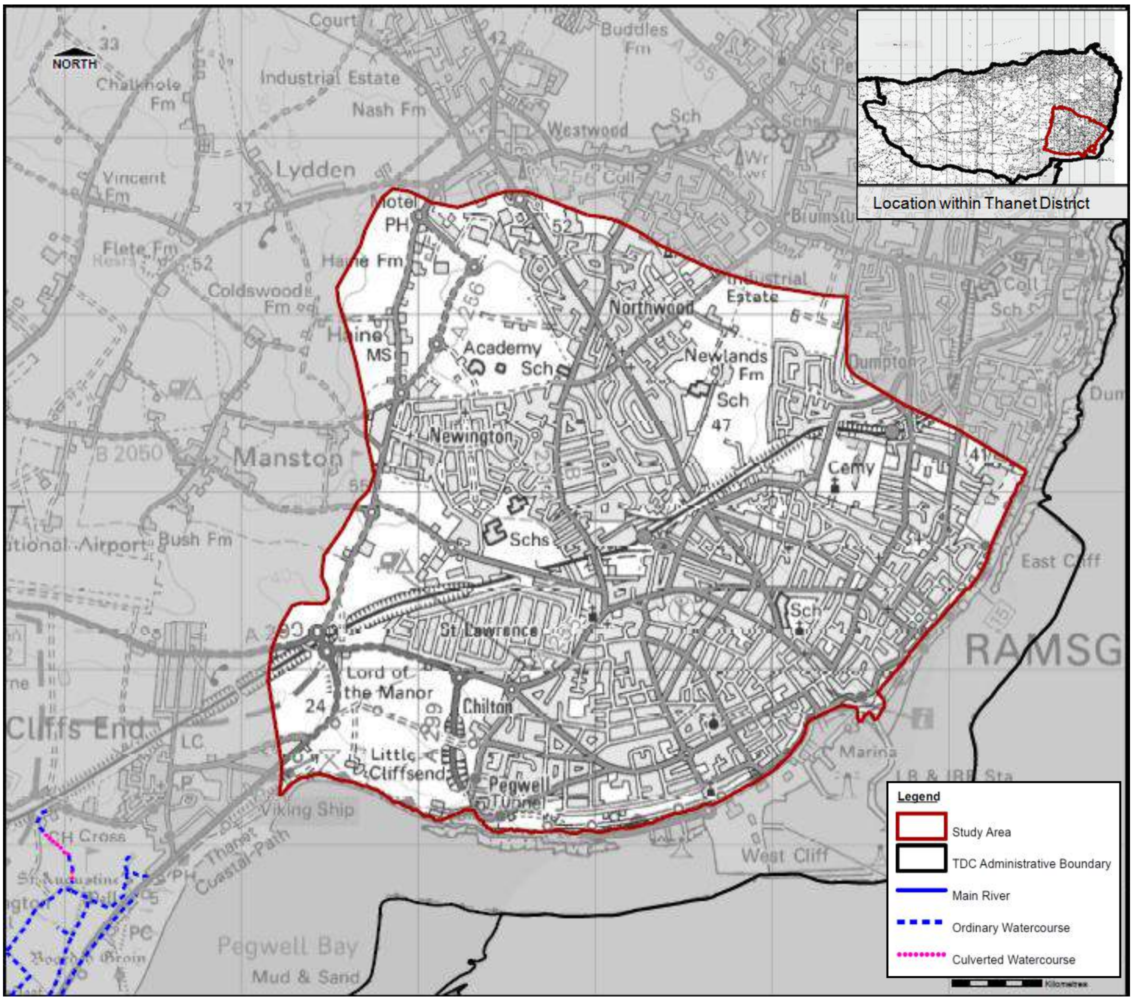


Figure 1-1 Ramsgate Study Area

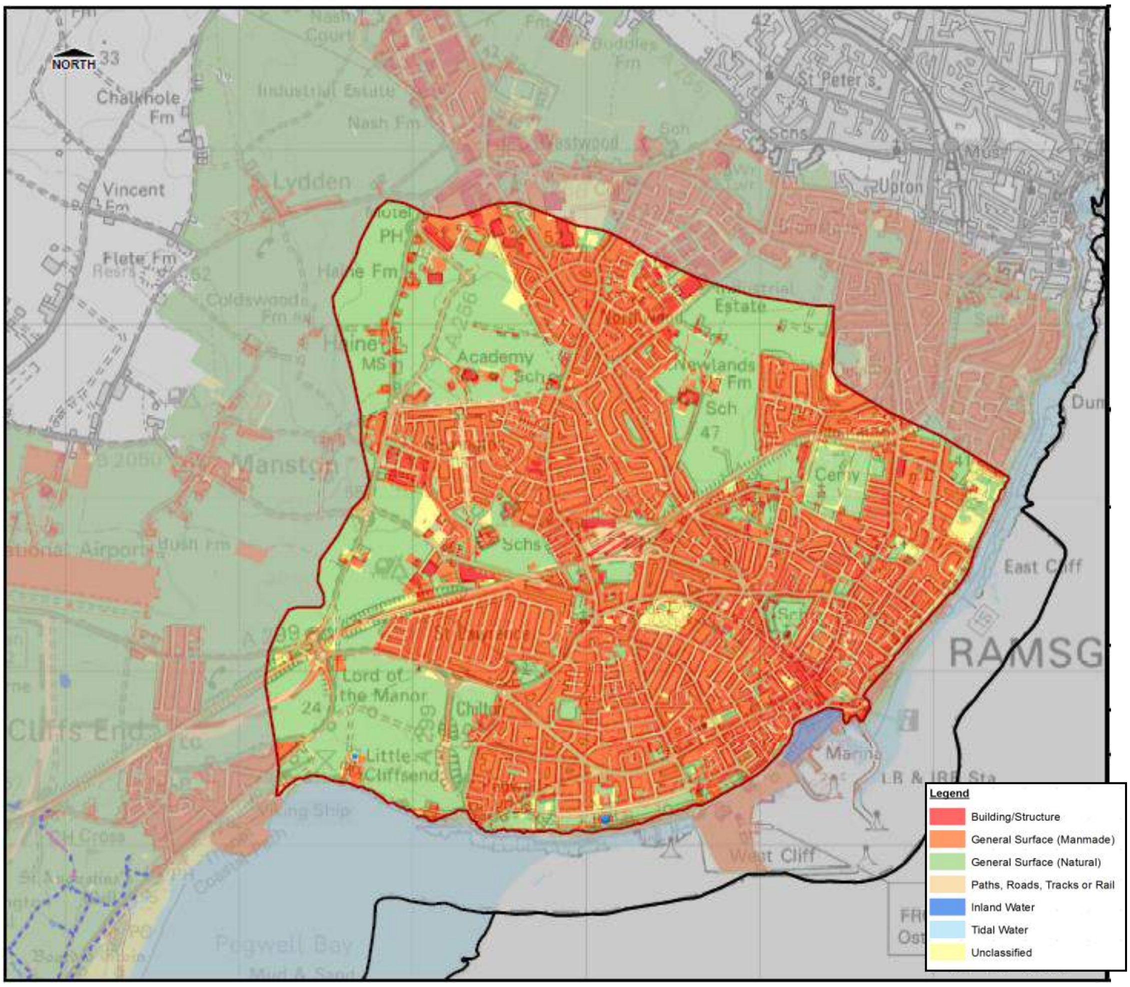


Figure 1-2 Land Uses within Ramsgate

Figure 1-3 identifies the general topography of the study area. This figure highlights that the topography of the Ramsgate town catchment varies between areas of high ground (50mAOD – 60mAOD) located inland in the north of the town down to sea level along the coast. The coastline is made up of two chalk cliffs, East Cliff and West Cliff, separated by a shallow valley which originates in the north of the town.

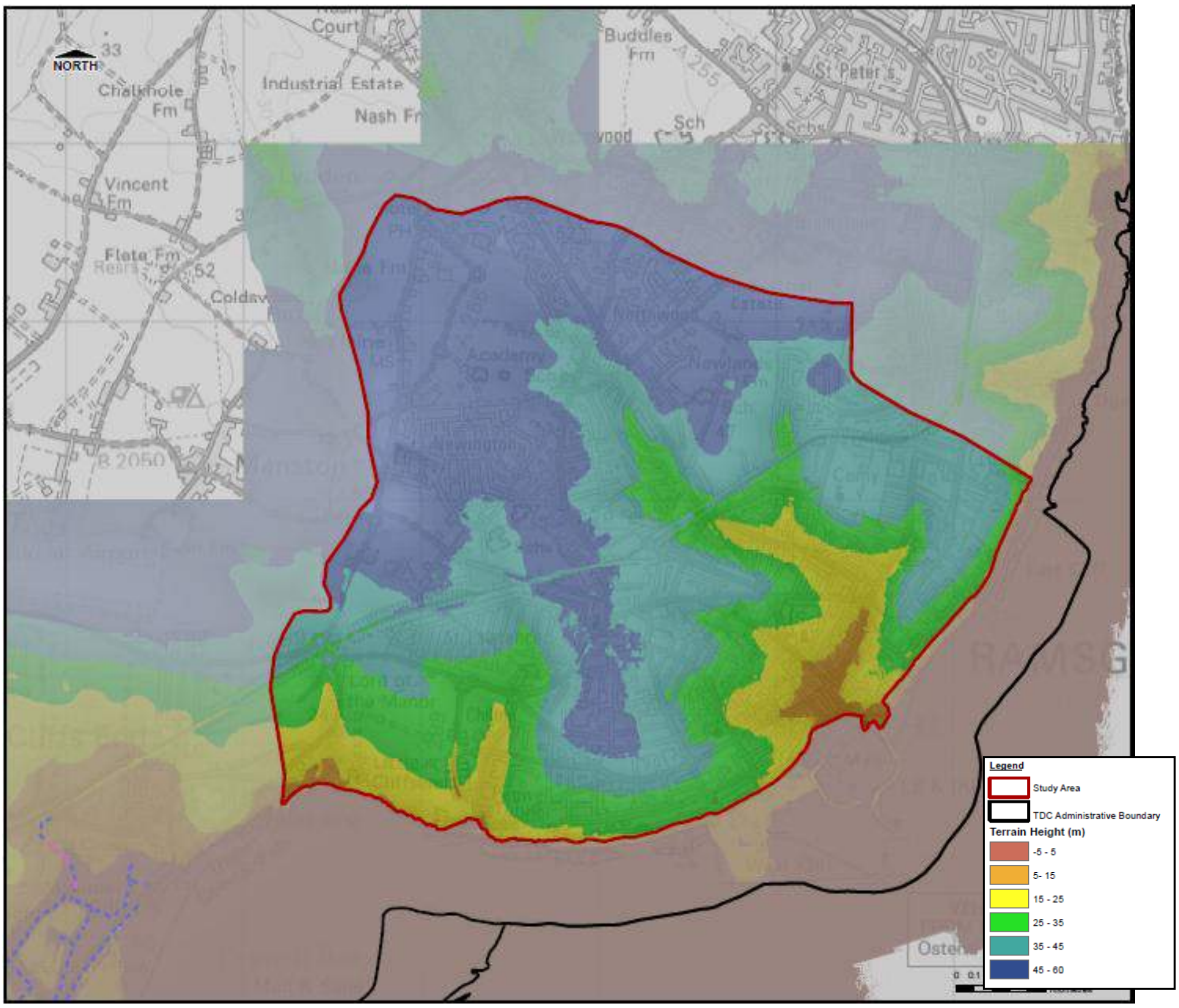


Figure 1-3 DTM Representation of the Topography within Ramsgate

The geology of Ramsgate is illustrated in Figure 1-4 overleaf. The solid geology of the area is dominated by Margate Chalk, with smaller regions of Seaford Chalk, Lewes Nodular Chalk and Newhaven Chalk along the coast. There are regions of Thanet Sand Formation in the upper reaches of the study area. The bedrock is overlain by superficial deposits of Head (clay and silt) in the topographic highs, as well as in the topographic lows of historic watercourse valleys. There are beach, tidal and storm beach deposits along the shoreline.

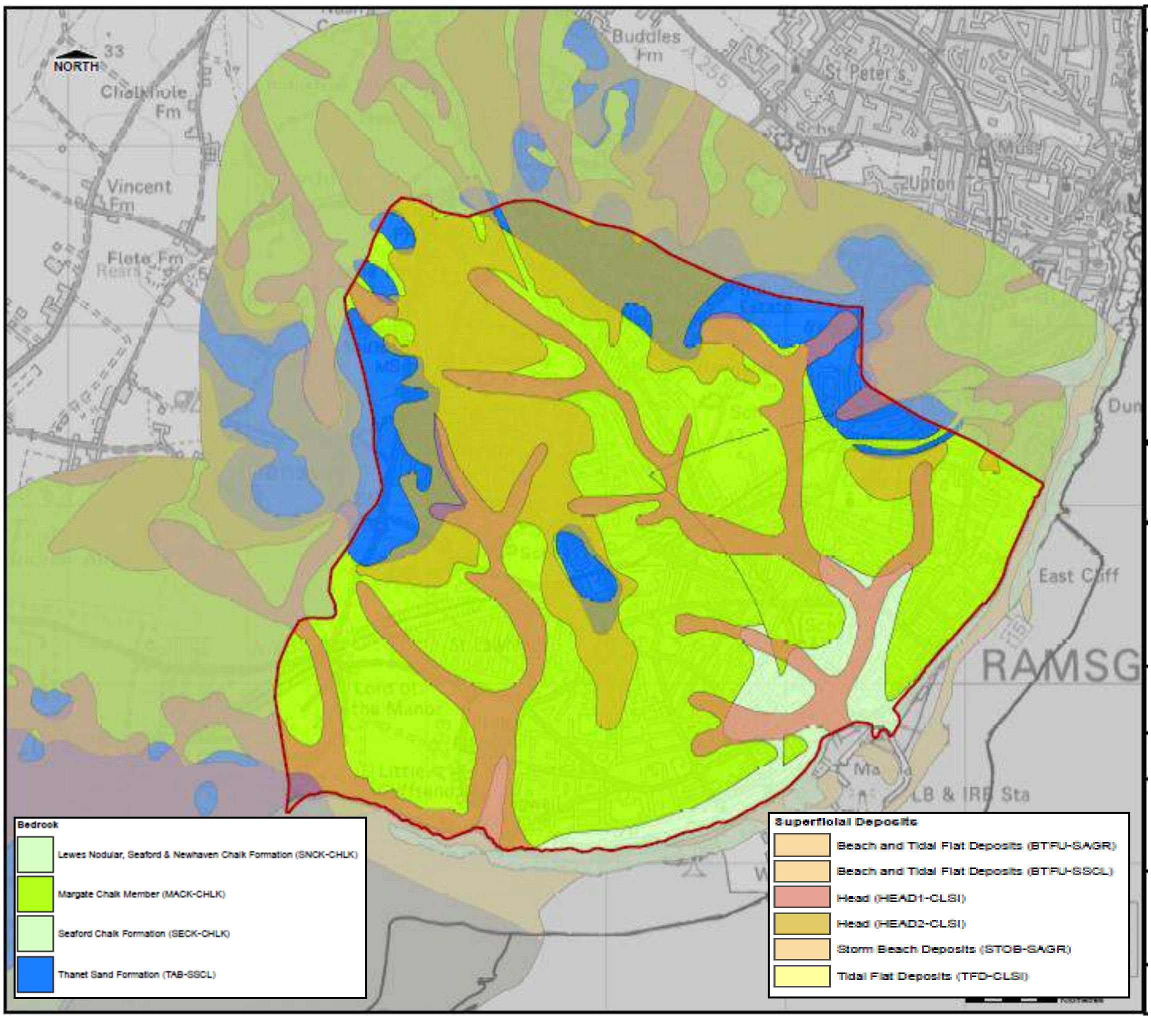


Figure 1-4 Geology of Ramsgate

1.4 Key Stakeholders

In order to provide an integrated approach to surface water management key stakeholders illustrated in Figure 1-5 have been engaged throughout this study. These groups have been consulted throughout the SWMP process and have provided key input at a number of stages of the study.

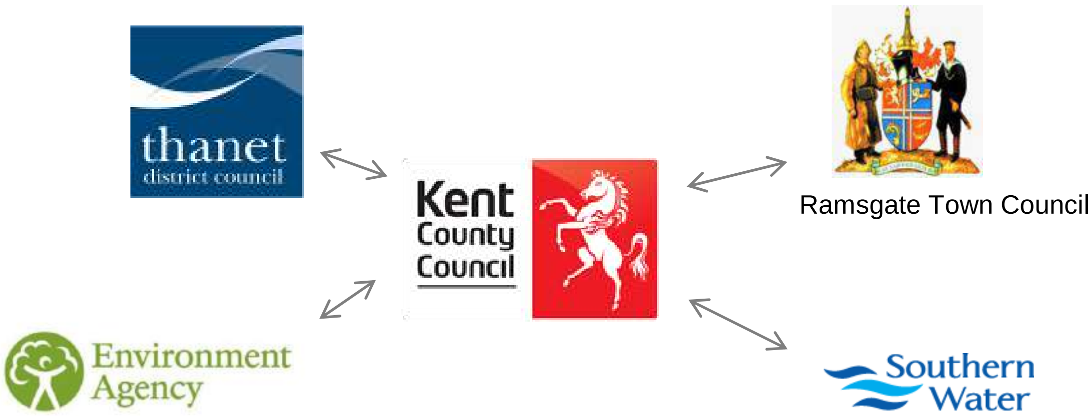


Figure 1-5 Key stakeholders engaged in the SWMP process

1.5 Significant Future Development Plans

Thanet District Council is currently producing a new Local Plan. The plan will set out how and where homes, jobs, community facilities, shops and infrastructure will be delivered and the type of places and environments TDC wants to create. It will also identify land to be protected from development, such as open space. The new Local plan will replace the Saved Policies from the 2006 Local Plan, and will remain in place until 2031.

Public consultation on the Draft Thanet Local Plan was completed in February 2015. A review of the consultation is currently being undertaken (April 2015) with the intention of a revised plan being ready for pre-submission consultation in September 2015. Along with other studies, the SWMP will form part of the Local Plan evidence base, to inform and guide the development of the Local Plan.

1.6 Links with Other Studies

It is important that the SWMP is not viewed as an isolated document, but one that connects with other strategic and local plans. It is also important that it fits in with other studies and plans and does not duplicate existing work. The following studies are relevant to Ramsgate:

- The South East England Regional Flood Risk Appraisal (2008)
- River Stour Catchment Flood Management Plan (2008) and Summary Report (2009)
- Thanet District Level 1 Strategic Flood Risk Assessment (2009)
- Kent Preliminary Flood Risk Assessment (2010)
- Isle of Grain to South Foreland Shoreline Management Plan (2010)
- National Flood and Coastal Erosion Risk Management Strategy (2011)
- Local Development Documents, including the Core Strategy
- Kent Local Flood Risk Management Strategy (2013)

2 Preparation

2.1 Data Collection

Data was collected from each of the following organisations:

- Thanet District Council
- British Geological Survey
- Environment Agency
- Kent County Council
- Southern Water
- Kent Highways

Appendix E provides a summary of the data sources obtained from the organisations listed above, provides a description of each dataset and how the data was used in preparing the SWMP. Key datasets are summarised in the next section.

2.2 Data Review

2.2.1 Historic Records of Local Flooding

The most significant data gap across the study area relates to records of past 'local' flooding incidents. This is a common issue across the UK as record keeping of past floods has historically focussed on flooding from rivers or the sea or has incorrectly attributed flooding to these sources. Records of past incidents of surface water, sewer, groundwater or ordinary watercourse flooding have been sporadic. KCC and TDC have provided all available historic records that were accessible at the time of request. Where possible, these have been digitised into GIS from, however there is very little information on the probability, hazard or consequence of flooding.

Southern Water has provided postcode linked data on records of sewer flooding (known as the DG5 register – Post Code Centroid). However, more detailed data on the location and cause of sewer flooding is not currently available.

2.2.2 Groundwater Records

Groundwater flooding is dependent on local variations in topography, geology and soils. The causes of groundwater flooding are generally understood; however it is difficult to predict the actual location, timing and extent of groundwater flooding without comprehensive datasets.

There is a lack of reliable measured datasets to undertake flood frequency analysis and even with datasets, this analysis is complicated due to the non-independence of groundwater level data. Surface water flooding incidents are sometimes mistaken for groundwater flooding incidents, such as where runoff via infiltration seeps from an embankment, rather than locally high groundwater levels.

2.2.3 Flooding Consequences

The National Receptors Database (NRD), version NRD 2011, data set was provided by the EA to allow property counts to be undertaken for this SWMP.

2.2.4 Topographic / Elevation Data

EA LiDAR information at 1m resolution provides good elevation data coverage of the entire catchment.

2.2.5 Sewer Network

Southern Water provided a sewer network model in Infoworks CS covering Ramsgate, which is part of the Weatherlees Wastewater Treatment Works sewer network. This included details of the infrastructure network including sewers, manholes, pumping stations and attenuation tanks. A review of this information indicated that the sewer network in Ramsgate is primarily combined.

Southern Water also provided post code-linked data (DG5 register) on records of sewer flooding up to October 2013 (data request was made in October 2013).

2.2.6 Highway gullies

Kent County Council provided the locations of highway gullies in Ramsgate. Gullies in Ramsgate were found to be fairly evenly distributed across the drainage network, with an average of four gullies per manhole, and have been represented accordingly in the model.

3 Flooding

3.1 Flooding mechanisms

The following sources of flooding are assessed and discussed in detail in the following sections of this report:

- Pluvial or surface water flooding: 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 a watercourse.
- Flooding from ordinary watercourses: flooding which occurs as a result of the capacity of the watercourse being exceeded resulting in out of bank flow (water coming back out of rivers and streams).
- Sewer flooding: Flooding which occurs when the capacity of the underground drainage system is exceeded, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters as a result of wet weather conditions.
- Flooding from groundwater sources: Occurs when the water level within the groundwater aquifer rises to the surface.

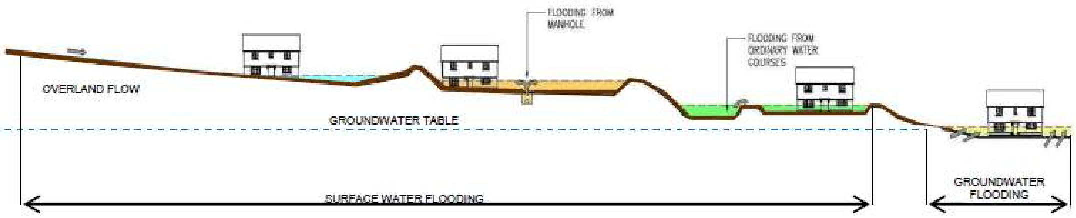


Figure 3-1 Illustration of Flood Sources[1]

The identification of areas at risk of flooding has been dominated by the assessment of pluvial flooding as these sources are expected to result in the greatest consequence (risk to life and damage to property), as well as by the quality of the information available for informing the assessment.

3.2 Historical Flooding

Past records of surface water flooding within the study area have been provided by various stakeholders. A breakdown of the incident data provided for the SWMP can be located within Appendix F, Figure 7.

Figure 3-2 overleaf, provides a graphical summary of key historical events. A review of this data indicates that a majority of these recorded incidents occur within the town centre and harbour areas. Causes of flooding appear to be the obstruction of natural flow patterns (predominantly by roads and properties) and drainage assets being compromised by debris and/or at capacity. Some of the areas that have experienced historical flooding are located within the corridors of 'lost' watercourses (that can be reactivated during a significant storm event). There are also areas of flooding caused by localised topographic low areas.

Recorded flood data has also been used to verify areas which are identified as being at risk of flooding with previous known flood events, and to highlight any areas that may not have been picked up in previous studies.

[1] Adapted from Thatcham Surface Water Management Plan Volume One

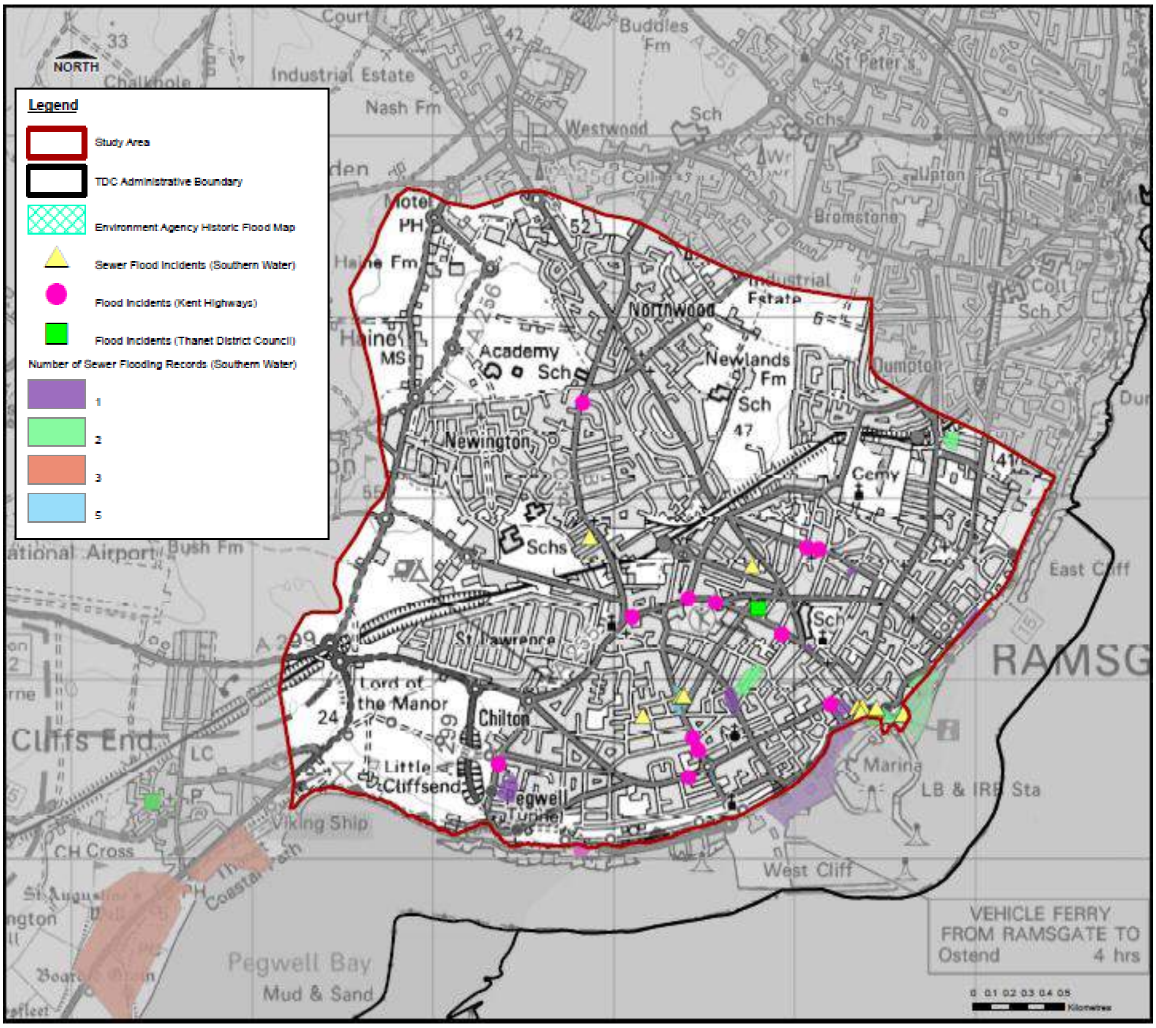


Figure 3-2 Historical Flood Events within Ramsgate

3.3 Flood risk assessment methodology

3.3.1 Surface water and sewer flooding

In an area drained by sewers, surface water flooding and sewer flooding need to be assessed together as they affect each other. Surface water flows into the sewers and sewers may surcharge to cause flooding or exacerbate surface water flooding. Water collected from roofs and paved areas is directed into the sewers in Ramsgate.

Different authorities are responsible for parts of the drainage network. Kent County Council, as the Highways Authority, is responsible for maintaining the highway drainage system including kerbs, road gullies and the pipes which connect the gullies to the sewers and soakaways. The sewerage undertaker, in this case Southern Water, is responsible for maintaining the sewers. Figure 3-4 shows a representation of the different ownership of surface water drainage features on a highway.

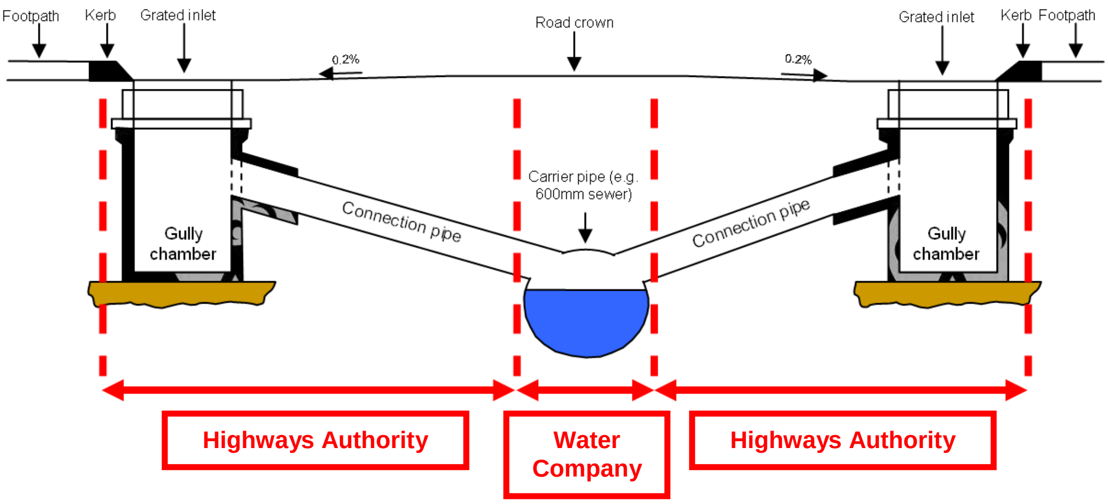


Figure 3-3 Representation of surface water sewer responsibility

These features along with roofs have been represented in the assessment of surface water and sewer flooding.

Model build

Detailed hydraulic modelling has been undertaken for a range of rainfall event probabilities in order to further understand the causes and consequences of surface water flooding. The purpose of this modelling is to provide additional information where local knowledge is lacking and forms a basis for future detailed assessments in areas identified as high risk. The hydraulic model includes a representation of the ground surface and the sewer network that surface water can flow into. The sewer network can become surcharged which can cause flooding and prevent surface water from being carried away.

The Weatherlees InfoWorks CS model was utilised to represent the drainage network in Ramsgate. The CS model was trimmed to remove the areas of the model that extend to Deal and Sandwich as these are outside of the area of interest.

Gullies have been represented in the model. Gully type in the model was determined based on a site inspection in which average dimensions and grate type at various locations across the town were observed. This data was used to specify a depth-discharge relationship for water into the network, better representing the exchange of water between the floodplain and the drainage network.

Appendix D provides a full methodology of the hydraulic modelling undertaken, including details of model parameters, hydrology and modelling assumptions.

Flooding simulation

This model was used to simulate the effect of rainfall on Ramsgate. The selected rainfall event return periods were chosen through consultation with KCC. Table 3-1 provides details of the return periods that have been selected and the suggested uses of the various modelling outputs.

Table 3-1: Selected return periods and suggested use of outputs

Modelled Return Period	Suggested Use
1 in 20 year event *(5% AEP)*	Southern Water utilised the 1 in 20 year to identify properties that might be at risk of flooding. The identification of flooding from this scenario is also required for populating the Flood and Coastal Risk Management Grant in Aid (FCRM GiA) funding applications as it assists with highlighting area at a very significant risk of flooding.
1 in 40 year event *(2.5% AEP)*	Assists in determining the benefit of flood risk management options should FCRM GiA funding be sought.
1 in 100 year event *(1% AEP)*	Can be overlaid with Environment Agency Flood Zone 3 layer to show areas at risk under the same return period event from surface water and main river flooding. Can be used to advise planning teams – please note that the pluvial 1 in 100 year event may differ from the fluvial event due to methods in runoff and routing calculations.
1 in 200 year event *(0.5% AEP)*	To be used by emergency planning teams when formulating emergency evacuation plans from areas at risk of flooding. The new NaFRA banding indicates that this event is also required by Cabinet Office policy for determining the risk and resilience of critical infrastructure.

As part of this study, maps of maximum water depth and hazard for each of the return periods above have been prepared and are presented in Appendix F of this report. When viewing the maps, it is important that the limitations of the modelling are considered – refer to key assumptions and uncertainties discussed later in this report.

The figures presented in Appendix F indicate that water is predicted to pond over a number of roads and residential properties. These generally occur at low points in the topography or where water is confined behind an obstruction or embankment. Some of the records of surface water flooding shown in Figure 3-2 have been used to verify the modelling results. Discussions with Council staff have also provided anecdotal support for several of the locations identified as being susceptible to flooding. The results of the assessment have been used to identify Opportunity Areas (OAs) across the study area.

Uncertainty in flood risk assessment

The surface water modelling provides the most detailed information to date on the mechanisms, extent and hazard which may result from high intensity rainfall across the study area. However, there are limitations and uncertainties in the assessment approach of which the reader should be aware.

There is a lack of reliable measured datasets and the estimation of the return period (probability) for flood events is therefore difficult to verify. The broad scale mapping provides an initial guide to areas that may be at risk; however there are a number of limitations to using the information:

- The mapping should not be used in a scale to identify individual properties at risk of surface water flooding. It can only be used as a general indication of areas potentially at risk.
- Whilst modelled rainfall input has been modified to reflect the possible impacts of climate change it should be acknowledged that this type of flooding scenario is uncertain and likely to be very site specific. More intense short duration rainfall and higher volume more prolonged winter rainfall are likely to exacerbate flooding in the future.

Comparison of modelling with flood history and local knowledge

Recorded flood history has also been used to verify areas which are identified as being at risk of flooding with previous known flood events. As discussed in Section 3.2, information on historical flood events was collected from a number of sources.

The use of a direct consultation with Southern Water and Council officers was also an effective way to validate the model outputs. Officers were invited to examine the modelling outputs and were able to provide anecdotal information on past flooding which confirmed several of the predicted areas of ponding from the model outputs, for example the Chilton/Pegwell area and the Ramsgate Town Centre.

3.3.2 Groundwater

Groundwater flooding assessment

No historical groundwater flooding records were highlighted within the data provided for this assessment. However, the majority of the study area is underlain by Chalk bedrock and thereby has the potential to store groundwater, which can rise and cause flooding problems in subsurface structures or at the ground surface under some circumstances.

Figure 3-4 shows the Environment Agency Areas Susceptible to Groundwater Flooding Map (EA, 2012). The map uses underlying geological information to infer groundwater flood susceptibility over an area of $1km^2$. Table 3-2 summarises the content of the map, and how it was used within the risk assessment.

Table 3-2: Review of Available Groundwater Information

Source	Summary	Risk Assessment Application
EA Areas Susceptible to Groundwater Flooding (AStGWF) Map	This data has used the top two susceptibility bands of the British Geological Society (BGS) 1:50,000 Groundwater Flood Susceptibility Map. It shows the proportion of each 1km grid square where geological and hydrogeological conditions show that groundwater might emerge.	This provides an overview of proportional area that is at high or very high risk of groundwater flooding. The categories are as follows: <25% (low) ≥25%<50%(moderate) ≥ 50% <75% (high) ≤75% (very high)

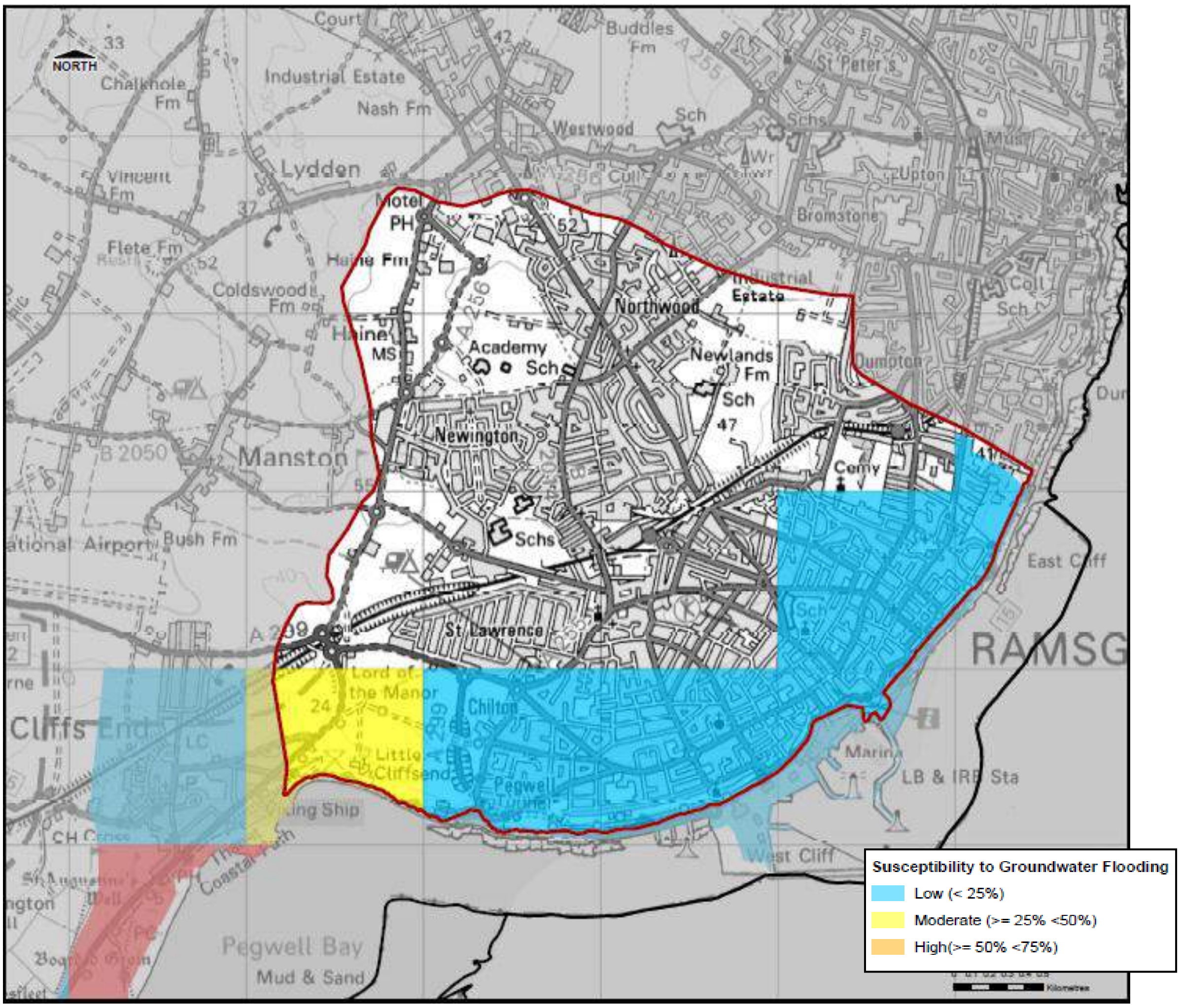


Figure 3-4 Environment Agency Areas Susceptible to Groundwater Flooding

It should be noted that this assessment is broad scale and does not provide a detailed analysis of groundwater; it only aims to provide an indication of where more detailed consideration of the risks may be required. If more detailed data relating to the risk of groundwater flooding is required, it is recommended that the reader contact the British Geological Society in order to obtain the Groundwater Flooding Susceptibility Maps.

Infiltration potential

The use of infiltrating SuDS is particularly effective in regions of Chalk bedrock due to its high porosity. Figure 3-5 highlights the location of the Environment Agency source protection zones (SPZs) within Ramsgate. These zones delineate regions in which there is a risk of groundwater contamination from activities which might cause pollution in the area. Zone 1 is the region of highest risk and Zone 3 the lowest. Source protection zones are used by the Environment Agency to set up pollution prevention measures in areas which are at a higher risk, including restrictions on certain activities. The source protection zones in the Ramsgate study area must be taken into account when considering infiltration SuDS options.

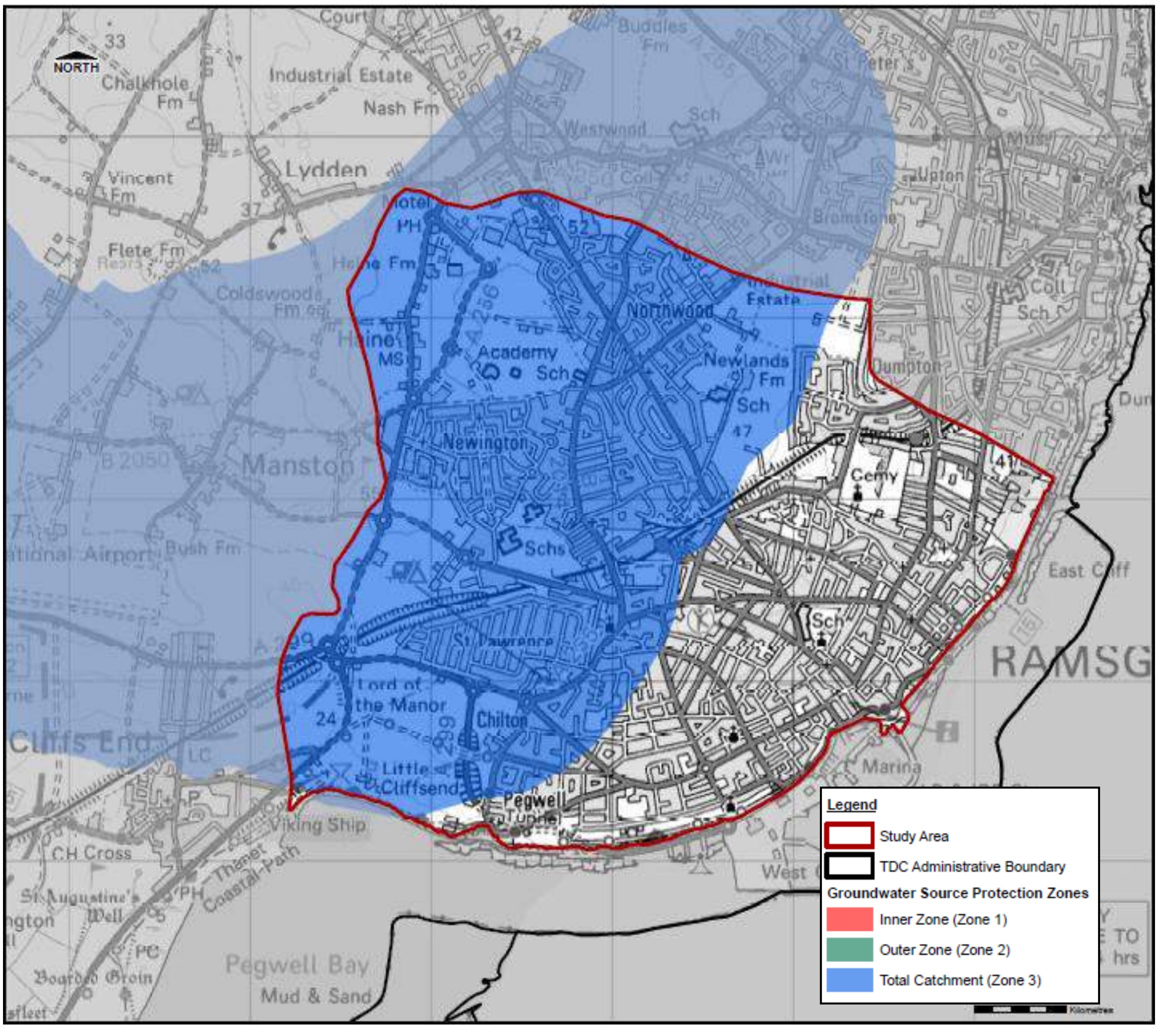


Figure 3-5 Environment Agency Groundwater Source Protection Zones

3.3.3 Ordinary Watercourse and Main River Fluvial Flooding

The Environment Agency Detailed River Network (DRN) indicates that there are no ordinary watercourses or Main Rivers in the study area. There are no known recorded incidents of ordinary watercourse flooding within the historical data provided. Based on this data, Ramsgate has been assessed to be at low risk of ordinary watercourse flooding.

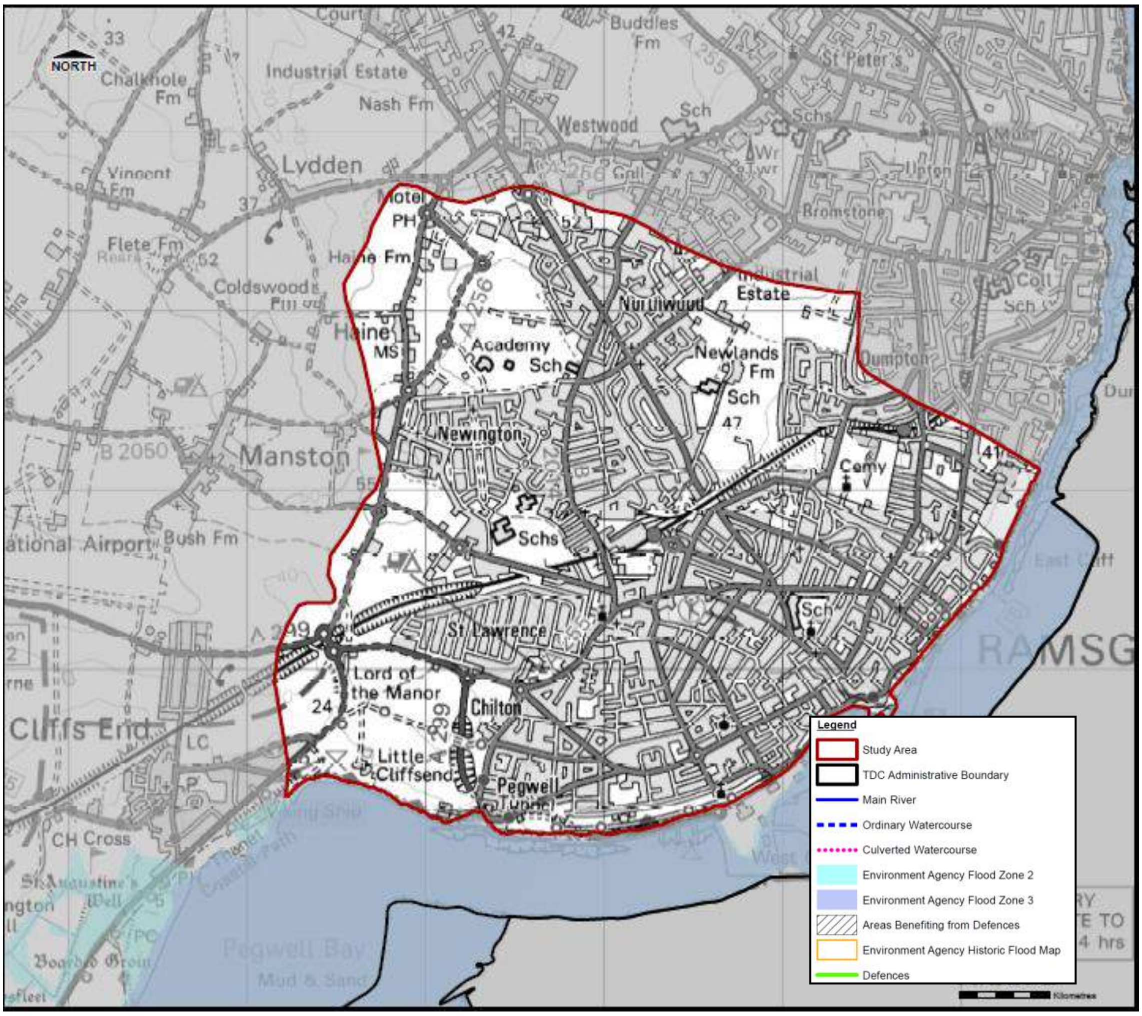


Figure 3-6 Flood Zones and Defence Locations within Ramsgate

4 Flood Risk

4.1 Flood Risk Summary

The results of the risk assessment, combined with site visits and a detailed review of existing data and historical flood records, indicate that there is a low risk of ordinary watercourse and groundwater flooding in Ramsgate. The risk assessment indicated a moderate to high risk to Ramsgate from surface water and sewer flooding[2] – particularly as rainfall intensities increase with climate change. The results indicate that the flood risk is widely dispersed across the study area with areas at low elevations and/or adjacent to obstructions to flow (raised road, rail embankments etc) being at the greatest risk. Urban areas within historic watercourse flow paths are also a risk, as the hydraulic model highlights the predicted flow paths which still convey runoff when reactivated.

In general, flooding across the study area is low to moderate in the lower order rainfall events (such as the modelled 1 in 20 year event) and is predicted to experience greater levels of flooding across the study area during higher order events (such as a 1 in 100 year event). This is reflected in the analysis of risk to properties, businesses and infrastructure that is discussed below.

4.1.1 Predicted Risk to Existing Properties & Infrastructure

Maps of predicted flood depths and extents which have been generated from the surface water modelling results are included in Appendix F. In order to provide a quantitative indication of potential risks, building footprints (taken from the OS MasterMap dataset) and the National Receptor Dataset (NRD) have been overlaid onto the modelling outputs in order to estimate the number of properties at risk within the study area. The NRD is not entirely comprehensive and may not include all known or recent properties.

Error! Reference source not found. shows the approximate number of predicted properties and critical infrastructure which may be affected during a 1 in 100 year probability rainfall event (1% AEP).

Properties with basements have been identified using the NRD dataset. These are shown separately in the tables below as basement properties are generally at a much higher risk than properties at ground level. It is recommended that the location of these basement properties is reviewed on site to confirm the level of potential risk.

Table 4-1 Flooded Properties Summary 1 in 100 year probability event

Property Type	Flood Risk Vulnerability Classification	Modelled Depths Greater Than –		
		0.1m	0.3m	0.5m
Infrastructure	Essential Infrastructure	-	-	-
	Highly Vulnerable	2	1	0
	More Vulnerable	25	3	1
Households	Non-Deprived (All)	1061	236	74
	Non-Deprived (Basements Only)	21	9	1
	Deprived[3] (All)	980	344	147
	Deprived (Basements Only)	45	26	8
Commercial / Industrial	Units (All)	272	54	9
	Units (Basements Only)	-	-	-

[2] Methodology and limitations relating to each source of flooding can be located within Section 2.
[3] Households are classified based on the relative deprivation of an area using the Indices of Multiple Deprivation provided by the Office of National Statistics.

Property Type	Flood Risk Vulnerability Classification	Modelled Depths Greater Than –		
		0.1m	0.3m	0.5m
Others	Other Flooded Properties	27	2	1
	Unclassified Flooded Properties	238	49	14
	Infrastructure Other	7	2	-

An analysis was also carried out to determine the predicted risk to properties and infrastructure from a lower order rainfall event, which would have a higher probability of occurring. The 1 in 20 year probability event (5% AEP) was used for this assessment and the results are summarised in **Error! Reference source not found.**. **Error! Reference source not found.** identifies the difference in flooded properties between the two events.

Table 4-2: Flooded Properties Summary 1 in 20 year probability event

Property Type	Flood Risk Vulnerability Classification	Modelled Depths Greater Than –		
		0.1m	0.3m	0.5m
Infrastructure	Essential Infrastructure	-	-	-
	Highly Vulnerable	1	-	-
	More Vulnerable	13	2	-
Households	Non-Deprived (All)	139	18	-
	Non-Deprived (Basements Only)	4	-	-
	Deprived (All)	185	30	7
	Deprived (Basements Only)	6	-	-
Commercial / Industrial	Units (All)	83	9	2
	Units (Basements Only)	-	-	-
Others	Other Flooded Properties	10	1	-
	Unclassified Flooded Properties	64	8	1
	Infrastructure Other	2	1	-

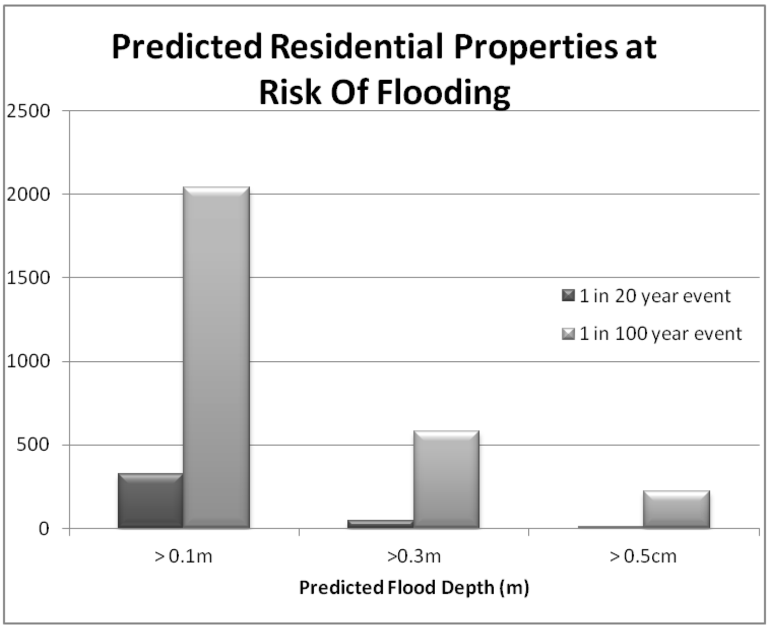


Figure 4-1 Comparison of Predicted Flooded Properties for the 1 in 20 year and 1 in 100 year Rainfall Event

As would be expected, the number of properties at risk of shallow flooding (>0.1m) is greater than the number at risk of deeper flooding (>0.3m), with the amount of properties at risk increasing as the storm probability increases due to the volume of predicted rainfall within the storm will increase.

4.1.2 Risk to Future Development

As discussed in Section 1.5 , a number of sites have been identified for future development. It is therefore important that surface water flood risk identified within this study should be a consideration in the site allocation process as their locations could either assist or exacerbate the risk to existing properties within Ramsgate. It is recommended that these developments adhere to specific policy relating to surface water management in this document in addition to the requirements of NPPF.

4.2 Opportunity areas

Five Opportunity Areas (OAs) have been identified in Ramsgate where the flood risk is considered to be most severe and where future monitoring and possible further work could be carried out to understand and reduce the risk. Figure 4-2 (below) identifies the location of the OAs within Ramsgate for the predicted 1 in 100 year depth outputs. These areas are reviewed in more detail within section 4.6.2 along with potential options to mitigate flood risk.

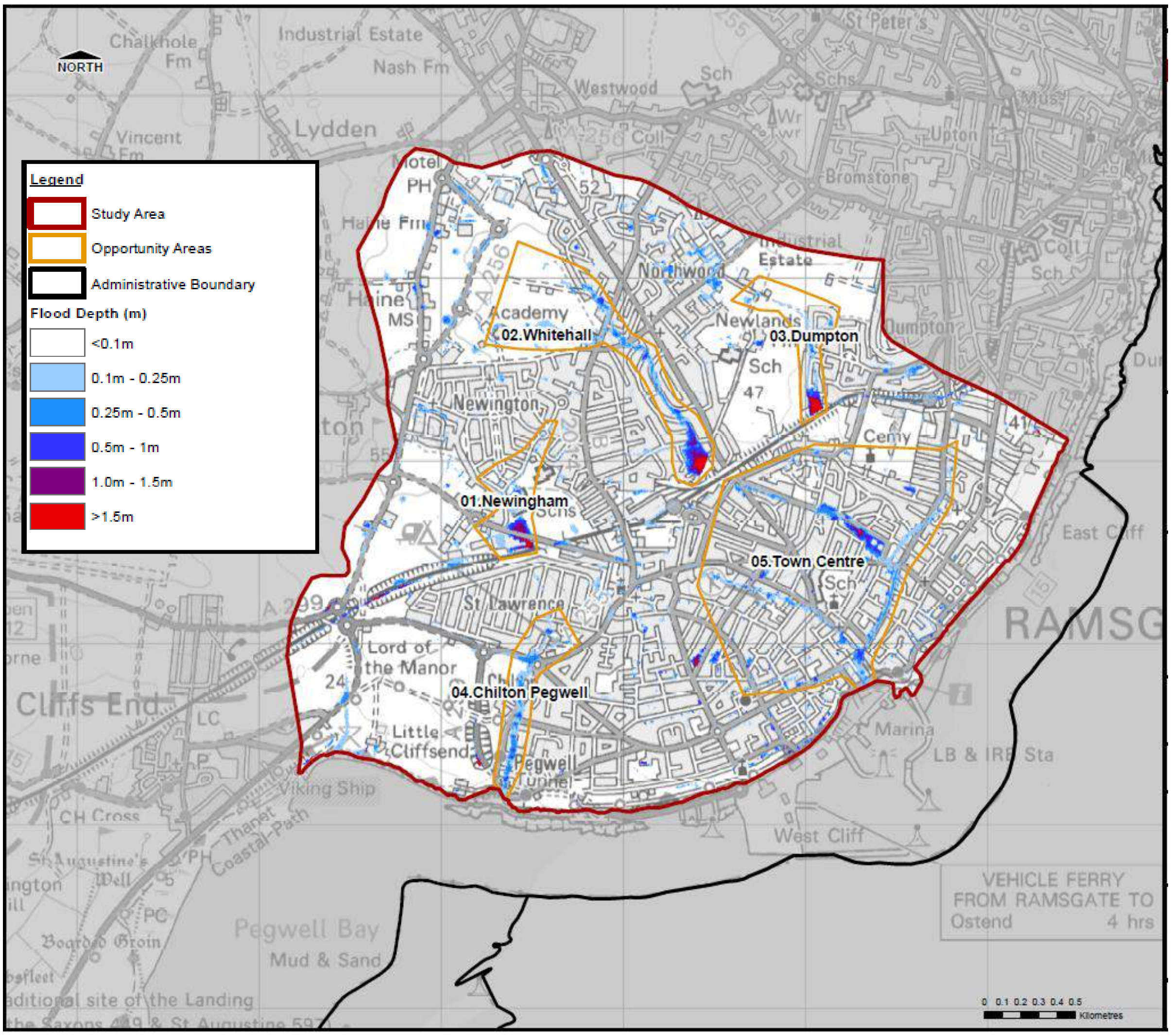


Figure 4-2 Opportunity Areas within Ramsgate

4.3 Flood Mitigation Assessment Overview

The following section indicates what options are generally available for reducing flood risk within Ramsgate. A high level options assessment was undertaken, which involved identifying a range of structural and non-structural options for alleviating flood risk in the study area, and assessing the feasibility of these options. As well as surface water, consideration was given to other sources of flooding and their interactions with surface water flooding, with particular focus on options which will provide flood alleviation from combined flood sources.

OAs delineate the areas where the impact of surface water flooding is expected to be greatest, it is acknowledged that the OAs do not account for all the areas that could be affected by surface water flooding. It is therefore recommended that KCC implement policies which will reduce the risk from surface water flooding throughout the whole study area, that TDC also implement similar policies, so that both authorities promote and apply Best Management Practises to the implementation of SuDS and the reduction of runoff volumes. To ensure

4.4 Methodology

4.4.1 Source-Pathway-Receptor Model

Surface water flooding is often highly localised and complex. There are few solutions which will provide benefits in all locations, and therefore, its management is largely dependent upon the characteristics of the OA. This section outlines potential measures which have been considered for mitigating the surface water flood risk within Ramsgate.

When identifying potential measures, it is useful to consider the source, pathway, receptor approach (refer to **Error! Reference source not found.**).

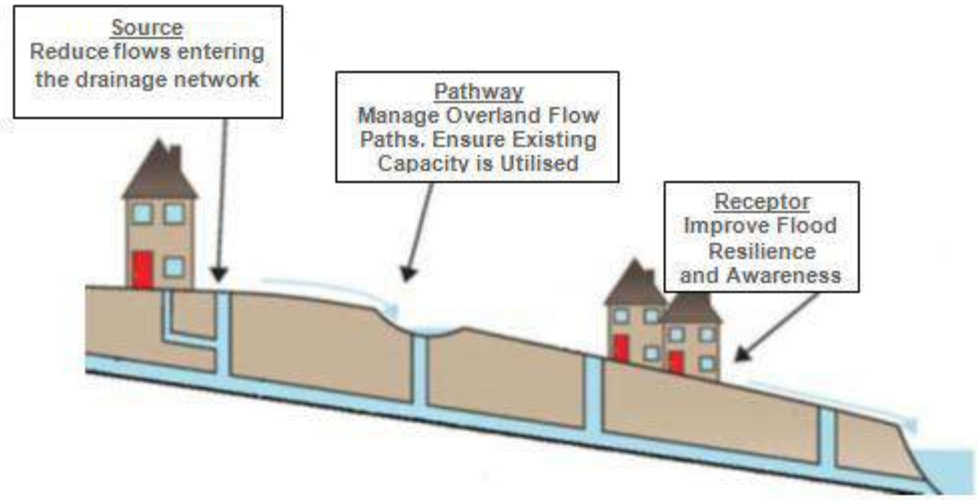


Figure 4-3 Source, Pathway and Receptor Model
(adapted from Defra SWMP Technical Guidance, 2010)

Methods for managing surface water flooding can be divided into methods which influence the Source, Pathway or Receptor, as described below:

- Source Control: Source control measures aim to reduce the rate and volume of surface water runoff through increasing infiltration or storage, and hence reduce the impact on receiving drainage systems.

Examples include retrofitting SuDS (e.g. bioretention basins, wetlands, green roofs etc) and other methods for reducing flow rates and volumes.

- Pathway Management: These measures seek to manage the overland and underground flow pathways of water in the urban environment, and include increasing capacity in drainage systems and separation of foul and surface water sewers.

- Receptor Management: These measures involve changes to communities, property and the environment that are affected by flooding. Mitigation measures to reduce the impact of flood risk on receptors may include improved warning and education or flood resilience measures.

Both structural and non-structural measures should be considered. Structural measures can be considered as those which require fixed or permanent assets to mitigate flood risk (such as a detention basin, increased capacity pipe networks). Non-structural measures may not involve fixed or permanent facilities, and the benefits to of flood risk reduction is likely to occur through influencing behaviour (education of flood risk and possible flood resilience measures, understanding the benefits of incorporating rainwater reuse within a property, planning policies etc).

4.4.2 Scale of options

Flood risk management activities should be undertaken at a variety of scales – generally from strategic planning policy down to site specific mitigation solutions. This approach is reflected in the options assessment by use of three scales:

- Study Area Wide – Recommended flood mitigation measures and policies that should be considered for the entire study area

- Opportunity Areas – 'Sub-catchments' (as defined in Section **Error! Reference source not found.**) within the study area where potential site specific flood mitigation solutions are proposed.

4.5 Study Area Wide Options

The Action Plan is included in Appendix B of this report. The Action Plan outlines a range of recommended measures that should be undertaken to manage surface water within Ramsgate more effectively. Within the Action Plan there are details of general measures that could be implemented across Ramsgate. The general actions are non-structural and encourage improved surface water management through planning policy and public education and awareness.

4.6 Opportunity Area Options

4.6.1 Recommendations for all Opportunity Areas

It is recommended that a community flood plan should be created for all OA areas. This document should advise residents and site users of the risk of flooding and appropriate techniques for flood risk management.

Before any works are undertaken in a OA, it is recommended that a combination of actions are undertaken to further confirm the risk in the OA, reduce costs of a preferred option and establish the benefit of the proposed scheme. The following recommendations are proposed:

- o Initial consultation:
  - Discussions with residents / land owners to confirm flooding history (if any)
  - Internal discussions with TDC and KCC teams

   - Discussions with the EA and Southern Water to determine if any synergy can be provided within any proposed schemes and determine potential for funding (FDGiA funding, Local Levy Funding, AMP 5 / 6 etc.)

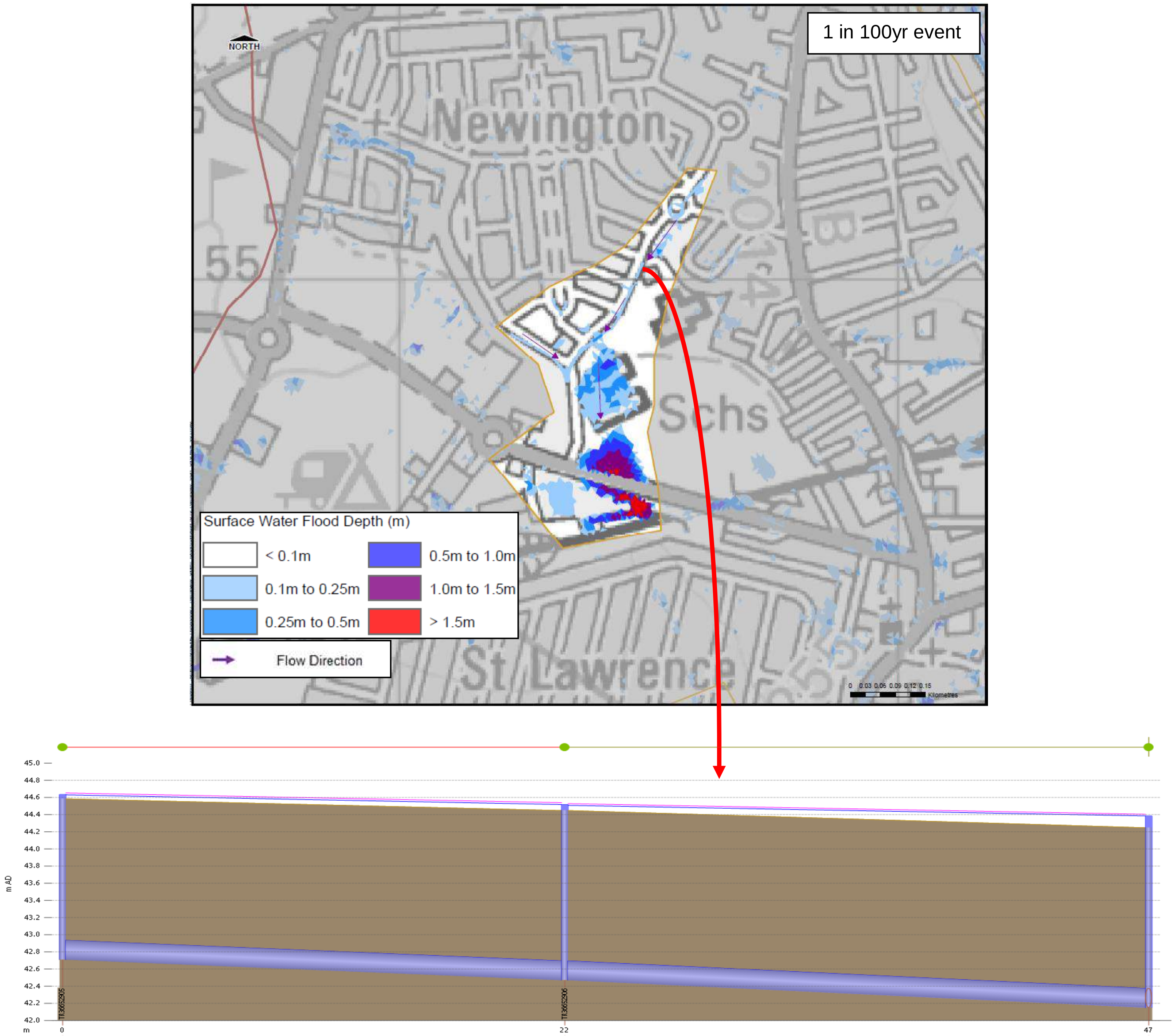
- Undertake a detailed feasibility study which includes:
   - Asset investigations (e.g. Inspection / CCTV of existing infrastructure to confirm condition, size and connectivity)
   - Detailed modelling of the OA (i.e. refined model grid size, include all pipes and gullies)
   - Initial underground service investigations (obtain and review relevant service plans)
   - Confirmation on land ownership issues
   - Conceptual sizing and locating of proposed measures / options based on updated data and constraints

4.6.2 Opportunity Area Specific Options

This section provides a summary of flood risk within each OA and discusses the preferred option identified for each OA based on the measures above. These options have been developed for the purpose of providing KCC a clear starting point should significant flooding occur in the OAs in future. No significant flooding has occurred in recent times that justifies short-medium term significant physical interventions or further feasibility / funding investigations at this stage.

Conceptual option appraisal assessments were undertaken on a range of options for each OA. Issues relating to feasibility, land ownership and conflicts with other services should be assessed before these conceptual options are progressed further. Full details of the option assessment process are included in Appendix C.

OA 01 - Newington

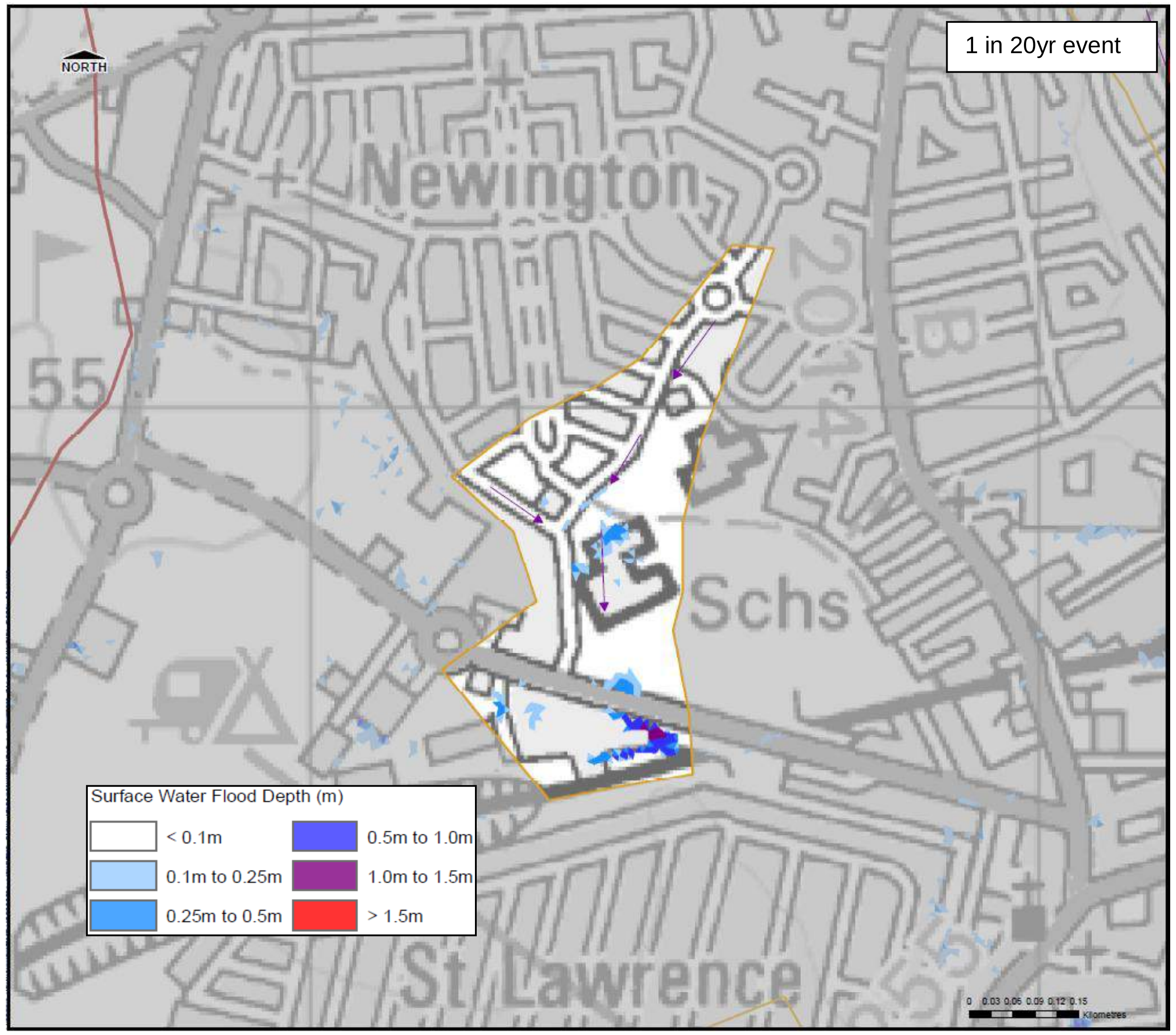


Summary of risk:

This OA is located in the north western portion of the study area. The pluvial modelling predicts that overland flow will pond in two main areas in the OA. According to the model, water is flowing along Auckland Avenue and Melbourne Avenue causing potential flooding to the Newington Community Primary School and the area to the south of Manston Road. The entire pipe network in the area is running full. As shown in Figure 4-2 manholes along Melbourne Avenue are predicted to be surcharging.

Table 4-3 Summary of local flood risk within OA 01

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	In extreme rainfall events surface water runoff from predominantly urban areas are conveyed as overland sheet flow towards the south of the OA.	Runoff from the local catchment is conveyed through properties, roads and the drainage network.	Newington Community Primary School and the area to the south of Manston Road.
Ponding of surface water (within topographic low spots and behind obstruction)	Topographic low points and obstructions to overland flow.	Ponding within Newington Community Primary School and building to the south of Manston Road.	Newington Community Primary School and the area to the south of Manston Road.
Hazard	Predominantly ‘moderate’ within the school boundary. ‘Significant’ hazards being predicted in the area south of the Primary School and south of Manston Road.		
Sewer	The drainage network within the OA is a combined drainage system.		
Validation	No information was provided on previous flood events in this area to support the validation of the model results.		
Groundwater	The OA is not susceptible to groundwater flooding.		



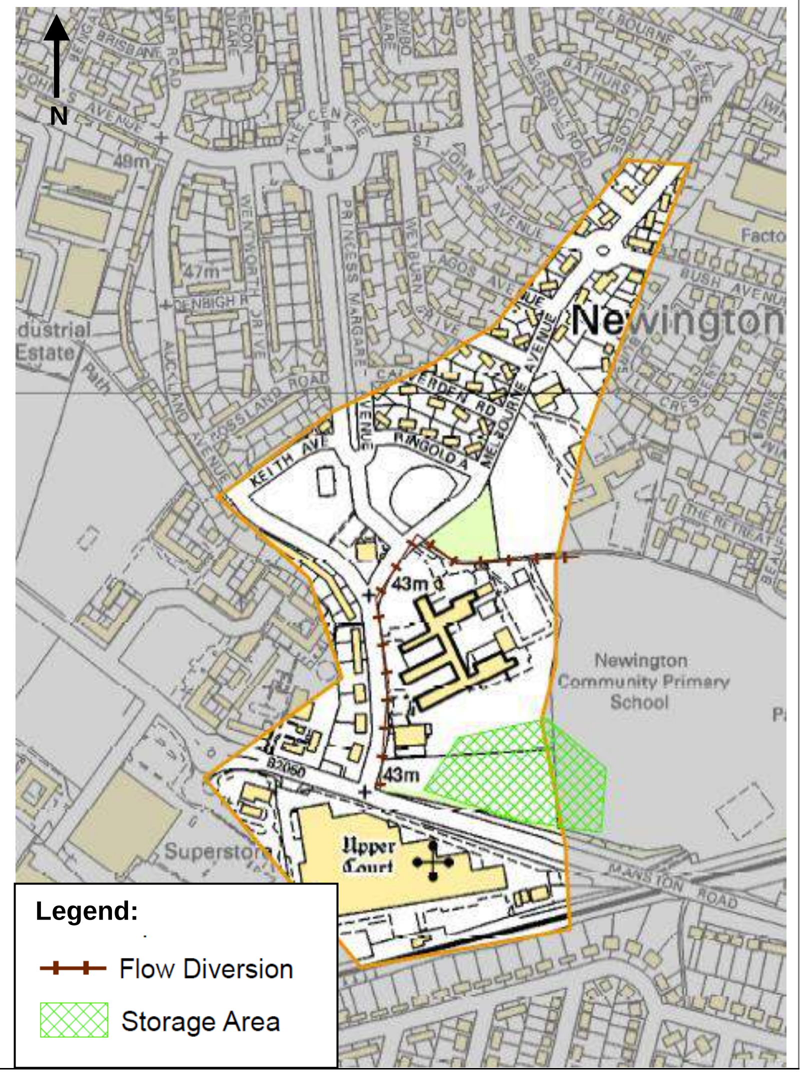
OA 01 - Newington

Preferred Option:

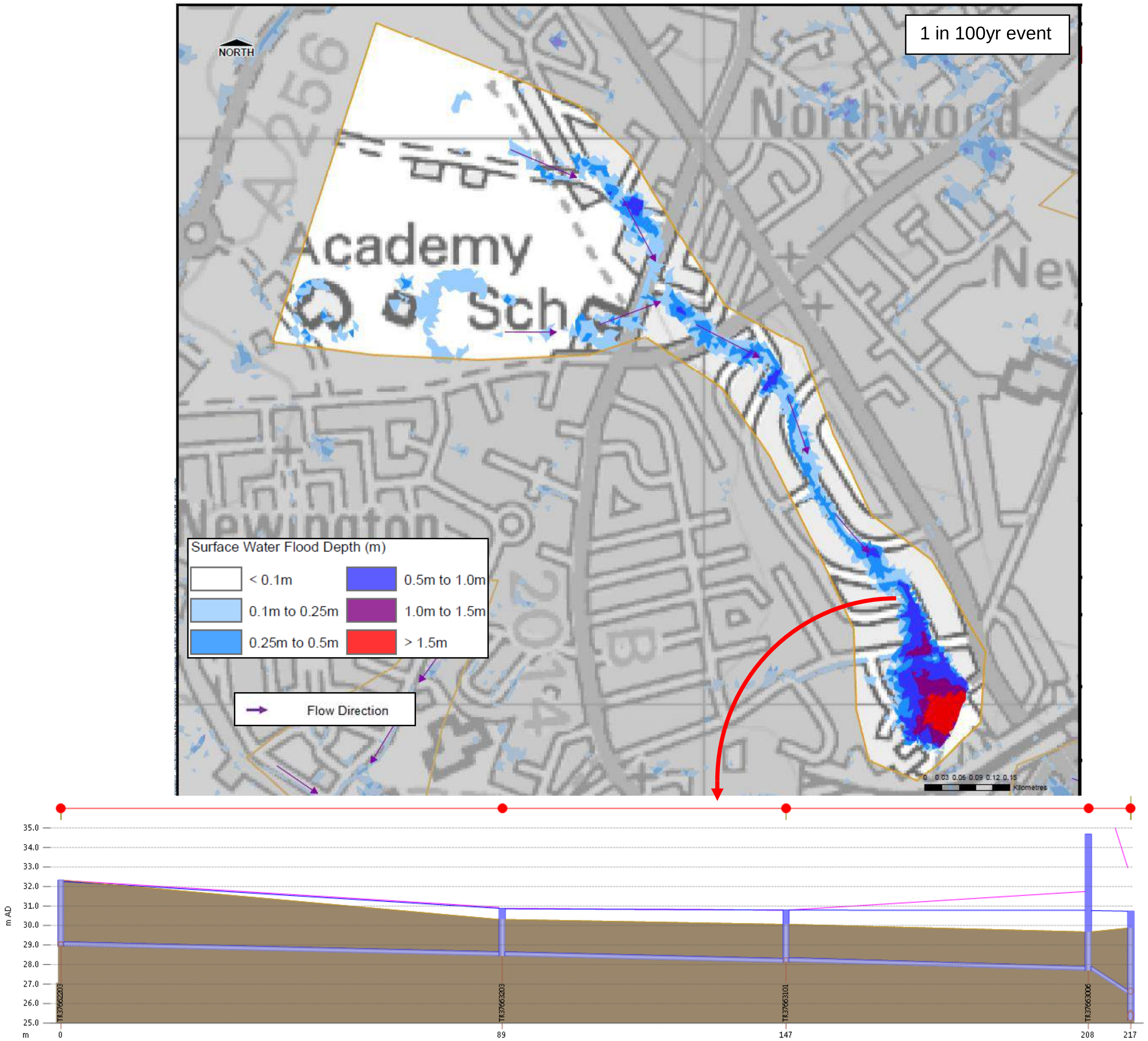
- Monitor flooding and verify risk

Mitigation Options:

- Investigate raised kerbing along Princess Margaret Avenue to divert surface water flow into the road
- Investigate the benefit of including a storage area within Newington Community Primary School playing fields
- Once the benefits of the above measures have been assessed, include local drainage improvements within the OA to ensure the storage area capacity is maximised
- Review risk of flooding and determine if warning signs are necessary



OA 02 - Whitehall

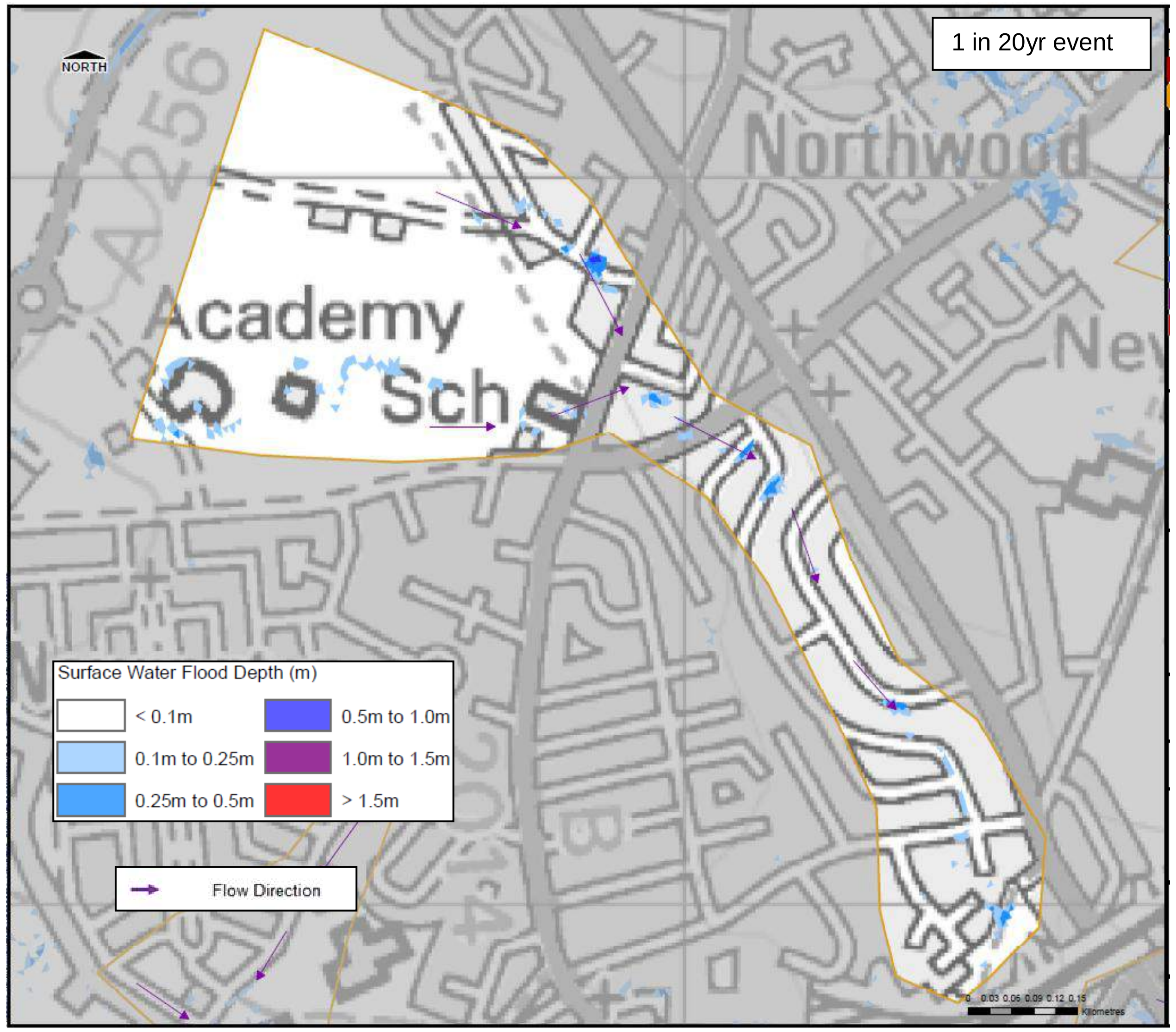


Summary of risk:

This OA is located in the northern part of the study area. Significant depths of water are predicted further south near Pullman Close. The main flood mechanism is exceedance of local drainage system capacity during extreme rainfall events causing overland flow. The overland flow path in the OA starts from further north, within the playing fields of the Marlowe Academy.

Table 4-4 Summary of local flood risk within OA 02

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	In extreme rainfall events surface water runoff is conveyed as overland sheet flow via the road network or other topographic low paths.	Runoff from the local catchment is conveyed through properties, roads and the drainage network.	Properties along the main flowpath and mainly the Pullman Close area.
Ponding of surface water (within topographic low spots and behind obstruction)	Topographic low points and obstructions to flow	Ponding within the Pullman Close area.	Properties along the main flowpath and mainly the Pullman Close area.
Hazard	Predominantly 'moderate' with 'Significant' hazards being predicted in the Pullman Close area.		
Sewer	The drainage network within the OA is a combined drainage system.		
Validation	No information was provided on previous flood events in this area to support the validation of the model results.		
Groundwater	The OA is not susceptible to groundwater flooding.		



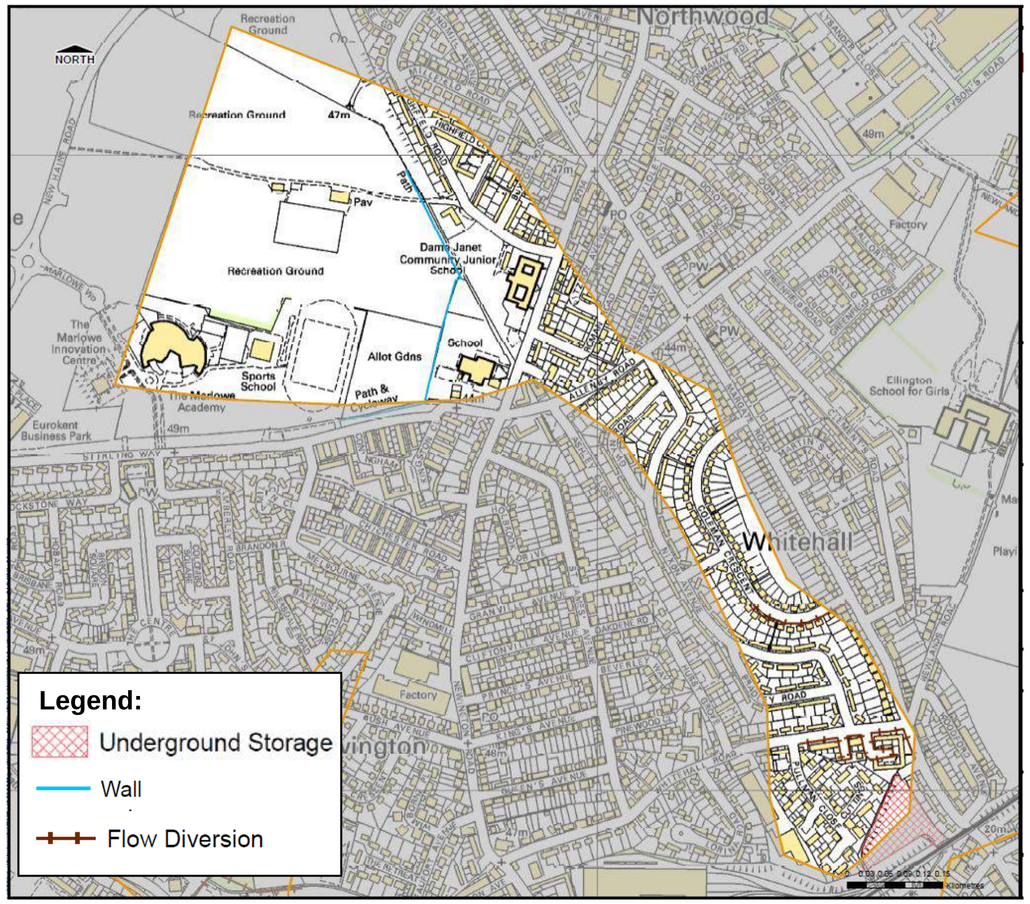
OA 02 - Whitehall

Preferred Option:

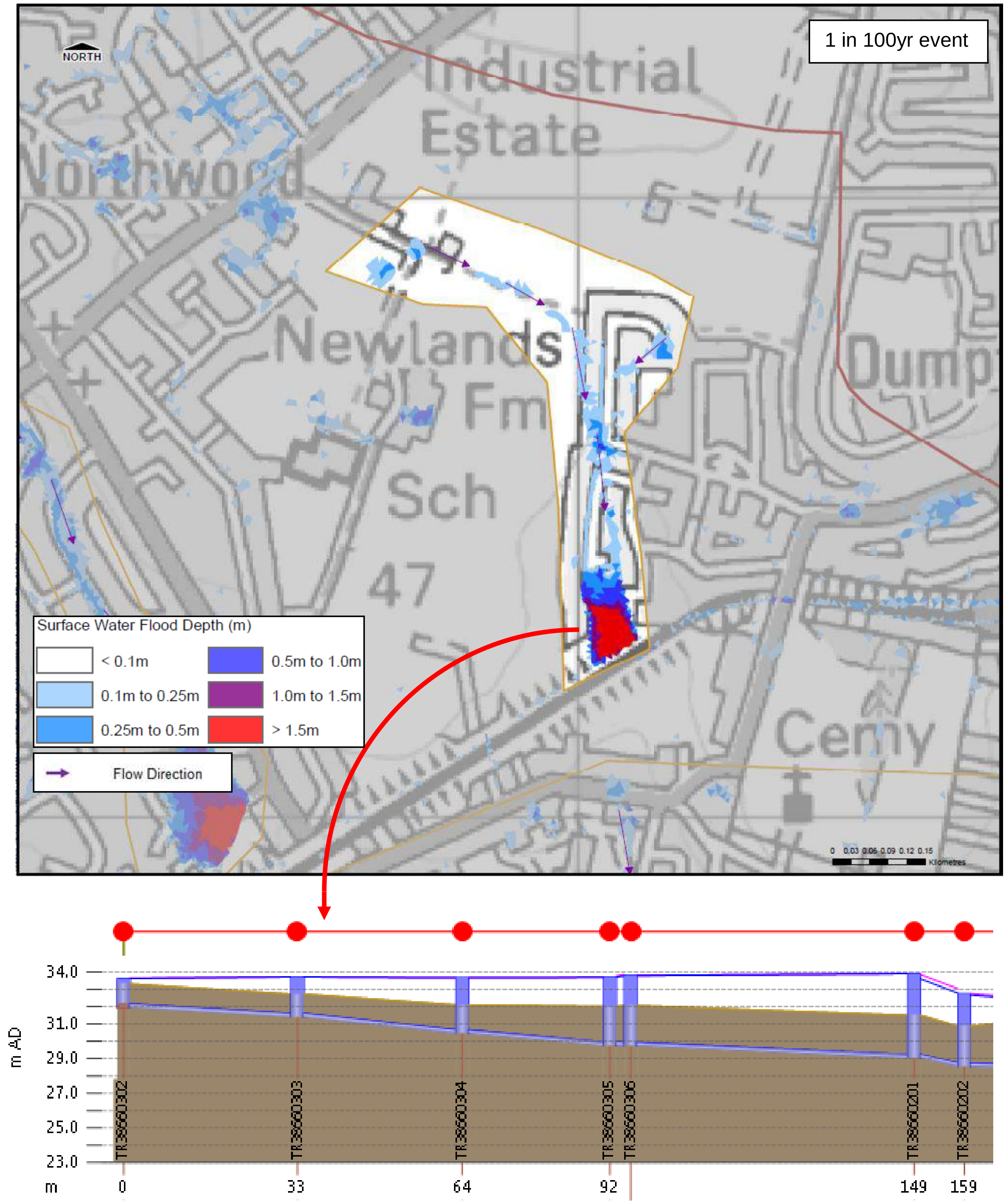
- Monitor flooding and verify risk

Mitigation Options:

- Investigate raised kerbing along Coleman Crescent and Whitehall Road to retain surface water within the road and prevent the properties in the area from flooding.
- Review drainage infrastructure in the area to ensure existing capacity is maximised.
- Investigate the benefit of including an underground storage area in the Pullman Close area.
- Determine risk to railway line (including their management procedures) and determine if the embankment can be used as part of an above ground storage area
- Determine benefit of raising ground levels in the north western part of the OA to retain surface water within the Marlowe academy playing fields.
- Review pipe network within the Pullman Close area to determine if a capacity increase is feasible
- If above options are not feasible - review resistance / resilience measures for properties directly at risk.
- Review risk of flooding and determine if warning signs are necessary



OA 03 – Dumpton



Summary of risk:

This OA is located in the north eastern part of the model. Surface water is flowing from higher ground towards the Stonar Close area where the ground elevation is lower. The drainage network in that area is predicted to be running full and most manholes are surcharging causing water to pond in the Stonar Close area.

Table 4-5 Summary of local flood risk within OA 03

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	In extreme rainfall events surface water runoff is conveyed as overland sheet flow via the road network or other topographic low paths.	Runoff from the local catchment is conveyed through properties, roads and the drainage network.	Properties in the Stonar Close area.
Ponding of surface water (within topographic low spots and behind obstruction)	Topographic low points and obstructions to flow	Ponding within the Stonar Close area.	Properties in the Stonar Close area.
Hazard	Predominantly 'moderate' with 'Significant' hazards being predicted in the southern edge of the Stonar Close area.		
Sewer	The drainage network within the OA is a combined drainage system.		
Validation	No information was provided on previous flood events in this area to support the validation of the model results.		
Groundwater	The OA is not susceptible to groundwater flooding.		

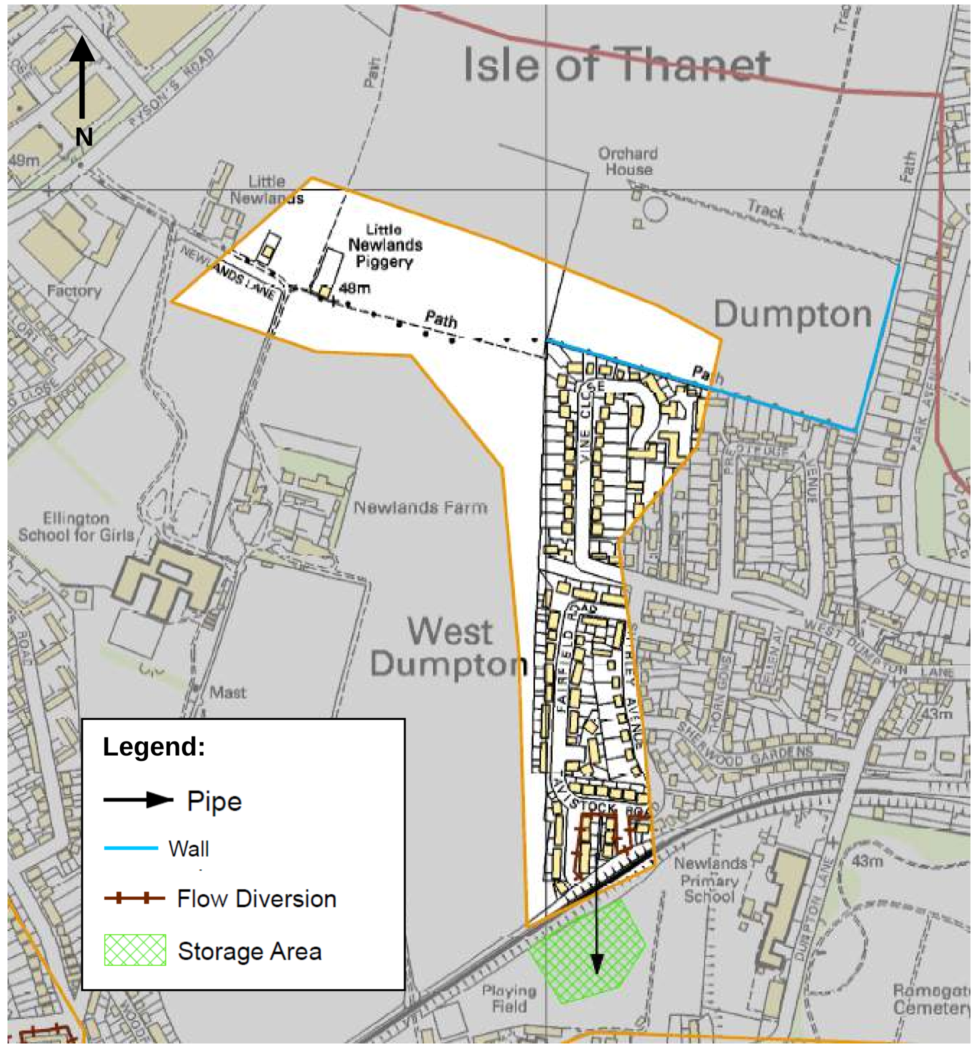
OA 03 - Dumpton

Preferred Option:

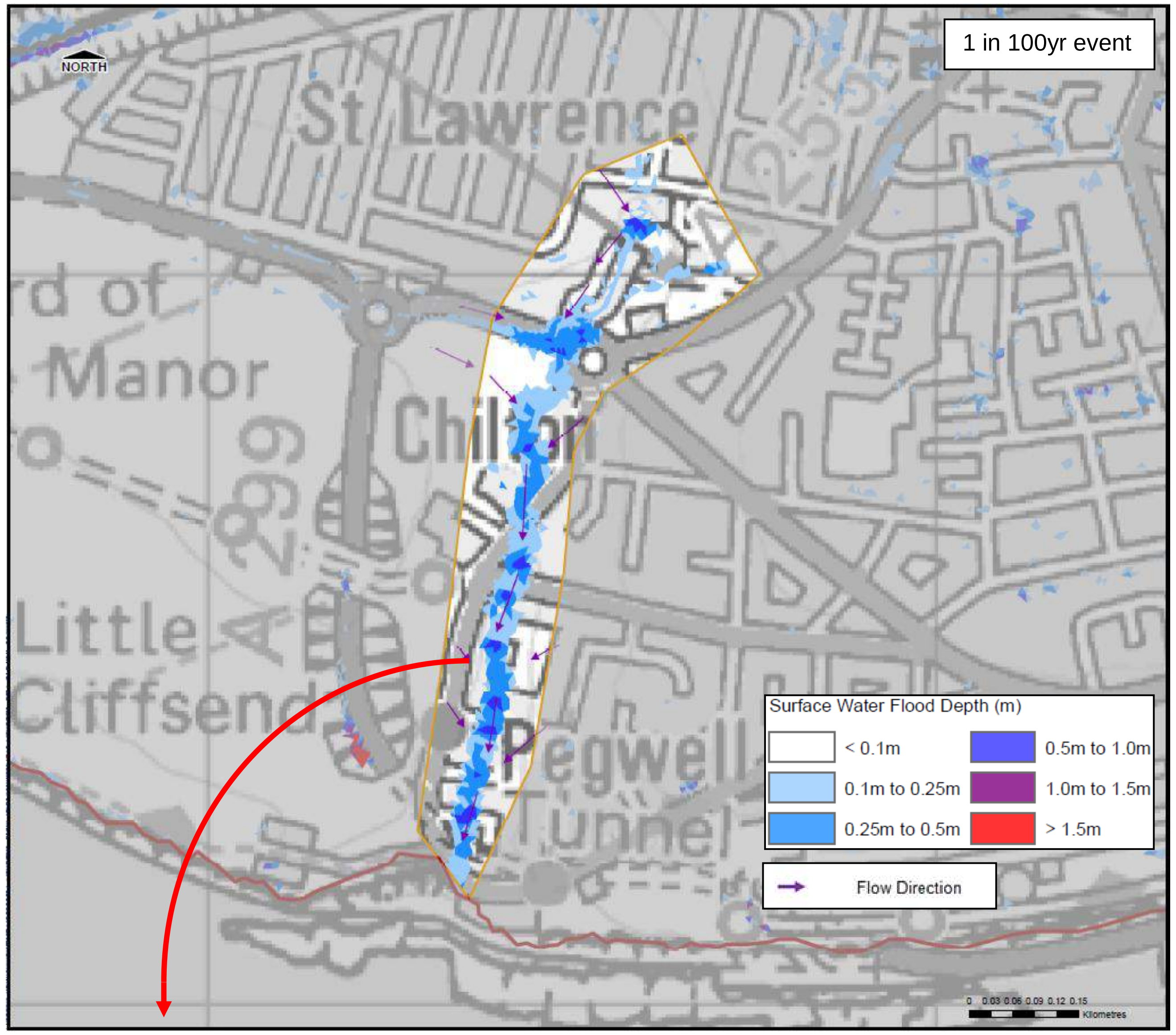
- Monitor flooding and verify risk

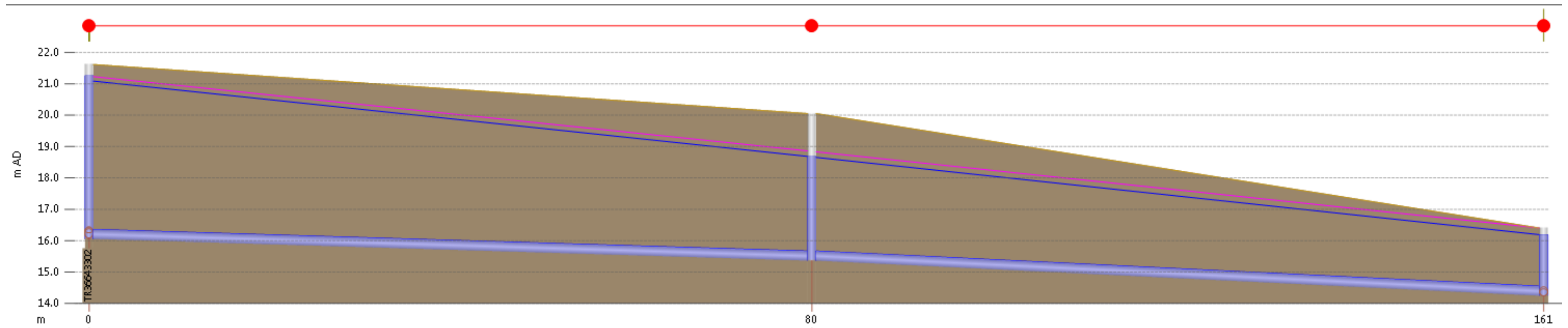
Mitigation Options:

- Investigate raised kerbing along Tavistock Road to retain surface water within the road and prevent the properties in the area from flooding.
- Determine risk to railway line (including their management procedures) and determine if the embankment can be used as part of an above ground storage area
- Determine benefit of raising ground levels in the northern part of the OA to retain surface water within the Dumpton area.
- Investigate the benefit of adding a culvert in the southern part of the OA to divert water in a storage area located south of the rail line.
- Once the benefits of the above measures have been assessed, include local drainage improvements within the OA to ensure the storage area capacity is maximised



OA 04 – Chilton / Pegwell



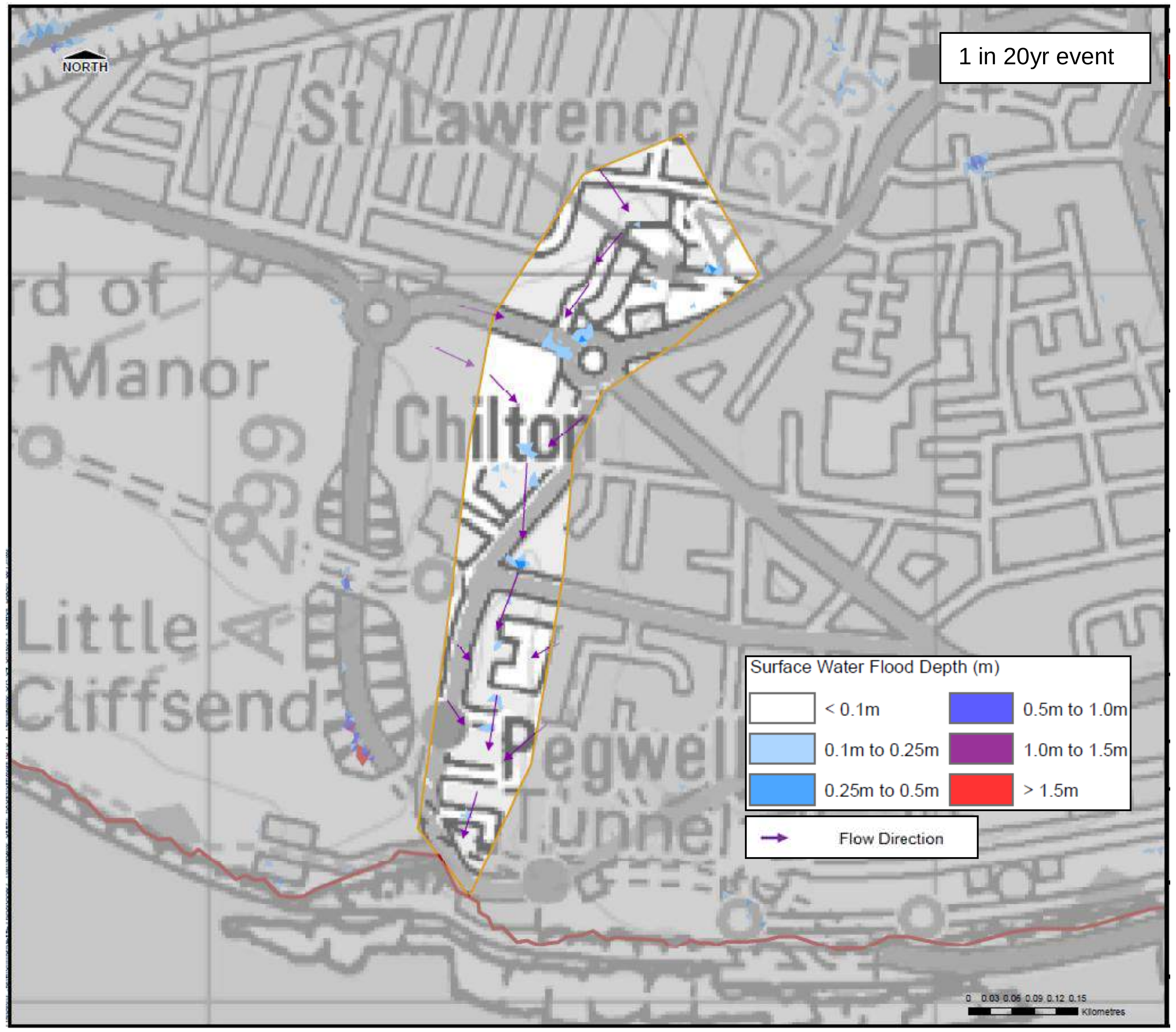


Summary of risk:

This OA is located in the south western part of the model. Less significant depths of water are predicted in this OA compared to the previously described ones. The pipe network in the area is predicted to be running full. Quite a few properties are potentially affected in that OA since surface water is not running along the roads but through properties which are located at a lower ground elevation.

Table 4-6 Summary of local flood risk within OA 04

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	In extreme rainfall events surface water runoff from predominantly urban areas are conveyed as overland sheet flow along the entire OA.	Surface water runoff from the local catchment is conveyed along properties located West of Chilton Lane and East of Pegwell Road.	Properties located West of Chilton Lane and East of Pegwell Road.
Ponding of surface water (within topographic low spots and behind obstruction)	Topographic low points and obstructions to flow	Quite a few areas of ponding along the entire OA.	Properties located West of Chilton Lane and East of Pegwell Road.
Hazard	Predominantly ‘Significant’ hazards are predicted along the entire OA (combination of predicted depth and velocity)		
Sewer	The drainage network within the OA is a combined drainage system.		
Validation	Flood events have been recorded within the OA (Kent Highways, Southern Water)		
Groundwater	The OA is highlighted to have a ‘low’ susceptibility to groundwater flooding (due to superficial deposits).		



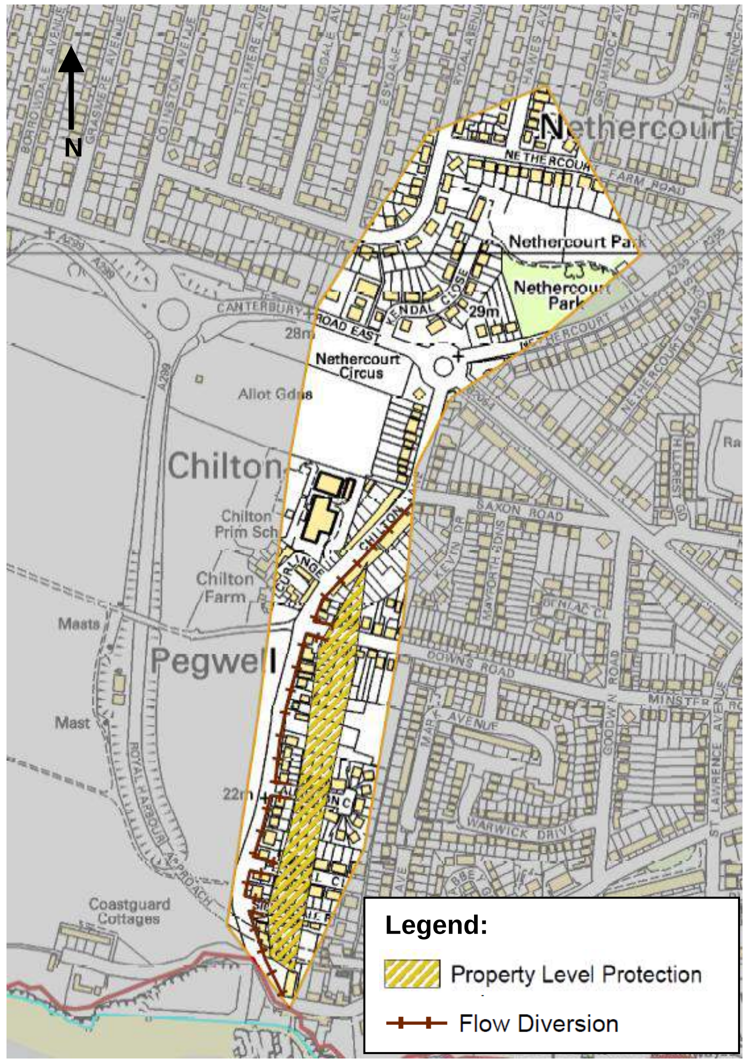
OA 04 – Chilton / Pegwell

Preferred Option:

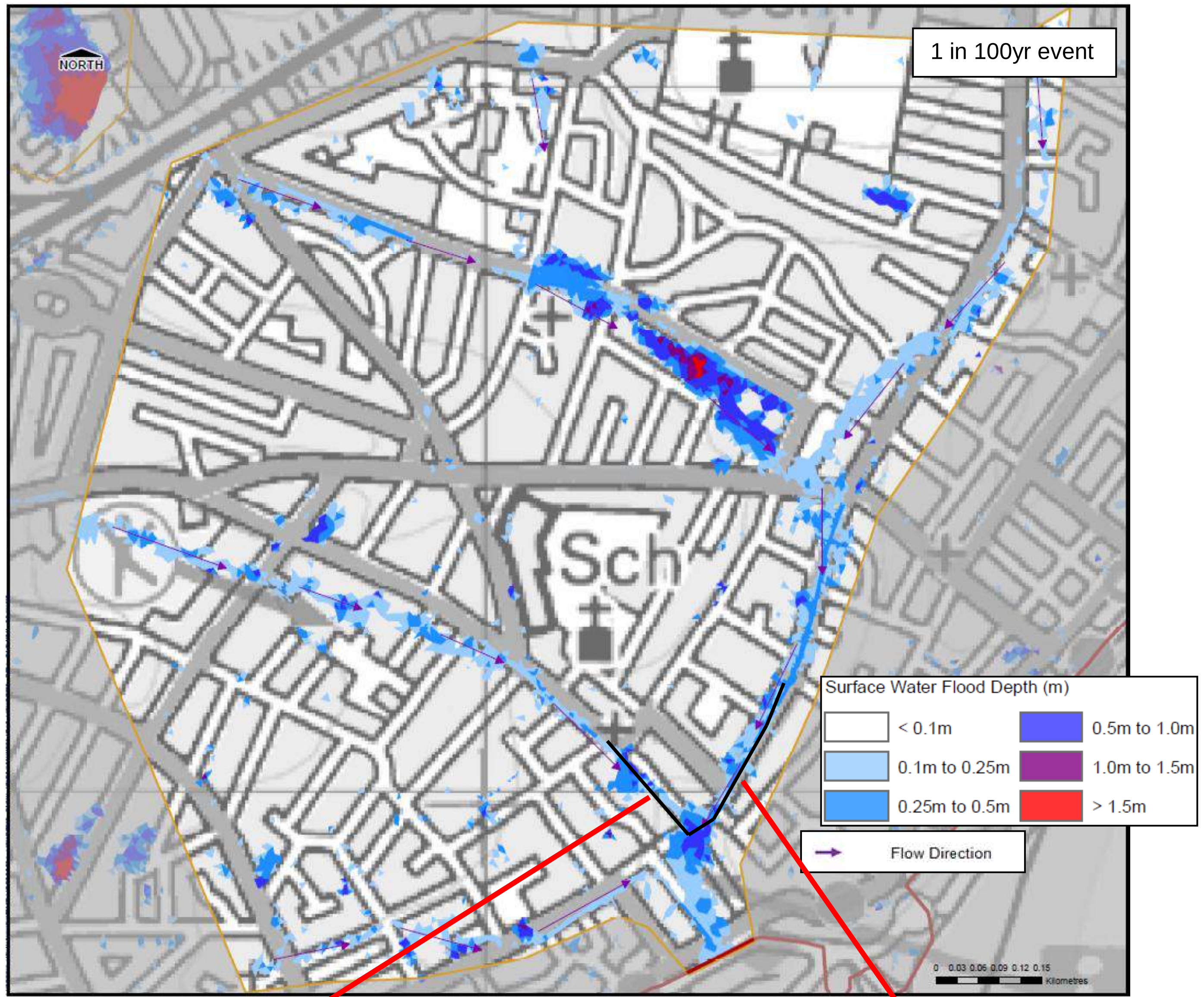
- Monitor flooding and verify risk

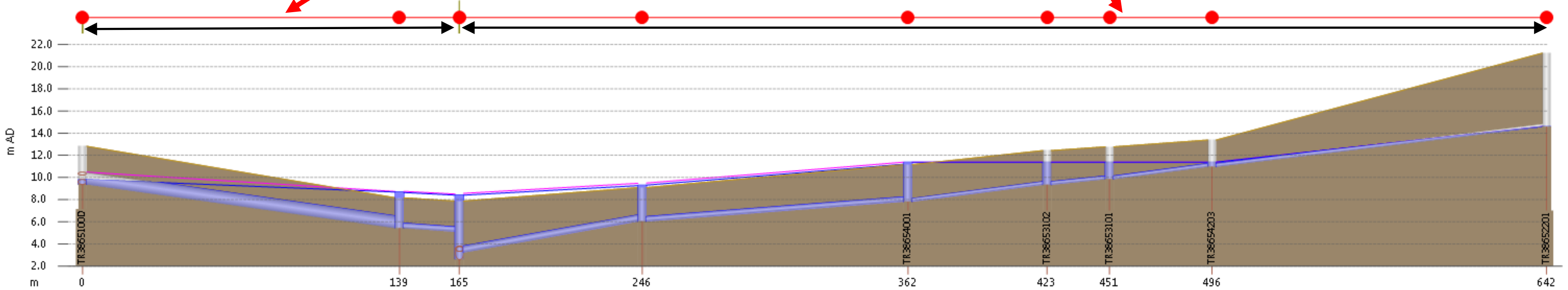
Mitigation Options:

- Investigate raised kerbing along Pegwell Road to divert surface water flow into the road.
- Review road drainage capacity and confirm what management measures are in place to ensure this is maintained at the maximum level.
- Consider local drainage improvements to ensure water diverted onto the road is drained away quickly.
- Investigate surface water separation.
- Investigate the benefit of providing property level protection for the properties located east of Pegwell Road.



OA 05 – Town Centre





Summary of risk:

This OA is located in the south eastern part of the model. There are four different flowpaths in the area which join in the southern part of the OA near Harbour Parade / Royal Parade. This area is located at a lower ground level causing surface water to pond there. In addition, the pipe network is joining in this area and does not have sufficient capacity to store all that water coming from different directions. Therefore, the manholes are surcharging in this area. Higher depths of surface water can also be found near the intersection of St Luke's Avenue and Denmark Road. This area is located at a lower ground level.

Table 4-7 Summary of local flood risk within OA 05

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	In extreme rainfall events surface water runoff is conveyed as overland sheet flow via the road network or other topographic low paths.	Due to the topography of the area four natural overland flowpaths are conveyed into the southern part of the OA from higher ground.	Properties along St Luke's Avenue and the area around Harbour Parade.
Ponding of surface water (within topographic low spots and behind obstruction)	Topographic low points and obstructions to flow	Ponding near the intersection of St Luke's Avenue and Denmark Road and around Harbour Parade.	Open space, residential properties, gardens, roads and potentially access to the Police Station on York Street.
Hazard	Predominantly 'Significant' hazards are predicted along St Luke's Avenue and near Harbour Street.		
Sewer	The drainage network within the OA is a combined drainage system.		
Validation	Flood events have been recorded within the OA (Southern Water, Kent Highways, TDC).		
Groundwater	The OA is highlighted to have a 'low' susceptibility to groundwater flooding (due to superficial deposits).		

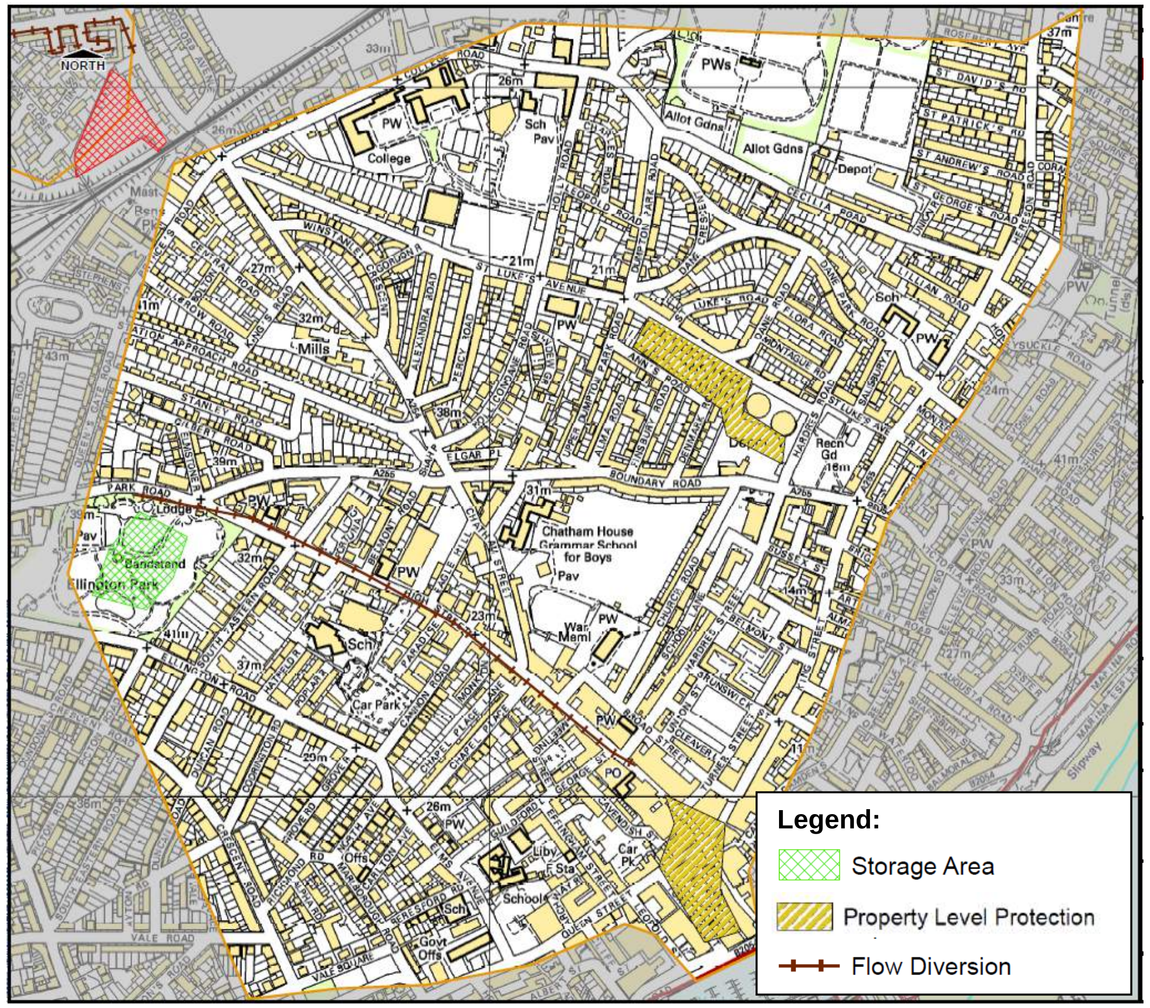
OA 05 – Town Centre

Preferred Option:

- Monitor flooding and verify risk

Mitigation Options:

- Investigate raised kerbing along High Street to retain surface water within the road and prevent the properties in the area from flooding.
- Investigate the benefit of providing property level protection for the properties located near Harbour Street and St Luke's Avenue.
- Review drainage infrastructure at the OA to ensure existing capacity is maximised.
- Investigate surface water separation.
- Investigate the benefit of creating a storage area within Ellington part to store some water in the upstream part of the OA.
- Review risk of flooding and determine if warning signs are necessary



5 Review and Update

5.1 Review Timeframe and Responsibilities

This SWMP and Action Plan identify the relevant internal departments and external partnerships that should be consulted and asked to participate when addressing an action. After an action has been addressed, it is recommended that the department responsible for completing the action should review the Action Plan and update it to reflect any issues (communication or stakeholder participation) which arose during the completion of an action and whether or not additional actions are required. It is recommended that the Action Plan is regularly reviewed and updated to reflect any necessary amendments.

5.2 Ongoing Monitoring

It is intended that the working arrangements established as part of the SWMP process, will continue beyond the completion of the SWMP in order to facilitate 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 annually as a minimum, but there may be circumstances which might trigger a review and/or an update of the Action Plan in the interim. Examples of something which would be likely to trigger an Action Plan review include:

- 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 which may require a revision to the action plan
- Additional (**major**) development or other changes in the catchment which may affect the surface water flood risk

It is in the interest of KCC, TDC and the residents of the catchment that the SWMP Action Plan remains current and up-to-date. To help facilitate this, the TDC and KCC should liaise with other flood risk management authorities and monitor progress.

6 References

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Appendix A: Glossary and Abbreviations

Appendix B: SWMP Action Plan

Appendix C: Options Assessment

Appendix D: Modelling Details

Appendix E: Data Collection

Appendix F: Maps and Figures

Limitations

Capita Property and Infrastructure Ltd ("Capita") has prepared this Report for the sole use of **Kent County Council** ("Client") in accordance with the Agreement under which our services were performed. No other warranty, expressed or implied, is made as to the professional advice included in this Report or any other services provided by Capita.

The conclusions and recommendations contained in this Report are based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested and that such information is accurate. Information obtained by Capita has not been independently verified by Capita, unless otherwise stated in the Report.

The methodology adopted and the sources of information used by Capita in providing its services are outlined in this Report. The work described in this Report was undertaken between October 2013 and June 2015 and is based on the conditions encountered and the information available during the said period of time. The scope of this Report and the services are accordingly factually limited by these circumstances.

Where assessments of works or costs identified in this Report are made, such assessments are based upon the information available at the time and where appropriate are subject to further investigations or information which may become available.

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Certain statements made in the Report that are not historical facts may constitute estimates, projections or other forward-looking statements and even though they are based on reasonable assumptions as of the date of the Report, such forward-looking statements by their nature involve risks and uncertainties that could cause actual results to differ materially from the results predicted. Capita specifically does not guarantee or warrant any estimate or projections contained in this Report.

Unless otherwise stated in this Report, the assessments made assume that the sites and facilities will continue to be used for their current purpose without significant changes.

Costs may vary outside the ranges quoted. Whilst cost estimates are provided for individual issues in this Report these are based upon information at the time which can be incomplete. Cost estimates for such issues may therefore vary from those provided. Where costs are supplied, these estimates should be considered in aggregate only. No reliance should be made in relation to any division of aggregate costs, including in relation to any issue, site or other subdivision.