ANNEX 1

CITY OF YORK COUNCIL

Surface Water Management Plan

Contents

Executive Summary

Background information

The enquiry into the wide scale flooding experienced in 2007 resulted in the publication of the Pitt Review. A key recommendation was for Lead Local Flood Authorities to prepare Local Surface Water Management Plans outlining the preferred strategy for the management of surface water in a given location(s), to establish a long term action plan and to influence future strategy development for maintenance, investment, planning and engagement.

While York is well known for flooding from fluvial sources and has a robust response procedure, knowledge of the effects of pluvial flooding is minimal, due mainly to the lack of any events that have caused significant problems, in particular property flooding. The Preliminary Flood Risk Assessment addressed this at a high level and the Surface Water Management Plan assesses local flood risk in more detail. The output from this, together with the Council's Strategic Flood Risk Assessment, will be used as key evidence in the preparation of the Local Flood Risk Management Strategy

The study and findings

A sample of areas where surface water flooding occurred in 2007 was modelled and investigated, enabling the cause(s) of the flooding to be identified and to propose potential solutions. At many locations it was found that the effects of flooding were greater than predicted by the model, either more frequent or more extensive and in some cases both. This is an indication of defective infrastructure limiting the capacity of the system, and this was confirmed by the investigations. The findings are considered to represent the citywide situation.

The investigations have highlighted a lack of knowledge of the location of surface water infrastructure and long term neglect in its maintenance. The causes of blockage were usually found to be root infiltration, silt or damage due to utility or other excavations, and often a combination of all of these.

The investigations also established that drainage infrastructure and natural flow paths have often been affected by development. While it may not be possible to remedy this it has highlighted the importance of managing flood risk correctly as part of the development control process.

It is clear that the significant data deficiency and maintenance backlog make local flood risk difficult to predict and manage. The effects of intense rainfall events, which are predicted to be more prevalent due to climate change, increase this risk. Investment in highway drainage investigations over the past four years has resulted in repairs and the acquisition of data covering approximately 10% - 15% of the Council's area.

Blockages of the pipe system serving gullies renders them ineffective, and cleaning gullies in isolation often does not address the cause of flooding problems. Therefore the performance of all of the elements of the highway drainage infrastructure needs to be confirmed and optimised, and gully cleaning needs to be planned on the principles of flood risk management.

The conclusions from the study are:

- The location of much of the surface water infrastructure is unrecorded and its condition consequently unknown.

- When it is located riparian owners are usually unaware of its presence or strategic importance, or of their responsibilities for its maintenance.

- Drainage infrastructure is often inaccessible due to development.

- Development has often paid little regard to the pre-existing natural flow paths and drainage infrastructure. For example former field drains and minor watercourses have frequently been filled during development, or inadequately piped in with no record of location or provision of any access points for maintenance.

- Blockage of pipes, ditches and culverts in Council, YWS and private ownership is common

- Pipes and culverts are commonly blocked with silt and roots.

- Damage to pipes and culverts by the utility companies is common.

- Maintenance of known infrastructure beyond the emptying of gullies is poor or non existent and when gullies are cleaned connections are not checked so re-blocking is common.

- Funding for maintenance of highway infrastructure, in particular gully cleaning, has been reduced annually over successive years to a point where it is now mainly a reactive operation. Such routine gully emptying that is carried out is generally not in the areas that suffer surface water flooding.

- Repairs to drainage systems and attempts at remedying flooding problems have often been badly executed and ill thought out with no regard to a holistic solution based on knowledge of the drainage of the area. Often these have not been effective, or have aggravated the problem.

- Designs for road alterations often do not take into account effects on drainage infrastructure. These can physically affect the drainage of a site and ease and access for maintenance, and also increase impermeable areas and flood risk. While this would be important anywhere it is an essential consideration in such a flat area. If not considered as an integral part of the design it can cause or aggravate flooding.

The recommendations from the study are:

- A commitment is made to fund continuing investigations to locate unrecorded drainage infrastructure in those areas where information is unavailable, and to record it.

- A commitment is made carry out repair work to damaged infrastructure already identified and remedial action taken to ensure that the performance of the existing surface water infrastructure is optimised.

- Future maintenance is scheduled rather than reactive and based on the requirements of the service.

- The effects of future rainfall events are monitored at known flood risk locations.

- CYC liaise with YWS to agree ownership of previously unrecorded assets.

- Riparian owners are made aware of their obligations with regard to maintenance of flows.

- CYC liaise with the relevant utility companies to remove their equipment where it has damaged the drainage system.

- Flood Risk Management should be an integral part of highway alteration and maintenance design.

- The Transport Asset Management Plan should be reviewed and updated.

- The Flood Risk Management Team continues to play a proactive role in the development control process to ensure that there is compliance with all relevant guidance.

Action Plan

Arising from the conclusions and recommendations the study has identified two principal ways in which future surface water flood risk can be effectively managed:

- Maintenance of assets.
- Control of development.

1) Maintenance of assets:

The deficiencies in the surface water infrastructure assets need to be addressed by appropriate investment to continue investigation work. This will enable the assets to be located and recorded, and to carry out cleaning and repairs as necessary. On the basis of the progress that has been made with the funding to date, it is estimated that a further £5m is required, calculated on a pro-rata basis, to complete the records and bring all of the assets up to a satisfactory standard. This will ensure that future flood risk is minimised. No capital schemes for improvements have been identified to date.

This is clearly a substantial amount and it has been calculated assuming that future investigations will be as complex as those already carried out. This may not be the case but can only be confirmed as investigations progress. Therefore this estimated amount should be regarded as confirmation that ongoing funding is required to address flood risk and provide highway asset data. In practical terms the amount that can be effectively spent in any year is limited by the availability of appropriately skilled resources to direct and carry out the work, and this should be the determining factor in deciding funding levels, together with an ongoing assessment of risk.

Taking the above into consideration it is recommended that:

1. Annual funding of £200k is made available to continue investigations and record data. The hierarchy for investigations will be:

    a) areas of known flood risk.

    b) areas where there are gullies but no recorded infrastructure serving them.

    c) areas where there is a risk of back up of sewage from combined sewerage systems during surface water flood events.

    d) other areas.

2. The Transport Asset Management Plan is reviewed and updated to reflect the improved asset information available from the investigations.

3. Progress on investigations, repairs and data acquisition is reported annually to enable:

    a) requirements for future funding to be reviewed and revised as necessary.

    b) the effectiveness and efficiency of the maintenance regime to be reviewed and amended as necessary.

    c) residual flood risk to be assessed to determine whether specific funding is required to resolve more significant flooding problems.

2) Control of development

The study has identified numerous locations where flood risk has been aggravated by development and highway works. While historically it has been acceptable for surface water from developments and highways to discharge unchecked into drainage systems this is no longer acceptable. PPS25, the NPPF, CYC's SFRA and the FWMA all require development to incorporate sustainable drainage to manage not only the risk of flooding to the site itself, but also the surrounding area.

The SFRA provides detailed guidance to planning development managers to manage this risk. The Flood Risk Management team takes a very proactive role in development management striving to resolve drainage and flood risk design issues at application stage to avoid the need for conditions. Without considering flood risk and drainage as a fundamental element of the design, options to provide sustainable solutions at a late stage of the process are difficult or impossible to achieve. Close working with the Development Management Team is necessary to ensure applications are dealt with appropriately.

The planning approval process does not cover highway works, which, if carried out incorrectly, can have an adverse effect on flood risk. There is a clear requirement in the F&WMA for highway authorities to make a contribution towards the achievement of sustainable development and the Flood Risk Management team will work with highway engineers to ensure that there is compliance with this requirement.

Taking the above into consideration it is recommended that:

1) Development in flood risk areas is only permitted strictly in accordance with the NPPF and SFRA.

2) The Flood Risk Management team continues to take a proactive role in development management with the aims of minimising the number of approvals that are given with drainage conditions attached.

3) Where drainage conditions are attached to approvals the Flood Risk Management team will ensure that they are realistic and achievable.

4) The Council sets up procedures to become the SuDS Approval Body when the relevant part of the Act is enacted and guidance is issued.

5) The Flood Risk Management team works with highway maintenance and design engineers to ensure that they fully understand the need for sustainable drainage in their work, and that suitable designs are implemented.

Abbreviations

Acronym	Definition
AStSWF	Areas Susceptible to Surface Water Flooding
CFMP	Catchment Flood Management Plan
CYC	City of York Council
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EC	European Commission
FCERM	Flood and Coastal Erosion Risk Management
FMfSW	Flood Map for Surface Water
FWMA	Flood & Water Management Act 2010
GIS	Geographical Information System
IDB	Internal Drainage Board
IUD	Integrated Urban Drainage
LDF	Local Development Framework
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
LRF	Local Resilience Forum
NPPF	National Planning Policy Framework
PPS25	Planning and Policy Statement 25: Development and Flood Risk
PFRA	Preliminary Flood Risk Assessment
RBD	River Basin District
SAB	SUDS Approving Body
SFRA	Strategic Flood Risk Assessment
SUDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
YWS	Yorkshire Water Services

1.0 INTRODUCTION AND BACKGROUND INFORMATION

1.1 The enquiry into the wide scale flooding experienced in 2007 at various locations across the country resulted in the publication of the Pitt Review. This contained a large number of recommendations for Government to consider and the key recommendation with respect to surface water management is Recommendation 18:

Recommendation 18: "Local Surface Water Management Plans, as set out in PPS25, and coordinated by Local Authorities, should provide the basis for managing all Flood Risk"

Surface Water Management Plans (SWMPs) are referred to in Planning Policy Statement 25 (PPS25) as a tool to manage surface water flood risk on a local basis by improving and optimising coordination between relevant stakeholders. SWMPs will build on Strategic Flood Risk Assessments (SFRAs) and provide the vehicle for local organisations to develop a shared understanding of local flood risk, including setting out priorities for action, maintenance needs and links into local development frameworks and emergency plans.

1.2 A SWMP outlines the preferred strategy for the management of surface water in a given location(s) and the associated study is carried out in consultation with local partners having responsibility for surface water management and drainage in that area. The goal of a SWMP is to establish a long term action plan and to influence future strategy development for maintenance, investment, planning and engagement.

1.3 Defra guidance on the production of SWMPs was published in March 2010 informed by the Integrated Urban Drainage (IUD) Pilot Studies carried out under the Government's Making Space for Water strategy, between 2007 and 2009. The stages for producing a SWMP are:

- Preparation;
- Risk Assessment;
- Options; and
- Implementation and Review.

1.4 The City of York SWMP was made possible by the availability of funding through the Surface Water Early Actions Grant Scheme in March 2010. The submission for funding highlighted the central area within the outer ring road as follows:

Within this area there are 2800 properties at risk of flooding. Many of these are protected from river flooding by flood defence structures which were constructed in the 1980/90s to withstand a 1 in 100 year event. The flooding in 2000 was within 50mm of overtopping those defences and subsequently it was assessed to be a 1 in 80 year event. Clearly the advent of climate change has *modified the perceived protection of the defences. The study will also look at the pluvial issues developing in the catchment".*

1.5 This funding was made available prior to the commencement of the Flood and Water Management Act and predated the availability of the supporting information which was issued to facilitate the compilation of the Preliminary Flood Risk Assessment (PFRA). However the information provided for the PFRA has been of use in this study.

1.6 York is well known for flooding from fluvial sources. This is well documented with a well rehearsed response. Monitoring of upstream rivers enables accurate warnings to be issued, events are predictable and rises in river level are usually slow, always affecting the same areas. However, knowledge of the effects of pluvial flooding is minimal, due mainly to the lack of any events that have caused problems which could be considered significant in terms of major impact on a particular area. Knowledge of such events is frequently dependent on reporting by the public, and it has been found that differing thresholds of tolerance and concerns regarding effects on property value and insurability may result in events going unreported to the Council.

1.7 Consideration of this background information and the SWMP Technical Guidance, published by Defra in March 2010, led to the decision that the study should focus purely on local sources of flooding to build up a clearer understanding of the risk specifically from those sources. In making this decision, consideration was given to the potential link between fluvial and pluvial flooding using the emerging information from Environment Agency surface water modelling and records of surface water flooding from one event in 2007. These sources of information confirmed that surface water flooding was independent of fluvial flooding and was likely to occur in relatively small isolated areas dispersed throughout the Council's area. The mapping also suggested that there is often no obvious connection between the flooded areas.

1.8 Taking this into account the study area for the SWMP has been extended from that defined in the funding bid to include the whole of the area defined by the administrative boundary of City of York Council. It studies a sample of those areas where surface water flooding was recorded in 2007 and identifies the causes and potential solutions. It discusses whether the conclusions from the study are representative of the citywide situation and gives recommendations for future action.

Preliminary Flood Risk Assessment

1.9 The Preliminary Flood Risk Assessment (PFRA) is a high level screening exercise to identify areas of most significant flood risk across Europe. The chief drivers behind its preparation are two sets of legislation: the Flood Risk Regulations (The Regulations), which came into force on the 10th December 2009, and the Flood & Water Management Act (FWMA) which gained Royal Assent on the 8th April 2010. Under this legislation, all Unitary Authorities, and in two-tier systems, all County Councils, are designated a Local Lead Flood Authority (LLFA) and have been allocated a number of key responsibilities with respect to local flood risk management, one of which is to prepare a PFRA. The aim of this PFRA is to provide an assessment of local flood risk across the study area, including information on past floods and the potential consequences of future floods.

1.10 The Council's PFRA has been completed and was approved by its Cabinet on 6 September 2011 and is available on the Council's website. This will be used to inform the preparation of the SWMP. The following is the executive summary:

Under the EC Floods Directive, which has been transposed into UK law through the Flood Risk Regulations (2009), City of York Council is required to undertake a Preliminary Flood Risk Assessment (PFRA) to assess the harmful consequences of past and potential future flooding, and to identify areas of significant flood risk ('flood risk areas').

City of York Council is a Lead Local Flood Authority (LLFA) as defined in the regulations, and has responsibility for preparing the deliverables of the Flood Risk Regulations for 'local flood risk' (flooding from surface runoff, ordinary watercourses and groundwater). The Environment Agency has responsibility for preparing the deliverables of the Flood Risk Regulations for flooding from Main Rivers and the Sea.

The PFRA process is aimed at providing a high level overview of flood risk from local flood sources, including surface water, groundwater, ordinary watercourses and canals. As a LLFA, City of York Council must submit their PFRA to the Environment Agency for review by 22nd June 2011. The methodology for producing this PFRA has been based on the Environment Agency's Final PFRA Guidance and Defra's Guidance on selecting Flood Risk Areas, both published in March 2011.

The first stage of the PFRA is to assess past floods that have had significant harmful consequences for human health, economic activity or the environment, or could have harmful consequences if they were to occur now. Little information on past flooding was available but that relating to one event in 2007, caused by flooding from local sources, was collected and analysed. This provided limited information but based on the evidence that was collected; no past flood events were considered to have had 'significant harmful consequences'.

The PFRA has also considered the potential risk of future flooding. This has been based on hydraulic modelling which predicts the potential impact of flooding on people, property and the environment. The best available information on potential future floods is the national Surface Water maps produced by the Environment Agency. This has been used to inform an assessment of the numbers and types of properties in York that are vulnerable to surface water flooding during an extreme rainfall event. The events modelled are in excess of any experienced or recorded in York to date.

The final stage of the PFRA process is the identification of 'Flood Risk Areas". Indicative Flood Risk Areas' have been calculated by the Environment Agency *using a threshold defined nationally by ministers at the Department for food and rural affairs (Defra). An indicative 'Flood Risk Area' has been identified where clusters of at least 30,000 people have been identified as being at risk of flooding from local sources.*

Of the ten indicative 'Flood Risk Areas' that have been identified nationally by the Environment Agency and Defra, none are located in York and City of York is not proposing to add a new 'Flood Risk Area' for the purposes of the PFRA.

1.11 Figure 1.1 shows the areas identified by the EA in their indicative mapping as being at theoretical risk of surface water flooding. Six of these 1km^2 areas fall within the CYC authority boundary. Four are in the City centre, one around the A59 north of Acomb, and one west of New Earswick. None of these produced clusters which would affect 30,000 people. One, the 1km^2 to the west of the centre encompasses an area that has recorded surface water flooding but the other squares do not.

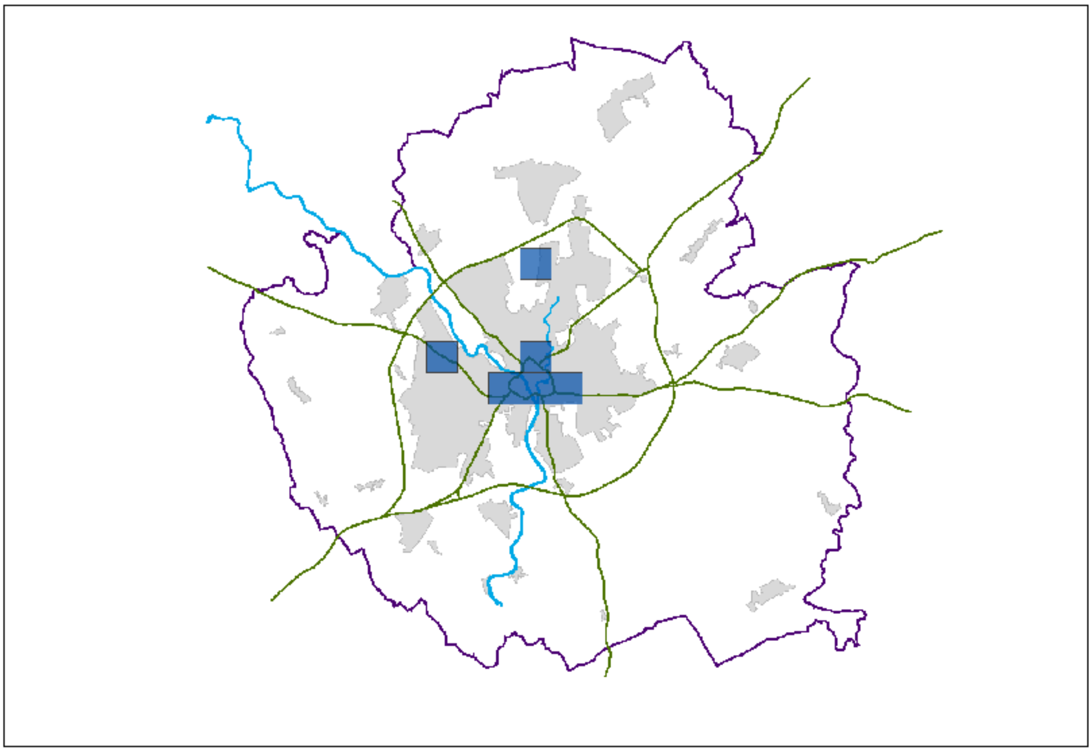


Figure 1.1: Flood Risk Locations identified by the EA

General Description of the York Area

Administrative Background

1.12 The study area for this SWMP is defined by the administrative boundary of City of York Council, located in the Vale of York in North Yorkshire, rather than that defined in the funding bid. The geographical extent of this area is shown in figure 1.2.

1.13 City of York Council Unitary Authority covers an area of approximately 275 km2 and was formed in April 1996. It comprises the former York City Council area extended to include a rural belt with many villages of various sizes which were formerly within the Ryedale, Selby and Harrogate District Council areas. It is bordered by North Yorkshire County Council on its northern, western and southern boundaries and by East Riding of Yorkshire Council on its eastern boundary, which is formed by the river Derwent. The study area has no coastline. The geographical context of the authority area is shown in figure 1.3.

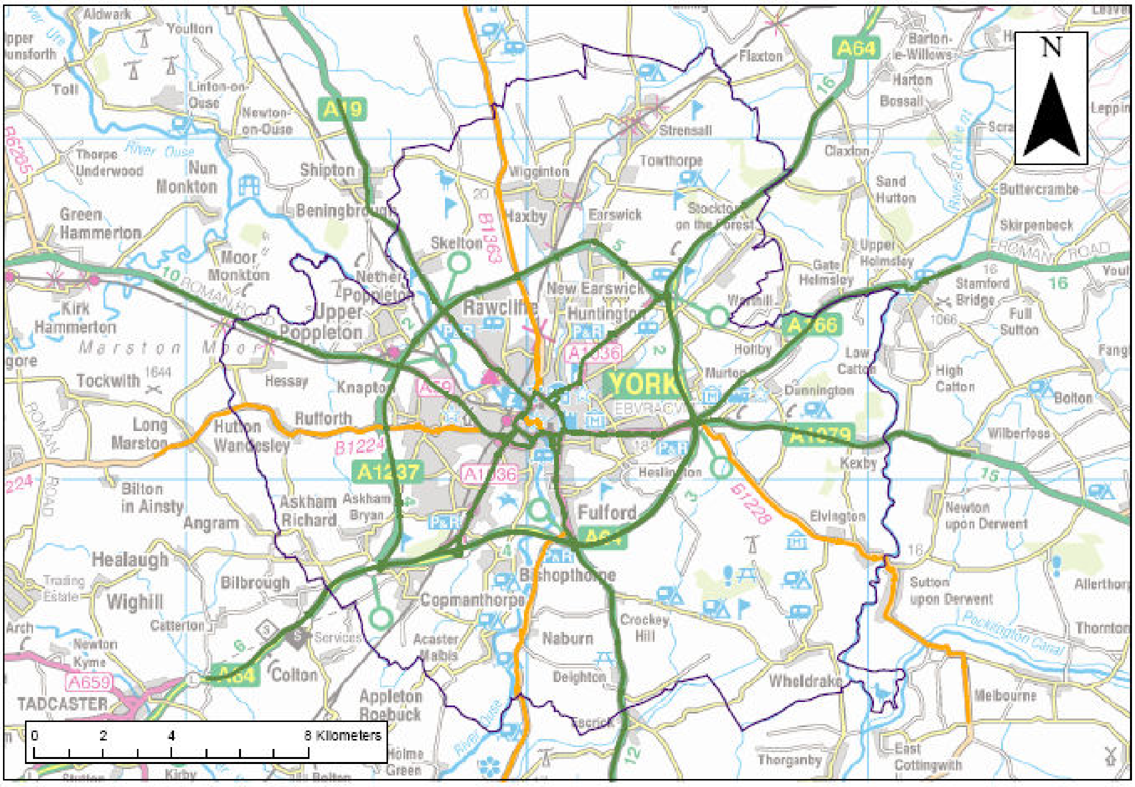


Figure 1.2 – Geographical Extent of City of York Unitary Authority

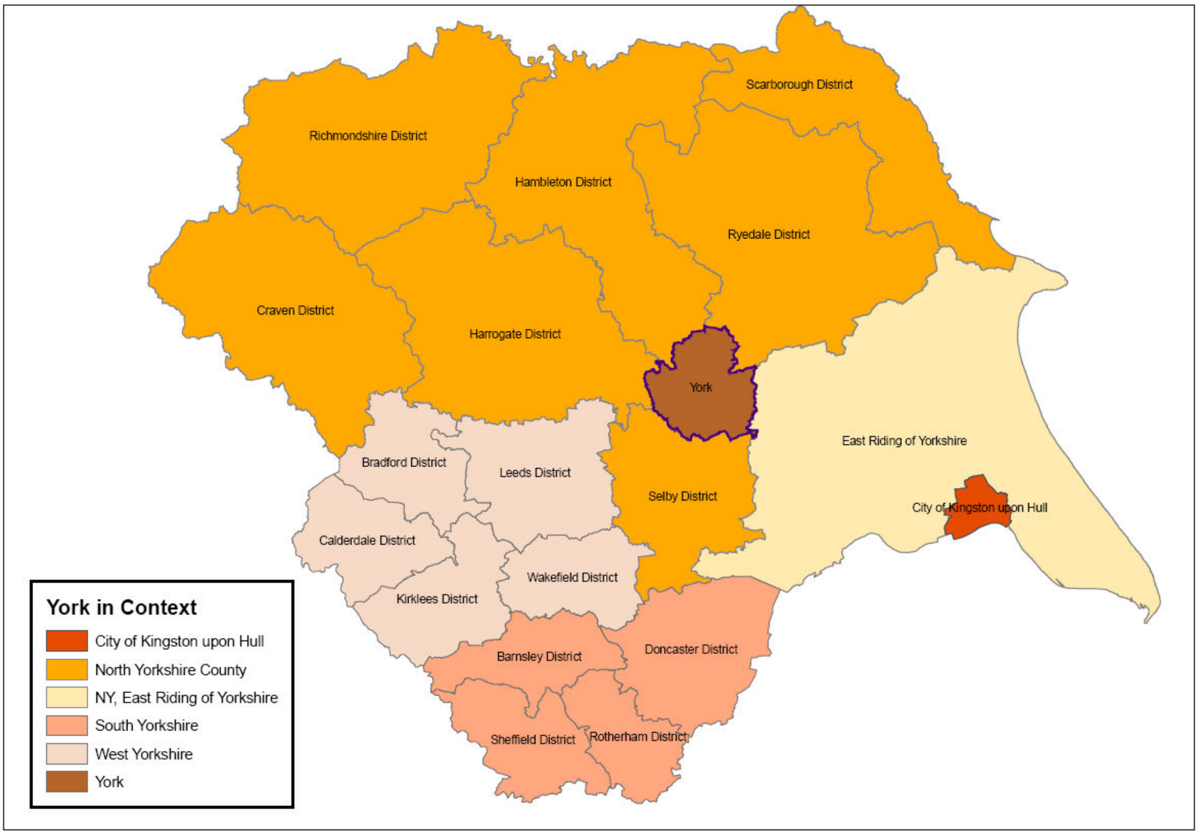


Figure 1.3 – Geographical Context of City of York Unitary Authority

The River Network

1.14 York is located at the confluence of the River Ouse and the River Foss with the River Derwent forming its eastern boundary with East Riding of Yorkshire Council. These rivers drain three catchments, the Yorkshire Dales, Howardian Hills and North York Moors respectively. The Ouse and Derwent are classified as Main Rivers, under the management of the Environment Agency, for their entire length though the area. The Foss is Main River for a distance of 3.3 km upstream of its confluence with the Ouse and beyond that point is an ordinary watercourse, the responsibility of the Foss (2008) IDB.

1.15 The three Main Rivers all run generally in a southwards direction, fed by a number of various sized tributaries. The river network is shown on Figure 1.4.

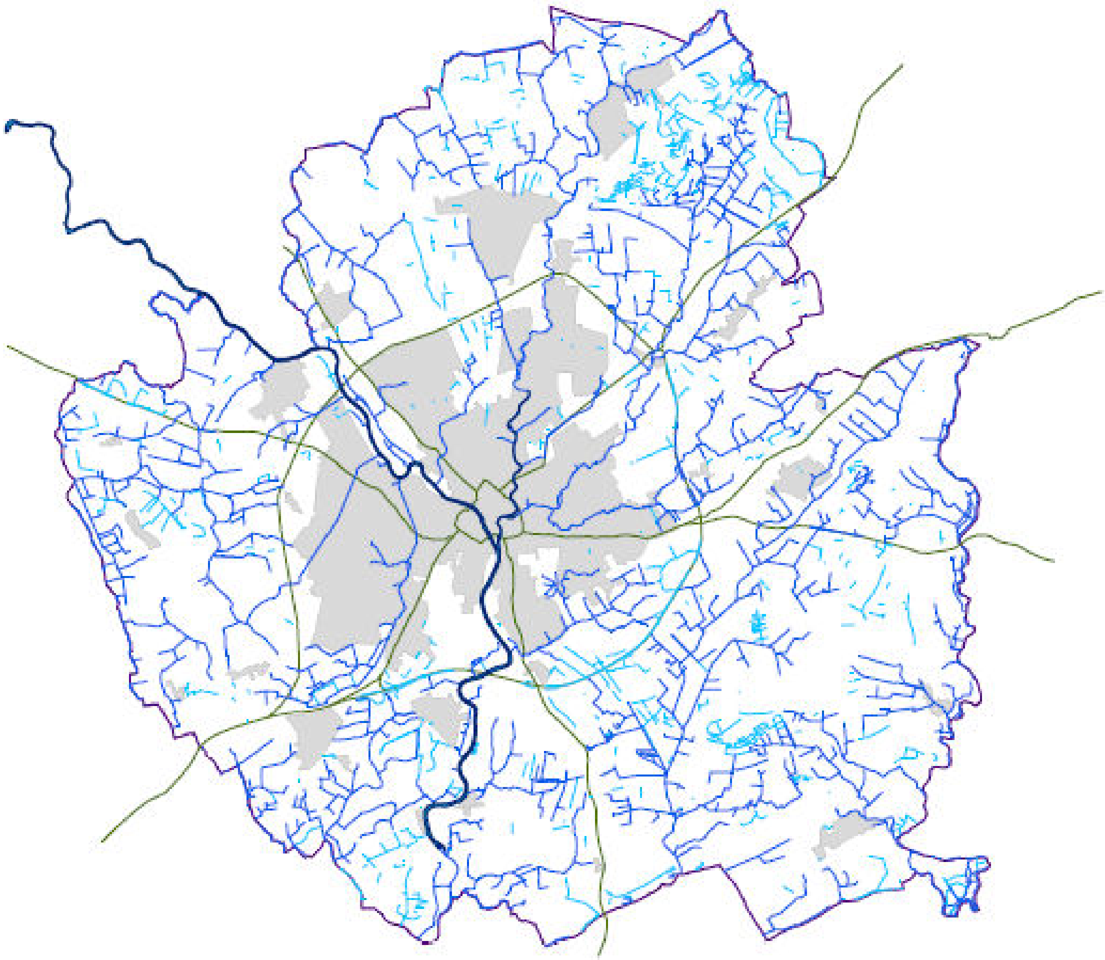


Figure 1.4 – Detailed River Network

1.16 In 2006 ordinary watercourses with potential to cause property flooding were also designated Main River and transferred to the EA's management. As a result the lower reaches of Blue Beck, Burdyke and Holgate Beck, all tributaries of the Ouse, and Tang Hall Beck and Osbaldwick Beck, tributaries of the Foss, are now the responsibility of the EA. Upstream lengths of these watercourses and their tributaries are designated ordinary watercourses and are the responsibility of the Council or appropriate IDB.

1.17 A summary of the rivers and watercourses, and responsibilities for them are as follows:

River Ouse - the largest river drains the Yorkshire Dales catchment and is formed from the Swale, Ure and Nidd upstream of York. The river downstream of Naburn weir is tidal and the Wharfe joins the Ouse at Kelfield just south of the York boundary. The Ouse has the following main tributaries within the York boundary: -

- Blue Beck, draining residential and commercial development in Rawcliffe and Clifton Moor northwest of the city, the responsibility of riparian owners to Rawcliffe Lake. The lake is the responsibility of YWS and its level is controlled by them. Downstream of this, to the Ouse, Blue Beck is Main River.

- Burdyke, draining residential and commercial development in Clifton north of the city, to the south of Bootham Stray, the responsibility of Kyle and Upper Ouse IDB. Downstream of this point to the Ouse is Main River, including Burdyke pumping station.
- Holgate Beck, draining residential development in Woodthorpe, Acomb and Holgate west of the city to the north of Hob Moor, the responsibility of Ainsty (2008) IDB. Downstream of this point to the Ouse is Main River, including Holgate Beck pumping station.
- Germany Beck, draining residential development in parts of Heslington and Fulford including the existing and new university campuses, along with agricultural land east of the city to the River Ouse south of Fulford. The entire length is the responsibility of Ouse and Derwent IDB.

River Foss - the third largest river has the following main tributaries within the York boundary: -

- Westfield Beck, draining areas of residential development in Haxby, Wigginton and New Earswick north of the city to join the Foss south of New Earswick. This is the responsibility of Foss (2008) IDB. Westfield Beck pumping station, owned by YWS, diverts excess flows from the Haxby and Wigginton catchments to the river Foss to protect the downstream village of New Earswick from flooding.
- South Beck, draining Monk's Cross Retail Park and residential development in Huntington north east of the city. The upstream of length is the responsibility of Foss (2008) IDB and final 350m to the Foss is the responsibility of CYC.
- Tang Hall Beck, draining residential development in Tang Hall and agricultural land in the upper catchment around Stockton on Forest north east of the city, the responsibility of Foss (2008) IDB to the outskirts of Heworth. Downstream is Main River.
- Osbaldwick Beck, draining residential development in Osbaldwick and agricultural land in the upper catchment around Holtby and Murton east of the city, the responsibility of Foss (2008) IDB to the outskirts of Tang Hall. Downstream is Main River.

River Derwent - the second largest river with the following main tributaries draining into the river within the York area: -

- Elvington Beck, draining residential development and agricultural land to the west of the village of Elvington, including part of the former airfield which is now in commercial and leisure use. The entire length is the responsibility of Ouse and Derwent IDB including the pumping station at the confluence of the beck and the River Derwent.

Broad Physical Characteristics of the City of York area

1.18 York and its surrounding areas have a diverse character consisting of urban, industrial and agricultural land-uses. The Vale of York consists mainly of valuable agricultural land, with the urban and residential areas centered on the two largest settlements of York and Selby.

Topography: The Vale of York is a low-lying mainly flat landscape, though minor ridges and glacial moraines provide subtle local variations in topography. The area lies between the Pennines to the west and the North York Moors and the Wolds to the east. South of York, much of the land is less than 20m above sea level.

Geology: British Geological Survey maps show the bedrock in the area to consist of the Sherwood Sandstone group, thick soft sandstone of Triassic age that forms the centre of the Vale of York. The superficial deposits, which overlay the sandstone, consist predominantly of sands and gravels, with some clay and till. Bands of alluvium deposits can be seen to intersect the City of York along the path of the River Ouse and River Foss.

Soils: Soil types are often a reflection of the underlying solid geology and similarly land use is often associated with the soil. The river valleys are dominated by soils formed from glacial till, sands and gravels that are generally fertile and suitable for agriculture. A band of groundwater clay soils, which are seasonally waterlogged and affected by shallow fluctuating groundwater table, extends south easterly from Thirsk, around York to Selby.

Hydrogeology: The hydrogeology of an area is directly influenced by the characteristics of the local drift and solid geology. Different rock types may either hold or transmit water or may act as a barrier to groundwater flow. Aquifers are important for several reasons; they act as a source of good quality water for water supply and provide base flow to rivers. The underlying bedrock for the whole flood risk area is Sherwood Sandstone, a formation always classified as a Major Aquifer. The drift deposits overlying the Sherwood Sandstone are classified as a Minor Aquifer, where the drift is relatively permeable, and a Non-Aquifer, where the drift deposits are fairly thick and have low permeability.

2 PREPARATION

Guidance

2.1 The guidance for preparing SWMPs is provided by Defra in their Surface Water Management Plan Technical Guidance and Annexes published in March 2010. The introduction to this document provides background information on the use of the guidance and its appropriateness, and in particular paragraphs i.6 and i.7 and i.9 are relevant to this study:

i.6 It is recognised that SWMP studies will vary to meet local needs and circumstances and the guidance offers a flexible approach that will allow lead local flood authorities to undertake a SWMP study which is tailored to their needs and requirements.

i.7 This guidance is primarily intended to be used for the development of SWMPs in areas of high flood risk with complex integrated drainage arrangements. The principles contained within this guidance may also be usefully applied to less complex or lower risk areas although the approach and level of analysis should be proportionate to the risk and complexity of the area concerned.

i.9 The guidance is not prescriptive, but it provides a clear and logical framework which should be adopted to undertake a SWMP study and to produce an action plan. Technical detail in the main body of the guidance is kept to a minimum and further technical information is signposted throughout the guidance and in annexes. The guidance draws on good practice from the IUD pilot studies and the first edition SWMPs.

2.2 SWMPs carried out to date by other authorities have usually been triggered by significant flooding and have therefore tended to concentrate on specific problem areas known to suffer frequent flooding with significant consequences. By targeting resources in such a way, solutions can be developed with significant benefits specific to the affected areas.

2.3 The local definition of significant flooding, as opposed to that in the PFRA, will be the subject of debate in the preparation of the Local Flood Risk Management Strategy. These will also serve as a trigger for the initiation of section 19 investigations into flood incidents under the FWMA. It is likely that criteria considered for inclusion will include:–

- The internal flooding of one or more residential or business properties.
- A risk to life as a result of the depth and/or velocity of floodwater.
- A risk of contamination from sewage back up or flooding arising from the overloading of combined sewerage systems by surface water.

- Critical infrastructure (e.g. emergency services buildings, utility company infrastructure, schools, day centres, hospitals and main transport routes) suffering flooding or obstruction, or were in imminent danger of flooding.

- The imminent danger of flooding of five or more properties

2.4 On the basis of these draft criteria, while there has been recorded flooding in some areas which would trigger investigations, it has not been on the scale for which the guidance is primarily intended. Therefore this SWMP has had to take a different approach which of necessity has required departures from the guidance.

Information

2.5 Two sources of information have been used to determine the scope and focus of this study:

1. The Council has records of surface water flooding at various locations across its area, mainly resulting from rainfall in 2007. At some locations the consequences would have merited a S19 investigation. The most comprehensive records relate to the consequences of intense rainfall in June 2007 when areas in Haxby, Wigginton, Rufforth, Strensall, Clifton, Rawcliffe, Acomb and Holgate were affected by very localised rainfall events ranging from 1 in 7 to 1 in 100 year return period. These records show that 138 locations reported flood related problems, of which 7 were believed to be habitable properties suffering from internal flooding. The flooding mostly affected roads where the rainfall exceeded the drainage infrastructure design capacity of 1 in 30 years. These flooding records correlated well with those of Yorkshire Water Services, with whom there was considerable liaison and sharing of information after the event during investigations. There are no other records available from other sources.

2. The Environment Agency has produced 2 sets of modelled surface water flood risk maps, “Areas Subject to Surface Water Flooding” (AStSWF) and “Flood Maps for Surface Water Flooding” (FMfSW). Both have been looked at in some detail during both the PFRA process and this study and the FMfSW is considered to be the most realistic representation of the situation for the York area in the absence of observed data. The FMfSW estimated that 13,200 properties would be affected by a 1:200 AEP event, 11,500 to a depth of 0.1m and 1,700 to a depth of 0.3m. However, neither this modelling, nor the observed flooding in 2007 (see below) shows any large areas affected by flooding, but shows small areas affected at discrete locations across the City. Due to the type of very localised rainfall that causes such events and the dispersal of the affected areas throughout the City it is most unlikely that such a number of properties would all be affected at the same time. Additionally, although many areas are shown to be susceptible to surface water flooding, most have no record of actual flooding although it may have happened and not been reported.

2.6 A further source of local flooding can be from groundwater. Modelled information on this is provided by the EA is their “Areas Susceptible to Groundwater Flooding” (AStGWF) map. Groundwater flooding occurs as a result of water rising up from the underlying aquifer or from water flowing from abnormal springs. This tends to occur after long periods of sustained high rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth.

2.7 Groundwater flooding is known to occur in areas underlain by major aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels. The British Geological Survey maps show the bedrock in the area to consist of the Sherwood Sandstone group, a thick soft sandstone of Triassic age that forms the centre of the Vale of York. This is always classified as a Major Aquifer. Superficial deposits overlaying the sandstone consist predominantly of sands and gravels, with some clay and till. Bands of alluvium deposits intersect the City of York along the path of the River Ouse and River Foss. The drift deposits overlying the Sherwood Sandstone are classified as a Minor Aquifer, where the drift is relatively permeable, and a Non-Aquifer, where the drift deposits are fairly thick and have low permeability.

2.8 Although the AStGWF map suggests a potential for groundwater flooding, the Council has no record of areas where groundwater emergence is known to be a cause of significant flooding. It has not therefore been considered in this study and was also ruled out as a potential cause of flooding in the PFRA.

2.9 The surface water drainage of many areas of York is poor due to the presence of clay. Flooding problems caused by this are often mistakenly referred to as groundwater flooding, whereas it is caused by the inability of water to drain downwards, not the effect of water rising from the ground.

2.10 Consideration of the available information has therefore led to the conclusion that York does not have any large areas susceptible to frequent surface water flooding with significant consequences. The main effect of recorded intense rainfall events, supported by evidence from the FMfSW, is occasional flooding, sometimes of significance as defined by the draft criteria, of isolated properties but more often flash flooding of roads at various locations dispersed across the area. By its nature this type of rainfall is localised and tends to affect different areas in each event. The study therefore examines the areas of recorded flooding in 2007 in conjunction with the FMfSW mapping.

Catchment Flood Management Plans

2.11 Catchment Flood Management Plans, prepared by the EA, provide an overview of all types of inland flood risk in each river catchment with recommendations for risk management now and over the next 50 – 100 years. Two CFMPs are relevant to the York area, covering the Ouse and Derwent.

River Ouse Catchment Flood Management Plan

2.12 There are 2 policy units in the CFMP covering areas within the York boundary, 7.1.25 the North York and City Centre, and 7.1.26 South of York. These contain short, medium and long term actions for flood risk management within those areas. Those relevant to surface water management are the same for both Policy Units and listed in Table 2.1

<table>
<tr><th colspan="2">SHORT TERM ACTIONS: Before the next review of the CFMP (1-5 years)</th></tr>
<tr><th>Action</th><th>Outcome</th></tr>
<tr><td>Work in partnership with the LLFA to reduce the risk of flooding from surface water. Carry out detailed studies in areas identified as at ‘significant risk’ in the preliminary flood risk assessment. This should include investigation of areas known to be susceptible to surface water flooding in the North York and City Centre policy unit.</td><td>Working in partnership to reduce surface water flood risk within the policy unit a long term prioritised plan of action will be developed to reduce the risk of flooding from this source. Further detailed understanding of the risk this source of flooding poses will ensure that future strategic flood risk management plans and development documents take the risk of surface water into account.</td></tr>
<tr><th colspan="2">MEDIUM TERM ACTIONS: 1-20 years</th></tr>
<tr><th>Action</th><th>Outcome</th></tr>
<tr><td>Promote the use of SuDS for the management of run-off, as per the recommendations of PPS25. This should be done by:

▪ incorporating policies within the LDDs;
▪ encouraging developers to utilise SuDS wherever practicable in the design of development, if necessary through the use of appropriate planning conditions or by planning agreements;
▪ developing WCS to further encourage the use of SuDS as an aid to mitigating the rate and volume of surface water flows;
▪ promoting the use of SuDS to achieve wider benefits such as sustainable development, water quality, biodiversity and local amenity.

The commencement of schedule 3 of the Flood and Water Act 2010 will require sustainable drainage to be considered in all new development.</td><td>By embedding the requirements for SuDs within regional and local policy we will be able to work together to influence the implementation of local drainage schemes to effectively manage surface water within all new developments. As part of this it is vital that we understand and plan for the long term management of such assets to ensure their operation and management is sustainable.</td></tr>
<tr><th colspan="2">LONG TERM ACTIONS: 20-100 years</th></tr>
<tr><th>Action</th><th>Outcome</th></tr>
<tr><td>None</td><td>None</td></tr>
</table>

Table 2.1 River Ouse Catchment Flood Management Plan – Surface Water Management Actions

River Derwent Catchment Flood Management Plan

2.13 There are no actions relating to surface water management for the Council's area in the River Derwent CFMP.

Partnership

2.14 The Council is a member of the North Yorkshire Flood Risk Partnership, comprising CYC and NYCC elected members and officers, YWS, EA, IDB and the RFCC. This meets quarterly to provide a forum for statutory flood risk authorities to:

- support a joint strategic understanding and mitigation of flood risk in the sub region; and
- ensure that partners collaborate in the development of LLFA based local flood risk strategies and other necessary tasks required by current legislation.

2.15 It is well known that York suffers frequent flooding from the rivers Ouse and Foss, and to a lesser extent from the Derwent. The effects are well recorded, predictable and subject to a well rehearsed response plan. Because of this there is a longstanding relationship between the various partners involved, and both the River Flood Emergency Plan and Multi Agency Plan are reviewed annually. Due to the increasing frequency of non river flooding, these reviews include discussions of the effects of surface water flooding and response. In addition to the various Directorates within the Council and the emergency services, the participants are:

The Environment Agency

The Council has had a good working relationship with the Environment Agency since its inception in 1996, and with its predecessors before that. Its drainage engineers have always worked closely with the Agency's officers in all aspects of flood risk management, particularly in managing the frequent fluvial flood events that affect York and also in liaison over planning issues.

Yorkshire Water Services Ltd

Until 1998 the Council was sewerage agent for YWS and engineers familiar with the network are still employed by the Council in the Flood Risk Management team. Since the loss of the agency they have continued to liaise with YWS in investigating drainage problems and this relationship has been strengthened by the signing of an information sharing protocol following the enactment of the Flood and Water Management Act 2010.

Internal Drainage Boards

There are four Internal Drainage Boards around York to which the Council pays a special levy and may nominate members. Since 1998 one of these nominees has been a Council drainage engineer and as a result the Council's Flood Risk Management team enjoys a good working relationship with all of the Boards. Within their Districts the IDBs are responsible for managing flood risk from ordinary watercourses. The Board districts, where they overlap the City, are shown in Figure 2.1. It should be noted that all Boards are responsible for considerable areas beyond the City boundary, though in each case the largest urbanised area is York.

2.16 Although the IDBs manage watercourses within their areas, CYC is the LLFA and therefore has overall responsibility for managing flood risk within its area.

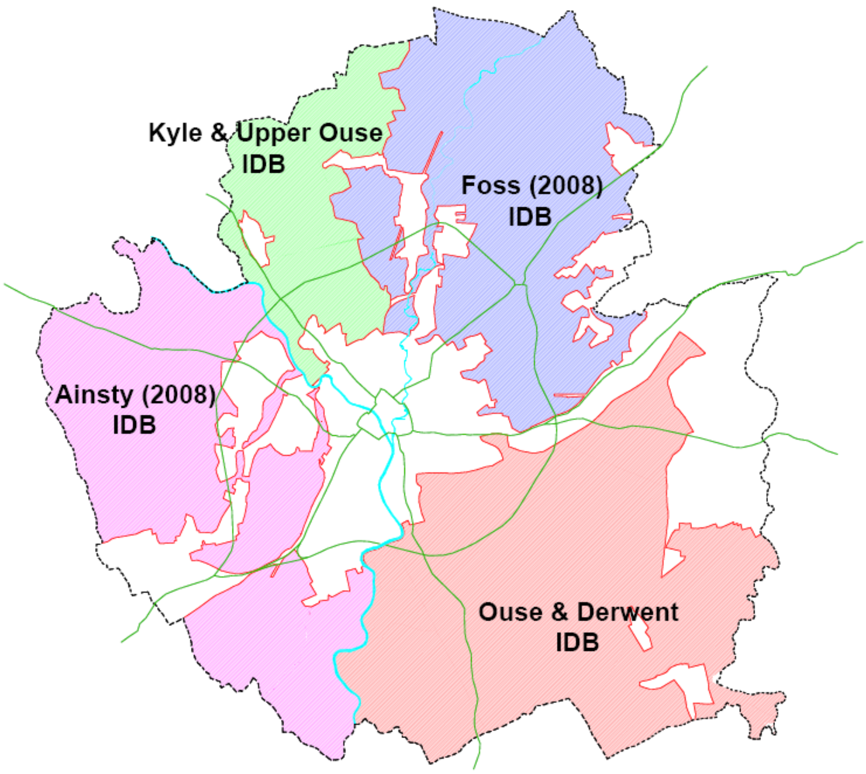


Figure 2.1 – IDB Districts

2.17 With reference to the Defra guidance a partnership should be formed of partners and stakeholders to progress the SWMP. Paragraph 2.2 states that "Due to the variable nature of organisations involved in a SWMP study, the guidance is not prescriptive about how the partnerships should be established, nor the specific roles and responsibilities of each partner. It is recognised that flexibility is required, and that the way a partnership operates in practice will vary."

2.18 This was taken into consideration in this SWMP study. Recorded and predicted surface water flooding is of a localised small scale, dispersed and infrequent.

There has been no impetus on the part of any communities to form action groups or to act collectively and as a consequence there have been no interest groups to involve as stakeholders in the study.

2.19 Because of the nature of the flooding to be investigated in this study the Council considered that there was no overall strategic driver which would require a formal partnership as all interested parties are in regular dialogue regarding flooding issues as required. In investigating specific problem areas prior to and during this study, Council engineers have liaised as necessary with the EA, IDB and YWS in conjunction with local ward members, parish councils and residents. This partnership working on a local and ad hoc basis has proved very effective in identifying the causes of flooding problems, potential solutions and responsibilities for their implementation.

2.20 Cross boundary surface water drainage issues with neighbouring authorities were considered. The principal neighbouring authority is North Yorkshire County Council and its boundary with York extends from near Stamford Bridge on the River Derwent, around the north, west and south sides of York, to Wheldrake, again on the River Derwent. The boundary is completed by the River Derwent itself between Stamford Bridge and Wheldrake, on the other side of which is East Riding of Yorkshire County Council. Consultation with both Councils has confirmed that there are no cross boundary surface water drainage issues.

2.21 In the circumstances of this particular study it is not felt that a more formalised approach would have reached different conclusions or produced a different action plan. However, the issue of a more formal partnership will be addressed in the preparation of the Council's Local Flood Risk Management Strategy and the findings of this study will be form a key role in progressing it.

Scope of study

2.22 With no areas recorded to have suffered large scale, frequent or persistent surface water flooding, and none that are predicted from the FMfSW or recorded in the PFRA, the SWMP study has concentrated on investigating a sample number of the areas which suffered surface water flooding in 2007. While the investigations were centred on the flooded areas they have in many cases extended beyond to establish the underlying cause.

2.23 The study comprises:

- Modelling of a sample of areas recorded to have flooded in 2007 to provide an understanding of the cause of the flooding and also a check on the accuracy of the FMfSW mapping.

- On site investigation centred on some of these areas, following consideration of the modelling, and either resolution as part of the investigation or to confirm an understanding of the cause for further action later.

2.24 Considering the flood risk situation in the Council's area the objectives of the study are:

1) A clear understanding of the causes of flooding at each location investigated.

2) A record of the infrastructure serving the location and its condition and ownership.

3) A validation of the EA Flood Map for Surface Water.

4) Recommendations for future maintenance to prevent a repetition of the problem.

5) An understanding of how representative the findings are of the situation citywide.

6) Recommendations for further investigation.

7) Recommendations for further work.

8) Advice and information to local authority planners.

2.25 This SWMP study may influence by or be influenced by other Flood Risk Management Authority local or regional delivery plans. Examples are the Environment Agency Catchment Flood Management Plans (CFMPs) which explain the policy for the management of flood risk from main rivers and may influence the development of a SWMP if there are areas where these interact with surface water. Figure 2.2 shows the potential inter-relationship between the multitude of plans which may exist, be in preparation, or be required in the future.

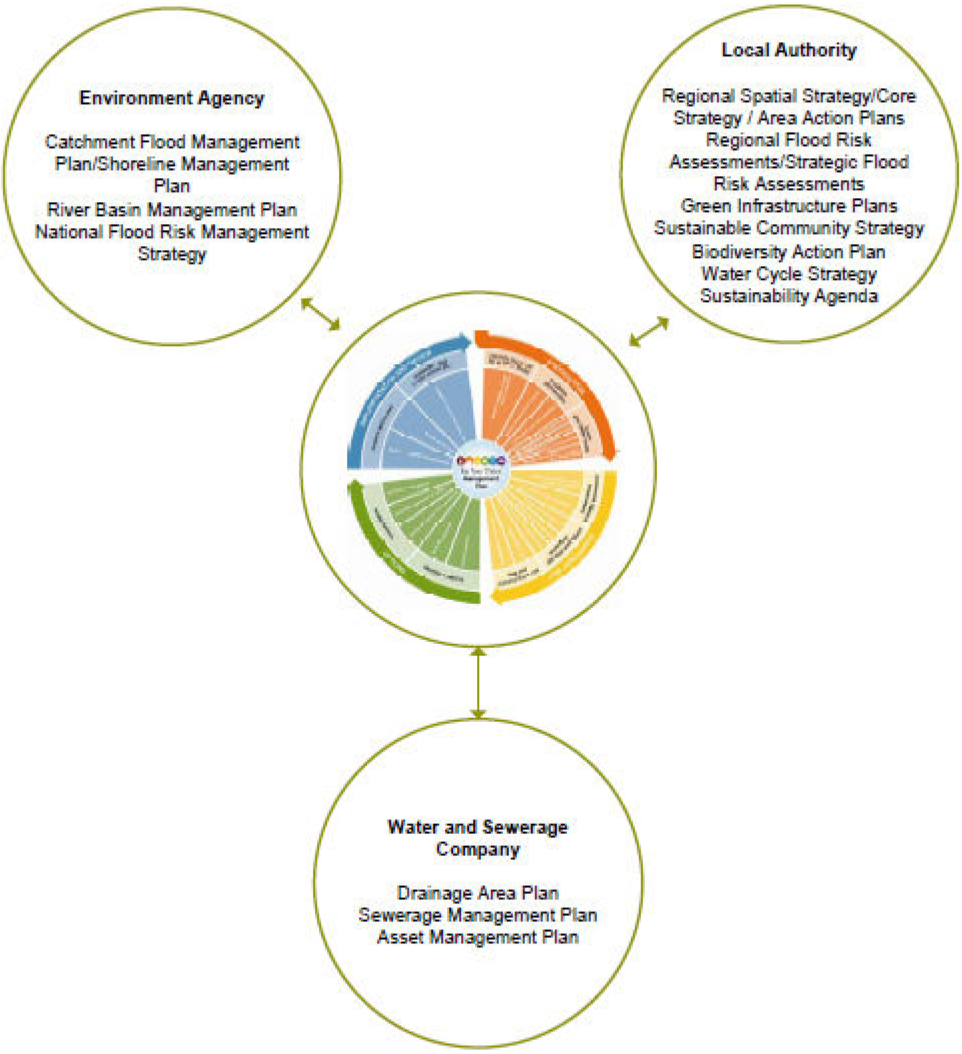


Figure 2.2 - Links between SWMP and other plans

3 AVAILABLE INFORMATION

3.1 Records of surface water drainage infrastructure in the Council's area are patchy. It is known that many watercourses have been culverted during development but their locations are poorly recorded, if at all. This is also the case for highway drainage in non sewered areas. Very little information was inherited from the predecessor authorities and there were also significant gaps in the former York City drainage records. The location of most of the highway gullies is recorded on the EXOR Highway Management System as surface features but there is no record of the drainage system serving them or details of connectivity. The YWS statutory sewer records provide some guidance where public sewers may serve the gullies but there is no information in many areas of the City regarding the location of any highway drainage network, though it is clear from the presence of gullies that there must be some. This shortage of information throughout the Council's area has long been a concern as it makes resolution of flooding problems difficult and effective maintenance impossible.

3.2 A citywide desk study of the location of gullies, available highway drainage network records and YWS records has shown that an estimated 5% of the gullies have no obvious network serving them. While this figure may not appear to be very high a significant number of these missing records affect major arterial roads into and around the City. The most major of these are:

- A19, boundary to A19/A1237 roundabout
- A1237, entire length from Askham Bryan to Hopgrove
- B1363 Wigginton Road, boundary to hospital
- Haxby road between Haxby and New Earswick
- Strensall Road, A1237 to Strensall
- Strensall, York Road
- Stockton Lane from Heworth Without to Stockton on Forest
- A1036 Heworth to Hopgrove
- A1079 Hull Road, Windmill lane to boundary
- A166 Stamford Bridge Road, outer ring road to Gate Helmsley
- B1228 Elvington Lane, Hull Road to Elvington
- A19 Selby Road, south of Fulford to boundary
- B1222 Naburn Lane, A19 to designer outlet
- Bishopthorpe Road, racecourse to Bishopthorpe
- Sim Balk Lane, complete length
- A1036, Sim Balk Lane to Tadcaster Road, Copmanthorpe
- Askham Lane, Woodthorpe to A 1237
- B1224 Acomb to Rufforth
- A59 Poppleton to Boundary

3.3 This lack of information can cause major disruption to traffic in the event of a flood incident. Two such examples have occurred in 2012:

- On Friday 27 April flooding at the A19/A1237 roundabout caused major disruption to the whole of the A1237 outer ring road from 7 am to 2 pm as a major part of the roundabout was impassable and 1½ to 2 hours were typically added to journey times. Resolution of the problem required an investigation to locate the drainage system and outlet, which was blocked with tree roots. None of the highway drainage routes were recorded on any readily accessible database

- On Sunday 10 June the A1079 both carriageways of the Hull Road flooded from the outer ring road roundabout to Badger Hill. The road was impassable for several hours and a subsequent investigation found major silt blockage in both highway drains and public sewers. None of the highway drainage routes were recorded. In addition at least 8 properties on the Badger Hill estate suffered internal flooding.

3.4 Following the flooding in 2007, and in recognition of this shortage of information and the recurrence of persistent highway flooding problems at many locations, funding has been made available for investigation and remedial work from the highway maintenance budget over the past four years.

3.5 The availability of funding for the SWMP has enabled modelling of areas to be carried which would not have otherwise been done. This has provided a better understanding of the problems and their causes, and a check of the accuracy of the FMfSW. Some of the funding was also used to assist with the cost of investigations, which have established the cause of many flooding problems and often resolved them, while also providing improved records of the drainage infrastructure.

3.6 In accordance with the SWMP Technical Guidance information is categorised as follows:

1. Asset data and information
2. Background information
3. Historical information
4. Future development information
5. Document and plans
6. Water quality information

3.7 In order to indicate the quality of the data the guidance suggests the following scoring:

1 Best possible
2 Data with known deficiencies
3. Gross assumptions
4. Heroic assumptions

Table 3.1 summarises the data available for the study:

Source of Information	Category	Knowledge/data type	Data quality score	Usage restricted?
City of York Council	5	Strategic Flood Risk Assessment (SFRA)	1	No
	5	Preliminary Flood Risk Assessment (PFRA)	1	No
	3	Historic flood event data	2	No
	1	Highway drainage records	2	No
	1	Information on ordinary watercourses	2	No
	1	Maintenance regimes and records	3	No
	2	OS mapping data	1	OS licence restrictions
Environment Agency	4	Catchment Flood Management Plans (CFMPs)	1	No
	1	Fluvial Flood Maps	1	No, if not modified
	2	Ground data (LIDAR)	1	Subject to EA license agreement
	2	Areas Susceptible to Surface Water Flooding (AStSWF)	2	No
	2	Flood Map for Surface Water (FMfSW)	2	No
	2	Areas Susceptible to Ground Water Flooding	2	No
Yorkshire Water	1	Foul/combined/surface water models	2	In accordance with Data Sharing Protocol
	1	Drainage asset data	2	
	3	DG5 register	1	
Internal Drainage Boards	1	Information on local watercourses	1	No

Table 3.1: Available Data

4 LEVEL OF ASSESSMENT AND MODELLING APPROACH

4.1 In accordance with the Defra technical guidance the appropriate level of assessment for the SWMP was considered to be a Detailed Assessment for the following reasons:

- A Strategic Assessment is inappropriate due to the small size of the authority's area, its topography, and the lack of any identified areas of significant flooding on the basis of records or EA modelling. The FMfSW provides a strategic broad scale assessment of risk.
- An Intermediate Assessment was not considered appropriate as sufficient data was available to identify localised small areas that had been affected by flooding, with further guidance provided by the FMfSW mapping.

4.2 At the time of commencing the Surface Water Management Plan there was little evidence in the from of reported incidents available pointing to widespread, frequent or persistent surface water flood risk at any location within the study area. However, it was considered that the opportunity should be taken to carry out a detailed assessment of those areas where flooding was recorded in 2007, and to use this to validate the EA's FMfSW, establish the causes of flooding and identify solutions.

4.3 To progress this Halcrow were engaged to provide modelling expertise. The following is an extract from their report regarding the selection of the modelling approach. The full modelling report is included as Appendix 1:

> *The purpose of the pluvial modelling was to provide quick and simple modelling of pluvial flows to identify the broad surface water risk areas. By applying rainfall directly onto a 2D mesh using TUFLOW software flood extent and depths was determined for eight hot spot areas. Allowance for storage capacity available within the below ground drainage network for each hot spot has been included. Further simulations to investigate the impact of blocked or insufficient gullies on flood extents and depths were also undertaken.*
>
> *The conceptual approach adopted was to assume that rainfall falling within each modelled hotspot area was the primary source of flooding in that area. Inflows generated by rainfall falling outside each area being secondary either because these flows are very small, or because their time-of-arrival at each study area would be much later than the occurrence of more severe flooding due to the local rainfall). This assumption was considered acceptable due to the very small size of the urban hotspots being investigated.*
>
> *Rainfall was computed using the Flood Estimation Handbook methodology with losses computed using the FEH rainfall-runoff model. Losses represent hydrological processes which do not directly contribute to surface flooding such as infiltration and interception. Rainfall depths were computed for a range of return period between 1 in 1 yr and 1 in 1000 yr. Allowance for the*

below ground drainage network capacity was made by subtracting the net rainfall for the estimated sewer standard of service from the specified return periods.

Resultant net rainfall was distributed onto a 2-D terrain model and routed using the TUFLOW hydrodynamic modelling package. A separate 2-D model was developed for each of the eight flooding hot spots. Maximum flood extents for depths greater than 0.1 m and 0.3 m were plotted for specified return periods.

4.4 Areas of surface water flooding concern (flooding hotspots) were identified by CYC based on known historic flooding, Yorkshire Water's sewer flooding record, and the Environment Agency's surface water flood maps. Twelve hotspots were identified as in Table 4.1:

Area	Hotspot Name
1	Strensall
2	Wigginton / Haxby
3	Rawcliffe
4	Clifton Without
5	Clifton
6	Heworth
7	Burnholme
8	Acomb
9	Holgate
10	a. Westfield b. Woodthorpe
11	Bishopthorpe
12	Rufforth

Table 4.1: Initial list of Hotspots

4.5 Each of these 12 hotspots was reviewed by Halcrow together with CYC, to understand better the existing flood risk and sources and causes of flooding. Where the reasons for flooding were well understood in a particular hotspot, or solutions had already been identified or implemented, hotspots were removed from the scope of further work**.** Table 4.2 summarises the review of the hotspots:

Area	Summary of review	Conclusions	Hydraulic modelling?
1	The key area of concern is that centred on York Rd where the EA mapping shows deep flood risk. More detailed modelling should be carried out here.	Hydraulic modelling required. CYC to consider a culvert survey of Strensall Drain d/s of this area.	Y
2	The key area of concern is The Village, in the vicinity of the property flooded in 2007.	Hydraulic modelling required. CYC to consider a flooding questionnaire for properties in this area.	Y
3	The key areas of concern are Howard Drive and Rawcliffe Croft.	Hydraulic modelling required. CYC to consider a flooding questionnaire for properties in this area.	Y
4	The key area of concern is in St Phillip's Grove area. Other areas of flood risk appear to be as a result of culvert capacity on Birdike.	Hydraulic modelling required. CYC to consider a flooding questionnaire for properties in this area. Birdike culvert may benefit from CYC culvert survey.	Y
5	Two key areas of concern are in Shipton St and Field View. The sewer system appears to be under capacity in Shipton St area, and there are vulnerable people at risk of flooding (elderly care home shown within EA flood risk area).	Hydraulic modelling required. CYC to consider a flooding questionnaire for properties in this area.	Y
6	The three key areas (in Straylands Grove, Elm Park Way and Elmfield Ave appear to be due to under capacity of existing drainage.	Hydraulic modelling required. CYC to consider a flooding questionnaire for properties in this area.	Y
7	Only key issue is at junction of Badbargain Lane and Gerard Avenue, due to known gully issues.	Hotspot removed from the scope of this study.	N
8	Two key areas are junction of Carr Lane and Boroughbridge Rd, and Ouse Acres.	Hydraulic modelling required. CYC to consider a flooding questionnaire for properties in this area. CYC to consider survey to determine capacity and condition of Ings Cliff Drain, as EA flood risk map show this area at risk, although no flooding reported here in June 2007.	Y
9	The area around Beech Ave appears to be an issue. Likely main cause is a sewer capacity issue.	Hotspot removed from the scope of this study.	N

Area	Summary of review	Conclusions	Hydraulic modelling?
10a	The key flood risk areas are around Huntsman Walk.	Hydraulic modelling required. CYC to consider a flooding questionnaire for properties in this area. There is a known DG5 issue with a property on Foxwood Lane. CYC to follow this up with YWS.	Y
10b	Key flood risk areas here are around Acombwood Dr and Alness Dr. Likely main cause is a sewer / land drain capacity issue.	Hotspot removed from the scope of this study.	N
11	It was agreed that the flooding issues here would not benefit from additional surface water modelling.	Hotspot removed from the scope of this study.	N
12	It was agreed that the flooding issues here would not benefit from additional surface water modelling.	Hotspot removed from the scope of this study.	N

Table 4.2: Review of hotspots

4.6 Following this review, focus areas within eight hotspots were taken forward for hydraulic modelling and further assessment. The complete list is included in Table 4.3 below.

Area	Hotspot Name	Focus Area Name
1	Strensall	York Rd
2	Wigginton / Haxby	The Village
3	Rawcliffe	Howard Drive Rawcliffe Croft
4	Clifton Without	St Phillip's Grove
5	Clifton	Shipton St Field View
6	Heworth	Straylands Grove Elm Park Way Elmfield Ave
8	Acomb	Junction of Carr Lane and Boroughbridge Rd Ouse Acres
10a	Westfield	Huntsman Walk

Table 4.3: Final hotspots and focus areas

4.7 Investigations were undertaken at and around the locations detailed in Table 4.4 to support the modelling and to help to understand its outputs and conclusions. The prioritisation of the investigations was determined by the scale and extent of the problems identified from the 2007 flooding records and available engineering and financial resources. Most investigations commenced with very minimal information on the existing drainage infrastructure so the process was slow and progress dependent on what was found. For this reason the investigations at many locations in Strensall, Haxby and Wigginton occupied a considerable part of the investigation time as they, of necessity, extended outwards as further problems were uncovered. This is discussed in part 5.

Area	Hotspot Name	Investigation
1	Strensall	Yes
2	Wigginton / Haxby	Yes
3	Rawcliffe	No
4	Clifton Without	No
5	Clifton	No
6	Heworth	No
8	Acomb	Yes
10a	Westfield	No

Table 4.4: Modelled areas investigated

5 ANALYSIS OF MODELLING AND SITE INVESTIGATIONS

5.1 The analysis has been carried out using three main sources of information:

1 A number of selected hotspots that flooded in 2007 have been modelled. The short listing is covered in part 4 and the full report is in Appendix 1.

2 The EA flood risk mapping “Flood Map for Surface Water Flooding” (FMfSW) which was agreed during the PFRA process as providing the best guidance for the Council’s area.

3 Investigations which have been carried out by CYC flood risk engineers focussed on some of the modelled hotspot areas as detailed in part 4 and more extensively where further problems have been identified.

5.2 The sections in the following analysis are referenced using the modelling report hotspot numbering shown in Table 5.1. Maps showing the locations of flooding are included in the modelling report, Appendix 1:

Area	Hotspot Name	Focus Area Name
1	Strensall	York Rd
2	Wigginton / Haxby	The Village
3	Rawcliffe	Howard Drive Rawcliffe Croft
4	Clifton Without	St Phillip’s Grove
5	Clifton	Shipton St Field View
6	Heworth	Straylands Grove Elm Park Way Elmfield Ave
8	Acomb	Junction of Carr Lane and Boroughbridge Rd Ouse Acres
10a	Westfield	Huntsman Walk

Table 5.1: Final hotspots and focus areas

5.3 Hotspot 1: Strensall

Location

Strensall is a large village 10km north of York, and 4km north-east of Haxby. It is located between the River Foss to the west and Strensall Common to the east. The Common covers over 500 ha and is a Special Area of Conservation, being an example of lowland heathland habitat. To the south of the village is Strensall Camp, built by the War Office in 1884 for training troops, covering an area of about 730 ha and stretches to Towthorpe at its southern end. The military estate includes an army firing range and training area on the Common. Before 1996 it was part of the Ryedale district.

Topography

The area is very flat with little variation in height, and the village is in the natural flow path from the western side of the Common to the river. The area is predominantly warp and lacustrine clay and drains poorly. There is a history of clay extraction in the area with consequent areas of land fill and ponds.

Drainage

The older part of the village is centred around The Village (road) and Bone Dyke, which flows to the River Foss from the Common and is culverted through the urbanised area. This dyke is one of the main routes for surface water drainage from the northern western part of the Common picking up flows from a network of field ditches. There are few surface water sewers in the old village and the sewerage system is mostly combined, flowing by gravity to the YWS Cobbs Cottage pumping Station then on to Walbutts treatment works northeast of Strensall.

Development

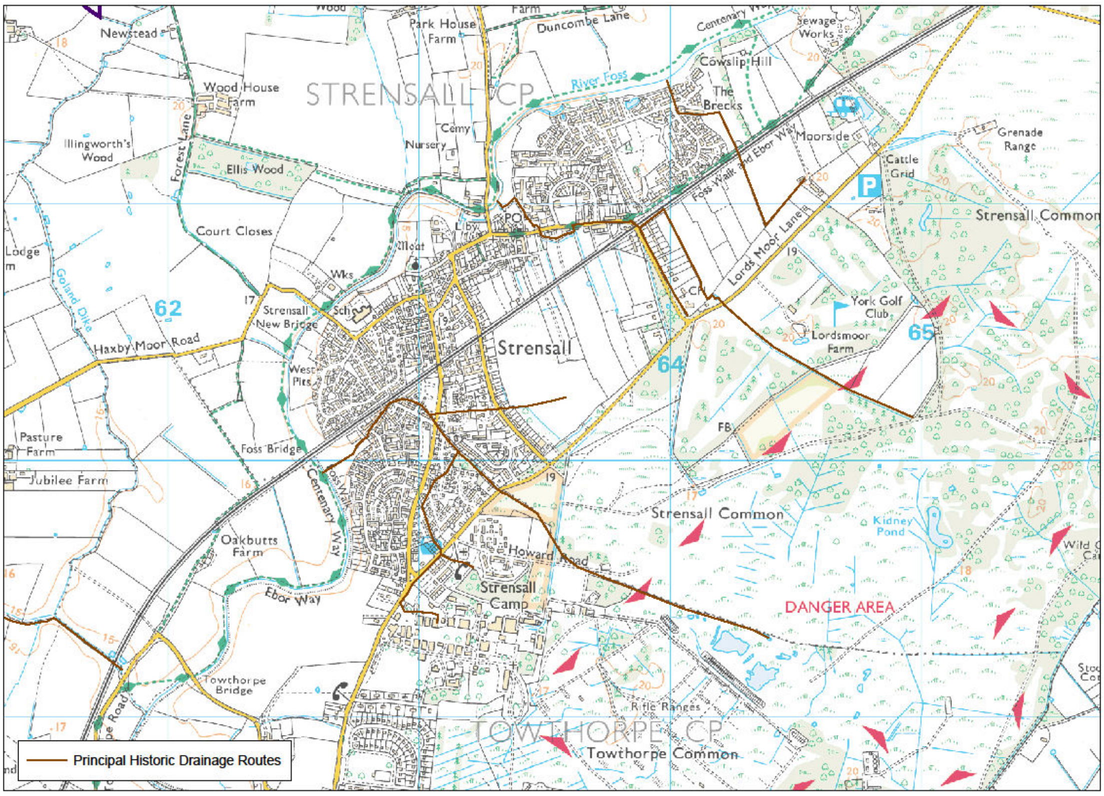
The first major expansion of the village occurred after 1950, to the south west of the old village east of York Road, significantly increasing its size. Surface water from these developments discharges to the Foss (2008) IDB Strensall Drain which in turn discharges to the River Foss south of the York to Scarborough railway line. It is largely culverted in various sizes and materials, and often inaccessible due to the developments either side. Strensall Drain had previously drained the south western part of the Common but it is understood that, prior to this area being developed, it was intercepted south of the junction of Ox Carr Lane and Moor Lane. A 600mm/750mm culvert was constructed which conveys flows from the Common on a route to the south east of Ox Carr Lane, discharging to the River Foss south of the village.

Subsequent development west of York Road extends from the junction of York Road and Strensall Road northwards across the York to Scarborough railway line to West End. This represents another very significant increase in the size of the village. Surface water from these developments is drained via the sewerage network to six outfalls into the River Foss.

The final area of significant development, known as The Brecks, is located to the north east of the old village. This is post 1990 development and surface water discharges directly to the River Foss through a further six sewerage system outfalls between Strensall Bridge and the eastern end of the development.

The railway, roads, housing development and military use of the Common have all affected the natural drainage of the area and surface water flooding has occurred at many locations throughout Strensall, affecting both urban and rural highways and also gardens and a few properties. It has been found that, in Strensall, there is often interconnectivity between the individual flooded areas that have been recorded and/or investigated indicating widespread infrastructure failure.

The historic drainage routes in relation to the current development are shown on drawing 5.2



Drawing 5.1: Historic Drainage Routes in Strensall

Recorded Flooding

Flooding has occurred at many locations throughout Strensall over a long period of time. The modelling concentrated on the area most affected in 2007. The following analysis groups some of the most significant problem areas together from the investigating engineers' reports mostly concentrating on the more urbanised areas. In most areas the investigations started with a very poor understanding of how the drainage systems should work, due to lack of records.

However, there are fundamental infrastructure problems that have been identified, which further links many of these grouped areas together.

Analysis

a) Hallard Way/Kirklands/Highland Avenue

This urban area was modelled and the findings are recorded in the report (Appendix 1) as Hotspot 1 (Strensall):

The flood evidence from the 2007 event indicates flooding of the Kirklands highway adjacent to the junction with Hallard Way. The Environment Agency Surface Water Flooding maps indicate flooding in a very similar area with deep water around Kirklands and an adjacent area between Kirklands and Oak Tree Close.

Results from the model are consistent with the 2007 and Environment Agency results. Shallow flooding in the 1 in 30 yr and 1in 75 yr occurs along Kirklands with limited property flooding commencing at 1 in 100 yrs. Results for the 1 100 yr + CC are very similar to the 1 in 200 yr. Confidence in model results is therefore good.

The extents and depth of predicted flooding for the gully blocked scenarios are more extensive than the baselines simulations, indicating that gulley maintenance is important in this area.

This area is centred on Strensall Drain. Investigations carried out following the 2007 flooding in this and surrounding areas have found root and siltation problems in both CYC and riparian owned pipes and culverts, both those discharging to Strensall Drain and within the Drain itself. It is likely that these blockages have affected the performance of gullies rather than them being blocked. Some of the problems have been solved by this investigation but more work is necessary to maximise the performance of the infrastructure both here and in the wider area.

Recommendation

As both models indicate a risk of flooding to both highways and property and the investigation is incomplete, it is recommended that investigation is continued to resolve remaining problems to minimise the risk.

b) York Road

This area, the main road into Strensall from York, is built up and adjacent to area a). It was affected by highway flooding in 2007, but no property is recorded to have flooded. Although the modelling report does not comment on this area it does show that very minor scattered shallow flooding may occur from a 1 in 200 year event. This correlates well with the FMfSW for the same return period. The scale of observed flooding exceeded that modelled, indicating that infrastructure failure could be the cause.

Little of the highway drainage infrastructure was recorded in this area and subsequent investigation found problems with roots, siltation, blocked gullies, damage by utilities affecting CYC owned pipes and culverts. The opportunity was taken to carry out repairs as the blockages were located.

Following this remedial work it is thought that future events will closely replicate the predicted flooding from the models.

Recommendation

Monitor effect of future rainfall events.

c) Flaxton Road (various locations) and junctions with Scott Moncrieff Road and Moor Lane

This mainly rural area has suffered persistent highway flooding at a number of locations over many years, most severely in the winter with depths up to 150mm, but also in summer. No modelling predicts flooding at these locations indicating that deficiencies in the drainage infrastructure together with the flatness of the area are likely to be the cause. Investigations carried out over several years as funding has permitted have confirmed this view.

Investigations have confirmed that this area should drain to the culvert which was constructed to intercept Strensall Drain. Little of the highway or other infrastructure in the area was recorded and much of the surrounding land on Strensall common is owned by the MoD which has riparian responsibility for ditches and culverts. Investigations found the cause of flooding to be minimal maintenance of these assets and root growth and siltation in the highway drainage system. Some repairs have been carried out but more work is to be done in some areas.

It is likely that, once effective repairs have been completed, flood risk in this area will be minimised and if the drainage systems are maintained there should be little risk of flooding and those areas still affected will correlate closely with both models.

Recommendation

While this flooding does not affect property, the standing water on this well used rural road can be hazardous, particularly in winter. It is recommended that investigation is continued to resolve remaining problems to minimise the risk.

d) Moor Lane

Internal flooding affected 39 Moor Lane in 2000, together with the highway midway along Moor Lane, in front of it and adjacent properties. The highway outside 52 Moor Lane, about 100m north of its junction with Flaxton Road has also flooded several times since 2000.

Both the study and FMfSW models confirm that the area in front of 39 Moor Lane would be affected by shallow flooding from a 1 in 200 year event. The FMfSW flood envelope extends slightly into the garden of 39 Moor Lane towards the property, while the study model just shows flooding in the highway. Both models also show highway flooding south of that observed outside 52 Moor Lane.

Investigations have established that the property flooding was due to overland flows through the garden from open fields behind to the road in front. This is on the line of a tributary to Strensall Drain from the north western area of the Common. The modelling reflects a low point in front of the property and the flows appear to have followed a natural flow path. Investigations have been carried out and it is likely that the flooding has been caused by root infestation and siltation in downstream culverts, but there are also problems with riparian drainage in nos. 37, 39 and 41 and complications with foul sewers which have not been resolved. Further work may reduce the flooding to that shown in the models, but onset of flooding could continue to be from less extreme events.

The extent of flooding nearer the junction with Flaxton Road is reasonably predicted by the models but, once again, the onset of observed flooding was probably from a lesser event. An investigation found a defective culvert with many buried manholes and the culvert was once again blocked with roots and silt. Since this has been cleaned it appears to have prevented the early onset of flooding, though more extreme events are likely to affect the area as shown by the modelling, which is considered to be a reasonable prediction of likely flooding.

Recommendation

It is recommended that the investigation be continued and necessary remedial work carried out to minimise risk of flooding to property.

e) Ox Carr Lane / Oak Tree Close

Ox Carr Lane: A 260m length of Ox Carr Lane from the west of its junction with Moor Lane to Strensall Drain behind Oak Tree Close has suffered persistent ponding at gully positions along its length. As with Flaxton Road, which is a continuation of this road north eastwards, this was not reflected in modelling, indicating that the gullies and associated infrastructure were probably not functioning correctly.

The investigation in this area established the previously unrecorded presence of the 600mm/750mm culvert which appears to have been constructed to intercept Strensall Drain. This conveys flows from the Common on a route to the south east of Ox Carr Lane, discharging to the River Foss south of the village. It is assumed that this was done prior to the urbanisation of the village around the original route. This culvert also has many connections from the Common. Poor quality land drains full of silt and roots, and in one location damaged by a lamp column, were found in the verges of both sides of the road. The pipes were of such poor quality that many disintegrated when jetted.

Limited repairs have been carried out, together with the provision of new gullies, and the system now operates more effectively though further investigation and repairs need to be carried out. It is unlikely that the flooding here has been completely remedied as it is known that there is further work to be carried out.

Recommendation

While this flooding does not affect property, the standing water on this well used rural road can be hazardous, particularly in winter. It is recommended that investigation is continued to resolve remaining problems to minimise the risk.

Oak Tree Close: Strensall Drain behind Oak Tree Close has caused flooding in the rear gardens of the odd numbered properties in Oak Tree Close. This is predicted in both models, but it is likely that the onset of flooding was sooner than predicted due to various ways in which the ditch had been interfered with - weirs, filling in, culverts of various sizes, built over with sheds etc., and was found to be aggravated by the problem investigated in Hallard Way/Kirklands/Highland Avenue ((a) above), further downstream on Strensall Drain.

Recommendation

It is recommended that the investigation be continued as resources permit to ensure that there are no obstructions to the flow of Strensall Drain and its adjoining drains.

f) Strensall Road

Highway flooding has occurred at various isolated locations on Strensall Road between Towthorpe Lane at the southern end and Ox Carr Lane at the north. This is beyond the extent of the study model and is not shown to be affected in the FMfSW. Investigation work found unrecorded highway drains and culverts blocked with silt, roots and damaged by utility work.

Repair and cleaning has been carried out, together with the improvement of poorly designed gullies, and the system now operates more effectively.

Recommendation

Monitor effect of future rainfall events.

g) Southfields Road

Highway flooding has occurred on several occasions across the full width of the road along a 200m length. This is beyond the extent of the study model but the FMfSW predicts that a shorter length may be affected by shallow flooding in a 1 in 200 year event. The frequency of observed flooding would indicate that infrastructure failure is the cause of the problem. The road is shown on the YWS sewer record to be served by a combined sewer and there was no clear evidence of how the road drained.

The investigation located blocked uncharted highway drains and a collapsed manhole flowing northwards to The Village. The repair of this has not completely solved the problem and further investigation is required.

Recommendation

It is recommended that the investigation be continued as resources permit.

h) The Village

Highway flooding has occurred on The Village (road) at its junction with the Sheriff Hutton Road and at its crossing of Bone Dyke 180 metres east. This older part of Strensall is served by a combined sewerage system but there was no clear evidence of how the road drained. Both of these areas are beyond the extent of the study model but the FMfSW predicts that both areas may be affected by shallow flooding in a 1 in 200 year event. The frequency of observed flooding would indicate that infrastructure failure is the cause of the problem.

The investigation at the Sheriff Hutton Road junction noted that the combined sewer is under capacity as sewage escapes from a YWS manhole cover have been noted on several occasions. A substantially blocked uncharted pipe was located discharging westwards from outside 22 The Village. This pipe was heavily silted and lacked any obvious means of access for maintenance. Excavations and further CCTV surveys revealed numerous chambers that were slabbed over, which have now been raised to the surface to provide future access. Although this pipe appears to be operating satisfactorily it outfalls to a section of culverted watercourse beyond Church Lane which may be affected by tree roots.

A pipe was also found running east from the same location, and then north along the Sheriff Hutton road discharging to the River Foss west of the bridge. Although apparently working, flooding was experienced in August 2011 and further investigation is required. There is evidence that an old ditch leading directly to the River Foss, which would have allowed the water level on the road to overflow, has been filled in.

The investigation at The Village crossing of Bone Dyke found blocked gullies and obstructions in the downstream open watercourse but has not been conclusive as to the cause of flooding.

Recommendation

It is recommended that the investigations at both locations be continued as resources permit.

5.4 Hotspot 2: Wigginton/Haxby

Location

Haxby is located 7km north of York and 4km south of Strensall. It is bordered on the east by the River Foss and to the west by the village of Wigginton. Expansion has caused the two settlements to form a continuous densely populated urban environment. The garden village of New Earswick is to the south with open farmland to the north as far as the villages of Sutton-on-the-Forest and Strensall. Before 1996 they were part of the Ryedale district.

Topography

The two villages sit on ground consisting mostly of clay with sand and alluvium soil, near the old Forest of Galtres. To the north is Goland Dike, a small tributary of the River Foss, to the east is the River Foss which flows southward towards York and the River Ouse. Forming the western boundary of Wigginton is Westfield Beck. The area is very flat with little variation in height. There is a history of clay extraction in the area with consequent areas of land fill and ponds.

Drainage: Haxby

The older part of Haxby is centred around the junction of The Village (road), Station Road and York Road. The area to the south of The Village and east of York Road drains eastwards towards the River Foss via several minor field drains which cross the York to Scarborough railway line. There are two large ponds at the site of former brickworks between York Road and the railway. North of The Village the natural drainage is northwards via the minor Foss (2008) IDB maintained watercourses Wigginton Drain, Usher Lane Drain and Haxby Grange Dyke, which discharge to Goland Dyke which in turn discharges to the River Foss at a point north of Haxby. Windmill Lane Culvert drains the north eastern corner of the village eastwards to the River Foss.

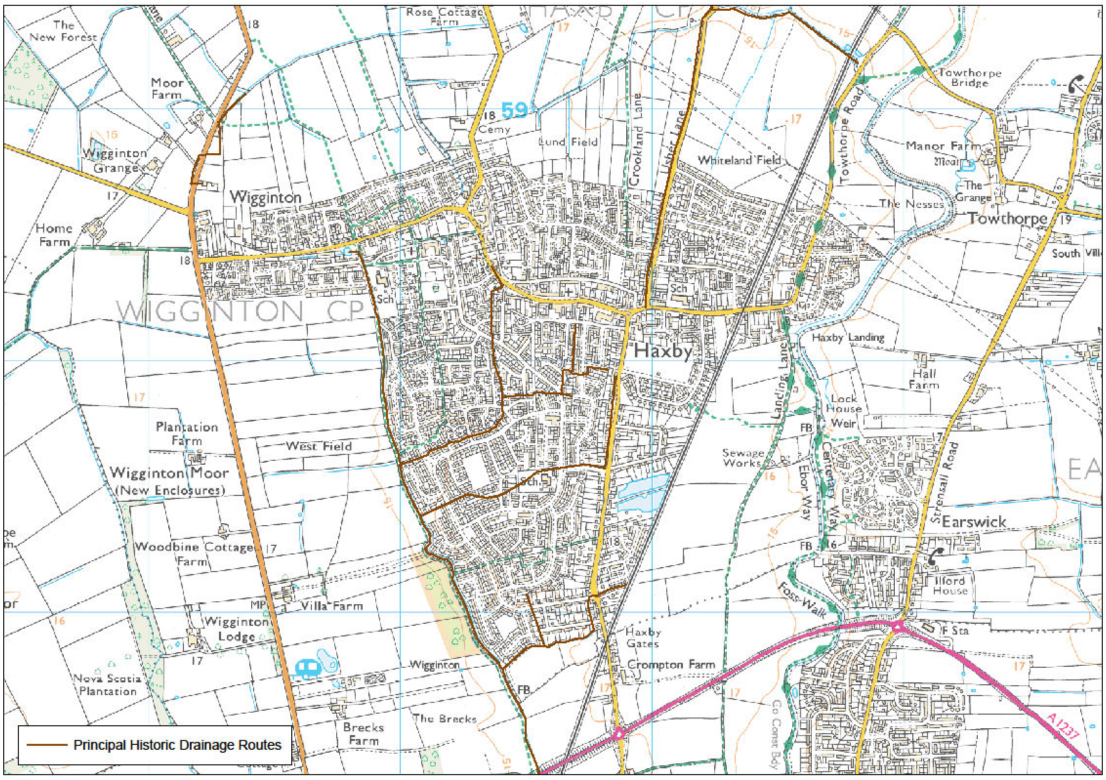
The older part of the village and York Road are served by a combined sewerage system which gravitates to a pumping station on Landing Lane, but generally all of the development beyond the rear curtilages of these properties both north and south of The Village and west of York Road (i.e. the vast majority of the area) is sewered separately. The expansion of the village is understood to be mostly post 1960 and there is now little or no scope for any further significant expansion.

Drainage: Wigginton

The older part of Wigginton is centred around Mill Lane and The Village (road), between the B1363 York to Helmsley Road and Haxby. As is the case with Haxby, the old village is served by a combined sewer, but all other areas, again post 1960, are separately sewered and there is little or no scope for any further significant expansion. Most, if not all, of the urbanised area west of York Road to Haxby (the western part of Haxby and all of Wigginton) ultimately drains to Westfield Beck which forms the western boundary of Wigginton. There are seven direct discharges to the beck and approximately twelve connections to the Headlands Lane Dyke Culverts which runs southwards through Wigginton before discharging to Westfield Beck. Westfield Beck and the Headlands Lane Dyke Culverts are the responsibility of the Foss (2008) IDB.

It has been found that, in Wigginton and Haxby, there is often interconnectivity between the individual flooded areas that have been recorded and/or investigated indicating widespread infrastructure failure.

The historic drainage routes in relation to the current development are shown on drawing 5.2



Drawing 5.2: Historic Drainage Routes in Wigginton and Haxby

Westfield Beck Pumping Station

Prior to the extensive development of Haxby and Wigginton flooding problems from Westfield Beck were experienced in certain areas of New Earswick downstream of Wigginton. To protect the village from future increased flooding, which would result from the proposed upstream development of Haxby and Wigginton, the then local authority and sewerage undertaker, Flaxton Rural District Council, constructed a pumping station at the south end of Wigginton next to Westfield Beck in the early 1970s. A rectangular penstock, controlled by depth sensors in the downstream beck, was built across the channel diverts excess flows to the pumping station. This lifts the flow and discharges it into a gravity sewer which passes through the southern side of the Hartrigg Oaks development and onwards directly to the River Foss. The pumping station has two no. $0.49m^3/s$ pumps which provide the capacity to discharge a 1 in 100 year flow[3]. The pumping station and sewer are owned by YWS. Subsequently, in 1988, the Foss IDB improved the culverted length of Westfield Beck running through New Earswick, further reducing the risk of flooding.

Westfield Beck Storage Lagoon

Areas of housing at the north of New Earswick have been identified as being at risk of fluvial flooding by the EA. Their Development Control Team is concerned that the flood risk could potentially increase in the future due to additional runoff from further development in the Westfield Beck catchment, primarily in Haxby and Wigginton upstream. The nature of this development, in the form of property extensions and the creation of patios and drives, is difficult to control through the planning regime, and has a cumulative effect in increasing runoff. Although there is little scope for more major development, if it does occur there is more opportunity to control its runoff and minimise the impact than there is with minor development.

The EA commissioned a study to investigate the feasibility of flood storage as a potential solution to this problem, and has proposed a scheme to construct a storage lagoon located next to the beck between Haxby and New Earswick to control maximum flood levels. However, it has not been possible to obtain funding for this at the time of writing though it still remains an aspiration both for CYC and the EA.

Recorded Flooding

Flooding has occurred at many locations throughout Wigginton and Haxby over a long period of time. The modelling concentrated on the area most affected in 2007. The following analysis groups some of the most significant problem areas together from the investigating engineers' reports mostly concentrating on the more urbanised areas. In most areas the investigations started with a very poor understanding of how the drainage systems should work, due to lack of records. However, there are fundamental infrastructure problems that have been identified, which further links many of these grouped areas together.

Analysis

a) Junction of The Village and York Road, Haxby

This urban area was modelled and the findings are recorded in the report (Appendix 1) as Hotspot 2 (Wigginton/Haxby):

Records indicate flooding at the junction of The Village and York Road in 2007. The Environment Agency Surface Water Maps indicate shallow flooding around Hall Rise and the Ambulance Station and to in the gardens between The Village and North Lane.

Output from the model indicates less extensive flooding than the Environment Agency surface flooding maps. The model 1 in 100yr + CC extent is very similar to the 1 in 200 yr, with very limited predicted flooding of property and limited flooding of highways within the hotspot area. For the 1 in 200 yr event, flooding is predicted of the roadway cul-de-sac in Hall Rise and adjacent to the Ambulance Station. The recorded 2007 flooding along highways of The Village and York Road is not replicated by the model.

A key difference between the Environment Agency Surface Water flooding maps and approach adopted here is explicit allowance for storage capacity in the below-ground drainage system. For this hotspot, it is assumed that the below-ground drainage network provides a 1 in 5 yr standard of service, which is represented through a reduction in net rainfall. The reduction in the 1in 200 yr rainfall is from 20.5 mm to 14 mm (equivalent to a 1 in 75 yr event).

The event severity of the 2007 event is recorded, in a report to the Council's Executive Member dated 10 December 2007, to vary across the city from 1 in 20 yr to 1 in 100yr. On basis of this event severity, even when taking into account drainage, the model results seem to under-estimate flooding.

It is plausible that flooding in 2007 was caused by localised blockages in the below-ground drainage system which are not replicated in the model. Similarly it is plausible that localised flow routes that cannot be defined at the scale of the model could also have contributed to flooding.

Due to poor replication of evidence from the 2007 event, confidence in model results for this hotspot is lower than other hotspots.

Investigation carried out in this area located both public sewers and CYC culverts blocked by roots and silt, with problems compounded by blocked gullies and damage by utilities, confirming the suggestion from the modelling. The surface water pipework outside 32 York Road was totally blocked causing floodwater to enter tthe gardens of nos, 28 and 30. Damage to the pipework was located and further work is required to resolve the problems in this area.

Recommendation

It is recommended that further investigations at this location be continued as resources permit.

b) The Avenue /York Road/Old Orchard/Little Meadows, Haxby

Flooding is recorded to have occurred in the highway and to some properties in The Avenue in 2004 and 2007 as a result of summer rainfall. The problem was compounded by foul flooding and both CYC and YWS have been involved in investigations to determine the cause. This section covers the findings of the surface water system investigation only.

The FMfSW shows that shallow flooding from a 1 in 30 year event may affect some gardens on the north side of The Avenue and a short length of the highway at the western end of Holly Tree Lane. It also predicts that in a 1 in 200 year event shallow flooding would affect a wider area including the four properties with recorded flooding. Therefore this prediction of affected areas is considered to be a good correlation with observed events but the onset of the observed flooding arises from a considerably less severe event indicating that there are infrastructure failures.

The Avenue is served by a separate sewerage system with the surface water public sewer within the road draining westwards towards the York Road/Holly Tree Lane junction. In the course of the investigation a silted up riparian owned culvert was found in the front gardens of the five properties on the southern side of the Avenue next to the junction. A further culvert was found between nos. 79 and 81 York Road extending to the rear of the properties on the north side of The Avenue. These, together with the public sewer, were found to be connected to a further riparian owned culvert crossing York Road and passing through several ownerships on the north side of Holly Tree Lane. Significant sections of these culverts were found to be blocked with silt and roots over a length of approximately 300 m. The Holly Tree Lane culvert was in poor condition at many locations with several collapses. Beyond Little Meadows this discharges to the Foss (2008) IDB maintained culvert Headlands Drain South which flows to Westfield Beck on the west side of Wigginton.

Flooding experienced in this area has been much more frequent than predicted by the FMfSW and the investigation has confirmed that this has been caused by infrastructure failure due to lack of knowledge of its location and consequently no maintenance. Although much has been done to date there is work still outstanding at this location.

Recommendation

Monitor the effect of future rainfall events and continue investigation and remedial work.

c) Station Road, Haxby

Persistent frequent highway flooding has occurred over many years at Station Road, and two properties, 51 and 55 Station Road, are recorded to have suffered internal flooding, most recently in 2009.

The FMfSW predicts that these properties and the adjacent highway would suffer shallow flooding from a 1 in 30 year event and more widespread shallow flooding from a 1 in 200 year event. This prediction of the affected area is considered to be a good correlation with observed events, but the onset of the observed flooding arises from a considerably less severe event indicating that there are infrastructure failures.

The investigation has established that the surface water sewer in the northern footpath, outside the affected properties, is significantly under capacity. The problem was compounded by tree root blockage and a high percentage of blocked gullies. These blockages have been cleared but there still remains the issue of under capacity which YWS are addressing.

Recommendation

Monitor the effect of future rainfall events and assist YWS in continuing their investigation and remedial work.

d) Mill Lane, Ascot Road and Delamere Close, Wigginton

Frequent and widespread highway flooding has occurred at Mill Lane and Ascot Road over many years and property flooding has only narrowly been avoided on several occasions.

The FMfSW indicates that shallow highway flooding from a 1 in 30 year event might be expected to affect the southern end of Ascot Road between its junctions with Mill Lane and Delamere Close, possibly affecting some of the odd numbered properties though they may be sufficiently elevated to avoid this. This shallow flooding becomes more extensive from a 1 in 200 year event, affecting a longer length of highway, more properties and rear gardens on the odd numbered side. The area is very flat and this prediction of the affected area is considered to be a good correlation with observed events, but the onset of the observed flooding arises from a considerably less severe event indicating that there are infrastructure failures.

There were four road gullies in the 150m length of Ascot Road and four in the 100m long Delamere Close which is slightly less than the current design standard. This alone would not help the situation in such a flat area but the investigation found that the surface water sewer in Delamere Close, to which Ascot Road flows, was up to 40% blocked with silt and the pipe to which that connects in Mill Lane was permanently surcharged above soffit level. In an attempt to lessen flows running off Mill Lane into ascot Road two additional gullies were installed by CYC. An uncharted highway drain/culvert was found to run the full length of Mill Lane which was affected by tree roots. Cleaning and CCTV surveying of this part of the network is planned. Some of the network connects to the head of a 145mm diameter SW sewer which had 50% blockage with silt, and this will be cleared by YWS.

Further investigation also found that a weir had been constructed in one of the YWS manholes upstream of this junction to divert flow into the village pond. This caused the sewer to be permanently 75% full, severely limiting its capacity to convey storm flows, and it has been removed. The investigation has also found that the problems are compounded by a backfall in a length of the sewer in Delamere Close and possibly a siphon at its connection in Mill Lane. YWS are to carry out further investigations in this area but it still currently remains at risk of flooding.

Recommendation

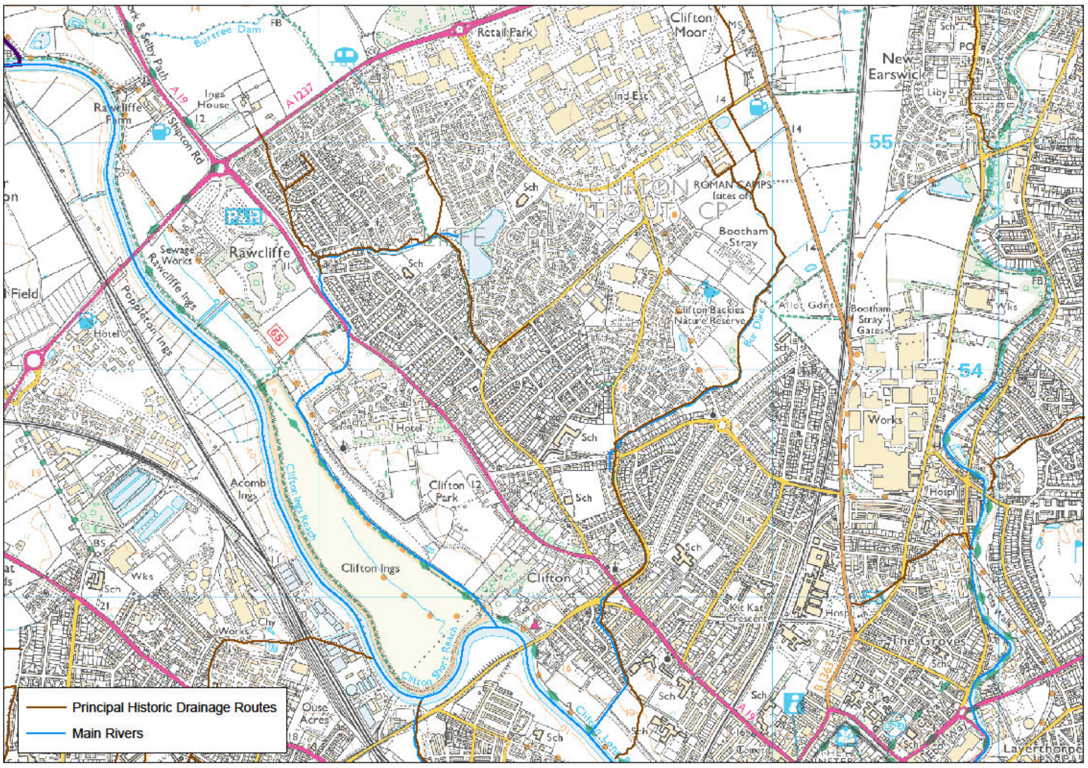
Monitor the effect of future rainfall events and assist YWS in continuing their investigation and remedial work, along with CYC remedial work on Mill Lane.

5.5 Hotspot 3: Rawcliffe

Location and Drainage

Rawcliffe is a suburb located 5 km to the north west of York. It is centred around Blue Beck, a watercourse draining Rawcliffe and the majority of Clifton Moor to the River Ouse. Blue Beck is a designated Main River as it can cause flooding to property, primarily fluvial, as a result of the River Ouse backing up. Clifton Moor was an airfield prior to its development as a residential, commercial and retail area in the 1980s. Rawcliffe Lake, owned by YWS, was created to provide storage and attenuation of surface water flows from the airfield redevelopment to protect the existing downstream properties. Surface water sewers serve the majority of the catchment draining either to the lake, which has a controlled discharge into Blue Beck, or directly to Blue Beck downstream of the lake. A flood detention area is situated next to the EA's floodbank to provide additional storage for flows from the Blue Beck catchment during high River Ouse levels. Surface water flooding affecting property is not a major problem in this area. However, some localised flooding occurred in 2007 including significant sections of highway drainage serving Shipton Road.

The historic drainage routes in relation to the current development are shown on drawing 5.3



Drawing 5.3: Historic Drainage Routes in Rawcliffe, Clifton and Clifton Without

Flooding

Flooding of several roads was recorded in 2007 including sections of Rawcliffe Croft and at the intersection of Howard Drive and Manor Park. No property is reported to have been affected.

Analysis

The affected area was modelled and the findings are recorded in the report (Appendix 1) as Hotspot 3 (Rawcliffe):

Two focus areas within this hotspot are identified, located along Rawcliffe Croft and at the intersection of Howard Drive and Manor Park. Records from the 2007 event indicate localised flooding of the highways in Rawcliffe Croft, Howard Drive and Manor Park. Environment Agency Surface Flooding maps replicate shallow flooding along a localised length of Rawcliffe Croft highway and adjacent properties. The Environment Agency maps show shallow flooding adjacent to Howard Drive but not along Manor Park.

The results from the latest model replicate the 2007 flooding well. Shallow flooding in Rawcliffe Croft commences at 1 in 30 yr although flooding of adjacent properties is not indicated even in the 1in 200 yr and/or 1in 100yr + CC. Flooding at Howard Drive/Manor Park is less well predicted by the model with very minor flooding predicted in the 1 in 200yr event.

Confidence in model results is therefore considered good.

Due to the relative lack of severity of this flooding with no property being affected, and confidence in the model, no investigations have been carried out in this area. However, in the same vicinity, the occurrence of flooding from rainfall events in spring and early summer 2012 has shown the highway drainage in Shipton Road to be inoperative on the outward bound lane, flooding half of the carriageway. While this is unlikely to be directly connected to the modelled area an initial investigation confirmed that this has been caused by infrastructure failure due to lack of knowledge of its location and hence no maintenance. Further investigation of this area is required.

Recommendation

Ensure surface water drainage infrastructure is located and restored to working condition and monitor effect of future rainfall events.

5.6 Hotspot 4: Clifton Without

Location and Drainage

The Clifton Without area is located approximately 3 km northwest of York and comprises a large area of post war residential development centred around Kingsway North and Water Lane, with further 1990s/2000s residential development north of Bur Dike Avenue. The drainage system is mostly separate with surface water draining to Bur Dike which drains predominantly open stray land upstream and a small part of the southern area of Clifton Moor. Bur Dike is culverted from the end of Lilbourne Drive at the northern end of the residential development all of its way to the River Ouse under Clifton Green and through the Clifton area, a distance of approximately 2 km. This length of Bur Dike is a designated Main River as it can cause flooding to property, primarily fluvial, as a result of the river Ouse backing up. To protect areas from this flooding, which occurs mostly around Clifton Green, a pumping station was constructed in the 1980s on the Bur Dike culvert approximately 110 m from the river in the flood bank, to prevent backflow from the river at times of high level and overpump flows from the catchment. This is owned and operated by the EA.

The historic drainage routes in relation to the current development are shown on drawing 5.3 in the section on Rawcliffe.

Flooding

Surface water flooding is not a major problem in this area, but some localised highway flooding occurred in 2007, affecting Water Lane, Rainsborough Way and St Philip's Grove.

Analysis

This affected area was modelled and the findings are recorded in the report (Appendix 1) as Hotspot 4 (Clifton Without):

> *Records from the 2007 event indicate flooding of the highway along Water Lane, Rainsborough Way and St Philip's Grove. The Environment Agency Surface Flooding maps indicate similar flooding along Water Lane and St Philip's Grove with a small number of adjacent properties affected. The localised flooding in Rainsborough Way is not indicated in the Environment Agency maps.*
>
> *Results from the latest modelling indicate flooding consistent with the 2007 event for the 1 in 30yr event along Water Lane. Flooding along St Philip's Grove is also predicted but concentrated at a central low point rather than the more extensive flooding indicated by the 2007 records. Localised flooding in Rainsborough Way is predicted in the 1 in 200 yr and 1in 100yr+CC event. Flooding of adjacent properties is not indicated.*
>
> *Confidence in model results is therefore considered good.*

Due to the relative lack of severity of this flooding with no properties being affected, and the confidence in the model, no investigations have been carried out in this area.

Other flooding

An additional area that has been known to flood on several occasions is the roundabout at Lilbourne Way, up to a depth of 0.5m, necessitating the closure of the road. The cause of this was found to be the non operation of the Surface Water pumping station serving the adjacent housing estate and it is understood that issues affecting this have now been resolved.

Recommendation

Ensure surface water drainage infrastructure is maintained and monitor effect of future rainfall events.

5.7 Hotspot 5: Clifton

Location and Drainage

The Clifton area is located approximately 3 km north of York and comprises Victorian era terraced housing east and west of Burton Stone Lane and south of Crichton Avenue. The area is served entirely by a combined sewerage system and comprises a high percentage of impermeable surfacing compared to suburban areas. Significant flooding occurred in the 1980s and 2007 saw some localised flooding affecting the highway at Field View to the west of the railway, Haughton Road, Baker Street, Pembroke Street and Shipton Street.

The historic drainage routes in relation to the current development are shown on drawing 5.3 in the section on Rawcliffe.

Flooding

Flooding of several short lengths of roads was recorded in 2007 though no property is reported to have been affected. The area was modelled and the findings are recorded in the report (Appendix 1) as Hotspot 5 (Clifton):

Analysis

Records from the 2007 event indicate flooding of the highways at

- *Field View to the west of the railway*
- *Haughton Road*
- *Baker Street*
- *Pembroke Street*
- *Shipton Street.*

Flood extents from the Environment Agency Surface Water flooding maps are broadly consistent with the 2007 event although do not replicate the full extent of flooding on Baker Street.

Results from the baseline model results indicate much less extensive flooding than indicated by the 2007 records. For the 1 in 200 yr and 1 in 100yr+CC there is some predicted flooding along Field View. Results from the blocked gully simulations indicate some further flooding but again less than indicated from the 2007 records.

For modelling this hotspot, it was assumed that the below ground drainage capacity provided approximately a 1 in 5 yr standard of service. This below ground capacity was represented by a commensurate reduction in the net rainfall. For the 1 in 200 yr event, net rainfall was reduced from 20.5 mm to 14 mm, equivalent to a 1 in 75 yr event. The inclusion of the below ground drainage capacity contributes, but does not fully explain the apparent under prediction of flooding in the model results.

The extents and depth of flooding are more extensive in the outputs from the modelling with blocked gullies, indicating that gulley maintenance is important in this area. For example, flooding of the area around the care home for the elderly is predicted with blocked gullies during the 1 in 200yr event.

Due to less replication of flooding evidence from the 2007 event, confidence in model results is lower than other hotspots.

Due to the relative lack of severity of the surface water flooding recorded in 2007 with no properties being affected no investigations have been carried out. However, the situation in this area differs from the others as the drainage system in the study area is combined. In addition there are properties on the YWS DG5 register that are known to flood internally in certain conditions. The wider catchment sewerage system has been subject to modelling by YWS in the past and it is understood that they are reviewing this with a view to resolving the issues for which they are responsible. It is therefore not proposed to take any further action other than to liaise with YWS as required.

Recommendation

Liaise with YWS in developing their hydraulic model.

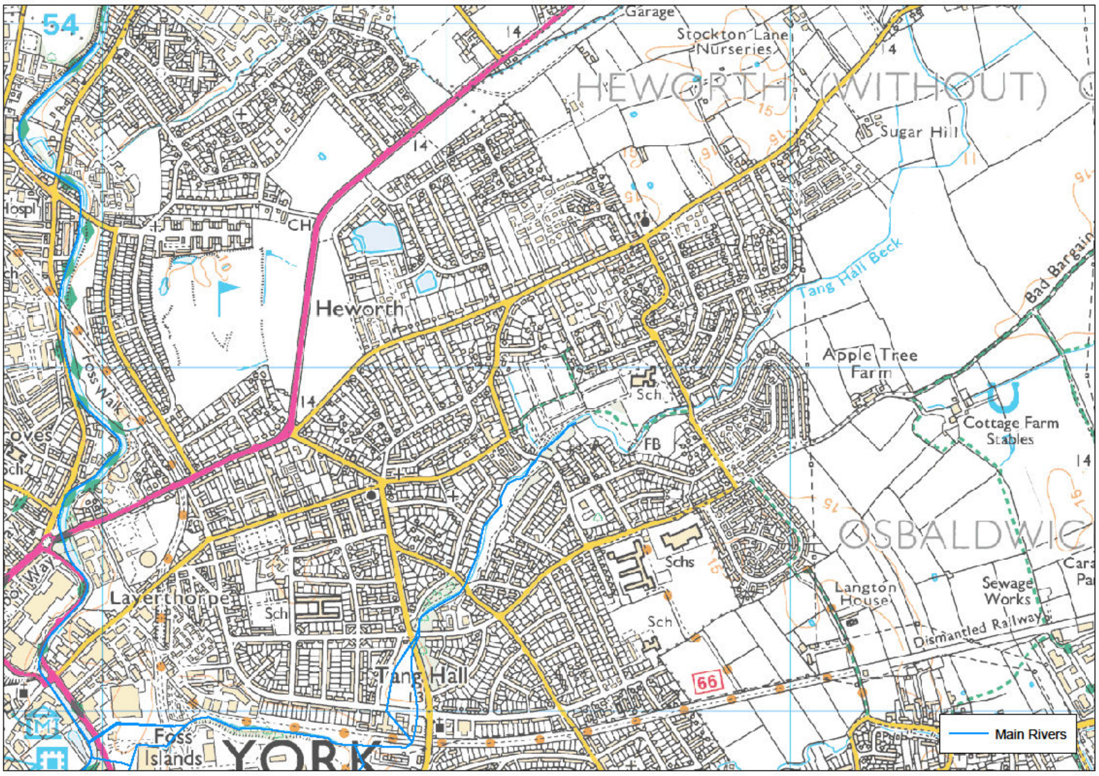
5.8 Hotspot 6: Heworth

Location and Drainage

Heworth is a suburb 2 km northeast of York. The original development of the area is around East Parade, Heworth Road and Heworth Green with later 1930s semi-detached houses on Stockton Lane. A considerable amount of suburban development has taken place since then, leaving Monk Stray as the only significant open space in the area. The basic road layout was established by the late 19th century and it appears that surface water drainage would have been via minor ditches to either the River Foss to the west or Tang Hall Beck to the south, both classified as main rivers. The locations of these are still very evident and they are critical elements of the surface water drainage system of the area.

Older parts of Heworth are served by a combined sewerage system while the newer development is drained separately, principally to Tang Hall Beck.

Drawing 5.4 shows the area in relation to the River Foss and Tang Hall Beck.



Drawing 5.4: Heworth, the River Foss and Tang Hall Beck

Flooding

The area that flooded in 2007 is located between the A1036 Malton Road and Stockton Lane adjacent to Monk Stray. Flooding of the highway occurred along Straylands Grove and in localised areas of Elmpark View/Way. The area is very flat and clay extraction and brick manufacture have been previous uses. As a result there are several ponds of various sizes, as well as known filled areas.

Analysis

The area was modelled and the findings are recorded in their report (Appendix 1) as Hotspot 6 (Heworth):

Records from the 2007 event indicate flooding of the highway along Straylands Grove and localised areas of flooding in Elmpark View/Way junction. Additionally localised highway flooding is indicated to the west of Malton Road on Elmfield Avenue. The Environment Agency Surface Water flooding maps indicate more extensive shallow flooding along Elmpark View and Elmpark Way but less extensive flooding along Straylands Grove. Localised flooding on Elmfield Avenue is replicated well in the Environment Agency maps.

Results from the model indicate commencement of highway flooding in Elmfield Avenue in the 1in 30 yr event. Model results indicate extensive highway flooding along Straylands, Elmpark View and Elmpark Way during the 1in 75 yr event.

Results from the 1 in 200 yr results indicate significant numbers of properties at risk.

Confidence in model results is considered good.

The flooding in this area is localised in natural low points, exacerbated by the underlying clay preventing infiltration. Infiltration measures are therefore unlikely to prove suitable for this area. One approach which could contribute significantly to the reduction of surface water flooding would be to reduce the amount of run-off entering the existing drainage system. By retrofitting source control attenuation and storage SUDS we can interrupt run-off and delay its entry into the underground drainage system, helping to manage peaks in flow. Pathway SUDS such as swales could potentially help to slow run-off as well, although these may be more difficult to design into the existing urban landscape. Source control SUDS measures appropriate for retrofitting are explained in more detail in the table in Appendix F.

Given that we are dealing with an existing urban area with limited available land, it is likely that property scale measures such as water butts, rainwater harvesting, permeable driveways and disconnection of downpipes will prove the most achievable and best value for money (based on research, including: Environment Agency science report SC060024, Cost Benefit of SUDS Retrofit in Urban Areas, SNIFFER report: Retrofitting Sustainable Urban Water Solutions" and "Stovin and Swan (2007)").

Depending on site specifics, however, there may be potential for other measures such as green roofs, community rainwater harvesting and street scale permeable paving to be considered.

No investigation has yet been carried out in this area as the flood risk to property is not severe and while it is believed that the drainage infrastructure is in good condition and operates effectively this should be checked. The fundamental problem in this area, as identified in the modelling report, is its flatness and the clay ground which rules out any form of infiltration drainage.

While property level attenuation may provide some relief this would be dependent on individual householders implementing and maintaining measures, which they would have to pay for. They would need to be convinced of their potential effectiveness, to understand how they work and be aware of what maintenance would be required. In making a decision as to whether it is worthwhile for them to make such an investment they would have to assess this against the relatively infrequent inconvenience of shallow road flooding, which they may not perceive as a high risk.

It is considered unlikely that householders would make a decision to implement such measures on the basis of their experience of flooding to date and theoretical future risk. Additionally it is doubtful how much impact the relatively small volume of storage that could be created at property level, should it all be available at the required time, would make on the overall flood risk in the area.

Recommendation

CYC and YWS will ensure surface water drainage infrastructure is in good condition as assumed and monitor effect of future rainfall events.

Other flooding

Extensive flooding has also been recorded several times on Malton Road adjacent to Heworth Golf Club, affecting a 500m length of both sides of the carriageway. Investigations have found a lack of ditch and pipe maintenance to be the main cause of the problem but this is undoubtedly compounded by the significant increase in impermeable area that drains to the system. A comparison of aerial photographs from 2002 and 2007 shows the overall road width to have been increased by almost 25% with the addition of pedestrian/cycle tracks on both sides, where there were formerly verges, and a bus lane. It is known that no consideration was given to improving the drainage system to take the extra flows generated from this extra impermeable area and it is therefore unsurprising that flood risk has increased at this location.

Recommendation

CYC will liaise with the golf club to clear its ditch and will carry out further investigations into the watercourse running through the Stray. It will also work with highway design and maintenance engineers to ensure that they are aware of the importance of managing flood risk properly in their designs.

5.9 Hotspot 8: Acomb

Location and Drainage

Acomb is a large suburb 3.6 km west of the centre of York extending from Woodthorpe in the south to the River Ouse in the north, Holgate in the east and the Outer Ring Road in the west. It encompasses the A59 Boroughbridge Road and the B1224 Wetherby Road. One of the highest areas of York, peaking roughly along the line of the Wetherby Road, it falls southwards through Westfield to Woodthorpe and northwards to the River Ouse.

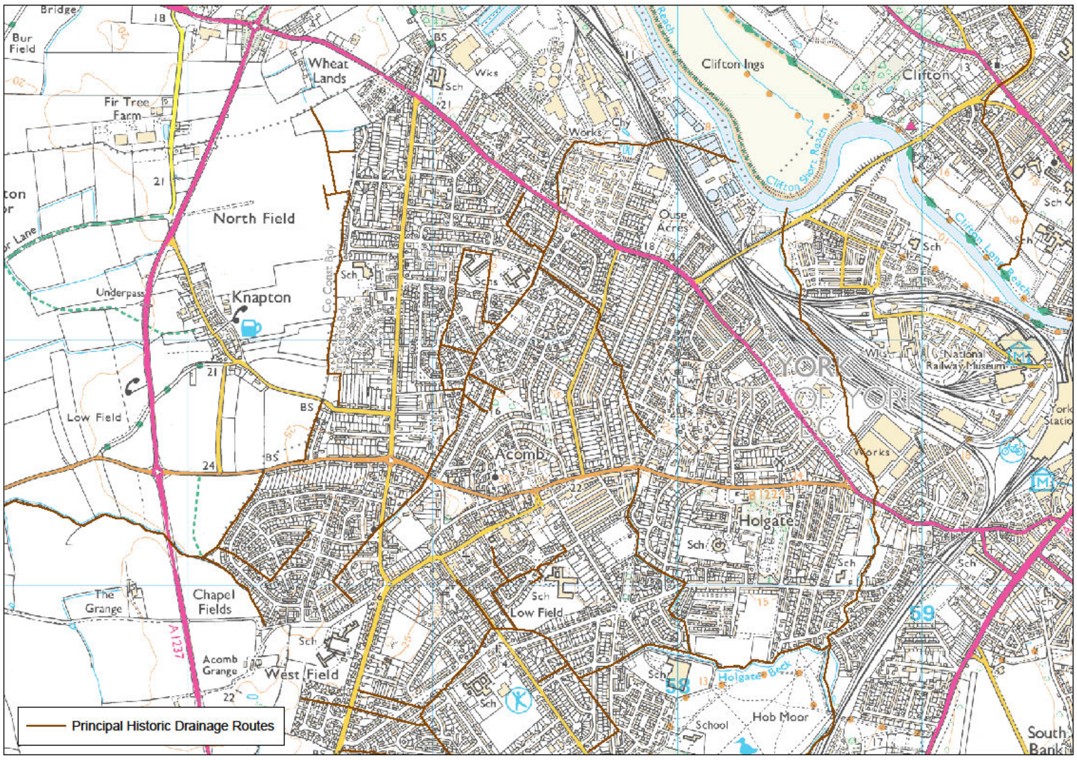
Drainage of north Acomb

Natural drainage northwards is by Carr Drain which originally flowed from near Walton Place in the Chapelfields estate. There is no trace of this now and the first evidence of it is where, in open ditch, it forms part of the north western boundary of Acomb cricket ground west of Acomb Green. From there it is culverted under Croftway and Wetherby Road and flows northwards in open ditch behind nos. 5 to 47 Danebury Drive. It is then culverted again for a distance of approximately 1 km through a large area of inter and post war housing, and under Boroughbridge Road. Access to the culverted lengths is very restricted and the precise route is not recorded, though it is roughly indicated by reference to former field boundaries on historical maps.

Changing name to Ing Cliffs Drain, the watercourse then forms the western boundary of the Sovereign Park development as an Ainsty (2008) IDB maintained watercourse before being culverted again under the southern end of the York Northwest development area (formerly the British Sugar works) and the railway (East Coast Main Line). It finally flows in open watercourse to the River Ouse through the water treatment works.

The majority of the housing areas, through which Carr Drain and Ing Cliffs Drain pass, are separately sewered. Although not entirely clear, it is likely that these sewers ultimately flow into this watercourse. A large part of the area through which the culvert passes is Council housing and it is assumed that culverting was carried out satisfactorily at the time and that ownership and riparian responsibility was clear. However, with the mass sale of Council housing over the past decades it is likely that there are many private house owners who are unaware of the presence of the watercourse, though it is still likely to be a Council owned asset. The culvert also passes through private housing and responsibility in these areas is likely to be individual riparian, though it is likely that house owners are unaware of the presence of this strategic watercourse in their property or their liabilities for it. This issue is not unique to this area.

The historic drainage routes in relation to the current development are shown on drawing 5.5.



Drawing 5.5: Historic Drainage Routes in north Acomb

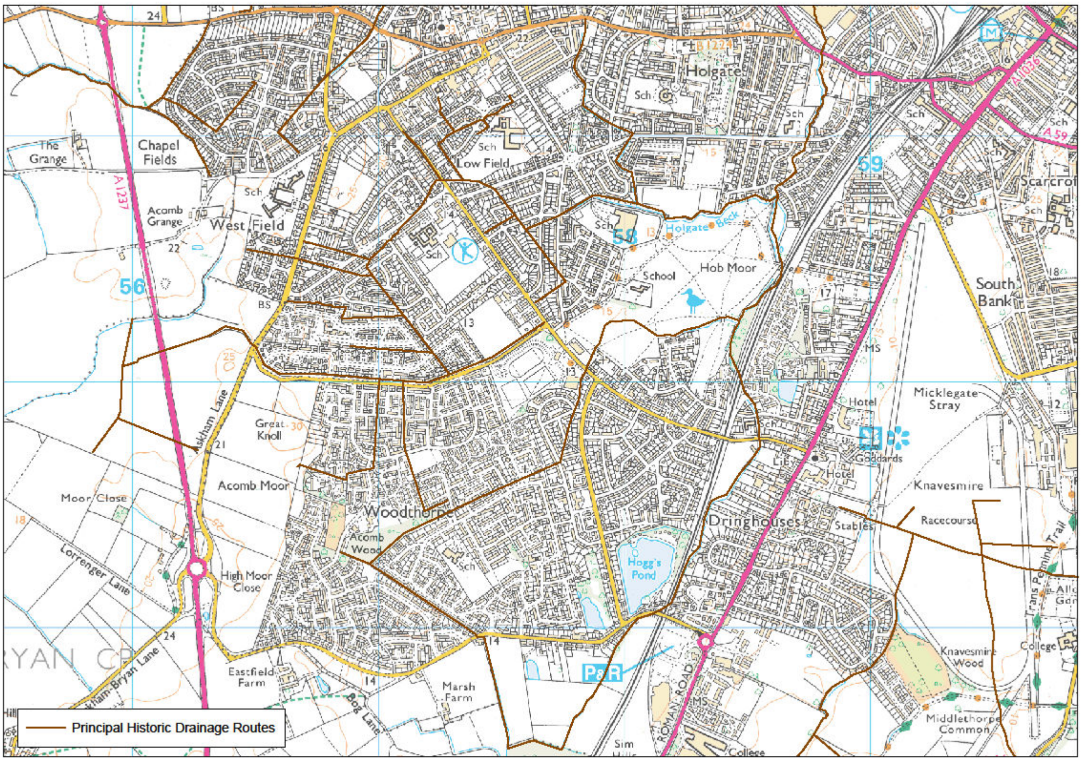
Drainage of south Acomb

The southern part of Acomb comprises the original village centred around Front Street, which is served by a combined sewerage system, and a large area of inter and post war housing further south which is separately sewered.

An examination of historical maps showing the area prior to development indicate the presence of a minor watercourse, Gale Lane Drain, half way down Gale Lane, and it is likely that a network of field drains conveyed flows to this. This flows to Acomb Moor Drain and is now an Ainsty (2008) IDB maintained culvert. Its route is not clear, but it passes though an area of largely Council housing around St Stephens Road and private housing near Foxwood Lane. The route of Acomb Moor Drain itself, flowing west to east and over 1 km long, is now Foxwood Lane. The drain is culverted along Foxwood Lane and is an Ainsty (2008) maintained watercourse discharging to the YWS Foxwood Lane surface water pumping station. This pumps flows onwards to Holgate Beck.

Further south, Moor Drain is shown on the historic maps, running from agricultural land at the western boundary of Woodthorpe eastwards to Hob Moor to Holgate Beck, a distance of almost 2 km. The route of the majority of this is untraceable due to development, mostly private housing. The first length is culverted between late 1970s houses and is thought to be about 900mm in diameter though it has not been seen by the Council's engineers. It then forms the southern boundary of Acomb Wood and from the eastern end of the wood is culverted for a distance of approximately 425 m through dense private housing and then a further 550 m through a Council housing area. There are few if any known access points and no knowledge of a definitive route. It is not known if the surface water sewers from the housing are connected to it, and it is unlikely that any of the residents are aware of its presence or their probable responsibilities as riparian owners.

The historic drainage routes in relation to the current development are shown on drawing 5.6.



Drawing 5.6: Historic Drainage Routes in south Acomb Westfield and Woodthorpe

Holgate Beck

Holgate Beck, into which all of the above watercourses discharge, flows northwards through Holgate, ultimately discharging to the River Ouse at Water End. It also picks up flows from the Hobgate and Moorgate area in Holgate. This tributary was culverted through a privately owned housing area from Hobgate to the south end of Lady Hamilton Gardens by York City Council in the early 1970s. The route of this is unrecorded though it is likely to follow the watercourse line visible on the historic maps. It is thought that access may be available in some gardens. Once again residents may be unaware of its presence or their probable responsibilities as riparian owners.

At the confluence of Holgate Beck with the River Ouse is a pumping station owned by the EA which prevents backflow into the beck from the river protecting lower lying areas in the Hamilton Drive area of Holgate from fluvial flooding. To provide further relief from flooding in the same area, which could be caused more directly by the beck, there is a flood relief culvert which intercepts flow from the beck on Hob Moor south of the housing area and conveys it, via a culvert laid under the racecourse, to the River Ouse south of the city near Bishopthorpe.

Ground conditions

Ground conditions in the Acomb area are perhaps the most variable in the whole of the Council’s area. The northern part is predominantly sand and gravel while further south there is silt and clay. This is evidenced by Acomb Green, a triangular hollow formed by the extraction of sand, and former brick extraction pits, now filled, in the vicinity of Gale Lane. Underlying the whole area are lenses of running sand, which break the surface locally at Fishponds Wood, situated between Danebury Drive and Rosedale Avenue. This is the site of an old pond which was filled in before 1950 but a continuous trickle of water still flows from it downwards towards Danebury Drive.

Flooding

The most persistent and longstanding flooding problem in the Acomb area occurs at the junction of Carr Lane, Boroughbridge Road and Ouseacres in the northern part. At least ten gardens and one property are known to have suffered flooding.

Analysis

The area was modelled and the findings are recorded in the report (Appendix 1) as Hotspot 8 (Acomb):

Records from the 2007 flood event indicate highway flooding along Ouse Acres. The Environment Agency Surface Water maps indicate deep flooding at the northerly end of Ouse Acres but additionally localised flooding along Carr Lane. The area at risk at the northerly end of Ouse Acres is considered to be at risk from fluvial flood risk rather than surface flooding and is therefore excluded from the hot spot area.

Results from the modelling study indicate commencement of highway flooding along Carr Lane in the 1 in 30 yr event. Flooding along the southerly end of Ouse Acres is not replicated even for higher order events. The 1 in 200 yr event indicates some property flooding.

Comparison of blocked gully scenarios with baseline simulations indicates that flooded areas and depths are similar.

Confidence in model results is considered good.

This problem has occurred over many decades and can affect up to 11 properties in a low area of Carr Lane near its junction with Boroughbridge Road. The area is predicted to be affected by flooding in the FMfSW, with both shallow flooding from a 1 in 30 year event and deep flooding from a 1 in 200 year event affecting properties. However, the frequency of observed flooding is indicative of infrastructure failure. The flooding has in the past been attributed to 'rainfall beyond the design capacity of the system' but this is not thought to be the case on the basis of the modelling and observed flood events. Previous attempts have been made to alleviate the flooding, including removing a tree, installing two additional gullies on the odd-numbered side, CCTV inspection and two repairs, but met with little success. An apparent increase in the frequency of flooding and increasing pressure from one of the residents instigated a more detailed investigation which commenced in 2009.

An uncharted highway drain was found in Carr Lane which was found at various locations to be blocked with silt, an inflatable bag-stopper, long length of nylon rope, large slabs of stone, broken pieces of pipe and tree roots. This has been extensively jetted, cleaned and surveyed by CCTV with the defective lengths repaired. A particular problem at this location is drives that fall away from the back of footpath to the properties. To prevent flow from the highway entering the drives additional gullies have been installed and the footpaths outside all of the affected properties have either been raised and/or cut-off channels installed. An existing gully was also enlarged at the junction with Boroughbridge Road to intercept run-off into Carr Lane.

The gullies on both sides of Boroughbridge Road, from its junction with Water Lane to Ings Cliff Drain, were checked. Some were found to be blocked and were subsequently cleared. An uncharted highway drain blocked with tree roots was found on the northern side of the road and was cleared by jetting along with a concrete obstruction and siltation. However, flooding of the highway in Carr Lane has recurred and further investigations have shown evidence of surcharge in both the highway drain and YWS's foul sewer to which some of the gullies are connected. There is also a YWS surface water sewer on the southern side of Boroughbridge Road which discharges to Ings Cliff Drain.

The opportunity was taken during a closure of Carr Lane to carry out further investigation and the remaining 10m section of highway drain was jetted up to the YWS public surface water sewer in Boroughbridge Road. The surface water sewer was found to be obstructed with large amounts of silt and rubble directly preventing the effective draining of Carr Lane. YWS raised two buried manholes on their surface water sewer in Boroughbridge Road and cleared their pipework.

YWS surveyed their foul/combined sewers in Carr Lane and Boroughbridge Road and found a large accumulation of fat. This was causing partial blockages and had a significant effect on flow. This has been cleared by YWS and the will monitor the effect of this action.

Recommendation

Continue investigation in conjunction with YWS, and monitor effect of future rainfall events. CYC has installed two additional conventional gullies in Carr Lane to prevent flow running past arterial (within kerbline) gullies and the effect of this will be monitored.

5.10 Hotspot 10a: Westfield

Location and Drainage

Westfield is the southern part of Acomb centred around Foxwood Lane and the drainage of the area is described in section 8 and shown on Drawing 5.6.

Flooding

Highway flooding occurred in 2007 affecting Huntsman's Walk but did not affect properties.

Analysis

The area was modelled and the findings are recorded in the report (Appendix 1) as Hotspot 10a (Westfield):

> *Records from the 2007 event indicate flooding of the highway along Huntman's Walk. The Environment Agency Surface Water maps indicate flooding centred around a similar area with deep flooding of Thornwood Covert and Huntman's Walk. Shallow flooding of property is predicted.*
>
> *Results from the modelling indicate commencement of highway flooding in the 1 in 75 yr with more extensive highway flooding in the 1in 200 yr event along Huntman's Walk and Thornwood Covert. Baseline simulations are less extensive than Environment Agency outlines, and very limited property flooding is indicated. Comparison of baseline and blocked gully simulations, indicate blocked simulation show more consistent flooding with areas of flooding/not flooding combining along the highway. Differences between blocked and unblocked scenarios are relatively small.*
>
> *Confidence in model results is considered good.*

Due to the relative lack of severity of the surface water flooding recorded in 2007 no investigations have been carried out at this location.

Recommendation

Ensure surface water drainage infrastructure is maintained and monitor effect of future rainfall events.

6 DISCUSSION OF ANALYSIS AND ASSESSMENT OF RISK

Discussion

6.1 The next stage in the Defra SWMP guidance following modelling and analysis is mapping and communication of flood risk. It has been established that the PFRA did not identify any areas of significant risk in accordance with its definition, but the SWMP provides the opportunity to define flood risk on the basis of locally agreed criteria, which will then be used to prioritise work in the local strategy for flood risk management.

6.2 Paragraph 2.3 suggests potential criteria for defining local flood risk, and this will be the subject of debate in compiling the Local Strategy. It has been established by the detailed modelling for this study that the FMfSW provides good guidance as to where surface water flooding may occur. However, it is not considered that it is, or will ever be, sufficiently accurate to be used to identify flood risk areas with any certainty for action in the strategy. Realistically actions will only relate to known problems of flooding, not theoretical, and therefore any action plan will be generic and non specific in terms of locations for this Council's area. Actions will be driven by future events as well as dealing with those problems that have already been identified.

6.3 As stated previously no incidences of widespread or frequent major surface water flooding have been recorded, but flooding that has occurred has been dispersed and usually affected small areas. A sample of these events have been modelled and investigated and no major schemes have been identified as being necessary. This section therefore discusses the analyses of the sample study areas, considers how representative they are of the wider situation, sets out conclusions and makes recommendations based on them.

6.4 This study has provided an opportunity to check the EA's Flood risk mapping with small scale area specific modelling at eight locations. This modelling has consistently shown the FMfSW map provides good indicative guidance of flood risk. The FMfSW mapping shows indicative affected areas for two flood events:

- 1 in 30 annual chance for two depth bandings (greater than 0.1m and greater than 0.3m).
- 1 in 200 annual chance for two depth bandings (greater than 0.1m and greater than 0.3m).

6.5 The site specific modelling produced flood depth maps for the following rainfall return periods:

- 1 in 30 year (3.3%)
- 1 in 75 year (1.33%)
- 1 in 100 year (1%)

- 1 in 100 year plus 30% to allow for future urbanisation and climate change
- 1 in 200 year (0.5%)

6.6 Throughout this study the site specific modelling has shown a close correlation with the FMfSW. Both models make assumptions regarding the capacity of surface water drainage infrastructure and have provided reliable guidance of the potential location, extent and probability of flooding.

6.7 While the FMfSW provided an indicative overview, the site specific modelling was able to target areas and verify scenarios for different levels of efficiency of the infrastructure i.e. to model not only the theoretical capacity of the system and the effects of exceedance on the area for different return periods, but also the effect of blockages and deficiencies.

6.8 A common theme that has emerged in those areas investigated is that the effects of flooding have been greater than predicted by both models. This has often been either more frequent or more extensive than modelled and in some cases both. This is invariably an indication of defective infrastructure limiting the capacity of the system.

6.9 The modelling report frequently concluded that this aggravation of flooding was caused by defective infrastructure, suggesting the cause to be either blocked gullies or blocked pipes. Investigations have confirmed this to be the case at most locations, highlighting a long term legacy of neglect in the maintenance of surface water infrastructure. Frequently, where the suggested cause of flooding has been the blockage and/or insufficient number of gullies, the investigation has found it to be a more fundamental blockage of the gully connections and pipe network, preventing the gullies working. The causes of blockage were usually found to be root infiltration, silt or damage due to utility or other excavations, and often a combination of all of these.

6.10 The investigations have also highlighted that a lack of knowledge of the location of the infrastructure, especially CYC highway drainage, is also a contributory factor in the lack of maintenance, a point which was raised in Section 3: Available Information. This is a longstanding issue which is discussed further in the next section, Maintenance and Asset Management.

6.11 In addition to the sample areas covered by this study, investigations, usually triggered by highway flooding, have also been carried out in the following areas over the past six years:

- Rufforth
- Foxwood
- Woodthorpe
- Bishopthorpe
- Wheldrake

- Naburn
- Elvington
- Stockton on Forest
- Dunnington

6.12 Every investigation has located unrecorded poorly maintained infrastructure essential to the efficient operation of the drainage system. The findings from these investigations are consistent in confirming that the sample analysed in the study is representative of the citywide situation.

Maintenance and Asset Management

6.13 The national standard for highway maintenance is Well-Maintained Highways - Code of Practice for Highway Maintenance Management (CoP) published by the Roads Liaison Group (2005, latest update 16 January 2012). There are two other Codes of Practice that cover highway structures and lighting. Relevant extracts from this CoP are included in Appendix 3 and are:

- Section 9.11: Service inspection Of Highway Drainage Systems
- Section 10.7: Condition Of Highway Drainage Systems
- Section 14.4: Flooding From Inadequate Drainage

6.14 The Council published its first Transport Asset Management Plan (TAMP) in 2006 and this confirms (para.1.5) that the CoPs *"...set out an acceptable approach to maintenance. They specify certain core standards and give guidance for development of other standards based on local decisions. The Code of Practice approach will be adopted as part of the York asset management plan"*. There are no declarations of any departures from the CoP in the TAMP so it is assumed that the Council's highway maintenance should be carried out generally in accordance with it.

6.15 This first version of the TAMP was a statement of the existing situation with an identification of performance gaps. The principle of the Asset Management process is to be able to manage the highway assets on a lifecycle planning basis. Subsequent versions would update the plan with more information as performance gaps were addressed.

6.16 Paragraph 1.3 of the TAMP, included in Appendix 2, estimates there to be approximately 40,000 carriageway gullies in the Council's area. In order to produce a TAMP within the required timescale many assumptions and estimates had to be made, due to the lack of records and limited resources to produce them, and this was identified as a performance gap to be addressed. Yorkshire Water Authority found itself in a similar situation with their public sewer records in the 1980s and invested heavily in locational surveys. This allowed the extent and condition of their assets to be recorded and assessed enabling future maintenance requirements to be programmed, and this should be the aim for CYC's highway drainage system.

6.17 Residential and commercial areas are invariably served by sewerage systems, and while it is not always apparent where they ultimately discharge to, it is a fair assumption that gullies are connected to them. The citywide desktop study of the location of gullies on the Exor database against the YWS sewer records, referred to in paragraph 3.2, has shown that some 2,000, 5% of the total number, have no obvious drainage infrastructure to which they could be connected. A significant number of these missing records affect major arterial roads into and around the City, as detailed in paragraph 3.2, and the lack of information can severely affect the time taken to remedy highway flooding at these locations. Two such recent incidents are detailed in paragraph 3.3.

6.18 Section 10.0 of the TAMP is included as Appendix 2. This covers highway drainage and subsection 10.2: Routine Maintenance defines the service provided. It states:

- Routine carriageway gully cleaning is carried out at: 6 monthly intervals on tree lined streets, arterial routes into the city centre and the city centre and annually on all other gullies

- All reactive gully cleans not causing an immediate hazard to road users or properties have been carried out on Fridays, a list being faxed to the contractor every Thursday. Recently this has been extended to a daily planned schedule, achieving additional savings and efficiency.

- Routine grip cutting is carried out annually, in late summer / early autumn.

- Drain clearance is carried out on a reactive basis following defect reports.

Comment

- The frequency of gully cleaning has been reduced in the six years since the publication of the TAMP due to budget cuts. Prior to changes introduced in 2012/13 the authority carried out scheduled annual cleans on all road gullies and a further clean where account had to be taken of leaf burden which had an adverse effect on the ability of gullies to function in times of precipitation. This was already a reduction in service from the TAMP.

- Blockages of the pipe system serving gullies renders them ineffective, and cleaning gullies in isolation often does not address the cause of flooding problems. Therefore the performance of all of the elements of the highway drainage infrastructure needs to be confirmed and optimised,

- Currently the only gullies that are cleaned on a scheduled annual basis are those on the defined network of primary and secondary gritting routes shown in Appendix 5. Gullies which are reported as defective and are not on the gritting routes are responded to on a reactive basis. Future gully cleaning needs to be planned on the principles of flood risk management.

- It is a false economy to minimise scheduled gully cleaning and rely on reactive cleaning. There are major efficiencies in proactive bulk cleaning on a scheduled basis and this would reduce the number of expensive one-off reactive visits which can disrupt routine work. It would also enable flood risk to be managed more effectively.

- The current priority of scheduled cleaning of gullies only on gritting routes is flawed, and is not based on flood risk management requirements. Locations that have suffered surface water flooding, affecting the highway as well as property, are unlikely to be on gritting routes, but are most likely to be residential areas. As this study has shown, lack of routine maintenance in such areas can aggravate the effects of surface water flooding.

- Routine cutting of existing grips in rural locations is carried out but due to resource limitations there are no new grips cut.

- There has been no statement of change of Council policy or review or revision of the TAMP. This should be reviewed.

- Routine or reactive gully cleaning only involves the emptying of the gully pot and does not include the checking of connections to ensure that the gullies work as recommended in para 10.7.4 of the CoP. Therefore problems frequently recur but due to a lack of a monitoring system are unlikely to be investigated.

6.17 Section 10.4 of the TAMP identifies performance gaps. It acknowledges that "The accuracy of inventory records for highway drainage ranges from approximate (carriageway gullies) to non existent (footway channels). It is proposed to collect inventory data for all surface drainage infrastructure during the carriageway and footway inventory surveys. A system is being introduced to record all subsurface drainage on the (highway management) Exor system, as and when details are confirmed by works or investigations".

Comment

- The proposed method of data collection during inventory surveys has severe limitations and is very unlikely to produce the required information. There is frequently no indication of sub-surface drainage infrastructure on the surface and the only way to locate it is to commence a locational survey by excavation.

- The funding for investigations of highway drainage related flooding problems (ref para 3.3) has been effective in producing inventory information and where possible the opportunity is taken to remedy faults. Evidence of this approach is recorded in section 5. Progress has been made in recording the information on Exor but it should be noted that the funding only became available in response to flooding. If this had not occurred it is unlikely that any progress would have been made in recording highway drainage assets, as required in the TAMP. Regardless of flood risk, funding should be available to improve the inventory information and efficiency of maintenance.

- The investigations often start with little or no information and are very labour intensive requiring direction by suitably experienced drainage engineers. It is estimated that perhaps 10% - 15% of the missing information has been acquired to date and therefore a future commitment to funding is required to enable further infrastructure to be located, repaired and recorded. The Local Strategy will provide guidance on triggers for instigating statutory investigations.

6.18 Section 10.4.2 of the TAMP states “There are no routine maintenance programmes for inspection and clearance of sewers, drains, catchpits and manholes. At present all such work is reactive following a fault report. When the inventory survey is complete it is proposed to investigate the introduction of such programmes in order to reduce reactive work by proactive intervention”.

Comment

- There are still no routine maintenance programmes for these items, and as stated above routine maintenance of gullies is now minimal. As infrastructure is located and repaired it will be in serviceable condition but consideration needs to be given to routine future maintenance to ensure that the condition of these assets do not deteriorate again through future neglect.

7 CONCUSIONS AND RECOMMENDATIONS

Conclusions

7.1 The conclusions arrived at from this study, which are also confirmed by investigations at other locations across the Council's area are:-

7.1.1 The location of much of the highway drainage infrastructure is unrecorded and its condition consequently unknown. This makes effective and efficient targeting of maintenance resources difficult and as a result work tends to be reactive.

7.1.2 When culverted watercourses and ditches have been located during investigations riparian owners are often unaware of their presence or strategic importance, or of their responsibilities for its maintenance.

7.1.3 Drainage infrastructure, especially watercourses and land drainage, is often inaccessible due to development.

7.1.4 Development has often paid little regard to the pre-existing natural flow paths and drainage infrastructure. For example former field drains and minor watercourses have frequently been filled during development, or inadequately piped in with no record of location or provision of any access points for maintenance. There is still a danger of this occurring without adequate consultation with the Flood Risk Management team during the development control process.

7.1.5 Blockage of pipes, ditches and culverts in Council, YWS and private ownership is common and with no inspection or maintenance regime cannot be monitored.

7.1.6 Pipes and culverts are commonly blocked with silt and roots.

7.1.7 Damage to pipes and culverts by the utility companies is common.

7.1.8 Maintenance of known infrastructure beyond the emptying of gullies is poor or non existent. When gullies are cleaned connections are not checked so re-blocking is common.

7.1.9 Funding for maintenance of highway infrastructure, in particular gully cleaning, has been reduced annually over successive years to a point where it is now mainly a reactive operation. Such routine gully emptying that is carried out is generally not in the areas that suffer surface water flooding.

7.1.10 Repairs to drainage systems and attempts at remedying flooding problems have often been badly executed and ill thought out with no regard to a holistic solution based on knowledge of the drainage of the area. Often these have not been effective, or have aggravated the problem.

7.1.11 Designs for road alterations e.g. speed tables, road and footpath widening and the creation of cycle paths, can affect existing drainage infrastructure and should be designed to take this into account, ideally incorporating the use of SUDS. Such alterations can significantly increase impermeable areas and increase flood risk. Alterations can also physically affect the drainage of a site and the ease of access for maintenance. While this would be important anywhere it is an essential consideration in such a flat area. If not considered as an integral part of the design it can cause or aggravate flooding.

Recommendations

7.2 On the basis of the conclusions from the study it is recommended that:-

7.2.1 A commitment is made to fund continuing investigations to locate unrecorded drainage infrastructure in those areas where information is unavailable, prioritised to where there are known flooding problems. The information should be recorded on a geo-referenced database, such as Exor, which can be used as a management tool.

Reason: It is not possible to have a planned maintenance regime if there is no record of the location and condition of the infrastructure to be maintained.

7.2.2 A commitment is made to carry out repair work to damaged infrastructure already identified, prioritised to where there are known flooding problems, and remedial action taken to ensure that the performance of the existing surface water infrastructure is optimised.

Reason: To minimise flood risk by ensuring that the existing infrastructure is effective.

7.2.3 Future maintenance is scheduled rather than reactive and based on the requirements of the highway maintenance service.

Reason: To enable effective budgeting for and planning of future maintenance and to make the most efficient use of resources.

7.2.4 The effects of future rainfall events are monitored at known flood risk locations, though this is likely to be a reactive process.

Reason: To check the effectiveness of works carried out.

7.2.5 CYC liaise with YWS to agree ownership of previously unrecorded assets.

Reason: To ensure that future maintenance responsibility is clear.

7.2.6 Riparian owners are made aware of their obligations with regard to maintenance of flows as assets are found.

Reason: To ensure that future maintenance responsibility is clear.

7.2.7 CYC liaise with the relevant utility companies to remove their equipment where it has been found to have damaged the drainage system.

Reason: To minimise flood risk by ensuring that the existing infrastructure is effective

7.2.8 Flood Risk Management should be an integral part of highway alteration and maintenance design.

Reason: To minimise flood risk by ensuring that the impact of proposed addition and alterations to existing highway infrastructure, including allowances for climate change, is factored into designs.

7.2.8 The Transport Asset Management Plan should be reviewed and updated.

Reason: To enable the highway network to be managed holistically.

7.2.9 The Flood Risk Management Team continues to play a proactive role in the development control process to ensure that there is compliance with all relevant guidance.

Reason: To ensure that future development does not increase flood risk.

7.3 These conclusions, together with the following action plan, will be used in the preparation of the Local Flood Risk Management Strategy.

8 ACTION PLAN FOR THE FUTURE MANAGEMENT OF SURFACE WATER

8.1 The objectives of the study, as detailed in paragraph 2.24, were:

1) A clear understanding of the causes of flooding at each location investigated.

2) A record of the infrastructure serving the location and its condition and ownership.

3) A validation of the EA Flood Map for Surface Water.

4) Recommendations for future maintenance to prevent a repetition of the problem.

5) An understanding of how representative the findings are of the situation citywide.

6) Recommendations for further investigation.

7) Recommendations for further work.

8) Advice and information to local authority planners.

8.2 Through the modelling and investigation work the study has achieved objectives 1 to 7. The recurrent conclusion throughout the study has been that neglect of drainage infrastructure in all ownerships has been deficient over a long period of time and that a significant backlog of maintenance needs to be addressed to enable future surface water flood risk to be managed.

8.3 It has also become clear from the investigations that poor control of development in the past has affected natural drainage paths and that increased impermeable areas both in developments and highway alterations have aggravated flooding problems. In order to minimise the further effect of this, flood risk management must be an integral part of development management and highway design, and this will address objective 8.

8.4 The study has therefore identified two actions for the future management of surface water flood risk. No other actions have been identified:

- Maintenance of assets.
- Control of development.

Maintenance of Assets

8.5 The study has identified very serious shortfalls in both past and current maintenance of surface water drainage assets (Refer to conclusions paragraphs 7.1.1, 2, 5, 6, 7, 8, 9, and 10). These assets are principally in the ownership of CYC and YWS, although some are privately owned. The IDBs rarely if ever own assets but have a responsibility to maintain flow in or through them. They have permissive responsibilities only.

8.6 Investigations have clearly identified that neglect of this infrastructure by all owners has been either the cause of flooding or has aggravated it. Furthermore it has clearly identified that there are very poor records of the highway drainage infrastructure throughout the Council's area. Even if funding were available maintenance would be very difficult to prioritise on the basis of existing information.

8.7 In the areas modelled specifically for the study the EA's FMfSW has been shown to provide good general guidance to the location of areas likely to suffer surface water flooding. In view of the topography of the Council's area and observations and investigations in other areas it has been concluded that the FMfSW provides good guidance throughout the Council's area. However, it is not considered that this mapping of theoretical flood risk can be used to plan routine maintenance, but it will continue to be used in conjunction with future investigations. It is not proposed to carry out any further modelling, but that carried out has been used by the EA to update the FMfSW.

8.8 Since 2008/09 funding has been made available through the highway maintenance service to investigate surface water flooding, driven by the flooding which occurred in June 2007. Of necessity this has taken a holistic approach, identifying and recording the location and condition of drainage assets as found, to enable the effective management of future flood risk. From a highway maintenance and asset management point of view this has had the benefit of providing information on the highway drainage infrastructure to address the performance gap identified in the TAMP in 2006, but without the flooding occurring it is unlikely that any progress would have been made on this issue. Priorities for investigation have been driven by targeting known flood risk areas.

8.9 The funding that has been available to date is a total of £855k:

2008/09	£200k
2009/10	£200k
2010/11	£235k
2011/12	£55k
2012/13	£165k

8.10 On completion of the ongoing investigations in the current financial year, it is estimated that progress will have been made in investigating, rectifying problems and collecting data, in approximately 10% to 15% of the Council's area where information is lacking. The study has shown that uncertainties over ownership can affect the progress and conclusion of investigations, and continuing liaison with flood risk management partners will be required. However, regardless of ownership or responsibility the location of the infrastructure will be recorded, and flood risk will be better understood, fulfilling the Council's responsibilities as LLFA.

8.11 It is estimated that further funding of approximately £5m will be needed, calculated on a pro-rata basis, to complete investigations citywide and to collect and record information and remedy defects. On completion of the work, continued funding will be required for maintenance but expenditure can be planned and prioritised, rather than being reactive, and therefore maximise future efficiency.

8.12 This is clearly a substantial amount, and it has been calculated assuming that future investigations will be of the same level of complexity. Investigations to date have targeted known flooding areas and sought to resolve, in many cases, longstanding problems. Future investigations may not be as complex but this can only be confirmed once they have commenced, so it is not possible to assign specific amounts of funding to particular areas.

8.13 Therefore this estimated amount should be regarded as confirmation that ongoing funding is required to address flood risk and provide highway asset data. In practical terms the amount that can be effectively spent in any year is limited by the availability of appropriately skilled resources to direct and carry out the work and this should be the determining factor in deciding funding levels, together with an ongoing assessment to enable higher risk areas to be prioritised.

8.14 An option to do nothing could be considered. Should this be chosen, the condition of the drainage infrastructure will continue to deteriorate and reactive action will become more frequent, as has been already been experienced. This disrupts the planned work programmes for both engineers and the workforce, and both of these resources are becoming more stretched with reduced funding. The two events detailed in paragraph 3.3 can be used to make an assessment of the implications of doing nothing and the resulting costs.

- On Friday 27 April flooding at the A19/A1237 roundabout caused major disruption to the whole of the A1237 outer ring road from 7 am to 2 pm as a major part of the roundabout was impassable and 1½ to 2 hours were typically added to journey times. Resolution of the problem required an investigation to locate the drainage system and outlet, which was blocked with tree roots. None of the highway drainage routes were recorded on any readily accessible database.

It is difficult to calculate actual losses in a case like this but using guidance provided by the Council's traffic modellers the following indicative calculation of economic loss has been made:

Allow for an assumed 3,000 vehicle movements per hour (peak).
Assume all vehicles delayed by average of 1 hour.
Assume the duration of disruption to be 4 hours.
Assume cost of delay to be an average of £7/vehicle/hour.

Economic losses = 3,000 x 1 x 4 x £7 = **£84,000**

Actual costs incurred in managing the incident and remedying the problem:

An engineer from the Flood Risk management team has spent approximately 40 hours dealing with the incident on the day and carrying out a subsequent investigation to locate the drainage system and manage various contractors.

40 hours@ £39 = **£1,560**

The Flood Risk Manager wrote a report on the incident, which took 5 hours. This was not a Section 19 report under the F&WMA.

5 hours @ £55 = **£275**

Contractor costs for jetting, CCTV, creating a track to gain access to the blocked drain etc. **£7,500**

Total costs actually incurred **£9,335**

None of this was programmed work and therefore there are further unquantifiable costs incurred in disrupting routine work.

- On Sunday 10 June the A1079 both carriageways of the Hull Road flooded from the outer ring road roundabout to Badger Hill. The road was impassable for several hours and a subsequent investigation found major silt blockage in both highway drains and public sewers. None of the highway drainage routes were recorded. In addition 8 properties on the Badger Hill estate Way suffered internal flooding.

Once again it is difficult to calculate actual losses but using guidance provided by the Council's traffic modellers the following indicative calculation of economic loss has been made:

Allow for an assumed 500 vehicle movements per hour (Sunday afternoon)
Assume all vehicles delayed by average of 0.25 hour.
Assume the duration of disruption to be 2 hours.
Assume cost of delay to be an average of £7/vehicle/hour.

Economic losses = 500 x .25 x 2 x £7 = **£1,750**

Had the event occurred on a weekday the repercussions would have been on the same scale as the A19/A1237 incident as the Hull Road is a major route in and out of the City.

Insurance costs for householders – unknown but assume to be £5,000 per property = **£40,000**

Actual costs incurred in managing the incident and remedying the problem:

Emergency callout on Sunday afternoon and plant costs. **£700**

Engineers from the Flood Risk Management team have spent approximately 40 hours to date carrying out an investigation to locate the drainage system and manage various contractors plus extensive liaison with YWS. A Section 19 report under the F&WMA is required due to the severity of the flooding.

80 hours@ £39 = **£3,120**
10 hours @ £55 = **£550**

Contractor costs for jetting, CCTV, etc. **£7,500**

Total costs actually incurred by Council to date **£11,870**

None of this was programmed work and therefore had a knock on effect on other work of the team.

8.15 The SWMP technical guidance requires LLFAs to consider whether a Strategic Environmental Assessment (SEA), an Appropriate Assessment (required by the Habitats Directive) or an Article 4.7 Water Framework Directive (WFD) assessment is required. As the recommendations arising from this study relate to the location and subsequent maintenance of existing surface water infrastructure and no major works are proposed that will have a significant environmental impact, it is therefore considered unlikely that a SEA will be required but it will be looked at on a case by case basis.

Maintenance of Assets: Recommendations

Taking the above into consideration it is recommended that:

1. Annual funding of £200k is made available to continue investigations and record data. The hierarchy for investigations will be developed in the local strategy based on:

    a) areas of known flood risk.

b) areas where there are gullies but no recorded infrastructure serving them, prioritising principal transport routes.

c) other areas.

2. The Transport Asset Management Plan is reviewed and updated to reflect the improved asset information available from the investigations.

3 Progress on investigations, repairs and data acquisition is reported annually to Cabinet as part of the regular review of the Local Strategy to enable:

a) requirements for future funding to be reviewed and revised as necessary.

d) the effectiveness and efficiency of the maintenance regime to be reviewed and amended as necessary, to enable any funding changes to be based on real efficiencies.

e) residual flood risk to be assessed to determine whether specific funding is required to resolve more significant flooding problems.

Control of Development

8.16 The study has identified numerous locations where development has aggravated flood risk (Refer to conclusions paragraphs 7.1.2, 3, and 11). It has done this by:

- affecting natural drainage paths; for example former field drains and minor watercourses have frequently been filled in during development, or inadequately piped in with no consideration of future liability or the effects on flood risk to the site or locality.
- Increasing impermeable areas
- adversely affecting access to infrastructure for maintenance.
- creating future maintenance liabilities for which responsibility is not established at approval stage.

8.17 While this refers to development sites with planning approval, it should be noted that the same problems have occurred as a result of highway alterations, ref conclusion 7.1.11:

Designs for road alterations often do not take into account effects on drainage infrastructure. These can physically affect the drainage of a site and ease of access for maintenance, and also increase impermeable areas and flood risk. While this would be important anywhere it is an essential consideration in such a flat area. If not considered as an integral part of the design it can cause or aggravate flooding.

Road alterations can cause significant increases in surface water flows and the sustainable management of drainage is rarely addressed by designers, leading to a consequent increase in flood risk. An example of this is given in section 5.8 Hotspot 6: Heworth, in the paragraph titled “Other Flooding”.

8.18 Historically, the development that has taken place over many decades has permitted the discharge of surface water, with no volume restrictions, to existing drainage systems. This was accepted practice for the scale and type of development at the time, taking into account the prevailing climatic conditions, and was not questioned. However, the more recent demands of development and urbanisation, largely driven by ever increasing vehicle ownership and use, together with proven evidence of climate change, have made this approach unsustainable and unacceptable. At the same time the gradual deterioration in the condition of surface water drainage systems through neglect has reduced available capacity further aggravating flood risk.

8.19 Depending on its scale, development in its widest sense can typically include:

- The construction of more and bigger roads.
- Out of town shopping centres and associated car parks.
- The creation of bus and cycle lanes.
- The hard surfacing of urban verges to create parking areas.
- The hard surfacing of gardens to create parking areas.
- The construction of larger houses and at a higher density than previously
- Domestic properties with multiple parking spaces.
- The construction of house extensions and garden infill development.

8.20 All of these activities reduce the available permeable areas which absorb surface water and therefore all development can increase surface water flood risk.

8.21 Planning Policy Statement 25 (PPS25) addressed this issue, requiring developers to consider all flood risk with a site specific Flood Risk Assessment (FRA). Section 10 of the new National Planning Policy

Framework (NPPF) and the associated technical guidance note maintains this requirement.

8.22 The Council's Strategic Flood Risk Assessment (SFRA) was produced in response to PPS25 and assesses the different levels of flood risk in the York Unitary Authority area and maps these to assist with statutory land use planning. It provides concise information on flood risk issues, to assist planners in the preparation of the Local Development Framework (LDF) and in the assessment of future planning applications. It is also intended that this document is used by the general public and those wishing to propose developments as a guide to the approach that Local Planning Authorities will follow in order to take flood risk issues into account in a sustainable manner. Part 4 of the SFRA includes detailed policy recommendations covering these issues and also guidance for Development Managers, and is reproduced as Appendix 4.

8.23 The SFRA states that all watercourses are at capacity and therefore surface water must be managed so as not to increase, and if possible reduce existing flows. Of particular relevance is paragraph 4.1.8 of Appendix 4, Forward Planning (FP) Policy Recommendation: Flood Zone 1. This is repeated as a policy recommendation for all fluvial flood zones:

> 4.1.8 The majority of the watercourses in York are up to maximum capacity. Consequently, 1 in 100-year (1%) surface water runoff rates for developments in this zone should be, where practicable, restricted to either: -
>
> - Existing runoff rates (if a Brownfield site, based on 140 l/s/ha, in accordance with The Building Regulations 2007, Part H.3, with a reduction of 30% in runoff where practicable (as agreed with the EA) or,
> - Unless otherwise calculated, agricultural runoff rates (if the site has no previous development) will be based on 1.4 l/s/ha. To achieve this, additional run off volume will require balancing.

8.24 Appendix 4 of the SFRA also includes guidance for Development Management and the Consideration of Planning Applications. Paragraph 4.1.108 provides General Surface Water Drainage Guidance:

> 4.1.108 The 2000 flood saw all the major Becks and rivers flowing at full capacity, in each of the three river zones. Flooding affected 365 properties and threatened a further 5000. Consequently, the following policy should apply to all new development / redevelopment, irrespective of which flood zone it lays in: -
>
> 1. In accordance with PPS25, surface water flows from all sites should, where practicable, be restricted to 70% of the existing runoff rate i.e. 30% reduction (as agreed with the EA), Existing runoff rates are calculated as follows:

a. Brownfield site = 140 l/s/ha (in accordance with The Building Regulations 2007, Part H.3) or

b. Undeveloped sites = 1.4 l/s/ha (agricultural runoff rates).

Storage volume calculations, using computer modelling, must accommodate a 1 in 30-year storm with no surface flooding, along with no internal flooding of buildings or surface run-off from the site in a 1 in 100- year storm. Proposed areas within the model must also include an additional 20% allowance for climate change. The modelling must use a range of storm durations, with both summer and winter profiles, to find the worst-case volume required.

If no connected impermeable areas (if the site has no previous development i.e.(Greenfield) then an Agricultural runoff rate of 1.4 l/s/ha shall be used.

Notes: In some instances, there may be no flow from the site that discharges to a watercourse and the land may be waterlogged. Development of such a site will require the compensatory attenuation of flow elsewhere to maintain the status quo.

Agricultural runoff rate of 1.4 l/s/ha is currently quoted to developers. However, it is recognised that this empirical figure may not be appropriate for all soil types and modelling carried out as part of the flood risk assessment specific to a particular development site may establish a different existing runoff from the site on which a design can be based and agreed.

2. Surface water from developments shall not connect to combined drains or sewers, if a suitable surface water sewer is available and unless expressly authorised by Yorkshire Water.

   Note: This is to prevent overloading of the sewerage system and prevent unnecessary treatment of surface water. Some areas are wholly combined systems of drainage (e.g. city centre).

3. All full planning applications shall have complete drainage details (including Flood Risk Assessments when applicable) to include calculations and invert levels (to AOD) of both the existing and proposed drainage system included with the submission, to enable the assessment of the impact of flows on the catchment and downstream watercourse to be made. Existing and proposed surfacing shall be specified.

   Note: This should be confirmed at plans processing stage and the application rejected when insufficient detail is provided, thus preventing the promotion of inappropriate development. This will also *reduce the need for conditions related to drainage and provide clarity for enforcement purposes.*

4. Sustainable Urban Drainage (SUDS) methods of source control and water quality improvement should be utilised wherever possible for all new developments in the catchment.

   Notes: In accordance with Approved Document Part H of the Building Regulations 2000, the first option for surface water disposal should be the use of sustainable drainage methods (SUDS) which limit flows through infiltration e.g. soakaways or infiltration trenches, subject to establishing that these are feasible, can be adopted and properly maintained and would not lead to any other environmental problems. For example, using soakaways or other infiltration methods on contaminated land carries groundwater pollution risks and may not work in areas with a high water table.

5. Where the intention is to dispose to soakaway, these should be shown to work through an appropriate assessment carried out under BRE Digest 365, (if possible carried out in winter) - to prove that the ground has sufficient capacity to accept surface water discharge, and to prevent flooding of the surrounding land and the site itself.

   Where permeable paving is proposed the same BRE Digest 365 assessment should be carried out to prove that the ground has sufficient capacity to accept surface water discharge, and to prevent flooding of the surrounding land and the paving itself.

   City of York Council's Drainage Section should witness the BRE Digest 365 test.

   Notes: The suitability of the use of soakaways and swales within York will be limited, due to the unsuitable clay ground encountered throughout most of the city. There should be a presumption that these will be unsuitable unless proven otherwise.

   Should follow on with other options, if infiltration does not work, i.e. on site retention, sewers, watercourses as per Building Regulations - Part H (Drainage & Waste Disposal) 2002 Edition.

6. Ground water / land drainage from proposed developments shall not be connected to public sewers and existing land-drainage systems should be maintained.

   Note: Yorkshire Water will not allow the connection of ground water to public sewers, to prevent hydraulic over-loading of the sewerage system and problems associated with siltation.

7. Applications for smaller scale developments in relation to surface water drainage, which are part of larger sites that already have

outline permission, must comply with any conditions that were applied to the larger site.

Note: This is to prevent a 'piecemeal' approach to SUD/drainage schemes. This will apply to both large-scale housing and industrial developments, where the drainage system should be designed "as a whole".

8. Proposed development near to existing areas served by combined sewerage systems (typically pre-1930 terraced housing and inner-city) will need careful consideration with regards to additional hydraulic loading

Note: Yorkshire Water should be consulted at an early stage for all developments over 10 dwellings or sites exceeding 0.5ha, as new connections to sewers suffering from under capacity may result in exacerbation of any existing problems. The proposed site may also flood itself due to surcharge during intense summer storms.

8.25 The Council's Core Strategy, a key part of its Local Development Framework, was submitted to the Secretary of State in February 2012, but has subsequently been withdrawn. However, Policy CS22 Flood Risk contained therein is a further confirmation of the requirement to control surface water risk during the planning process, both strategically and at application level. It is unlikely that these requirements will be amended in the revised submission, as the basic principles of the policy are confirmed by the NPPF and associated guidance. Policy CS22 is included in Appendix 4.

8.26 The Council's Flood Risk Management team takes a very proactive role in development management and aims to resolve drainage and flood risk design issues at application stage to avoid the need for planning conditions. Without considering flood risk and drainage as a fundamental element of the design, options to provide sustainable solutions at a late stage of the process are difficult or impossible to achieve. Close working with the Development Management Team is necessary to ensure applications are dealt with appropriately in accordance with the SFRA and NPPF..

8.27 This principle is supported by the Flood and Water Management Act 2010 which requires LLFAs to establish a Sustainable Drainage Systems Approving Body (SAB). This body must approve drainage systems in new developments and re-developments before construction begins. The Act also removes the automatic right of connection to the sewerage system. Enactment of this part of the Act is expected in 2013.

8.28 The preferred option for a SUDS design is for it to mimic the pre development drainage of the site, which would ideally be achieved by the use of soakaways. However, due to the clay ground conditions prevalent across the majority of the York area, opportunities for infiltration drainage are very limited. As a result, sustainable drainage solutions are, of necessity, most frequently based on the retention of surface water on the site using ponds or tanks, with a controlled discharge to the downstream sewer or watercourse. While this can help to reduce the peak rate of flow of the runoff from the site, and the total volume of flow will remain the same, the duration of flow will be extended. This may lead to extended periods of higher water levels in receiving watercourses or drains and the impact of this will depend on the scale of the development and the characteristics of the downstream infrastructure. While small developments may not have a great impact the cumulative impact of many developments may be a cause for concern.

8.29 Should there be concerns regarding the effects of development on flood risk in an area there is legislation available which might help to manage it. The Town and Country Planning (General Development Procedure) (Amendment) (No. 2) (England) Order 2006 allows for a Local Planning Authority to designate an area within Flood Zone 1 which has critical drainage problems, as a Critical Drainage Area. The Council has not so far designated any areas but will consider it if is necessary to manage flood risk in specific areas.

8.30 It is of concern that the above procedures will not cover the effect of highway works on flood risk, which do not require planning approval. However, there is a clear requirement in the F&WMA for highway authorities (S27 (3)(d)) *"...to make a contribution towards the achievement of sustainable development"* . This is expected to be clarified on the enactment of the part of the Act referred to above and the Flood Risk Management team will work with highway engineers to ensure that there is compliance.

Control of Development: Recommendations

8.31 Taking the above into consideration it is recommended that:

1) Development is only permitted strictly in accordance with the NPPF and SFRA.

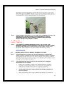
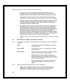
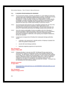
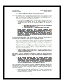
2) The Flood Risk Management team continues to take a proactive role in development management with the aims of minimising the number of approvals that are given with drainage conditions attached.

3) Where drainage conditions are attached to approvals the Flood Risk Management team will ensure that they are realistic and achievable.

4) The Council sets up procedures to become the SuDS Approval Body when the relevant part of the Act is enacted and guidance is issued.

5) The Flood Risk Management team works with highway maintenance and design engineers to ensure that they fully understand the need for sustainable drainage in their work, and that suitable designs are implemented.

Appendices

Appendix 1		**Hydraulic Modelling Report** **Halcrow June 2011**
Appendix 2	**City of York Council** **Traffic Asset Management Plan September 2006**	
		**Section 10** **Highway Drainage**
		**Paragraph 1.3** **Assets Included**
Appendix 3	**Well-maintained Highways** **Code of Practice for Highway Maintenance Management**	
		**Section 9.11** **Service inspection Of Highway Drainage Systems**
		**Section 10.7** **Condition Of Highway Drainage Systems**
		**Section 14.4** **Flooding From Inadequate Drainage**
Appendix 4		**City of York Council** **Strategic Flood Risk Assessment (rev 2011)** **Section 4**
Appendix 5		**Gritting and Gully Cleaning Routes**