
Manhood Peninsula Surface Water Management Plan

Prepared for
West Sussex County Council

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Acronyms and Abbreviations

Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
GIS	Geographic Information System
MPP	Manhood Peninsula Partnership
MWHG	Manhood Wildlife and Heritage Group
SW	Southern Water
SWMP	Surface Water Management Plan
WSCC	West Sussex County Council

Introduction

1.1 Project Context

This Surface Water Management Plan (SWMP) has been undertaken as part of a commission to develop SWMPs for five areas of West Sussex which have a history of significant flooding from surface water, groundwater and drainage systems. The five study areas were:

- Easebourne;
- Lancing;
- Manhood Peninsula;
- Upper Lavant Valley, and;
- West Chichester, including Fishbourne and Parklands.

These areas were selected as part of West Sussex County Council's (WSCC) response to the severe flooding in the summer and winter of 2012, although it is recognised that many of these have suffered flooding on multiple occasions.

A SWMP is described as a framework through which key local partners with a responsibility for surface water and drainage in their area work together to understand the causes of surface water flooding and agree the most cost effective way of managing that risk. The purpose is to make sustainable surface water management decisions that are evidence based, risk based, future proofed and inclusive of stakeholder views. Managing surface water flooding requires a range of partners, organisations and individuals to work together. The roles and responsibilities for those involved in helping to manage surface water flooding are described in Appendix A.

1.2 Background to the Manhood Peninsula SWMP

Drainage and flooding has long been recognised as a key issue in the Manhood Peninsula. In 2005 and 2006 Chichester District Council commissioned Royal Haskoning to undertake a three phase land drainage study. Part of this study involved considering flooding records as far back as 2001, although we recognise that flooding has been an issue in the Peninsula for a much longer time horizon. Furthermore, during the June 2012 extreme summer storm, and the two wet winters of 2012/13 and 2013/14 there was substantial flooding across large parts of the Manhood Peninsula affecting people, property and roads. Since then there has been significant drainage improvements to reduce flood risk and local communities, parish councils and flood action groups have played a critical role in delivering these improvements. However, flooding and drainage remains a key issue in the Peninsula and the purpose of this SWMP is to understand improvement works to date and formulate a clear action plan to reduce flood risk to people, property and infrastructure.

1.2.1 Objectives

The primary objectives of this SWMP were to:

- understand the surface water drainage in this area and gather additional data to reduce gaps in knowledge;
- identify pinch points in the network and connectivity issues;
- identify potential improvement works to reduce flood risk to communities in the Peninsula including capital and maintenance measures, building on the work already undertaken by communities, partnerships and other organisations;
- produce up to date GIS data of the ditch network, building on the work undertaken by Royal Haskoning, based on site visits undertaken to various locations in the Peninsula.

1.2.2 Scope

The scope for this SWMP was established during the early part of the overall project programme through discussions with WSCC, a rapid assessment of available data, and early identification of the flooding issues and mechanisms. A scoping document was prepared in March 2014 and agreed by WSCC. The scope is outlined below. The scope of work broadly follows the Surface Water Management Plan (SWMP) Technical Guidance published by Defra in 2010, ensuring the work was aligned with the national best practice. The SWMP Technical Guidance describes a four step process, as outlined in Figure 1-1.

Stage 1 – Data collection and review

Initially, data collection, compilation and mapping of flood incident data was undertaken. This included obtaining and compiling third party data (Southern Water, EA data on work on main rivers (i.e. the Rifes). Review of all the obtained data and all necessary past reports was undertaken to gain full understanding and appreciation of the problem. This included a thorough review of the Royal Haskoning land drainage study to understand the comprehensiveness of current data and where there may be gaps in knowledge and understanding.

Stage 2 – Develop stakeholder engagement plan & engagement with all relevant stakeholders

During this stage a stakeholder engagement plan was developed, to:

- identify the objectives of each stakeholder;
- identify stakeholders understand the role of all stakeholders within the Peninsula;
- ensure engagement with relevant stakeholders is undertaken at appropriate points in the decision making process, and;
- ensure stakeholders understand how they can help inform other stakeholders on flood management.

Some flood action groups and parish councils have gathered additional data on the ditch network, in addition to that already collated by Royal Haskoning. Therefore, we held a series of meetings with flood action groups and parish councils to:

- understand data they hold and use this to build up a complete picture of currently available data;
- identify pinch points in the network where water backs up;
- identify riparian ownership and responsibilities, and;
- identify locations for connectivity and/or topographic survey.

During this stage we also engaged with Chichester District Council and Southern Water to gain additional understanding of local issues.

Stage 3 – Undertake survey work

Following identification of gaps and the location of pinch points a walkover survey of critical locations was undertaken to establish the connectivity of the drainage network. It focussed on identifying flow pathways, pinch points and potential areas for improvement. The walkover surveys helped to reduce data gaps in this study area and enhance our understanding of flooding problems and likely solutions

Stage 4 – Identify measures to improve drainage

In pinch point locations the knowledge gained throughout the study was used to identify suitable measures to improve the capacity or conveyance of the drainage network. This involved a range of small or large capital works, or improving the maintenance of the network to enable water to flow more freely through the system and thus reduce flood risk. Action plans have been developed for pinch point locations which recommends who needs to do what and when.



Figure 1-1 SWMP Process

1.2.3 Study Area

The study area covers the entire area known as the Manhood Peninsula. The A27 forms the northern boundary of the study area while the Pagham Rife forms the eastern boundary. To the west the study boundary is determined by Chichester Harbour. Drainage in the Manhood Peninsula discharges either to Chichester Harbour, Pagham Harbour or direct to the sea. A map of the study area is shown in Appendix B.

1.2.4 Key stakeholders

For each of the five SWMP areas a stakeholder engagement strategy was prepared which identified who to engage with and when and how this should be done. Stakeholder engagement is an important part of the overall approach to the development of the Surface Water Management Plan and is integral to the agreed methodology for the study as a whole. The approach aimed to ensure that professional stakeholders,

landowners, parish councils and other relevant groups were given an opportunity to help shape the study. Engagement, in different forms, was undertaken throughout the study to help:

- ensure the study was robust and that the data used to underpin it were as accurate as possible - ensuring that best use is made of local knowledge and that our analysis of flood risk matches local experience;
- ensure the study addresses the key problems that are of the most concern to local communities;
- generate greater understanding about, and buy in for, the way in which local flooding will be managed going forward, and;
- encourage stakeholders and the general public to take actions to help protect themselves against flooding.

The key stakeholders identified for the Manhood Peninsula SWMP are:

- West Sussex County Council as the Lead Local Flood Authority and Highways Authority;
- Chichester District Council as the Land Drainage Authority
- The Environment Agency;
- Southern Water;
- Parish Councils and Local Flood Action Groups;
- Manhood Peninsula Partnership (MPP), and;
- Manhood Wildlife and Heritage Group (MHWG).

A list of engagement activities undertaken during the Manhood Peninsula SWMP are described in Table 1-1

Table 1-1 Engagement activities for the Manhood Peninsula SWMP

Activity	Purpose/Detail	Timescale
Initial meeting with WSCC	To agree the scope of the work	March 2014
Technical discussions with Environment Agency Staff	To understand how the Environment Agency issue flood alerts/warnings, how trigger levels are set, and ongoing capital/maintenance work in the catchment	Throughout study
Engagement with Southern Water	To understand operational issues in the foul sewer network due to infiltration, actions taken over the past 2 wet winters, and future plans to manage infiltration	Throughout study
Meetings with Parish Councils and Flood Action Groups	To understand local issues within the catchment and what actions have been undertaken / proposed	October 2014
Presentation to MPP	To share the emerging findings of the SWMP and gain additional local insight into flooding issues	December 2014
Walkover survey and site visits	To ensure problems from a local perspective are understood. Representatives from various parish councils and WSCC were in attendance where relevant	December 2014 and February 2015
Presentation to MPP	To report back on the results of the analysis and modelling and share the emerging SWMP	September 2015

1.2.5 Data collected for study

A summary and analysis of the data received for the SWMP is provided in Table 1-2 and includes a commentary of any known data quality issues.

SECTION 1

Table 1-2 Data received for Manhood Peninsula SWMP

Dataset	Data received from	Comments	Data Quality Issues
Common data received across all five study areas			
Bedrock and Superficial Geology	British Geological Society	Maps of the bedrock and superficial geology	-
Digital Terrain Model (DTM)	Environment Agency	This is a model of the ground surface, used by the Environment Agency for their national surface water mapping	The data is a composite of LiDAR and NextMap. The NextMap has a much lower accuracy which makes it less reliable as a data source
Flooded Properties Register (DG5)	Southern Water	This is the register of flooded properties held by Southern Water which are the result if hydraulic capacity issues in the public sewer network	-
Flood Map for Planning	Environment Agency	National fluvial flood map provided by the Environment Agency for Flood Zone 3 (1 in 100 chance of occurring in any given year) and Flood Zone 2 (1 in 1000 year)	Only shows flooding from watercourses where the upstream catchment is >3km ²
Flood Map for Surface Water	Environment Agency	National surface water flood mapping provided by the Environment Agency for the 1 in 30 year, 1 in 100 year and 1 in 1000 year rainfall probability events	This is the most comprehensive surface water mapping available, but given the mapping is at a national scale there are a number of generic assumptions which may not be locally relevant.
Groundwater Susceptibility Mapping	WSCC	A groundwater flood risk map provided by WSCC, dividing areas into low, moderate and high groundwater flood risk	
Highway drainage data	WSCC	Details of the public highway network	This dataset only contains the location of highway gullies, but does not include details of the pipework
Historic Flood Outlines	Environment Agency	Recorded flood outlines from fluvial flooding collated by the Environment Agency	

Historic flooded properties	WSCC	A point dataset showing the location of flooded properties	Known limitations with this dataset, as there are many properties not recorded on this dataset which have flooded. The data goes back to 2012
Historic flooded roads	WSCC	A point dataset showing the location of flooded roads	Known limitations with this dataset, as there are many roads not recorded on this dataset which have flooded. The data goes back to 2012
June 2012 Flood Investigation	WSCC	Investigation in June/July 2012 flooding incidents across West Sussex	-
Local Flood Risk Management Strategy	WSCC	A statutory document produced by WSCC as part of their responsibility as a LLFA	-
National Receptor Dataset	Environment Agency	Provides location and details on residential, non-residential properties, and critical infrastructure	-
Operation Watershed details	WSCC	Details of the schemes completed or ongoing as part of Operation Watershed	-
Public Sewer Network data	Southern Water	Location, connectivity and details of the public sewer network	Asset details of the surface water sewer system are generally of poorer quality than the foul or combined system
River network	Environment Agency	Location of watercourses	This is a national dataset and there are some assumptions about the routes of watercourses, especially where watercourses go into culverted sections
Data received bespoke to Manhood Peninsula SWMP			
Borehole data	Environment Agency	Continuous (logger) and spot (manual dip) sample groundwater data for Lagness, in Paghams	Gap in the data between late March 2009 and December 2009
Rainfall data	Environment Agency	Rainfall data at Fishbourne and South Mundham. Also access to Skyview dataset which records rainfall every 15 minutes	Some missing data in records

River flow data	Environment Agency	River flow data has been provided by the Environment Agency for the Pagham Rife	
Land Drainage Study (Phases 1-3)	Royal Haskoning	Three phased report on land drainage in the Manhood Peninsula.	-
Review of Medmerry scheme	Black & Veatch	Report by Black & Veatch considering the impact of the Medmerry temporary works on flooding in June 2012	
Flood Reports and incident logs	WSCC	Over 500 flood reports from June 2012 to March 2014	Limited information on extent of flooding, source of flooding or impact (whether road or property was flooding). Useful to build up an overall picture of areas vulnerable to flooding
DG5 Register	Southern Water	Southern Water provided their DG5 sewer flooding register (based on postcode envelopes), which contains records of reported flooding from 2009 to March 2014	-
Drainage review – Bell Lane and Bookers Lane	WSCC	WSCC report looking into the drainage system on Bell Lane and Bookers Lane	-
Birdham Parish Ditches Condition Assessment	MWHG	Comprehensive survey of ditch network in Birdham with recommendations about priority actions	-
Itchenor Parish Ditches Condition Assessment	MWHG	Draft outputs of survey of ditch network in Itchenor with recommendations about priority actions	Survey report is in draft report
Bookers Lane FAS drawings	Environment Agency	Drawings of the Bookers Lane scheme	-
Operation Watershed bids	WSCC	Operation Watershed bids across the Manhood Peninsula by parish councils and flood action groups	-

Flood information and actions taken / proposed	Parish Councils	Information gathered from 2 days of stakeholder meetings in October 2014	-
Report on proposed action by Birdham and Earnley Flood Prevention Group	Birdham and Earnley Flood Prevention Group	Report on status on 70 actions proposed by Birdham and Earnley Flood Prevention Group	-

Overview of Manhood Peninsula

2.1 Introduction

This section provides a brief overview of the key characteristics of the topography, geology, and drainage system of the Manhood Peninsula. It should be noted that the Royal Haskoning Land Drainage Study Phase 1¹ provided a comprehensive and in-depth summary of the key characteristics noted in the sections below. The Royal Haskoning report therefore provides a useful reference point for further background information on the Manhood Peninsula, which is not repeated in this SWMP report.

2.2 Description of the Peninsula

2.2.1 Topography

The Manhood Peninsula is a flat, low-lying plain and drainage in the Peninsula flows through local ditches and Rifes² before discharging into Chichester Harbour, Pagham Harbour, Medmerry re-alignment scheme, or directly to the sea. On average the Manhood Peninsula has a slope of approximately 1:1000. Due to the low-lying nature of the Peninsula water can take a long time to drain away and the function of the drainage network is highly sensitive to localised blockages, constrictions and poor maintenance as well as wider effects such as the tide level.

Whilst the Peninsula is low-lying there are defined high points. These include an area of Selsey running through to Church Norton, South Mundham and Donnington. In addition, the road (A286/B2179) from Birdham to West Wittering acts as a relatively high ridge. North of the road flows generally drain towards Chichester Harbour, whereas south of the road flows drain towards Medmerry and Pagham Harbour.

2.2.2 Geology and Hydrogeology

An in depth analysis of the underlying geology and the influence that the hydrogeological characteristics of the peninsula have on the mechanisms of flooding and associated flood risk across the peninsula is provided in Appendix C.

The geology of the peninsula is significantly influenced by its structure. Folds in the underlying sedimentary rocks impart a southerly dip to the solid strata and are such that a number of different formations occur (north to south) beneath the peninsula, each with different hydrogeological characteristics.

Although only partly exposed as sub crop beneath the drift deposits, the major regional aquifer of the Chichester Chalk occurs beneath the northern part of the peninsula, brought near surface by folding. Regional southerly groundwater flow from the Lavant catchment of the “Chichester Chalk” to the north is diverted east and west by the synclinal (“downfold”) structure beneath Chichester. As a result, the influence of regional groundwater flow within the peninsula is generally limited to the northern part of the peninsula, but results in:

- large emergent springs just south of Fishbourne;
- possible discharges (through River Terrace gravels) to the River Lavant to the west of Stockbridge, and;
- discharge to the River Terrace Deposits and other permeable drift deposits and a probable contribution to baseflow the upper reaches of Pagham Rife.

Some of the younger “solid” strata to the south may contain limited amounts of groundwater, but these are not significant aquifers and are unlikely to contribute to significant groundwater flow. The London Clay

¹ Royal Haskoning (2003), Land Drainage Study of the Manhood Peninsula

² Main watercourses in the Peninsula are known as Rifes

Formation, present beneath a large north and central part of peninsula, contains no or very limited amounts of groundwater and also limits downward infiltration of rainfall.

The solid strata are overlain by varying depths of superficial (drift) deposits, primarily comprising River Terrace Deposits derived from the former (historic) course of the River Lavant. Alluvial fan and beach deposits are associated with river courses and the coastal margins. The majority of these deposits are characterized by coarse sands, with occasional gravels, interbedded with clays and silts. These shallow deposits (rarely above 10m thick and more typically 5m thick) may be very permeable. Groundwater occurs at relatively shallow depths, primarily recharged directly by incident rainfall in central and southern areas, although to the north there may be some groundwater associated with the regional groundwater flow in the underlying Chalk.

The permeable superficial deposits are also likely to be in direct hydraulic continuity with watercourses across the peninsular. They may discharge “baseflow” into the water courses (particularly the main Rifes) although it is not clear how much this might impact overall conveyance capacity.

2.3 Drainage System

The drainage system across the Manhood Peninsula is characterised by Rifes, the local ditch network, highway drainage, and foul sewerage. A summary of the most salient drainage features across the Peninsula is provided in subsequent sections.

2.3.1 Rife Network

The main drainage network through the Manhood Peninsula is via a series of Rifes³, and the majority of local ditches connect into these Rifes before discharging into the Chichester Harbour, Pagham Harbour, Medmerry re-alignment scheme, or directly to the sea. To the east of the Peninsula the Bremere Rife, Forebridge Rife, Keynor Rife and Pagham Rife⁴ all drain towards Pagham Harbour, which is gradually silting up and has been the subject of a study by Royal Haskoning in 2005 (see Section 3.3.3.1 for more details). These Rifes drain through a series of small settlements. As the Rifes flow through these settlements there are often significant constrictions to flow (e.g. due to the presence of culverts under driveways and highways). A specific example of this is the culverted sections of the Bremere Rife through Hunston.

Further west the Easton Rife and Earnley Rife flow through Somerley, Earnley and Almodington before discharging into the newly built Medmerry re-alignment scheme, completed by the Environment Agency in 2014. In Earnley the Environment Agency have also completed the Bookers Lane Flood Alleviation Scheme to reduce the risk of fluvial flooding to properties on Bookers Lane, Earnley. In Almodington the Environment Agency is currently promoting a scheme to improve the conveyance of the Easton Rife as it flows through significant constrictions in the village.

There are also two additional Main Rivers which flows through East Wittering known as the Hale Farm Ditch and Cakeham Green Ditch. The Hale Farm Ditch starts as two small watercourses near Hale Farm and Holmes Farm before converging near Hilton Park Business Centre. The watercourse then flows in a generally southerly direction as it enters East Wittering where it is joined by the Cakeham Green Ditch, before discharging into the sea.

West of East Wittering and north of the A286/B2179 the drainage all flows into Chichester Harbour via smaller ordinary watercourses

³ These Rifes are predominantly Main River and therefore the responsibility for flood risk management rests with the Environment Agency

⁴ NB: the Pagham Rife will take flows from the River Lavant diversion scheme during times of high flow in the River Lavant once it is fully implemented (Phase 2 commenced January 2014)

2.3.2 Local ditch network

Historically the local drainage and ditch network in the Manhood Peninsula was built to drain agricultural land. However as the population and industry⁵ of the Manhood Peninsula has grown over the past 60-70 years the nature of the landscape has changed and significant parts of the local drainage and ditch network now flow through villages and towns. In many cases this has led to narrowing of the ditch network, loss of sections of ditches, use of culverts under highways or driveways which are typically under-sized compared to the cross-sectional area of the open ditch sections. In addition, in many of the villages and towns the ownership of the ditches and culverts is unknown or is the responsibility of numerous householders. Over time maintenance of the local drainage and ditch network has been poor which has exacerbated flooding in many locations across the Peninsula. The majority of the local drainage and ditch network is owned by private landowners and householders who are legally responsible for ensuring the ditches are well maintained under the Land Drainage Act (1991).

Phase 1 of the Royal Haskoning Land Drainage Study analysed the causes of flooding in numerous locations across the Peninsula and noted that “the majority of land drainage and flooding problems appear to have lack of maintenance and lack of system capacity as a common factor. With such problems it is important that those who have responsibility for the watercourses undertake appropriate works. The works must be undertaken in a coordinated way so that the flooding problem is not simply moved elsewhere, i.e. further downstream.”⁶

The same report also notes that “the drains in the Peninsula are made up of both open watercourses and culverts. It is not uncommon to see a large open ditch flow into a small culvert, then open up again and then be culverted and so on. Many of the culverts in the Peninsula may have been privately constructed without formal land drainage consent. It is currently difficult to distinguish the direction in which some of the drains on the Peninsula flow making it difficult to find the source of some flooding problems.”⁷ During site visits undertaken for this SWMP in December 2014 and February 2015 this was a commonly observed issue.

2.3.3 Highway drainage

In many of the villages and towns there is a positive highway drainage via gullies and piped networks which outfall into the ditch network. It is commonplace for highway gullies to drain directly to open ditches, but there are also locations with extensive piped highway drainage before it outfalls into ditches or Rifes (e.g. East Wittering). WSCC is responsible for managing and maintaining the highway drainage network. WSCC undertakes a routine gully clearance programme, whereby gullies are surveyed annually and cleaned if they are more than 50% silted. During the SWMP we surveyed large sections of highway drainage in the hotspot locations to identify any blockages or collapses in the system.

2.3.4 Sewerage network

Southern Water is the sewerage undertaker for the Manhood Peninsula and is responsible for draining and treating foul effluent, and effectually draining surface water from roofs and yards. For the most part there is no Southern Water operated surface water sewer system except in Selsey where the northern part of Selsey drains to a pond at East Beach before discharging into the sea.

With respect to the foul sewerage system there is a collection system across the majority of the Peninsula which take foul effluent to three sewage treatment works at Sidlesham, Pagham and Apuldram. In some locations (e.g. South Mundham) there are private treatment plants or septic tanks which are not owned or maintained by Southern Water. As part of the study Southern Water has provided their DG5 flooding

⁵ There is significant consensus locally that many of the green houses in the Manhood Peninsula have increase the rate and volume of runoff into the ditch network, with little/no attenuation.

⁶ Royal Haskoning (2003), Land Drainage Study of the Manhood Peninsula

⁷ *Ibid.*

register (based on postcode envelopes), which contains records of reported flooding from 2009 to March 2014. This information is summarised in Section 3.3.1.

2.4 Environment of Manhood Peninsula

This section includes a summary of the key baseline environmental characteristics (see Table 2-1) and details the findings of a preliminary desk-based study, against which the environmental effects of the drainage and flood management strategy for Manhood Peninsula can be assessed.

Table 2-1 *Environmental Characteristics and Issues associated with Manhood Peninsula*

Baseline	Environmental Issues
Local Community	
<ul style="list-style-type: none"> • There are approximately 16 settlements on the Manhood Peninsula, with populations varying from 169 in Apuldram (Office for National Statistics, 2011 Census) to around 10,550 in Selsey (Office for National Statistics, 2011 Census). • The population of all wards in the Manhood peninsula is 27,000 (West Sussex County Council and West Sussex Public Health Authority, 2009) • The presence of the South Downs National Park and Chichester to the north of the study area together with the Chichester Harbour Area of Outstanding Natural Beauty (AONB) attracts tourists to the area. It is estimated that around £146.6 billion was spent by visitors (excluding residents) during their visit to the Manhood Peninsula in 2009, supporting approximately 1,973 local full time jobs (Tourism South East, 2009). • Population growth in coastal areas around East Wittering is increasing. • Land around East Wittering and Selsey is safeguarded for strategic development. 	<ul style="list-style-type: none"> • Direct effects on the population and properties within flood risk areas, including businesses and visitors to the Manhood Peninsula. • Quality of life is affected by flooding • Population growth is increasing development pressure on land and within the flood plain. • Development Lland could exacerbate flood risk and increase surface run-off if developed.
Material Assets	
<ul style="list-style-type: none"> • The A286 runs in a north-east to south-west direction, in the west of the study area, from Chichester to Birdham. • The B2145 runs in a north to south direction, through the centre of the study area, from Chichester to Selsey. • The B2145 is prone to flooding during heavy rain, which can make it inaccessible (Manhood Peninsula Partnership, 2015). This is the main route in and out of Selsey. • Other minor roads are interspersed throughout the study area; some of which are at risk of flooding (some examples include; Church Lane and Crooked Lane in Birdham/Westlands, Solent Road, Stocks Land and Bracklesham Lane (B2186) in East Wittering/Bracklesham, Church Lane in Hunston, High Street and Elm Tree Close in Selsey, Keynor Lane, Church Lane and Chalder Lane in Sidlesham, Bell Lane and Bookers Lane in Earnley/Somerley, Rookwood Road, Elms Land and Cakeham Road in West Wittering and Mill Lane and Saltham Lane in Runcton). 	<ul style="list-style-type: none"> • Risk to existing, critical and proposed key transport infrastructure. • New development will need to be appropriately located in terms of flood risk from fluvial and coastal flooding.

Baseline	Environmental Issues
<ul style="list-style-type: none"> • The Chichester Ship canal (disused) and a dismantled railway crosses parts of the study area. • Several marinas lie within the study area including Birdham Pool Marina, Chichester Marina and Yacht Club in the north-western section of the study area, just off Chichester Harbour, north of Birdham. • Various holiday complexes lie at the southern end of the study area at Bracklesham Bay e.g. Medmerry Park Holiday Village. 	
Biodiversity, Flora and Fauna	
<ul style="list-style-type: none"> • International designated nature conservation sites: <ul style="list-style-type: none"> • Pagham Harbour Special Protection Area (SPA) and Ramsar site, designated for populations of breeding and overwintering bird species, lie within the study area • Chichester and Langstone Harbours SPA borders the western edge of the Manhood Peninsula, designated for breeding and overwintering birds. • 3 national designated Sites of Special Scientific Interest (SSSI) within the study area comprising <ul style="list-style-type: none"> • Pagham Harbour (biological and geological), Selsey East Beach (geological) and Bracklesham Bay (biological and geological) SSSIs. • 1 Local Nature Reserve (LNR) within the study area: Pagham Harbour, designated for mudflats and breeding bird habitat. • 1 Local designated Site of Nature Conservation Interest (Crabland Farm Meadows) within the study area. • The presence of other sites of local wildlife importance, such as Sites of Importance for Nature Conservation (e.g. Keynor Copse Ancient Woodland) (WSCC, 2003) and the presence of non-statutory nature reserves within and around the study area (available from Sussex Biodiversity Records Centre), would need to be taken into consideration for any option taken forward to detailed appraisal. • There are known rare, notable and/or protected species (including water voles) within the study area in terrestrial, riverine and aquatic environments. Such species may be sensitive to changes in hydrology, flood regime and water quality. • Details of Tree Preservation Orders (TPO) will need to be confirmed with Chichester District Council prior to implementation of any SWMP measures. Where possible, the detailed design of a scheme should seek to avoid the loss of and damage to trees, particularly those protected by TPOs. However, where works to a tree designated by a TPO are required, this will need to be consented by the local planning authority. 	<ul style="list-style-type: none"> • Potential for negative or positive effects on international, national and local conservation sites and terrestrial, aquatic or riparian habitats. • Need to ensure that soil erosion measures and the Action Plan do not adversely affect flow, frequency or duration of flooding to water-dependent habitats, particularly those within designated sites. • Need to ensure that any works on watercourses are compliant with the Water Framework Directive (WFD) regarding fish passage as well as water quality and geomorphology. • Potential requirement for Habitat Regulations Assessment (HRA) in accordance with the Conservation of Habitats and Species Regulations 2010 due to presence of international conservation sites. • Potential requirement for SSSI assent from Natural England for any works affecting a SSSI under the Wildlife and Countryside Act 1981 (as amended).

Baseline	Environmental Issues
<ul style="list-style-type: none"> Land near Almodington and Highleigh has been designated Horticulture development areas by Chichester District Council. A new nature reserve, Medmerry Realignment, is nearly finished being built. This is located on the coast between Selsey and Bracklesham. 	
Soil, Geology and Geomorphology	
<ul style="list-style-type: none"> Marine sands of higher raised beach and gravel of lower raised beach overlain by brickearth of coastal plain (BGS, 1983). There are 11 historic landfill sites within the study area (Environment Agency, 2015) and areas of potential contamination (e.g. associated with the former canal/railway). Study area experiences soil erosion problems, including deposition through sediment transport and soil wash (where water contains soluble pollutants such as pesticides) (BGS, 1983). Predominantly Grade 2 (good quality for crop production) with small areas of Grade 3 (moderate quality for crop production) and even smaller areas of Grade 1 (excellent quality for crop production) (Natural England, 2010). 	<ul style="list-style-type: none"> Flood risk affects soil quality and erosion, which affects other environmental receptors Geology can influence the extent and likelihood of an area to flooding and/or the suitability of some types of SUDS options. Potential requirement for a preliminary WFD Assessment.
Water	
<ul style="list-style-type: none"> There are rivers (e.g. River Lavant) and Rifes throughout the study area including Pagham Rife, Bremer Rife and Broad Rife. Study area subject to flooding from drainage system being overloaded by surface run-off and coastal flooding. Two surface water Nitrate Vulnerable Zones (NVZ) (www.magic.org.uk, 2015) 12 surface water abstractions and 7 ground water abstractions within the study area (Environment Agency, 2015). 	<ul style="list-style-type: none"> Direct and indirect effects on water resources, both surface and ground water, which could affect their chemical and ecological status as required by the WFD. Potential requirement for a preliminary WFD Assessment.
Historic Environment	
<ul style="list-style-type: none"> Over 100 listed buildings and 3 Scheduled Monuments (SMs) (Ringwork south of St Wilfred's Chapel and Cakeham Manor) within the study area (www.magic.org.uk, 2015). The eastern edges of Fishbourne Roman Palace and Fishbourne Roman Site SM are within the study area. Fishbourne Roman Palace Registered Park & Garden is located on the border of the study area, south east of Fishbourne (www.magic.org.uk, 2015). Selsey Conservation Area is along the B2145 within Selsey. There are likely to be non-designated sites and Historic Environment Records (HER) sites of importance within the study area, which should be obtained in advance of project 	<ul style="list-style-type: none"> Potential to reduce flood risk to archaeological assets and their setting Potential for impacts on the character of the historic landscape, archaeological assets and their setting Potential opportunities to improve heritage assets in conjunction with delivering action plans

Baseline	Environmental Issues
<p>implementation, where appropriate and dependent on the nature of the works.</p> <ul style="list-style-type: none"> Buried and unrecorded archaeological potential. 	
Landscape	
<ul style="list-style-type: none"> Chichester Harbour AONB covers the western edge of the study area, which is characterised by a series of tidal inlets, with a narrow mouth to the sea (NAAONB, 2015). Study area lies within the South Coast Plain National Character Area, characterised by; <ul style="list-style-type: none"> Flat coastal landscape Intricately indented shoreline 	<ul style="list-style-type: none"> Existing landscape, seascape and visual resources currently under pressure and subject to dynamic coastal processes. Action Plans needs to consider visual amenity of valuable shoreline. Increasing coastal erosion and evolving sediment systems are likely to significantly change the coastal landscape and geomorphology along undefended sections of frontage. Flood risk management measures may present opportunities to protect and enhance the existing landscape.

2.5 Flooding history and impacts

The Manhood Peninsula has suffered from fluvial and coastal flooding, such as overtopping of the coastal defences to the west of Selsey in 2005. Furthermore, during extreme rainfall events or very wet winters significant flooding occurs across the Manhood Peninsula, as was the case in autumn 2000, June 2012, Winter 2012/13 and Winter 2013/14. During these extreme rainfall events or wet winters flooding occurs from Rifes, local ditch networks and the highway drainage system as they do not have sufficient capacity to drain water away. During extreme rainfall events (e.g. June 2012) and long wet periods (e.g. Winter 2013/14) flooding will continue to occur in the Manhood Peninsula because the drainage systems were never designed (nor could be) to accommodate such flows.

In addition to flooding during more extreme rainfall events or wet winters, the Manhood Peninsula is vulnerable to regular flooding due to its low-lying nature. This regular flooding is often caused by poor maintenance of ditches and culverts, discontinuity of the ditch network, or collapses/blockages in piped ditches or drainage. Flooding of this nature can emerge anywhere if ditches are blocked or there are collapses/blockages in the piped network. As a result the Manhood Peninsula requires ongoing flood risk management investment by WSCC, parish councils, landowners and riparian owners to ensure the drainage infrastructure is fully functioning. For example, ditches need to be cleared on a regular basis to ensure flooding issues do not re-appear. Across the majority of the Manhood Peninsula there is not a quick fix solution to flooding problems, rather it requires continuing vigilance and investment to maintain the drainage infrastructure.

The most detailed evidence of flooding across the Manhood Peninsula is available from WSCC highway incident logs from June 2012 to March 2014. As the time period covers a major summer storm event, and two extremely wet winters (2012/13 and 2013/14) it is reasonable to assume that the incident logs provide a good representation of the flooding impacts across the Manhood Peninsula. The areas which experienced the highest number of properties (>5) affected by flooding during this period included:

- Almodington;
- Birdham;

- Earnley;
- East Wittering;
- Hunston;
- Selsey;
- Sidlesham;
- Somerley, and;
- West Wittering.

More details on the causes and impacts of flooding in the key flooding locations are provided in Section 3.4 and the action plans in Section 4 of the report.

Approach for the SWMP

3.1 Introduction

This section describes the key principles which have adopted for the SWMP (Section 3.2) and the technical approach (Sections 3.3 to 3.6). The technical approach is also illustrated in Figure 3-1.

3.2 Key principles

The approach to the SWMP has been governed by five key principles which have enables a focus on identifying clear and prioritised actions for the SWMP.

1. Take account of the work being promoted and undertaken locally

From stakeholder meetings in October 2014 it was evident that parish councils, local flood action groups and the MWHG are promoting and undertaking a significant amount of work locally to alleviate flood risk within settlements across the Peninsula. The SWMP takes this work into account, and does not duplicate or replicate existing efforts.

2. Focus on the key strategic issues in priority locations

The purpose of the SWMP is not to map and assess the entire drainage network across the Manhood Peninsula. Indeed the MWHG have applied for funding to undertake a comprehensive ditch mapping and condition assessment for the Peninsula. Rather, the SWMP should identify the **strategic flood mitigation measures** required which will have the most significant impact on reducing flood risk. The SWMP has identified and focused on the settlements where flooding is causing the biggest impact to people and infrastructure, and the key measures to address flood risk in these locations. In some locations (e.g. Birdham) the MWHG, parish councils, and local flood action groups have identified many more actions than are included in the SWMP. This is because the SWMP is seeking to focus on the key strategic measures, whereas others may have identified all actions to improve the drainage situation (e.g. clearance of gully).

3. Focus on small scale improvements

Across most of the Peninsula flooding arises due to localised constrictions or discontinuity of the ditch or highway drainage network. During site visits there were numerous observations of ditches being filled in, cracked/broken pipes, or discontinuity of the network. These localised constrictions and discontinuities in the network cause pinch points in the system where flooding occurs into property and infrastructure. Therefore, it is anticipated that the majority of mitigation measures will be small scale, resulting in incremental improvements to flooding in the Peninsula. There are areas where more significant investment is needed in flood risk management infrastructure to alleviate flood risk (e.g. Bookers Lane) which have been identified in the SWMP. However, for the most part small scale measures which seek to rehabilitate and improve the existing drainage infrastructure will be the preferred approach to reduce flood risk. These small scale improvements are proportionate to the benefits in terms of numbers of people and properties affected by flooding. For the most part there is insufficient economic justification to implement large scale capital measures. Multiple small scale improvements can help to resolve key strategic issues within the priority locations identified.

4. Use engineering judgement to identify measures

Flood risk management infrastructure is often assessed and designed using hydraulic and hydrological techniques (e.g. hydraulic modelling) where the complexity of the flooding problems or the proposed mitigation measures justify this level of technical analysis. As the majority of problems are caused by localised pinch points in the system mitigation measures across the Peninsula can be identified and delivered using engineering judgement rather than detailed technical analysis. Therefore most of the

measures identified in the SWMP have been identified using engineering judgement from experience and evidence gained from the site visits and discussions with local parish councils / flood action groups. These measures can, for the most part, be delivered through discussions with contractors rather than requiring extensive design drawings or calculations. Equally, some of the proposed measures may require some additional calculations to support an outline or detailed design before implementation.

5. Consider the downstream impacts of measures

The SWMP offers an opportunity to ensure that mitigation measures do not cause an increase in flood risk downstream. From discussions with stakeholders during development of the SWMP it is evident that current mitigation measures often do not consider downstream impacts. Therefore as part of the SWMP action plan any potential downstream impacts of proposed measures have been identified, and what needs to be done to mitigate these impacts.

SECTION 3

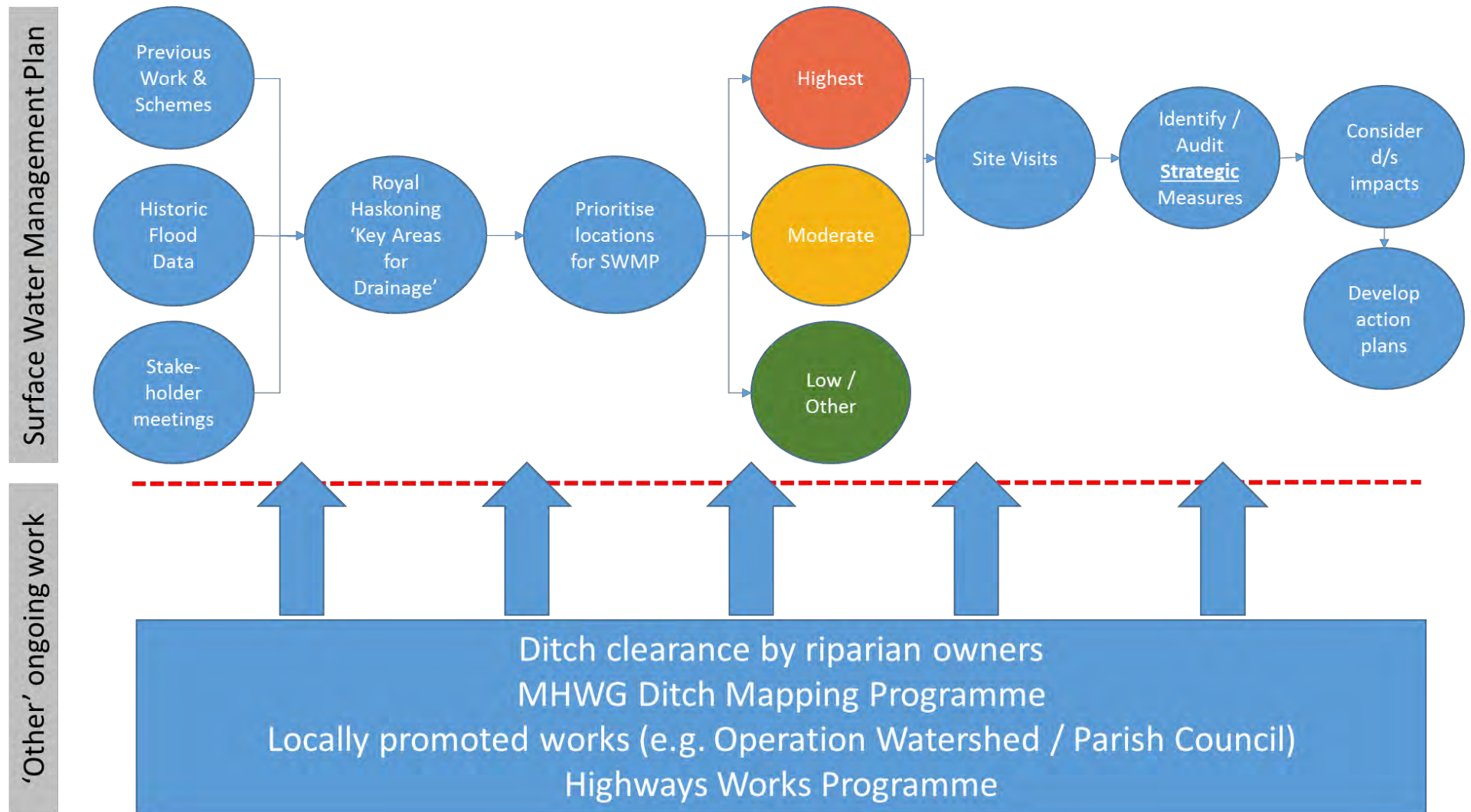


Figure 3-1 Technical approach for SWMP, and linkages to other ongoing work in the Manhood Peninsula

SECTION 3

3.3 Initial review of data

3.3.1 Historic flooding data

WSCC has provided records of the highways incidents logs from June 2012 to March 2014. The highway incident logs record customer inquiries and reporting about flooding issues during this time period. There were over 700 records provided by WSCC. As the time period covers a major summer storm event, and two extremely wet winters (2012/13 and 2013/14) it is reasonable to assume that the incident logs provide a good representation of the flooding impacts across the Manhood Peninsula. Locations which did not experience flooding at all during this period will be less vulnerable to flooding than locations which did experience flooding during this period.

The highways incident logs do not record whether a property has flooded or not, but from the customer notes it is often possible to identify whether a property had flooded or was at risk of flooding. Therefore, each incident has been categorised into one of the following:

- property flooded;
- property at risk of flooding;
- property not flooded, or;
- unknown.

These data have also been analysed to identify where flooding on the highway caused the road to be impassable. This process is important to focus investigations in locations where property flooding is occurring, or where highway flooding is affecting the movement of people along key transport routes. Section 3.4 outlines how these data have been used to prioritise the areas of investigation.

Southern Water has also provided their DG5 flooding register (based on postcode envelopes), which contains records of reported flooding from 2009 to March 2014. When plotted in GIS, the majority of urban areas show incidents of sewer flooding at some point during this period. The sources are defined as either 'hydraulic overload' or 'overloaded pumping station' and predominantly involved the public foul sewers. Table 3-1 gives a summary of the areas for sewer flooding in the Manhood Peninsula. Our primary objective for the SWMP has been to evaluate surface water and land drainage issues. However, given the sewer flooding issues in the catchment Southern Water have been engaged during the SWMP to identify their proposals to mitigate sewer flooding. Therefore, Southern Water's proposed actions to address sewer flooding have been included in Section 5. In addition, as WSCC or Southern Water deliver proposed mitigation measures further engagement will be required to identify whether the causes of foul flooding are linked to surface water or land drainage issues.

Table 3-1 Sewer flooding incidents based on evidence from Southern Water

Area	Number of reported incidents
West Wittering	21
Selsey	18
Birdham	12
Bracklesham Bay	11
Sidlesham	9
East Wittering	8
North Mundham	7

Area	Number of reported incidents
Itchenor	5
Runcton	4
Hunston	4
Highleigh	4
Earnely	3
Almodington	1

3.3.2 Previous and ongoing flood alleviation work within the Peninsula

As stated in Section 3.1 it is important to take into account the significant work that has been done, or is proposed, within the Manhood Peninsula to alleviate flooding to properties and highway infrastructure. This has included:

- a ditch mapping project by MWHG in Birdham and West Itchenor, with plans to extend this across the entire Peninsula – this seeks to map the location and condition of every ditch across the Peninsula in the long term;
- the identification of pinch points in the network (e.g. damaged culverts, silted gullies, ditches which are in need of maintenance) which has been undertaken by flood action groups, parish councils and local communities;
- flood action groups, parish councils and local communities working with landowners to encourage them to maintain the ditch network, and;
- securing funding for flood alleviation schemes or drainage improvements from the Environment Agency, Regional Flood and Coastal Committee (RFCC) and Operation Watershed).

A significant body of evidence has been collated from parish councils, flood action groups, the MWHG and WSCC about the work being promoted and undertaken locally.. This evidence has been critical in identifying where flood risk issues have been mitigated, ensuring the SWMP can focus on areas where additional mitigation measures are still required to reduce flood risk.

3.3.3 Previous reports and studies

3.3.3.1 Royal Haskoning Land Drainage Study

This study was undertaken in 3 phases, with the first report issued in 2003 and the final report in 2006. The three phases were:

- **Phase 1 - Initial assessment:** submitted August 2003 and involved data collection and investigation to gain a basic understanding of the land drainage issues and identify gaps in the understanding and available data. Provided a platform for further assessment.
- **Phase 2 - Further assessment:** submitted 2005 and involved a study into the effects of siltation in and around Pagham Harbour taking into account the effect of climate change. Also included were suggested remedial measures, the potential effect on the Lavant flood alleviation scheme and the impact on the environment.
- **Phase 3 – Detailed study and options assessment:** submitted May 2006 and involved a study of the role of the ditch system in terms of transport and storage, an investigation of possible storage sites and consideration of SuDS.

The summary findings of the three phases are detailed below.

Phase 1

The initial assessment identified the peninsula as a low lying area prone to flooding in periods of heavy and prolonged rainfall. Flooding does not occur persistently in any one area and flooding may occur once or twice before action is taken. Types of reported problem include: culvert problems, lack of maintenance, poorly defined systems, highway problems, foul water, new development, tide locking and system capacity.

Flooding has occurred historically, including an extreme event in autumn 2000, however there are no detailed records and therefore evidence to support this. In general, the public's perception is that flooding is getting worse, however this could be due to a number of factors, including heightened awareness, increased population and levels of tolerance.

The geology and history of the peninsula (used to be an island) have a significant impact on drainage and during high rainfall, the land quickly becomes waterlogged. The system depends greatly on the drainage network. Most flooding events appear to be due to a lack of maintenance and issues with capacity of the drainage network. Two thirds of the peninsula drains to Pagham Harbour, and therefore processes here affect the efficiency of the drainage system.

Phase 2

Pagham Harbour is getting drier and gradually silting up. This is causing concerns that it will eventually be naturally reclaimed, which could lead to the closure of the harbour mouth. This would have consequences for drainage, environment and future flooding problems.

Key land drainage outlets exist within the harbour and therefore increased siltation would prevent the drainage system draining down at low water. This would reduce the available storage in the Rifes/channels during times of high rainfall and cause flooding in vulnerable locations.

There is a flood alleviation scheme on the River Lavant that should be ok in the short term but could be compromised by increased siltation should there be prolonged periods of low flow through the system.

As there are currently no records of property flooding in the area, options were proposed to maintain the status quo of the system. These included dredging to re-instate channels from outfalls to the harbour entrance, and temporarily holding back water through the construction of sluices or adjustment of existing systems.

Phase 3

The key areas for drainage were defined by considering areas where it was most important to move water away from people and property. Watercourses and ditches that drain these areas were classified as important transport routes. The remaining ditches were classified as more suitable for storage. In some areas the drainage was uncertain, but believed to be important. These areas were highlighted for further study. Consultation on these maps was undertaken with Chichester District Council, West Sussex County Council and the Environment Agency.

Based on this information, areas where it would be possible to provide storage without having a detrimental impact on the important transport routes were identified. It was also noted that significant storage already exists in the floodplains of the Pagham, Bremere and Broad Rifes and that maintaining these is important. A further recommendation was a trial ditch clearance regime in a small area, because it was considered that many of the ditches were not at their full capacity.

The options assessment concluded that:

- The viability of using SuDS on the Peninsula as a method for reducing existing problems is limited due to the difficulty of retrofitting.
- SuDS would be effective and should be included in all future development whatever the scale. The inclusion of SuDS techniques should be viewed as a valuable asset to any development.
- Suitable ongoing management and maintenance of SuDS are essential to their continued effectiveness and therefore future responsibilities must be fully agreed at the time of implementation.

The resulting work from these recommendations need to be further understood and their impacts analysed. This mapping-based information could provide a useful starting point for considering this extensive network. Also noted is that the GIS dataset sent with this report includes more extensive surface water drainage network in Chichester than is seen in other records received by CH2MHILL.

3.3.3.2 Report on the June 2012 flooding

West Sussex County Council produced a report in November 2012 reviewing the major flood event of June 2012. It investigated all elements of the event from the days preceding to the aftermath, including clarification of roles and responsibilities of all involved parties.

The report identifies the event as a 1 in 200 year event that ultimately overwhelmed the drainage network, which typically was only designed to withstand 1 in 25-100yr rainfall conditions. Whilst no significant long term damage to infrastructure was sustained, 110 properties were reported as flooded in the Manhood Peninsula. Due to the low lying nature of the area, water levels remained high, particularly in the Rife network, and was slow to drain away.

The vast majority of the flooding was from surface water exceeding the capacity of the drainage system during the high intensity rainfall, however lack of riparian maintenance and a loss of important land drainage were also contributing factors. The Manhood area has few watercourses capable of dealing with excessive rainfall, therefore the management and maintenance of drainage ditches plays a key role in flood risk management.

There is also a significant risk of flooding from the sea, but this has largely been addressed by the Environment Agency's Medmerry Scheme. During the 2012 flood event, communities expressed concerns that the scheme may have had an adverse effect on drainage. This led to the Agency commissioning an independent review of the scheme by Black and Veatch, which was published in January 2013.

The flooding highlighted weaknesses in both the management of drainage and the drainage infrastructure itself. Some have since been resolved, including an extension of a diversion channel (part of the Medmerry realignment works) along Bookers Lane, Earnley. During the 2012 event 22 properties were flooded along this road.

3.3.4 Stakeholder meetings

In October 2014 one to one meetings were held with representatives the MWHG, parish councils and local communities. The purpose of these meetings was to obtain additional local knowledge on flooding problems across the Peninsula, and understand existing and proposed actions to mitigate flooding. The information captured during these meetings was used to help prioritise the areas to focus investigations. Appendix D provides a summary of the information gathered during these sessions.

3.4 Prioritisation process

To identify the priority locations for the SWMP the 'key areas for drainage' identified in Phase 3 of the Royal Haskoning Land Drainage Study were considered. There were 48 key areas for drainage identified by Royal Haskoning. Subsequently, in each of these areas it was identified whether there had been flooding to property and infrastructure based on the WSCC highway incident logs, Southern Water's sewer flooding register, and information gathered from the stakeholder meetings. Areas where no flooding was recorded were excluded from further analysis. In addition, during this stage any additional areas which suffered flooding which had not been identified as key areas for drainage were considered. Following this process there were 21 locations short-listed for further consideration.

The remaining 21 locations were prioritised into the highest, moderate, or low/other priority areas, based on the approach outlined in Table 3-2.

Table 3-2 Criteria to prioritise areas for SWMP

Criteria	Priority for SWMP		
	High	Moderate	Low / Other
No. properties at risk or flooded internally	Greater than 5	2-5	Less than 2
Road flooded	A or B Road flooded and impassable	A or B roads flooded but passable with care	Other local roads (e.g. access tracks) or roads not flooded
Cause of flooding	e.g. Incapacity in drainage system or lots of enhanced maintenance needed		Isolated flooding (e.g. because gully blocked)
Level of actions taken in location	Some action taken or proposed but further investment needed		Significant investment taken, or proposed (with funding in place)

3.5 Identify flooding causes

For each of the 12 prioritised locations the causes of flooding have been considered through site visits, discussions with stakeholders, and reviewing existing reports, studies and investigations. The causes of flooding are summarised in the action plans in Section 5.

3.6 Identify measures to alleviate flooding

For each of the prioritised locations an over-arching investment approach has been identified which should be used to determine the scale and type of measures which are applicable in each location.

- Upgrade and Maintain – this approach focusses on increasing the capacity of drainage infrastructure within a location through upsizing of ditches, culverts or storage areas. This is relevant where drainage infrastructure is inadequate to drain surface water. Following upgrades to the drainage infrastructure ongoing maintenance will be important to ensure that the mitigation measures continue to function. This is the most expensive of the three investment approaches and should be focused on alleviating the most significant flooding problems in the Manhood Peninsula.
- Repair and Maintain – this approach focusses on repairing drainage infrastructure where there are existing deficiencies in the network such as collapsed culverts or blockages. This is relevant where drainage infrastructure should be adequate to drain surface water once it is repaired. As with the upgrade and maintain approach following repairs to the drainage infrastructure ongoing maintenance will be key by the relevant stakeholder to ensure that the mitigation measures continue to function.
- Maintain – this approach focusses purely on ensuring the existing drainage infrastructure is maintained to allow surface water to drain more effectively within a location. This includes locations where jetting is needed to remove siltation from a manhole, or a gully network needs maintaining, for example. This is the least expensive of the three investment approaches.

The SWMP considered any proposed mitigation measures by the MWHG, parish councils and/or flood action groups. As outlined in Section 3.1 the SWMP has focused on the strategic and highest priority flood mitigation measures required which will have the most significant impact on reducing flooding within each location. The strategic flood mitigation measures have formed the basis of the action plans in Section 5. There will be other actions required locally (e.g. ditch clearance, gully maintenance) but the action plans are focused on the key actions which stakeholders should prioritise. The potential cumulative downstream

impacts of mitigation measures in each location has been considered to ensure flood risk will not be exacerbated in other locations. These are included in the action plan in Section 5.

Priority locations for the SWMP

Using the methodology described in Section 3.4 a prioritisation process has been undertaken to identify the communities to be considered in further detail in the SWMP. The prioritised locations are described in Table 4-1. Seven locations are considered to be high priority, and a further five are considered to be moderate priority. These 12 locations have been taken forward as the priority locations for the SWMP to identify suitable actions to mitigate flooding. There are nine locations which are considered to be lower priority and are not considered in detail in the SWMP⁸. The reasons for this are described below:

- Allmans Business Park – this suffered from isolated flooding and is understood to have been due to blocked gullies which have subsequently been cleared⁹.
- Almodington - a flood alleviation scheme is being progressed on the Grange Rife by the Environment Agency and the flood action group which will alleviate flood risk to properties in Almodington. The proposed works are being finalised but are likely to include a combination of ditch clearance and re-grading, clearance and re-establishment of removal or upsizing of culverts and access bridges which are constricting flow.
- Apuldram – there were no properties affected in Apuldram and flooding of the roads are linked to the condition of the ditches and tide levels. Ditch clearance should be undertaken by riparian owners and is not considered to need further investigation.
- Donnington – following a site visit in December 2014 it was evident that the majority of flooding is related to isolated problems with the highway drainage network and open ditches which are in need of jetting and/or clearance.
- Fletchers Estate and Highleigh – Sidlesham Parish Council and the MHWG are actively progressing a localised diversion scheme to divert the Keynor Rife over a short section in Highleigh. Therefore the SWMP does not need to consider this area any further.
- North Mundham – flooding in North Mundham is primarily related to foul sewerage which is the responsibility of Southern Water to investigate and action. This SWMP focusses on surface water issues.
- Wophams Lane - this suffered from isolated flooding and is understood to have been due to blocked gullies which have subsequently been cleared.

⁸ Both Earnley and Sussex Beach Holiday Village were considered to be low priority but have been included in the Earnley and Somerley action plan and are therefore not included in the bullet list.

⁹ WSCC have an existing gully maintenance programme, which is outlined at <http://westsussexhighways.org/pages/gully-emptying>

SECTION 4

Table 4-1 Priority locations for the SWMP

Location	Priority	No. properties flooded or @ risk (June 2012 - March 2014)	Road flooded (June 2012 - March 2014)	Cause of flooding
Birdham & Westlands	High	>20	Local road	Incapacity in drainage system or lots of enhanced maintenance needed
East Wittering & Bracklesham	High	>20	A or B roads flooded but passable with care	Incapacity in drainage system or lots of enhanced maintenance needed
Hunston	High	5-10	A or B roads flooded but passable with care	Incapacity in drainage system or lots of enhanced maintenance needed
Selsey	High	10-20	A or B roads flooded but passable with care	Incapacity in drainage system or lots of enhanced maintenance needed
Sidlesham	High	>20	A or B roads flooded but passable with care	Incapacity in drainage system or lots of enhanced maintenance needed
Somerley	High	5-10	A or B roads flooded but passable with care	Incapacity in drainage system or lots of enhanced maintenance needed
West Wittering	High	5-10	A or B roads flooded but passable with care	Incapacity in drainage system or lots of enhanced maintenance needed
Crouchers	Moderate	2-5	A or B roads flooded but passable with care	Incapacity in drainage system or lots of enhanced maintenance needed
Runcton	Moderate	2-5	A or B roads flooded but passable with care	Incapacity in drainage system or lots of enhanced maintenance needed
South Mundham	Moderate	2-5	A or B Road flooded and impassable	Incapacity in drainage system or lots of enhanced maintenance needed
Stockbridge	Moderate	2-5	A or B roads flooded but passable with care	Incapacity in drainage system or lots of enhanced maintenance needed
West Itchenor	Moderate	2-5	A or B Road flooded and impassable	Incapacity in drainage system or lots of enhanced maintenance needed
Allman Business Park	Low	None	A or B roads flooded but passable with care	Isolated flooding

Almodington	Low	5-10	A or B roads flooded but passable with care	Incapacity in drainage system or lots of enhanced maintenance needed	sch
Apuldram	Low	None	A or B Road flooded and impassable	Incapacity in drainage system or lots of enhanced maintenance needed (linked to tides)	pr
Donnington	Low	<2	A or B roads flooded but passable with care	Isolated flooding	fu
Earnley ¹⁰	Low	>20	A or B Road flooded and impassable	Incapacity in drainage system or lots of enhanced maintenance needed	
Fletchers Estate and Highleigh	Low	<5	A or B roads flooded but passable with care	Incapacity in drainage system or lots of enhanced maintenance needed	s
North Mundham	Low	<2	A or B roads flooded but passable with care	Isolated flooding	pr
Sussex Beach Holiday Village ¹¹	Low	Unknown	Unknown	Isolated flooding because culvert on caravan site too small	.
Wophams Lane	Low	None	A or B roads flooded but passable with care	Isolated flooding (gully blockages)	pr

¹⁰ Some of the improvement works to alleviate flooding in Somerley (Bell Lane) require works in Earnley. Therefore Earnley and Somerley have been merged for the action plans

¹¹ This has been included in the Earnley and Somerley action plan

Drainage and flooding strategy for Manhood Peninsula

5.1 Introduction

In the past few years there has been a concerted effort by WSCC, parish councils, local flood action groups, the Environment Agency, and the MWHG to manage drainage and flooding across the Manhood Peninsula. This has made a significant improvement to the management of flooding. Further capital and maintenance mitigation measures are needed to reduce flooding and ensure the drainage infrastructure is functioning as intended.

However, in a low-lying area such as the Manhood Peninsula the drainage system is highly sensitive to blockages and poor maintenance which hinder conveyance of flood water. Therefore the drainage system needs to be maintained on a cyclical basis rather than relying solely on one off capital improvements. There is a risk that without ongoing maintenance and management the works undertaken over the past few years will prove ineffective in (say) five years' time and flooding will re-occur. This is because without ongoing maintenance and management ditches will not be maintained, culverts and piped drainage will become blocked, and householders will continue to infill ditches without thought to flooding issues. In addition, the current approach tends to be reactive to flooding problems as they emerge. A proactive approach would reduce the risk of flooding before it began.

It is therefore critical to consider both the short-term (0-2 years) and ongoing measures to reduce flooding to people, property and roads in the Manhood Peninsula. This section of the report outlines the proposed drainage and flooding strategy for the Manhood Peninsula for the next 10 years. It outlines the short-term actions (Section 5.2) needed to reduce flooding in the 12 locations prioritised in this SWMP and then sets out the ongoing management and investment based around four key themes, which are described in Section 5.3. The drainage and flooding strategy is illustrated in Figure 5-1.

SECTION 5

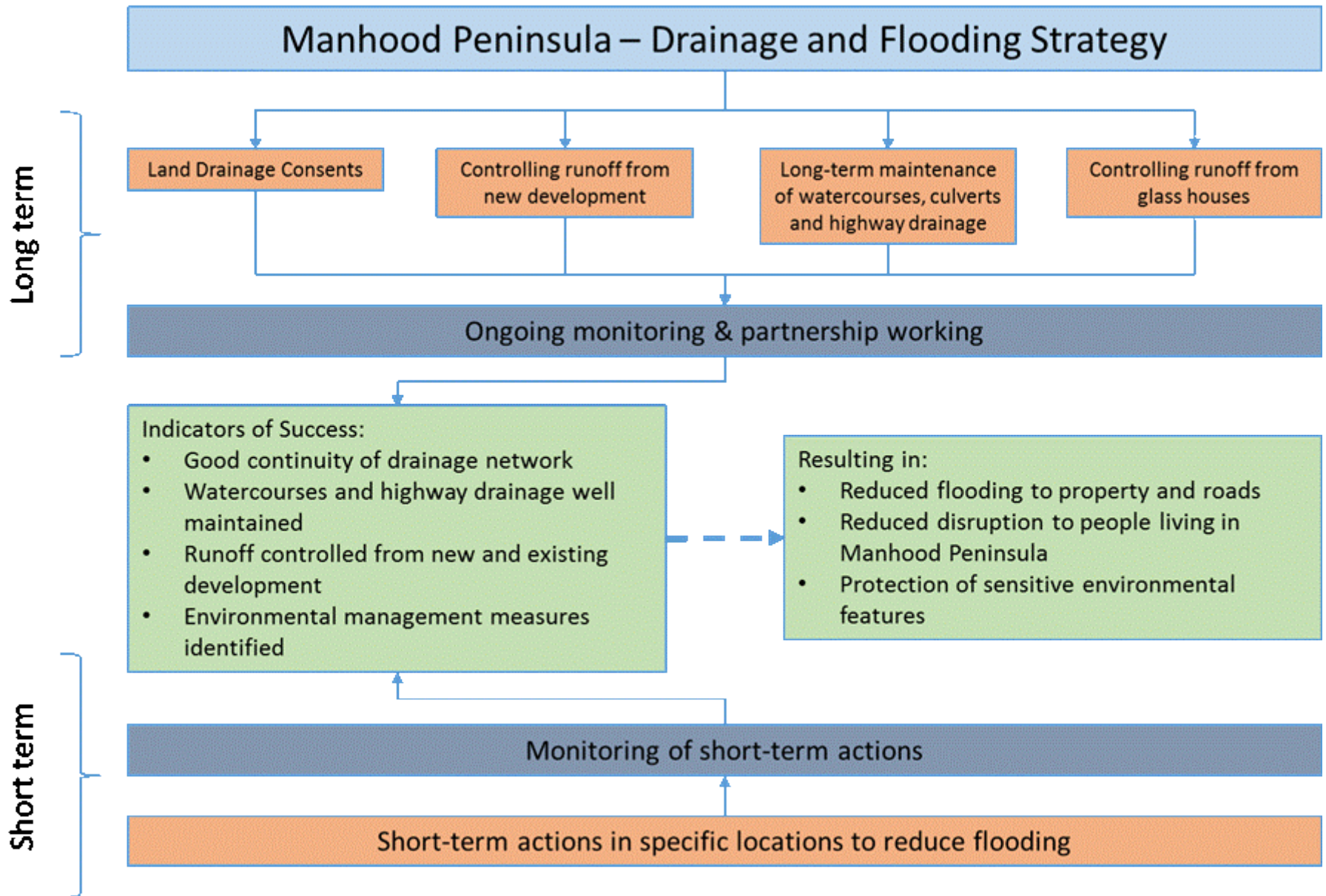


Figure 5-1 Drainage and flooding strategy for Manhood Peninsula

SECTION 5

It is critical to understand that even with all of these short-term and ongoing measures in place the Manhood Peninsula will still be at risk of flooding during more extreme weather events as occurred in June 2012 and the winters of 2012/13 and 2013/14. This is because drainage systems (both natural and man-made) and any other flood risk infrastructure will be completely overwhelmed during extreme weather events. This concept is described in Figure 5-2 and defines different flood risk management approaches dependant on the rainfall event within a catchment. For 'everyday rainfall' the drainage system should function according to its natural or designed capacity to limit the impact of any flooding. Conversely during extreme events, it is recognised that drainage systems (both natural and man-made) and any other flood risk infrastructure will be completely overwhelmed and therefore emergency response is the most appropriate management technique to reduce the impacts of flooding. The action plans in the SWMP focus on ensuring the drainage systems are functioning as designed for the 'everyday rainfall' and 'drainage design rainfall' through capital and maintenance investment¹².

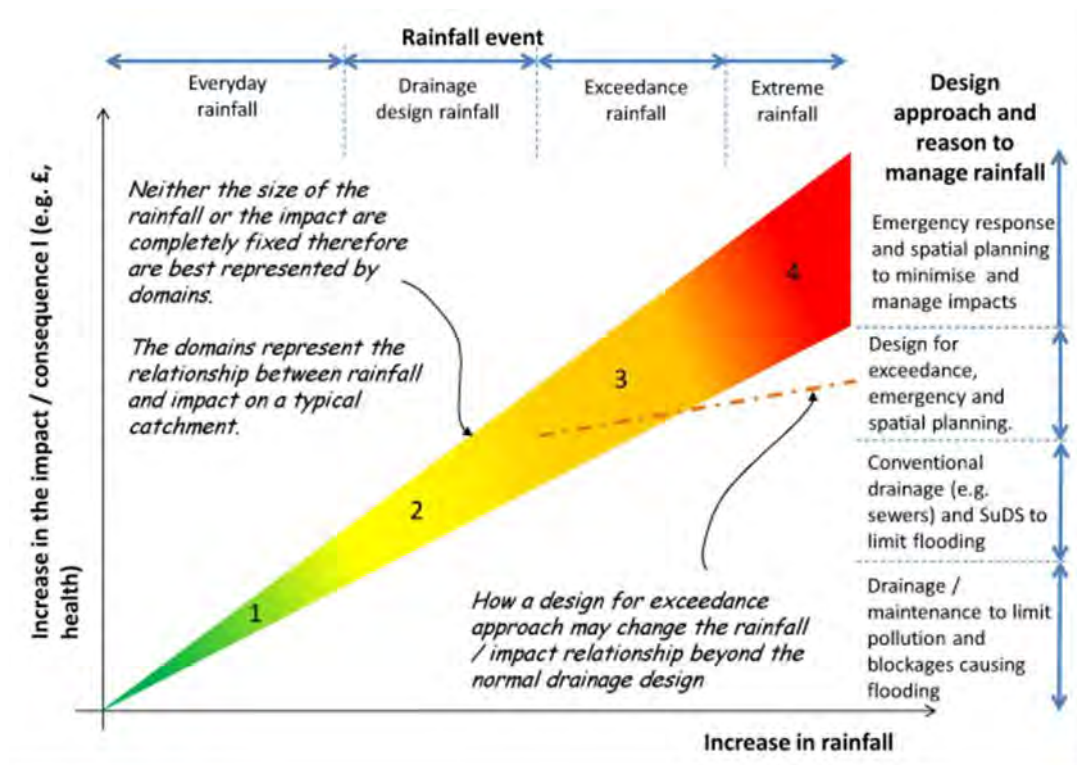


Figure 5-2 Flood risk management concept (taken from CIRIA's *Designing for Exceedance* guidance¹³)

5.2 Short-term action plans

Sections 5.2.1 to 5.2.2 describe the capital and maintenance actions required to reduce flooding and ensure the drainage infrastructure is functioning as designed in the 12 hotspot areas identified in the SWMP. The tables are supported by maps of the proposed measures in Appendix E. A detailed description of the key environmental impacts of the short-term measures at each identified location is provided in Appendix G, with a summary provided in the tables in Section 5.2.

¹² Information on roles and responsibilities during a flooding emergency are outlined at <http://www.chichester.gov.uk/article/24787/Flooding#planning>

¹³ Digman, C.J., Ashley, R.M., Hargreaves, P. and Gill, E. (2014a) *Managing urban flooding from heavy rainfall - Encouraging the uptake of designing for exceedance – recommendations and summary*, CIRIA, C738a.

SECTION 5

5.2.1 High priority locations

5.2.1.1 Birdham and Westlands

<p>Summary of flooding issues: The primary flooding issues in Birdham and Westlands which affect people and infrastructure (particularly roads) are along Church Lane and Crooked Lane, although flooding does occur in other parts of Birdham (e.g. Westlands Lane). Historically, flooding has primarily been caused by poor maintenance of the ditch network through Birdham and Westlands and localised constrictions due to blockages, collapses, and under-sized pipes. 10 to 20 properties are believed to have flooded or been at risk of flooding from June 2012 to March 2014.</p>				
<p>Existing investment: There has been significant investment in Birdham and Westlands to alleviate flooding problems. The investment has focused on clearance and de-silting of ditches to improve conveyance of flows through Birdham and Westlands. In addition there has been de-silting of the Florence Close Pond in January 2015. In Westlands the drainage system is considered to be functioning largely as designed, although in Birdham there remain some key actions to improve conveyance. The Birdham and Earnley Flood Prevention Group (BEFPG) have identified over 70 actions needed in Birdham to reduce flood risk. In the action plan below we have identified the key 10 actions which should be prioritised as they will have the greatest impact on flood risk in Birdham. The remaining actions proposed by BEFPG should still be taken forward locally, but we believe the actions below remain the priority and most urgent next actions.</p>				
<p>Investment strategy: Upgrade and maintain</p>				
Ref (in priority)	Type of measure	Description	Status	Action owner
BIRD_001* (Item 10a)	Capital	Extend the village pond in the field to the west of the current pond to provide additional storage at downstream end of Birdham drainage system	Proposed by BEFPG & MWHG	Birdham Parish Council and BEFPG
BIRD_002 (Item 11a)	Maintenance	Continue to maintain Rife from village pond to Birdham pool to ensure that water can drain away from village effectively	Proposed by BEFPG	Riparian Owner
BIRD_003 (Item 17a)	Capital	The culvert under The Causeway is completely blocked which is keeping water levels in Birdham Pool to the south of The Causeway high and preventing the main ditch from Birdham village pond to drain away. The culvert needs to be repaired and the owners have installed a temporary 8 inch pipe to alleviate the problem in the short-term	Proposed	Private owners of Birdham Pool
BIRD_004	Capital	Crooked Lane ditch has a significant number of pinch points due to access bridges to properties. Over time these need to be removed or upsized to reduce the constrictions to flows.	Proposed by SWMP	Riparian Owner / WSCC / Parish Council
BIRD_005	Capital	The 18 inch culvert under Longmeadow Gardens is cracked in places under properties and needs repairing. It is believed the 18 inch pipe becomes a 9 inch pipe near at some point, and should be repaired with an 18 inch pipe along its length	Proposed by BEFPG	Parish Council / WSCC / BEFPG
BIRD_006 (Item 49)	Capital	The culvert to the rear of Walwyn Close is crushed and not functioning. The Flood Action Group is looking to replace existing drainage pipe (Operation Watershed Bid No. 2025)	Proposed by BEFPG	Parish Council / WSCC / BEFPG

BIRD_007 (Item 34)	Maintenance	Chambers and gullies at the top of Crooked Lane are silted and blocked. They need to be jetted		Parish Council / WSCC
BIRD_008 (Item 7 & 66)	Maintenance	Clearance of ditches and jetting of culverts on the southern side of Westlands Lane, with improvements to narrow culverts. Associated jetting of culverts at junction of Crooked Lane and Westlands Lane where there is believed to be 3 culverts	Proposed by BEFPG & MWHG	Riparian owner / WSCC
BIRD_009 (Item 64, 65, & 67, link also to Item 10))	Capital & Maintenance	Improve Kingfisher pond and The Triangle Pond to store additional flood water and provide better water vole habitat. The ditches connecting the pond are also in need of clearance, with associated jetting of culverts. The outfall from the Triangle Pond should flow north-east, then east and connect to the ditch downstream of the Village Pond to avoid adding flows to the village pond	Proposed by BEFPG & MWHG	Riparian owner / WSCC

Commentary on impacts to downstream flood risk:

The majority of drainage in Birdham is routed to the 450mm culvert under Crooked Lane which then passes along the southern boundary of Church Lane before discharging into the village pond. Most of the current and proposed improvement works in Birdham will increase the rate and volume of conveyance through Birdham. The 450mm culvert under Crooked Lane only has a maximum conveyance capacity of 150 l/s¹⁴. There are further constrictions further upstream on Crooked Lane as householders have built driveways over the ditch with small culverts which will have a smaller capacity than the 450mm under Crooked Lane. There is a risk that increasing conveyance from the A286, Church Lane, Walwyn Close and Longmeadow Close could increase flows to the ditch on Crooked Lane.

Downstream of Birdham the ditch network flows into Birdham Pool, which subsequently discharges into Chichester Harbour. Therefore once surface water flows are north of Birdham there will not be an increase in flood risk to property and infrastructure.

Summary of Environmental Risks

The increased flow and storage capacity of the drainage system will reduce flood risk to people, properties and the highway network in Birdham and Westlands, improving the quality of life for residents and presenting some opportunities for habitat creation or improvement, particularly where flood storage measures are proposed. However, care will be required during action implementation to avoid temporary construction impacts on designated environmental features (e.g. culvert repairs at the causeway in close proximity to Chichester and Langstone Harbour SPA/Ramsar, the setting of listed buildings) and sensitive habitats (e.g. works to village ponds affecting aquatic flora and fauna). Pre-construction checks will be required to assess value of habitat in affected areas and its potential to support protected, notable and invasive species and care will be required to avoid pollution of surface water and groundwater, particularly within the Nitrate Vulnerable Zone, and avoid negative landscape impacts within Chichester Harbour AONB.

* Reference from Birdham Ditch Report by Birdham and Earnley Flood Prevention Group (BEFPG) in brackets

¹⁴ Using Colebrook-White formula to calculate pipe flows for full pipes assuming there are no effects on downstream controls. We have assumed a culvert size of 450mm and a gradient of 1:500 (based on available ground level data)

SECTION 5

5.2.1.2 East Wittering and Bracklesham

<p>Summary of flooding issues: In East Wittering and Bracklesham (including flows which drain from the north) the incident logs from June 2012 to March 2014 suggest that 10-20 properties flooded or were at risk of being flooded. In addition there were numerous other reports of highway flooding. Flooding appears to have been caused by overtopping of watercourses, blockages in ditches/culverts, and from the extensive piped highway drainage which runs through the urban area. During the site visit in February 2015 there was evidence of poor maintenance of ditches, under-sized culverts, and issues with the highway drainage.</p>				
<p>Existing investment: On the recently published 6 year Medium Term Plan the Environment Agency has a proposed scheme after 2012 to consider fluvial improvements to the Main Rivers which flow through East Wittering. Outside of the urban area some minor work has been undertaken by the landowner at Webb's Farm to clear ditches and improve flow conveyance.</p>				
<p>Investment strategy: Upgrade and maintain</p>				
Ref (in priority)	Type of measure	Description	Status	Action owner
EWIT_001	Investigation	<p>Within East Wittering the historic flooding records indicate three primary areas which have suffered flooding: Solent Road, Stocks Lane and Bracklesham Lane (B2186). The recommended actions for these areas are below:</p> <ul style="list-style-type: none"> • 001a - Solent Road – check the highway drainage run to confirm it is clear and jet where required. • 001b - Stocks Lane – from the site visit there remains some uncertainty about the connectivity of this drainage system and where it outfalls. There was evidence of collapsed pipes and heavy siltation (see MH9 and MH12 in Appendix E as examples) within the highway network which should be repaired. In addition no outfall was observed from the highway drainage system which runs from the junction with Cakeham Road and Wessex Avenue. Based on topography the natural outfall should be into the ditch which runs along Coney Road, but no outfall was observed. Further investigation is needed to confirm there is no outfall and install a new one where required¹⁵. Clearance and associated improvement to the ditch on Coney Road would also be required • 001c - Bracklesham Lane – from the site visit there is little clarity about where the drainage system along Bracklesham Lane drains to. There is a 450mm outfall to the Main River under Stocks Lane (480220, 96872) which would appear to drain a large catchment. Further investigation of this drainage run because of property and highway flooding 	Proposed	WSCC

¹⁵ Notes from one of the highway incident logs (on Stocks Lane near unction with Coney Road) states “needs ditching for system to work” which would seem to corroborate the evidence that there is no outfall at this low spot.

EWIT_002	Capital	On Church Road near St. Peter's Church there is an open ditch network with short culverted sections. Downstream of St. Peter's Church we believe the ditch flows into a highway drainage system which flows to the junction with Northern Crescent. The culverted sections were collapsed or full of silt in several places, and there were under-sized relative to the upstream 600mm culvert. There are three box culverts which should be replaced with 450mm circular pipes ¹⁶ to maintain the flow conveyance through the system. Immediately downstream of the church there was a 225mm pipe which also needs to be upsized	Proposed	TBC
EWIT_003	Capital / Maintenance	The ditch network around Holmes Farm should be cleared to reduce flooding on Chapel Lane. There is also evidence of a collapsed pipe under the access to Holmes Farm which reduces the conveyance capacity and should be repaired	Proposed	Riparian owner
EWIT_004	Capital / Maintenance	On Piggery Hall Lane near Furzefield there has been deep road flooding reported threatened to flood properties. The main watercourse to the west of Piggery Hall Lane had been well maintained from site visit observations (February 2015) and flooding on the two corners of the road is most likely to be due to ineffective highway drainage off the road. Additional highway gullies should be installed at the low spots of the road and connected to the adjacent watercourse, especially opposite the new development to the north of Furzefield	Proposed	WSCC
<p>Commentary on impacts to downstream flood risk: We do not consider that the proposed measures will cause an increase in downstream flood risk. The conveyance improvements at Holmes Farm are relatively minor. Furthermore we are proposing to upsize the Church Road to a suitable size given downstream constraints in the highway network. The proposed improvements to the highway drainage in East Wittering will not increase flood risk, although caution is required to ensure the Coney Road ditch is well maintained if a new outfall is installed.</p>				
<p>Summary of Environmental Risks</p> <p>The increased flow of the drainage system will reduce flood risk to people, properties, agricultural land and the highway network in East Wittering and Bracklesham. However, care will be required during action implementation to avoid temporary construction impacts on designated environmental features (e.g. the setting of listed buildings) and sensitive habitats (e.g. around new outfalls and in ditches to be cleared). Pre-construction checks will be required to assess value of habitat in affected areas and its potential to support protected, notable and invasive species and care will be required to avoid pollution of surface water and groundwater, particularly within the Nitrate Vulnerable Zone.</p>				

¹⁶ No larger because this could exacerbate flooding downstream. The outfall from this system seems to be a 450mm pipe at the junction of Church Lane and Northern Crescent

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5.2.1.3 Hunston

<p>Summary of flooding issues: The primary flooding issues in Hunston which affect people and infrastructure are along the B2145 through Hunston and Church Lane. Along the B2145 the flooding issues are caused by overtopping of the Bremere Rife (e.g. June 2012) particular at locations where the Rife crosses under roads through culverts, and exceedance from the highway drainage due to incapacity and blockages. On the B2145 properties are generally higher than the road so flooding is primarily constrained to the road, with the exception of bow waves from passing traffic. There is also flooding at the mini roundabout near Swan Cottage. On Church Lane flooding is primarily caused by inadequately sized culverts, overgrown ditches and silted ponds.</p>				
<p>Existing investment: The ditch which runs north of the B2145 (north of Hunston Villas) was cleared by the riparian owner following the June 2012 flooding and is now considered to be flowing well (feedback from Parish Council). This ditch flows under the B2145 via a new culvert installed by WSCC post June 2012, which has alleviated flooding, although feedback from the Parish Council did indicate there is a risk of culvert blockage as there is no trash screen on the inlet. There is a ditch network which runs around the boundary of Hunston Copse which flows towards the main road and discharges into the Bremere Rife. There is a further ditch which flows east of Southover Way, which connects to the ditch from Hunston Copse. Since a new tenant farmer has been in place the maintenance of this ditch network (and associated piped drainage) has improved and is regularly maintained. Bremere Rife is well maintained by the Environment Agency with regular vegetation cuts as it flows through Hunston (and beyond).</p>				
<p>Investment strategy: Upgrade and maintain</p>				
Ref (in priority)	Type of measure	Description	Status	Action owner
HUNS_001	Investigation	The route and condition of the drainage from the electricity sub-station on the B2145 (near roundabout with B2166) to the ditch north of Hunston Villas is unknown. It is culverted in this section and was not surveyed as part of the SWMP. A further investigation is needed to establish the route, connectivity and condition	Proposed	WSCC
HUNS_002	Capital	There is a single outfall from the 225mm highway drainage system which flows from Little Boultons to near Wood Cottage and discharges (NB: the outlet is opposite the village hall). During the site visit in December 2014 the level of the Rife was at the invert of the outfall, and during periods of higher river flows the outfall would be completely submerged. This would prevent highway drainage from flowing into the Rife. The options here are to install a higher level overflow outfall at the same location or install additional outfalls from the highway drainage system to the north and south to alleviate the pressure on the single outfall.	Proposed	WSCC
HUNS_003	Investigation	Further work is needed to confirm the size of all the culverted sections of the Bremere Rife through Hunston to establish whether they cause constrictions to flow and hence increase flood risk. A survey is recommended.	Proposed	WSCC / Environment Agency
HUNS_004	Capital	There are two culverts on the Church Lane watercourses, both of which are inadequate and cause flooding onto Church Lane. These need to be upsized in accordance with the plan area of the ditch	Proposed by MHWG	Landowner

HUNS_005	Maintenance	The ditch network along Church Lane is overgrown and silted. Maintenance is required along this section to improve conveyance away from properties on Church Lane	Proposed by MHWG	Landowner
HUNS_006	Capital	MWHG have identified two ponds which they want to clear to improve drainage and habitat. This should be undertaken as part of the improvement works on Church Lane	Proposed by MHWG	MWHG
HUNS_007	Maintenance	Consider installing a trash screen on the newly installed culvert which passes under the B2145 near Hunters Lodge	Proposed	WSCC
<p>Commentary on impacts to downstream flood risk: Once the Bremere Rife crosses under the B2145 it flows along the eastern edge of the road for 0.5km before flowing east away from the road. From this point the Rife flows through rural land before discharging into Pagham Harbour a further 6km downstream. Therefore improvement works in Hunston will not have an impact on downstream flood risk.</p>				
<p>Summary of Environmental Risks</p> <p>The increased flow of the drainage system will reduce flood risk to people, properties, heritage and the highway network in Hunston. However, care will be required during action implementation to avoid temporary construction impacts on designated environmental features (e.g. the setting of three listed buildings) and sensitive habitats (e.g. pond to be cleared). Pre-construction checks will be required to assess value of habitat in affected areas and its potential to support protected, notable and invasive species and care will be required to avoid pollution of surface water and groundwater</p>				

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5.2.1.4 Selsey

Summary of flooding issues: Flooding records in Selsey indicate two primary hotspot locations on High Street and Elm Tree Close during the period June 2012 to March 2014. On the High Street records indicate that flooding was primarily due to blocked highway drainage on the road which caused highway flooding and some property flooding. On Elms Tree Close flooding is related to the condition of the highway drainage system on the road. There are other isolated locations of highway flooding across Selsey, with some property flooding also reported by local residents. Historically there have been foul sewer flooding issues in Selsey, some of which have been resolved through works undertaken by Southern Water. Some parts of Selsey are also vulnerable to overtopping of sea defences which causes flooding. North of Selsey the B2145 is vulnerable to flooding near Norton and Coles Farm because of blockages in the highway drainage and ditch network

Existing investment: Southern Water have taken action on the East Beach Estate to resolve sewer flooding in that location. Furthermore following the June 2012 and winters of 2012/13 and 2013/14 WSCC have investigated and jetted some gullies and highway drainage which has contributed to flooding in Selsey. On the B2145 WSCC has jetted and cleaned the B2145 system near Norton including pipework, gullies and catchpits.

Investment strategy: Maintain

Ref (in priority)	Type of measure	Description	Status	Action owner
SELS_001	Maintenance	Ensure the highway drainage route along High Street is clear to reduce flood risk to the highway and properties	Proposed	WSCC
SELS_002	Investigation	Investigate drainage route on Elm Tree Close and take remedial action where defective	Proposed	WSCC
SELS_003	Maintenance	Monitor the highway drainage and ditches on the B2145 because it is the only road out of Selsey and therefore is critical infrastructure for the town	Ongoing	WSCC
SELS_004	Investigation	Southern Water is undertaking a Drainage Area Plan for Selsey which will identify sewerage flooding issues and identify remedial measures	Ongoing	Southern Water

Commentary on impacts to downstream flood risk: We do not believe the actions proposed of ongoing in Selsey will increase downstream flood risk

Summary of Environmental Risks

The increased flow and storage capacity of the drainage system will help to reduce flood risk to people, properties, heritage and the highway network in Selsey, and will have the additional benefit of reducing flood risk to land safeguarded for strategic development. The proposed maintenance and investigations involve minimal structural measures and therefore are likely to have minimal negative impacts on the environment. There may also be opportunities to reduce diffuse pollution and integrate amenity and habitat benefits as part of any remedial measures or SUDS components identified by Southern Water. However, care will be required by Southern Water during the implementation of any remedial actions to avoid impacts on designated environmental features (e.g. the setting of listed buildings along the B2145), soils, water quality and habitats. Pre-construction checks may be required to assess value of habitat in affected areas and its potential to support protected, notable and invasive species and care will be required to avoid pollution of surface and groundwater.

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5.2.1.5 Sidlesham

Summary of flooding issues: Up to 20 properties have been affected by flooding in Sidlesham during the past three years. Flooding has primarily been caused by poor maintenance of the ditch network and blockages/collapses in culverted sections. In addition there have been foul sewer flooding problems in the village. A large number of the roads in Sidlesham have been affected to some level, with some roads becoming impassable (e.g. Keynor Lane). Access to Sidlesham Primary School is affected by flooding (which is a community place of safety).

It should be noted that flooding also occurs in Highleigh, but there is a funded proposal to divert some flows from the Keynor Rife into an historic ditch network west. Therefore Highleigh has not been considered in this action plan.

Existing investment: There have been a range of mitigation measures in Sidlesham over the past three years. These have included clearance and improvements of farmland ditches on land between Church Farm Lane/B2145 and Rookery Lane, improvements to the pond on Chalder Lane near Chalder Farm, localised farm ditch clearance, and works to alleviate flooding in Manhood Lane. In addition the Sidlesham Land Drainage and Flood Group have submitted applications for Operation Watershed funding in 2014/15 which are included in the action plan below.

Investment strategy: Upgrade and Maintain

Ref (in priority)	Type of measure	Description	Status	Action owner
SIDL_001	Capital	Keynor Lane suffers very deep flooding which causes access issues to Sidlesham Primary School (a community place of safety) in heavy rainfall. Flooding is caused by blockages in local ditches and culverts. There is an Operation Watershed bid (No. 2041) to clear these ditches and culverts to enable water to flow into the ditch network on Chalk Lane and eventually out to Pagham Harbour. However, the topography of the land means water will naturally flow in an easterly direction along Keynor Lane (rather than south to Chalk Lane) in a largely open ditch section (except a collapsed 600mm culvert near Muttons Farm House) to a pipe under the B2145. This should then connect to the watercourse east of the B2145. Mitigation measures should clear the easterly drainage route, culvert and outfall along Keynor Lane to allow water to flow into the watercourse east of the B2145.	Proposed	Riparian owners and WSCC
SIDL_002	Maintenance	Check and clear the culvert under the B2145 near Green Trees to ensure it can flow freely into Watery Lane and reduce backing up to Street End Lane and Church Lane (Operation Watershed bid No. 2042)	Proposed by Sidlesham Land Drainage and Flood Group	WSCC
SIDL_003	Investigation	Undertake CCTV Survey of the 600mm culvert which runs from The Shutters to south of the junction with Rookery Lane to check condition. Jetting and repair to be completed where necessary	Proposed	WSCC
SIDL_004	Capital	The ditches along Rotten Row, Watery Lane and the surrounding area need to be opened up and connected. In addition the culvert underneath Rotten Row into	Proposed by Sidlesham Land	Sidlesham Land Drainage and Flood Group

		Watery Lane needs to be investigated and cleared where necessary (Operation Watershed bid No. 2042)	Drainage and Flood Group	
SIDL_005	Capital	The entrance to Church Farm Lane is a low spot and exceedance flows from Street End Road will flow towards this location, causing property flooding. There is a gully at this location, but it is lower than the manhole it discharges to, so will surcharge. We are proposing to elevate the road entrance to the 'Challens' and Church Lane to reduce the risk of water pooling at this low spot. Property Level Protection may be required in addition to the capital works.	Proposed	WSCC / Property owners
SIDL_006	Maintenance	On Church Lane / Chalder Lane there has been historic flooding, some of which has been alleviated with improvements to the ditch network. Maintenance of the whole ditch network and associated culverts should be undertaken	Proposed	Riparian owners
SIDL_007	Capital	On Church Farm Lane there is a drainage network flowing east from Florence Pond. Along this route there are several pinch points causing flood risk to property and the highway. Proposed actions include: <ul style="list-style-type: none"> • 007a - Rebuild the culvert on the outfall from Florence Pond which has collapsed (NB: a manually operated Penstock could be installed to maintain water levels in the summer for water vole populations) • 007b - As the open channel flows along the boundary of Church House it becomes very narrow which will act as a constriction to flow. The capacity of the channel should be increased by widening the channel on the southern side (NB: the retaining wall to Church House on the northern side of the channel is a listed structure) • 007c - Upsize the culvert under the access road to the church which is a 300mm (smaller than outfall from Florence Pond) • 007d - There is a pond on the north of Church Farm Lane near Church Farm. The pond has a very low southern bank which should be raised to reduce the risk of over-topping onto the road and affecting surrounding properties 	Proposed	Riparian owners, Sidlesham Land Drainage and Flood Group, MWHG
SIDL_008	Investigation	There is concern locally about un-restricted runoff from glass houses which contribute large flows to the ditch network (and direct onto the highway) following heavy rainfall. A further investigation is required to ensure the drainage from glass houses is connected properly, and attenuated wherever possible	Proposed	TBC
SIDL_009	Investigation	There are foul sewer flooding problems in Sidlesham. Southern Water is currently preparing a Drainage Area Plan (DAP) for Sidlesham and will work with stakeholders to understand foul sewer issues and potential mitigation measures.	Ongoing	Southern Water

		Local residents have reported concerns about foul flows from Jury Lane which should be included in the DAP		
<p>Commentary on impacts to downstream flood risk: The main drainage route through Sidlesham collects runoff from Rotten Row, Street End Lane and Street End Road before flowing along Watery Lane, then into the main 600mm culvert under the B2145. Shortly after the junction with Rookery Road the 600mm culvert discharges to become an open watercourse where it flows towards Pagham Harbour. The measures proposed in this action plan and by the Sidlesham Land Drainage and Flood Group focus on improving conveyance of the drainage system. Most of the improvements will increase flows towards the main drainage route, where there are two areas of concern:</p> <ol style="list-style-type: none"> 1. the cross-sectional area of the open channel becomes significantly narrower as it flows adjacent to the access track north of The Shutters – this could cause local out of bank flows and/or backing up of the ditch further north, and; 2. the main 600mm culvert has an estimated maximum conveyance capacity of approximately 300 l/s¹⁷ which is likely to have capacity to drain flows up to a 1 in 10-1 in 20 year return period¹⁸ – increases in flows towards this culvert could cause backing up and flooding <p>To mitigate the potential increases in flood risk further investigation of the changes in the flow along the main drainage route with improvements to the ditch network is required. Should this identify a potential to increase flood risk we would recommend considering some flow control on the ditch in Watery Lane to allow water to flow onto surrounding fields rather than affecting property and the B2145. This would need to be subject to further consideration of ground levels in the ditches and surrounding fields</p>				
<p>Summary of Environmental Risks</p> <p>The increased flow and storage capacity of the drainage system will reduce flood risk to people, properties (including Sidlesham primary School), historic landfill sites, good quality agricultural land, heritage and the highway network in Sidlesham. However, care will be required during action implementation to avoid construction impacts on designated environmental features (e.g. the setting of listed buildings, most notable the retaining listed wall of Church House from 007b) and affected habitats. Pre-construction checks will be required to assess value of habitat in the pond north of Church Farm Lane and ditches to be cleared, and its potential to support protected, notable and invasive species, and care will be required to avoid pollution of surface water and groundwater.</p>				

¹⁷ Using Colebrook-White formula to calculate pipe flows for full pipes assuming there are no effects on downstream controls. We have assumed a culvert size of 600mm and a gradient of 1:500 (based on available ground level data)

¹⁸ Based on ICP SuDS runoff calculations in Microdrainage, with a catchment area of 34 hectares

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5.2.1.6 Earnley and Somerley

<p>Summary of flooding issues: There has been significant flooding to properties and infrastructure on Bell Lane and Bookers Lane, most notably in June 2012. However flooding has also occurred on Bell Lane and parts of Bookers Lane during the past two wet winters (2012/13 and 2013/14). Flooding on Bell Lane appears to be linked to the highway drainage and ditch system which runs from the north of Bell Lane. The highway drainage system that runs along the western verge of Bell Lane from the A286 roundabout feeds into an open ditch opposite the entrance to Tawny Nurseries. This ditch then flows south until it cross under Bell Lane near Bell Caravan Park. From the site visit it is evident that there are collapsed and silted culverts under access tracks along the open ditch section which is causing backing up to the highway drainage system to the north of Bell Lane (see Action EARN_002). On Bookers Lane the majority of flooding was caused by overtopping of the Earnley Rife as it flows adjacent to properties. However, localised ditches and highway drainage also contributed to the flooding issues. Downstream of Bookers Lane there is isolated flooding on Drove Lane, caused by possible collapse of the culvert under the Lane.</p>				
<p>Existing investment: There has already been significant investment within this area to alleviate flood risk to properties and infrastructure. Most notably the Bookers Lane Flood Alleviation Scheme was completed in October 2014 to divert flows away from Bookers Lane and into the Medmerry re-alignment scheme. The Bookers Lane FAS is estimated to have a capacity of 4 m³/s. In addition Earnley Parish Council undertook further work with Operation Watershed funding to clear and re-grade a 60-70m section of the ditch network at the back of houses on Bookers Lane. Measures identified below therefore focus on residual flood risk upstream and downstream of the Bookers Lane FAS, where there remains flood risk to people and infrastructure. Some of these measures have been identified through the Flood Prevention Group and work undertaken by OPUS for WSCC.</p>				
<p>Investment strategy: Upgrade and maintain</p>				
Ref (in priority)	Type of measure	Description	Status	Action owner
EARN_001	Capital	<p>The OPUS survey report commissioned by WSCC identifies upsizing at key culverts on Bookers Lane and Bell Lane to alleviate flood risk. The key measures are to:</p> <ul style="list-style-type: none"> • 001a - upsize culverts no.1B-1F and 2 to have the same conveyance capacity as culvert no.1A (1200 mm)¹⁹ • 001b – undertake improvements to the entry taper and bag work at culvert no. 5 (NB: culvert under Bell Lane near junction with Bookers Lane) 	Proposed	Flood Prevention Group
EARN_002	Capital	The access culverts on the open ditch section along Bell Lane need replacing and/or de-silting to alleviate flooding at the top of Bell Lane.	Proposed	WSCC
EARN_003	Capital	Replace culvert under Drove Lane (private) which is believed to have collapsed, causing flooding to properties on Manor Farm	Proposed	Landowner
EARN_004	Capital & Maintenance	Replace 2 x collapsed culverts on ditch along eastern edge of Drove Lane, and clear the ditch network	Proposed	Environment Agency (who are the landowner)

¹⁹ NB: The OPUS Survey identified further improvement works at Culvert 1A which is an existing 1200mm and has the same cross-sectional area as Culvert 5 which flows under Bell Lane near the junction with Bookers Lane. There is no need to upsize Culvert 1A. In addition the OPUS Survey identified the need to upsize culvert 7 from 3x300mm culverts to a single 750mm culvert. We do not believe this is necessary because any backing up at the 3x300mm culverts will weir over Somerley Lane and re-join the watercourse.

EARN_005	Capital	Upsize 1 x culvert in Sussex Beach Holiday Village which is under-sized causing localised problems to static caravans	Proposed	Owner of Holiday Village
<p>Commentary on impacts to downstream flood risk: Any changes to culverts on Bell Lane and Bookers Lane (EARN_001) will increase flows towards the new diversion channel created as part of the Bookers Lane FAS. However, the Bookers Lane FAS has an estimated capacity of 4 m³/s, whereas the peak flow capacity of culvert no. 1 (just upstream of the diversion channel) is approximately 1.2 m³/s. Upsizing culvert upstream of the Bookers Lane FAS will not cause an increase in downstream flood risk. Measures EARN_003 to EARN_005 will improve the conveyance of the ditch network from Drove Lane through Sussex Beach Holiday Village. Provided each of these measures are implemented flood risk will not increase to property or infrastructure.</p>				
<p>Summary of Environmental Risks</p> <p>The increased flow and storage capacity of the drainage system will reduce flood risk to people, properties, heritage, agricultural land and the highway network in Earnley and Somerley.</p> <p>However, care will be required during action implementation to ensure that the works complement the objectives of the Medmerry Realignment Scheme and that they avoid construction impacts on designated environmental features (e.g. the setting of listed buildings) and affected habitats. Pre-construction checks will be required to assess value of habitat in footprint of the culvert upgrades and replacement, and its potential to support protected, notable and invasive species, while care will be required to avoid pollution of surface water and groundwater.</p>				

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5.2.1.7 West Wittering

<p>Summary of flooding issues: The majority of drainage within West Wittering flows towards the village green via culverted drainage. The main drainage routes are under Rookwood Road, Elms Lane and Cakeham Road which collect flow into a single manhole on the kerb immediately east of the village green. Downstream of the village green the drainage becomes an open channel as it flows past two cottages off Pound Road and continues to the rear of properties on The Wad. Flooding has occurred in various locations of West Wittering because of collapses in the culverted drainage on Rookwood Road and Elms Lane. This has flooded properties internally and caused extensive access issues for local residents. To the north of West Wittering there is a ditch network which drains from Redlands towards Chichester Harbour and passes under two culverts on Sheepwash Lane and Rookwood Road. Near Redlands there are reports of flooding related to the condition of the ditch network and culverts. In addition, the culverts under Rookwood Road is collapsing and requires replacing to reduce flooding to the top of Rookwood Road which hinders access to approximately 20 properties</p>				
<p>Existing investment: Following flooding in previous years in West Wittering the parish council successfully applied for Operation Watershed funding in 2013/14 to undertake investigative works and identify the mitigation measures required to alleviate flooding. Many of the measures proposed below have been identified through that work. In addition, from our stakeholder meeting with West Wittering Parish Council in October 2014 it is evident that there has been significant ditch clearance by riparian owners across the parish through close collaboration with landowners. In addition a new culvert has been installed near Sheepwash House to alleviate flooding at this location.</p> <p>NB: This action plan only considers the drainage network and catchment which drains west and discharges into the sea. Some of West Wittering Parish Council administrative area drains towards East Wittering and is therefore covered in the East Wittering action plan</p>				
<p>Investment strategy: Upgrade and maintain</p>				
Ref (in priority)	Type of measure	Description	Status	Action owner
WWIT_001a	Capital	Replace 80m of defective drainage on Rookwood Road (300mm and 375mm pipes renewed with 375mm)	Proposed by Parish Council	Parish Council
WWIT_002	Capital	Replace of 42m of defective 450mm drainage on Elms Lane	Proposed by Parish Council	Parish Council
WWIT_003	Capital	From the site visit it was evident that the highway drainage system on Cakeham Road was completely silted. The system needs to be jetted to improve conveyance of this system	Proposed	WSCC
WWIT_004	Investigation	The foul pumping station on Pound Road is known to be inundated which results in backing up and foul flooding on the Village Green and other areas in West Wittering. Southern Water are investigating the flooding problems within West Wittering	Proposed	Southern Water
WWIT_005	Capital	The culvert under Rookwood Road which drains the ditch network from Redlands is collapsing, and should be replaced with a 600mm to replicate the new culvert installed further upstream at Sheepwash Lane	Proposed	Landowner of private road
WWIT_006	Capital & Maintenance	The ditches which flow on either side of Sheepwash Lane immediately to the west of Redlands need clearance and culverts jetted to alleviate flood risk to properties at Redlands	Proposed	Landowner

Commentary on impacts to downstream flood risk: The improvement works on Rookwood Road, Elms Lane and Cakeham Road will improve conveyance of the highway drainage and thus reduce flood risk to affected properties on these roads. All of the highway drainage connections flow into a single manhole on the kerb immediately east of the village green. The outlet from this manhole is 3x500mm culverts (cross-sectional area of 2.3m² and maximum conveyance capacity of 575 l/s²⁰) towards the open channel which emerges adjacent to two properties just off Pound Road. Adjacent to the two properties the open channel is heavily constrained, and was estimated to be 1m wide x 1.5m deep (cross-sectional area of 1.5m²). The drainage improvements will move additional flows towards the downstream open channel more quickly which could increase flood risk to these properties and the surrounding area. Currently flows to this location in West Wittering are lower because of constrictions in the drainage system on Rookwood Road, Elms Lane and Cakeham Road. In addition, we do not know the capacity of the open channel downstream and whether increased flows could affect properties further downstream.

Summary of Environmental Risks

The increased flow and storage capacity of the drainage system will reduce flood risk to people, properties, agricultural land, heritage and the highway network in West Wittering. However, care will be required during action implementation to ensure that the works avoid construction impacts on designated environmental features (e.g. the setting of Walnut Tree House listed building associated with 001a, and Chichester Harbour AONB) and affected habitats. Pre-construction checks will be required to assess the value of habitat in footprint of the new drainage pipes, culvert replacement and ditch clearance, and its potential to support protected, notable and invasive species, while care will be required to avoid pollution of surface water and groundwater, particularly within the surface water NVZ. Any works that may be required following Southern Water's investigations of the foul pumping station on Pound Road (004) may need to be assessed under the Habitats Regulations due to the presence of Chichester and Langstone Harbour SPA and Ramsar site.

²⁰ Using Colebrook-White formula to calculate pipe flows for full pipes assuming there are no effects on downstream controls. We have assumed a culvert size of 3x500mm and a gradient of 1:500 (based on available ground level data)

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5.2.2 Moderate priority locations

5.2.2.1 Crouchers (A286)

<p>Summary of flooding issues: This hotspot includes the A286 from Mile Pond (just south of Stockbridge) to Oak Lane. The area is drained via two highway drainage systems, one which flows north from Dell Quay Road and the other which flows south from Dell Quay Road. The flooding issues in this location appear to be primarily linked to the condition of highway gullies and the pipe network. In addition, it is evident that runoff from adjacent fields flows onto the highway which exacerbates the flooding on the A286 (a main arterial route on the Manhood Peninsula). From available evidence it is estimated that 2-5 properties have flooded although this is uncertain.</p>				
<p>Existing investment: From the highways incidents logs received from WSCC there is evidence that gullies were cleared following flooding over the past 2-3 years. Some land drainage improvements have also been undertaken by local residents near Cedar Nursery.</p>				
<p>Investment strategy: Upgrade and maintain</p>				
Ref (in priority)	Type of measure	Description	Status	Action owner
CROU_001	Maintenance	The highway drainage system which runs north from Dell Quay Road is a 300mm system. Towards the downstream end of the system there is a manhole near the junction of Donnington Park which is heavily silted and causing backing up of the system. This should be jetted along the length to its outfall	Proposed	WSCC
CROU_002	Maintenance	Along the same system as CROU_001 there were several surcharged manholes during the site visit in December 2014 (MH2, 3, 4 and 5 on plan in Appendix E). These could be surcharged because the downstream system is heavily silted. However, when MH5 was lifted the manhole flooded (MH2, 3 and 4 did not flood) which would indicate a partial or full collapse between MH4 and MH5. This should be investigated and repaired where necessary.	Proposed	WSCC
CROU_003a	Capital	South of Dell Quay Road there is another highway drainage system running along the eastern verge of the A286 (this is a 450mm system), which was flowing relatively well. There is only one gully between the junction of Dell Quay Road and A286 and the pond south of Cedar Nursery, a distance of 250m. Additional gullies are required at the low spot near Cedar Nursery to capture additional flow	Proposed	WSCC
CROU_003b	Capital	South of Dell Quay Road there is also surface water runoff from the fields to the west of the A286 which contribute to flooding on the A286. To alleviate this a ditch could be established to the west of the A286, connecting into the open watercourse which emerges near Windmill Farmhouse.	Proposed	WSCC / Landowner
<p>Commentary on impacts to downstream flood risk: Improvements to the highway drainage which runs north (CROU_001 and CROU_002) will drain to an open ditch which flows near Mile Pond Cottages. Improvements to the highway and land drainage which runs south will drain to the open ditch near Windmill Farmhouse. This ditch is well established and subsequently drains away from properties into another ditch network which flows to Chichester Marina. We do not believe the improvements identified will increase downstream risk to properties.</p>				
<p>Summary of Environmental Risks</p>				

The increased flow and storage capacity of the drainage system will reduce flood risk to people, properties, agricultural land, heritage and the highway network in Crouchers. However, care will be required during action implementation to ensure that the works avoid construction impacts on designated environmental features (e.g. the setting of Crouchers and Little Crouchers listed buildings, and Chichester Harbour AONB) and affected habitats. Pre-construction checks will be required to assess the value of habitat in the footprint of new gullies and a new ditch, and its potential to support protected, notable and invasive species, while care will be required to avoid pollution of surface water and groundwater, particularly within the surface water NVZ.

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5.2.2.2 Runcton

<p>Summary of flooding issues: Pagham Rife is the main watercourse flowing through Runcton. During the site visit in February 2015 the Rife was flowing freely and had been well maintained. Through the majority of Runcton the Rife has not caused flooding historically, but downstream of the bridge on Mill Lane there some properties were flooded in June 2012. On Brookside there is a small brook which flows in a southerly direction and connects into Pagham Rife downstream of Saltham Lane. The small brook is shallow and heavily constrained by access culverts which cause overtopping of the brook. Properties adjacent to the brook are higher than the road so no internal property flooding has been recorded. On Saltham Lane there is an existing pond which overtops causing flooding to the road and property. In addition the drainage pipe from the pond towards Pagham Rife is collapsed in one location, exacerbating the flooding. South of the B2166 there is a limited highway drainage system. North of the B2166 there is a highway drainage system flowing down Vinetrow Road before flowing west towards the Pagham Rife. In some locations this drainage system was surcharged and there was evidence of partial collapse near the outfall.</p>				
<p>Existing investment: The Pagham Rife is maintained on an annual cycle by the Environment Agency and was flowing well during the site visit in February 2015. There have been historic sewerage flooding issues within Runcton because of surface water inundating the sewerage network. These appear to have been resolved by sealing of the vulnerable manholes.</p>				
<p>Investment strategy: Upgrade and maintain</p>				
Ref (in priority)	Type of measure	Description	Status	Action owner
RUNC_001	Capital	Repair the collapsed pipe on Saltham Lane between The Pond Place and Manor Cottage	Proposed	Landowner (private road)
RUNC_002	Capital	Raise the south bank of the pond on Saltham Lane to reduce flood risk to property and the road	Proposed	Landowner (private road)
RUNC_003	Capital	On Brookside the culverts under driveways to properties are generally very small and will cause backing up and flooding on the highway. No pro-active intervention is proposed, but as and when driveways are replaced the parish council should work with residents to increase the size of these culverts.		Parish Council
RUNC_004	Investigation & Capital	Investigate the condition of the highway drainage on Vinetrow Road and the B2166 where there was evidence of partial/full collapse, and repair where necessary	Proposed	WSCC
<p>Commentary on impacts to downstream flood risk: None of the proposed measures will have any significant impact on flows in Pagham Rife, and are therefore not considered to have any detrimental impact on downstream flood risk.</p>				
<p>Summary of Environmental Risks</p> <p>The increased flow and storage capacity of the drainage system will reduce flood risk to people, properties, agricultural land, heritage and the highway network in Runcton. However, care will be required during action implementation to ensure that the works avoid construction impacts on sensitive habitats. Pre-construction checks will be required to assess the value of habitat in the footprint of the pond bank and replacement pipe at Saltham Lane, and its potential to support protected, notable and invasive species, while care will be required to avoid pollution of surface water and groundwater.</p>				

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5.2.2.3 South Mundham

<p>Summary of flooding issues: The drainage in South Mundham is predominantly open ditches which some short culverted sections. There are two primary drainage routes, one flowing east along Punches Lane before flowing north into Camic Pond, and the other flowing north before flowing east into Camic Pond. Camic Pond then discharges east via a ditch into the Pagham Rife. Along both drainage routes into Camic Pond there was evidence of constrictions to flows during the site visit in December 2014, although it is recognised that the works undertaken by WSCC post 2012 have already helped to alleviate flooding in South Mundham. The flooding issues in South Mundham are primarily located at the junction of Punches Lane and Manor Lane where property and road flooding occurred most notably in June 2012.</p>				
<p>Existing investment: Following the June 2012 flooding WSCC cleared the ditch and associated culverts which flowed along Punches Lane to Camic Pond. According to feedback from local residents this has made a significant improvement to the flooding situation in the village. North-west of the village landowners have undertaken ditch clearance to alleviate flooding on Manor Lane.</p>				
<p>Investment strategy: Repair and maintain</p>				
Ref (in priority)	Type of measure	Description	Status	Action owner
SMUN_001	Maintenance	North of Punches Corner the culverted drain becomes open ditch again. During the site visit it was observed that this section of open ditch was very narrow and constricted, which could cause backing up within the culverted section and affect properties and infrastructure on Punches Lane	Proposed	Landowner
SMUN_002	Maintenance	Further north on Punches Lane there is a culvert which takes flows from the ditch into Camic Pond. The culvert appeared to have collapsed and needs repairing	Proposed	Landowner
SMUN_003	Capital	Along Manor Lane there are various access culverts which have a significantly smaller cross-sectional area than the incoming ditch (e.g. 75mm culvert north of Manor Farm, and 150mm culvert 100m further to the north). These will cause backing up of the ditch network and could cause localised flooding. To maintain consistent flow through the network these should be upsized to a 225-300mm pipe	Proposed	Landowner
SMUN_004	Capital	At the junction of Punches Lane and Manor Lane some properties are lower lying than the road. To drain additional surface water and reduce flood risk new gullies could be installed at the low points (e.g. outside Cornwood)	Proposed	WSCC
<p>Commentary on impacts to downstream flood risk: None of the proposed measures will have any significant impact on flows in the localised ditch network or the Pagham Rife, and are therefore not considered to have any detrimental impact on downstream flood risk.</p>				
<p>Summary of Environmental Risks</p> <p>The increased flow and storage capacity of the drainage system will reduce flood risk to people, properties, agricultural land, heritage and the highway network in South Mundham. However, care will be required during action implementation to ensure that the works avoid construction impacts on designated sites (e.g. two listed buildings) and sensitive habitats. Pre-construction checks will be required to assess the value of habitat in the footprint of the culvert repairs, upsized ditch and new gullies, and its potential to support protected, notable and invasive species, while care will be required to avoid pollution of surface water and groundwater, particularly within the surface water NVZ.</p>				

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5.2.2.4 Stockbridge

<p>Summary of flooding issues: Flooding in Stockbridge is limited to a few locations where there has been flooding on the highway. From available records up to five properties have also been flooded in Stockbridge. From the highway incident logs and the site visit undertaken in December 2014 it is likely that the flooding in Stockbridge is primarily linked to the condition of highway gullies, the piped network and soakaways. The majority of highway runoff drains to soakaways. During the winter discharge from these soakaways may be less effective as they will be influenced by high groundwater levels in the superficial river terrace deposits. This may account for some of the drainage issues noted in Stockbridge during winter months. This could be counteracted by installing a positive drainage system discharging to the gully to the north-west of the estate. The cost of installing would likely far outweigh any benefits.</p>				
<p>Existing investment: We are not aware of any significant investment in drainage infrastructure in Stockbridge, other than routine maintenance</p>				
<p>Investment strategy: Maintain</p>				
Ref (in priority)	Type of measure	Description	Status	Action owner
STOC_001	Maintain	Check the condition and discharge from soakaways (and any pipe network) on Grayden Avenue, Stockbridge Gardens, Granville Gardens and Marden Avenue where some historic flooding has been records	Proposed	WSCC
STOC_002	Capital	On Wiston Avenue there appear to be two gullies halfway along the road (total length 125m). Two further gullies at the northern end of Wiston Avenue would provide more effective drainage of the highway and reduce flooding.	Proposed	WSCC
<p>Commentary on impacts to downstream flood risk: None of the proposed measures will have any significant impact on flows in the downstream ditch network, and are therefore not considered to have any detrimental impact on downstream flood risk.</p>				
<p>Summary of Environmental Risks</p> <p>The increased flow and storage capacity of the drainage system will help to reduce flood risk to people, properties, heritage and the highway network in Stockbridge, and will have minimal impacts on the environment.</p> <p>Care will be required during the construction of the new gullies to ensure that the works avoid pollution of surface and groundwater, particularly within the Eutrophic NVZ.</p>				

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5.2.2.5 West Itchenor

<p>Summary of flooding issues: The drainage in West Itchenor is primarily open ditch with short culverted sections. The ditch network is generally in poor condition with many sections infilled and culverts blocked or collapsed. The village pond is also overgrown and silted which exacerbated flooding in the village. For the most part flooding is limited to the highway although there has been some property flooding in West Itchenor</p>				
<p>Existing investment: The Parish Council have commissioned an independent contractor to consider drainage issues within West Itchenor and Phase 1 of that study has been completed. In addition the MWHG (in partnership with the parish council, Chichester Harbour Conservancy and Chichester District Council) completed a ditch condition assessment in 2015 which identified the condition of ditches and potential remedial actions</p>				
<p>Investment strategy: Upgrade and maintain</p>				
Ref (in priority)	Type of measure	Description	Status	Action owner
ITCH_001	Capital	The village pond could be improved to store additional flood water and improve its habitat for water voles	Proposed by MWHG	TBC
ITCH_002	Capital	Culvert under Itchenor Road (near junction with Shipton Green Lane is blocked. This needs to be cleared	Proposed by Parish Council	WSCC
ITCH_003	Maintenance	The drainage ditch along the western edge of Itchenor Road (north of Lark Rise) should be cleared. This drains into a pond which should connect to a further pond on the northern side of the access to Pond Cottage. From this pond there should be a further ditch (which has now disappeared). These sections of ditch network should also be re-established.	Proposed by Parish Council	Landowner
ITCH_004	Maintenance	Near Spinney Barn there is a ditch which properties pump surface water into. This ditch has been filled in causing flooding to the road. It is also clogged with vegetation. The Itchenor Parish Ditches Condition Assessment Report also identified the culverts from this ditch network to be ineffective and may require jetting.	Proposed by Parish Council	Landowner
<p>Commentary on impacts to downstream flood risk: There is an increase in the cross-sectional area of culverted sections as the drainage flows in a generally northwards direction towards the village pond. Therefore clearance of the key ditch network within West Itchenor should not cause an increase in downstream flood risk as the capacity of the drainage system increases downstream. Improvements to the village pond will help to ensure a balancing of any additional flows which are generated with clearance of ditches and culverts.</p>				
<p>Summary of environmental risks</p> <p>The increased flow and storage capacity of the drainage system will reduce flood risk to people, properties, Grade 2 agricultural land, heritage and the highway network in West Itchenor. Measures to increase 'storage of additional flood water' also presents opportunities for habitat creation/improvement with associated effects on notable and protected species e.g. potential positive effect on water voles. However, care will be required during action implementation to ensure that the works avoid construction impacts on designated sites (e.g. the Parish Church of St Nicholas Listed Building adjacent to the village pond, and Chichester Harbour AONB) and sensitive habitats. Pre-construction checks will be required to assess the value of habitat in the footprint of pond improvements</p>				

and culvert/ditch clearance, and its potential to support protected, notable and invasive species, while care will be required to avoid pollution of surface water and groundwater, particularly within the surface water NVZ.

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5.3 Ongoing measures to manage flooding

5.3.1 Key principles

There are five key principles which are considered the fundamental elements for key to ensuring continued long term maintenance and management of the drainage system across the Manhood Peninsula. These are described in turn below

1. Ditch clearance remains the responsibility of riparian owners and landowners

Under Section 25 of the Land Drainage Act (1991) riparian owners remain responsible for ensuring that any watercourse through, or adjacent to, their land is maintained to allow the proper flow of water. Where the watercourse is not maintained the land drainage authority (WSCC) can enforce the riparian owner to clear the watercourse, or undertake the work and reclaim the costs²¹. The majority of drainage infrastructure in the Manhood Peninsula falls into this category. Therefore the majority of maintenance work should be undertaken by riparian owners. However, because there is a legacy of councils undertaking maintenance of ditches and watercourses the public expectation is that this should continue. Continued education and awareness raising is required with riparian owners and landowners to ensure this happens.

2. Local communities have a key role to play

In light of point 1 above local residents, parish councils and local flood action groups will continue to have a key role in helping to manage flooding and drainage across the Manhood Peninsula. Much of the significant watercourse management which has happened during the past few years has occurred through local residents, parish councils and local flood action groups working with riparian owners to encourage clearance of watercourses.

3. Runoff into the ditch network needs to be controlled

The local ditch and Rife network is sensitive to increased flows. Therefore rigid planning control needs to be enforced for new developments so that they do not increase the peak flow rate (and volume) to the local ditch and Rife network²². In addition, there is significant local concern about uncontrolled runoff from the glass houses across the Manhood Peninsula which contribute to rapid runoff into the local ditch and Rife network.

4. The continuity of the drainage network is critical

Many of the flooding problems in the Manhood Peninsula have occurred because the drainage network has become discontinuous or heavily constricted. This has occurred where sections (or whole) ditches have been infilled, where small culverts have been built within ditches to allow access to property or land, where ditches have become silted and thus ineffective, or where ditches have become narrowed. In a low-lying area such as the Manhood Peninsula such discontinuities in the drainage network will cause localised pinch points where flooding will occur onto the highway and/or into property. Maintaining the continuity of the drainage network is therefore critical to maximise conveyance of water downstream as intended.

5. A consequence-based approach should be adopted

Given the scale and length of the drainage network in the Manhood Peninsula, it is not possible or practicable for a single body to ensure that every part of the drainage system is fully functioning. There is simply insufficient resource and funding available for this to happen. In addition, we strongly recognise that different parts of the drainage system have different levels of influence on overall functionality and hence the occurrence (or otherwise) of flooding. For example, there are primary (or “critical”) conveyance routes

²¹ WSCC will take legal action where necessary

²² It is worth noting that new development, if designed appropriately, can reduce peak runoff

which need to be maintained. If these are not maintained and functioning appropriately then the whole drainage system within an area will not function the consequence of which may be flooding of property at least locally and perhaps also elsewhere on the drainage network. On the contrary, an isolated field ditch which is badly maintained may cause some localised flooding or ponding on the highway, but the consequence of this is less significant than if the primary conveyance route is blocked. Therefore one of the key principles will entail the identification of the primary conveyance drainage routes on the Manhood Peninsula and the adoption of measures to ensure they are maintained and functioning.

5.3.2 Identifying primary and secondary conveyance routes

To identify the Rifes, ditches, culverts and highway drainage routes which should be the highest priority for clearance, survey and monitoring the drainage network should be categorised according to its importance for managing the consequences of flood risk (as per Key Principle 4 above). Across the Manhood Peninsula the following categorisation has been made:

- primary conveyance routes – these are the critical routes of the drainage network which will cause the most significant flooding to property and infrastructure if they are blocked or poorly maintained (NB: these routes include all of the Rifes, and builds upon the ‘key transport routes’ initially proposed by Royal Haskoning in 2006²³);
- secondary conveyance routes – these are the routes of the drainage network which could cause some property or highway flooding if they are blocked or poorly maintained, and;
- other routes – this is the remaining drainage network and is made up of small ditches which are not considered critical to manage flooding to property or infrastructure. We have not identified these.

The primary and secondary conveyance routes are provided in Appendix F.

5.3.3 Long term management approaches

The ongoing management and investment should be based around four key themes:

1. the importance of **land drainage consents** to prevent culverting or infilling of watercourses where it will increase flood risk;
2. the need to **control runoff from new developments**;
3. the requirement to **continue maintaining watercourses, culverts and highway drainage** on a cyclical basis, and;
4. the need to **control runoff from glass houses** in the Peninsula.

The objective is to ensure that the drainage system is managed and maintained on a proactive, cyclical basis²⁴ to ensure it is functioning as intended. This can be achieved through an annual walkover survey of the primary (and possibly secondary) conveyance routes to identify their condition, maintenance requirements and any land drainage consent issues. This should take place in late autumn to allow vegetation die back following the summer, but also to identify any remedial measures before the wet winter months when the Manhood Peninsula is primarily affected by flooding²⁵.

5.3.3.1 Land Drainage Consenting

During site visits there were numerous examples of ditches being infilled and small culverts under driveways which will constrict flow in the local ditch and Rife network, for example²⁶. Works which affected watercourses fall within the remit of Section 23 (consenting) and Section 24 (enforcement) of the Land Drainage Act (1991). To prevent further constrictions of the local ditch and Rife network it is critical that

²³ Royal Haskoning (2006), Manhood Peninsula, Land Drainage – Phase 3

²⁴ This is assumed to be annual

²⁵ We also recognise that the Manhood Peninsula is vulnerable to intense summer storms, as occurred in June 2012

²⁶ This process has most likely been ongoing over several decades

residents and businesses know of, and abide by, the need for a land drainage consent. Furthermore, there is a need for monitoring across the Manhood Peninsula (focussing on primary and secondary conveyance routes) to identify any new constrictions, and remedial action taken under Section 24 of the Land Drainage Act where necessary. Two ongoing actions are necessary:

1. education of residents, businesses and local builders of the need for a land drainage consent for any works on a watercourse, and;
2. ongoing monitoring as part of the annual walkover survey to identify any remedial actions required

5.3.3.2 Controlling runoff from new development

The local ditch and Rife network is sensitive to additional flows, particularly during winter months when baseflows in the network are high due to groundwater flows from the superficial layer (and some direct flows from chalk groundwater) and because the flat topography causes water to drain away slowly. Therefore additional runoff (peak flow or volume) from new development could increase downstream flood risk. The volume of runoff is the critical issue in the Manhood Peninsula because the ditch network has limited capacity for additional volume, particularly during winter months. To reduce the impact of volumetric changes due to development Long Term Storage should be used where possible which allows the site discharge rate to be a maximum rate of 2 l/s/ha for a 100 year 6 hour event. This requires strict adherence to the requirements set out by the Environment Agency²⁷. No planning applications have been reviewed as part of the SWMP and therefore the need for long term storage to control volume of runoff has been identified to note its importance, rather than as a commentary on current practice by the local planning authority.

5.3.3.3 Maintenance of watercourses, culverts and highway drainage

As part of the annual walkover survey a standard reporting template should be populated to identify the “drainage asset” condition and need for remedial works in a systematic manner. Currently reporting to WSCC occurs on an ad-hoc basis via email or telephone conversations which is difficult to record systematically and prioritise actions. These reporting templates would be completed, reviewed by WSCC (in partnership with others), and prioritised so that remedial action can be taken by the responsible body. The reporting template should report the condition of the drainage network in accordance with the Environment Agency’s Condition Assessment Manual²⁸.

A community-led approach is the most efficient mechanism to ensure the long-term maintenance and management is secured on the Manhood Peninsula. The working assumption is that the Environment Agency will continue to undertake annual maintenance and clearance of the Rife network in the Manhood Peninsula. However, we believe there would be merit in aligning the Rife maintenance with other maintenance and management across the Peninsula.

A community-led approach focuses on local communities undertaking the majority of walkover surveys (with the exception of piped highway drainage due to health and safety considerations), and issue a report (using a standard template) to WSCC or Chichester District Council. Subsequently local communities would take the lead on liaising with riparian owners to ensure the required maintenance is undertaken. Once these actions are completed local communities would report these to WSCC or Chichester District Council. WSCC or Chichester District Council could lend support to local communities through liaison meetings, providing details of appropriate contractors, delivering appropriate health and safety messages, and ensuring the environment is protected, for example. Under this approach any enforcement against riparian owners²⁹ and any works on highway drainage would be undertaken by WSCC as the Lead Local Flood Authority and the Highways Authority.

²⁷ Environment Agency (2013), Rainfall runoff management for developments, Report – SC030219

²⁸ Environment Agency (2006). *Condition Assessment Manual. Managing flood risk*. Document reference 116_03_SD01

²⁹ Under Section 25 of the Land Drainage Act (1991)

A key advantage of this approach is that to some extent the community-led approach represents a continuation of practice over the past 2-3 years on the Manhood Peninsula. Local communities have played a key role in improving drainage over the past 2-3 years. Therefore this approach builds upon that knowledge and excellent work undertaken to date. However, our recommendations mean that this process will become more formalised, robust and occur on a cyclical basis rather than ad-hoc.

On the contrary it will be more difficult to ensure consistency and a universal coverage across the Manhood Peninsula through a community-led approach. This may result in inconsistent reporting and some areas receiving a disproportionate level of investment. Careful management by WSCC would be required to ensure this did not happen.

5.3.3.4 Controlling runoff from glass houses

There is significant local concern that runoff from the significant number of glass houses in the Manhood Peninsula contributes rapid runoff into the local ditch and Rife network during heavy rainfall events, and therefore contribute towards flooding. It is difficult to quantify the contribution of glass houses to total flows within the ditch network. We believe that as part of the long-term management strategy further investigation is required to identify how glass houses drain to the local ditch and Rife network, the potential impact of these flows on flooding, and the potential for on-site attenuation (and re-use) of rainfall.

5.3.4 Environmental considerations

The protection of habitats and wildlife is a key consideration when undertaking ditch maintenance on the Manhood Peninsula. Ditches form important habitats and contain species of flora and fauna that are protected under the Wildlife and Countryside Act 1981. In the Manhood Peninsula there are large water vole populations living in wetlands and ditches. Clearance of ditches and watercourses must be sensitive to water vole populations and other flora and fauna. Riparian owners need to be aware of the flora and fauna within their ditches to ensure any maintenance is sensitive to wildlife and habitats. Preliminary guidance for ditch clearance has been provided in Appendix G, and further information is available from MWHG³⁰ and WSCC³¹.

³⁰ <http://mwhg.org.uk/getting-to-grips-wetland-management-for-people-and-wildlife/>

³¹ https://www.westsussex.gov.uk/media/1983/good_practice_for_watercourse_maintenance.pdf

Appendix A Roles and Responsibilities

1. Roles and Responsibilities

Appendix B Study boundary

1. Manhood Peninsula Study Boundary

Appendix C Geology and Hydrogeology

1. Geology and Hydrogeology Technical Note

Appendix D Flood Information Maps

1. Highway incident logs June 2012-March 2014
2. Information from parish council meetings.zip (Maps and Spreadsheet)
3. Site visit maps (.zip file)

Appendix E Action Plan Maps

Appendix F Primary and Secondary Conveyance Routes

1. ManhoodPeninsula_KeyWatercourseRoutes_A
2. ManhoodPeninsula_KeyWatercourseRoutes_B
3. ManhoodPeninsula_KeyWatercourseRoutes_C
4. ManhoodPeninsula_KeyWatercourseRoutes_D
5. ManhoodPeninsula_KeyWatercourseRoutes_E

Appendix G Environmental Constraints

1. Environmental Constraints – Summary
2. Environmental Constraints – Short-term action plans
3. Environmental Constraints - General Guidance