Shropshire Council

Oswestry Surface Water Management Plan

Detailed Assessment and Options Appraisal Report

Final

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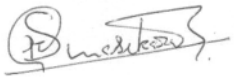
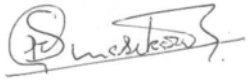
Checker	Renuka Gunasekara	
Approver	Renuka Gunasekara	

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Executive Summary

This report forms the outputs from the 'Detailed Assessment', 'Options' and 'Implementation and Review' stages of the Oswestry Surface Water Management Plan (SWMP).

Hydraulic Modelling

InfoWorks ICM v2.5.2 has been used to add a detailed 2D surface model to the existing Severn Trent Water (STWL) 1D sewer model. The model also incorporates several small sections of open channel watercourses on the periphery of the Oswestry urban area.

A validation exercise was undertaken to compare historic flood locations with those locations predicted to flood by the model. In general, the model results are consistent with the reported incidents suggesting that drains in areas where water naturally collects due to the topography may be more susceptible to blockage and / or inundation during storm events.

Three scenarios were modelled using the newly developed ICM model:

- The 'Do Nothing model included blockages and known siltation build up identified by a new CCTV survey, increased pipe roughness where modelled velocities were less than 0.75m/s and increased roughness applied to all open channel sections within the model to represent reduced maintenance / channel clearing;
- The 'Do Minimum' model represents the existing situation with all elements of the pipe network running clear; and
- The 'Do Something' model was used to assess the impacts of potential mitigation options.

However, the model was initially used to assess the impacts of climate change, urbanisation and river levels on flood risk and found that:

- The potential impact of climate change on rainfall increased the flood risk in all wetspots;
- Increased runoff from urbanisation of currently undeveloped sites increased flood depths at sewer nodes on the elements of the surface water network connected to the sites; and
- River levels at sewer outfalls had a negligible impact on sewer flooding.

Wetspot Prioritisation

The results from the modelling were reviewed along with new survey data in order to determine the prioritised wetspots for which mitigation options would be reviewed. A total of 14 wetspots were selected.

Groundwater

A desk top study into the risk of groundwater flooding in Oswestry has been completed as part of the SWMP Risk Assessment Phase. This found that there is a potential for groundwater flooding to contribute to flood events and that the complex nature of the superficial deposits across Oswestry means site specific assessments will be required for particular developments when considering use of infiltration based SuDS.

Shortlisted Measures

A measures shortlisting exercise was carried out to determine those measures which were likely to be suitable for mitigating surface water flood risk in Oswestry and which could then be combined into options for the 'Do Something' scenario. This shortlisting exercise concluded that:

- Some remedial work on the surface water sewer network is required as identified by the CCTV survey;
- Due to the layout of the majority of roads in Oswestry, swales and roadside rain gardens are unlikely to be a suitable measure as the space between the highway and property boundaries is small to non-existent;
- Improved watercourse maintenance as identified from channel surveys is applicable in wetspots OSW4, OSW1, OSW13, OSW18, OSW10, OSW9 and OSW11;
- Improvements to the sub surface drainage network did not score highly because model results indicated that the network is performing to its design standard;
- There are potential locations for attenuation storage in Brogyntyn Park, Brynhafod Road Playing Fields Open space near the Railway Heritage Centre; and
- Property level protection is likely to be suitable for properties in Oswestry although funding will depend on the benefits realised on an individual basis.

Options Analysis

In order to assess the relative costs and benefits of the 'Do Nothing', 'Do Minimum' and 'Do Something' scenarios, the following monetised costs were assessed:

- Capital costs associated with implementation of measures
- Operational costs; the on-going costs associated with maintenance of assets, land or equipment.
- Residential flood damages
- Non-residential flood damages
- Emergency Services recovery costs

The following monetised benefits were assessed:

- Reduction in residential flood damages
- Reduction in non-residential flood damages
- Reduction in recovery costs

For each of the 14 prioritised wetspots, six options were defined and assessed:

- Do Nothing
- Do Minimum
- Improved Maintenance
- Local scale works in conjunction with improved maintenance
- Capital works (modelled attenuation schemes) in conjunction with improved maintenance
- Planning, policy and social

The model was used to assess the 'Do Nothing',' Do Minimum' and 'Do Something - Capital Works' option (where applicable) whereas the other options were assessed on a qualitative basis. An economic assessment was undertaken for the modelled options which compared the 'Do Something' to the 'Do Nothing' and 'Do Minimum'.

Guidance on the preferred option for each wetspot is summarised within Section 9, in each case categorised into a long term option, a capital investment option (where applicable), a quick win and a policy based option.

Action Plan

An SWMP Action Plan is included in Section 10.1.2 which summarises all the mitigation actions identified within the report along with their lead responsibility and timescale for completion.

The report recommends that Shropshire Council takes responsibility for monitoring the implementation of the Action Plan and that a review should take place in line with the Local Flood Risk Management Strategy (LFRMS) and Preliminary Flood Risk Assessment (PFRA) as a minimum once every six years. However, given that the SWMP Action Plan is a working document, it is suggested that Shropshire Council review it in detail at least annually. Shropshire Council should also be aware of the immediate and short term actions which may require more frequent, perhaps quarterly reviews.

CONTENTS

Glossary

Term	Definition
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
AMP	Asset Management Plan
Asset Management Plan	A plan for managing water and sewerage company (WaSC) infrastructure and other assets in order to deliver an agreed standard of service.
AStSWF	Areas Susceptible to Surface Water Flooding
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
Civil Contingencies Act	This Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums must put into place emergency plans for a range of circumstances including flooding.
CLG	Government Department for Communities and Local Government
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Critical Infrastructure	For the purposes of this SWMP, this is identified as being Infrastructure identified from the Environment Agency NRD datasets as being hospitals, schools, power (generation & distribution), water, transport etc. For the purposes of this assessment, these items have been defined as being critical so as to identify the risk of surface water flooding to assets other than residential and commercial.
Culvert	A structure that conveys a watercourse below the level of the ground.
Defra	Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload.
DTM	Digital Terrain Model
EA	Environment Agency
Indicative Flood Risk Areas	Areas determined by the Environment Agency as indicatively having a significant flood risk, based on guidance published by Defra and WAG and the use of certain national datasets. These indicative areas are intended to provide a starting point for the determination of Flood Risk Areas by LLFAs.
FCERM	Flood and Coastal Erosion Risk Management
FMfSW	Flood Map for Surface Water
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Forum	A group set up to gather information from and to provide flooding and drainage support and advice to communities.

Term	Definition
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG.
Flood Risk Regulations (FRR)	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Flood and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a watercourse
IUD	Integrated Urban Drainage
LDF	Local Development Framework
Lead Local Flood Authority (LLFA)	Local Authority responsible for taking the lead on local flood risk management. In Shropshire, Shropshire Council is the LLFA.
LiDAR	Light Detection and Ranging
Local Resilience Forum (LRF)	A multi-agency forum, bringing together all the organisations that have a duty to cooperate under the Civil Contingencies Act, and those involved in responding to emergencies. They prepare emergency plans in a co-ordinated manner.
LPA	Local Planning Authority
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency is the managing authority and has certain powers
NRD	National Receptor Dataset – a collection of risk receptors produced by the Environment Agency
Ordinary Watercourse	All watercourses that are not designated Main River. The local authority, in this case Shropshire Council is the managing authority for ordinary watercourses and has certain powers in this regard under the Land Drainage Act.
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
PFRA	Preliminary Flood Risk Assessment
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial Flooding	Flooding from water flowing over the surface of the ground; often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with additional flow.
PPS25	Planning and Policy Statement 25: Development and Flood Risk
RBMP	River Basin Management Plan
River Basin Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river basin catchment to identify and agree policies to secure the long-term improvement to the water environment.
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.

Term	Definition
Risk Management Authority (RMA)	As defined by the Floods and Water Management Act
SC	Shropshire Council
STWL	Severn Trent Water Limited
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer/urban drainage system.
SFRA	Strategic Flood Risk Assessment
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS	Sustainable Drainage Systems
Sustainable Drainage Systems	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner.
Surface water	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.
SWMP	Surface Water Management Plan
WaSC	Water and Sewerage Company
WW	Dwr Cymru Welsh Water

1 Introduction

1.1 Terms of Reference

Hyder Consulting (UK) Limited (HCL) was appointed by Shropshire Council (SC) to produce a Detailed Surface Water Management Plan (SWMP) for Oswestry. This report forms the outputs from the 'Detailed Assessment', 'Options' and 'Implementation and Review' stages of the study as described in Section 1.3 below. The background to the process of surface water management planning is set out in the Scoping and Intermediate report[1] which should be read prior to this report.

1.2 Scoping and Intermediate Assessment

The combined Scoping and Intermediate Assessment report was completed in Jul 2012. This previous stage reviewed 22 potential wetspot areas in Oswestry in terms of historic, current and future flood risk, before taking these through a prioritisation exercise to determine the wetspots which would be taken forward to the detailed assessment phase. The report made a number of recommendations made in relation to:

- Planning and policy
- Data management
- Asset survey and maintenance
- Implementation and use of findings
- Monitoring
- Next steps for the Detailed Assessment, Options and Implementation Report

Discussion on the findings from the Scoping and Intermediate Assessment report is included within this report in the relevant chapters.

Green text boxes at the start of each chapter summarise the elements of the Defra SWMP guidance[2] addressed within the subsequent text.

1.3 Study Methodology

Figure 1-1 illustrates the overall approach to the study methodology. This report focuses on the final two stages. Additional detail on the study methodology and outcomes is given in subsequent chapters of this report.

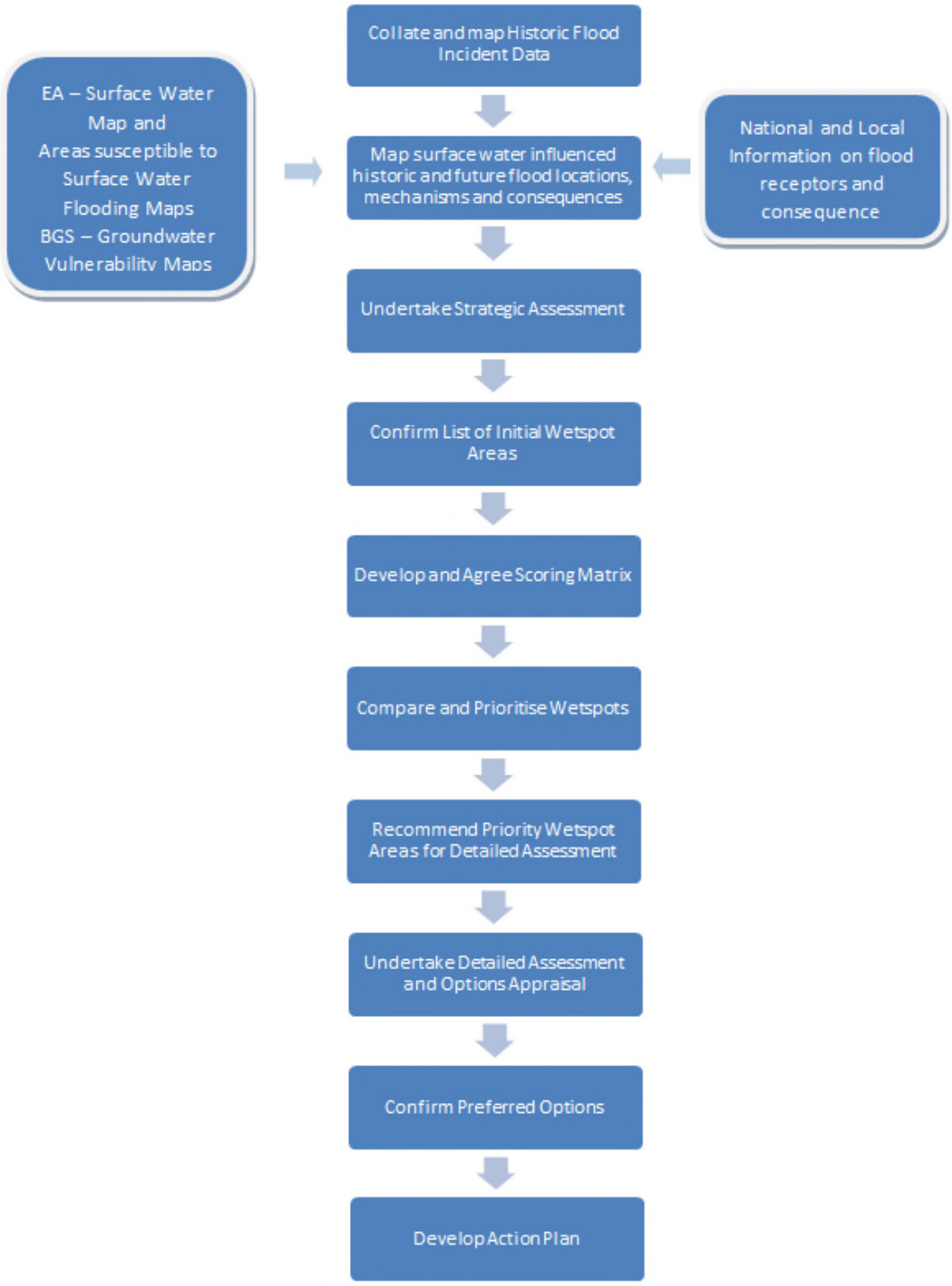

Figure 1-1 SWMP Assessment Methodology

1.3.1 Level of Assessment for SWMPs

SWMPs can function at different geographical scales and therefore different levels of detail are used when considering the outputs. Table 1-2 defines the three potential levels of assessment within a SWMP.

Level of Assessment	Appropriate Scale	Outputs
Strategic Assessment (completed)	Shropshire Council Administrative area	▪ Broad understanding of locations that are more vulnerable to surface water flooding ▪ Prioritised list for further assessment ▪ Outline maps to inform spatial and emergency planning
Intermediate Assessment (completed)	City / Large Town	▪ Identify flood hotspots which might require further analysis through detailed assessment. ▪ Identify immediate mitigation measures which can be implemented ▪ Inform spatial and emergency planning
Detailed Assessment and Options Appraisal (this study)	Known flooding hotspots, small towns	▪ Detailed assessment of cause and consequences of flooding ▪ Use to understand the mechanisms and test mitigation measures, through modelling of surface and sub-surface drainage systems. ▪ Assess options
Action Plan (this study)		▪ Develop action plan ▪ Develop framework for implementation and review of action plan

Table 1-2 Level of Assessment for SWMPs

1.3.2 Detailed Assessment and Options Appraisal Objectives

The objectives of this final stage of the Oswestry SWMP (comprising the remaining three phases of the SWMP framework) are to:

- Obtain and review additional survey data for watercourses, both open and culverted in Oswestry
- Build an integrated river, sewer and overland model of Oswestry
- Use the integrated model to assess baseline flood risk to Oswestry
- Map and communicate the updated flood risk information for Oswestry
- Identify and assess suitable measures and options for mitigating flood risk in Oswestry
- Undertake economic assessments
- Identify a Surface Water Management Action Plan for Oswestry
- Identify a framework for monitoring and review of the Action Plan

2 Study Updates

This section of the report highlights any key new work and the additional data obtained since the publication of the Scoping and Intermediate Report. It also gives a summary of the wetspots identified in the Intermediate Assessment Stage.

2.1 New Work

2.1.1 Local Flood Risk Management Strategies

The Flood and Water Management Act 2010 (FWMA) requires each Lead Local Flood Authority (LLFA) to produce a Local Flood Risk Management Strategy (LFRMS). Whilst this report is not a LFRMS, the SWMP, Preliminary Flood Risk Assessment (PFRA)[3] and associated risk maps will provide the necessary evidence base to support the development of LFRMS. No new modelling is anticipated to produce these strategies. Shropshire Council is writing its LFRMS at present; a draft is expected in summer 2013.

2.1.2 Environment Agency Updated Flood Map for Surface Water

The Environment Agency is currently engaged in updating the Flood Map for Surface Water (FMfSW) to make best use of improved data and modelling techniques, incorporate local information and to provide consistency across all LLFAs. As of April 2013, Shropshire Council has the opportunity to review these updated maps to:

- Assess how well the national mapping correlates with historic flooding
- Review confidence scores based on historic flooding
- Decide whether to recommend any locally produced mapping

An updated FMfSW will be produced by the end of December 2013; consultation is also underway regarding the phasing of the publication of these maps.

2.2 Additional Data

An updated list of the data provided by stakeholders to date is provided in Table 2-1 below; new data is in italics. A complete and updated data register is included in Appendix A.

Stakeholder	Data Supplied	
	Publicly Available	**Not Publicly Available**
Canal and Rivers Trust		Canal network, GIS dataset showing historic overtopping and breaches
Environment Agency	River Severn Catchment Flood Management Plan, River Severn River Basin Management Plan	National Receptor Databases, historical and modelled flood event outlines, main rivers, detailed river network, modelled flood outlines for surface and fluvial sources, LiDAR, *Flood Map for Surface Water DTM*
Natural England	Special Area of Conservation (SAC), Site of Special Scientific Interest (SSSI), Special Protection Areas (SPA), Ancient woodland, Local Nature Reserve (LNR), National Nature Reserve (NNR), Ramsar sites, woodland, agricultural land classifications	
Shropshire Council	Former Oswestry Borough Council Strategic Flood Risk Assessment (SFRA) – Level 1 (2007); Shropshire Core Strategy Final Plan (2010), Oswestry & Surrounding Area Place Plan (2011/2012); Shropshire Outline Water Cycle Study (2010), Shropshire PFRA. Surface Water Management - Interim Guidance for developers	Ordinary watercourses, historical flooding locations, transport infrastructure, Administrative boundaries, OS 10k and 50k Mapping, OS Master Maps *Channel survey data for ordinary watercourses (surveyed June 2012)* *CCTV survey data for selected culverts in the town (surveyed July 2012)*
Severn Trent Water		Sewerage networks, asset information, DG 5 Register *Oswestry InfoWorks Model including completed surface water sewer network*

Table 2-1 Stakeholders contacted and the information provided (updated as of March 2013)

2.3 Wetspot Summary

The Scoping and Intermediate report identified 22 wetspots and multi criteria assessment (MCA) was completed for each identified wetspot. Table 2-2 summarises the wetspots in priority order as determined in the Scoping and Intermediate report. Figure 2-1 shows the locations of the wetspots.

Wetspot	Location	No. of Historical Reports	Area Weighted MCA Score	Final Priority Score
OSWS9	Town Centre	19	462	1
OSWS8	Victoria Road	8	288	2
OSWS5	Oswald's Well Lane	8	256	3
OSWS15	Whittington Road Works	4	240	4
OSWS12	Llwyn Road	8	224	5
OSWS4	Liverpool Road / Oakhurst	5	169	6

Wetspot	Location	No. of Historical Reports	Area Weighted MCA Score	Final Priority Score
	Road			
OSWS13	Jasmine Gardens / Offa Drive	3	168	7
OSWS20	Weston	3	152	8
OSWS14	Cabin Lane / Unicorn Road	8	144	9
OSWS10	Chesnut Avenue	7	120	10
OSWS18	Hazel Grove / College Road	3	120	10
OSWS1	Brynhafod Lane / Hampton Road	13	100	12
OSWS16	Ascot Road	3	88	13
OSWS21	Morda Bridge	2	85	14
OSWS6	Weston Avenue	8	64	15
OSWS22	Millar's Field, Morda	1	28	16
OSWS11	Oswald Road	17	22	17
OSWS3	Upper Well Close / Trefonen Road	2	15	18
OSWS7	Croes Wylan Crescent	0	12	19
OSWS17	Aston Way	0	10	20
OSWS19	Mile Oak	2	10	20
OSWS2	Maserfield	1	6	22

Table 2-2 Wetspots Ranked by Priority (as determined in the Scoping and Intermediate report)

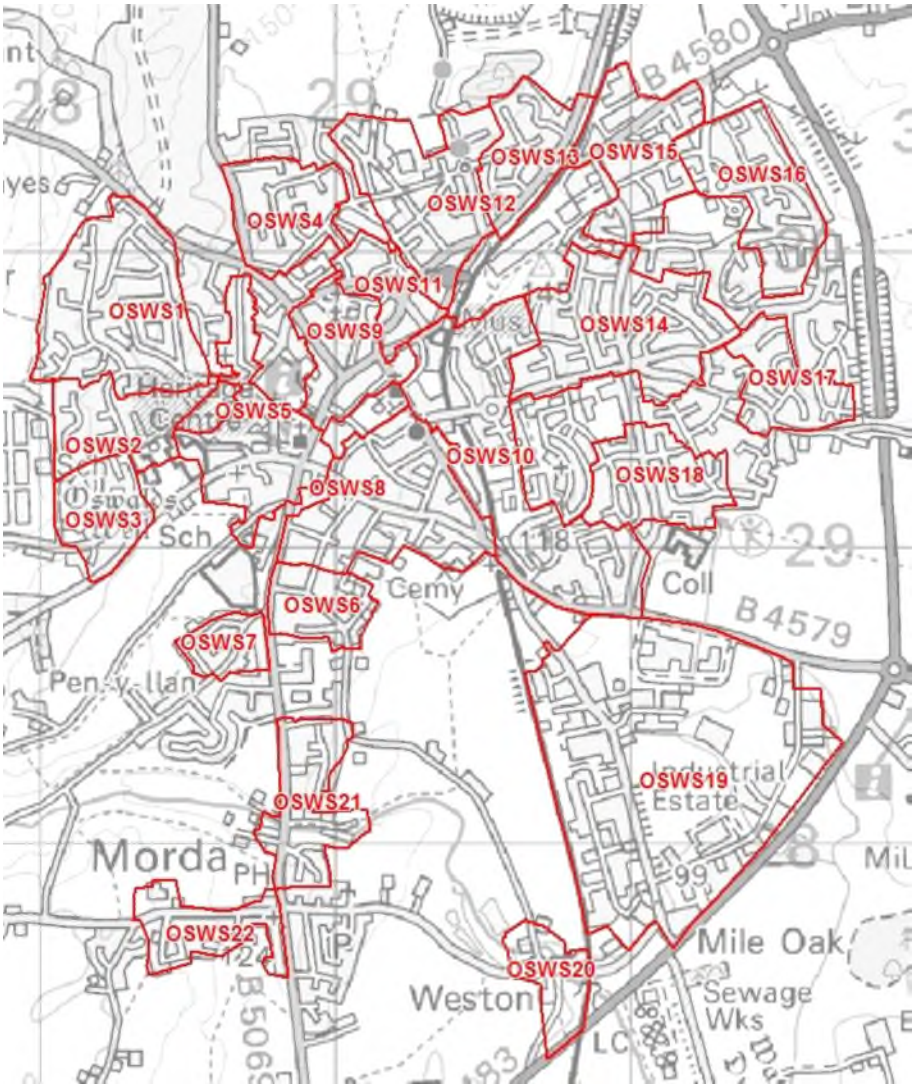

Figure 2-1 Wetspot Location

The detailed assessment now takes these wetspots forward in order to prioritise those for further assessment. This process is described in the subsequent chapters.

3 Phase 2 Detailed Risk Assessment: Modelling

Select modelling approach
Develop modelling approach

3.1 Selected Approach

InfoWorks ICM v2.5.2 has been used to add a detailed 2D surface model to the existing Severn Trent Water (STWL) 1D sewer model. The model also incorporates several small sections of open channel watercourses on the periphery of the Oswestry urban area. These enhancements have been undertaken to create a fully integrated model capable of deterministic analyses of the various drainage systems to allow the identification of key risk areas.

The modelling approach taken represents a significant change in the level of precision to which flood risk, the capacity of a sewerage system and surface water flows can be assessed. The attributes for which notable improvements have been made are the accuracy of boundary conditions, the representation of interactions between the various systems and the level of confidence in flooding predictions due to the full inclusion of the pluvial element. However, there still remains a level of uncertainty in the data used in the modelling and the accuracy of the model results is a reflection of this.

Six design events (5%, 3.33%, 2.5%, 1%, 1% (plus climate change) and 0.5% Annual Exceedance Probability (AEP) events) were assessed for five storm durations (20, 60, 120, 240 and 480 minutes).

Full detail of the ICM modelling is included in the ICM Model Build Report, included in Appendix B.

3.2 Hydraulic Model Parameters

3.2.1 2D Terrain

In InfoWorks ICM, the 2D model domain is represented using a triangular “mesh” that covers the extent of the study area. This mesh is created using topographic elevation data (DTM), with each triangle being set at a ground level equal to the average of the ground levels at each of its three corners. Discussion on the available DTM used in the study is included in Section 4 of the ICM Model Build Report. The mesh can be made more detailed by adjusting the size of the triangles comprising the mesh. Section 3.4.2 provides more details of the grid sizes used.

Further definition can be added to areas within the mesh by lowering or raising of levels as required, for instance to lower small ditch channels to more accurately model the channelling effect along a ditch. Figure 3-1 illustrates an example of the 2D mesh area with more detailed triangles along a small drainage ditch.

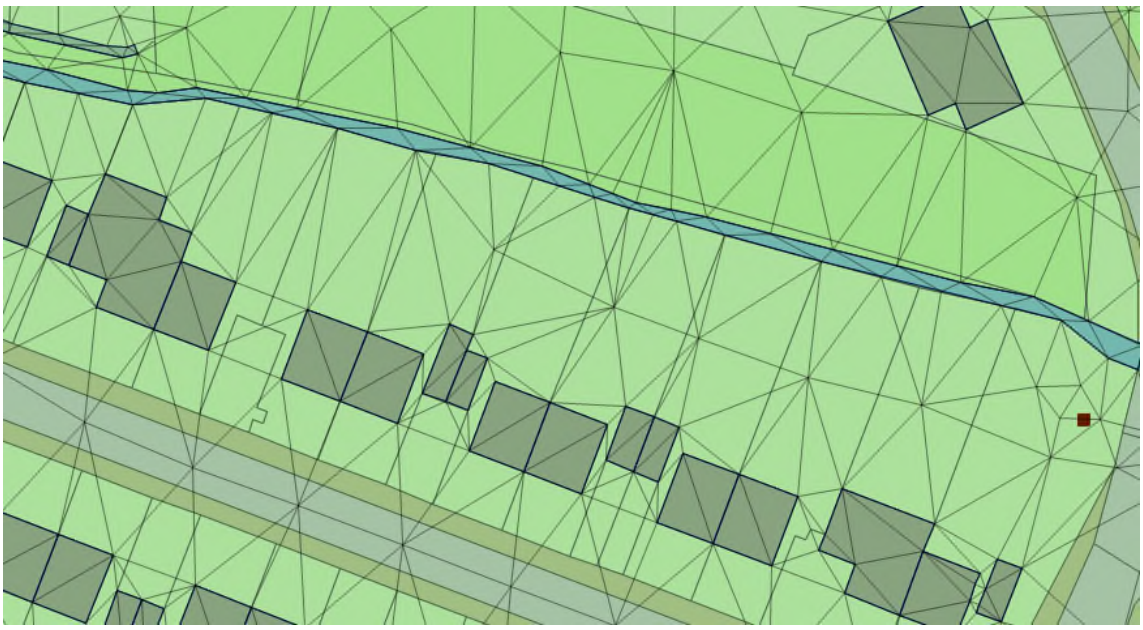

Figure 3-1 2D Mesh Representation © Crown Copyright and database right 2013. All rights reserved. Ordnance Survey licence number 100026380

3.2.2 Roughness

Roughness polygons were used in ICM to represent the varying surface types within the 2D area. OS MasterMap data was used to identify the different land use types. The Manning's n roughness values applied are summarised in the ICM Model Build Report in Appendix B.

3.2.3 Representation of Buildings

The only available underlying DTM for Oswestry includes 5m high building footprints stamped onto the surface. These raised buildings force runoff to flow around the building, representing a more realistic routing of surface water flows although it can result in over estimation of flood levels if water becomes trapped between buildings. The DTM supplied is the same data set used to create the Environment Agency Flood Map for Surface Water (FMfSW).

3.2.4 Representation of Roads

MasterMap data was used to extract all roads within the study area. This separate road polygon dataset was stamped onto the underlying DTM with a 100mm drop applied. The 100mm height difference is designed to represent the kerb level allowing flow to run along the lower road network before spilling over the kerb and affecting other areas. This represents a more realistic routing of surface water flows as the original DTM is unlikely to capture the road kerb and footpath levels in sufficient level of detail.

3.3 Stage 1 - Bare Earth Model Construction

The first stage of modelling was to create a bare earth model for the study area. This model comprises a 2D model terrain mesh and incorporates the surveyed sections of open river channel on the periphery of Oswestry by lowering the mesh accordingly. The extent of the model is shown in Figure 3-2.

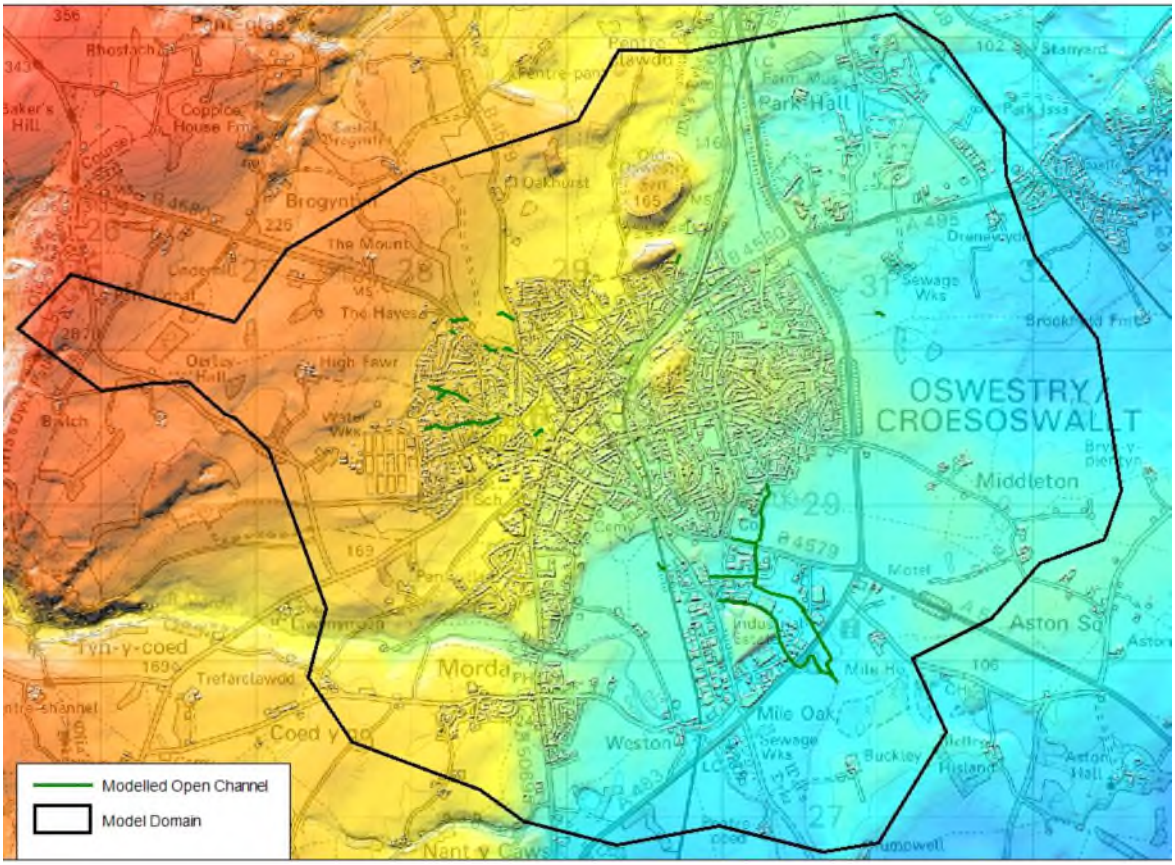

Figure 3-2 Oswestry Bare Earth Model Extent © Crown Copyright and database right 2013. All rights reserved. Ordnance Survey licence number 100026380

The Oswestry ICM model domain was initially established by drawing a buffered polygon around the urban area of Oswestry. The bare earth model was run with a coarse mesh to ensure that all key flow paths affecting the urban area were captured within the 2D domain.

The bare earth model results for a 0.5% AEP 120 minute storm are shown in Figure 3-3. This model output shows several areas of deep ponding on the periphery of the town with disaggregated areas of shallower flooding within the urban area. The rainfall parameters used for the pluvial modelling are further described in Section 3.3.1.

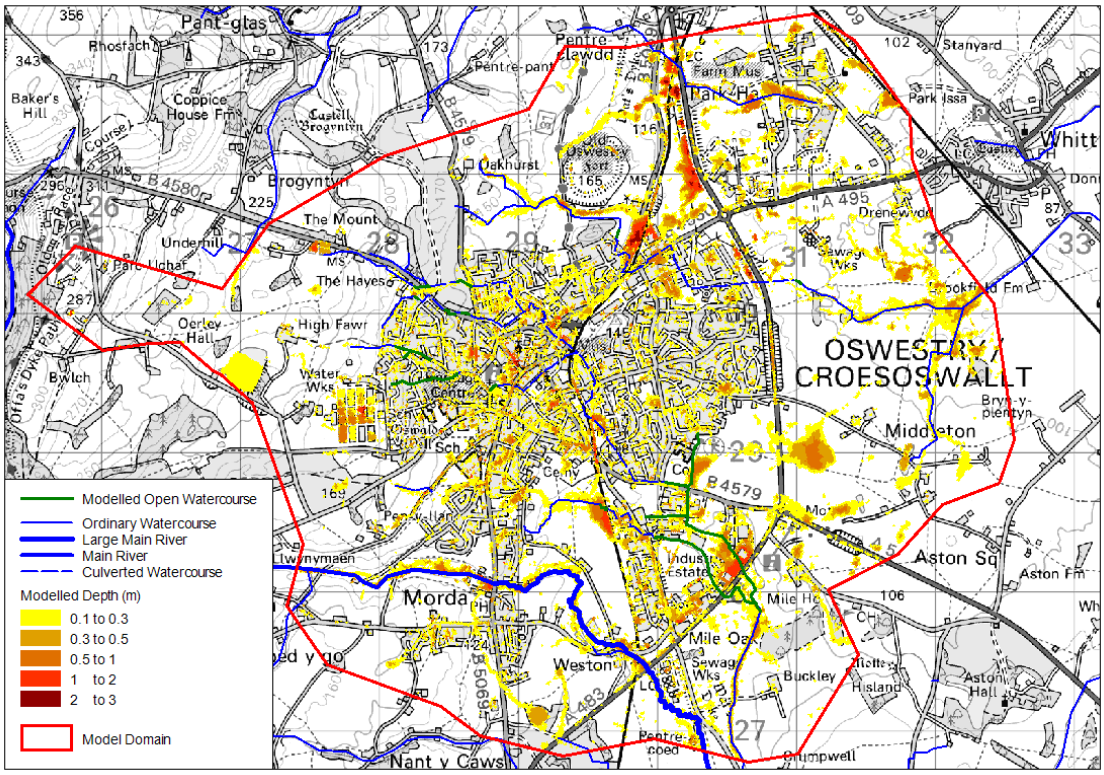

Figure 3-3 Bare Earth and River Model Results for 0.5% AEP storm

3.3.1 Hydrological Analysis

A Depth Duration Frequency (DDF) rainfall, derived from the FEH CD-ROM, was applied over the model area. To avoid overestimating flow in the smaller sections of modelled open watercourse, base flows were calculated using the Revitalised Flood Hydrograph (ReFH) methodology[4].

Whilst the direct rainfall model explicitly simulates the channelling and ponding of surface water, losses to the ground through infiltration are not immediately accounted for. A scenario in which no infiltration losses are represented could be assumed to be indicative of a frozen or highly saturated catchment response. This is a conservative assumption, and represents a worst case scenario. Variable infiltration polygons are used to represent the natural infiltration of rainfall into the ground however an inherent problem in the model software resulted in the true impacts of these polygons being excluded from the analysis. It is recommended that in model simulations, as well as using improved topographical data, the software manufacturers are consulted to confirm that the issue with the infiltration polygons has been resolved.

3.3.2 Design Rainfall

Design rainfall for a variety of return periods and storm durations was generated using Depth Duration Frequency (DDF) rainfall catchment descriptors, derived from the FEH CD-ROM. These catchment descriptors are inputted directly into ICM, which automatically creates rainfall hyetographs defining point rainfall and duration which are then applied over the catchment area. Figure 3-4 illustrates the hyetograph used with the bare earth model.

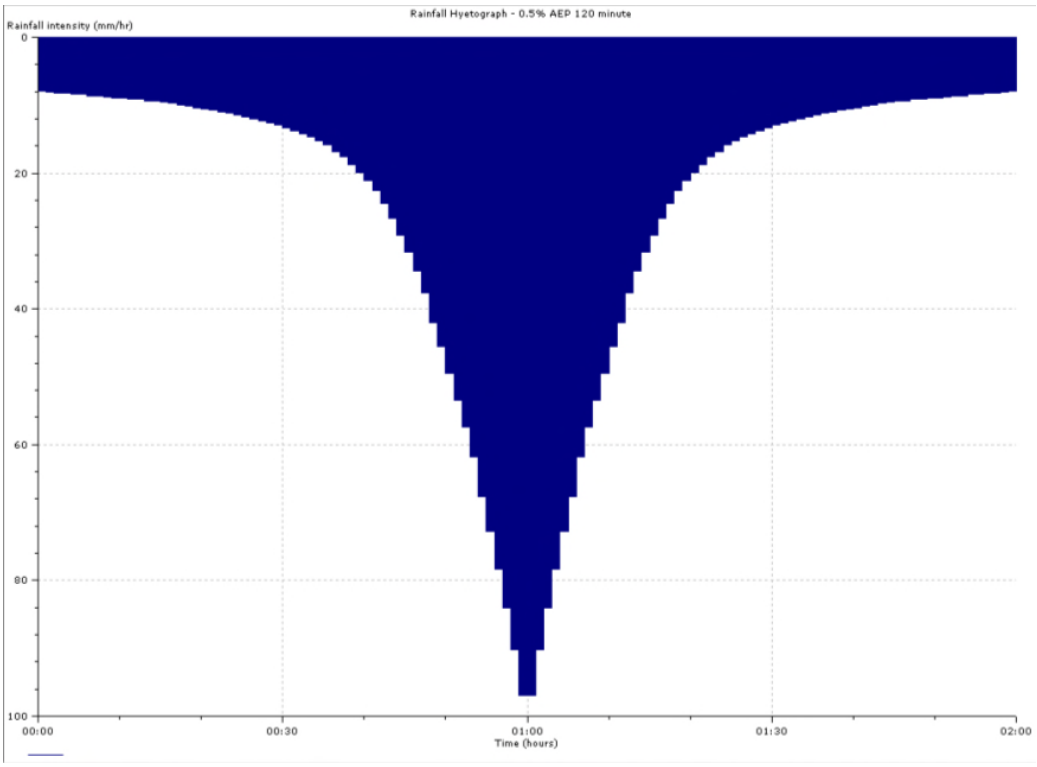

Figure 3-4 Hyetograph for 0.5% AEP 120 minute duration storm

3.4 Stage 2 – Integrated Model Development

Following construction of the bare earth model, development of the integrated model was undertaken. This model incorporates the 2D surface and open sections of watercourse with the underground drainage network.

3.4.1 Underground Drainage Network

Severn Trent Water (STWL) provided their verified Mile Oak WwTW InfoWorks CS model for use in the SWMP. The model represents the existing sewer network in Oswestry, including combined, foul and storm water sewers, as well as ancillary assets such as outfalls and pumping stations.

The Oswestry network is comprised of both combined and separate sewerage systems, illustrated in Figure 3-5, with the combined system predominantly located in the older town centre. The newer portions of the town to the east and west are served by predominantly separate systems.

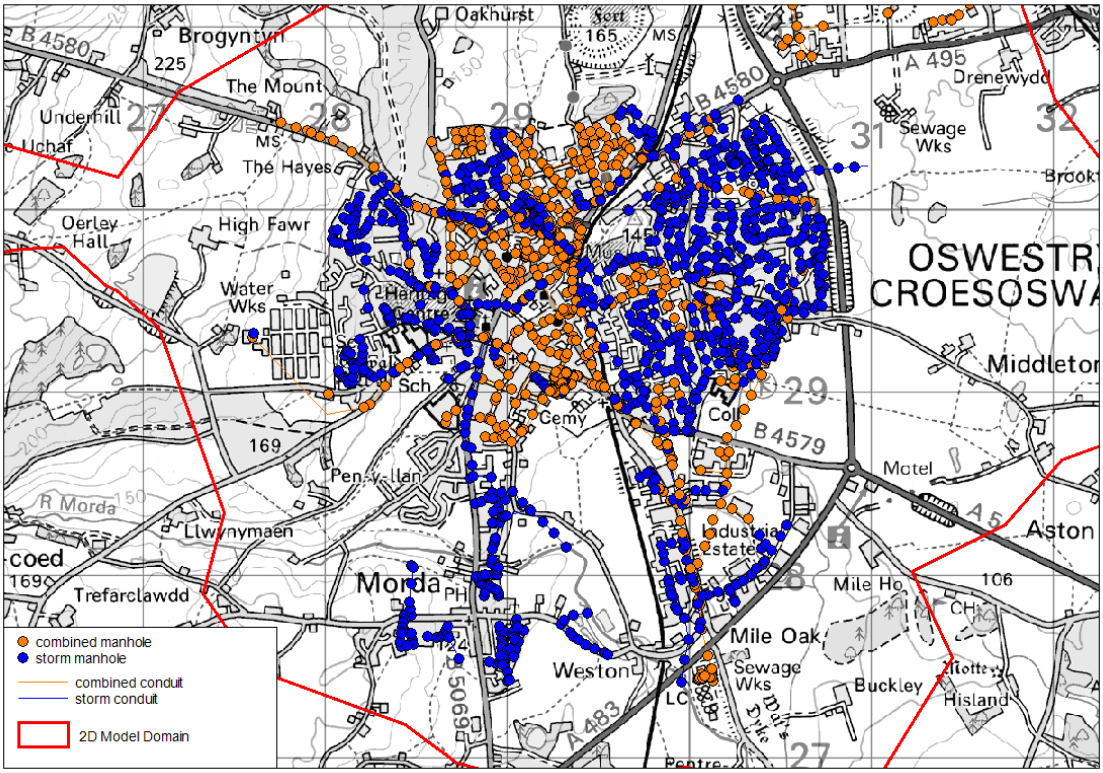

Figure 3-5 Combined and Storm Sewer Network

A CCTV survey of the key areas of the sewer network was undertaken by IETG in January 2013 as part of this SWMP work. This information was used to spot check the STWL modelled network and to report any pipe condition issues to Shropshire Council and STWL (see Section 7.2).

3.4.2 Model Parameters

A summary of the key model parameters are outlined in Table 3-1.

Model Parameter	Value
Grid Size	25 m^2 – 100 m^2
Time Step	10 seconds
Storm Duration	30, 60, 120, 240, 480, 960 minutes
Return Periods	5%, 3.33%, 2.5%, 1% and 0.5% AEP

Table 3-1 Model Parameters

The 2D model grid was set up with a maximum triangle size of 100 m^2 and a minimum of 25 m^2 to provide a sufficiently detailed grid to pick up key flow routes through the study area.

The total simulation time was longer than the duration of the storm to allow for an accurate assessment of flow paths following a storm event. The critical storm duration was found to be 120 minutes for Oswestry. The critical duration was determined by the storm duration which resulted in the maximum number of wet cells during the 1% and 0.5% AEP events. The shorter duration events particularly in the larger return periods resulted in large volumes of water trying to enter the pipe network in a short space of time. This overwhelmed the system resulting in a larger modelled flood extent.

3.4.3 Summary of Modelling Assumptions and Limitations

- The 2D domain is based on the FMfSW DTM which is a composite of LiDAR and SAR data. The SAR data is up to 2m different to actual ground levels and consequently this has had a significant impact on the conclusions of the modelling study.
- Roads and buildings have been defined using MasterMap data. A 5m stub for each building was present in the FMfSW DTM and roads have been lowered by a nominal 100mm.
- FEH derived rainfall was applied across the catchment. Base flows were added to watercourses.
- Problems inherent in the modelling software have resulted in a conservative approach to infiltration losses.
- The pipe network is based on the InfoWorks model supplied by STWL.
- River channels are based on survey data collected as part of this SWMP

3.5 Model Validation

3.5.1 Modelled Flood Locations with Supporting Historic Events

Table 3-2 discusses the model results with reference to incidents recorded in the flood incident register compiled as part of the Scoping and Intermediate Report. In general, the model results are consistent with the reported incidents suggesting that drains in areas where water naturally collects due to the topography may be more susceptible to blockage and / or inundation during storm events.

Wetspot	Model Results	Historic Events
OSWS9	Flooding is predicted on Willow Street and New Street during the 0.5% AEP event. Limited flooding is predicted during higher frequency events.	Cluster of incidents relating to blocked drains on New Street. Surface water runoff on Willow Street
OSWS8	Flooding is predicted behind properties on Stewart Road, Victoria Road and Weston Avenue in the 0.5% AEP event. There is also ponding predicted at the junction of Victoria and Salop Road in the same event. Limited flooding is predicted during higher frequency events.	Surface water runoff reported on Victoria Road, Victoria Fields, West Street, Roft Street and Ferrers Road as a result of localised drain blockage.
OSWS5	Ponding flow is predicted at the back of properties on the western side of Park Avenue in the 5% AEP event. Flooding is predicted on Brynhafod Road/Welsh Walls in the 3.33% AEP event. A majority of the predicted flooding even in the 0.5% AEP event remains in the road carriageways.	Cluster of drain blockages on Brynhafod Road and Welsh Walls leading to localised surface water flooding. One reported incident of foul flooding on Oswald's Well Lane.

Wetspot	Model Results	Historic Events
OSWS15	Flooding is predicted on Whittington Road in the 0.5% AEP event. Ponding flow in industrial area to north of Whittington Road in the lower frequency events. Limited flooding is predicted during higher frequency events.	Drain blockage reports on Unicorn Road and New Park Road.
OSWS12	Flooding is predicted on Swan Lane, Old Fort Road, Woodside Primary School and Gatacre Road allotments in the 5% AEP event.	Drain blockages reported on Beatrice Street, Gobowen Road, Gate Street and Gatacre Avenue.
OSWS4	Flooding is predicted to the rear of properties on York Street and Oakhurst Road/Liverpool Road West in the 5% AEP event. Extensive road carriageway flooding in the lower frequency events throughout this wetspot.	Cluster of surface water flooding incidents on Oakhurst Road.
OSWS13	Deep area of ponding in the open area of land resulting in flooding to Gobowen Road and Guinevere Close in the 5% AEP event. More extensive road flooding in lower frequency events on Gobowen Road, Guinevere Close and Jasmine Gardens.	No reported incidents.
OSWS20	Flooding on Weston Road is predicted in 5% AEP event.	Cluster of drain blockages on Weston Road between Weston Cotton Farm and Weston Farm.
OSWS14	Shallow flooding predicted to the rear of properties on Monkmoor Road and on the carriageway at Malory Road in the 5% AEP event.	Eight widespread reports of drain blockages within this wetspot.
OSWS10	Shallow flooding predicted in the road carriageway on Shrewsbury Road, Greystones Way, Middleton Road and Brookhouse Road in the 5% AEP event.	Drain blockages reported on Shrewsbury Road, Greystone Way, Chestnut Avenue, Brookhouse Road and Powis Avenue.
OSWS18	Shallow patches of flooding to the rear of properties on Holly Green, Hawthorne Grove and Hazel Grove in the 5% AEP event.	Cluster of drain blockage incidents on Holly Green and a highway flooding report at the junction of Hazel Road/College Road.
OSW1	Flooding is predicted on Brynhafod Road during events equal to or greater than the 3.3% AEP	Line of recorded incidents due to blocked drains along Brynhafod Road Flooding in gardens behind Hampton Rise due to blocked inlet
OSWS16	Limited flooding is predicted during all frequency events.	Three reported incidents – two drain blockages at Henley Drive and Blenheim Drive and highway flooding at Cabin Lane near Balmoral Drive.
OSWS21	Flooding predicted on Glentworth Avenue in the 5% AEP event.	Two reported incidents – one drain blockage on Weston Lane and one unspecified flood incident.

Wetspot	Model Results	Historic Events
OSWS6	Flooding predicted at the junction of Weston Lane and Morda Road in the 5% AEP event.	Two clusters of drain blockage incidents – one at the junction of Weston Avenue and Weston Lane and the second on Weston Lane at the cricket ground.
OSWS22	Flooding predicted on Trefonen Road, Cae Onan and in Milars Field in the 5% AEP event.	Two flood reports at properties adjacent to Trefonen Road.
OSWS11	Deep areas of flooding predicted to the rear of properties between Oswald Road and Orchard Street and at the end of Albert Road in the 5% AEP event.	There are 17 reported flood incidents in this wetspot. There is a cluster of drain blockage incidents on Orchard Street and Prince Street.
OSWS3	Flooding predicted on Watkin Drive in the 5% AEP event. Limited flooding is predicted during all frequency events.	Two drain blockage reports – one on Bentley Drive and one on Trefonen Road.
OSWS7	Flooding predicted to the rear of properties on Croeswylan Crescent adjacent to the playing fields and flooding to the road carriageway on Croeswylan Lane.	No reported incidents.
OSWS17	Limited flooding is predicted during all frequency events.	No reported incidents.
OSWS19	Flooding predicted adjacent Radfords Field, Maesbury Road and Maes-y-Clawdd in the 5% AEP event.	Two reported drain blockage incidents- one on Maesbury Road and Maes-y-Clawdd.
OSWS2	Limited flooding is predicted during all frequency events.	No reported incidents.

Table 3-2 Modelled Flood Locations with Supporting Historic Events

3.5.2 Modelled Flood Locations without Supporting Historic Events

As part of the validation process areas which are predicted to flood more significantly by the model but for which there are no reported incidents have also been noted and are listed in Table 3-3 below.

Location	Wetspot	Comment
Jasmine Gardens / Gobowen Road:	OSWS13	The DTM is causing significant ponding against the road embankment. Flooding is predicted in open land therefore less likely that any flooding would be reported.
Oswestry School / Croeswylan Crescent	OSWS7	Water is ponding against building stubs which are included in the FMfSW DTM. This is giving an unrealistic representation of flooding in the model.
Albert Road	OSWS11	Water is ponding in the road carriageway

Location	Wetspot	Comment
Between the railway line and Plas Ffynon Way	OSWS10	Flood water is trapped by the embankments in DTM which results in significant flooding. Additional drainage pathways may exist in reality.

Table 3-3 Modelled Flood Locations without Supporting Historic Events

3.5.3 Flood Map for Surface Water

The modelled outputs were compared against the Flood Map for Surface Water (FMfSW). Results from both the FMfSW and the ICM modelling identified key overland flow pathways in Oswestry. In general, more flooding is predicted by the FMfSW than by the ICM model. This is to be expected given the level of additional detail included in the ICM model in terms of subsurface piped drainage flow routes.

3.6 Sensitivity Testing

A number of sensitivity tests have been carried out to assess how the model responds to changes in the following parameters:

- Urban creep
- Siltation
- Climate change
- River levels at sewer outfalls

Further discussion on the results of these tests is provided in Section 4.5.1 and Section 4.6.

4 Phase 2 Detailed Risk Assessment: Quantification of Flood Risk

Risk Assessment Phase; Quantify current and future flood risk

4.1 Critical Infrastructure

A critical infrastructure database for Shropshire Council is not currently available. In future, when this information does become available, Shropshire Council should assess the flood risk to each item of critical infrastructure using the outputs from this SWMP.

4.2 Proposed Development Areas

The SWMP guidance requires that the detailed assessment should demonstrate an understanding of where new development or regeneration can contribute to reducing existing surface water flooding. Proposed development areas have been supplied for the study and used to inform an outline assessment of the impacts of urban creep (Section 4.6). The impact of new development on flood risk and the flood risk posed to new development is reviewed and discussed further in Section 8.2.4.

4.3 Selection of Wetspots for Further Analysis

The Scoping and Intermediate report recommended that further investigations were required prior to discounting any wetspots from further analysis. Additional survey data has been collected for the ordinary watercourses and selected culverts within Oswestry. In using this to inform a more detailed and updated model, 14 wetspots have been selected for further analysis. The top ten ranked wetspots were reviewed and it was found that the reduction in flood risk predicted by the integrated model was consistent across all wetspots. Consequently no change in priority was deemed necessary. Those wetspots outside the top ten were also reviewed and their priority altered based on integrated model results. The decision making process is described in Table 4-1 with the prioritised wetspots highlighted in bold.

Wetspot	Location	Intermediate Priority Score	Detailed Priority Score	Recommendation
OSWS9	Town Centre	1	1	Take forward for further analysis. Top 10 priority score. Recorded incidents correlate with flooding predicted by the ICM model.
OSWS8	Victoria Road	2	2	Take forward for further analysis. Top 10 priority score.
OSWS5	Oswald's Well Lane	3	3	Take forward for further analysis. Top 10 priority score. Recorded incidents correlate with flooding predicted by the ICM model.
OSWS15	Whittington Road Works	4	4	Take forward for further analysis. Top 10 priority score.
OSWS12	Llwyn Road	5	5	Take forward for further analysis. Top 10 priority score.

Wetspot	Location	Intermediate Priority Score	Detailed Priority Score	Recommendation
OSWS4	Liverpool Road / Oakhurst Road	6	6	Take forward for further analysis. Top 10 priority score. Recorded incidents correlate with flooding predicted by the ICM model.
OSWS13	Jasmine Gardens / Offa Drive	7	7	Take forward for further analysis. Top 10 priority score.
OSWS20	Weston	8	8	Take forward for further analysis. Top 10 priority score. Recorded incidents correlate with flooding predicted by the ICM model.
OSWS14	Cabin Lane / Unicorn Road	9	9	Take forward for further analysis. Top 10 priority score.
OSWS10	Chesnut Avenue	10 (=)	10 (=)	Take forward for further analysis. Top 10 priority score. Recorded incidents correlate with flooding predicted by the ICM model.
OSWS18	Hazel Grove / College Road	10 (=)	10 (=)	Take forward for further analysis. Top 10 priority score.
OSWS1	Brynhafod Lane / Hampton Road	12	12	Take forward for further analysis. Number of recorded incidents which correlate with flooding predicted by the ICM model.
OSWS16	Ascot Road	13	15	Not taken forward for further analysis. Very little flooding predicted by the ICM model.
OSWS21	Morda Bridge	14	16	Not taken forward for further analysis. The flooding predicted by the ICM model is a result of the way in which the River Morda (main river) is modelled therefore outside the scope of the SWMP.
OSWS6	Weston Avenue	15	13	Take forward for further analysis. Number of recorded incidents which correlate with flooding predicted by the ICM model.
OSWS22	Millar's Field, Morda	16	17	Not taken forward for further analysis. Low priority score.
OSWS11	Oswald Road	17	14	Take forward for further analysis. Number of recorded incidents which correlate with flooding predicted by the ICM model.
OSWS3	Upper Well Close / Trefonen Road	18	18	Not taken forward for further analysis. Very little flooding predicted by the ICM model.
OSWS7	Croes Wylan Crescent	19	19	Not taken forward for further analysis. Very little flooding predicted by the ICM model. Flooding along boundary with open land only.
OSWS17	Aston Way	20 (=)	20 (=)	Not taken forward for further analysis. Very little flooding predicted by the ICM model.

Wetspot	Location	Intermediate Priority Score	Detailed Priority Score	Recommendation
OSWS19	Mile Oak	20 (=)	20 (=)	Not taken forward for further analysis. Only significant flooding predicted by ICM model is in open area where water is trapped by the road embankment.
OSWS2	Maserfield	22	22	Not taken forward for further analysis. Very little flooding predicted by the ICM model.

Table 4-1 Selection of wetspots for further analysis

4.4 Economic Damages Assessment

An understanding of the current annualised damages due to surface water flooding

This section addresses the requirement to quantify current flood risk. This allows the costs to be compared against future options so that the economic benefits of those options can be determined.

4.4.1 Methodology

The assessment of cost associated with flood damage of properties in Oswestry has been assessed using the Defra and Environment Agency approved approach outlined in the Multi-Coloured Handbook[5]. This method for assessing damages uses depth/damage curves based on property type, age and social class of the dwellings occupants to evaluate the overall damages in a flood risk area. The methodology was developed for use in fluvial flooding and therefore this report discusses the potential problems encountered in translating the method for use in surface water flooding in Section 7.4.1.

The National Property Dataset (NPD) has been used as the basis of the damages assessment. In order to calculate flood damages at a property level, the following information is required for each property:

- A property 'type' (detached, semi-detached, terraced, flat)
- A floor area (for non-residential property)
- A property threshold

The NPD dataset used for this study does not provide the property threshold level therefore the corresponding LiDAR elevation plus 0.3m was used to determine the threshold level of each property. This excludes modelled depths at buildings that are less than 0.3m deep on the assumption that such a depth would not breach the property threshold. It is envisaged that this approach would generally avoid possible significant over estimation of flood damages at this early stage of high level economic appraisal. By applying the maximum predicted flood depth adjacent to each property (adjusted to account for threshold), the flood damages were calculated using the depth-damage curves for each individual event which then enabled calculation of the Annual Average Damages (AAD). As the threshold is unknown, a sensitivity test whereby the threshold level was set to a lower value of 0.1m above the LiDAR level was undertaken; this showed a significant impact on the flood damages and Section 7.4 discusses this in further detail.

Depending on the size or severity of each individual flood event of a given annual probability, each flood event will cause a different amount of flood damage. The AAD is the average damage per year in monetary terms that would occur at each specific address point, within the modelled domain, from flooding over a 100 year period, assuming that present-day conditions (in terms of frequency of extreme rainfall) are maintained.

In some years there may be no flood damage, in other years there will be minor damage (caused by small, relatively frequent floods) and, in a few years, there may be major flood damage caused by large, rare flood events. Estimation of the AAD provides a basis for comparing the effectiveness of different flood alleviation and management measures (i.e. through measuring the reduction in AAD).

Key Parameters

For reference, key parameters which have guided the economic assessment process, in line with Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG)[6] /Multi Coloured Manual (MCM) techniques, are repeated below:

- **Property values**: Properties were assigned a market value in order that present value damages (PVd) were 'capped' if they exceeded a property's market value over the appraisal period. These 'capping values' were derived according to Environment Agency best practice. Distributional impacts (DI) were considered in order to remove social class bias from the property value estimates. A DI factor was calculated using Approximate Social Grade (UV50) data for the former Oswestry District Council Area, available from neighbourhood.statistics.gov.uk.
- **Emergency services costs**: These were incorporated in the assessment by adding 5.6% to all calculated property damages. This is as stated in the Multi-Coloured Handbook and is based on data from the 2007 floods, a revision downwards from the previous values of approximately 10%, reflecting economies of scale of providing emergency services in urban areas during flood events.
- **Temporary accommodation costs**: These were excluded from the assessment as flood depths due to surface water flooding are generally considered below the level at which temporary accommodation is required.

The following section highlights the key assumptions made in damage assessment; specific attention should be given to these prior to using the currently published SWMP economic assessment outputs.

Key Assumptions

Assumption 1 – Property thresholds across the study catchment are 0.3m and no flooding of properties will occur below this 0.3m threshold. Due to the number of properties across the study area it is not possible to determine threshold levels for each property therefore an assumption of a 0.3m threshold at all properties has been made. Furthermore it has been assumed that no damage occurs to property when the flood level at the property is between 0 - 0.3m (below the threshold). It is possible that flood water can still enter properties below the threshold level via airbricks but this is not considered in this damages appraisal to ensure a robust assessment.

Assumption 2 – Damage to property does not occur at return periods lower than 5% AEP. The lowest return period modelled was the 5% AEP storm event. Whilst it is possible within the flood damages equations to interpolate flood damages for return periods below the lowest return period modelled, these damages are not based on any modelled outputs. As such it is assumed that no damages occur to property within the study area at flood events lower than the

5% AEP event to ensure a robust assessment, given the limitations of the level data available for this study.

Assumption 3 – Maximum depth extracted from model results is representative of flood depth at properties. The worst case depth is currently used in the economic analysis by capturing the maximum depth of flooding at each property. However in some cases the maximum depth extracted may have been exaggerated by anomalies in the underlying LiDAR, more noticeable in the DTM supplied for Oswestry. This can lead to an overestimation in the level of damages recorded at a property.

Assumption 4 – Raw modelled outputs have been used to calculate flooding at properties. The modelled outputs have not been post-processed to remove small isolated patches of flooding. This may result in properties being identified as flooded when in reality the model is ponding in an anomalous low spot in the underlying LiDAR. The Environment Agency's current surface water mapping was processed to remove such small flooded areas. However, it should be noted that the Environment Agency mapping was carried out on a coarser scale ground terrain than the detailed surface water modelling described in this report.

Key Exclusions

The following key items were excluded from the assessment:

- **Risk to life**: whilst all flooding poses a risk to life, it can be argued that the nature of the widespread surface water flooding such as is assessed in this study limits maximum depths and velocities such that overall risk to life is low. Furthermore, its calculation for a large study area would require appraisal time that would be disproportionate to the scale of benefits expected.
- **Transport disruption**: flooding in a populated urban area has the potential for significant impact of transport networks, which can add to the economic impact of flooding. Although surface water flooding is frequently associated with transport disruption, it is not practical to assess, on the scale of this study, the sort of alternative routes and diversions required. Since these are unlikely to result in significant benefits in comparison to property damages, it is recommended that assessment of this is postponed until further appraisal stages of the potential schemes.
- **Environmental benefits**: no accounting has been made for the potential environmental/amenity improvements associated with any of the proposed options.
- **Health and social benefits**: these perceived benefits attributable to undertaking flood prevention works and increasing health and well-being were not included. This view was taken because it was considered unlikely that the local population would necessarily perceive any significant such benefit by avoiding/mitigating a form of flooding which does not result in a noticeable flood pathway or a great depth of flooding and disruption (as would be the case for river or sea flooding).

The methodology described above was used to assess the damages for the 'Do Nothing', 'Do Minimum' and 'Do Something' scenarios.

4.5 Results

4.5.1 Do Nothing Scenario

A 'Do Nothing' scenario was developed in discussion with STWL and Shropshire Council. Severn Trent has planned maintenance programmes which target limited resources to the highest risk areas. These high risk areas are identified based on historic information as well as

predictive modelling. The surface water sewer system in Oswestry is not considered high risk for the following reasons:

- Surface water sewers carry fewer solids than foul and combined sewers and are therefore less likely to silt up or block; consequently they generally require less maintenance.
- The Oswestry catchment does not suffer from a high number of blockages or collapses
- Oswestry is not highlighted as a high risk area based on predictive modelling

Therefore, although STWL have a duty to maintain the surface water network in Oswestry, it is unrealistic to assume that no deterioration will occur and consequently this has been taken into account in the 'Do Nothing' model.

Guidance on modelling the accumulation of silt was provided by STWL and this was used in combination with data from the CCTV survey. Note that the CCTV survey covered approximately 10% of all the modelled sewers and thus represents a small sub-set of the entire sewer network. The 'Do Nothing' scenario is comprised of the following elements:

- Blockages and known siltation build up from the CCTV survey was applied to the model
- Guidance supplied by STWL used to add increased roughness to pipes where velocities are less than 0.75m/s
- Increased roughness applied to all open channel sections within the model to represent reduced maintenance / channel clearing.

4.5.2 Do Minimum Scenario

The 'Do Minimum' scenario was modelled as the existing situation with all elements of the pipe network running clear. Although at present the CCTV data indicates that the 'Do Minimum' scenario is proving insufficient to maintain the network in a completely clean state, the 'Do Minimum' in this case represents a suitable scenario for comparison with 'Do Nothing whilst not overestimating flood damages for the economic assessment purpose.

Table 4-2 summarises the present value damages (PVd) for the 14 wetspots taken forward in this study.

Wetspot	Location	Final Priority Score	Total Damages (Do Nothing)	Total Damages (Do Minimum)
OSWS9	Town Centre	1	£1,821,000	£1,328,000
OSWS8	Victoria Road	2	£507,000	£387,000
OSWS5	Oswald's Well Lane	3	£507,000	£489,000
OSWS15	Whittington Road Works	4	£916,000	£841,000
OSWS12	Llwyn Road	5	£1,269,000	£1,172,000
OSWS4	Liverpool Road / Oakhurst Road	6	£1,117,000	£985,000
OSWS13	Jasmine Gardens / Offa Drive	7	£733,000	£726,000
OSWS20	Weston	8	£789,000	£789,000
OSWS14	Cabin Lane / Unicorn Road	9	£11,000	£11,000
OSWS10	Chesnut Avenue	10	£82,000	£37,000
OSWS18	Hazel Grove / College Road	10	£9,000	£9,000
OSWS1	Brynhafod Lane / Hampton Road	12	£911,000	£909,000
OSWS6	Weston Avenue	15	£1,046,000	£1,046,000
OSWS11	Oswald Road	17	£12,002,000	£11,849,000

Table 4-2 Wetspot Present Value damages

4.6 Rural Runoff

Consultation with Severn Trent Water highlighted the requirement to make an outline assessment of the vulnerability of the surface water sewer system to runoff from rural fringes. Results from the 'Do Minimum' model were used to identify key locations where this mechanism is predicted to occur. Overall, the results of this review found that for the 5% AEP and 3.33 % AEP, the surface water systems have sufficient capacity to accept the runoff and pass it along the system. Although the surface water system is 'at capacity' in the majority of locations reviewed, the manhole chambers have not yet been overwhelmed so the water stays within the system. Key locations of interest are discussed in detail below.

4.6.1 High Fawr

Runoff from the fields at High Fawr flows eastwards, and on reaching the urban area the flow is channelled along the road network. Where there is sufficient capacity within the surface water sewer network the surface water flow passes into the surface water system. Figure 4-1 illustrates the velocity outputs for the 5% AEP Do Minimum modelled event and clearly highlights the flow paths across the rural area.

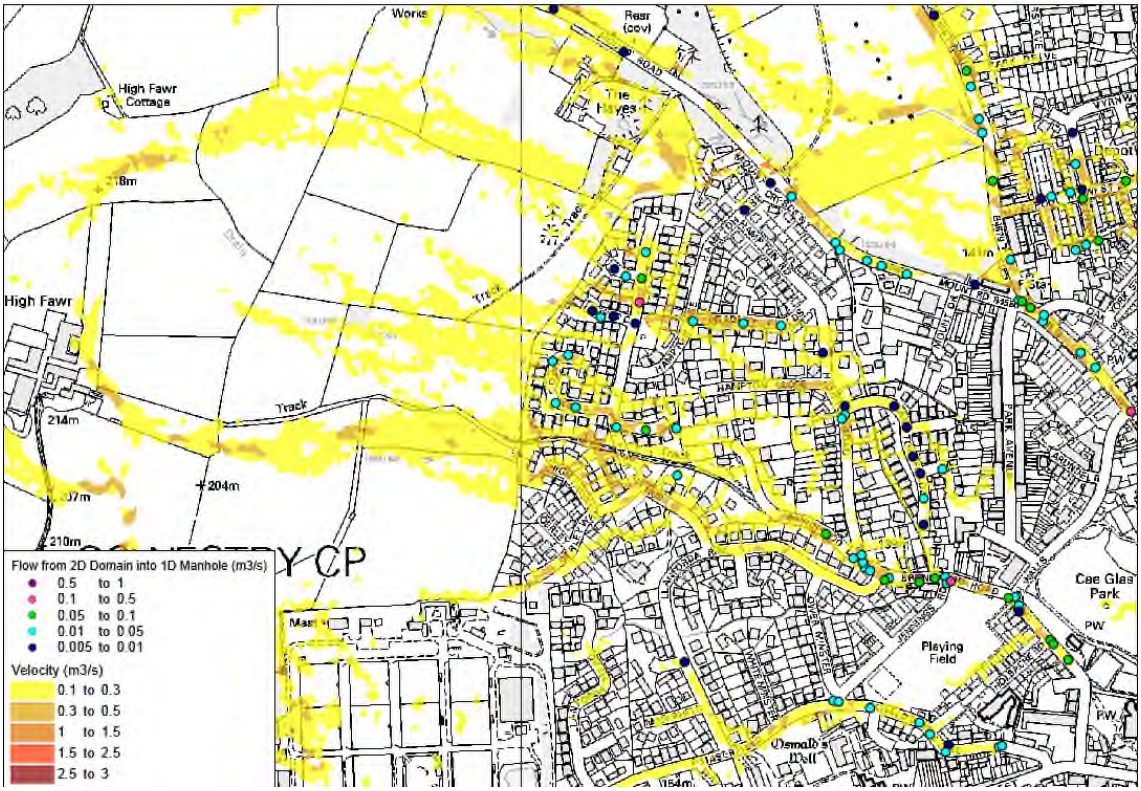

Figure 4-1 5% AEP Flow Pathways from High Fawr

Figure 4-2 shows where the piped network is at capacity in the 5% AEP modelled event. There are only a few locations where the water is leaving the surface water system via the manholes; in general this is less than 0.1m³/s with the remainder in the sections of network highlighted as at capacity staying within in the piped network. When comparing the results of the 5% AEP and 3.33% AEP, around an additional 1% of the network in this area is surcharged in the 3.33% AEP. There is a minimal difference in predicted flood extents between the two scenarios.

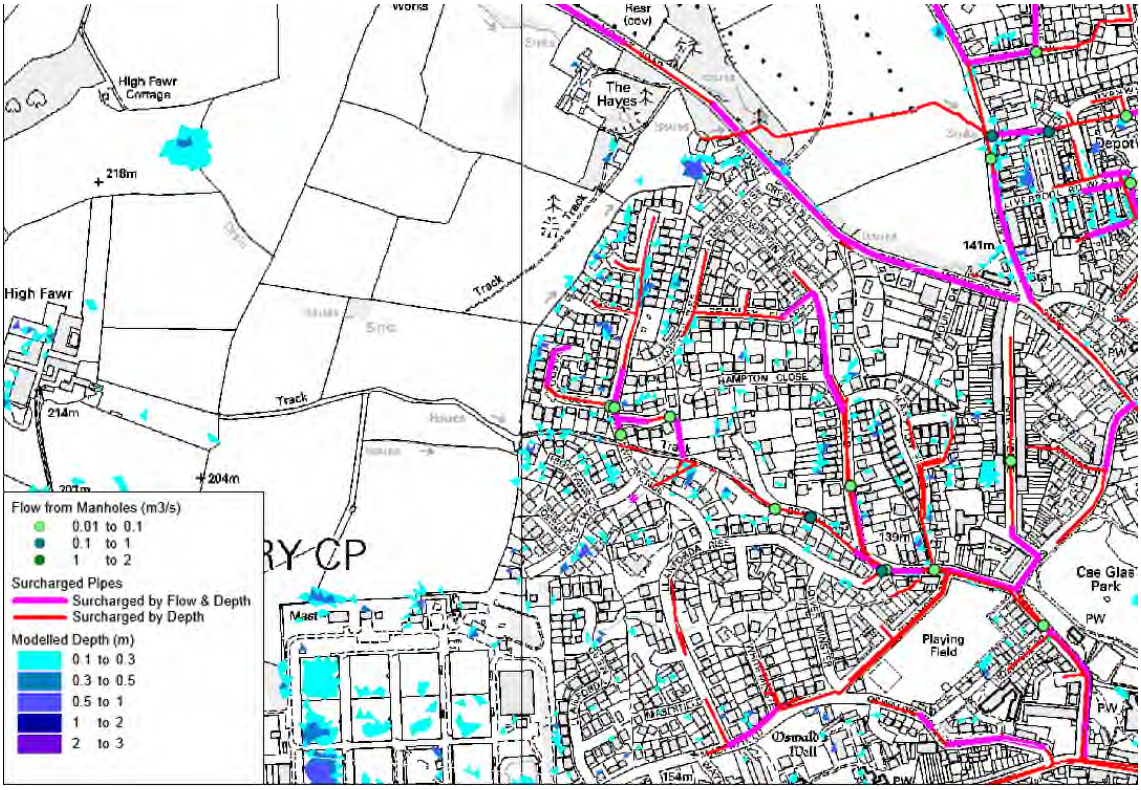

Figure 4-2 High Fawr 5% AEP flood depth and surface water network surcharge

4.6.2 Mount Road and Oakhurst Road

Runoff occurs from open areas of land adjacent to Mount Road and Oakhurst Road. Figure 4-3 illustrates the velocity outputs for the 5% AEP Do Minimum modelled event and clearly highlights the flow paths across the rural area.

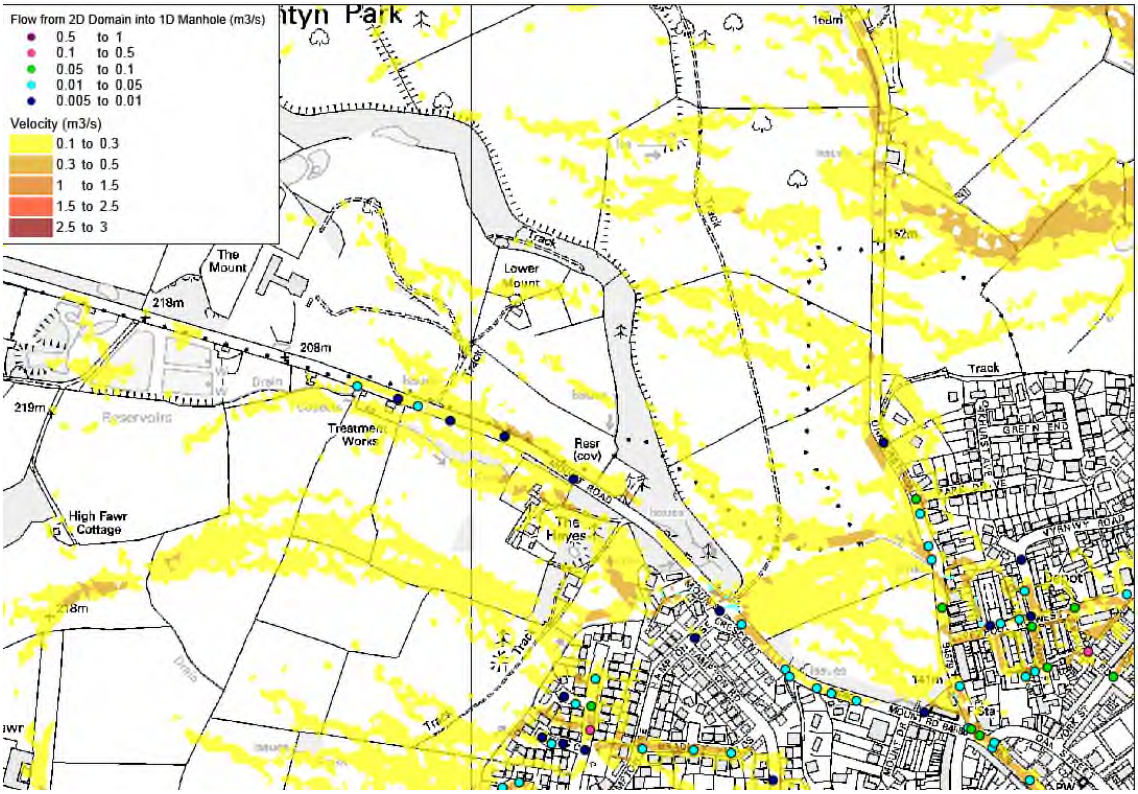

Figure 4-3 5% AEP Flow Pathways towards Mount Road and Oakhurst Road

Figure 4-4 shows that the majority of the network along both Mount Road and Oakhurst Road is at capacity although there is very little flow out of the system in the 5% AEP event. This is reflected by the model results which show no increase in network surcharge by flow and depth for the 3.33% AEP compared to the 5% AEP.

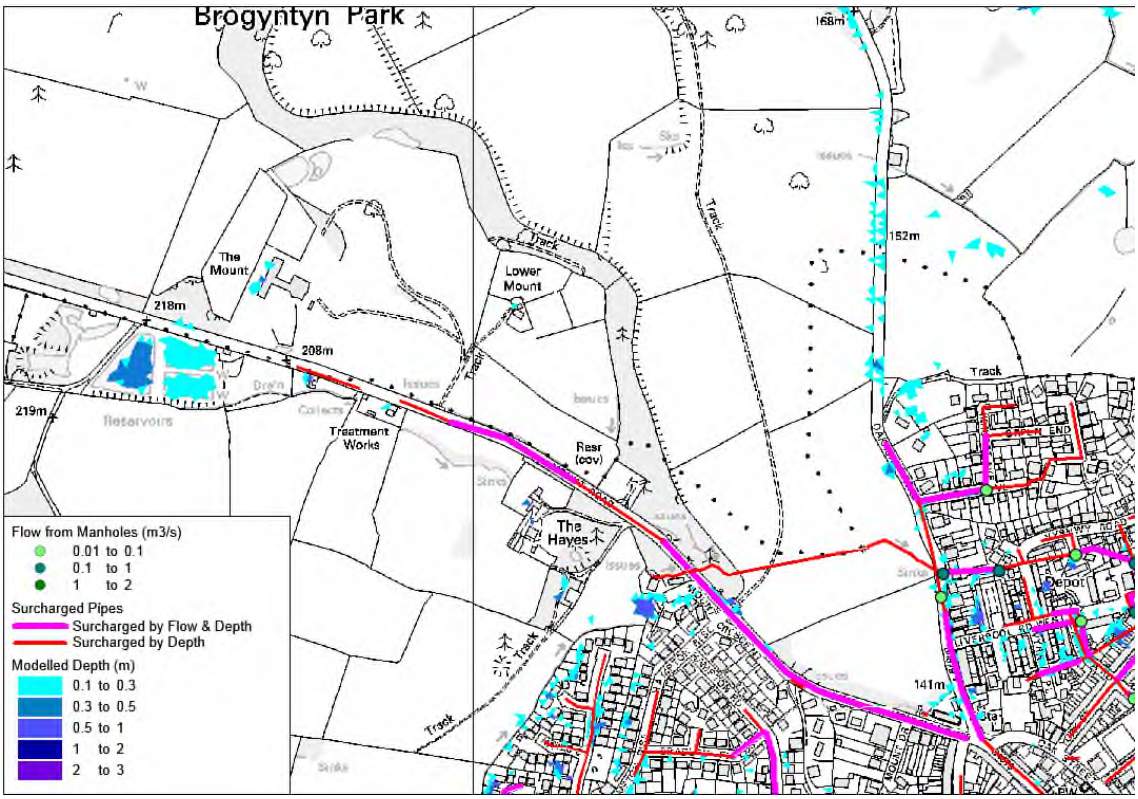

Figure 4-4 Mount Road / Oakhurst Road 5% AEP Flood Depth and Surface Water Network Surcharge

4.6.3 Morda Road

Runoff occurs from the open area between Trefonen Road and Penylan Lane and flows towards Morda Road. Figure 4-5 illustrates the velocity outputs for the 5% AEP Do Minimum modelled event and clearly highlights the flow paths from this open area.

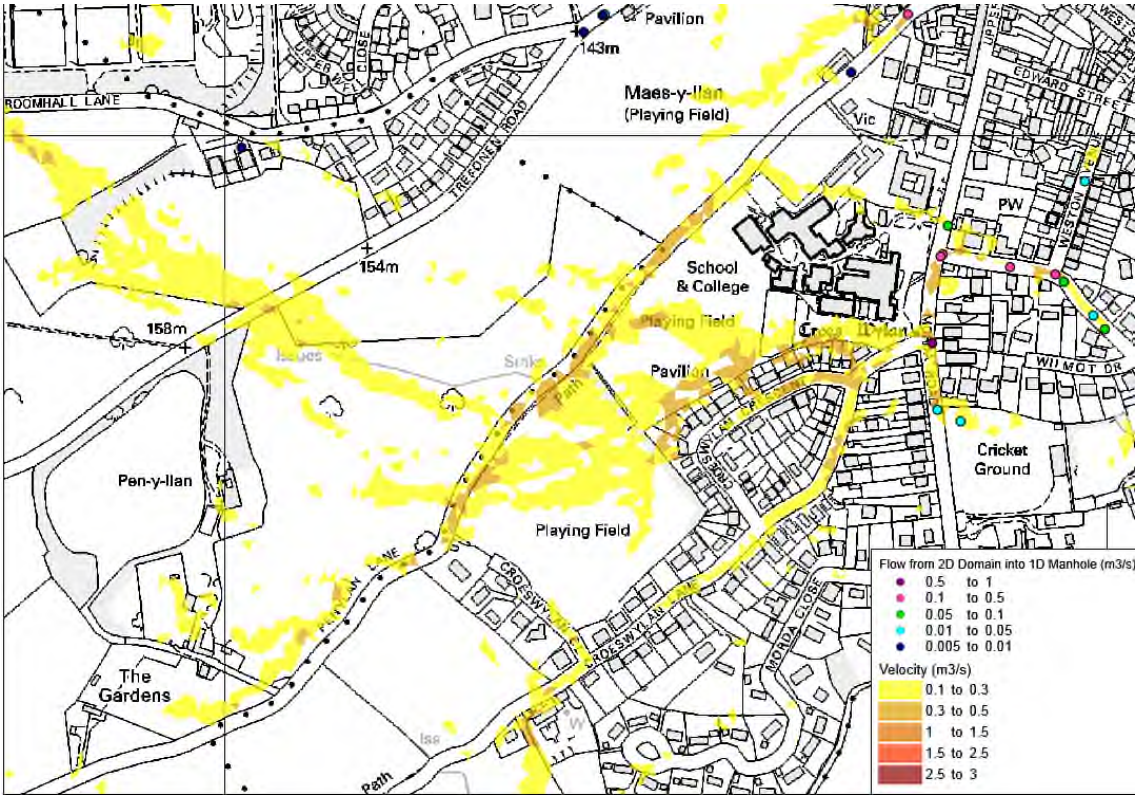

Figure 4-5 5% AEP Flow Pathways From Trefonen Road / Penylan Lane

Figure 4-6 highlights that although several sections of the surface water network are at capacity; however in a 5% AEP event flow is remaining in the network. This is reflected by the model results which show no increase in network surcharge by flow and depth for the 3.33% AEP compared to the 5% AEP.

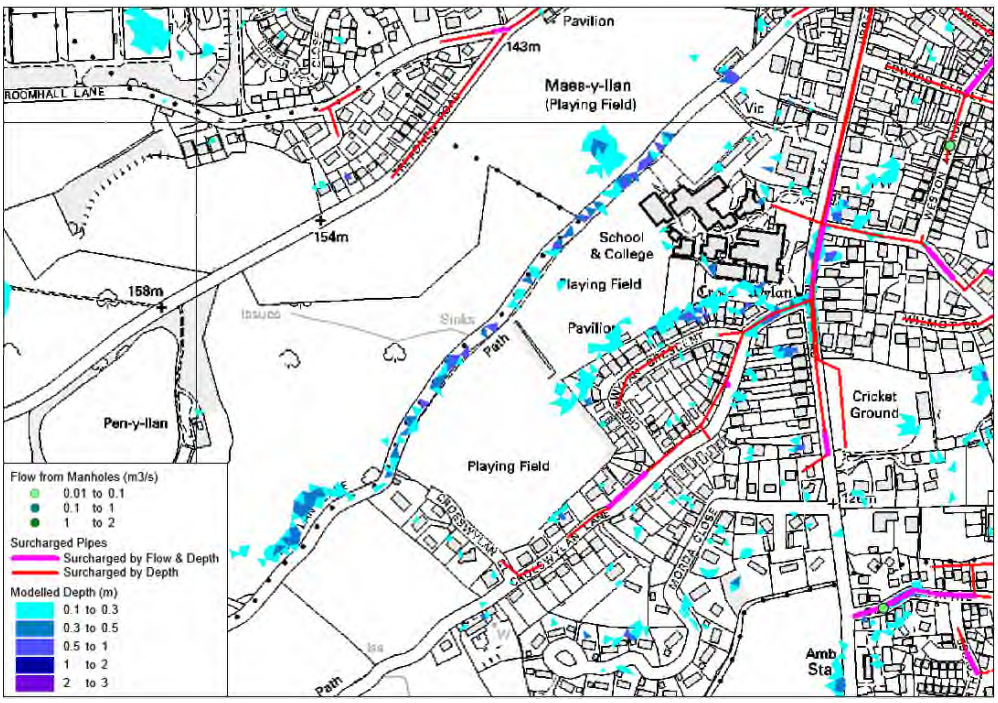

Figure 4-6 Morda Road 5% AEP Flood Depth and Surface Water Network Surcharge

4.6.4 Town Centre

Runoff occurs from Brogyntyn Park and onto Oakhurst Road before flowing through the urban area towards the town centre. Model results show that surface water flows enter the surface water network in a number of locations. Figure 4-7 illustrates the velocity outputs for the 5% AEP Do Minimum modelled event and clearly highlights the flow paths across from rural area towards the town.

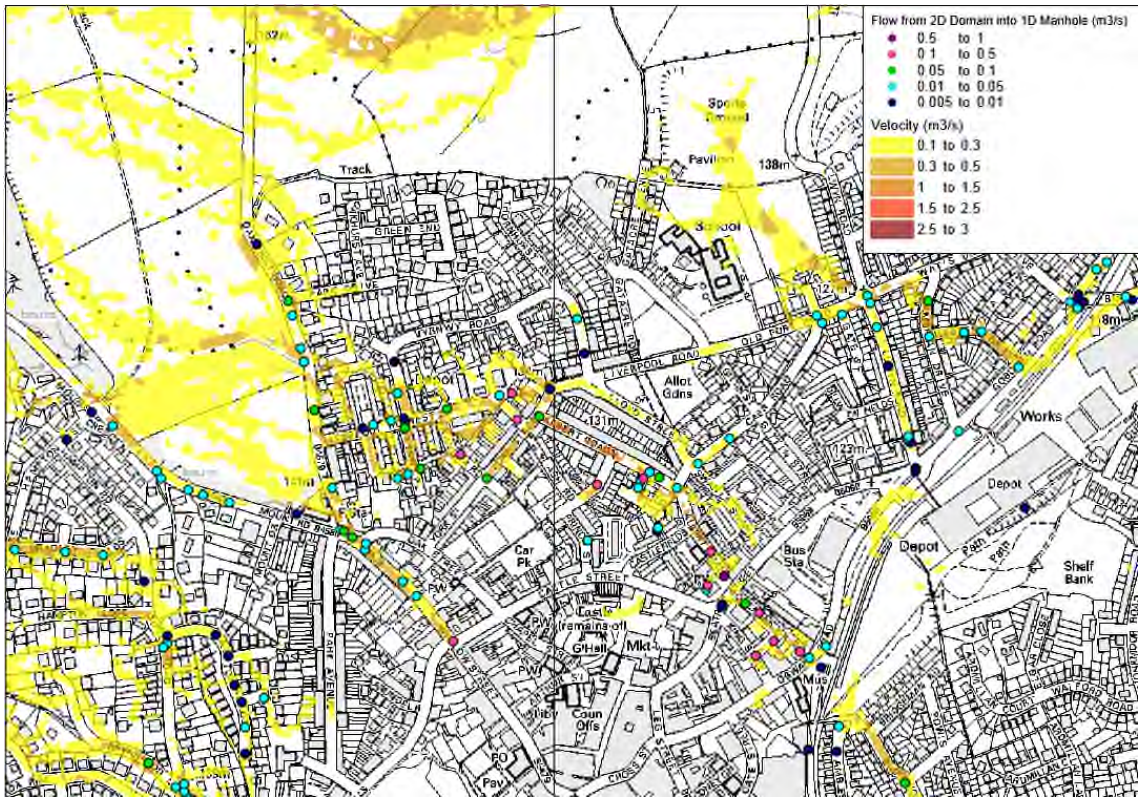

Figure 4-7 5% AEP Flow Pathways from Brogyntyn Park towards the Town Centre

Figure 4-8 illustrates that large sections of the network in this location are shown to be surcharged in the 5% AEP event. In addition, there are a number of model nodes which pass flow from the surface water system to the surrounding area. However, the underlying issues with the DTM in Brogyntyn Park should be born in mind in this location. Model results suggest that there is an increase of around 4% in network surcharge by stage and flow in the 3.33% AEP compared to the 5% AEP.

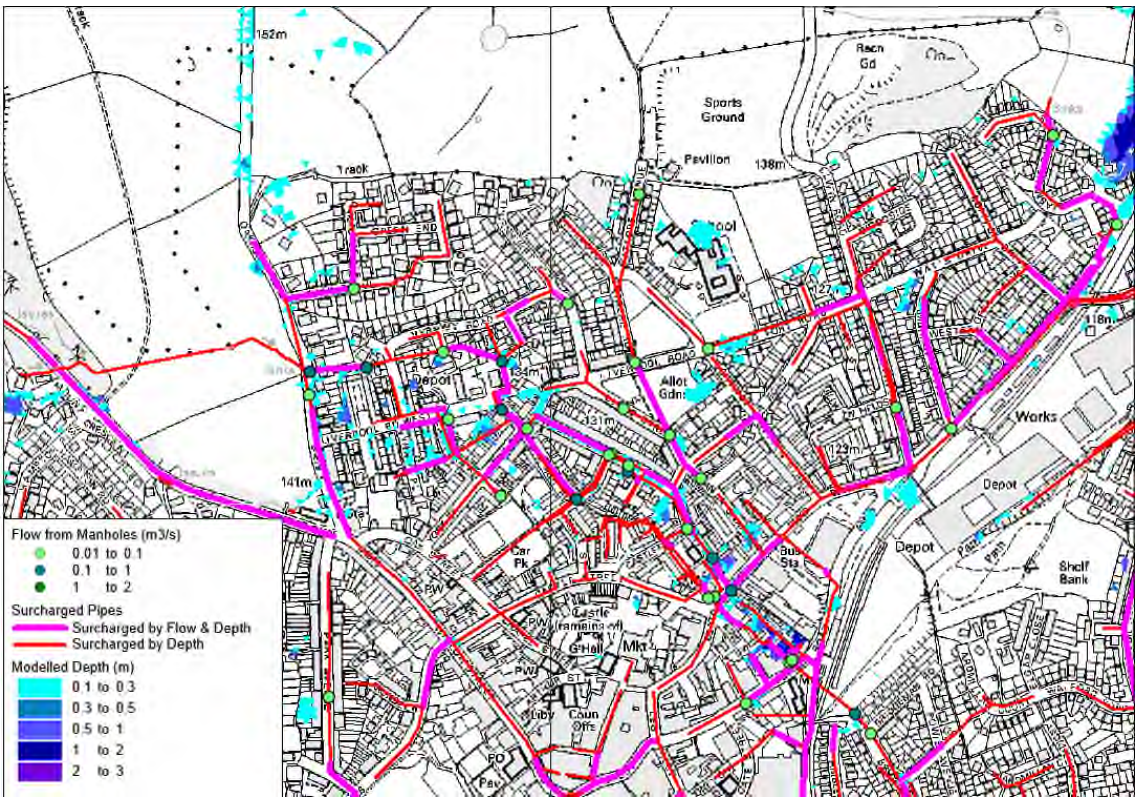

Figure 4-8 Town Centre 5% AEP Flood Depth and Surface Water Network Surcharge

4.7 Future Flood Risk

4.7.1 Scenarios

Climate Change

The ICM model has been used to assess the potential impact on surface water flood risk of increasing the 1% AEP rainfall by 20%. Based on Environment Agency guidance[7] an increase of 20% on extreme rainfall should be used for assessments beyond 2100.

Urbanisation

An assessment of future urbanisation has been applied based on the guidelines in the UK Water Industry Research (UKWIR) Impact of Urban Drainage on Sewerage Systems'[8] report. Urban creep has been applied to areas of future development identified by Shropshire Council in the Oswestry Place Plan[9]. The number of properties proposed in each area has not been explicitly specified in the Place Plan therefore an assumption has been made that there will be approximately 30 dwellings per hectare[10]. This enabled the application of 0.75m^2/house/year to each development area. Due to the relatively dense housing layout in much of Oswestry, particularly the historic areas, there is little scope for further increasing impermeability and consequently it was deemed inappropriate to increase runoff across the entire town. It is considered that identified development areas represent a more realistic pattern of development for the future. Further details are included in the Model Build Report in Appendix B.

Change in River Levels

Sensitivity to changes in river levels has been assessed by modelling the following scenario:

- Increased water levels in the receiving watercourses at all outfalls by 100% compared to the baseline level.

- Applied a 100% increase in base flows in open channels.

4.7.2 Results and Analysis

Climate Change

The increase in damages for each wetspot occurring as a result of climate change was assessed by running the model with rainfall increased by 20%. Table 4-3 summarises the increase in present value flood damage (PVd) and the increase in properties at risk for the 'Do Minimum'. Figures C1 to C4 in Appendix C illustrate the changes in flood extents and depths for the 1% AEP and 1% AEP plus climate change for both the 'Do Nothing' and the 'Do Minimum' scenarios for comparison.

Wetspot ID	Increase in Damages (£k)	Increase in Number of Residential Properties Flooded	Increase in Number of Non Residential Properties Flooded
OSWS9	£2,251	1	25
OSWS8	£724	28	6
OSWS5	£374	10	7
OSWS15	£2,350	0	1
OSWS12	£201	2	0
OSWS4	£241	10	0
OSWS13	£158	5	0
OSWS20	£277	1	0
OSWS14	£32	3	0
OSWS10	£105	8	1
OSWS18	£19	1	0
OSWS1	£72	3	0
OSWS6	£1,337	4	1
OSWS11	£445	7	1

Table 4-3 Impact of Climate Change, 'Do Minimum' scenario

The greatest increase in total damages is predicted for OSW15; this is due to the presence of two very large industrial premises which accrue the majority of the damages. In the 1% AEP flood levels barely reach the threshold level however in the 1% AEP plus climate change, flood levels are high enough to flood both properties.

In terms of increased in numbers of properties flooded, OSWS9 has the highest increase in non-residential properties flooded as it covers the town centre. OSWS8 has the highest increase in residential properties flooded as a result of climate change, 28 properties or 4% of the total properties in the wetspot.

The extents and depths recorded for the 1% AEP plus climate change are broadly similar to the 0.5% AEP results, giving an increase in extents and depths across the modelled area.

Urbanisation

Figures C5 to C8 in Appendix C illustrate the changes in flood extents and depths for the 3.3% AEP and 0.5% AEP, 'Do Minimum' scenario.

The high level methodology used to apply increased urbanisation to the model increases the surface runoff coefficients and roughness to reflect the built environment. On the larger sites where land was previously undeveloped (notably the sustainable urban extension and land north of Whittington Road), flooding can be seen in the baseline situation and not in the urbanised situation. This occurs because the higher runoff coefficient results in more efficient transfer of flow away from the development area. However, in reality any new development will have a more complex impact on drainage pathways and therefore mapping the changes in flood depth at sewer nodes provides a better illustration of the extent of the impacts of increased runoff from development sites. No proposed drainage layouts were available for use in this SWMP. Impacts on the network are observed some distance from the development sites. Consequently, any additional flows added to the network in these locations could result in further flooding.

Change in River Levels

Figures C9 to C12 in Appendix C illustrate the changes in flood extents and depths for the 3.33% AEP and 0.5% AEP, 'Do Minimum' scenario. Only the two design events were run for this sensitivity test, consequently the present value damages have not been estimated.

Increasing the river levels by 100% and the base flows by 100% resulted in a minimal impact on the modelled flood extents in both events. There was a localised increase in the number of surcharged pipes and similarly there were increases in depth of flooding at the manholes immediately upstream of the outfalls on the River Morda and immediately downstream of the open channel sections.

In general, the model results suggest that river levels have a negligible impact on sewer discharge.

4.8 Summary of Flood Risks Requiring Mitigation Actions

The following flood risks have been identified as requiring potential mitigation action through the identification and assessment of mitigation options.

- Susceptibility of drains and culverts to blockage and consequent increase in flood risk
- Poor condition of culverts and sewers in certain locations, reducing conveyance and increasing flood risk as a result
- Overland flow from the rural fringe to the north and west of Oswestry
- Overland flow from the disused railway depot onto residential areas to the south and commercial area to the north
- Surcharge in the pipe network during the 3.33% AEP 'Do Minimum' is highlighted by the model in:
    - Areas of the town centre core served by a combined sewer system
    - Sewer system draining flows south of the town centre towards Shrewsbury Road
    - Downstream reaches of the sewer system draining the Brynhafod Road / Maserfield area of Oswestry

    - The sewer system draining the Liverpool Road (downstream of Brogyntyn Park) area of Oswestry
- The sewer system draining the east of Oswestry shows much lower levels of surcharge compared to the west
- Inundation of the network during more severe rain storms due to runoff from adjacent, and often impermeable areas
- Potential for new development to add to flows in the sewer system and increase flood depths within the network

5 Phase 2 Risk Assessment: Map and Communicate Risk

5.1 Updated Surface Water Flood Depth Mapping

Figure C13 and C14 in Appendix C show the maximum depths predicted by the surface water modelling for the study area. Figures C15 and C16 show the maximum predicted flood depths for the proposed development sites.

Drawings showing the impact of surface water flooding on critical infrastructure are to be produced at a later date once Shropshire Council have access to this data set.

5.2 Surface Water Flood Hazard Maps

Risk Assessment Phase; Map and Communicate Risk

Flood hazard mapping has been produced for Oswestry based upon the ICM model constructed for this SWMP. Figures showing the flood hazard are included in Appendix C.

Flood hazards are used in the assessment of flood risk and evacuation of the general public. Three categories of flood hazard have been identified in Flood Risk Assessment Guidance for New Development[11] (Defra Report FD2320) and Flood Risks to People Methodology[12] (Defra Report FD2321). These are "Danger for All", "Danger for Most" and "Danger to Some". The equation below gives the relationship between hazard, depth, velocity and debris:

$H = (v+0.5) \times d + Df$ Where:

H = hazard
v = velocity
d = depth
Df = 0.5 for d < 0.25m
Df = 1.0 for d > 0.25m

The mapping presented in the SWMP has been based upon the following thresholds, taken from Defra Report FD2320:

- Danger to Some Category 1 H > 0.75
- Danger to Most Category 2 H > 1.25
- Danger to All Category 3 H > 2.00

It is noted that Defra Report FD2321 places a different hazard rating at the transition to Category 3; the change occurs at 2.0 in FD2320 and 2.5 in FD2321. This will have a significant impact on the interpretation of the results for the SWMP as the results presented are conservative.

5.3 Surface Water Flood Velocity Maps

Flood velocity maps are included in Appendix C.

5.4 Communicate Risk

Shropshire Council is part of the West Mercia Local Resilience Forum (LRF). Surface water maps are listed on the Community Risk Register produced by the LRF and should therefore be used to inform this register as it is updated. Section 8.2.5 and 8.2.6 further discuss recommendations on Campaigns and Communication, and Emergency Planning.

5.5 Groundwater Flooding

A desk top study into the risk of groundwater flooding in Oswestry has been completed as part of the SWMP Risk Assessment Phase. The full report is included in Appendix E. The key findings from the assessment are:

- There are no known groundwater flood incidents within the Study Area.
- None the less, the presented assessment shows that there is a potential for groundwater flooding to contribute to flood events.
- Superficial deposits that comprise glacial till and fluvial glacial sands and gravels completely cover bedrock across the whole of the study area.
- Oswestry is underlain by Secondary A Carboniferous bedrock aquifers.
- Based on monitoring boreholes outside the study area (but within 6km of Oswestry), groundwater levels in the Kinnerton Sandstone are unlikely to be a cause of groundwater flooding as groundwater levels appear to be much lower than the ground surface elevations and watercourses within the study area.
- Carboniferous bedrock groundwater levels may vary and have the potential for perched water levels depending on the location of low permeability mudstones and faulting. There are no relevant groundwater monitoring observation boreholes and only old borehole logs.
- The superficial deposits may vary in permeability and give a locally more complex hydrogeological regime than appears from British Geological Society mapping. There is the potential for localised perched water within the superficial deposits. Hydraulic connection with the underlying bedrock may vary.
- There is no direct evidence for manmade discharges to the ground increasing the likelihood of groundwater flooding. Mains water leakage within Oswestry town centre is above the national average which could result in additional recharge to perched groundwater tables and hence a possible local rise in groundwater; this could exacerbate the risk of groundwater flooding.
- Infiltration SuDS are likely to be most appropriate in areas underlain by the Kinnerton Sandstone. However the complex nature of the superficial deposits means that site specific assessments will be required for particular developments. In addition the risk of increasing nitrate into the groundwater in the nitrate vulnerable zones (NVZ) should be assessed.

6 Phase 3 Options: Measures Identification

6.1 Identify Measures

Options Phase; Identify Measures

6.1.1 Approach

The measures evaluated in this section are based upon employing the most appropriate techniques for the various sites. Where possible and economical, the use of sustainable drainage systems (SuDS) and surface water reduction strategies has been promoted over hard infrastructure alternatives such as increasing the capacity of drainage systems.

Section 6.1.2 introduces the range of measures reviewed as part of this SWMP for Oswestry. Section 6.2.2 then discusses the applicability of these measures to resolving the known issues in the key wetspots listed in Section 4.3. These measures are then developed into options and assessed from Section 7 onwards.

6.1.2 List of Measures

The following sections list the potential measures that could be implemented in Oswestry in order to mitigate surface water flooding. The Defra SWMP guidance requires that *'a wide range of structural, non-structural and adaption measures should be proposed and considered, which provide different levels of protection from surface water flooding and have a range of costs and benefits associated with them'.*

In the SWMP guidance, a measure is defined as *'a proposed individual action or procedure intended to minimise current and future surface water flood risk or wholly or partially meet other agreed objectives of the SWMP. An option is made up of either a single or a combination of previously defined measures'.*

Improved Maintenance

This measure requires the maintenance of the existing systems to a better standard to help ensure that any blockages as a result of excess vegetation or deposition will not reduce the hydraulic capacity of the existing drainage infrastructure. This will apply to watercourses, highway gullies and surface water networks.

Maintenance works include regular inspections of assets, cutting, mowing, pruning, jetting and clearance of debris, gravel and siltation where required. The objective of these works would be to reduce the amount of debris available to block, constrain or otherwise impair the assets.

Improved maintenance also assumes the enforcement of any notices served under the Land Drainage Act[13]. The advantages and disadvantages of improving the maintenance regime are given in Table 6-1.

Measure	Advantage	Disadvantage
Improved Maintenance	Clearance of drains to remove water at the design capacity. Regular/effective maintenance and record keeping could help to support flood defence funding decisions. Regular maintenance is more likely to result in local pride and ownership whereby communities want to look after their assets.	Increased inspection frequency and maintenance tasks will have increased cost and time implications.

Table 6-1 Improved Maintenance: Advantages and Disadvantages

Sustainable Drainage Systems (SuDS)

Attenuation Basins

An attenuation basin is a large depressed area of ground laid to grass. They are dry for the majority of the time and fill up with water during periods of heavy rainfall which is then released slowly. Permanent ponds may be incorporated towards inlets and outlets for visual amenity and settlement of silts. They can also act as offline storage structures when positioned alongside existing watercourses, which fill when river levels are high. This can help to alleviate pressure on the drainage network elsewhere in the catchment.

Swales

Swales are landscape elements designed to remove silt and pollution from surface runoff water whilst providing flow attenuation and increased ground infiltration. They consist of a drainage channel with gently sloped sides and filled with vegetation. The flow path along the wide and shallow ditch is designed to maximize the time water spends in the swale, which aids the trapping of pollutants and silt. A common application is around car parks or alongside roads, where substantial automotive pollution is collected by the paving and then flushed by rain. The swale treats the runoff before releasing it to the watershed or storm sewer.

Infiltration Basin

An infiltration basin is used to manage surface water runoff, prevent flooding and downstream erosion, and improve water quality in an adjacent river, stream or lake. It is essentially a shallow artificial pond that is designed to infiltrate surface water though permeable soils into the groundwater aquifer. Infiltration basins do not discharge to a receiving water body under most storm conditions, but can be designed with overflow structures (pipes, weirs, etc.) that operate during flood conditions.

Permeable Paving

Permeable paving systems are designed to allow water to infiltrate to the underlying granular sub-grade material and eventually provide local groundwater recharge. They provide significant benefits in relation to rainfall interception as well an option for removal of surface water volume.

Road Side Rain Gardens

A road side rain garden system creates a chain of surface water storage areas each connected with a filter / French drain. Surface water is temporarily stored in the soil and granular layer at the base of the structure before being gradually released into the groundwater through infiltration into the ground below. Intentionally situated in roadside verges, this will provide areas

of storm water infiltration and planting into the smallest of places. Road side rain gardens typically contain hydrophilic flowers, grasses, shrubs and trees.

Advantages and Disadvantages

The advantages and disadvantages of the above SuDS measures are summarised in Table 6-2.

Measure	Advantages	Disadvantages
Attenuation Basins	Attenuation of storage of flood water Manage the rate of runoff and reduce flooding caused by urbanisation. Encourage natural groundwater recharge.	Potential health and safety implications of adding flood storage areas in and around urban areas and the need for warning requirements. Relatively high land take up and cost constraints.
Swales	Decrease conveyance of overland flow of flood water toward an area with historical flooding. Manage the rate of runoff and reduce flooding caused by urbanisation. Encourage natural groundwater recharge. Water treatment by pollutant removal.	Temporary closure of the areas during construction. Swales need regular maintenance.
Infiltration Basin	A decreased conveyance of overland flow of flood water toward an area with historical records of flooding. Manage the rate of runoff and reduce flooding. Encourage natural groundwater recharge.	Temporary closure during construction. Usage dependent on underlying ground conditions / soil type. Relatively high land take up and cost constraints.
Permeable Paving	Permeable paving surfaces have been demonstrated as effective in managing and reducing runoff from paved surfaces. Management of potential flooding at the source, 'upstream' of any high risk areas. Sustainable alternative to creating a larger capacity sewer network. Encourage natural groundwater recharge. Water treatment by pollutant removal. Reduces net volume required in sewer system.	Construction within the road will lead to temporary road closures. High associated construction cost. Can only be constructed on highways with low traffic volumes where speed restrictions not exceeding 30mph are present. Annual inspection of permeable pavement will be required.

Measure	Advantages	Disadvantages
Roadside Rain Garden	Road side rain gardens have been demonstrated as effective in managing and reducing runoff conveyed by highway surfaces. Sustainable alternative to creating a larger capacity sewer network. Encourage natural groundwater recharge. Reduces net volume entering sewer system. Contribution to aesthetic appeal and habitat in urbanised areas. Flexible for use in areas of various shapes / sizes.	Regular maintenance of vegetation, such as weeding, soil replacement and watering during dry periods. Inspection following large rainfall events. This includes clearing of the inlet channel from the road to the soil. Periodic replacement of planting is required.

Table 6-2 SuDS Measures: Advantages and Disadvantages

Sub-Surface Drainage Network Improvements

Drainage network improvements could involve increasing highway gully entry capacity and storage, upsizing highway drains / public sewers / culverts, construction of off or on-line storage tanks, for example. Their advantages and disadvantages are listed in Table 6-3.

Measure	Advantage	Disadvantage
Improve sub surface drainage network	Storage tanks control volume/rate of surface water entry into network. Reduce surcharge risk of system. Increase capacity.	Temporary closure of the roads during construction causing disruption. Network improvements are generally expensive to carry out. Below ground constructions more costly and difficult to maintain in comparison with above ground works. Problems tend to be passed downstream.

Table 6-3 Sub-surface network drainage improvements: Advantages and Disadvantages

Property Level Protection

Property level protection incorporates flood resistance and resilience measures. Examples of resistance measures at a property level include flood boards for property access points, replacement flood doors, air brick covers, threshold raising and building 'skirt' systems. Property level resilience measures include replacing timber floors with waterproofed concrete, raising electricity points, replacing gypsum plaster with lime plaster and the use of metal and plastic fittings rather than chipboard or similar. The advantages and disadvantages of these systems are shown in Table 6-4.

Measure	Advantage	Disadvantage
Property Level Resistance	Will keep water wholly out of a property up to a given depth. Directly protects property therefore benefits are simple to determine.	Can be expensive, especially for prolonged flooding. Can be complicated to fund and assign responsibility. Difficulties with deploying the measures prior to a flood event unless self-managed.
Property Level Resilience	Damage to the property is limited and residents remain out of their properties for less time.	Measures can be more expensive than like for like non flood resilient products.

Table 6-4 Property Level Protection: Advantages and Disadvantages

Watercourse and Culvert Improvements

Watercourse improvements can involve bank raising, building of walls and increasing channel size for example. Associated with watercourse improvements is the replacement of inadequate culverts. Their advantages and disadvantages are listed in Table 6-5.

Measure	Advantage	Disadvantage
Watercourse/ Culvert Improvements	Increases conveyance.	Can be expensive to carry out. Problems can be passed downstream.

Table 6-5 Watercourse and Culvert Improvements: Advantages and Disadvantages

Planning Policy and Development Control

Planning policies can be used to set out a framework for best practice and specify additional guidance to achieve locally agreed aims and objectives. Further information and recommendations are set out in Section 8.

Interim Guidance for Developers

Shropshire Council has produced a guidance document for developers which sets out their requirements for surface water management. Consultation on this document was closed in March 2011. It is the aspiration that this document will eventually be replaced by the proposed Sustainable Water Management SPD and further supported by the implementation of Schedule 3 (Sustainable Drainage) of the Flood and Water Management Act. Further discussion is given in Section 8.2.

Supplementary Planning Documents (SPD)

Supplementary planning documents provide guidance on local planning matters. As they are not required to be listed in the Local Development Scheme, they can be brought forward as circumstances change. An SPD is subject to a process of consultation and engagement with relevant parties. They will take the form of:

- Masterplans
- Development briefs
- Issue based documents (provides additional information on a specific theme)

- Design Guides

Development Management Polices

Development Management Policies set out local authority detailed policies for managing development in the unitary area and support the core strategy.

Development Control

The role of development control is important in ensuring that planning regulations are followed correctly.

Campaigns and Communication

Raising awareness of surface water flooding and efficient communication of the associated risks and responsibilities is an important element in managing surface water flood risk. Further detail and recommendations are set out in Section 8.2.5.

6.2 Shortlist Measures

Options Phase; Shortlist Measures

6.2.1 Approach

The measures listed above were assessed using a two stage approach; the methodology for this is set out in the following sections.

Stage 1

Each measure is scored independently with respect to **ease of implementation**, **effectiveness** and **cost**. A score ranging from 0 to 3 is assigned based on the criteria shown in Table 6-6.

Score	Implementation	Effectiveness	Cost
3	Targeted behavioural changes	Significantly contributes to the full resolution of the problem	Low
2	Installation and retrofitting not requiring intrusive works	Contributes to the resolution of the problem	Moderate
1	Locally constrained disruption	Has a small scale impact which is effective when assessed cumulatively	High
0	Significant capital works	Minimal, local or piecemeal impact	Very High

Table 6-6 Stage 1 Measures Scoring Criteria

In each case, the scores for each measure are summed and a final stage 1 score assigned. Measures scoring greater than 5 are progressed to the next stage. A threshold score of 5 was chosen following analysis of the Stage 1 scores to ensure that sufficient measures would be progressed to enable a variety of options to be developed. An exception to this was the construction of proposed storage areas within wetspots OSW4, 5 and 10 as these are anticipated to benefit not only the wetspot in which they are constructed but others in the town. Therefore despite obtaining a stage 1 score of less than 5, these were progressed to Stage 2.

Stage 2

The measures shortlisted from Stage 1 are scored separately in terms of **technical**, **economic**, **social** and **environmental** suitability against the criteria set out in Table 8-2 of the SWMP guidance. Table 6-7 sets out these scoring criteria.

Score	Technical, Economic, Social and Environmental Suitability
U	Unacceptable - measure eliminated from further consideration
-2	Severe negative outcome
-1	Moderate negative outcome
0	Neutral
1	Moderate positive outcome
2	High positive outcome

Table 6-7 Stage 2 Measures Scoring Criteria

6.2.2 Shortlisted Measures

The complete set of measures scoring tables are included in Appendix E. Key findings from the measures short listing exercise are:

- Due to the layout of the majority of roads in Oswestry, swales and roadside rain gardens are generally unlikely to be a suitable measure as the space between the highway and property boundaries is small to non-existent. There are some exceptions and these have been identified in subsequent sections.
- In general, improvements to the sub surface drainage network did not score highly. This is because model results indicate that the network is generally performing to its design standard and therefore significant capital works associated with raising the standard of the network would be costly, disruptive and would be unlikely to realise sufficient benefits.
- Where the supplied CCTV or channel survey data collected during spring / summer 2012 did not highlight any problems within a wetspot, the 'improved maintenance' measure has not be progressed as a specific action. However, the principle of maintaining a clear and functioning network of watercourses and culverts should be applied across Oswestry.

Table 6-8 discusses the applicability of the potential measures for specific use within Oswestry wetspots. The channel and CCTV survey data collected during spring / summer 2012 have been used to inform areas for improved maintenance. Structural grades are assigned by the CCTV company and are classed as:

- Structural grade 3: rehabilitation is necessary within three to five years
- Structural grade 4: rehabilitation is urgent and has to be completed within one to two years
- Structural grade 5: rehabilitation is urgent and short term. In order to prevent further damage, necessary temporary spot repair should be conducted on an emergency level

Section 7.2 further discusses the chosen measures for each wetspot following the options appraisal process.

Measure	Applicability in Oswestry	Suitable Wetspots
Improved Maintenance	Screened culvert inlet upstream of Oakhurst Road Screened culvert inlet upstream of Hampton Rise Channel upstream of Mount Close Channel upstream of Jasmine Gardens Screen on outlet behind Maple Close Inlet to culvert at Brynhafod Lane Culvert under and downstream of High Fawr Avenue Longitudinal fractures and hole in SWS at Greystones Way (defect grade 3 / 4) Hole in SWS at Fir Grove (defect grade 4) Circumferential fracture in SWS at Albert Grove (defect grade 3) Fractures and cracks in SWS at Lorne Street (defect grade 2/3) Longitudinal fractures, infiltration and encrustation along SWS in Oak Street (defect grade 3). Blockage resulting in 20% cross sectional area loss near the junction with Oak Street with Willow Street Encrustation and debris in SWS along Vrynwy Road resulting in a loss of up to 30% of the sewer cross sectional area Encrustation of the SWS at Hampton Rise Blockage in the SWS at English Walls / Smithfields resulting in a loss of 20 - 30% of the SWS diameter Multiple fractures in the SWS at Leg Street (defect condition 4) Hole and displaced bricks in the SWS at Beatrice Street (defect condition 4)	OSW4, OSW1, OSW13, OSW18, OSW10, OSW9, OSW11
Attenuation Basins	Parks, public open space and other available green areas within Oswestry could be used to provide attenuation (in particular, if designed to encourage multiple land use purpose): Brogyntyn Park Brynhafod Road Playing Fields Maes-y-Llan Open space near the Railway Heritage Centre	OSW1, OSW4, OSW10
Swales	Green space in local parks listed above Green margins besides roads in limited number wetspots where additional space available. Many roads in Oswestry have no space between properties and the highway.	OSW10, OSW1, OSW4

Measure	Applicability in Oswestry	Suitable Wetspots
Infiltration Basin	Parks and public open space within Oswestry could be used to provide attenuation: Brogyntyn Park Brynhafod Road Playing Fields Maes-y-Llan Open space near the Railway Heritage Centre Oswestry is underlain by siltstone, sandstone and conglomerates overlain by diamicton till and glacial sand. This indicates a moderate permeability[14] and therefore suitability for infiltration. However, Oswestry is underlain a minor aquifer to the west and a major aquifer to the east therefore due care must be given to maintaining water quality.	OSW1, OSW4, OSW10
Permeable Paving	Oswestry is underlain by siltstone, sandstone and conglomerates overlain by diamicton till and glacial sand. This indicates a moderate permeability[14] and therefore suitability for infiltration. However, Oswestry is underlain a minor aquifer to the west and a major aquifer to the east therefore due care must be given to maintaining water quality.	Potential for inclusion to some extent in all wetspots, either at a property or wider scale
Roadside Rain Garden	Many roads in Oswestry have little or no space between properties and the highway therefore installing roadside rain gardens is unlikely to be a realistic option across much of the town.	Limited, possibly OSW10, OSW1, OSW4
Improve Drainage Network	The CCTV survey of the surface water system identified a variety of issues ranging from minor siltation to extensive fractures and cracking. These are considered to fall under the remit of 'improved maintenance'. Where modelling identified areas where the network was surcharged this information has been used to inform options in some of these locations.	Limited
Property Level Protection	Where flooding is known to occur, or is predicted to occur property level protection can be installed. The extent of measures installed is dependent on the scale of the flooding as well as the source of funding. It can be driven by the property owner or Shropshire Council.	Scope for installation anywhere in Oswestry although private funding may be required
Watercourse and Culvert Improvements	The channel survey of open watercourses around Oswestry identified some areas where improvements to the channel and culverts could be undertaken.	OSW4, OSW1, OSW13, OSW18

Table 6-8 Applicability of Measures in Oswestry

7 Phase 3 Options: Assess Mitigation Options

Options Phase; Assess Options

The first step in the options assessment process is to determine which benefits and costs are to be included in the analysis.

7.1 Analysis Criteria

7.1.1 Costs

In order to justify and present a business case for a proposed scheme, an economic assessment is required. In line with the Defra guidance[15] published in 2011, funding levels for a given scheme will relate directly to the number of households protected, level of damage prevented and the other benefits afforded by the scheme. In a change from previous protocol, grants for surface water management and property level protection schemes will also be available. Where full funding for a scheme is not available, this new approach clarifies how much additional partnership funding need be sourced from alternative sources or by how much the project costs need to be reduced. This contributes to meeting the recommendation from the Pitt Review which states that 'government should allow and encourage communities to invest in measures to protect them, so that more can be done whilst giving communities a bigger say'.

The following ***monetised*** costs have been assessed for the Oswestry SWMP:

- Capital costs associated with implementation of measures
- Operational costs; the on-going costs associated with maintenance of assets, land or equipment.
- Residential flood damages
- Non-residential flood damages
- Emergency Services recovery costs

Estimation of Capital and Operational Costs

There are a number of economic risks or uncertainties associated with the development of the cost estimates. Section 4.4.1 discusses how Optimum Bias takes into account these risks in the economic assessment. The following items will influence costs and have not been explicitly included in the costs listed below:

- Utilities diversions
- Land negotiations and compensation for disruption
- Ecological, archaeological and other environmental surveys / mitigation and associated costs
- Impact of weather (e.g. winter working).
- Access constraints
- Disposal of excavated materials (e.g. for flood storage or soakaway clearance).

The requirements for consultancy, design, supervision, planning process and permits have been included within a general 5% uplift in capital costs only based on guidance in Annex 1 of the SuDS Standards[16].

The costs of providing the options have been estimated using a range of data sources and are a guide as to the potential capital costs for implementation of the scheme. They should be used for indicative purposes only for comparison with the potential benefits derived. Table 7-1 summarises the unit costs used to develop cost estimates. A summary of costs for all options is included in Appendix F.

Measure	Description	Capital Cost	Operational Cost	Data Source
Do Minimum	Continuation of existing situation	N/A	Ratio of north west area maintenance allocation budget (note 1)	Shropshire Council Environmental Maintenance Plan[17]
Improve Drainage Network / Watercourse and Culvert Improvements	Removal of blockages in the sewer system	N/A	Confidential Rates	Shropshire Council Framework Rates
	Remediation of cracks and fractures in the sewer system	£73/m (note 2)	N/A	Anglian Water Project Briefing on sewer re-lining[18]
	Channel clearance	N/A	Confidential Rates	Shropshire Council Framework Rates
	Clearance of inlet screens	N/A	Confidential Rates	Shropshire Council Framework Rates
	Regular cleaning of all drains in wetspot	N/A	Double north west area allocation	Shropshire Council Environmental Maintenance Plan[17]
SuDS	Attenuation / Infiltration Basins	£24.03/m³ (note 3)	£0.30/m³	CIRIA SuDS Manual[19]
	Swales	£14.67/m²	£0.10/m²	Cost Benefit of SuDS retrofit in urban areas[20]
	Permeable Paving (note 4)	£63.24/m²	£0.40/m²	Cost Benefit of SuDS retrofit in urban areas[20]
	Roadside Rain Garden	£19.07/m²		Drain London Study[21]
	Property Level Protection (note 5).	£4,832 / property		Evaluation of the Defra Property Level Flood Protection Scheme[22]
Planning and Policy	Annual Planner Salary	N/A	£30,000 (note 6)	Local Government Jobs Website[23]

Table 7-1 Data Sources for Estimated Costs

Note 1

Ratio based on total length of public roads in the wetspot compared to the total length of public roads in Shropshire highways north west area. Budget for 2011/2012 drainage cleaning and gully emptying used.

Note 2

Some economies of scale assumed such that mobilisation costs of plant and personnel are not accrued individually for wetspots. Costs are highly dependent on local conditions.

Note 3

Cost of constructing attenuation basins is apportioned across the wetspots benefitting from the basin based on the number of residential properties in each wetspot (i.e. where the basins provide flood risk reduction benefits to multiple wetspots).

Note 4

Permeable paving applied as a function of the number of existing residential properties within the wetspot. An area of 0.5m² assigned to each property to account for the likelihood that few properties in the wetspot will implement retrofitting of permeable paving.

Note 5

A Defra study into the benefits of property level protection[24] concluded that:

- Resistance measures (designed to keep water out of a property) are economically worthwhile for properties at risk of flooding from a 2% AEP (1 in 50 annual chance) or greater.
- The largest percentage savings are for residential properties at risk of flooding from a 4% AEP (1 in 25 annual chance) or greater.
- Temporary resistance measures (for example temporary flood guards and airbrick covers) reduce the costs of damage by about 50% if they are properly deployed prior to a flood.
- A full package of resilience measures (i.e. the use of flood resilient plaster, resilient kitchens and resilient flooring) will only be economically worthwhile when installed in a building that is at risk of flooding from a 4% AEP (1 in 25 annual chance) or greater.

The cost of property level protection for each wetspot is based on the number of properties at risk in the 2.5% AEP (1 in 40 annual chance) as this is the closest modelled (as part of this SWMP) event to the 2% AEP quoted in point 1 above.

Note 6

Salary of an additional planning officer was apportioned across wetspots based on wetspot area.

Investment Profile

All the capital costs were applied in the first year. Costs in the following years are assumed to be maintenance only.

Optimism Bias

At the strategy stage, detailed design has not been carried out and lessons learnt from post project evaluations indicate that an allowance for error should be made for the uncertain nature of costs estimates at a strategic level[6]. HM Treasury suggests that 60% is added to the cost estimate used in the cost benefit assessment.

Estimation of Damage and Recovery Costs

The estimation of damage and recovery costs is discussed in Section 4.4.

7.1.2 Benefits

The following ***monetised*** benefits have been assessed for the Oswestry SWMP:

- Reduction in residential flood damages
- Reduction in non-residential flood damages
- Reduction in recovery costs

7.1.3 Benefit Cost Analysis

The cost of each option and the relative damages incurred are combined to create the benefit-cost ratio (BCR). This ratio is used to assess the viability of the option and also the levels of effectiveness for how capital can be spent to protect against the effects of flooding. The BCR is the ratio of benefits produced through introduction of flood alleviation options, expressed in monetary terms, relative to its cost, identifying the greatest 'value for money'.

The Multi-Coloured Handbook states that;

'Projects are only viable if the benefits exceed the costs (i.e. the ratio of benefits to costs is greater than 1.0). Where benefits marginally exceed costs, there is often high uncertainty as to whether an option is justified, because only a small change or error in either the benefits or costs would tilt the balance the other way. So when comparing a 'Do Something' option to the baseline option, confidence is needed that a 'Do Something' option is clearly preferable.'

Guidance states that ordinarily, a potential scheme is compared against the 'Do Nothing' scenario through an assessment of associated damage values and the benefits incurred. However, discussion with Stakeholders concluded that the 'Do Minimum' scenario is a more realistic baseline situation for Oswestry, against which potential schemes can be compared. See Section 4.5 for further discussion on 'Do Nothing' and 'Do Minimum'.

The incremental benefit-cost ratio of each option estimates the ratio of the additional benefit to the additional cost when two options are compared and is used to identify how 'much' can be delivered. This has also been calculated for each option.

7.2 Selected Measures for Wetspots

Table 7-2 gives a description of the measures identified for the 14 priority wetspots. These measures have been combined into six options for each wetspot, assessed in Section 7.3. The options are divided into:

- Option 1 Do Nothing
- Option 2 Do Minimum
  - At present, gully cleaning is undertaken once per year with additional reactive cleaning as required
- Option 3 Improved Maintenance
  - For the locations as identified by review of new survey data and known flooding issues due to blocked drains

- Additional funds to undertake more regular, proactive and focussed maintenance work. At present, once per year is the objective; obtaining funding to double this budget would enable considerably more resources to be deployed.

- Option 4 Local Works and Improved Maintenance
  - Businesses and property owners should be encouraged to increase permeability by using permeable paving in car parks and curtilages. This will help slow and reduce runoff to the drainage network.
  - Where the urban environment is suitable, swales and roadside rain gardens should be used to further slow and reduce runoff to the drainage network.
  - Individual properties at risk of flooding or with a known history of flooding should be encouraged to install property level protection and guidance given by Shropshire Council regarding funding. For each wetspot the number of properties predicted to flood in the 2.5% AEP (using a 0.3m threshold) are quoted in Table 7-2 based on the statistics quoted in the Defra study[24].
- Option 5 Capital Works and Improved Maintenance
  - Review of model results in conjunction with local topography and urban layout suggested three locations where there may be scope for constructing attenuation basins; Brynhafod Playing Fields, Brogyntyn Park and the Railway Depot, these locations are described further in Section 7.3.1. Detailed discussion on the inclusion of these options in the hydraulic model is also given in the Model Build Report included in Appendix B.
- Option 6 Planning, Policy and Social
  - Full details on the concepts, procedures and measures included within this option are provided in Section 8.

For the remaining eight non priority wetspots, the principles set out in Section 8 should be applied.

Section 9 details the preferred options for the 14 priority wetspots.

Wetspot	Option	Description
OSWS9	1	**Do Nothing**
	2	**Do Minimum:** Maintain existing situation.
	3	**Improve maintenance**: Remove the blockage in the Surface Water Sewers (SWS) at English Walls / Smithfields resulting in a loss of 20 - 30% of the SWS diameter. Remediate multiple fractures in the SWS at Leg Street (defect condition 4). This will reduce the likelihood of imminent collapse as well as reducing the potential for infiltration into the network. The historic incident register highlights a number of flood incidents due to blocked drains. Regular cleaning should therefore take place to mitigate for this. Removal of blockages and maintenance of clear culverts will facilitate efficient conveyance of surface water.
	4	**Local Works and Improved Maintenance** **Permeable paving** **Property level protection**: There is 1 property at risk of flooding during the 2.5% AEP event. **Improved maintenance**: As above
	5	**Capital Works and Improved Maintenance** **Improved maintenance**: As above No capital works identified
	6	**Policy Driven:** See Section 8
OSWS8	1	**Do Nothing**
	2	**Do Minimum:** Maintain existing situation.
	3	**Improve maintenance**: The historic incident register highlights a number of flood incidents due to blocked drains. Regular cleaning should therefore take place to mitigate for this. Maintenance of clear culverts will facilitate efficient conveyance of surface water.
	4	**Local Works and Improved Maintenance** **Permeable paving** **Property level protection**: There are no properties at risk of flooding during the 2.5% AEP event. **Improved maintenance**: As above
	5	**Capital Works and Improved Maintenance** **Improved maintenance**: As above **Capital Works:** Wetspot may benefit from the reduction in flood risk afforded by attenuation basins at Brynhafod Road and/or the Railway Depot.
	6	**Policy Driven:** See Section 8
OSWS5	1	**Do Nothing**
	2	**Do Minimum:** Maintain existing situation
	3	**Improve maintenance**: The historic incident register highlights a number of flood incidents due to blocked drains. Regular cleaning should therefore take place to mitigate for this. Maintenance of clear culverts will facilitate efficient conveyance of surface water.

Wetspot	Option	Description
	4	**Local Works and Improved Maintenance** **Permeable paving** **Property level protection**: There are 13 properties at risk of flooding during the 2.5% AEP event. **Improved maintenance**: As above
	5	**Capital Works and Improved Maintenance** **Attenuation / infiltration basins**: There is scope to construct a storage area on the edge of Brynhafod Playing Fields. This will attenuate flows passed down Brynhafod Road. The addition of a high level overflow from the existing surface water sewer system into the storage area will help to relieve the pressure on the drainage network. Any benefits are likely to be realised both within and outside OSW5. **Improved maintenance**: As above
	6	**Policy Driven:** See Section 8
OSWS15	1	**Do Nothing**
	2	**Do Minimum:** Maintain existing situation
	3	**Improve maintenance**: The historic incident register highlights some flood incidents due to blocked drains. Regular cleaning should therefore take place to mitigate for this. Maintenance of clear culverts will facilitate efficient conveyance of surface water.
	4	**Local Works and Improved Maintenance** **Permeable paving** **Swales**: There may be scope for installing swales along existing green verges in Unicorn Road / Whittington Road. This will assist in slowing and attenuating surface water runoff into the sewer network. **Roadside rain gardens**: The majority of roads in this wetspot have insufficient space for the installation of rain gardens. Only Unicorn Road / Whittington Road are likely to be suitable. Rain gardens will help to attenuate and slow the passage of flow into the drainage network. **Property level protection**: There are 0 properties at risk of flooding during the 2.5% AEP event. **Improved maintenance**: As above
	5	**Capital Works and Improved Maintenance** **Improved maintenance**: As above No capital works identified
	6	**Policy Driven:** See Section 8
OSWS12	1	**Do Nothing**
	2	**Do Minimum:** Maintain existing situation
	3	**Improve maintenance**: The historic incident register highlights flood incidents due to blocked drains. Regular cleaning should therefore take place to mitigate for this. Maintenance of clear culverts will facilitate efficient conveyance of surface water.

Wetspot	Option	Description
	4	**Local Works and Improved Maintenance** **Permeable paving** **Swales**: There may be scope for installing swales along existing green verges in Liverpool Road / Gateacre Road. This will assist in slowing and attenuating surface water runoff into the sewer network. **Roadside rain gardens**: The majority of roads in this wetspot have insufficient space for the installation of rain gardens. Only Liverpool Road / Gateacre Road are likely to be suitable. Rain gardens will help to attenuate and slow the passage of flow into the drainage network. **Property level protection**: There are 25 properties at risk of flooding during the 2.5% AEP event. **Improved maintenance**: As above
	5	**Capital Works and Improved Maintenance** **Improved maintenance**: As above **Capital Works:** Wetspot may benefit from the reduction in flood risk afforded by attenuation basins at Brogyntyn Park and/or the Railway Depot.
	6	**Policy Driven:** See Section 8
OSWS4	1	**Do Nothing**
	2	**Do Minimum:** Maintain existing situation
	3	**Improve maintenance:** Clear the screened culvert inlet upstream of Oakhurst Road; remove blockage which is currently resulting in 20% cross sectional area loss near the junction with Oak Street with Willow Street; remove encrustation and debris in SWS along Vrynwy Road which is currently resulting in a loss of up to 30% of the sewer cross sectional area. Removal of blockages and maintenance of clear culverts will facilitate efficient conveyance of surface water. Remediate longitudinal fractures, infiltration and encrustation along the SWS in Oak Street (defect grade 3). This will reduce the likelihood of imminent collapse as well as reducing the potential for infiltration into the network. Removal of encrustation will improve conveyance in the network.
	4	**Local Works and Improved Maintenance** **Permeable paving** **Swales**: The only road in which there may be scope for installing swales is Liverpool Road West. This will assist in slowing and attenuating surface water runoff into the sewer network. **Roadside rain gardens**: The majority of roads in this wetspot have insufficient space for the installation of rain gardens. Only Liverpool Road West is likely to be suitable. Rain gardens will help to attenuate and slow the passage of flow into the drainage network. **Property level protection**: There are 51 properties at risk of flooding during the 2.5% AEP event. **Improved maintenance**: As above

Wetspot	Option	Description
	5	**Capital Works and Improved Maintenance** **Attenuation / infiltration basins**: There is scope to construct a storage area in Brogyntyn Park, behind Oakhurst Road and/or in the corner of Brogyntyn Park, behind the Fire Station. This will intercept overland flow routes and attenuate flows before they enter the urban area and consequently relieve the pressure on the drainage network. A storage area in this location may benefit a number of wetspots downstream on the drainage network. Any benefits are likely to be realised both within and outside OSW4. **Improved maintenance**: As above
	6	**Policy Driven:** See Section 8
OSWS13	1	**Do Nothing**
	2	**Do Minimum:** Maintain existing situation
	3	**Improve maintenance:** Clear the channel upstream of Jasmine Gardens. This will improve conveyance.
	4	**Local Works and Improved Maintenance** **Permeable paving** **Swales**: The only road in which there may be scope for installing swales is Jasmine Gardens. This will assist in slowing and attenuating surface water runoff into the sewer network. **Roadside rain gardens**: The majority of roads in this wetspot have insufficient space for the installation of rain gardens. Only Jasmine Gardens is likely to be suitable. Rain gardens will help to attenuate and slow the passage of flow into the drainage network. **Property level protection**: There are 22 properties at risk of flooding during the 2.5% AEP event. **Improved maintenance**: As above
	5	**Capital Works and Improved Maintenance** **Improved maintenance**: As above No capital works identified
	6	**Policy Driven:** See Section 8
OSWS20	1	**Do Nothing**
	2	**Do Minimum:** Maintain existing situation
	3	**Improve maintenance**: The historic incident register highlights two flood incidents due to blocked drains. Regular cleaning should therefore take place to mitigate for this. Maintenance of clear culverts will facilitate efficient conveyance of surface water.
	4	**Local Works and Improved Maintenance** **Permeable paving** **Property level protection**: There are 8 properties at risk of flooding during the 2.5% AEP event. **Improved maintenance**: As above

Wetspot	Option	Description
	5	**Capital Works and Improved Maintenance** **Improved maintenance**: As above No capital works identified
	6	**Policy Driven:** See Section 8
OSWS14	1	**Do Nothing**
	2	**Do Minimum:** Maintain existing situation
	3	**Improve maintenance**: The historic incident register highlights flood incidents due to blocked drains. Regular cleaning should therefore take place to mitigate for this. Maintenance of clear culverts will facilitate efficient conveyance of surface water.
	4	**Local Works and Improved Maintenance** **Permeable paving** **Swales**: There may be scope for installing swales along existing green verges in Unicorn Road / Chaucer Road. This will assist in slowing and attenuating surface water runoff into the sewer network. **Roadside rain gardens**: The majority of roads in this wetspot have insufficient space for the installation of rain gardens. Only Unicorn Road / Chaucer Road are likely to be suitable. Rain gardens will help to attenuate and slow the passage of flow into the drainage network. **Property level protection**: There are 7 properties at risk of flooding during the 2.5% AEP event. **Improved maintenance**: As above
	5	**Capital Works and Improved Maintenance** **Improved maintenance**: As above No capital works identified
	6	**Policy Driven:** See Section 8
OSWS10	1	**Do Nothing**
	2	**Do Minimum:** Maintain existing situation
	3	**Improve maintenance**: The historic incident register highlights flood incidents due to blocked drains. Regular cleaning should therefore take place to mitigate for this. Maintenance of clear culverts will facilitate efficient conveyance of surface water. Remediate longitudinal fractures and hole in the SWS at Greystones Way (defect grade 3 / 4), and the hole in the SWS at Fir Grove (defect grade 4). This will reduce the likelihood of imminent collapse as well as reducing the potential for infiltration into the network.

Wetspot	Option	Description
	4	**Local Works and Improved Maintenance** **Permeable paving** **Swales**: The only road in which there may be scope for installing swales is Plas Ffynon Way. This will assist in slowing and attenuating surface water runoff into the sewer network. **Roadside rain gardens**: The majority of roads in this wetspot have insufficient space for the installation of rain gardens. Only Plas Ffynon Way is likely to be suitable. Rain gardens will help to attenuate and slow the passage of flow into the drainage network. **Property level protection**: There are no properties at risk of flooding during the 2.5% AEP event. **Improved maintenance**: As above
	5	**Capital Works and Improved Maintenance** **Attenuation / infiltration basins**: There is scope to construct a storage area in open space near the Railway Heritage Centre. This will intercept overland flow routes and attenuate flows passed forward onto Brookhouse Road / Ambleside Road. The addition of a high level overflow from the surface water sewer system into the storage area will help to relieve the pressure on the drainage network. Any benefits are likely to be realised both within and outside OSW10. **Improved maintenance**: As above
	6	**Policy Driven:** See Section 8
	1	**Do Nothing**
	2	**Do Minimum:** Maintain existing situation
	3	**Improve maintenance**: Clear the screened outlet behind Maple Avenue. This will improve conveyance and reduce the likelihood of a blockage
OSWS18	4	**Local Works and Improved Maintenance** **Permeable paving** **Swales**: There may be scope for installing swales along existing green verges in Hazel Grove / Hawthorne Grove. This will assist in slowing and attenuating surface water runoff into the sewer network. **Roadside rain gardens**: The majority of roads in this wetspot have insufficient space for the installation of rain gardens. Only Hazel Grove / Hawthorne Grove / Beech Grove are likely to be suitable. Rain gardens will help to attenuate and slow the passage of flow into the drainage network. **Property level protection**: There are no properties at risk of flooding during the 2.5% AEP event. **Improved maintenance**: As above
	5	**Capital Works and Improved Maintenance** **Improved maintenance**: As above No capital works identified
	6	**Policy Driven:** See Section 8
OSWS1	1	**Do Nothing**
	2	**Do Minimum:** Maintain existing situation

Wetspot	Option	Description
	3	**Improved maintenance**: Ensure the open channel upstream of Mount Crescent is kept clear; clear the screened inlet to the culvert at Brynhafod Lane; clear the culverts under and downstream of High Fawr Avenue; remove the encrustation in the SWS at Hampton Rise. These measures will improve conveyance as well as reducing the likelihood of a blockage.
	4	**Local Works and Improved Maintenance** **Permeable paving** **Swales**: The only road in which there may be scope for installing swales is High Fawr Avenue. This will assist in slowing and attenuating surface water runoff into the sewer network. **Roadside rain gardens**: The majority of roads in this wetspot have insufficient space for the installation of rain gardens. Only High Fawr Avenue is likely to be suitable. Rain gardens will help to attenuate and slow the passage of flow into the drainage network. **Property level protection**: There are 33 properties at risk of flooding during the 2.5% AEP event. **Improved maintenance**: As above
	5	**Capital Works and Improved Maintenance** **Improved maintenance**: As above **Capital Works:** Wetspot may benefit from the reduction in flood risk afforded by attenuation basins at Brynhafod Road
	6	**Policy Driven:** See Section 8
OSWS6	**1**	**Do Nothing**
	2	**Do Minimum:** Maintain existing situation
	3	**Improve maintenance**: The historic incident register highlights flood incidents due to blocked drains. Regular cleaning should therefore take place to mitigate for this. Maintenance of clear culverts will facilitate efficient conveyance of surface water.
	4	**Local Works and Improved Maintenance** **Permeable paving** **Property level protection**: There are 4 properties at risk of flooding during the 2.5% AEP event. **Improved maintenance**: As above
	5	**Capital Works and Improved Maintenance** **Improved maintenance**: As above **Capital Works:** Wetspot may benefit from the reduction in flood risk afforded by attenuation basins at Brynhafod Road
	6	**Policy Driven:** See Section 8
OSWS11	**1**	**Do Nothing**
	2	**Do Minimum:** Maintain existing situation

Wetspot	Option	Description
	3	**Improve maintenance**: The historic incident register highlights flood incidents due to blocked drains. Regular cleaning should therefore take place to mitigate for this. Maintenance of clear culverts will facilitate efficient conveyance of surface water. Remediate the circumferential fracture in SWS at Albert Grove (defect grade 3); remediate fractures and cracks in the SWS at Lorne Street (defect grade 2/3); fix hole and displaced bricks in the SWS at Beatrice Street (defect condition 4). This will reduce the likelihood of imminent collapse as well as reducing the potential for infiltration into the network
	4	**Local Works and Improved Maintenance** **Permeable paving** **Property level protection**: There are 57 properties at risk of flooding during the 2.5% AEP event. **Improved maintenance**: As above
	5	**Capital Works and Improved Maintenance** **Improved maintenance**: As above **Capital Works:** Wetspot may benefit from the reduction in flood risk afforded by attenuation basins at the Railway Depot
	6	**Policy Driven:** See Section 8

Table 7-2 Oswestry Wetspot Options

7.3 Assessment of Options

7.3.1 Modelled Schemes

Three potential capital schemes were suggested for incorporation into the ICM model following consultation with Shropshire Council. Figure C21 in Appendix C shows the location and layout of the modelled schemes. The ICM Model Report in Appendix B provides further detail on how these options were modelled. The schemes are not assigned to an individual wetspot as benefits are realised in wetspots other than the one the scheme is located in. Table 7-3 summarises the components of each scheme.

Scheme ID	Components	Attributes	Notes
BP	Storage area in Brogyntyn Park, behind Oakhurst Road	Maximum Attenuation Volume: 3,267m³ *	Brogyntyn Park is owned by Oswestry Town Council. Shropshire Council support the addition of a storage area here as Oakhurst Road is known to flood. Discrepancy of around 1 – 2 m between the DTM (based on SAR data) and the survey data / reality means that it is not feasible to accurately model this situation. See Section 10.1.3 and the Model Build Report for further discussion.

Scheme ID	Components	Attributes	Notes
RD	Storage area upstream of Ambleside Road / Brookhouse Road in the old Railway Depot	Maximum Attenuation Volume: 3,344m³	Shropshire Council are aware of the road flooding around Orchard and Eden street due to road surcharge and have received complaints from property owners. The DTM data is poor in this location which has resulted in a featureless terrain which does not match well with reality. Additional features, such as a 0.5m high bund, have been introduced to the model to improve representation although in reality these may not be required. See section 10.1.3 and the Model Build Report for further discussion.
	High level overflow from storm system pipe SJ29293898	Elevation of Overflow: 121mAD 300mm diameter	
BH	Storage area at Brynhafod Playing Fields	Maximum Attenuation Volume: 2273m³	Playing fields are owned by Shropshire Council. Surface water from Brynhafod Lane (RUPP) causes flooding in local gardens.
	High level overflow from storm system pipe SJ28296603	Elevation of Overflow: 132.5mAD 225mm diameter	

Table 7-3 Modelled Schemes (*Poor quality SAR data currently used in the model which would not reflect accurate modelling of this option (see Appendix B Model Report) therefore estimate of attenuation storage volume based on 0.5% AEP overland flow volume across the attenuation feature used)

The recommendations made in Table 7-3 are conceptual only at this stage and are subject to a detailed feasibility study before firm proposals can be made. The principle of attenuating and slowing water throughout the catchment is one that should be integrated into any new development or changes to the urban environment.

Modelled schemes were introduced to the model and the results used to inform an economic assessment of the scheme, the results of which are included in Section 7.4.

7.3.2 Non-Modelled Measures

None of the 'improved maintenance' proposals have been modelled explicitly as this is outside the agreed scope of the SWMP study. A qualitative assessment of the benefits is given in Section 7.5.

No swales, permeable paving or roadside rain gardens have been introduced to the model. As a concept, this should be communicated to residents and businesses within the town to encourage not only the retrofitting of permeable paving to existing impermeable areas but also looking to alternative options when considering changes to their property.

Explicit modelling of property level protection is also beyond the scope of this study, and a qualitative assessment has been made and is presented in Section 7.5

A series of social and policy measures have been identified and are described in Section 8. These have been combined into an option which is included in the qualitative assessment in Section 7.5.

7.4 Economic Assessment of Modelled Options

A full set of economic assessment tables for the wetspots benefitting from modelled options are included in Appendix F. A discussion of the results is presented below. At present, any scheme should generally achieve a benefit-cost ratio of 1:5 or more to be considered for Defra Flood Defence Grant in Aid (FDGiA) funding although the expected average return for investments receiving funding is currently 1:8. Availability of additional alternative partnership funding sources or further cost savings during the detailed project appraisal/detailed design stage can still influence the availability of FDGiA funding for those schemes that a have a benefit-cost ratio less than 1:5.

Where the incremental benefit-cost ration for an assessed scheme is robustly greater than one (e.g. when compared to the 'Do Minimum' in this case for Oswestry) it may be possible to justify extra spending on a mitigation scheme even in cases where the benefit-cost ratio for 'Do Minimum' is higher than the benefit-cost ratio for the scheme.

OSWS1

Damages are reduced slightly (approximately £2,000) for the 'Do Minimum' and Brynhafod Road scheme compared to the 'Do Nothing' scenario however both have a negative net present value and low benefit cost ratios indicating that the benefits of doing anything do not outweigh the costs.

The CCTV survey did not identify any issues within OSWS1 therefore the only changes for the 'Do Nothing' scenario compared to the 'Do Minimum' scenario is an increased roughness in some low velocity pipes and open channels. Consequently the negative impacts are not pronounced enough to make the 'Do Minimum' look economically favourable. However, should regular maintenance cease, the rate of siltation in the network would increase resulting in an increase in flooding for the 'Do Nothing' scenario with the resultant impact of making the 'Do Minimum' look increasingly favourable into the future.

OSWS4

Flood damages are reduced by £133,000 and £295,000 for the 'Do Minimum' and Brogyntyn Park scheme compared to the 'Do Nothing' scenario. The benefit-cost ratio for 'Do Minimum' is highest at 6.1 indicating that this is the preferred option. The incremental benefit-cost ratio for the Brogyntyn Park scheme is greater than one therefore this scheme should not be discounted without further assessment.

The CCTV survey identified are several issues with the surface water sewers in this wetspot, hence the 'Do Minimum' is clearly shown to reduce damages following removal of these problems.

OSWS5

Flood damages are reduced by £18,000 and £74,000 for the 'Do Minimum' and Brynhafod Road scheme compared to the 'Do Nothing' scenario although neither achieve benefit-cost ratios of greater than 5.

The CCTV survey did not identify any issues within OSWS5 and there are only a few low velocity sewers therefore the negative impacts associated with the 'Do Nothing' are extremely limited. As described above, the 'Do Minimum' would look increasingly favourable into the future should regular maintenance cease.

OSWS6

The 'Do Minimum' scenario does not result in a reduction in damages compared to the 'Do Nothing' scenario as no issues with the surface water sewers were identified in the CCTV survey and no low velocity sewers were identified. As described above, the 'Do Minimum' would look increasingly favourable into the future should regular maintenance cease.

The Brynhafod Road scheme reduces damages by £25,000 however the benefit-cost ratio is only 2.3 and therefore unlikely to attract any funding.

OSWS8

Damages are reduced by £120,000 for the 'Do Minimum' compared to the 'Do Nothing'; the CCTV survey did not identify any issues with the surface water sewers in this wetspot and there are few low velocity sewers. Consequently the 'Do Nothing' is not significantly worse than the 'Do Minimum' in this wetspot. Implementing either the Brynhafod Road scheme or the Railway Depot scheme reduces damages by £340,000 and £173,000 respectively compared to 'Do Nothing'. None of the options achieve a benefit cost ratio greater than 5 although the 'Do Minimum' would look increasingly favourable into the future should regular maintenance cease.

OSW10

Damages are reduced by £45,000 for the 'Do Minimum' compared to the 'Do Nothing'; the CCTV survey identified only one surface water sewer issue at the very upstream extent of OSWS10 the 'Do Nothing' is not significantly worse than the 'Do Minimum' in this wetspot. Implementing either the Brynhafod Road scheme or the Railway Depot scheme reduces damages by £58,000 and £49,000 respectively compared to 'Do Nothing'. None of the options achieve a benefit cost ratio greater than 5 although the 'Do Minimum' would look increasingly favourable into the future should regular maintenance cease.

An economic assessment for the Brogyntyn Park scheme was not undertaken for OSWS10. This was due to the problems with the SAR data described in Section 7.3.1 producing inaccurate results. This wetspot could be revisited in future when LiDAR data becomes available as it is downstream of Brogyntyn Park and therefore it would be expected that some benefit would be realised.

OSW11

Flood damages are reduced by £153,000 and £126,000 for the 'Do Minimum' and Railway Depot scheme respectively compared to the 'Do Nothing' scenario. Only the 'Do Minimum' achieves a benefit cost ratio of greater than 5.

An economic assessment for the Brogyntyn Park scheme was not undertaken for OSWS11. This is due to the problems with the SAR data described in Section 7.3.1 producing inaccurate results specifically within this wetspot following implementation of attenuation measures. This area could be revisited in future when LiDAR data becomes available as it is downstream of Brogyntyn Park and therefore it would be expected that some benefit would be realised.

OSW12

Damages are reduced by £98,000 for the 'Do Minimum' compared to the 'Do Nothing'; the CCTV survey did not identify any issues with the surface water sewers in this wetspot and there are few low velocity sewers. Consequently the 'Do Nothing' is not significantly worse than the 'Do Minimum' in this wetspot. Implementing either the Brynhafod Road scheme or the Railway Depot scheme reduces damages by £554,000 and £109,000 respectively compared to 'Do Nothing'. None of the options achieve a benefit cost ratio greater than 5 although the 'Do Minimum' would look increasingly favourable into the future should regular maintenance cease.

OSWS9

OSWS9 is downstream of Brogyntyn Park, however due to the problems with the SAR data described in Section 7.3.1 results were inaccurate and have therefore not been reported. This area could be revisited in future when LiDAR data becomes available it would be expected that some benefit would be realised.

7.4.1 Sensitivity to Threshold Level

As described previously, threshold data was unavailable for this study and consequently a sensitivity test has been carried out to demonstrate the impact on damages of changing the threshold level applied. On average, damages were tripled as a result of lowering the threshold level from 0.3m to 0.1m. Changing threshold levels can also result in schemes which are currently not economically viable becoming so therefore it is critical that threshold surveys are undertaken in order to inform any detailed project appraisals in future in support of FDGiA funding applications. This is a particularly critical issue when dealing with surface water flooding where flood depths tend to be low compared with fluvial flooding.

7.5 Assessment of Non Modelled Options

7.5.1 Option 3 Improve Maintenance

The costs of improved maintenance for each wetspot are informed by:

- Doubling the existing routine maintenance costs to enable a more proactive and informed approach to clearing and cleaning gullies (Section 10.1).
- CCTV survey results: The costs associated with removing any blockages or defects highlighted by the CCTV survey are included based on the current Shropshire Council framework rates.
- Channel survey results: The costs associated with clearing any inlet screens and clearing obviously overgrown watercourses are included based on the current Shropshire Council framework rates.

Table 7-4 summarises the estimated costs of Option 3 for each wetspot. These costs are placed into indicative bands only and are subject to change following detailed tender specification and contract award.

Wetspot	Cost (2012 Prices)			
	Proactive Increased Gully Cleaning	Sewer Cleaning / Remediation*	Watercourse Remediation**	Total
OSWS9	£1000 - £5000	Less than £1000	N/A	£1000 - £5000
OSWS8	£1000 - £5000	N/A	N/A	£1000 - £5000
OSWS5	£1000 - £5000	N/A	N/A	£1000 - £5000
OSWS15	Less than £1000	N/A	N/A	Less than £1000
OSWS12	£1000 - £5000	N/A	N/A	£1000 - £5000
OSWS4	Less than £1000	£5000 - £10000	N/A	£5000 - £10000
OSWS13	Less than £1000	N/A	Less than £1000	£1000 - £5000
OSWS20	Less than £1000	N/A	N/A	£1000 - £5000

OSWS14	£1000 - £5000	N/A	N/A	£1000 - £5000
OSWS10	£1000 - £5000	£5000 - £10000	N/A	Greater than £10000
OSWS18	Less than £1000	N/A	N/A	£1000 - £5000
OSWS1	£1000 - £5000	Less than £1000	£1000 - £5000	£1000 - £5000
OSWS6	Less than £1000	N/A	N/A	£1000 - £5000
OSWS11	Less than £1000	£5000 - £10000	N/A	£5000 - £10000

Table 7-4 Option 3 (Improved Maintenance) Costs (*some economies of scale assumed with plant mobilisation, one off cost, **one off cost of resolving issues identified on survey)

Compared to other options, the costs associated with doing this are generally small. Furthermore, it is suggested that by providing additional resources to fully investigate the causes of flooding incidents as opposed to addressing only the resulting problems would reduce the number of times a maintenance team was called back to any given area.

Option 3 is likely to reduce the flood damages compared to Option 2.

7.5.2 Option 4 Local Works and Improve Maintenance

Option 4 combined the improved maintenance proposals described above with localised SuDS works to encourage infiltration and consequently reduce or slow surface water runoff through the catchment. For each wetspot, the likely cost of implementing permeable paving, swales and roadside rain gardens (where urban layout allows) was combined with the costs of installing property level flood protection for all residential properties at risk of flooding in a 2.5% AEP event. Figure C22 in Appendix C shows the potential locations for swales / roadside rain gardens in appropriate wetspots. Table 7-5 summarises the estimated costs for Option 4 in addition to the costs for improved maintenance listed above in Table 7-4 for Option 3.

Wetspot	Permeable Paving		Swales		Roadside Rain Gardens		Property Level Protection	Total Capex	Total Opex
	Capex	Opex	Capex	Opex	Capex	Opex*			
OSWS9	£5000 - £10000	Less than £100	N/A	N/A	N/A		Less than £10000	Less than £20000	Less than £100
OSWS8	Greater than £20000	£100 - £200	N/A	N/A	N/A			£20000 - 50000	£100 - £200
OSWS5	£10,000 to £20000	£100 - £200	N/A	N/A	N/A		£50000 - £100000	£50000 - £100000	£100 - £200
OSWS15	£5000 - £10000	Less than £100	£10,000 to £20000	Less than £100	£5000 - £10000			£20000 - 50000	£100 - £200
OSWS12	£10,000 to £20000	£100 - £200	£5000 - £10000	Less than £100	Less than £5,000			£20000 - 50000	£100 - £200
OSWS4	£10,000 to £20000	Less than £100	£5000 - £10000	Less than £100	Less than £5,000		More than £100000	More than £200000	£100 - £200
OSWS13	£5000 - £10000	Less than £100	Less than £5,000	Less than £100	Less than £5,000		More than £100000	£100000 - £200000	Less than £100

OSWS20	Less than £5,000	Less than £100	N/A	N/A	N/A	£10000 - £50000	£20000 - 50000	Less than £100
OSWS14	Greater than £20000	£100 - £200	£10,000 to £20000	Less than £100	£5000 - £10000	£10000 - £50000	£50000 - £100000	More than £200
OSWS10	Greater than £20000	£100 - £200	£10,000 to £20000	Less than £100	£5000 - £10000		£20000 - 50000	More than £200
OSWS18	£10,000 to £20000	Less than £100	£10,000 to £20000	£100 - £200	£10,000 to £20000		£20000 - 50000	More than £200
OSWS1	£10,000 to £20000	Less than £100	Less than £5,000	Less than £100	Less than £5,000	More than £100000	£100000 - £200000	£100 - £200
OSWS6	Less than £5,000	Less than £100	N/A	N/A	N/A	£10000 - £50000	£20000 - 50000	Less than £100
OSWS11	£10,000 to £20000	Less than £100	N/A	N/A	N/A	More than £100000	More than £200000	Less than £100

Table 7-5 Option 4 (Local Works and Improved Maintenance) Costs excluding Option 3 Improved Maintenance Costs (*indicative costs not available however regular maintenance required)

Permeable Paving

The current incentive scheme operated by STWL gives customers an annual reduction of approximately 36% in their sewerage standing charge if all surface water connections to the STWL system are removed[25]. Annual sewerage charges for 2011/2012 in the Severn Trent region are between £88.35 and £265.05 for a property with a rateable value of £100 to £300[26]. This would therefore equate to a reduction of £31 to £95. At a cost of £73.99/m² (2012 price), applying permeable paving to a driveway of 30m², would total £2,220 giving a payback period of more than 100 years. Furthermore, it is unlikely that a permeably paved area of just 30m² would enable a total disconnection from the surface water sewer system. Therefore it is doubtful that customers would see this current scheme as attractive purely from a financial aspect and a greater level of investment by the water company and / or local authority combined with the potential for a sliding scale of reductions would be necessary. For households to see the £2,220 (Present Value) returned in a more realistic timeframe the annual incentive payments would need to be around:

- 50 year period = £90
- 20 year period = £150
- 10 year period = £240

A study carried out for the Greater London Authority[27] suggested that financial incentive of £17 per m² would be reasonable. This was based on an indicative cost benefit analysis of the quantifiable environmental benefits realised from installing green roofs. This indicates that such a scheme may be worth pursuing in future.

Swales and Roadside Rain Gardens

The costs and ease of installing swales and roadside rain gardens in roads in Oswestry will be heavily influenced by the existing urban form. A study carried out in Westerville, Ohio found that installation of rain gardens in residential and public areas reduced the volume of runoff reaching the local storm water outfall was reduced by 82 – 95% during an 18 month monitoring period[28]. Additional benefits for wildlife and visual improvement are also realised as a result of installing these measures and it is therefore suggested that such schemes are worth pursuing in future.

Property Level Protection

The average benefit-cost ratio for the Defra pilot schemes[22] was 4.8 to 1, just below the threshold of 5 to 1 required for FDGiA funding, although the highest was 8.14 to 1. However, many of the pilot schemes assessed reviewed fluvial flooding where flood depths tend to be larger and thus damages greater. Consequently, a higher benefit-cost ratio is likely to be incurred compared to surface water flooding and therefore caution should be exercised when viewing these figures in respect to dealing with surface water flood alleviation. Where a property in Oswestry has confirmed reports of flooding due to surface water, it is suggested that property level protection may provide the protection required to mitigate future flood risk subject to frequency of flooding and further investigation.

7.5.3 Option 6 Policy Driven

The measures set out as part of Option 6 should be considered in conjunction with the other options as they will assist in supporting any option proposals. Although it is difficult to assign costs to planning and communication based measures, an estimate could be made by assuming for each additional team resource and annual cost of around £30,000[23] would be incurred. However, this extra cost would be expected to focus across the wetspots rather than being dedicated to a single wetspot. Therefore total costs are pro-rated downwards to reflect the remit of the works undertaken.

Shropshire Council along with other SWMP partners should work together to encourage public engagement with existing incentive schemes. Incentives are recognised as a key part of any package of measures to promote behaviour change through encouraging action[29].

Realisation of the benefits of policy based measures is likely to be a long term process. However, the permeable surfaces impact assessment carried out by the Department for Communities and Local Government[30] concluded that dependent on the cost of the permeable surfacing used, there was a net benefit (NPV) of up to £74,000,000 as a result of implementing a policy (within England) which would prevent householders from laying impermeable paving on their front garden without planning permission. It is therefore suggested that pursuing planning policies which contribute to reducing surface water runoff would also be beneficial.

7.6 Environmental Assessment

At this stage, an assessment of the impacts of each option on the environmental, amenity and cultural receptors has not been undertaken. As part of a pre-feasibility study, a review of the potential impacts, positive and negative, on these receptors must be carried out prior to implementing the proposed capital works. One Local Nature Reserve (LNR) at Shelf Bank and one Millennium Green at Plas Ffynon are located within the study area.

8 Phase 3 Options: Planning, Policy and Social

The Intermediate Assessment Report outlined a number of options focussed planning, policy and social based actions that could be implemented in Oswestry. They are discussed under the following headings:

- Data and Asset Management (Section 8.1)
- Planning Policy (Section 8.2)
- Development Control (Section 8.2.4)
- Campaigns and Communication (Section 8.2.5)
- Emergency Planning (Section 8.2.6)

8.1 Data and Asset Management

Asset Register

Shropshire Council should ensure that asset registers are kept up to date in line with current guidance concerning their development and maintenance. Shropshire Council has developed a GIS database of known assets. Currently the asset data fields are not completed in their entirety and it is therefore recommended that Shropshire Council continue to pursue this so that a comprehensive database is collated which identifies as a minimum:

- Asset owner
- Condition

The survey data collated as part of this phase of the SWMP should be used to assist in this process in conjunction with the previously collated data. As the database develops, Shropshire Council (in consultation with other flood risk management authorities) will be in a position to identify those assets which they consider critical.

Culverted Watercourses

There are a number of culverted watercourses within Oswestry, some of which are identified as such on the Severn Trent Asset Database (UADMS). In other locations, culverted watercourses are identified as surface water sewers and in other locations the culverted watercourses do not appear in the database.

Further discussion between stakeholders is required to agree the point at which a culverted watercourse becomes a public sewer, the locations of culverted watercourses and the ownership in each case. To facilitate this discussion, the SWMP has identified:

- Locations where the classification of culverted watercourses and surface water sewers are ambiguous for example where a culverted watercourse joins a surface water sewer.
- Locations where OS mapping suggests a culverted watercourse should be present but no surface water sewers or culverted watercourses are identified in UADMS
- Locations where an open channel flows into a surface water sewer (identified in UADMS)

These are located in five main areas, listed below and shown in Figure C23 in Appendix C.

- Brynhafod Lane
- Mount Road to Beatrice Street
- English Walls
- Jasmine Gardens
- Radfords Field

CCTV Survey

The CCTV survey procured as part of this detailed SWMP has been reviewed. The following findings have been highlighted and mapped:

- Significant blockages
- Siltation (percentages estimated by survey company)
- Condition grade 5 (as identified by the survey company)

These are shown in Figure C24 in Appendix C.

Further opportunities to obtain additional data on the existing drainage network to improve understanding should be identified where practicable. This may include new surveys, condition assessments and capacity analysis for example, where the drivers for such work are identified and understood.

8.2 Planning, Policy and Social

8.2.1 Existing

Planning policy has a key role in guiding the principles of surface water management and ensuring that they are sustainable, appropriate and enforceable. There are two key planning policy documents which discuss surface water management in relation to planning policy.

Core Strategy

The adopted Shropshire Council Core Strategy[31] was published in March 2011 and states that development in Oswestry will be around 5000 to 6000 homes along with employment land. At least 750 dwellings and 4 to 6 hectares of employment land are proposed on a Sustainable Urban Extension (SUE) to the south east of Oswestry. This new development presents an opportunity to not only manage the existing situation but to improve and showcase sustainable surface water management in Oswestry.

Policy CS18 Sustainable Water Management states in relation to surface water management that:

All development within local surface water drainage areas, as identified by the Water Cycle Study, and any major development proposals, demonstrate that surface water will be managed in a sustainable and coordinated way. Proposals should be supported by either a Surface Water Management Statement or Plan, depending on the scale of the development;

All developments, including changes to existing buildings, include appropriate sustainable drainage systems (SuDS) to manage surface water. All developments should aim to achieve a reduction in the existing runoff rate, but must not result in an increase in runoff

Further guidance on designing safe developments, surface water management and water efficiency will be provided in a Water Management SPD.

Oswestry Place Plan

The Oswestry Place Plan[32] highlights a SWMP for Oswestry as a priority however, surface water management has not been raised as a need or priority by the Oswestry Local Joint Committee. This suggests that surface water management is not considered of high importance by the local community and that a more concerted effort will be required to engage the community in surface water management activities.

8.2.2 Future (Countywide)

It is recommended that the policy CS18 from the Core Strategy is pursued and that stronger links between surface water management proposals and the Place Plans across the county are made where appropriate as this will further support implementing existing policy, strengthen any initiatives and maximise further opportunities to reduce flood risk.

SPD

The proposed Water Management SPD should be used to increase stakeholder awareness and communicate local solutions for mitigating any increases in surface water flood risk as well as adapting to the existing risks. The SPD should make use of the wide evidence base collected as part of the Local Development Framework and consequently share this with planning applicants, the development industry and the community. The Planning Advisory Service[33] notes the following benefits to addressing sustainable development through SPDs:

Sustainability SPDs can address sustainable development and climate change by:

- Providing more detail on policies in the core strategy;
- Giving local evidence and guidance to applicants on the requirements and opportunities in an area;
- Being flexible enough to account for changing local, regional and national policies;
- Helping development management officers implement strategic policies;
- Forming the basis for collaboration and internal training with officers, councillors and external partners; and
- Making the case for sustainable development by outlining the benefits to developers and the community.

Local Flood Risk Management Strategy (LFRMS)

The FWMA states that a LFRMS must contain certain information and updated guidance was published by the Local Government Association (LGA) in November 2012 to assist LLFAs in producing the first round of LFRMS[34]. The LFRMS will specify the following:

- The risk management authorities in the LLFA area and what flood and coastal erosion risk management functions they may exercise in relation to the area. It will be important for the local strategy to identify any special arrangements agreed in the area where functions normally carried out by one authority are done by another.
- The objectives for managing local flood risk. These should be relevant to the circumstances of the local area and reflect the level of local risk. The Regulations have a narrow scope focussing on identifying and addressing 'significant' flood risk. The scope of the LFRMS is not specified in the FWMA and can be much wider to reflect the local circumstances.
- The measures proposed to achieve the objectives.
- How and when the measures are expected to be implemented.
- The costs and benefits of those measures and how they are to be paid for.
- The assessment of local flood risk for the purpose of the strategy. In the first instance it is likely that the LLFA will use the findings from the PFRA[3] and any other studies that are available, such as Catchment Flood Management Plans and Strategic Flood Risk

Assessments. The strategy can identify gaps in understanding of the local flood risk and specify what actions need to be taken to close these gaps.

- How and when the strategy is to be reviewed. A review cycle is not specified, so it is up to the LLFA to decide what is appropriate. It may be advisable to link it to the cycles for the Flood Risk Regulations outputs.

- How the strategy contributes to the achievement of wider environmental objectives

The LFRMS must consider a full range of measures including resilience and other approaches which minimise the impact of flooding. It must also interact with the National Flood and Coastal Erosion Risk Management Strategy (henceforth referred to as the 'National Strategy')[35] whilst maintaining distinct objectives relevant to the local community.

The National Strategy sets out long-term objectives for flood and coastal erosion risk management and how these will be achieved. In guiding the LFRMS, the National Strategy aims to improve the communities which are at greatest risk. The strategy should also aim to encourage more effective risk management by enabling people, communities, business and the public sector to work together to:

- Ensure a clear understanding of national and local flood and erosion risks in order to effectively prioritise investment in risk management;
- Make clear and consistent risk management plans for risk management so that communities and businesses can make informed decisions;
- Encourage innovative management of flood and coastal erosion risks taking account of the needs of communities and the environment;
- Support communities in their response to flood warnings whilst also ensuring that emergency responses to flood incidents are effective, and;
- Assist communities with rapid and effective recovery post flooding.

The LLFA has a duty to maintain and monitor the LFRMS.

This SWMP report should be used to inform the LFRMS, particularly in terms of setting objectives for managing local flood risk, the strategies for doing so and where the responsibilities for actions and funding lie. It is recommended that the monitoring framework for both the LFRMS and SWMP should be consistent to enable effective and efficient review of progress.

8.2.3 Future (Local)

The following specific policies for Oswestry should be considered as part of the SPD or future Development Management Policies:

Blue and Green Corridors

Where watercourses flow in open channel within urban areas, efforts should be made to ensure that the watercourse corridor is protected to prevent any encroachment onto the floodplain. Specific locations identified include:

- High Fawr Avenue
- Llanforda Rise / Whiteminster / Lower Minster / Jennings Road
- Maesbury Road Industrial Estate

There may be potential for de-culverting of some watercourses to provide increased floodplain storage and slow runoff into the sewer system. There are limited opportunities due to the urban nature of the town but possibilities include:

- Cae Glas Park
- Railway Heritage Centre
- Plas Ffynon Millennium Green

The potential impacts of this approach must be investigated prior to undertaking any works.

Runoff to the Sewer System

As much of Oswestry is currently impermeable and the predominant method of surface water removal is via a below ground system, it is important that residents are aware of the impact of increased surface water runoff on both volume and rate of surface water runoff.

Watercourse Maintenance

All watercourses in Oswestry should be inspected and maintained regularly to ensure that they are free of debris. Any structures on or in the watercourse should also be regularly inspected and maintained. Section 7.2 identifies locations where the survey highlighted overgrown channels or blocked screens. Section 8.2.5 further details how community campaigns and communication can help in this process.

8.2.4 Development Control

Planned New Development

Table 8-1 summarises the potential new development sites identified for Oswestry.

Site Reference	Location	Proposed Use	Area	Wetspot ID
OSW003	Oldport Farm, Gobowen Road	Residential	2.4	N/A
OSW029	Oswestry Leisure Centre, College Road	Housing (Education)	1.0	OSWS18
OSW030	Land at The Cottams, Morda Road	Residential	2.3	N/A
OSW034	Land south of The Cemetery (site A)	Residential	2.0	N/A
OSW035	Land south of The Cemetery (site B)	Residential	2.3	N/A
OSW045	Land off Victoria Fields	Residential	0.6	N/A
OSW033	Council Depot, Alexandra Road	Residential	0.9	OSWS4
OSW002	Gobowen Road, north of Jasmine Gardens	Residential	2.8	N/A
OSW004	Gobowen Road / Whittington Road	Residential	12.1	N/A
OSW042	Richard Burbidge Whittington Road	Residential	5.9	OSWS15
SUE OSW	Oswestry Sustainable Urban Extension, Shrewsbury Road / A5	Employment Land	5.7	N/A
SUE OSW	Oswestry Sustainable Urban Extension, Shrewsbury Road / A5	Housing Land	24.3	N/A
SUE OSW	Oswestry Sustainable Urban Extension,	Open Space	2.7	N/A

	Shrewsbury Road / A5			
SUE OSW	Oswestry Sustainable Urban Extension, Shrewsbury Road / A5	Open Space	0.5	N/A

Table 8-1 Proposed Development in Oswestry

The potential new development sites listed in Table 8-1 were introduced to the integrated model as an additional test to assess potential development impacts. The model was updated with the estimated number of dwellings per site and the sub-catchment impermeability altered accordingly. This demonstrated that the new development increased flood depths recorded at manholes in the vicinity; the greatest increases in flood depth were observed around development OSW033. It is therefore recommended that suitable guidance is provided to developers to control runoff from these developments. Shropshire Council should also investigate the possibility of Section 106 / Community Infrastructure Levy (CIL) / Partnership Funding contributions for any works in Brogyntyn Park if the development OSW033 was to go ahead.

Sites on Gobowen Road (OSW002 and OSW004) and OSW042 on Whittington Road have surface water flow pathways across them during the 3.33% AEP and 0.5% AEP. Consequently, the development of these areas should look to implement surface water management that intercepts, attenuates and slows this overland flow.

Development site OSW042 is adjacent to the potential location of the attenuation area at the Railway Depot. Therefore any attenuation works carried out at the Railway Depot should consider working with the development site to reduce flood risk in the surrounding area. Partnership funding opportunities from the developer to implement the proposed attenuation scheme at the Railway Depot should be explored.

Although the level of planned development at present appears relatively low, due attention should be paid to that which is planned and also to the potential for windfall sites. It is also highlighted that the cumulative impacts of piecemeal development can also be significant.

Existing Shropshire Council Guidance

Shropshire Council has produced an interim guidance document for developers[36] which sets out the council's requirements for surface water management. Consultation on this document was closed in March 2011. It is the aspiration that this document will eventually be replaced by the proposed water management SPD. Shropshire Council should be consulted with reference to the key guidance points from this document which fall under the heading of:

- Runoff Rates; considering new development and re-development
- Surface Water Drainage; disposal methods, network requirements, ownerships and responsibilities
- SuDS; location, capacity, maintenance and responsibilities
- Designing for exceedance: principles and assessment of routes
- Role of river corridors

Proposed Additional Guidance

It is recommended that the following additional development guidance is provided:

- Information should be provided on any contributions required for strategic measures or local schemes. For example, attenuation works in Brogyntyn Park or the Railway Depot. (See above)

- Who should be consulted on new development when preparing and obtaining approvals for flood risk management measures and links to the asset register required under the FWMA in order to clarify ownership and responsibility.
- Use of the wetspots identified in this SWMP to further guide site specific flood risk assessments.
- Encouragement to use green roofs and permeable paving material wherever possible
- How to generate / where to find the most up to date information on SuDS suitability and proposals. For example CIRIA guidance, Environment Agency guidance, Buildings Regulations, planning and ground investigations with reference to the Groundwater report in Appendix D.

SuDS Specific Guidance

As well as the interim developer guidance produced by Shropshire Council, the following should be consulted and adhered to where necessary.

Standards and Regulations

A new on line resource was launched by CIRIA in October 2012; Susdrain is a community that provides a range of resources for those involved in delivering SuDS.

The existing CIRIA SuDS guidance (SuDS Manual[19], Preliminary Rainfall Runoff Management for New Development (revised in 2012)[37] , Model Agreements and Interim Code of Practice for SuDS[38]) are referenced in the Shropshire Council guidance and provide a useful starting point for promoting SuDS uptake in Oswestry. However there is a raft of guidance, information, photos and case studies available on the Susdrain website which should also be used to inform and refine SuDS guidance.

Following the FWMA, Defra published draft national standards for the design, operation and maintenance of SuDS[39] which set out the criteria on which the type of drainage appropriate to any given site or development can be determined. Consultation on these standards was undertaken during Spring 2012 and a summary of responses published in August 2012[40]. Shropshire Council must ensure it keeps up to date with any advances.

Adoption

The FWMA introduces the concept of a SuDS Approving Body (SAB), to be constituted by unitary authorities or county councils (LLFAs).

The role of a local SAB will be to approve local SuDS applications where construction work has implications for the performance of drainage system. They will apply strict standards that will achieve benefits for water quality as well as flood management. The SAB also has a duty to adopt SuDS providing they are constructed in accordance with the approved proposals and the system functions accordingly. As part of the approval process, the SAB can require a non-performance bond to be paid which would be refunded in full once the work was completed to the satisfaction of the approving body.

The FWMA also enables SABs to devolve the responsibility of SuDS adoption to other organisations such as land owners on the condition that all partners are in agreement.

This will ensure that the proposed ownership responsibilities are suitable and, in particular, that the responsibility for SuDS serving more than one property rests with an organisation that is both durable and accountable.

8.2.5 Campaigns and Communication

Alongside any capital schemes and proposed planning policies, there is a need to engage communities with the concept of surface water flood risk. Education is key to achieving this and, therefore, it is recommended that Shropshire Council, in conjunction with the Environment Agency, Severn Trent Water and Oswestry Town Council where appropriate, consider the following actions.

Raising awareness of culverted watercourses

Identify culverted watercourses and other hydraulic structures. It is important for the public to know where these culverts are located and the importance of keeping them clear, particularly during high rainfall events. This improved public understanding is important to maintain the function of assets in Oswestry and has the potential to reduce the impact of high rainfall events.

Raising awareness of the impacts of increased impermeable areas

Educate residents and businesses with regard to the impacts of increasing impermeable areas within their properties. Use this opportunity to encourage the minimisation of inappropriate increases in impermeable areas. In conjunction with this raise awareness of the STWL scheme, for reduced sewerage charges; this scheme gives a 36% reduction if a property owner can demonstrate that no surface water drains to the public sewer system[25]. Shropshire Council should also look for opportunities to provide subsidies for permeable materials and any national schemes to this effect.

The responsibilities of riparian owners

Identifying and raising awareness of the duties of riparian owners of watercourses and how failure to meet the requirements of riparian ownership will impact on both the immediate and wider area.

Community flood plans

A community flood plan helps community members and groups plan how they can work together to respond quickly in the event of a flood. The Environment Agency has a guidance document which is available on their website[41]. A flood plan should:

- Improve communication and ensure appropriate people are involved at each stage
- Optimise resources
- Help share knowledge
- Clarify responsibilities
- Encourage involvement of volunteers
- Reduce damage and distress

Shropshire Council should be prepared to support the development of community flood plans as required.

Supporting community groups

Continued support of community groups and forums (e.g. North West Shropshire Flood Forum) as well as looking to broaden their understanding of surface water flooding. Engage these groups to assist Shropshire Council by monitoring the local area for littering of assets, rising water levels etc.

Developer forums

Facilitate developer forums where necessary to consider cumulative impacts and strategic solutions, as well as opportunities to reduce local flood risk.

Cumulative benefits of individual actions

Increase the uptake of water butts by householders and businesses either by raising awareness of existing subsidy schemes (e.g. STWL offers on water butts) or by developing a Shropshire specific scheme. This will, cumulatively, help slow runoff into the surface water system.

Encourage residents to 'green' their gardens and existing curtilages, again to slow the entry of water into the surface water network.

8.2.6 Emergency Planning

Multi Agency Flood Plan

The information provided in the SWMP, including outputs from the FMfSW, AStSWF and modelling should be used to assist in the future development and revisions of the Shropshire Multi Agency Flood Plan (MAFP) which Category 1 Responders (SC in this case) are required to produce[42]. Specifically this will include identifying safe evacuation routes, meeting points, traffic management arrangements, shelters and reception centres, vulnerable people, critical infrastructure as listed in the MAFP checklist[43].

9 Phase 3 Options: Agree Preferred Options

The SWMP guidance states that the preferred option should include mix of immediate and long term options, capital investment, quick wins, aspirations and policy recommendations. Table 9-1 summarises the preferred options for the 14 priority wetspots.

Wetspot	Long Term	Capital Investment	Quick Win	Policy
OSWS9	Option 4: Encourage reduction in impermeable areas including use of permeable paving Consider property level protection for properties with known flooding problems	Option 3: Removal of blockages and remediation of cracks in sewers	Option 3: Removal of blockages and remediation of cracks in sewers Focussed and pro-active maintenance	Implement Option 6 recommendations
OSWS8	Option 4: Encourage reduction in impermeable areas including use of permeable paving	At this stage, capital options are not economically viable but further work is recommended when more reliable topographical data is available	Option 3: Focussed and pro-active maintenance	Implement Option 6 recommendations
OSWS5	Option 4: Encourage reduction in impermeable areas including use of permeable paving Consider property level protection for properties with known flooding problems	At this stage, capital options are not economically viable but further work is recommended when more reliable topographical data is available	Option 3: Focussed and pro-active maintenance	Implement Option 6 recommendations
OSWS15	Option 4: Encourage reduction in impermeable areas including use of permeable paving /swales / rain gardens	None identified	Option 3: Focussed and pro-active maintenance	Implement Option 6 recommendations Proposed development within wetspot should be used to improve surface water management

Wetspot	Long Term	Capital Investment	Quick Win	Policy
OSWS12	Option 4: Encourage reduction in impermeable areas including use of permeable paving /swales / rain gardens Consider property level protection for properties with known flooding problems	At this stage, capital options are not economically viable but further work is recommended when more reliable topographical data is available	Option 3: Focussed and pro-active maintenance	Implement Option 6 recommendations
OSWS4	Option 4: Encourage reduction in impermeable areas including use of permeable paving /swales / rain gardens Consider property level protection for properties with known flooding problems	Option 3: Removal of blockages and remediation of cracks in sewers At this stage, no other capital options are economically viable but further work is recommended when more reliable topographical data is available	Option 3: Removal of blockages and remediation of cracks in sewers Focussed and pro-active maintenance	Implement Option 6 recommendations Proposed development within wetspot should be used to improve surface water management
OSWS13	Option 4: Encourage reduction in impermeable areas including use of permeable paving /swales / rain gardens Consider property level protection for properties with known flooding problems	None identified	Option 3: Channel clearance Focussed and pro-active maintenance	Implement Option 6 recommendations
OSWS20	Option 4: Encourage reduction in impermeable areas including use of permeable paving Consider property level protection for properties with known flooding problems	None identified	Option 3: Focussed and pro-active maintenance	Implement Option 6 recommendations

Wetspot	Long Term	Capital Investment	Quick Win	Policy
OSWS14	Option 4: Encourage reduction in impermeable areas including use of permeable paving /swales / rain gardens Consider property level protection for properties with known flooding problems	None identified	Option 3: Focussed and pro-active maintenance	Implement Option 6 recommendations
OSWS10	Option 4: Encourage reduction in impermeable areas including use of permeable paving /swales / rain gardens	Option 3: Removal of blockages and remediation of cracks in sewers At this stage, no other capital options are economically viable but further work is recommended when more reliable topographical data is available	Option 3: Removal of blockages and remediation of cracks in sewers Focussed and pro-active maintenance	Implement Option 6 recommendations
OSWS18	Option 4: Encourage reduction in impermeable areas including use of permeable paving /swales / rain gardens	None identified	Focussed and pro-active maintenance	Implement Option 6 recommendations Proposed development within wetspot should be used to improve surface water management
OSWS1	Option 4: Encourage reduction in impermeable areas including use of permeable paving /swales / rain gardens Consider property level protection for properties with known flooding problems	Option 3: Removal of blockages and remediation of cracks in sewers At this stage, no other capital options are economically viable but further work is recommended when more reliable topographical data is available	Option 3: Removal of blockages and remediation of cracks in sewers Focussed and pro-active maintenance	Implement Option 6 recommendations

Wetspot	Long Term	Capital Investment	Quick Win	Policy
OSWS6	Option 4: Encourage reduction in impermeable areas including use of permeable paving /swales / rain gardens Consider property level protection for properties with known flooding problems	At this stage, capital options are not economically viable but further work is recommended when more reliable topographical data is available	Option 3: Focussed and pro-active maintenance	Implement Option 6 recommendations
OSWS11	Option 4: Encourage reduction in impermeable areas including use of permeable paving Consider property level protection for properties with known flooding problems	Option 3: Removal of blockages and remediation of cracks in sewers At this stage, no other capital options are economically viable but further work is recommended when more reliable topographical data is available	Option 3: Removal of blockages and remediation of cracks in sewers Focussed and pro-active maintenance	Implement Option 6 recommendations

Table 9-1 Preferred Options

10 Phase 4 Implementation and Review

10.1 Action Plan

Implementation & Review Phase; Prepare Action Plan

10.1.1 Requirements

The Defra Technical Guidance sets out the key elements the SWMP Action Plan should cover. These requirements are addressed as part of this report and the relevant section is referenced in brackets.

- The objectives set out at the start of the SWMP (Section 1.3.2)
- Capital and maintenance actions and programmes of work for each partner including proposed timing and manner of implementing the actions (Section 10.1.2)
- Advice and information to local authority planners (Section 8)
- Advice and information to local resilience forums and emergency planners (Section 8.2.6)
- A programme of further work or follow up actions (Section 10.1.3)
- When the SWMP will be reviewed and updated and how implementation will be monitored (Section 10.2)
- A list of any other flood risk management measures being undertaken in the plan area to achieve objectives in European legislation (Section 10.3)

10.1.2 Actions

Table 10-1 lists the key actions pertaining to the capital and maintenance and planning, policy and social elements identified throughout this SWMP report. Previous chapters should be consulted for further details. The following timescales have been assumed:

- Immediate: To be commenced as soon as the SWMP is published
- Short Term: To be commenced within the next year
- Medium Term: To be commenced within the next two to five years

Actions relating to further work are included in Section 11.2.

ID	Action	Lead Responsibility	Timescale
Capital and Maintenance			
CM1	Clearance of overgrown channels and inlet screens	Riparian Owners coordinated by Shropshire Council as Land Drainage Authority	Short Term

CM2	STWL to review CCTV data and add to database in order to justify future work. Works to be prioritised in line with current priorities and processes.	STWL	Short Term
CM3	STWL to review CCTV data and add to database in order to justify future work. Works to be prioritised in line with current priorities and processes.	STWL	Short Term
CM4	Commence discussions between Shropshire Council and STWL regarding culverted watercourses / surface water sewers	Shropshire Council / STWL	Immediate
CM5	Implement a proactive and intelligent gully cleaning system to better focus funds and improve effectiveness of works carried out.	Shropshire Council	Continuous
CM6	Investigate potential for deculverting watercourses where practical	Shropshire Council	Medium Term
CM7	Regular inspection of open channel watercourses and screens followed by developing a targeted maintenance programme	Riparian Owners coordinated by Shropshire Council as Land Drainage Authority	Immediate
CM8	Obtain improved LiDAR data when available (note that it is not in Geomatics schedule for 2013)	Shropshire Council to make contact with Environment Agency / Geomatics	Medium Term
CM9	Obtain property threshold levels to inform assessment of any capital schemes	Shropshire Council	Medium Term
CM10	Review capital schemes once improved topographic data is available	Shropshire Council	Medium Term
CM11	Review the feasibility and potential for installing swales / permeable paving / rain gardens in the wetspots highlighted in Table 7-2. Identify requirements for additional studies to inform decision making	Shropshire Council	Medium Term
Planning, Policy and Social			
PPS1	Publish, maintain and monitor the LFRMS	Shropshire Council	Immediate and Continuous
PPS2	Use opportunities arising from proposed development in Oswestry to showcase sustainable water management	Shropshire Council	Continuous
PPS3	Consider setting up developer forums to discuss integrated approaches to surface water management	Shropshire Council	Continuous
PPS4	Use SPD to communicate local solutions for mitigating any increases in surface water flood risk as well as adapting to the existing risks	Shropshire Council	Short Term

PPS5	Review the most appropriate vehicle for implementing surface water drainage policies, noting that SPDs can only provide guidance rather than setting policy.	Shropshire Council	Short Term
PPS6	Monitor/update/ maintain the Shropshire Council Developer Guidance prior to the water management SPD being produced	Shropshire Council	Immediate
PPS7	Provide additional development guidance on any requirements for contributions to local schemes, asset ownership / consultees / the SAB process	Shropshire Council	Short Term
PPS8	Ensure duties of the SAB are maintained either by Shropshire Council or by devolving the responsibility to a third party	Shropshire Council	Short Term
PPS9	Engage with Town Council and Oswestry Local Joint Committee to raise awareness of the need for sustainable surface water management across the town incorporating aspirations to embed more green space within Oswestry	Shropshire Council / Oswestry Town Council	Short Term
PPS10	Enhance communication with communities to develop the notion of responsibility for and ownership of surface water management and protection from flooding of private property including awareness of culverted watercourses, increases in impermeable area and riparian responsibilities	Shropshire Council / Oswestry Town Council	Short Term
PPS11	Ensure that policies and guidance results in protection of watercourse corridors	Shropshire Council	Short Term
PPS12	Ensure policy CS18 from the Core Strategy is pursued and make stronger links between surface water management proposals and the Place Plans across the county are made where appropriate to further support and strengthen any initiatives	Shropshire Council	Short Term
PPS13	Continue to develop and maintain the Shropshire Multi Agency Flood Plan (MAFP)	Shropshire Council	Immediate
PPS14	Support Community Flood Plans as appropriate	Shropshire Council	Continuous
PPS15	Take part in consultations on the uFMfSW	Shropshire Council	Immediate

Table 10-1 Oswestry Action Plan: Capital, Maintenance, Planning, Policy and Social Actions

10.1.3 Further Work and Follow Up Actions

Further work and follow up actions are listed in Section 11.2.

10.2 Monitoring

Implementation & Review Phase; Implement and review action plan

10.2.1 Monitoring Implementation

Shropshire Council will take responsibility for monitoring the implementation of the SWMP. The Action Plan associates timescales with each action.

The FWMA requires that an LLFA must develop, maintain, apply and monitor a strategy for local flood risk management in its area. The LGA guidance on LFRMS is a 'Living Document' and this should be considered in conjunction with the SWMP.

10.2.2 Review Framework

As a minimum the SWMP should be reviewed in line with the LFRMS and PFRA[3] every six years. However, given that the Action Plan is a working document, it would be advantageous that Shropshire Council review it in detail at least annually. Shropshire Council should also be aware of the immediate and short term actions which may require more frequent, perhaps quarterly reviews.

10.2.3 SWMP Updates

Ownership of the SWMP rests with Shropshire Council. As an evidence base, the previous phases of the SWMP do not require updating. Instead, the recommended works should be added to this evidence base and only the Action Plan element requires updating unless new data sources, priorities or opportunities dictate otherwise.

10.3 European Legislation

10.3.1 Water Framework Directive

The Water Framework Directive (WFD) came into force in December 2000 and was enacted into UK law in December 2003. The WFD identifies river basin districts which are used to manage the water environment, and also to identify the different types of water bodies for example, artificial and heavily modified, and by characterising surface waters by their physical and chemical characteristics. The WFD requires Member States to achieve 'good ecological status' in all surface freshwater bodies by 2015. Any modifications or measures which would put a water body at risk of failure to meet WFD would be unlikely to be permitted.

The River Morda and the River Perry are classified under the WFD, as shown in Table 10-2.The River Morda is within the study area. The River Perry is outside the study area but receives flows from Oswestry via the Common Brook.

	Current		2015	
Watercourse	**Ecological**	**Chemical**	**Ecological**	**Chemical**
River Morda	Moderate	Does not require assessment	Moderate	Does not require assessment
River Perry	Bad	Does not require assessment	Bad	Does not require assessment

Table 10-2 WFD Classification

There are surface water sewer outfalls to the River Morda, Consequently any changes to contributions to the network upstream of these outfalls should take due account of the WFD targets and the requirement to restore the watercourse to 'good ecological condition'.

The surface and combined sewer systems in wetspots OSWS13, 15 and 16 as well as part of OSWS12 drain east towards the Common Brook. Shropshire Wildlife Trust are managing on-going work in the Perry Catchment as part of their Magnificent Severn programme. Any works in these wetspots have the potential to interact with these on-going plans. Furthermore, it is the aspiration of Shropshire Wildlife Trust that foul and surface water flows are separated and only surface water flows allowed to discharge into the Common Brook. As with the River Morda this will assist in achieving 'good ecological condition' in the River Perry.

In April 2010, the Environment Agency updated their on line groundwater maps to use aquifer designations consistent with the WFD which also reflect the importance of aquifers in terms of groundwater as a resource as well as in supporting surface water flows and wetland ecosystems. The designation of the superficial deposits beneath Oswestry are 'Secondary A Aquifers'; these are 'permeable layers capable of supporting water supplies at a local rather than strategic scale' which can in some locations form an important source of base flow to rivers. Any schemes arising from the SWMP that will alter infiltration processes should ensure that they do not have negative impacts on groundwater.

10.3.2 Habitats Directive

The Habitats Directive requires Member States to take measures to maintain or restore at favourable conservation status, natural habitats and species of community importance. It created a network of protected areas around the European Union of national and international importance, termed Natura 2000 sites.

These sites include:

- Special Areas of Conservation (SACs) supporting rare, endangered or vulnerable natural habitats, plants and animals (other than birds).
- Special Protection Areas (SPAs) supporting significant numbers of wild birds and their habitats.

In the UK, the Habitats Directive is implemented by the 'Conservation of Habitats and Species Regulations 2010 referred to as the Habitats Regulations. Where plans or projects are proposed which may have a likely significant effect on a site, an assessment of the impact (appropriate assessment) is required. There are currently no Natura 2000 sites within the Oswestry study area although there is one Local Nature Reserve (LNR) at Shelf Bank and one Millennium Green at Plas Ffynon. Due account of these designations should be taken when considering the implementation of any measures.

10.3.3 Flood Risk Regulations

The Flood Risk Regulations transpose the EU Floods Directive into UK law and were introduced in December 2009. These set out the lead local flood authority role for unitary authorities and county councils. They require Preliminary Flood Risk Assessments and identification of Flood Risk Areas to be completed by June 2011.

The Flood Risk Regulations also set out the requirement to produce flood hazard and flood risk maps for all sources of flooding which must be published by December, 2013 and Flood Risk Management Plans by December 2015. Flood Risk Management Plans should set objectives for flood risk management and establish proposed measures for achieving those objectives.

The PFRA for Shropshire has been completed by Shropshire Council[3]. No nationally significant flood risk areas have been identified within Shropshire therefore there is no requirement to produce flood hazard and risk maps, or a flood management plan in this regulatory cycle.

11 Conclusions and Recommendations

11.1 Conclusions

Study Updates

- Since the publication of the Scoping and Intermediate Report:
  - A CCTV survey of selected parts of the sewer network and a channel survey of urban watercourses have been completed.
  - STWL have completed and supplied their InfoWorks Sewer model for use in this study.

Detailed Risk Assessment: Modelling

- InfoWorks ICM v2.5.2 has been used to apply a detailed 2D surface model to the existing STWL 1D sewer model and to incorporate several small sections of open channel on the periphery of the Oswestry urban area.
- The FMfSW DTM was used as the base DTM and detail was added using MasterMap and the channel survey data
- The critical storm duration was assessed as 120 minutes and five design events were modelled.
- Model validation was carried out using the historic event database and the Environment Agency FMfSW. Overall, the model results demonstrated consistency with reported events and predicted slightly less flooding than the FMfSW.

Detailed Risk Assessment: Quantification of Flood Risk

- A prioritisation exercise was undertaken for the wetspots, informed by the Scoping and Intermediate Report and the additional survey data collected. Fourteen wetspots were selected for further review.
- The assessment of cost associated with flood damage of properties in Oswestry has been assessed using the Defra and Environment Agency approved approach outlined in the Multi-Coloured Handbook.
- A 'Do Nothing' scenario was developed in discussion with STWL. The CCTV survey was used to add identified blockages and siltation and nominal sediment depths were added to pipes where velocities are less than 0.75m/s. Roughness in open channels was increased to 0.06.
- The 'Do Minimum' scenario was modelled as the existing situation with all elements of the pipe network running clear.
- There were some small reductions in damages for the 'Do Minimum' compared to the 'Do Nothing' scenario. As a result of the way in which the 'Do Nothing' scenario was modelled, the instantaneous negative impacts are not always pronounced enough to make the 'Do Minimum' look economically favourable. However, should regular maintenance cease, the rate of siltation in the network would increase resulting in an increase in flooding for the 'Do Nothing' scenario with the resultant impact of making the 'Do Minimum' look increasingly favourable into the future.
- The potential impact of climate change was modelled by adding 20% to rainfall (to assess impacts beyond 2100). Economic damages and properties at risk increased as a result.
- The potential impact of urbanisation was modelled by adding proposed development to the model with an increase in impermeable area of 0.75m²/house/year. The urbanisation

sensitivity testing resulted in observable flood extent variations in the vicinity of the development areas. However, there was only a minimal difference in flood extent elsewhere in the catchment.

- Increased urbanisation was not applied to areas away from proposed development sites due to the high density of the existing development.
- The sensitivity of the model to changes in the river levels at sewer outfalls was assessed and found to have a localised impact on pipe and manhole surcharge and only a minimal impact on flood extents.
- Potential impact of planned development on future flood risk was also assessed and it was found that flood depths at manholes some distance from the development sites were increased as a result of adding this new development.
- Results from the 'Do Minimum' model were used to identify key locations where overland flow from the rural fringe to the sewer system is predicted to occur. Overall, the results of this review found that for the 5% AEP and 3.33 % AEP, the surface water systems have sufficient capacity to accept the runoff and pass it along the system. Although the surface water system is 'at capacity' in the majority of locations reviewed, the manhole chambers have not yet been overwhelmed so the water stays within the system
- The groundwater assessment highlighted that the geological and hydrogeological attributes within and around Oswestry have the potential to result in groundwater flooding.
- Mains water leakage within Oswestry town centre is above the national average which could result in additional recharge to perched groundwater tables and hence a possible local rise in groundwater; this could exacerbate the risk of groundwater flooding.

Detailed Risk Assessment: Map and Communicate Flood Risk

- Updated surface water mapping, flood hazard and flood velocity maps have been produced as part of this study. Drawings are included in Appendix C.

Options: Flood Mitigation Measures Identification

- A series of measures were identified and evaluated for their potential use within Oswestry wetspots. These measures were then shortlisted using a two stage approach which scored their ease of implementation, effectiveness and cost and technical, economic, social and environmental suitability.
- Key findings from the measures short listing exercise were:
  - Swales and roadside rain gardens are generally unlikely to be suitable as the space between the highway and property boundaries is small to non-existent in many of the wetspots.
  - Improvements to the sub surface drainage network did not score highly because model results indicate that the network is performing to its design standard.
  - Scope for improved maintenance was identified from surveys as applicable in wetspots OSW4, OSW1, OSW13, OSW18, OSW10, OSW9 and OSW11.
  - There are potential locations for attenuation storage in Brogyntyn Park, Brynhafod Road Playing Fields Open space near the Railway Heritage Centre.
  - Property level protection is likely to be suitable for properties in Oswestry although funding will depend on the benefits realised.

Options: Assess Mitigation Options

- The measures identified for the 14 priority wetspots were combined into six options for assessment on a per wetspot basis:

- Option 1 Do Nothing
- Option 2 Do Minimum
- Option 3 Improved Maintenance
- Option 4 Local Works and Improved Maintenance
- Option 5 Capital Works and Improved Maintenance
- Option 6 Planning, Policy and Social

- Three capital works schemes, attenuation areas at Brynhafod playing fields, Brogyntyn Park and the Railway Depot were introduced to the integrated model in order to facilitate an economic assessment of costs and benefits.
- Damages for the 'Do Minimum' were less than or equal to the damages for the 'Do Nothing' in all wetspots, confirming that maintaining the pipe network in good condition is important.
- The economic assessment showed that in a number of wetspots no level of capital intervention is economically viable due to low benefit cost ratios. However the model parameters used in the 'Do Nothing' scenario represent only an instantaneous worst case. Cessation of any maintenance activities will increase the rate of siltation in the network resulting in an increase in flooding for the 'Do Nothing' scenario in future. As a consequence the 'Do Minimum' will look increasingly favourable into the future.
- None of the modelled capital schemes are shown to have a sufficiently robust economic justification at this outline stage to attract 100% Defra FDGiA funding without additional partnership funding contributions. However, further work using improved topographical data may increase the economic viability of the some of the capital schemes assessed to date.

Options: Planning, Policy and Social

- The Shropshire Core Strategy and the Oswestry Place Plan indicate that surface water management is on the local agenda and further work should be done to consolidate this.
- The recommendations for planning, policy and social measures are summarised in Section 10.1.2 and 11.2.

Options: Preferred Options

- Table 9-1 summarises the preferred options for the prioritised wetspots
- For the remaining, non-prioritised wet spots, the general principles set out in Section 8 should be implemented

Implementation and Review

- Table 10-1 summarises the main actions for the SWMP stakeholders. This table should be consulted for relevant information
- Monitoring of the implementation of the SWMP is to be undertaken by Shropshire Council; a review should be carried out every six years in line with the PFRA as a minimum. Intermediate reviews should be considered.

11.2 Recommendations

The SWMP Action Plan presented in Table 10-1 should be implemented and monitored accordingly. A summary of the key recommendations is given below.

Modelling

- During the model development, it was identified that overland flows from Brogyntyn Park contribute to surface water flooding in Oswestry. Due to the poor quality of DTM data across Oswestry, but particularly in this area, explicit modelling of the storage area was not possible. However indicative testing of reducing downstream flows suggests that benefits would be realised by constructing a storage area in this location. It is therefore recommended that once more accurate ground level data becomes available this option is re-visited.
- The model development identified another key overland flow path through the Railway depot adjacent to Oswald Road. There was poor quality DTM in this location as well therefore only an indicative option test was undertaken in this location. As above it is recommended that this area is re-visited once more accurate ground level data becomes available.

Economics

- If further modelling is pursued following provision of updated LiDAR data, it is recommended that threshold levels are collected before any detailed assessment of costs and benefits is carried out.

Capital Works

- Any scheme costs will require detailed feasibility assessment followed by a design process to accurately reflect the true costs incurred.
- Any changes to contributions to the network upstream of the river Morda outfalls should take due account of the WFD targets.
- Any changes to the network contributing flows into the River Perry catchment should consider both the WFD targets and also the on-going Perry Catchment initiatives.
- Any schemes arising from the SWMP that will alter infiltration processes should ensure that they do not have negative impacts on groundwater
- An environmental assessment will be required for any proposed schemes to ensure no detrimental impacts

Local Works and Maintenance

- See Table 10-1

Asset and Data Management

- Shropshire Council should ensure that asset registers are kept up to date in line with current guidance concerning their development and maintenance using the survey data collated as part of this phase of the SWMP where applicable.
- Further discussion between stakeholders is required to agree the point at which a culverted watercourse becomes a public sewer, the locations of culverted watercourses and the ownership in each case.
- Further opportunities to obtain additional data on the drainage network to improve understanding should be identified where the drivers for such work are identified and understood.

- Shropshire Council should assess the flood risk to each item of critical infrastructure using the outputs from this SWMP when the dataset is available.

Planning Policy

- See Table 10-1

Development Control

- Investigate the possibility of Section 106 / Community Infrastructure Levy (CIL)/ Partnership Funding contributions for any works in Brogyntyn Park if the development OSW033 was to go ahead (following recommendations for further work above).
- Liaise with developers for sites at Gobowen Road, Whittington Street and The Cemetery to implement measures to improve local surface water management
- Any future proposals for attenuation works at the Railway Depot should consider working with the developer of site OSW042 to reduce flood risk in the surrounding area and explore partnership funding opportunities.
- Use guidance, information, photos and case studies available on the Susdrain website to inform and refine SuDS guidance.
- Keep up to date with any advances on the publication of SuDS National Standards and the formulation of the SAB
- See also Table 10-1

Campaigns and Communication

- Surface water management has not been raised as a need or priority by the Oswestry Local Joint Committee therefor Shropshire Council should aim to engage the community in surface water management activities.
- Encourage the minimisation of inappropriate increases in impermeable areas. In conjunction with this raise awareness of the STWL scheme, for reduced sewerage charges
- Identifying and raising awareness of the duties of riparian owners of watercourses, the presence of culverted watercourses in the town and the need to green gardens and curtilages.
- Shropshire Council should be prepared to support the development of community flood plans as required.
- Facilitate developer forums where necessary to consider cumulative impacts and strategic solutions, as well as opportunities to reduce local flood risk.
- Make SWMP information available to inform Multi Agency Flood Plan
- Shropshire council to take responsibility for monitoring the implementation of the SWMP
- See also Table 10-1

Groundwater

- Improve flood incident reporting and recording in order to build up a better understanding of problem areas (if any) and whether these are during rainfall events or post rainfall events;
- If problem areas are identified then a second phase of reporting should be formulated which could include a more detailed investigation of cause, possibly including drilling;

- Undertake consultation with the North West Shropshire Flood Forum including presentation of findings along with 'training' on SUDS and groundwater issues to facilitate better understanding of risks of development proposals;
- Review of Coal Authority records to check for mine flooding.

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