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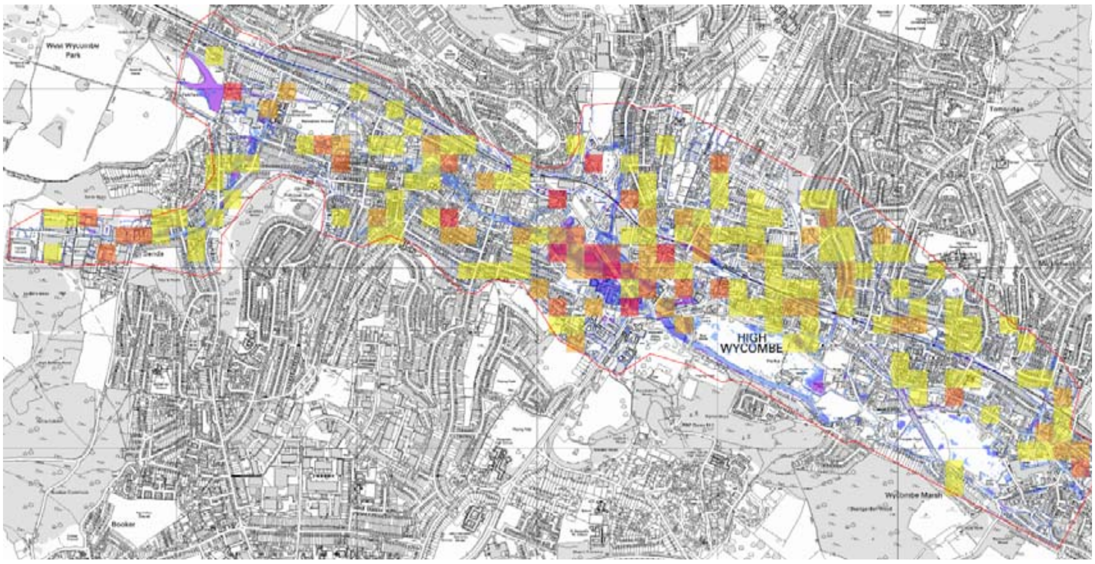
Buckinghamshire County Council

Surface Water Management Plan for Chesham and High Wycombe

Volume 1 – Summary Report and Action Plan

Photo of flooding in Broad Street, Chesham, in 2006 courtesy of Robert Craig



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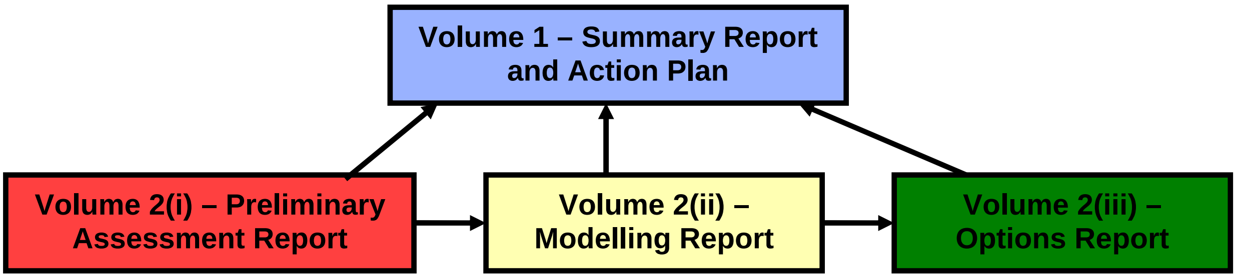
Map of the Surface Water Management Plan (SWMP) for Chesham & High Wycombe

Structure of the Reports



SWMP Report	Key Contents
Summary Report and Action Plan	• Study background and key surface water flooding issues (Sections 1.1 - 1.3) • Modelling results and economic damage assessment (Section 1.4) • Description of individual measures and approach to development of options to improve management of surface water flooding (Section 1.5) • Description of generic and location-specific options (Section 2.1) • Implementation and funding opportunities (Sections 2.2 & 2.3)
Preliminary Risk Assessment	• Buckinghamshire Strategic Flood Management Group and responsibilities of SWMP Partner organisations (Section 1.3) • Records of flooding in Chesham and High Wycombe (Section 3 & Appendix A & B maps) • Observations from site inspections (Section 5)
Modelling Report	• Details of model development (Sections 3 & 4) • Predicted pattern of flooding and maps of maximum depth and velocity (Section 5 and Appendix C – F maps) • Economic damage assessment in the current situation (Section 6 & Appendix G & H maps) • Results of modelling selected management options (Section 7 & Appendix I)
Options Report	• Details of individual measures (Section 2) • Details of options appraisal including feedback from the workshops (Section 3 and Appendix E) • Opportunities and constraints for all options (Tables 3.4 – 3.6) • Options considered but not included in the Action Plan (Appendix F)

Where to Find…

Topic	Report Section
Location map and detailed information on all options	This report Appendices A & B and Options Report Tables 3.4 to 3.6
Appraisal of options through indicative benefit:cost analysis, multi-criteria analysis and feedback from the options workshop	This report Tables 4 to 6
Natural drainage routes, topographic depressions, locations of past flooding etc.	Preliminary Risk Assessment Appendix A & B maps
Maps of maximum depth of flooding in the 3.33% (1 in 30) and 0.5% (1 in 200) AEP rainfall event	Modelling Report Appendix C to F maps
Details and maps of economic damage due to surface water flooding	Modelling Report Section 6 and Appendix G & H maps
Details of modelling of selected options	Modelling Report Section 7 and Appendix I

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Glossary

Term	Definition
AEP	Annual Exceedance Probability. A flood or rainfall event with a 1 in 100 (1%) chance of being exceeded in any year has an AEP of 1/100 or 1%.
Attenuate	Providing temporary storage or other measures designed to reduce the volume of surface runoff which could cause flooding. A particular focus is on reducing the peak flow.
BCC	Buckinghamshire County Council
BSFMG	The Buckinghamshire Strategic Flood Management Group was formed in 2009 to help meet the requirements of the Flood & Water Management Act and co-ordinate work amongst relevant stakeholders and partners. Meetings are held every two months with flexibility for quarterly meetings when work load decreases.
CDC	Chiltern District Council
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Culvert	A channel or pipe that carries water below the level of the ground.
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
FMfSW	Flood Map for Surface Water
Flood & 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 (partly) is to clarify the legislative framework for managing surface water flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a river.
LLFA / Lead Local Flood Authority	Local Authority responsible for taking the lead on local flood risk management
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers.
MCA	Multi Criteria Analysis (MCA) is a tool to assist decision-making where there are a number of different factors to consider. Each factor is scored and weighted to weigh up the benefits of different intervention options.
NRD	National Receptor Dataset – a collection of risk receptors produced by the Environment Agency
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
Pluvial Flooding	Flooding from water flowing over the surface of the ground or ponding before it has reached a watercourse or drainage system; often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with additional flow.
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.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment

Term	Definition
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	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
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.
Swale	A shallow vegetated channel designed to conduct and retain water, but also may permit infiltration. The vegetation filters particulate matter.
SWMP	Surface Water Management Plan
Symology	A Geographical Information System (GIS) database used by Buckinghamshire County Council (BCC) to record information on highway assets as well as other themes e.g. flood incidents
TW	Thames Water Utilities Ltd
UKCP09	The UK Climate Projections provide climate information designed to help those needing to plan how they will adapt to a changing climate. The data is focussed on the UK.
WDC	Wycombe District Council

1 Summary of the SWMP for Chesham and High Wycombe

1.1 Background and Document Structure

Based on national mapping provided by the Environment Agency, Defra identified that a significant number of properties in Chesham and High Wycombe may be susceptible to surface water flooding[1]. Subsequently, Buckinghamshire County Council (BCC), as the Lead Local Flood Authority (LLFA) was allocated funding to prepare a Surface Water Management Plan (SWMP) covering the two areas.

The purpose of the SWMP study is to identify sustainable responses to manage surface water flooding and to prepare Action Plans. The Action Plans and supporting material provide an evidence base for future decisions and funding applications for putting the recommendations into practice. Preparation of the Action Plans for Chesham and High Wycombe has followed the latest Defra guidance[2]. The Action Plan is presented in Chapter 2. Full technical detail can be found in the supporting reports listed in Table 1.

Table 1 Structure of the BCC SWMP reports

Report Volume	Title	Defra Guidance Stage
Volume 1	SWMP Summary Report and Action Plan	Implementation and Review
Volume 2(i)	Preliminary Risk Assessment	Preparation
Volume 2(ii)	Modelling Report	Risk Assessment
Volume 2(iii)	Options Report	Options

1.2 Types of Flooding Considered in this SWMP

Surface water flooding can be caused by intense rainfall before it enters a watercourse or sewer, overland flow resulting from high groundwater levels, exceedance of the capacity of the sewer network and 'out of bank flow' from small watercourses which are not designated as Environment Agency Main River. In addition to damage to properties, roads and other infrastructure, the onset of surface water flooding can be relatively sudden and can lead to both high velocity flows in steep areas and deep ponding of flood water. There is, therefore, a risk to life associated with significant surface water flooding.

This study considers that the greatest risk of local flooding in both Chesham and High Wycombe is from short duration high intensity rainfall. Options for better management of surface water are, therefore, focussed on reducing this type of flooding. Although improved maintenance of existing drainage systems is a key theme in the Action Plan, the SWMP also considers more extreme events which would overwhelm the finite capacity any drainage or sewer system.

In addition, the risk of flooding posed by substantially raised groundwater levels in the Chalk is recognised. This is most likely to be manifest in Chesham and High Wycombe by runoff along roads and other natural drainage paths into the urban areas, as well as increased baseflow in the watercourses. Runoff along natural

[1] http://archive.defra.gov.uk/environment/flooding/manage/surfacewater/index.htm
[2] Defra (2010) Surface Water Management Plan Technical Guidance March 2010

drainage paths caused by high groundwater levels can typically be managed in the same way as runoff from high intensity rainfall. Therefore, options are focussed on reducing runoff down natural drainage paths caused by either high intensity rainfall or raised groundwater levels, which are unlikely to occur at the same time.

Flooding from Main Rivers continues to be managed by the Environment Agency and is not within the scope of this SWMP study. However, interactions with Main Rivers have been considered and, in particular, close working with the Environment Agency on the Vale Brook culvert in Chesham has been included in this study. This is because the Vale Brook can be viewed as an open-channel and culverted watercourse which receives a substantial proportion of peak flow from inside the urban area and, therefore, performs an urban drainage function. A separate study is being undertaken by the Environment Agency building on the modelling work in this SWMP to further understand the risk posed by the limited capacity and poor condition of the Vale Brook culvert in Chesham. The results of this study will be reported alongside this SWMP when completed.

1.3 Partnership Approach to Flood Risk Management

The partnership approach to integrated flood risk management, as encouraged by the Flood & Water Management Act 2010[3], has been strengthened in this SWMP through integrated working between BCC (lead partner), Chiltern District Council (CDC), Wycombe District Council (WDC) the Environment Agency (EA), Thames Water (TW) and other stakeholders. Coordination of this Partnership working and the strategic direction for the SWMP has been overseen by the Buckinghamshire Strategic Flood Management Group (BSFMG).

The vision for the project has been interpreted from the objectives set out in the Project Brief as shown in Figure 1.

Options need to be technically feasible and affordable:

- Seek options providing social and environmental benefits
- Take advantage of development opportunities
- Cumulative benefit of a number of smaller options

Managing the risk will involve:

- Controlling runoff as close to its source as possible
- Keeping runoff on the surface and separate from foul water
- Not passing the problem downstream

Identify viable options to manage the risk of surface water flooding, for the benefit of the towns and people of Chesham and High Wycombe, both now and in the future.

Sustainable management will involve:

- Keeping likely flow routes clear of obstructions through planning and maintenance
- Raising stakeholder and public awareness of flooding so that its consequences can be reduced

Figure 1 The 'working' vision for the SWMP studies, highlighting key concepts

[3] http://www.legislation.gov.uk/ukpga/2010/29/contents

1.4 Assessment of the Risk of Flooding

Key flooding issues identified at the outset of this SWMP are summarised in Box 1.

Key surface water flooding issues common to Chesham and High Wycombe

- In many locations, flooding is likely to be caused by a mix of surface water and high river levels, both of which may be made worse by high groundwater levels.
- Identified natural drainage routes often have significant upstream catchments which could be activated when the surrounding Chalk hills become saturated or frozen and have reduced ability to absorb water. In some locations, these surface flow routes can follow steep terrain through dense residential housing and could pose a risk to life through high velocities.
- Few basements were observed although numerous properties had low thresholds, sometimes below the surrounding road/ground level.

Issues specific to Chesham

- The Vale Brook culvert in Chesham is known to be in a poor state of repair and of limited capacity. Although designated as Environment Agency Main River, the ability of the culvert to discharge surface runoff is integral to effective surface water management through central Chesham.
- Beyond a limited central area draining surface water to the culvert, the majority of surface water drainage is to soakaway. Maintenance of these soakaways and management of silt in runoff will be important to maintain their effectiveness over time.

Issues specific to High Wycombe

- Although High Wycombe is served by separate surface water and foul sewers, there is a known issue of ingress of surface water and/or groundwater into the foul sewer. Certain surface water sewers serving High Wycombe are known to operate regularly at full capacity but Thames Water has no evidence of flooding issues to justify improvements in the surface water network.
- Although culverts through the town centre have reduced fluvial flooding in high magnitude events, the River Wye is perched above the valley floor through some of the Desborough area, thus impeding discharge of surface water to the River from certain directions.

Box 1 Key surface water flooding issues in Chesham and High Wycombe

Two dimensional computer models have been developed to support the SWMP for Chesham and High Wycombe. The models have been used to better understand the locations and mechanisms of flooding and inform identification and development of management options.

The models cover the highest risk areas of both locations and are able to represent:

- direct rainfall on the urban areas
- overland flow through the built environment at 5m resolution
- groundwater discharge from the surrounding Chalk valleys
- the impacts of varying water levels in the various receiving watercourses, including the best available representation of the Vale Brook and the culvert through Chesham

The models have been used to predict the maximum flood depths and velocities for the following range of design events: 20% (1 in 5) AEP for Chesham and 10% (1 in 10) AEP for High Wycombe, 3.33% (1 in 30), 1% (1 in 100) AEP and 0.5% (1 in 200) AEP. The potential impacts of climate change have been represented in the models by increasing the rainfall intensities for the 1% (1 in 100) AEP events by 29% for Chesham and 23% for High Wycombe, in accordance with the latest UKCP09 guidance[4]. General observations from the modelling are summarised in Box 2. The maximum depths and velocities of flooding predicted for the 0.5% (1 in 200) events are displayed on the options maps in Appendix A (Chesham) and Appendix B (High Wycombe). It is noted that the models represent large and hydrologically complex areas and that a number of simplifications have had to be made. Therefore, the models should only be used for large-scale purposes similar to this study and any detailed design should include necessary improvements and refinements to the model. A parallel Environment Agency modelling study is investigating the impact of blockage of the Vale Brook culvert.

Maximum depths at individual properties in the Environment Agency National Receptor Database (NRD) have been used to estimate economic damages due to surface water flooding in the existing ('do minimum') situation. Assuming a uniform property threshold level of 0.15m above surrounding ground level, it is estimated that approximately £160M of damage (including indirect, intangible and emergency service costs where applicable) due to surface water flooding will be experienced across the modelled area of Chesham in the next 100 years, and £230M of damage across the modelled area of High Wycombe. For the 2,000 or so residential properties which are predicted to experience flooding in Chesham, the average annual damage could be around £1,700. For High Wycombe, around 2,800 residential properties are predicted to experience flooding, with average annual damages of £1,100. These high values are due, in part, to the relatively high market values for properties. The proportion of total residential properties experiencing flooding at some point in the 100 years is about 35% in both areas. This proportion is greater than the 17% (1 in 6) of all properties nationally which have been estimated by the Environment Agency to be at risk of flooding from the rivers, sea or surface water. It is also noted that non-residential properties account for a higher proportion of the total damages in High Wycombe (about 60%) than for Chesham (about 40%).

[4] http://ukclimateprojections.defra.gov.uk/

General observations from the modelling

- Predictions of deep and/or extensive flooding are largely consistent with recorded evidence of surface water flooding. Key risk areas identified by the model and historical evidence in Chesham include Berkhampstead Road, Broad Street and the Newtown area, St Mary's Way and the High Street, Pednormead End, Germain Street, Amersham Road and Waterside. Isolated flooding is predicted at locations on the steeper valley slopes, for example Hilltop and Hivings Hill which is consistent with anecdotal evidence. For High Wycombe, key risk areas identified by the model and historical evidence include locations through Sands, Desborough, Frogmoor through to St Mary's, London Road and steep roads running down to London Road.
- Throughout the majority of the modelled area of Chesham, the extent of flooding predicted by the SWMP model and the EA Flood Map for Surface Water (FMfSW) is similar, although the SWMP model generally predicts a somewhat smaller flood extent. For High Wycombe, the locations of deepest flooding predicted by the SWMP model and the EA FMfSW are similar, but the SWMP model consistently predicts a smaller flood extent.
- During the summer and autumn months, the large Chalk catchments draining to Chesham and High Wycombe are unlikely to be responsive to extreme rainfall (e.g. 1% AEP storm of 1 hours duration). After first making good the soil moisture deficit, the rainfall then recharges the aquifers so the impact on flows in watercourses is delayed for a number of months. Should such an extreme storm occur on a typical wet catchment, peak flows will substantially increase but only after a few weeks. If an extreme storm occurs on a saturated catchment, the catchment responds in days although the peak flows are not substantially higher.
- The maximum flood depths within the urban areas are not substantially influenced by flows from the chalk valleys arising from typical wet or dry catchments. The influence of outflows from the Chalk similar to those experienced in the winter of 2000/1 has not been tested since the long term rainfall leading to the 2000/1 event had an annual probability of less than 1% and the coincidence of this with a further extreme short duration (e.g. 1 hour) storm over the urban areas is a highly unlikely scenario. However, impeded discharge of surface water to the River Chess, Hughenden Stream and River Wye has been shown to have a substantial local impact on maximum flood depths which could occur during extremely high baseflow conditions.
- The Vale Brook culvert appears to have a capacity to convey between a 20% (1 in 5) and 3.33% (1 in 30) AEP storm flow when fully operational. The increase in flood depths suggested by removing the culvert is in the order of 0.1m and is greatest in the High Street area between Broad Street and the Star Yard car park. The extent of flooding is correspondingly increased.
- Comparison of the maximum flood depths in the 1% (1 in 100) AEP event indicates that a predicted 29% increase in rainfall intensity in Chesham due to climate change could result in an increase in flood depths of greater than 20%, depending on location. In High Wycombe a predicted 23% increase in rainfall intensity due to climate change could result in an increase in flood depths of between 10% and 50%, depending on location.

Box 2 Observations from the modelling in Chesham and High Wycombe

1.5 Options for Sustainable Management of Surface Water Flooding

Undertaking no maintenance on existing infrastructure and not planning for any improvement in flood risk management will result in an increasing flood risk as existing drainage capacity, resistance and resilience deteriorates and future climate change increases the frequency of extreme events. Therefore, a range of options has been identified to improve management of surface water flooding across Chesham and High Wycombe. The options have been developed from a review of previous studies, Multi-Criteria Analysis (MCA) of individual measures, site inspection, detailed modelling and consultation with project partners and stakeholder organisations. The options have been designed to fit within the overall philosophy as outlined in Box 3 and are designed to lead to sustainable management of surface water flooding, linking with reducing pollution and sediment transport and increasing aquifer recharge and open space where possible.

Philosophy for the Identified Options

- Seek management options providing social and environmental benefits – schemes with multiple benefits are more likely to attract funding
- Manage runoff and sediment transport close to its source and keep runoff on the surface wherever possible – this will be sustainable and have reduced maintenance costs
- Keep likely flow routes clear of obstructions through planning and maintenance – to reduce both the likelihood and consequences of flooding
- Raise stakeholder and public awareness of flooding – this will reduce the consequences of flooding and improve reporting and evidence of issues
- Implement identified options incrementally and take advantage of opportunities as they arise – 'piggy-back' flood risk management activities with other schemes

Box 3 Philosophy for the identified options

Options have been developed by grouping individual measures (which are introduced in Table 2) under the following headings:

- **Source control and Sustainable Drainage Systems (SuDS)**: Source control measures aim to reduce the rate and volume of surface water runoff through infiltration or storage. They can also provide some natural removal of pollutants and sediments, as well as aquifer recharge, which all provide environmental benefits. In constrained and highly developed urban areas like Chesham and High Wycombe, controlling inflows and reducing sediments and pollutants from entering the drainage system and watercourses will be a particularly desirable option.

- **Design for exceedance:** Roads, buildings and other features can be designed to control overland flow and direct it safely through the urban environment, such that floodwater is less likely to enter buildings or other structures. Designing for exceedance recognises that flows that exceed the below ground drainage capacity are always possible but can be managed to some degree by creating designated flow routes or other measures such as threshold raising at access points. These measures could be particularly successful in Chesham and High Wycombe which both have limited available open space along some key natural flow routes. However, potentially high flow velocities will require careful coordination with emergency planners.

- **Increasing capacity:** Adding storage and/or increasing the capacity of the sewer network, drainage infrastructure, and the various watercourses could improve the conveyance of floodwater and limit overland flow and flooding. This may be particularly relevant to the Vale Brook culvert in Chesham and surface water sewers in High Wycombe.

- **Separation of foul and surface water:** Alongside effective surface water management, this can reduce flooding and pollution. These options will be particularly applicable in High Wycombe.

- **Non-structural measures:** Non-structural measures can reduce the consequences for the receptors of flooding, e.g. people, property and the environment. In most cases, these are likely to be implemented across both locations through the introduction of council policy.

Options to improve management of surface water flood risk have been sought which also seek environmental benefits. The following have been identified as key environmental factors which should be considered during further development of the options:

- **Chalk streams:** The River Chess, Vale Brook, River Wye and Hughenden Stream are internationally rare ecosystems which are a priority to protect from pollution, sedimentation and the impact of low flows.

- **Source Protection Zones:** The Chalk aquifer underlying Chesham and High Wycombe is an important water resource which the Environment Agency Source Protection Zones (SPZs) seek to protect from pollution. Infiltration-based SuDS must respect the requirements of the SPZs.

- **Designated habitats:** The urban areas of Chesham and High Wycombe are surrounded by the Chilterns Area of Outstanding Natural Beauty and contain other environmentally designated areas.

1.6 Communication and Engagement

The SWMP has been developed in Partnership with key stakeholders and has included a number of consultation and engagement activities. These have included:

- Regular reports of progress and findings to the Buckinghamshire Strategic Flood Management Group
- Site inspections in December 2010 involving a number of elected members, including portfolio holders and ward councillors
- Internal BCC consultation in July 2011 involving a number of officers and technical experts
- Options workshop in High Wycombe on 13 July 2011 involving representatives from all key stakeholder organisations
- Options workshop in Chesham on 21 July 2011 involving representatives from all key stakeholder organisations
- Eight week public consultation during August and September 2011 which gathered responses from more than 30 individuals and organisations

Feedback from individuals and organisations has been used throughout the study to provide direction. In particular, the public consultation provided (i) anecdotal evidence of flooding which could be used to support funding applications and (ii) evidence of locations where improved maintenance of drainage may be warranted.

Table 2 Description of individual measures considered to improve surface water management

Category	Measure	Illustration	Category	Measure	Illustration	Category	Measure	Illustration
Source control and Sustainable Drainage Systems (SuDS)	**Fringe Interception** of runoff could reduce the volume of water entering the urban areas via overland flow or in the watercourses. The hills to the north and west of both locations are characterised by a number of dry valleys. Potentially, runoff from the saturated Chalk could be attenuated in detention basins or through alternative land management practices (e.g. contour ditching or afforestation).		Source control and SuDS	**Soakaways** are filled excavations which store runoff from single properties or larger developments and roads and allow infiltration into the surrounding soil. They only work in freely draining soils.		Separation of foul and surface water	**Greenfield developments** are usually separately sewered and such opportunities should be maximised. **Brownfield development** opportunities are generally as for Greenfield but the existing drainage system may be combined. Opportunities should be taken to convert to a separate piped system where practical.	
	Detention basins are surface water storage areas which provide flow control and reduction through attenuation. They are normally dry and therefore could be used as car parks (including underground car parks), recreational facilities etc for much of the time. It may be possible to reuse the stored water on site (e.g. irrigation or aquifer recharge) depending on storage arrangements.			**Water butts** are used to collect rainwater from individual properties for outside use although some capacity must be available at the start of a storm. Alternatively, downpipes can be disconnected from discharging directly into surface water drains and be routed through a SuDS attenuation feature. **Rainwater harvesting** collects rainwater for non-potable reuse both internally and externally.			**Misconnections** between the surface water and foul systems, or to reduce ingress into the foul system, should be rectified as opportunities arise. This can reduce pollution associated with surface water flooding.	
	Ponds and wetlands are designed to be areas of permanent standing water which can provide attenuation of flows and a certain degree of treatment. In doing so they can provide some improvement in water quality. They can provide ecological, aesthetic and amenity benefits.		Design for exceedance	**Surface flow routes**, formalised through road profiling etc, can be used to safely route exceedance flows through urban areas. **Green Streets** use attractive kerbside planters into which surface water on the road is directed. The plants provide some cleaning of the water, attenuation of peak flows and possibly infiltration of the stored water.		Non-structural measures	**Maintenance, desilting and removal of obstructions** can ensure that the watercourses and drainage infrastructure (particularly soakaways) are operating to their design potential. In the case of surface water features (e.g. watercourses, ponds, swales etc) this also provides improved amenity and aesthetic value.	
	Swales are shallow linear vegetated drainage features which can store and convey surface water. As part of an engineered flowpath, they can pass water from one storage/treatment area to the next and provide infiltration where underground conditions are suitable. Swales can be designed to be permanently wet or generally dry and are often located next to roads, car parks or other open spaces.			**Resistance and resilience** measures can be fitted to prevent surface water entering buildings and minimise the damage caused by flood water. Some form of grant assistance could be allocated to property owners for installation. The practicality of resistance measures that are deployed upon receipt of a flood warning would need to be carefully considered.			**Raising Awareness** of surface water flood risk within the councils, partner organisations and with the public may encourage property owners to consider property level resistance and resilience measures; discourage paving over property curtilage, building over watercourses or otherwise blocking of natural drainage routes; and encourage reporting and recording of flooding.	
	Green roofs covered with vegetation can intercept and retain precipitation to reduce the volume of runoff and attenuate peak rainfall flows. Large flat or gently sloping roofs (e.g. commercial buildings, schools and hospitals) are particularly suited and cost-effective.		Increasing capacity	**Increasing the capacity of the current drainage network** may be possible through enlarging existing sewers, adding new sewers (which can be oversized to provide additional storage) or providing overground storage through interruption of the existing surface water sewers. These measures could reduce the likelihood of discharge of potentially polluted floodwater.			**Flood Warning:** the Met Office and the EA operate an Extreme Rainfall Alert Service which provides county-scale alerts of extreme rainfall to Category 1 and 2 responders. Given the knowledge of areas most susceptible to surface water flooding, these alerts could be used to target responsive action.	FLOODFORECASTINGCENTRE
	Pervious pavements are suitable for pedestrian and vehicular traffic. Construction can use porous material which permits infiltration across the entire surface or material which is impervious to water but which is laid with void spaces to permit infiltration. The sub-base of the pavement may use geocellular block systems which provide storage.			**Opening up of culverted watercourse sections** has the potential to improve the capacity of the watercourses to receive and convey flood flows. Where rapidly passing peak flows could cause flooding downstream, any local improvement in conveyance should be offset with increased storage to attenuate the peak.			**Planning policies** could be developed and adopted by the councils to steer new development away from known surface water flood risk areas and flow paths or, if necessary, to control their development. Policies should also aim to control or limit urban creep.	

2 SWMP Action Plan

2.1 Generic and Location-specific Actions

Based on the work summarised in Chapter 1, Tables 4, 5 and 6 list the proposed options to manage the risk of surface water flooding in Chesham and High Wycombe. Six options have been identified for generic implementation across both areas, most likely through the introduction of CDC, WDC or BCC policy. Fourteen options have been identified for potential implementation at specific locations within Chesham and nine within High Wycombe. The number of options identified does not indicate the degree of risk. Table 4 lists the options which could be implemented generically across the two Districts. Table 5 and Table 6 list the location-specific options for Chesham and High Wycombe, respectively. The tables provide the following information:

- **Where?** For location-specific options, the location of the option.
- **What?** A brief description of the option.
- **How?** The suggested approach to implementing the option, including any identified priority actions.
- **Who?** The partner organisation(s) best placed to lead implementation. Primary and secondary action owners are identified because of the partnership working required.
- **When?** An indication of the timescales within which the option could be implemented:
  - Priority 1: A 'quick win' or action urgently required within 12 months
  - Priority 2: Consider now for implementation in the next 1-5 years
  - Priority 3: Consider now for longer term implementation (5 years+)
  - Priority O: Consider implementing if opportunity arises

  This priority therefore balances the degree of flood risk with the likely required timescale for implementation.
- **Multi-Criteria Appraisal:** For location-specific options, the sum of scores based on criteria in Table 3 (maximum score of 10 per option). Where applicable, technical (T) and economic (Ec) scores have been assigned on the basis of modelling and a high level assessment of the likely benefits and costs of implementing the option. SWMP scores have been assigned based on feedback from the Options Workshops and various consultations.

Table 3 Criteria and scoring for Multi-Criteria Appraisal of actions

Criteria	Description	Score
Technical (T)	Is it technically possible and do-able? Will the option actually reduce flood risk?	-2 severe negative outcome -1 moderate negative outcome 0 neutral outcome 1 moderate positive outcome 2 high positive outcome
Economic (Ec)	Is there a sufficient existing risk? Will benefits exceed costs?	
Social (S)	Will the community benefit or suffer from its implementation	
Environmental (Env)	Will the environment benefit or suffer from its implementation	
SWMP	Did the wider SWMP Partnership support this option via discussion at the Options Workshop?	

- **Potential Funding Route:** For location-specific options, the potential route to secure funding to implement the option is suggested, including where funding bids have been submitted as part of this SWMP. Ideas for funding opportunities are provided in Section 2.2.

The MCA of options in this scoping study has been undertaken at a high level. Feasibility studies and more detailed assessments are recommended in the Action Plan as a first step for further consideration of most options, except those concerned with property resistance/resilience. In particular, the following is noted for the economic assessment of options:

- Options have been represented in the model using 'reasonable' sizes and characteristics and such conceptual design has not focussed on reducing flood depth in any particular storm event. Detailed assessment is required to optimise the option design and may improve the indicative benefit:cost ratios stated.

- The assessment of damages avoided through implementing the options has ignored the beneficial impact of reducing flood depth on roads and other areas beyond property footprints, as well as environmental and social benefits which have not been quantified. Again, consideration of these factors may improve the indicative benefit:cost ratios stated.

- Cost estimates have been built up from unit costs of the main components of each option and include allowances for preliminaries, risk and optimism bias. They are, therefore, indicative of stand-alone projects. Some of the options could be undertaken locally without many of the overheads of stand-alone projects. In such cases, the allowances made for preliminaries, risk and optimism bias may be high or even not required and the actual cost of implementing the options could be lower.

- In many of the larger options concerned with reducing flooding in the town centres, a substantial proportion of the damages avoided is from non-residential properties. This may be relevant when considering funding of these options.

2.2 Implementation and Review

Improved and sustainable management of surface water flooding is unlikely to arise through implementation of some of the proposed options alone. Instead, the overall philosophy is for *incremental* change which *takes advantage of opportunities* as they arise to implement options which *cumulatively* have the effect of better managing flood risk. Therefore, it is strongly recommended that all options are kept in mind by the various key council teams and their potential reviewed on a regular basis. The SWMP Partnership should continue to meet quarterly to review the progress of implementing the options and identify opportunities. This is mostly likely to occur in the context of the Buckinghamshire Strategic Flood Management Group (BSFMG), which will assume overall responsibility for implementation and review of the SWMP.

Box 4 highlights some key messages which have been developed throughout the SWMP study. It is recommended that these key messages are considered alongside the options in Tables 4, 5 and 6. It is also recommended that the following are considered during further assessment and implementation:

- Although various SuDS measures proposed can provide some improvements in water quality and sediment control, runoff from roads and other areas of hardstanding should contain appropriate pollution and sediment control, especially when discharging into watercourses or through infiltration in Source Protection Zone areas.

- Chesham and High Wycombe lie within or near the Chilterns Area of Outstanding Natural Beauty and contain other designated habitats as well as rare Chalk stream habitats

- Green street planters would need to be maintained as any other SuDS feature, including removal of litter. Dual use of public areas for temporary storage of flood water would need to consider costs and responsibility for post-event clean up.

- Health and safety concerns over lowered roundabouts, dual use of public space for temporary flood storage and open watercourses in public areas would need to be resolved.

Key SWMP Messages

Sustainable surface water flood risk management requires considering flood risk when undertaking other council or stakeholder activities. If this is done:

- flood risk will be managed through the cumulative benefit of numerous smaller schemes (e.g. swales and temporary storage around Chesham);
- opportunities for 'piggy-backing' flood management activities onto other works will be identified and could result in cost savings, efficiencies and even implementation of flood management schemes which would otherwise be uneconomical (e.g. daylighting the Vale Brook culvert);
- the Districts will incrementally adapt to the potential impacts of climate change through creative water management, leading to multiple benefits and win-win solutions (e.g. ponds in Desborough); and
- awareness will be raised and maintained which will develop expertise (e.g. all generic options).

Examples of putting these into practice should include:

- When **new developments** are being considered – Could the layout be modified to better respect the natural drainage routes? Could larger SuDS features be created which also store high flows from outside the site?
- When **existing developments** are being modified – Could the building support a green roof or rainwater harvesting? Could car parks be made pervious or support shallow temporary storage? Could the resistance or resilience to flooding be improved?
- When **road works** are being undertaken – Could road drainage and/or sewers be cleaned? Could the road be re-surfaced so that surface water drains more easily in the right direction or green street planters be installed?
- When **sewers** are being maintained – Could oversized pipes be retrofitted? Could misconnections be identified and rectified?

Box 4 Key SWMP messages

2.3 Funding Opportunities

The following may provide opportunities to fund implementation of the options:

- **Buckinghamshire County Council:** As the Lead Local Flood Authority for the county which includes Chiltern and Wycombe Districts, BCC will be in receipt of formula grant funding provided by Defra to undertake the lead authority role. This grant is not ring fenced and so BCC will need to determine, in consultation with the other risk management authorities, how much is spent on which local priorities. Although BCC will retain overall responsibility for managing local flood risk, some of its responsibilities can be delegated. Therefore, there may be opportunities for CDC and WDC to work with BCC to build expertise and invest some of the available funding in improving surface water management in Chesham and High Wycombe.

- **Local Levy (Environment Agency):** The EA administers this source of funding which is raised by way of a levy on the county councils and unitary authorities within the Thames Regional Flood and Coastal Committee boundary. The local levy is used to support, with the approval of the relevant committee, flood risk management projects that are not considered to be national priorities and hence do not attract national funding through Flood Defence Grant in Aid (see next). The local levy allows locally important projects to go ahead to reduce the risk of flooding within the committee area.

- **Environment Agency/Defra Flood Defence Grant-in-Aid (FDGiA) funding**: The EA administers Flood Defence Grant in Aid (FDGiA) which is government money allocated to Risk Management Authorities, which now includes local authorities. The funding is for capital works which manage and reduce flooding, including for property level flood protection. Projects arising from flooding from ordinary watercourses, surface runoff, or from groundwater, are now eligible, although those arising from flooding from sewerage systems are not. To allocate FDGiA funding, the EA collates and appraises applications on an annual basis. From 2012/13 onwards, a fixed amount of FDGiA funding will be offered to any project, based on the outcomes it will deliver. Projects whose costs do not qualify for full FDGiA funding will require cost savings to be found and/or local contributions to proceed.

- **Developer's Section 106 contribution / Community Infrastructure Levy (CIL):** When new development occurs, a levy can be charged by the council which is designed to cover the cost of new public facilities required as a result of the development. Larger strategic developments have the potential to generate Section 106 / CIL funds which could be used to contribute to some of the options proposed in this SWMP and especially those which will have multiple benefits, e.g. pond or wetlands which can receive surface water as well as providing improved amenity value.

- **Thames Water - Investment Plan 2010 – 2015:** By 2015, Thames Water has committed to reduce flooding to around 1,700 properties on its 'risk register' which have flooded internally and over 500 which have flooded externally at least once every ten years. However, it is understood that the only investment planned within Chesham and High Wycombe is for improvements to the foul sewer down Micklefield Road. For Thames Water to consider implementing a scheme to reduce flooding, the cause must be related to the hydraulic inadequacy of the public sewerage system and, as a general rule, for each cluster of properties affected at least one of the properties must have been flooded internally. Thames Water works within a framework of cost and benefit so that where solution options do not meet specific criteria for affordability or benefit they do not proceed and more local measures (e.g. property resistance/resilience) may be considered. Working with the councils and the EA to implement some of the options proposed in this SWMP may be more cost-beneficial than, for example, enlarging the sewers. However, Thames Water investment in any scheme will have to be justified by the severity and frequency of sewer flooding and must be agreed with Ofwat at the start of the next five year period (2016 - 2020). Reporting sewer flooding to Thames Water is therefore crucial to seeking future investment.

Finally, it is emphasised that the voluntary sector could play an important role in improved flood risk management, supported by initiatives such as the Bucks Big Society Bank. The Environment Agency and other partners have established relationships with a number of volunteer organisations, some of who have expressed an interest during this study in assisting with e.g. maintenance of watercourses.

Table 4 Generic management options (in order of indicative priority) for both Chesham and High Wycombe

Generic Option ('What?')	Priority Actions ('How?')	Priority ('When?')[1]	Action Owners ('Who?')[2]	
			Primary	Secondary
Develop and implement a targeted maintenance schedule BCC (TfB), EA and TW should develop and implement a targeted (i.e. risk based) maintenance schedule so that the highway gullies, grips, soakaways, surface water sewers, other drainage assets (including SuDS) and the various watercourses operate to the maximum available capacity. A single organisation should coordinate maintenance activities where applicable.	1. Identify and record where existing infrastructure is and who owns and/or is responsible for maintaining it. This is particularly relevant for drainage to the Chesham culvert. A register of assets should be available to all partners via an online portal, including TW sewer network details. 2. Partners to develop maintenance schedules to target areas at higher risk of flooding. These should include at least the following: a. Chesham: Berkhampstead Road/Broad Street, Cameron Road, Hivings Hill, Waterside, Fullers Hill, Germain Street, Missenden Road (including River Chess culvert), Pednor Road, White Hill b. High Wycombe: London Road, Bowerdean Road, Micklefield Road, Lane End Road/Mill End Road, Desborough Road, Amersham Hill Where applicable, coordination of e.g. road and sewer cleaning could reduce traffic management costs. 3. Communicate coordinated maintenance activities with the public to manage expectations. In Chesham, the Town Council should be fully involved. 4. Arrange workshops on good maintenance practice, for both traditional and SuDS drainage infrastructure.	1	• BCC (TfB; highway drainage gullies)	• EA (Main Rivers) • TW (sewers in High Wycombe) • CTC (Chesham) • Riparian owners
Raise awareness of surface water flood risk Raise awareness of surface water flood risk within BCC, CDC, WDC and with the wider public. Link with encouraging use of rainwater harvesting, rain gardens and other source control measures, as well as uptake of property level resistance and resilience measures. Improved recording of flood events will benefit future funding applications.	1. Brief relevant council teams (particularly development planning and emergency planning) on surface water flood risk using SWMP materials. Consider adjoining authorities where runoff crosses political boundaries, e.g. runoff along Vale Road from Hertfordshire into Chesham. 2. Improve record keeping of flood events as evidence to support grant applications. Ensure all partners have access to the central data store. 3. Provide guidance on use of green roofs, rainwater harvesting, water butts, other source control measures and property level resistance and resilience measures. 4. Provide information regarding paving over of front gardens and construction within watercourses to appropriate council teams and the public via BCC website, and consider enforcement in some situations to encourage compliance 5. Undertake targeted awareness raising in identified high risk areas	1	• BCC • CDC • WDC • EA	• CTC (Chesham)
Develop a policy which prioritises green roofs, pervious paving or other appropriate SuDS where practicable Where practicable, green roofs should be the preferred option for new large non-residential buildings and retrofitted where existing roofs are being replaced. Similarly, car parks should be designed to use pervious paving during re-surfacing works or as part of new development.	1. Identify existing buildings and car parks with potential for green roofs or pervious paving 2. Partnership to agree a position statement on the preferred use of green roofs and pervious paving such that EA can provide necessary support in response to planning applications 3. Develop a sustainability policy regarding use of green roofs, pervious paving and other appropriate SuDS where practicable 4. Produce a map of areas with the potential for improved Green Infrastructure. Link this with the SWMP mapping of natural drainage routes to identify where Green Infrastructure could inform sustainable development through reduced surface water runoff.	1 (Position statement) 2 (Policy)	• BCC	• EA • CDC • WDC
Use highway design to improve management of surface water Permit temporary routing of surface flow along roads where practicable. Design roundabouts to accommodate shallow storage where beneficial and install green street planters to receive surface runoff where space permits.	1. Using information in the SWMP, identify key flow routes along roads, which roundabouts could provide useful storage and where planters could be installed to manage runoff and sedimentation 2. Submit funding applications to support proposed works	1	• BCC (TfB)	• EA
Continue to improve management of agricultural land to reduce runoff volume and sediment transport Maintain and further improve land management practices around urban centres to reduce surface runoff and associated erosion and sediment transport. Link with maintenance of farm ditches.	1. Identify agricultural land adjacent to primary natural flow routes and establish the status of land with respect to membership of stewardship schemes. Raise with Buckinghamshire Strategic Flood Management Group or one of its technical groups. 2. Where appropriate, promote and assist with applications to Higher Level Stewardship which tackle potential impacts of climate change, diffuse pollution, erosion, water quality and quantity.	1 (Identify land) 2 (Promote applications)	• BCC	• Natural England • Chiltern Conservation Board

Generic Option ('What?')	Priority Actions ('How?')	Priority ('When?')[1]	Action Owners ('Who?')[2] Primary	Secondary
Rectify misconnections and explore potential for surface water sewer interruption TW should develop a policy (in conjunction with other Partners) which could permit schemes to interrupt surface water sewers to provide overground attenuation and storage in extreme events. Individual schemes would still need to be justified. TW and councils should proactively seek to rectify misconnections.	1. CDC and WDC to raise awareness of potential household misconnections and seek their rectification. 2. TW to develop policy of sewer interruption based on discussions with Ofwat and other providers 3. TW to proactively identify/rectify misconnections between the foul and surface water sewers and ingress of groundwater into the foul sewer.	1 (Raise awareness) 2 (Development of policy on misconnections)	• CDC • WDC • TW	• BCC

Notes: [1] Priority 1: A 'quick win' or action urgently required within 12 months; Priority 2: Consider now for implementation in the next 1-5 years; Priority 3: Consider now for longer term implementation (5 years+); Priority O: Consider implementing if opportunity arises

[2] EA – Environment Agency; BCC – Buckinghamshire County Council; CDC – Chiltern District Council; CTC – Chesham Town Council; WDC – Wycombe District Council; TW – Thames Water

Table 5 Location-specific management options (in order of indicative priority) for Chesham

Option Location ('Where?')	Location-specific Option ('What?')	Priority Actions ('How?')	Priority ('When?')[2]	Action Owners ('Who?')[1] Primary	Action Owners ('Who?')[1] Secondary	Multi-Criteria Appraisal Technical	Economic[3]	Social	Environ-mental	SWMP	Overall Score (max. 10)	Potential Funding Route
Berkhampstead Road / Broad Street	***Property resistance/ resilience*** Improve property resistance/resilience for selected properties along Berkhampstead Road and Broad Street.	1. Submit a Flood Defence Grant in Aid (FDGiA) funding bid to EA/Defra for property level protection supplemented by any property-owner evidence of flood history 2. Encourage uptake of resistance/ resilience measures	**1** High priority due to flood history and future risk	• CTC • BCC (TfB)	• CDC	2 Products available	2 £101-£250k to protect 6-20 properties. Indicative B:C ratio of up to 4:1	0 No wider social benefits	0 No wider environ-mental benefits	2 Strong support	**6**	Flood Defence Grant in Aid (FDGiA) for property level protection
Amersham Road	***Property resistance/ resilience*** Improve property resistance/resilience for selected commercial establishments and residential properties adjacent to Amersham Road and Mineral Lane.	1. Submit a Flood Defence Grant in Aid (FDGiA) funding bid to EA/Defra for property level protection supplemented by any property-owner evidence of flood history 2. Encourage uptake of resistance/ resilience measures	**1** High priority due to flood history and future risk	• CTC • BCC (TfB)	• CDC	2 Products available	2 £51-£100k to protect 1-5 non-residential properties. Indicative B:C ratio of up to 6:1	0 No wider social benefits	0 No wider environ-mental benefits	2 Strong support	**6**	Local Levy to collate evidence of previous flooding
Waterside	***Property resistance/ resilience*** Improve property resistance/resilience for selected properties along Waterside.	1. Submit a Flood Defence Grant in Aid (FDGiA) funding bid to EA/Defra for property level protection supplemented by any property-owner evidence of flood history 2. Encourage uptake of resistance/ resilience measures 3. Lower kerbs under Riverside Court to ease surface flow into the River Chess	**1** High priority due to flood history and future risk	• CTC • BCC (TfB)	• CDC	2 Products available	2 £51-£100k to protect 1-5 residential properties. Indicative B:C ratio of up to 4:1	0 No wider social benefits	0 No wider environ-mental benefits	2 Strong support	**6**	Local Levy to collate evidence of previous flooding
The Spinney, Hilltop	***Attenuation of surface flow*** Provide kerbside storage at junction of The Spinney and Chesnut Avenue. Install a slot drain across The Spinney. Depending on infiltration rates, link the drain to a storage tank sited behind The Spinney properties via the adjacent footpath.	1. Check infiltration capacity at The Spinney 2. Pursue local levy funding bid (submitted) for feasibility study into all north Chesham options.	**1** High priority due to flood history and future risk	• BCC (TfB) • CTC	• None	1 Check availability of land behind properties on The Spinney	0 £51-£100k to protect 1-5 residential properties. Indicative B:C ratio of up to 1:1	1 Visual benefits from green street planters	1 Environ-mental benefits from green street planters	2 Strong support for an option at this location	**5**	Local Levy to supplement TfB funding to undertake a feasibility study. Consider together with other north Chesham options.

Option Location ('Where?')	Location-specific Option ('What?')	Priority Actions ('How?')	Priority ('When?')[2]	Action Owners ('Who?')[1] Primary	Secondary	Multi-Criteria Appraisal Technical	Economic[3]	Social	Environ-mental	SWMP	Overall Score (max. 10)	Potential Funding Route
White Hill	***Attenuation of surface flow*** Attenuate surface flow in detention basins formed by lowering existing grassed areas adjacent to junction with Victoria Road.	1. Pursue Local Levy funding bid (submitted) for feasibility study into all north Chesham options	**1** High priority due to flood history	• BCC (TfB) • CTC	• None	2 Technically feasible	-1 £26 - £50k to reduce flooding on Broad Street. Indicative B:C ratio for all north Chesham options of up to 1:1	1 Reduced flooding of roads	0 No change to existing open space	2 Strong support for an option at this location	**4**	Local Levy to supplement TfB funding to undertake a feasibility study. Consider together with other north Chesham options.
Hivings Hill	***Maintenance and attenuation of surface flow*** Supplement improved programme of maintenance of drains and soakaways with attenuation of surface flow in green street planters or rain gardens adjacent to the junction with Belmont Road.	1. Ensure Hivings Hill is prominent on the list of soakaways to be maintained by TfB 2. Pursue Local Levy funding bid (submitted) for feasibility study into all north Chesham options	**1** (Improved maintenance due to flood history) **2** (Feasibility of SuDS measures)	• BCC (TfB)	• CTC	2 Technically feasible	-1 <£25k to reduce flooding on Hivings Hill. Indicative B:C ratio for all north Chesham options of up to 1:1	1 Visual benefits from green street planters. Reduced flooding of road and footpath	1 Environ-mental benefits from green street planters	2 Strong support for an option at this location	**5**	Local Levy to supplement TfB funding to undertake a feasibility study. Consider together with other north Chesham options.
Newtown	***Routing and attenuation of surface flow*** Route surface flow from Bellingdon Road (via Sunnyside Road and Higham Road) into overground or underground storage in the Higham Mead industrial estate. Also route surface flow from Berkhampstead Road into the same storage.	1. Pursue Local Levy funding bid (submitted) for feasibility study into all north Chesham options 2. Undertake maintenance of the open Vale Brook between Higham Road and Townsend Road. 3. Consider area in any strategic redevelopment for uses compatible with natural storage for the Vale Brook	**1** (Maintenance of Vale Brook) **O** (Routing & attenuation during any strategic redevelopment)	• CTC (Vale Brook) • CDC	• BCC (TfB)	2 Underground storage technically feasible but will depend on plans for redevelopment	-1 £1M-£10M to protect 21-50 properties. Indicative B:C ratio for all north Chesham options of up to 1:1.	2 Reduced flooding on roads and pavements. No loss of overground land use.	0 No wider environ-mental benefits	1 Support for an option during redevelop-ment	**4**	Local Levy to supplement TfB funding to undertake a feasibility study. Consider together with other north Chesham options.
Pednormead End	***Attenuation of surface flow*** Attenuate flow along Missenden Road in a swale on the north side of the road between the junctions with Delmeade Road and Dawes Close. Reprofile Pednor Road adjacent to the Chesham Lawn Tennis & Squash Club to direct surface runoff into the River Chess and adjacent field.	1. Agree responsibility for maintaining River Chess culvert under Missenden Road and undertake maintenance as a high priority 2. Pursue Local Levy funding bid (submitted) for feasibility study into options for Pednormead End.	**1** (Maintenance of River Chess culvert) **2** (Feasibility study into attenuation)	• EA (River Chess) • BCC (TfB)	• CTC	2 Technically feasible with appropriate pollution control	1 £51-£100k to protect up to 6-20 properties. Indicative B:C ratio for this and Fuller's Hill option of up to 3:1	0 No change to existing open space	1 Additional pollution & sediment control could improve quality of runoff into River Chess	1 Support for an option at this location	**5**	Local Levy to supplement TfB funding to undertake a feasibility study

Option Location ('Where?')	Location-specific Option ('What?')	Priority Actions ('How?')	Priority ('When?')[2]	Action Owners ('Who?')[1] Primary	Action Owners ('Who?')[1] Secondary	Multi-Criteria Appraisal Technical	Economic[3]	Social	Environ-mental	SWMP	Overall Score (max. 10)	Potential Funding Route
Vale Road / Nashleigh Hill	***Routing and attenuation of surface flows*** Route surface flows which exceed the new road culvert into a detention basin on the west side of Vale Road to the north of Vale Farm. Route exceedance flows from Vale Road and Nashleigh Hill into a detention basin in the Recreation Ground.	1. Pursue Local Levy funding bid (submitted) for feasibility study into all north Chesham options	**2** Flood history and future risk balanced with timescale for feasibility study and implementation	• CTC • BCC (TfB)	• CDC	1 Technically feasible if carefully planned and designed	-1 £101-£250k component of £1M-£10M north Chesham options to protect 21-50 properties. Indicative B:C ratio for all north Chesham options of up to 1:1.	0 No change to existing open space	1 Reduced pollution & sediment runoff into Vale Brook and Chesham. Potential for aquifer recharge.	2 Strong support for an option at this location	**3**	Local Levy to supplement TfB funding to undertake a feasibility study. Consider together with other north Chesham options.
Cameron Road	***Attenuation of surface flow*** Attenuate surface runoff from Cameron Road in a swale adjacent to the Allotment Gardens running from the junction with Nalders Road to the junction with Greatacre.	1. Pursue Local Levy funding bid (submitted) for feasibility study into all north Chesham options.	**2** Flood history and future risk balanced with timescale for feasibility study and implementation	• BCC (TfB) • CTC	• None	2 Technically feasible	-1 £51-£100k component of £1M-£10M north Chesham options to protect 21-50 properties. Indicative B:C ratio for all north Chesham options of up to 1:1.	0 No change to existing open space	1 Reduced pollution & sediment runoff down Cameron Road.	1 Support for an option at this location	**3**	Local Levy to supplement TfB funding to undertake a feasibility study. Consider together with other north Chesham options.
Fuller's Hill	***Attenuation and routing of surface flow*** Attenuate surface flow along Fuller's Hill in a detention basin formed by lowering existing grassed area adjacent to junction with Fuller's Close. Route exceedance flow along Germain Street and into the River Chess.	1. Pursue Local Levy funding bid (submitted) for feasibility study into Fuller's Hill option.	**2** Flood history and future risk balanced with timescale for feasibility study and implementation	• BCC (TfB) • CTC	• None	2 Technically feasible	1 £26-£50k to protect 6-20 properties. Indicative B:C ratio for this and Pednor-mead End option of up to 3:1	1 Reduced flooding on Germain Street	0 No change to existing open space	1 Support for an option at this location	**5**	Flood Defence Grant in Aid (FDGiA) to undertake feasibility study.
Amersham Road junction with Amy Lane and Moor Road	***Attenuation of surface flow*** Lower roundabout to attenuate surface flow in a grassed detention basin / rain garden before discharging at a controlled rate to the River Chess.	1. Undertake feasibility study into scheme	**2** Flood history and future risk balanced with timescale for feasibility study and implementation	• BCC (TfB)	• CTC	1 Technically feasible if carefully planned and designed with appropriate pollution control	1 £26-£50k to protect 1-5 properties. Indicative B:C ratio of up to 3:1	1 Reduced flooding on Amersham Road	1 Reduced pollution & sediment runoff on Amersham Road and into the River Chess	1 Support for an option at this location	**5**	Council funding

Option Location ('Where?')	Location-specific Option ('What?')	Priority Actions ('How?')	Priority ('When?')[2]	Action Owners ('Who?')[1] Primary	Secondary	Multi-Criteria Appraisal Technical	Economic[3]	Social	Environ-mental	SWMP	Overall Score (max. 10)	Potential Funding Route
Sainsbury's, Library and Star Yard car parks, St Mary's Way	***Attenuation of surface flow and increase capacity*** Attenuate surface flow through pervious paving and underground storage in existing car parks. Incorporate daylighting of the Vale Brook through Library and Sainsbury's car parks to increase storage capacity.	1. Undertake feasibility study into storage and culvert daylighting scheme	**O** Future risk balanced with low benefits for flood risk reduction. Option would need to be driven by other considerations.	• EA	• CDC • CTC	1 Technically feasible if carefully planned and designed	-2 £1M-£10M component of £1M-£10M central Chesham options to protect 6-20 properties. Indicative B:C ratio for central Chesham options of only 0:1.	1 Open water-course through town centre could improve public amenity	1 Return culverted Vale Brook to a more natural watercourse	2 General support for an option which returns the Vale Brook to a more natural watercourse and reduces maintenance costs	**3**	Environment Agency to consider further as part of Vale Brook culvert feasibility study
High Street, between The Broadway and Red Lion Street	***Increase capacity of Vale Brook culvert*** Attenuate surface runoff in a rain garden at the Broadway. Route surface flows from The Broadway and the Vale Brook through the High Street via an open channel, discharging into the existing culvert at Red Lion Street.	1. Undertake feasibility study into storage and culvert diversion and daylighting scheme	**O** Future risk balanced with low benefits for flood risk reduction. Option would need to be driven by other considerations.	• EA	• CTC • CDC	1 Technically feasible if carefully planned and designed	-2 £1M-£10M component of £1M-£10M central Chesham options to protect 6-20 properties. Indicative B:C ratio for central Chesham options of only 0:1.	1 Open water-course through town centre could improve public amenity	1 Return culverted Vale Brook to a more natural watercourse	2 General support for an option which returns the Vale Brook to a more natural watercourse and reduces maintenance costs	**3**	Environment Agency to consider further as part of Vale Brook culvert feasibility study

Notes: [1] Priority 1: A 'quick win' or action urgently required within 12 months; Priority 2: Consider now for implementation in the next 1-5 years; Priority 3: Consider now for longer term implementation (5 years+); Priority O: Consider implementing if opportunity arises
[2] EA – Environment Agency; BCC – Buckinghamshire County Council; CDC – Chiltern District Council; CTC – Chesham Town Council; WDC – Wycombe District Council; TW – Thames Water

Table 6 Location-specific management options (in order of indicative priority) for High Wycombe

Option Location ('Where?')	Location-specific Option ('What?')	Priority Actions ('How?')	Priority ('When?')[1]	Action Owners ('Who?')[2] Primary	Secondary	Multi-Criteria Appraisal Technical	Economic	Social	Environ-mental	SWMP	Overall Score (max. 10)	Potential Funding Route
Coates Lane / Hughenden Road	***Improve property resistance/ resilience and reroute surface flow*** Improve property resistance/resilience for identified properties between Hughenden Road and Hughenden Stream. Route surface flow along Coates Lane into Hughenden Park via road reprofiling.	1. Submit EA/Defra Flood Defence Grant in Aid (FDGiA) funding bid to protect selected properties 2. Encourage uptake of resistance/ resilience measures at identified properties.	**1** (property level protection high priority due to flood history and future risk) **2** (routing and attenuation)	• BCC (TfB) • WDC	• NT	2 Property protection products available.	1 £51-£100k to protect 1-5 properties. Indicative B:C ratio of up to 2:1	0 No wider social benefits	1 Reduced pollution & sediment runoff on Coates Lane and into the Hughenden Stream	1 Support for works in this area	**5**	Flood Defence Grant in Aid (FDGiA) for property level protection and to supplement TfB funding
Lane End Road and Mill End Road, Sands	***Improve property resistance/resilience*** Improve property resistance/resilience for selected properties along Lane End and Mill End Roads. Provide kerbside storage along Lane End Road and Mill End Road in green planters/ rain gardens.	1. Pursue Local Levy funding bid (submitted) for property protection along Lane End and Mill End Roads and feasibility of kerbside storage at junctions of Lane End Road/Chapel Lane/New Road/Mill End Road, and Mill End Road/Gallows Lane 2. Encourage uptake of resistance/ resilience measures	**1** (property level protection high priority due to future risk) **2** (Kerbside storage)	• WDC • BCC (TfB)	• None	2 Products available	1 £101-£250k to protect 6-20 properties. Indicative B:C ratio of up to 2:1	1 Visual benefits from green street planters. Reduced flooding of roads	1 Environmental benefits from green street planters	1 Support for an option at this location	**6**	Flood Defence Grant in Aid (FDGiA) for property level protection and to supplement TfB funding.
Arnison Avenue / Bowerdean Road	***Improve property resistance/ resilience and attenuation and routing of surface flow*** Provide attenuation along Arnison Avenue and Bowerdean Road through use of detention basins sited at junctions of, Adelaide Road, Hill View Road and Totteridge Avenue and green street planters where space and parking requirements permit. Improve property resistance/ resilience along route as required. Route surface flow from Bowerdean Road into the River Wye at junction with London Road via lowered access track to High Wycombe Cricket Club ground.	1. Pursue local levy funding bid (submitted) to collate evidence of previous flooding and refine option. 2. Submit full FDGiA funding bid for property level protection and to supplement TfB funding for feasibility study into detention basins, kerbside attenuation and routing of surface water across London Road and into the River Wye via the Cricket Club access track. 3. Encourage uptake of resistance/ resilience measures at identified properties.	**1** (property level protection high priority due to future risk) **2** (attenuation and routing)	• WDC • BCC (TfB)	• None	1 Technically feasible if dual use of public and private areas can be agreed and with appropriate pollution control	1 £101-£250k to protect 6-20 properties. Indicative B:C ratio of up to 2:1	2 Visual benefits from green street planters and reduced flooding of Bowerdean and London Roads	2 Environmental benefits from green street planters and reduced pollution & sediment runoff into the River Wye	1 Support for options at this location	**7**	Local Levy to collate evidence and consultation to submit a full FDGiA funding bid

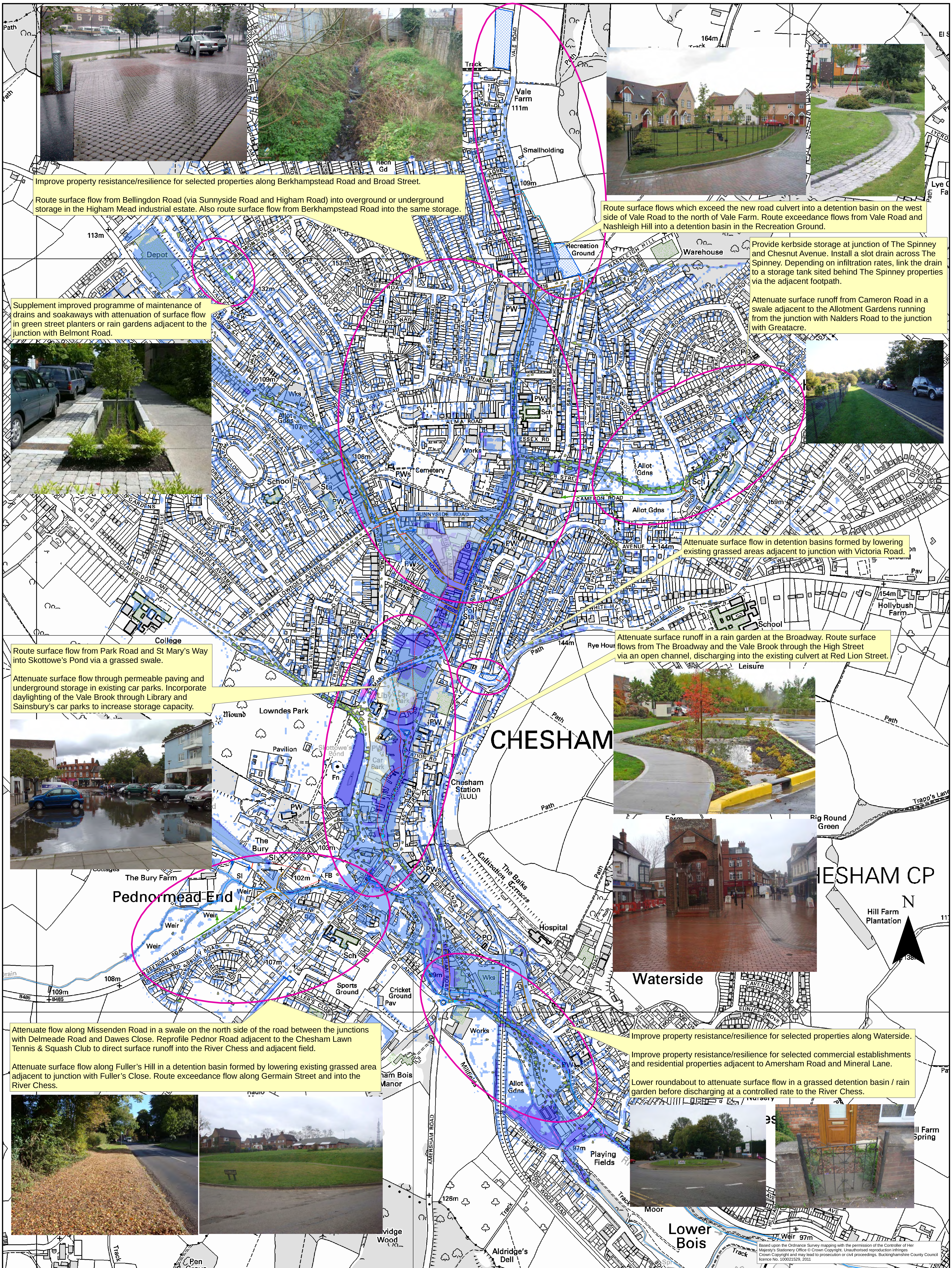
				Action Owners ('Who?')[2]		Multi-Criteria Appraisal						
Option Location ('Where?')	**Location-specific Option ('What?')**	**Priority Actions ('How?')**	**Priority ('When?')[1]**	**Primary**	**Secondary**	**Technical**	**Economic**	**Social**	**Environ-mental**	**SWMP**	**Overall Score (max. 10)**	**Potential Funding Route**
Micklefield Road	***Improve property resistance/ resilience and attenuation and routing of surface flow*** Provide attenuation along Micklefield Road through use of a detention basin sited at the junction of Herbert Road and green street planters where space permits. Improve property resistance/ resilience along route as required. Route surface flow from Micklefield Road into River Wye at the junction with London Road.	1. Pursue local levy funding bid (submitted) to collate evidence of previous flooding and refine option. 2. Submit full FDGiA funding bid for property level protection and to supplement TfB funding for feasibility study into detention basin, kerbside attenuation and routing of surface water across London Road and into the River Wye 3. Encourage uptake of resistance/ resilience measures at identified properties.	**1** (property level protection high priority due to future risk) **2** (attenuation and routing)	• WDC • BCC (TfB)	• None	1 Technically feasible if dual use of public areas can be agreed and with appropriate pollution control	1 £101-£250k to protect 6-20 properties. Indicative B:C ratio of up to 2:1	2 Visual benefits from green street planters and reduced flooding of Micklefield and London Roads	1 Environmental benefits from green street planters	1 Support for options at this location	**6**	Local Levy to collate evidence and consultation to submit a full FDGiA funding bid
West Wycombe	***Attenuation of surface flow*** Attenuate surface flow along the Oxford Road from the west through improved road drainage and a swale. Improve road drainage at low spot adjacent to the Library. Intercept and attenuate roof runoff and lateral flow which would otherwise discharge directly onto the High Street using green street planters where space permits. Raise kerbs at key locations along the High Street.	1. Pursue local levy funding bid (submitted) to collate evidence of previous flooding and refine option. 2. Submit full FDGiA funding bid to undertake feasibility study into drainage improvements, kerb raising and use of green street planters to intercept roof runoff.	**2** Flood history and future risk balanced with timescale for feasibility study and implementa tion	• BCC (TfB) • NT	• WDC	1 Technically feasible if NT agrees to works adjacent to its properties	1 £101-£250k to protect 6-20 properties. Indicative B:C ratio of up to 2:1	1 Visual benefits from green street planters and reduced flooding of the High Street	1 Environmental benefits from green street planters and reduced pollution & sediment runoff into West Wycombe and the River Wye	2 Strong support for works in this area	**6**	Local Levy to collate evidence and consultation to submit a full FDGiA funding bid

Option Location ('Where?')	Location-specific Option ('What?')	Priority Actions ('How?')	Priority ('When?')[1]	Action Owners ('Who?')[2] Primary	Secondary	Multi-Criteria Appraisal Technical	Economic	Social	Environ-mental	SWMP	Overall Score (max. 10)	Potential Funding Route
Desborough	***Attenuation and routing of surface flow*** Attenuate surface flows in pond or wetland as part of proposed open space on Abercromby Avenue and in a detention basin sited in the existing Desborough Street car park and pond or wetland in the currently open space at the junction with Victoria Street. Use green street planters / rain gardens at suitable places along Desborough Road. Route surface flow along Desborough Road to discharge into the existing storage tank under the Bus Station on Bridge Street.	1. Undertake feasibility study into attenuation and routing scheme, including ascertaining the capacity of the storage tank under the Bus Station	**3** Flood history and future risk balanced with timescale for feasibility study and implementa tion	• WDC	• BCC (TfB)	1 Technically feasible but will depend on redevelopment plans	1 £1M-£10M to protect 21-50 properties. Indicative B:C ratio of up to 3:1	2 Social benefits from green infrastruct-ure and improved open space	2 Environmental benefits from green infrastructure and reduced pollution & sediment runoff into the River Wye	2 Strong support for options in this area	**8**	Council funding supplemented by Council Infrastructure Levy (CIL) linked to appropriate new development
Frogmoor, St Mary Street	***Route surface flow*** Route surface flow from a detention pond at the Hughenden Road roundabout in a shallow cobbled swale/ channel through Frogmoor, White Hart Street and St Mary Street into the River Wye adjacent to the Fire Station, with online storage in a water feature in Frogmoor.	1. Submit full FDGiA funding bid for a feasibility study into the proposed scheme	**3** Flood history and future risk balanced with timescale for feasibility study and implementa tion	• WDC	• BCC (TfB)	1 Technically feasible but will depend on redevelopment plans and appropriate pollution control	2 £1M-£10M to protect 21-50 properties. Indicative B:C ratio of up to 5:1	2 Social benefits from open/ visible water-course in town centre	1 Environmental benefits from an open watercourse	1 Support for works as part of wider develop-ment proposals for the Hughenden corridor	**7**	Flood Defence Grant in Aid (FDGiA) for feasibility study
Amersham Hill / Crendon Street	***Attenuation and routing of surface flow*** Route surface flow down Amersham Hill and Crendon Street and into the River Wye adjacent to the WDC offices.	1. Investigate the construction and infiltration capacity of the escape lane on Amersham Hill to help determine the feasibility of using this as attenuation storage.	**O** Low perceived risk	• BCC (TfB)	• None	1 Technically feasible if minor changes to town centre roads permitted and with appropriate pollution control	1 £51-£100k to protect 1-5 properties. Indicative B:C ratio of up to 2:1	0 No wider social benefits	1 Environmental benefits from reduced pollution & sediment runoff into the River Wye	1 Some support for works in this area	**4**	Council (TfB) funding
West Wycombe Road at the junction with The Pastures and Desborough Avenue	***Route surface flow*** Route surface flow from The Pastures, across West Wycombe Road to discharge into the River Wye through road reprofiling	1. Undertake feasibility study into routing of surface water across West Wycombe Road and into the River Wye	**O** Low perceived risk	• BCC (TfB)	• None	1 Technically feasible depending on plans for road works and with appropriate pollution control	1 £26-£50k to protect 1-5 properties. Indicative B:C ratio of up to 4:1	0 No wider social benefits	1 Environmental benefits from reduced pollution & sediment runoff into the River Wye	1 Some support for works in this area	**4**	Council (TfB) funding

Notes: [1] Priority 1: A 'quick win' or action urgently required within 12 months; Priority 2: Consider now for implementation in the next 1-5 years; Priority 3: Consider now for longer term implementation (5 years+); Priority O: Consider implementing if opportunity arises
[2] EA – Environment Agency; BCC – Buckinghamshire County Council; CDC – Chiltern District Council; CTC – Chesham Town Council; WDC – Wycombe District Council; TW – Thames Water

Appendix A Options Map for Chesham

Appendix B Options Map for High Wycombe



Legend

- Road Profiling
- Property Resistance/Resilience
- Swale / Planters
- Surface Flow Routes
- Green Roofs
- Detention Basin
- Urban Storage
- Drainage Channel

Maximum Velocity (m/s) 0.5% AEP: 0.5 - 1.0; 1.0 - 2.0; >2.0

Maximum Depth (m) 0.5% AEP: <0.1; 0.1 - 0.5; 0.5 - 1; 1.0 - 1.5; >1.5

Digital River Network: Primary River; Secondary River; Tertiary River (MasterMap single line); Lake / Reservoir; Extended Culvert (greater than 50m)

0 0.125 0.25 0.5 Kilometers

Drawing Title	Chesham Options Map
Drawing Number	Appendix A

Chesham and High Wycombe SWMP

Buckinghamshire County Council

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU

Produced	DC	Nov 2011
Checked	NW	Nov 2011
Approved	DC	Nov 2011

Legend

- Road Profiling
- Property Resistance/Resilience
- Swale / Planters
- Surface Flow Routes

Maximum Velocity (m/s) 0.5% AEP

- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

- Green Roofs
- Detention Basin

Maximum Depth (m) 0.5% AEP

- <0.1
- 0.1 - 0.5
- 0.5 - 1
- 1.0 - 1.5
- >1.5

- Pond & Wetland
- Urban Storage
- Increase Capacity

Digital River Network

- Primary River
- Secondary River
- Tertiary River (MasterMap single line)
- Lake / Reservoir
- Extended Culvert (greater than 50m)

Drawing Title

High Wycombe Options Map

Drawing Number

Appendix B

0 0.25 0.5 1 1.5 2 Kilometers

Chesham and High Wycombe SWMP

BUCKINGHAMSHIRE COUNTY COUNCIL

JACOBS

1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU

Produced	DC	Nov 2011
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Approved	DC	Nov 2011