tend to have a shallow water table and are drained by the surface watercourses running through them. When water levels in these watercourses are high, less groundwater is able to drain away, leading to water-logging and groundwater emergence.

The Environment Agency's records of groundwater flooding reports broadly correspond with the ASGWF. There are several incidents recorded in the Cirencester and Siddington areas, and a few isolated incidents on the Great Oolite, probably related to springs.

4.6 Flooding from sewers

Sewer flooding occurs when intense rainfall overloads the sewer system capacity (surface water, foul or combined), and/or when sewers cannot discharge properly to watercourses due to high water levels. Sewer flooding can also be caused when problems such as blockages, collapses or equipment failure occur in the sewerage system. Infiltration, entry of soil or groundwater into the sewer system via faults within the fabric of the sewerage system, is another cause of sewer flooding. Infiltration is often related to shallow groundwater, and may cause high flows for prolonged periods of time.

Since 1980, the Sewers for Adoption guidelines have meant that most new surface water sewers have been designed to have capacity for a rainfall event with a 1 in 30 chance of occurring in any given year, although until recently this did not apply to smaller private systems.

This means that even where sewers are built to current specification, they are likely to be overwhelmed by larger events of the magnitude often considered when looking at river or surface water flooding (e.g. a 1 in 100 chance of occurring in a given year). Existing sewers can also become overloaded as new development adds to their catchment, or due to incremental increases in roofed and paved surfaces at the individual property scale (urban creep).

Thames Water has identified nine areas where properties were flooded internally by sewers in the 2007 event (Fairford, South Cerney, Ampney St Peter, Ampney St Mary, Upper and Lower Slaughter, Moreton-in-Marsh, Bourton-on-the-Water, Quenington). However, it recognises that there were many other areas where sewers caused flooding to gardens and open spaces[23].

In the winters of 2012/13 and 2013/14, sewer flooding problems have been experienced in South Cerney and Cirencester. The surface water sewer network in Cirencester is prone to surcharging when there are high river levels in the River Churn. This affected the Spitalgate/Trafalgar Road area. Some properties have been affected by foul sewer flooding. Sewer flooding has also been highlighted as a problem in recent years in combination with high river levels and surface water flooding at Lechlade and Fairford.

4.7 Flooding from reservoirs, canals and other artificial sources

4.7.1 Reservoirs

The risk of inundation to Cotswold District as a result of reservoir breach or failure of a number of reservoirs within the area was assessed as part of the National Inundation Reservoir Maps (NRIM) study[24]. The reservoir register for Cotswold District Council is detailed in Table 4-5.

Reservoir flooding is very different from other forms of flooding. It may happen with little or no warning and evacuation will need to happen immediately. The likelihood of such flooding is very difficult to estimate, but it is less likely than flooding from rivers or surface water. It may not be possible to seek refuge from floodwaters upstairs as buildings could be unsafe or unstable due to the force of water from the reservoir breach or failure. The Environment Agency maps represent a credible worst case scenario. In these circumstances it is the time to inundation, the depth of inundation, the duration of flooding and the velocity of flood flows that will be most influential.

The Environment Agency maps show there is a risk to Cirencester by a breach or failure of a The Lake at Cirencester Park (shown in Figure 4-1). Flood water would flow south east through the town affecting the A419 and roughly following Sheep Street, Querns Lane, Trinity Road and Watermoor Road before joining the River Churn floodplain.

[23] Hyder (2008) Review of Summer 2007 floods Phase 1 Hyder

[24] Environment Agency "What's on your back yard"? - Risk of flooding from Reservoirs

Table 4-5: Reservoir Register for Cotswold District Council

Reservoir	Situation	NGR	Year Built	Dam Type	Max Height (m)	Capacity (m3)	Surface Area (m2)
Cirencester Park - The Mansion	Cirencester	SP 01750 01750	1736	Unknown	2	38326	34200

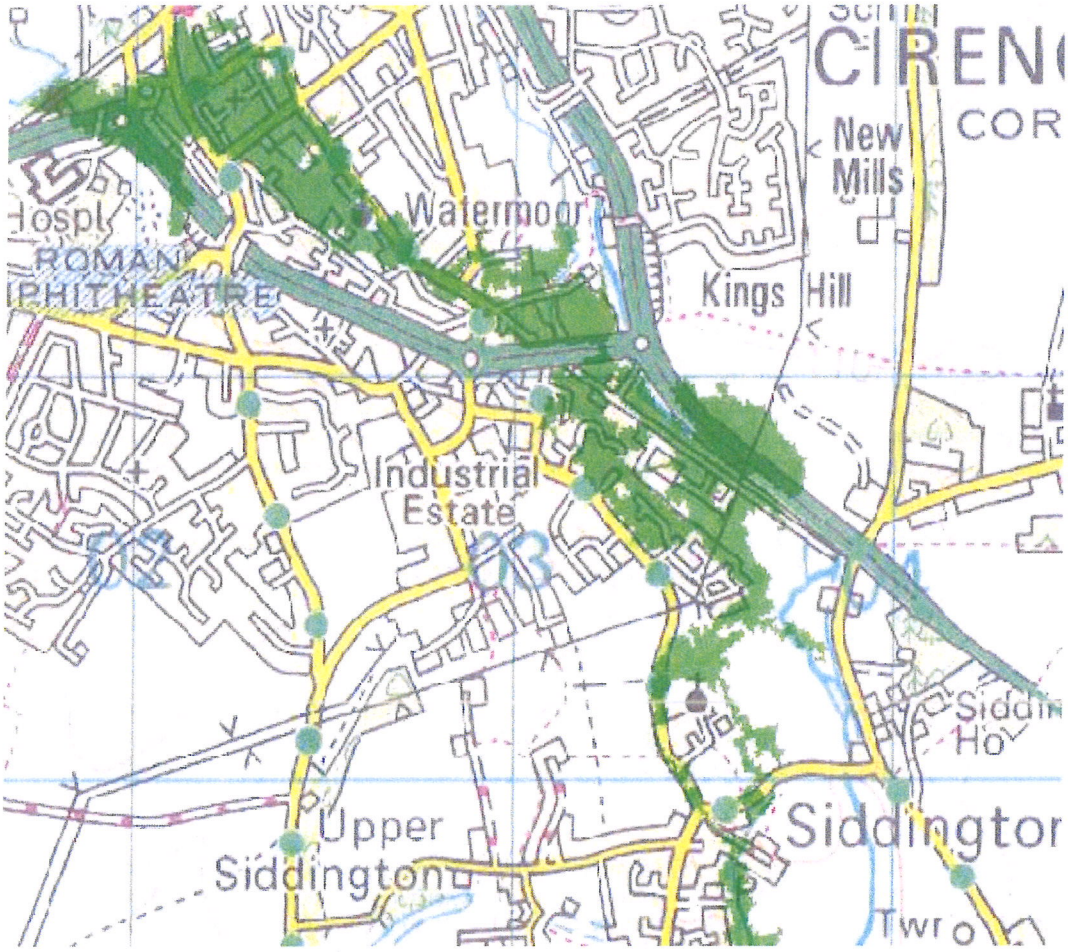

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Figure 4-1 Risk of flooding from reservoirs

4.7.2 Canals

There is one canal located within the District. The Thames and Severn Canal is located at the northern extent of the District and runs parallel to the River Frome for much of its length. There are no records of breach or overtopping of this canal in the District. The Canal and River Trust has indicated that there are no raised sections of canals within the Cotswold District.

At present canals do not have a level of service for flood recurrence (i.e. there is no requirement for canals to be used in flood mitigation), although the Canal and River Trust, as part of its function, will endeavour to maintain water levels to control the risk of flooding from canals to adjacent properties. It is important, however, that any development proposed adjacent to a canal be investigated on an individual basis regarding flooding issues and should be considered as part of any FRA.

4.8 The impact of climate change[25]

4.8.1 Fluvial flooding

On larger main rivers in wider valleys such as the River Churn and the River Thames, the estimated increase in flow under climate change scenarios has been modelled. The effect tends to be a noticeable increase in the mapped flood extent. Smaller watercourses in Cotswold (e.g. River Cam, Blockley Brook, and upper River Windrush) tend to be in areas of steeper topography with quite confined floodplains, and in these cases increases in flow do not result in a significant increase in flood extent. Even where no model is available, the difference between Flood Zone 3 and Flood Zone 2 can give a good indication of the impact of an increase in flows due to climate change on extent (a 100 year plus climate change event would usually be between these two in magnitude).

However, climate change does not just affect the extent of flooding. It is important to remember that even where the extents do not significantly increase, flooding is likely to become more frequent under a climate change scenario. For example, what is currently an event with a 2% probability of occurring in any one year, may increase to say a 5% probability under climate change.

The impact of an event with a given probability is also likely to become more severe, for example depths, velocities, hazard and therefore risk to people will increase. Although qualitative statements can be made as to whether extreme events are likely to increase or decrease over the UK in the future, there is still considerable uncertainty regarding the magnitude of these changes locally. Further details regarding the uncertainties in predicting the impacts of climate change can be found in

- Environment Agency (2011) Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities. September 2011
- UK Climate Projections (UKCP09)

4.8.2 Surface water

Climate change is predicted to increase rainfall intensity in the future by up to 30%. This will increase the likelihood and frequency of surface water flooding, particularly in impermeable urban areas, and areas that are already susceptible such as Moreton in Marsh and Fairford.

4.8.3 Groundwater

The effect of climate change on groundwater flooding problems, and those watercourses where groundwater has a large influence on winter flood flows (such as the River Churn), is more uncertain. Milder wetter winters may increase the frequency of groundwater flooding incidents in areas that are already susceptible. However, warmer drier summers may counteract this effect by drawing down groundwater levels more during the summer months, meaning that lower levels are experienced at the start of winter and it takes longer for recharge to occur.

[25] Environment Agency (2011) Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities. September 2011.

5 Review of potential development areas

5.1 Introduction

At the time of production of the SFRA, CDC identified 20 settlements for the SFRA to assess, 18 from the preferred development strategy of the Local Plan and an additional two requested by the Council's Principal Engineer. For the purposes of the SFRA, Cirencester and Siddington have been grouped together due to their proximity. The SFRA has therefore examined flood risk in and around these settlements. Table 5-1 lists the settlements identified.

Table 5-1: Settlements assessed by the SFRA

Andoversford	Moreton-in-Marsh
Blockley	Naunton ***
Bourton-on-the-Water	Northleach
Chipping Campden	Siddington*
Cirencester *	South Cerney
Down Ampney**	Stow-on-the-Wold
Fairford	Tetbury
Kemble	Upper Rissington
Lechlade	Weston Subedge** *
Mickleton	Willersey
* Cirencester and Siddington have been grouped together in the SFRA due to their proximity.	
**Down Ampney - Included in the SFRA but not the Preferred Development Strategy (May 2013). Substantial development opportunities have since been put forward for review in the draft SHLAA; and combined with Down Ampney's potential as a sustainable location, as noted in the 2nd Issues and Options Paper (2010) and Evidence Paper it was considered pragmatic and appropriate to include this settlement in the SFRA	
** *Weston Subedge and Naunton - Locations requested for inclusion in the SFRA by the Principal Engineer for West Oxfordshire and Cotswold District Councils.	

A review of the draft SHLAA/SELAA in early 2014 identified potential sites for development, contained within this SFRA. The SFRA has assessed flood risk at the potential sites for development.

5.2 Settlement summary sheets and maps

Flood risk from all sources has been described in more detail for each key settlement. This information is provided in a 'summary sheet' format in Appendix B. Each summary sheet also gives further information about the implications for development. The following information is provided for each site:

- Description of flood risk in terms of sources, pathways and receptors
- Historic Flooding
- Fluvial flood risk summary, source of Flood Zone information, flood defences and flood warning.
- Surface water flood risk summary
- Groundwater flood risk summary
- Sewer flood risk summary
- Reservoir flood risk summary (where applicable)
- Effects of climate change
- Available survey and detailed modelling
- Suitability of SuDS
- Implications for potential development sites (if applicable)

Maps showing the available flood risk information are provided with this report:

- Map 1 - Fluvial Flood Risk: Flood Zone 3b, 3a, 2 and 2 plus the 10m buffer zone , Historical Flood Map, flood depth and hazard mapping (where available), AIMS flood defence and asset data.
- Map 2 Flood Risk from Other Sources: Flood Map for Surface Water, Areas Susceptible to Groundwater Flooding, Sewer Flooding Register

Each map is in the form of a GeoPDF, with a drop down menu to choose the layer you want to view. Each map has an 'index map' of the whole District, which can be clicked on to open a more detailed map of an individual sustainable settlement.

5.3 Site flood risk hierarchy

There are 126 potential development sites considered in this SFRA. A flood risk hierarchy table has been compiled below assessing each site against key flood indicators, and is intended to help CDC carry out their Sequential Test. It has also been supplied to CDC as an Excel spreadsheet to enable easy querying and sorting of the information.

Table 5-2 shows flood risk to potential housing sites, and Table 5-3 shows flood risk to potential economic sites:

Vulnerability classification: Exact land use for each site is not known at this stage. For the purposes of this assessment it has been assumed that housing sites will be 'More Vulnerable' and employment sites will be 'Less Vulnerable'. If 'Highly Vulnerable' uses are proposed at more detailed planning stage they will have to be treated as per Table 3 of the NPPF Planning Practice Guidance.

Flood risk mapping: The percentage of the site within the different Flood Zones, uFMfSW 100 year and Historic Flood Map has been noted and colour coded. Where a site falls within 8m of any watercourse this has also been noted, in order to highlight sites that fall outside the Flood Zones but which may still be at risk from an ordinary watercourse.

Hazard and depth: Where models are available, the maximum hazard category on the site and the maximum depth are noted.

Comments on constraints: In order to aid CDC in carrying out the Sequential Test, the final column in Table 5-2 and Table 5-3 notes:

- Potential sites where intersection with a Flood Zone represents a constraint to development under the NPPF in terms of certain types of development not being permitted, or the Exception Test being required. It should be noted that for many sites these constraints only affect a relatively small area, and sequential site planning to ensure the built environment is all within Flood Zone 1 may be able to overcome these constraints.
- Potential sites which were not in the fluvial Flood Zones but where flood risk from other sources is present
- Potential sites where no flood risk indicators were identified.

Table 5-2: Flood risk to potential housing development sites

Settlement	Site code	Vulnerability class (NPPF)	% Flood Zone 3b	% Flood Zone 3a	% Flood Zone 3a plus CC	% Flood Zone 2	% uFMfSW 1000yr	Within 8m of a water-course?	% Historic Flood Map	Hazard category (where available)	Max Depth (m) (where available)	Comments on constraints (e.g. development not permitted/Exception Test required)
Andoversford	A_2	More										No constraints
Andoversford	A_3A	More										No constraints
Blockley	BK_11	More										No constraints
Blockley	BK_5	More	10% to 50%	10% to 50%	10% to 50%	10% to 50%	10% to 50%	Yes				More Vulnerable use not permitted in FZ3b. Exception Test required for More Vulnerable use in FZ3a. Sequential planning of the site would be necessary.
Blockley	BK_14A	More	10% to 50%	10% to 50%	10% to 50%	10% to 50%	10% to 50%	Yes				More Vulnerable use not permitted in FZ3b. Exception Test required for More Vulnerable use in FZ3a. Sequential planning of the site would be necessary.
Blockley	BK_14B	More	< 10%	< 10%	< 10%	< 10%	10% to 50%	Yes				More Vulnerable use not permitted in FZ3b. Exception Test required for More Vulnerable use in FZ3a. Sequential planning of the site would be necessary.
Blockley	BK_8	More										No constraints
Bourton-on-the-Water	B_20	More										No constraints
Bourton-on-the-Water	B_32	More					< 10%					Flood risk from other sources
Broad Campden	R_432	More					10% to 50%	Yes				Flood risk from other sources
Broad Campden	R_484	More					< 10%	Yes				Flood risk from other sources
Chipping Campden	CC_23B	More										No constraints
Chipping	CC_23C	More										No constraints

Settlement	Site code	Vulnerability class (NPPF)	% Flood Zone 3b	% Flood Zone 3a	% Flood Zone 3a plus CC	% Flood Zone 2	% uFMfSW 1000yr	Within 8m of a water-course?	% Historic Flood Map	Hazard category (where available)	Max Depth (m) (where available)	Comments on constraints (e.g. development not permitted/Exception Test required)
Campden												
Chipping Campden	CC_23E	More										No constraints
Chipping Campden	CC_38A	More					< 10%					Flood risk from other sources
Chipping Campden	CC_40	More					< 10%					Flood risk from other sources
Chipping Campden	CC_41	More					10% to 50%					Flood risk from other sources
Chipping Campden	CC_43	More					< 10%					Flood risk from other sources
Chipping Campden	CC_44	More					10% to 50%					Flood risk from other sources
Chipping Campden	CC_48	More					< 10%					Flood risk from other sources
Chipping Campden	CC_51	More										No constraints
Chipping Campden	CC_52	More					< 10%					Flood risk from other sources
Chipping Campden	CC_53	More					< 10%					Flood risk from other sources
Cirencester	C_101A	More										No constraints
Cirencester	C_173	More					< 10%					Flood risk from other sources
Cirencester	C_174	More					< 10%					Flood risk from other sources
Cirencester	C_17	More					< 10%					Flood risk from other sources
Cirencester	C_39	More					10% to 50%					Flood risk from other sources
Cirencester	C_76	More					< 10%					Flood risk from other sources
Cirencester	C_82	More					< 10%					Flood risk from other sources
Cirencester	C_84B	More					< 10%					Flood risk from other sources
Cirencester	C_89	More		< 10%	10% to 50%	> 50%	< 10%	Yes		Significant	0.506	Significant flood risk. Exception Test required in FZ3a for More Vulnerable use

ttlement	Site code	Vulnerability class (NPPF)	% Flood Zone 3b	% Flood Zone 3a	% Flood Zone 3a plus CC	% Flood Zone 2	% uFMfSW 1000yr	Within 8m of a water-course?	% Historic Flood Map	Hazard category (where available)	Max Depth (m) (where available)	Comments on constraints (e.g. development not permitted/Exception Test required)
Cirencester	C_97	More					< 10%					Flood risk from other sources
Cirencester	C_111	More					< 10%					Flood risk from other sources
Cirencester	C_75	More					< 10%					Flood risk from other sources
Down Ampney	DA_1A	More										No constraints
Down Ampney	DA_2	More										No constraints
Down Ampney	DA_5A	More										No constraints
Down Ampney	DA_5C	More					< 10%					Flood risk from other sources
Down Ampney	DA_8	More										No constraints
Down Ampney	DA_9	More					< 10%					Flood risk from other sources
Fairford	F_32	More										No constraints
Fairford	F_35B	More										No constraints
Fairford	F_44	More					< 10%					Flood risk from other sources
Fairford	F_46	More										No constraints
Kemble	K_1B	More										No constraints
Kemble	K_2	More					< 10%					Flood risk from other sources
Kemble	K_5	More					< 10%					Flood risk from other sources
Lechlade	L_18B	More				< 10%			< 10%			Exception Test required in FZ2 for Highly Vulnerable use
Lechlade	L_19	More	< 10%	< 10%	< 10%	10% to 50%	< 10%	Yes	10% to 50%	Low	0.252	More Vulnerable use not permitted in FZ3b. Sequential planning of the site would be necessary.
ickleton	MK_4	More					< 10%					Flood risk from other sources
oreton-in-arsh	M_12A	More					< 10%					Flood risk from other sources
Moreton-in-Marsh	M_14A	More					10% to 50%					Flood risk from other sources