Witney Flood Review July 2007

An investigation into the causes and flood risk management options

Nick Reid February 2008

ea/br/e/std/v1

We are the Environment Agency. It's our job to look after your environment and make it **a better place** - for you, and for future generations.

Your environment is the air you breathe, the water you drink and the ground you walk on. Working with business, Government and society as a whole, we are making your environment cleaner and healthier.

The Environment Agency. Out there, making your environment a better place.

Published by:

Flood Risk Management
Environment Agency
Red Kite House, Howbery Park
Wallingford, Oxfordshire
OX10 8BD
Tel: 08708 506 506
Email: thwest@environment-agency.gov.uk
www.environment-agency.gov.uk

Executive summary

The flooding of July 2007 affected approximately 240 properties in Witney, along with many businesses. This review examines the extent of the flooding, the areas that were most affected, and improvements that could reduce flood risk for local residents and businesses in the future.

The keys findings are that an unusually wet May and June led to saturated ground conditions. The exceptional rainfall on 20 July was more than twice the average monthly total, falling in just 24 hours. This created unprecedented flow in the River Windrush and its tributaries. River flows exceeded the capacity of watercourses, culverts and bridges, forcing flood water over and/or around the structures, into roads and residential areas. This caused widespread flooding throughout the town.

The recommendations of this report are:

- We will install a flood warning telemetry site in Witney.
- We will seek funding to carry out a feasibility study into flood storage areas above Hailey Road.
- We will remove barriers to flood flow in the Hailey Road area.
- We will encourage vulnerable groups put flood plans in place.
- We will ensure proper maintenance is carried out on key culverts in the town.
- We will investigate whether the River Windrush floodplain is working to its full capacity.
- We will investigate further the possibility of flood bunds for the town.

We will work with West Oxfordshire District Council, Oxfordshire County Council, and Witney Flood Action Group to ensure these actions are carried out.

Nick Reid Flood Risk Management Engineer

Contents

1 Background

Witney is a market town in West Oxfordshire, approximately 15km to the west of Oxford, with a population of circa 22,000 people. The River Windrush flows through the centre of town, and it has several main river tributaries;

- Colwell Brook
- Emma's Dyke
- Madley Brook
- Hailey Road Drain

These are shown in figure 1.

In Witney there are approximately 243 properties at risk in Flood Zone 3 and 928 properties in Flood Zone 2. During the flooding of July 2007, approximately 240 properties flooded, some of which were from surface water flooding rather than directly from rivers bursting their banks.

This review will look at the causes of the flooding, and at what can be done to reduce the risk and impact of flooding in the future.

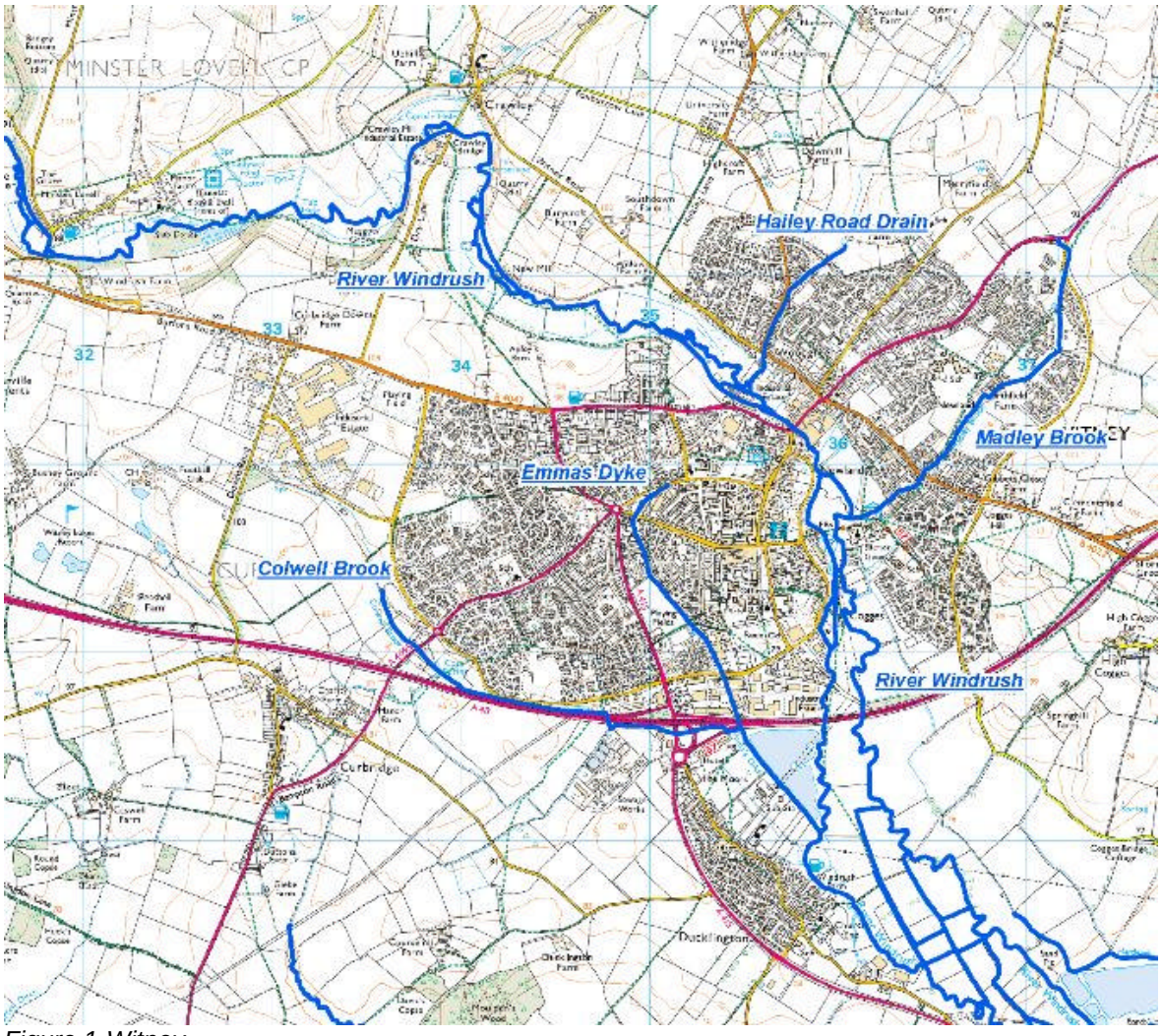

Figure 1 Witney

2 The problem

2.1 Flooding mechanism

2.1.1 Introduction

Witney saw two flood events during July 2007: The first as a direct result of rainfall on Friday 20 July, the second on Saturday 21 July as a result of rain falling further up the catchment and travelling down the River Windrush.

For the purposes of this review, the flooding can be divided into two parts:

- Flooding from the River Windrush
- Flooding from surface-water (pluvial) and/or tributaries to the River Windrush

The areas that flooded in Witney grouped according to location are shown in Table 1.

Location	Source of flooding	Number of properties flooded
Witney Town Centre	River Windrush	120
West End	Hailey Road Drain & pluvial	35
Madley Park	Madley Brook	30
Burwell Meadow	Pluvial	35
Ducklington	Windrush/Emmas Dyke	Less than 5
Queen Emmas Dyke	Pluvial	10
Crawley	River Windrush	Less than 5
Minster Lovell	River Windrush	Less than 5
	Total	**245**

Table 1 Number of flooded properties

2.1.2 Recorded rainfall

On the 19 July 2007, 113mm of rain fell at Bourton-on-the-Water in 28 hours. This equates to more than twice the average monthly rainfall for July. Several rain gauges in the upper parts of the Windrush catchment recorded even greater totals: Sherbourne recorded 122mm, and Guiting 140mm. This extraordinary rain is what caused the majority of flooding in the town centre, from the River Windrush.

Comparing this to other flood events shows how extreme these totals were. In October 2000, for example, 66mm was recorded at Bourton-on-the-Water over a period of 4 days. From the 26 December until 1 January 2003, 73mm of rain fell at Bourton-on-the-Water in 7 days. No properties flooded in Witney from either of these events, other than minor surface water flooding.

Rainfall totals for Witney (from the rain gauge at the Thames Water Sewage Treatment Works) are more relevant when considering flooding that the town witnessed on Friday 20 July – the pluvial flooding. This rain gauge recorded 84mm in 17 hours.

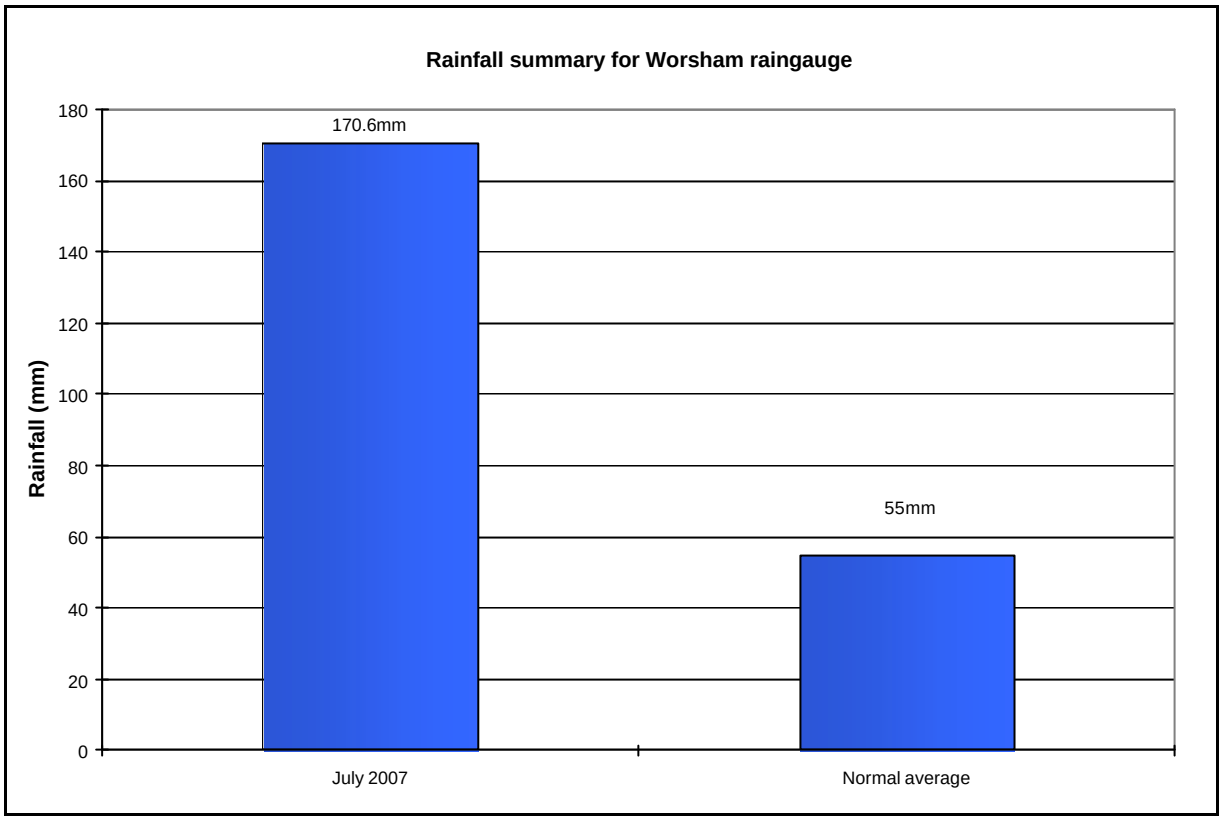

Figure 2 Comparison of July 2007 rainfall with average July rainfall

2.1.3 Recorded river flows

Windrush
There are two primary flow gauges on the River Windrush which are relevant to Witney, one each at Worsham and Newbridge. Both have lengthy historic records, with data available from 1942 and 1950 respectively.

Worsham gauge recorded a peak flow of 29.26m^3/s at 0945 on Saturday 21 July – as shown in figure 3. For comparison, the next highest figures on record are 18.70m^3/s in February 1990 and 18.90m^3/s in December 1979. The normal summer flow is approximately 3m^3/s.

Similarly, Newbridge flow monitoring station recorded a maximum of 31.83m^3/s at 1745 on Monday 23 July 2007. The previously highest flow was 22.52m^3/s recorded on 4 January 2003.

Hence the river flows during this flood were more than 50% greater than anything previously recorded.

According to the Lower Windrush Flood Study from February 1996, 21m^3/s is the approximate flow for a 1 in 25 year flood event.

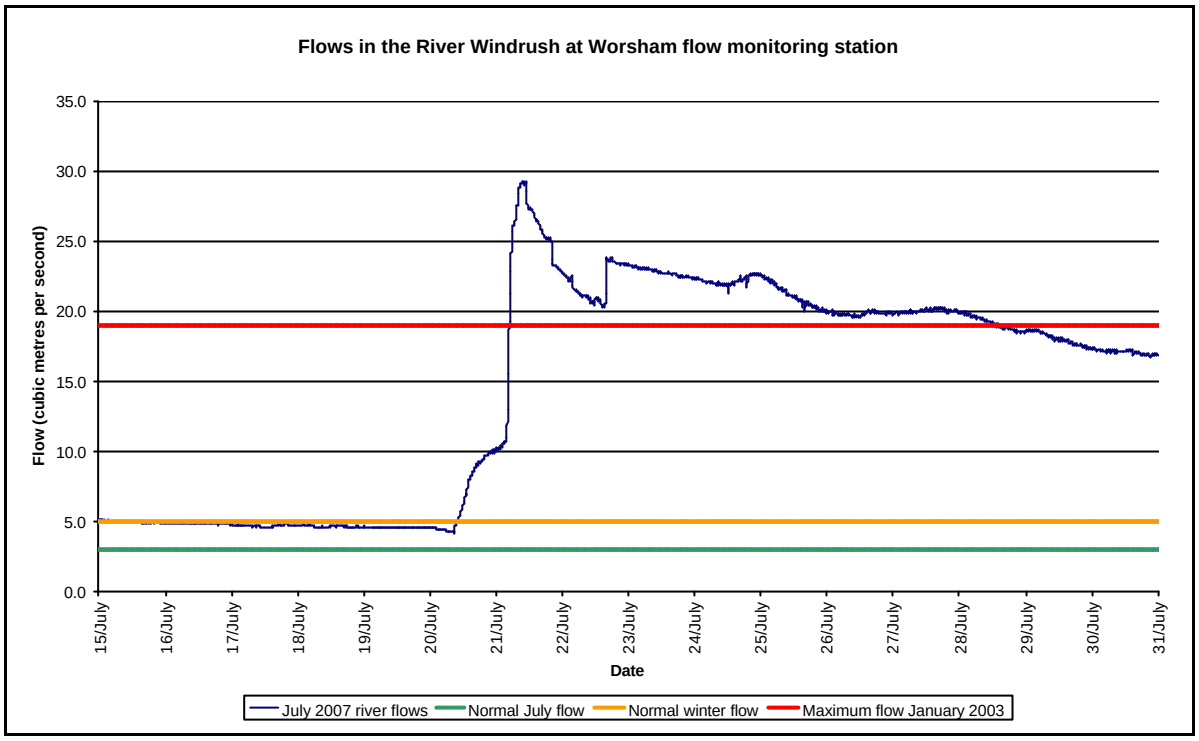

Figure 3 July 2007 river flows for the River Windrush

Other areas
There is no flow gauging on any of the tributaries to the River Windrush. The only way of measuring the scale of flooding is by comparison with other flood events – and, with the exception of the Hailey Road Drain, none of the properties that flooded in July 2007 have any history of flooding since they were built. This in itself shows the extreme nature of this flood event.

2.1.4 Return periods

The severity of a flood is often expressed as a 'return period'. If a flood has a return period of five years, for example, then a flood of this size or greater might be expected to occur approximately every five years or 20 times in a 100 year period. The five year return period flood has a 1 in 5, or 20%, chance of being equalled or exceeded in any one year.

It should be noted that flow return periods have only been calculated for the River Windrush, and not for any of its tributaries. This is because, as mentioned above, there is no flow gauging for any of these rivers in Witney. Therefore, only the rainfall return periods can be used as an indicator of the probability of this flood event.

The rainfall return period for Witney for this event has been estimated at 1 in 150 years, based on figures taken from the tipping bucket gauge at Witney sewage treatment works.

The flow return period is estimated at 1 in 300 years, using the Flood Estimation Handbook Statistical method on Newbridge flow data.

The return period presented here should be regarded as an indication of the severity of the event rather than a definitive measure, and cannot be used for flood risk assessments.

In many parts of West Oxfordshire this appears to have been the biggest flood for 50 or 100 years. Any information such as flood levels recorded in previous big floods (e.g. 1947, 1903, 1894, 1809 etc) is extremely useful in verifying return period estimates and putting the 2007 event in context. Please send any information to the External Relations team, using the address at the front of this document.

2.1.5 Sources of flooding

River Windrush
Witney town centre flooded primarily from the River Windrush coming out of banks. The Windrush can convey approximately 8-10m^3/s in banks, and once flows exceed that level, the floodplain starts to be used. As figure 3 shows, the river very quickly went from a steady 4m^3/s to 30m^3/s in a very short space of time.

The floodplain would have been filling from around midnight on 21 July. With flows steadily increasing, the rate at which the floodplain was filling would also have been increasing. For some distance upstream of Witney, there is considerable capacity in the floodplain, and only small developments, such as Crawley and Minster Lovell. This storage capacity is a natural defence mechanism for Witney, allowing large volumes of storage of floodwater.

Once the river enters Witney town, the floodplain becomes very much more heavily developed, and the river runs in a single channel – see figure 4. Over the years the expansion of the town has encroached on the functional floodplain, choking the channel and restricting both the amount of floodplain storage and the flow. The heaviest restriction is Bridge Street and the buildings immediately downstream.

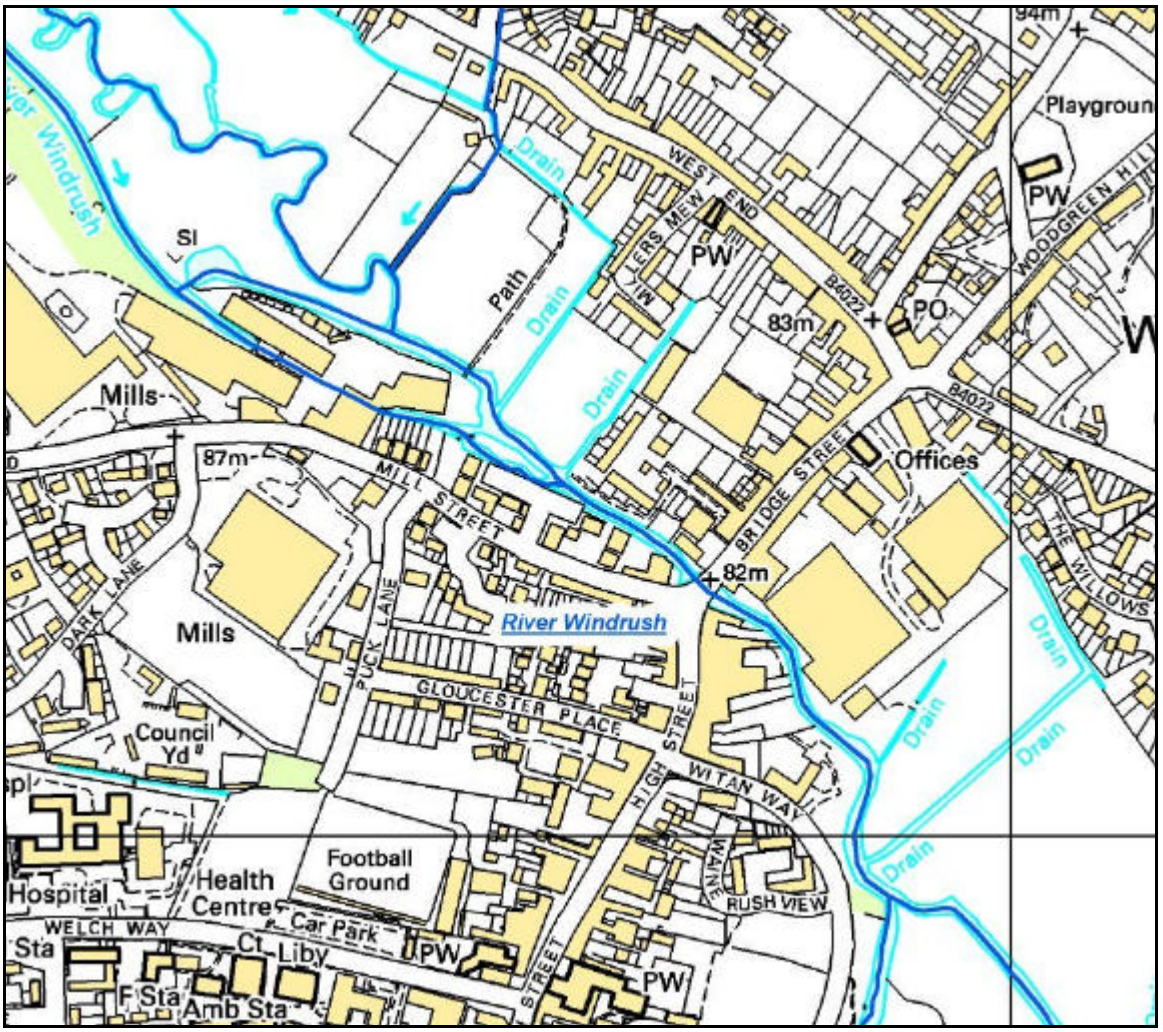

Figure 4 River Windrush in Witney Town Centre

With Bridge Street limiting the flow of the river, and the floodplain upstream of the town filling, flooding of the town centre was dependant on the amount of rain that had fallen the previous day and the total capacity of the floodplain. Either the flows had to recede as quickly as they had increased, or the town centre faced flooding.

By around 2pm on 21 July, the capacity of the undeveloped floodplain was reached. Flows had very marginally begun to drop, but not anywhere near quick enough. The flood level reached the underside of Town Bridge, which immediately caused water to back up as the river flow tried to find a flow path.

At this point, flood levels rose incredibly quickly, with many witnesses reporting a surge or wave effect. The rate of rise was reported as several inches per minute – 100cm in 30 minutes according to some. This caused the widespread flooding of the town centre including Bridge Street, High Street, Grangers Place, Millers Mews, Riverside Gardens, Woodford Mill and Mill Street.

Bridge Street and the properties on it act as a barrier to floodplain flow. The properties on the north side of the road flooded first, via the rear of the houses. As the floodwater came inside the properties extremely quickly, many people became trapped as the pressure of water inside the houses prevented front doors from being opened. Fire & Rescue crews smashed through front doors to allow water pressure to equalise, making it possible to evacuate residents safely.

This shows the difficulty that floodwater has in finding a flowpath, and how much of a restriction Bridge Street can be. Floodwater was also finding pathways via Grangers Place and Mill Street. Once it had got beyond these points, it flooded the properties on the south side of Bridge Street, including Mill House nursing home. From there the flood spread through to Zedoc Business Park and on to the new Aquarius development.

Upstream of Witney
Similarly, Crawley and Minster Lovell both flooded because of their location on the River Windrush. As with Witney, the historical development is linked to the growth in industry – specifically milling, for which water was essential. The flow control and infrastructure that is required to power a mill inevitably means that restrictions are put across the floodplain. In the case of Minster Lovell and Crawley, the mill structure, sluices and raised embankments were inundated by the extremely high flows in this event. This resulted in floodwater spilling out of the river banks and into the floodplain, bypassing the normal route of flow. In both villages, the road crossing the floodplain also acts as a restriction to flow and these were flooded as well.

It must be stated that, even without the presence of any of this development in the floodplain, the channel capacity would have been well exceeded. Water would have spread across the floodplain, and the presence of development only serves to alter the flood flowpath.

Other areas
The Hailey Road Drain flooded severely on Friday 20 July, as a result of the rain that fell that day. The catchment area for the Hailey Road Drain is 4.7km², and the main river section is relatively short – see figure 5.. However, the gradient is steep, and much of the immediate area is heavily developed. Coupled with the saturated ground conditions from rainfall in May & June, the rate of rainfall run-off for the area would have been very high. This means that the time between rain landing in the catchment and finding its way into the watercourse would have been very short, leading to a high peak flow.

The majority of the main river section of the Hailey Road Drain is culverted, and as such it has a limited capacity. This was easily exceeded during the flooding, and by some significant degree. This led to an alarming flow travelling overland down the Hailey Road at very high speed. See photo A1 in Appendix A1.

The flooding on the Hailey Road should be considered the most significant flooding in Witney, at least for the July 2007 event, because it posed the biggest threat to life. Witnesses talk of the difficulty of wading through the floodwater, and the fact that some manhole covers had lifted, leading to one vehicle breaking down after it drove over an open manhole at high speed. The speed that the floodwater travels down Hailey Road and the fact that manholes are known to lift mean that there is a risk to life when flooding occurs.

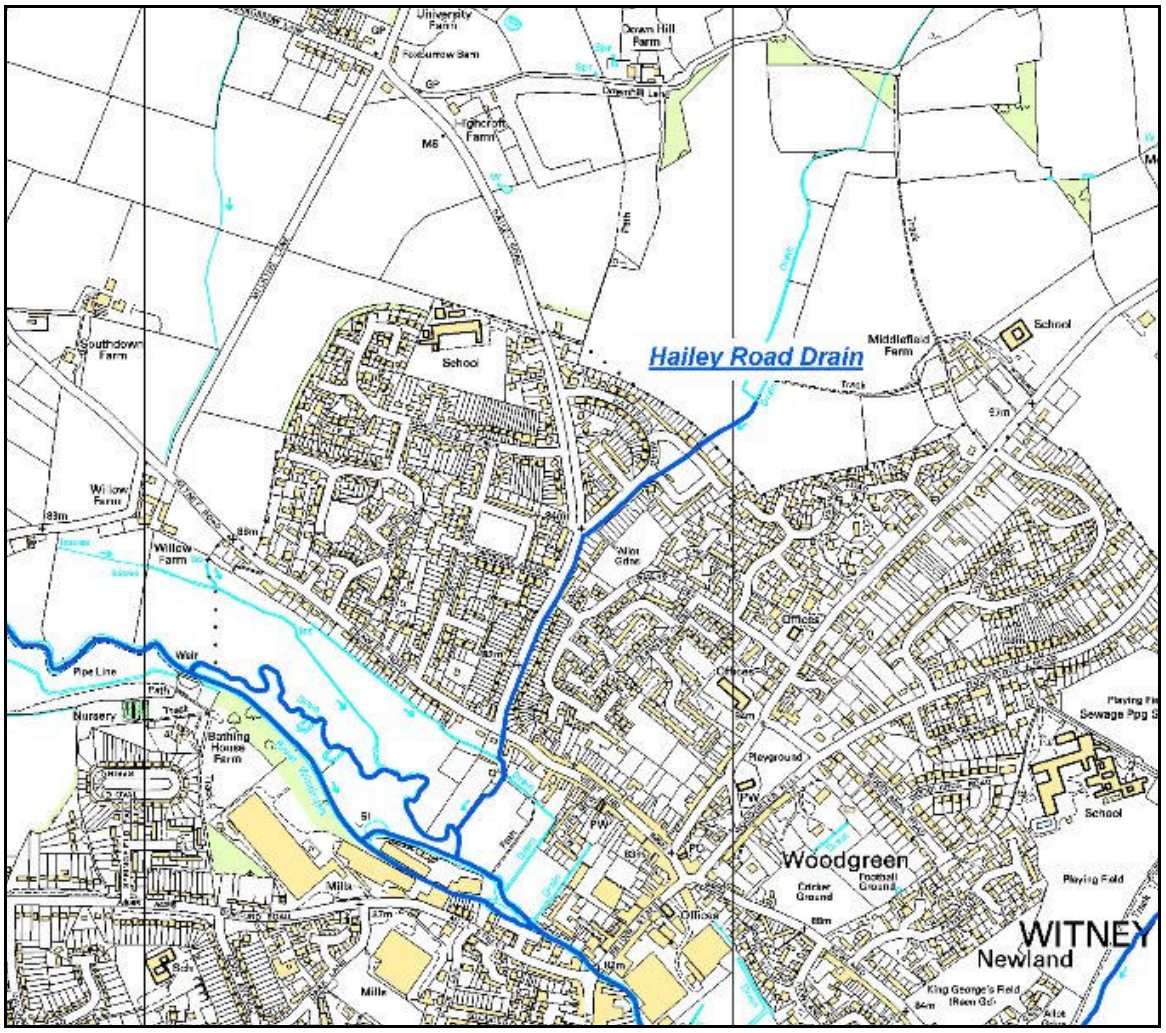

Figure 5 Hailey Road Drain

Madley Brook
Madley Park is a recent housing development situated on the upper part of the main-river Madley Brook. It is similar in character to the Hailey Road Drain, in that it has a relatively small catchment area, and drains from farmland above the housing. The developers have built in several flood management measures, agreed in liaison with West Oxfordshire District Council and ourselves. It is estimated that these measures, including a well-preserved natural channel and two surface-water attenuation ponds, protect the houses from flooding from a 1 in 100 year flood, but during the July 2007 event the system was overwhelmed. The result was that approximately 17 houses flooded.

On 20 July 2007, the rainfall across the area very quickly drained from the fields and flowed into the Madley Brook. The river reacted accordingly, and flows started to increase. The channel, which has a number of restrictive culverts along its length, became inundated and spilled out of its banks into the floodplain.

At the footbridge immediately upstream of the flood storage ponds, there is a culvert which is significantly smaller than any other on Madley Brook within Madley Park, and represents the biggest restrictor to flow. Water backed up behind this footbridge, filling the floodplain, before spilling out onto the right-bank. Here it pooled, caused the houses to flood, and found its way back into the brook via the storage ponds.

Burwell Meadow
Burwell Meadow is an area of housing just to the north of Thorney Leys. Immediately to the south of Thorney Leys lies the Colwell Brook, and then the A40 trunk road. This is shown in figure 6.

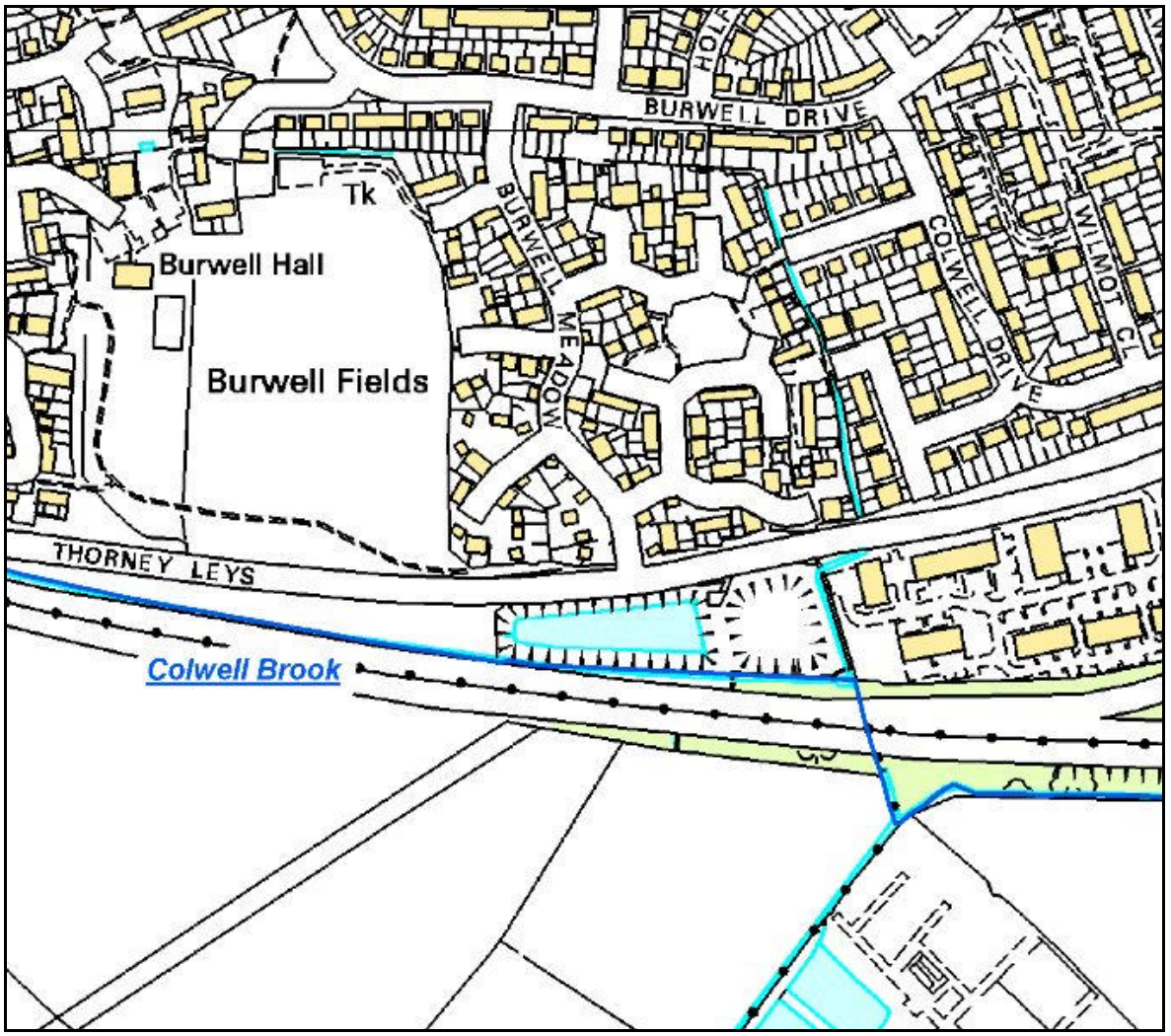

Figure 6 Burwell Meadow & Colwell Brook

The flooding in Burwell Meadow was caused by surface water not being able to flow away from the area. There is a particular low spot in the road along Thorney Leys, as shown in the photo A2 in Appendix A1. This low spot appears to be the location of a former watercourse, which ran approximately along the boundary between properties in Burwell Meadow and Colwell Drive.

Immediately south of Thorney Leys at the low spot, is a section of ordinary watercourse known as the Burwell Meadow Drain. This watercourse appears from a culvert beneath Thorney Leys, flows through the Thames Water property, and receives flow from the adjacent industrial estate. It then travels through a culvert beneath the A40 before joining the Colwell Brook.

Whilst this investigation has not been able to find any solid evidence as to why the water failed to flow away, there are three reasons which are the most probable and plausible:

- There may have been a blockage to the culvert
- The amount of water coming into the area was too great, overwhelming the culvert
- The Colwell Brook may have been running very high, preventing the Burwell Meadow Drain from discharging

Queen Emmas Dyke

Queen Emmas Dyke is a road and housing estate to the west of Witney town centre. A small number of properties flooded here in July 2007.

Drainage problems in this area have been known of for some time. The issue appears to lie in the capacity and conveyance of the culverted channel running parallel to Ducklington Lane, the

capacity and conveyance of the open channel at the northern edge of Henry Box playing fields, and the gradient in the area.

West Oxfordshire District Council and Oxfordshire County Council Highways Department have been looking at solutions to improve drainage in the area. During early December 2007, it should be noted that Pye Homes carried out desilting works of the open channel section, in response to the flooding. See photo A3 in Appendix A1.

2.1.6 Restrictions to flow

There have been no reports received of any extraordinary blockages that caused or exacerbated the flooding during this event. Blockages in the watercourses can cause flooding that would otherwise be avoidable – Witney is not unique in this respect. However it must be recognised that a large number of properties and businesses can flood from the River Windrush and that Bridge Street is a significant structure in its ability to pass or block flows.

In this respect, maintenance and regular inspection is vital to reducing flood risk.

For the tributaries to the River Windrush, there are more instances of restricted capacity culverts. These are of equal importance in their own way, but generally where they become blocked, they cause localised flooding on a smaller scale.

Whilst the smaller rivers may pose a threat to a smaller number of properties, they can be susceptible to flooding from much shorter duration high-intensity rainfall events – or flash flooding. Queen Emmas Dyke, Burwell Meadow and Hailey Road all face this threat. As above, appropriate maintenance and inspection is the vital as a flood risk management tool. This is discussed further in section 3.4 *Maintenance Regime*.

2.1.7 Conclusion

The May-July three-month period had the highest recorded rainfall since records began. The storm of 20 July 2007 was inevitably going to cause flooding, because historic development and human interaction with the river corridor has put many homes and businesses at flood risk.

With river flows of an estimated 1 in 300 year return period, a lot was being asked of the river and its floodplain. It was unable to cope with the massive volumes of water feeding it from the upper catchment. Once the volume of water entering an area exceeds the volume that can leave, flooding will occur. Regular maintenance makes sure that the river works as efficiently as possible, but regardless of this there will always be a limit to how much flow the channel can carry.

3 Management of flood risk

3.1 Catchment flood management plans

3.1.1 Introduction

Witney sits within the Upper Thames policy unit for Catchment Flood Management Plans (CFMPs). The Upper Thames policy unit is characterised by extensive floodplains, with small clusters of development in a rural landscape. CFMPs describe the approach that we will take to manage flood risk in this area:

- The floodplain is our most important asset in managing flood risk.
- Maintaining (and in some places enhancing) the capacity of the natural floodplain to retain water, combined with maintaining conveyance of watercourses in urban areas reduces the risk of flooding and has benefits for the natural environment.
- We want to safeguard the natural floodplain from inappropriate development.
- Managing the consequences of flooding will become increasingly important, particularly by buildings and communities becoming more resilient to flooding and those who are at risk taking effective action at times of flooding.

We want to maintain the conveyance of watercourses in developed areas and maintain and where we can, enhance the ability of the floodplain to retain water. This is to manage the impacts from low order – normal winter – fluvial flood events.

3.1.2 Witney specific

What this means for Witney is that, to allow adequate channel capacity of the River Windrush, we must ensure that conveyance is maintained in the main channel.

There is already a sizeable amount of storage capacity in the Windrush floodplain upstream of Witney. This natural storage plays an important role in protecting the town centre from flooding. However there is still a finite capacity within the natural system, and even with the most rigorous maintenance programme (or even large-scale engineering works) there will be extreme storms that overwhelm the system. It is imperative that other flood risk management tools are used to help communities cope with emergencies.

These tools include a minimum standard of flood warning provision, collective community and local authority based action and emergency planning and adaptation of vulnerable assets including homes and businesses. These options for Witney are covered in section 3.6 *Flood Resilience*.

3.2 Third party structures

3.2.1 Introduction

There are a number of structures which have an impact on the flood risk in and around Witney. During the investigation for this review, no evidence has been found that the operation of these structures increased the impact of the flooding. However some of them have the potential to cause localised flooding, and as such their operation is covered in this review.

3.2.2 River Windrush

On the River Windrush, many witnesses have reported seeing river levels rising at an alarming rate. The River Windrush had been rising steadily from Friday 20 July through to around 1300 the following day, at a slow and steady rate, inundating the floodplain. Then from around 1400 to 1600, the rate of rise massively increased, which led to the widescale flooding of the town centre. This phenomena has been described as a surge or wave coming down the river, causing concern to the residents affected.

This rate of rise has led to accusations of human intervention, and that a flood gate must have been opened further upstream to cause the reported surge. There are 4 historical mill sites upstream of Witney that have been looked at as part of the investigation into these allegations. Travelling upstream from Witney, these sites are:

- New Mill, Witney
- Crawley Mill
- Minster Lovell Mill
- Worsham Source Works.

New Mill
The structure at New Mill was fully opened on Thursday 18 July. This was done in reaction to the rising levels and the warnings that had been broadcast in the media. If the sluice at New Mill remains closed during high flows, it would cause localised flooding to the buildings at New Mill.

Crawley Mill
The sluice at Crawley Mill was confirmed as being open throughout the high flows. Had the sluice been left closed, it would have caused far more extensive flooding of the various workshops and buildings at that site.

Minster Lovell Mill
The sluice at Minster Lovell Mill was also confirmed as being opened throughout the flood event. The conference centre that now occupies the mill, along with a small number of properties in the village, all suffered flooding as a result of the extremely high flows, and it is likely that this flooding would have been more severe if the gates had been opened.

Worsham Source Works
Worsham Source Works is a site that was formerly owned by Thames Water and was the main abstraction site for water supply to Witney. Abstraction there ceased in 2002, with water supply instead coming from Farmoor Reservoir.

When the abstraction ceased, the requirement to operate the sluice also ceased. The sluice has been set in position ever since, at a level which holds back a small head of water upstream, whilst not significantly impeding high flows.

Since the sluice has not been operated in more than five years, and it is situated some 8km upstream, there can be no doubt that it had no impact on the flooding in Witney whatsoever.

3.2.3 Flooding impact of mill structures

The concern of some residents that the mill structures upstream of Witney caused or exacerbated the flooding are completely unfounded. There are several reasons to explain why.

For each of the four sites mentioned above, the first consequence of a gate remaining closed would be for that individual's property to flood. Therefore they have a vested interest in ensuring all sluices are open as early as possible during periods high flow.

The physical effect of suddenly opening a gate during flood flows would be to increase the flow downstream by a relatively small amount. Taking New Mill as an example, there are 4 principle restrictors to flow – three weirs (one of which has a movable sluice) and the channel. Each of these act to slow the water to some degree. The channel will only allow a flow of around $10m^3/s$ before

spilling out into the floodplain. The three weirs at New Mill will have a total flow capacity of around the same – if you assume that it is split evenly, each has a capacity of 3.3m^3/s. Therefore the total flow between a fully closed and fully open weir can vary from 6.6 to 9.9m^3/s. As mentioned previously, the flow recorded at Worsham was 30m^3/s. Therefore, as an estimate, the maximum percentage flow difference that could be caused by the inappropriate operation of a sluice would be to add no more than 10% additional flow.

This does not take into account the water that will be bypassing the structures, as happens during a flood. Therefore a more realistic figure for additional flow caused by suddenly opening a sluice during a flood is 5% increase.

In reality, such operations rarely occur because it is either extremely dangerous or physically impossible to gain access to such weirs at the peak of a flood, as the land surrounding is normally flooded.

3.2.4 Other areas

Each of the outlying areas that flooded are almost entirely dependant on the conveyance capacity of the natural channel as their primary defence from flooding. This means that the state of the channel governs how quickly water will flow away from a given area. Similarly, all of these channels have culverts through which the river flows, and these have the potential to cause water to back up if they block with silt or debris.
In the absence of any other options for defending from floods, a periodic maintenance regime for each of the culverts mentioned below should be considered as the minimum work required to keep flood risk to a minimum.

Hailey Road
The limited capacity of the culvert through which the Hailey Road Drain flows is the primary cause of flooding in that area. It is not the sole cause though. Behind the properties in Eastfield Road (at the upstream end of the culvert) sits a brick wall which holds back floodwater, and causes it to pond before it overtops the garden walls of the adjacent houses. This brick wall serves no purpose, and indeed has already had a section removed from it to allow floodwater to pass through with less hindrance.

At the downstream end of the culvert lies a property which also prevents the overland flow of floodwater. The property has a garden wall at the front which acts as a dam, as does the property itself. These cause water to pond at the junction of Crawley Road and Hailey Road, leading to flooding of approximately 10 properties.

Madley Park
There is one particular culvert which is of a lower capacity on the Madley Brook. As with any culvert, it has a finite capacity, but because it is of such limited size, debris and silt inside it would restrict a large proportion of the flow – a large piece of timber could feasibly reduce the capacity by 25%.

Burwell Meadow
The most significant structure on the Burwell Meadow Drain is the culvert beneath the A40. Again, as with any culvert it has a finite capacity, and any blockage or reduced capacity of it will cause water to back up, preventing the surface water from draining away from Burwell Meadow.

This culvert, along with the Colwell Brook culvert running alongside it, both have trash screens attached to them. Clearance of these during high flows is imperative to prevent water backing up and causing flooding.

Queen Emmas Dyke
The most significant structure relating to flooding at Queen Emmas Dyke is the culvert running alongside Ducklington Lane. However, because of the shallow gradients in the area, the condition of this culvert has to be considered in conjunction with the condition of the open watercourse at the northern edge of Henry Box playing fields. Proper maintenance of both sections is critical to ensuring the lowest flood risk for properties on Queen Emmas Dyke.

3.3 Flood warnings

3.3.1 General

We have river level gauging stations at several locations on main rivers. We use data from these stations to determine when to issue flood warnings. Currently there is not a gauging station near enough to Witney to allow accurate prediction of when flooding to properties will occur.

In Witney we can currently offer a flood watch service. A flood watch is issued for an entire river catchment when rivers are expected to overtop, but only low lying land and roads will be flooded. No property flooding is expected at this stage. A flood watch is an early indicator that low level flooding is likely and to keep extra vigilant in case the situation becomes worse.

Our advice to people receiving a flood watch in Witney is that they should then ring Floodline to get more in-depth information (0845 988 1188) and to stay in touch with local flooding and river conditions. When calling Floodline, the public need to know a second quick dial number which will take them to their local area information. For Witney the relevant quick dial codes is **0112315**.

Witney is on our programme, which commences in April 2008, to have a river level gauge installed on the River Windrush. It is recognised that Witney is one of the biggest gaps in our flood warning capability, and is the highest priority site on our programme.

Once the new river level gauge is in place we will be able to offer a full flood warning service. This means that we will be able to issue flood warnings and severe flood warnings when we are expecting flooding of properties in the area. Once it is in place and operational we will be carrying out a recruitment campaign to get as many people signed up to the system as possible.

The four levels of our flood warning system are shown in figure 7.

Flood Watch
Flooding is expected. Be aware! Be Prepared! Watch Out!

Flood Warning
Flooding of homes, businesses and main roads is expected. Act now!

Severe Flood Warning
Severe flooding is expected. Extreme danger to life and property. Act now!

All Clear
Issued when flood watches or warnings are no longer in force. Check all is safe to return. Seek advice

Figure 7 Flood warning codes

3.4 Maintenance regime

3.4.1 Main river maintenance

We have permissive powers to carry out works on main river. We use these powers to carry out works, and is one of the key ways in which we manage flood risk. We only have a limited budget to carry out works, and hence we have to have a prioritisation system. The most important factor used in deciding where to carry out works is the number of properties at risk of flooding.

Witney has 928 properties at risk in Floodzone 2, which makes it one of the highest populations at risk of flooding in our area. This risk to people and properties means we carry out a significant amount of watercourse maintenance in the town. Details are shown in table 2 below.

River	Typical works	Extent	Frequency
Windrush	Clearance of aquatic weed, removing obstructions	From A40 up to New Mill	Biennial
Hailey Road Drain	Clearance of aquatic vegetation	Lower section downstream of culvert	Annual
Madley Brook	Clearance of aquatic vegetation, removing obstructions	Full length	Annual
Colwell Brook	Clearance of aquatic vegetation, removing obstructions	Full length	Annual
Emmas Dyke	Clearance of aquatic vegetation, removing obstructions, periodic desilting	Full length	Annual
All of the above	Desilting	As required	As required

Table 2 Summary of EA main river maintenance in Witney

3.4.2 Responsibilities

Several organisations carry out some form of flood defence activity. This section will clarify what involvement each organisation has.

Environment Agency

- Build & operate defences to protect against flooding from main rivers
- Provide flood warning service
- Create floodplain maps
- Permissive powers to maintain main rivers
- Regulating development along main rivers
- Statutory consultee on planning applications

West Oxfordshire District Council

- Carry out emergency planning
- Support the emergency services
- Permissive powers to carry out drainage works on ordinary watercourses
- Organising emergency evacuation centres
- Planning authority

Oxfordshire County Council

- Maintaining local road drainage network
- Responsible for dealing with flooding relating to all adopted highways (excluding trunk roads)

Thames Water Utilities Ltd

- Maintaining public sewer network
- Responsible for dealing with flooding from the sewer network

Riparian owners

- Maintaining the bed and banks of the watercourse
- Maintaining and operating any river control structures such as sluices or trash screens
- Responsible for passing on flow without obstruction

3.5 Intervention Options

3.5.1 Introduction

The previous sections have identified the causes where known, or the most probable cause where information has not been available. This section will consider what actions could be taken to reduce the flood risk. This will generally fall into two categories:

- Engineering works
- Maintenance

The engineering works (E) have been considered in section 4.1 as to their viability. The maintenance works (M) have been grouped in Appendix 2 as part of the long-term management plan for Witney.

It should be noted that these works, and the aim of this review, is to identify potential solutions. Delivery of these solutions is not guaranteed by their inclusion in this report, as that decision is dependant upon many factors, including the availability of resources & funding.

3.5.2 River Windrush

As discussed in section 2.1.5, the single-channel River Windrush beneath Bridge Street is a significant asset in terms of flood risk. The capacity of the channel in that area is an obvious weak point in the system.

The options for this area:

3.5.2.1 Desilting River Windrush (M)
3.5.2.2 Maintenance or enhancement of River Windrush floodplain (E)
3.5.2.3 Dredging River Windrush (E)
3.5.2.4 Construction of flood bunds along River Windrush (E)

3.5.3 Hailey Road Drain

The main culvert through which the Hailey Road Drain flows is seen as the source of all problems in the area. The option of replacing the culvert with an open-channel section is simply not realistic because of the lack of physical space and the excessive cost. Instead, flood risk is best managed by ensuring the proper functioning of the culvert, and looking at what improvements can be made up or downstream.

The options to be considered are:

3.5.3.1 Construction of flood storage area(s) above Eastfield Road (E)
3.5.3.2 Removal of property walls at Canon Pool and Eastfield Road (E)
3.5.3.3 Improvements to river channel downstream of main culvert (E)
3.5.3.4 Survey and clearance (as required) of main Hailey Road Drain culvert (M)

3.5.4 Madley Park

As discussed in section 2.1.5, the issue on the Madley Brook is the capacity of some key culverts through which the river flows. No blockages were reported during the flood, but it should be recognised that the risk of flooding would increase dramatically if any blockages occurred.

The possible options for improvement works on the Madley Brook are:

3.5.4.1 Survey and clearance (as required) of culverts along length of Madley Brook (M)
3.5.4.2 Construction of upstream flood storage on Madley Brook (E)

There is one other possible option to reduce flood risk, namely by increasing the capacity of some the culverts along the brook. However, this is not likely to be a viable option as the culverts furthest downstream could only be increased by a relatively small amount due to the amount of space available. The option of increasing the size of only the culvert furthest upstream is not viable, as this would increase the flood risk downstream. There is no sense in carrying out works simply to pass the problem from one area to another.

3.5.5 Burwell Meadow

There are no obvious options for reducing flood risk at Burwell Meadow, other than ensuring proper maintenance of the Burwell Meadow Drain, to maximise the flow away from the area.

The options for Burwell Meadow are:

3.5.5.1 Clearance of Burwell Meadow Drain culvert beneath A40 (M)
3.5.5.2 Clearance of Burwell Meadow Drain open channel section (M)

Further investigation is required to determine whether the Colwell Brook contributed to the flooding, and if this is found to be the case, then there are two additional options to be considered:

3.5.5.3 Clearance of Colwell Brook culvert beneath A40 (M)
3.5.5.4 Investigation of use of supplementary channel from Coral Spring to south side of A40 (culvert C14) (E)

3.5.6 Emmas Dyke

Maintenance of the culvert along Ducklington Lane is critical because of the shallow gradients in the area. It will be particularly susceptible to silting up, and an increase in silt means a decrease in flow capacity.

The works for Emmas Dyke are:

3.5.6.1 Survey and clearance (as required) of culvert adjacent to Ducklington Lane (M)
3.5.6.2 Clearance of ditch to the north of Henry Box playing fields (M)

3.6 Flood resilience

3.6.1 Introduction

Flood resilience refers to measures that reduce the amount of damage caused by water entering properties. There are a wide range changes that can be made to a property and any changes would be very specific to each property in order to ensure that they are suitable.

At present the Environment Agency policy is not to provide financial assistance with any protection to individual properties, however the Department for Environment Food and Rural Affairs (DEFRA) are currently funding a pilot grant scheme to encourage flood resilience as part of the Making Space for Water strategy. The outcome of this study could influence the decision of householders in the future.

3.6.2 Witney

Where it is not possible for flood defence schemes to provide protection against flooding, individual flood protection and flood resilience measures are recommended.

Flood resilience measures should be based on advice from either the Royal Institute of Chartered Surveyors (RICS) or the Flood Protection Association. For further information please see the National Flood Forum website at: www.floodforum.org.uk

In general if such measures are installed as part of repairs after the recent floods then insurance companies will expect the householder or business to meet the extra costs themselves. Possible measures include:

- Timber floors above solid concrete
- Raised cupboards
- Water resistant door frames
- Non-return valves on drainage pipes
- Water resistant plaster

Flood defence products for individual properties are also widely available and we support the BSI Kitemark standard which signifies that the product has been rigorously tested.

3.6.3 Flood plans

Research shows that being prepared for flooding can reduce the personal and financial impact significantly. To this end, we encourage anyone affected by flooding to write a Flood Plan. This may take the form of a plan for an individual householder, a business, or a community, and it should include information such as who to contact during a flood, emergency contact details, vital items to pack in the event of evacuation, and where to move personal effects to.

More information about preparing for a flood can be found at: www.environment-agency.gov.uk/floodline

3.6.3 Vulnerable groups

There are a number of groups who are more vulnerable during a flood because they have less ability to look after themselves. A case in point is the Mill House Care Home on Bridge Street, which was evacuated during the July floods.

It is imperative that such groups are identified and resilience plans put in place to help in the event of a flood. The responsibility for such plans lies with the management team of each individual group, but organisations such as the Environment Agency, West Oxfordshire District Council, and Witney Flood Action Group also have a moral responsibility of to ensure that appropriate plans are in place.

3.6.4 Infrastructure

The flooding nationally during Summer 2007 showed the impact that flooding can have to critical infrastructure. Fortunately, the threat to water and electricity supplies that affected Gloucestershire did not arise to the same degree in Oxfordshire.

The infrastructure that was most seriously affected by the flooding in Witney were the highways. Bridge Street was closed due to concern over the structural stability of the bridge over the Windrush. Hailey Road was almost impassable to traffic, and residents were seeking a road closure because the wash from cars that were using the road was exacerbating flooding to some properties – see photo A4 in Appendix A1. Thorney Leys was also flooded, but for a relatively short time.

Plans should be put in place to manage traffic in Witney during a flood event, both to prevent unnecessary flooding to properties, and to allow a continued emergency response. West Oxfordshire District Council have already started putting such plans in place.

4 Preliminary Costs, Benefits, Contributions

4.1 Benefit/Cost analysis

4.1.2 Capital works

Of the works identified in section 3.5, some are capital works (ie. Creating new structures) and some are revenue works (ie. Maintenance of existing structures). All works that we carry out have to be justified economically, environmentally and socially, and this section will deal with the economic justification to see whether there are schemes which warrant further detailed investigation. All capital schemes must have benefit/cost ratio of at least 1.00 to be considered.

Reference	Title	Estimated cost	Estimated benefit	Benefit/Cost ratio	Action
3.5.2.2	Maintenance of Windrush floodplain	Not known	Not known	N/A	EA to investigate
3.5.2.3	Dredging River Windrush	£675,000	£338,000	0.50	Not viable option
3.5.2.4	Flood Bunds along River Windrush	£514,500	£520,000	1.01	EA to carry out more detailed analysis
3.5.3.1	Flood storage ponds above Hailey Road	£560,000	£1,006,000	1.80	EA to carry out feasibility study
3.5.3.2	Removing property walls	£10,000	£90,000	9.00	WODC & EA to progress
3.5.3.3	Improving culvert below Canon Pool	£13,000	£80,000	6.14	EA to progress
3.5.4.2	Flood storage above Jubilee Way	£500,000	£22,500	0.04	Not viable option
3.5.5.5	Investigating extra channel from Coral Spring	Not known	Not known	N/A	EA to investigate

Table 4 Summary of capital works options

4.1.2 Revenue works

Those options listed in section 3.5 should be considered as general maintenance which is essential to any drainage system to ensure it operates efficiently. The full detail of maintenance is not necessary for the purposes of this report, but it should be noted that lack of maintenance probably exacerbated the flooding in July 2007 in some areas. Benefit/cost analysis has not been carried out in detail, but normally the cost of flood damage from a poorly-maintained urban drainage system far outweighs the cost of maintenance, and hence is easily economically justified.

5 Project Justification & Priority Score

5.1 Future options

5.1.1 Funding mechanism

The most common way for large flood risk management schemes to be funded is through grant-aid from DEFRA. In order to be eligible for this funding, a given scheme must achieve an appropriate priority score. The current threshold for this is around 24 points. None of the schemes identified in this report achieve 24 points – the highest score calculated is 9.9 points. Hence there is no realistic chance of funding any of these schemes through grant aid.

In the absence of grant aid, the next potential source of funding is from local levy. This is the most likely source of funding for the works proposed in this report.

5.1.2 River Windrush

As shown in table 4, the only option which has a benefit/cost ratio of greater than 1 is for flood bunds alongside the river, upstream of Bridge Street. However, because the benefit/cost ratio is so close to 1, further detailed assessment of the construction costs and economic flood damage should be carried out to decide whether a scheme is justified.

No detailed assessment of option 3.5.2.2 has been undertaken, because of the amount of survey data that is required to inform such an assessment. Several residents have reported witnessing parts of the floodplain staying dry when they were previously known to flood during high flows. As mentioned previously, the floodplain upstream of Witney is the best natural defence for the town against flooding. A proper assessment should be carried out to ensure that the floodplain is working to its full capacity.

Dredging of the river is not an economically viable option, as the cost far outweighs any benefits that the work would bring. It is also possible that dredging the river to such a depth is not technically possible, as it may cause damage to the foundations of the bridge and buildings alongside the river, especially those on Bridge Street.

5.1.3 Hailey Road

The option for flood storage in the rural catchment upstream of the main river limit of the Hailey Road drain has been initially documented and discussed in two reports (1995 and 2003) from Peter Brett Associates. The benefit/cost analysis carried out for this report proves that there is merit in continuing the work that this report set out to achieve.

There are also possible small local works that can be carried out to remove obstructions to overland flood flow. It is extremely difficult to accurately say what benefit these works will have, but the estimates made in the production of this report are that the costs are relatively low, and the potential benefits are relatively high.

5.1.3 Other areas

For Madley Park, Burwell Meadow, and Queen Emmas Dyke, there are no large scale schemes arising from the investigation for this report. There are however some significant maintenance works identified, which the relevant operating authority will need to fund from annual maintenance budgets.

6 Recommendations & conclusion

6.1 Recommendations

6.1.1 We will install flood warning telemetry in Witney.

6.1.2 We will seek finding to carry out a feasibility study of flood storage above Hailey Road, if possible during financial year 2008/09.

6.1.3 The Environment Agency and West Oxfordshire District Council will carry out short-term improvements to overland flood flow in the Hailey Road area.

6.1.4 Vulnerable groups will be encouraged to create flood plans, with support from Witney Flood Action Group, West Oxfordshire District Council, the Environment Agency, and other relevant bodies.

6.1.5 A maintenance plan for all key flood risk management assets will be written and agreed between all operating authorities. This includes survey and clearance of culverts and silted watercourses. See Appendix A2.

6.1.6 We will carry out a topographical survey of the River Windrush floodplain, with the aim of ensuring that the floodplain capacity is maximised.

6.1.7 We will carry out further investigation into the construction of flood bunds to defend properties from the River Windrush.

6.2 Conclusion

The flooding in Witney in July 2007 has dramatically raised public awareness of the danger that floods pose to the town, and highlights the long-term problem that developing in the floodplain can bring.

This review has found no evidence of blockages or actions by any party that caused any flooding. There are undoubtedly parts of the local drainage system that are in need of maintenance, but it cannot be determined whether this led directly to any flooding, as the sheer volume of rain that fell on 20 July was so large that it would have overwhelmed the drainage system even if it had been in peak condition.

The July 2007 flood has clearly shown that Witney faces a very real risk of flooding. More measures should be in place in order both to prevent flooding occurring, and help people to cope better when a flood does occur. The actions from this review will help put these measures in place for the future.

[Appendix A1] Photographs

Photo A1 Floodwater and traffic on Hailey Road, 21 July 2007

Photo A2 Low spot in Thorney Leys road

Photo A3 Channel at north end of Henry Box playing fields

Photo A4 The impact of bow waves from cars on Hailey Road

[Appendix A2] Maintenance Plans

ID	Name	Watercourse	Grid reference	Proposed inspection frequency	Work required now	Priority rank
C01	Woodstock Road	Madley Brook	437172, 211207	10 yearly	None	3
C02	Jubilee Way	Madley Brook	437203, 211151	10 yearly	None	3
C03	Jubilee Way	Madley Brook	437199, 211081	10 yearly	None	3
C04	Madley Way	Madley Brook	437175, 210801	5 yearly	None	2
C05	Footpath	Madley Brook	437175, 210602	5 yearly	None	2
C06	Cherry Tree Way	Non-main river	437251, 210601	5 yearly	None	2
C07	Jubilee Way	Non-main river	437339, 210594	10 yearly	None	3
C08	Harvest Way	Madley Brook	437175, 210801	10 yearly	None	3
C09	Newland	Madley Brook	436447, 209951	5 yearly	Survey	1
C10	Meadow View	Madley Brook	436305, 209848	10 yearly	Survey	2
C11	West End	Hailey Road Drain	435600, 210551	5 yearly	Clear	1
C12	Henry Box footpath	Emmas Dyke	435209, 209160	5 yearly	None	2
C13	Station Lane	Emmas Dyke	435381, 208892	5 yearly	None	2
C14	A40	Non-main river	433822, 208845	5 yearly	None	2
C15	Thorney Leys	Non-main river	434773, 208760	5 yearly	Survey	1
C16	A40 culvert	Colwell Brook	434770, 208649	6 yearly	Survey	1
C17	A40 culvert	Burwell Meadow Drain	434773, 208650	5 yearly	Clear	1
C18	A40 culvert	Emmas Dyke	435475, 208636	5 yearly	None	2
C19	A40 culvert	Windrush West Arm	435933, 208647	5 yearly	Survey	2
C20	A40 culvert	Windrush East Arm	436129, 208673	3 yearly	Survey	2
C21	A40 culvert	Non-main river	436454, 208759	5 yearly	Survey	2
-	TF Smith yard	Madley Brook	436417, 209919	5 yearly	Survey	1
-	Ducklington Lane culvert	Surface drainage system	434846, 209561	5 yearly	Survey	1
-	Bridge Street	River Windrush	435771, 210191	5 yearly	Clear	1
-	Hailey Road culvert	Hailey Road Drain	435953, 211096	5 yearly	Survey	1

Table A2 Maintenance items

Proposed principles of maintenance plan:

1. Survey and clearance should be carried out by the responsible operating authority, for example Oxfordshire County Council clearing highway culverts.
2. Where responsible authority is unclear, survey should be carried out by watercourse authority – for example, Environment Agency for main river culverts.
3. Proposed inspection frequency is an estimated suitable time period between inspections. These inspections will decide whether clearance work is required.
4. A prioritised programme of clearance should be decided between Oxfordshire County Council, West Oxfordshire District Council and the Environment Agency, as per action 6.1.5
5. Culvert ID refers to numbering convention created by West Oxfordshire District Council, as per Appendix A3.
6. After a survey is carried out, it will be the responsibility of the authority carrying out the survey to judge whether further clearance or other works are required, and to what timescale. Where blockages are found that are impeding the proper flow of water, efforts should be made to remove these blockages.
7. Review of this maintenance programme should be carried out periodically – a suggested timescale is every 5 years.
8. This plan can be added to as and when extra maintenance items are identified.

[Appendix A3] Map of culverts

Glossary of terms

Critical Ordinary Watercourse
These are ordinary watercourses which have been identified by DEFRA as being strategically important.

Culvert
A covered channel or large pipe for carrying a watercourse below ground level, often under a road or other development.

Enmained
Process through which an ordinary watercourse becomes main river.

Flash flooding
A flood of short duration, normally occurring immediately following heavy rainfall.

Flood Estimation Handbook
The Flood Estimation Handbook (FEH) is the main method of estimating flood peak magnitudes in the UK. It was issued by CEH Wallingford in early 2000, and supersedes the Flood Studies Report of 1975. Typical applications include the design of flood alleviation schemes, floodplain mapping, operational investigations and development control.

Flood plain
A flood plain is an area of land over which river or sea water flows or is stored in times of flood. A flood plain can extend beyond the land immediately adjacent to a watercourse.

Flood storage area
A flood storage area is that a part of the flood plain that allows flood waters to be temporarily stored. The purpose of such an area is generally to retard larger floods from reaching a main watercourse for a designed flood return period.

Flood Zone
Flood Zones are the Environment Agency's nationally agreed geographical layers of information that define the extend of flood risk. They are split into Flood Zone 1, 2 and 3.
Flood Zone 2 is flooding from rivers without defences at a 1% (1 in 100) chance of happening each year. It is the natural flood plain area that could be affected in the event of flooding from rivers.
Flood Zone 3 is the outline of a flood extent in an extreme flood with a 0.1% (1 in 1000) chance of happening each year.

Fluvial flooding
Flooding where the source is river water.

Groundwater flooding
Flooding caused when water levels in the ground rise up above the natural surface. It will often occur when accumulated rainfall over a long period of weeks or months is significantly above normal. It is most likely to occur in low-lying areas underlain by permeable strata such as chalk.

Main river
Rivers in England and Wales are classified into 'main river' and 'non-main river'. Main rivers are the legal responsibility of the Environment Agency whereas non-main rivers are the responsibility of the relevant local council. The classification is primarily decided in terms of flood risk.

Ordinary watercourse
An ordinary watercourse is any river, stream, ditch, drain, cut, dyke, sluice, sewer (other than public sewer) through which water flows which does not form part of a main river. On ordinary watercourses, the local authority and, where relevant, Internal Drainage Boards (IDB) have similar permissive powers as the Environment Agency has on main rivers.

Operating authority
Any body which has powers to make or maintain works for the drainage of land. Includes the Environment Agency, local authority and county council.

Non-main river
Any watercourse not designated as main river.

Pluvial flooding
Flooding where the source is surface water.

Return period
A measure of the rarity of an event: the longer the return period, the rarer the event. It is the average length of time (usually in years) separating flood events of a similar magnitude.

Riparian owner
The owner of the river in terms of property. The usual situation is for the landowner of each bank to own up to the centreline of the river. There are responsibilities and rights associated with owning the river – principally that of maintenance of the watercourse and associated structures.

Sewer flooding
Flooding due to failure or inadequate capacity of the man-made system which is designed to carry away flows of sewage and drainage water.

Soil moisture deficit
A measure of the effective rainfall which would theoretically be necessary to saturate the soil.

Trash screen
A grill or grate that is installed on a culvert or other limited opening on a river to collect debris and prevent blockages forming inside the culvert.

References

Rainfall and flood return periods: Summer 2007 Flood Hydrology Analysis, JBA.

NRA Thames Region Lower Windrush Study, February 1996, Peter Brett Associates.

The Benefits of Flood and Coastal Risk Management - A Handbook of Assessment Techniques, February 2006, Edmund Penning-Rowsell et al.

Drainage Study Hailey Road and Eastfield Road, Witney, revised June 2003, Peter Brett Associates

Catchment Flood Management Plan – Thames Region summary document, January 2007, Environment Agency.
http://www.environment-agency.gov.uk/yourenv/consultations/1695546/1696092/?lang=_e

Review of Thames Region Summer 2007 Floods, September 2007, Environment Agency.

What you can do to protect your home in the future, Factsheet 4, National Flood Forum.
http://www.floodforum.org.uk/infoanddownloads/bgtf/

Repairing your home or business after a flood – how to limit damage and disruption in the future, Association of British Insurers.
http://www.abi.org.uk/BookShop/ResearchReports/Flood%20Repair%20Doc%201.pdf

Making Space for Water – Encouraging & Incentivising Flood Resilience, DEFRA.
http://www.defra.gov.uk/environ/fcd/policy/strategy/rf1rf2.htm

Flood Products – Using Flood Protection Products – A guide for homeowners, Environment Agency.
http://www.environment-agency.gov.uk/commondata/acrobat/flood_product_guide_lowres.pdf

Damage Limitation – How To Make Your Home Flood Resistant, Environment Agency.
http://www.environment-agency.gov.uk/commondata/acrobat/dlimitation_aug03_354620.pdf

Would you like to find out more about us, or about your environment?

Then call us on
08708 506 506 (Mon-Fri 8-6)

email
enquiries@environment-agency.gov.uk

or visit our website
www.environment-agency.gov.uk

incident hotline 0800 80 70 60 (24hrs)
floodline 0845 988 1188

Environment first: This publication is printed on paper made from 100 per cent previously used waste. By-products from making the pulp and paper are used for composting and fertiliser, for making cement and for generating energy.

Environment Agency Witney 2007