

05 May 2015

Buckinghamshire County Council

Flood Investigation Report

Marlow, 9th January to 20th February 2014



05 May 2015

Revision Schedule

Buckinghamshire County Council
Marlow Flood Investigation Report

April 2015

Draft for Review number 1

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Executive Summary

This document has been produced by Buckinghamshire County Council (BCC) to report on the investigation of the flooding that occurred in Marlow during January and February, 2014. The report provides details of the event and makes recommendations for Risk Management Authorities (RMAs) to undertake to reduce flood risk.

A Section 19 Investigation is a statutory requirement for Lead Local Flood Authorities (LLFA) under the Flood and water Management Act (FWMA) 2010. On becoming aware of a flood in its area, the LLFA must, to the extent that it considers it necessary or appropriate to investigate:

- which RMAs have relevant flood risk management functions; and
- whether each of those RMAs has exercised, or is proposing to exercise, those functions in response to the flood.

It was deemed necessary to produce this report as the flood event in Marlow exceeded BCC criteria for carrying out a Section 19 Investigation. The aim of the Section 19 Investigation is to give an explanation of what happened in the flood event and to identify the RMAs responsibilities during the event. The recommendations are there to help the RMAs learn lessons from the event and to move forward with the management of flood risk in the future.

The flood event in Marlow occurred after a prolonged period of above average rainfall which caused groundwater levels in the underlying aquifer to rise to unusually high levels and the surrounding land to become saturated. Subsequent rainfall, along with groundwater emergence, caused flooding where surface water drainage pumps were overwhelmed and a culvert on an ordinary watercourse had insufficient capacity for the flow. Water levels in the River Thames peaked twice, overtopping the banks and flooding low lying areas of Marlow. The sewer system became overwhelmed from groundwater infiltration and caused flooding. Recommendations are included which, if undertaken, will reduce the flood risk in Marlow.

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1. Introduction

1.1 Background to investigation

Buckinghamshire County Council (BCC) as the Lead Local Flood Authority (LLFA) has a responsibility to record and report flood incidents as detailed within Section 19 of the Flood and Water management Act 2010:

Section 19

- (1) On becoming aware of a flood in its areas, a lead local flood authority must, to the extent that it considers it necessary or appropriate, investigate-
 - (a) which risk management authorities have relevant flood risk management functions, and
 - (b) whether each of those risk management authorities has exercised, or is proposing to exercise, those functions in response to the flood.
- (2) Where an authority carries out an investigation under subsection (1) it must-
 - (a) publish the results of its investigation, and
 - (b) notify any relevant risk management authorities.

BCC has established criteria for Section 19 flood investigations which can be found in the appendix.

It was deemed necessary to complete an investigation into the flood incident in Marlow because it meets the following threshold:

- Internal flooding (including to basements) to five or more residential properties within an area of 1km².
- Class C highways – 10 hours or more unless the route is the only means of access, or is primary route for critical infrastructure then reduce to 4 hours

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1.2 Site Location

Marlow is located adjacent to the River Thames in Wycombe District in south Buckinghamshire, approximately 6.5km southwest of High Wycombe (Figure 1). Figure 2 shows the two areas within Marlow where flooding was experienced in January and February 2014.

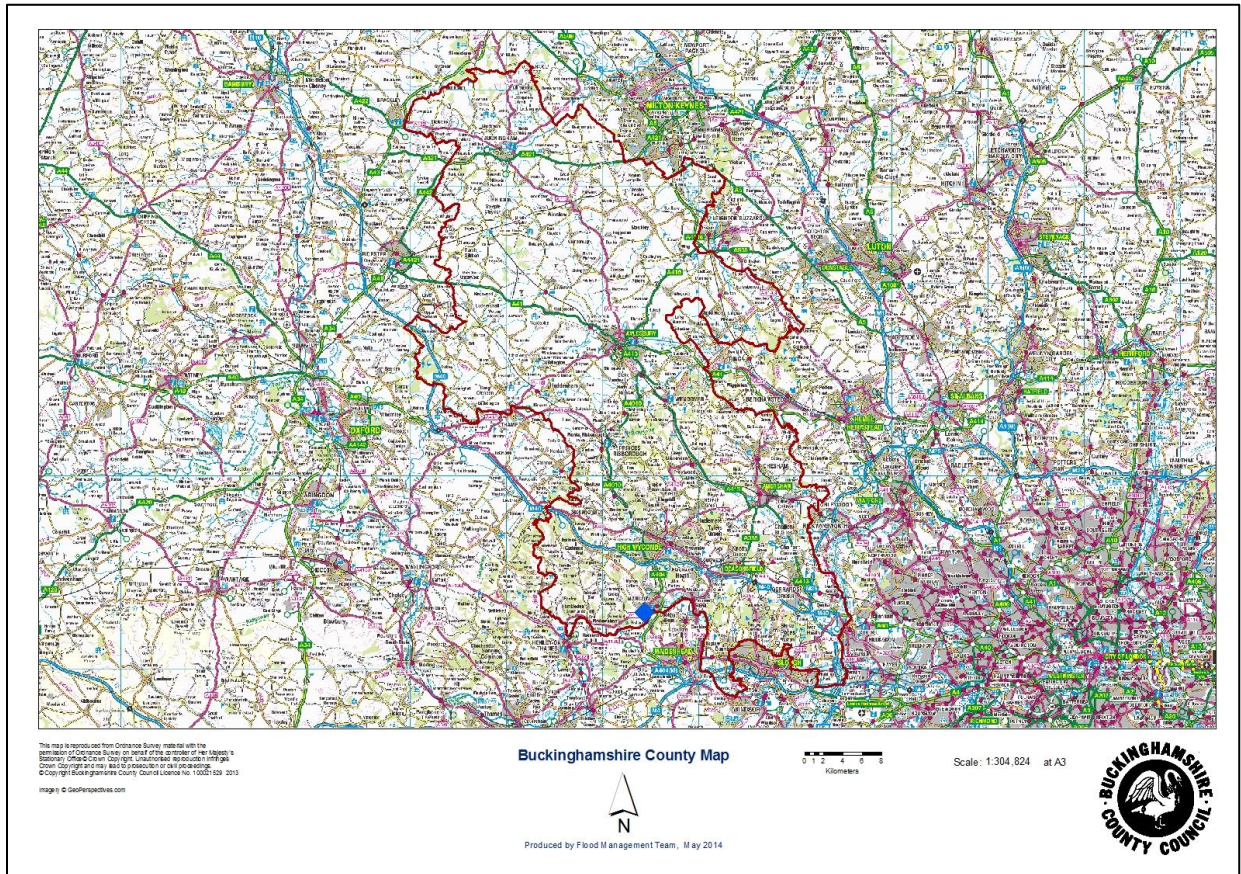
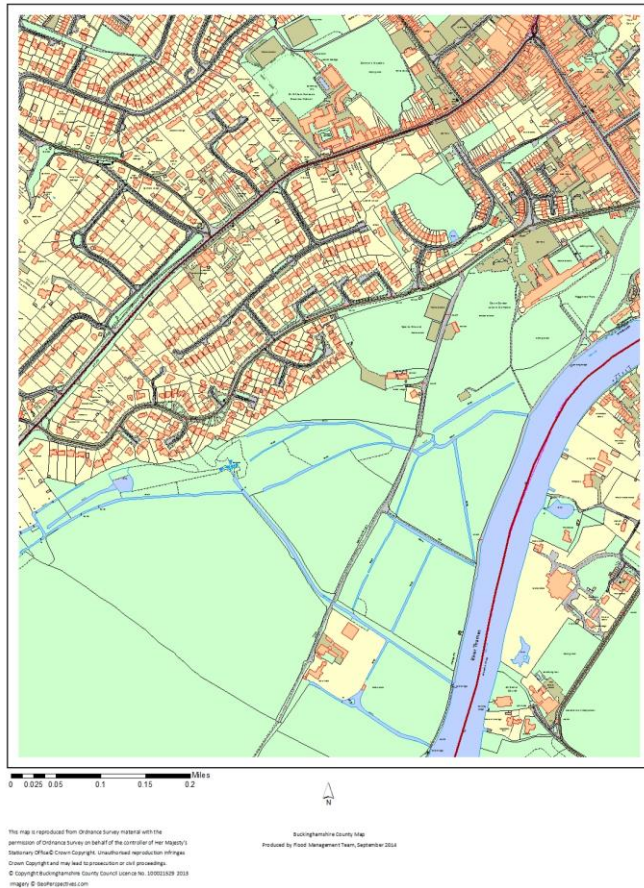
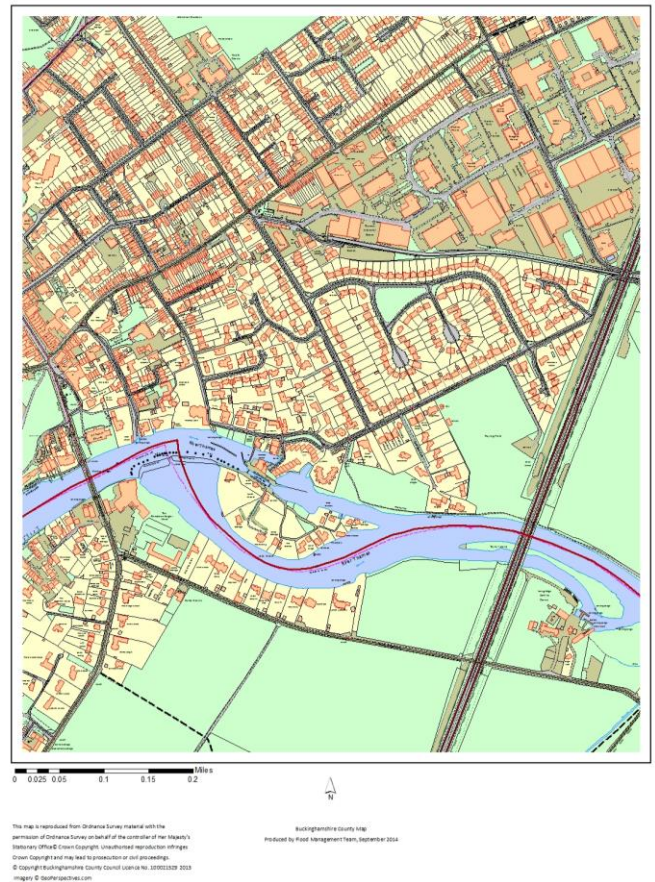


Figure 1 Buckinghamshire county Map

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a. Pound Lane Area, Marlow



b. East Marlow

Figure 2 Area within Marlow where flooding was experienced

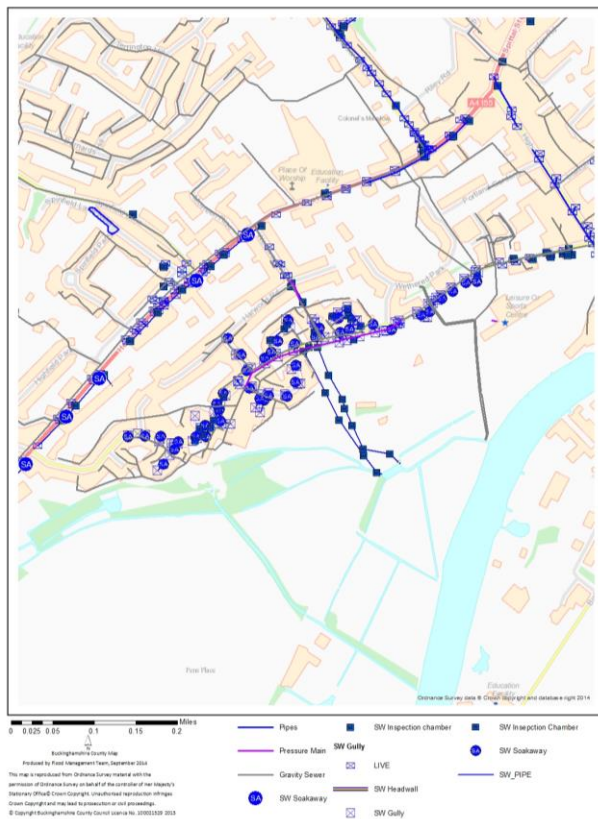
1.3 Drainage system and river network

Marlow is located on the left bank of the River Thames (designated by the EA as a Main River) on permeable River Terrace deposits (gravels). Throughout most of Marlow, these gravels are utilised for infiltration drainage in the management of surface water. In the Pound Lane area of Marlow, surface water is primarily managed through local soakaways (Figure 3a) with excess water collected in sumps and pumped to the River Thames.

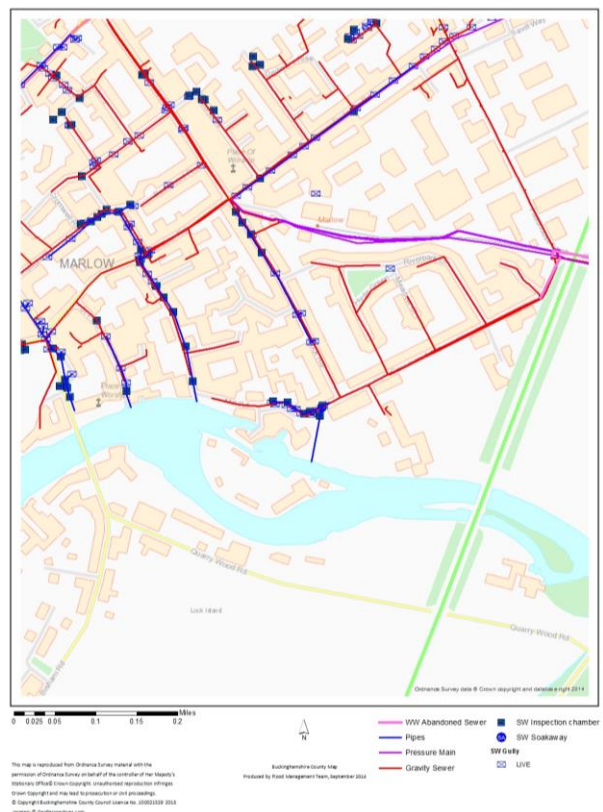
In the eastern area of Marlow, surface water runoff is managed via a piped drainage network (Figure 3b). Here, runoff from Seymour Court Road, Little Marlow Road and

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broadly from the junction of these roads through to Dedmere Road, is routed through pipes which discharge into the Newt Ditch. This ditch is the only other recognised watercourse within Marlow and is designated as an Ordinary Watercourse. It has a short open section, otherwise it is culverted in an approximately 0.9m diameter pipe between the end of Dedmere Road and the open section, and then under the A404 to the outfall into a ditch system (termed as the 'ski pit') on the east side of the A404 (Figure 3b).



a. Pound Lane Area



b. East Marlow Area

Figure 3 Study area assets

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2. Background

2.1 Catchment characteristics

Marlow is located on River Terrace Gravels that overly a Chalk aquifer. To the north of Marlow is the Chilterns, a major Chalk aquifer in which groundwater flows south towards the River Thames and Marlow. Figure 4 shows the bedrock and superficial geology around Marlow. Water levels in the gravels respond to changes in the water levels in the River Thames but are also fed from the underlying Chalk aquifer and the Chilterns Chalk aquifer that lies immediately to the north of Marlow.

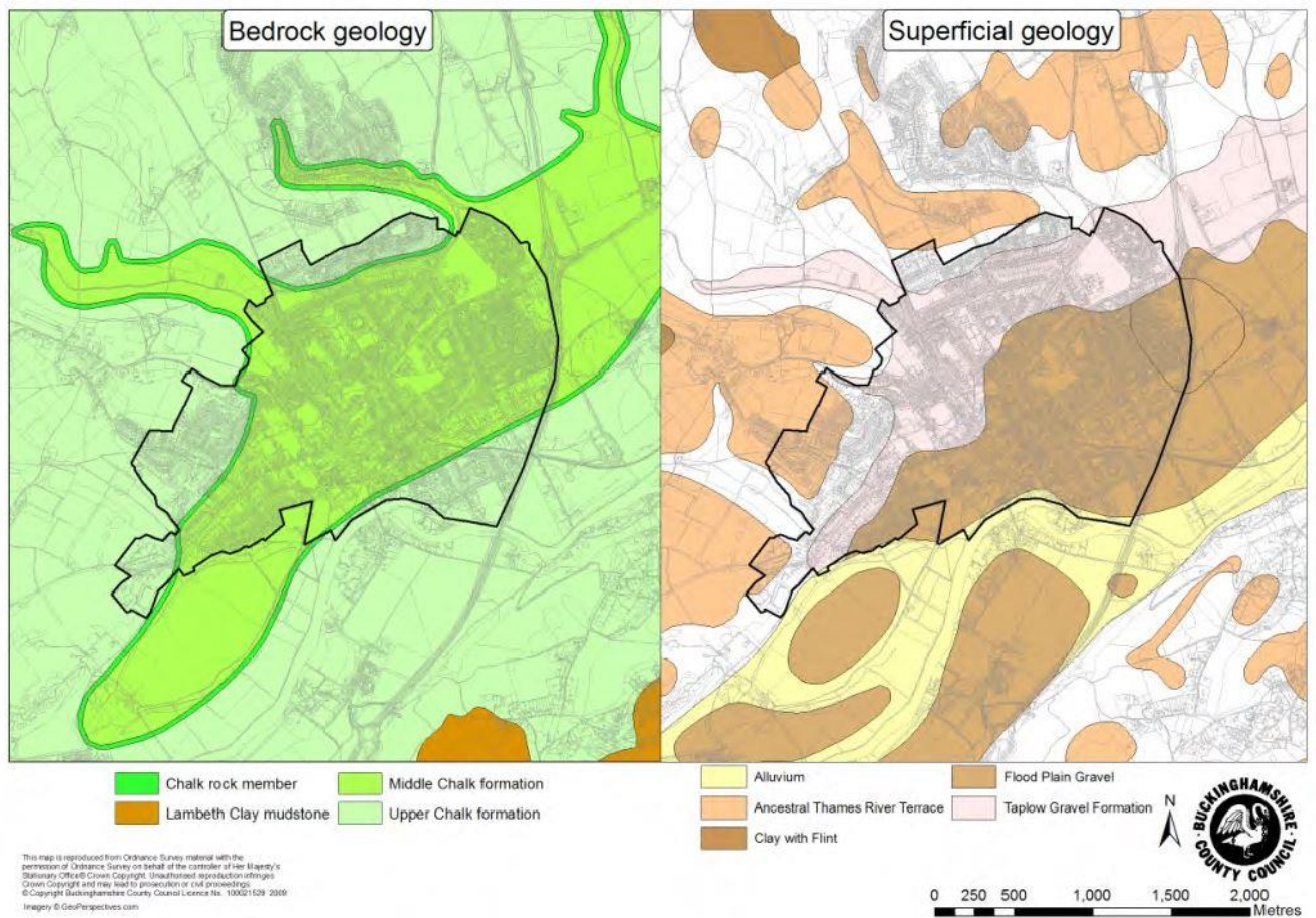


Figure 4 Geology of Marlow

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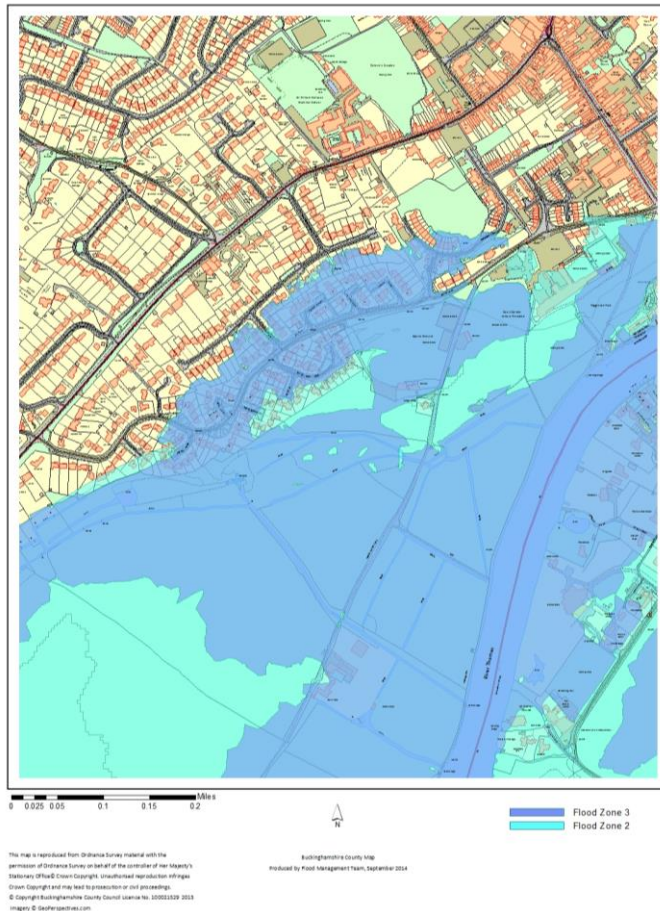
The River Thames is a Main River as designated on the Main River Map produced by the Environment Agency. At Marlow the river drains a catchment area of over 6700 km². Both the size of the catchment and the characteristics of the geology it drains, leads to the River Thames responding slowly to rainfall events. Typically, the river rises slowly over a week or more to its peak and recedes equally slowly.

The fluvial flood map (see Figure 5) shows the flooding that would occur from the River Thames in a 1 in 100 event (1% chance of occurring in a year) (medium blue) and 1 in 1000 (0.1%) (light blue). The dark line represents the center line of the River Thames. These show that the southern areas of Marlow are vulnerable to the 1 in 100 (1%) AEP flood event and that the northern part of the eastern area is vulnerable in the 1 in 1000 (0.1%) AEP flood.

The surface water flood map (see Figure 6) shows the extent of flooding in the 1 in 30 (3.3% AEP), 1 in 100 (1% AEP) and the 1 in 1000 (0.1% AEP) events for the Marlow area. Surface water flooding occurs when extreme or prolonged rainfall cannot infiltrate into the saturated ground or flow into the rivers or highways drainage due to the high volumes of water. Many of the areas vulnerable to surface water flooding in Marlow are those same areas vulnerable to fluvial flooding.

The DEFRA groundwater flood map also indicates that large areas of Marlow would have groundwater at, or within 2m of, the ground surface in a winter similar to that of 2000/01. Detailed maps of the areas vulnerable to groundwater flooding are not currently available for this area. Groundwater flooding can occur when water levels in the underlying Chalk and Terrace Gravels rise and water emerges at the surface. It can emerge as increased flows from existing springs, from new springs or from diffuse sources. Where watercourses draining these areas have insufficient capacity or are obstructed and in those areas where there is no defined watercourse, flooding from groundwater can occur.

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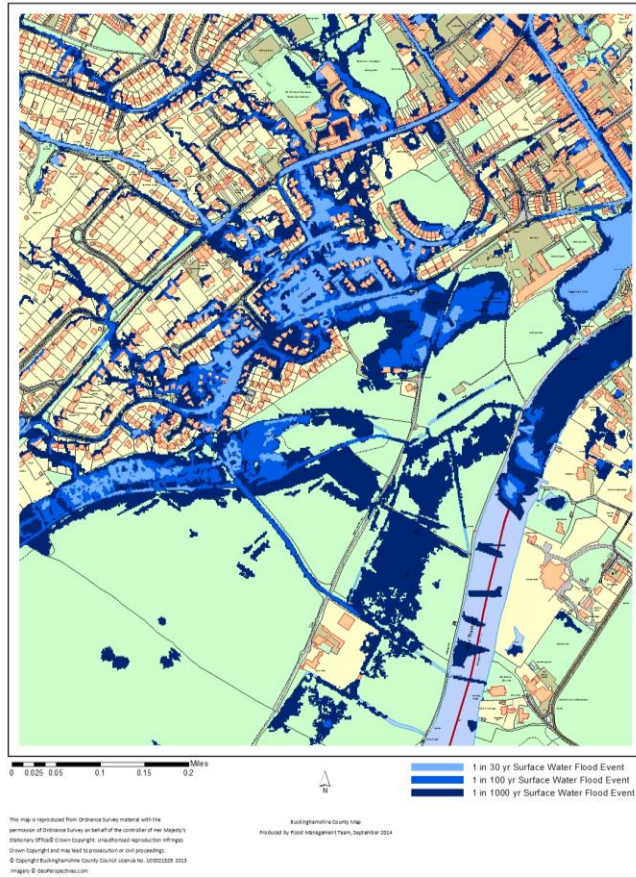
a. Pound Lane, Marlow Flood Map



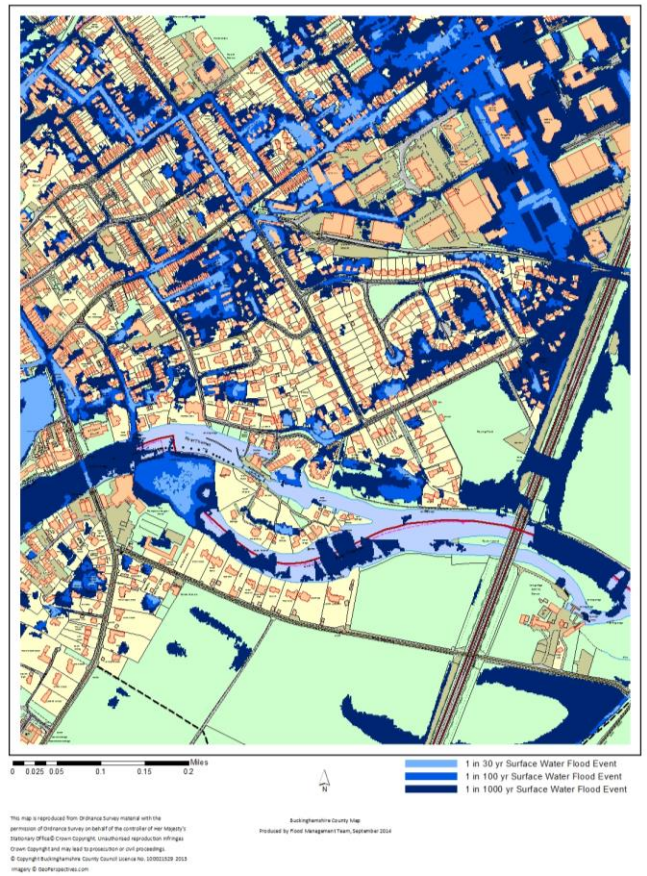
b. East Marlow Flood Map

Figure 5 EA flood map showing the River Thames 1:100 year event (flood zone 3) in dark blue and 1:1000 year (flood zone 2) in light blue (EA, 2014)

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a. Pound Lane



b. East Marlow

Figure 6 EA Surface Water Flood Map showing the 1 in 30, 1 in 100 and 1 in 1000 events (EA, 2014)

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2.2 Previous flood events

There is a long history of flooding from fluvial, surface water and groundwater sources within Marlow. Table 1 provides a brief summary of the flood history.

Table 1 Marlow Flood History

Date	Source	Detail	Reference
1768	Fluvial (Thames)	By letters from Great Marlow, in the county of Bucks, by Monday's post, we are informed of great losses sustained by the inhabitants, from the overflowing of the River Thames by the late heavy rains, and that the navigation of the river is stopped, the Thames being then above a mile over by the flood. The banks of the river are at present so much overflowed in Berkshire, that the West-country barges cannot come to London."	BHS Chronology
1894	Fluvial (Thames)	Notably the highest flood was that of November 1894, followed by March 1947.	BHS Chronology
1897	Snowmelt	1897 February 1-5 Rainfall observer at Slough (Upton) noted (p[5]) "Rain 1.92 in., followed by floods, which culminated on the night of the 7th. The melting of snow on the Marlow Hills was greatly responsible for the flood."	BHS Chronology
1903	Unknown	1903 November 29 rainfall observer at Marlow noted "More than an inch of rain in 24 hours caused a renewal of the floods." [Thames]	BHS Chronology
1947	Fluvial (Thames)	"...Oxford, Reading, Maiden head, Windsor-all the towns of the Thames valley suffered gravely from the Thames flood. The thaw in the Cotswolds was felt almost immediately in the waters of the Thames, which rose steadily, and by March 11 had already overflowed its banks at Windsor, familiar victim of floods. By next morning, though, things were beginning to look serious in the Thames valley. The river was rising at the rate of 1.5 inches an hour and thousands of acres of low-lying ground on its banks were already inundated. By the following day, March 13, the river was four feet above normal at Windsor bridge, and was still rising. The water was into the town at Maidenhead, and quite deep in the low-lying parts of Marlow. On March 14, with the rivers all over southern England overflowing, the Thames was in monstrous flood, more than eight feet above normal, for instance, on the gauge at Bray lock. Its waters were spreading deeply across many of the riverside towns above Teddington.	BHS Chronology
Dec 2000	Fluvial (Thames)	River Thames	Wycombe District SFRA
Winter 2000/1	Groundwater	3 locations in Marlow	Defra GEM

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Date	Source	Detail	Reference
	Groundwater	30 properties flooded	WDC
	Unknown	Internal flooding recorded at some properties on: Marlow Rd, Glade Rd, The Causeway, Dedmere Rd, Gossmore La, Firview Cl, The Croft, Garnet Court, Pike Cl and Pound Crescent.	Marlow SWMP
Jan 2003	Fluvial (Thames)	Internal flooding recorded at some properties on: Glade Rd, The Causeway, Dedmere Rd, Gossmore La, Gossmore Cl, Firview Cl, The Croft, Garnet Court, Pike Cl, Bream Cl, Dedmere Court, Henley Rd, Quarrydale Rd, Maple Rise, Pound Lane and Pound Crescent. Claremont Rd. River Park Dr. and Hyde Green	Wycombe District SFRA and Marlow SWMP
2006	Fluvial	Beamont Rise, Dedmere Rd, Mill Rd, Newtown Rd, Pound Lane Spinfield La,	SFRA
	Drain	Dean Street, Victoria Rd,	SFRA
	Various	Claremont Rd, The Causeway, Station rd, Dedmere Rd, Firview Cl, The Croft, Pound Lane	Marlow SWMP
July 2007	Fluvial/ Surface water	Cambridge Road, Chapel Street, Claremont Road, Dean Street, Dedmere Road, Foxes Piece, Garnet Court, Glade Road, Gossmore Lane, Gypsy Lane, Harwood Road, Henley Road, High Street, Hillside Road, Institute Road, Little Marlow Road, Lock Road, Maple Rise, Newtown Road, Oak Tree Road, Peacock Road, Pound Lane, Seymour Court Road, South Place, Southview Road, Spinners Walk, St Peter Street, Station Road, Templars Place, The Croft, West Street, Wycombe Street, Badgers Way, Marlow Bottom Road	SFRA
		Green Verges, Henley Road, Hillside Road, Maple Rise, Newfield Gardens, Pound Lane, Marlow Bottom Road	SFRA
		Internal flooding: Garnet Court, Pound Lane	WDC
	Surface water	Higginson Park	SFRA
July 2007		Claremont Road, Glade Road, Fieldhouse Lane, The Causeway, Dedmere Road, Gossmore Lane, Lock Road, Firview Close, The Croft, Garnet Court, Pound Lane, Chapel Street	Marlow SFRA
Jan 2008		Moyleen Rise and Mundaydean Lane	Wycombe District SFRA
Feb 2009	Various	High Street, Claremont Road, The Causeway, Dedmere Road, Gossmore Lane, Firview Close, The Croft, Pound Lane, Chapel Street	Marlow SWMP
2010/11	Groundwater	Groundwater - Willow Mead estate, Dedmere Road, The Acre, Little Marlow Road (near Maple Rise), Kenton Close, Pound Lane (groundwater and surface water)	Wycombe DC (Brian Rodgers)
2012	Fluvial (Thames)	River Thames	Wycombe District SFRA
Dec	Surface water	Dedmere Rd and The Croft area	SWMP

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Date	Source	Detail	Reference
2012			
Uncertain	Fluvial (Thames)	Pound Lane and Gossmore Lane Marlow	TfB

3. Analysis of January- February flood event

3.1 Conditions at the time

Rainfall

The Environment Agency provided rainfall data for the period 1st December 2013 to the end of February 2014. This data was recorded at the Hambleden raingauge which lies approximately 8km to the west of Marlow and can be considered as representative of the rain that fell in Marlow. Figure 7 shows the daily rainfall for three months starting December 2013. This winter period was unusually wet. There were many days when rain fell and a large number of very wet days. The 23rd January and 6th February were particularly wet with over 30mm recorded on both days at the Hambleden raingauge.

To put this into context, from October 2013 to the end of February 2014, the area received 193% of the long term average rainfall. February 2014 was unusually wet receiving 334% of the long term average rainfall for February making it the wettest February on record in the area (Environment Agency, 2014).

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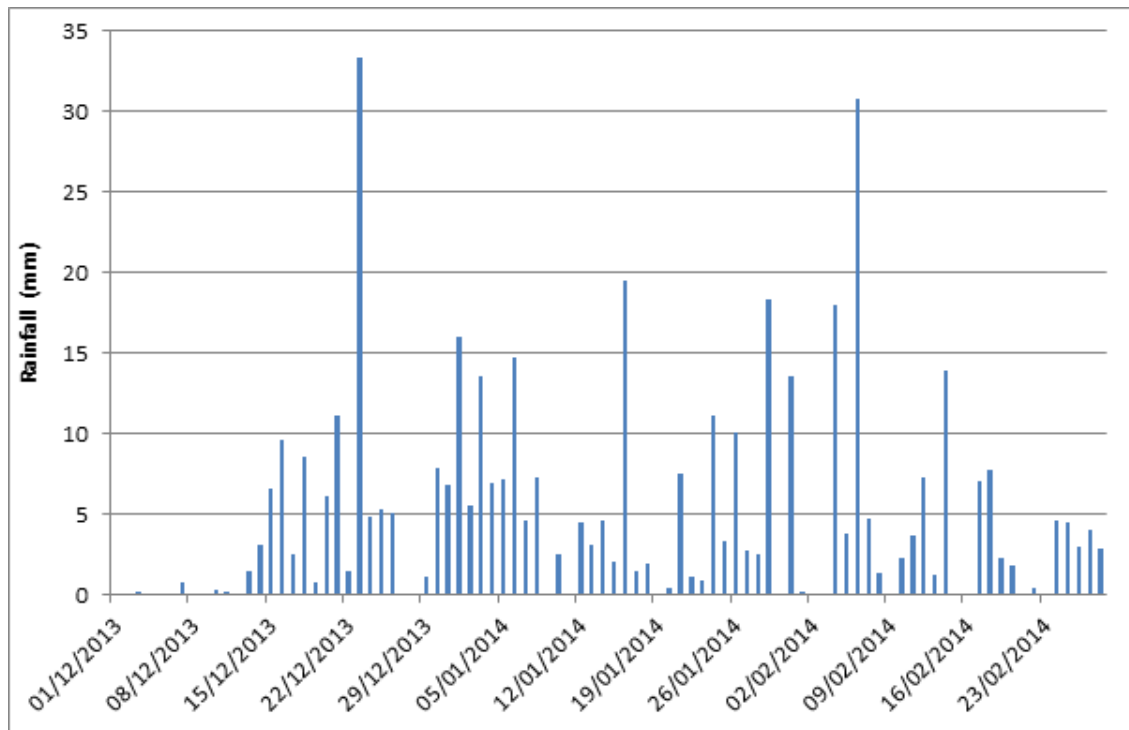


Figure 7 Hambleton Rainfall (December 2013 to February 2014)

Groundwater

Groundwater levels started rising in December 2013 in the Chalk aquifer underlying the Chilterns as is normal in the late Autumn. However, the exceptional rainfall allowed water levels to rise within the Chalk to unprecedented levels as measured at the observation borehole at Stonor (this borehole is considered representative of the Chilterns). By the new year, groundwater levels at Stonor had reached new highs and continued to rise throughout January (Figure 8). The water held within the Chilterns Chalk flows south to the River Thames and can, in unusually wet years resurface through the gravels on which Marlow is built.

The water levels in the Terrace Gravels beneath Marlow are also controlled by water levels in the River Thames. As the river levels rise, they cause water levels in the gravels to rise. Therefore groundwater levels rose in and around Marlow from both the excess flow from the Chilterns and are held up by the high water levels in the River Thames.

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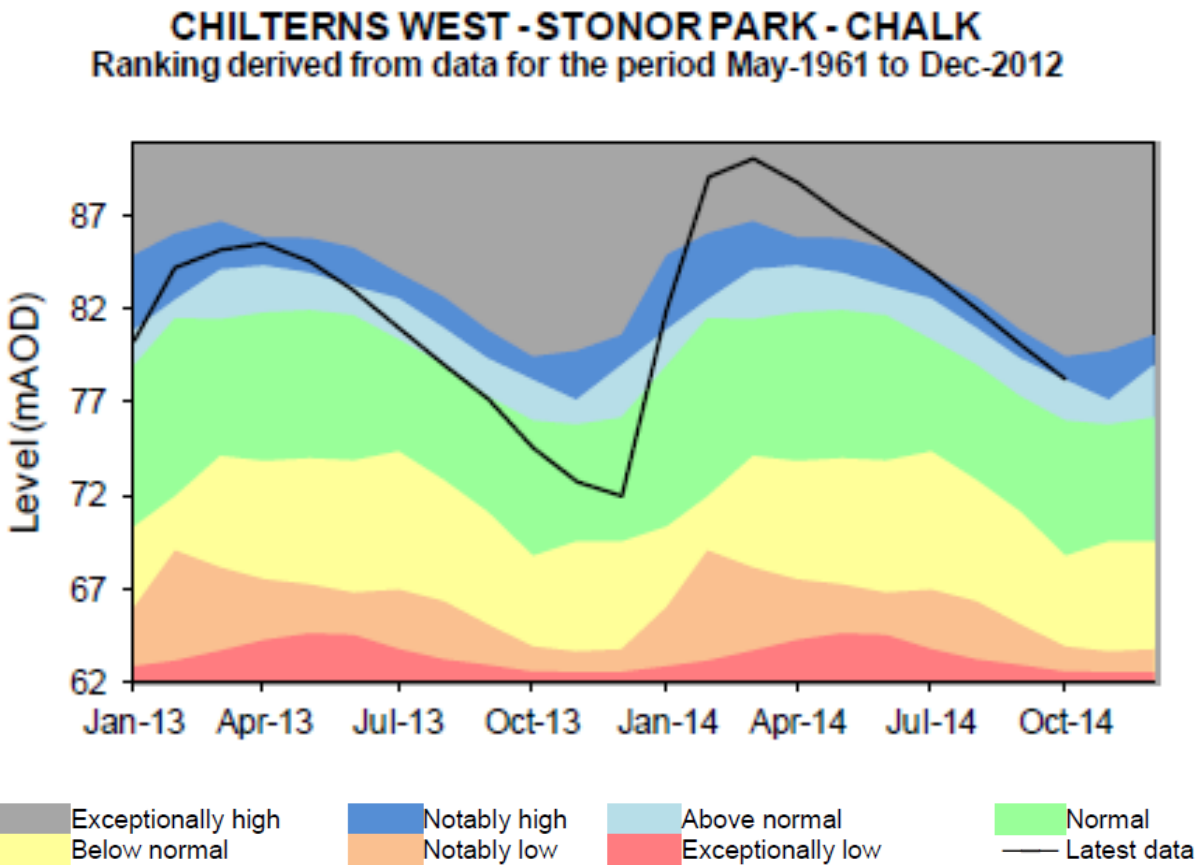


Figure 8 Groundwater levels in the Chilterns (From EA Monthly Water Situation Report, South East Water Situation Report (October 2014))

River Levels

The unusually wet weather occurred across much of the catchment of the River Thames that drains to Marlow. Water levels in the River Thames peaked on the 10th January 2014 and then steadily dropped. However, following further rainfall in February 2014 the Thames rose to a higher peak between the 9th and 11th February 2014 in Marlow. Figure 9 shows the water levels in the River Thames as measured upstream of Marlow Lock.

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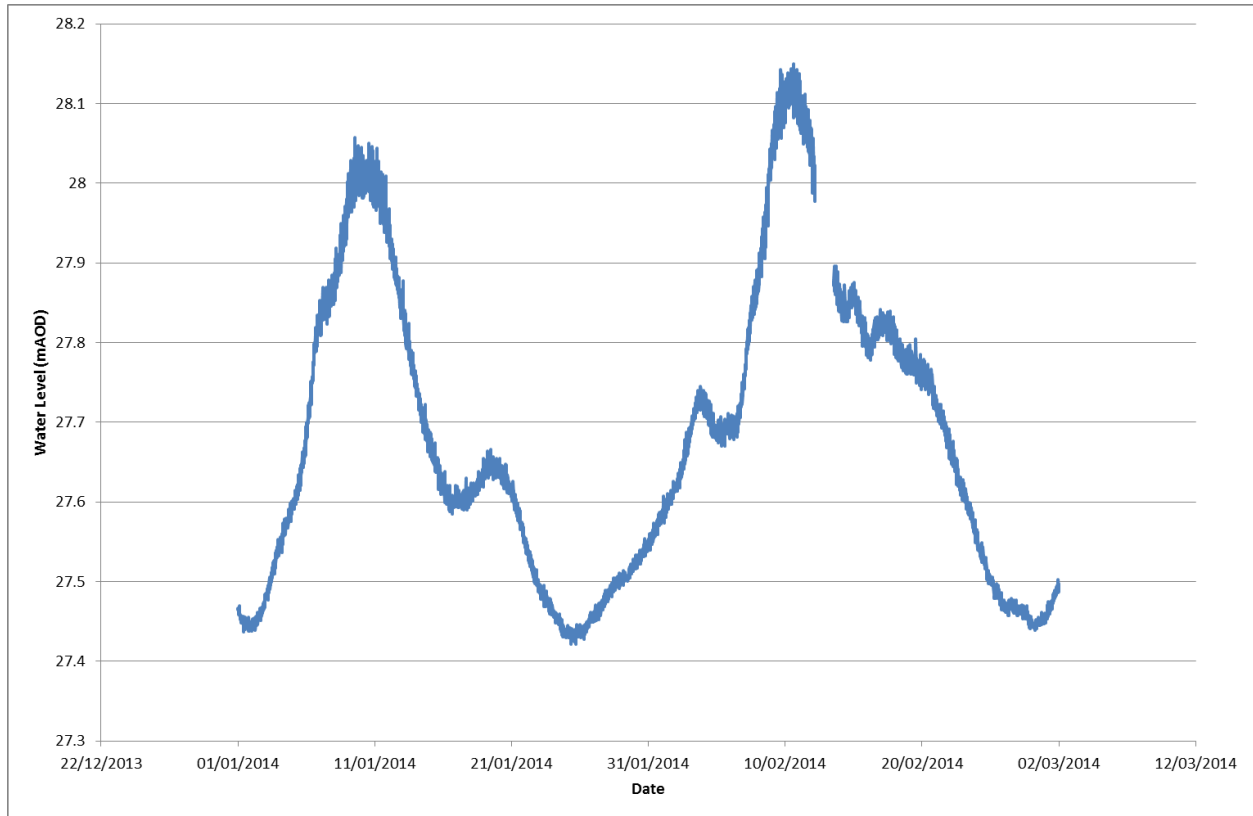


Figure 9 River Thames water levels measured upstream of Marlow lock

3.2 Condition of features

No reports have been identified of any failure of pumps or temporary blockages of watercourses, drains or culverts immediately prior to or during the January and February floods. No reports have been received of any blockages in the River Thames and at the Lock at Marlow. However, a photograph of culverts on the Newt Ditch taken months before the floods shows very significant sediment deposition (Figure 10) suggesting that there may be a permanent blockage.

The section of pipe between the end of Dedmere Road and the open section is known to be half full of silt, with excessive root growth which cannot be cleared by jetting. The large catchment draining through this culvert in its current poor condition is suspected by the highway engineers to be the greatest local flood risk in Marlow, after flooding from the River Thames.

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Figure 10 Newt Ditch culvert (29-05-2013)

3.3 What happened?

At the beginning of January 2014, with the ground waterlogged and water levels in the River Thames high, problems of flooding began in low lying areas primarily from groundwater. On the 6th January 2014 the EA issued a Flood Warning for the Marlow reach and the River Thames peaked on about the 10th January 2014. Problems of flooding continued until mid-January as the River Thames slowly dropped. However, this was only a brief lull before the rainfall on the 6th February 2014 and a second peak on the River Thames on the 11th February 2014 caused further and more severe flooding. Those areas of Marlow below 28.2m AOD (approximately the peak River Thames level – see Figure 9) and close to the River Thames are likely to have been inundated from flood waters directly from the River Thames. Distinguishing between the other flood mechanisms is difficult as problems of groundwater, surface water and sewer flooding are usually interlinked. However, from the information provided by residents and RMA the following is likely:

- A. Pound Lane, Pound Crescent, Trout Close, Pike Close and Garnet Court Area. These areas (identified as Area A in Figure 11) flooded from groundwater and some also from the River Thames. Householders in the area have submersible pumps, but can only pump to the local sumps. Council pumps that are permanently sited in sumps could not cope with the volume of water. To protect properties and support the community, Buckinghamshire Fire & Rescue service

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(BFRS) initially pumped the water away. However, levels continued to rise until a higher volume pump was employed. This area was the main focus for the BFRS.

A forward control point was established close to the scene in Higginson Park which enabled a multi-agency tactical co-ordination group to operate.

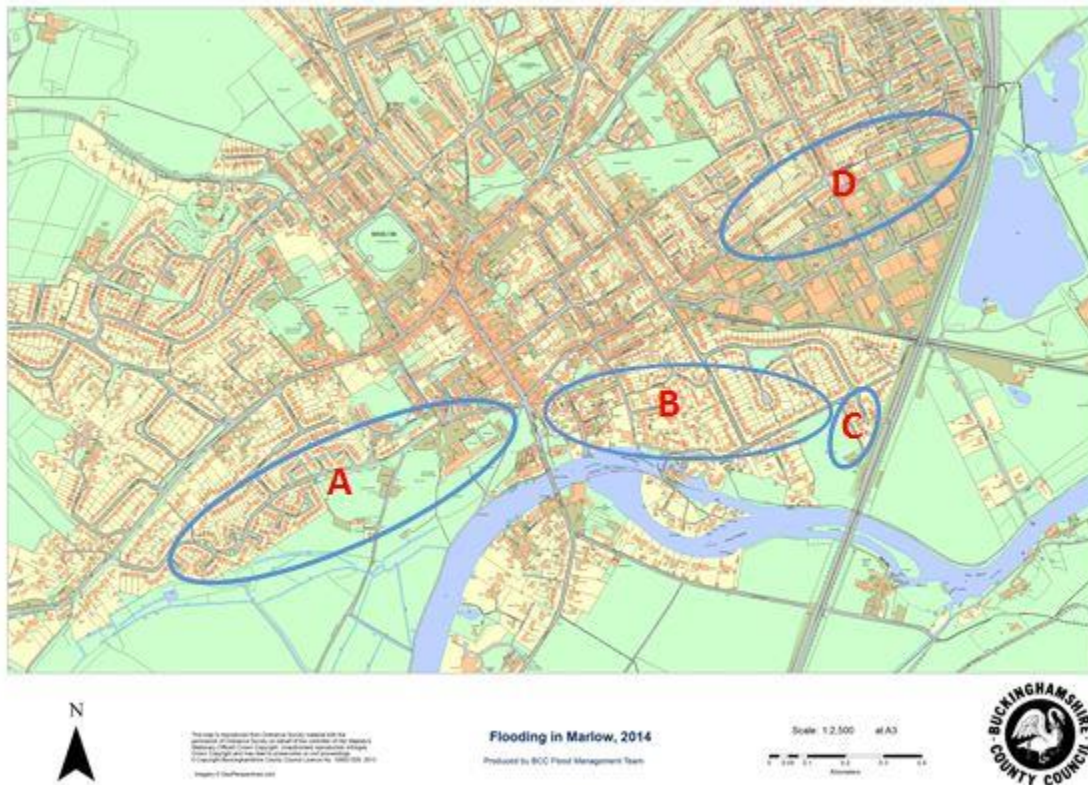


Figure 11 Areas subject to flooding January and February 2014 (areas outlined in blue)

- B. St Peter Street, Mill Road, Lock Road, Gossmore Close and Gossmore Lane Area.

This area (identified as Area B in Figure 11) flooded directly from the River Thames although some areas may have also had groundwater flooding prior to the River Thames going out of bank. There are reports of sewage problems throughout most of this area. The BFRS protected properties in St Peters Street.

- C. Firview Close.

Backing up of piped drains in the road and rising groundwater came close to flooding many properties in this area (identified as Area C in Figure 11).

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However, residents were able to limit the number of properties flooded by pumping the water back over an informal bund in the A404 drainage ditch. This bund prevented the River Thames backing up the ditch and flooding properties in Firview Close (Figure 12). The residents reported a problem with the sewer system but not of contaminated flood water.



Figure 12 Informal bund on the A404 ditch

D. Dedmere Road, Fieldhouse Lane, Holland Road, Saville Way and The Acre Area.

This area (identified as Area D in Figure 11) lies outside the modelled flood extents of the River Thames. However, much of the piped drainage in Marlow drains to the Newt Ditch that passes through this area predominantly in a culvert. Residents report that the drains were blocked with leaves and as a consequence the area flooded from surface water that could not drain away.

It is likely that other individual or small groups of properties within Marlow had problems with groundwater emergence that have not been reported or identified. BFRS estimated that approximately 150 properties were affected by flooding in some way (not necessarily internally) in the Pound Lane area of Marlow. Wycombe District Council

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estimate that approximately 55 to 60 properties flooded internally. BCC are aware of 2 assisted self-elected evacuations that have taken place (Pike Close, Marlow and Ferry Lane, Marlow). Figure 11 provides an overview of the flooded areas.

3.4 Possible causes

The weather conditions

- Unusually wet December 2013, January and February 2014
- Intense rainfall in February 2014

The ground conditions

- Water levels in the Chalk in the Chilterns and in Marlow (Chalk and gravels) were unusually high causing groundwater to emerge at the surface
- Soils were completely waterlogged and unable to hold any further rainfall.

The condition of the watercourses and drainage systems

- Water levels in the River Thames overtopped the banks and flowed into the floodplain. There were no reports of blockages in the River Thames or at the lock. The Environment Agency estimate that at Marlow the flows equate to a 1 in 20 (5% AEP) flood event.
- Where Marlow is serviced with soakaways, these were unable to operate due to high groundwater levels.
- Surface water pumps were overwhelmed by the volume of water.
- The piped surface water drainage system was unable to discharge into Newt Ditch. The culverts may have had reduced capacity due to sediment.
- Groundwater infiltrated into the foul sewer network thereby reducing its capacity to take foul water. The sewers then surcharged and flooded low lying areas.

3.5 Incident response

Table 2 provides a summary of the incident response following a request to response providers to provide information. At the time of writing, no information has been received from Thames Water. The EA did not grant access to their incident log. The response of the EA has been determined from their West Area Flood Report (EA, 2015). Largely excluded from this table is the response of individuals and businesses in protecting their own assets. For example, we are aware that businesses in Fieldhouse Lane protected their own assets but the dates and means are not known.

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Thames Valley Police declared the Thames-wide flooding as a major incident. The Thames Valley Local Resilience forum facilitated Strategic Coordination Group meetings twice daily where partner agencies could work together to support each other. The Strategic Coordination Group liaised closely with the Government and the Ministry of Defence.

Within Marlow, a rendezvous point was established in Court Garden car park in Pound Lane, where the Rapid Relief Team, run by members of the Plymouth Brethren Christian Church, provided sustenance for the BFRS crews.

The National Assets Team provided BFRS a High Volume Pump from Staffordshire Fire & Rescue Service that could pump six times the volume of water of a standard fire engine.

The BFRS community safety team were active in the Marlow area, specifically handing out advice and fitting carbon monoxide detectors to properties that were using portable heating systems, generators and pumps.

Table 2 Incident Response Collated Log

Date (2014)	Location	Response Provider
6 January	Flood Warning issued for Properties closest to the River Thames from All Saints Church, Bisham to Little Marlow	EA
	Pumping in Firview Close	Residents
	TfB confirm that the 4 pumps in the Pound Lane area are working satisfactorily.	TfB
7 January	Sandbags issued – see table 3 below	WDC
8 January	Pound Lane – residents self helping. TfB surface water pumps operating (some continuously)	Residents/TfB
	Pumps in gardens in Garnet Court operating to reduce groundwater levels. TfB highway pumps checked and reported to be working continuously.	TfB
	<i>Groundwater flooding reported in Riverpark Drive</i>	
	Buckinghamshire Red Cross volunteer teams on standby for ERCs	Red Cross
	Front and rear Gardens in Garnet Court flooded due to rising groundwater. Action taken by householders using their own pumps to pump water into the street to be handled by the pump in the underground culvert in the road	Residents
9 January	Environment Agency Flood ambassadors visit Marlow	EA
	Flooding in St Peter Street – mobile light pump deployed	BFRS
	Garnet Court: Firefighters used pumps, checked on the welfare of residents and provided flood safety leaflets. Relief crews from Marlow, High Wycombe and Beaconsfield worked in shifts for the next five days, remaining at the scene until Tuesday 14 January.	BFRS
	Sandbags issued – see table 3 below	WDC
	Marlow Town Council deploy community payback workers under supervision to Gossmore Lane to help with sandbags.	MTC

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Date (2014)	Location	Response Provider
	Marlow TC clerk and councilors door knock to offer assistance with sandbags	MTC
	BFRS at The Lodge, St Peter St and Marlow pumping station	BFRS
	Pump supplied to Firview Close	WDC
	Pound Lane surface water pump overwhelmed, BFRS pump	BFRS
10 January	Environment Agency Flood ambassadors visit Marlow and Bourne End	EA
11 January	Flooding at Mill Road, BFRS assessed and monitored	BFRS
	Environment Agency Flood ambassadors visit Marlow and Bourne End	EA
12 January	Environment Agency Flood ambassadors visit Marlow and Bourne End	EA
14 January	Environment Agency Flood Warning for Properties closest to the River Thames from All Saints Church, Bisham to Little Marlow no longer in force	EA
5 February	Flooding at Garnet Court. BFRS pump 24 hrs a day for 8 days from large storm drain	BFRS
6 February	Flood Warning issued for Properties closest to the River Thames from All Saints Church, Bisham to Little Marlow	EA
	<i>Basement floods, High Street</i>	
	Flooding near Garnet Court. BFRS pump water from large storm drain until 13 February	BFRS
7 February	Flooding at Quarrydale Drive (BFRS attend and give advice)	BFRS
	Pound Lane road closed due to flooding	TfB
	Sandbags delivered: <ul style="list-style-type: none"> • Firview Close (200) • Field House Lane (200) • Pound Lane (150) 	WDC
	TfB issue flooding updates on www.transportforbucks.net/winter-maintenance/blog.aspx	TfB
	Pumping at Garnet Court	BFRS
	Environment Agency Flood ambassadors visit Marlow and Bourne End	EA
9 February	<i>Flooding at:</i> <ul style="list-style-type: none"> • Pound Lane (BFRS attend and give advice) • Trout Close (BFRS attend and give advice) • Dedmere Road (BFRS attend and give advice) • Pike Close (BFRS attend and give advice) • St Peter Street (2 pumps deployed) 	BFRS
	Environment Agency Flood ambassadors visit Marlow	EA
10 February	Flooding at <ul style="list-style-type: none"> • Gossmore Walk (BFRS attend and give advice) • West Street (BFRS attend and give advice) • Pike Close (BFRS attend and give advice) • Quarrydale Drive (BFRS attend and give advice) 	BFRS
	Sandbags issued: <ul style="list-style-type: none"> • 200+400 Pound Lane • 200+150 St Peters Street • 150+150 Gossmore Lamne • 150+100 Quarrydale Drive 	WDC
	Pump in Pound Lane	TfB

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Date (2014)	Location	Response Provider
11 February	<i>Carpark floods in Fieldhouse Lane BFRS attend and give advice</i>	BFRS
	Control Centre set up in Penwood Lane for BFRS	BFRS
	Marlow TC call out BFRS to Pike Close to evacuate a resident	MTC/BFRS
	Sandbag station set up in Pound Lane area manned 24hrs/day	BFRS/MTC
	Environment Agency Flood ambassadors visit Marlow	EA
	Multi agency meeting held in Control Centre	All
	300 gel sacs given to MTC by WDC	WDC
	Sandbags issued <ul style="list-style-type: none"> • 100 Mill Road • 50 Tierney Court • 200 Pound Lane 	WDC
12 February	<i>Flat in Mill Road floods BFRS office attends to assess</i>	BFRS
	Additional 500 sandbags delivered to Pound Lane (1200 now in total)	WDC
	Sandbags issued <ul style="list-style-type: none"> • 100 Fieldhouse Lane • 100+100 Tierney Court • 100+200 Court Garden 	WDC
	3 pumps in Pound Lane area +super sucker	BFRS
	Additional sandbags delivered to Pound Lane – see table 3	WDC
	Supersucker has pumped out 7 properties	TfB
	Military vehicle with staff and sandbags arrive at Marlow Town council (unexpected)	
	Environment Agency Flood ambassadors visit Marlow	
13 February	810 sandbags in Pound Lane. 12 sandbag walls built around properties	WDC
	Discussion on sending out portaloos	WDC
	Sandbags issued: <ul style="list-style-type: none"> • 100 Meadow Close • 100 Court Garden • 100 Fieldhouse Land 	
	Supersucker pumped out 10 properties	With TfB and army
	3 pumps moved to Lock Rd	
	Portaloo sourced for Garnett Close	
	Environmental Health Officer located in at Bronze command in Court Garden car park	WDC
	Incident Control unit set up at Marlow Sports Centre in Pound Lane	BFRS
	Supersucker clears 5 more properties in Pound Lane	
	RAF supply 250 men to be placed in 7 sectors in Marlow – providing security for sand bags & 4x4 taxi service to assist TfB.	RAF
Quick response force monitors Dedemere Rd and Gossmore Rd helped by RAF	RAF	
14 February	Supersucker moved out of Marlow having cleared 4 properties in Marlin Court	TfB
	3 pumps in Pound Lane and Lock Rd areas	
	4 portaloos issued to Garnet Court	WDC
	TfB station moved to Harwood Rd with sandbags (100)	TfB
	Sandbag station set up in Dedmere Rd (500)	WDC

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Date (2014)	Location	Response Provider
15 February to 16 February	Flooding at Quarrydale Drive. Mobile light pump utilised to protect 4 homes.	BFRS
	BSAR Swift water rescue team arrive in Marlow	
	Thames Water issue advice (Bucks Free Press) to reduce flushing for next 2 weeks as sewers full	TW
	Environmental Health Officer and Housing officer located at Court Garden over weekend to provide advice and guidance to residents	WDC
	BFRS raise concern about leaking sewers	BFRS
17 February	BFRS started a pumping operation at Quarrydale Drive which has successfully reduced groundwater levels in the gardens and thus reducing flooding risk in that area although levels rose overnight	BFRS
	4 portaloos issued to Quarrydale Driver	WDC
18 February	Wycombe District Council encourage Marlow residents, even those not directly affected by the flooding, to restrict water usage in the home to help with the sewer capacity issue.	WDC
	Sewers continue to contaminate flood water in Marlow. Public Health advice issued.	WDC
	Groundwater level drops in lower Pound Lane but rise in Quarrydale Drive.	
	Higginson Park closed due to contamination. WDC put up more signs and barriers.	WDC
	BFRS pump in Quarrydale Dr	BFRS
	Quarrydale Dr floodwater becomes contaminated with raw sewage –WDC consider potaloos	WDC
	Military move out	
20 February	Pound Lane re-opened	TfB
21 February	BFRS Incident Control Point closed	BFRS
	Flood warning no longer in force for Properties closest to the River Thames from All Saints Church, Bisham to Little Marlow	EA
	Sewerage problem in Quarrydale Road. Thames Water pump sewer for 2 weeks	TW
25 February	Flooding at Quarrydale Drive - BFRS pump from garden into drain.	BFRS

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Table 3 Sand bags distributed in January 2014 by Wycombe District Council (courtesy of WDC)

	Monday 06/01/2014	Tuesday 07/01/2014	Wednesday 08/01/2014	Thursday 09/01/2014	Friday 10/01/2014	Total
Bourne End						
Jeffries Court					50	50
Lock Lane / The Drive	50					50
Riversdale / Orchard Mill	100				100	200
Sailing Club Road / The Drive				100		100
Station Road		20				20
						420
Little Marlow						
The Moor		100				100
Marlow						
Gossmore Lane / Firview Close	100	200		300		600
Lock Road			100			100
Meadow Close			50			50
Mill Road (Lock Island)				50		50
Pound Lane (various drops)			200	150		350
Riverwoods Drive		250	100			350
St Peter's Street	50		100	150		300
Tierney Court		100				100
						1900
Medmenham						
Ferry Lane	100	50	300	200		650
Mill End						
Skirmett Road / A4155			50			50
Monks Risborough						
Mill Lane / Kingsmead		30		50	50	130
Total	400	750	900	1000	200	3250

*Marlow, Riverwoods Drive: 50 of 250 were Gel Sacks
Medmenham, Ferry Lane: 100 of 200 were from BCC*

4. Responsible authorities and landowners

There are different responsibilities for flood management depending on the type of flooding. Organisations responsible for flooding are known as Risk Management Authorities (RMAs) and their responsibilities are detailed below. Riparian landowners also have responsibilities for watercourses across their land and these are also detailed below. These are summaries of the details included in the Buckinghamshire County Councils Local Flood Risk Management Strategy (2013-2018).

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4.1 Lead Local Flood Authority

The Lead Local Flood Authority in this area is Buckinghamshire County Council (BCC). BCC has a role as a RMA in coordinating management of local flood risk from surface water, ground water and ordinary watercourses in the county.

4.2 Wycombe District Council

Wycombe District Council have responsibilities to inspect and maintain watercourses on District Council land, respond to requests for assistance during flood events and have the power, if instructed by BCC, to carry out flood risk management work which will benefit management of surface runoff, groundwater and ordinary water courses.

4.3 Environment Agency

The Environment Agency is one of the RMAs as defined by the Flood and Water Management Act 2010. Protecting the river environment and managing flood risk is part of their job. The EA is the RMA for flooding from main rivers.

4.4 Highways Authority – Transport for Buckinghamshire

Any flooding from highways is managed by the Highways Authority which is BCC and the highways function is managed by Transport for Buckinghamshire (TfB).

4.5 Water Utility Company – Thames Water

Thames Water is responsible for flooding from foul sewers and surface water sewers which they own. Whilst undertaking this they must manage flood risk from sewers.

4.6 Landowners and riparian owners

Landowners and riparian owners must maintain any culvert, or the bed and banks of any adjacent watercourse. They should clear away any debris from the watercourse or culvert even if it did not originate from their land.

Riparian owners can find further guidance on their responsibilities as landowners in the Environment Agency document 'Living on the Edge' which can be found online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/297423/LI_T_7114_c70612.pdf.

4.7 Residents

Residents have a responsibility to take measures to protect themselves and their property when flooding is imminent.

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4.8 Emergency Responsibilities

The emergency responsibilities are outlined in Table 4 below. Please note that Parish and Town Councils do not have a legal obligation to respond to emergencies. Whatever service they provide is voluntary and unique to each Parish or Town Council.

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Table 4 Roles and responsibilities in an emergency, during and after a flood event

<p>Local (County and District) Authorities</p> <ul style="list-style-type: none"> • Coordinate emergency support within their own functions • Deal with emergencies on 'non main rivers' • Coordinate emergency support from the voluntary sector • Liaise with central and regional government departments • Liaise with essential service providers • Open rest centres • Manage the local transport and traffic networks • Mobilise trained emergency social workers • Provide emergency assistance • Deal with environmental health issues, such as contamination and pollution • Coordinate the recovery process • Manage public health issues • Provide advice and management of public health • Provide support and advice to individuals • Assist with business continuity 	
<p>Police Force</p> <ul style="list-style-type: none"> • Save life • Coordination and communication between emergency services and organisations providing support • Coordinate the preparation and dissemination <p>Fire and Rescue Service</p> <ul style="list-style-type: none"> • Save life rescuing people and animals • Carry out other specialist work, including flood rescue services • Where appropriate, assist people where the use of fire service personnel and equipment is relevant <p>Ambulance Service</p> <ul style="list-style-type: none"> • Save life • Provide treatment, stabilisation and care at the scene 	<p>Utility Providers</p> <ul style="list-style-type: none"> • Attend emergencies relating to their services putting life at risk • Assess and manage risk of service failure • Assist with recovery process, that is, water utilities manage public health considerations <p>Internal Drainage Board</p> <ul style="list-style-type: none"> • Operate strategic assets to reduce flood risk in partnership with RMAs and public <p>Town and Parish Councils</p> <ul style="list-style-type: none"> • Support emergency responders • Increase community resilience through support of community emergency plan development <p>Voluntary services</p> <ul style="list-style-type: none"> • Support rest centres • Provide practical and emotional support to those affected • Support transport and communications • Provide administration • Provide telephone helpline support
<p>Environment Agency</p> <ul style="list-style-type: none"> • Issue Flood Warnings and ensure systems display current flooding information • Provide information to the public on what they can do before, during and after a flood event • Monitor river levels and flows • Work with professional Partners and stakeholders and respond to requests for flooding information and updates • Receive and record details of flooding and related information • Operate water level control structures within its jurisdiction and in line with permissive powers • Flood event data collection • Arrange and take part in flood event exercises • Respond to pollution incidents and advise on disposal • Assist with the recovery process, for example, by advising on the disposal of silt, attending flood surgeries 	

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5. Conclusions and recommendations

5.1 Conclusions

A number of issues contributed to the prolonged flooding that occurred in parts of Marlow in January and February 2014. These are summarised as follows:

- The ground in and around Marlow was saturated due to above-average prolonged rainfall and unusually high groundwater levels;
- Groundwater emerged and flooded low lying areas;
- Surface water drainage systems that rely on infiltration were unable to function due to the high groundwater levels;
- Surface water drainage systems that are supported by permanent pumps failed when the pumps were unable to cope with the volume of water;
- Where the surface water is piped to the Newt Ditch flooding occurred when the Newt Ditch was overwhelmed. The capacity of Newt Ditch may have been reduced by sediment at the time of the flood;
- Infiltration into the foul sewers caused surcharging and flooding. Reduced capacity in the sewers led to some areas being unable to use the sewer system;
- Those areas of Marlow close to the River Thames were flooded directly when water levels rose above the river bank. The flood on the River Thames was estimated to be a 5% AEP event.

Flooding in Marlow was widespread and arose from fluvial, groundwater, surface water and sewage. The likelihood of it occurring was probably rarer than a 5% AEP based on historical data. In such an extreme event, local drainage systems are unlikely to have sufficient capacity to cope.

5.2 Recommendations

Table 5 shows recommendations that if implemented would improve the management of future flood events. They are drawn from an analysis of the January-February 2014 flooding and from a review of correspondence and documentation that followed the flooding.

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Table 5 Recommendations

Authority/ Stakeholder	Recommended actions
All RMAs	<p>To work together to liaise and look at the catchment to consider options for flood management which could include:</p> <ul style="list-style-type: none"> • Make improvements to the emergency response and co-ordination from all organisations • Share information regarding operation of structures and assets • Work with the Flood Working Group in this area to help to develop Community Flood Groups and flood action plans and continue to discuss any issues which arise • Implement discussions with key service providers of electricity and sewage to ensure continuity of service • Look at how clearer information can be provided for residents • Provide support where required as partners on the Marlow Flood Alleviation Scheme
EA	<ul style="list-style-type: none"> • Continue to progress with leading the Marlow Flood Alleviation Scheme • Investigate where Flood Alerts/Warnings had been inconsistent and why and improve where necessary • Encourage those at risk to sign up to Flood Warning service
BCC	<ul style="list-style-type: none"> • Identify the riparian owners of Newt Ditch and ensure the owners are aware of their responsibilities. • Facilitate sharing of information between RMAs and the community. • Provide information to Flood Group as to who is responsible for what • Determine a clear picture of surface water assets and establish where the gaps are • Continue with next phase of Surface Water management plan to look at options going forward alongside the Marlow Flood Alleviation Scheme • Continue to develop more accurate maps of groundwater flooding • Distribute information on groundwater flooding to residents.
TfB	<ul style="list-style-type: none"> • Investigate drainage network throughout the Pound Lane area to assess inflows and pump capacities. • Maintenance and improvement of Newt Ditch culverts • Carry out cleansing of all gullies and highway drainage throughout as part of the ongoing maintenance schedule.
WDC	<ul style="list-style-type: none"> • Clarify the process of issuing of sandbags to residents, town and parish Councils – work with other RMAs on this

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Authority/ Stakeholder	Recommended actions
MTC	<ul style="list-style-type: none"> Facilitate the development of the community flood plan and work with the Flood Working Group to take issues forward with the different Agencies
Thames Water	<ul style="list-style-type: none"> Work with other RMAs to address potential infiltration problems. Share the outcomes of their information gathering exercise for catchments affected by infiltration problems with other RMAs. Improve provision of temporary toilets. Improve assistance following sewer flooding. Improve community communication.
Riparian Landowners	<ul style="list-style-type: none"> Ensure that the Newt Ditch is maintained in a suitable manner. The guidance given in the EA's 'Living on the Edge' booklet regarding riparian owner responsibilities should be followed. Especially in the vicinity of the railway bridge. Undertake clearance of vegetation with guidance from relevant RMAs.
Residents	<ul style="list-style-type: none"> Develop a household flood action plan. Participate in a community flood group. Work together to develop further the Marlow Community Flood Plan
Highways Agency	<ul style="list-style-type: none"> Formalise the bund on the A404 drainage ditch and include a flap valve to prevent River Thames backing up the ditch – <i>this is part of the Marlow Flood alleviation Scheme</i>

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Explanation of Acronyms

Term	Definition
Act (or The Act)	The Act refers to the Flood & Water Management Act 2010
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
BFRS	Buckinghamshire Fire & Rescue Service
BGS	British Geological Survey
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency, which has a Strategic overview role for flood and coastal erosion risk management
Flood	The temporary inundation by water of property or land not normally covered with water
FMfSW	Flood Map for Surface Water
Flood & Water Management Act 2010 (FWMA)	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 local flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a river.
Groundwater Flooding	Occurs when water levels in the ground rise above the natural surface. Low lying areas underlain by permeable strata (e.g. Chalk) are particularly susceptible.
LLFA / Lead Local Flood Authority	Local Authority responsible for taking the lead on local flood risk management
Local Flood Risk	Flooding from sources other than Main Rivers, which principally concerns surface runoff, groundwater and ordinary watercourses. BCC has a responsibility under the Flood & Water Management Act to manage flooding from these sources.
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers.
MTC	Marlow Town Council
Ordinary Watercourses	All watercourses that are not designated Main River, and which are the responsibility of local authorities or IDBs
Partner	A person or organisation with responsibility relating to flood risk management for the decision or actions that need to be taken.
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.

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Term	Definition
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.
Risk Management Authorities (RMA)	Organisations that have a key role in flood and coastal erosion risk management as defined by the Flood & Water Management Act 2010. These are BCC (the Lead Local Flood Authority and Highways Authority), District Councils, Environment Agency, Buckingham and River Ouzel Internal Drainage Board, Anglian Water and Thames Water
SFRA	Strategic Flood Risk Assessment. These are produced by each District to give an assessment of flood risk from all sources and its implications for land use planning.
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.
Strategy	Under the Flood & Water Management Act 2010, BCC have a duty to develop, maintain, apply and monitor a strategy for local flood risk management
Sustainability	In the context of this Strategy, the risk of flooding must be reduced now, but in a way which does not compromise the interconnected needs of the economy, society and environment in the future.
Surface water/runoff	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. The term 'surface water' is used generically to refer to water on the surface and is often associated with periods of intense rainfall.
SWMP	Surface Water Management Plan
TfB	Transport for Buckinghamshire
TW	Thames Water Utilities Ltd
WDC	Wycombe District Council

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References

Reference in document	Refers to:
Defra GEM	Defra/Jacobs (2004) Strategy for Flood and Coastal Erosion Risk Management: Groundwater Flooding Scoping Study (LDS 23). Volume 2.
Environment Agency (2014)	Environment Agency Monthly Water Situation Report South East Region. February 2014
Environment Agency (July 2014)	Environment Agency Flood Report Winter Floods 2013/14 West Thames Area (July 2014)
Buckinghamshire County Councils Local Flood Risk Management Strategy (2013-2018)	http://www.buckscc.gov.uk/environment/flooding/
Environment Agency 'Living on the Edge'	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/297423/LIT_7114_c70612.pdf
Marlow Surface Water Management Plan	Jacobs (2013) Marlow Surface Water Management Plan Preliminary Risk Assessment.
Wycombe District SFRA	Jacobs (2008) Wycombe District Council Strategic Flood Risk Assessment. April 2008

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Contacts

Lead Local Flood Authority



Flood Management Team
Buckinghamshire County Council
County Hall
Walton Stree
Aylesbury
Bucks HP20 1UY

Telephone: 084537 08090

Email: FloodManagement@buckscc.gov.uk

Website: www.buckscc.gov.uk/flooding

Environment Agency



**Environment
Agency**

National Customer Contact Centre
PO Box 544
Rotherham
S60 1BY

Telephone: 03708 506506

Email: enquiries@environment-agency.gov.uk

Website: <http://www.gov.uk/government/organisations/environment-agency>

District Council



Wycombe District Council
Queen Victoria Road
High Wycombe
HP11 1BB

Telephone: 01494 461 000

Opening times

Monday - Thursday

8.45am – 5.15pm

Friday

8.45am – 4.45pm

Highways Authority

Transport for Buckinghamshire

Telephone: Transport and roads – 0845 2302882

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Out of hours emergencies (Highways) – 01296 486630

Email: tfb@buckscc.gov.uk

Website: <http://www.transportforbucks.net/Transport-and-roads.aspx>

Water Utility



Thames Water
PO Box 286
Swindon
SN38 2RA

Telephone: 0845 9200 800

Website: <http://www.thameswater.co.uk/help-and-advice/16739.htm>

Emergency Response

Buckinghamshire Fire and Rescue Service

Address: Buckinghamshire Fire & Rescue Service, Brigade HQ, Stocklake, Aylesbury, Bucks, HP20 1BD

Telephone: 01296 744400

Website: <http://www.bucksfire.gov.uk/BucksFire/Contact+Us/>

Thames Valley Police

Telephone: 101 in non-emergency, 999 in emergency

Website: <http://www.thamesvalley.police.uk/contactus-phone.htm>

Buckinghamshire Ambulance Service

Telephone: 111 in non-emergency, 999 in emergency

Website: <http://www.southcentralambulance.nhs.uk/content/press-release/buckinghamshire/flooding-advice.ashx>

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Appendices

Appendix A: BCC criteria for a Section 19 Investigation

- Internal flooding (including to basements) to five or more residential properties within an area of 1km²
- Internal flooding of two or more business premises within an area of 1km²
- Internal flooding (including to basement) of at least one property for one week or longer
- Flooding of one or more items of critical infrastructure, which could include hospitals, health centres, clinics, surgeries, colleges, schools, day nurseries, nursing homes, emergency services (police, fire, ambulance) stations, utilities and substations.

- Caused a transport link to be impassable for the following periods:
 - Motorways, trunk roads and major rail links – 2 hours or more
 - Class A and B highways and other railway links – 4 hours or more
 - Class C highways – 10 hours or more unless the route is the only means of access, or is primary route for critical infrastructure then reduce to 4 hours
 - Class U highways – 24 hours or more unless the route is the only means of access, or is primary route for critical infrastructure then reduce to 4 hours

- Any flooding event that a risk management authority deems significant does not meet the agreed thresholds should be brought to the next strategic flood management committee for consideration.

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Appendix B: Flood Review Meeting Public Comments 9th October 2014

Category	Detail
<p>Communications</p>	<p>A need for better communication in all areas Lack of information and where to find information Dedicated website for local flooding issues containing contact numbers <u>etc</u> One central dedicated communication portal / hub 24 hour help / information line Have all agencies working together Accurate up to date contact information for residents EA flood alerts were inconsistent or absent Set up a <u>24/7 command centre</u></p>
<p>Pumps</p>	<p>Not enough pumps available Pumps need to work effectively and require more funding How and where do residents get pumps from Ensure pumping stations work</p>
<p>Drains</p>	<p>Establish regular gulley clearing Remove leaves from drains, ensure drains are cleared regularly Speed humps in Pound Lane adversely affect drainage Provide port-a-loos for residents when system is backed up Have port-a-loos on standby if alert is raised</p>
<p>Sewage</p>	<p>Sewage was not draining and backing up</p>

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<p>Sandbags</p>	<p>Disappointment with lack of sandbag availability 8-10 per home not enough Produce a database to <u>prioritise</u> sandbag distribution Appoint sandbag “champions” More control needed over distribution at point of delivery to stop removal by <u>non affected</u> residents WDC took too long to respond to requests Plastic sheeting needed to make sandbags effective Help needed to move and place sandbags for elderly / disabled Would gel sacks be better</p>
<p>Volunteers / Community</p>	<p>Set up a “<u>Neighbourhood Watch</u>” type of operation Set up a “Flood Committee” involving residents A need to establish who is vulnerable and risk Compile a list of volunteers who could <i>move sandbags, offer car parking, be-friend someone</i></p>
<p>Responsibilities</p>	<p>A list of who / which agency / authority is responsible for what Agencies / authorities need to be proactive not reactive</p>
<p>Preventative Measures</p>	<p><u>Recognise</u> early warning signs and prepare Information required regarding ventilation covers What grants are available to purchase flood prevention measures Advice wanted on bulk buying Advice wanted on how to prepare homes if flooding is expected i.e. moving / raising furniture Advice wanted on safe lifting</p>

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Fireview Area	Is the pump / pipe effective as it pumps out of a pipe 1' in diameter
Fire Brigade / Army	Held in high regard – did a fantastic job Turned up too late
Financial	Advice on grants available Advice on how to seek compensation if flooded
Dredging	Dredge the river
Post Flood	Improve / speed up the clear up operation Need advice on contaminated sandbags / property
The Future	Is there an action plan in place now - If so aims and timings should be shared Establish best building practice Don't build any more on the flood plain

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Appendix B: Flood Photographs

	<p>Garnet Court</p> <p>9 February, 2014</p> <p>Source: BFRS</p>
	<p>Quarrydale Drive</p> <p>20 February 2015</p> <p>Source: Resident</p>

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