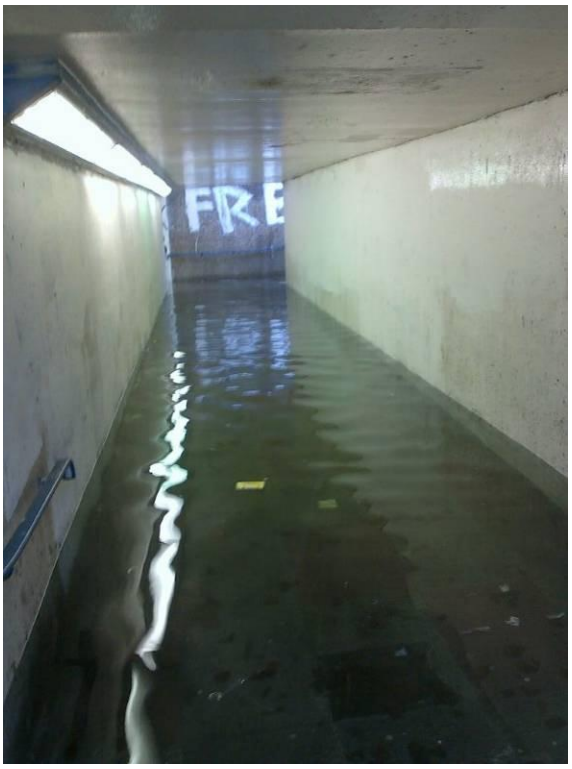
Brighton & Hove City Council



Section 19 Flood Investigations Report

Groundwater Flooding in Brighton and Hove City (February 2014)

May 2014

Revision Schedule

Rev	Date	Details	Author	Checked and Approved by
1	April 2014		M Moran	N Fearnley
2	May 2014	Following comments from the EA and Southern Water (6/05/2014)	M Moran	N Fearnley
3	June 2014	Following comments from Southern Water	M Moran	N Fearnley

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Glossary

Term	Abbreviation	Definition
Aquifer		A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
Brighton and Hove City Council	B&HCC	
Combined Sewer		A sewer that is normally in the older parts of towns where wastewater and surface water is conveyed in the same pipe
Dry Valley		A dry valley is formed by permeable rock, such as limestone and chalk, or sandy terrains that do not regularly sustain surface water flow. These valleys do not hold surface water because it sinks into the permeable bedrock.
Emergence		Groundwater flooding is the emergence of groundwater at the ground surface
Environment Agency	EA	
Flood Alert		The Environment Agency issue a flood alert where they have data available to them via telemetry that indicates that flooding is possible.
Foul Sewer		Sewers designed to convey wastewater only from connected properties
Flood and Coastal Erosion Risk Management Grant in Aid	FCERM GiA	A flood risk and coastal erosion management authority can apply for an allocation of government funding annually from the Environment Agency (EA). The Flood and Coastal Erosion Risk Management Grant in Aid (FCERM GiA capital grants) is used towards the costs of building new flood and coastal erosion defences.
Flood and Water Management Act	FWMA	The Act is the UK Government's response to the Sir Michael Pitt Review of the Summer floods 2007, which aims to make provision about water, including about the management of risks in connection with flooding and coastal erosion.
Flood Warning		The Environment Agency issues a flood warning where they have data available to them via telemetry, which indicates that flooding is expected.
Ground Water Level	GWL	
Ladies Mile Borehole	LM	The Environment Agency monitors groundwater levels using telemetry at the Ladies Mile borehole.
Lead Local Flood Authority	LLFA	Local authority responsible for taking the lead on local flood risk Management as defined in the FWMA.
Local Authority	LA	
Local Levy		The Local Levy is an additional source of income for flood and coastal erosion schemes. The income is raised through a levy on the county councils and unitary authorities. Southern Regional Flood and Coastal Committees (RFCC) decide on the amount of the levy and its distribution.
metres Above Ordnance Datum	mAOD	In the British Isles, an Ordnance Datum or OD is the theoretical height of sea level, all heights above ordnance are therefore heights above sea level. A spot height may be expressed as AOD for "above ordnance datum".
Millimetres	mm	
Property Level Protection	PLP	Property-level protection is all about the measures we can take to protect properties from flooding.
Rainfall Gauge		A rain gauge is a type of instrument to gather and measure the amount of liquid precipitation over a set period of time.
Southern RFCC		Southern Regional Flood and Coastal Committees.
Surface Water Sewer		Sewers that are designed to convey rainwater only arising in storm conditions where the rainwater is from roofs, yards and highways which are legitimately connected to the surface water sewers.

1. Introduction

During the winter of 2013 to 2014, the south east was subject to flooding from groundwater in many locations in Hertfordshire, Hampshire, Berkshire, Buckinghamshire, Surrey and South London.

In Brighton and Hove, rising high ground water levels following extreme rainfall impacted upon:

- Seven cellars and one basement dwelling in Patcham
- Four basements in Portslade
- A basement on Preston Road
- A basement in Peacock Lane
- Railway between Patcham and Preston Park
- Underpass in Coldean
- The road at The Highway, Bevendean
- The road at Audrey Close and Brangwyn Drive, Patcham

This report provides a review of the rights and responsibilities of all risk management authorities involved, and an outline of their past or proposed actions. Recommendations have been made for a possible way forward.

1.1. Flood and Water Management Act (2010)

B&HCC 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 (FWMA):

Section 19 (1) *On becoming aware of a flood in its area, 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.

1.2. Roles and Responsibilities

The Flood and Water Management Act 2010, establishes that County and Unitary local authorities (LAs) have responsibility for addressing groundwater flooding risk locally. The Civil Contingencies Act (2004) requires Brighton & Hove City Council to have a plan in place to respond to all emergencies, including flooding.[1]

The Environment Agency has a strategic overview for all sources of flooding including groundwater. They supply information in the form of monitored groundwater levels. The Environment Agency provide a groundwater alert service in Brighton and Hove City.[2]

[1] Defra (2011) Detailed Guidance on Developing a Multi-Agency Flood Plan
[2] Environment Agency (2014) Groundwater: current status and flood risk

Southern Water's responsibility is to provide effectual drainage of wastewater from properties connected to the sewerage system. In addition, Southern Water provides surface water drainage to areas legitimately connected to a public surface water or public combined sewer.

There are generally three types of sewer :

- Foul sewers – these are designed to convey wastewater only from connected properties.
- Surface water sewers – these are designed to convey rainwater only arising in storm conditions where the rainwater is from roofs, yards and highways which are legitimately connected to the surface water sewers.
- Combined sewers – these are normally in the older parts of towns where wastewater and surface water is conveyed in the same pipe.

Normal sewer design is for foul sewers to be sized to convey six times the average dry weather flow and for surface water and combined sewers to provide a 1 in 30-year internal flood protection to properties. The public sewerage system is not designed or constructed to convey groundwater and Southern Water does not have a duty to drain this type of flow.

1.3. Groundwater Flooding

Flooding from groundwater occurs when the level of water (the water table) within the underlying rock or soil rises above ground level or interacts with properties or infrastructure below ground level. The level of the water table changes with the seasons due to variations in long-term rainfall and water abstraction. When the water table rises and reaches ground level, water starts to emerge and surface flooding can occur. Groundwater emergence is most common in areas where the underlying bedrock is chalk.

The key features of flooding from groundwater may include:

- Flooding can occur days or even weeks after heavy or prolonged rainfall
- Flooding can take several days or even weeks to dissipate
- The water does not necessarily appear where expected, and floods may be some distance from watercourses, and no two flood events are identical.
- Water may rise internally through the ground/floor rather than through doors.
- There are significant interactions with surface water and sewer flooding.

The reason the south east is one of the primary areas at risk of groundwater flooding in the UK is due to the geology. The chalk outcrops of the North and South Downs and the sand and gravels overlaying adjacent areas mean that there is a large potential for the aquifers to absorb water. Figure 1 shows the underlying chalk bedrock of Brighton, this is referred to as the "Brighton Block"

1.4. Site Location

The city of Brighton and Hove encompasses an area of approximately 85km². Patcham, Portslade and Moulsecoomb are located in dry valleys, see Figure 2.

Figure 1 Geological bedrock map. (Environment Agency)

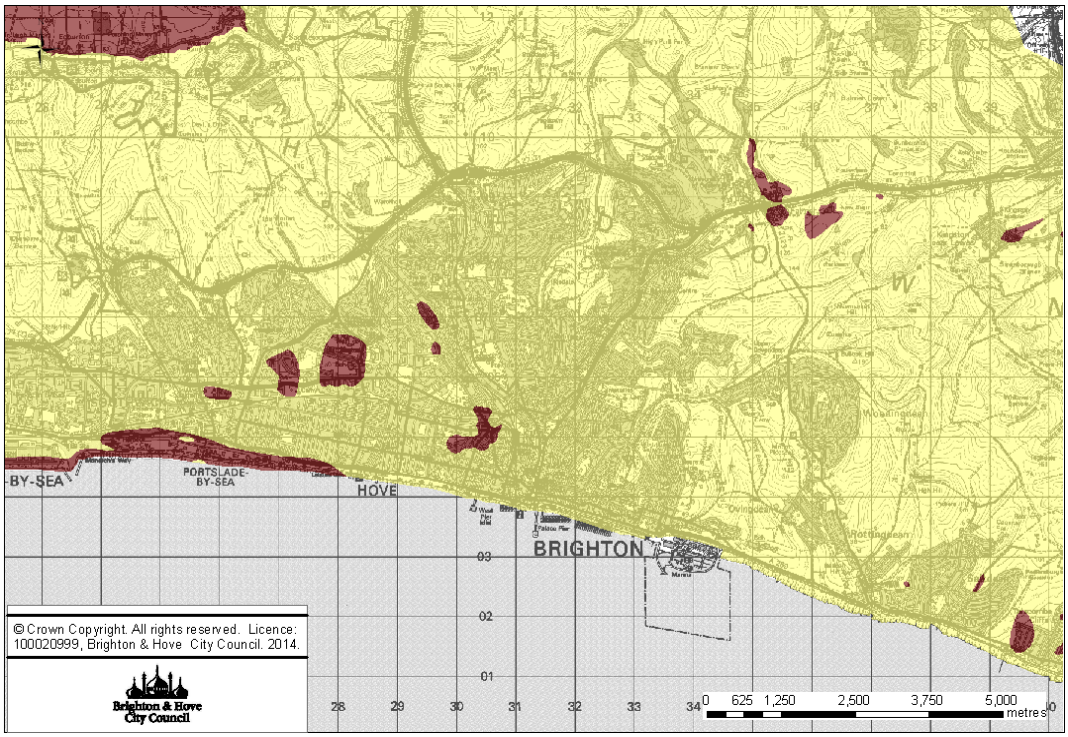
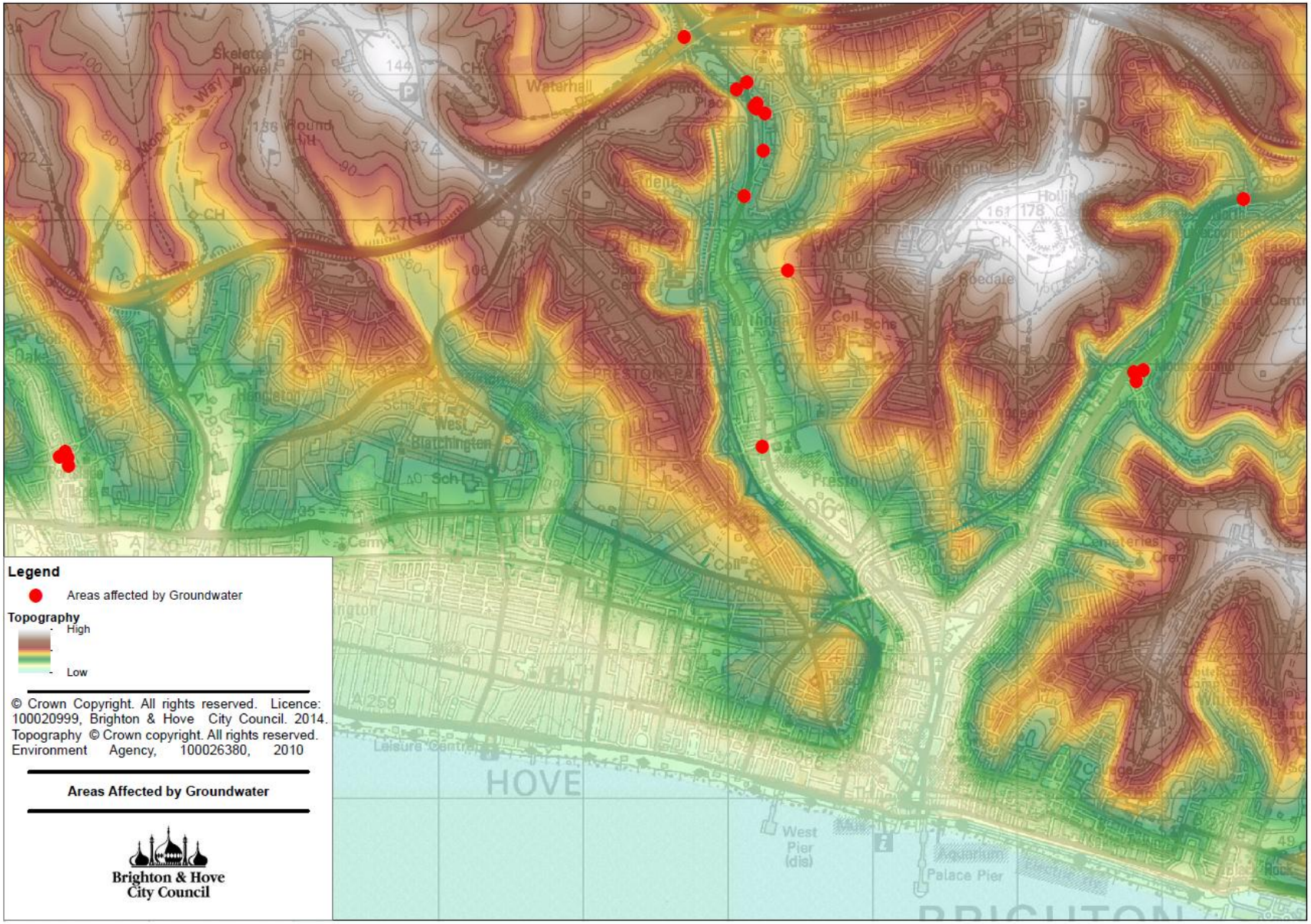


Figure 2 Topography and Areas Affected in Brighton and Hove City – February 2014



2. Groundwater Flood History

2.1. Historical flooding

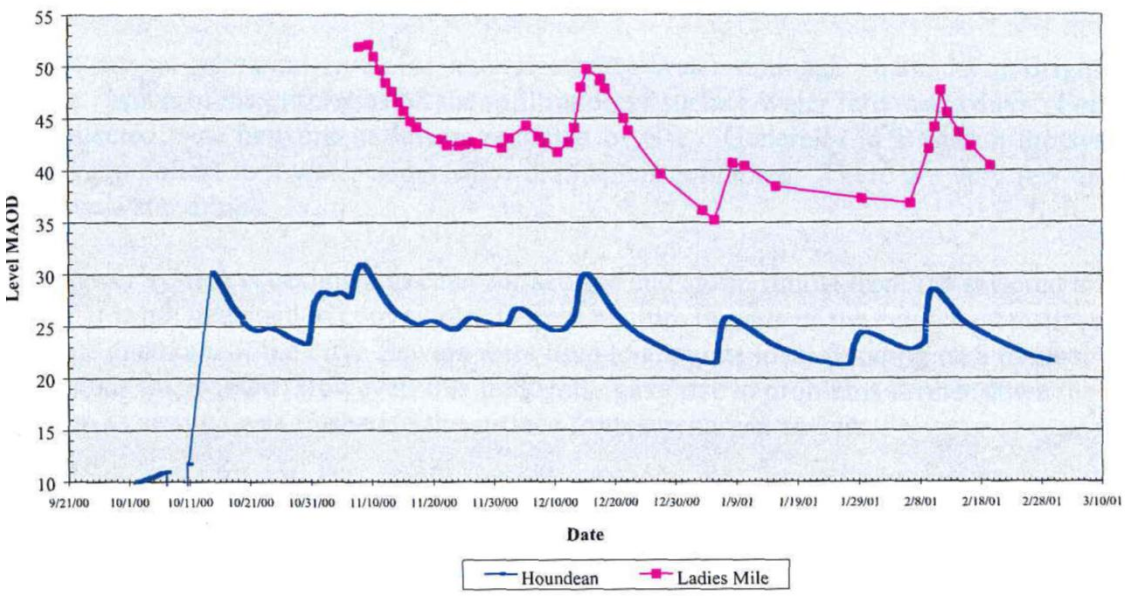
There are records of groundwater flooding in the Patcham area going back to 1877. Appendix A provides a list of reported flood events in Brighton. Prior to 2014, the last occasion the city significantly flooded was during the winter of 2000/1 when the groundwater levels at Ladies Mile reached 52 and 53 mAOD, see Figure 3.

2.2. Flood Winter 2000/2001[3]

A combination of groundwater and surface water flooding affected Patcham between November 7th – 19th, 2000. Groundwater emerged from the railway embankment adjacent to the petrol station on Mill Road. The overland flow combined with surface water, unable to infiltrate into the saturated ground, followed the local topography across the playing fields and on to the A23 trunk road. This caused closure of the London to Brighton railway line and the A23 trunk road south of its junction with the A27, see Figure 4. The ground floors of 15 properties along with several basements were flooded during this event. On the 15th of December 2000, further rainfall exacerbated the event, sewers surcharged discharging sewerage on to the Old London Road, Patcham and at Preston Park. In February 2001 rainfall again caused groundwater levels to rise and enter into basements in Patcham.

Anecdoctal evidence suggests that the A270, Lewes Road has been affected by high groundwater levels in the past. In November 2000, no properties were recorded as being affected but the Underpass at Coldean was recorded as being completely submerged. In 1958, Lewes Road is said to have flowed like a river. In 2000 rising groundwater affected basements of properties in Portslade.

Figure 3 Groundwater Levels – 2000/2001[4]



[3] Binnie Black & Veatch Report (2001) Flood Defence Assessment of Downland Flooding

[4] Binnie Black & Veatch Report (2001) Flood Defence Assessment of Downland Flooding – Figure 3.6

Figure 4 Flood Event 2000/2001

Old London Road, Patcham

Playing fields, Patcham

2.3. Rainfall Data

During the winter 2013-14, the United Kingdom experienced extreme weather events. The Met Office described this winter as one of the wettest on record.[5]

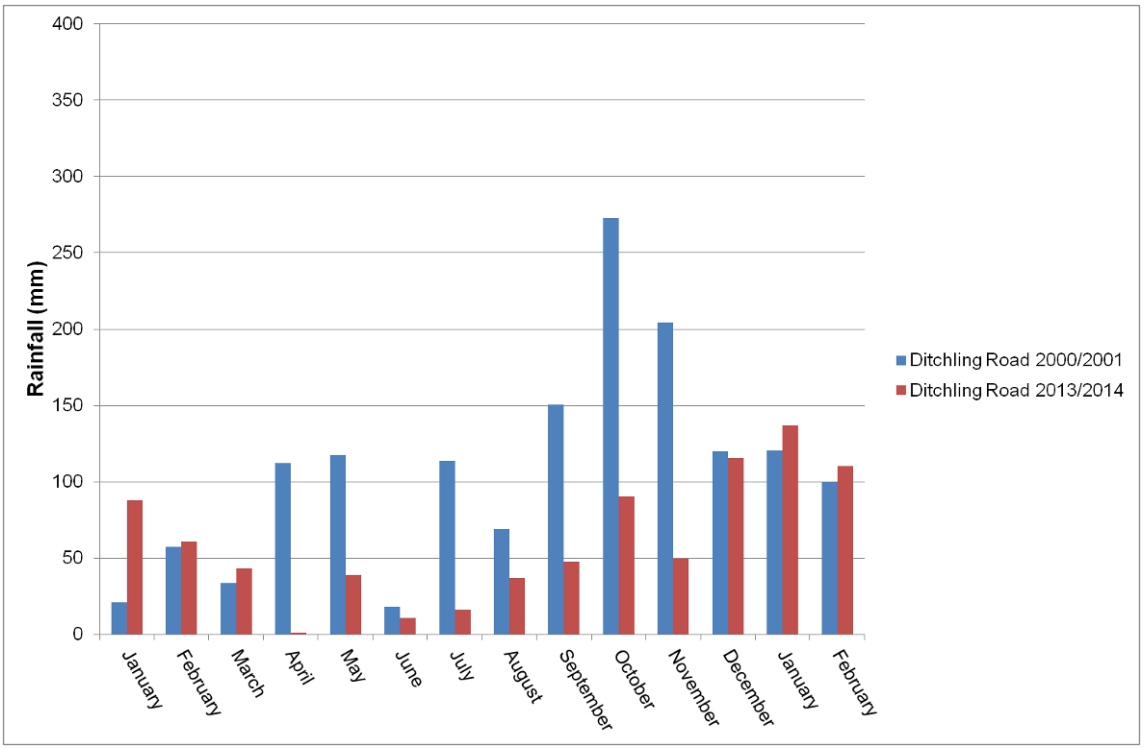
Data from two rainfall gauges are summarised in Table 1 to describe the amount of rainfall in Brighton and Hove, one is located in Ditchling Road and one in High Park Farm, South Downs National Park. Figure 7 illustrates the location of the rainfall gauges. Rainfall recorded in the South Downs National Park is significantly higher than recorded at in Brighton at Ditchling Road. However, they both recorded high rainfall in 2000/2001 and 2013/2014.

Table 1 Rainfall (mm) Winter 2014

	Ditchling Road **Rainfall (mm)**	**High Park Farm** **Rainfall (mm)**
December	186.7	115.8
January	142	137
February	259.8	110.2
Total	**363**	**588.5**

It should be noted that although Winter 2013/2014 was one of the wettest winters on record. Overall 2000/2001 was a wetter year. Figure 5 and Figure 6 compares the rainfall data as per the Environment Agency records.

Figure 5 Ditchling Road - Rainfall (mm)



[5] Met Office (February 2014) Winter so far – 20th February rainfall update

Figure 6 High Park Farm - Rainfall (mm)

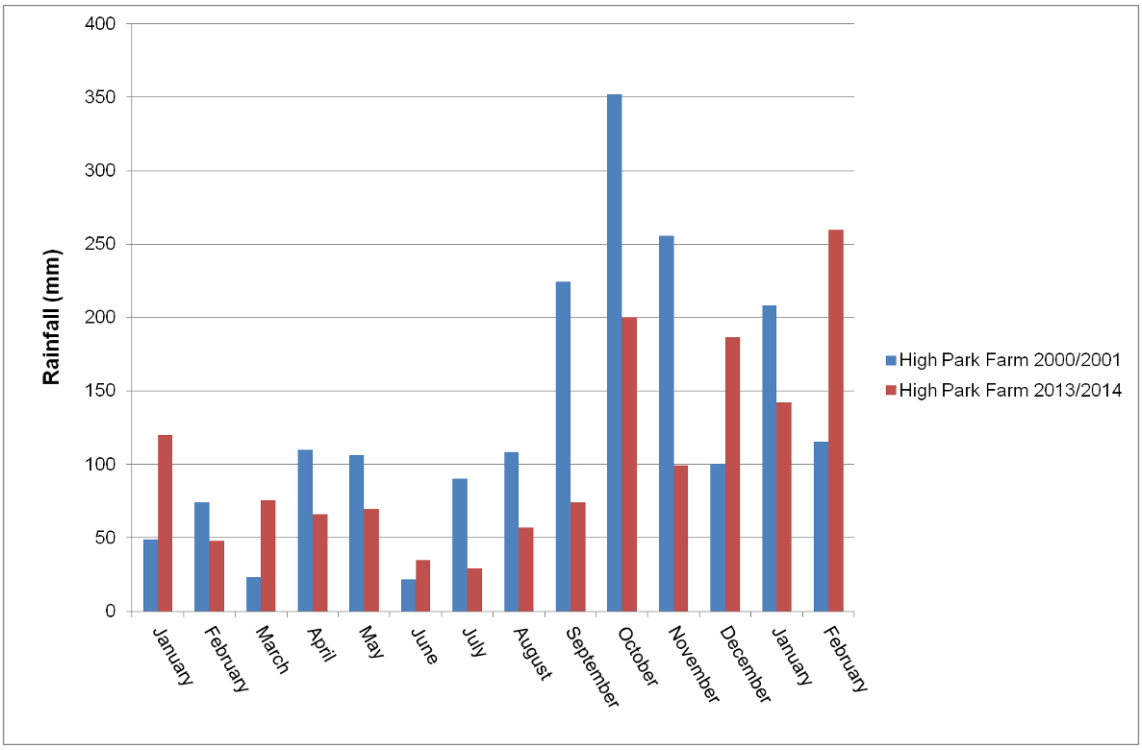


Figure 7 Environment Agency Rainfall Gauges

2.4. Groundwater Levels

The Environment Agency monitors groundwater levels using telemetry at the Ladies Mile borehole (1.5km east of Patcham village). This indicator borehole gives readings, which are used to forecast flood risk, with 4 to 5 days lead-time, before flooding is seen in Patcham. The Environment Agency manually record groundwater levels in Portslade. Levels are measured in metres above Ordinance Datum (mAOD).

Figure 8 describes the groundwater levels observed at Ladies Mile over the period of the event.

2.5. Emergency Measures

On the 30th of January 2014, groundwater levels at the Ladies Mile Borehole reached 40 mAOD; a flood alert was issued by the Environment Agency and the Brighton and Hove Multi Agency Flood Plan was activated.

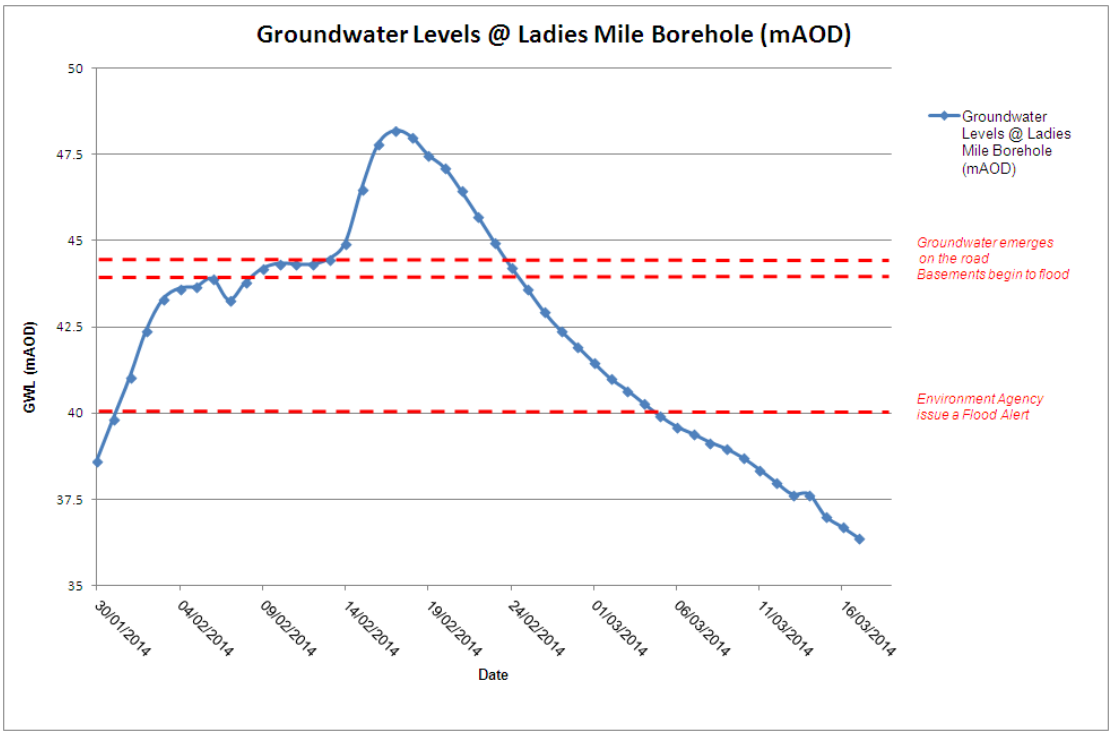
The groundwater emerging and flowing above ground was diverted into the highway drainage system, which connects to Southern Water's combined sewerage system in London Road. Although the purpose of the public sewerage system is not to convey groundwater, it was accepted that this was an effective means of mitigation given the potential disruption. This was an emergency measure to reduce the impact of groundwater on properties and local traffic.

Due to the volume of groundwater, the combined system became overwhelmed at points downstream of the inflow. To mitigate this, Southern Water and the East Sussex Fire and Rescue Service laid additional temporary pipes along London Road in preparation to relieve pressure from groundwater on sewer capacity, should it be required. B&HCC laid a permanent pipe across London Road to facilitate this temporary measure. It should be noted that this measure was not intended to, nor would it be able to, prevent groundwater rising and flooding basements.

A number of actions were carried out to disseminate information to vulnerable residents in Patcham:

- A letter drop informing residents of rising groundwater levels
- A public meeting was held with representatives from a Brighton & Hove City Council, Environment Agency, East Sussex Fire and Rescue Service and Southern Water.
- A "hub in the pub" information point was set up in Black Lion, Patcham, staffed by Brighton & Hove City Council officers daily, during the threat of the flooding from groundwater.

Figure 8 Groundwater Levels - February 2014



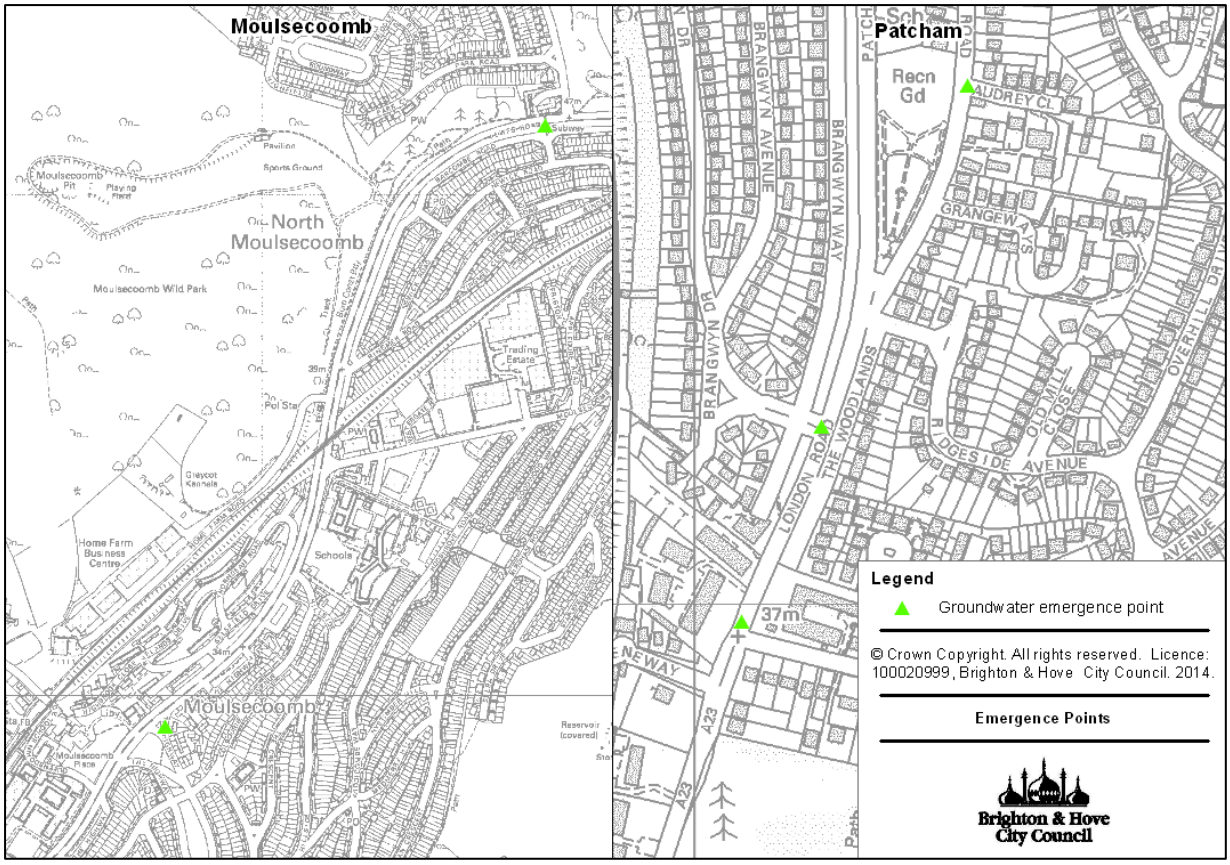
2.6. Timeline

Table 2 below provides a timeline of events and their associated groundwater levels in Brighton and Hove City during the event.

Table 2 Timeline of event – February 2014

Date	GWL @ LM mAOD	Event
31st January	39.84	The EA issues a flood alert for Patcham.
5th February	43.67	Groundwater appears in a basement in Withdean.
8th February	43.8	Basements in Patcham begin to flood from groundwater.
13th February	44.47	Groundwater emerges at Brangwyn Drive; at the junction of Audrey Close/Old London Road; and at The Highway, Moulsecoomb, see Figure 9. The EA issue a flood warning for Patcham
14th February	44.93	Southern Water turn on 12" pump by Towergate as water and sewage are flowing down London Road.
15th February	46.51	Basements begin to flood in Portslade. Groundwater floods the London to Brighton Railway. The Environment Agency issues a further flood warning for Patcham.
16th February	47.80	Groundwater emerges north of Carden Avenue, see Figure 9
17th February	48.19	Pedestrian subway in Coldean Lane flooded from groundwater and closed off, see Figure 6. Groundwater levels at Ladies Mile peaks.
18th February	48.01	Groundwater levels begin to fall at Ladies Mile, but levels continue to rise in Patcham.
22nd February	45.72	Groundwater levels in Patcham peak.
27th February	42.4	Groundwater ceases to flow at Audrey Close.
28th February	41.94	Groundwater ceases to flow at Brangwyn Drive. Groundwater levels begin to fall in Portslade.
3rd March	40.67	Groundwater levels begin to fall in Patcham.

Figure 9 Emergence Points



2.7. Lessons Learnt

The main lesson learnt from the February 2014 event is there is no simple solution to groundwater flooding; little can be done to prevent groundwater from rising through the aquifer and flooding properties. However, when groundwater emerges at the surface, measures can be taken to reduce risk of floodwater entering properties.

Brighton & Hove City Council existing Multi Agency Flood Plan focuses on emergency measures for Patcham village. The plan will be revised to include the entire city. Measures will be based on the groundwater levels and emergence observed in the February 2014 event

The partnership worked well between Southern Water, Environment Agency, East Sussex Fire and Rescue Service, UK Power Networks and Brighton & Hove City Council.

Feedback from residents indicated that the “hub in the pub” proved successful, however if the event continued for a longer period; additional staff resources would have been needed.

The situation could have been much worse. Even though this winter was the wettest winter on record, overall 2000/2001 was a wetter year. Brighton and Hove City did not experience the same level of flood impacts witnessed in 2000/2001. In 2000/2001, the combination of rising groundwater, saturated ground and surface water runoff resulted in significant flooding in Patcham.

This year, there were breaks in the rainfall events, which allowed some infiltration into the ground. Groundwater is thought to have infiltrated in to the sewers, which may have delayed groundwater emerging to the surface. If ground water levels continued to rise to the levels observed in 2000/2001, infiltration into the sewers would not have prevented flooding.

2.8. Mitigation Measures

As stated earlier in this report the Public sewerage system is not designed or constructed to convey groundwater. Southern Water does not have responsibility in this regard. There are points on the combined sewer network which, although adequately sized to convey wastewater and rainfall related flows, will become overwhelmed if high groundwater flow is drained by this system. A scheme to upsize the sewers along Old London Road has been discussed with Southern Water and the Environment Agency. Southern Water has explained that the sewers in this area operate, as per their duty to effectually drain foul and rainwater derived flow. Under its obligation, there is no requirement for Southern Water to upsize the sewerage system to allow conveyance of groundwater. Furthermore upsizing the parts of the system which do become overwhelmed would result in issues downstream and the system would require upsizing along its length to the coast to ensure there is no knock on effect on the capability to drain flows legitimately connected and that flood risk to properties downstream did not increase. These measures would not prevent groundwater rising and flooding basements.

In Brighton and Hove, it is basements that are particularly prone to groundwater flooding and remedial measures are often difficult to implement. Pumping out and sealing walls (tanking) need to be carefully considered, as it can lead to an increase in external water pressure. This in turn can lead to structural damage or cause tanked areas to be 'floated'. It is important to remember that water exerts considerable pressure, $1m^3$ of water weighs 1 tonne, which is the equivalent of a Ford Focus.

Some actions make be suitable to help with property level protection but as flow paths may be from below properties themselves, the majority of flood prevention measures associated with above ground flooding may prove ineffective. Appendix B sets out the Environment Agency advice on mitigation options for groundwater flooding.

It should be noted that it is extremely difficult and costly to prevent groundwater flooding. As a Lead Local Authority, we can warn and inform, and where practical and affordable, undertake engineering works to manage overland flows once the groundwater reaches when groundwater reaches the surface.

3. Recommendations

Brighton & Hove City Council is considering the following measures:

- A review of the Multi Agency Flood Plan to cover the city as a whole
- Complete further studies to understand their local aquifer
- Improve the flood warning system through data collected from the 2013/2014 event
- Increase the level of data collected by implementing further telemetry in key locations.
- Liaise with the Environment Agency and Southern Water to assess if a solution can be found through partnership schemes
- Promote Property Level Protection (PLP) schemes in Patcham, where feasible
- Engage with the Patcham Local Action Team to encourage an active role in the dissemination of information regarding flooding

Next steps include:

- Brighton & Hove City Council has applied for funding through the Flood and Coastal Erosion Risk Management Grant in Aid (FCERM GiA) and Local Levy for further investigative studies and schemes. These include schemes such as:
    - A combination of earthworks to create a bund on Patcham Place playing field to store flood water and the use of PLP on properties in Old London Road. The proposed bund across the playing field will have two functions

        1. Attenuation for surface water events
        2. Provide an obstruction to divert some of the overland flow away from the Patcham Village, during an extreme flood event.

    - A project to implement telemetry within boreholes and increase the number of locations of groundwater level monitoring.
    - A detailed investigations into groundwater flooding in Brighton and Hove and the “Brighton Block” aquifer.
    - Continued partnership with Southern Water and the Environment Agency’s to consider potential solutions to reduce and/ or to manage flood risk to Brighton and Hove City.

Appendix A Historic Flood Events

Table 3 Historic Flood Events[6]

Year	Months	Source	Text	Location
1850	July	http://www.dundee.ac.uk/geography/cbhe/#searching	"Storm at Brighton: The rain came down in torrents, and the widest streets were turned into streams over their whole width. The torrents flowed down the steep streets towards the sea, and, being stopped by the embankments, laid the lower part of the town under water. ..."	
1877	25-Jan	Map from East Sussex County Council	The water all sank into the ground at this point on Jan 25 but before this it had run in very large quantities	TQ 297 092
1877	Jan-31	Map from East Sussex County Council	About 360 gallons per minute ran past this point on Jan 26, 1877; but on Jan 31, no water ran here but there was water standing on the ground above.	TQ 298 092
1877	Jan-25	Map from East Sussex County Council	Water ran out of the top of this well	TQ 301 089
1877	Jan-31	Map from East Sussex County Council	About 550 gallons per minute flowing past this point on Jan 26 1877. No water ran past this point on Jan 31 but sank into the ground at this point and higher up.	TQ 292 103
1888	August	http://www.dundee.ac.uk/geography/cbhe/#searching	1878 August Rainfall observer at Brighton (Buckingham Place) noted, p[47], "Rainfall 4.52 in., greatest in Brighton in any August during 30 years"	
1882	October	http://www.dundee.ac.uk/geography/cbhe/#searching	1882 October Rainfall observer at Brighton (Hove Town) noted (p[71]) "the largest amount of rainfall recorded as having fallen in Brighton in one month during 60 years; on 15th and 16th, 3.00 in fell., and from 20th to 22nd, 2.35 in."	

[6] This table was produced from the BGS (2007) Flood 1 Final Report – Appendix 1

Year	Months	Source	Text	Location
1913	February 1 - 20	Map from public records office	Water commenced to run out of the ground from channel on both sides of the road, at this point, and ceased on Feb 20.	TQ 301 081
1915	Dec-30	Map from public records office	Water broke up here and formed pond but did not run over the roadway southwards	TQ 298 092
1916		Map from public records office	Water ceased running at Sunnyside on Jan 24 1916. The last spot on the road where water ceased running	TQ 302 087
1925	January 10 - 24	Map from public records office	Springs broke out Jan 10 ceased flowing about Jan 24	TQ 302 087
1958		Binnie Black & Veatch Report 2001[7]	Flooding where the bypass in Patcham now crosses the A23 road. Fire brigade installed a permanent pump, which removed flood water and remained pumping for over a year.	TQ 298 092
1960		Binnie Black & Veatch Report 2001	The ground floor of the Park Court buildings flooded soon after being built before occupancy. 1960 floods not generally thought to be as bad as 2000.	TQ302 108
1962		Binnie Black & Veatch Report 2001	References to flooding in a letter to Mr. Harris from his father.	
1974		Binnie Black & Veatch Report 2001	Flooding in Patcham believed to include surface runoff.	TQ302 086
1988		Binnie Black & Veatch Report 2001	Reports of flooding in the basement of the BT building next to Southern Water Authority in Preston Park	TQ030 064
1995		Binnie Black & Veatch Report 2001	Flooding of basements which nearly but not quite reached the surface.	TQ302 086

[7] Binnie Black & Veatch Report (2001) Flood Defence Assessment of Downland Flooding

Year	Months	Source	Text	Location
2000		Binnie Black & Veatch Report 2001	Extensive flooding throughout Patcham caused by the emergence of springs and prolonged surface runoff. At least 15 properties inundated. A23 road and the main London-Brighton railway closed. Estimated cost of flooding impact (excluding closure of railway) £800,000.	TQ302 086
2001		Binnie Black & Veatch Report 2001	Cellars of houses in Old London Road begin to fill again. Groundwater also discharging to the surface from drain covers lower down the road.	TQ302 086
2009		Brighton and Hove MAFP[8]	The levels at Ladies Mile Borehole peaked at 39 mAOD; no flooding was reported.	
2012		Brighton and Hove MAFP	In 2012, groundwater levels were high, reaching 42 mAOD at Ladies Mile but no flooding was reported.	

[8] Brighton and Hove City Council (2013) Multi Agency Flood Plan – Patcham

Appendix B - Environment Agency Guidance on Groundwater Mitigation Options

National Recovery

Environment Agency

Options for Mitigation of Groundwater flooding

1. Controlling Groundwater Levels in the Subsurface

Engineering solutions to mitigate groundwater flooding are limited because of the large volumes of water and spatial areas involved, and because it is not contained or channelled.

Pumping:

Wide scale dewatering of chalk (or other) aquifers by pumping are not a viable option. Lowering the risk of flooding over large areas will not be effective due to the constraints of well installation/design and operation coupled with the sheer volume of water involved. In addition there would be significant logistical problems associated with dealing with the discharges (where you pump the water to).

The opportunity to reduce flooding by pumping groundwater will be very site specific. The cone of depression (the area in which groundwater is lowered), generally ranges from a few hundred meters to a few kilometres depending on the nature of the local aquifer (storage/permeability) and the ability to pump harder without compromising the borehole (moving the packing material/mobilising turbidity etc.).

Pumping is generally only possible with a specifically designed well field to enable cones of depression to overlap. Clearly it would not be possible to drill a large number of bespoke boreholes for this purpose and the existing borehole sites may only occasionally be situated at sites which may benefit from dewatering.

Pumping would be impractical on any large scale but it may be worthwhile for LLFAs to work with Water Companies and other key infrastructure providers to:

a) Identify if there are any candidate sites in existence where boreholes and pumping systems are already in place (e.g. a public water supply site upstream of a village with groundwater flooding). **If** such sites exist then consideration can be given to setting up potential pilot studies.
b) Consider based upon the impact and threat to existing infrastructure (electricity, gas, water etc.) whether a site-specific groundwater control/dewatering scheme could be viable in future as a contingency measure to increase resilience.

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2. Controlling Groundwater levels at the Surface

Where groundwater emerges as a spring it will rapidly inundate low lying areas and begin to flow following the local topography/ground levels. Impacts not immediately above the point of emergence can thus be protected in the same way as handling surface water flooding. Options exist therefore for:

- Channelling and diverting the flow of water at the surface away from sensitive downstream receptors.
- Dealing with "pinch points" where water is forced through a narrow corridor such as an existing culvert – causing water to backup and flood the vicinity.

By capturing data on the extent and behaviour of groundwater flooding within their areas during the current incident, Lead Local Flood Authorities can identify alternatives for potential overflow/diversion channels and dealing with "pinch points".

3. Controlling Recharge to Aquifers

Some of the options for management of upland areas that would have an effect on mitigating surface water flooding may (to a lesser degree) have an impact on controlling the recharge of water into aquifers and hence the potential for groundwater flooding.

Wetlands may prevent flooding by functioning as natural sponges that trap and slowly release groundwater. Woodlands may act to decrease the rate of recharge during the spring and summer due to evapo-transpiration and may increase soil moisture deficits having the effect of shortening the period over which recharge is most effective.

4. Dealing with the Consequences of Groundwater Flooding

Strategic Actions:

Following 2012/13 groundwater flooding event in West Dorset, Dorset County Council commissioned their own investigation of the causes of flooding in the villages of Martinstown, Winterbourne Steepleton and Winterbourne Abbas. The purpose of the study was to improve understanding of the flood risks in the area and to identify possible measures for flood alleviation. The following recommendations were made to improve management of flood risk across all three villages:

- A Community Flood Action Group to be formed to create a representative voice for flood concerns for the community and to share responsibility for management and maintenance of the South Winterbourne.

- Household level flood protection to be implemented to protect individual properties against groundwater, surface water and fluvial flooding.

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- The potential for encouraging improved land management techniques in the catchment to reduce flood risk in the catchment to be explored, working in collaboration with Wessex Water and other potential partners such as the West Countries River Trust and the Farming and Wildlife Action Group South West.

- Additionally, specific recommendations were made to improve management of flood risk for each village.

We would recommend that a similar approach is adopted by LLFAs as part of the recovery phase from this incident.

Site Specific (Property Owner) Actions:

Property owners and specifically householders can be encouraged to help themselves. Joint badged LGA / EA Advice is already available via our website (See http://www.environment-agency.gov.uk/static/documents/Leisure/flho0911bugi-e-e.pdf).

The advice includes the following:

- Floors, lower parts of walls and openings such as airbricks are the most vulnerable parts of properties and can be sealed to prevent or limit water entry.
- Sump and Pump Systems can be operated at basement and ground floor levels in buildings, but can only have a localised effect and may not be effective with large volumes of groundwater.
- Foul drainage (waste from sinks, baths and toilets) - Foul sewage systems often back up and causes problems during ground water flooding.

Contingency measures include:

- Main drainage systems - range of non-return valves are available which may be able to help a continuing problem with sewage flooding.
- Septic tanks and cess pits - trap solids and then discharge semi-treated fluid to soak away or land drains. Adding a pump to the outlet side of the tank may help and pump the sewage to high ground above the groundwater table.
- Cess pits are sealed tanks which store five or six week's worth of waste and are better protected with a concrete surround.

Other specific measures for property owners include the following, but their effectiveness will depend on the pressure exerted by the groundwater level:

- Basements - 'Tanking' materials can be applied on the outside walls to seal the walls, but this can increase water pressure which may cause structural damage
- Floors - A replacement floor constructed to a high standard with reinforced concrete and with a continuous damp proof membrane can be effective where groundwater pressures are low.
- Suspended floors - constructed with concrete (often by raising floor levels) can create a void beneath the floor which will flood before water rises to enter the house.

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