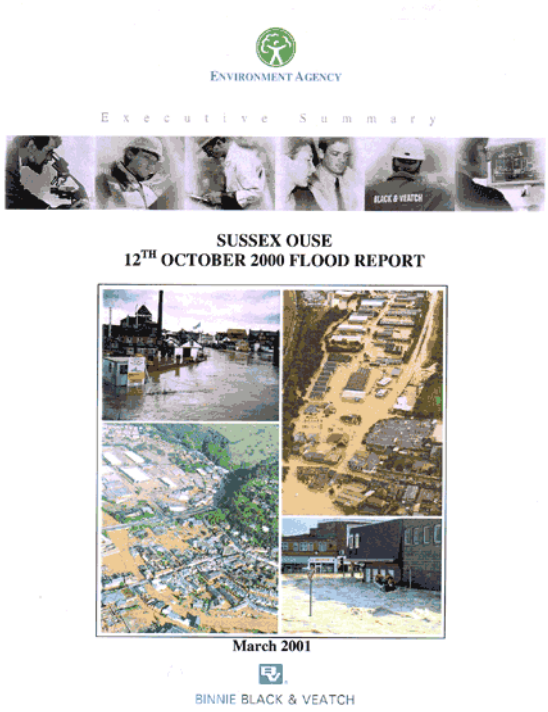
Flood Report: March 2001



EXECUTIVE SUMMARY

[Cover photographs courtesy of: the Environment Agency; Solent News & Photo Agency; John Gower; Dr Alan Thompson.]

E.1 Introduction

E.1.1 Following the devastating flooding in Uckfield and Lewes on 12th October 2000, consulting engineers Binnie Black & Veatch (BB&V) were asked by the Environment Agency to compile a detailed report into the flooding throughout the River Ouse catchment. The aim of the report was to provide a factual record of the flood, and assess its cause, severity and impact. The brief did not include judging the performance of any of the professional bodies involved or proposing possible solutions.
E.1.2 The resulting Sussex Ouse 12th October 2000 Flood Report (the Flood Report) is a detailed and lengthy document and this Executive Summary has been prepared so that an abbreviated version can be easily and widely distributed.
E.1.3 This Executive Summary concentrates on Chapters 4, 5 and 7 of the Flood Report which is divided into the following sections:

- Chapter 1 - Introduction
- Chapter 2 - The River Ouse Catchment
  (describes the geographical, geological and hydrological characteristics of the catchment and its river system, as well as briefly looking at the history of development on the flood plain)
- Chapter 3 - Flood History
  (summarises all the known previous flood events, as well as the studies and flood defence schemes undertaken in the last 50 years)

- Chapter 4 - Description of the 12th October 2000 Flood Event
  (details and discusses the development and extent of the flood, as well as the flood warnings that preceded it, and the subsequent emergency response and aftermath work)
- Chapter 5 - Discussion
  (assesses the cause and the severity of the flood, and discusses a number of related issues)
- Chapter 6 - Flood Impact and Cost
  (assesses the physical, financial and social impact of the flood event)
- Chapter 7 - Conclusions
  (summarises the main points and makes a number of recommendations)
- Appendices

E.1.4 In writing the Flood Report, BB&V have relied upon information collected from a wide number of sources, in particular:

- records and hydrometric data provided by the Environment Agency,
- interviews and correspondence with many representatives from the Environment Agency, Local Authorities, Emergency Services, and other third parties,
- the flood maps produced by Halcrow Survey, Symonds Group and Lewes District Council,
- information supplied by those affected by the flooding via 427 completed Post Flood Questionnaires. (Completed Questionnaires were received from approximately 44% of residential and 34% of non-residential properties flooded).

E.2 Description of the 12th October 2000 flood event

Catchment overview

E.2.1 The flooding in the central part of the Ouse catchment on Thursday 12th October 2000 was preceded by 3 days of storms and heavy rain across the whole area. The ground became increasingly waterlogged, and there was widespread, localised flooding from surface water run-off. The Environment Agency opened their flood monitoring room on the 9th October and issued a series of Flood Watches and Flood Warnings the same day. The District Councils also responded to public requests across the area for sandbags. River levels fell on the 10th October then rose and fell again on the 11th October, before rising for a third time overnight on the 11th/12th October.

E.2.2 On the night of the 11th/12th October particularly intense rainfall fell across the saturated catchment, and the rivers responded very quickly. River levels rose extremely rapidly, passing through all the flood warning alarm levels within the space of a few hours and during the early hours of the morning the Environment Agency opened its Area Incident Room, and issued further flood warnings for the Uck and the Upper and Middle Ouse.

E.2.3 Uckfield flooded dramatically from about 5.00am on the 12th October, with river levels rising rapidly to a peak between 9.00am and 10.00am, at which point a torrent of water up to 1.9m deep, was flowing through the town centre causing considerable damage. From early afternoon water levels dropped as fast as they had risen, with the floodwaters disappearing completely by late afternoon, leaving the local authorities and residents with the task of clearing up.

E.2.4 Little flooding in the upper parts of the River Ouse valley has been reported. However the middle section of the river also flooded during the early hours of the morning of the 12th October, inundating the floodplain from above Sheffield Bridge to Hamsey, and flooding all the low lying properties within it.

E.2.5 As the floodwaters receded in Uckfield, and the flood peaks from both the Uck and the Middle Ouse passed downstream, the focus of attention shifted to Lewes. Throughout the morning of the 12th October the floodplain between Barcombe and Lewes filled up.

E.2.6 Widespread flooding in Lewes started at about 1.00pm, as the rising river backed up behind the Cliffe Bridge and overtopped the flood defences at a number of locations. Within about an hour or so the flood defences throughout the town were completely overwhelmed and the town centre rapidly filled with floodwater. Many hundreds of people were stranded and had

to be rescued by the Emergency Services in boats. By the time the floodwaters peaked at about 9.30pm, some parts of Lewes were under 3.6m of water.
E.2.7 The floodwaters, trapped behind the flood defences, remained high within Lewes throughout the following day and generally residents were only able to return to their devastated homes and businesses on Saturday 14th October. It was quickly apparent that the extent and depth of flooding in Lewes, as in Uckfield, were worse than anything experienced since at least November 1960, if ever.
E.2.8 It is believed that downstream of the A27 Lewes bypass, the River Ouse stayed in channel all the way down to Newhaven, although the Rodmell Brooks flooded via an underpass beneath the A27 embankment.
E.2.9 As well as responding to the flooding in the Ouse catchment on the 12th October, the Environment Agency, Local Authorities and Emergency Services (which included the Police, Fire Brigade, Ambulance Service, RNLI and HM Coastguard) also had to respond to serious flooding elsewhere within the area on the same day, most notably on the rivers Rother, Adur, Arun and Cuckmere. The emergency response across the County was coordinated at a strategic level from a single 'Gold Command' centre at Sussex Police Headquarters, whilst tactical 'Silver Command' centres were set up in both Uckfield and Lewes. Throughout the 12th October, all the above organisations were severely hampered in their work by the widespread flooding of roads, which caused traffic chaos across the County.
Uckfield
E.2.10 The Environment Agency issued a Flood Warning for the River Uck at 11:40pm on the 9th October and a Severe Flood Warning at 2:40am on the 12th October, by which time Wealden District council staff had already sand-bagged shop entrances on the High Street. As the Emergency Services mobilised, the Police established a Silver Command at Uckfield Police Station at 4.00am. Arrangements were immediately initiated for an organised evacuation of local residents from threatened areas, and Wealden District Council opened two Emergency Rest Centres. In the event no formal evacuation was undertaken, and during the course of the day only about 11 people self-evacuated to the rest centres. The Fire Brigade and RNLI were involved in a number of rescues in the town centre, and a HM Coastguard helicopter rescued a man swept down the river.
E.2.11 We believe that flood waters flowing off the flood plain upstream of Somerfield's car park, initially collected behind the supermarket, before flowing onto the High Street via the Somerfield passageway at about 4.00am. At about the same time, the main river overtopped its banks upstream of Uckfield Mill, and excess river flows diverted into the bypass channel (via the arch in the railway embankment), overflowed this channel and spilled into the car park to join the water coming off the flood plain.
E.2.12 Between 4.00am and 5.00am the flood levels rose rapidly, inundating the Somerfield car park and Mill Lane areas, so that the floodwaters from the river, bypass channel and floodplain merged into one, flowing onto the High Street. We believe that at around 5.00am these accumulating flood waters flowed onto the High Street via River Way and Mill Lane - to join that already flowing down the High Street from the Somerfield passageway. River water may have also started to overtop the High Street bridge at this time. As the High Street flooded, Uckfield was split into two.
E.2.13 The first property to flood was the low lying Bridge Cottage, at about 3.30am, when the river overtopped its adjacent right bank, shortly before water also came down the High Street. More widespread flooding began between 5.00am and 6.00am, by which time the District Council had abandoned its efforts to protect the town centre shops with sandbags.
E.2.14 The floodwaters poured across the High Street, flowed down Bell Walk, Bell Lane and the B2102 road to the bypass, and continued flowing broadly parallel to the river through the Bellbrook Industrial Estate. As the levels rose, the floodwaters started to flow through many of the properties in its path with increasing force. This particularly applied to the shops along the High Street and the eastern end of the Bellbrook Industrial Estate, where doors and windows were smashed and considerable damage done to fixtures and fittings. Large quantities of stock were washed out into the High Street - some of it reportedly ending up on farmland as far downstream as near Isfield and Barcombe. Similarly, the flow velocities around the buildings were also extremely high, causing prominent standing waves on Bell Lane and reportedly

preventing the upstream movement of a RNLI inshore lifeboat. Cars were also reportedly swept 50m along Mill Lane.

E.2.15 The floodwaters continued to rise very rapidly until about 8:30am, when the rain began to ease off. It is believed that the flood peak in Uckfield was between 9.00am and 10.00am, when maximum flood water depths are estimated as being:

- Mill Lane - approximately 1.9m
- High Street - approximately 1.9m
- Bell Walk - approximately 1.6m
- Bellbrook Industrial Estate - approximately 1.1m (upstream) to 0.1m (downstream)

E.2.16 It is reported that the flow remained within the 2 stage channel through the downstream section of Bellbrook Industrial Estate, and flowed beneath the A22 bypass bridge with about 0.6m clearance at the peak, although it is not known if there was a head loss through the bridge. The A22 bypass was however closed when a significant length was flooded by water overtopping from the Ridgewood Stream.

E.2.17 Although the River Uck is not tidal, concern was expressed by some that midday high tides in Lewes would cause backing up of the flood waters in Uckfield in the early afternoon. This did not occur and from about 1.00pm water levels in the town began to fall very rapidly, as if "a plug had been pulled". By 5.00pm the town was clear of water and the clear up operation began, continuing through the weekend.

Lewes

E.2.18 The heavy overnight rain on the 11th/12th October caused flow in the Winterbourne Stream to rise very rapidly, and localised flooding occurred early in the morning of the 12th October in the Bell Lane area when a culvert grille became blocked. As the heavy rain continued through the morning, drains throughout the town started to back up and overflow causing further localised flooding most notably in the Phoenix Industrial Estate, Eastgate Wharf and Morris Road areas. The morning news reports were dominated by the flooding in Uckfield and Barcombe Mills and the situation was monitored closely by the Environment Agency, Local Authorities and Emergency Services. By 10.00am the flood plain upstream of the town was rapidly filling up, with the river having overtopped its embankments to below Hamsey

E.2.19 At 10.00am the Environment Agency issued a Flood Warning for Lewes, and the Local Authorities and Police initiated their emergency plans and mobilised. During the course of the morning, Lewes District Council opened Emergency Rest Centres at the Town Hall and Malling Community Centre, and a 'Silver Command' Centre was established by Sussex Police at Lewes House. The Council's initial concern was that Harvey Brewery's new river wall might fail, and at about 11:30am, following the receipt of a Severe Flood Warning from the Environment Agency, the Police decided to evacuate the Cliffe area of the town. At this point water levels were reported as being about 0.5m below wall crest level, but rising fast.

E.2.20 Initial advice from the Environment Agency was that only the Cliffe area was expected to be at risk from flooding, and that river levels should start to fall in the early afternoon following the 12.30pm High Tide. However the river levels continued to rise at an extremely fast rate and between 12.00pm and 1.30pm the flood defences were breached at a number of locations in quick succession, causing rapid flooding across the town. These included:

- over the embankments upstream of the North Street area, across the Pells and into Landport Road, Pelham Terrace and North Street;
- over the river bank onto Malling Playing Fields;
- via a breach in the river wall in the Phoenix Industrial Estate, and into the industrial estate;
- over a low point in the river bank by the Riverside Surgery, and into the Cliffe area;
- up the old "Cut" by the Rowing Club, and onto South Street.

E.2.21 The evacuation effort was quickly extended to the Morris Road, South Street and Landport Road areas. At about 2.00pm the floodwater collecting on Malling Playing Field spilled over the car park beneath the Mayhew Way viaduct and flowed rapidly down Spences Lane and into the Malling Brooks area. At about the same time river levels overtopped the flood defence walls throughout the centre of Lewes:

- along the left bank along the Phoenix Industrial Estate;

- along the left bank between the Phoenix Causeway and Cliffe Bridge;
- on the right bank upstream of Cliffe Bridge;
- on the left and right banks downstream of Cliffe Bridge.

E.2.22 As the flows passing downstream from Barcombe continued to increase at a rapid rate, the floodwaters weired over the river walls and surged through the streets and open areas in Lewes, rapidly filling up sections of the urban floodplain to a depth of 1m in about half an hour. The Police abandoned the centre of town, and the evacuation turned into a rescue operation as the RNLI and Emergency Services used inflatable lifeboats to reach people suddenly trapped in their homes or businesses. The rescue operation, involving the Police, Fire Brigade, Ambulance Service, RNLI and HM Coastguard, continued throughout the afternoon and evening and, despite the speed and force of the flooding, there were no lives lost.

E.2.23 Whilst flood depths of 1.2m were common throughout the town, the low-lying Malling area was particularly deeply flooded (up to 3.6m). By early evening Lewes was also effectively cut in two when Malling Street and the Cuilfail Tunnel became impassable. Flooding of the railway lines had already closed Lewes Station. Over a hundred and forty people spent the night of the 12th/13th October at the two Emergency Rest Centres.

E.2.24 Downstream of Cliffe Bridge, the floodwaters overtopping the right bank embankment steadily filled up the designated flood storage area between Lewes and the A27 bypass throughout the afternoon and evening, eventually flooding the Southdown Sports Club and the Ham Lane Seage Treatment Works in the late evening. Floodwaters appear to have backed up the tide-locked Winterbourne Stream and flooded the Tanners Brook area in the early evening. On the left bank, Southerham Farm flooded as water backed up drains from the river, and water running off the Downs was prevented from draining away.

E.2.25 It is estimated that the floodwaters peaked in the centre of Lewes at about 9.30pm on the 12th October, and river levels started falling noticeably in the early hours of the following morning. However most of the floodwater remained trapped behind the flood defences, so that the water levels in the flooded areas of the town remained high throughout the 13th October. With pumping stations disabled by the flooding, the Environment Agency and Fire Brigade used mobile pumps to pump water back into the river, at the same time collecting and removing over 70,000 litres of oil-polluted water. This operation continued throughout Friday 13th and Saturday 14th October, and it wasn't until the Saturday afternoon that residents were able to return to their homes to begin cleaning up.

E.3 Impact of the Flood

E.3.1 The 12th October flood devastated the centres of Uckfield and Lewes, as well as causing significant damage to surrounding rural properties and the farming community. We estimate that in total 2000 hectares and 1033 properties across the catchment were flooded, and that 682 vehicles were damaged or written off. We have estimated that the total financial cost of the flood, including the costs of the emergency response and aftermath work, is approximately £130 million. A breakdown is shown in Table 6.3 below:

E.3.2 It should be emphasised that this is an estimate. It is based upon the estimated insurance claim information received in the completed Post Flood Questionnaires, extrapolated to cover those for whom no specific data is available, together with information supplied by the various organisations involved. It is also likely to be significantly greater than the 'economic' cost allowed by MAFF in cost-benefit calculations for justifying any future publicly funded flood alleviation schemes

E.3.3 The extent of the flooding in Uckfield and Lewes, and the broad categorisation of the type property flooded, is shown in Figures 6.1 and 6.4 respectively. In Uckfield, 86% of the133 affected properties were businesses or public buildings. In Lewes, businesses and public buildings represented about 27% of the 836 properties affected, the remainder being residential properties.

E.3.4 In addition to the immediate damage to property and contents, the widespread disruption to transport systems and electricity supplies, and the resulting stress, distress and trauma experienced by many of those affected, a number of longer term problems and issues have been reported. These include:

- long periods of drying out and repair mean that many homes have remained uninhabitable for many months after the event, with residents having to live in alternative, temporary accommodation;
- similarly, many businesses remain closed months after the flood, and a small number are believed to have closed permanently;
- a long term loss of trade, both for the flooded businesses, and for the wider business community;
- widespread concerns about property values and insurance;
- losses of agricultural crops and livestock;
- impact on County Council Social Services provision due to the loss of day centres and buses;
- long term damage to road surfaces, and widespread blockage of highways drainage systems;
- impact on Lewes District Council's housing provision due to temporary re-accommodation of flood victims;
- disruption to the Fire Brigade and Ambulance Service due to the temporary loss of several of their buildings, including their control centres, and loss of vehicles;
- in Lewes, 118 Listed Buildings and 230 other 'traditional' buildings within the Conservation Area were damaged, requiring specialist repair;
- long term needs for emotional support amongst some.

E.3.5 It is not believed that the flood has resulted in significant environmental or public health impacts, or has generated any significant related crime.

E.3.6 These problems have been particularly evident in Lewes, where a coordinated County and District Council response has been organised by the Lewes Flood Recovery Group.

	No.	**Cost (£'000)**	**Notes**
Uckfield			
Residential Properties	18	729	
Businesses	110	17,062	
'Public' Buildings	5	28	
Vehicles 153	153	750	
subtotal	**133**	**18,569**	cost excludes "Organisations" properties
Lewes			
Residential	613	20,466	
Businesses	207	63,999	
'Public' Buildings	16	1,874	
Vehicles 503		1734	
Subtotal	**836**	**88,073**	cost excludes "Organisations" properties
Rural areas			
Residential/Business	64	2,900	
Agriculture		4,000	
Vehicles 26		97	
Subtotal	**64**	**6,997**	
Organisations			
East Sussex County Council		8,250	- includes damaged Council property
Lewes District Council		896	

Wealden District Council	85	
Environment Agency	839	- no data available
Police		- includes damaged property
Fire Brigade	5,000	- includes damaged property
Ambulance Service	250	- no data available
RNLI	20	- Ham Lane PS only
HM Coastguard		- no data available
Southern Water	140	- no data available
British Telecom		- excludes infrastructure repair costs
Seeboard	500	- no data available
Transco		
Railtrack	717	**rounded to £130 million**
Connex		
subtotal	**16,697**	
TOTAL	**130,336**	

sources: as detailed in Section 6

Table 6.3
Financial cost summary

E.4 Impact of catchment characteristics and flood plain development

Catchment characteristics

E.4.1 From our study of the catchment area we believe that there are a number of natural and man-made features which make occasional serious flooding of property in the River Ouse and River Uck valleys likely.

E.4.2 Firstly, the topography and geology of the catchment as a whole is such that these valleys are naturally prone to periodic flooding. Whilst most of the downstream section of the catchment below Lewes is underlain by free-draining chalk, large parts of the upper and middle sections of the catchment are underlain by relatively impermeable geology. Most of this area is also covered by clayey topsoils. This means that the upper and middle sections of the catchment become quickly saturated following heavy rainfall. During wet periods a large proportion of the rainfall will quickly run-off into the river system rather than drain through the ground, and this effect is exacerbated by the hilly nature of the upper parts of the catchment.

E.4.3 It is worth noting that historically much of the lower lying parts of the River Ouse corridor, including the Lewes area, were semi-tidal marshy areas - regularly under water.

E.4.4 Because of these natural characteristics, the main sections of the River Ouse and the River Uck have well developed flood plains. For centuries the only building on the flood plain was related either to specific river-based industry such as mills and barging inns, or at commercially attractive river crossing points, such as around Cliffe Bridge in Lewes. Periodic flooding would therefore have had comparatively little impact, and only the most extreme events would probably have been considered noteworthy.

Floodplain development

E.4.5 It was not until the economic and population expansions that came with the Industrial Revolution in the 19th century, that major land drainage and river engineering works were undertaken which enabled widespread building on the floodplains. At the river's commercial heyday in the mid 1800's, barges travelled as far upstream as Upper Ryelands Bridge (north of Haywards Heath) and sea going ships were built in Lewes, where significant commercial development in the Cliffe, Malling and Phoenix areas of the town took place. The centre of Uckfield however appears to have been further up the hill, with only a limited number of commercial properties on the actual floodplain around the bridge. It is notable that it is about this time that there started being regular reports of flooding in Lewes and Uckfield.

E.4.6 There does not appear to have been significant further development on the floodplains in Lewes or Uckfield until the late 1950's and early 1960's, when the second and current phase of floodplain development began.

- In Uckfield this has included the commercial and residential development of: the Mill Lane area; the Olives Meadow area; the lower High Street area; and the Bellbrook Industrial Estate.
- In Lewes this has included the removal of the Lewes-Uckfield railway line and the construction of the Phoenix causeway, and significant additional commercial and residential development of: the Malling Brooks area; the High Street; and the North Street/Phoenix Industrial Estate areas - as well as residential development along Landport Road, Monks Way, Court Road and at Hillman Close.

E.4.7 During this period flood alleviation schemes have also been carried out in both Uckfield and Lewes, to protect the buildings on the floodplain:

- The River Ouse Tidal River Walls Improvement Scheme (1953-79) constructed flood defence embankments between Newhaven and Barcombe, with river walls through Lewes. The aim of the scheme was to pass a design flow of 170m3/s through the town, protecting it from an event of similar magnitude to that of 3rd November 1960 (reported to be a 1:100 year event).
- The Winterbourne Improvement Scheme (1960's and 1985) improved the capacity of the channel and culverts to pass a design flow of 2.8m3/s (reported to be a 1:20 year event), with the 500m long culvert beneath the railway station having a 1:50 year design capacity.
- The Uckfield Flood Relief Scheme (1978-81) improved the flow capacity of the river channel through Uckfield with the intention of passing a design flow of 72m3/s (reported to be a 1:50 year event)

E.4.8 Flood defence schemes can however only ever reduce the risk of flooding of the urban floodplain to the stated design standard - they cannot eliminate it. We also believe that the floodplain developments over the last 40 years have had a particularly significant effect on the impact of those extreme flood events which do exceed the engineered capacity of the river channel.

E.4.9 Firstly there are now many more properties and businesses at risk than ever before, and modern materials and goods are particularly vulnerable to flood damage, and expensive to replace. The significance of floodplain development is illustrated by the following broad figures which estimate (based on historic maps) what the impact of the 12th October 2000 flood would have been if it had occurred in 1960 or in the 19th century.

Year:	2000	1960	19th century
No. of properties that would have flooded in Uckfield	133	approx. 30-40	approx. 10-20 (1874)
No. of properties that would have flooded in Lewes	858	approx. 550-600	approx. 200 (1824)

E.4.10 Secondly we believe that the extent, location and orientation of the various structures that have been constructed on the flood plain, both in Uckfield and in Lewes, made the effect of the 12th October 2000 flood worse than it would have been otherwise, by:

- increasing the amount and rate of surface water run-off, thereby increasing flows;
- reducing the area available for flood storage, thereby increasing peak levels;

- reducing the area available for flood flow conveyance, thereby increasing peak levels, contributing to rapid inundation and high flood velocities, and extending the period of flooding.

Uckfield

E.4.11 In Uckfield, the river channel is constricted at Uckfield Mill and the High Street Bridge, we believe limiting its actual channel capacity to 50-60m3/s. Analysis of flow and level data from the 1974 and 1993 floods indicates that the improvements carried out under the Uckfield Flood Relief Scheme (1978-81) do noticeably reduce flood levels. Nevertheless we calculate that the peak flow on the 12th October was twice this channel capacity, thus flooding was inevitable.

E.4.12 The excess flows that flooded across the floodplain were however significantly obstructed by the blocks of shops constructed on both sides of the High Street, and orientated across the flood plain. We estimate that the width of floodplain available for flood flow conveyance at the High Street is approximately 1/3 of that available immediately upstream. As a result of floodwater backing up behind the buildings, water levels in the High Street area were therefore higher than they would otherwise have been. Flow velocities in between and through the buildings were also very high - causing significant physical as well as saturation damage.

Lewes

E.4.13 In Lewes, we believe that the peak flows were 'well in excess of 200m3/s' - compared to the river channel's stated design capacity of 170m3/s, so again flooding was inevitable.

E.4.14 It is notable that the Monks Way, Landport Road, Pelham Terrace, Malling Deanery and North Street areas are protected by a combination of:

- river side embankments, which have a design channel capacity of 85m3/s, but which are believed to have settled considerably since their construction in the 1960's, and which overtopped mid morning on the 12th October; and
- the storage capacity of the floodplain between the embankments and the buildings, which was exceeded by about 1.00pm on the 12th October - before there was widespread overtopping of the main river walls in the town centre.

E.4.15 It is also noticeable that the Phoenix Causeway was not overtopped and it effectively acted as a dam across the floodplain preventing the downstream passage of flood flows. All the flood flows passed beneath the bridge - although it appears that there was a 0.3m headloss across the bridge, suggesting that it did have a throttling effect. This is a significant difference from the flooding in 1960, when the flood waters were able to pass downstream without such obstruction.

E.4.16 The Cliffe Bridge and the river channel immediately upstream and downstream of the bridge, clearly acted as the principle bottlenecks in Lewes, causing upstream water levels to back up and overtop the flood defences, typically by the amounts shown in Table 5.14

	Peak Flood Level (mAOD)	Flood defence design level (mAOD)	Depth of overtopping (m)
Upstream of Phoenix Causeway	5.80	4.95	0.85
Upstream of Cliffe Bridge	5.50	4.95	0.55
Downstream of Cliffe Bridge	5.07	4.725	0.345

sources: Appendices A and H and Halcrow survey

Table 5.14
Overtopping Depths in Lewes

E.4.17 It can be seen from Table 5.14 that the river significantly overtopped its defences downstream of Cliffe Bridge as well as upstream. This suggests that:

- the lack of capacity through Cliffe Bridge created the constriction which caused the overtopping upstream of the bridge; and
- the lack of capacity in the river channel through the urban area downstream of Cliffe Bridge, caused overtopping downstream of the bridge.

E.4.18 In Lewes, unlike in Uckfield, the existence of raised flood defences protecting low lying areas of town means that:

- the town is protected from more frequent flood events, but
- when in very extreme events the standard of defence is exceeded and the flood defences are overtopped, the resulting flooding is likely to occur rapidly and with devastating impact - as evidenced on 12th October 2000, and
- these flood waters then become trapped behind the flood defences prolonging the period of flooding.

E.5 Cause and severity of the flood

Rainfall event

E.5.1 We believe that the rainfall that caused the flooding was the result of a coincidence of exceptional meteorological conditions and local geography. In the days preceding the 12th October, a succession of complex Low Pressure systems came in from the Atlantic, bringing gales and rain sweeping across the UK. These combined into a single massive area of intense Low Pressure drawing extremely cold air down from the Arctic in the upper atmosphere. As the Low Pressure then filled, warm moist air was drawn up from the Bay of Biscay in the southwest, and forced up into the unusually cold upper air by the south-west facing South Downs coastline. This generated a series of intense thunderstorms on the 11th/12th October, which formed along a trough - on the line of the prevailing southwesterly wind - across the central part of the Ouse catchment.

E.5.2 The result of these conditions was that, between the 9th and 12th October, an average of over 150mm of rain fell over a broad diagonal belt across the Ouse catchment, with 200mm being recorded between Plumpton and Barcombe. Accordingly the north-western and southern parts of the catchment were not affected to the same degree as the central part.

E.5.3 During this 4 day period, there were actually 3 distinct rainfall events: on the 9th October, the 10th October and the 11th/12th October. The average catchment rainfall during these separate events was 35mm, 22mm and 85mm, which respectively represent about 39%, 25% and 95% of the catchment's average annual rainfall for the whole of October - the second wettest month of the year.

E.5.4 The especially heavy, thunderstorm generated rainfall, on the 11th/12th October saw localised rainfall of up to 134mm in 24 hours - as shown on Figure 5.3. Most of this actually fell over a 16-hour period, with the first 8 hours of the 12th October being particularly intense. Calculations show the following return periods for these rainfall events:

- the average 100mm rainfall over the River Uck subcatchment, in the 16 hour period ending 10:00 GMT on 12th October was a **1:150 year event**.
- the average 85mm rainfall over the River Ouse catchment to Lewes, in the 16 hour period ending 10:00 GMT on 12th October was a **1:90 year event**.
- the average 150-160mm rainfall over the River Ouse catchment to Lewes, over the 4 day period of 9th-12th October exceeded a **1:200 year event**.

E.5.5 Not only was the 11th/12th October rainfall an extreme event, but it fell upon a completely saturated catchment - the result of both the preceding rainfall events on 9th and 10th October and an unusually wet September. This resulted in a very rapid run-off response, and river levels rose extremely rapidly - particularly in the upper sections of the catchment. This is illustrated by the hydrographs shown on Figures 5.4 and 5.6.

E.5.6 It is interesting to note that the 3rd November 1960 flood is similarly reported to have occurred when an extreme rainfall event followed a period of wet weather, and it is clear that the catchment is particularly vulnerable to flooding under these circumstances.

Historical comparison

E.5.7 The River Ouse catchment has a long history of flooding with the earliest references dating back to 1671 for Lewes, and 1852 for Uckfield. In total we have encountered references to 78 previous flood events, the majority in the last 150 years. This suggests that flooding of some sort within the catchment occurs on average about every second year. The lack of any quantitative data prior to 1960 prevents the accurate ranking of all these historic events. However based on anecdotal evidence, we estimate that of these 78 previous events, 31 were either "Serious" or "Extreme" floods involving significant flooding of property, somewhere in the catchment.

E.5.8 Prior to the 12th October 2000 event, the worst flood in both Lewes and Uckfield in living memory was that of 3rd November 1960. All the evidence suggests that for both towns, the 12th October 2000 flood was significantly worse. In Uckfield High Street, the 12th October 2000 peak water levels were approximately 1.0m to 1.2 m higher than those recorded for 1960. In Lewes, the 12th October 2000 peak levels at the two level recorders were respectively 0.83m (Corporation Yard) and 0.7m (Gas Works) higher than those recorded in 1960. Flows down the Winterbourne Stream, although significant, were however less than those in 1960.
E.5.9 The absence of reliable annual maximum flow series, and the lack of flood flow data from both historic floods and the 12th October 2000 event makes a statistical assessment of the flood return period very difficult. Nevertheless we have been able to derive sensibly consistent series of Annual Maximum Peak Flows for Gold Bridge and Isfield Weir, based on recorded river level data, and estimated rating equations. Flood frequency analysis of these series indicates the following return periods:

- River Ouse at Gold Bridge (85m3/s estimated peak flow) = **a 1:25 year return period**
- River Uck at Isfield Weir (113m3/s estimated peak flow) = **at least a 1:150 year return period.**

E.5.10 It has not been possible to undertake a similar analysis for Lewes due to the absence of any reliable peak flow data or rating curve at Barcombe Mills or further downstream. We believe that peak flow at Barcombe Mills was about 200m3/s and that the peak flow through Lewes was well in excess of 200m3/s.
E.5.11 Based upon the limited historical information available we believe that the 12th October 2000 flood in Lewes was:

- the most severe since at least October 1852, and
- probably the most severe since at least 1801.

Tidal Influence
E.5.12 Although almost coinciding with a spring tide, tidal conditions were not exceptional. We estimate that the midday High Tide on 12th October would have been exceeded by almost 30% of the year's High Tides. There appears also to have been a slight negative surge effect, reducing actual tidal levels below predicted levels.
E.5.13 Comparison of recorded levels at Newhaven and Lewes at the beginning of October suggest that a High Tide of about 3.27mAOD might have been expected in Lewes, at about 12:20pm on the 12th October. As can be seen from Figure 5.6, this was the order of the High Tides on the 10th and 11th October, despite the high river flows resulting from the rainfall of the 9th and 10th October, and appears to have been the basis of Environment Agency predictions for the 12th October. However the massive volumes of water passing down the River Ouse as a result of the 11th/12th October rainfall, drowned out the tidal effect from about 3.30am on the 12th October.
E.5.14 In total the river flows completely drowned nearly 4 full tidal cycles at Lewes, including 3 High Tides. We therefore do not believe that the tide itself was a major causal factor in the 12th October flood.
'Flood Wave'
E.5.15 We do not believe that there is any evidence to support rumours that operation (or lack of operation) of flood gates or sluices contributed to the flooding. Environment Agency records show that all the main gates - which are retained for management of low flows - were opened several days before the flooding.
E.5.16 We believe that the very rapid rise and fall of river levels in Uckfield was due to a combination of:

- the very intense rainfall on the 11th/12th October, falling on a saturated catchment and generating a very rapid run-off response, and
- the natural characteristics of the Uck sub-catchment above Uckfield which encourage a rapid run-off, and also mean that the flows down the Uck and its main tributaries all peak in Uckfield at the same time.

E.5.17 We believe that the 'flood wave' effect witnessed by residents in Lewes was caused by the very rapid inundatation of the areas behind the flood defences, which occurred when the river defences were overtopped on a widespread basis, combined with the effect of the flood waters being channelled through comparatively narrow gaps between buildings. Once the

170m3/s design capacity of the river channel through Lewes was exceeded all excess flows inundated the urban areas of the flood plain. This occurred between 1.00pm and 2.30pm on the 12th October. The inundation was so rapid and so deep because:

- River flows were increasing very rapidly at this time and continued to do so for several hours after the flood defences were overtopped.
- The upstream flood storage areas were already 'full' so that the majority of the flood flows passed straight downstream to Lewes with little attenuation.
- Once overtopped, the flood defences acted like weirs allowing large volumes of water to pass over them in a short space of time, rapidly filling the low lying areas behind them, with high velocities being witnessed where flows were channelled through narrow gaps.
- The natural narrowing flood plain as it approaches Lewes, together with the artificial obstructions across its path in Lewes (Phoenix Causeway, Mayhew Way, Cliffe High Street shops) severely reduces the ability of the flood plain through Lewes to convey flood waters, causing levels to rise higher still.

Winterbourne Stream

E.5.18 The Winterbourne is an 'ephemeral' stream which is normally dry but responds quickly to run-off during wet periods, and is also fed by spring flows which emerge when ground water levels in the chalk rise above about 13.0mAOD. Nearby groundwater levels rose from just below 11.0mAOD on the 5th October to about 13.5mAOD at midnight on the 11th/12th October, whilst flow down the Winterbourne Stream was just 0.003m3/s at 8.00pm on the 11th October.

E.5.19 In response to the intense overnight rainfall, flow increased extremely quickly to a peak of 2.813m3/s - the design capacity of the channel - by 2:45am on the 12th October. This was the result of an almost instantaneous response to surface water run-off, and flows subsequently reduced to 0.16m3/s by about midday. Although the flows were at (or slightly above) the stated channel capacity, all reports indicate that the early flooding in the Bell Lane area of Lewes was the result of a blocked culvert weed-screen at the Recreation Ground - of which the Environment Agency had no knowledge until too late.

E.5.20 Groundwater levels in the chalk continued rising to about 26.0mAOD by midday on the 12th October - causing flows in the Winterbourne Stream to steadily rise again to a second peak of 3.217m3/s on the 14th October. There were no reports however of flooding from this second, larger peak.

E.5.21 Apart from weed-screen blockages, the improvements made on the Winterbourne Stream in the 1960's and 1980's appear to have worked well, with channel and culverts coping with stream flows at, or in excess of the design flow of 2.8m3/s. Although weedscreen blockage may have contributed to the flooding at Tanners Brook on the evening of the 12th October, we believe that the principal cause of this flooding was the inundation of the downstream flood storage areas by flood waters from the River Ouse, which then caused flow down the Winterbourne to back up.

E.6 Flood forecasting and warning

E.6.1 Accurate flood forecasting and warning are extremely complex and difficult tasks. Following the severe Easter 1998 flooding in the Midlands, the Environment Agency completely overhauled its procedures and structures, and introduced new Flood Warning codes. Increased resources were also invested in staff teams, training and equipment. We believe that the 12th October 2000 flood in the Ouse catchment was the first major flood event in the UK under the new system - which was only fully implemented on 12th September 2000. Improvements to river gauging and river modelling have been built into long term plans, but are not as yet completed.

E.6.2 The Environment Agency has detailed and catchment specific flood forecasting and flood warning procedures and systems. These appear to have been implemented correctly both prior to and during the 12th October 2000 event, in that:

- Duty Officers and incident rooms were fully mobilised prior to the flooding;
- flood forecasting and warning procedures appear to have been followed;
- severe flooding was correctly forecast;
- flood warnings were issued;

- 82% of the AVM flood warning messages issued on the 12th October to the Environment Agency's 'professional partners', the media and registered local residents were successfully disseminated (the remaining 18% were attempted 3 times without success);
- the target 2 hour *Flood Warning* lead time was met in all areas before there was widespread flooding.

E.6.3 However it is also clear that the flood warning system did not meet the needs of a significant number of those who were actually flooded, in that:

- the 2 hour target *Flood Warning* lead time was not met for some of the low lying properties that were the first to be flooded;
- many residents did not receive *any* warning that they might be flooded,
- many residents who did receive some form of warning, were unprepared for the extent, speed and depth of the subsequent flooding;
- whole areas of Lewes flooded that were not expected to be affected.

E.6.4 With the benefit of hindsight we believe that two issues are apparent. Firstly the extreme severity of the 12th October 2000 event appears to have been under-forecast by the Environment Agency - who accordingly did not initially anticipate the full extent of flooding in Lewes. We believe that this was due to a combination of factors including:

- Meteorological Office weather forecasts (central to flood forecasting) appear to have significantly under-forecast rainfall quantities. The total rainfall forecast by the Meteorological Office for the 4 day period 9th-12th October was 65mm-110mm, whilst an average of 180mm actually fell across the central part of the catchment during this period.
- Important river level recorders at Uckfield, Barcombe and Lewes were respectively washed away, damaged and overtopped well before the eventual flood peaks. This left gaps in the information available to Environment Agency staff at key locations at critical times.
- A lack of high flow measurement and topographic information available to flood forecasting and warning staff.
- The very rapid rise in river levels gave very little time for the available information to be assimilated and a true appreciation of the severity of the flood to be gained. The river levels in both Uckfield and Lewes passed through all of the four alarm levels which normally initiate 'monitoring', *Flood Watch, Flood Warning* and *Severe Flood Warnings*, within about 4 hours.
- The 12th October 2000 flood event was, in flood forecasting terms, unprecedented. Only one other flood event (ie the 3rd November 1960 flood) in living memory has even approached it in terms of severity, and that was 40 years ago - probably well outside the personal experience of any current member of Environment Agency staff, and long before current flood forecasting systems were developed.

E.6.5 Secondly there appears to have been a gap in practical terms between the issue of flood warnings by the Environment Agency, and more widespread public awareness and appreciation of the flood risk. We believe that there are a number of underlying issues that need resolving:

- The Environment Agency's principal tool for issuing flood warnings to local residents is its Automated Voice Messaging (AVM) Service. Public registration with AVM is stubbornly low, despite the Environment Agency's regular efforts to increase it.
- Whilst AVM flood warnings appear to have been successfully received by the Local Authorities and Emergency Services, there are numerous practical reasons (outside of the Environment Agency's control) why they may not have been received by a significant minority of registered residents.
- Although *Flood Warnings* remain valid until an *All Clear* is issued, we believe that many residents may have understandably assumed that the *Flood Warnings* issued on the 9th October ceased to be valid when river levels subsequently dropped on the 10th October. The re-issued *Flood Warnings*, and *Severe Flood Warnings* of the 12th October gave very little, if any, lead time due to the rapid response of the catchment to the rainfall.

- We also believe that there is a gap between the expectations of many local residents, in terms of the lead-time, detail and accuracy of flood warnings demanded, and the ability of the Environment Agency to meet those expectations.

E.7 Conclusions and Recommendations

E.7.1 Having studied the event in some detail, we believe that the 12th October 2000 flood in the River Ouse catchment was the result of an extreme natural event, which was neither caused by, nor could have been prevented by any individual, organisation or action.

E.7.2 We believe that the devastating effect of the flood was principally a function of:

- the characteristics and severity of this natural rainfall event
- the natural characteristics of the catchment itself
- the widespread development, over many years, of the natural floodplain

E.7.3 It is an obvious point, but maybe worth stating, that the 12th October 2000 flood inundated the floodplain - so named for a good reason. The devastating impact of the flood was because large numbers of properties have over the years been built on the floodplain, and although artificial flood defences or river improvement works have protected those properties from more frequent flooding events, all property constructed on the flood plain is at risk of flooding occasionally. The Environment Agency's Flood Warning slogan of "You cannot prevent flooding, you can only prepare for it" is unfortunately true.

E.7.4 The evidence suggests that the 12th October 2000 flood was at least a 1:150 year event in Uckfield and probably a 1:200 year event in Lewes. It is worth noting also that since widespread floodplain development began some 150-175 years ago, there have probably only been about three or four events of anything like the severity of the 12th October 2000 flood, and there have been significant river improvement and flood defence works constructed in the meantime.

E.7.5 The existing flood defences were overwhelmed by the 12th October 2000 flood flows, and it may be possible to justify future improvements to raise the current standards of defence to protect against an event of similar magnitude. A number of options are likely to be considered in the forthcoming Catchment Strategy Plan being commissioned by the Environment Agency. However, given the extreme severity of 12th October 2000 event, and the nature of the long-standing government rules and arrangements for project appraisal and flood defence funding, we do not believe that it is reasonable to assume that they should already have been of such a standard.

E.7.6 Nevertheless we believe that there are a number of important issues relating to the existing flood defences in Lewes which need to be urgently addressed, in particular the apparently poor condition of many of the river walls through the town, and the long term settlement in the upstream flood embankments. The floodwalls were breached or damaged in at least 8 locations through the town, and the sudden failure of the river wall at Phoenix Industrial Estate is particularly worrying.

E.7.7 The flooding took many residents by surprise, and it is clear that the Environment Agency and a significant number of affected residents have very different perceptions about the performance of the flood warning system. This is partly an issue of communication and education. We believe that it is important that the Environment Agency vigorously continues its efforts to educate local residents, and that it is explicit about its actual responsibilities and capabilities.

E.7.8 With the benefit of hindsight, we also believe that a number of important improvements in the flood warning and forecasting service can be identified, and should be undertaken. These would not have had any impact on the extent, speed or depth of the actual flooding, but they may have meant that for many, vehicles, stock, or precious personal possessions might have been saved.

E.7.9 The ability of the Environment Agency to make improvements in its flood forecasting and warning capabilities, or in the flood defences, is constrained by the funding that it receives. The construction of any future improvement schemes will require full economic justification and the support of both the local Flood Defence Committee and MAFF.

E.7.10 The recommendations we have made in the Flood Report, summarised below, do not attempt to solve the flooding problems in the Ouse catchment. We believe however that these are the minimum steps that the Environment Agency should take to maintain the current standard of flood defence in a safe and effective condition, whilst improving flood forecasting and warning in the light of lessons learned from the 12th October flood.

E.7.11 We recommend that the Environment Agency:

1. Undertakes a detailed review of flood forecasting/warning over the period 9th-12th October to ensure any possible lessons are learned.
2. Measures or calculates high flows at key locations such as Buxted, Uckfield, Isfield, Gold Bridge, Barcombe, and Lewes.
3. Replaces and upgrades the key existing level recorders damaged or lost in the flood.
4. Undertakes a topographic survey of:
(a) the flood defences and river banks in Lewes and Uckfield,
(b) the remote, secondary defences in Lewes, and
(c) property thresholds across the catchment.
5. Incorporates the results of the topographic surveys into the flood forecasting and warning manuals.
6. Reviews flood warning trigger levels for low lying properties.
7. Addresses the practical problem of maintaining public awareness of flood warnings over a long period, particularly when river level fluctuate.
8. Considers alternative means of warning local residents of imminent flooding in addition to AVM.
9. Installs telemetry on the Winterbourne Stream's culvert weed screens
10. Fills in low spots in the Lewes embankments (short term) and raises the settled embankments back to their design levels (medium term)
11. Carries out a detailed condition survey and structural review of the river walls in Lewes
12. Ensures that the issues raised by local residents are investigated:
(a) abandoned culvert under South Street,
(b) seepage beneath the wall at end of Timberyard Lane, also check wall level,
(c) inadequate stoplogs on the old slipway by Island Cottage, Lewes,
(d) inoperable drainage flap valves.
13. Improves post flood drainage in Lewes, by:
(a) Installing Malling Drain Pumping Station controls above flood level,
(b) Including additional pumping stations/flood gates/etc in any future improvement schemes.
14. Reviews the information and comments in the Post Flood Questionnaires, and continues open communication with local residents.

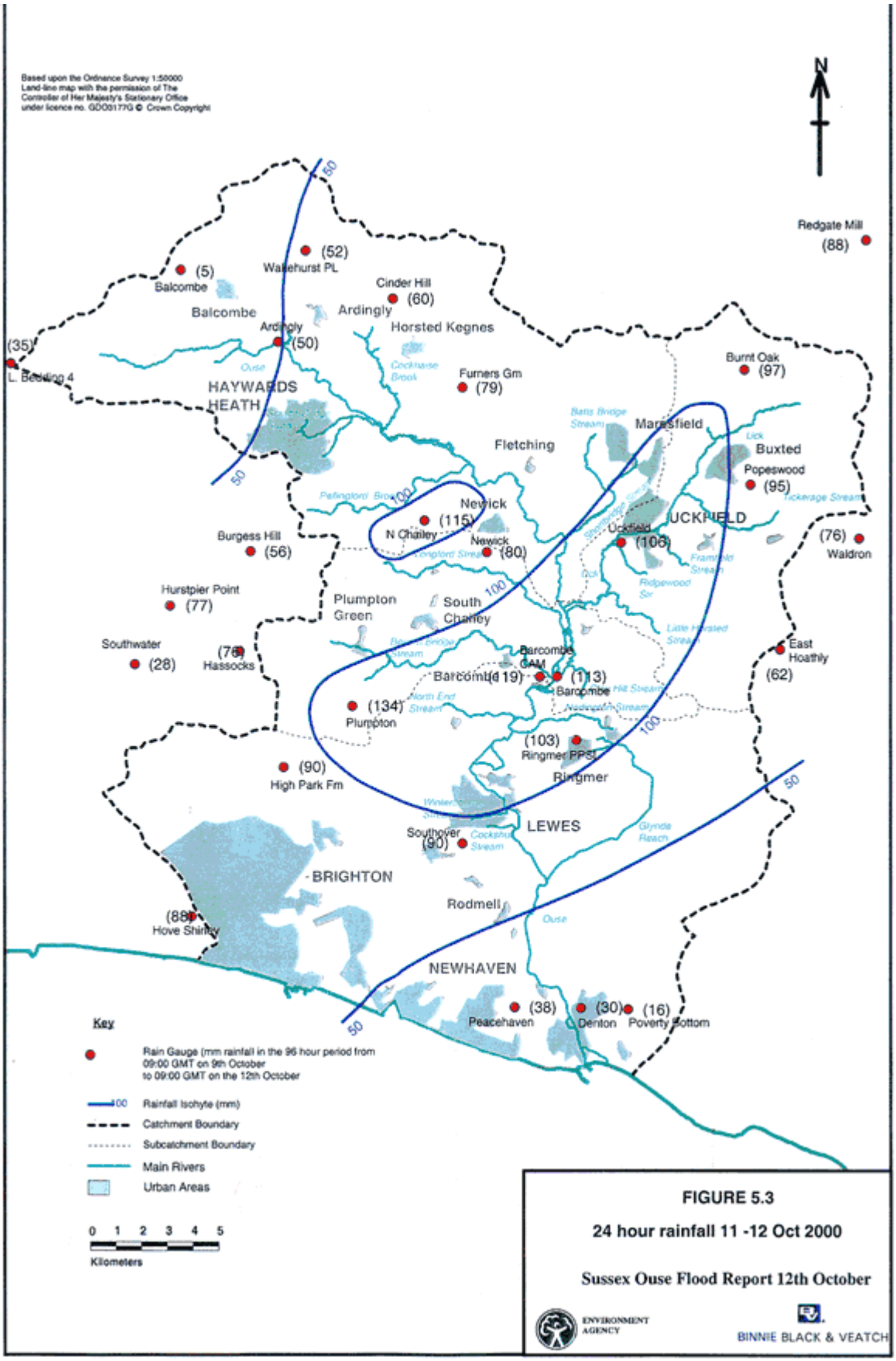


FIGURE 5.3

24 hour rainfall 11 -12 Oct 2000

Sussex Ouse Flood Report 12th October

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Figure 5.4
4 day Level Hydrograph with Hourly Rainfall (9th-13th October 2000)
RIVER UCK AT ISFIELD WEIR

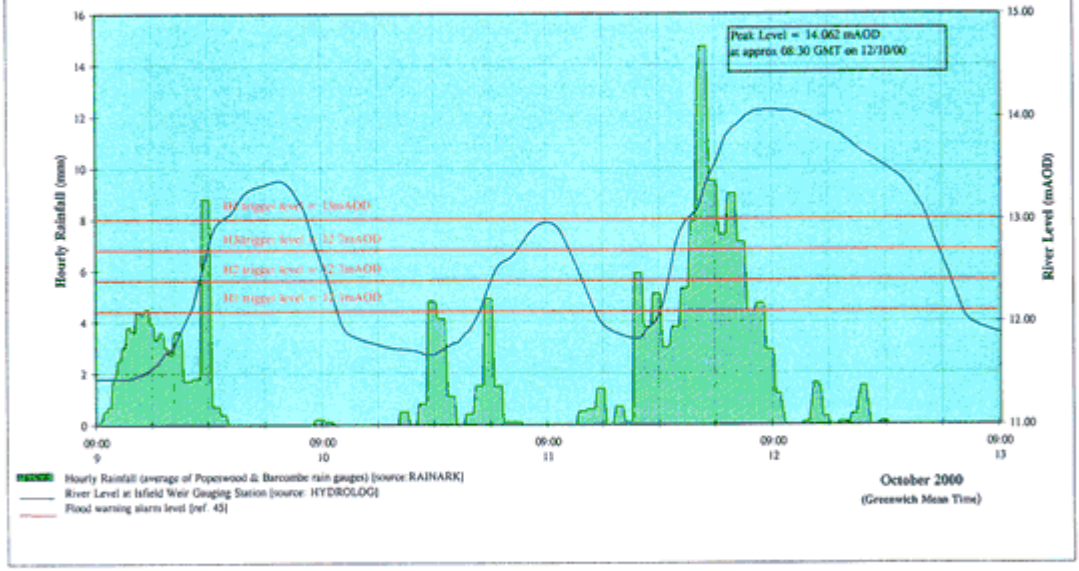
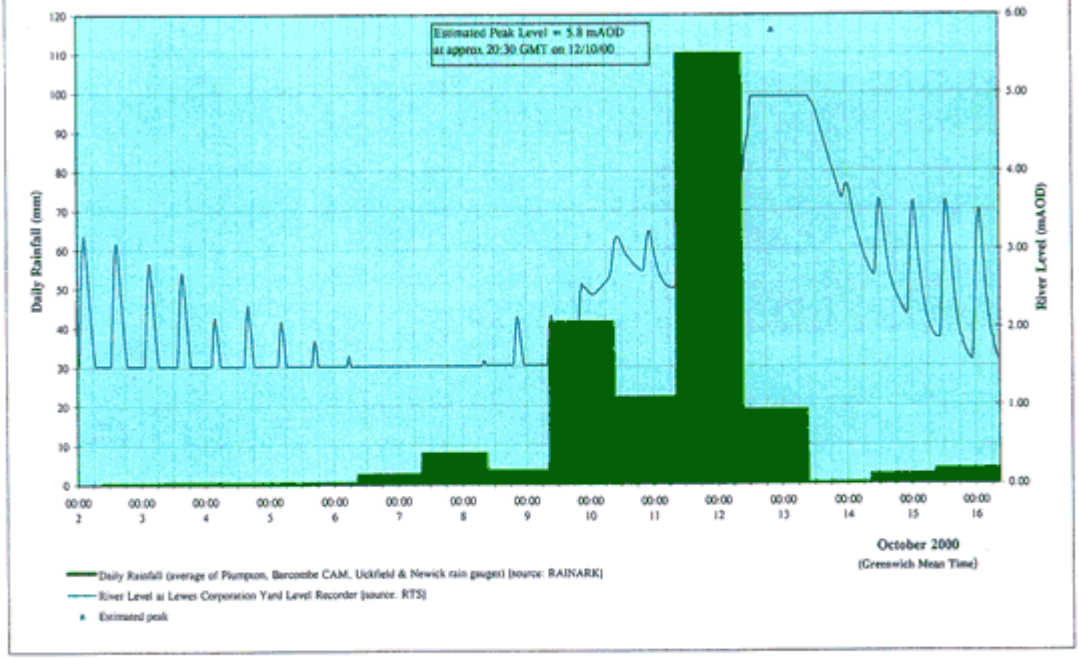
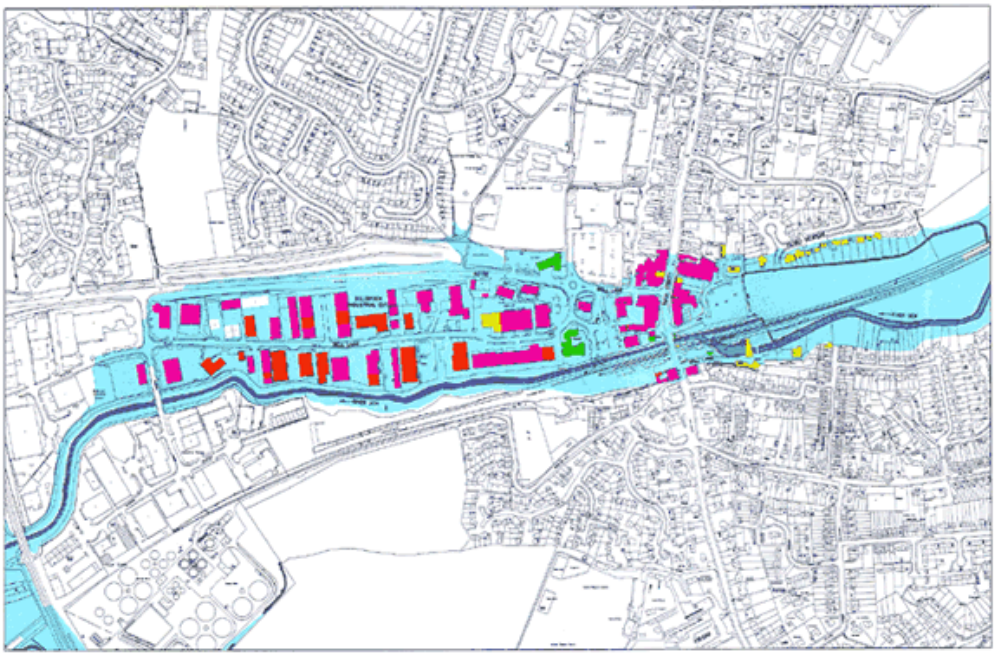


Figure 5.6
15 day Level Hydrograph with Daily Rainfall (2nd to 16th October 2000)
RIVER OUSE AT LEWES





KEY

Flood envelope 12 October 2000

Flooded Properties

Residential

Office

Manufacturing

Retail

Public

Symonds

NOTES

1. Based upon the Ordnance Survey 1:1250 Land-line map with the permission of The Controller of Her Majesty's Stationery Office, under copyright licence no. 600971170 © Crown Copyright
2. The flood envelope shown on this drawing was produced by Symonds Group Limited from a combination of direct observations and photographs. It represents peak flow conditions at about 9am on 12th October 2000
3. This map is for illustrative purposes only. It has been produced to indicate the perceived general extent of the flooding to allow investigations to be undertaken in an attempt to minimise the risk of future flooding on such a scale. It is not definitive as to whether a particular property was or was not flooded and should not be relied upon for that purpose

SCALE 1 : 5000

m 100 0 100 200 m

FIGURE No. 6.1

A3 VERSION OF FLOOD MAP 3
UCKFIELD

Sussex Ouse 12th October 2000 Flood Report

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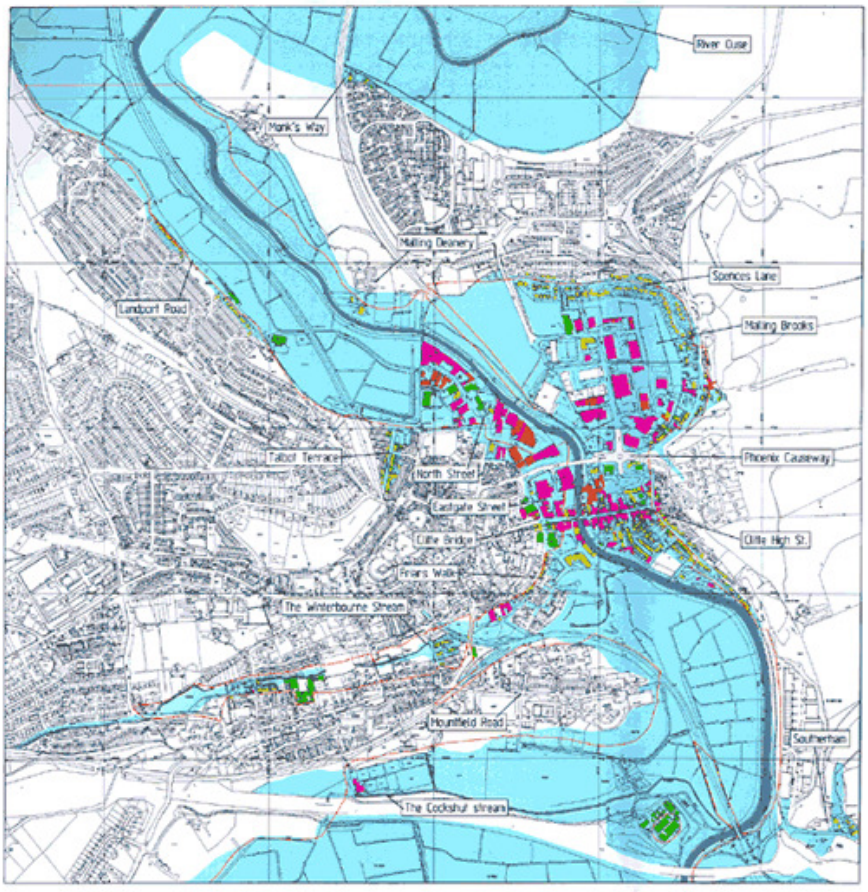

NOTES

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2. The flood envelope shown on this drawing was produced by Lewes District Council from a combination of direct observations, information received from members of the public and photographs. It represents peak flow conditions
3. This map is for illustrative purposes only. It has been produced to indicate the perceived general extent of the flooding to allow investigations to be undertaken in an attempt to minimise the risk of future flooding on such a scale. It is not definitive as to whether a particular property was or was not flooded and should not be relied upon for that purpose

KEY

Flood envelope 12 October 2000

Flooded Properties

Residential

Office

Manufacturing

Retail

Public

Flood envelope 3 November 1960

SCALE 1 : 10000

m 100 0 5000 m

FIGURE No. 6.4

A3 VERSION OF FLOOD MAP 4
LEWES

Sussex Ouse 12th October 2000 Flood Report

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