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# Reducing the impacts of flooding – extemporary measures



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Food & Rural Affairs

Association of British Insurers

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## Reducing the impacts of flooding – extemporary measures

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*Construction Industry Research and Information Association*

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RP619

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# Summary

The report details the findings of CIRIA Research Project 619 “Reducing the impacts of flooding – extemporary measures”. The study objective was to provide practice guidance on measures that may be applied to property, using readily available materials, to reduce the costs and other impacts associated with flooding. As part of the study a literature search of flood, flood damage and property publications, principally using databases and websites, has been undertaken to identify relevant information. A survey of occupants of flooded property has also been carried out to develop additional information on the effects of flooding and identify any extemporary measures taken and their success

The literature review has revealed a considerable quantity of information, from both UK and overseas, in the form of technical and guidance literature and in publicly accessible information on websites. This has been reviewed by the project team and information appropriate to UK issues is highlighted in this report. The literature discusses issues related to the dangers of floods, including personal safety, and examines how to limit damage to property. Information sources identified include governments, government agencies, disaster relief organisations, commercial and community bodies, weather and environmental organisations. The roles of the information sources identified in relation to flooding, extemporary measures and the information they provide are discussed.

Details of relevant extemporary measures identified during the review and consultation are provided, along with post-flood actions that can be taken to repair buildings. These have been summarised in leaflet form, available from the Environment Agency’s Floodline and on a website ([www.ciria.org/flooding](http://www.ciria.org/flooding)). Although some of the information is of a technical nature, much of the publicly available information is designed to be easy to follow and to enable people to prepare for flood events. The sources of information were varied, however, much of the publicly available information is similar in content as it has a similar aim; to limit loss of life and damage to property.

The study has confirmed that extemporary measures have the potential to reduce the impacts of flooding. However, the success of these measures will depend on the time available to take action and, in the case of buildings, or whether they could be protected from sources of ingress over which extemporary measures had no effect.

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# Abbreviations

EA	UK Environment Agency
EU	European Union
FEMA	United States Federal Emergency Management Agency
Pers comm	personal communication
QUANGO	quasi-autonomous non-governmental organisation
OFWAT	the UK water regulator



# 1 Introduction

## 1.1 BACKGROUND

Many buildings are threatened by flooding resulting from the overtopping of river or coastal flood defences or the backing up through sewers or other underground services. The risk of flooding is likely to increase with climate change (more extreme events) and the increasing need for more dwellings and industrial properties. Many existing developments are situated in flood plains and further development in these areas along with the re-development of waterside and flood plain locations could increase the risks and impacts of flooding. Property owners or occupiers may take measures to reduce the effects and costs (by minimising damage and/or speeding up property repair) of flooding. These practices may then help to speed up the re-occupation of property following a flood and help to reduce the impacts to health that may be associated with a flood.

A recent report *Inland flooding risk – issues facing the insurance industry* (Association of British Insurers, 2000) highlights some of the impacts and challenges resulting from flooding. The report estimates that between 950 000 and 1 200 000 properties are at risk within the inland floodplain (some 4% of the total property stock) with most of the “at risk” property lying within the catchments of the rivers Thames and Trent. Between 1989 and 1998, the average level of weather related insurance claims was £710 million per year and it is thought that the flood component of this figure is typically between £50 million and £120 million per year. Although deaths due to flooding in the UK are relatively uncommon, the risks should not be dismissed. For example, the Easter 1998 floods resulted in five deaths directly attributable to the floods.

This study forms part of a linked series of research initiatives led by DEFRA/Environment Agency in collaboration with other organisations that includes the following studies:

- improving the flood resistance of domestic and small business properties (this includes two studies, one developing guidance on the flood resistant construction of properties and a second identifying performance standards for proprietary flood defence products)
- temporary and demountable flood defences (covering flood defence systems that may be used to protect a group of properties).

## 1.2 REPORT AND OBJECTIVES

This report provides details of a study carried out to identify techniques that may be used to reduce the impacts of flooding using readily available materials and skills. In addition to this report, summary guidance has been provided for dissemination to the public via the Environment Agency and via a website on the *Repair and restoration of buildings following floods* ([www.ciria.org.uk/flooding](http://www.ciria.org.uk/flooding)). The summary guidance has been published by the Environment Agency as two booklets *Damage limitation – how to make your home flood resistant*, and *After a flood – how to restore your home*. These are available from the Environment Agency’s *Floodline* (Tel: 0845 988 1188).

The objectives of this study were to:

- provide practical guidance on extemporary measures that may be applied to existing property to minimise the impact of flooding
- directly engage those at risk from flooding in the protection of their assets (through consultation and the development of easy-to-follow guidance on extemporary measures), implemented through the provision of summary guidance
- reduce the social impact and health risks of flooding events
- reduce the costs of flooding through proactive measures
- provide regulators, insurers and the construction industry with a proactive approach to the minimisation of flood impacts and, thereby, improve relationships between the stakeholders.

## 1.3

### SCOPE AND APPROACH

This study has considered the key impacts on buildings through a literature review, consultation with those affected by flooding, and the examination of case studies. The main routes of floodwater ingress into buildings have been determined and possible extemporary solutions identified. The study also examines possible materials available in and around a building and how they might be utilised. It considers what measures should be a priority and what may be safely and realistically applied within the likely time available. As part of this review, factors such as likely flood height and duration, along with peoples' physical capabilities have also been addressed.

The project has drawn on worldwide experience to identify techniques that can be applied and courses of action property owners may take. This information is drawn together in the discussion of measures that may be taken to reduce flood damage in existing properties in the UK. The guidance also covers any particular requirements for flooding from salt water.

As outlined in Section 1.2, summary guidance on the practical steps that can be taken to reduce the impacts of floods has been produced for publication by the Environment Agency. These are being distributed by the Agency as two booklets. It is also recommended that the information is followed up in the event of a flood to refine and add to the advice.

## 2 Literature review and consultation

### 2.1 INTRODUCTION

A literature review was carried out to identify published information (from both the web and publications databases) covering two main areas:

- the effects of flooding on buildings, flood related building damage and building regulations associated with and resulting from flooding, and related human issues
- extemporary measures, that is the immediate problems of coping with an imminent flood and how to take precautionary action to limit flood damage to a home, including warning systems, disaster kits, emergency evacuation and procedure on drying-out a home after a flood.

In addition to the literature review a consultation exercise was carried out to develop information on the experiences of victims of flooding, to highlight flood-related issues and, where possible, identify any extemporary measures taken and their success.

### 2.2 LITERATURE REVIEW

The initial literature search was conducted via an Internet search of relevant databases, building and construction organisations and worldwide government and government-related organisations associated with the environment in general and flooding in particular. Typical examples were the Flood Hazard Research Centre at Middlesex University and the United States Federal Emergency Management Agency (FEMA). General internet searches were carried out using standard search engines such as Yahoo Environment & Nature. Many Internet sites were accessed via “link” connections highlighted on environmental, government and weather related sites. This method of search produced further worldwide environmental, weather and government/official sites and also gave access to numerous non-government and local sites detailing localised flooding and personal accounts.

The initial search key words were “flood”, “flooding” and “flood damage”. Such terms often produced a prohibitively large number of responses. The search field was, therefore, narrowed by the inclusion of terms such as “building” and “prevention”. The information obtained from the literature review has been collated into a database, held by CIRIA, to allow queries on specific topics and further categorisation.

#### 2.2.1 Literature types

The literature resulting from the database and the Internet searches fell into seven broad categories.

1. Building, construction and technical information.
2. Government publications detailing planning regulations and flood prevention measures.
3. Medical information, including the physical and emotional/psychological effects resulting from flooding.

4. Research information into the causes and effects of floods and associated damage, including flood mitigation, and flood preparedness.
5. Financial information, including insurance costs.
6. Disaster relief.
7. Public information, detailing general information regarding floods, what to do in a flood, and procedures for limiting flood damage to a home.

Whilst it could be expected that specific databases or websites would tend to produce information relative to their subject area, flooding and the effects of flooding cover such a large area of human experience and endeavour that the results obtained are anything but clear-cut. This is particularly true in the areas of public information, research and disaster relief, where organisations draw information from a wide variety of sources and disseminate it accordingly.

## **2.2.2 Information available**

A wide range of information was identified during the review, some of which is not directly relevant to the use of extemporary measures but is relevant to flooding in general. A brief overview of the available information and its relevance to extemporary measures is provided below. The more directly relevant information on the use of extemporary measures is covered in Chapter 4.

### **Literature databases**

The search of literature databases highlights the extensive amount of literature published that relates to flooding. A keyword search using the terms “flood”, “flood damage” and “flooding” resulted in at least 20 000 hits, although not all these are directly relevant to the project area. Also, some databases do not identify the total number of ‘hits’ and limit the number available for review, as well as detailing documents found on other databases. However, this figure provides a good indication of the number of documents located. As outlined in Section 2.2 the initial search fields were narrowed down to identify the publications most directly relevant to this study. These were then incorporated into the literature database.

### **Websites**

The quantity and type of information obtained depended greatly on the targeted website and its purpose. Websites detailing information designed to promote public safety and health and research were generally accessible and provided the majority of the readily available information. This was also true of government-associated organisations (quangos) and organisations independent from Government. However, not all websites visited were useful. Attempts to obtain web-based information from UK and overseas government departments responsible for policy regarding flood extemporary measures proved difficult.

Many of the websites visited included links to other sites, the most common links being with other flood related or environmental web sites and research institutions. As many of these websites detailed public information and advice, they frequently referred to the same documents or website. In particular, FEMA is cited as a source of information by many worldwide flood-related organisations.

## **Building, construction and technical material**

This section of the literature search focused on the existing guidance and technical information available in the UK and worldwide that looks at ways of minimising the impact of flooding on buildings. Initially, the search was carried out using construction-based databases focusing on journal articles and books.

Although the review has highlighted a large number of publications related to flooding, the available literature focusing directly on extemporary measures taken to reduce the impact of flooding to property is limited. That which is available is mainly in the form of public information leaflets that are available from organisations such as the Environment Agency, which has produced a number of leaflets including *Flood warning information: what to do if your property is at risk*. These are reviewed below.

The literature search identified various flood-related issues and research being undertaken in developing countries. This includes, for example, information on methods of living with floods, in areas such as Bangladesh (Schmuck-Widmann, 1996). However, most of this information has limited relevance to the UK because of the difference in culture and building technologies.

The review indicated that most relevant literature dealt with the remedial measures to be taken after floods. The Building Research Establishment has carried out research into the repair and renovation of flood-damaged buildings and produced a number “*good repair guides*” (BRE, 1973-1997). This guidance has now been incorporated into the CIRIA website on the *repair and restoration of buildings following a flood* (<http://www.ciria.org/flooding>). BRE has also provided design guidance on flood damage to buildings for The Scottish Office and Building Control Group (BRE, 1996). In the design guides, BRE suggests that there are two basic approaches to the design and specification of buildings in flood risk areas. The first is to accept a level of flooding in the property and choose materials that may be damaged but would be easy to replace. The second method is to aim to build a flood resistant structure. Two recent draft British Standards detail anti-flooding devices under development and their performance requirements. Such information is more relevant to new buildings or retrofitting existing buildings but, nonetheless, applied in conjunction with extemporary measures, may well limit flood damage to property (BSI, 1999a & b).

A CIRIA report on the prevention of flooding from sewers details numerous methods available to prevent sewage entering a property, including check valves, flap gates, pumped and vacuum sewage systems (May *et al*, 1998). However, the report is more concerned with the sewer system itself rather than dwellings and the measures detailed are more appropriate to retrofitting rather than extemporary measures.

A number of articles from American sources also investigate the retrofitting of property after flood damage. This includes articles on flood retrofit of coastal residential structures in North Carolina (Work *et al*. 1999), and flood proofing in Watertown, Minnesota (NTIS, 1986). The research carried out in Watertown presents some conceptual solutions to the flood proofing problems of structures. Other works include an information bulletin from The Building Research Association of New Zealand “*Restoring a house after flood damage*” (BRENZ, 1984). A comparatively small number of publications and websites do, however, detail action home-owners can take to minimise the impacts of floods to their homes – in both passive and active measures. The literature search has not identified many European texts regarding post flood retrofitting of property or in extemporary measures.

Several texts identify a problem with mould following a flood, and an article entitled *Mould contamination in flooded homes* (Pearce *et al*, 1995) looks at the results of monitoring six flooded homes in Marshall, Minnesota, including periodic measurement of indoor mould spore levels. The report suggested that more effective decontamination procedures may be needed to prevent subsequent mould problems in flood-damaged homes.

### **Government publications and information**

Many governments disseminate flood-related information via technically independent organisations such as FEMA, Emergency Preparedness Canada and the UK Environment Agency, or via ministerial departments, such as the New Zealand Ministry of Civil Defence. Information made available in this way is, for the purposes of this project, considered public information, as it is made freely available to aid the general population in times of need and is discussed later.

The literature search has indicated that it is difficult to obtain information regarding official government policy relating to flooding. Although proposals to conduct flood alleviation measures, such as river engineering, are comparatively simple to locate, information available from government sources relative to housing and floods seems to be limited to the planning and building of new structures. The Singapore Ministry of the Environment Drainage Department, for example, provides information regarding the prevention of flooding of the underground Rapid Transit System and levels of development platforms for new structures, but provides little general public information, even though the website included photographs of flooded residential areas (SMEDD, Undated). Similarly, accessing the UK Department of the Environment, Food and Rural Affairs (DEFRA) ([www.defra.gov.uk](http://www.defra.gov.uk)) and the Department of Transport Local Government and the Regions (DTLR) websites provides limited information on extemporary measures for existing developments ([www.dtlr.gov.uk](http://www.dtlr.gov.uk)). The sites do, however, provide policy-level and research information on flooding, Planning Policy Guidance notes and press releases regarding new developments. An exception was a UK Home Office fact sheet detailing public warning systems, including the use of sirens and the Environment Agency's use of an automatic telephone system, to alert the public in areas of flood risk (HO, 2000). Many Dutch cities disseminate general flood information via websites, and the Fire Department at Nijmegen has compiled a total disaster plan in case of flooding. The plan details the co-ordination of officials and authorities dealing with a disaster (P Ford, 2000).

UK county councils in areas of flood risk generally offer contact telephone numbers and addresses enabling the public to access flood information. It is also known that areas such as Calderdale have produced flood awareness information as a result of a recent flood, advising the public as to what action to take, but the literature search was unsuccessful in accessing this information. After floods in 1998, Warwick District Council offered an advice surgery for flood victims dealing with topics such as loss adjusters, insurance, repair work and damp penetration (WDC, 1998). In many instances, the advice offered by local councils seems to be limited to contacting the Environment Agency.

This lack of information from government and local government sources may, in part, be due to the way governments disseminate information, either through relevant ministries or via agencies such as the Environment Agency and FEMA. As this appears to vary from country to country, it may explain the lack of flood extemporary information available from direct government sources.

A similar lack of information was apparent from a search of the European Union (EU) website. However, this is not to say that flooding is not considered important by such organisations. The literature search revealed numerous EU flood-related projects. In particular, the Directorate General XIII initiated workshops to study the problems and risks of flooding. Known as RIPRIUS (Risk of Inundation – Planning and Response Interactive User System), the project is concerned with flood risk in non-tidal river reaches and aims to identify a generic, pan-European method of flood risk assessment. Objectives of the project include contributing to sustainable development, providing increased and accurate environmental information to concerned parties and encouraging the flow of information between such parties in an easily accessible form. The project is also designed to contribute to integrated environmental emergency management systems and complement local and regional environmental management support systems (RIPRIUS, Undated).

The literature search also revealed that the EU, through the Council of Europe, has an agreement with numerous EU and non-EU countries (known as the EUR-OPA Major Hazards Agreement), in which member states combine resources to research major hazards including floods. Specialised centres have been set up to provide research and training programs into major hazards. Of relevance to the project are the Associated European Centre for Flood, in Kishinev, Moldova; the European Centre on Training and Information of Local and Regional Authorities & Population in the Field of Natural and Technological Disasters, in Baku, Azerbaijan, and the Higher Institute of Emergency Planning, in Archennes, Belgium. It is unknown what kind of information is available from these organisations as, at the time of the literature search, the websites appeared to be under construction (EUR-OPA, 2000).

### **Medical information**

Much of the medical information revealed by the literature search was concerned with the emotional and psychological effects suffered as a result of a flood. It was less concerned with physical injuries. Regular topics identified included stress and trauma suffered by flood victims and the feeling of loss resulting from the destruction of items with a sentimental value. Numerous articles referred to surveys carried out to assess peoples' feelings and the long-term psychological effects of floods, some surveys making a comparison with other types of disaster. The Flood Hazards Research Centre at Middlesex University conducted research into the health effects of floods with reference to floods at Kidlington and Banbury in 1998 (FHRC, 2000), whilst the Disaster Mental Health Institute at the University of South Dakota promotes research into disaster related mental health. The Institute also offers training to professionals and international organisations, and publishes documents and advice related to the effects on mental health resulting from disasters such as floods (DMHI, 2000).

As this project is more concerned with extemporary measures and less concerned with the emotional and psychological effects of a flood, only a limited number of medical based articles were entered into the bibliography. However, the literature search revealed many articles of a medical/psychological nature and a search of relevant medical databases and journals would increase the quantity of literature already located.

### **Research information**

Much of the research information revealed by the literature search is concerned with flood prevention and alleviation and with developing technologies that enable the early detection and, therefore, warning of floods. A high proportion of this research is conducted by universities in conjunction with other education centres, government

organisations and emergency management organisations – a UK example being the Flood Hazard Research Centre at Middlesex University (FHRC, Undated). Whilst much of the information found is of a technical nature and less concerned with extemporary measures, some research centres do detail actions a householder can take to limit flood damage. Of note is the North Dakota State University Extension Service (NDSUES, Undated). Although a complete search of individual university databases and libraries has not been conducted, it is assumed that those universities conducting flood related research will have numerous texts concerning floods and flooding at their disposal.

In conjunction with the cross-discipline nature of flood research, the majority of websites visited contain internet links with other research organisations and environmental and emergency management organisations. A vast quantity of information is made available to the public from these links, much of which deals specifically with limiting flood damage to property and what to do when a flood is imminent. In particular, organisations and individuals that are connected to the “ALERT” User Group website of American flood warning systems (ALERT being an acronym for Automated Local Evaluation in Real Time) and the American based Extension Disaster Education Network have access to up-to-date, concise and clear information on procedures to take regarding flooding and flood extemporary measures. Much of this information is designed for general public use and is discussed below (ALERT, Undated; EDEN, Undated).

### **Financial and insurance information**

Information on the financial and insurance issues arising from flooding can provide a useful insight into the effects of flooding and how floods cause damage. It must, however, be remembered that factors such as claim fraud, costs of builders, etc. can lead to variations in the levels of claims, so care must be taken in interpreting the information. As part of this study, information held on the National Flood Insurance Claims Database, held at the University of Dundee, has been reviewed and is summarised in Chapter 3. This database includes information from 27 major insurers and includes details from several thousand claims from all major flood events from Perth in 1993 to the Midlands in 1998. Outputs from the database are provided in anonymous form only, and financial information is based on claim values rather than total costs, but the information is still extremely useful in assessing the effects of floods.

The literature search revealed a number of documents relating to the insurance cost of flood damage. The majority seemed to be exclusively concerned with the financial, business and commercial aspect of insurance and re-insurance, and less so with public perception or opinion of insurance companies in relation to flood damage claims.

Many of the insurance and financial documents located were related to the recent spate of natural disasters that have resulted in many millions of pounds in insurance claims. Warwick District Council offered advice to the public regarding delayed payment of claims after floods during 1998 (WDC, 1998), but this type of document was found to be the exception rather than the rule during the literature search. The Association of British Insurers, in response to the 1998 Warwickshire floods, has been working with the Environment Agency and Warwickshire Trading Standards to establish greater co-ordination in flood management and defence. The website of the Association of British Insurers details a news release that provides some information on limiting flood damage to property and belongings. Advice offered includes moving items and belongings upstairs when a flood alert is given including: food, drinking water, clothes, a radio and a torch, keeping important telephone numbers and documents safe and to hand, and not using gas, electricity or water until the all clear is given. Further advice is given about



repairing flood damage, including a suggestion to contact the relevant insurance company who can advise on procedure to prevent flood damage becoming worse (ABI, 1999).

With some countries' household insurance policies not covering flood damage as a standard clause, many of the websites detailing public information offered advice on obtaining the correct type of insurance and the benefits of so doing. In particular, the American National Flood Insurance Program, via FEMA, is regularly contained within the internet links on American flood-related websites (FEMA, 2000). The Canada Mortgage & Housing Corporation website details considerable information of a public nature regarding personal safety and procedures to limit household flood damage, but would appear to be unusual amongst the financial and insurance organisations searched (the American National Flood Insurance Program and the Association of British Insurers excepted (CMHC, 2000)).

Some of the research institutions conducted research into flooding for the purposes of providing information to the insurance industry. The Natural Hazards Research Centre, Macquarie University, Sydney, Australia, aims to conduct strategic research and offers training programs into hazards, such as floods, and produces information it hopes will be indispensable to the insurance industry and other collaborators. A search of its database revealed numerous flood and insurance related documents (NHRC, 2000). Swiss Re, a global risk and capital management company with interests in the insurance market, publishes a journal, *Sigma*, which provides analysis of the re-insurance markets, including discussion of natural hazards such as floods and the financial implications of such disasters. Accessing the Swiss Re database revealed numerous articles referring to floods and insurance, the majority of which seemed to be business related rather than discussing flood extemporary measures or offering advice. (SR, 2000).

### **Disaster relief**

The information provided by the disaster relief organisations investigated is mainly concerned with the immediate aftermath of numerous types of disaster. Much of their work is in Developing Countries and is, therefore, less applicable to the UK. However, the databases and libraries of disaster organisations, such as the International Red Cross, contain numerous flood-related publications covering topics such as disaster preparedness, the non-monitory impacts of flooding and erosion hazards. The International Red Cross is developing a policy of disaster mitigation and preparedness in an attempt to minimise loss of life and damage to property (IRC, 2000). Such information may well be applicable to some UK situations.

Many American-based disaster organisations, such as the American Red Cross, Disaster Resources at the University of Illinois, and the Extension Disaster Education Network, provide access to comprehensive and easy to understand information on disaster preparedness and mitigation and provide links to similar websites, including the FEMA website. The aim of many such organisations is to reduce the impact of disasters by co-ordinated, multidisciplinary research and education. This co-ordination is achieved not only by producing fact sheets but also by allowing access to shared databases of disaster related resources (DRUI, 2000; EDEN, 2000; ARC, 2000).

### **Public information**

While much of the information obtained via the search was of a technical and governmental nature, a considerable portion of the information sourced from websites is pertinent to the general public in that it details flood warning systems and procedures to be employed before, during and after floods. The information offered is vast and covers

many aspects of modern life, although often tailored to the country of origin. Too numerous to detail fully, readily accessible information includes: personal safety, action to take whilst driving in floods, measures to take to limit property damage before and after flooding, advice regarding children, disaster kits, sewer traps, insurance programs, and potential chemical, biological and physical hazards etc. Some websites provide specific details on flood related topics, examples being blocking drains, repairs to walls, checking appliances, making insurance claims; financial difficulties etc. There is even consumer advice available on avoiding flood related scams (FMA, 2000; FEMA, 2000; NDSUES, 2000; WEMO, 2000; NZCD; 2000). Much of the more detailed information is to be found on American based websites, such as the websites of the Floodplain Management Association and the North Dakota State University Extension Service. However, as websites tend to be linked, the information is accessible the world over and much of the information available on different websites in different countries is similar in content.

The literature search indicated that the method of disseminating the information varied from country to country. In the Netherlands, the Interior Ministry and the Fire Department, in a general awareness campaign, have issued instructions as to what action to take in floods. Perhaps due to the low-lying nature of much of the country and the possible rapid inundation by seawater, a quick response to warning sirens and evacuation preparations are primary considerations, with the protection of property being less important, in the information so far obtained (P Ford, 2000). Much of the information available in America is provided by agencies such as FEMA, research institutions and a nation-wide network of weather and flood warning organisations, whilst countries such as New Zealand and Canada use government and government-related departments: respectively, the New Zealand Ministry of Civil Defence and Emergency Preparedness Canada (NZCD, 2000; EPC, 2000). Furthermore, many UK government bodies also provide information, including American State governments, Local councils such as Somerset County Council, and in New Zealand, Wellington City Council Emergency Management Office. Depending on the country, river management organisations also provide information, examples being the USA's Floodplain Management Association and the UK's Environment Agency, which provides information through its recently launched "Floodline", including fact sheets, its website and a telephone service (EA, 2000). Although organisations such as the US Environmental Protection Agency also offer limited advice, particularly on post-flood bacterial and micro-biological hazards (EPA, 2000), the Environment Agency seems to be one of the few government-related environmental organisations that offers flood advice to the public, although problems in obtaining information from European environmental agencies make this difficult to confirm. Finally, disaster relief organisations offer flood-related advice. Much of the advice is relative to countries such as Bangladesh, but organisations, such as the American Red Cross, also provide information available worldwide.

Not only is information given on personal safety and the mitigation of flood damage to property, but many websites also give information regarding what causes floods, the speed at which they can occur and the power of flood waters, using simple terms and examples to convey their message. Examples include the effect of increasing water depth on a car's buoyancy and the depth of flowing water in which it is unsafe to walk (NOAA, 2000). A common theme throughout the majority of these websites is that, having evacuated from an area of danger, residents should wait until the emergency services arrive before returning home, and listen to the radio for advice and information.

## 2.3

### CONSULTATION

Some 500 questionnaires have been circulated and a total of 49 have been received and analysed to date. Emerging key themes are described below.

The majority of responses related to flooding incidents in Melton Mowbray (33%), Todmorden (28%) and Hebden Bridge (11%). These areas were selected as they had been flooded within the last five years but were not currently affected by floods and were broadly representative of other areas. As a consequence, the detailed results could be influenced by particular characteristics of these areas, although it is suggested that the general issues identified from the data are representative of those arising elsewhere.

#### 2.3.1

### Background information from respondents

#### Age range of respondents

Only four (20%) respondents answering the questions were over 60, with 10 (50%) covering those aged 40–49 and 50–59. The biggest single category of seven (30%) respondents were aged between 30–39. None of the respondents was under 30.

#### House types

Most respondents (90%) lived in terrace-type properties. No respondents owned a timber framed building although 33% of those who answered did not know if it was timber framed or not.

#### Number of floors

Respondents were asked to give details of the number of floors in their property and a total of 21 responded.

- all respondents had two floors or more
- eight (38%) had three floors
- 11 (52%) had four floors.

(note the above numbers reflect the typical construction types of terraced properties found in the Todmorden/Hebden Bridge areas).

When asked if they had a basement or cellar area, 49 people responded and of these 17 (35%) had a basement or cellar areas.

#### 2.3.2

### Flooding details

#### Source and ingress route of flooding

Respondents were asked to name the source of flooding. Of the 45 responding:

- the majority 43 (88%) reported a river as the cause of the flood.
- only two (12%) responded otherwise; one identified a blocked street drain and the other identified rainfall as the source.

Respondents were asked for details of the ingress routes of the flood water. To facilitate the analysis these routes were grouped into three categories:

- through openings (doors, windows, vents)
- seepage through walls/ground
- through drains.

The total number of responses was 41 and of these:

- 36 (88%) had water coming through openings
- 19 (46%) had water seeping through walls and floors
- 15 (37%) had water coming up through the drains.

The percentage figures above total more than 100% because floodwater commonly entered the property via more than one route.

### **Depth of flooding**

Respondents were asked to estimate how deep the flood was. Most gave a depth above the ground floor level but some used the cellar floor as the datum. This distorted some of the responses. To assist the analysis, the data was grouped into three categories.

- nine (18%) had flooding at a depth over 1.0 m
- 10 (21%) had flooding at a depth between 0.5 m and 1.0 m
- 20 (61%) had flooding at a depth under 0.5 m.

### **Duration of flooding**

The duration of the flood (ie the length of time that floodwater surrounded and remained within the property) varied from four hours to two weeks. The time periods were categorised for convenience:

- 17 (44%) flooding period under 12 hours
- 12 (31%) flooding period 12–24 hours
- 4 (10%) flooding period 24–48 hours
- 3 (8%) flooding period 2–3 days
- 0 (0%) flooding period 4–5 days
- 2 (5%) flooding period 6–7 days
- 1 (2%) flooding period 1–2 weeks.

The majority (75%) of flood events lasted less than 24 hours.

## **2.3.3**

### **Flood damage**

Originally it was planned to evaluate the damage to both the buildings and personal possessions against other important factors, such as the depth and duration of the flood and the level of householder preparations. To make this process easy, respondents were asked to select options from a range of categories. This resulted in the available data being spread thinly across these different choices. As a consequence, it is inappropriate to place too high a degree of confidence on the statistical links between depth, duration and damage to buildings and possessions. Therefore, the tables of responses should be regarded as indicative. Despite this, it has been possible to identify some general conclusions.

## Structural repairs/depth of flooding

The total number of responses received was 26.

**Table 2.1** *Structural repairs and depth of flooding*

Damage to building	Depth of flood			Total for all depths
	Under 0.5 m	0.5 m–1.0 m	Over 1.0 m	
Structural repairs to the walls	1		1	2 (8%)
Repointing of external walls	2	2		4 (16%)
Replacement of timber floors	4		2	6 (23%)
Treatment of timber floors	1		3	4 (16%)
Repairs to Foundations	1	1		2 (8%)
Replastering of internal walls	6	2	3	11 (43%)
Repair of electrical wiring	6	2	3	11 (43%)
Replacement of kitchens	4	3	2	9 (37%)
Number of respondents experiencing damage	17 (66%)	6 (23%)	3 (12%)	

The three most frequent structural repairs after flooding at all depths were:

- replastering works to the internal walls (43%)
- repair of the electrical wiring system (43%)
- replacement of kitchens (37%).

In each category, the proportion of properties requiring repairs increased with flood depth. The responses also indicate that this is the case for the other categories of repair.

## Damage to goods/depth of flooding

The total number of responses received was 32.

**Table 2.2** *Damage to goods and depth of flooding*

Damage to goods	Depth of flood			Total for all depths
	Under 0.5 m	0.5 m–1.0 m	Over 1.0 m	
Electrical goods	10	5	2	17 (53%)
Curtains or fabrics	5	4	1	10 (31%)
Personal items	8	4	2	14 (43%)
Furniture	12	6	2	20 (63%)
Carpets	13	5	1	19 (59%)
Other	5	4	1	10 (31%)
None	2	1		3 (10%)
Number of respondents experiencing damage	20 (63%)	10 (31%)	2 (6%)	

The three most common categories of damage were:

- furniture (63%)
- carpets (59%)
- electrical goods (53%).

Almost one-third of respondents (31%) said they had experienced damage to other types of possessions. These included garden and woodworking tools, lawn mowers, books etc.

In the case of electrical goods and furniture, the incidence of damage appeared to increase significantly at flood depths greater than one metre. This also appeared to be the case for damage to personal items. In the case of curtains or fabrics, flooding at depths of greater than half a metre seemed to cause greater incidence of damage than flooding at less than this depth. However, depth of flooding did not appear to affect damage to carpets.

#### **Damage to building related to duration of flooding**

The relationship between flood duration and types of damage caused was not strong because of the low number of respondents who had experienced flooding for more than 24 hours.

#### **Flood warning**

Of the 49 respondents who had experienced flooding, 12 had received an official flood warning. The average time was 4 hours prior to the event. Of those who had received flood warnings only three (25%) had managed to take measures. However, it was perceived that these measures had a large impact on the effects of flooding.

### **2.3.4 Extemporaneous measures taken**

Of the 49 that were affected by flooding, 30 respondents (61%) did not prepare for the flood. Those who did used a variety of measures, which included:

**Table 2.3** *Measures taken to prevent flooding*

Measures	Number of responses	Percentage of the responses
Towels/sheets around doors	3	16%
Sand bags	6	32%
Inserting door boards	3	16%
Raising furniture	3	16%
Moving furniture upstairs	7	37%
Lifting carpets	1	5%
Other	3	16%

Note: total number of responses 19.

The two most common methods of preparation were:

- using sand bags
- moving furniture upstairs.

Only one respondent lifted the carpets in the building.

These respondents were asked if they thought the measures they took had any effect on the damage.

They had three responses to choose from:

- the measures had little impact on the effects of flooding
- the measures had some but the flood still caused some damage
- it was clear that the measures reduced the level of damage considerably.

**Table 2.4** *Perceived effect of measures taken to prevent flooding*

Measure	Perceived effect of the measure		
	Little	Some	Large
Towels/sheets around doors		1	1
Sandbags	1	2	1
Inserting door boards		1	1
Raising furniture	3		
Moving furniture	3	1	1
Lifting carpets			1
Other	1		1
<i>Total out of 19</i>	8	5	6

The findings indicate that:

- eight (42%) respondents felt the measures had little impact on the effects of flooding
- 11 (58%) respondents felt the measures had at least some impact on the effects of flooding.

The relationship between the respondents' knowledge of flooding, the type of assistance received and the perception of measures was also investigated. The data did not reveal any significant relationship.

#### **Age in relation to preventative measures, assistance given and costs of flood damage**

Only four (20%) of the respondents were over 60. Of these:

- none had carried out any preventive measures
- when asked if they had been given any assistance, only one said yes – “a carton of disinfectant”.

There was not enough information to give average cost of losses.

Of the 10 (50%) respondents who were aged 40–59:

- three had carried out preventative measures and two felt these measures made little impact
- no one replied that they had received any assistance.

There was not enough information to give average cost of losses.

Of the six (30%) of respondents who were aged 30–39:

- two had carried out preventative measures and one respondent felt that the measures reduced the level of damage considerably
- three replied that they had been given assistance. One reported that cleaning implements had been delivered, and two mentioned that they would receive warnings in the future.

There was not enough information to give average cost of losses.

## 2.3.5

### Insurance issues

Of the 49 affected by flooding, 32 (65 %) were insured.

#### Costs of flood damage

It was clear from the individual responses that people were unwilling to give financial details. Only eight gave full details of losses, with 15 more giving a limited indication while 26 (53%) of respondents gave no indication at all of their losses.

#### Depth/duration/costs relationships

The low number of respondents willing to give details on costs made any relationship between flood duration, depth and costs impossible to evaluate.

#### Future insurance

There was a clear indication from the sample that future insurance cover had been affected by the flooding incident. Eight (25%) respondents who had insurance stated that the flooding incident had affected their future insurance:

- four said they had premium rises
- one was told the current policy will be unavailable after renewal date
- one said other insurers have declined offer to cover
- one uninsured respondent stated “they were insured but not for flooding” as no one would cover them.

#### Time taken to settle claim

Those respondents who had claimed on their insurance (24 in number) were asked how long it had taken to settle their claim.

**Table 2.5** *Time taken to settle insurance claims*

Time	Number
1 month or less	1
1–3 months	3
3–6 months	2
6–9 months	4
9–12 months	0
More than one year	12
Still waiting at time of survey	2

The findings above indicate that:

- 12 (50%) of those who responded said they had waited more than a year for the claim to be settled
- two (8.5%) were still waiting at the time of the survey (18+ months after the flood event).

The claim settled in one month was for contents only (note that there may be other factors behind the time taken to settle claims for building damages related to repair times etc).



### **Uninsured losses**

Many respondents (20) who had claimed on insurance reported uninsured losses. These included damage to external areas, camping equipment, carpets, cellar and shed contents, garden tools, electric tools, welding equipment, bicycles, hay fertiliser and farm equipment.

A total of 26.5% of the respondents had no insurance. Many of these appear (from the additional comments given) to be low-income households.

## **2.3.6**

### **Review of qualitative feedback from questionnaires**

To supplement the quantitative analysis of the questionnaires, the additional comments of the respondents have been reviewed. These, often disparate and highly personal comments, were categorised into broad themes and summarised for information only since many of the comments are not directly relevant to the study. The results are described below.

#### **Comments relating to the Environment Agency**

Seven of the respondents made negative comments about the assistance provided by the EA. These included:

- flood victims receiving warnings of possible flooding after their houses had been affected
- recorded messages on EA telephone lines saying that they were busy and people should phone back later
- one respondent contacted the EA but found that the long list of flood warnings was difficult to process and translate into what it meant for his house
- one person said that the only assistance they received from EA was a box of disinfectant after the flood.

#### **Insurance issues**

Three respondents were very concerned about insurance-related issues:

- many loss adjusters “negotiated” over the cost of replacing items damaged in the flooding, many found this approach upsetting and insensitive
- great concern was expressed about the availability of insurance cover in flood affected areas.
- there were several examples of refused cover.

#### **Neighbouring properties**

Two people who owned houses in a terrace expressed concern. If the neighbouring owner did not “flood-proof” their house, it could undermine any work carried out in their own property.

Another respondent’s house was next door to one that had been empty for a long time. The floodwaters, silt etc remained in the neighbouring basement for a long time after the flood. This seeped back into the respondent’s basement that had been pumped dry and treated.

## **Psychological/health impacts**

In addition to the physical damage to properties and possessions, all ten respondents described how stressful and upsetting the experience was. Typical factors include:

- after a flood, occupants get very worried by bouts of heavy rain and regularly checked the levels of rivers etc. Several stated how this affects sleep levels
- several people identified the problems that arose during the drying out period:
  - keep having to visit the property to empty de-humidifiers
  - the terrible smell lasting for weeks after the flood
  - vulnerability of the property to vandalism and theft when left empty
- two disabled respondents were very disappointed by the lack of additional support that they received from all agencies. They had to cope with most of the clearing up themselves
- respondents on benefits/low income could not afford building insurance and so worried about flooding happening again
- the stress associated with alternative accommodation:
  - living elsewhere with only a few possessions
  - further to travel to work
  - if pets were involved, then kennel/cattery fees etc
- no proper kitchen so a family had to eat out all the time. This led to more expense.
- “tourists” came to look at the flood damage. This:
  - jammed up the few accessible roads
  - caused a constant “wash” that made it difficult for victims to pump out their houses
  - offended the respondents as strangers watched them moving their personal possessions out of flood-damaged dwellings
- clearer lines of communication are required between landlord and tenants (private and social landlords) to make sure the appropriate people receive warnings, guidance etc
- employers have to be supportive as respondents had to spend a long time on the telephone arranging builders, suppliers etc. This can take many hours.
- respondents often found dealing with builders difficult and frustrating, especially where they know little about the building process.

## **Positive comments**

Only a few positive comments were made:

- neighbours, the emergency services (fire brigade especially) and local charitable organisations were praised a number of times
- local trades people appear to have set themselves up to offer support during the floods
- several people have invested in their own water pumps to assist de-watering in the event of future floods.

## 2.3.7

### Discussion

#### Analysis of flooding

The relatively small number of respondents prevented the drawing of statistically significant conclusions from the survey. Even so, there is clear evidence that extemporary measures can reduce the amount of damage to goods and property.

The key factors affecting the preservation of goods and personal effects are: the time available to lift items above the flood level and the physical ability to do so. Damage to property is more complex. In addition to the factors of time and physical ability, there is a requirement for equipment and materials for blocking openings. However, there is also potential for ingress through seepage and, in the case of adjoining properties where one is unoccupied, this may occur for some considerable time after the flood has subsided. It is evident that where seepage occurs, extemporary measures used for blocking openings may prove to be of little value unless it is possible to reduce water levels by pumping or some other means.

Where insufficient warning was available to take action, the damage to goods was generally proportional to the depth of flooding. This is presumably related to the height at which goods stand above floor level.

The three respondents who were given sufficient warning to take extemporary measures all reported that the impact of these measures was large. Of these three, one property was not flooded and the occupier was able to move vehicles to higher ground and to assist neighbours in their preparation.

#### Cost of flooding

The cost of damage could not be identified fully. This was because individuals were reticent to divulge information. However, the majority of respondents answering the second questionnaire gave details of their insurance company but due to the confidential nature of this information, cost details were not sought from their insurers. Insurance companies have, however, assisted in the development of databases containing information on the costs of claims. One such source of information is held by the University of Dundee and has been utilised in this study.

#### Insurance issues

Although the survey indicated that insurance was affected to some extent by the occurrence of flooding, it was not possible to identify the details of individual circumstances. However, this was of great concern to many people affected by flooding, not just to those who had insurance cover refused following a flood. The period to settle claims was, in general, lengthy, but this may be due to the nature of the damage caused to buildings and the time taken to effect repairs. The process of settling claims appears to have been relatively difficult for those involved. In particular, the attitude of loss adjusters was perceived as being particularly insensitive in times of great stress. Owner-occupiers were, in general, insured through their mortgage lenders. There were some cases where buildings were insured but the contents were not, possibly because these properties are in the private rented sector and the occupiers are unwaged or on low incomes.

### **Environment Agency, emergency services and local authorities**

The respondents to this study generally had poor perceptions of the Environment Agency, but this may reflect the circumstances of particular events prior to the full implementation of Floodline. It should, however, be noted that extemporary measures cannot be taken if warnings are given after the event and that communication systems must work and direct correct information to specific individuals. There appears to be a lack of understanding of the responsibilities of the Environment Agency, emergency services and local authorities in preventing flooding and in responding to the impacts of a flood. In general, the time taken to respond and the lack of response to public requests for assistance and information suggest to people that there is little formalised planning or concern. At a time of great personal stress, it is clear that individuals appreciate support regarding the safety of their property and the recovery of their lives. This is reflected in praise for the emergency services, neighbours, local traders and charities.

# 3 Impacts of flooding

## 3.1 ROUTES OF FLOODING INTO BUILDINGS

As the consultation has shown (see Section 2.3.2), there are three main routes of flooding into buildings:

- through openings (door, windows and vents)
- seepage through walls/ground
- through drains.

The consultation indicated that the ingress of water occurred in the order shown above.

## 3.2 FLOOD DAMAGE TO BUILDINGS

The consultation suggests (see Section 2.3.3) that the areas of buildings most damaged by flooding (irrespective of flood depth) were:

- plastering of the internal walls
- electrical wiring system
- kitchens.

Other areas of a building that may experience damage have been highlighted in other sources of information, and include:

- building structure
- brickwork
- wall coverings
- floors
- glass and windows
- insulation systems
- gas systems
- water systems
- oil supply systems
- sewers.

As might be expected, the level of damage tends to increase with an increase of flood depth and the duration of the flooding. Information held in the National Flood Insurance Claims Database at the University of Dundee (Black and Evans 1999) suggests that the velocity of the floodwater and the season are also important in the level of insurance claims (analogous to the level of damage and subsequent impacts). The variability in claim levels may also be due to other factors (eg fraudulent claims, claims cost inflation due to demand for builders exceeding supply, strictness of claims control by loss adjusters and insurers, and additional costs resulting from looting and theft).

The seasonal effects on the cost of flooding are shown in Table 3.1, with the median cost of flooding increasing by some 86% in the winter due to the increased time it takes to dry a property out.

**Table 3.1** *Seasonal effects on flood-related insurance claims*

Season	Building insurance claims	Flood event
Summer (April to September)	£9922	Llandudno 1993 Folkestone 1996 Moray 1997 Midlands 1998
Winter (October to March)	£18 492	Perth 1993 Strathclyde 1994 Devon 1997

Note: Figures quoted are median losses according to season (all figures adjusted to 1999 values).

The effects of flood depth on the levels of insurance claims for buildings also show that flood damage increases with depth (Black and Evans 1999). The figures provided in Table 3.2 show that flooding can result in damage even when the depth of water relative to the ground floor is zero due to the effects on the foundations and walls of the property.

**Table 3.2** *Building losses and flood depths*

Sum insured	Depth			
	0 m	0.3 m	0.9 m	1.4 m
£50 000	£1846	£12 406	£20 137	£24 659
£100 000	£2046	£12 606	£19 291	£24 859
£250 000	£2646	£13 206	£19 891	£25 459
£450 000	£3446	£14 006	£21 737	£26 259

The level of claims for losses to a building's contents shows a strong link to depth of flooding. Table 3.3 shows that as little as 0.3 m depth of flooding can cause damage that exceeds the level of insurance. It also suggests that extemporary measures, if successful, could significantly affect the cost of a flood even if the flood is at a low level (eg 0.3 m).

**Table 3.3** *Contents losses and flood depths*

Sum insured	Depth			
	0 m	0.3 m	0.9 m	1.4 m
£5 000	£82	£5000	£5000	£5000
£10 000	£312	£6310	£10 000	£10 000
£25 000	£1002	£7000	£11 391	£13 959
£45 000	£1922	£7920	£12 311	£14 879

Insured losses often do not correlate well with the total losses to the community since some of those affected by a flood may not be insured. In the Strathclyde floods of 1994, of those in Paisley council housing estates only around 30% of the tenants had contents insurance. In the 1990 Towyn floods in North Wales, many homes were owned by retired people who had purchased their homes outright. As they had no mortgages they were not required to have buildings insurance and there were few insured properties.

### 3.3

## FLOOD DAMAGE TO OTHER PROPERTY

Consultation showed (Section 2.3.3) that other properties most damaged by flooding were:

- furniture
- carpets
- electrical goods.

Floodwater can and will damage a large range of property. Of particular concern are personal items that cannot be replaced, such as photographs and letters.

# 4 Extemporaneous measures

## 4.1 INTRODUCTION

The majority of the information obtained about extemporaneous measures has been obtained from websites and is easy to obtain and understand. Depending on the website and the activities of the host organisation, the information can either be basic and limited to evacuation procedure, or, alternatively, can be very detailed. In some instances, specific instructions and dimensions of extemporaneous measures are provided along with illustrated procedures for their use. These are discussed later.

The information found in journals and books has, in the main, been less concerned with extemporaneous measures, dealing instead with building development on floodplains, floodplain management plans and the increased risk of flooding posed by development and urbanisation (Thompson & Hine, 1998; Wood *et al*, 1985; Parker, 1995). Further articles discuss the damage caused by floods and the use of damage management companies (eg insurance assessors) to limit unnecessary costs, particularly where commercial interests are concerned (Hadley, 1992; Hoare, 1995). Methods of calculating the costs of flooding by the use of flood frequency zones are discussed (Arnell, 1986), and managerial aspects of disasters and flood alleviation measures, such as those at Towyn in 1990 (Roberts, 1994) and Brecon in 1980 (Paynting, 1980), are reviewed. Smith (1994) briefly mentions the benefits of removing high value, small electrical items out of the reach of floodwaters during a flood in Sydney, Australia, in 1986. However, the article is more concerned with the use of stage-damage curves in the formulation of flood policies.

The use of Meteorological Office weather data by Severn-Trent Water, to improve response to floods resulting from sewer overloading during storms, is discussed by McCann (1997), who also comments on the effects on the value of property which is placed in Ofwat's "at risk" from flooding category. Booth (1988) describes the flooding of Morecambe, Lancashire, in 1977 and 1983 and the efforts of the Local Authority to remove debris and assist the local population in clear-up operations, including providing carpet drying facilities and co-ordinating clean-up operations. Although extemporaneous measures are not covered, the article details lessons learned from the flooding incidents, including the setting up of an emergency plan that provides a warning system via the use of vehicles to warn people of impending floods, and the use of volunteers going from house to house to warn of imminent flooding.

Lave and Lave (1991) suggest, as a result of conducting a survey of three Pennsylvania flood-affected towns, that people know little about what causes floods and often want someone to blame, either governments or engineers; the implication being that floods do not happen naturally. The article briefly mentions some psychological effects suffered by people living with the threat and experience of floods and concludes that the communication between flood agencies and the public needs to be improved, particularly with regard to the risk of flooding and why floods happen. The information provided often contains technical language that the general public find difficult to understand. In a similar vein, research into the catastrophic 1993 floods of the American mid-West details the environmental, social and economic impacts of the floods (Changon, 1996). Although the scale of the floods and the area of land involved make comparisons with the UK difficult, an evaluation of the floods concluded that most

monitoring and prediction techniques were inadequate. This was compounded by the release of inaccurate information during the flood, much of this coming from the media in a poorly presented and inaccurate manner. It was also noted that past approaches to limiting flood damage had failed. Much of the information found on websites, such as FEMA's, suggest that a considerable amount of effort has been made, in America at least, to correct this communication breakdown since the articles were written.

Of the articles that have been located and reviewed that deal with extemporary measures, Ennis (1997) describes the emergency flood proofing of a casino in the State of Mississippi using inflatable flood barriers and also comments on the problems of poorly built earth and sandbag dykes creating more damage than they were designed to prevent. Also discussed are the problems with disposing of the sandbags after a flood event. With regard to flood-retrofitting, Work *et al* (1999) describe the elevation of property to above the expected flood level in the Outer Banks, North Carolina, USA. As this deals with elevating mainly wooden properties on pilings and stilts, it is not particularly relevant to UK property and extemporary measures. Although not an extemporary measure, Pearce *et al* (1995) discuss the problems of mould contamination in homes resulting from flooding. Using domestic residences in Minnesota flooded during 1993 as case studies, the report concludes that even though houses were dried, disinfected and cleaned after flooding, mould contamination continued long after floodwaters had subsided. As mould contamination can have adverse effects on health, homeowners may face more flood-remediation work than anticipated, thus affecting insurance claims and giving credence to flood extemporary measures.

Brenniman (1994), in discussing a survey on flood damage in north-eastern Illinois conducted over 1236 households, mentions the routes of entry by floodwaters into property including floor drains, toilets, sinks, seepage through walls and floors, and overland via streets and from the Des Plaines River and its tributaries. Flood protection measures mentioned and used by residents responding to the survey include sealing floors and walls, installing sump pumps, drain check valves, drain plugs, stand-pipes, overhead sewers and/or disconnecting downspouts. Further flood prevention work carried out by fewer residents include the use of sandbags, drain tiles, the grading of land and building of walls around property, installing windows with better seals and taking out flood insurance. Brenniman further details the mean cost of flood damage experienced by residents and the mean cost of flood protection measures. However, the article is more concerned with the responses of residents and the costs and inconveniences caused by flooding, than with extemporary measures.

In discussing non-structural flood hazard management in the Snohomish River Basin in Washington State, USA, Beyer *et al* (1980) briefly mention extemporary measures such as blocking entrances to property and generally attempting to make a property more flood resistant. They comment that flood-proofing, extemporary or otherwise, will only reduce flood damage, not prevent it. It is also noted that flood-proofing may instil an overconfidence in the property owner, encouraging them to stay in the property, implementing fewer extemporary measures, rather than evacuate when it is safe to do so. Lave and Lave (1991) note that individuals need to be informed about how they can flood-proof their homes and provide examples to this end. These include bricking up basement windows or replacing them with glass blocks, installing anti-backflow devices in drains, installing sump pumps, the use of sand bags, shutting off services and placing valuable and sentimental items in the upper stories of property. The article also comments that the greater the time period since the last flood, the less people maintain flood prevention measures. Furthermore, the article suggests that better-educated property-owners who read books and newspapers and own their homes are generally more flood-aware. Thus, education and continual reminders are necessary to maintain



flood awareness within the whole population (Anon, 2000). Changon (1996) comments that there was considerable pro-active community support during the 1993 American mid-West floods. While not an extemporary measure in itself, developing a sense of community involvement would greatly benefit the application of many of the extemporary measures detailed below.

#### **4.1.1 Categorisation of measures to reduce the impacts of flooding**

The measures taken to reduce the impacts of flooding can be categorised into two main types.

1. “Dry proofing” property or properties – these approaches attempt to prevent the ingress of water into a building.
2. “Wet proofing” property – these approaches allow the ingress of water into a building but reduce the impacts of flooding by minimising the resultant damage to the structure and its contents.

The extemporary measures identified in this study include both dry and wet proofing techniques since both can, to a greater or lesser extent, be carried out using equipment and materials that may be readily available. It should, however, be noted that the wet proofing measures identified may only protect buildings contents since it is not likely to be possible to wet-proof a building structure as an extemporary measure.

In addition to the above, flood defence systems in themselves can be categorised into three general classes according to their location as follows.

1. Riverbank defences: these are designed to raise the height of the riverbank (or floodplain margin) to contain flood water within the river channel or an area of the floodplain.
2. Garden perimeter: these may take the form of a stout wall enclosing an area of land around a house, or houses, with a floodgate that may be closed to keep floodwaters at bay.
3. Building perimeter: these are defences that prevent water entering a property through its external walls, doors, windows, air bricks and ventilation systems.

Although extemporary measures may form part of all three of the above, the most common application of them will be to the perimeter of a building. Extemporary measures are only likely to be applied to river bank defences where those defences are in danger of failing or their design capacity is likely to be exceeded. In these cases, sandbags or other forms of temporary barriers may be used to strengthen or raise existing defences. The use of extemporary measures in providing garden perimeter defences is unlikely since they would generally require specialist equipment or materials in large quantities (e.g. bricks in sufficient quantities to build a strong wall). As a result, most of the extemporary measures identified are either aimed at preventing the entry of water into a building or minimising the loss of a property’s contents. However, it should be stressed that some measures, such as the use of sandbags or temporary barriers, could also be used in combination with existing river bank or garden perimeter defences if required.

## 4.2

### MEASURES TO PREVENT ENTRY OF FLOODWATER INTO BUILDING

Floodwater can enter a building by many means (see Section 3.1) and, as many entrances are higher than the internal base levels of many dwellings, the water can stay long after the flood has receded, thereby exacerbating the damage.

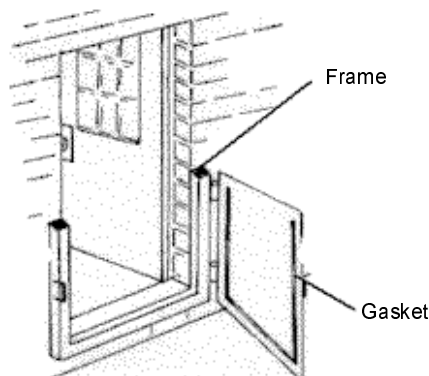
#### Costs of systems to prevent entry of floodwater into buildings

As the systems identified within this report are produced using readily available materials, their cost should not be excessive. However due to the variability of the materials involved, the costs are difficult to quantify. It is also important to remember that, once produced, most of the extemporary measures identified can then be re-used in the future. One general exception to this may be sandbags, which are generally disposed of after use as they are not easily cleaned and can biodegrade. When considering the relative costs of different systems it is also important to assess issues such as costs of transporting materials, labour costs, the effectiveness of the prevention approach and possible damage that may result from their use. For example, sandbags may be cheaper in terms of materials than constructing a flood barrier. However if labour, transport and disposal costs are taken into account, especially if an area is frequently affected by flooding, it may be more cost-effective to use flood barriers as they can be re-used once constructed and can generally be fitted at short notice by the householder.

#### 4.2.1

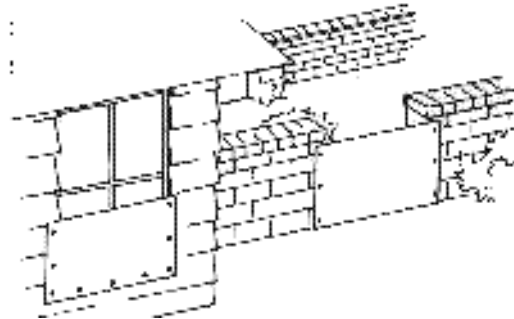
#### The use of panels and sheeting

Flood water entry can be lessened, particularly in entrances that open into the house, by sandbagging or placing previously prepared plywood or metal sheeting on the outside of the door frame, the pressure of flood water increasing the sealing capability. This can be further enhanced by placing a 'gasket' of suitable material, such as a blanket or a silicone-type sealing compound, between the door frame and plywood/metal barrier. A similar approach may be adopted for windows, patio doors and French windows. However, owing to their width, it may be necessary to construct, in a pre-prepared, positive action manner, a more robust barrier which can be placed in front of patio doors and windows prior to the flood reaching the property. Many modern doorways are draught and rain-proof and the additional pressure of flood water forcing them closed could be used to increase their sealing potential if the external doors opened outwards. The effectiveness of the seal between the door (or window) and its frame can be increased temporarily using silicone sealant or similar.

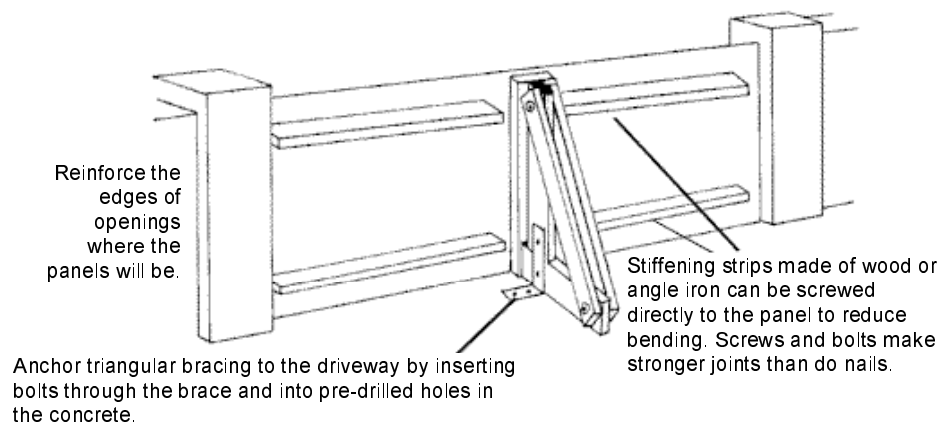


**Figure 4.1** Detail of a hinged panel across a doorway (source LSU 2000)

When considering such extemporary measures, consideration must be given to the strength of the walls and fixings that wooden and metal panels or sheeting are fixed to. It is worth noting that permanently mounted panels are more likely to be used than panels stored elsewhere that have to be collected, carried to the door or window and then fixed in place. Time may not allow this to be done (FMA, 2000; LSU, 2000).



**Figure 4.2** *Examples of panels used to prevent floodwater entry to property and gardens (source LSU 2000)*

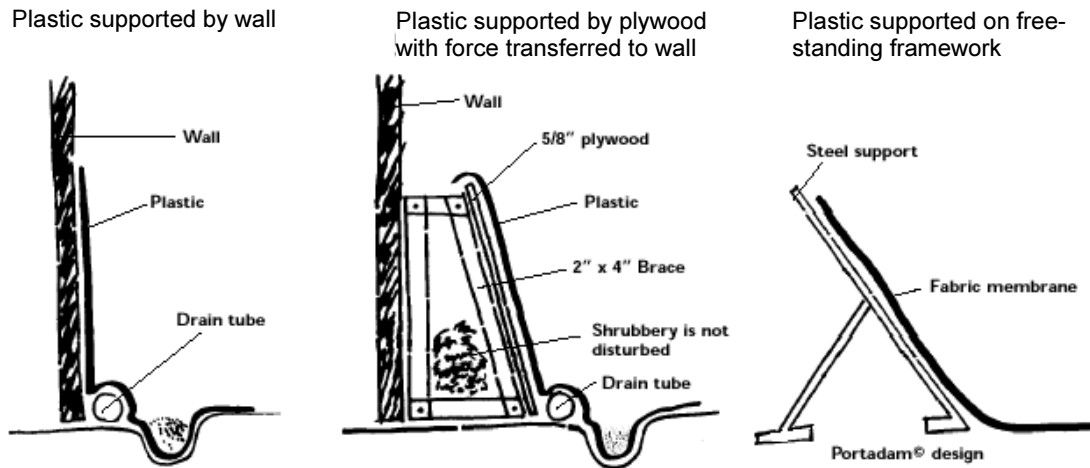


An engineer can estimate the total force on a panel and determine whether the particular materials and support structure are strong enough to withstand that force.

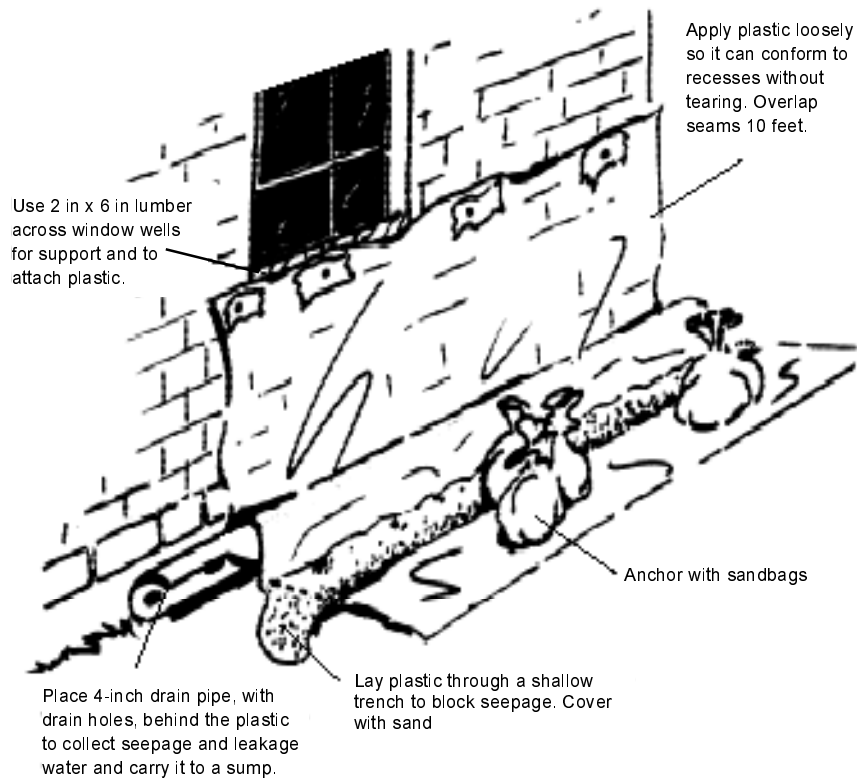
**Figure 4.3** *Illustration of supports and bracing required on panels spanning large gaps such as driveway entrances or patio doors (source LSU 2000)*

## 4.2.2 Wrapping a house

Many websites suggest wrapping houses in plastic or visquine sheeting, and give precise instructions, including diagrams, on how this can be achieved, including the use of wood supports, drains at the base of the plastic and bricks to hold plastic in place. Whilst this may not be suitable for many houses, it will, nonetheless, limit the exposure of walls to water penetration. Seepage could also be lessened by applying waterproof sealant to walls as a matter of general maintenance. It is also suggested that weighted down plastic sheeting be placed over lawns and gardens to limit soil saturation and potential mudslides, whilst diverting water away from property (Thomson, 1993; LSU, 2000; CMHC, 2000). It is not suggested that the entire house be wrapped in plastic sheet. Wrapping to a height of 0.5–1 m (2–3 feet) should be sufficient in most cases. Beyond that height, the pressure of floodwater on the wall may cause structural damage unless equalled by pressure from within the house.



**Figure 4.4** Methods of using and supporting plastic sheeting to limit floodwater entry into a building (source LSU 2000)



**Figure 4.5** Illustration of a property being “wrapped” using plastic sheeting (source LSU 2000)

### 4.2.3

#### Air bricks

Water can also enter a dwelling via air bricks. These can be blocked in a similar way to door frames, by placing a sheet of suitable material on the outside of the air brick, or by using a cushion or sand bags, (EA, 2000; Thomson, 1993). While it may be difficult to obtain a complete seal, the entry of floodwater will be reduced. It is important that any air brick covers are removed once the flood has receded, as they are essential in allowing ventilation of the wall cavity.

#### 4.2.4

### Drains and sewers

Floodwaters can prevent the operation of drains and sewers causing a backlog of waste in drainage systems. Floodwaters can also enter dwellings via drains, toilets, washing machine outlets etc. In such instances, the floodwater is often contaminated with sewage, with the potential for spreading illness and disease. Items that are contaminated by floodwater containing sewage will require thorough cleaning or, preferably, disposal. Prevention of floodwater access to dwellings via drains and waste outlets is, thus, of primary importance.

Some of the information found is very specific in its detail with regard to the blocking of drains etc. Details include giving the dimensions of flexible balls that may be placed into drains to block them, the size of timber used to wedge the balls into drains, and how to limit damage to the ceiling when wedging the ball in place with timber (i.e. a length of timber is placed between the ball and the ceiling of the bathroom to hold the ball in place). Advice is given on the use of semi-inflated inner-tubes to temporarily block floor drains, and the use of plywood and timber joists to prevent back-flow through drains. It is also suggested that toilets be removed and the outlet plugged using flexible balls, and doing similar with washing machine and sink outlets (NDSUES, Undated. Depending on the fittings, it may be sufficient to place bags of sand into toilets to prevent back-flow. Plugs can be placed in sink and bath outlets and covered with sandbags or other heavy objects. However, the pressure generated by floodwater can be considerable and this should be considered in any action taken. A more permanent though less extemporary measure, being particularly relevant if a property is in a high flood-risk area, is to fit anti-backflow valves to drains and sewers (FEMA, 2000; Thomson, 1993; KCRG, 1999; LCES, 1986).

In many cases (eg removing toilets), it will not be possible to carry out the task unless the individuals involved have a good understanding of DIY and sufficient time. However, it is recommended that some form of temporary back-flow prevention is used (eg blocking toilets/plug holes using sandbags) as flooding from sewers will be contaminated with sewerage.

For dwellings not connected to the main sewer system but using septic tanks, it is important to remember that the septic tanks may tend to float if it is near empty and, in an extreme case it could lift out of the ground, damaging the drainage connections.

As well as blocking drains within a property, advice is given to limit the egress of wastewater from sewers and drains with manhole covers and entry grids within property boundaries. This can be achieved either by weighting down manhole covers to prevent them lifting, or by placing a suitable diameter of concrete or metal pipe up-ended over the manhole cover or drain entry. A pyramid of sandbags and plastic sheet are placed up the sides of the pipe to provide a seal and prevent it from being washed away. This prevents debris entering the drainage system and causing blockages and also provides a surge chamber should the sewers and drains back-up (SSD, 2000). Whilst this may be impractical for many householders, individual circumstances, time available and flood characteristics being taken into consideration, it may well limit the potential problems associated with flooded sewers, particularly in slow developing and shallow flooding instances.

## 4.2.5

### Sandbags

Sandbags are the most familiar and often used means of flood defence, either on their own or in conjunction with other flood defence measures. Websites detailing recent flood events frequently include photographs illustrating the barriers built using sandbags to contain flooded rivers or streams. Some websites provide information on how to fill sandbags (SSD, 2000; CERES, 1998; LSU, 2000), and suggest their use during floods to prevent property damage (Thomson, 1993; CMHC, 2000). Other websites detail the use of sandbags to their best effect, often including diagrams. Examples include the use of sandbags to divert water away from property, building walls with sandbags, using sandbags to support other flood extemporary measures (such as sheeting to block entrances) and blocking entrances and air bricks with sandbags (LSU, 2000; EA, 2000).

#### Using sandbags

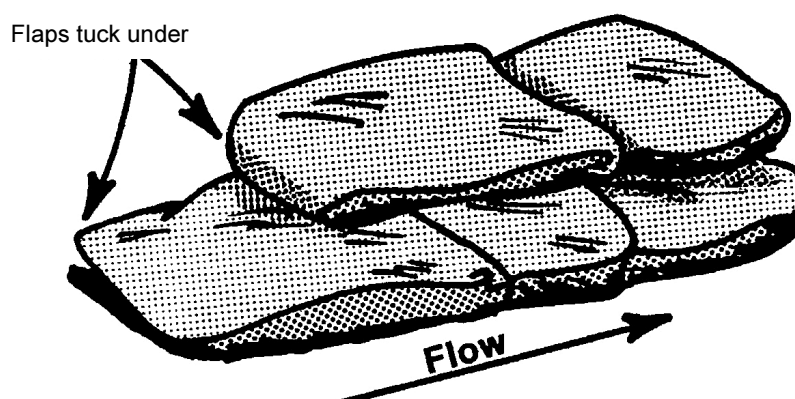
Unfilled sandbags may be purchased from some DIY stores and may be filled with sand or earth. Alternatives, such as pillowcases or refuse sacks, may be used. When the bag has been filled, it is not necessary to tie the end unless it needs to be moved an appreciable distance. If the bags are laid properly, the sand should not escape (see Figure 4.6). To be effective, they must be filled and laid correctly. The sandbags should not be overfilled (no more than half full) and should be well stamped down to ensure the bags seal with one another.

The US Army Corps of Engineers recommends the following approaches to laying sandbags where they are to form a temporary defence away from your property:

1. Remove any debris from the area where the bags are to be placed.
2. Fold the open end of the unfilled portion of the bag to form a triangle. If tied bags are used, flatten or flare the tied end.
3. Place the partially filled bags lengthwise and parallel to the direction of flow, with the open end facing against the water flow. Tuck the flaps under, keeping the unfilled portion under the weight of the sack.

Place succeeding bags on top, offsetting by one-half ( $\frac{1}{2}$ ) filled length of the previous bag, and stamp into place to eliminate voids, and form a tight seal.

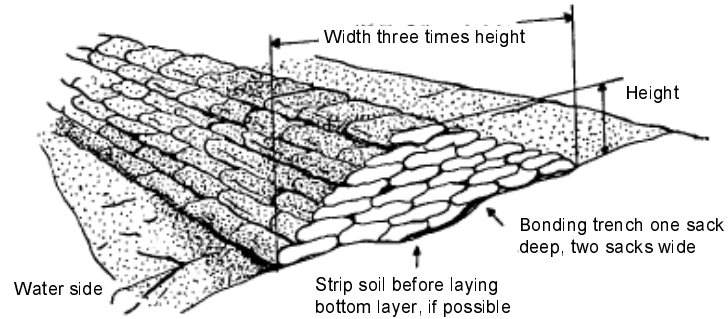
4. Stagger the joint connections when multiple layers are necessary. For unsupported layers over three (3) courses high, use the bags in a pyramid form as shown in the figures below.



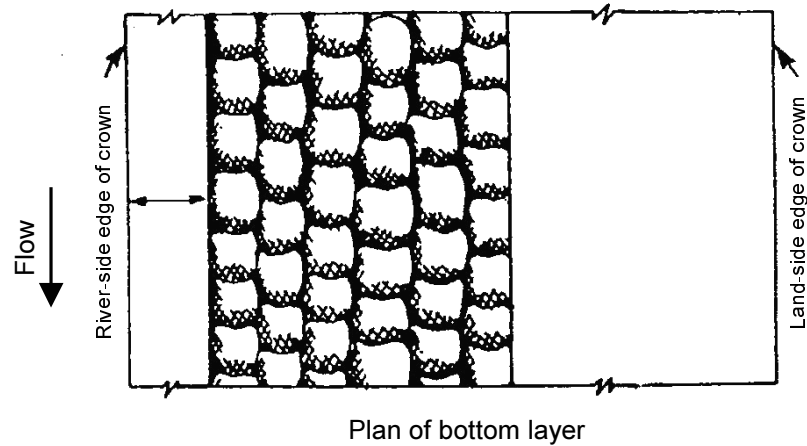
**Figure 4.6** Sandbag placement – face the open end of the bag against the water flow and tuck the flaps underneath the bag

### Pyramid placement method

Pyramid placement should be used to increase the height of sandbag protection. Place the sandbags to form a pyramid by alternating header courses (bags placed crosswise) and stretcher courses (bags placed lengthwise). Stamp each bag in place, overlap the bags to ensure that the joints between the bags are staggered and tuck in any loose ends.

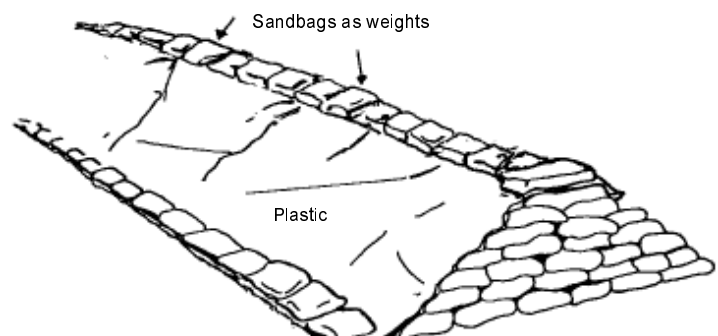


**Figure 4.7** Sandbag pyramid placement method – build the wall three times as wide as it is high for the structure to be stable (source NDSUES)



**Figure 4.8** Pyramid placement of sandbags viewed from above

Plastic sheeting can be used in the side of the wall facing the floodwater to provide additional waterproofing. This will need to be weighted in place using extra sandbags.



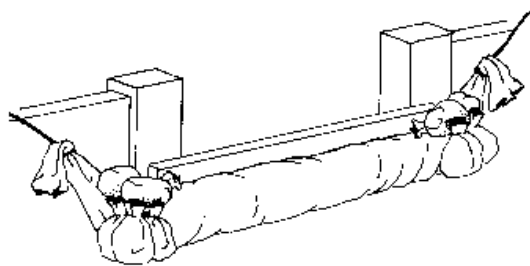
**Figure 4.9** Using plastic sheeting to improve the effectiveness of sandbag flood defences (source NDSUES)

The drawback of using sandbags is that they are difficult to handle and tend to retain contaminants such as sewage when used. Additionally, if the sacking material used is biodegradable, they can disintegrate if left in place for long periods of time.

#### 4.2.6 Water inflated barriers

A recent and innovative method of limiting damage to property is the use of water filled barriers or tubes of the type often used to contain oil spills or divert water in river engineering works. These can be placed across entrances, around buildings or used to increase the height of sandbag or permanent walls. The tubes used to make the barrier may be purpose made or may be adapted from other uses (eg flexible irrigation tube or large diameter inner tubes that have been cut open, have their ends tied and closed and are filled with water). The tubes are weighted or tied down to prevent them moving. The ends of the tube do not need to be sealed, but must be secured in an upright position. Stakes, breeze-blocks and sandbags can be used to keep the tube in position and to prevent floodwater pressure pushing the tube through the entrance that is being blocked. Water inflated barriers are only suitable for level ground, and will contain a depth of floodwater up to approximately three quarters the diameter of the tube. Whilst it is possible to place two tubes side by side, with a third on top to increase the depth of protection, it is important not to apply too much load as this may cause the lower tubes to burst (LSU, 2000).

Ennis (1997) describes the use of inflatable barriers to protect a casino in Robinsonville, Mississippi, from the Mississippi flood of 1997. As sufficient warning was given of the impending flood, time was less of an issue and the barriers were installed to good effect in less time and at considerably less cost than traditional sandbags. Furthermore, unlike sandbags, inflatable barriers can be re-used. Whilst they may be impractical for domestic use in many instances, their use to protect commercial premises could well be beneficial, limiting damage and lessening the risk of business failure by enabling normal business operations to continue with less time and, therefore, revenue being spent on clean-up operations. Such benefits would also have implications on insurance claims.



**Figure 4.10** Water inflated barrier supported by a wooden plank across a gateway (source LSU 2000)

#### 4.2.7 Allowing a property to flood

Should floodwaters reach the level of the ground floor windows, there is little an occupier can do except evacuate the dwelling, as properties are not designed to cope with such levels of flooding. The hydrostatic pressures produced by water over 1 m deep may overwhelm any extemporary measure and is likely to cause structural damage to the property itself. In particular, if the house remains empty of water, whilst the level of water outside is at the ground floor window level, there is a high risk that the wall may collapse due to the uneven pressure and/or the undermining of foundations (by water seepage through a mechanism known as “piping”). This would suggest that it is more important to place sentimental, uninsured and easily moved items in the upper reaches of the dwelling prior to attempting to block doorways and air bricks etc, particularly in



expectations of severe flooding. It is preferable to return to a wet house with possessions comparatively safe, rather than attempting to keep all water out of a property, which then suffers from structural damage caused by hydrostatic pressures. In carrying out flood retrofit modifications, many websites stress the importance of allowing water into, and out of, a property so that pressure forces are balanced, reducing the loading on walls and lessening structural damage (FEMA, 1995; FMA, 2000).

## **4.3 MEASURES TO REDUCE DAMAGE TO PROPERTY**

The first and foremost consideration in any emergency situation is evacuation, and many of the websites visited gave information on evacuating flooded areas and the supplies, or disaster kits, that should be taken when evacuating property. However, many people are concerned about the damage that their property may suffer, not only from flooding but also from theft and vandalism whilst they are absent. Thus, occupiers are often reluctant to leave property and often return before it is prudent to do so. Whilst Individuals can do little about theft and vandalism occurring in their absence, there are numerous things that can be done to limit damage to property by floodwaters.

### **4.3.1 Prioritisation**

It is human nature to think that “it will never happen to me”, but, for those living in areas liable to flood, the likelihood is that it will happen and they will get flooded. It is important, therefore, that people are encouraged to have a plan as to what to do in the event of a flood and to prioritise their actions (FMA, 2000). Many websites suggest, particularly for those living in high-risk flood areas, that a stockpile of emergency building materials should be kept to hand. This should include plywood, general timber, plastic sheeting, sandbags, sand, nails, hammer, shovels, saw etc (FEMA, 2000; SSD, 2000; NDEC, 1999). While prevention of the loss of expensive-to-replace items is often what first comes to mind, it is the loss of irreplaceable, sentimental items that can cause the most upset. Individuals have their own priorities, but unfortunately many people, in a rush to save what they can, often save the replaceable rather than the irreplaceable. (Chapter 5 considers prioritisation in further detail).

### **4.3.2 Documentation and contact details**

Recurring advice given on many websites is to make copies of important documents, for example insurance policies, bank details etc and contact telephone numbers and addresses, particularly of emergency services. It is suggested that these are either kept in a secure location in the upper reaches of the dwelling, or are kept at another safe location, such as with friend. Should the originals be lost, the copies can be used to contact insurance companies, relatives etc. Similarly, copies of irreplaceable photographs etc can also be kept in the same location. Some websites suggest using photographic and/or video format to make copies of documents, to illustrate damage caused and items lost. Many websites also suggest that each member of the household carries the telephone number of a friend or relative, in a flood-free area, whom they can contact, thereby enabling family members to keep in touch should they get separated. Likewise, it is suggested that family members have a pre-arranged point at which to meet should they become separated (WEMO, 2000; FMA, 2000; ARC, 2000; FEMA, 2000; KCRG, 1999; Xtreme, 2000).

### 4.3.3

#### Services

During flooding, all household services are liable to be affected and should be turned off at their entry point into a property. In particular, electrical items can be damaged by water and potentially cause fire via short circuits. Escaping gas is also a potential fire hazard. If possible, appliances that are fixed to services by a rigid connection, such as gas and water pipes, should be disconnected to prevent damage to and future leakage from the pipe should the appliance float during flooding. The fitting of automatic shut-off valves, particularly to oil storage tanks, may be appropriate for properties in high flood-risk areas. Once turned off, services should only be reconnected when the flood has receded and the services and appliances connected to them have dried and then been checked for damage. If there is any doubt as to the condition of the services or appliances, professional help should be sought (CMHC, 2000; FMA, 2000; Thomson, 1993).

### 4.3.4

#### Valuables

“Valuables” covers items that may have a high monetary or a high sentimental value, or both. Items of high sentimental value, in particular, may be irreplaceable (although this could also apply to a rare, high-monetary-value item). In prioritising items to move to avoid getting wet, it may be more pertinent to save sentimental, uninsurable and irreplaceable items rather than the more expensive but insured and replaceable television set (in ideal circumstances all of the above could be saved). The advice generally recommends placing sentimental items and portable items such as televisions, hi-fi equipment, pictures etc upstairs and, where possible and if there is enough time, chairs, carpets and rugs as well. Such action will save a great deal of upset and work in replacing them. If time is limited, small sentimental items and items such as jewellery and cameras can be taken out of the house. Children often have favourite toys and the upset caused by their loss can be considerable, so consideration should be given to children’s valuables. Depending on the item, these can be evacuated with the children, and so be a source of comfort to them, or placed in a safe area of the house (EA, 2000; NDSUES, Undated; ABI, 1999; WEMO, 2000; FMA, 2000; KCRG, 1999).

### 4.3.5

#### Medicines, chemicals, food and cleaning materials

People who regularly take medication will need to carry sufficient supplies with them should they be required to evacuate their homes. Any medicines left in the dwelling should be placed in the upper reaches of the house, if they are not already kept there (NZCD, 2000). It is suggested that they be placed in a water-tight container to prevent floodwater contaminating them. In such cases, it may be necessary to provide a relative or friend with a list of medicines required, enabling supplies to be obtained should the local hospital, doctor or pharmacy also be affected by floodwaters (FMA, 2000).

Chemicals, non-perishable food (including a supply of drinking water) and cleaning agents and materials should be moved to the upper reaches of the house to prevent contamination by floodwater or each other. This will preserve a food supply for after the flood as well as having cleaning materials to hand for when the floodwaters subside (NZCD, 2000; WEMO, 2000; FMA, 2000).

### 4.3.6

#### Pets and farm animals

Advice also deals with farm animals, dogs and cats, with less information being available for smaller, caged pets such as mice and rabbits. Many people have strong emotional attachments to pets and may take great risks to protect them, so any extemporary action taken regarding floods should include pets as well as property.

Should evacuation be necessary, dogs and cats etc can be evacuated from the property (NZCD, 2000). Smaller animals in cages, where practical, can be placed in the upper floors of a dwelling, if there is sufficient provision for supplies of food and water within their cage. Although it may be distressing if pets go missing during a time of flood, owners should not return to their homes to look for their pets until it is safe to do so. Many pets are capable of surviving on their own for a short period and will not, in the main, suffer undue harm. Supplies of pet food should also be placed in the upper reaches of the house and added to disaster kits if evacuation is required.

Larger animals, such as farm animals, should be moved to higher ground, if possible, and will do so themselves if allowed. Consideration should be given to livestock food supplies and access to the stock should flood waters remain for any length of time. In such instances, a strong community assistance network will be of great benefit to those needing to find temporary homes for livestock (NDSUES, Undated).

#### **4.3.7 Electrical goods and apparatus**

In the event of flooding, electrical appliances should be disconnected from the main supply as soon as possible to avoid damage and potential electric shocks (NZCD, 2000). Advice given includes placing smaller electrical apparatus in the upper floors of the property or some other dry location. Where possible, items such as washing machines and deep freezers can be raised off the floor, for example; on breeze-blocks. Some websites suggest wrapping electrical apparatus in plastic sheeting and tape to limit water penetration (FMA, 2000; Thomson, 1993). On retreat of floodwaters, all electrical apparatus must be thoroughly dried and checked before it is reconnected to the electrical supply.

#### **4.3.8 Furniture and fixings**

Prevention of damage to furniture and fixings depends on the individual items. Much advice suggests removing items, such as chairs, cabinets and carpets, to higher locations, but this depends greatly on the item concerned and the time allowed. Placing or wrapping items in plastic bags or sheets will limit damage and may be the only feasible action. Curtains can be hung over the curtain rods out of harms way. Furniture and fixings that cannot be moved should be emptied of all items liable to damage, with the items being placed in a safe location. In the case of sofas, tables etc it may be beneficial to place heavy items on them, or tie them together, to prevent them floating around within the house and potentially causing damage, such as breaking windows etc. Furniture should be pulled away from walls as this will allow more rapid drying of the dwelling after a flood. Removing or leaving cabinet drawers and room doors open will prevent them swelling and sticking. Fire places should be emptied of ashes to prevent the spread of ashes around the house (ARC, 2000; FMA, 2000; LCES, 1986).

#### **4.3.9 Food and water supplies**

Whilst not an extemporary measure with regard to property, food and water are of considerable importance, particularly for people trapped in their property and cut-off from help. Insurance claims to cover food lost through deep freezers thawing may also be lessened by the application of simple extemporary measures.

Much information suggests placing canned and non-perishable foodstuffs in the upper reaches of the property along with kitchen and dining utensils. Bathtubs and containers should be filled with drinking water, having sterilised them if necessary. It is of importance that all food contaminated with floodwater is disposed of or, if it is tinned

and undamaged, that the tins are thoroughly cleaned and sterilised before opening. Appliances such as fridges and freezers should be turned to their lowest temperature setting and where possible kept shut to prevent the entry of warm air. They can also be covered in blankets to help keep them cool should power supplies be disrupted. They will also benefit from being filled with containers full of water prior to flooding and power disruption, as this will also help maintain cool temperatures for longer. This may be difficult to achieve at short notice but may help to prevent total losses if the flood and power disruption is short (LCES, 1986; SSD, 2000; Xtreme, 2000; NDEC, 1999).

#### **4.3.10 Vehicles, garage contents and outside objects**

Many websites advise moving vehicles to higher locations before floodwaters arrive and also offer advice regarding driving in floods. They also suggest that vehicle fuel tanks are filled as fuel supplies may be disrupted by flooding (NOAA, 2000; ARC, 2000; Xtreme, 2000; NDEC, 1999). Removing vehicles from the flood zone also provides an opportunity to remove other items such as garden equipment, pedal cycles, tools etc, although the vehicle will need to be locked and parked in a secure area to limit the risk of theft.

Where possible, items such as oils, paints, cleaning agents, garden pesticides etc should be placed out of reach of floodwaters. (NZCD, 2000; WEMO, 2000; LCES, 1986). Not only will this prevent contamination by floodwater, but it will also limit environmental pollution caused by such materials leaking from damaged containers (FMA, 2000).

Items that are kept outside and are not fixed to the ground should either be moved to a safer location, or anchored to a suitable, immovable object. Examples include propane tanks, oil drums and similar containers. If possible, such items should be filled with water to prevent floatation (FMA, 2000; WEMO, 2000; Xtreme, 2000; NDEC, 1999).

# 5 Prioritisation of actions

## 5.1 PRE-FLOOD ACTIONS

The type of action that can be taken prior to the onset of a flood depends greatly on the length of time between the initial flood warning (if any) and the arrival of the floodwater. Whilst floods can develop comparatively slowly allowing people to prepare themselves for flooding, they can also develop extremely quickly. In the latter instances, particularly if occurring at night, people may have little time to react. For this reason, whether considering flash floods or slowly developing floods, the majority of the information found highlights the importance of personal safety and evacuation plans above the prevention of damage to property. Much of the information repeatedly stresses the importance of being prepared, prioritising activity and preparing disaster kits, as there may be no time to rescue anything but self and family.

Options available to people living in flood-prone areas can be described as passive action and positive action. Passive action is the taking of action on the assumption that a flood will occur at some time, and is aimed at limiting the potential damage regardless of the dwelling being occupied at the time of flood or not. Positive action relies on the occupiers being present in the dwelling at the time of, or preferably prior to, the flood, and taking action to limit damage in the immediate period before flood waters enter the property (FMA, 2000).

### 5.1.1 Passive action

Passive action options generally entail the construction of new property in a flood resistant manner (ie wet-proofing it), or the retrofitting of existing property with flood resistant materials and features. Retrofit features include fitting one-way valves in sewers and drains, flood-proofing walls and entrances, raising electrical ring-mains to the upper floors and moving appliances to higher levels in the property (if feasible). Further passive action could include the building of embankments or flood-proof walls around properties. However, care must be taken to ensure that such structures are strong enough to withstand the forces of floodwaters and that any water breaching the wall or levee can also find a way out (FMA, 2000; FEMA, 2000). Such structures may also require planning consent.

These actions are considered passive in their approach as they do not necessarily stop a property being flooded and do not rely on the occupier taking action but can, nonetheless, reduce the damage caused by flooding. For many people, however, retrofitting a property is not practical, either through the design of the property, or simple financial considerations; retrofitting could be prohibitively expensive. Thus, for the majority of people, whether in flood resistant property or not, positive action is the only option in an attempt to limit property damage.

### **5.1.2 Positive action**

Whilst most people, given sufficient warning, will be able to take some action to limit damage to property and belongings, such action may well be unplanned and without preparation. Timely flood warnings can allow people to take action and significantly reduce the losses from floods, in some cases by as much as 50% (Parker & Penning-Rowell, 1991). Positive action, however, requires forethought and planning to be effective and a prioritisation of actions to be carried out (FMA, 2000).

### **5.1.3 Community action and education**

The amount of positive action that can be carried out depends greatly on the situation at the time of an impending flood, this being affected by weather conditions, the time of day or night, and the ability of the dwelling occupiers. People with young children, and the elderly or infirm, may not be able to take action other than leaving their homes and many such people may feel isolated and on their own in emergency situations. Thus the primary positive action should, perhaps, be education and raising flood awareness on a community level, particularly as much of the information provided can often be inaccurate and incomplete (Beyer *et al*, 1980; NDEC, 1999; Chagon, 1996). It is suggested that, as well as educating and raising public awareness regarding flood hazards, it is in flood agencies' interests to involve the public in flood awareness programmes as this promotes community activity, provides good feedback for the flood agencies and lessens the apportionment of blame onto the agency during floods (Beyer *et al*, 1980). To this end, during a meeting of the USA-based Flood Plain Management Forum in Washington DC on 26 June 2000, it was suggested that, as many communities have Neighbourhood Crime Watch programmes, a "Neighbourhood Flood Watch" programme might also be appropriate (Anon, 2000). As well as the more usual route to education via schools and information leaflets, it was suggested that "be flood alert" could be stencilled on roadside kerbs near drains, or placed on road signs as a method of maintaining flood awareness amongst the population. It was noted at the meeting that many peoples' perception of floods were raging storms and torrential rivers, and less of rainwater draining off the land directly into areas of habitation. The implication is that you do not have to live near a river or the sea to be at risk from flooding.

In a similar vein to a neighbourhood flood watch, the ALERT User Group in America uses a series of automatic real-time monitoring systems to provide communities with accurate weather and flood information. In operation across much of America and easily accessible via computer, ALERT enables communities to assess their local weather and flood situation and issue warnings accordingly. Coupled with a supportive community network, such programmes enable communities to work together, thus lessening flood damage to the community as a whole (NOAA, 2000: ALERT, Undated).

### **5.1.4 Flood warnings**

Flood warnings are only effective if they are heard and heeded. There is an increasing number of households that are empty during the day, with adults working and children at school. Because of this (and the increase in single occupancy dwellings) it is possible that flood warnings are never heard. Consequently, no action is taken and, by the time occupiers hear of the flood and return home, the damage is done. Thus, it is important that people living in areas of potential flooding are informed of the probability of flooding and advised on what action they can take to reduce damage to their property, irrespective of where they are at the time of the flood.

## 5.1.5

### Flood plan checklist

The UK Environment Agency recommends the compilation of the following checklist.

1. Keep a list of useful numbers to hand eg: your local council, the emergency services, your insurance company and Floodline – 0845 988 1188.
2. Have a few sandbags or floorboards prepared to block doorways and airbricks.
3. Make up a flood kit, including a torch, blankets, waterproof clothing, wellingtons, a portable radio, first aid kit, rubber gloves and key personal documents. Keep it upstairs, if possible.
4. Talk about possible flooding with your family or those you live with. Consider writing a flood plan, and store these notes with your flood kit.
5. Make sure you know where to turn off your gas and electricity supply.
6. What about your pets? Where will you move them to if a flood is on the way?
7. Think about your car. Where could you move it to in the event of a flood warning?
8. Get into the habit of storing valuable or sentimental personal belongings upstairs or in a high place downstairs.
9. Think about medication. In the event of a flood, you will still need to take it.

## 5.2

### POST-FLOOD ACTIONS

A website recently established by CIRIA, with input from BRE, (<http://www.ciria.org.uk/flooding>) highlights some of the post-flood actions that can help to reduce the impacts of a flood. In particular it notes that:

- during a period of flooding, the water levels may rise and fall over a period of several weeks, dependent upon rainfall and drainage. It is pointless, therefore, to carry out all restoration work until there is confidence that the floods have gone. However, any necessary immediate work to make the structure safe should be carried out, if possible
- weather and flood warnings should be continually monitored. If further floods are forecast, priority should be given to preparing for this eventuality before attempting property repairs
- buildings that still contain standing water must not be occupied. All standing water should be removed with pumps or pails, followed by a wet/dry vacuum to mop up any remaining water
- after a flood, anything that has potentially come into contact with floodwater should be cleaned and disinfected before use to avoid potential infections or other illnesses. It is also vital to open doors and windows to ventilate the building and to remove, where possible, fixtures such as kitchen cupboards to allow walls to dry out.





## 6 Repair of buildings

Advice on the repair of buildings following flood damage can be found via the CIRIA website *Repair and restoration of buildings following floods*  
<http://www.ciria.org.uk/flooding>

It is suggested that, during repair, measures can be taken to limit further damage by subsequent floods. Such measures are often referred to as *resilient reinstatement* and include:

- when replacing floorings, consider using materials that are less vulnerable to damage from flooding or that are more easily moved following a flood warning (eg rugs rather than fitted carpets)
- when replacing plaster, consider using an alternative that is less vulnerable to damage in the event of another flood, for example, tanking
- consider replacing laminated chipboard kitchen units and chipboard floorings with those made from materials less vulnerable to damage
- when replacing wiring, sockets etc., re-route cables to drop down from above to socket outlets on the ground floor. It is also advisable to raise socket outlets to at least 900 mm (3 ft 0 in) above floor level on the ground floor.



During the consultation phase of the study, several comments were received that provide a useful insight into the personal and psychological effects of flooding. A selection of these are provided below since they not only provide information on the human impacts of incidents but also give an insight into the wide range of issues that can be involved in using extemporary measures to reduce the impacts of flooding.

The case studies relate to two flooding incidents in Hebden Bridge, West Yorkshire, and Todmorden, Lancashire, in the summer and autumn of 2000. Flooding occurred in Hebden Bridge in both the June and October/November 2000 and in Todmorden in June 2000 as a result of high river flows. Water entered houses via a range of routes including seepage through cellar walls and floors, drains and through doorways and coal chutes. The depths of flooding ranged from 60 cm to more than 1.5 m and resulted in estimated costs of up to £15 000 per household.

#### **Feedback from residents of Hebden Bridge**

*“Nothing has been done to prevent this happening again. Businesses and homes were destroyed along the River Calder. There is plenty of undeveloped wasteland that could be used to widen the river and therefore reduce its power and the risk of it bursting again, as has happened with the flood plain in Mytholmroyd. We can’t just sit and wait for it to happen again. Apart from the obvious distress and devastation, we may never be able to sell our homes and it won’t be long before we move into negative equity. The people of Hebden Bridge and Todmorden deserve better. The climate is changing and positive steps need to be taken quickly before it happens again. The media has reported that money is available for work on Callis Bridge and along the Calder – why the wait?”*

*“When the cellar flooded in June, we were both away on business and more damage occurred. It took a long time to clean up and the smell was awful. The cellar was full of silt. The October flood seemed to be cleaner and we caught it in time (by chance). We know the cellar had been under water a long time in the past and so declared this on our insurance applications. We could find only one company which were willing to cover us and, whilst they will provide cover if we are flooded from above, they will not cover us for the seepage. As a result, we mainly keep belongings in the cellar which cannot be damaged by water – bicycles, outdoor gear etc. We have content insurance only as we do not own the house. The lack of cover meant that, whilst our neighbour was able to replace her washing machine etc and have her cellar professionally cleaned through her insurance company, we had to deal with everything ourselves. This was particularly unpleasant as we were away on business and did not return until one week after the floods. By this stage the water had subsided, but there was silt everywhere an inch thick and everything was mouldy. The smell was awful for several weeks. We feel very unlucky to have been flooded twice in the last 12 months and are very worried about leaving the house unattended.”*

#### **Feedback from residents of Todmorden**

*“I am glad it is acknowledged that flooding also impacts on people’s health and welfare as well as the more obvious practical problems of dealing with insurers, loss adjusters, builders, cleaners etc. The drying-out time (7 weeks) was most frustrating as one feels that restoration should commence as soon as possible (though I realise this would be*

*foolhardy). However, if adjoining neighbours in the terrace fail to carry out similar safeguards, this can affect one's own property. Having to go in daily to the property and empty dehumidifiers was very depressing. People often don't realise you're dealing with mud, sewage, the contents of a river bed and drains – not just clear, clean water. My employers were sympathetic, allowing me time to make numerous phone calls and time to see loss adjusters and builders but, nevertheless, this added to pressure at work. I eventually had to take two weeks sick leave because of the stress. Finding alternative accommodation was a headache and having no clear limit on what the insurers would be willing to pay. The alternative accommodation meant I had to travel further to work too. I also had to arrange alternative accommodation for my cat who was already traumatised from the flooding and died just before I was ready to return home. It has been a real hassle haggling with the loss adjuster, chasing the builders appointed by the loss adjusters (who were over-committed in the area and worked short days due to travelling from Blackpool). They made many errors in the house restoration and did stupid, frustrating things like leaving me without a letter-box for three days! My major concern now is, will I be re-insured? At what cost? Will there be exemptions and a higher compulsory excess? Also, of course, my home is completely devalued and so the future looks bleak. The Environment Agency can make no assurances that this will not happen again. The temporary repair of the river wall by my house is a questionable solution. I guess it will break at the next weakest point along the river.”*

*“I am aware that there were many people worse hit than myself in the summer flood but, as a disabled person on income support living in a relatively small house, I am sure you can appreciate the upset and inconvenience this caused. Being on benefits, I cannot afford contents insurance and, were it not for the helpful donations from local charities (the Mayor of Todmorden's Flood Appeal in particular), I would have been pretty much ruined, frankly. I believe the Environment Agency has a lot to answer for in this case – (1) for their lacklustre approach to warnings and prevention measures and (2) their complete lack of offer of any financial help to anybody, especially those in similar or worse situations than myself.”*

*“I live on my own. I'm classified as severely disabled due to partial sight. I also have osteoarthritis. I had no help from anyone except the Todmorden flood relief fund. I had £100 to cover repairs. As far as the clean-up was concerned, I had to cope as best I could. Luckily, the flood happened in what passed for summer here. It took me about three weeks to dry the carpet and chairs out. Everything stank. I didn't know how the floodwater was contaminated at the time, the cellar is probably a breeding ground for all kinds of deadly diseases, such as bubonic plague, cholera, typhus and typhoid but, as I only own a quarter share of the property, it's not my problem. The housing association pays the building insurance but there's a £30 excess to pay by me. I've had to move out due to harassment from the “yob element” of the local population. The local council and police are less than useless. I'm now stuck in a freezing cold flat. I go back to the house to check on it from time to time in fear of being attacked or finding the place vandalised. It's up for sale. I've already knocked £1000 off the asking price.”*

*“We now live in constant fear of long spells of rain, checking constantly that no rain is coming in. The emotional stress and the upset caused to ourselves and our children. The lack of concern shown by the Environment Agency. The only people willing to help or show concern that weekend were the firemen who pumped out the cellar. The EA just spent the weekend driving around the streets through water. No one offered guidance; neighbours supported each other. People came from all around just to look, instead of using the main road. The traffic was then diverted down our streets where people were emptying their damaged possessions out of their homes; passers-by found this afternoon entertainment. We did not.”*

*“Ruined family life for four months. As we had no kitchen, we all had to eat out at different times. My husband and myself had to take time off work for workmen and delivery of household items. Now always checking the river level when it rains. Lack of sleep when raining as always getting up to check if everything OK. Lack of compassion from insurance companies, council workers, environment agency and other officials who quite often were rude and arrogant. A small road outside my house does not belong to us or the council – is in a right state when it rains. It turns into mud, the council will not fix it and we cannot afford to have it repaired properly. All this mess is now being traipsed into the house and cats are using it as a toilet area, which we have to clean up. This was caused by the water lifting the tarmac away”*

*“I was seven months pregnant at time of flood. The house next door was suddenly unoccupied and it took two weeks for environmental health to get into property. They only made haste when, having rung a number of times I had to insist that, should I go into premature labour due to stress, I would be suing whoever was responsible. I feel the response to my family’s concerns regarding the empty (still having full furnishings) flooded property, considering I have a five-year-old and I was pregnant, were unsatisfactory. I’m sure if any person in the said office was living next door to a property which continued to have contaminated flood water which was being drawn into their own due to the dehumidifiers they would have done something sooner and without the relentless pushing I had to do.”*



The literature search and review has demonstrated that a wealth of information relating to floods, flood damage and property is available worldwide. While much of this is related to technical information and research, a large proportion of the information is made available to enable the general public to assist them in understanding the dangers of floods and to prepare themselves for flood events, including mitigating potential property damage. Although certain areas have been difficult to access, such as the European Union and individual European countries, not least because of the different languages, there is a considerable quantity of information available via English-speaking countries such as the United Kingdom, America, Canada and New Zealand. The publicly available information is generally accessible via the Internet and much of the information is also obtainable in the form of fact sheets.

Regardless of the country of origin, the literature search has shown that much of the information is of a similar nature, excepting local circumstances, and originates from organisations such as UK's Environment Agency and USA's Federal Emergency Management Agency, as well as private, commercial and community organisations. A large amount of flood related information is available from the USA, and much of that from FEMA and the National Flood Insurance Program. The information available is generally simple to understand and, given enough warning, it is probable that the majority of householders would be able to carry out some of the extemporary measures mentioned, given individual circumstances. The same may be said for people and organisations responsible for caring for those who are unable to look after themselves.

Apart from lack of warning, or not being at home when flooding occurs, problems may arise due to people's lack of perception of the dangers of flooding, lack of knowledge regarding their property and its flood-risk status, and simply being unaware of the availability of information regarding extemporary measures. As well as providing information on what to do during flooding, much of the available information also attempts to raise people's awareness of flooding and the damage floods can do. This is perhaps crucial to limiting property damage caused by flooding. Making people more aware of the potential for flooding and that it may happen to them, and encouraging them to prepare their properties for floods through retrofitting, should reduce the potential for damage and increase the effectiveness of extemporary measures that are applied in times of flooding.

The survey has confirmed that, given sufficient warning, extemporary measures can serve to reduce the damage to goods, personal property and buildings. However, in the case of the latter, it may also be necessary to take more permanent measures to reduce ingress of water through seepage.

The survey has also highlighted the need to clearly identify the responsibilities of organisations such as the Environment Agency and local authorities in preventing flooding and in helping the general public understand the implications of flood risk and living in flood plains (even if they are provided with flood defences). There is clearly an identified need to raise awareness and promote the message that proper preparation can significantly reduce the impact of flooding on buildings, goods and property and on the welfare of individuals living in at risk areas.

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