Carlisle Flooding

Health Impact Assessment

SWP3: Urban Flood Modelling

WP3.1: Health and flooding – source and receptor factors

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1. Introduction

An exploratory health impact assessment (HIA) and quantitative microbial risk assessment (QMRA) of gastrointestinal illness has been conducted on part of the Carlisle population flooded during the 2005 floods. The report includes a review of the 2005 Carlisle flood and the local impact studies that were carried out following the flooding. It also includes a review of the health impacts which are amenable to quantification and are known to result from flooding before outlining the methodology for the QMRA and the results of the analysis. The results of the analysis are discussed in relation to some of the assumptions made and possible mitigation strategies to help reduce the impacts of future flooding events.

2. Carlisle flooding

Carlisle is situated on the River Eden where two significant tributaries, the Caldew and the Petteril, join the main river and the city has a history of flooding, as can be seen in Table 1. The floods experienced in January 2005 (which are described in 2.1) resulted in water levels one metre above the 1822 flood mark (the previous highest flooding level).

The flooding in 1968, which affected more than 400 properties, led to the construction of flood defences in Carlisle. These have been augmented by the construction of additional flood defences between 2006 and 2010 (EA, 2008). These were constructed in two phases and consisted of:

- Phase 1: Improvements to the existing defences (raising and widening) along with the localised setting back of the existing line of defence on the River Petteril upstream of Botcherby Bridge. The scheme is designed to provide protection against a 0.5 per cent annual probability (1 in 200 years event).
- Phase 2: This includes floodwalls and embankments along the Rivers Caldew and Eden, along with a pumping station that will pump water from the Little Caldew to the River Caldew when river levels pose a flood risk.

Table 1: Historical flooding in the Eden catchment - Carlisle area (EA, 2008)

Specific location	Watercourses	Date	Extent and severity
Warwick Rd, Botcherby	Petteril, Eden	1903	Low lying roads, fields and properties
Warwick Rd, Eden Bridge	Petteril, Eden	1918	Low lying roads, fields and properties
Willow Holme, Caldewgate	Caldew, Eden	1925	Low lying roads, fields, properties and commercial/industrial premises
Botcherby Bridge, Warwick Rd	Petteril, Eden	1931	Low lying roads, fields and properties
Warwick Rd, Botcherby Bridge, Willow Holme, Caldewgate	Caldew, Little Caldew, Petteril, Eden	1966, 1967, 1968	Low lying fields, roads and > 400 properties and industrial premises
Willow Holme, Dalston, Durranhill, Botcherby, Warwick Rd	Petteril, Eden, Caldew, Little Caldew	1979	Low lying roads, fields and properties
Warwick Rd, Durranhill, Willow Holme	Petteril, Eden, Caldew, Little Caldew	1982	Low lying roads, fields and properties
Warwick Rd, Willow Holme	Caldew. Little Caldew	1984	Widespread flooding, approx 400 residential and 50 industrial properties
Chapel St, Warwick Rd, Willow Holme	Eden, Caldew, Little Caldew	1995	Approx 18 properties
Catchment wide	Eden	2002	Isolated flooding of properties. Low lying roads, fields and recreational areas
Warwick Rd, Harraby Green	Eden, Petteril	2005	1147 residential properties and commercial properties
Denton Holme, Willow Holme, City Centre, Etterby Terrace, Rickerby	Eden, Caldew	2005	697 residential properties and commercial properties
Low Crosby to Warwick Bridge	Eden	2005	90 residential properties

2.1 January 2005 storm

In January 2005, severe storms and heavy rain falling on already saturated ground led to major flooding in the Carlisle area (and a number of other locations in northern England). As a result there were three immediate deaths, over 2000 homes and businesses were flooded and more than 3000 people were homeless for up to 12 months and more (Pitt Review, 2008).

Rain started to fall on the evening of January 6th and continued to fall almost continuously for 36 hours, falling onto ground already saturated from previous rainfall. On the 7th and 8th of January the rain was accompanied by storm force winds, with the equivalent of one month's rainfall falling in just 24 hours (Calvert and Murphy, 2005). In Carlisle, the flooding started to occur in the early morning of Saturday January 8th and by 10am, the same day, had become extremely serious, with many people in need of rescue

(Anon, 2005a). Although the flooding was extensive and, in places, up to 2m deep many people chose not to evacuate and remained in their homes. The police station, fire station and local authority offices (Carlisle civic centre, which had been designated as the emergency response headquarters) were all severely flooded, as were the main electricity substation (Photo 1), telephone exchange and sewage treatment works (EA, 2005).

The strong winds contributed to the flooding by causing obstructions resulting in the bypassing of flood defences on the Petteril and Caldew (EA, 2005). An outline of the timing of the flood event (from EA, 2005) is given in Appendix 1.

The problems caused by the storms were exacerbated by power cuts (caused by the flooding of the electricity substation) and loss of landline communication and many mobile phone connections.

Photo 1: Willowholme industrial estate (site of electricity substation)

Photo credit: David Humphreys Cumbria EPU

The extent of the flooding is shown in Figure A1 (in the Appendix), with the number of properties affected and the sources of flooding shown in Table 2. Although the water generally subsided quickly, flooding in some areas reached 7 feet in depth and took four days to subside (UK Resilience, 2005).

Table 2: Extent and sources of flooding – Carlisle January 2005 (EA, 2005)

	Warwick Road & Harraby Green	Denton Holme, Willow Holme & City, Etterby Terrace & Rickerby	Low Crosby to Warwick Bridge
Number of flooded properties	1147	697	90
Observed return period (years)		>1:150 (Eden)	
Current standards (return period protection)	1:50 – 1:70	1:20 – 1:50	1:20 – 1:25
Flooding from main river	yes	yes	yes
Flooding from ordinary watercourse	no	yes	no
Flooding from surface water drains	yes	yes	no
Flooding from sewerage infrastructure	no	yes (1)	no

The flooding mechanisms in Carlisle are complex, with a number of critical ordinary watercourses interacting with the three main rivers (Eden, Caldew and Petteril) along with sewers and surface water systems. The surcharging sewers in the January flooding resulted from the combined foul and surface water sewers being gravity locked by the river Eden, which prevented flows discharging from the treatment works (EA, 2008).

2.2 Local impact studies

A number of studies examining the impacts of those affected by the flooding in Carlisle as a result of the 2005 floods have been conducted, although not all of these have been formally published. Research has included questionnaire surveys by Communities Reunited and BBC Radio Cumbria as well as interview and focus group studies. The majority of studies focus on how people coped with the flooding event and its aftermath. In addition, some health research was conducted at the time of the flooding, with increased GP and pharmacy surveillance in the area. People were encouraged (via the media) to visit their GP if they had any symptoms. No significant increases were reported (Nigel Calvert, pers. com.).

2.2.1 Living in Fear: Health and Social Impacts of Floods in Carlisle 2005

The aims of this project, conducted by Carroll *et al*. (2006) were to:

1) Provide evidence of the most salient issues and the health and social effects of the floods upon those households in Carlisle which had been flooded.
2) Provide evidence for policies and guidance for local agencies in the event of future floods.
3) Provide a basis for further research work.

The research was conducted with the co-operation of Carlisle City Council, Communities Reunited, Carlisle Council for Voluntary Services and North Cumbria Primary Care Trust. The study used in-depth focus groups and individual interviews. A random population sample was taken from a database of flooded properties. There were five focus groups, totalling 27 people, and six individual interviews to provide information for the first aim (which is most relevant to the current work). The interviews were semi-structured and tape recorded and were conducted between 10 and 13 months after the flooding event (Carroll *et al*., 2009).

In summary, most people were surprised by the speed, power and depth of the flood waters and they did not have enough time to save their possessions. People were concerned about pollution and contaminated water and often people were told by restoration and insurance companies to throw away everything from downstairs. Most people described their experience in strong emotional terms, such as ‘horrifying’, ‘traumatic’ and ‘absolutely petrified’. Many people reported that they or their families had suffered from a number of minor ailments as a result of the flooding and everyone reported various degrees of worry and anxiety about factors related to the floods which resulted in stress.

The research illustrates the complex factors that impact on people including loss of possessions, difficulties in finding suitable alternative accommodation or the stress of living in the flood damaged property, problems dealing with insurance companies and builders and also fear that it might happen again.

2.2.2 BBC Radio Cumbria Survey

The local radio station conducted a small-scale survey of residents in the Warwick Road area of Carlisle. They received 64 responses from approximately 240 questionnaires (Anon, 2005b). Of the questionnaire respondents, over 50% said that they or their partners, children or relatives had health problems and continued to suffer as a result of the floods some six months after the event. Problems reported included frayed tempers, mild depression, anxiety and migraine.

2.2.3 Communities Reunited Health Survey

Communities Reunited (an organisation set up and funded by Carlisle City Council, Cumbria County Council and the Carlisle Churches Flood Response Team shortly after the flood) carried out a questionnaire survey approximately ten months after the flooding event (Communities Reunited, 2006). The survey was mailed to 1400 properties (not all of which would have been occupied) and 213 responses were received. 65% of respondents noted that they (or others in their home) had experienced difficulties coping with the floods, although most (63%) did not seek any help with their problems. Of those who did seek help 39% went to their GP, while others sought counselling or took part in various support groups. The most commonly reported symptoms resulting from the flooding were sleeplessness, feeling low, tiredness, irritability, feelings of being overloaded and anxiety. Over 65% of respondents said that their stress levels were higher at the time of the survey than they had been 12 months ago (i.e. before the flood). People reported a variety of means for managing stress including relying more heavily on friends and family, alcohol, medication, exercise and smoking. The biggest causes of stress were reported to be builders, loss adjustors, loss of personal effects and delays in returning home.

Carroll *et al.*, 2010 have recently published a paper which draws the research outlined in Sections 2.2.1, 2.2.2 and 2.2.3, where the findings are presented in five sections covering flood risk awareness, water contamination issues, physical health, mental health and impact on frontline support workers.

2.2.4 After the flood

The heath and social impacts on flooded Carlisle residents were also examined by Convery and Bailey (2008) in research commissioned by Communities Reunited. A total of 16 flooded householders were interviewed in April 2006. In terms of impacts, similar results to those reported by Carroll *et al*., 2006 were found. Recovery was aided by both informal support and local ongoing support centres.

2.2.5 Response and resilience in post-flood communities: lessons from Carlisle

This case study was conducted as part of an Environment Agency study into improving institutional and social responses to flooding (Watson *et al*., 2008) and aimed to investigate how local communities in Carlisle have attempted to recover from the January 2005 flood. The group developed a series of questions on resilience, which ranged across issues affecting the individual and households to the broader community. The questions were put via either focus groups (three) or interviews with selected individuals (four) who played an important role in the local response to the flooding. The research was conducted approximately 35 months after the flood. The small focus groups were recruited through established Flood Action Groups in Carlisle and each group session lasted two hours. Many of the responses were similar to those already reported, although in terms of adaptation to future floods there was a marked feeling of fatalism among some residents who believed there was little they could do because of the age and design of their properties and the fact that in most cases new fixtures and fittings (such as electricity sockets and boilers) had been installed in their original positions, doing nothing to alleviate the impacts of any future flooding. Additionally, few people had made contingency plans in event of another flood.

3. Health impacts

In addition to the studies reported for Carlisle, numerous other studies, conducted worldwide, have reported health impacts as a result of flooding (reviews: Ohl and Tapsell 2000; Hajat *et al.*, 2003; Tapsell and Tunstall, 2003; Ahern *et al.*, 2005; Fewtrell *et al.*, 2008a) and the health effects have been categorised into a number of groups, namely:

- Mortality and injuries;
- Infections; and
- Mental health effects.

A number of these health effects are amenable to quantification in a health impact assessment, as outlined below. Where possible health impacts will be quantified in terms of disability adjusted life years (DALYs) in order to give an overall health impact and allow comparisons between different causes of health impact and different flood-related scenarios. DALYs are summary measures of health that allow the comparison of effects across a wide range of health outcomes, including death, injury and illness. The measure combines years of life lost by premature death (YLL), with years (or days, weeks or months) lived with a disability (YLD), standardised using severity or disability weights. The weights range from 0 (perfect health) to 1 (dead). The calculation of premature death requires an estimate of life expectancy. This varies according to age group and gender but, in the UK. overall average life expectancy at birth is 79.8 (ONS, 2011) and this figure has been used in the calculations.

3.1 Mortality and injuries

This Section considers mortality as an immediate and direct consequence of flooding, as opposed to flooding acting as a stressor on a vulnerable person and a subsequent death, some weeks or months afterwards, from say a heart attack (hastened mortality). Injuries may occur during the pre-onset and onset phase of flooding (when people are trying to escape or remove valued possessions from the approaching floodwaters) or during the post-onset phase, when people return to their property and start the clean-up process (Ahern and Kovats, 2006).

3.1.1 Mortality

USA

Duclos and Isaacson (1987) report on 24 deaths related to flooding events in the USA, only nine of which had drowning as the primary cause. Another nine were due to heart attacks while people were involved with unusual flood-related stress or activities (including moving furniture and clean-up processes). The other two deaths relevant to the flood event were asphyxiation while using a gas generator to pump water out of a basement and electrocution while connecting a pump in a flooded basement. In flash floods affecting Georgia, 28 deaths were classified as flood-related (CDC 1994), 27 of these deaths were due to drowning (cause of death was unknown in one case), with 20 being motor-vehicle related (i.e. victims drove into low-lying areas, across washed out bridges or off the road into deep water). Enhanced surveillance of emergency departments was conducted in North Carolina, USA, following Hurricane Floyd (CDC 2000). In total, 52 deaths were attributed to the event with drowning being the most common cause (Table 3). Five of the deaths were in rescue workers.

Table 3: Deaths related to Hurricane Floyd, by cause of death (CDC 2000)

Cause of death	Number	%
Drowning	36	69
In motor vehicle	24	
In boat	7	
As pedestrian	4	
In house	1	
Motor-vehicle crash (excluding drowning)	7	13
Heart attack	4	8
Fire (burns and trauma from escape attempts)	2	4
Hypothermia	1	2
Electrocution	1	2
Fall	1	2

Due to the scale of the flooding and damage caused by Hurricane Katrina, attributing deaths to specific storm-related causes was difficult. In the Greater New Orleans area, of 750 cases, the Louisiana coroner determined that Hurricane Katrina explicitly caused 727 fatalities. The majority of deaths were recorded in residents of the New Orleans metro area, with only 2% of deaths among residents of other areas in Louisiana, visitors from out of state or people of unknown residence (Schlenger *et al*., 2006). Identified causes of death included (Schlenger *et al*., 2006):

- Lack of access to care; only three hospitals remained fully functioning throughout the hurricane, and many hospitals ran out of food, water and ice, putting patients at risk of starvation, dehydration and heat stroke. People also died from lack of medication (such as insulin). In addition, a number of nursing homes and hospitals were investigated regarding possible euthanasia and one has been charged with 34 counts of negligent homicide.
- Drowning.
- Infection; five deaths were attributed to wound-associated vibrio infection.
- Suicide.
- Homicide.
- Accident; there were at least five deaths due to carbon monoxide poisoning. Other people died as a result of being crushed under rubble, trapped in their homes (where they probably died of dehydration). At least 25 people died during evacuation, a variety of reasons were reported including exploding oxygen canisters on a bus.

UK

Analysis of events surrounding the autumn 2000 floods suggests that four drownings may have been related to the flooding and the fact that there weren't many directly attributable to the event seemed to be more the result of luck than judgement (Kelman 2003). There were three immediate deaths as a result of the Carlisle flood (2 drowning, 1 fatal injury), 13 during the summer 2007 floods (9 drowning, 2 carbon monoxide poisoning, 1 hypothermia, 1 fatal septicaemia) and 1 (drowning as a result of bridge collapse) during the autumn 2009 Cumbria floods (Ward and Jones, 2005; Pitt Review, 2008; Batty, 2009).

3.1.2 Injuries

Injuries may occur during flooding (e.g. impact with flood-related debris or being knocked over by the floodwater) and also from the subsequent clean-up process. During surveillance of emergency departments and enhanced surveillance (including contact with emergency shelters) following the Midwest flood in Missouri, USA, in 1993, 524 flood-related conditions were reported, 250 (47.7%) of which were injuries, with the most common being sprains, strains and lacerations (CDC 1993). It was estimated that 60,000 people were displaced during these floods – giving a reported injury rate of 0.4%. Following Hurricane Floyd in the USA, surveillance of emergency departments recorded a variety of flood-related visits, many of which were related to orthopaedic and soft tissue injury (28%). Comparison of injury data following the hurricane with pre-hurricane emergency department visits found an increase in dog bites, insect bites and violence (CDC 2000). A survey of police officers and fire fighters in New Orleans, following Hurricane Katrina, found that lacerations and sprains were the most common injuries (CDC 2006). A total of 22% of those surveyed reported lacerations (311/1437), 17% reported sprains or strains and 10% reported animal bites or stings. Sullivent *et al.*, 2006, also examined non-fatal injuries in residents and relief workers over a five week period shortly after the hurricane struck. Over 7500 injuries were recorded, with falls and cut/stab/pierce injuries being the most common. Injuries were most frequently associated with the clean-up process.

In France, Duclos *et al.*, 1991, reported three serious injuries as a result of flooding (arm and face burns, a broken leg, broken arms) and found that 6% of occupants in households surveyed following flooding in Nîmes reported mild injuries (such as bruises, cuts and sprains).

Following flooding in Lewes, UK, Reacher *et al.* (2004) noted that 11.8% of flooded respondents completing a telephone interview nine months after the floods reported sustaining injuries as a result of flooding. Injuries included sprain/strains, broken bones, burns or scalds, electric shock, inhalation of smoke, gas or vapour and hypothermia. If the percentage of injuries reported by non-flooded respondents is subtracted from this total, it suggests that 3.9% of reported injuries are attributable to flooding.

3.1.3 Quantification

The 'Flood risks to people' project (DEFRA/EA 2004, 2006) developed a formula to estimate death and serious harm occurring as a direct result of flooding either during the actual flood event or for up to one week after the event (Appendix 2) . The formula has a number of components, namely:

- Estimation of flood hazard - based on the depth of flooding, typical velocity and the likely debris;
- Estimation of area vulnerability - based on the nature of the area (e.g. type of property), the speed of onset of flooding and the effectiveness of the local flood warning; and
- Estimation of the vulnerability of the local population – based on the percentage of residents aged 75 and over and those suffering from a long-term illness.

Relatively minor injuries will be quantified by assuming that 3.9% of occupants of flooded properties are affected (based on the figures from Reacher *et al.*, 2004). A moderately high severity weight has been chosen (0.12), based on an average for broken bones (hand, feet and ankle) from VDHS, 1999.

3.2 Infection

A number of infections can result from contact with floodwater. These can be caused by a variety of different agents (bacterial, viral, protozoal and fungal), they can occur via a range of exposure routes (e.g. ingestion, inhalation, wound infection, insect transmission), with the severity of infection ranging from subclinical or mild to fatal. In developed countries, fatal infections are probably rare, although cases have been reported including septicaemia and vibrio infection in the USA (e.g. Spice, 2004; CDC, 2005) and fatal septicaemia in the UK (de Bruxelles, 2008). In fatal cases of infection, underlying illness is common.

Flood-related infection has previously been reviewed (Fewtrell *et al.*, 2008a) and only areas amenable to quantification will be outlined below.

3.2.1 Respiratory disease

Research conducted in the UK by the Flood Hazard Research Centre (FHRC), has suggested that respondents at focus group meetings following flooding in the northeast of England (June 2000) were likely to report asthma, chest infections, coughs, colds and flu, which were believed to be due to the flooding (Tapsell *et al.*, 2002), although the specific symptoms reported vary by the area studied. In a DEFRA/EA study (2003), respondents were asked to report on physical health effects following flooding. Respiratory symptoms (namely colds, cough, sore throats and flu) were reported by 20% of the respondents. Reacher *et al.* (2004), in a study of the health impacts experienced as a result of flooding in Lewes found a significant association between flooding and self-reported worsening of asthma in adults (Relative Risk - RR 3.1; 95% Confidence Interval – CI 1.2 – 4.4) but not for respiratory illness in children or adults.

The figures above, on the worsening of asthma in adults, have been used to quantify the impact of flooding on one aspect of respiratory health. In the UK, 5.4 million people are currently receiving treatment for asthma; 1 in every 12 adults (8.3%) and 1 in every 11 children (Asthma UK, 2011).

3.2.2 Gastrointestinal infection

A study conducted in the northeast of England found that many people who had been flooded reported diarrhoea and upset stomach symptoms following the flooding (Tapsell *et al.*, 2002), although the study was not designed to determine whether these effects were statistically significant.

Following topical storm ‘Allison’ in Houston, Texas (USA) in June 2001, the Department of Health and Human Services conducted a rapid needs assessment in the areas most affected by flooding (CDC 2002). The survey took place one week after the heaviest rainfall. Questionnaires were completed by people from 420 households, 137 had floodwater in the home during the event. Almost 13% of the surveyed households reported at least one person with illness that occurred after the onset of the flood and people living in flooded homes were significantly more likely to report illness than those from non-flooded homes (Odds Ratio – OR 4.7; 95% CI 1.8 – 12.0). Gastrointestinal illness in people from flooded homes was especially elevated (OR 6.2: 95% CI 1.4 – 28.0).

In a retrospective study of self-reported health impacts arising from riverine flooding in Lewes, East Sussex, Reacher *et al*. (2004) did not find that gastroenteritis was a statistically significant health outcome, when comparing flooded with non-flooded properties (RR 1.7: 95% CI 0.9 – 3.0), although there was a relationship with the depth of flooding.

The flooding component of a study by Wade *et al*. (2004) was an opportunistic addition to an ongoing project studying the incidence of gastroenteritis related to drinking water. Flooding along parts of the Mississippi River occurred over a period of six weeks in April and May 2001; during some of this time the floodwater would have contained untreated sewage and wastewater. After the flood had subsided participants in the study were sent a questionnaire asking them about the extent to which they had come into contact with floodwater or flood-contaminated items. Health data continued to be collected on a routine basis. The rate of diarrhoea resulting in a doctor's visit; days of missed work or school due to gastrointestinal symptoms; and days of vomiting were not elevated following flooding. There was, however, an overall elevation in the reporting of highly credible gastrointestinal (HCGI) symptoms (HCGI symptoms include any of the following: liquid diarrhoea, soft diarrhoea and cramps, nausea and cramps, vomiting) during the flood period in comparison with other periods (Incidence Rate Ratio – IRR 1.29; 95% CI 1.06 – 1.58). This was particularly marked in those people who reported flooding in their house or yard (IRR 2.36; 95% CI 1.37 – 4.07), especially in children aged 12 or less (IRR 2.42; 95% CI 1.22 – 4.82). As noted by the authors, direct contact with floodwater did not entirely explain the increase in gastrointestinal symptoms observed during the flood period, as the incidence was still elevated in people who had no reported floodwater contact.

Where properties have private drinking water supplies, flooding may result in contamination of the source water with a variety of microorganisms including gastrointestinal pathogens, such as *Cryptosporidium* spp. (Duke *et al*., 1996; Fewtrell *et al*., 1998). Increased turbidity in the source water as a result of flooding may overwhelm treatment systems and, in some cases, where properties are still occupied and water is not boiled or chemically treated an increase in gastrointestinal illness is likely.

Given the range of figures reported in the literature, from no apparent increase in gastroenteritis, up to an OR of 6.2 (95% CI 1.4 – 28), it is difficult to know what to choose for quantification. The study by Wade *et al*. (2004), however, provides a reasonable compromise with an IRR of 2.36 (95% CI 1.37 – 4.07) and this has been used in the HIA. An elevation in serious gastrointestinal problems, however, was not reported so the duration and severity of cases has been assumed to be short and mild, respectively. Estimates of the typical number of episodes of gastrointestinal illness per person per year in developed countries vary, with a range of 0.03 to 2.6 (Payment and Hunter 2001). Hence, for simplicity, a figure of 1 episode per person per year has been assumed as a general incidence rate.

It is likely that the level of gastrointestinal illness as a result of flooding will be determined by the pathogen content of the floodwater (i.e. how polluted it is). This may explain the wide range of figures reported in the literature. To examine this is more detail a Quantitative Microbial Risk Assessment (QMRA) of flooding and gastrointestinal health will be conducted in parallel to the use of the figures derived from Wade *et al.* (2004). This is outlined in Section 5 and accounts for a number of selected gastrointestinal pathogens, reported behaviour during a flood event and locally relevant water quality data.

Effects on private water supplies are site and event specific and have not been considered in either the health impact evaluation or the QMRA as the case study area (Section 4) is not served by private supplies.

3.2.3 Earache

Reacher and colleagues performed a historical cohort study using telephone interviews in residents from 103 flooded and 104 non flooded properties in the same postcode area in Lewes, Southern England (Reacher *et al*., 2004). The telephone interviews were conducted nine months after the flooding: information was recorded for a number of symptoms (some of which have already been outlined). In subjects of all ages, earache was significantly associated with having been flooded (RR 2.2; 95% CI 1.1 – 4.1).

Earache can be quantified using the relative risk outlined above. No details are given by Reacher *et al*. (2004) on duration or severity so these have been assumed to be short (three days) and mild. The general incidence of earache is unknown, but the incidence of acute otitis media (inflammation of the middle ear) in the Netherlands in general practice is about 20 per 1000 patients (Appleman *et al*. 1999). Given that fewer people would be expected to visit their general practitioner for less serious and short-lived earache a general incidence of 50/1000 has been assumed to apply to the UK population (a figure not dissimilar to the projected annual incidence of earache based on non flooded respondents in the study by Reacher *et al*., 2004 (66/1000).

3.3 Mental health

Mental health is a wide ranging and complex area. It has been reviewed in Fewtrell (2011) and the following section focuses on those studies which allow the quantification of impacts.

Reacher *et al*. (2004) performed a historical cohort study using telephone interviews to establish physical illness and psychological distress (measured using GHQ-12) in residents from 103 flooded and 104 non-flooded properties in Lewes, Southern England.

Psychological distress in adults was significantly raised in the flooded group (RR 4.1; 95% CI 2.6-6.4).

A large-scale study conducted at 30 locations throughout England and Wales examined both flooded and non-flooded populations using the standard GHQ-12 (to assess current mental state) and a version designed to capture the mental state at the respondents 'worst time' after the flood event (Defra/EA 2003; Tunstall *et al.*, 2006). The study was conducted between 2 and 4½ years after flooding (depending on the location). A marked difference was found between the worst time and current GHQ-12, with RR values of 6.46 (95% CI: 4.92-8.49) and 2.52 (95% CI: 1.88-3.38) respectively.

More recently, a team from the Health Protection Agency (HPA) in the UK conducted an assessment of four mental health symptoms in two English regions following the summer 2007 flooding using a questionnaire survey (Paranjothy *et al.*, in press), comparing flooded and non-flooded populations. Data were collected from South Yorkshire (3 to 4 months after flooding) and Worcestershire (6 to 7 months after flooding). Psychosocial impact was determined using four standard instruments, namely the General Health Questionnaire (GHQ-12), Generalised Anxiety Disorder (GAD-7), Patient Health Questionnaire (PHQ-9) and the Post-Traumatic Stress Disorder (PTSD) checklist – shortform (PCL-C), which assess psychological distress, probable generalised anxiety, probable depression and probable PTSD respectively. The prevalence of all measured mental health symptoms was 2 to 5 times higher among individuals who experienced flood water above floor level in their homes. The following odds ratios were recorded:

- Psychological distress: OR 5.0 (95% CI 3.4-7.3);
- Anxiety: OR 4.8 (95% CI 3.0-7.8);
- Depression: OR 2.6 (95%CI 1.6-4.3);
- Probable PTSD: OR 3.9 (95% CI 1.9-7.8).

In a small-scale study, Fewtrell (2011b) also found that mental health symptoms were elevated in respondents who had been flooded (3 years after the flooding event) but that none of the differences were statistically significant.

The availability of baseline illness data (i.e. levels in the general population), for the reported mental health symptoms, varies widely. Probably the best characterised is psychological distress (GHQ-12), where data are available on a regional basis in England from the NHS Clinical and Health Outcomes Knowledge Base (Lakhani *et al*., 2011). In 2005, the year of the Carlisle floods, the incidence of psychological distress in adults in England was 13%, while in the North West region it was 15.4%. The latter value, along with the OR from Paranjothy *et al*. (in press) of 5.0 will be used to characterise distress caused by flooding for up to a year after the event. The figure of 2.5 from Defra/EA (2003) will be used to characterise distress during the second year after flooding.

According to the literature, the one-year prevalence rate for generalized anxiety disorder is between <1 and 12.7% (Kruger *et al*., 2009; Gale and Davidson, 2007; Somers *et al*., 2006; Kessler *et al*., 1994; Barlow *et al*., 1986). In the UK, Singleton *et al*. (2001) found GAD in 44 adults per 1,000 in the week before the interview. In a systematic review of the literature published between 1980 and 2004, Somers *et al*. (2006) derived a best estimate for the 1-year prevalence rate of GAD as 2.6% (95% CI: 1.4-4.2). Gender differences in mental health symptoms are often reported and GAD is no exception, with symptoms being more common in women (best estimate 1-year prevalence rates of 1.4 in men and 2.6 in women – Somers *et al*., 2006).

In a systematic review, Waraich *et al.* (2004) found that the 1-year prevalence of low grade depressive symptoms was between 0.8 and 3.3%, with a best estimate of 2.0% (95% CI: 1.3-2.8). Symptoms were more common in women (2.4%) than men (1.7%). Moussavi *et al.* (2007) reported that the prevalence of depression in respondents with chronic diseases is significantly higher than in respondents without chronic diseases.

In the USA, results from the National Comorbidity Survey has allowed the estimation of the 12-month prevalence of PTSD in the general population. The overall rate of PTSD in the population is 3.6% (National Comorbidity Survey, 2011).

3.4 Summary of health impacts and quantification measures

The health impacts to be quantified in the HIA are summarised in the Table below (Table 4), along with information on severity weights and assumed duration.

Table 4: Health impacts summary

Impact	Baseline incidence rate	Severity weighting	Assumed duration (days)	Relative risk
Death	Calculated from the flood risks to people formula			
Serious harm*	-	0.372	56	-
Minor injuries	-	0.12	21	-
Earache	0.001	0.09	3	2.2
Gastrointestinal illness	0.020	0.09	3	2.3
Worsening of asthma (adults)	0.083	0.07	2	3.1
Psychological distress (year1)	0.154	0.065	365	5
Psychological distress (year 2)	0.154	0.065	365	2.5
Anxiety	0.026	0.17	183	4.8
Depression	0.020	0.14	183	2.6
PTSD	0.036	0.13	183	3.9

* based on a broken leg

The majority of severity weights have been taken directly from the literature (VGDHS, 1999) or, where this was not possible, extrapolated from the literature by basing the weights on illnesses of a similar nature. The severity weight for psychological distress is based on half of that for PTSD.

To estimate the amount of illness from flooding ($IR_{flooded}$), the baseline illness rate ($IR_{baseline}$) is multiplied by the excess relative risk of illness (RR-1), assuming that those unaffected by flooding have a relative risk of illness of 1.

$$IR_{flooded}=IR_{baseline} \text{ x } (RR-1)$$

The derived illness rate is then applied to the number of people affected by flooding.

4. Case study population

The case study population is based on those people in the Denton Holme area of Carlisle who were flooded by the River Caldew during the January 2005 floods. The number of households flooded, the depth to which they were flooded and the velocity of the flood water were calculated from a model simulation of the flood (Jeff Neal, pers. com). Figure 1 shows the model outputs for water depth for the whole of Carlisle, while Figure 2 gives an example of the localised depth data for part of the Caldew flooding.

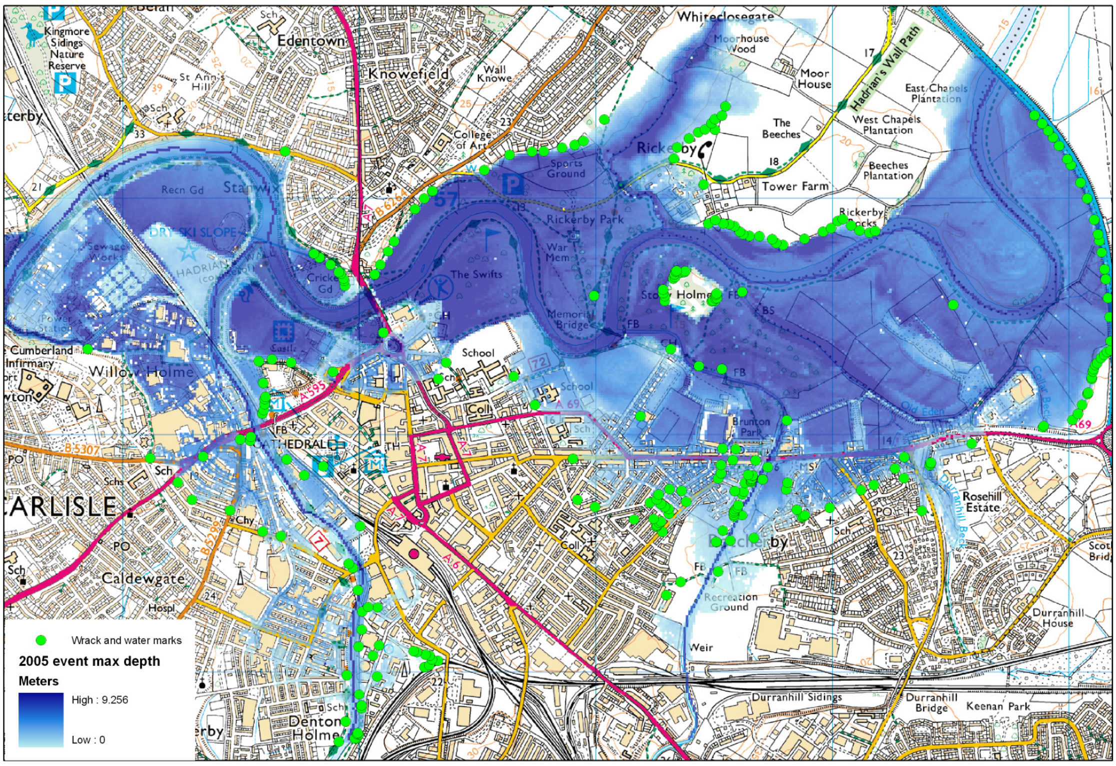

Figure 1: Maximum modelled depths during the Carlisle January 2005 flood

The Caldew was chosen as the case study flood for a number of reasons, including the availability of modelled data, the reasonably large number of homes flooded and the availability of microbial water quality data (Fewtrell, 2011a).

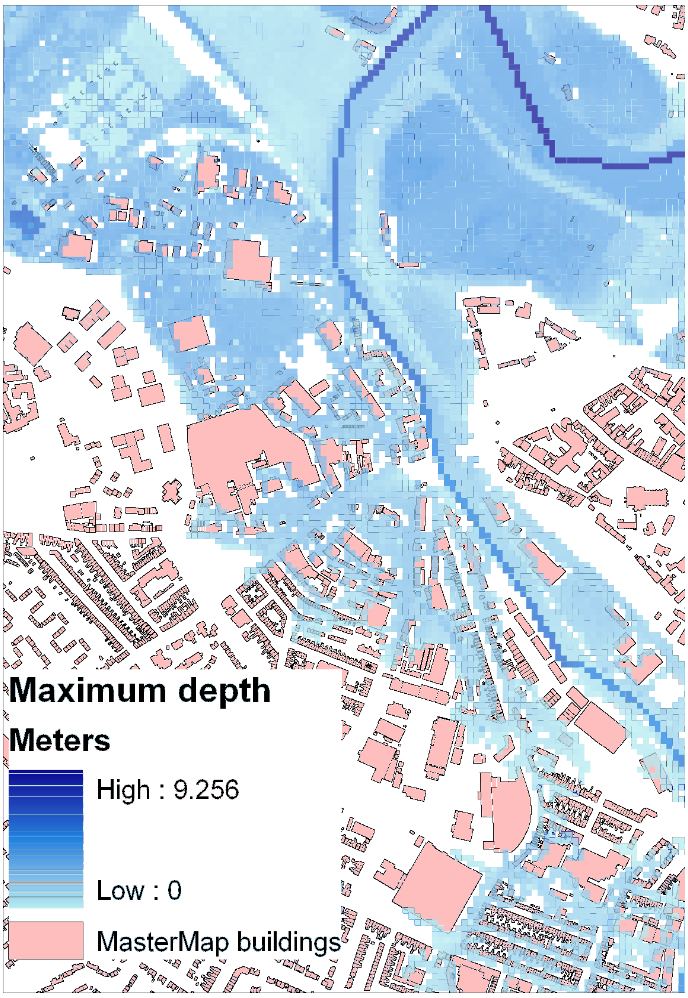

Figure 2: Maximum modelled flood depths around the river Caldew (January 2005 flood)

On the basis of the model, it was determined that a total of 725 homes were flooded by the River Caldew. The depth of flood water varied between <0.01 to 2.25m (based on 339 measurements), with an average (and median) value of 0.66m. The velocity of the flood water varied according to the local topography and ranged between 0 to 1.1m/s. The average velocity was between 0.11 and 0.35m/s.

Census data for the flooded population was based on the Denton Holme ward (16UDGJ), shown in Figure 3, and output area 16UDGF0013 (Figure 4), which comprised a total population of 6165 living in 2877 households.

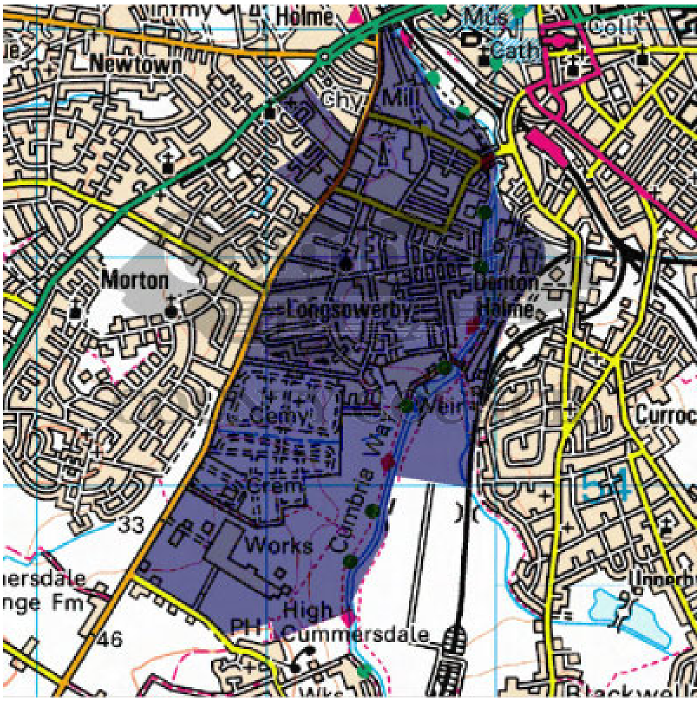

Figure 3: Denton Holme ward

Data on a number of parameters, including age, general health, long term health and household occupancy were derived from the Office of National Statistics Neighbour Statistics website (http://www.neighbourhood.statistics.gov.uk), based on data from the 2001 national census.

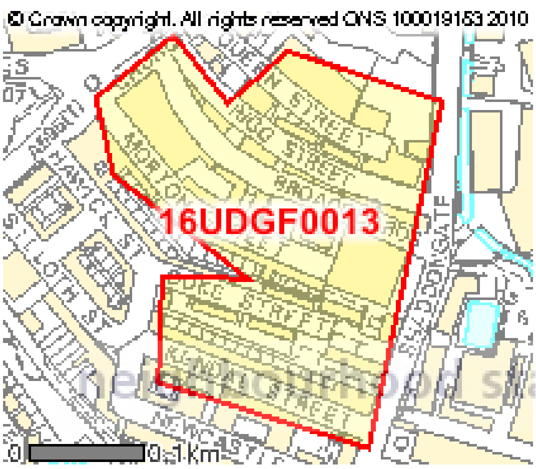

Figure 4: Output area map

A summary of the census data is shown in Table 5.

Table 5: Summary of census data

Category		Number	Percentage
Total population		6165	100
Age Profile (UV04)			
	0 to 4	381	6.18
	5 to 9	390	6.32
	10 to 14	369	5.98
	15 to 64	4101	66.52
	65+	924	14.98
	Children	1140	18.49
	Adults	5025	81.50
	Adults 75+	517	8.38
Health status (UV20)			
	Good	4102	
	Fairly good	1417	
	Not good	656	10.62
Long-term illness (UV22)			
	With a limiting long-term illness	1240	20.08
	Without a limiting long-term illness	4935	

The average household occupancy in the area is 2.14, suggesting that 1551 people experienced flooding during the January 2005 floods (based on 725 homes). The majority of household spaces in the Denton Holme ward are terraced (59.1%), followed by semi-detached houses (20.7%), flats (16.4%) and detached homes (3.8%). There are no caravans in the area.

5. Quantitative microbial risk assessment

Quantitative microbial risk assessment (QMRA), which is a formal probabilistic process for estimating microbial risks, was applied to gastrointestinal illness in a hypothetical flooded population in FRMRC1 (Fewtrell *et al*., 2008b; Fewtrell *et al*., 2010; Fewtrell *et al*., 2011). This initial application highlighted a number of research gaps, including those relating to the exposure of a flooded population to floodwater and sediment. Although actual exposure will always be incident specific the research conducted as part of FRMRC2 allows empirical data (Fewtrell, 2010a) to be applied to an actual population (outlined in Section 4).

The QMRA examines the risk of infection from three reference pathogens, namely *Campylobacter* spp. (bacterial), *Cryptosporidium* spp. (protozoal) and rotavirus (virus) contracted through exposure to floodwater. The pathogens chosen all have well characterised dose-response relationships as shown in Table 6 (more information on dose-response relationship can be found in Appendix 3).

Table 6: Dose-response relationships

	Beta-poisson		Exponential	Reference
Pathogen	α	β	γ	
Campylobacter spp.	0.145	7.584		Medema *et al*., 1996
Cryptosporidium spp.			0.004005	Teunis *et al*., 1996
Rotavirus	0.265	0.442		Haas *et al*., 1993

Information relating to the calculation of DALYs can also be found in Appendix 3.

5.1 Flood scenario

The flood scenario is based on the flooding of the River Caldew in January 2005, where it has been estimated that 725 homes were flooded (see Section 4). The reference pathogen concentrations are outlined in Table 7 and are based on empirical- and literature-derived data.

The pathogen concentrations for the withdrawal scenario are based largely on the measured concentrations from the small-scale water quality study of the Caldew (Fewtrell, 2011a). The pathogen concentrations for the clean-up scenario are based on sediment concentrations which have been extrapolated from the measured water sample concentrations (Fewtrell, 2011a) and previously conducted sediment analysis (Fewtrell *et al*., 2011). *Campylobacter* concentrations in a microcosm study (Fewtrell *et al*., 2011) were similar for both water and sediment samples (in both sewage and combined river/sewage samples) at day one, however survival was prolonged in the sediment samples, with virtually no die off up to 3 to 4 days. Thus, for *Campylobacter* spp. during clean-up the same concentrations are assumed to be present in the sediment as in the water samples during withdrawal. The situation for *Cryptosporidium* spp. was somewhat different, with concentrations in sediment being generally 1 to 2 orders of magnitude greater than the corresponding water samples. Again, there was very little apparent die-off in the sediment samples up to day 7.

Table 7: Pathogen concentrations in principal flood components

Pathogen	Scenario	River /litre	Foul flow /litre	Data source
Campylobacter	Withdrawal	3 – 180	10 – 1800	Fewtrell, 2011a
	Clean-up	3 - 180	10 - 1800	Fewtrell 2011a; Fewtrell *et al.*, 2011
Cryptosporidium	Withdrawal	0 – 2	0 – 10	Fewtrell, 2011a
	Clean-up	1 - 200	1 - 1000	Fewtrell 2011a; Fewtrell *et al.*, 2011
Rotavirus	Withdrawal	1.8 – 34	288—689	Rutjes *et al.*, 2009; Li *et al.*, 2011
	Clean-up	1.8 – 34	288 - 689	Fewtrell *et al.*, 2011a

Assumed flood composition (90 % river; 10% raw sewage)

There are no empirical data for rotavirus concentrations in the River Caldew and no literature data on rotavirus concentrations in rivers or sewage have been found for the UK. The withdrawal figures are based on river data for infectious PCR detectable units (using an optimized cell culture-PCR assay, determining most probable numbers by using the presence or absence of replicated virus in different sample volumes) in the Netherlands (River Maas, December sample) and primary sewage effluent for winter samples taken from three wastewater treatment works in Beijing, China. The same levels are assumed to apply to sediment during the clean-up process. This is based on the similar concentrations of F-specific phage (often used as an indicator for pathogen viruses) in water and sediment from microcosm studies with only slow die off seen in sediment samples up to 3 to 4 days (Fewtrell *et al.*, 2011).

5.2 Exposure scenarios

In an earlier QMRA (Fewtrell *et al.*, 2011) it was assumed that people would be exposed to floodwater during withdrawal[1] (i.e. leaving their home) and during the clean-up process and that all residents were at home at the time of the flood and they would all choose to withdraw. Recent work, as part of FRMRC2, has explicitly examined people's behaviour during the flood and clean-up process (Fewtrell, 2010a) and, thus, allows more appropriate generalisations to be made.

The behaviour questionnaire was targeted at two populations flooded during the summer of 2007, Toll Bar and Tewkesbury. The flood characteristics were very different between the two sites, with Toll Bar remaining flooded for an extended period, while in Tewkesbury the flooding was relatively rapid and short-lived.

[1] The term withdrawal is preferred to evacuation, as evacuation is generally taken to refer to a process which is only complete when those who have left their homes have properly returned (e.g. Ketteridge and Fordham, 1998).

5.2.1 Withdrawal/non-withdrawal

The withdrawal rates were different between the two areas, with 93.6% of respondents withdrawing from their property in Toll Bar, compared to 42.6% in Tewkesbury. In the Carlisle flooding in 2005 it is known that a large number of people chose to stay in their homes.

It was found that typically most people leave when the water is between ankle and knee deep (30- 50%), but about 20% leave when the floodwater is between knee and waist deep and 10% leave when the water is above waist deep. Most people withdraw (at least partially) by foot and report getting wet during the withdrawal phase, with respondents generally reporting contact with the floodwater for an hour or so. Generally, everyone within a household chooses to stay or go as a household unit.

Where people reported staying in their home during the flooding period, water generally remained for between 2 to 3 days and, during that time, 84% of people reported being in contact with the floodwater.

5.2.2 Clean-up

Between 76% and 82% of respondents reported being involved with the clean-up, typically 55% of those people reported using gloves during the clean-up process.

5.2.3 Exposure assumptions

Based on the questionnaire survey, three different scenarios (Table 8) will be examined: two based on the flood phase, i.e. withdrawal and non-withdrawal, and one on the recovery phase, i.e. clean-up. It has been assumed that children under the age of 5 will be kept out of the flood water.

Table 8: Flood exposure assumptions

Phase	Scenario	% population affected	Numbers affected
Flood	Withdrawal	65% (aged 5 and above)	946
Flood	Non-withdrawal	40% (aged 5 and above)	437
Recovery	Clean-up	75% of those aged 15 and above	948

5.2.3.1 Exposure during withdrawal

People will be exposed to a variety of different water depth during withdrawal. In the questionnaire study only one person (1% of those who withdrew) reported consciously swallowing water during the withdrawal process, so a gulp of water is likely to be rare and will most probably be restricted to those exposed to water depths of knee deep or greater. It has been assumed that 30% of those who withdrew (284 people) were exposed to water of knee deep or greater and that 1% of these people swallowed water (~3 people affected). It was assumed that an immersion resulted in a single gulp of water being swallowed (i.e. approximately 30 ml for adults and 20ml for children - Westrell *et al.*, 2004).

For the rest of those exposed during withdrawal it has been assumed that they were exposed for the period of an hour and that they ingested 1ml of water per hour of exposure (from hand to mouth transfer). This figure is based on that used by a number of authors (including Westrell *et al.*, 2004; Tanaka *et al.*, 1998 and Asano *et al.*, 1992).

5.2.3.2 Exposure during non-withdrawal

It has been assumed that 30% of people chose not to withdraw (with 5% of the population assumed to be unexposed to flood water as they were away from their home and unable to return during the flooding period).

The same degree of exposure from hand to mouth transfer (i.e. 1 ml per hour) as the withdrawing population has been assumed, but the duration of exposure will be greater and a period of 4 to 5 hours has been assumed.

5.2.3.3 Clean-up

People are constantly exposed to soil land dust and, through hand to mouth contact, ingest small amounts on a daily basis. Thus, in line with other similar QMRAs (Strachan *et al.*, 2002; Donovan *et al.*, 2008) ingestion of pathogens has been based on daily soil consumption rates (excluding soil intake from food).

In this QMRA, the exposure to pathogens through flood sediment has been based on the adult soil ingestion study of Stanek *et al.*, 1997, where the average adult ingestion was 10 mg per day, with a high estimate being 50 mg per day. This represents the amount of soil and dust transferred from hand to mouth and excludes soil consumed on food (from unwashed vegetables for example), so represents a useful estimate for sediment ingestion during clean-up. Where people wear gloves (50% of cases) exposure is assumed to be zero. The clean-up duration (when there is exposure to sediment) is likely to be between 1 to 4 days. It has been assumed that less people will be involved with the clean-up as time progresses, thus the following probabilities of exposure were assumed:

- Day 1: 1
- Day 2: 0.5
- Day 3: 0.25
- Day 4: 0.1

5.3 Calculations

Where possible, parameters for inclusion in the QMRA have been represented as probability distributions rather than point estimates, in order to examine the effects of uncertainty. Monte Carlo sampling (5000 iterations) was used for each simulation run using @Risk version 4.5 Professional edition software (Palisade Corporation 2002).

6. Results

6.1 QMRA

Gastrointestinal illness during the flood phase (withdrawal and non-withdrawal) from the bacterial and protozoan reference pathogens based on the scenarios above is negligible. It is estimated (based on mean figures) that exposure would result in less than two cases of infection and, thus, less than a single case of illness (campylobacteriosis and cryptosporidiosis combined) in the flood phase (Table 9). A slightly higher level of illness is predicted as a result of the clean-up process (due to the higher *Cryptosporidium* concentration in sediment and greater period of exposure), with approximately five cases of infection (based on the mean estimate) and almost two cases of illness.

The situation with rotavirus gastrointestinal illness, however, is very different, with a mean estimate of infection during the flood phase of 36, which translates to 18 cases of clinical illness. The predicted illness is slightly greater during the clean-up phase with 23 estimated cases of illness (mean estimate). As can be seen from Table 9 – the range of predicted infection varies widely from, for example, 6 cases up to over 170 for rotavirus infection during clean-up.

Table 9: Gastrointestinal illness risk characterization

Pathogen	Phase	Estimate	Cases of infection	DALYs
Campylobacter	Flooding	min	0.256	2.24×10^{-4}
		mean	1.788	1.57×10^{-3}
		max	8.960	7.86×10^{-3}
	Clean-up	min	0.370	3.25×10^{-4}
		mean	4.185	3.69×10^{-3}
		max	34.84	3.08×10^{-2}
Cryptosporidium	Flooding	min	0.018	1.75×10^{-5}
		mean	0.019	1.88×10^{-5}
		max	0.021	2.03×10^{-5}
	Clean-up	min	0.086	8.89×10^{-5}
		mean	1.041	1.07×10^{-3}
		max	9.620	9.77×10^{-3}
Rotavirus	Flooding	min	8.350	5.31×10^{-3}
		mean	36.30	2.10×10^{-2}
		max	109.17	6.90×10^{-2}
	Clean-up	min	6.650	4.23×10^{-3}
		mean	45.63	2.90×10^{-2}
		max	172.88	1.10×10^{-1}

Summing the DALY scores for the mean estimates for each of the pathogens and exposure scenarios results in a total of 5.8×10^{-2} over the whole population.

6.2 HIA results

The results of the HIA quantification are shown in Table 10. The full calculation for death and serious harm is shown in Appendix 2.

It can be seen from this Table that, based on the flooding experienced by residents of Denton Holme it would be expected that there would be at least one fatality.

Table 10: HIA quantification by health impact

Health outcome	Population affected by health impact	Numbers affected by symptoms	Years lived with disability (YLL)	Years of life lost (YLL)
Death	1551	1.93	NA	78.95
Serious harm	1551	65.3	3.728	NA
Minor injuries	1551	60.5	0.417	NA
Earache	1551	1.8	0.001	NA
GI	1551	42.2	0.031	NA
Worsening of asthma (adults only)	1264	220	0.085	NA
Mental health (adults only)				
Psychological distress (year 1)	1264	779	50.61	NA
Psychological distress (year 2)	1264	292	18.98	NA
Anxiety	1264	125	10.64	NA
Depression	1264	40	2.84	NA
PTSD	1264	132	8.60	NA

The DALY scores for gastrointestinal illness are similar between the QMRA estimate (0.058) and the HIA estimate (0.031).

The overall DALY score is 175, which equates to a score of 0.112 DALYs per person. Overall, and despite there being predicted fatalities, the greatest DALY score is attributable to mental health problems. This is largely as a result of the large number of people affected and the predicted length of the symptoms.

It is likely that the DALY score of 175 is an overestimate of the actual DALYs suffered by the flooded Denton Holme population. It is known that three people died during the 2005 floods, but none of the fatalities were in the case study area and two of the three deaths were in elderly people. Adjusting the YLL to account for the victims being elderly (rather than using the average age of the case study population) results in a DALY score attributable to deaths of 12.56 rather than 78.95. It is also possible that the DALYs resulting from mental health symptoms are an overestimate. Most studies into mental health symptoms have poor return rates. Thus, it may be the case that people with a greater number (or more severe) symptoms will see the personal relevance of the questionnaire and be more likely to complete and return the form, leading to a possible over-estimation of the symptoms. However, even if the quantification is limited to psychological distress lasting for a single year and the years lived with a disability is assumed to be 50% less than that originally calculated – mental health symptoms (scoring 25 DALYs) are still a very significant negative health outcome. The amended DALY scores are shown in Figure 5.

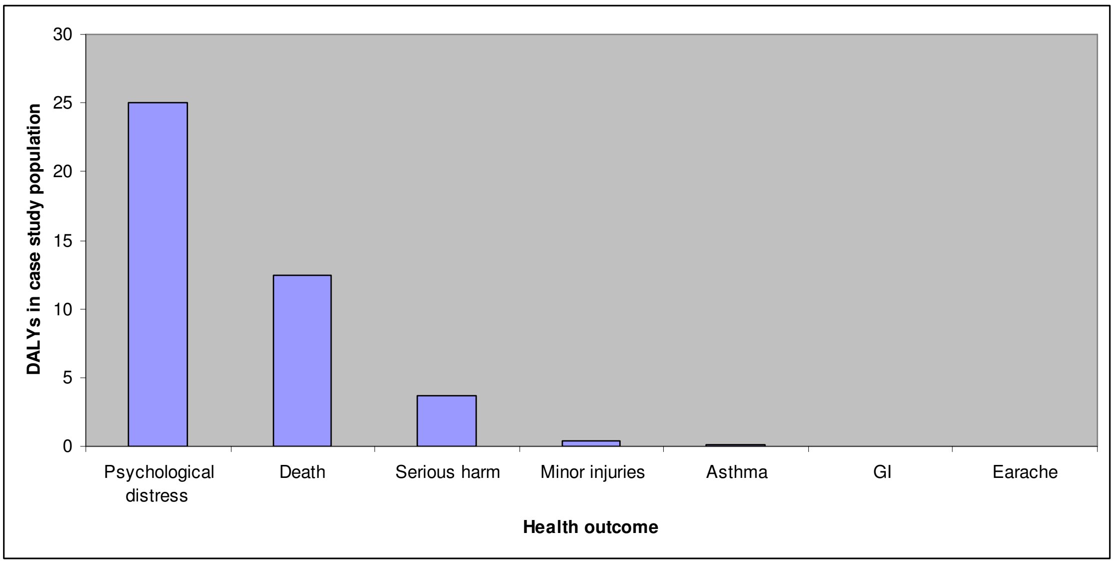

Figure 5: Amended DALY scores*

* Age at death assumed to be 72 (rather than average population age) mental health symptoms confined to psychological distress and reduced by 50%

7. Discussion

This methodology provides a quantitative estimate of the likely health impacts of flooding. Although subjective assumptions (some of which are explored further below) are an inherent part of this protocol, they are clearly specified and based on published, or new empirical data. The HIA and QMRA methodology allows explorations of the type and magnitude of problems likely to be experienced which, in turn, can inform improved mitigation strategies.

The QMRA analysis, using three reference pathogens, suggest that the presence of virus in sediment during the clean-up process is the greatest cause of illness. The sediment exposure levels used in the QMRA were based on research in adults and assumed a much lower ingestion estimate: i.e. 10mg per day; than that normally used. For example, the USEPA, in their chemical risk assessments, assume an adult daily mean soil ingestion rate of 50 mg for each 24 hour period (USEPA, 1996). It is known that mud and sediment, even in small amounts, can transmit infection where ingestion has occurred via splashes to the face or mouth during a mountain bike race (Stuart *et al*., 2010) or through hand to mouth contact while camping on a contaminated pasture (Ogden *et al*., 2002). Thus, the transmission of pathogens during clean-up is very plausible. Clearly, if people actually ingest greater amounts than estimated here then levels of infection will be higher.

As part of the QMRA, two different means of accounting for exposure during clean-up were explored. The first (and the one shown in the results) assumed that the dose of pathogens received over the entire clean-up period was cumulative. The second assumed that pathogen doses consumed on separate days were independent of each other. As there was little difference in the outcomes predicted by the two methodologies, only the cumulative exposure is shown.

Exposure levels in this QMRA were based on new empirical data gathered from two flooded populations (Fewtrell, 2010a). These data provided the evidence-base for key assumptions concerning behaviour during flooding and clean-up. For example, it has been possible to account for those people who chose not to withdraw from the flooded area but remained in their homes during the flood event (Fewtrell *et al*., 2011). There was an indication from the empirical data (Fewtrell, 2010a) that at least 50% of people involved with the clean-up process wore gloves. This was accounted for in the QMRA by assuming that, where people wore gloves, they would not be exposed to pathogens. This is likely to be an optimistic assumption and the efficacy of gloves in reducing exposure to sediment-borne pathogens is unknown but unlikely to provide a totally effective barrier.

There are currently no UK rotavirus data available for the QMRA and data from The Netherlands and China were used in this analysis. In the absence of representative empirical data, it is not possible to judge how applicable these data are to the UK. The rotavirus concentrations used in the QMRA may be an overestimate given the source regions, although the levels were relevant to the time of year when the Carlisle flooding occurred.

While it would be interesting to obtain some UK data on concentrations of rotavirus in river water, sewage and floodwater; this information would probably not change the thrust of the mitigation advice which should be to avoid contact with flood water and sediment where possible. Where contact is unavoidable, this should, ideally, be minimised by using protective clothing and washing hands with clean soap and water (or using an antimicrobial hand gel). It would probably be more useful to look at how effective different gloves are at reducing exposure and whether face masks provide a useful addition to protective equipment.

It is known that there were no flood-related fatalities within the case study area, but the HIA estimate of 1.9 deaths fits well with the 'rule of thumb' proposed by Jonkman and Vrijling (2008) of a mortality of 0.1% as a result of river flooding, based on a study of global flood-related deaths.

Most of the data used to inform the HIA have been derived from UK based studies and baseline incidence rates and, therefore, should be applicable to the case study area. Excluding mental health symptoms, the HIA estimates that just under 400 people in the case study population (roughly 25%) were affected by some flood-related symptoms. Although the enhanced GP/pharmacy surveillance set up after the flooding (Section 2.2) did not detect a significant increase in reporting, the level of symptoms experienced fit in with anecdotal reporting from a number of studies conducted at the time (Sections 2.2.1 [p5], 2.2.2 [p6], 2.2.3 [p6]) and the observation that most people did not seek any help with their problems (Communities Reunited – Section 2.2.3 [p6]). The HIA suggests that the biggest physical health impact in terms of the number of people affected is a worsening of asthma in the adult population which would, in most cases, probably have been self-treated (e.g. increased use of inhalers). It is, however, important to remember that the HIA only accounts for health outcomes that can be quantified and currently excludes hastened mortality, most respiratory symptoms (such as coughs, colds and flu) and mental health symptoms in children.

The mental health symptoms dominate the DALY score, accounting for over 50% of the total amount. This is largely due to both the projected number of people affected and the duration of the symptoms experienced. Numerous studies, conducted using a variety of different methodologies, have found that flooding negatively impacts on mental health and that the symptoms can be long-lived (for a review see Fewtrell, 2011b), so it seems that the effect is a genuine one. What is potentially more open to debate is the degree to which people are affected. Most studies rely on people being prepared to take part in the research (either through completing a questionnaire or being interviewed about their experiences). Even where people are randomly targeted, they chose whether to become involved, i.e. the respondents are self-selecting. This may mean that people with more mental health symptoms: i.e. those who were most affected by the flood; preferentially complete the questionnaire. This could mean that the results are not readily generalised to the whole of the flooded population and that relative risks applied to the whole population lead to an over estimate of the problem. However, even if the mental health symptoms are confined to psychological distress in the first year only and are assumed to apply to only one tenth of the adult population (to account for possible over-reporting) the DALY score (5.04) is still second in order importance behind those resulting from death. Thus, it would seem that mental health impacts are relatively 'insensitive' the assumptions made and deserve greater attention in terms of mitigating the effects of flooding.

Carroll *et al*. (2010) have conducted interviews with people who were flooded during the Carlisle floods and noted that many respondents spoke of psychological stress. They noted that "*people did not seek medical help* [for these symptoms] *for a variety of reasons, such as belief that the stress would soon go away, underestimating and* *misunderstanding the nature of stress (for example, they were in denial), misperceptions of mental health issues, and possible diagnosis of depression and treatment with drugs, which they did not want.*"

Flooding is a complex process and its impact on people cannot be reduced to simply their property being inundated with (often dirty) water, dried out and restored. As noted by Nesbitt (2011), for example, during the Carlisle flooding when homes were flooded, power was cut to the whole city, making communication with the outside world and the emergency services impossible. "*Without radio contact, those affected did not know how to raise help, receive information about the severity of the event or get advice on what to do. Families experienced difficult physical conditions in the depth of winter, with homes rapidly losing heat, filled with freezing sewage-contaminated water and many people were without food or clean water for over 24 hours*." However, as observed by Whittle *et al*. (2010) the actual flood is only the start and they argue that it is not the flood which is the main problem, but the secondary stressors resulting from the poor management during the recovery period which are more distressing for residents. Many of their study diarists reported that the flood did not represent their lowest point and it was only later that the true implications of what had actually happened really began to impact, as illustrated by the following quote from Lucy and her husband Len:

> Lucy: "*The house seemed worse after they had come in and gutted it. It didn't seem so bad when it was flooded, I know it had to be done.*"
> Len: "*That was the heartbreaking part of it. When they walked down the drive with crowbars in their hands I thought 'they aren't going to be nice about this …'.*"

There is a pressing need to improve the quality of the services to flooded communities provided by insurance companies, loss adjustors and builders/contractors. There is also a need to manage expectations and improve communications. Paul Hendy who has studied the work and role of insurers and builders in the flood recovery process identified the central issue as that the length of time required to restore and repair flood damaged property (Paul Hendy, pers. comm.). Often, those flooded, especially in the Carlisle 2005 flood, were given unrealistic dates by their insurance companies. Empirical data from restoration studies suggests that work will require between 12 and 18 months. This was the estimate given to Hull residents which might not have been what they wanted to hear but it avoided disheartening false expectations. Another area relating to expectations is that many people's pre-flood experience of insurance companies is probably limited to minor household claims or car accidents and, as such, Hendy (pers. comm.) has suggested that peoples' perception is that when a claim is submitted to an insurance company it is dealt with in a similar timescale and manner to that of a car accident: i.e. the garage removes the damaged car, provides the policyholder with a replacement during the repair process and returns their car upon completion of the claim. In most cases, everything is done with minimal stress. This is not the case in flood claims and people would benefit from having a clearer idea of the process. The Association of British Insurers have produced a short document entitled "*Responding to major floods: What to expect from your home insurer*", which clearly outlines the process and how long it can be expected to take (Appendix 4). It also outlines the role of loss adjustors and loss assessors (ABI, 2009). Hendy (pers. comm.) also suggests that there is an urgent need for independent monitoring and assessment, quality control and effective project management for all those responsible in dealing with insurance loss.

Currently, there is no standard method for assessing flood damage, which may mean that two similar homes in the same flooded street are assessed and, consequently, repaired in different ways. This can lead to problems when the homeowners subsequently compare the extent and nature of repair works carried out to their properties (Nicholas *et al*., 2001; Wordsworth and Bithell, 2004). This applies not only for the fabric of the building, but also for the contents.

8. Conclusions

Although it is largely unrecorded within routine (or even enhanced) surveillance systems, HIA suggests that flooding leads to a significant burden of disease. Communities have largely come to expect to be protected from flooding, believing that it will not happen to them and making them less aware of the potential risk (Tapsell and Tunstall, 2008). This process needs to be reversed and people need to be both aware of the risks and informed as to how to minimise them.

Timely information and good communication are likely to be key factors in mitigating the health impacts of flooding. There is a need to raise general awareness; people need to understand the hazards and risks before the flooding happens so that they can take appropriate action if they are affected. This, however, is far from straightforward, as information given out pre-flood may be seen by most people as irrelevant, while information post-flood may help, but it may also be too late. A possible means to raise general awareness (and embed the flood message in the collective unconscious) would be through the use of ***realistic*** flood scenarios in TV soap operas/dramas.

Although the newspaper media (at least) does not seem, on the whole, to contribute to flood-related stress and anxiety (Fewtrell, 2010b) they could do much more in terms of providing balanced, helpful and timely advice in terms of:

- what to do during evacuation - where to go, what to take and hazards to be aware of (Appendix 5);
- what problems are likely to be experienced if people remain in the flooded property (e.g. lack of utilities); and
- information on how to cope with the aftermath of the event and the distress that will be experienced (Appendix 6)

There needs to be clear guidance on what to expect during a flood-related insurance claim. For example, it would be useful if the assessment process could be more standardised, with clear information provided on what it may be possible to replace and/or renovate. Stripping out (where everything from floor to ceiling is removed) may often not be necessary (Whittle *et al.,* 2009 p37) while increasing the distress experienced by home owners and the amount of work required and the length of the recovery process.

Insurance companies need to ensure that they have good channels of communication. Local or free-phone contact numbers or local offices may be useful. This should help to reduce the level of frustration some people report during the recovery process. It is also important that loss adjustors, cleaning companies, builders and contractors, used by insurance companies, are accredited to certain standards and, ideally, also have training in dealing with people recovering from a major disaster.

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Appendix 1 Flood event details

Taken from EA, 2005 (section 4.3.3)

Carlisle is split into five warning zones (A-D, plus Denton Holme). These are shown in Figure A1, which also shows the location and timing of significant events during 7 and 8 January. For all five warning zones, flood warnings were issued, with the last on Saturday 8 January. This is some three hours or more before the overtopping of the main flood banks from the River Eden.

Early reports of flooding in the Carlisle area mainly related to surface or groundwaters, and included Cumwhinton and Willow Holme. Some 40 people were evacuated from a club in Gilford Park, shortly after midnight. This was because of road flooding and the club itself did not flood. At a similar time, the Turf Inn basement began to flood, probably from rising groundwater. This was the first flooding in Carlisle A, for which a warning had been issued more than 6 hours previously. Similarly, for Carlisle B warnings were issued more than 2 hours before any flooding.

In the Warwick Road area (Carlisle D), a combination of high flows and blockages to bridges caused backing up within the channel of the River Petteril. Eventually water spilled around the upstream end of the flood banks across fields and then into streets, which carried these flows towards lower ground in Warwick Road. Some properties are also believed to have been flooded by rising groundwaters. Outflanking of defences on the Petteril was observed by Environment Agency staff and began around 02:45 on Saturday January 8. The warning for Carlisle D was issued at 03:14. Carlisle D is a large area that would have taken a substantial time to flood to a significant depth. Therefore, nearly all properties registered for the AVM (automatic voice messaging) service would have received advance warning of flooding from the river.

In Denton Holme, flooding occurred from a number of sources. On the left bank of the River Caldew, flooding began shortly before 02:00, and was caused by a tree obstructing the South Vale footbridge. On the right bank, the gasworks area began flooding from around 02:00, due to a damaged wall and subsequent overtopping of the defences. Further downstream. Below Victoria Bridge, CCTV and video evidence collected after the event shows that the initial flooding on the right bank was from manholes surcharging. The left bank (Shadongate) was affected from approximately 02:00 by flows from Dow Beck culvert and sewer flooding. Subsequently, from around 11:00 both left and right banks were inundated by water backing up from the River Eden. The trigger level at Denton Holme station was exceeded at around 02:00 and Environment Agency staff observed and reported the obstruction and flooding at South Vale footbridge at around the same time. The Denton Holme warning was issued at 02:22.

The first reports of road flooding from Area C (Willow Holme) were received from 22.30 on 7 January. Environment Agency staff inspected the area at the time and found that this flooding was caused by surface waters and sewer surcharging. Subsequent evidence suggests that this was compounded by water flowing into the area from Caldewgate from around 02:00. This originated from surface waters and a culvert (the Dow Beck). Flooding may also have occurred from the Little Caldew and Caldew, caused by flows backing up following obstruction of the railway bridge by trees and debris. It would not have been practicable for forecasting systems to include these events. A warning was issued at 05:02 on January 8, based on local knowledge and forecasts for the River Caldew. Ultimately the area was inundated later in the morning (probably around 11:00) by flows backing up from the River Eden.

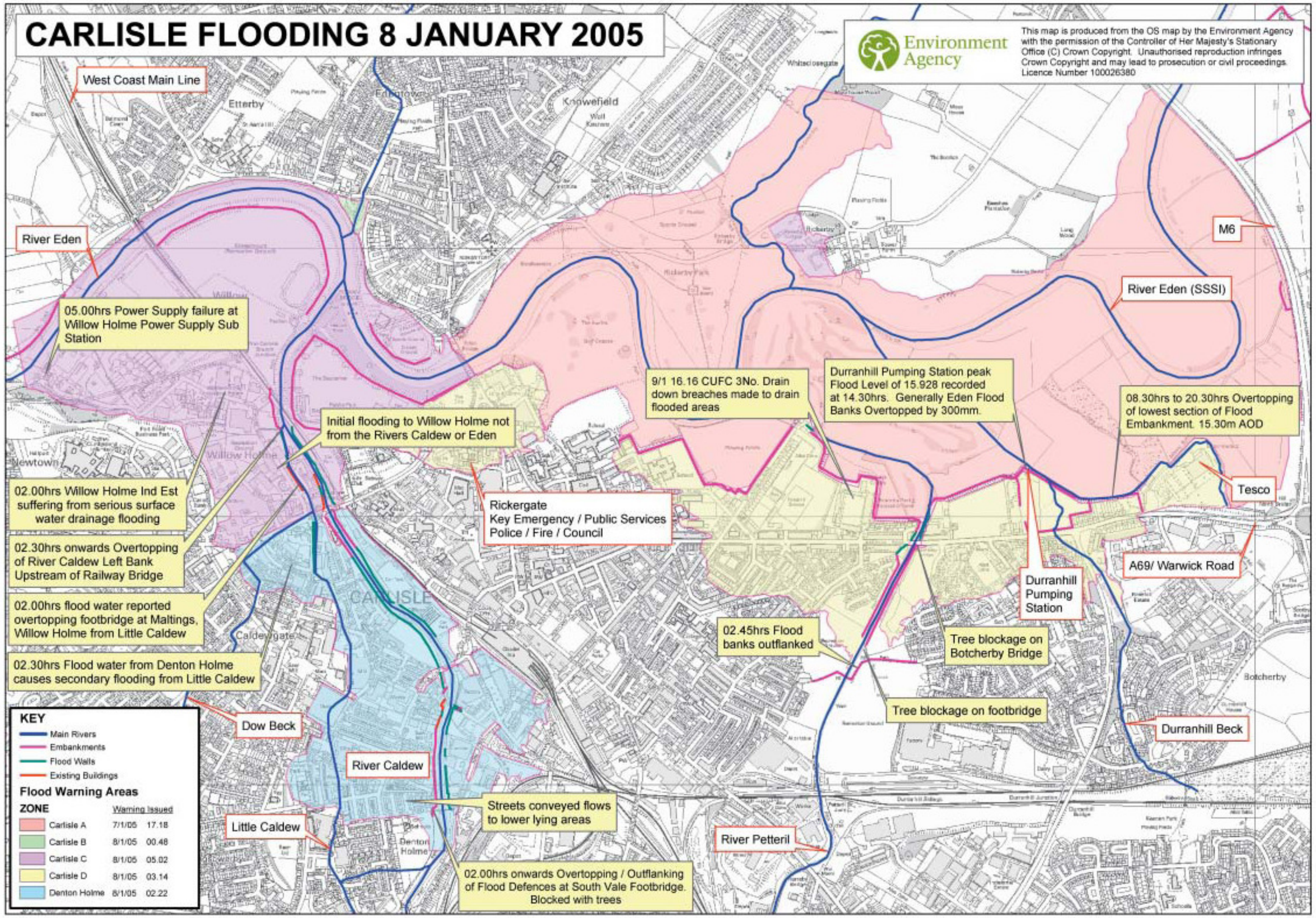

Figure A1: Carlisle flooding and flood warning areas

Appendix 2 Quantification of deaths and serious harm from flooding

Flood Risks to People (a project conducted under the DEFRA/EA Flood and Coastal Defence R&D Programme) examined death or serious harm occurring as a direct result of flooding either during or up to one week after the event (DEFRA/EA, 2006). A formula has been derived based on flood hazard, area vulnerability (based on proximity to river or coastal flood areas) and people vulnerability.

1 Flood hazard formula

The flood hazard rating is based on the velocity of the water, the depth and the presence of debris:

$$HR = d \times (v + 0.5) + DF \qquad 1$$

HR hazard rating

d typical depth (m)

v typical velocity (ms^{-1})

DF Values of 0, 0.5 and 1 depending upon the likelihood of debris (Table 2 – outlines guidance on likely debris factors by dominant land use)

Based on the depth and velocity, flood hazard classes have been defined, as shown in Table A2.1.

Table A2.1: Flood hazard classes (as a function of velocity and depth)

d x (v + 0.5)	**Degree of flood hazard**	**Description**
<0.75	Low	Caution. "*Flood zone with shallow flowing water or deep standing water*"
0.75 – 1.25	Moderate	Dangerous for some (i.e. children). "*Danger: flood zone with deep or fast flowing water*"
1.25 – 2.5	Significant	Dangerous for most people. "*Danger: flood zone with deep fast flowing water*"
>2.5	Extreme	Dangerous for all. "*Extreme danger: flood zone with deep fast flowing water*"

Table A2.2: Debris factors by flood depths, velocities and land use

	Dominant land use		
Depths	**Pasture/Arable**	**Woodland**	**Urban**
0 – 0.25 m	0	0	0
0.25 – 0.75 m	0	0.5	1
d>0.75 m and/or v>2	0.5	1	1

2 Area Vulnerability

The vulnerability of an area is based upon the speed of onset of flooding, the nature of the area and the effectiveness of the flood warning system as shown in Table A2.3.

Table A2.3: Area vulnerability

Parameter	**1 – low risk area**	**2 – medium risk area**	**3 – high risk area**
Speed of onset	Onset of flooding is very gradual (many hours)	Onset of flooding is gradual (an hour or so)	Rapid flooding
Nature of area	Multi-storey apartments	Typical residential area (2 storey homes); commercial and industrial properties	Bungalows, mobile homes, busy roads, parks, single storey schools, campsites etc.
Flood warning	Effective tried and tested warning and emergency plans	Flood warning system present but limited	No flood warning system

Area vulnerability (AV) = sum of scores for 'speed of onset'. 'nature of area' and 'flood warning'

3 People vulnerability

People vulnerability (PV) is simply based upon the sum of the percentage of residents suffering from a long-term illness and the percentage of residents aged 75 and over.

4 Number of injuries and deaths

The estimated number of injuries (N_{inj}) and deaths (N_f) for an area with a total population of N_z are calculated from the following equations:

$$N_{inj} = 2 \times N_z \times (HR \times AV/100 \times PV/100) \qquad 2$$

$$N_f = 2 \times N_{inj} \times HR/100 \qquad 3$$

5. Case study flood

From the flooding model it was estimated that 725 homes were affected by flooding. The census data for the area suggests an occupancy level of 2.14 people per home, thus it is estimated that 1551 people were flooded. The average depth (d) of flood water was 0.6m; the typical velocity (v) was 0.3 m/s and, based on Table A2.2 the debris factor (DF) was 1.

Thus: HR = 0.6 x (0.3 + 0.5) + 1

HR = 1.48

From Table A2.3 the area vulnerability is the sum of speed of onset (1), nature of the area (2) and flood warning (2).

Thus: AV = 5

The people vulnerability is calculated from the long term illness (20.08%) and population aged 75+ (8.38 %) figures.

Thus: PV = 28.46

N_{inj} = 2 x 1551 x 1.48 x 5/100 x 28.46/100 = 65.3

Nf = 2 x 65.3 x 1.48/100 = 1.93

References

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Appendix 3 – Dose-response relationships and hazard characterization

Dose-response

The dose-response function characterizes the relationship between exposure and the incidence of the health effects, as exposure to the hazard does not necessarily mean that a health impact is inevitable. In many cases, the body may be able to deal with the pathogen without any obvious ill effect, as actual illness depends on what dose is received (and how it is received) as well as the level of immunity developed as a result of prior exposure. Dose-response relationships are typically characterized by exposing a population of volunteers (usually young healthy people) to various concentrations of the pathogen under investigation. The results are then modelled to enable extrapolation to low doses.

Dose-response models are usually described by either the exponential or Beta-Poisson model. The exponential model is derived from the assumption of random occurrence of microorganisms along with a constant probability of initiation of infection by a single organism r, the probability of infection P_I is given as a function of the ingested dose (d) by:

$$P_I = 1 - \exp^{(-rd)} \qquad (1)$$

For many microorganisms, the dose-response relationship is shallower than reflected by equation 1, suggesting some degree of heterogeneity in the microorganism-host interaction. This can be successfully described by the Beta-Poisson model, which can be developed from equation 1 if the infection probability is itself distributed according to a beta distribution. This model is described by two parameters, a median infectious dose (N_{50}) and a slope parameter (α):

$$P_I = 1 - [1 + d/N_{50} (2^{1/\alpha} - 1)]^{-\alpha} \qquad (2)$$

This can be written more simply (McNab, 1997) where

$$\beta = N_{50} / (2^{1/\alpha} - 1) \quad (3)$$

$$\text{thus } P_I = 1 - (1 + d/\beta)^{-\alpha} \quad (4)$$

Given a set of dose-response data, i.e. exposure of population to various doses of microorganisms and measurement of response (such as infection), the best fitting parameters of a dose-response relationship may be computed via maximum likelihood techniques.

Hazard characterization

This section summarises the key characteristics of the pathogens in terms of QMRA and DALY quantification. Where pathogens are predicted to result in fatal cases of illness the years of life lost have been based on UK specific figures.

Campylobacter spp.

Infection with *Campylobacter* spp. proceeds to clinical illness in 30% of cases (WHO, 2004). The severity weight (0.086) and duration (6 days) for uncomplicated cases of campylobacteriosis are based on values described by Havelaar *et al*., 2000a for illness in the general population and illness reported to general practitioners. The severity weight (0.28) and duration (365 days) for complicated campylobacteriosis are based on the mean value for Guillain-Barré syndrome (adapted from Havelaar *et al*., 2000a), with the incidence based on the campylobacteriosis hospitalisation rate of 0.5% reported by Mead *et al.* (1999). Mortality statistics from the UK indicate that fatalities from campylobacteriosis occur in people aged over 65. An age-related case-fatality rate of 0.0083% for the UK has been estimated, with a mean age of death of 80 (ONS 2007) and a resultant loss of 8.3 years of life (based on additional life expectancies for males and females aged 80 of 7.57 years and 9.03 years respectively; GAD 2007).

Cryptosporidium spp.

Infection with *Cryptosporidium* spp. in developed countries is believed to result in infections in the immunocompetent population in 71% of cases, while infection in the immunocompromised population is thought to lead to illness in virtually 100% of cases (Havelaar *et al*., 2000b). The severity weight and duration for cryptosporidiosis in the normal (immunocompetent) population are 0.054 and 6 days, while the corresponding figures for the immunocompromised population are 0.13 and 47 days (Havelaar *et al*., 2000b). A case fatality rate of 0.0158% has been estimated from age-related UK data on incidence, known under-reporting of non-fatal cases and population statistics (FSA 2000, Adak *et al*., 2002; HPA 2007a; ONS 2007). The mean age at death from cryptosporidiosis is 63.7 years, although for simplicity this figure has been rounded up to 65.

The effect of HIV/AIDS on mortality from cryptosporidiosis infection is unclear. A study in 1986 showed that cryptosporidiosis in patients with HIV/AIDS had a case-fatality rate which was significantly higher ($p<0.01$) than the case-fatality rate for patients without HIV/AIDS (Navin and Hardy, 1987). Furthermore, Rusin *et al*. (2000) suggested that about 10-15% of AIDS patients die of complications related to cryptosporidiosis. However, examination of UK mortality data (ONS 2007) indicates a mean age of death from cryptosporidiosis of 63.7 years, and of death from HIV disease of 42 years. Over the period 2001-2005 in the UK there were limited (6) deaths from cryptosporidiosis, and only one incident of mortality under 50 years of age. With such limited data, it is not appropriate to try to quantify mortality from cryptosporidiosis in AIDS cases separately from the rest of the population. In the QMRA, the influence of HIV/AIDS is thus restricted to an estimation of the additional severity and duration of the infection in the population aged 15 and over.

Viruses

Infection is assumed to proceed to clinical illness in 50% of cases (WHO 2004). The severity weight of 0.093 is based on an uncomplicated case of diarrhoea (VGDHS, 1999). The duration of symptoms (vomiting and diarrhoea) are usually between 3 and 8 days

(Rusin *et al*., 2000; HPA 2007b). Rotavirus infection is not usually fatal in people over the age of four (ONS, 2007), thus fatalities have only been estimated for children under the age of five. The mean age at death is 1.1 years (ONS, 2007). A case-fatality rate of 0.0013% has been estimated based on age-related UK data on incidence, likely under-reporting of non-fatal cases, mortality and population statistics (FSA, 2000; Adak *et al*., 2002; HPA 2007b; ONS, 2007).

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Appendix 4 – Responding to major floods (ABI, 2009)

Association of British Insurers

Responding to major floods: What to expect from your home insurer

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This leaflet explains how your insurance company will respond in an emergency situation where many thousands of homes have been affected by flooding. This guide sets out the support you can expect from your insurer in the days, weeks and months after a major flood.

Insurers will do everything they can to help customers as quickly as is practically possible given the scale of the flooding and its continuing impact on access to flooded areas.

Emergency steps

If you think that your home may be flooded, consider your personal safety first and whether it is necessary to evacuate your home immediately. Stay informed of latest developments by listening to local radio, TV or calling the Environment Agency's floodline on 0845 988 1188. Do not do anything that may endanger your health and safety and follow any advice to leave your home as soon as possible. Call 999 if you feel in danger from rising floodwater at any point.

If there is time and it is safe to do so, there are some steps you can take to minimise the potential impact of the flooding.

- assemble a 'flood kit' containing your mobile phone, contact telephone numbers, torch, battery, radio, insurance policy details, rubber gloves, wet wipes, hand gel and first aid kit;
- ensure your pets are cared for;
- move valuable or essential items upstairs or to a high place.

If you leave your home and if there is time:

- consider taking any valuables with you;
- lock your doors and windows if possible;
- inform family and neighbours of your plans and how to contact you;
- take with you emergency contact details including mobile phone numbers and e mail addresses if possible. Your insurer will need this information so they can keep in contact with you.

Only return to your home after a flood when it is safe to do so.

CILA

If your home has been flooded

If you have to move out of your home due to flood damage and have buildings or contents insurance, your insurer will offer to provide or pay for the cost of appropriate alternative accommodation and other related additional expenses, such as the removal and storage of undamaged property. If you have buildings cover, your insurer will dry, clean, repair and restore your home. If you have contents cover, your insurer will dry, clean and restore your possessions or replace or pay for any possessions that are so damaged they cannot be cleaned up or repaired.

If your home is badly damaged by flooding, it may take up to one year or more for your home to be restored and become habitable again. This is mainly due to the time it takes for properties to dry out after being flooded. Your insurer or their appointed loss adjuster will do everything possible to restore your home as quickly as possible and discuss progress with you throughout. As a guide, after the floods of summer 2007, around half of those people that had to leave their homes were back in them within six months, almost three quarters within nine months and the vast majority were home after 12 months.

If your home is badly flooded, your insurer is likely to use a variety of specialists to ensure it is repaired as quickly as possible and to a high standard. This may include a loss adjuster to assess the damage and oversee the repair process, a surveyor to oversee major building works, specialist cleaning and drying companies, and professional builders and decorators. Your insurer or loss adjuster will explain to you the timetable for restoring your home, which specialists will be involved at each stage and how long each stage will take.

The remainder of this guide sets out a typical process for restoring a home after a major flood. It is intended as a guide as to what expect. If the process or timetable for restoring your home differs substantially, your insurer or loss adjuster will be able to explain why.

There are six main steps in putting your home back together after a flood:

Step 1: Immediate aftermath

Who You should contact your insurer as soon as possible if your home or possessions have been damaged. Most insurers have a 24-hour helpline. If you have separate buildings and contents insurers, contact them both. If you rent your home, contact the property owner as they are likely to be responsible for repairing any damage to the building.

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Under normal circumstances your insurance claim will run smoothly. Your insurer's claims process is designed to provide all the support you need. However, you may be approached by a loss assessor who offers to help you make a claim. If you do consider employing a loss assessor, ask for information about all their costs and charges as you are responsible for their costs. These are not recoverable from your insurer. The Financial Services Authority regulates loss assessors and you should only employ one that has been authorised by them.

What Your insurer will take your details and give advice on immediate next steps. Your insurer is likely to discuss with you whether you need alternative accommodation and to ask you various questions to find out the extent of the damage to your home and possessions. As many claims are being made after a major flood, your insurer is likely to seek information to determine if you need priority attention, such as if you are ill, disabled, elderly or have young children.

If your home or possessions are badly damaged, your insurer may arrange for a loss adjuster to contact you to assess the damage in more detail and oversee the restoration as soon as possible. You will then proceed to step two below. If the damage is relatively minor, your insurer may be able to handle your claim without requiring a detailed assessment and will be able to avoid some of the steps below.

When If your home is badly damaged and your insurer appoints a loss adjuster, the loss adjuster will contact you as soon as possible. If your damage is relatively minor, your insurer will arrange for you to move to the appropriate step below as soon as possible. Further details about timescales are contained below.

Step 2: Assessing the damage and finding temporary accommodation

Who If your home is badly damaged, your insurer is likely to commission a loss adjuster to contact you to assess the damage in detail, arrange your alternative accommodation and plan the restoration process. Depending on the extent of the damage, your loss adjuster will either visit you or liaise with you over the telephone. If your home is severely damaged, your loss adjuster may appoint a surveyor to provide additional expertise. The loss adjuster will act as the project manager during the restoration of your home.

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What Many insurers employ loss adjusters because they are specialists at assessing damage, arranging appropriate alternative accommodation for long periods and planning the restoration of your home. Once your loss adjuster has completed their initial assessment, they should be able to provide you with an approximate timetable outlining what needs to be done to restore your home, who will do it and how long it will take. They may provide you with a 'claims plan' setting this out.

If you need to leave your home during the restoration process, most building and contents policies include up to 20% of the total insured value to cover your alternative accommodation needs and associated additional costs, such as additional heating costs. Provided you have adequate insurance (buildings insurance that reflects the full rebuild costs and contents cover that reflects the value of your possessions) this will normally be sufficient to cover the whole of your stay in alternative accommodation. If you only have contents cover, your cover will be limited by the sum insured of your contents policy. If you rent your home, talk to your landlord or buildings manager about the insurance they might have in place to provide for your housing needs or the action they are taking to re-house you.

When In normal conditions, your loss adjuster would get in contact within 24 hours of you contacting your insurer and undertake any necessary visits within 3 days. However, after a major flood, this may take a little longer both due to the volume of claims and difficulties accessing areas affected by flooding. Nevertheless, you should expect to hear from your loss adjuster within 2 days of contacting your insurer. If they need to visit, they should do so within 7 days of the area becoming accessible.

In normal circumstances, any carpets, furniture or other goods that have been removed from your home should be retained until your loss adjuster has agreed that they can be disposed of. However, if it is going to take several days for your loss adjuster to visit, you may need to throw some things away. If you do this, seek the agreement of your loss adjuster first and follow their advice. If this is not possible, use common sense to provide evidence to your loss adjuster of what you have thrown away. Take several photographs of everything you dispose of and write down details such as the make and serial number of the products. If you need to get rid of flood damaged carpets, cut off and keep samples. This will speed up the settlement of your claim.

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Step 3: Cleaning and stripping out

Who Your insurer or loss adjuster will organise the cleaning and stripping out of your home. If necessary, they may employ a specialist cleaning firm to do this, often known as a disaster restoration firm.

What The first step to restoring your home is to remove the silt and other debris left by the floods, to clean affected areas, and to check the gas and electricity supplies and appliances. This will be followed by ‘stripping out’ your home where necessary – this is likely to include removing damaged and wet furnishings and fittings and hacking off damaged plaster and woodwork. The full extent of the damage caused by floodwater may not be apparent on the surface, and so it is possible that the extent of the stripping out required may be more than expected. This is, however, essential to allow proper drying out and no more stripping out will take place than is necessary.

If you have any valuables or personal items (for example, photo albums) still in your home, discuss how to clean and remove them from your home with your insurer, loss adjuster or disaster restoration firm.

When Depending on the extent of flooding, you should expect this work to be started within four weeks of notifying your claim or discussing it with your loss adjuster. If it is likely it will take longer, your loss adjuster will discuss this with you.

Step 4: Disinfecting and drying your home

Who Your insurer or loss adjuster is likely to appoint a specialist drying company to disinfect and dry your home. At the end of this process, they will then certify that your home is dry enough for repair work to start.

What After cleaning and stripping out your home, the next stage is to dry and disinfect affected areas. Drying homes can take some time. Floodwater can penetrate deep into the fabric of your home even if the flooding seems minimal and shallow. This deep-seated moisture can take a long time to move back through walls and floors, even if the surface appears dry. The disinfecting and drying process must be completed before repair work begins because otherwise the repair work will not be sustainable and the damage may reappear in the future.

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It is important that you do not switch off any drying machines installed in your home unless requested to do so by your insurer or loss adjuster as this could delay the drying out period. Any additional electricity costs incurred as a result of using the drying out machines will be covered by your insurance.

When The most important factor will be the length of time it takes for your home to dry out. Depending on the severity of the flooding, this can take a few weeks to several months or more. It is important not to cut short this process because this could lead to severe damp problems in the future and damage any repair and redecoration work. Your insurer or loss adjuster will provide an estimate of the likely timescale and keep you fully informed of progress.

Step 5: Repair and reconstruction work

Who Your insurer or loss adjuster is likely to appoint a building contractor to undertake the repair and reconstruction work. Insurers and loss adjusters will only employ builders that meet their criteria and are competent to do the work. Your insurer is responsible for the work of builders they appoint.

If you prefer, however, you may be able to use your own builder rather than use the builder recommended by your insurer or loss adjuster. If you do appoint your own builder, you will be responsible for ensuring that they are competent and for arranging any guarantees. Insurers will not pay to correct poor quality building work by builders you appoint.

What Once your home is dry, work can begin to restore and repair your home, including for example re-plastering and fitting a new kitchen where necessary.

Your insurer or loss adjuster will also discuss with you whether you would like to design the repairs to your home to make it more resistant and resilient to future flooding. If this does not cost more than the cost of repairing your home to its pre-flood condition, your insurer will not charge you for these changes. If this does cost more than repairing your home to its pre-flood condition, you will be responsible for paying the additional cost. Many resistant or resilient features do not cost more than standard repairs. For more information, ask for a copy of the ABI's leaflet "Repairing your home or business after a flood - how to limit damage and disruption in the future".

Most contents policies will pay for the full cost of replacing damaged items with the equivalent new ones. If the value of your contents is more than the sum insured the settlement of your claim may be reduced to reflect this.

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When The repair and reconstruction work should commence shortly after your home has been issued with a certificate confirming that it is fully dried out.

Step 6: Moving back into your home

Who Your insurer or loss adjuster will discuss with you when it is safe for you to move back in to your home.

What You may be able to move back in your home while some of the repair work is ongoing. Where re-plastering has been necessary, it is quite usual for people to move in before redecoration has been completed. Your claim is settled once all the work has been completed and the outstanding payments have been made.

When Depending on the degree of damage, you could be back in your home just a few weeks after the flood or it could take around a year before you can move back into your home. Your insurer and loss adjustor will enable you to move back into your home as soon as possible taking into account the work necessary to clean, dry, repair and redecorate your home. It is important not to cut short essential parts of the process as this could lead to problems resurfacing in the future.

What if things go wrong?

All insurance companies will do everything they can to ensure that your claim is handled as quickly and smoothly as possible. If you feel unhappy about any aspect then contact your insurer. If you are unhappy about the way in which your claim is handled, you should ask your insurer how to make a formal complaint to them. If you are still unhappy at the end of your insurer's complaints procedure, you can complain to the independent Financial Ombudsman Service on 0845 080 1800.

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Glossary of terms

Disaster Restoration Company – A company employed to clean and strip out your home after a flood. These firms may also supply drying equipment for you home.

Drying company – A firm which specialises in supplying and operating drying equipment after a flood.

Excess - An amount of money that the policyholder has to pay towards the cost of a claim, for example, the first £50.

Loss Adjuster - A person, independent of an insurance company but engaged and paid by it, who checks that a claim is covered and negotiates with the policyholder the amount payable for a claim. The fee for this service is paid for by your insurer.

Loss Assessor - A person who negotiates claims on behalf of policyholders. The fee for this service is paid for by the policyholder, not the insurer.

New-For-Old - Cover for property where an item lost or destroyed would be replaced with a brand new one, with no deduction for wear and tear. Also called “replacement as new”.

Reinstatement - Where insured property is damaged, it is usual for settlement to be effected through the payment of a sum of money, but a policy may give either the insured or insurer the option to restore or rebuild instead.

Sum Insured - The amount for which property is insured, and the maximum amount that the insurance company will pay for any claim.

The Flood Claims Process

Step 1: **Immediate aftermath.**
Contact your insurer as soon as possible. Your insurer will advise you on arranging alternative accommodation if necessary, the evidence needed to support your claim and how to go ahead with the clean up and repair process.

Step 2: **Assessing the damage and finding temporary accommodation.**
A loss adjuster will be appointed to assess the claim. An initial assessment of the damage will be done, the reinstatement process explained and the options for alternative accommodation. You should expect to hear from your loss adjuster 2 days after contacting your insurer. If your loss adjuster needs to visit you, they will aim to do so within 7 days of the water receding.

Step 3: **Cleaning and stripping out.**
Your loss adjuster will organise the cleaning and stripping out of your home

Step 4: **Disinfecting and drying out your home.**
Your insurer or loss adjuster will appoint a drying company to disinfect and dry out your home. This can take from a few weeks to several months. Your loss Adjuster will give you a timetable and keep you informed.

Step 5: **Repair and reconstruction work.**
Your loss adjuster will appoint a builder to do the repair and reconstruction work. This should begin shortly after you get your drying certificate form the drying company. Antibacterial and antifungal treatments are done. Drying equipment is installed to dry out the house before reinstatement can begin.

Step 6: **Moving back into your home.**
Your insurer or loss adjuster will discuss with you when you can return home. Depending on how badly damaged your home is, this can be between a few weeks and a year or more after the flood.

Appendix 5 – Example leaflet – Coping with the aftermath of a major incident

Coping with the aftermath of a Major Incident

Gloucestershire County Council

Gloucestershire NHS Primary Care Trust

If you or people in your community have been involved in a major incident or event, you may find this leaflet helpful. It explores how you might feel in the days and months after the incident and has information about how you can get help, if you need it.

After an incident or event

Often, major events can make us feel life is unfair and unsafe. But despite our feelings and problems at the time, it is clear that looking back afterwards, most people do cope well and recover without long-term problems.

Everyone is different and each person has his or her own feelings afterwards.

What you have seen and heard is likely to have an effect on you, even if you have not been injured or directly affected. Coping can be difficult. What has happened can cause strong feelings, but, usually, these settle in a short while.

How you might be affected

Major events are shocking and some of them can feel overwhelming. After any major event, it is normal to have feelings such as anxiety and shock. These experiences may continue for some weeks.

People who are directly involved and those who lose loved ones, are the people who are likely to be most affected. However, witnesses, friends and relatives may have reactions too.

In the following few weeks, you might experience:

- tears and sadness
- fear
- anxiety
- numbness or dreaminess
- unpleasant memories about the event
- problems with your concentration
- difficulties with your memory
- difficulties with sleeping and nightmares
- feeling less confident or, sometimes, helpless
- reduced energy
- feeling angry or irritable
- reduced appetite
- guilt about the incident
- headaches and other aches and pains
- feelings of reluctance to discuss the event or alternatively wanting to talk about it all the time
- sleep problems and tiredness
- wanting to avoid people, places or activities that remind you of the event
- elation about surviving.

Immediately afterwards, you might feel:

- stunned, dazed or numb
- cut off from what is going on around you
- unable to accept what has happened
- that it hasn't really happened.

Usually, these feelings fade and others may take their place in the hours or days afterwards.

Children and young people are as likely to be as affected as adults and may have similar experiences. Often, they become unsettled and more aggressive or fearful and it is usual for them to become more clingy and demanding. Also, they may 're-play' the event in their games. These reactions are understandable and, usually, reduce gradually over time. Like adults, children cope surprisingly well in the longer-term.

What can I do that's helpful?

You should:

- take each day at a time
- do things that make you feel safe and secure
- be patient with yourself; it may take weeks or months to feel that you and your life are back to normal
- try to re-establish your usual routines such as going to work or school
- spend time with family, friends, and others who may be able to help you through this difficult time
- give reassurance to children to help them to feel safe and to talk about their fears and worries
- take good care of yourself physically; eat well, exercise regularly, reduce alcohol and recreational drug use and get enough sleep
- talk it over when you are ready, but, don't worry if you get upset or cry while you think or talk about what happened
- take extra care; after a major incident or event, people are more likely to have accidents

Do I need professional help?

Most people who have experienced a major incident find they get better over time. However, if you are still having difficulties after a month, you might need some help from professional sources.

The same advice applies to your children; they, too, may benefit from help if their feelings and behaviour are a worry to you a month after the event. It is helpful to seek advice if this is the case. Going to school and also pursuing leisure and recreational interests, may be very helpful to children and young people because it re-establishes a routine and brings them into contact with friends.

Where do I find help?

Speak to your family doctor (you could take this leaflet along) or contact NHS Direct on **0845 4647** (24 hours), **www.nhsdirect.nhs.uk**

Other support groups and caring organisations you may find helpful include:

The Samaritans – Offers a 24-hour helpline for those in crisis. Gloucester and District Branch Tel: **01452 306333**. Tel: **08457 909090** **www.samaritans.org.uk**

Cruse – Bereavement Care – Offers counselling, advice and support throughout the UK. Gloucestershire Branch Tel: **01242 252 518**. Tel: **0870 167 1677** (Monday - Friday 9.30am - 5pm) **www.crusebereavementcare.org.uk**

Disaster Action – Provides support and guidance to those people who are affected by disasters. Tel: **01483 799 066** **www.disasteraction.org.uk**

Assist Trauma Care – Offers telephone counselling and support to individuals and families in the aftermath of trauma. Tel: **01788 560800** (Helpline).

What isn't helpful?

- Bottling up your feelings – let yourself talk when you feel ready
- Alcohol and recreational drugs – while they can numb your feelings, they can also stop you from coming to terms with what has happened or cause more problems later.

What professional help can I expect?

Advice, help, and treatment can help people of all ages to come to terms with an event, by talking about their feelings and learning to cope better.

Your GP might suggest that you talk with someone who specialises in helping people cope with traumas. This might involve a 'talking treatment', such as counselling or psychotherapy. Sometimes, medication is helpful. Your GP will be able to guide you to the most appropriate resources.

For useful information on coping with trauma, see the following websites:

www.istss.org
www.rcpsych.ac.uk/info/index.htm
www.uktrauma.org.uk
webmaster@uktrauma.org.uk

If you feel comfortable talking to your local faith leader they may also be able to help.

For help with dealing with practical social care issues due to the current situation contact Gloucestershire County Council's Social Care Emergency helpline on 0800 954 8966 from 8.30am-5.00pm weekdays.

This leaflet has been produced by Gloucestershire Primary Care Trust and Gloucestershire County Council, working with their partner agencies.

For a copy of this leaflet in English please call 01452 396928.

તમોને જો આ દસ્તાવેજની ગુજરાતી નકલ જોઈતી હોય તો, મહેરબાની કરીને ટેપિસ્ટ્રિને ૩૯૬૯૦૯ નંબર પર ફોન કરશો.

আপনি যদি এই কাগজটির একটা বাংলা কপি চান, তাহলে দয়া করে ৩৯৬৯০৯ নম্বরে ট্যাপেস্ট্রীকে টেলিফোন করবেন।

如果你需要這份文件的中文譯本，請致電達意處 396926。

اگر آپ کو اس دستاویز کی نقل اردو زبان میں درکار ہے تو براہ مہربانی ٹیپسٹری کو 396928 پر فون کریں۔

Jeśli potrzebujesz kopii owej ulotki w języku polskim, proszę zadzwoń pod podany numer Tapestry: tel (01452) 396909.

Appendix 6 – Example flood evacuation guidance

- If you are informed by the Environment Agency, Local Authority or Emergency Services that there is an imminent risk of severe flooding and you are advised to evacuate or prepare to evacuate yourself and your family from your property, you should prepare yourself and your family to move immediately or as directed.

- In the event that you do evacuate your home contact the police to inform them of the address of the evacuated property. Contact the police again when you return

Remaining in your home against advice is dangerous. You should therefore be aware of the following warning points:

- Floodwater is contaminated it contains sewage and other dangerous toxic and hazardous materials.

- Utility supplies cannot be guaranteed, you will almost certainly lose all power, gas, water and sewage supplies.

- To ensure the safety of responding staff and protect them from dangers such as raised man hole covers, the council will not be able to provide services of any kind in flooded areas until the floodwaters have fully receded.

As part of the Emergency Plan Newark and Sherwood District Council may, in some instances, hire security staff for property protection.

Environment Agency

Flood-line: 0845 988 1188

Relevant Websites:

Environment Agency: www.environment-agency.gov.uk/subjects/flood/floodwarning/

National Flood Forum: www.floodforum.org.uk

Newark and Sherwood District Council: www.newark-sherwooddc.gov.uk

Newark and Sherwood District Council
Kelham Hall
Newark on Trent
Nottiingahmshire NG23 5QX

FLOOD EVACUATION GUIDANCE

Newark & Sherwood District Council

Flooding Emergency
Call: 01636 650000

IMPORTANT PUBLIC WARNING

- Should the Environment Agency decide that there is imminent danger of flooding they will issue a:

- The warning may occur in the form of a request to evacuate your home from the Emergency Services or Local Authority as a result of the water continuing to rise or expecting to rise in the area over the next few hours.
- Evacuations can take place at short notice if water levels rise quickly.
- In response, you should prepare yourself and your family to be evacuated from your property
- If possible try and arrange temporary accommodation with friends or family in an area away from the flooding.
- Do not worry if you do not have other accommodation to go to NSDC will provide safe, temporary shelter for you and your family as well as hot food and beverages, first aid and various welfare support facilities at one of our designated Rest Centres.
- Rest Centres will be located at the Southwell, Grove, and Dukeries Leisure Centres as required.
- NSDC will organise transport for those people who do not have transport of their own.
- Don't forget to take your pets with you; the RSPCA will be available to look after them at the Rest Centre.

DOMESTIC PREPARATIONS

There are a number of things to do to prepare your property in order to minimise the risk of damage to building and contents:

- Ensure you know how to turn off the electricity, gas, oil and water supplies. If the water enters your home, or you evacuate the property, turn them off immediately. This will protect your property from the risk of fire or explosion.
- Identify and keep your important documents such as house insurance, mortgage and passports in a location safe from flooding, better still take them with you.
- Ensure your personal memorabilia and any family heirlooms are in an area safe from flooding.
- Move food and drink stores from downstairs to upstairs so that they will be available to you after the flood.
- Televisions, Videos, Stereos, Hoovers and other minor electrical products can be moved above ground or upstairs.
- Heavier items such as fridges, freezers and washing machines can be moved onto suitable tables or worktops or even upstairs if time allows. But do not injure yourself by lifting heavy objects at this stage; if possible get some help from neighbours and friends.
- Heavy items of furniture such as suites can be moved upstairs last if time allows.
- If using or moving your car, don't try and drive through floodwater and never over ankle deep.

PERSONAL PREPARATIONS

Clothing

- Take some time before evacuating to get some suitable warm clothing prepared. Use several thin inner layers and a waterproof outer layer to keep in the warmth.
- Wear Wellington boots in low water or non-slip footwear in high water but never go barefoot.
- If you have to evacuate through flooded areas, have a change of clothes and shoes in a waterproof bag ready for use. Don't forget wash kit, a towel, bedclothes and sleeping bags if you have them.

Documents and Medication

- Take with you any vitally important items, which you may need such as chequebooks, passports, credit cards, money, mobile phones, keys and any medication or prescriptions you will need.

Safety and Security Issues

- If you are evacuating at night the streetlights may fail or be off due to power cuts. Wear bright reflective clothing and carry a torch.
- Make sure you lock all your windows and doors when you leave your home. **Never plan to stay inside; you will have no heating, power, water or gas and the toilets wont work**. We cannot support families who do not evacuate when requested.
- Keep out of floodwater unless absolutely necessary. Floodwater is contaminated. Do not place unwashed hands near the mouth, or eat, any floodwater-contaminated products.

What Should I do now?

- Give some thought to what you would do if you had to evacuate your property today. Prepare an emergency pack to take with you.