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URBAN FLOODING

Urban flooding due to drainage systems being overwhelmed by rainfall is estimated to cost £270 million a year in England and Wales; 80,000 homes are at risk. Its impacts are expected to increase if no policy changes are made. This POSTnote sets out the current approaches to managing urban drainage and examines proposals for improving them.

Background

This note deals with urban flooding caused by rainfall overwhelming drainage capacity. Other types of flooding, such as river and coastal flooding, are not considered. The risk of flooding is defined as a function of both the probability of a flood happening and its impact. In urban areas, the impact can be very high because the areas affected are densely populated and contain vital infrastructure. Continuing development in flood-prone areas increases the risk. Urban flooding is also expected to happen more often, as discussed below.

Future increase in urban flooding

A Foresight report[1] said that the costs of urban flooding could rise to between £1-10 billion pounds a year by the 2080s if no action were taken to reduce the risks. Factors that tend to increase the risk include:

- **ageing drainage infrastructure**. A lot of the sewerage and drainage network is old and its condition is unknown.
- **more buildings**. As new developments cover previously permeable ground, the amount of rainwater running off the surface into drains and sewers increases dramatically.
- **increase in paving**. The proportion of impermeable ground in existing developments is increasing as people build patios and pave over front gardens.
- **climate change**. Wetter winters and heavier summer showers are expected to put more pressure on urban drainage. Climate models predict that winter rainfall will increase by 20-30% by the 2080s. Such an increase could lead to a much larger (up to 200%) increase in flood risk.

Urban drainage

The conventional way of dealing with rainfall and waste water in urban areas has been to carry it away as quickly as possible via underground pipes and sewers. Older (pre 1940s) areas normally have a combined sewer system, where rainfall drains into sewers carrying foul water and both are transferred to sewage treatment works.

Most newer developments have separate sewer systems: water from gutters and roads is carried to soakaways, through pipes to the nearest watercourse, but often simply joins a combined sewer. Foul water travels by foul sewer either directly to a sewage treatment works, or also connects to the existing combined sewer network.

Most modern drainage systems are designed to cope with rainfall events that occur with a one in thirty year probability. Older parts of the system may be operating to a lower standard. It is inevitable that the capacities of sewers, covered urban water courses and other piped systems will sometimes be exceeded.

Consequences of overflow

Flooding

When the piped system is overwhelmed or cannot drain effectively into an outfall because river levels are raised, the excess travels down roads and other paths of least resistance and floods low lying areas. These can contain property and infrastucture. Flooding can cause costly damage, distress and sometimes loss of life.

Pollution

Drainage overflow can be a major source of pollution. It picks up potentially harmful substances from surfaces, including oil, household chemicals and faecal material, and transfers them to urban watercourses. When combined sewers overflow in times of heavy rainfall, excess foul water is discharged directly into urban watercourses. Untreated discharges pose risks to human health as they may contain toxins and pathogens such as the virus that causes hepatitis A, and *E. coli*.

Sustainable drainage systems (SUDS)

An alternative to conventional drainage is to mimic natural drainage, with the aim of reducing flooding and improving the quality of water draining from urban surfaces (runoff). These approaches are known as sustainable drainage systems (SUDS, Box 1).

Box 1. SUDS

These may take the form of areas of vegetation like grassy banks or green roofs, or natural water storage features like ponds. There are some engineered components such as porous paving. While the components can differ greatly, all SUDS employ one or more of the following:

- encouraging uptake of water by the ground ('infiltration'),
- reducing peak flow rates of runoff ('attenuation'),
- transferring runoff in a controlled manner to other sites ('conveyance'),
- capturing water directly on site for controlled discharge later ('storage').

SUDS also employ a range of natural process to purify urban runoff. Removal of sediment, biofiltration, biodegradation and water uptake by plants all help to remove pollutants.

Benefits of well-designed SUDS are:

- a lower risk of flooding because runoff is reduced (although not when there are bigger storms);
- increased recharging of natural groundwater levels;
- improved quality of water returned to water bodies;
- provision of an aesthetically-pleasing environment that encourages urban wildlife and biodiversity.[2]

Although SUDS principles have been well-known for many years and are widely used in some other European countries, there has been little up-take in England and Wales (see Issues). Recent changes to legislation in Scotland have led to greater use of SUDS there.[3]

Policy

There are different institutional arrangements for urban drainage in each of the countries of the United Kingdom.

- **Scotland**. The local authority has primary responsibility for flood management and leads groups that coordinate flood risk assessment and management. Scottish Water has a duty to adopt all public SUDS, except for roads-only systems.
- **Northern Ireland**. The Rivers Agency and the Water and Roads services (all government agencies) all play a role in managing urban flooding.
- **England and Wales**. There is no single body with overall responsibility for surface water drainage in urban areas. The Environment Agency, local authorities, water companies and land owners have separate responsibilities and powers (Table 1 gives a simplified list).

A Department for Environment, Food and Rural Affairs (Defra) consultation said that "the existing system does not encourage responsible management of storm water by developers, householders or highway authorities." The difficulties that arise from the division of responsibility are discussed under Issues on page three.

Table 1. Division of responsibilities in England and Wales

Environment Agency	General supervisory duty over all flood defence matters. Statutory planning consultee (England only).
Local authorities (including highway authorities)	Surface drainage from roads and public spaces. Development planning control.
Water company (as the sewerage undertaker)	Statutory duty to deal with foul water and storm water received from water customers.

Flood warning

Both the Environment Agency and the Scottish Environment Protection Agency operate flood warning schemes. However urban drainage flooding often happens very suddenly and there is little time to warn those likely to be affected.

Integrated urban drainage pilot studies

In January 2007, Defra launched 15 integrated urban drainage pilot studies to test new ways to reduce the impact of urban flooding. The pilots are all in England. They will run until 2008 and focus on three issues:

- identifying causes of flooding in urban areas and considering the best ways of managing urban drainage to reduce flooding.
- examining the effectiveness of partnership working between the various drainage authorities, and how it could be improved;
- testing new approaches to reduce the future impact of urban flooding on people and the environment, including: use of models to identify where the water is coming from, surface water management plans, SUDS and above-ground flood routing.

Defra are conducting several other projects that will affect urban drainage management (Box 2).

Box 2. Defra work on urban drainage

- 20 year cross-government strategy for flood and coastal erosion risk management '*Making Space for Water*';
- Integrated Urban Drainage Pilot studies on institutional and technical issues in urban drainage management;
- Transfer of some private sewers to water companies;
- Review of Section 106 of the Water Act (1991) covering the automatic right to connect to the public sewer system;
- Legislative proposals to promote sustainable drainage;
- Options to reduce non-agricultural diffuse pollution.

Development Planning

Planning is central to managing flood risk. Both the location and design of new developments can have a large impact on flood risk. In December 2006 the government published a new Planning Policy Statement for England, PPS 25, on development and flood risk. This requires that all new developments are assessed for flood risk from all sources, including flooding from sewers and groundwater, for all new developments. It also made the Environment Agency a statutory consultee for

development in areas at risk. It promotes sustainable drainage (SUDS, see below) as the default option, with developers needing to indicate the SUDS provisions they are planning.

Issues

It is widely held that urban drainage management must change to cope with greater urbanisation and climate change. There is also broad consensus on many of the problems with the current systems. Some of the most commonly-cited issues are the division of responsibility for flooding, lack of funding, a lack of understanding of the causes of flooding, difficulties in improving drainage in existing developments and barriers to the wider use of SUDS. These are discussed below. Beyond these operational issues, some argue that a dramatic change in attitude is necessary. This is addressed at the end of this POSTnote.

Division of responsibility

Defra's integrated urban drainage pilot studies have confirmed that "current institutional arrangements mean that responsibilities for managing storm water in urban areas are complex, confusing and distressing for the public". It says that this leads to,

- a lack of information for those affected by flooding; people may get passed between organisations with no-one taking responsibility;
- insufficient risk assessment, as no single organisation has the incentive to carry it out;
- development planning decisions being taken without a full understanding of the risks of urban flooding;
- separate organisations making investment decisions based on priorities in their own area of responsibility, without considering the wider drainage issues.

It has set out initial policy options for addressing these issues, which are open for comment until August 2007[4] (Box 3).

Box 3. Defra's integrated drainage policy options[5]

Defra set out the following policy options developed in the early stages of its work on integrated urban drainage

- **Do nothing**. This is thought to be likely to lead to a sharp rise in the costs of flood damage.
- **Voluntary Guidance**. Authorities would be provided with information and guidance on good practice.
- **Clarify or change the responsibilities** of operating authorities. Responsibilities for particular aspects of integrated urban drainage would be assigned to different organisations, so that each had an appropriate set of duties. PPS25, if properly enforced could be enough to clarify these.
- **Improve incentive structure**. This would consider whether funding should better reflect the 'polluter pays' principle, perhaps by strengthening requirements from Ofwat to water companies to vary their existing drainage charge to reflect the cost of storm water more accurately. The charge could reflect the area drained.
- **Establish a single authority for storm water**. All responsibilities for managing storm water would be assigned to a single body, either an existing operating authority or a newly created one.

Before the pilots, cross-authority work on drainage often occurred only in response to a serious flood (Box 4). Participants in these collaborations have said that good leadership is crucial, but that it does not necessarily matter which authority takes the lead.

Box 4. Glasgow strategic drainage plan[6]

In July 2002 parts of Glasgow experienced severe flooding, an unexpected feature of which was that several hundred of the properties affected were far from water courses.

As a result, Scottish Water took the lead in developing a better understanding of where water would flow when the drainage system was full, including modelling both sewers and urban watercourses.

Once the problem had been well characterised, the authorities involved (Glasgow City Council, Scottish Water, The Scottish Environment Protection Agency and Scottish Enterprise Glasgow) were able to identify actions that could address the flooding and drainage problems and promote economic development and quality of life.

One outcome is the Integrated Water Plan for a major regeneration area in the east end of Glasgow. This plan considers water infrastructure, drainage improvement options and land planning strategies and aims to promote a sustainable drainage and water supply system.

The authorities have tried to coordinate and optimise their investment planning. However, there is still some doubt about how all the actions identified will be funded.

Funding

Solutions to urban flooding problems rarely lie within the remit of a single authority. Each authority usually needs to fund part of the work, so some way of co-ordinating this investment is necessary. However, each has its own funding cycles, project appraisal systems and regulatory oversight, which may not be aligned with those of the others.

- Water and sewerage companies' price limits, and therefore investment plans, are set every five years by the industry's economic regulator, Ofwat.
- Local authorities have annual spending plans.
- The Environment Agency is subject to a three year spending review period.

As discussed in Box 3, some of Defra's policy proposals address this issue.

Understanding the causes of flooding

Integrated drainage plans have relied on detailed flood modelling that identifies where the water comes from and the pathways it follows. For instance, the Glasgow plan (Box 4) calculated the percentage of floodwater attributable to the assets of different authorities in different parts of the city. Such modelling requires information about the drainage systems in place and their condition. Defra officials and representatives of local authorities and water companies say that such information is necessary where responsibilities for different parts of the system are spilt. Put simply, if the parts of the systems under one authority are responsible for 20% of the flood water, it might be expected to pay for 20% of the solution.

However, some academics and people representing those affected by flooding argue that some basic risk assessments are all that is necessary in some situations. For example, readily available topographic data show where the water will go downhill. Most agree that the appropriate level of investigation will differ from place to place.

Improving drainage in existing developments
Given the right regulatory and funding framework, there is broad scope for improving urban drainage in new developments. However, on brownfield sites and existing development, it is harder to change the way runoff is managed, although there is often some scope for using a more sustainable approach, particularly during redevelopment. Planners can use an understanding of the drainage issues in an area to identify opportunities to improve it during regeneration.

Barriers to wider use of SUDS
Normally, once a drainage system is built, the water company 'adopts' it, that is, takes on responsibility for its maintenance and performance. Other than in Scotland, it is not clear who should have responsibility for maintaining SUDS; this is seen as one of the biggest barriers to their wider use. Water companies are one possibility, at least for the harder engineered types of SUDS. They are supportive of SUDS in principle[7], but have rarely adopted them. Their concerns about taking on SUDS management include:[8]

- funding for SUDS upkeep. Water companies say it is not clear whether they could be allowed to charge customers for this. An alternative would be to secure funds from developers when the system is built;
- the right to connect to a public sewer. People whose property is served by a SUDS could later make a connection to a public sewer. This could overload the foul sewer network;
- the direction of any overflow from SUDS, especially as a recent test case found that water companies have no right to discharge to private watercourses;
- liability for the safety of open water features in residential areas;
- disposal of sediment from SUDS. This is likely to be classed as 'controlled waste' and so could not be left on site.

Attitude to flooding
Some researchers and representatives of people who have been flooded think that minor adjustments to the way urban drainage is managed are not enough and that a major change in attitude is necessary. They argue that piped systems can never economically be designed to cope with all storms and that there is an unrealistic expectation that flooding should never happen. Instead, people should accept that flooding in some places is normal. Rather than attempting to prevent flooding by building bigger pipes, planners should aim to manage excess water on the surface and direct floodwater to areas where it will do the least damage, such as 'sacrificial' storage areas in parks and car parks.

Managing runoff on the surface
Under this approach, runoff from roofs, roads and paving would be disconnected from underground drainage. Instead, developments would be designed to direct the flow on the surface. Under normal rainfall conditions, the water would either soak into the ground, or be collected for use, such as for watering gardens. When there is heavy rainfall, the excess water would be directed to low value areas (with warning) and away from houses and important infrastructure. Green spaces and roads could provide temporary storage of the floodwater. Simple aspects of development design, such as kerb heights and the amount of vegetation cover, can have a dramatic impact on the way water flows though the urban environment.[9]

Overview

- Urban flooding is caused by heavy rainfall overwhelming drainage capacity.
- It already has large economic and social impacts. These are very likely to increase if no changes are made to the management of urban drainage.
- In England, the division of responsibility for urban drainage is seen as an important barrier to better management. Defra has proposed policy options, some of which address this.
- Alternative drainage techniques such as SUDS may help in some situations, especially for smaller floods, but there are barriers to their wider use.
- Some experts argue that the public may have to accept more frequent short term flooding of some areas to prevent more damaging flooding of property.

Endnotes

1 Future Flooding, Foresight OST 2004. http://www.foresight.gov.uk/Previous_Projects/Flood_and_Coastal_Defence/
2 Woods-Ballard, B et al. The SUDS Manual. CIRIA 2007
3 The Water Environment and Water Services Act (Scottish Executive 2003) amended the Sewerage (Scotland) Act (Scottish Office 1968) to give public SUDS the same legal status as traditional sewers and gave Scottish Water responsibility for their adoption and maintenance. The SUDS manual. CIRIA 2007
4 http://www.defra.gov.uk/environ/fcd/policy/strategy/ha2.htm
5 http://www.defra.gov.uk/environ/fcd/policy/strategy/ha1bltranb.pdf
6 http://www.ciwem.org/events/IUD_2007_delegate_notes.doc
7 Speech by the Chief Executive of Water UK, November 2005 http://www.water.org.uk/home/news/chief-executive-speeches/flooding-conference
8 SUDS Issues of concern to the water industry. Water UK 2005
9 Balmforth, D. et al. Designing for exceedance in urban drainage – good practice. CIRIA 2006

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POST is grateful to all contributors and reviewers of this POSTnote. For further information on this subject, please contact Dr Kate Trumper, at POST.

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