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Post-event flood assessments — Guidance on investigating flooding incidents

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Summary of pages

This document comprises a front cover, and inside front cover, pages i to ii, pages 1 to 19, an inside back cover and a back cover.

1 Scope

This British Standard gives guidance and recommendations for investigating flood events and carrying out a post-event flood assessment to ensure that consistent, good quality data can be collected repeatedly for a variety of potential uses. Specifically, it gives guidance and recommendations for:

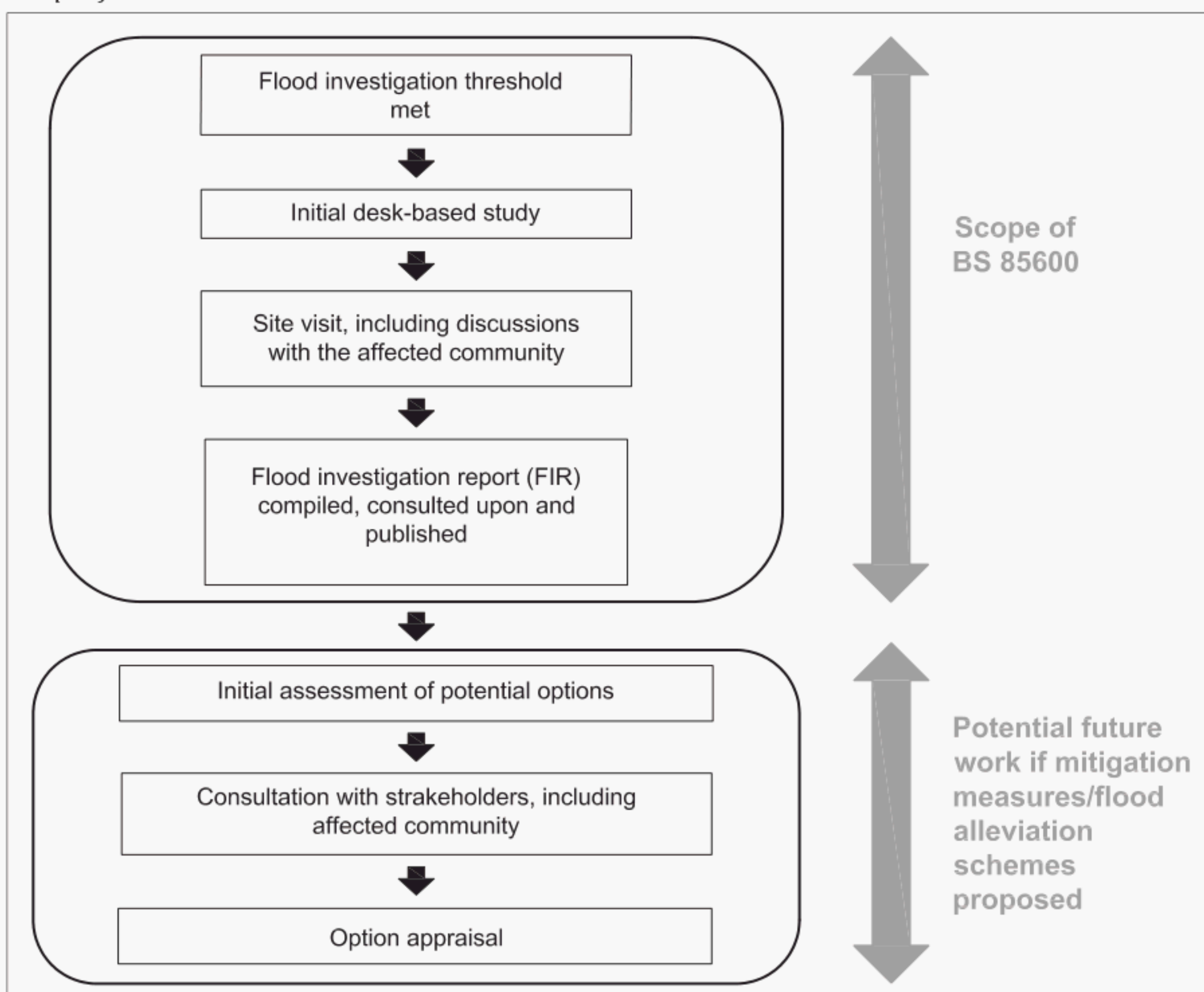
- investigating flooding incidents according to the type and severity of flooding;
- thresholds for different levels of investigations based on the communities, businesses and infrastructures affected (e.g. domestic and commercial buildings, utilities, road and rail networks);
- the most useful information to collect;
- the organizations to contact to supply or corroborate the information; and
- the preparation of a report containing information collected and initial recommendations for risk management authorities.

NOTE In England and Wales, Section 19 of the Flood and Water Management Act 2010 [1] requires Lead Local Flood Authorities to investigate and publish reports on significant flood incidents. The recommendations of this British Standard go beyond the legal requirements of Section 19, but provide a useful basis for informing such reports. No legal requirement for post-flood surveys exists in Scotland or Northern Ireland (NI). In Scotland, such reporting is carried out on an ad hoc basis only, with an annual report to Parliament on flood incidents and affected communities, produced by Scottish Government officials. In Northern Ireland, post flood investigations are carried out as a matter of course where there is flooding from a watercourse only. In both countries good practice is followed for the surveys, although it is recognized that some form of technical standardization would be of benefit.

This British Standard is applicable to investigation of natural sources of flooding, rather than failure of structures or other assets.

This British Standard does not give guidance on resolving flooding or what measures to take to prevent flooding from occurring in the future (see [Figure 1](#)).

This British Standard is intended to be used by flood risk management authorities and consultants engaged to undertake post-flood investigations.

Figure 1 — *Scope of BS 85600*

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

3.1 close proximity

reasonable assumption that the properties affected were flooded from the same source or combination of sources, such as surface water and groundwater acting together

3.2 flood incident

overflow of water onto land which is usually dry

NOTE The various sources of flooding are defined in [3.3](#).

3.3 flood sources

3.3.1 coastal/estuarine flooding

flooding that results from sea levels exceeding the natural or constructed bank or defence level of coasts and estuaries, typically caused by storms at sea raising sea and wave levels, which can combine with periods of high river flows in estuaries

3.3.2 internal flooding

flooding arising from flood water entering a commercial or residential property

NOTE Property includes basements and ground level floors, garages if these are within the fabric of the building and occupied static caravans and park homes, but not tents.

3.3.3 groundwater flooding

flooding that occurs when the water table (the water level below ground) comes close to and/or above the ground surface levels, typically caused by prolonged periods of above average rainfall over weeks and months

3.3.4 river flooding

flooding resulting from river levels exceeding the natural or constructed bank or defence level of a river or stream, typically caused by prolonged and/or heavy rainfall across catchments over days and weeks

3.3.5 sewer flooding

flooding caused by a blockage or overflow in a sewer, or capacity issues, or electro-mechanical failure of the pumping stations

NOTE Includes flooding from storm/surface water and combined sewers.

3.3.6 surface water/pluvial/urban flooding

flooding from intense rainfall falling on impermeable or saturated surfaces and/or exceeding the ability of any drainage channel to manage the flows, typically caused by short period storms over a matter of hours or less

3.4 hydrometric data

data that describe the flood event in terms of incident rainfall, water levels and flows

NOTE These may also include data on catchment conditions such as soil moisture deficit or snow cover, and whether frozen ground existed at the time of the flood.

3.5 lead local flood authority (LLFA)

local authority responsible for taking the lead coordinating role on local flood risk management

NOTE In England, this is a unitary authority or a county council. In Wales, this is a county council or a county borough council.

3.6 local sources of flooding

flooding from surface water, groundwater and watercourses (see [3.10](#))

NOTE See [3.3](#).

3.7 riparian owner

person who owns land or has property adjacent to a watercourse, whether open or culverted, running through their property

3.8 risk management authority (RMA)

Environment Agency, lead local authority, district council for an area for which there is no unitary authority, internal drainage board, water utility or highway authority

[SOURCE: Flood and Water Management Act 2010 [\[1\]](#), Section 6(13), modified]

3.9 Sewers

3.9.1 combined sewer

underground pipes which collect both surface water runoff and foul wastewater

3.9.2 foul sewer

separate underground pipe system designed specifically for transporting foul wastewater from houses and commercial buildings for treatment or disposal

3.9.3 surface water sewer

separate underground pipe system designed specifically for transporting excess rain and surface water from houses, commercial buildings and roads for treatment or disposal

NOTE A surface water sewer can be public (owned by a water and sewerage company) or private/un-adopted (owned by the landowner or management company).

3.10 Watercourses

NOTE Watercourses include all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers) and passages, through which water flows.

3.10.1 main river

watercourse or river shown on a Main River Map for England or Wales

NOTE In Scotland and Northern Ireland, "main river" has not been defined.

3.10.2 ordinary watercourse

watercourse that is not part of a main river

NOTE Examples include smaller brooks, drainage channels, ditches, cuts, dykes, sluices, soughs or culverts that might only convey water for a short length of time in a year.

4 Instigating a post-event survey investigation

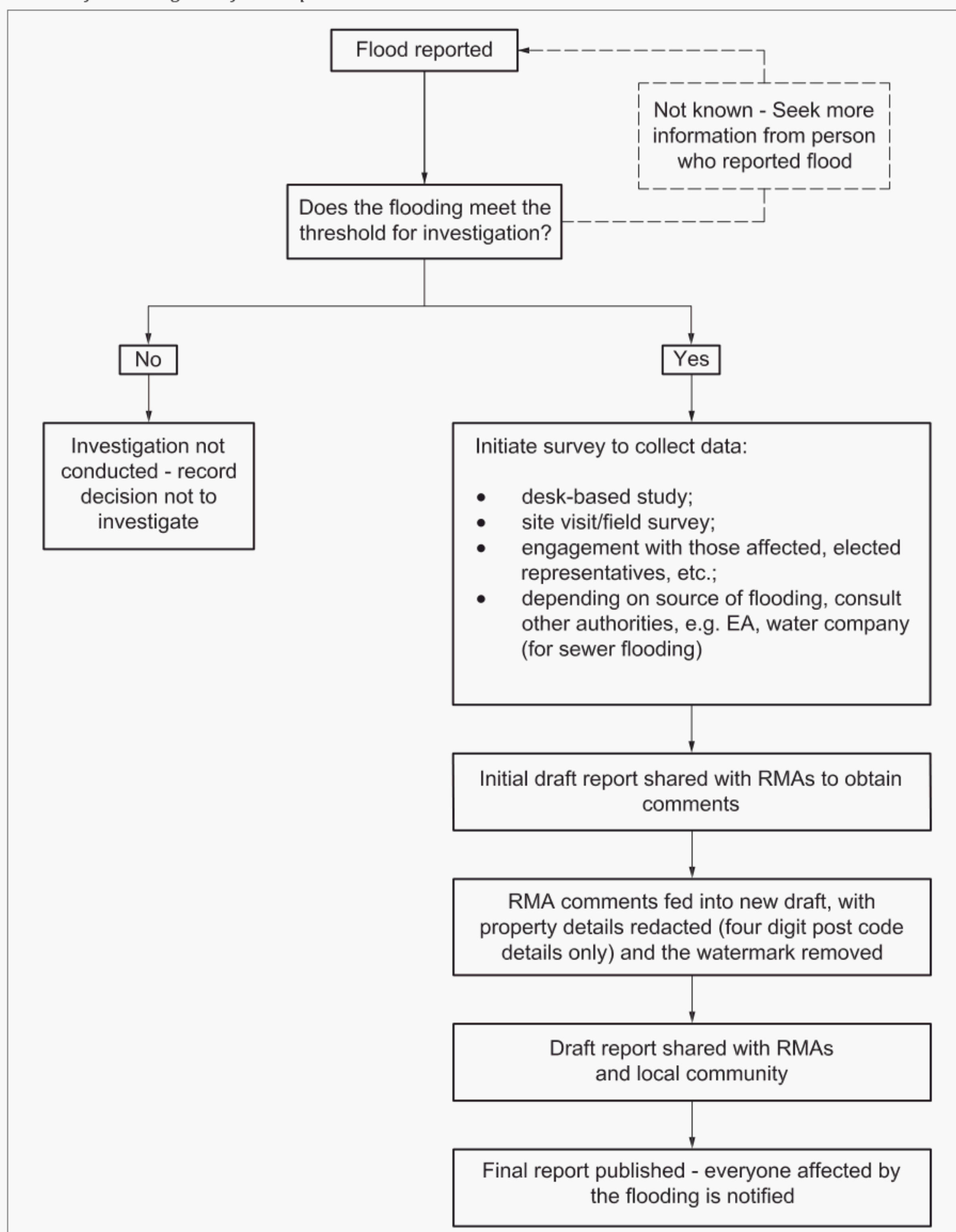
Flood events should be investigated in accordance with the procedure set out in [Figure 2](#).

The following information should, where possible, be obtained when a flood incident is first reported:

- a) severity/nature of flooding;
- b) residential/commercial properties/infrastructure affected;
- c) source of flooding;
- d) any time-critical hydrometric data;
- e) frequency of flooding;
- f) depth/level of flooding; and
- g) cause of flooding.

When considering if it is necessary or appropriate to investigate a flood event, each flood incident should be assessed on a case by case basis, reviewing the severity of the incident, the number and type of properties/assets (homes, businesses and significant infrastructure) affected, and the frequency of such an occurrence. In the case of a major or widespread flood incident, it will be necessary to prioritize the order of undertaking the flood surveys and, where appropriate, to consult with other responsible organizations.

Investigations should be proportionate to the scale of flood being considered.

Figure 2 — *Process for dealing with flood reports*

The following are guideline thresholds for determining the need for an investigation, but can vary depending on whether the area(s) affected is rural or urban and whether there is any ambiguity as to the source of the flooding:

- 1) flooding of significant infrastructure (hospital, school, utilities, treatment works, etc.);
- 2) flooding of a key transport link, e.g. primary routes (A-roads and motorways), key rail links;

- 3) internal flooding of one or more premises on more than one occasion in the past five years (excluding gardens and detached garages/out-buildings, but including integral garages); and
- 4) internal flooding of five or more properties in close proximity during a single incident.

If any of the criteria are met then a flood investigation should be commenced, taking account of the severity and extent of flooding (to inform timescales and resources). If the criteria are not met, then this fact and the decision not to investigate should be recorded. The recorded incidents should determine the initial scope and methodology for the survey(s) (one incident might involve several different surveys), and the decision as to whether the survey will involve a desk study and/or a site visit. This should involve identifying the means of capturing the data and in what format they should be recorded and stored to ensure the information can be viewed and shared for use by any relevant parties in the future.

5 Desk-based study

Where necessary, an initial data gathering exercise should be conducted to inform the requirements of the site survey (see [Clause 6](#) and [Clause 7](#)). Following the site survey a more in-depth, desk-based study should be used to complete the collation of all relevant information.

The following information may be obtained, where available and relevant, as part of a desk-based study:

- a) main parties involved (see [Annex A](#));
- b) location of event (including catchment or coastal area);
- c) identification of the catchment of the area concerned (including contour mapping and assessment of topography);
- d) location in relation to Environment Agency flood map and LLFA spatial datasets;
- e) location in relation to Environment Agency national surface water map;
- f) land use (e.g. residential, agricultural);
- g) geology and site ground conditions (e.g. permeable/impermeable);
- h) weather conditions and records during the flood event;
- i) relevant and sufficient hydrometric data to undertake an appropriate hydrological and hydraulic analysis, e.g. for the determination of the return period or likelihood of occurrence of the event;
- j) asset register, including structures and features which could have an effect on flood risk;
- k) asset condition before and after the flood, level and frequency of maintenance, etc., level and position of assets (e.g. number of road gullies, size of sewers, missing ditches);
- l) historic mapping, e.g. good illustration of watercourse location and route of flow;
- m) history of flooding – historic, similar flood events to define a pattern;
- n) impact on transport infrastructure (public transport/road closures/school closures/requests for assistance, etc.);
- o) land ownership to inform the site survey;
- p) any recent developments or changes in land use, including possible loss of flood storage;
- q) assessment of drainage systems and watercourses over the entire catchment, if appropriate; and
- r) media coverage and any video footage of the flooding.

6 Preparations for site survey

6.1 Health and safety

COMMENTARY ON 6.1

If the site survey begins a day or two after the notification, the flooding might not have receded. After a week infrastructure could still be affected, which might be dangerous.

In addition to obtaining the necessary permissions, other people might be on site, e.g. damage management consultants and loss adjusters, and this is another source/layer of hazard.

It is therefore important when sending someone to conduct a survey that they identify and record potential risks and implement the measures necessary to keep themselves safe.

- 6.1.1** A risk assessment should be performed and control measures put in place consistent with ensuring the health and safety of the person(s) conducting the flood survey/investigation and others.

NOTE Attention is drawn to *The Health and Safety at Work etc. Act 1974* [2] and the *Management of Health and Safety at Work Regulations 1999* [3].

- 6.1.2** An estimate of each potential risk should be made, which might include the following:

- a) working on or near water;
- b) adverse weather;
- c) damage to infrastructure, such as bridges;
- d) potential contamination;
- e) electrical hazards;
- f) hostile situations.

- 6.1.3** The risks identified may be mitigated by:

- a) current weather and flood forecasts;
- b) pre-emptive asset inspections (to remove obstructions etc.);
- c) effective planning and preparation;
- d) a flood briefing for all persons undertaking the site survey;
- e) a buddy system, with team contact and call-back;
- f) local emergency and rescue plans;
- g) appropriate hygiene arrangements;
- h) immunization against hepatitis, tetanus, etc.;
- i) local/dynamic risk assessment in the field; and
- j) the provision of appropriate equipment.

6.2 Equipment

To permit a flood survey/investigation to be carried out rigorously, appropriate equipment such as the following should be provided to the investigator, possibly in a waterproof “grab bag”:

- a) tablet or other recording device;
- b) appropriate personal protective equipment;
- c) a camera;

- d) a torch;
- e) sufficient batteries;
- f) phone with pre-programmed numbers;
- g) maps/plan of drainage/layout of infrastructure;
- h) GPS;
- i) tape measures;
- j) marker crayons; and
- k) blank questionnaires.

7 Site survey/investigation

7.1 Elements recorded during a flood event

To determine the effectiveness of the response, the site survey/visit should gather and record the following information about the flood incident and the area affected:

- a) date and duration of flood event;
- b) any mitigation measures taken during the flood;
- c) flood water level/depth at the peak of the flood, e.g. wrack marks on walls and fences, deposits of silt and debris;
- d) speed and direction of flood water;
- e) extent of flooding;
- f) overland flows/pathways;
- g) road closures – diversions;
- h) any loss of services/infrastructure;
- i) onset/mechanisms of flood event;
- j) landslips/erosion/deposition of material;
- k) number of calls/rescues;
- l) location of blockages (e.g. culverts and gulleys);
- m) site ground conditions, including flood defence and drainage condition observed;
- n) approximate location, post code, street name of properties affected;
- o) eye-witness accounts (previous/similar flooding events), including use of social media;
- p) verbal evidence of flood history;
- q) timelines and effectiveness of weather and flood warnings, if applicable;
- r) effectiveness of existing community plans and property level resilience (PLR);
- s) images; and
- t) video footage (CCTV) or aerial remote sensing and drones.

The local community should be engaged and consulted, including property owners and elected representatives, and, where this could be helpful, risk management authorities (RMAs) such as the national risk management authorities [i.e. Environment Agency/Scottish Environment Protection

Agency (SEPA)/Natural Resources Wales], the internal drainage board (IDB), water companies (for sewer flooding) and highways authority.

NOTE Engagement could be through drop-in sessions, community outreach/partner (e.g. fire rescue) vehicles ("flood bus"), attending parish council meetings, or postage drops.

Entry to private land should normally only be made with the permission of the landowner in advance if possible or via a public footpath/road access.

7.2 Source of the flood event

Following the initial desk-based study, the source of the flooding should be identified, which could be one or a combination of the following:

- a) storm rainfall;
- b) river flow;
- c) coastal/estuarine;
- d) urban/pluvial/surface water; and
- e) groundwater.

7.3 Cause of flooding

The cause of the flooding should also be identified, which could be one or a combination of the following:

- a) natural overtopping of coastal areas, river channels, urban/rural runoff or just runoff;
- b) surcharging of foul and/or surface water sewer or combined;
- c) poor maintenance or infrastructure failure:
 - 1) faulty flood-related assets;
 - 2) poor or insufficient drainage networks;
 - 3) inadequate maintenance of watercourses; and
 - 4) blockage or collapse;
- d) development and planning issues:
 - 1) inappropriate development in floodplains;
 - 2) building on land in a way that prevents rainfall from draining away naturally, including roads and car parks that are impermeable to water which can increase the risk of flooding from rainwater runoff; and
 - 3) defence overtopping whereby flood defence schemes are exceeded.

7.4 Severity and consequences of flood incident

The investigation should provide sufficient information to help determine the following:

- a) the likelihood of recurrence of the event (both rainfall and river flow);
- b) catchment and coastal conditions before the onset of flooding;
- c) availability of flood warnings and advice prior to the event, and any other local flood warning systems;
- d) health risks, including injury or loss of life;
- e) flooding of external property areas (e.g. gardens, driveways);
- f) flooding of internal property areas and premises, including number of properties;

- g) damage to designated environmental or cultural heritage sites;
- h) extent of flooding to important services (e.g. police stations, hospitals);
- i) obstruction and flooding of significant infrastructure (e.g. railway station, railway line) and impact on the economy, i.e. time delays getting to and from work;
- j) obstruction of access (e.g. road or pedestrian) and the impact on the economy – time delays getting to and from work;
- k) impact on community infrastructure (e.g. schools);
- l) impact on businesses;
- m) length of time that infrastructure, services, property, etc., were affected;
- n) any differences identified between mapped and actual flood extents; and
- o) environmental incidents and pollution, i.e. Natech hazards.

NOTE There is evidence that natural disasters can trigger technological disasters (a dynamic also called “domino effect”), and that these concomitant events (also known as “Natechs”) can pose tremendous risks to countries and communities that are unprepared for such risks.

7.5 Operation and performance of assets

7.5.1 For locations where static flood defences have been constructed, the following information should be obtained:

- a) whether the flood peak level reached the top of any flood defences, i.e. whether the defence level was exceeded, and where the defence level was not reached, any obvious low points which could be due to embankment settlement and which might require re-profiling;
- b) whether the flood defence structure showed any signs of structural failure or damage, e.g. by piping, slumping, burrowing animals or observed seepage, that might lead to a breach; and
- c) any evidence of the capacity of a designated flood channel being reduced by the build-up of silt or the accumulation of larger items of debris upstream of structures such as bridges or culverts.

7.5.2 For locations where operated flood defence structures have been installed, the following information should be obtained:

- a) whether manually-operated sluices and flood storage reservoirs were operated as planned or intended by design and, if not, the reason;
- b) whether temporary flood defences were available and deployed as planned and, if not, the reason;
- c) whether demountable flood defences were available and installed as planned or intended by design and, if not, the reason;
- d) whether any flood-carrying structure became blocked or its capacity became impeded by debris and, if so, whether it was cleared by operatives in a timely manner; and, if not, the reason;
- e) whether the inlet and outlet structures of any off-line flood balancing reservoir worked as planned or intended by design and, if not, the reason;
- f) whether the inundation of any off-line flood balancing reservoir worked according to plan and, if not, the reason; and
- g) whether there was limited provision for rural runoff resulting in flooding flowing on to roads whose drainage is sized only to serve the roads themselves.

7.5.3 For locations where fixed drainage systems are installed, the following information should be obtained:

- a) whether overland flows resulted in flooding of properties located in the flood flow path;
- b) whether flooding arose from inadequate assessments of the impact of drainage system failure or exceedance of design (see CIRIA's *Designing for exceedance in urban drainage – good practice* [4]);
- c) the potential for discharge at outfalls, e.g. a gully into a receiving pipe, or highway drain or sewer draining into a watercourse, being constrained by water levels in downstream receiving systems or rivers; and
- d) whether maintenance was performed as required or any asset failed (i.e. did not perform as designed).

8 Effectiveness of response

8.1 Post-event analysis/assessment of data

The information collected should be reviewed to establish whether it is adequate to inform the assessment of causes and consequences of the flooding. If not, the uncertainties/potential for error should be indicated. If sufficient data are available it might be appropriate to attempt to determine the annual exceedance probability of the flood event, with the advice of a qualified professional. The scale of the incident in relation to the historical record of floods should be established and recorded.

8.2 Effectiveness of communication of the flood incident

Where a warning was provided, reference may be made to the National Flood Warning Services offered by the Environment Agency or Natural Resources Wales (see [Annex B](#)) or any local arrangements in place, including locations where flood wardens are involved. This will allow an assessment to be made of whether this gave sufficient lead time to allow a meaningful response to be made, e.g. evacuation of property, installation of temporary flood defences, and what the response was.

The effectiveness of the communication which occurred during the flood event as part of the responses by the organizations listed in [Annex A](#) should be assessed to determine:

- a) whether those affected were warned;
- b) whether the public knew if flood information and forecasts were available;
- c) whether the information was readily understood by the public;
- d) the media used to communicate about the flood:
 - radio;
 - television;
 - phone calls;
 - emails;
 - text messages;
 - face-to-face; and
 - social media, e.g. photographs, tweets, news links; and
- e) the lead time that the warning gave of the flooding incident.

The lead time of the warning in relation to the occurrence and nature of the event is a key aspect for consideration. For example, for river flooding this can include the accuracy of the warning of the onset of overbank flow and the total duration of these conditions, as defined by the downgrading of warnings.

8.3 Effectiveness of response to flooding

Once the site survey is completed the responses of the organizations listed in [Annex A](#) before, during and after the flood should be established, to assess whether these were effective, and recorded.

9 Learning from the flood event

Identifying learning points from flood events is a key step to understanding and improving flood risk management. Learning points might be relevant to individuals, groups, organizations or across the flood risk management sector; to establish what went well and could be seen as good practice and what did not go well and needs to be improved.

Learning points should be related to the main areas covered in the report (see [Annex C](#)) and should be proportionate to the scale of the flooding e.g. incidents. Efforts should be made to record what went well (positives) and areas for improvement (negatives) to demonstrate balance. For example:

- Did the flood occur as expected?
- Were local arrangements in place, e.g. emergency plans, community flood plans, and, if so, did they work as planned?
- Was there engagement and data/resource sharing between RMAs?
- Did the flood asset infrastructure work? If it failed, could the cause be established?
- Was any warning sufficient: timely, understandable and of the appropriate level? (See [Annex B](#) which describes the aspirations of the Environment Agency to provide a flood warning service.) Did the dissemination of the warning to the public work?
- Did stakeholders heed any warning and take appropriate mitigation action? Were there adequate resources to deal with the flooding?

Learning points should be as specific and clear as possible, and should cover each issue and what happened.

It is not necessary to identify how something can be improved or make a commitment to addressing an issue that has arisen, but if there is an obvious solution this should be reported. Any commitment to act should be reviewed more widely than is possible during the flood reporting stage. However, learning points should stand alone so they can feed swiftly into improvement plans.

If any learning points are identified for other organizations, i.e. not those drafting the report, these should be discussed with the other party before finalizing any recommendation.

10 Compilation and publication of the report

10.1 Initial draft and consultation with RMAs

The outcomes of the data collection ([Clause 5](#) and [Clause 7](#)), including photographs, maps, eyewitness reports, etc., should be fed into an initial draft report. The report should also include any identified

issues (see [Clause 8](#) and [Clause 9](#)) for the risk management authorities, bodies, individuals and communities identified as having responsibilities and observations made during the investigation.

NOTE A report by Defra [5] suggests that the most effective reports are concise and focus on reporting the specific event, the hydrological aspects, the drainage systems behaviour and the causes of flooding. A template for a report is given in [Annex C](#), while a number of example actions are listed in [Annex D](#).

The report should contain recommendations for addressing the issues identified, which take account of the whole catchment area, rather than only the flooded area, so that any measures recommended do not adversely affect current assets or arrangements or increase flood risk elsewhere.

This initial draft should be shared with relevant RMAs for a predetermined period of time to obtain their comments and views, particularly on the recommendations.

10.2 Publication of final report

Once the views of the RMAs have been obtained and any changes made to the report in response to these, the “non-public” watermark should be removed and any personal/property-specific information redacted in line with data protection requirements. If any information is to be mapped and published, this should be presented at such a level to ensure that individual properties that have been flooded are not identifiable.

NOTE 1 Attention is drawn to the Data Protection Act 1998 [6] and the need to maintain a sound system of version control.

The final report should be published, e.g. posted on the relevant website, and all RMAs, parish/town council, and affected residents/homeowners/landowners should be notified of this.

NOTE 2 On occasion key stakeholders might not be fully engaged during the site investigation or key information not obtained, in which case it might be necessary to add an appendix to the published report.

Annex A (informative)

Organizations potentially involved in a flood response

The following is a list of organizations that might be involved in the response to flooding:

- a) risk management authorities;
- b) LLFA;
- c) Environment Agency/SEPA/Natural Resources Wales;
- d) Department for Infrastructure (Northern Ireland);
- e) Maritime Coastal Protection Authority;
- f) NHS Trusts/health providers;
- g) unitary and district authorities (e.g. activation of flood emergency plans);
- h) emergency planning teams;
- i) parish councils/flood wardens/flood action groups;
- j) local observation group;
- k) flood action groups;
- l) utilities and communities groups;
- m) businesses;
- n) landowners/riparian owners;
- o) home owners, tenants/residents, landlords or management companies; and
- p) emergency services.

Annex B (informative)

Environment Agency Flood Warning Service

COMMENTARY ON ANNEX B

The Flood Warning Service is applicable only to England, but Wales has its own similar system, as does SEPA in Scotland. There is not currently a public warning service in Northern Ireland.

Full details of this service are given in the document *Principles and use of Flood Warning Service codes and messages*, as given in Environment Agency Operational Instruction 352 05 of 29/04/2015 [7].

However, in the context of this document, the Flooding Warning Service is as follows:

- a) **a five day public flood risk forecast** is provided every day for England and Wales and is available at <https://www.gov.uk/> (last viewed 21 June 2017);
- b) **flood alerts** are warning messages covering low impact events and are intended to:
 - 1) cover a stretch of coastline, a river reach, a small river catchment or a specific community;
 - 2) provide advice in terms of the likelihood of flooding in the near future; and
 - 3) advise the recipients to be vigilant and aware of the risk of flooding;

- c) **flood warnings** are warning messages issued to specific locations, such as towns or villages or rural communities, which:

- 1) advise the public of when flooding is expected to occur, and to take any pre-determined actions to protect themselves and their property against the impact of the flooding;
- 2) warn of flooding to specific points such as key roads and parts of urban areas, and encourage the public to use the Agency's website where real-time hydrometric data from key river gauging stations can be downloaded if necessary;

NOTE 1 This supplements more general flooding information that can be obtained via the Agency's telephone-based Floodline.

- 3) seek to give a minimum of two hours' lead time of the onset of the flooding (individual counties might have their own target lead time);
- 4) may be divided into sub-areas based on the local information and situation, though isolated communities are not generally given this service at the present time.

NOTE 2 This only applies in England, but Wales has its own similar system under development.

- d) **severe flood warnings** are warning messages that are aimed at locations where:

- 1) there is a real risk to life or loss of key infrastructure, and where widespread property damage is expected to occur; and
- 2) level of flooding invariably involves the widespread deployment of the emergency services, usually at county level but potentially requiring the Cabinet Office Briefing Room (COBR) to be set up to coordinate a national response;

- e) **updated messages** are issued every two hours when a situation is deteriorating or changing, but this reduces to eight hours when conditions are stabilized or the risk of flooding is receding;

- f) **no longer in force** messages are issued when the risk of flooding is likely to have passed and river or coastal conditions will return to normal.

Performance validation is undertaken by the Environment Agency after every flood. Discussions should be held with the local Environment Agency office to determine performance of the service against local and national standards.

Annex C (informative)

Possible template for flood report

The following is a possible template for a flood report.

- a) Executive summary
- b) History of flooding
- c) Scope/purpose of report – report may cover multiple locations
- d) Event background
 - Flooding incident/extent
 - Location characteristics/plan
 - Current flood defences

e) Investigation

- Responsibilities for maintenance of main rivers, ordinary watercourses (see [3.10.2](#)), surface water systems and sewers
- Rainfall event(s), in terms of depth and duration

NOTE For a high-intensity short duration storm, or even a long event which has high-intensity rainfall within it, daily data are insufficient for determining the severity of the flood event.

- River gauge levels and flows
- Groundwater levels
- Coastal levels, wave heights and period
- Flooding flow routes, including flood inundation maps
- Likely causes of flooding (by area)
- Failure of drainage systems and the mechanisms of failure
- Flood incident response
- Timeline

f) Summary of impacts and findings

g) Conclusion

h) Rights and responsibilities (authorities and landowners)

i) Recommended actions

j) Next steps

k) Appendices

- Appendix X: Glossary
- Appendix X: Summary of relevant legislation and flood risk management authorities
- Appendix X: Links to other information on flooding
- Appendix X: Useful contacts and links
- Appendix X: Flood warnings and alerts
- Appendix X: Photographs from flood incident investigation

Annex D (informative)

Examples of actions that might be recommended in a flood investigation report

The following is a list of actions that might be recommended in a flood investigation report. It is for the relevant responsible organization or persons to assess each recommendation in terms of legal obligations, resource implications, priority and cost/benefit analysis of undertaking such actions.

a) **For communities and residents (e.g. town/parish councils, flood forum, community group, landowners and affected residents):**

- 1) establish observation networks in flood prone catchments;

- 2) appoint a community flood warden (and a deputy) to coordinate:
- i) preparation of an overall plan of the catchment area that includes:
 - any historic routes of drainage from the various catchment areas of the settlement, which could be reinstated or improved;
 - riparian ownership and responsibilities for field drainage systems such as ditches, culverted watercourses and open watercourse sections; and
 - land uses within the catchment that could affect the normal flow of surface water;
 - ii) preparation of household emergency plans for vulnerable properties in the area; and
 - iii) regular inspection of drainage and flood defences in the area of flood risk, with blockages or other issues reported to the landowner, asset owner, LLFA, and, if necessary, Environment Agency/SEPA/Natural Resource Wales;
- 3) explore options for property level protection and implement any recommendations, e.g. additional drainage at the rear of properties, self-sealing air bricks and flood barriers;
- 4) explore options for alternative pedestrian and vehicular routes at times of flooding;
- 5) explore community-wide solutions, e.g. natural flood retention measures; and
- 6) explore permanent building measures, e.g. installing floodgates, raising electrical sockets and fitting non-return valves on pipes.
- b) **For the Environment Agency and Lead Local Flood Authority (LLFA):**
- 1) work with their Emergency Planning Team and the Environment Agency to support the community in the instatement and training of a community-based flood warden; and
 - 2) work with their emergency planning team, the Environment Agency and other flood management authorities to support the community in the production of a community flood plan and provide advice to residents on how to explore options for property level protection; inform owners of drainage systems and watercourses within the catchment area of their legal responsibilities; and recommend appropriate maintenance regimes.
- c) **For the transport sector:**
- 1) regular highway drainage inspection and cleansing;
 - 2) assess the capacity of their assets, identify any areas with insufficient capacity for draining runoff from the highway and, where this leads to flood risk to properties, consider improvement works;
 - 3) install real-time monitoring cameras or alarm systems to alert them to any blockages/maintenance issues; and
 - 4) assess any potentially damaged bridges and embankments, including use of underwater surveys.
- d) **For the water and sewerage utility companies:**
- 1) assess sources of water entering the public sewerage system;
 - 2) assess the capacity of their assets, identify any areas of insufficient capacity and, where this could lead to flood risk to properties, consider improvement work; and
 - 3) install real-time CCTV cameras or alarm systems to alert them to any blockades/maintenance issues.

e) **For other utility companies:**

- 1) examine bespoke protection options where assets were shown to be at high risk of flooding, including using resistant and resilient building repairs.

f) **For developers:**

- 1) work with local authorities to ensure all development is completed in accordance with approved plans and documents, and planning policy; and
- 2) take care when constructing the approved development and, in particular, prior to drainage systems being built or connected, ensure that flood risk to adjacent properties/land is not increased.

g) **For landowners:**

- 1) undertake regular inspection and maintenance of their drainage systems in accordance with a defined maintenance regime;
- 2) assess the capacity of their drainage systems and identify any areas with insufficient capacity for the collection, conveyance, storage and disposal of surface water, and, where this could lead to runoff to the public highway or nuisance to third party private property, consider improvement works; and
- 3) agricultural landowners carry out works to their land to reduce surface water runoff, such as following principles of good soil husbandry, natural flood management and providing land drainage systems, e.g. ditches.

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