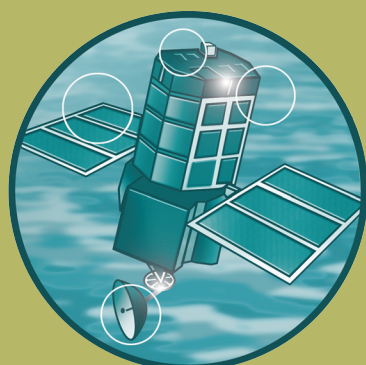


Joint Defra/EA Flood and Coastal Erosion
Risk Management R&D Programme

Post Event Appraisal – (Outline) Best Practice Guide Monitoring, recording and analysing events

R&D Technical Report: FD2012/TR



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Department for Environment
Food and Rural Affairs

Joint Defra/EA Flood and Coastal Erosion Risk
Management R&D Programme

Post Event Appraisal –
(Outline) Best Practice Guide
Monitoring, recording and
analysing events

R&D Technical Report: FD2012/TR

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Produced: August 2003

Statement of Use

The project documents provide guidance to identify the need and scope for the development of a working “pilot” post event appraisal “system” to inform subsequent policy, strategy and decision-making processes, engineering design, managerial and operational procedures and performance evaluation. Primary responsibility for incorporating this into internal operations systems lies with the Environment Agency and, where appropriate, other operating authorities.

Dissemination Status:

Internal: Released Internally

External: Released to Public Domain

Keywords: Post event appraisal, Flood, Data, Monitoring, Recording, Risk, Performance, Management.

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www.defra.gov.uk/environ/fcd

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Published by the Department for Environment, Food and Rural Affairs. Printed in the UK, June 2005 on recycled material containing 80% post-consumer waste and 20% totally chlorine free virgin pulp.

PB No 10915 ISBN: 0-85521-150-4

Acknowledgements:

JBA Consulting prepared and distributed the questionnaire survey, analysed the responses and undertook follow up questioning; their help on this and in providing other information is gratefully acknowledged. In particular we would like to thank Mr Mark Bentley and his colleagues for their time. Thanks are also due to Mr Terry Oakes, Defra and Environment Agency staff and all who contributed information in response to the questionnaire and other requests.

Executive summary

Background/need

Defra commissioned this research project to examine the benefits, costs and use of post event appraisal, particularly in respect of its use to measure performance. Bullen Consultants has led this study with additional expertise provided by JBA Consulting.

Technical report FD2012/TR is a Best Practice Guide, which can be used without reference to project reports FD2012/PR1&2. It sets down the basic requirements for effective monitoring, data collection and recording for flood and erosion events. This report (FD2012/PR1) is a free standing record of the aims, methodology and findings of the project; the major recommendations are given in Section 7. FD2012/PR2 describes in more detail the questionnaire survey and presents a full analysis of the responses.

Main objectives/aims

It has been found that post event analysis is regarded as a "one-off" activity. It was not seen as a part of the continuum of providing feedback on past performance nor was it seen as an integrated element of the FCD R&D programme. Many potential cross-links with post event analysis were poorly appreciated. One exception is the work on Performance Appraisal; the comment has been made (Simm *et al*, 2002) that:

".it is judged that there has been a failure to collect and analyse data in a sufficiently systematic, comprehensive and consistent way to enable all of the following to be carried out:

- Assess the performance of policies, plans and schemes against their original aims and objectives;
- Provide insights for effective future monitoring and management of the system being evaluated;
- Identify lessons for future practice in similar situations."

This study establishes priorities for data collection based on:

- The importance of the data (identified from questionnaire responses);
- The need to collect data which are either destroyed or degraded soon after an event;
- Data that would not be captured by routine practices or operational procedures.

Examination of recent post event data collection exercises has identified several areas in which the conduct of future studies can be improved. Adoption of a National Standard should not be a once and for all initiative. After each event

lessons should be learned, good practice shared and post flood and erosion action plans updated. There are multiple benefits of such an approach:

- The sharing of good practice nationally;
- A wider understanding of the issues;
- More effective targeting of resources;
- Systematic post-event action plans that have been agreed by all relevant agencies;
- More effective use of data collected;
- Improved forecasting and focus on flood and erosion risk areas.

The project brief commented that several recent reviews of the effectiveness of post event appraisal indicate that current approaches and techniques in the area of monitoring and recording events and subsequent performance evaluation have been neglected in the past and remain rudimentary. This is supported by the findings of this study.

Results

This study has concluded that:

- a. There is no national consistency in methods of collection or analysis. Where a "national" procedure has been established it is not widely used. The Lessons Learned; Autumn 2000 floods report (extended to include erosion events) and the SE Region¹ initiative to collect consistent data about coastal features provide role models for the future;
- b. Post event data collection and analysis is heavily weighted to technical interests. Post event appraisals of emergency responses and long-term recovery are very much less common than appraisals of the weather and flooding experienced;
- c. Little regard is given to the human, community, and social dimension of flooding and erosion events. The longer term psychological impacts on health and social well being, along with the issue of social support require more investigation;
- d. The monitoring and recording procedures do not pay enough attention to the impact of events on victims of flooding and erosion, communications with the public and emergency planning issues;
- e. Records are kept in a variety of formats and media, which makes data transfer and sharing between organisations inefficient and difficult. Data are not generally distributed widely and are not held centrally thereby allowing easy access to the information. Consequently the usefulness of the data is devalued. The Agency recognises the weakness of this and has started to

¹ See PR2 Section 3.4

address the problem;

- f. A number of initiatives will improve information gathering, storage and access. These include a variety of current R&D projects and the NFCDD;
- g. There is poor exploitation of new technology. The effectiveness of data collection procedures could be improved by the use of modern technology during surveys and the processing of data;
- h. The majority of respondents consider that there are great benefits in undertaking post event data collection exercises and appraisals. Operating Authorities consider that data collected during post event exercises are vital to improve management of flood and coastal defences. (Concerns have been expressed that the availability of resources, particularly among local authorities may not be able to sustain the required standard of input to obtain the data.);
- i. No information on the numerical assessment of the benefits of post event appraisal has been identified. Nevertheless, we have found that post event appraisal is needed and that the benefits include:
 - The impact of flooding on victims and the recovery process will be better understood and thereby improved,
 - Learning from experience how to respond to flood and erosion events and how these impact on victims,
 - Improve the process of long-term recovery,
 - Monitoring the performance of defences and improving their design and maintenance,
 - Gaining a greater understanding of the causes of events,
 - The identification of flood risk areas,
 - Processing of the data creates a historic record of the event allowing comparison with other events and the predicted performance of schemes, and
 - Storage of the data and appraisal mean that long-term trends can be assessed and provides information to justify future decision-making;
- k. Overseas practices are no further developed than in the UK.

Concluding remark

A major challenge for the future will be to dovetail effectively with other ongoing developments and existing reporting procedures (e.g. for Defra High Level Targets), avoid duplication and the introduction of unnecessary variations in methodologies. This will require further attention by Defra and Operating Authorities as a significant management challenge remains to co-ordinate these activities to avoid duplication of effort and data storage.

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1. Introduction

1.1 Background

This guide presents a framework of best practice for post event data collection. It is the primary output from Project FD2012 in the Policy Theme of the combined Defra/Environment Agency R&D programme. The two other outputs describe the studies and main conclusions in a free standing report (Project Record, FD2012/PR1) and report the results of the detailed questionnaire survey into current post-event data collection and appraisal (Project Record FD2012/PR2).

The survey has produced no evidence that other regions of the Environment Agency have adopted the national standards that have been developed for flood data collection by Thames region. As a result, records are kept in a variety of formats and media, which makes data transfer and sharing between organisations inefficient and often labour intensive; this also leads to difficulties in analysis and appraisal. A full statement of the findings appears in Chapter 6 of FD2012/PR1 along with principles underlying best practice.

This best practice guide uses a framework based on four characteristics of the data, namely:

- Importance
- Durability
- Availability
- Significance

for 29 “Headline Topics”. These characteristics are used to set priorities for prompt attention during an event².

The Headline Topics satisfy the requirements of the broad range of post event analysis needs, identified by the questionnaire and review, and lead to effective performance analysis of all flood and coastal events. In addition, lead organisations are nominated to oversee gathering and to collate data.

This guide does not cover data needed in real or near real-time to manage flood and erosion events, even though some items may overlap with those required for post event analysis. Nor does it consider which data should be published and in what form; it is recommended that this is examined when drawing up detailed procedures for access to the data. Detailed data collection activities or methods of archiving are not prescribed; these will require further and detailed development. Consideration of these, along with analysis methodologies and principles, should form the second phase of the project.

The project has identified links with, and the potential for, duplication of work underway in a number of other R&D projects and policy initiatives. Further work

² These characteristics have been applied in the NE post event data collection project (see FD2012/PR1, section 5.18)

is required to identify any shortfalls, to meet the needs of post event analysis in these developments and to develop detailed specifications for data collection programmes and storage systems. In particular, the development of a common terminology with that used for Performance Evaluation, will require further attention. In addition, it will be essential to integrate fully with the Concerted Action on a Strategic Approach to Data and Information (FD2314) within the Risks Evaluation and Understanding Uncertainty Theme.

The tables referred to in the text are in section 5

2. Best practice advice

2.1 Principles and issues

The principles underpinning the development of this best practice are presented in Chapter 6 of FD2012/PR1. Underlying these are a set of data management principles drawn from CIRIA Report C541 (Millard and Sayers, 2000), which presents best practice guidelines for maximising the use of coastal data based on work by BSI (Mayon-White and Dyer, 1997). They also take account of the results of the questionnaire, the findings from our examination of previous post event analyses, of a wide range of recent and ongoing initiatives and research, of published reports and of Defra's Policy Aims and High Level Targets.

The primary driving force for post event appraisal is Performance Evaluation leading to learning and improved practice. Monitoring is an essential part of performance evaluation, which in turn requires post event analysis. The Executive Summary of the Defra Strategy for Flood Management³ states:

"Monitoring, that is the checking on progress, condition or operation, is an essential element of any scheme of works or warning system. Monitoring during and after construction of a defence, can ensure more effective management and implementation, and will be a key element of soft defence measures where continued effectiveness depends on the maintenance of certain standards."

Data and information obtained for post event appraisal also contribute to R&D and are an important resource for the design of engineered solutions to flood and coastal events.

The key issues and examples of sub issues, that need to be addressed in developing best practice for post-event data collection are:

WHAT data should be collected?

- Who needs these data?
- How important are the data?
- How will the data be used?

WHO should collect these data?

- How to avoid duplication?
- Which is the lead organisation?

WHEN should the data be collected?

- Will information be lost or degrade if not captured promptly?

HOW to collect this data

- What methods are most appropriate?
- How much data?

³ <http://www.defra.gov.uk/enviro/fcd/pubs/stratsum.htm>

WHERE will these data be stored?

- How will users access these data?

The key attributes to achieve meaningful and effective data for post event analysis are:

- Appropriate data;
- Efficient and timely data collection and processing (including that from routine long-term monitoring programmes);
- Access by multiple users in many organisations.

These require:

- Prior identification of data to be collected;
- Pre-defined standards and formats for recording data;
- Staff allocated specifically to post event data activities to ensure data are collected during and immediately after an event;
- Specifications for contracts with short call-out times;
- Training of "in-house" and contractors' staff.

2.2 Indicator themes and headline topics

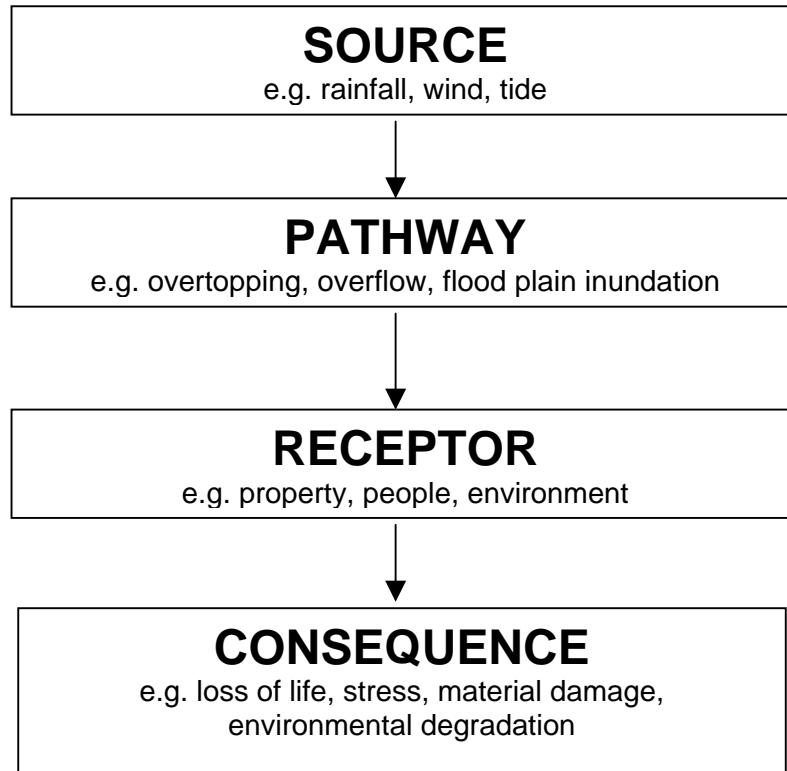
Five Indicator Themes were established in FD2012/PR1; these crosscut the whole of flood and coastal defence activities. These Indicator Themes and their sub-sets of Headline Topics (Table 2.1) were confirmed by the questionnaire responses that identified only three additions. They include all the classes of information required for comprehensive and effective post event analysis of all the activities identified in the brief, namely:

- 1) Policy and strategic decision-making
- 2) Scheme design and engineering
- 3) Scheme performance
- 4) Operational procedures
- 5) Flood forecasting and warning
- 6) Emergency planning and response
- 7) Flood inundation mapping

The Source - Pathway - Receptor - Consequences (S-P-R-C) model was advocated by both the ICE Presidential Commission (ICE, 2001) and in the Risk, Performance and Uncertainty in Flood and Coastal Defence report (Sayers *et al.*, 2002) (see box). It is being adopted for flood management as a simple conceptual tool to understand the linkage between hazard and consequence and to promote consistent terminology and philosophy. Headline Topics are linked to the S-P-R-C model in Table 2.1 and classified by "output" and "outcome".

SOURCE - PATHWAY - RECEPTOR - CONSEQUENCE MODEL

The Source-Pathway-Receptor-Consequence (S-P-R-C) model is a simple conceptual tool for representing systems and processes.



**Simple conceptual tool for representing systems –
Source - Pathway - Receptor - Consequence**

Based on: Sayers PB, Gouldby BP, Simm JD, Meadowcroft I, Hall J, Risk Performance and Uncertainty in Flood and Coastal Defence. R&D Technical Report FD2302/TR1. Flood and Coastal Defence. R&D Technical Report FD2302/TR1.

“Outputs” inform about the process of managing things and “outcomes” inform about what actually happened during an event. Information on “outputs” will lead to improved management of events and of the immediate response activities. Information on “outcomes” is required to guide the future management of flood and erosion risk and is an important input for strategic and policy decisions.

These Themes and Headline Topics will ensure coverage of those aspects of performance which need to be monitored to appraise performance, and provide feedback on:

- (a) The causes, magnitude and extent of the event;
- (b) The impact of the event on people and society;
- (c) The performance of forecasting, warning and dissemination systems;
- (d) The performance of flood and coastal defence assets (e.g. embankments, pumping stations etc.);
- (e) Actions taken during the event to alleviate flooding or erosion impacts;
- (f) Actions the Operating Authorities and others will take to alleviate problems in the future;
- (g) Actions the public might take to alleviate problems during future events.

Reliable routine data requires good system design, with an appropriate network and supporting systems. Agency areas and Coastal Authorities should regularly review to confirm that all routine items are being collected and archived.

The Lessons Learned report on the Autumn 2000 floods is a unique example of post event analysis that brings together all features in a concise and coherent way. We have developed its contents (see FD2012/PR1) into a generic form for high level reporting.

High-level structure for reporting by Operating Authorities

Impact of flood and erosion events on society and the environment:

- Impact on people; evacuation, recovery and aftercare
- Impact on society; disruption to business and infrastructure
- Impact on the environment

How the event(s) developed:

- Tides, waves, storm surges and erosion extent
- Rainfall, river levels and flood extent

Response and management of event(s):

- Forecasting and delivery of warnings
- Incident management
- Public awareness and
- Communications during the event(s)
- Views of professional partners

Performance of defences:

- Protected properties
- Near misses
- Emergency actions
- Condition of defences

Cross cutting policy and strategy issues:

These will depend upon the findings of the appraisal; recent events identified:

- Developments in areas vulnerable to flooding and erosion
- Dealing with uncertainty of climate change
- Victim support; aftercare provision, insurance, vulnerable people
- Funding: investment needs, emergency response costs

Recommendations and actions

- Strategy and policy
- Response management
- Investment planning
- Information

2.3 Data management principles

Aspects of data management, derived from the CIRIA report, which require particular attention in deriving best practice are:

Data understanding

Establishing information needs, the complexities introduced by a multiplicity of supplier and customer organisations, communication and the development and supply of metadata.

Process and procedures

Documenting procedures from pre-planning to data storage and access

Legal framework

The "duty of care" to data is often poorly recognised and valuable records have not been preserved during past reorganisations or through ignorance of their significance.

Enabling technologies

These offer the potential for greater efficiency in measurement and collection and provide wider access to datasets.

Audit

Every new flood or erosion event creates a different challenge to those previously experienced. Application of the "learning circle" should become a routine part of post event appraisal and applied to itself.

Lead Authorities will need to regularly review application of these principles.

2.4 Lead organisations

Experience during the Autumn 2000 floods revealed the extent to which flooding may be caused by inadequate surface water drains and other non-arterial sources.

As the cause of flooding and erosion may not be identified until surveys are complete, it is essential that a lead organisation is responsible for establishing responsibilities and overseeing development of protocols for collecting data on the extent and impacts of events. The Agency supervises all matters relating to flood defence and is well placed to be the principal lead organisation, and to develop this role through its existing liaison arrangements with professional partners.

Flood warning is the responsibility of the Environment Agency, who should have overall responsibility for gathering data on its delivery and effectiveness. These procedures should form part of an integrated monitoring and recording plan also covering extent, properties and infrastructure, and impacts on people and society. These plans should identify the detailed information needs of other organisations on these Headline Topics.

Table 2.2 lists lead organisations.

2.5 Importance

Three classes of *Importance* have been defined, guided by an analysis by category of interest* of the responses to the questionnaire. Respondents had been asked to indicate the importance of data as:

1. High significance
2. Useful
3. Minor value
4. Not required

* Insurance, Policy and Strategy, Emergency Response, and Operation and Design; Overseas and Scottish was not used in this analysis. (See FD2012/PR2 section 2.3)

Table 2.3 shows the importance levels ascribed to Headline Topics from an analysis of the responses to the questionnaire reported in Table 3.15 of FD2012/PR2, which takes into account the different number of responses by each interest group. Importance is used to set Priorities for data collection.

2.6 Priorities for data collection

Guidance on priorities for data collection are based on the importance of the data, together with their *Durability* and *Availability*. These are defined below.

Durability - three classes of Durability have been defined:

Transient - items that must be captured immediately or the information will be lost

Degrades - items whose information content will degrade with a few days

Invariant - data which can be collected over a period of a few weeks, without information loss.

Transient Data would include a check gauging at a river flow station to measure the peak flow, or photographs of extreme waves overtopping an embankment that cannot be obtained when the wind has abated.

Degradable Data includes obtaining a critical beach profile before successive tidal cycles change it, peak levels throughout a flood zone, and flood extent marking (followed promptly by surveying) before the evidence is destroyed.

Invariant Data will provide the majority of the information on many physical and human impacts required for post event analysis.

Availability

Data collection activities can also be usefully classified according to how data are, or would need to be, collected:

<i>Routinely collected</i>	Activities for which systems and procedures exist, often with dedicated resources.
<i>Operational Records</i>	Data on operational activities and time-critical information collected in any event.
<i>During and Post event</i>	Surveys of victims, flood and erosion extent etc., which require pro-active mobilisation or use of special teams.

Routine Data include river and tidal levels, but only at network measuring sites, hydrometeorological measurements, asset condition surveys, identification of flood plains and areas at risk. These usually form part of long-term networks or may be held by NFCDD.

Operational Data will comprise those collected day-to-day in operational logs and other records.

During and Post Event, some items may require repeat surveys to obtain a complete picture i.e., successive health surveys, progress on repairs and recovery actions.

2.7 Priorities

Three classes of priority have been established using the first three classifications, to ensure attention is given to important data, which could be lost, before gathering less important data, and that which should still be available if not collected immediately. The basis on which the three levels of priority have been set are shown in Table 2.4 below. The Headline Topics are assigned Priorities on this basis in Table 2.3

The use of these categories will assist in the planning of activities, by targeting resources and establishing Priority Topics for data collection. Tables 2.5(a) to Table 2.5(e) allocate the *Importance, Durability & Availability* categories to the Headline Topics. Table 2.6 brings together, for quick reference on one page, all those Headline Topics in the *First Priority*.

Table 2.4 Priority Classes for Post Event Data Collection

PRIORITY	IMPORTANCE			DURABILITY			AVAILABILITY		
	1 - HIGH SIGNIFICANCE	2 - USEFUL	3 - MINOR VALUE	TRANSIENT	DEGRADES	INVARIANT	ROUTINE COLLECTION	OPERATIONAL RECORDS	DURING & POST EVENT
1 st Priority	✓			✓	✓				✓
		✓		✓					✓
2 nd Priority		✓			✓			✓	✓
			✓	✓	✓			✓	✓
3 rd Priority	✓					✓	✓	✓	✓
		✓				✓	✓	✓	
			✓			✓	✓	✓	

2.8 Significance

A further classification has been established to cover the scale of data collection that should be undertaken. This is required to recognise that it would be uneconomic to collect all items, or all elements of them, in the same detail for small events as for major ones comparable to Easter 1998 or Autumn 2000. Events are classified as:

<i>Minor</i>	Small scale and local impacts
<i>Moderate</i>	Medium scale and regional impacts
<i>Major</i>	Widespread and national impacts

Table 2.7 provides general guidance on criteria to assist managers in deciding upon the significance of the event and on the level of data collection. The items are illustrative, with indicative criteria, and may not all be experienced together. Managers will need to exercise judgement, based on local considerations, in deciding the level of data collection to initiate. (For example repeated occurrences of a "minor" event at a location will require more extensive data collection, as could a development pressure or proposed scheme.)

Generic plans, based on this guidance, must be prepared to prioritise actions for data collection so that they can be activated promptly at the start of an event.

2.9 Planning

Event data recording is inevitably a non-programmed activity and must be initiated at short-notice when organisations and their staff are under considerable pressure responding to flood and erosion events. The advanced planning of activities for monitoring and recording during and after an event is, therefore, an important and essential pre-requisite to effective post event analysis.

Operating Authorities must develop plans (based on their local knowledge of the likely impacts of events) which fully recognise the need to provide information that is important to other parties. It will be essential to anticipate that unexpectedly severe flooding or erosion can require a rapid review of pre-established priorities for data collection.

Extreme events also provide opportunities to capture additional data (e.g. waves, overtopping, check gaugings, velocity profiles, etc.), but may also test installations at design limits. For these reasons, staff (including those responsible for networks) should be deployed during an event, to capture extra transient information and to check equipment is fully operational.

Pre-planning and call-off contracts will be required to ensure rapid mobilisation, which is essential to capture many features of the event. Plans for post event data collection must ensure that identified staff are allocated to these and other

time-critical data gathering activities, and not diverted to the operational response.

Both the time available and the resources that can be mobilised, (including external resources) may limit data collection activities, when priorities are the protection of life and property. Consequently a hierarchy of data collection is required. This recognises that:

- Priorities for data collection tasks must ensure time critical data will be captured;
- It will be necessary to escalate the scale of data collection from low levels appropriate for events with minor consequences, in increments to incorporate all items for events of national significance⁺;
- The importance of the data varies between categories of user and in its final application.

The requirements of users will change with time; therefore, procedures must be established to review data collection plans on a regular basis. For example, data to support investment planning which could change includes:

- Locations where schemes are in place;
- Locations where the need for schemes has been identified;
- Other sensitive locations (e.g. on main river and critical ordinary watercourses, such as undefended flood warning zones) and areas identified in local plans for development;

Plus data for:

- Catchment Flood Management Plans and Shoreline Management Plans.

Pre-planning must also extend to the specification, at the design stage of schemes, of the data (including levels, flows, wind, tide etc) needed to assess their performance. Defra should include this requirement in the project appraisal procedures.

Table 2.5(a) to Table 2.5(e) expands the Headline Topics to show, at the next level of detail, what to collect, how to collect it, and indicate methods for assessment, together with follow up actions.

2.10 Pro forma

Collection of data will require the use of pro forma, adaptable to different situations, as recent experience has shown that events will affect locations at which flooding and erosion may not have been anticipated. Appendix A is a modified version of a Data Requirement Checklist (the original was drawn up

⁺ Events comparable to those in 2000, 1953, 1947 would have national significance.

after the Easter 1998 floods) reordered under Headline Topics, which offers guidance on data items for fluvial events listed under Headline Topics.

Individual pro forma will be required for the Headline Topics, tailored to the local needs of an Area or Coastal Authority, so that staff or contractors can be allocated specific data collection tasks. Appendix A, as currently written, may encourage an individual or team to attempt to cover too wide a range of data at a location, or to embark on items which could more effectively be collected from system records or surveys after the event (e.g. flood warning performance information). Table 2.3 provides guidance on priorities.

Efficient and effective post event monitoring and data collection requires the prior identification pro forma of the data items to be collected and of the preferred methods. Methods will be dictated by the type of data and include:

- Aerial and ground survey techniques;
- Remote sensing techniques;
- Market research techniques:
 - House to house surveys
 - Focus groups
 - Questionnaires;
- Interrogation of databases (tidal, hydrometry, incident management logs, etc.);
- Inspection and extraction of data from manually produced records.

Appendix B, originally developed by the Agency, lists data collection methods, under the appropriate Headline Topic, for fluvial events data listed and guidance on their suitability and limitations.

To support fieldwork briefing packs containing checklists, information and advice should be developed for each priority location. For example in the case of surveying this would include:

- Maps
- Data sheets
- Location photographs
- Predetermined measuring points
- Equipment for the data collection tasks that will produce data in formats compatible with processing and storage technologies

2.11 Resources and training

Experience suggests that in-house resources are often unlikely to be sufficient, except for very local and small-scale events, and that where local resources are known to be insufficient, external resources will also be required to carry out post event data collection. Consequently, it will be essential to have

arrangements in place that guarantee the availability of a dedicated team of in-house and external staff, all of whom have had prior training. They will also require regular refresher courses to cater for staff turnover and the possibility of years during which they do not collect data.

Whilst local teams have the advantage of local knowledge and should provide the front-line response, the merits of regional response teams available to work at any location should be examined. Events occur somewhere every year, in most parts of England and Wales, and these teams would be able to develop expertise and skills. The appointment of one team to provide a national lead and oversight is recommended to prepare standards and to develop best practices, which are then issued as national procedures. A full-time national lead team would also ensure continuity between events, thereby increasing the utility of the data collected at different times.

Emergency exercises offer an opportunity to test the initiation of event data collection procedures and allocation or deployment of resources. Exercises should include, as a minimum, identification of actions required, if not actual mobilisation of the data collection team. Major exercises should include mobilisation.

2.12 Data management and storage

Quality assurance procedures are not widely used at present and need to be developed for post event monitoring and data collection to ensure both consistency in data densities, formats, accuracy etc. and to achieve quality control of the data collected.

Attention also needs to be given to data format. (Specifications requiring survey results to be provided in Access[®] database formats gives wide scope for interpretation and has been found⁴ to result in incompatibility of data from different sources and events). In addition to consistency and compatibility, the formats must be able to accept data from field collection with the minimum of intervention, which can be time consuming and therefore expensive.

Responses to the questionnaire and recent exercises have identified several areas in which the conduct of future studies can be improved. Particular areas that have been identified include:

- Preparation of a clearly defined specification, (format of data, equipment);
- Staff training, (including prioritisation of data collection issues);
- Preserve continuity from previous events;
- Maximising the data collection opportunities during initial site visits;
- Liaison between Operating Authorities and surveyors during an event, debriefing of surveyors;

⁴ JBA Consulting.

- Post event processing - quality assurance of data, definition of deliverables and associated formats, dynamic feedback.

Having collected the data, there is a need to develop techniques to automate the processing of field data into floodplain maps and other deliverables such as databases and GIS. The data warehouse concept of NFCDD offers the facility to hold post event data and to make them widely available to all users and should become the primary repository for post event data. This will require development of NFCDD into data areas not currently being considered. Appendix C reproduces a standard data sheet developed (Bullen Consultants, 2001) for the presentation of flood survey data for locations in Yorkshire.

2.13 Further development

The use of modern technology during surveys and for their subsequent processing could improve the effectiveness of data collection procedures. The use of hand-held GPS systems linked to palm top computers would improve the efficiency of data collection during walkover surveys, but requires weatherproof equipment, which may not be readily available.

The Agency's project Checkmate is examining hand-held data loggers and the NE region's project is exploring hand-held GIS systems. These are still ongoing and may identify opportunities to streamline post event data collection. Their results should be reviewed and where appropriate incorporated into procedures for post event data collection.

The results of investigations, by the Agency's NCEDS and the R&D project to test Side Aperture Radar, should be used to develop new procedures, as and when these and other techniques are found to be viable for flood and erosion monitoring, and under extreme weather conditions.

3. Concluding remarks

These conclusions⁵ summarise opportunities for improving and consolidating current best practice:

1. Regional teams, able to support local resources in Agency Areas and Coastal Authorities should be established. One regional team should be nominated as the national lead team, with a small core of full time staff, responsible for developing the generic plans, procedures and standards;
2. Emergency exercises offer an opportunity to test the initiation of event data collection procedures and allocation or deployment of resources. Exercises should include, as a minimum, identification of actions required, if not actual mobilisation of the data collection team. Major exercises should include mobilization;
3. Post event data activities need prior planning:
 - a) Operating Authorities should set priorities for post event data collection based on their local knowledge of the likely impacts of flooding and erosion;
 - b) Generic plans to prioritise areas for data collection must be prepared in advance;
 - c) Priorities for post event data collection must be clearly stated and recognised within Operating Authorities to ensure identified staff are allocated to time-critical data gathering activities and not diverted to the operational response;
 - d) Pre-planning must also extend to the specification, at the design stage of schemes, of the data (including levels, flows, wind, tide etc) needed to assess their performance. Defra should include this requirement in the project appraisal procedures;
 - e) Data items to be collected and the preferred methods should be identified on pro-forma;
 - f) The use of the Priority Classes (based on Importance, Durability, Availability and Significance of the data) and the hierarchy of data collection presented in Tables 2.3 & 2.5(a)-(e) will assist in the planning;
 - g) Fieldwork briefing packs containing checklists, information and advice should be developed for each priority location;

⁵ Our main recommendations, for the development of post event data collection and appraisal, are presented in Section 7 of FD2012/PR1.

4. Operational logs should not be used as the primary source of data on impacts. Procedures should be developed to confirm their information by post event surveys;
5. Enabling technologies offer the potential for greater efficiency in measurement and collection and by providing wider access to datasets:
 - a) The effectiveness of data collection procedures should be improved by the use of modern technology during surveys and the processing of data. The results of investigations by the Agency's NCEDS, the R&D project to test SAR, and Project Checkmate should be used to develop new procedures as and when these and other techniques are found to be viable;
 - b) Techniques should be developed to automate the processing of field data into floodplain maps and other deliverables such as databases and GIS;
 - c) Standard data formats should be established and their use made obligatory;
 - d) Equipment used in the field must produce data in formats compatible with processing and storage technologies;
6. Application of the "learning circle" should become a routine part of post event appraisal and used to improve the post event appraisal process at national and local level.

4. References

Bullen Consultants 2001 November 2000 Flood Event Mapping (Ref 100B282), July 2001

ICE, 2001 Learning to live with rivers. Final report of the Institution of Civil Engineers' Presidential Commission, Institution of Civil Engineers, London, 2001

Mayon-White W and Dyer B 1997 Principles of good practice for information management, Version 2.0 IMDA, London School of Economics, British Standards Institute

Millard K and Sayers P 2000 Maximising the use and exchange of coastal data; A guide to best practice, CIRIA, London

Sayers PB, Gouldby BP, Simm JD, Meadowcroft I, Hall J, 2002 Risk Performance and Uncertainty in Flood and Coastal Defence. R&D Technical Report FD2302/TR1.

5. Tables

Table 2.1 Indicator themes and headline topics (with Source-Pathway-Receptor-Consequence Outputs & Outcomes)

Indicator themes	Headline topics	Source	Pathway	Receptor	Consequence
1 Impacts on Society and the Environment	1.1 Human dimension (incl. vulnerable people / health / insurance / recovery and aftercare) 1.2 Evacuation (achieved and attempted) 1.3 Extent of areas inundated (including residual water) / locations eroded 1.4 Properties and businesses affected 1.5 Major infrastructure, archaeological and environmental assets affected 1.6 Financial and economic losses 1.7 Pollution threats and occurrences			Outcome	Outcome Outcome/output Outcome Outcome Outcome Outcome
2 Service Delivery Performance	2.1 Weather forecasting performance 2.2 Flood and tidal surge forecasting performance 2.3 Systems (telemetry, AVM & Floodline) performance 2.4 Receipt of flood warning / properties not warned 2.5 Property and assets protected 2.6 Incident & Emergency management / response 2.7 Resource availability / Resources used (costs) 2.8 Health and safety (employees)	Output/ outcome Output/ outcome Output/ outcome			Outcome Outcome Output/output Output/output Outcome
3 Performance of Defences	3.1 Performance of defences 3.2 Near misses (A-overtopping events; B-breach events; C-erosion events)		Outcome Outcome (A & B)	Outcome (C)	
4 Source Monitoring and Event Magnitude	4.1 Antecedent conditions & weather experienced 4.2 River flows & levels, groundwater levels & outflows experienced 4.3 Tidal events experienced 4.4 Sources and causes of flooding 4.5 Severity of flood / tidal event 4.6 Ground movements and erosion losses experienced	Outcome Outcome Outcome Outcome Outcome		Outcome Outcome	
5 Cross-cutting Strategy & Policy Issues	5.1 Media 5.2 Feedback from public, & MPs 5.3 Liaison & feedback from professional partners 5.4 Reporting mechanisms 5.5 Mitigation options and assessment	Output/ outcome Output Output/ outcome	Output/ outcome Output Output/ outcome	Output/ outcome Output Output/ outcome	Outcome Outcome Output/ outcome Output Output/ outcome

NOTES:

OUTPUTS inform about the process of managing
OUTCOMES inform about what actually happened.

Table 2.2: Lead organisations for headline topics

Indicator themes	Headline topics	Lead organisation
6 Impacts on Society and the Environment	6.1 Human dimension(incl. vulnerable people / health / insurance / recovery and aftercare)	Agency
	6.2 Evacuation (achieved and attempted)	Agency
	6.3 Extent of areas inundated (incl. residual water)/. locations eroded	Agency
	6.4 Properties and businesses affected	Agency
	6.5 Major infrastructure, archaeological and environmental assets affected	Agency
	6.6 Financial and economic losses	Agency
	6.7 Pollution threats and occurrences	Agency
7 Service Delivery Performance	7.1 Weather forecasting performance	Met Office
	7.2 Flood and tidal surge forecasting performance	Agency for rivers / Met O for tides
	7.3 Systems (telemetry, AVM & floodline) performance	Agency
	7.4 Receipt of flood warning / properties not warned	Agency
	7.5 Property and assets protected	Agency
	7.6 Incident & Emergency management / response	Agency
	7.7 Resource availability / Resources used (costs)	Individual operating authorities
	7.8 Health and safety (employees)	Individual operating authorities
8 Performance of Defences	8.1 Performance of defences	Individual operating authorities
	8.2 Near misses (A-overtopping events; B-breach events; C-erosion events)	Agency
9 Source Monitoring and Event Magnitude	9.1 Antecedent conditions & weather experienced	Agency
	9.2 River flows & levels, groundwater levels & outflows experienced	Agency
	9.3 Tidal events experienced	Met Office
	9.4 Sources and causes of flooding	Agency
	9.5 Severity of flood / tidal event	Agency - flood / coastal - LA erosion
	9.6 Ground movements and erosion losses experienced	Agency - inland / Coastal LA - coast
10 Cross-cutting Strategy & Policy Issues	10.1 Media	Agency
	10.2 Feedback from public, & MPs	Agency
	10.3 Liaison & feedback from professional partners	Agency
	10.4 Reporting mechanisms	Agency
	10.5 Mitigation options and assessment	Operating authorities

Table 2.3 Importance and priorities for data collection during and immediately after a flood or erosion event

Indicator themes	Headline topics	Importance			Priority		
		1	2	3	1	2	3
11 Impacts on Society and the Environment	11.1 Human dimension (incl. vulnerable people / health / insurance / recovery and aftercare)		✓			✓	
	11.2 Evacuation (achieved and attempted)		✓			✓	
	11.3 Areas inundated (incl. residual water) / locations eroded	✓			✓		
	11.4 Properties and businesses affected	✓			✓		
	11.5 Major infrastructure, archaeological and environmental assets affected	✓			✓		
	11.6 Financial and economic losses	✓					✓
	11.7 Pollution threats and occurrences	✓			✓		
12 Service Delivery Performance	12.1 Weather forecasting performance		✓				✓
	12.2 Flood and tidal surge forecasting performance	✓					✓
	12.3 Systems (telemetry, AVM & Floodline) performance			✓		✓	
	12.4 Receipt of flood warning / properties not warned		✓			✓	
	12.5 Property and assets protected		✓			✓	
	12.6 Incident & Emergency management / response		✓				✓
	12.7 Resource availability / Resources used (costs)	✓			✓		
	12.8 Health and safety (employees)		✓			✓	
13 Performance of Defences	13.1 Performance of defences	✓			✓		
	13.2 Near misses (A-overtopping events; B-breach events; C-erosion events)	✓			✓		
14 Source Monitoring and Event Magnitude	14.1 Antecedent conditions & weather experienced	✓					✓
	14.2 River flows & levels, groundwater levels & outflows experienced	✓			✓		
	14.3 Tidal events experienced	✓			✓		
	14.4 Sources and causes of flooding	✓			✓		
	14.5 Severity of flood / tidal event	✓					✓
	14.6 Ground movements and erosion losses experienced	✓			✓		
15 Cross-cutting Strategy & Policy Issues	15.1 Media		✓			✓	
	15.2 Feedback from public, & MPs		✓			✓	
	15.3 Liaison & feedback from professional partners		✓			✓	
	15.4 Reporting mechanisms		✓			✓	
	15.5 Mitigation options and assessment	✓					✓

Table 2.5(a) Importance, urgency, and classification with outline information needs

Impacts on society and the environment	Priority	Durability			Availability			What to collect	How to collect	How to assess & follow-on actions
		Transient	Degrades	Invariant	Routine collection	Operational records	During & post event			
Headline topics										
1.1 Human dimension (incl. vulnerable people, health, recovery and aftercare, and insurance)	2		✓				✓	Changes in physical and mental health, ethnic and social background, losses not recovered from insurance No. of properties insured / uninsured Health visits post flood Hospital Accident and Emergency cases Repairs required post flood	Post event survey & questionnaires, and focus groups (repeated as required over time) Insurance company claims Local authorities social service records NHS Trusts NHS Trusts Insurance company claim records	Analysis to determine notable features and issues requiring future attention
1.2 Evacuation attempted and achieved	2		✓				✓	Numbers and locations of proposed evacuees, numbers of actual evacuees, transport arrangements. Numbers at evacuation centres	Police and Social Services records Emergency service records Army deployments	Analysis of successes and failures, difficulties encountered etc.
1.3 Extent of areas inundated (including residual water) & locations eroded	1	✓					✓	Aerial extents Aerial photographs SAR Mapped wrack marks Lead authority	Deployment of aircraft Site visits immediately after event to identify and mark flood envelope and survey as soon as practicable. Photographs	Establish sources and causes of flooding under 3.1
1.4 Properties and businesses affected	1		✓				✓	Numbers and locations and types of properties Businesses affected Length of time before usable again (see also 1.1)	Local authority records/ flood outlines Local chambers of commerce Post event interviews / questionnaires	Analysis to determine magnitude of losses, length of disruption to business, numbers of homeless and duration Monitoring status of investigations and summary of decisions made on solutions.
1.5 Major infrastructure, archaeological and environmental assets affected	1	✓					✓	Roads closed / length of time affected Railways/ Services disrupted SSSI's affected Archaeological sites affected	Highways Agency / Local authorities Railtrack English Nature	Analysis of losses and costs

Table 2.5(a) Importance, urgency, and classification with outline information needs

Impacts on society and the environment	Priority	Durability			Availability			What to collect	How to collect	How to assess & follow-on actions
		Transient	Degrades	Invariant	Routine collection	Operational records	During & post event			
Headline topics										
1.6 Financial and economic losses	3			✓			Information on flood damages, losses and costs	Collation of data from other Headline Topics (e.g. 1.1, 1.3, 1.4, 1.5, 2.6 & 2.7)	Methods used in "Assessment of National Economic and Financial Losses" (FHRC,2002)	
1.7 Pollution threats and occurrences	1	✓				✓	Combined sewer overflows operating Emergency overflows operating Hazardous sites affected	Environment Agency Water Companies	Changes in water quality and ecological status Risk assessments leading to identification of solutions, risk management plans etc.	

Table 2.5(b) Importance, urgency, and classification with outline information needs

Service delivery performance	Priority	Durability			Availability			What to collect	How to collect	How to assess & Follow-on actions
		Transient	Degrades	Invariant	Routine collection	Operational records	During & post event			
Headline topics										
2.1 Weather forecasting performance	3			✓		✓	Records of Weather forecasts pre- and during event Records of weather experienced	Met. Office / Local Weather Centres))))	
2.2 Flood and tidal surge forecasting performance	3			✓		✓	Forecast predictions pre and during event Records of tide and surge levels experienced	Storm tide warning service Agency flood forecasting teams) Review methodologies developed by R&D Project on) Development of Flood Warning Management System	
2.3 Systems (telemetry, AVM & Floodline) performance	2		✓			✓	No. of calls to Floodline No. of messages sent on AVM No. of messages received by AVM Records of breakdowns & operational problems	Telephone call and system performance logs))))	
2.4 Receipt of flood warning / properties not warned	2		✓			✓	Records of flood warnings issued Properties affected Properties warned Properties where warning not received	Local authorities Environment Agency warning teams)	
2.5 Property and asset protected	2			✓		✓	Location of flood defences Numbers of properties Major infrastructure etc.	Mapping and GIS systems FCD scheme reports and records) Analysis to determine value of properties and assets which did not experience flooding	
2.6 Incident and emergency management & response	3			✓		✓	No. of calls to emergency services Response time of emergency services No. of fire engines deployed No. of ambulances deployed No. of police deployed	Telephone call logs Fire / Ambulance / Police services) Review experiences against Emergency Plans and update as appropriate	
2.7 Resource availability and resources used (costs)	1		✓			✓	No. of staff hours No. of sandbags etc. used No. of pumps used Army deployments	Staff timesheets Local Authorities Emergency Services Ministry of Defence) Methods used in FHRC report (see 1.6)	

Table 2.5(b) Importance, urgency, and classification with outline information needs

Service delivery performance	Priority	Durability			Availability			What to collect	How to collect	How to assess & Follow-on actions
		Transient	Degrades	Invariant	Routine collection	Operational records	During & post event			
Headline topics										
2.8 Health and safety (employees)	2		✓			✓	No. of injuries No. fatalities Risk assessments used	Health & Safety Executive Agency / Emergency Service H&S records	Review of Accident and other Health and Safety Reports, leading to improved risk assessment procedures and safety practices	

Table 2.5(c) Importance, urgency, and classification with outline information needs

Performance of defences	Priority	Durability			Availability			What to collect	How to collect	How to assess & Follow-on actions
		Transient	Degrades	Invariant	Routine collection	Operational records	During & post event			
Headline topics										
3.1 Performance of defences	1		✓				✓	Locations of defence failures Damage sustained by defences Post event repairs required Photographs / descriptions of damage, blockages, records of operations, control of sluice pumps etc	NFCDD & FDMS and LA records Post flood inspections Post flood works undertaken Post event inspection, Logs and other records	Methods under development in R&D projects on: Performance and reliability of flood and coastal defence structures, and Condition monitoring and asset management of complex infrastructure systems.
3.2 Near misses (A-overtopping events; B-breach events; C-erosion events)	1		✓				✓	Details of emergency works undertaken	Contractors, EA & LA workforce and Army etc records Survey of modified defences	Assessments based on items 4.2 & 4.3 and records

Table 2.5(d) Importance, urgency, and classification with outline information needs

Source monitoring and event magnitude	Priority	Durability			Availability			What to collect	How to collect	How to assess & Follow-on actions
		Transient	Degrades	Invariant	Routine collection	Operational records	During & post event			
Headline topics										
15.6 Antecedent conditions & weather experienced	3			✓		✓		Soil moisture, wind, tide, flow, level and rainfall data Rain gauge data Snow Data Temperature data Weather radar data	(Available from archived data) Local weather centre records Environment Agency records Met. Office records	Use in 3.3
15.7 River flows & levels, groundwater levels and outflows experienced	1		✓				✓	As 4.1 plus surveys of flood levels and groundwater levels Spot gaugings for rating curves Flow records at gauging stations Wrack marks Peak water levels	As 4.1 plus field surveys Current metering during event Environment Agency records Site visits soon after events Maximum level gauges	Use in 3.3
15.8 Tidal events experienced	1		✓				✓	As 4.1 plus surveys of tidal flood levels Tide gauge data	As 4.1 plus field surveys Environment Agency Data Port Authorities Storm Tide Warning Service	Use in 3.3
15.9 Sources and causes of flooding	1		✓				✓	Local cause and source of flooding (including designation of watercourse) Flood routes Witness statements	Post flood interviews Local Authority / Agency operations teams	Investigations and modelling studies, classification as in "Lessons learned" Report-Table 1.
15.10 Severity of flood / tidal event	3			✓			✓	Flow station records Peak water level data	Hydrometric records	Assessments based on items 4.2 & 4.3 and records
15.11 Ground movements and erosion losses experienced	1		✓				✓	Spatial extent of erosion and ground movement	Ground survey of erosion extent and beach profiles	Determine extent and significance of loss of land and beach profile

Table 2.5(e) Importance, urgency, and classification with outline information needs

Cross-cutting strategy & policy issues	Priority	Durability			Availability			What to collect	How to collect	How to assess & Follow-on actions
		Transient	Degrades	Invariant	Routine collection	Operational records	During & post event			
Headline topics										
5.1 Media	2		✓			✓	News cuttings Press releases Records of communications with media	Local/ National newspapers Environment Agency Keep logs and accurate notes; review media reports	Review of media coverage Market Survey questionnaires	
5.2 Feedback from public & MP's	2		✓			✓	Records of feedback from public and MPs	Keep logs and accurate notes; public meetings etc.	Review of issues raised at meetings in letters etc	
5.3 Liaison & feedback from professional partners	2		✓			✓	Records of liaison and feedback from partners	Keep logs and accurate notes; post event meetings	Post event meetings and workshops	
5.4 Reporting mechanisms	2		✓			✓	N/A	Pre-arranged reporting mechanisms	Post event meetings and workshops	
5.5 Mitigation options and assessment	3			✓		✓	N/A		Project appraisal techniques	

Table 2.6 Priority information needs

Headline topic	What to collect	How to collect
1.3 Extent of areas inundated (including residual water) & locations eroded	Aerial extents Aerial photographs SAR Mapped wrack marks	Deployment of aircraft Site visits immediately after event to identify and mark flood envelope and survey as soon as practicable. Photographs
1.4 Properties and businesses affected	Numbers and locations and types of properties Businesses affected Length of time before usable again (see also 1.1)	Local authority records/ flood outlines Local chambers of commerce Post event interviews/ questionnaires
1.5 Major infrastructure, archaeological and environmental assets affected	Roads closed/ length of time affected Railways/ Services disrupted SSSI's affected Archaeological sites affected	Highways Agency / Local authorities Railtrack English Nature
1.7 Pollution threats and occurrences	Combined sewer overflows operating Emergency overflows operating Hazardous sites affected	Environment Agency Water Companies
2.7 Resource availability and resources used (costs)	No. of staff hours No. of sandbags etc. used No. of pumps used Army deployments	Staff timesheets Local Authorities Emergency Services Ministry of Defence
3.1 Performance of defences	Locations of defence failures Damage sustained by defences Post event repairs required Photographs / descriptions of damage, blockages, records of operations, control of sluice pumps etc	NFCDD & FDMS and LA records Post flood inspections Post flood works undertaken Post event inspection, Logs and other records
3.2 Near misses (A- overtopping events; B- breach events; C-erosion events)	Details of emergency works undertaken	Contractors, EA & LA workforce and Army etc records Survey of modified defences
4.2 River flows & levels, groundwater levels and outflows experienced	Surveys of flood levels and groundwater levels Spot gaugings for rating curves Flow records at gauging stations Wrack marks Peak water levels	Field surveys Current metering during event Environment Agency records Site visits soon after events Maximum level gauges
4.3 Tidal events experienced	Surveys of tidal flood levels Tide gauge data	Field surveys Environment Agency Data Port Authorities Storm Tide Warning Service
4.4 Sources and causes of flooding	Local cause and source of flooding (including designation of watercourse) Flood routes Witness statements	Post flood interviews Local Authority / Agency operations teams
4.6 Ground movements and erosion losses experienced	Spatial extent of erosion and ground movement	Ground survey of erosion extent and beach profiles

Table 2.7 Significance

	Minor Event	Moderate Event	Major Event
Criteria	More than 20% probability (<5 year return period)	More than 4% probability (<25 year return period)	Less than 4% probability (> 25 year return period)
	Flood watches issued	Flood warnings issued	Severe flood warnings issued
	Minimum impacts on wider community	Significant population at risk	Extensive numbers of population at risk
	Isolated properties / businesses flooded	Impacts restricted to local communities affected (ie local road diversions required)	Impacts extend beyond areas affected (i.e. regional and local disruption to travel)
	Superficial (non threatening) damage to defences and other assests	Groups of properties / businesses flooded	Significant numbers of properties affected and / or a large number of locations
		Defences suffer damage, which if not repaired could pose problems in a repeat event of similar magnitude	Defences require emergency repairs
		Assets approaching design capability	Assets tested at or beyond design capability
	Some erosion	Erosion of beaches requires remedy	Erosion of beaches requires immediate remedy
Collect Data	On locations flooded / eroded	On locations flooded / eroded	On locations flooded / eroded
	For calibrating / verifying hydraulic models	For calibrating / verifying hydraulic models	For calibrating/ verifying hydraulic models
	For assessing severity	For assessing severity	For assessing severity
	To support catchment and shoreline management plans and development control	To support catchment and shoreline management plans and development control	To support catchment and shoreline management plans and development control
		Extent of impacts	Extent of impacts
		People affected	People affected
		Service delivery	Service delivery
		Performance of defences	Performance of defences
			Plus all data identified in Table 1
Output	Information recorded on databases (including NFCDD)	Information recorded on databases (including NFCDD)	Information recorded on databases (including NFCDD)
	Identification of problems	Identification of problems	Identification of problems
		Identify strategic issues and mitigation options for EA Areas and Local Authorities	Identify strategic issues and mitigation options for EA Areas and Local Authorities
			Regional and National reports using Autumn 2000 reports as a model

Appendix A

Example DATA REQUIREMENTS CHECK LIST (Developed from Field Collection of Flood Event Data EFAG/A1.28)

Based on Appendix A (from Field Collection of Flood Data - EFAG/A1.28)

DATA COLLECTION REQUIREMENTS CHECK LIST

This list of data requirements may not apply to all events or staff undertaking specific tasks. However, it does provide a check list of information required for the selected Headline Topics.

IMPORTANT

ALL READINGS, OBSERVATIONS, PHOTOGRAPHS, VIDEOS ETC. MUST INCLUDE **DATE** AND **TIME** (24 HOUR CLOCK LOCAL TIME) AND AN ESTIMATE OF WHETHER LEVELS ARE **RISING** OR **FALLING** AND THE **TIME** OF **PEAK** IF FALLING.

PHOTOGRAPHS ARE AN IDEAL METHOD OF RECORDING FLOODING BUT MUST BE CLEARLY ANNOTATED WITH LOCATION DETAILS, DATE, TIME ETC.

HEADLINE TOPIC	FLOODING INFORMATION REQUIRED	Info. Collected
1.3 Areas inundated and locations eroded		
	FLOOD ENVELOPE: Flood envelope by marking, noting debris lines etc	
	OTHER FLOODING: roads, parkland, agricultural etc. (all out of bank flows both rural and urban):- Where flows are deepest and fastest: - estimate velocity - direction of flow - depth of flooding - extent of flooding - disruption caused - if possible comparison with previous levels	
1.4 Properties and businesses affected		
	PROPERTIES FLOODED, including gardens:- - addresses, type i.e. residential, offices, factory, school, hospital etc. - depth of flooding and whether above or below threshold levels - names of occupiers of flooded properties and contact details if possible - if only gardens flooded, extent of flooding - date / time of water entering and leaving property, source of entry (air bricks / threshold etc.) - damage to other assets (e.g. vehicles), extent of damage, estimate of value of damage - disruption caused - direction of water flow - where velocities are greatest - requests for and Agency assistance, and where this was provided	
1.7 Pollution threats and occurrences		
	- pollution or waste arising from flooding	
2.4 Receipt of flood warnings / properties not warned		
	FLOOD WARNINGS:- - was any warning received? - if so, from whom? Official EA, Police, LA, radio, TV - by what means? Loud hailer, telephone (AVM), personal call etc. - at what time (24 hour clock)? - was there enough time to take remedial action? - was any remedial action taken? - did resident use Agency's FLOODLINE service?	
3.1 Sources and Causes of flooding		

	<p>TYPE/CAUSE OF FLOODING (can be 'composite', e.g. start as surface water system, followed by raising of river levels later):-</p> <ul style="list-style-type: none"> - main river - ordinary watercourse - secondary flooding from surface water drains or sewers - resulting from blockages - resulting from structures - low points in river bank, or embankments - deficiencies in structures 	
3.2 Performance and condition of defences and other assets		
	<p>AGENCY FLOOD DEFENCE ASSETS, flood banks, control structures etc</p> <ul style="list-style-type: none"> - are defences functioning properly, still offering protection? - any visible signs of damage / blockage - position of operable controls, especially if not regularly attended - flooding impacts on or emanating from, Agency construction works - damage to other assets 	
	<p>STORAGE PONDS & "RESERVOIRS ACT" RESERVOIRS:-</p> <ul style="list-style-type: none"> - levels and freeboard - discharge from pond, controlled or overflowing - amount of debris and afflux at outlet grille, any structural damage 	

4.2 River flows & levels, groundwater levels & outflows experienced		
	<p>RIVER/FLOOD LEVELS:-</p> <ul style="list-style-type: none"> - gauge board readings - peak level indicator readings (post event) - levels, by marking structures, noting brick courses etc. - levels upstream and downstream of structures - low points in river bank, or embankments - levels / flows in vicinity of river level gauging stations, to enable level / flows to be verified and corrected - flood / sluice gate openings (i.e. number and % openings), size of gate opening (or photograph), time of alterations to opening. Any control structure, not just Agency. - afflux (water level head difference across gate or bridge structures) - time of water going out of banks, and coming within banks again - time of peak 	
	<p>FLOWS (will normally be collected by flow gauging team). However, staff could estimate flows where possible.</p> <ul style="list-style-type: none"> - width of flood plain - maximum velocity, width over which this applies - average velocity 	
	<p>GAUGE WEIRS:-</p> <ul style="list-style-type: none"> - extent of flow by-passing the weir (i.e. Unmeasured flows) - overtopping points - reporting of drowned weirs 	

Appendix B

Tables of data collection methods (Developed from Field Collection of Flood Event Data EFAG/A1.28)

Flood Data Collection Methods	Head-line Topic	Best Practice Guidance	Suitable Application and Practical Limitations
Flood Marks	1.3	<p>Flood marks can be measured as a height below a known feature so that there is no need for physically marking the point.</p> <p>Alternatively the depth and extent of flooding can be marked on structures with road spray paint, chalk or pegged. Paint gives the clearest mark, but does not rest well on wet surfaces. Chalk is generally more suitable since it cannot be dislodged or moved, though more difficult to locate again later.</p> <p>Approval should be gained from residents or owners before marks are placed on buildings.</p> <p>The direction of flow may have an impact upon the height of flood water at different locations of a structure. If necessary more than one level should be recorded. Marks should note the afflux across structures</p> <p>Marks should be photographed to aid their location by survey teams. Clarity is aided by placing a survey staff by the mark for the picture, or a colleague being pictured pointing to the mark.</p> <p>Consideration should be given to the location of marks in relation to the available line of sight for levelling purposes.</p>	<p>More suitable within urban areas where there are plenty of structures and features to mark. Cannot successfully be used on soft landscape features.</p> <p>Not appropriate for large scale floods unless there is plenty of manpower available, or resources are directed to specific areas.</p> <p>May become confusing if several marks are made at the same location due to not capturing the peak of the flood on the first visit.</p> <p>May result in extensive surveying being needed after the event (although not all marks have to be surveyed if some turn out to be redundant).</p>
Recording levels from known feature	1.3	<p>Can use any suitable features, or add e.g. soffit or parapet of bridge at known height, marker plate on structure</p> <p>Allows levels to be recorded with less risk of vandalism than gauge boards or peak level indicators.</p>	<p>Requires measurements to be made with a tape measure or similar rather than observation. Prevents observation by the public and promotion of the Agency's name.</p>

Flood Data Collection Methods	Head-line Topic	Best Practice Guidance	Suitable Application and Practical Limitations
<p>Photographic Records</p>	<p>1.3 / 1.4</p>	<p>Must show identifiable locations and show clearly the depth or extent of flooding against permanent features. It may be necessary to achieve this by taking both a general shot of the location, and a further shot of the flood mark. A level staff, or other means of recording depth, should appear within the frame.</p> <p>When taking photographs there are two common errors, either the photograph is too general and does not show sufficient detail, or the detail is too great and the flood level is not shown in context.</p> <p>Supplementary photographs are useful if it is clear where the detailed photograph has been taken.</p> <p>Photographs will be used to give proof of where water levels reached, to developers and members of the public.</p> <p>Cameras recording date and time, or both, on pictures should be used. Film is relatively cheap, so more pictures should be taken if there is any doubt over coverage.</p> <p>The location and orientation of photographs must be recorded on the data collection sheets, with a reference number to an agreed cataloguing system added by the Officer (either numbers or letters etc). The storage of photographic material following events will need to be considered carefully.</p> <p>Establishment of an index database should be considered, which can also generate adhesive caption labels for individual pictures.</p>	<p>Ideal in urban areas where specific features can be picked up.</p> <p>Only suitable as a supplement to additional data.</p> <p>Provide hard evidence of flooding particularly of potential or controversial development sites. A programme of sites to be visited during a flood may allow site specific evidence to be collected</p>

Flood Data Collection Methods	Head-line Topic	Best Practice Guidance	Suitable Application and Practical Limitations
<p>Video Coverage</p>	<p>1.3 / 1.4</p>	<p>Low-resolution digital cameras lack the quality to pick up fine detail such as waterline marks and should not generally be used for this purpose. Backup capacity may also be needed. The cost of high-resolution cameras is falling and their potential should be kept under review.</p> <p>Video can provide a good visual record of flooding events, but without careful planning may not provide any significant level or extent data.</p> <p>A professional should ideally take aerial videos from helicopters, with guidance from trained Agency Staff upon which features to record. The full extent of flooding across the flood plain should be flown to pick up the necessary detail (high level flights above the entire floodplain are of little value for Flood Defence purposes). Separate passes may be needed to identify each side of the flood plain.</p> <p>All videos should be recorded with an audio facility, and verbal location descriptions, direction of view, which bank etc should be recorded for future reference. Written index log with locations and time into the video should be produced and attached to the case.</p> <p>Where possible a video which features a date and time facility should be utilised (alternatively the narration should provide this information)</p> <p>Enquiries should be made about acquiring other sources of video coverage, e.g. news broadcasts, police helicopter footage</p>	<p>Aerial coverage via helicopters is suitable during major flood events.</p> <p>Can provide visual evidence of flooding, but does not give data from which levels may be accurately identified</p> <p>Ground level videos have minimal use due to their limited scope, and should only therefore be used at specific locations.</p> <p>Ensure that the recording shows the extent and level of events adjacent to identifiable features (buildings, boundaries etc), rather than expanses of open water.</p> <p>Background noise (especially for aerial filming) may limit or prevent a commentary being added to a video. Throat microphones or an overdubbed commentary can be considered if commentary is required.</p>

Flood Data Collection Methods	Head-line Topic	Best Practice Guidance	Suitable Application and Practical Limitations
Local Knowledge	1.3 / 1.4	<p>Local residents can often provide information about the extent or depth of flooding in their locality - mainly anecdotal, or highlighting locations and properties flooded, or provide photographs. Longer-term residents may have knowledge of previous floods as well.</p> <p>At some locations, it may be possible to enlist the help of local Flood Wardens to provide a record of the flood event and to mark maximum flood levels. They would require appropriate training the same as any other Officer. This could help to maximise data collection whilst resources are stretched.</p>	<p>The accuracy of this information should be treated with caution, and should ideally only be used to confirm evidence of flooding found on site. Only suitable in addition to other data collection methods as a means of clarification.</p> <p>Can provide useful information with regard to the nature of the flood and direction of flow for example. Staff need to respect feelings of residents who may have been badly flooded, and show appropriate concern</p>
Gauge Boards	4.2	<p>Gauge boards need to be located carefully, where they will still be safely accessible during flood events (and can be read in the night or in poor visibility), and where they will provide useful and relevant information. Boards are often subject to vandalism, and this may have further implications upon suitable locations and likely maintenance costs.</p> <p>Boards shall be positioned to cover the predicted 1 in 100-year event and above (or 600mm above the highest recorded event), as well as smaller events. The style of gauge board can be chosen to make reading easier (although less accurate), rather than use of the traditional hydrometric boards.</p> <p>Times of gauging must be recorded to establish whether the peak level, or otherwise, has been read. Repeat visits are likely to be needed to identify peak level and time.</p>	<p>Localised, or river-wide flood event only.</p> <p>Provide good supplementary data to an area with an existing flood history. Provide continuous recording point to allow comparisons to be made both during an event, and between historic events</p> <p>Local residents and flood wardens can read boards to allow them to monitor the flood and take appropriate action</p> <p>If marked with Agency logo, boards can offer visible linking of the Agency with flooding, and reassurance that staff will be in the vicinity observing the flood.</p>

Flood Data Collection Methods	Head-line Topic	Best Practice Guidance	Suitable Application and Practical Limitations
		<p>Manpower requirements can become onerous during larger events.</p>	<p>Provide limited additional benefit for an area where no history is available, unless undertaken in conjunction with other data collection methods.</p>
<p>Maximum Level Recorders</p>	<p>4.2</p>	<p>Can be located alongside gauge boards or in addition to gauge boards. Subject to vandalism risks and need to be located accordingly.</p> <p>Need a high level of maintenance to frequently read and replace the tapes. Resource implications can become onerous for larger events.</p>	<p>Allow peak level to be recorded after the event. This could be important at locations with difficult access or during very widespread or rapid events</p> <p>For providing additional data to an area with a flood history</p>

Other Data Collection Methods	Best Practice Guidance	Suitable Application and Practical Limitations
GPS	Hand held receivers will not record to more than about 100m accuracy, not suitable for accurate work. Better accuracy can be obtained with Differential GPS but still not to more than 5m vertical accuracy, not suitable for recording flood levels. Kinematic or static survey GPS would be accurate enough, but units cost approximately £30k for single receiver	Generally not suitable for data collection, due to poor level accuracy, and costly unless equipment is also used for other purposes. Position fixing can be as accurate from digital maps on a data logger.
Solar Telemetry	This method has a very short range and is therefore not likely to be appropriate for flood data capture.	Major events only.
Lidar (or other aeroplane mounted)	There are concerns over the accuracy of this method, and it will not therefore be considered for this purpose until these problems have been overcome. Not generally accurate for levels to more than 500mm	Major events only.
Military Planes with Radar	Radar provides good quality data, but civilian use of military planes can be virtually impossible to co-ordinate, and also very costly.	Unlikely to be mobilised quickly enough for the response time required during flood events.
Satellite Coverage	The location of the satellites is paramount to the availability of such data. The accuracy of data will vary according to the type of satellite and the weather conditions. Purchase of views is also costly.	The frequency of satellite crossings is relatively sparse, and subsequently can only be relied upon as a supplementary source of information.
Other external sources of information	Insurance Companies Records can be requested, but are unlikely to be readily available, nor necessarily very accurate	All these sources of information should be treated as a supplementary source to support our own records.

Other Data Collection Methods	Best Practice Guidance	Suitable Application and Practical Limitations
	<p>Local Authorities (District, Borough and Unitary Councils) often have staff on duty during such events and may have comprehensive records. Free sharing of information between the Agency and Councils is generally promoted. Agency should offer representative information, photographs, reports etc. as requested.</p> <p>Police/Fire brigade Records - Logs of times, and locations of problems. Police may video events, especially from helicopters.</p> <p>Transport Company Logs details of flooded roads, railways and approximate times.</p> <p>Media – information, broadcast footage, unused footage may be bought for a nominal price if used for non-commercial purposes. Newspaper photographs and interviews can offer limited information.</p> <p>British Waterways will inspect canals and may operate control structures affecting flows.</p>	<p>There is no common agreement on obtaining information from these sources, and the willingness to help may vary markedly between, say, adjoining Councils or Police Forces</p>

Appendix C

Standard data sheets for presentation of survey data

DERWENT CATCHMENT FLOOD EVENT OCT/NOV 2000



Location

R. Derwent. Lower Derwent, Hull Rd, A63. Loftsome Bridge, north side, Right bank.

Number of continuation sheets

Environment Agency Reference Number

170/bu/01/R02

National Grid Reference

E-470521
N-430097

Surveyed By
MJH/MSW



Flood Water Level

Mark on bridge. 5.34m.

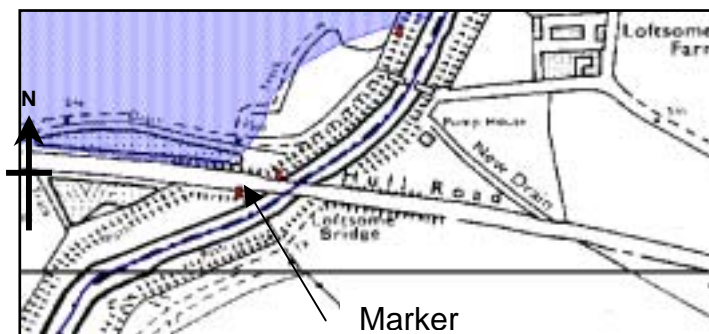
Comments

Mark on side culvert 1m. above silt level in invert.



Photograph

Sketches



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ISBN 0-85521-150-4



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