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Temporary and Demountable Flood Protection Guide

Project: SC080019

Flood and Coastal Erosion Risk Management Research and Development Programme

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Our work includes tackling flooding and pollution incidents, reducing industry's impacts on the environment, cleaning up rivers, coastal waters and contaminated land, and improving wildlife habitats.

This report is the result of research commissioned by the Environment Agency's Evidence Directorate and funded by the joint Environment Agency/Defra Flood and Coastal Erosion Risk Management Research and Development Programme.

Published by:
Environment Agency, Horizon House, Deanery Road, Bristol, BS1 5AH
www.environment-agency.gov.uk

ISBN: 978-1-84911-225-3

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Changes in version 2 of this report - A revised version of the table Structural Characteristics of Temporary Flood Protection Systems has been included in Appendix 3 (Page 112 of this report). One of the headings in the table has been changed from 'Seepage greater than 40 l/m/h' to 'Seepage greater than 40 l/m/h (on level ground)'.

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Dissemination Status:
Released to all regions
Publicly available

Keywords:
Temporary defences, demountable defences, local flood protection, flood protection product,

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Project Number:
SC080019

Product Code:
SCHO0711BUAK-E-E

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This report was produced by the Research, Monitoring and Innovation team within Evidence. The team focuses on four main areas of activity:

- **Setting the agenda**, by providing the evidence for decisions;
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- **Delivering information, advice, tools and techniques**, by making appropriate products available.

Miranda Kavanagh

Director of Evidence

Executive summary

Background

The increasing availability of other forms of temporary defence products other than sandbags and demountable flood defence products other then flood gates and planks and stanchions led to the development of the Interim Guidance for Temporary and Demountable Flood Protection by the Environment Agency in 2002. The interim guidance used limited knowledge about available systems and even more limited experience of use to develop a categorisation system and guidance for safe use of the systems. The guidance recommended the need for an update once better experience of use was available to better inform the design and whole life management of the products and their associated systems.

During the past eight years there has been a lot more use of these products as parts of defence systems. This included formal trials by the Environment Agency on the River Severn as well as formal schemes developed by the Environment Agency, local authorities, utility companies and private organisations. Despite these increased use, major flood events, in particular the 2007 floods highlighted the untapped potential that still remained. It also provided significant lessons on the appropriate use of these systems. The Pitt Report noted the continued reliance on sandbags despite newer forms of temporary and demountable products and called for the development of guidance on the use and usefulness of alternatives to sandbags. The availability of significant new information regarding new products as well as experience of use made this recommendation by the Pitt Report timely, leading the Environment Agency to commission new research into temporary and demountable flood protection. This guide is the primary outcome of the commission.

Development of the Guide

Information for the guide was sourced from three sources. The first was from a literature review of other available guidance and documents providing accounts and lessons learnt from the use of the products. The second source was a practitioner workshop with users and managers of existing systems to obtain information and feedback on the lessons and performance issues associated with their use. The third source was from the manufacturers and suppliers of available proprietary products through interviews and the use of product questionnaires. Review of the information obtained and further analyses underpinned the development of the guidance and its associated approaches and methods. The guide was developed in tandem with the update of British Standard's Publicly available specification for Flood Products PAS 1188, ensuring consistency of the two products.

Research Findings and approach to Development of Guidance

The research found that in the large majority of situations where temporary and demountable systems have been used, they have provided adequate protection. There have been some occasions however where operational processes or inaccurate hydraulic assessments has led to a failure of the systems. These failings highlighted the importance of reinforcing the performance and failure characteristics of temporary and demountable systems, and the role of the understanding of the hydraulic loading and operational management within this. They also highlighted that these systems only perform their flood protection role when fully in place before inundation occurs and the

importance of the success of the associated operational processes within this. The guide therefore focuses on the whole life cycle of the design and management of the systems and associated products to ensure the development of an appropriate product and the achievement and continued maintenance of an optimum level of reliability. These are underpinned as necessary by an understanding of the risk and performance issues, including how the risk can be minimised and performance enhanced.

The Content of the Guide

The guide takes a user through a systematic process from deciding whether the use of temporary and demountable systems are appropriate for particular scenarios, through the design of systems that offer appropriate solutions to the required functional, structural and operational requirements. It then provides guidance on optimising the operational reliability and taking other local, economic, environmental and whole life management issues into consideration to enable the design to be finalised. This is supported by Appendices containing information on available products and their characteristics to aid design choices. The user is then guided through the development of operational support plans and protocols to ensure the system and associated products can be managed effectively over its life.

Key Changes from the Interim Guidance

The guidance is underpinned by a lot more information than the interim guidance. There is information and product fact sheet on over 50% more products. As a result of significantly more products, the generic categorisation system has been expanded and updated and now contains a tiered structure to provide appropriate representation of the products.

This guide contains guidance on completely new aspects such as the typical strategic uses of temporary flood protection, measures to improve the reliability of the design and associated operational processes and the assessment of whole life costs and benefits. The system risk, performance and reliability information are particularly enhanced within this guide.

This report contains information about temporary and demountable flood protection products that were available when the research was completed in 2009. People considering the use of temporary or demountable flood protection products are advised to undertake their own searches to identify any updates to products referred to in this report, or new products that have become available since the research was completed.

Acknowledgements

The Environment Agency hereby acknowledges the significant contributions made to the guide by the following groups:

Practitioners, through various levels of input of their experience of use, attendance at the workshop, one to one discussions and review of draft outputs. These included representatives from the Environment Agency national, regional and area teams, York City Council, Bristol City Council, Gloucester City Council, National Grid, the Association of Drainage Authorities and various consultants.

Manufacturers and suppliers of flood products, through their provision of information to support development of product information and factsheets provided in the Appendices

Flood victims, primarily represented by the National Flood Forum, through provision of information from the perspective of the flooded victims.

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1 Introduction

1.1 Background

Defra's strategy for managing flood risk in England as outlined in Making Space for Water calls for a portfolio of measures for managing flood risk. Temporary and demountable systems are increasingly forming an important part of this portfolio, given the ever increasing conflict of defence lines with other uses, unacceptable visual impact of high defences, difficulties in economic justification of more strategic defences and need for flexibility to manage extreme events.

Following the publication of the Interim Guidance on the use of Temporary and Demountable Flood Defences by the Environment Agency in 2002, there have been many advances in the variety and forms of flood products available, significant experience in use by practitioners, as well as focussed pilots and science projects. All these have added to an improved understanding of these systems. To capture the information on the new developments and lessons from use over the past seven years, the Environment Agency commissioned Royal Haskoning in 2008 to update the interim guidance they prepared eight years ago.

Other drivers for this update include calls from the independent review into the summer 2007 floods chaired by Sir Michael Pitt, which noted that "there is an increasing variety of these non-permanent defences and the flexibility they offer can have the potential to offer flood protection to locations that are not, or cannot be, protected by permanent flood defences." He also noted that despite the availability of newer products, sandbags continue to be by far the most used form of temporary protection during the recent major flood event of summer 2007. The Pitt Report then called on the government to develop guidance for local authorities and the public on the use and usefulness of sandbags and other alternatives. He highlighted within this, the requirement for further advice and support. The Environment Agency also recognised the increasing role required by these organisations in the effective use of temporary and demountable flood defences, by commissioning the updated guidance.

The development of this guide has included reviews of literature, currently available products, practitioner experience and lesson's learnt from use. A workshop with practitioners and a review of the draft guidance by experienced practitioners has also fed into the development of the guide.

1.2 Purpose and scope

This guide supersedes the interim guidance of 2002 and draws upon lessons learned from the experience of use of temporary and demountable flood protection systems to date. It provides guidance to support practitioners in assessing the appropriateness of temporary and demountable flood protection systems for particular situations as well as for wider operational use. It then guides the choice and design of appropriate systems and the planning and management of operation and reliability. The information on available proprietary products has been updated and extended.

Although the guide covers all the reasonable considerations necessary when designing a flood protection system incorporating temporary or demountable products, it should be noted that the amount of effort must be commensurate with the level of risk. In the case of smaller scale local schemes, while the overall principle applies, it is not expected that all the considerations discussed within the guide are necessary, and as

The guide is one of a suite of documents aimed at reducing flood risks by temporarily closing pathways for the floodwater, diverting the flow of floodwater or restricting its spread. Its scope only covers protection distant from (i.e. not integral with) individual properties. It does not cover individual property flood resistance measures to block apertures such as doorways or air-bricks or improvement of their flood resilience. These are currently covered in targeted leaflet guides available from the Environment Agency's website www.environment-agency.gov.uk/flood; and other publications including: Preparing for floods (ODPM, 2003); Improving the flood performance of new buildings – Flood resilient construction (CLG, 2007); and C623 Standards for the repair of buildings following flooding (CIRIA, 2005).

In addition the guide is based upon the assumption of fluvial flooding situations. Some of the products discussed within the guide are appropriate for coastal situations; however the additional issues of coastal surge, wave action and saline conditions will need to be considered.

This guide was updated alongside the update of the Publicly Available Specification, PAS 1188 Parts 2 and 4 for temporary and demountable flood products respectively (BSI, 2009a and BSI 2009b) to ensure consistency. PAS 1188 forms the basis of a product conformity certification scheme to provide assurance to potential purchasers of flood protection products that they have been independently tested to a set minimum standard. More information on performance testing is provided in Section 3.2.3.

This report contains information about temporary and demountable flood protection products that were available when the research was completed in 2009. People considering the use of temporary or demountable flood protection products are advised to undertake their own searches to identify any updates to products referred to in this report, or new products that have become available since the research was completed.

1.3 Users of the guide

The guide is intended for:

- technically competent persons from organisations or groups with responsibilities or need for the planning and design and operation of flood risk management measures, and their advisers. Such users include asset managers, emergency and civil contingency planners and responders, appraisers and designers of flood alleviation, property developers and local community groups.
- developers, manufacturers and other organisations involved with the development or improvement of temporary and demountable flood protection systems.

Whatever the legislative or planning context of use, users of temporary and demountable flood protection systems need to recognise that they work by closing and diverting potential flood pathways thereby intervening in the existing flooding processes. When considering these products for planned locations or their use for incident management, the user has a responsibility to ensure the effects on flood levels and the flow and spread of floodwaters are understood so as to avoid unintended consequences.

This guide presents the process that should be followed and the considerations required when implementing a typical scheme which incorporates temporary or demountable flood protection. It should be noted that in some situations where the level of risk is low not all the considerations included within the guide will need to be considered and the level of effort should reflect the level of risk. And consequently in high risk and complicated situations, additional considerations may be important that are not covered by this guide.

1.4 Structure of the Guide

This guide mirrors the process through which the most appropriate system(s) for a particular flood protection scenario can be selected, designed into the particular situation and managed over its expected life. It first provides an understanding of temporary and demountable systems, their basic characteristics and factors that affect their performance. It then follows a risk-based development process. It starts with the confirmation of the appropriateness of temporary and demountable systems, then a systematic process of design development through the strategic to the detailed design and selection of appropriate systems for the particular local requirement. Finally, the operational protocols are developed to support continued performance.

The guide is presented in two parts. The main body provides the guidance on the why, when and how to use temporary and demountable products and systems, while the Appendices provide more detailed information about currently available proprietary products, linked to the generic classifications presented within the main body.

Section 1 of this document introduces the guide, while Section 2 provides a basic understanding of temporary, demountable and permanent flood protection systems.

Section 3 presents a review of the performance and reliability issues associated with temporary and demountable flood protection systems. Section 4 explores determination of the key hydraulic criteria, including lead time and its importance.

Section 5 presents the categorisation of available temporary and demountable flood protection products. Section 6 presents a review of the characteristics that should be considered when selecting the most suitable product for a situation.

Section 7 provides a systematic process for designing appropriate systems and how to optimise their operational reliability. Section 8 provides guidance on the operational planning and management to ensure whole life performance and reliability.

Brief descriptions of known proprietary systems within the generic groups and relevant contact details are given in Appendices A1 and A2. Information about individual product characteristics are provided in Appendices A3 and A4. Where sufficient information was available, product fact sheets for the products were also developed and are also presented in Appendix A5.

Figure 1.1 relates the process of designing and implementing a temporary or demountable flood defence system to the relevant sections within the guide.

1.5 How to use the guide

The guide is designed for use primarily for by technically competent asset managers, developers, communities or their advisers to design new flood protection systems, select appropriate flood protection products, optimise the performance and reliability of the associated operational processes and to develop and manage operational plans to enable whole life performance of the systems. The design process systematically eliminates systems that cannot reliably be fully in place. It then provides further guidance to help consider particular local, economic and environmental issues and confirm the option choice that best fits the technical requirements and organisational capabilities to ensure reliability in the whole life management of the final design.

While the guidance on design of new systems or operationally planning of new or existing ones are set out in Sections 7 and 8 respectively, the user is advised to ensure a good understanding of the underpinning characteristics, performance and reliability issues provided in the earlier Sections. This is particularly important for those using this guide for the first time. For users needing to dip in and out of particular sections, the

guide is written in such as way that all information about a particular aspect can be found in one location (with references provided to other sections as necessary).

The design and whole life management process is illustrated in Figure 1.1. This indicates where within the guide the information relating to each stage may be found.

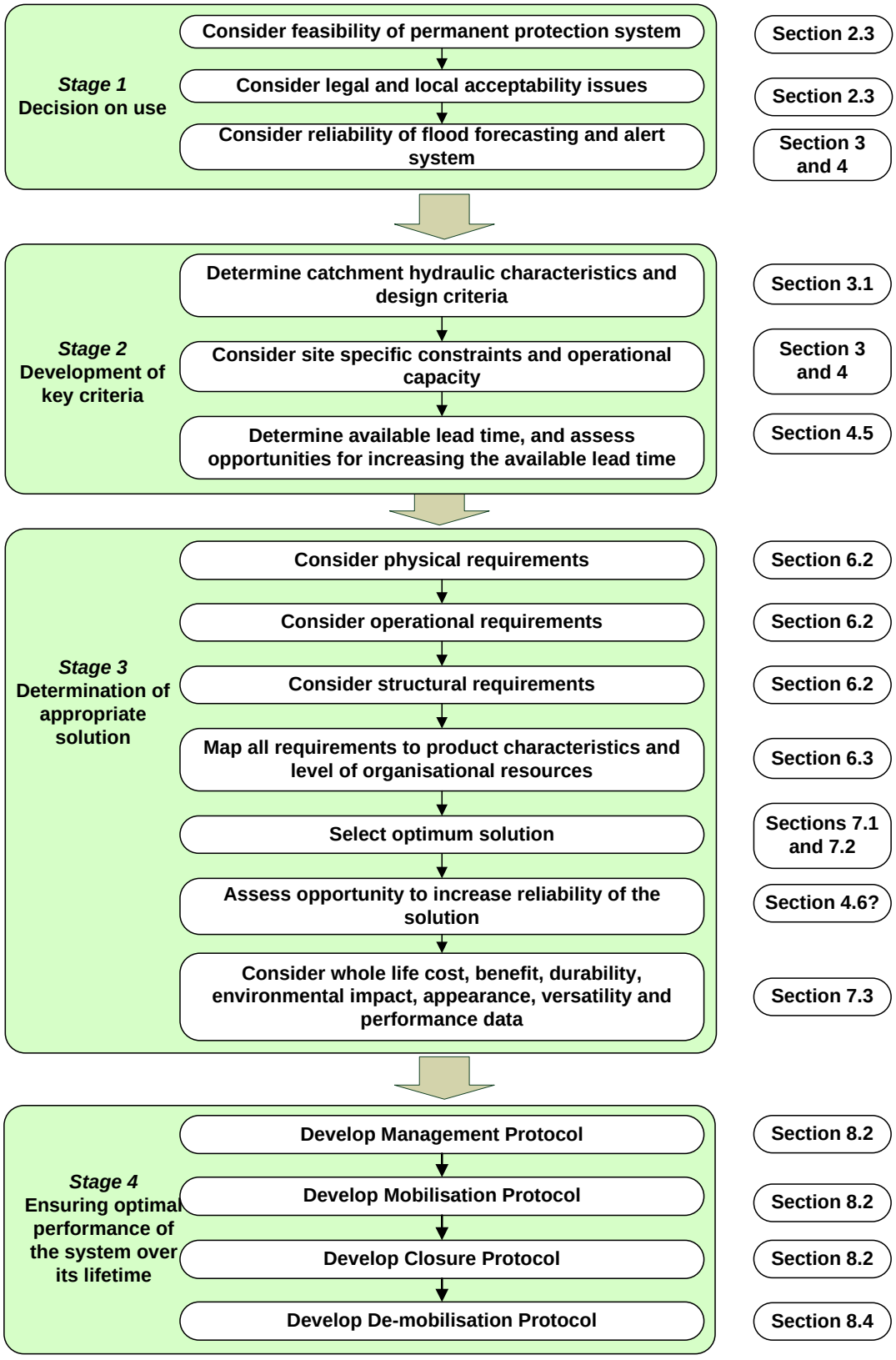


Figure 1.1: The design and whole life management process diagram

2 Flood Protection Systems

In considering the use of temporary and demountable flood defences it is necessary to understand exactly what they are and how they relate to permanent defence systems. Section 2.2 describes the general differences between the three generic types of flood protection system. While Section 2.3 describes the initial considerations that are necessary to determine when it is appropriate to use temporary or demountable flood protection systems.

2.1 Forms of flood protection

Flood protection systems need to be understood in the context of other techniques that form the wider portfolio of flood risk management measures. These include:

- Development planning – preventing inappropriate development in flood risk areas and managing run-off using sustainable drainage systems (SuDS);
- flood storage – hold back some potential floodwater and release it at a controlled rate;
- channel improvements/control structures – increase conveyance to achieve higher flows;
- diversion channel – divert water around the area;
- flood walls/embankments – permanent flood defence structures that prevent floodwater getting into protected area.

This guide deals with the reduction of flood risk by preventing the floodwater from getting into the protected area.

A flood protection system is made up of ‘components’ and ‘operational systems’. For the system to operate successfully and prevent the entry of floodwater into a protected area both aspects must be considered. The components of a flood protection system refer to the physical defence structure itself and include:

- the barrier superstructure (which is usually the flood product);
- the foundation or bedding structure;
- the seepage cut-off (if applicable);
- the seals, joints and interactions within the structure and with the adjacent structures and subsoil.

The operational systems are the activities that are required to ensure the flood protection system operates successfully. In the case of non permanent defences these activities include all of the elements required for the correct deployment and installation of the components of the defence system including:

- Forecasting systems and methods;
- Flood alert systems and monitoring;
- Mobilisation of equipment and manpower and materials;
- Closure of the defence system.

The details of a flood protection system and the critical factors affecting its performance vary according to the type of protection system. The different types of flood protection systems are discussed below.

2.2 Types of flood protection systems

There are three main types of flood protection systems:

- Temporary
- Demountable
- Permanent

For systems of similar scales, the extent of operational activities generally decreases from temporary through demountable to permanent flood protection systems. This reduction in the operational requirements is as a result of the flood protection system becoming more passive. Temporary defences would normally require the most operational activities in their deployment however temporary systems are the most versatile and able to be used in previously undefined locations and situations making temporary systems ideal for use within incident response scenarios.

While temporary and demountable systems are considered separately within this guide in order to highlight their individual characteristics, there will be situations where they are used within composite flood protection system made up of sections of permanent protection combined with temporary or demountable sections, or both.

2.2.1 Temporary

A temporary flood protection system is formed by removable flood protection products that are wholly installed during a flood event and removed completely when levels have receded, its connection with the underlying surface, and the end connections.

Sandbags are the most common form of temporary flood products. A lot of newer and more competent products are now available and are described in Section 5 and the Appendices. Temporary flood protection systems may be needed where permanent or demountable flood protection systems do not and/or are unable to completely provide the protection required for an area. Reasons for this include:

- insufficient economic justification for a permanent or demountable system;
- management of flood risk above the permanent standard of protection;
- stop-gap during the development and construction of a permanent or demountable system;
- dual use of function such as the need for access through a flood protection system;
- unacceptable environmental or social impact of permanent protection.

A temporary flood protection system is only functional when the barrier is fully erected before the water rises to the lowest safe permanent protection level. The temporary flood protection system therefore includes:

- the barrier or flood protection product(s);
- the seals and joints between the elements within the temporary flood barrier;
- the interaction between the structure and the underlying surface;
- the end connections to either adjacent high ground or permanent defence structures
- associated operational processes.

Temporary systems can be designed for site specific use, however as they do not require pre-installation, they are not tied to particular locations and therefore offer more versatility and potential for multiple uses within incident response scenarios.

While the foundations for permanent and demountable systems are designed as part of the installation of the permanent parts, by their nature temporary systems are placed on whatever surface or existing foundation is available. The bedding surface therefore needs to be appropriate and adequately prepared to prevent seepage at the interface with the flood product. The need to ensure the suitability of the location, terrain or underlying soil is therefore a particular requirement for temporary systems. Temporary flood protection systems rely on the existing subsoil or structure on which they are erected to prevent seepage beneath the structure.

Typical elements of a temporary protection system are shown in Figure 2.1.

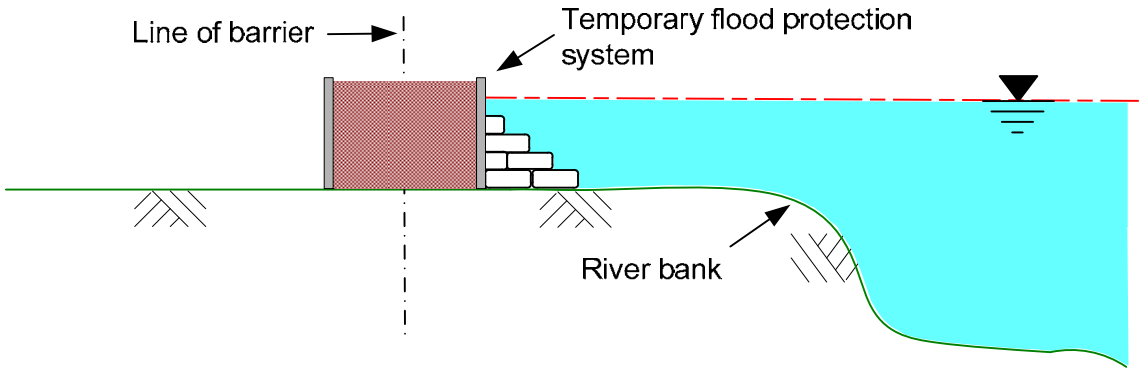


Figure 2.1 Typical elements of a temporary flood protection system

2.2.2 Demountable

A demountable flood protection system is a moveable flood protection system that is fully pre-installed and requires operation during a flood event, or a system that requires part-installation into pre-installed guides or sockets within a pre-constructed foundation.

Demountable flood protection systems may be needed in addition or as an alternative to permanent flood protection systems where they are unable to completely provide the protection required for an area. Reasons for this include:

- dual use of function such as the need for access through a flood protection system, but where defence can be part of fully pre-installed;
- unacceptable environmental impact of a permanent flood protection system;
- management of flood risk at specific locations above the permanent standard of protection;

In contrast to a permanent system, a demountable system is only functional when the barrier is in a closed position before the water rises to the lowest permanent protection level. A demountable flood protection system therefore includes:

- the temporary and permanent elements;
- the foundations, seals and joints within the structure;
- the connections between the structure and the underlying surface;
- the end connections;

- the associated operational processes.

The performance of a fully erected or closed demountable system depends on the performance of its barrier, interaction with its formation and subsoil, as well as its joint and end details. To ensure system integrity, these must be carefully considered as part of the selection and design process.

Typical elements of a demountable protection system are shown in Figure 2.2

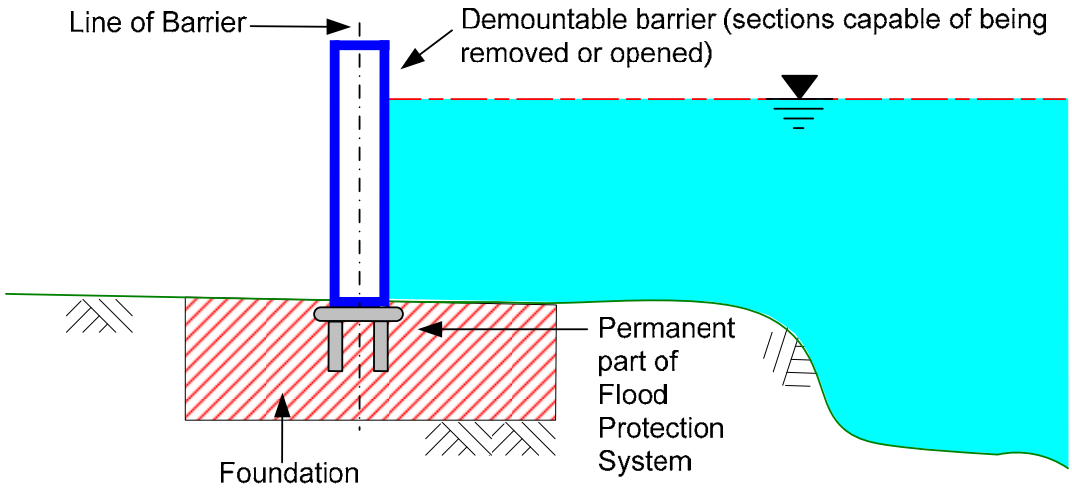


Figure 2.2 Typical elements of a demountable flood protection system

2.2.3 Permanent

In this Guide, a 'permanent' flood protection system is one that is fully in place and does not require operation during a flood event in order to close the pathway for flooding. This does not negate the need for usual maintenance and operational requirements to maintain its condition or to manage the water levels within the associated watercourse. It is technically the most reliable flood protection system, as it is always in place to offer flood protection up to its design standard.

Common examples of permanent flood protection infrastructure include flood banks and flood walls. A flood wall consists of a barrier above ground level, a foundation supporting the barrier, a cut-off barrier below ground level to control seepage and uplift (extending to an impermeable layer if present), and joints and end details. A flood embankment has a similar function to the flood wall, but in most cases without a cut-off barrier as the width of a flood bank at its base is usually sufficient to prevent significant seepage and uplift pressure except in very porous soils. A soak dyke, which is often provided close to the landward toe of an embankment, helps to collect any seepage close to the surface.

Figure 2.3 shows the typical elements of a permanent flood protection system.

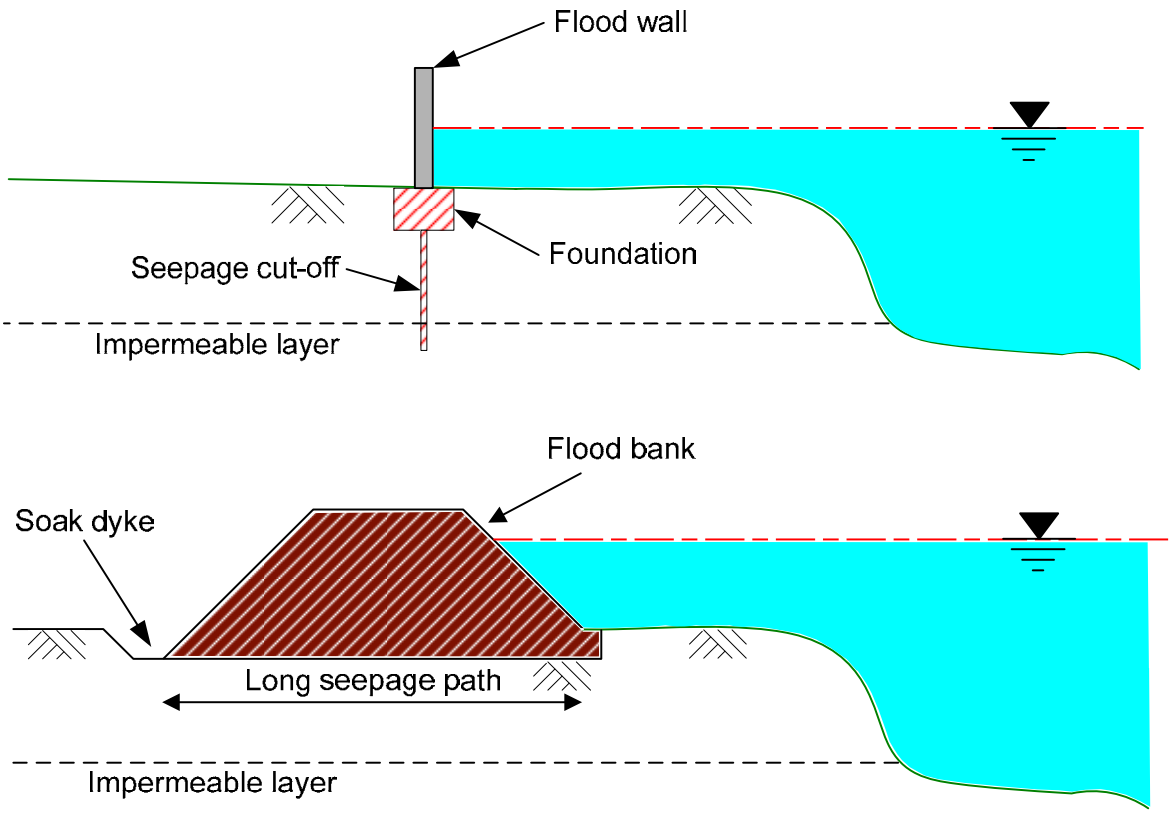


Figure 2.3 Typical elements of a permanent flood protection system

2.3 When to use temporary and demountable systems

For any flood alleviation solution to be worth pursuing, it needs to be technically feasible, environmentally acceptable, locally acceptable, offer good value for the investment and have a high level of operational reliability.

An assessment of the additional operational risk that is introduced by the use of non permanent defence presented in Chapter 3 shows that the decision to use temporary or demountable flood protection systems should not be taken without proper assessment of the risks and a clear intention to manage them to a provide a reasonable level of operational reliability.

The process for determining whether or not to use temporary or demountable flood protection is risk based. It follows the risk management hierarchy of avoid, reduce and manage residual risk, with a provision that if the operational risk cannot be reduced to a level to enable a high chance of success, then the use of temporary or demountable systems should be avoided.

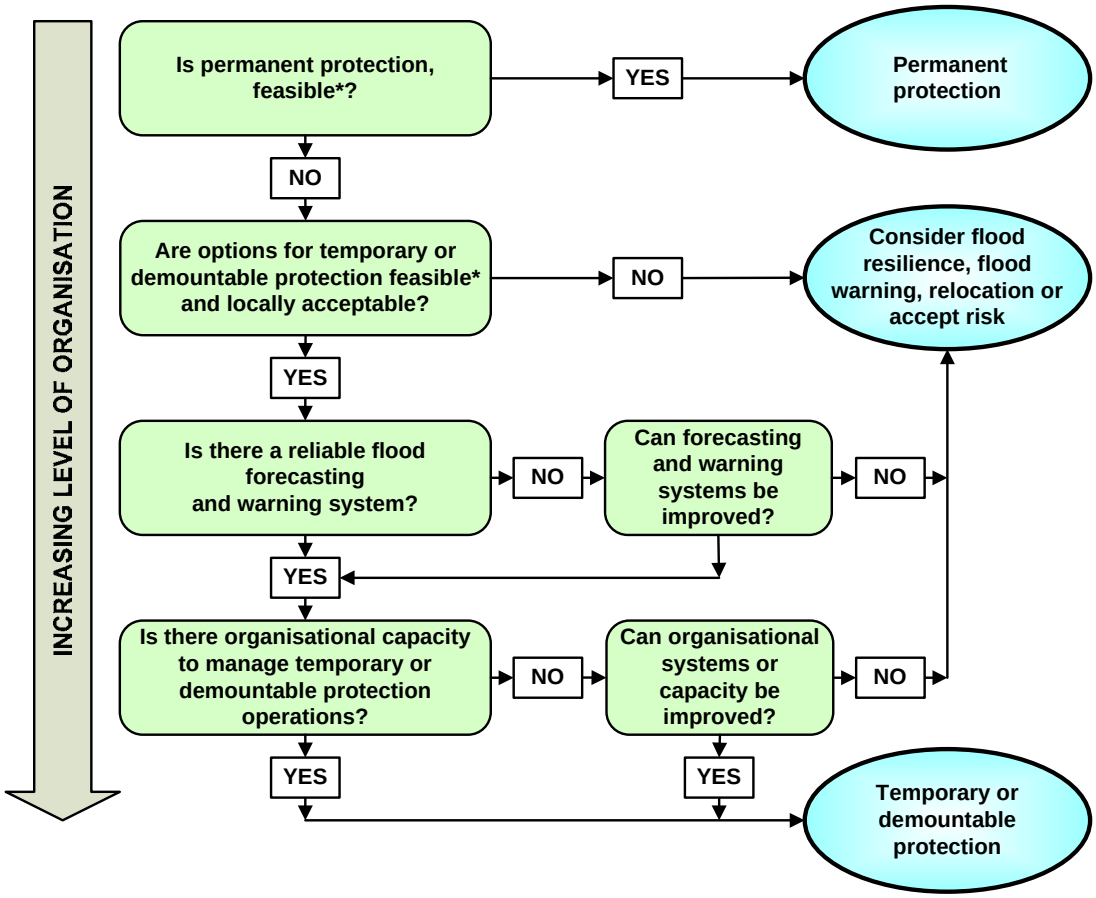
The first step in the risk management process is to seek to eliminate the operational risk. If a permanent flood protection system can be constructed that is technically, economically and environmentally feasible, then this should be done and the operational risk of non permanent protection avoided.

The decision whether to use a permanent, temporary or demountable system should follow a review of a number of factors at a high level including:

- Technical, economical and environmental feasibility
- local acceptability
- Forecasting and alert capabilities

- organisational capacity
- legal issues

These issues should be appraised using the decision process illustrated in Figure 2.4 below.



* NOTE: Technically, economically, environmentally and Legally

Figure 2.4 Decision-making flow chart

Assessment of feasibility

Once it has been decided that a temporary or demountable protection system is a potential option, the next step is to carry out a high-level feasibility study. This will need to assess whether there are technically sound solutions that can be applied to the problem. An assessment of the potential environmental opportunities and impact of the study will also need to be carried out. This could be very crucial, particularly if environmental acceptability was the reason why a permanent scheme was not feasible. A high level economic assessment would also be necessary to see whether options are likely to be cost beneficial.

Local acceptability

If the local community is not involved in the high level assessment of feasibility, once temporary or demountable protection identified is as a potential option, the likely acceptability of such a system in the locality should be investigated. A feeling of safety is an important factor in obtaining public acceptance. The potential for public acceptance or constructive public input can be increased by their early engagement.

Forecasting and alerts

If temporary and demountable systems are in principle acceptable locally, the next step is to review the reliability of existing flood forecasting and alert systems, and their use to trigger closure. The capability of the forecasting and alert systems should be assessed to see if they reliable. Factors that affect reliability are discussed in Sections 3.3. The required reliability level will depend on the acceptable flood risk. Where the systems are not reliable enough, then the potential for improving them to reliable levels should be assessed at a high level. Section 7.3 discusses options for improving reliability.

Organisational capacity

If the existing forecasting and alert system is deemed sufficiently reliable, the capability of the organisation(s) who would be responsible for carrying out and managing the operational processes should be considered at a high level. These should be considered with regard to the likely scale of the defences and associated operations. Issues such as capacity to provide 24 hour cover and standby as well as resources and support systems should be appraised.

Legal issues

Whichever organisation is deemed responsible, it is important to consider their legal position. For example, the legal issues faced by a Flood Defence Operating Authority under their operational powers may differ from those for a developer or landowner. The organisation or person responsible for its management must ensure that they are legally allowed to erect or use such a system. Third party concerns such as ownership issues, rights of access, effect of barriers on third party flood risk, conflict with other parties or local bye-laws should be considered and any requirement for planning or other consent checked with the local planning authority. This is particularly necessary for demountable systems as they include permanent parts.

The use of a temporary or demountable protection system should only be considered further if:

- it is not feasible or acceptable to construct permanent protection to the required level;
- a reliable flood forecasting and alert system exists;
- local and legal issues are favourable;
- there is a reliable organisation with sufficient resources to manage the system.

3 Performance and reliability of flood protection systems

The aim of a flood protection system is to reduce the probability of flood occurrence to an area of interest ('receptor'). The flood risk to the area depends on the potential damage or loss within the area (the consequence) and its frequency of flooding (the probability of occurrence).

The performance of a flood protection system is the degree to which it succeeds when evaluated against its objectives. Conversely, a flood protection system is deemed to have failed when it is no longer able to meet its pre-defined performance objective. To assess how well a flood protection system will perform, it is therefore necessary to understand the factors that affect its likelihood of failure or non performance. The modes of failure for flood protection systems are described first for permanent systems (Section 3.1.1) and then the additional considerations for temporary and demountable systems are explored (Section 3.1.2).

The non-operational considerations that are common to permanent, temporary and demountable systems are discussed in Section 3.2. While the addition operational considerations that are unique to temporary and demountable systems are outlined in Section 3.3.

3.1 Failure Mechanisms

3.1.1 Failure of permanent flood protection systems

Two principal modes of failure affect permanent flood protection systems. The first mode is the inability of the structure to restrict flow of water over, around, under or through it to a pre-determined performance level under specified conditions. For example, a flood protection system may be designed to limit overtopping and seepage to a maximum of 1 litre/second during a flood event with a 1% annual probability of occurrence. A failure is deemed to have occurred if a flood event with less than a 1% annual probability of occurrence results in overtopping or seepage higher than 1 litre/second. This type of failure is termed **functional failure**.

The second mode of failure is the structural failure of the system due to breaching, piping, foundation failure, collapse, overturning, rolling or sliding. The flood protection system fails when, as a result of any of these occurrences, the system is unable to meet its performance objective. The failure of a component of a protection system does not necessarily imply the failure of the system, even though it could progressively lead to a system failure. This type of failure is termed **structural failure**.

A simplified failure tree for a permanent flood protection system is as shown in Figure 3.1.

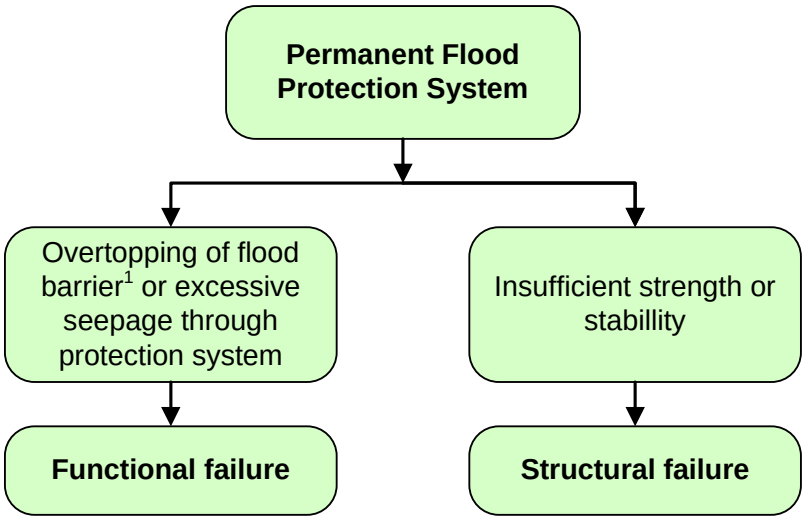


Figure 3.1 Failure tree for a permanent flood protection system
([1]Only where this is not in line with the predefined performance objectives)

3.1.2 Failure of temporary and demountable flood protection systems

In addition to the two types of failure modes described above, a third type of failure can occur with temporary and demountable flood protection systems. This is the failure to successfully erect or close the barrier before water rises above the lowest permanent protection level. This can occur if any of the associated operational processes fail. This type of failure is termed **operational failure**.

Figure 3.2 shows a simplified failure tree for a flood protection system that includes demountable or temporary sections.

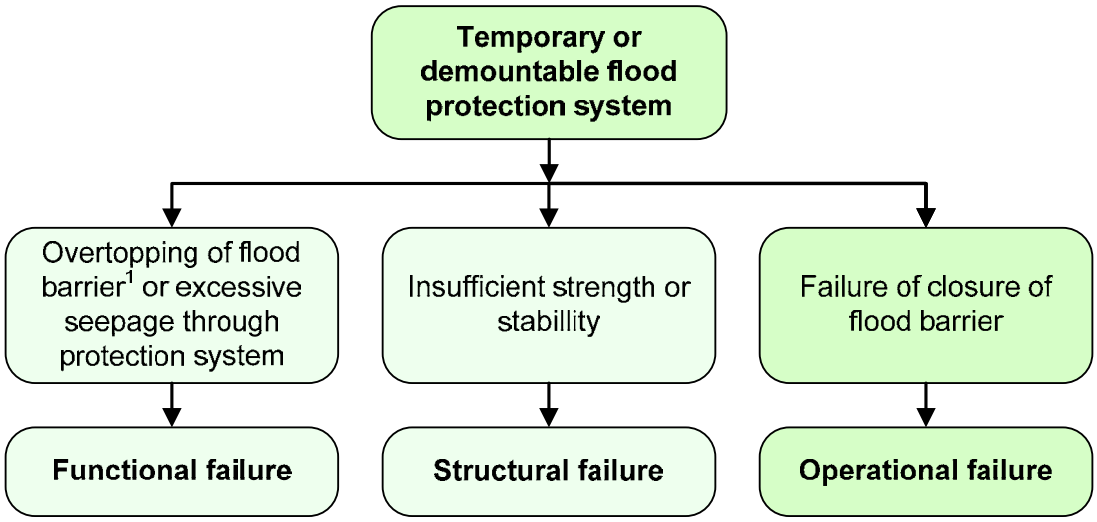


Figure 3.2 Failure tree for a temporary or demountable flood protection system
([1]Only where this is not in line with the predefined performance objectives)

For the purposes of this guide, a temporary or demountable flood protection system is deemed to have failed if any of these three types of failure occur. These three failure modes are considered further in Sections 3.2 and 3.3.

3.2 Non Operational Performance

This section addresses the structural and functional performance issues of flood protection systems and their associated failure modes within Sections 3.2.1 and 3.2.2. The performance testing and accreditation scheme set up to test product conformity in accordance with minimum standards set out in the publicly available specification PAS 1188 for flood products is discussed in Section 3.2.3.

3.2.1 Failure due to overtopping, outflanking and seepage (Functional failure)

This type of failure refers to the inability of the flood protection system to achieve its performance criteria due to water passing over, under, around or through the system in excess of its predefined performance criteria.

Overtopping of a barrier occurs when the adjacent water level rises above the lowest point along its crest. These low points can occur during construction, general or local settlement or deterioration over time. They can also occur due to changes to the crest level during periods of high flows or water loading.

The forecasting of flood levels used for the design of any protection system relies on the statistical analysis of rainfall, flows and expected catchment response. Inherent within these are uncertainties in the data, hydrology, hydraulic assessment, climatic effects and future trends. These uncertainties act together to form an error bandwidth around the design level.

An estimate of these errors is normally allowed for as part of the freeboard for the defence level. This is illustrated in Figure 3.3.

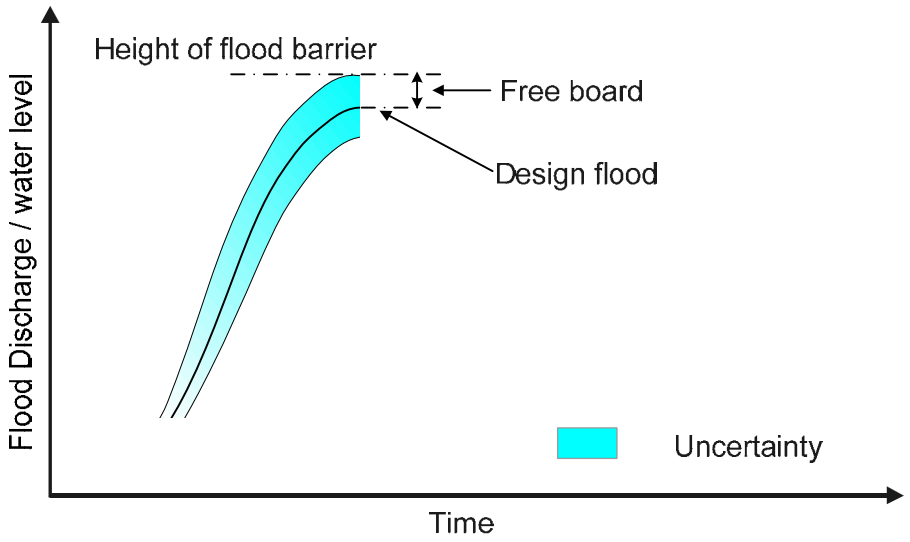


Figure 3.3 Uncertainties in design flood levels

Flood water can also outflank the flood protection, where the associated barrier does not tie well into a high point at either end.

Seepage occurs when water percolates through the barrier, joint, seals or subsoil.

The factors affecting excessive seepage and overtopping of temporary and demountable systems are similar to those for permanent systems. These issues need to be properly considered as part of the design of the system.

Overtopping, outflanking or seepage can lead to the failure of a flood protection system if the amount of water that passes through to the protected area exceeds the performance criteria for the protection system. This is normally based on the consequence of flooding and acceptable values.

The avoidance of this type of failure relies on ensuring appropriate hydrological and hydraulic analyses, topographical surveys and a good understanding of the seepage characteristics of the soil and flood protection products are carried out. This information should support the assessment and design of temporary and demountable systems, ensuring within these that adequate allowances are made for uncertainties. This is no different from what is currently done for permanent protection systems and is therefore adequately covered by existing guidance. As a result, this guidance does not focus particularly on this type of failure.

3.2.2 Failure due to insufficient strength or structural stability (Structural failure)

Structural failure of a closed protection system can occur in any of the following forms:

- sliding or rolling;
- overturning;
- bearing capacity failure;
- collapse or excessive yielding of component parts;
- internal erosion or piping.

Adequate design of the structure and foundations of demountable systems should ensure that most of these failures do not occur.

Excessive seepage through a defence or its subsoil can cause internal erosion and lead to loss of integrity and strength of soil, resulting in movement of the soil particles.. The result is the generation of a flow condition within the soil, movement and a risk of foundation failure. This phenomenon is known as ‘piping’.

The risk of structural failure can be minimised by adequate design and testing. The risk of structural failure for temporary and demountable systems is comparable with that for similar permanent structures. It should be undertaken to the same standards to ensure they are no less safe. It should be noted in particular that as temporary and demountable flood protection systems tend to be made of a number of parts or components all working together, if the failure of one or more components of the protection system results in the whole system being unable to fulfil its performance objective, then the system is deemed to have failed.

Some types of failures, such as rolling or collapse, are not always easy to analyse; such systems require laboratory or field testing to ensure their integrity. Innovation in this field has also led to the use or mix of materials whose performance characteristics are less well established. As a result, the assessment of these systems through normal structural and stability design principles sometimes push at the limits of their application.

To provide improved confidence in the structural responses of temporary and demountable systems to the typical loadings associated with inland flood water, a publicly available specification (Parts 2 and 4 of PAS 1188:2009) have been developed by the British Standards Institute (BSI) with the support of the Environment Agency for temporary and demountable flood protection products respectively. This PAS provides the basis of a product conformity certification scheme to provide assurance to potential purchasers of flood protection products that they have been independently tested and that the manufacturer’s production controls are in accordance with stated requirements.

It provides confidence that a barrier is able to resist, at a minimum, set loadings that are typical of expected exposure conditions as well as limiting leakage to generally acceptable standards. Further information about the PAS 1188 and the associated kitemark certification system is provided in Section 3.2.3.

Piping and bearing capacity failure can be avoided by adequate design for demountable systems and the appropriate choice of subsoil, terrain, foundation and bedding surface conditions for temporary systems. Standard stability analysis methods can be used to consider resistance to sliding or overturning for a range of loading and foundation conditions.

In the case of temporary systems, it is not always possible to investigate or designate their location before use. This makes it difficult for individual structural analysis to be performed because soil or bedding information is not available. In these cases, testing may be necessary to confirm the system's suitability for a number of standard or typical soil types or bedding surfaces (such as asphalt).

3.2.3 Performance testing and accreditation

The primary objective of performance assessment and testing for a temporary or demountable flood protection system is to determine whether the system can perform its stated function in its stated deployment environment for a specified length of time. Testing helps to confirm or define the characteristics and limitations of a system, making it possible to map protection types to different flood risk scenarios.

A lot of flood protection products have been developed through the combination of different materials and composites to accommodate the challenging requirements of strength, stability, function and ease of deployment and storage. The innovations required have meant that most of them are stretching the limits of standard structural analyses methods. The need for adherence and connection to other structures also makes the assessment of seepage characteristics very challenging. The full scale physical testing of these products against typical loadings that would be expected during a flood event therefore provides added confidence in the products.

Analyses and testing to various scales occur as part of the development of most products. However, enhanced confidence in the products is provided for potential buyers where they have been tested independently and accredited as conforming to minimum industry standards. Most accreditation systems also include a programme of ongoing periodic assessments to ensure the standards are maintained over time.

There are currently only a few test specifications and conformance certification schemes across the world that deal with temporary and demountable flood protection. Publicly Available Specification for Flood Products, PAS 1188 (BSI 2009a and 2009b) was specifically set up within the UK to enable independent conformance testing. Further information about it is given below.

BSI Kitemark Accreditation Scheme

PAS 1188 (BSI 2009a and 2009b) has been developed by the British Standards Institution (BSI) in association with the Environment Agency.

PAS 1188, Flood protection products – Specification, is available in four parts:

- Part 1: Building aperture products
- Part 2: Temporary products;
- Part 3: Building skirt systems;
- Part 4: Demountable products.

The two parts of PAS 1188 relevant to this guidance are Parts 2 and 4 for Temporary and demountable flood protection products respectively. PAS 1188-2 and 4:2009 have replaced PAS 1188-2:2003, which has now been withdrawn by BSI. PAS 1188 forms the basis of a product conformity certification scheme to provide assurance to potential purchasers of flood protection products that they conform to minimum industry standards and that the manufacturer's production controls are, and continue to be in accordance with stated requirements.

PAS 1188 details the requirement for conformance testing of flood protection products within a kitemark certification scheme. The PAS Scheme has two components; regular manufacturing control checks and laboratory tests to evaluate product performance under standard minimum requirements. In particular, it specifies requirements for the designation, testing, factory productions control, installation documentation and marking, method of testing and allowable leakage rates under set conditions for products intended for use in the UK or locations with similar exposures. It is important to note that the testing is carried out in laboratory conditions with concrete floors and concrete/masonry walls. While there is a requirement as part of the certification process for provision of information about suitable locations and terrains of use, these are not currently formally tested within the accreditation scheme. In addition to the initial conformance testing, BSI also carries out ongoing type testing of the product and periodic visits to factories to ensure production quality is being maintained.

PAS 1188 uses the same categorisation system as this guidance, ensuring compatibility and consistency between both documents.

A number of temporary and demountable flood protection products have successfully been tested to PAS 1188 and received the BSI kitemark accreditation. Information about accredited products can be obtained from BSI or linked through the website link: www1.kitemark.com/cms/listing/guide/flood-protection-products.

A certified flood product test centre is available at HR Wallingford to enable manufacturers to test their products in accordance with this national standard. Figure 3.4 shows the test site.

Figure 3.4 HR Wallingford Test Site

3.3 Operational Performance and Reliability

The reliability of a flood protection system is the probability that the system does not fail. As shown in Figure 3.2, operational failure is an additional risk of failure to temporary and demountable systems as compared with permanent flood defences. In terms of functional and structural failure risks, there is no significant difference in the way permanent or non permanent defence systems behave, as long as they are properly designed for the expected loadings and conditions. The operational reliability is made further challenging by the fact that the assembly or closure of demountable and temporary systems often occurs in dark, wet, cold and windy conditions, which could introduce an increased likelihood of incorrect installation and failure.

Following on from the above principle, a permanent defence system will be taken as setting the benchmark for reliability due to lack of operation or the defence to be in place (as opposed to operations such as sluice/pump operation to manage flow processes). The focus is therefore on reducing their operational risks of failure temporary and demountable systems as much as possible to optimise their reliabilities such that they are as close as possible to those of equivalent permanent defences. The benefits derivable from temporary and demountable flood protection systems are therefore less than those provided by an equivalent permanent defence; this is discussed further in Section 7.4.

This section discusses the different operational processes that are necessary for the successful deployment of temporary and demountable systems. The process of operational failure is described in Section 3.3.1. The performance and reliability issues associated with each of the operational processes are then described in Sections 3.3.2 to 3.3.5.

3.3.1 Operational failure

The operational processes necessary to ensure the successful deployment of a temporary or demountable barrier during the life of a flood event can be summarised into the four processes namely forecasting, alert, mobilisation and closure. Failure of a flood protection system will occur when the water level is higher than the lowest permanent defence level and the temporary barrier or demountable flood protection system is not fully in position. Figure 3.5 shows a simplified failure tree for non-closure of a flood protection system. If any of the four operational processes do not occur then the barrier would not be in place and the system would be deemed to have failed.

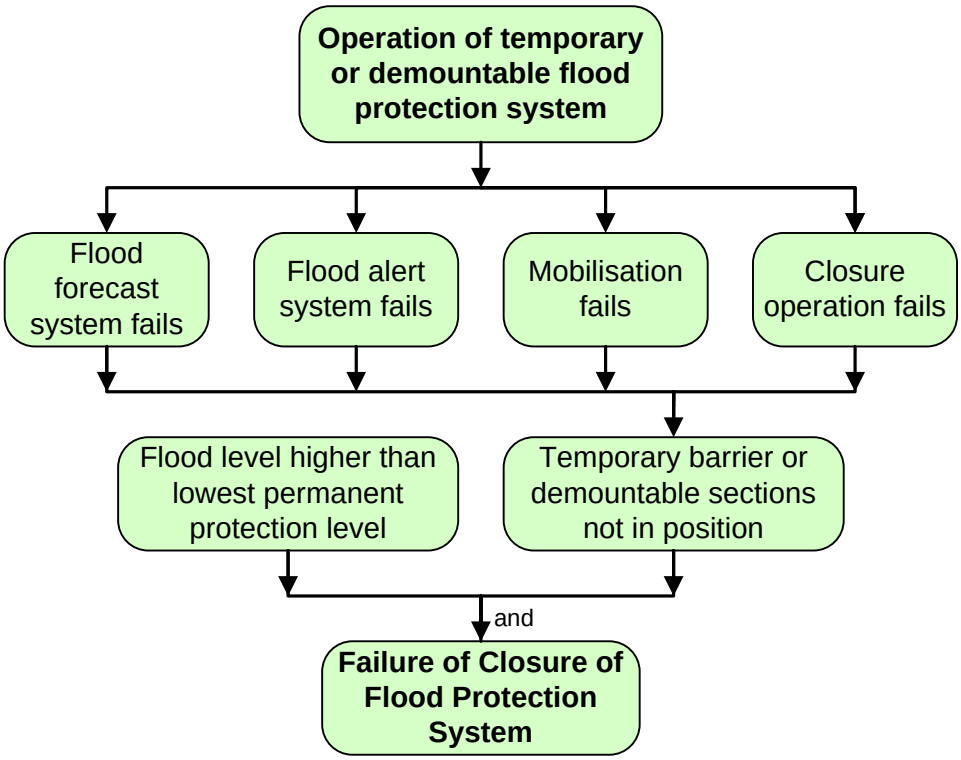


Figure 3.5 Failure tree for non-closure of a flood protection system

The following sub-sections provide an understanding of the performance and reliability issues associated with the operational processes that require effective management to reduce the chances of failure and enhance the successful deployment of the systems. The other key aspect that affects the reliability of operational processes is the led time. This is discussed in Section 4.2.

3.3.2 Flood forecasting

The flood forecasting process

This is the process of determining that a water level or flow will be or has been reached at a location that requires deployment or closure of removable or moveable parts of the defence. It is the trigger for flood alert (or closure operation in the case of passive systems).

The purpose of a flood detection or forecasting system is to provide information regarding the magnitude and timing of flood water to allow as much advance warning of an impending flood as possible. Some watercourses, particularly in upland areas, respond very quickly to an increase in water level, while others that flow through larger and flatter catchment areas respond more slowly. Urbanised catchments can also respond quickly, with local storm events causing high surface water and watercourse flow. Therefore, the type of catchment and the physical location of the forecast point within its catchment would affect the ease of reliable forecast as well as the relevant forecasting techniques. A wide range of methods and systems are used within flood detection and forecasting, depending on whether the forecast is from weather radar, precipitation, watercourse levels or flows, surface or ground water flows or from the sea.

The forecasting methods vary from correlations between the area of interest and forecast precipitation from weather radar at one extreme to real time flood routing or hydrodynamic modelling. With these varying scales of methods come a wide range of success and reliability.

Reliability of flood forecasting

The operational stage of forecasting and detection relies on the accuracy of the operational process or system being used in providing the forecast. As the level of accuracy increases so too does the operational reliability of the stage. The ability to provide a reliable forecast primarily depends on the type of forecasting system applied. The types of forecasting system available are outlined below:

- Forecast from weather radar; direct correlation of forecast of expected precipitation or tide conditions from meteorological conditions or weather radar equipments
- Forecast from precipitation; direct correlation between precipitation at a point of a number of rain gauges and their use with hydrological and hydraulic analyses to assess the timing and extent of levels and flow at a point of interest
- Forecast from upstream water levels and flows; correlation between the actual river or tide level at some point upstream and the area of interest
- Forecast from real time water levels and flows; use of real time modelled flow and level information at a range of upstream locations and the area of interest
- Detection of a trigger level at the point of interest; actual detection of the water level at the point of interest

The types of systems that can be applied are constrained by the sources of flooding, meteorological conditions, environmental conditions and physical properties of the catchment and the location of the area of interest within it. The main objective of the forecasting process is to provide as reliable a forecast of flood levels and how this changes with time, with as much lead time as possible to allow subsequent activities to be carried out. There is a constant balance being struck between lead time and reliability. There are a number of constraints that affect this balance, the type of forecasting system that can be applied and the reliability that can be achieved from it. The typical constraints upon the forecasting system that need to be considered are:

- Response of the catchment; in terms of translating precipitation or water from other sources downstream is dependent on its size, topography and artificial structures or objects along the flow path.
- Complexity of the catchment; physical characteristics of the catchment such as its topography, geology and size affect the ability to forecast and the type of forecasting system that may be applicable.

3.3.3 Flood Alert

The flood alert process

In the context of this guidance, this is the process of providing advance information about the timing and scale of flooding at a particular location to the person(s) or organisation(s) responsible for taking action to erect or close the non permanent or moveable parts of the defence. This process follows the positive forecast or detection of need for erection or closure of the non permanent parts of the defence.

An alert notifies a designated person, group or operating authority that a flood event has been forecast or is occurring and that the deployment of the system is required.

Following receipt of the alert notifications to designated operatives needs to undertaken to initiate mobilisation.

The actual alert process can be automated, a manual call-out, direct word of mouth or a combination of these. For a local community, this might be activated by a more general alert from the Environment Agency, for example through Floodline, or as a result of some local trigger level.

Reliability of the Alert System

A reliable flood alert will be one which identifies correctly the need for action, communicates that action as required and the recipient of the information receives it to enable the action to be carried out. For a demountable system with automatic operation, the closure of the system occurs irrespective of the alert. However, receipt of the alert can still increase the reliability of the closure operations as this allows relevant personnel to check that the required closure process has occurred successfully.

Within the context set above, reliability of the alert system is focussed on the communication of the alert to those needing to take action to secure the defences. The reliability of the forecasting and detection system would cover the detection of the need for an alert. Factors that affect the reliability of the flood alert is primarily related to the flood alert system and associated processes. Particular aspects within this that should be considered are:

- Method of communication; how the alert is communicated to those who are required to carry out the mobilisation and closure operations.
- Availability of personnel; the chance that the required personnel would be available to send and receive the alert.
- Operational Processes; the reliability of the process, its simplicity, clear assignment of responsibility and appropriate training of personnel.

3.3.4 Mobilisation

The mobilisation process

The mobilisation process follows the successful receipt of the flood alert. It includes all activities required to assemble all operational personnel, plant and material (including the flood products) at their required location on site, ready for the defence closure process.

There is no mobilisation phase for fully pre-installed demountable systems with automatic operation. The more the operational requirements during this phase (e.g. significant labour, plant and material transport), the more the mobilisation requirements and time required. For all non-permanent systems requiring some form of human operational intervention, this is a necessary phase for successful closure.

The aim of mobilisation is to ensure that all resources required to commence deployment or closure of a temporary or demountable protection system are on-site as quickly as possible to allow enough time for the erection or closure processes to be complete before flooding commences. Where flooding has commenced prior to deployment certain temporary and demountable defences can still be effective in reducing the impacts of flooding.

Reliability of Mobilisation

There are two key factors that affect the reliability of the mobilisation process, namely the available lead time and the required operational processes. The lead time affects both the mobilisation and closure. It is addressed separately in Section 4.2.

The factors that affect the reliabilities of the operational above activities are detailed below.

- The level and type of organisation; the type of organisation, the resources they have at their disposal and how they manage them.
- The extent of mobilisation required; the size of the temporary or demountable protection system, and the amount of separate operational activities required as part of the mobilisation
- Availability and readiness of resources; the availability of trained staff, back-up to cover non availability, exclusivity of use of resources and condition of required resources.
- Transportation of resources to the defence location; where transportation of personnel, plant and material to the defence location is required, the factors include the distance to the deployment site and safety of transport route, especially in times of flood.

3.3.5 Closure

The closure process

This is the process of erecting and/or closing the gap or low point in the defence. It includes all the activities required to close the non permanent parts of the defence and ensure it remains closed until the water level recedes below the opening level.

The resourcing of this phase depends on the time available for closure which is normally constrained by the amount of time required by the preceding activities and the steepness of the relevant flood hydrograph (Section 4). The actual time for the erection and closure process will depend on a number of factors including:

- The extent of preparation works required before closure can commence such as temporary road or path closures, erection of signage and removal of obstruction
- the type of operational activity required (whether closure of fully pre-installed system only or erection of non permanent parts)
- the length, size and ease of erection of the temporary or demountable products
- the requirement or otherwise of heavy machinery or other materials for bulk filling or stability
- the associated operational processes, skills and readiness of the operational team
- the prevailing weather and flood conditions

Two further processes that occur once the high water level has passed are opening of the defences and the demobilisation and clean-up processes to ensure the resumption of the normal functioning of the wider system.

Reliability of Closure

Similar to mobilisation, lead time has a significant effect on the reliability of closure. Lead time is addressed separately in Section 4.2.

The reliability of the closure process reduces with the increase in extent or complexity of the operational activities that are required to prepare the defence line for closure.

This includes the extent of surface preparation for temporary systems or preparation of the surface permanent parts of demountable systems and the level of interaction with external influences; including access to the defence location, and closure or diversion of roads.

The reliability of the actual closure operation depends on the complexity of operational requirements and the level, competence and readiness of organisation supporting the process. How these issues affect the reliability of closure is outlined below.

- Whenever human intervention or action is required within the closure process, the competence and readiness of the teams play an important role in the reliability of the closure process.
- The ease with which the closure of the defences occurs reduces the potential for errors.
- The extent or complexity of operation required increases the potential of things to go wrong and hence the reliability of the closure operation.

Figure 3.6 shows the effect of the extent of operational processes on reliability of the closure process. It should be remembered that the size of the temporary or demountable system will have an overall impact upon the operational processes and hence the reliability of closure.

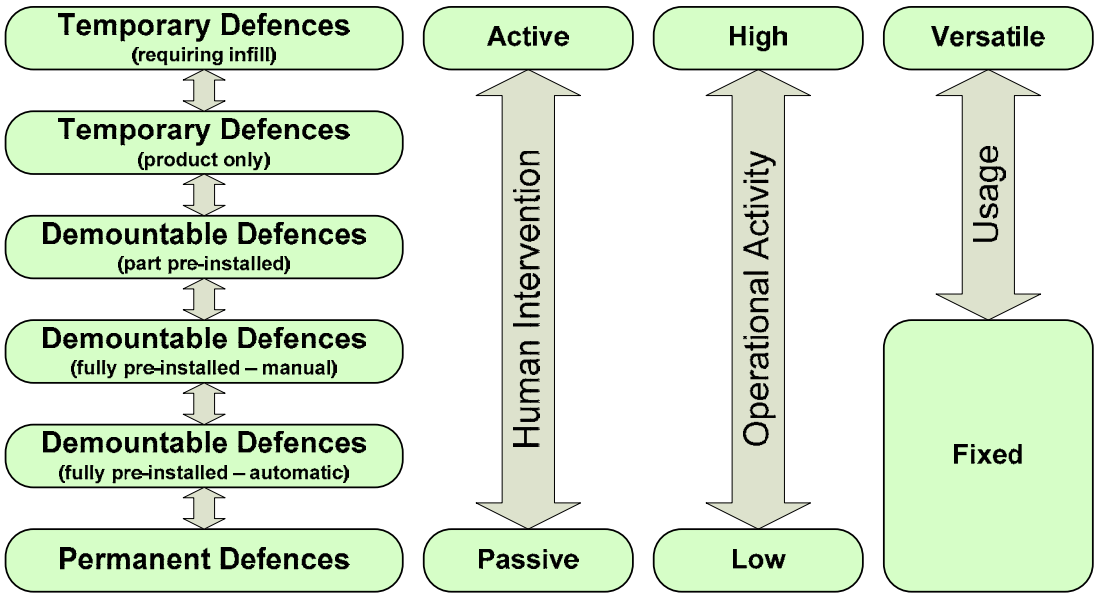


Figure 3.6 Extent of operational processes on the reliability of closure

4 Hydraulic Assessment

Appropriate understanding of the hydrological processes and the associated timing and scale of the hydraulic loadings are fundamental to the design and operation of temporary and demountable flood protection solutions for any particular location. The precipitation or other source of water and the response of the catchment to this will determine the shape of the hydrograph and the characteristics of the loading on the flood protection systems. The development of the hydraulic criteria for temporary or demountable flood defence schemes are outlined in Section 4.1. A major output from the hydraulic analyses is the available lead time. The lead time and how it affects the design process is discussed in Section 4.2.

4.1 Development of the hydraulic criteria

The hydraulic conditions are fundamental to the design of temporary and demountable systems. It is important that the correct level of assessment is carried out to ensure sufficient robustness of the information on which forecast, alert trigger levels and design protection levels are determined. Information on the hydraulic parameters can be obtained from sources including hydrological studies, calibrated hydraulic model runs and historical catchment knowledge and records.

An important outcome of the hydraulic analysis is the development of the level hydrograph. The relationship between the level hydrograph and operational processes associated with temporary and demountable flood protection operational processes is illustrated in Figure 4.1.

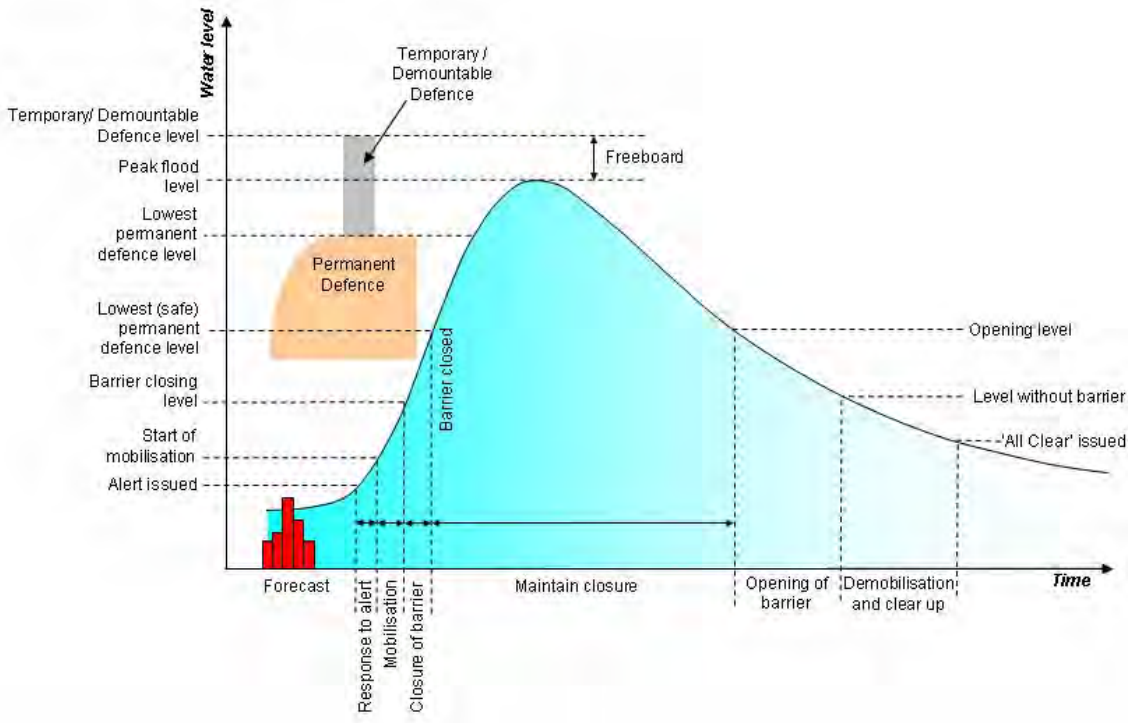


Figure 4.1 Operational processes during a flood event

With the hydrograph established, the point at which a reliable forecast can be achieved can then be determined. This is the earliest point at which the alert can be issued.

The next step is to determine the lowest (safe) permanent protection level. Firstly, one needs to establish the lowest permanent protection level. This is the lowest level of the permanent flood defence where one exists or the lowest point along the line of defence through which a pathway of water can be created into the protected area. Using the level hydrograph information and the lowest permanent protection level, the lowest (safe) permanent protection level is then determined as the level of water above which safe closure of any temporary or demountable flood protection would not be possible. This level would either be the same or lower than the lowest permanent flood protection level. These levels and their interaction with the flood hydrograph, mobilisation and closure processes are illustrated in Figure 4.1.

4.2 Lead time

Sufficient analysis of the catchment hydrology and response needs to be undertaken to ensure that the shortest available lead time is identified. This sensitivity to the flood hydrograph was experienced first hand during the Environment Agency's trials of temporary flood barriers during the February 2004 floods.

'*The prolonged rainfall pattern concentrated in three main periods over a few days resulted in a complex river response with multiple peaks moving downstream. The heaviest rainfall on the 3rd February saw the most rapid and pronounced rise leading to 3 severe warnings and an acceleration of the barrier deployment plans. (Stokes and May, 2004)*'.

The "available lead time" can then be estimated from the time it takes for flood level to rise from the flood alert level to the lowest safe permanent protection level. The "required lead time" to carry out the alert, mobilisation and closure processes depends on the type of system and the organisation or people responsible for its deployment. It needs to be less than the available lead time for closure of the defences to occur successfully before inundation. Where the available time is a lot more than the required time, the reliability is greater because there is more chance that unexpected delays or mishaps can be addressed within the extra time available. Measures to maximise the difference between the available and required led time are discussed in Section 7.3.

A temporary or demountable system that requires significant mobilisation and closure time may be suitable for areas at the downstream end of a large river catchment where the available lead time is likely to be longer. However, a demountable system that is operated automatically by water level sensors may be the only viable non-permanent option for the protection of an area at the upstream end of a catchment where river levels rise quickly following a storm.

Particular factors that affect the required and available lead times are discussed below.

4.2.1 Factors affecting available lead time

As outlined earlier in Section 4.1, the available lead time is dependent on the shape of the flood hydrograph and the point within it at which a reliable alert can be provided. The available lead time is affected by the following factors:

- Source of flood forecasting, whereby lead time increases as it moves up the hydrological processes from detection at the defence location, to forecast from upstream level or flow, to forecast from recorded precipitation to forecast from

expected precipitation or coastal/tidal conditions from meteorological information or weather radar.

- The timing of the flood alert, whereby the earlier the trigger for flood alert, the more time is available for the mobilisation and closure processes. This however needs to be balanced with the need to ensure the trigger point is not too soon to risk the reliability of the flood alert itself
- Catchment characteristics, whereby with all other things being equal, the lead time reduces with:
    - increased steepness
    - increased antecedent catchment wetness and soil saturation
    - smaller catchment sizes and
    - closeness of the defence location to the upstream end of the catchment
- The lowest permanent defence level, whereby the higher it is, the more lead time is available for mobilisation and other operational activities before it is reached by flood water.

Figure 4.2 below illustrates the effect of different shapes of flood hydrographs and the timing of the flood alert on the available lead time.

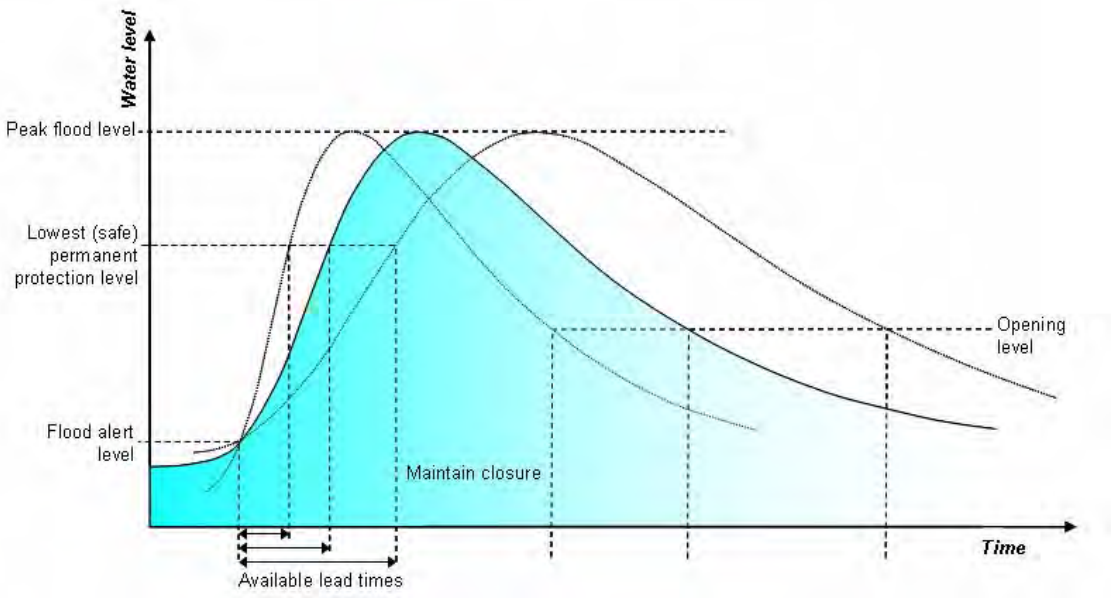


Figure 4.2 Effect of catchment response and flood alert trigger level on available lead time and length of defence closure

Figure 4.3 illustrates the impact of the lowest permanent protection level on the available lead time. It can be seen that the defence in Figure 4.3b side which has a higher permanent protection level has a much longer available lead time that can be used for mobilisation and closure of the non permanent parts.

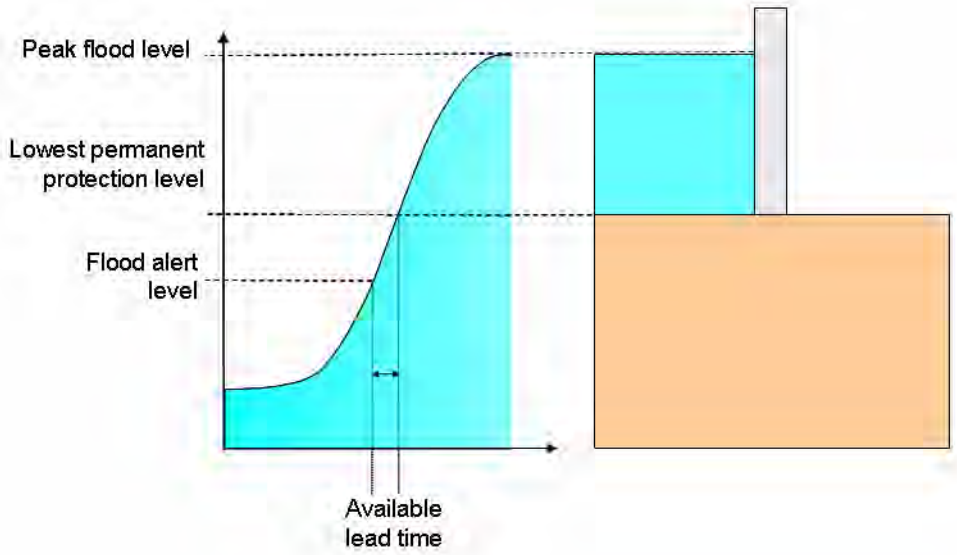


Figure 4.3a Effect of the lowest permanent protection level on available lead time with a lower permanent defence level

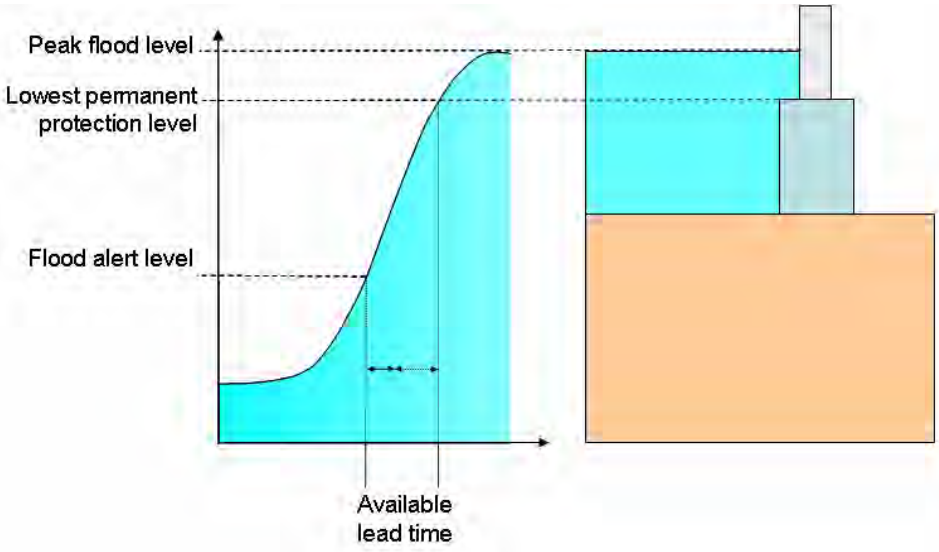


Figure 4.3b Effect of the lowest permanent protection level on available lead time with a higher permanent defence level

5 Flood Protection Products

Over the past decade, there has been a significant development from limited number of temporary flood protection products such as sandbags (temporary) or planks and stanchions, and flood gates (demountable) to a wide variety of flood protection products. Within this section, the different types of temporary (Section 5.2) and demountable (Section 5.3) are described highlighting their generic advantages and disadvantages. Section 5.4 explores the different potential uses for temporary defences and which defences are best suited for each potential use.

5.1 Approach to Categorisation

A review of available temporary and demountable flood products showed a significant number of new or improved products during the seven years following the publication of the interim guidance. A new categorisation system for temporary and demountable products has been developed taking account of all currently available systems, better understanding of their forms and behaviour, and the improved experience of use over the past seven years.

The key changes to the categorisation system include:

- Development of a tiered system;
- Improvement of consistency of terms across categories and with PAS 1188 (BSI, 2009a and BSI 2009b);
- Use of simpler more generic terms;
- Extension to cover currently available and foreseeable products.

The generic categories represent groups of products based their forms, physical characteristics and modes of operation are applicable across both temporary and demountable systems.

Every temporary or demountable flood protection system has its unique form, functional, operational and structural characteristics which limit how, where and when it can be effectively deployed. While it could be argued that more or less categories would have been appropriate, a balance was made between having enough generic groups to minimise large behavioural ranges within each category and having a manageable number of groups.

The generic categorisation of flood protection products can be seen in Figure 5.1.

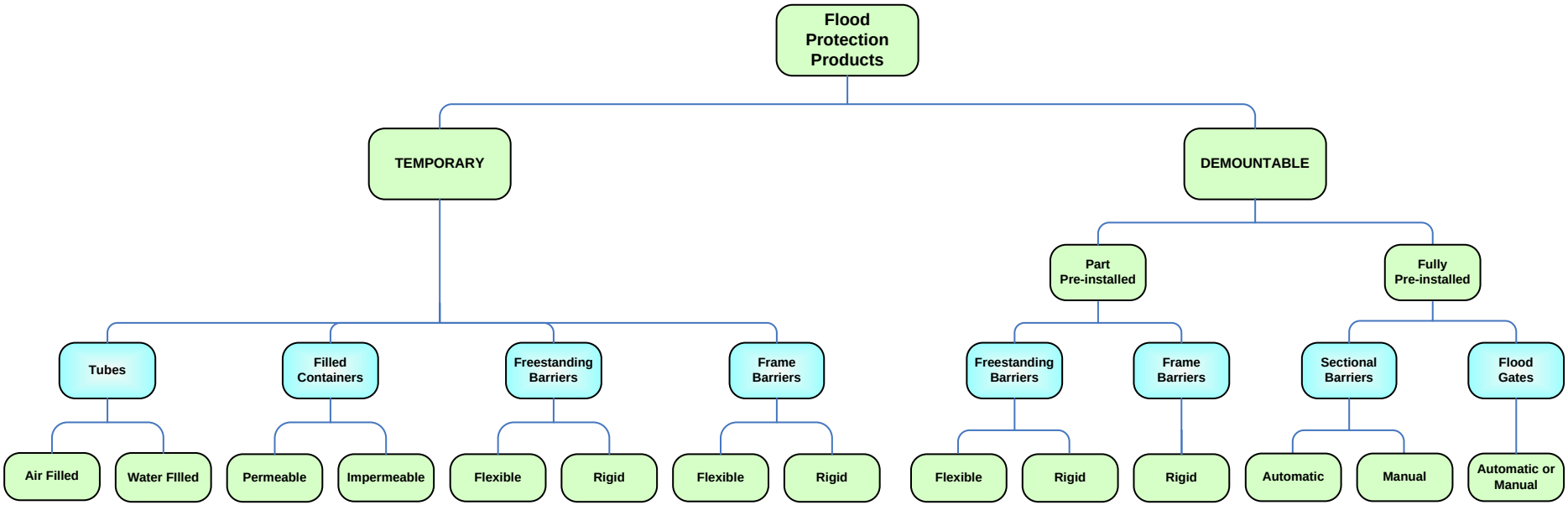


Figure 5.1 Temporary and demountable flood protection product categorisation

5.2 Temporary Defence Categorisation

Four categories of temporary flood protection products have been identified. These are:

- Tubes – air filled and water filled;
- Filled containers – permeable and impermeable;
- Freestanding barriers – flexible and rigid;
- Frame Barriers – flexible and rigid.

The primary classification is based on the form of the material as this is seen as being the most crucial in determining appropriateness of use. Other sub divisions are made regarding other characteristics of the barrier material or its fill.

A brief description of each type of barrier is given below, together with a summary of their advantages and disadvantages. To ensure adequate system performance, all types of barrier need to be deployed on suitable underlying surfaces (preferably previously identified and/or prepared)

Figure 5.2 shows the categorisation of temporary flood protection products.

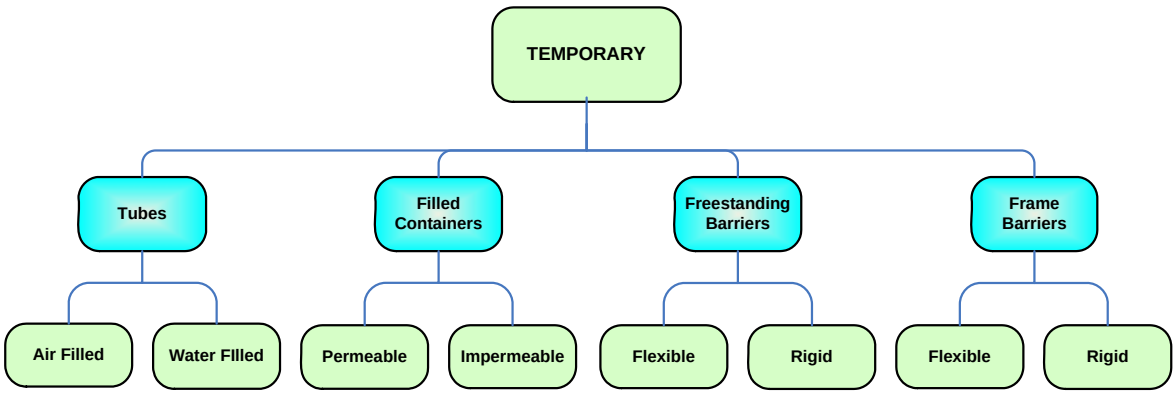


Figure 5.2 Temporary flood products categorisation

5.2.1 Tubes

These flood protection products are typically pre-fabricated geo-membrane or reinforced PVC tubes filled with air or water to form a dam. They utilise air or water – usually in abundance during flood events.

Air and water filled tubes are generally suitable for long lengths of protection close to a water source. They are not ideal for filling small gaps. They are susceptible to vandalism, tears and punctures. Loss or air or water resulting from this can significantly affect its ability to continue functioning as a defence.

Figure 5.3a shows a typical air or water filled tube.

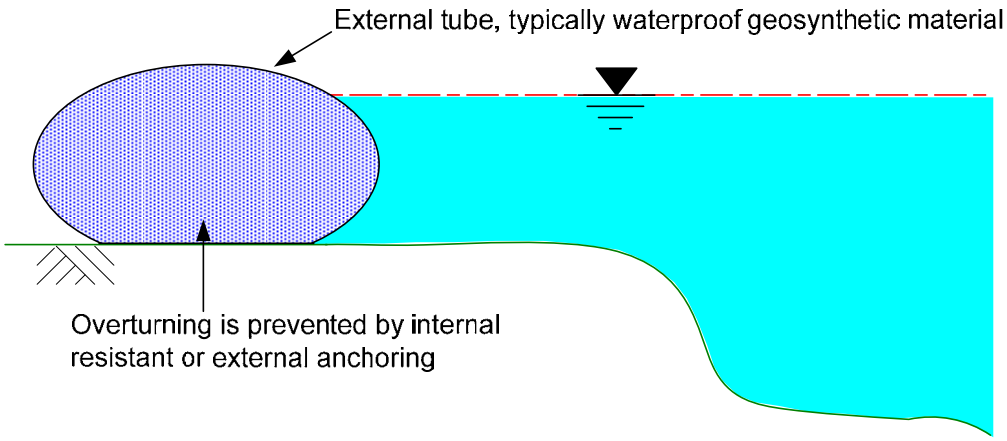


Figure 5.3a Air or water filled tube

Air-filled tube

Air filled tubes are typically pre-fabricated impermeable membrane tubes that can be filled with air to form a dam. They are usually anchored down with pins or through the provision of an extended pre-weighted skirt. The tubes are portable and require pumps or blowers for inflation.

Air-filled tubes rely on external anchoring methods for their stability and sealing with the underlying surface due to their light weight.

Figure 5.3b Air filled tube in operation

Advantages:

- Low bearing pressure on the bedding surface.
- Very versatile – can be used for many other emergency or operational scenarios.
- Quick and easy to install.
- Small storage space required.
- Installation only requires people and mobile pumps.
- Easily cleaned and reusable.

Disadvantages:

- High width-to-height ratio is restrictive due to front extending skirt.
- Highly susceptible to vandalism or damage by sharp objects.
- Tears or punctures can rapidly lead to failure of the whole system.
- Require relatively flat surfaces.
- Improper storage or exposure to UV radiation can result in loss of strength over time

Water filled tube

The water-filled tubes are typically pre-fabricated impermeable membrane tubes that can be filled with water to form a dam. They are gravity dams, using the weight of water to provide stability. The tubes are normally portable and require water pumps for filling. Some are stackable and bound together using straps to increase the height of the defence. This should be performed with caution, as the tubes do not necessarily adhere to each other as well as they do to the bedding surface.

The tubes have a significant width-to-height ratio when fully deployed (a 2 m high tube can occupy a width of about 7 m). They can be quickly deployed and require only manual installation and one or two mobile pumps. Larger tubes may, however, require more people for deployment.

To prevent rolling, most systems have some form of anchoring. Internal anchoring methods include using internal baffles, internal tubes and multiple tubes secured to form a stable shape.

Figure 5.3c Water filled tube in operation

Advantages:

- Quick and easy to install.
- Relatively small storage space required.
- Installation only requires a small team and mobile pumps.
- Tears can usually be repaired in service.

- Reusable.

Disadvantages:

- High width-to-height ratio is restrictive for larger tubes.
- Highly susceptible to vandalism or damage by sharp objects
- Major tears or punctures can lead to failure of the whole system.
- Require relatively flat surfaces.
- Difficulty in expelling all water from tube following use can lead to deterioration
- Risk of water freezing in tubes at low temperatures leading to failure.
- Improper storage or exposure to UV radiation can result in deterioration over time

5.2.2 Filled Container

These are cellular barriers filled with aggregates or water to form a barrier against floodwater. Containers can be divided into two categories, permeable and impermeable. In both cases they are gravity dams, using the weight of the aggregate or water for stability. The more flexible materials are susceptible to tearing by sharp objects and some ground preparation is therefore necessary before installation.

Figure 5.4a shows a typical filled container.

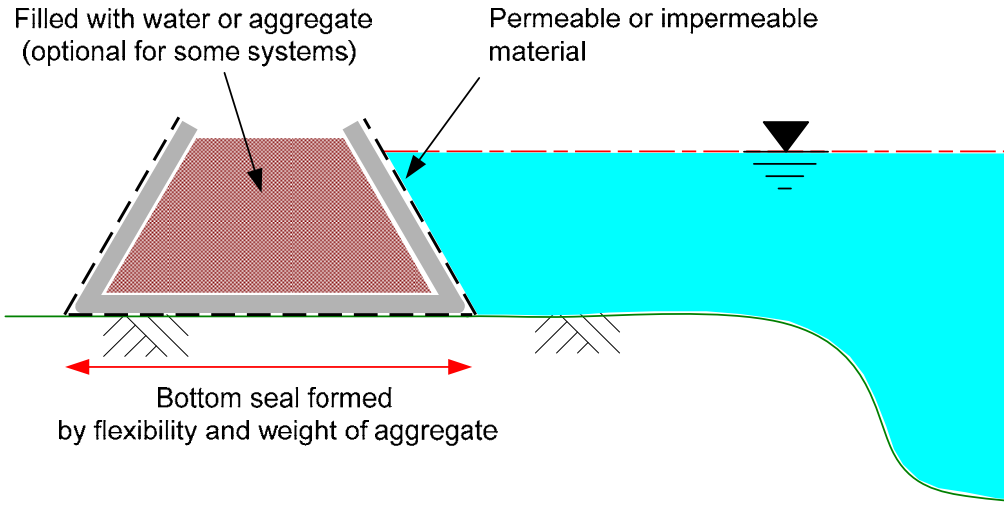


Figure 5.4a Permeable and impermeable containers

Filled permeable container

These are cellular barriers made of permeable materials such as geo-textile or geo-synthetic fabrics and filled with aggregates to form a barrier against floodwater. Some containers are strengthened and held in place by wire meshes, pins and frames. As the geo-textile liners are permeable, water tightness is achieved by the properties and density of the material with which they are filled. Some are stackable, providing the flexibility to increase the barrier height during service. They are generally flexible and adapt well to uneven terrain. They are usually collapsible for storage purposes. Sandbags are included within this category.

Figure 5.4b Filled permeable containers

Advantages:

- Height of some systems can usually be increased during service by stacking.
- Can usually be installed by relatively unskilled labour.
- Small storage space required.
- Adapts to uneven formation/terrain.
- Can use readily available fill material.

Disadvantages:

- Clogging of material/effluents within the fabric can make cleaning difficult or impossible.
- Stacked defences require significant width, which may not always be available.
- Some steel supports and pins may buckle or deform beyond reuse under stacking and service loading.
- Need to dispose of large volumes of probably contaminated material after flood event.
- Seepage can be a problem, but this can be minimised by using a suitable choice of geo-textiles and fill.
- High bearing pressure on bedding surface when stacked.
- Some can be re-used, but only a limited number of times.

Filled impermeable container

These are barriers made of impermeable materials such as polyester, polyethylene and plastic. The containers themselves are impermeable and are filled with water or aggregates only to provide additional weight. These systems are gravity structures achieving stability through their weight and shape. Minor leaks can usually be repaired in service. These systems are generally more rigid than permeable filled containers and do not adapt as well to uneven terrain.

Figure 5.4c Filled impermeable containers

Advantages:

- Height of some systems can be increased during service by stacking.
- Does not rely on fill material for water tightness.
- Can be filled with any available material (including water).
- Easily washed and reusable.
- Minor repairs to tears or punctures can usually be made in service.

Disadvantages:

- Significant seepage may occur under the barriers in uneven terrain due to their rigidity.
- May requires large storage area and transport.
- Mobilisation and demobilisation operations often significant.
- High bearing pressure on bedding surface when stacked.

5.2.3 Free-standing Barriers

These modular systems are made of impermeable materials and are joined together to form a continuous barrier or wall. These products are self supporting and do not rely on frames. Free-standing barriers are divided into two groups, flexible and rigid.

Figure 5.5a shows the components of a typical free-standing barrier

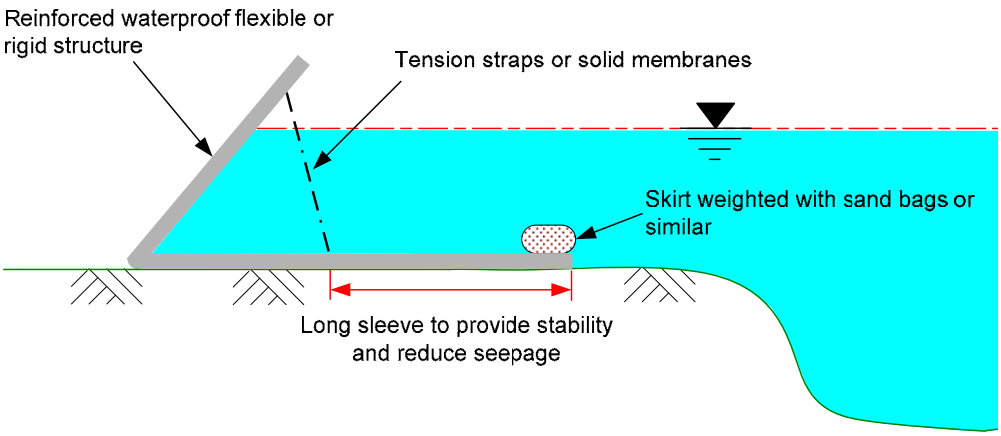


Figure 5.5a Temporary free-standing barrier

Flexible free-standing barriers

These barriers are made of free-standing sections, which are self-supporting. The barrier material is flexible and impermeable. The stability of these barriers depends on direct anchorage or the weight of water acting on a long skirt on the upstream side of the defence. The length of the skirt is designed to ensure adequate stability. These are often weighted at the ends to minimise seepage.

The materials used for the barriers are susceptible to tear or puncture, but can usually be repaired during service conditions. They are easily cleaned and reusable. Deployment does not require any equipment, and is quick and easy.

Figure 5.5b Flexible free-standing barrier in operation

Advantages:

- Quick and easy to install (usually requiring only hand tools).
- No equipment or machinery required for installation.
- Small storage space required.
- Easily transportable in cars and small pick-up trucks.

- Low bearing pressure on bedding surface.
- Low mobilisation, demobilisation and clean-up requirements.
- Easily cleaned and reusable.

Disadvantages:

- Susceptible to leakage at low water levels.
- Skirt may twist or flap under heavy winds and current.
- Susceptible to vandalism and accidental tear or puncture.
- Membrane is susceptible to heavy winds (especially before flood peak).

Rigid free-standing barriers

Barriers within this category may differ in design, however, their behaviour under operation and hydraulic loading are similar. These barriers are made of rigid self supporting units which connect together to make a continuous barrier or wall. They are made of rigid single elements, prefabricated materials or hinged panels with internal supports. Seepage under the barriers can be significant in uneven terrain due to their rigidity.

The single rigid elements and hinged panel products utilise the weight of the flood water over the front leading edge to make a seal with the ground surface. They are interlocking or joined by flexible connectors which allow the systems to form arcs or curves. Some systems have elements for 30°, 60° and 90° corners.

The prefabricated units use their weight for stability and are relatively resistant to impact and vandalism, however, they require heavy lifting equipment, transportation and a large storage area. They transmit high bearing pressures onto the bedding surface due to their weight and may not be suitable for direct deployment on soft soils.

Figure 5.5c Rigid free-standing barriers

Advantages:

- Quick and easy to install.
- Most products do not require large equipment or machinery for installation.
- Low mobilisation, demobilisation and clean-up requirements.
- Easily cleaned and reusable.

Disadvantages:

- Significant seepage may occur under the barriers in uneven terrain due to their rigidity.

- Some units require large storage areas.
- Some units have high bearing pressure on bedding surface.

5.2.4 Frame Barriers

Frame barriers consist of rigid frames with impermeable membranes or sections spanning between them. They rely on supporting frames and the weight of the water to provide the barriers stability. They are modular and are connected together to form a continuous barrier. Frame barriers can be further sub-divided into flexible and rigid types. These sub categories refer to the materials which span between the frames to provide the barrier.

The frames have a tendency to exert high bearing pressures on the bedding surface and thus may not be suitable for areas with direct application onto soft soils. Seepage may occur at low water levels. To minimise this, weighting with sand bags or similar material is advised at the upstream end of the skirts.

Figure 5.6a shows a typical frame barrier

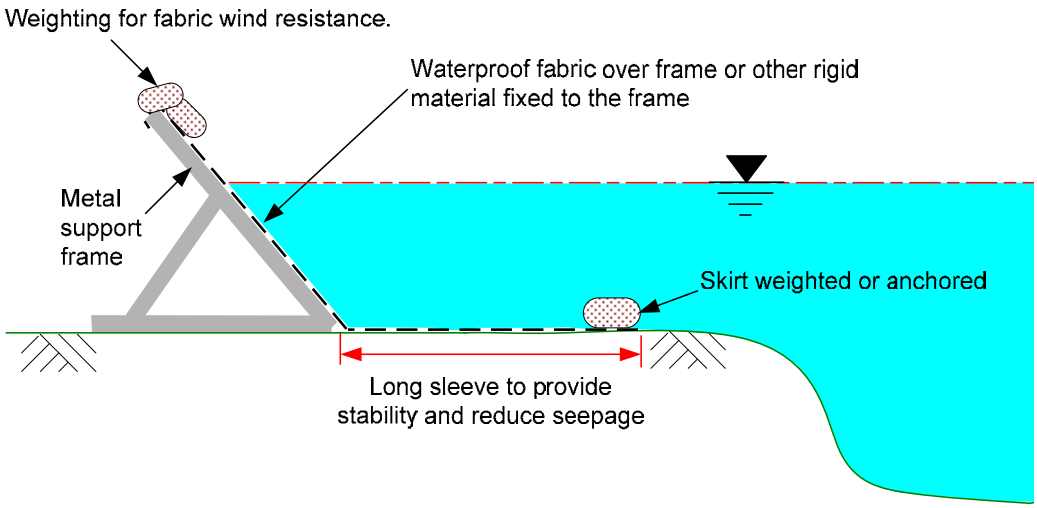


Figure 5.6a Temporary frame barrier

Flexible frame barriers

These barriers consist of metal frames with flexible impermeable membranes spanning between them. The impermeable membrane extends upstream to form a long skirt and relies on the weight of the water acting on the membrane for increased stability and sealing with the ground surface.

Figure 5.6b Flexible frame barrier in operation

Advantages:

- Adapt well to various terrain conditions (except hard surfaces).
- Easily cleaned and reusable.
- Minor repairs to membrane can be made under service conditions.

Disadvantages:

- Membrane is susceptible to heavy winds (especially before flood peak).
- High bearing pressure on soil.
- Susceptible to leakage at low water levels.
- Heavy transportation and storage requirement.
- Susceptible to vandalism, accidental tear and puncture damage.

Rigid frame barriers

These barriers consist of metal frames with rigid panel elements that span between the frames which are often covered by an impermeable membrane. The separate units are connected together to form a continuous barrier.

Figure 5.6c Rigid frame barrier in operation

Advantages:

- Adapt well to various terrain conditions.
- Some systems can be increased in height during service.
- Easily cleaned and reusable.
- Minor repairs to membrane can be made under service conditions.

Disadvantages:

- Membrane is susceptible to heavy winds (especially before flood peak).
- High bearing pressure on soil.
- Susceptible to leakage at low water levels.
- Heavy transportation and storage requirement.

5.3 Demountable Defence Categorisation

Four categories of demountable flood protection products have been identified. These are:

- Freestanding Barriers – flexible and rigid.
- Frame Barriers.
- Sectional Barriers – automatic and manual.
- Flood Gates – automatic and manual.

When compared to the categorisation system for temporary products, two additional functions have been introduced for demountable products. The first is the introduction of an additional primary tier distinguishing between fully erected barriers requiring only a closure operation as compared to those requiring part erection into pre-existing permanent parts. The second difference is the introduction of an operational aspect to the fully installed demountable systems to reflect their requirement for manual intervention to effect closure. These two additions are important for demountable products and systems as they can significantly affect the applicability to particular local or hydraulic situations as well as operational requirements.

A brief description of each type of barrier is given below, together with a summary of their advantages and disadvantages. All these barriers rely on the design of their permanent foundation to ensure adequate bearing capacity and to prevent excessive seepage or piping through the subsoil.

Figure 5.7 shows the categorisation of demountable flood protection products.

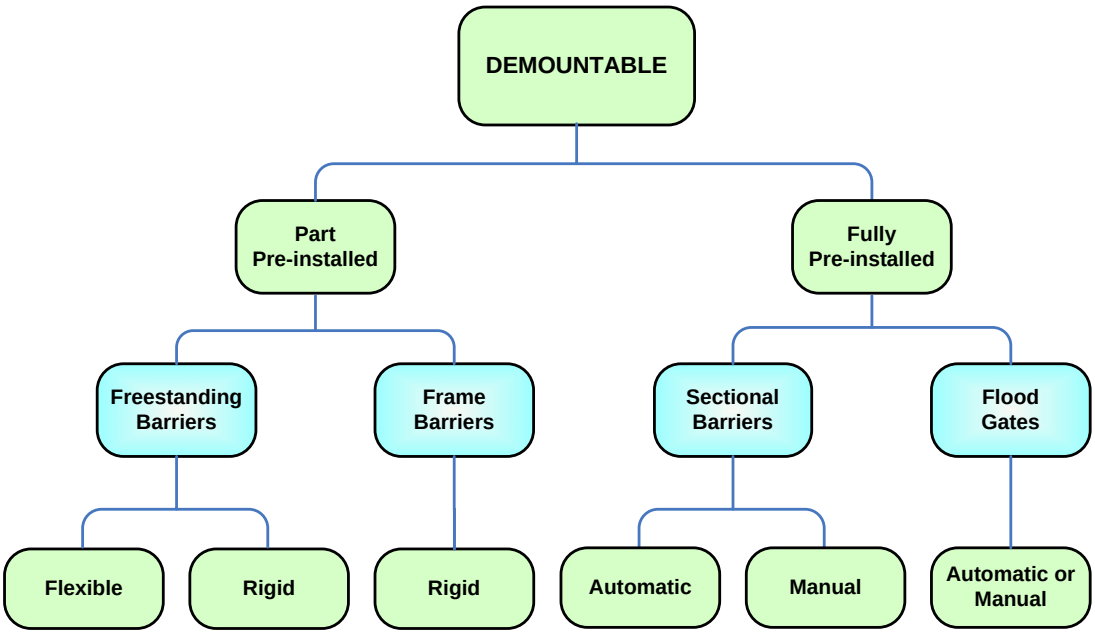


Figure 5.7 Demountable flood products categorisation

5.3.1 Free-standing Barriers – Part Preinstalled

These are barriers without supporting frames which are made of sections joined together to form a continuous barrier. They are made of heavy duty impermeable materials. The barriers are removable, with ground fixing connections and foundation being the only permanent parts. They are similar to the 'temporary free-standing barrier' type described in Section 5.3.3, except their stability and water-tightness relies on connection to the underlying foundation. Just as the temporary free-standing barriers, demountable free-standing barriers are also divided into two types, flexible and rigid.

Figure 5.8 shows the components of a typical free-standing barrier in both normal and flood conditions.

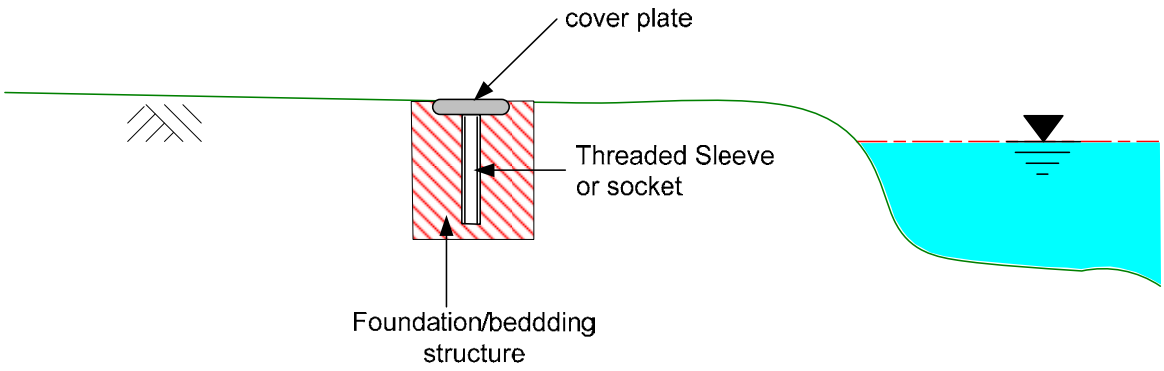


Figure 5.8a Demountable free-standing barrier – under normal conditions

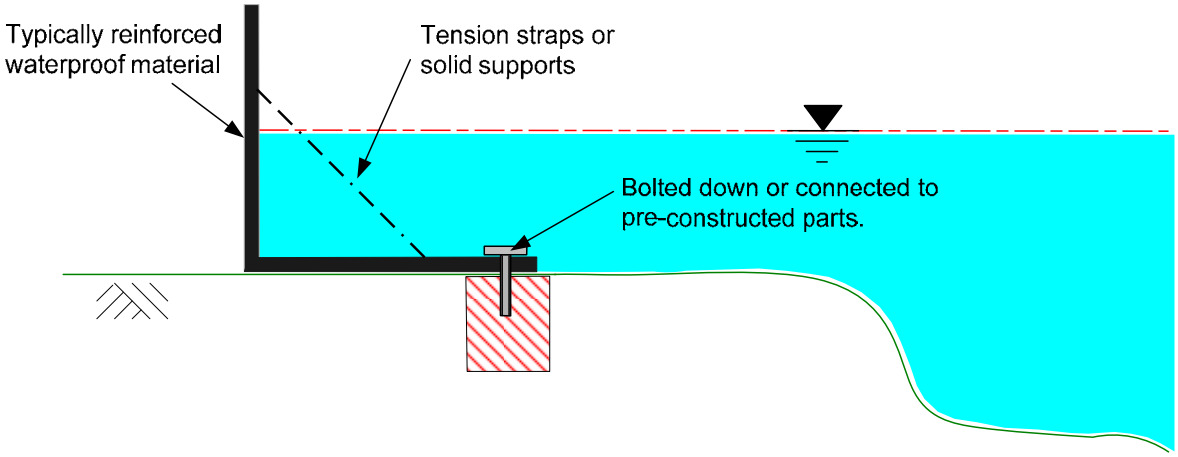


Figure 5.8b Demountable free-standing barrier – under flood conditions

Flexible free-standing barrier

The materials used for the barriers are non-rigid. They are susceptible to tear or puncture, but can usually be repaired during service conditions. They are easily cleaned and reusable. Deployment is quick and easy. Currently available systems come in set heights, which cannot be increased in service conditions. They are similar to the flexible free-standing barriers within the temporary categorisation. As their leading edge is connected to the permanent foundations provide their fixity and stability, they do not rely on long skirts, other forms of anchorage or on the weight of the water to provide a water tight seal with the ground surface.

Figure 5.8c Flexible free-standing demountable barrier

Advantages:

- Quick and easy to install (usually requiring only hand tools).
- Available in long unit lengths.
- Small storage space required.
- Easily transportable in cars and small pick-up trucks.
- Low mobilisation and demobilisation requirements.
- Easily cleaned and reusable.

Disadvantages:

- Susceptible to vandalism and accidental tear or puncture.
- Currently available systems come in fixed heights.

Rigid free-standing barrier

Barriers within this category may differ in design, however, their behaviour under operation and hydraulic loading are similar. These barriers are made of rigid self supporting units which connect together to make a continuous barrier or wall. The units are attached to pre-installed connections along the ground surface to provide their stability. They are modular in design and standard units can usually adapt to slight curves. Non standard corner units are available for some systems.

Figure 5.8d Rigid demountable free-standing barriers

Advantages:

- Some are quick and easy to install
- Easily cleaned and reusable.

Disadvantages:

- Large storage area required for some products.
- Currently available systems come in fixed heights.

5.3.2 Frame Barrier – Part Preinstalled

These are rigid panels placed horizontally between stanchions supported by permanent foundations. The panels and stanchion guides are usually lined with seals to ensure water tightness. Sealing between the panels and onto the stanchions is normally of high quality, with on-sealing pressures maximised within most product designs. The stanchions can be permanently installed, or capable of being attached to permanently installed connections.

This is one of the few product types that can be used for temporarily increasing the flood protection of a narrow wall. However, the foundation of such a wall needs to be able to withstand the new imposed loading.

Depending on the time available for installation, these systems can be erected with a small team. For barrier heights over 1.2 m, lifting equipment is usually required for safe installation.

Figures 5.9a and 5.9b show a typical demountable frame barrier under normal and flood conditions.

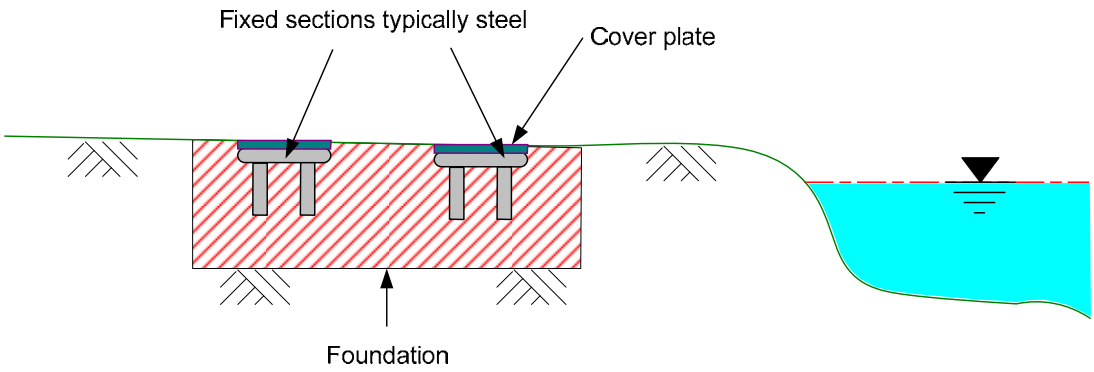


Figure 5.9a Demountable frame barrier - under normal conditions

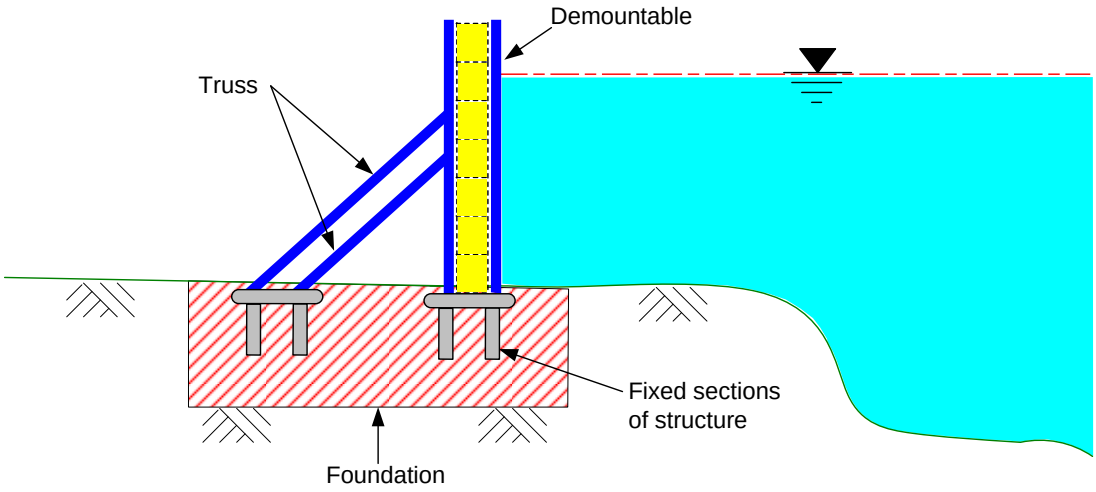


Figure 5.9b Demountable frame barrier - under flood conditions

Figure 5.9c Demountable frame barriers

Advantages:

- Generally robust and well engineered.
- Good resistance to loading and impact.
- Very durable.
- Can be increased in height by adding panels up to the height of the frame.
- Very low seepage through and under the structure.

Disadvantages:

- Large storage area required.
- Heavy transportation and lifting requirements.
- Long installation and mobilisation period.
- Permanent parts susceptible to damage and vandalism.

5.3.3 Sectional Barrier – Fully Preinstalled

These systems consist of multiple sections made of rigid materials such as steel or fibreglass which are joined or interlocked to form a continuous barrier. The barriers are fully preinstalled and only require operation during an emergency. Operation can be either manual or automatic. They are normally hidden away in an underground compartments or housings and once deployed attach to an adjacent structure or permanent protection.

As the products are fully preinstalled the operational risk of transporting products to the site is removed.

Figure 5.10a and 5.10b show a typical sectional barrier under normal and flood conditions.

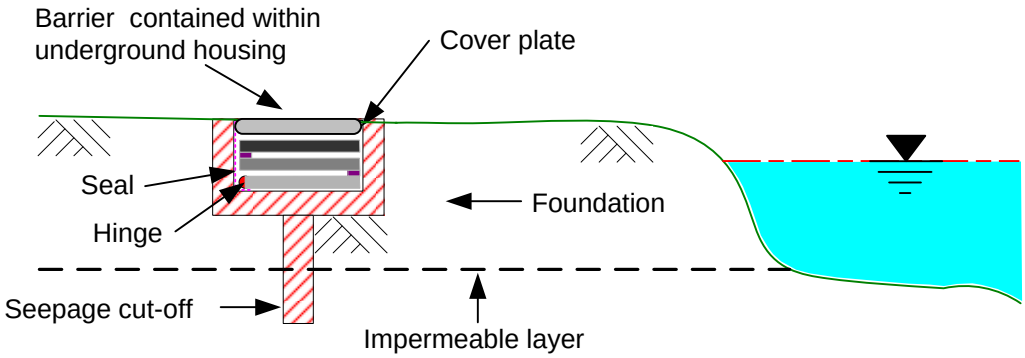


Figure 5.10a Sectional barrier – under normal conditions

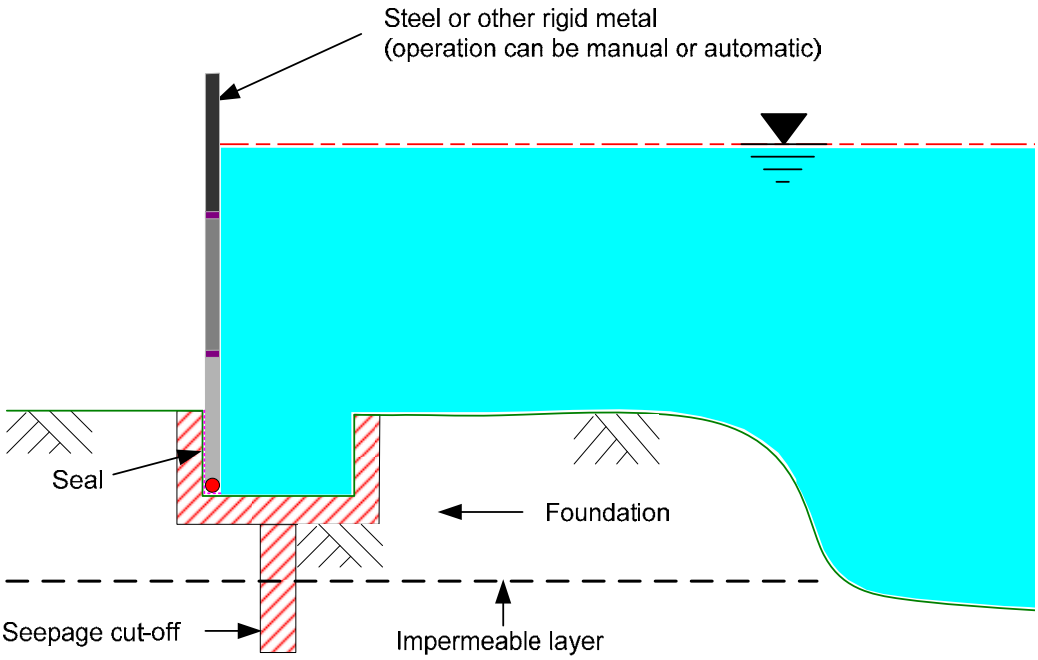


Figure 5.10b Sectional barrier – under flood conditions

Automatic sectional barrier

Automatic sectional barriers are fully preinstalled. The barriers are typically housed within chambers located in the ground. They are activated automatically by the onset of flooding. The activation can either be by direct hydraulic link to the watercourse or may be instigated by electric signals from water level sensors.

Figure 5.10c Automatic sectional barrier

Advantages:

- No installation or construction required during event.

- Automatic operation (can be backed up with inspection or sensors to confirm closure).
- No off-site storage or transportation is required.
- Products are typically highly resistant to impact.

Disadvantages:

- Defence height cannot be increased during service.
- Possibility of failure of mechanical or electrical operation.
- Cover or structure can get jammed with debris.
- Risk of conflict of dual use of defence line (e.g. with people, animals or vehicles) during automatic operation.

Manual sectional barrier

Manual preinstalled sectional barriers can be laid on the ground, folded down or laid flat into a recess below the ground. They are accessed by either the removal of a top cover or by unlocking and lifting the barrier into place. Some designs are cantilevered to assist in their deployment and to provide stability by flood waters pushing against the bottom of the barrier.

Figure 5.10d Manual sectional barriers

Advantages:

- No installation or construction required during event.
- Easy and quick operation.
- No off-site storage or transportation is required.
- Stable and high resistance to impact.

Disadvantages:

- Defence height cannot be increased during service.
- Cover or structure can get jammed with debris.

5.3.4 Flood Gates – Fully Preinstalled

These barriers are made of a single or pair of rigid sections (usually steel or fibreglass), designed to close a gap within a flood defence. They are normally fully pre-installed and only require closure during an emergency. The closure operation can be manual, semi-automated or automatic. Automatic operation can be controlled by sensors and actuators, or by direct hydraulic link to the watercourse. They are normally attached to an adjacent structure or permanent protection or laid flat into a recess within the ground. Manual closure normally involves swinging, rolling or raising into position.

Figure 5.11 Fully preinstalled flood gates

Advantages:

- No installation or construction required during event.
- Easy and quick operation.
- No off-site storage or transportation is required.
- Stable and high resistance to impact.

Disadvantages:

- Defence height cannot be increased during service.
- Possibility of failure of mechanical part or electricity supply (automatic only).
- Cover or structure can get jammed with debris.
- Risk of conflict of dual use with automatic operation.

5.4 Typical Uses of Temporary Flood Protection

Temporary defences can be used in a variety of situations and to perform different tasks in controlling flooding. Four typical uses are outlined below and discussed in more detail in the following sections with accompanying schematic diagrams. The four possible scenarios considered are:

- Raising the level of protection above the permanent level of protection.
- Strengthening and reinforcing existing defences.
- Containing flood water from either overtopping or breaching of the permanent defences, or where there are no permanent defences.
- Diverting and directing flood water within the floodplain.

5.4.1 Raising the level of protection

In this situation the predicted flood level would be higher than the lowest permanent level of protection when allowances for wave run-up are incorporated. If this is the case it may be possible using certain types of temporary flood protection to raise the protection level by placing temporary defences on top. This is highly dependent upon the permanent defences being able to withstand the additional loading and the crest having a suitable width and surface for deployment of temporary systems. The products that could be considered for this situation are dependent upon the form of the permanent flood defences that they are intended to sit on.

Figure 5.12 shows an example scenario of this particular use.

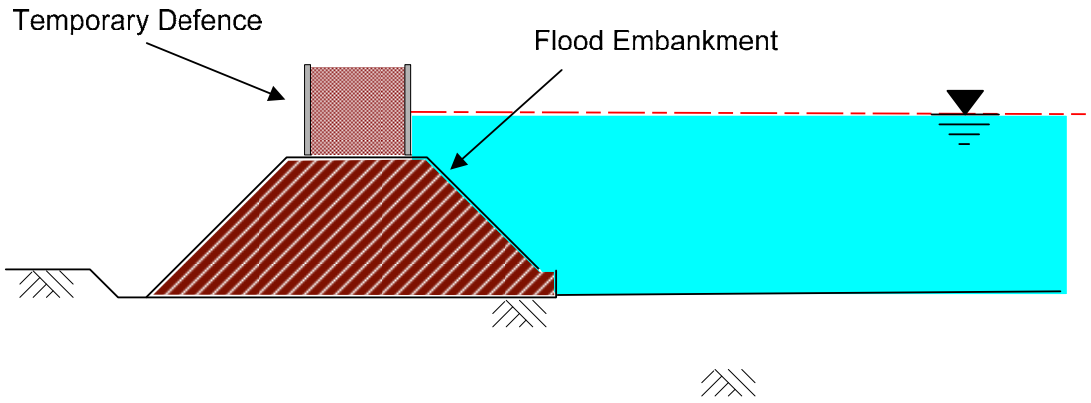


Figure 5.12a Cross-sectional example of use of a temporary system to raise the level of protection

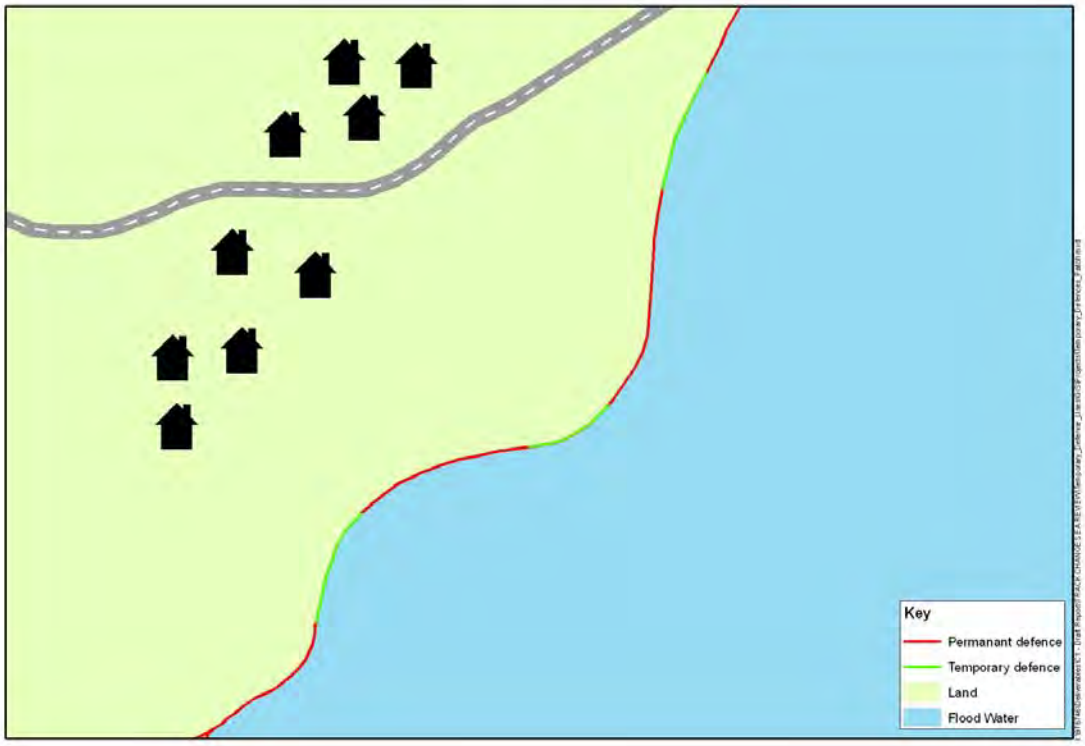


Figure 5.12b Plan view example of use of a temporary system to raise the level of protection

5.4.2 Strengthening the existing defences

The existing permanent defences could be reinforced by certain types of temporary flood protection to reduce the chance of breaching during a flood event. A likely scenario would be to place defences with significant mass immediately behind floodwalls to give them support additional. Suitable products would include filled containers. In this situation a major consideration is access to and space behind the permanent defence line. Any product that could perform this task would be bulky and require plant either to place the units or to fill the units once they have been positioned.

Figure 5.13 shows an example scenario of this particular use.

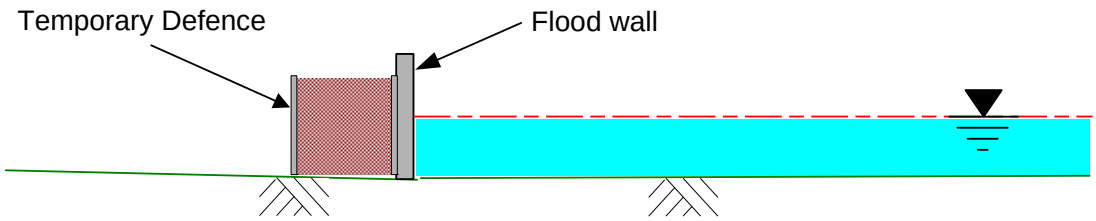


Figure 5.13a Cross-sectional example of use of a temporary system to strengthen existing defences

Figure 5.13b Plan view example of use of a temporary system to strengthen existing defences

5.4.3 Containing flood water

This scenario of containing water once it has either overwhelmed the existing permanent defence line or overflowed the banks of a watercourse where there are no permanent defences is the most common use for temporary defences. In this situation the water is allowed onto the floodplain but he temporary defences are used at a set back position to protect valuable features such as infrastructure and properties. The selection of the product to use in this scenario is primarily constrained by the requirements of the location as outline by this guide.

Figure 5.14 shows an example scenario using temporary defences set back from the original defence line to contain or divert flood water.

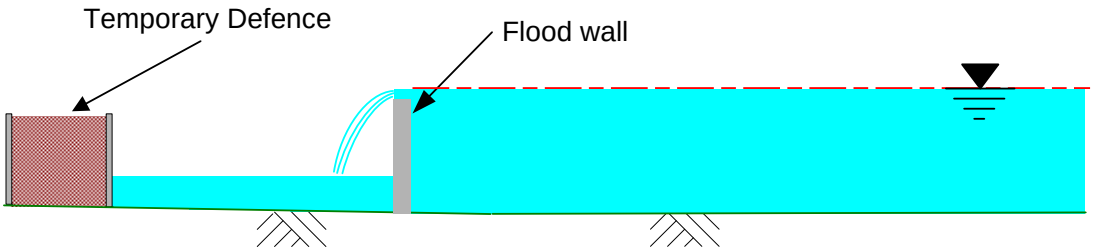


Figure 5.14a Cross-sectional example of use of a temporary system to contain flood water

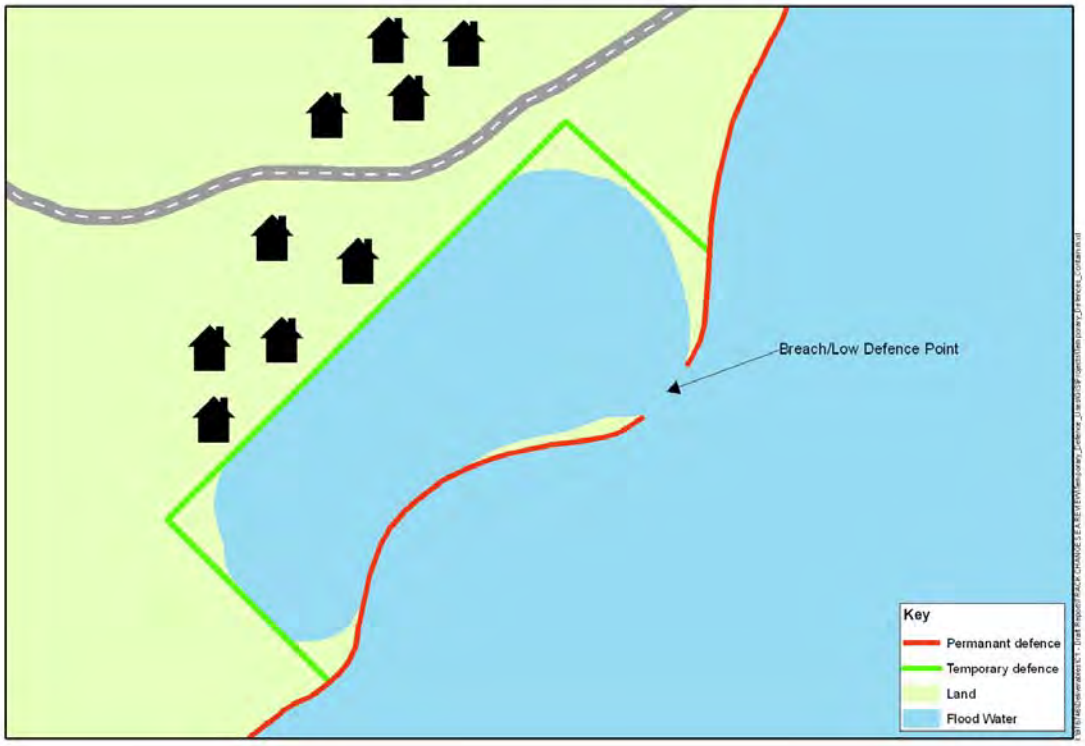


Figure 5.14b Plan view example of use of a temporary system to contain flood water

5.4.4 Diverting and directing the flow of water

An alternative strategy to containing water on the floodplain could be to direct and divert it away from property and other features, routing it back to the watercourse further downstream. This reduced the risk to the protected area; however it introduces flowing water and associated debris to areas where this may not be the norm. The impact of these should be assessed and managed.

Figure 5.15 shows an example scenario of this particular use.

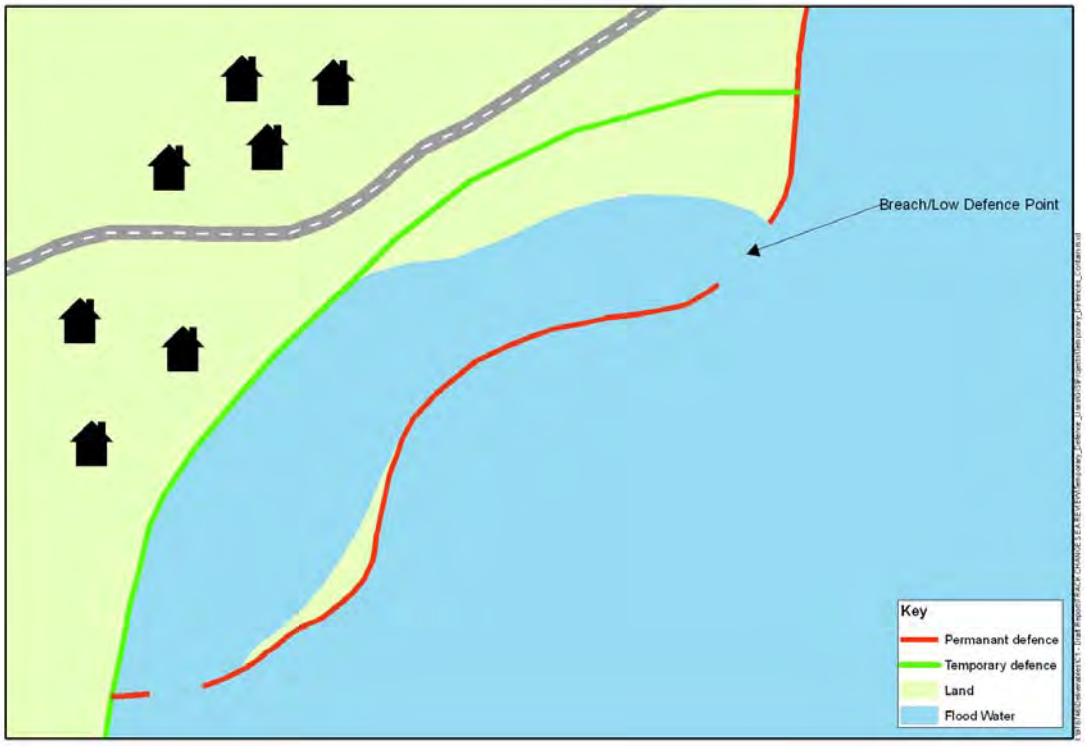


Figure 5.15 Plan view example of use of a temporary system to divert and direct flood water

Table 5.1 Generic temporary protection products appropriate to typical uses

Use of temporary defence	Potentially suitable types of temporary defence product
Raising level of permanent defences	▪ Primarily dependent on the available crest width of existing defence, local constraints and stability under expected hydraulic and debris loading
Strengthening the existing defences	▪ Primarily filled containers
Containing flood water	▪ Depends on required location/terrain and stability under hydraulic and debris loading.
Diverting / directing flood water	▪ Depends on required location/terrain and stability under hydraulic and debris loading.

6 Characteristics of Temporary and Demountable Systems

The performance characteristics of a temporary or demountable flood protection system determine its ability to be used within a particular scenario. Three main characteristics namely physical, operational and structural have been identified as the key to the performance and applicability of the systems to various requirements and conditions. These characteristics are discussed in Sections 6.1 and 6.2 below.

6.1 Performance Considerations

By this stage, the hydraulic requirements would have been determined, the acceptable highest level of permanent protection established and the required length and height of flood protection assessed. The next step then involves the assessment of generic temporary and/or demountable flood protection system(s) that can deliver the particular requirements of the project.

The generic categorisation for temporary and demountable flood protection products is described in Chapter 5. Their physical, operational and structural characteristics are discussed in this chapter. This stage of the design process aims to map the physical, structural and operational characteristics requirements and available organisational resources to that of the generic groups of temporary and demountable products to appraise which ones would be suitable to manage the risks.

Physical considerations

Physical considerations generally relate to dimensions, location and water tightness. They include:

- required protection height versus available height range;
- ability to increase the height of protection during service conditions;
- available width versus required width for protection system (including space for installation or closure operations);
- available ground and terrain conditions versus suitable terrain conditions for temporary barrier;
- suitability of the protection system for the required horizontal and vertical alignment;
- sub-soil (in particular seepage characteristics).

Operational considerations

Operational considerations involve mapping the time and organisational resources available to that required for the erection or closure of the moveable part of the protection system. This ensures that an organisation does not choose a system that it may not be able to install completely within the lead-in time available. Operational considerations include:

- available period for mobilisation and closure versus period required for operation of the protection system with the resources available;
- required resources (labour, plant, materials) for different system types;

- required storage, transportation and lifting facilities;
- requirement for site preparation and clean-up;
- ease of installation.

Structural considerations

Structural considerations involve an appraisal of the ability of typical products within the generic product range to resist the required loading and maintain structural stability and systems to support continued performance. The characteristics to be considered include:

- resistance to failure by sliding, overturning, foundation bearing capacity failure, excessive seepage and piping;
- resistance to damage and tear and the ability to repair any such damage during service;
- the likelihood of progression of local damage to whole defence failure;
- the availability of industry standard conformance certification such as BSI Kitemark within available product range;
- the availability of manufacturer's warranty within available product range.

The functional, operational and structural characteristics for available products categories have been assessed for both temporary and demountable systems. The outcome is presented in Appendices A3 and A4. The requirements for the systems should be compared with the characteristics within these tables to decide on which generic products are applicable to a particular scenario. This stage should eliminate all generic groups of systems that are not suitable for the expected loading, available resources and site conditions.

6.2 Description of Performance Characteristics

6.2.1 Physical characteristics

These are the physical characteristics of a protection system such as dimension, shape and form. In particular, the following attributes need to be considered:

Height of the protection system

The deployed height of the system above its bedding surface determines the maximum head of floodwater that can be retained before overtopping occurs. This height also limits the location where the system can be deployed – especially where physical height restrictions exist. The height of the system is sometimes higher than the design head of water to be retained or the protection capability. The protection capability is deduced from structural analyses and performance testing.

The ability to increase the height of a flood defence system during service conditions is also important. A protection system with the capability to be increased in height after installation is useful when the flood event is higher than predicted. This is important for sites where there is insufficient reliability in the accuracy of the forecast flood levels. Where the system height can be increased during service, it is important to confirm the

structural adequacy of the barrier and the bearing capacity of the underlying soil for the total stacked loading.

Width of the protection system

The deployed width of the protection system is important in deciding whether it can be deployed within the site's space constraints. This can be a key characteristic when protection is required on top of an embankment or a wall with a set crest width, or in areas where there is limited width for closing or erecting the barrier.

Adaptability to terrain and bedding conditions

The barrier acts with its bedding surface, end connections and foundation to form the protection system. The ability of the barrier to adapt to various terrain and bedding conditions therefore needs to be considered. The rigidity of barriers affects their ability to adapt to types of terrain such as undulating or sloping, and soft or hard surfaces. This adaptability affects the system's seepage and stability characteristics.

Adaptability to change in alignment

The ability of a barrier to adapt to the required vertical or horizontal change in alignment at its location of use can be critical to its suitability – especially where sharp bends or steps are involved. Adaptability is normally achieved either through the flexibility of the system due to its form, or the provision of fixings or procedures that allow some form of alignment change.

Joints and end fixings

The form of a barrier and its accessories/fittings affect both its ability to achieve an effective connection with its end conditions and the integrity of the joints between separate connected units. Good connections are essential to ensure effective performance of the whole of the temporary or demountable system. Connections and joints are unique to a particular system and are not generally assessable at a generic level.

6.2.2 Operational Characteristics

These are the operational characteristics of the products which can influence the operational reliability of a system. They are the requirements that are necessary to store, transport, deploy and remove a flood protection system. These operational issues are critical to ensuring the system is available for use and is erected before the relevant flood levels are reached. Relevant operational characteristics include the following.

Time required for deployment

The time required for the deployment of a flood protection barrier is one of the most important attributes that governs its suitability for a particular scenario. The total time required for deployment is the time from when mobilisation begins to the time when the protection system is fully in place.

The mobilisation process depends on:

- the organisational capabilities, processes and procedures;

- the location of the non permanent products and other required resources;
- the remoteness of the site;
- transportation requirements;
- the amount of site preparation required.

The second stage of the deployment process is the erection or closure of the temporary or demountable barrier. The time required for closure depends on the type of product, the available resources, the length of the required protection, the complexity of the operation, the, and the competence and readiness of the deployment teams.

Resources required for installation

The number of people and the amount of plant required for the installation of a system and the requirement for other materials affect the ability of an organisation to install a temporary or demountable system effectively. The minimum resource requirement is governed by the weight, size and installation requirement of the system. The type of plant that can be used in an area may be limited by site constraints, which in turn affect the type of protection systems suitable for the area.

Maintenance requirements

The type of maintenance required over the life of the flood protection product to keep it in an operable state is an important operational consideration. The level and complexity of maintenance operations or the need for specialist maintenance will be relevant. This includes an understanding of whether, and how, critical components age and require replacement. The location and exposure of the product and its component parts may introduce additional maintenance requirements than that provided by the manufacturer. It is important that the maintenance requirement when the product is not used and the particular requirement following use is known and considered in terms of the organisational and resource requirements and capabilities. The level and frequency of maintenance is directly linked to the while life cost of the product and this may also be important.

Storage and transportation requirements

For maximum reliability of, the ideal situation is for all sections required for the installation of a temporary or demountable flood protection system to be stored at or near their proposed deployment. Where this is not practical due to space or other constraints, off-site storage should be provided.

The amount and type of storage required depend on the size of the components in their packed state, their form, the design of individual components and the requirements for loading and unloading. The type of storage depends on the need for protection from external factors such as rain, ultraviolet radiation and vandalism. The review of available systems in Sections 5.3 and 5.4 considers storage and transport requirements for different types of system.

The organisation or people responsible must have access to the vehicles and/or lifting equipment required for loading or transporting barrier components. The deployment site must be accessible by these vehicles during an emergency.

Site preparation and clean-up requirements

The site preparation required for a temporary or demountable system can be significant. It depends on the particular system and, for temporary systems, on the degree to which the alignment is already designated and/or pre-prepared. Preparation is usually carried out to remove any debris or blockage from the line of protection and to prepare the bedding surface. Actual requirements normally depend on:

- the form and design of the barrier;
- the bedding surface;
- other functions for which the line of protection is used
- external impacts of the deployment process such as need for diversion or signage.

Clean-up requirements after demobilisation or opening of the system can also be significant and again depend on the system. They usually involve:

- the physical removal of dirt and debris from the barrier components and the deployment area;
- correct storage of all barrier components including inspection, repair and replacement if necessary
- removal and disposal of materials such as aggregates and water used as part of the protection;
- return of the bedding surface to its usual state.

Ease of deployment

Temporary and demountable flood protection systems are almost always deployed in cold, wet and windy conditions. Deployment can be made easier by:

- using modular systems whose sections can only be connected the correct way;
- using modular systems which have generic interchangeable components
- providing training and operational manuals;
- minimising operational activities.

Although the ease of installation or closure of barriers is influenced by the design of individual barriers, some appreciation of the ease of deployment on a generic scale was made during the review.

6.2.3 Structural Characteristics

These characteristics reflect the structural stability of the systems. The nature and design of a product will result in different characteristics with regards to its stability and effectiveness during service conditions. They also affect the system's ability to resist the loads to which it might be subjected in service. As well as the importance of the design of the product in determining the structural characteristics, these depend heavily upon correct installation. Some relevant characteristics include the following.

Likely structural failure modes

The resistance of a temporary or demountable system to typical failure modes such as sliding, rolling, excessive seepage, piping, bearing capacity failure, overturning and collapse provides an indication of its likely mode of failure under extreme loading. The form and design of structures can also provide some clues. An understanding of the

likely modes of failure is a critical input into determining the appropriateness of the use of a product in a particular situation and to design measures to mitigate against these modes of failure. Stability calculations and testing are required to obtain data on the expected performance of individual systems.

In addition to structural stability under design loading conditions, other structural considerations include:

- wind resistance – usually critical before the floodwater arrives;
- deflection and performance of critical components under extreme load and wheter there are visible signs of this before failure occurs (i.e. would itt be gradual or sudden)

Excessive seepage and piping

Seepage characteristics are important as they can exceed acceptable limits for the required use or lead to structural failure of the system due to the development of internal erosion, piping and foundation failure.

Seepage through a system can occur:

- through the barrier;
- at the joints between the barrier and the bedding surfaces or adjoining structures or surfaces;
- through the subsoil and any voids (e.g. drains, disused service ducts etc) that are present

Factors that can influence seepage include:

- the permeability of the barrier;
- the design or condition of the seals, joints and end details;
- the connection between the barrier and its foundation;
- seepage through the subsoil, depending on the subsoil structure and characteristics.

For temporary systems, the appropriate choice of location and use of systems with adequate designs for sealing and horizontal seepage path extension should reduce the likelihood of excessive seepage and piping. For temporary systems it may be necessary to complement seepage reduction with the capture of residual seepage in sumps and removing the collected water by appropriate means such as pumping.

For demountable systems, such issues must be dealt with as part of their foundation design by one or more of the following methods:

- stopping or reducing seepage using joint and edge sealing methods;
- increasing the seepage path horizontally (wide barriers or use of aprons/skirts);
- increasing the seepage path vertically by providing a seepage cut-off;
- removing or blocking any significant voids in the subsoil.

Resistance to damage

The resistance of the flood protection product to damage or tear either accidentally or by vandals is an important characteristic that can affect the appropriateness of a product type for particular locations or uses. In particular, the important aspects are:

- the general robustness and over-design of the component parts of the temporary or demountable barrier and their resistance to damage by impact, vandalism and tear/puncture;
- how easy it was to repair damage during service conditions;
- the likelihood of component damage leading to a progressive failure of the system.

These attributes are important in mapping the strength of the barriers to the expected loading or potential form of damage for a particular scenario. In general, rigid structures such as steel and aluminium are more resistant to damage and failure progression, but are less easy to repair under service conditions compared with more flexible systems.

6.2.4 Other relevant characteristics

In addition to the functional, structural and functional characteristics described above, other characteristics can also have major or minor impacts on the potential to use particular temporary or demountable product types for particular locations. Some of these are discussed below:

Whole life cost and benefit

When assessing whether to use temporary or demountable flood defence product, careful consideration has to be given to the whole life cost of a system. Permanent defence solutions comprise of an initial cost for design and construction of a defence plus the maintenance and repair costs through its design life. Temporary and demountable systems, in addition to these costs, also require the consideration of operational costs such as training, practice deployments, staff costs, storage, transportation, supervision and security. The benefit of the system is the damage and loss which is expected to be avoided by the use of the system over its life. As discussed in Section 7, the actual benefit depends on the reliability of the operational systems in avoiding these damages and losses. The value provided by the system is a function of both the cost and the benefit. This will be important in the choice of systems. In some cases, limited availability of funds may mean that cost plays a greater part.

Durability and re-usability

The nature of temporary and demountable defences means that the defences are not permanently left in position and are only deployed when required. The behaviour of flood products following repeated use can be very important considerations in determining appropriateness for particular uses. Some products can only be used once, some a number of times and others for much longer.

Versatility

Some of the products available for flood protection purposes are also marketed as multi- functional. These products add value by their versatility for use for other functions required by an organisation or operating authority. Examples of dual use functions are:

- Pollutant or chemical spills
- Water storage and retention
- Recreation

- Traffic control

Temporary products due to not being tied to particular locations are more likely to fall into the versatile category. The versatility can be seen as a significant benefit where an organisation has a number of locations or activities which could benefit from the use of the product and their uses are unlikely to be coincidental, giving them the potential to derive more value from the products. It is important however, that where products are chosen due to their multifunctional uses then consideration should be given to ensuring they can be available when required for flood protection.

Environmental and aesthetic qualities

The visual impact (positive or negative) of a product or system can be very important in some locations. Particular issues here relate to loss of view (temporarily or permanent), perceived visual aesthetic impact and how the product blends in with the appearance of the area. Other environmental issues such as sustainable procurement and disposal, and carbon efficiency could also affect the decision on use.

6.3 Comparison of Performance Characteristics for Different Products

The comparison of the performance characteristics of different products are contained within Appendices A3 (Temporary) A4 (Demountable). In addition, the functional, operational and structural characteristics have been separated as well. Where relevant, the other relevant characteristics identified in Section 6.2.4 have also been included

7 Designing the appropriate system

At this stage in the process it has been confirmed that temporary or demountable systems are appropriate for a particular scenario (Section 2.3). The baseline constraints (hydraulic criteria and lead time) and requirements (Functional, Structural and Operational) of the system have also been determined (Sections 4 and 6). This section provides the logical design process for determining the appropriate systems that are able to provide effective protection against the loadings and local characteristics and constraints (Sections 7.1 and 7.2). The process of optimising the reliability of the design solution is described in Section 7.3. Having achieved an optimum design solution, the guidance for assessing the costs and benefits of the preferred option or short list of options is described in Section 7.4. Section 7.5 outlines the consideration of other design considerations to enable the finalisation of the design.

7.1 Design process for the strategic option selection

The strategic option selection process is illustrated in Figure 7.1.

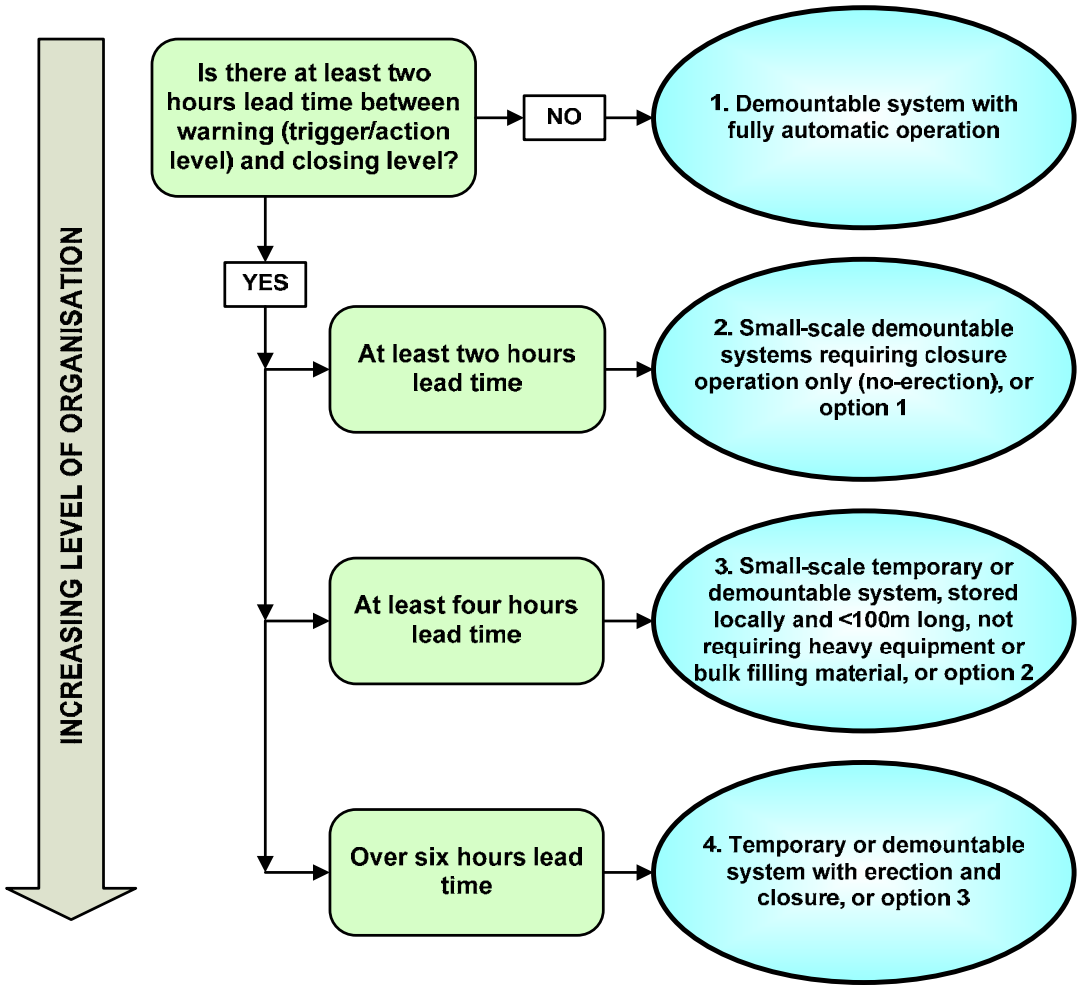


Figure 7.1 Strategic decision chart for temporary and demountable flood protection

The design process is risk based, and acknowledges the outcome of the risk assessment carried out in Section 4 and the management of the additional operational risks through using systems that have a reasonably high potential of being fully in place and operational within the available lead time.

Where automatic operation is chosen, it is necessary to manage potential conflicts from dual use in order to avoid failures or accidents.

The lower the option in the Figure (Figure 7.3), the more organisational resources and management are required. The ability of the organisation or community concerned to manage the required emergency operational activities should therefore be considered at a high level. The organisational capability will depend on available personnel, plant and the organisational systems, which include:

- available emergency systems;
- call-out and standby systems;
- extent of training and emergency drills;
- availability of good supervision.

If the organisational capabilities are considered inadequate, either a higher option can be selected from the chart (Figure 7.1) or they can be improved in line with the measures outlined in Section 7.3.

This stage should eliminate systems that cannot be safely and effectively closed within the available lead time. It should be noted that the times suggested in Figure 7.1 are based on the assumptions outlined in Section 1. That is that the guide is based on a typical scheme that includes temporary or demountable defences and that in different situations the site specific parameters may lead to either higher or lower available lead time. It is also important to remember that the lead time is the time between the forecast being generated to the complete deployment of the system.

7.2 Designing the Appropriate System

During this stage, the detailed requirements of the project will be assessed against the individual products to select a preferred solution. It is noted that in some cases, preferred solutions may not be available off the shelf as proprietary products and may involve amendment of existing designs or development of bespoke solutions where a perfect fit does not exist.

This stage requires further information on specific products; Appendix A provides a primary source of the additional information to carry out this next stage. It contains a list of the currently available proprietary systems which the research supporting this project identified. It provides a brief summary of the available products within each generic category and contact details of the manufacturers or suppliers. Appendix A also contains detailed fact sheets for all products where sufficient information was available about the functional, structural, operational and other relevant characteristics to enable them to be developed. Despite this being a very comprehensive information source, it is not an exhaustive list as new products and changes to existing ones are continuously being made. As a result, where appropriate products cannot be identified, it is advisable to contact the Flood Protection Association (FPA) for further information at www.floodprotectionassoc.co.uk.

During this stage the following assessments would be carried out regarding physical compatibility:

- compatibility of the specific product dimensions (protection depth and width) and any space requirements for installation with the requirements of the project
- ability of the specific product designs to accommodate the end tie-in details, alignment and terrain characteristics of the required use.

Regarding structural compatibility, the specific product assessment will include the following:

- ability to protect against the expected loadings, including the expected pressure head, waves, surges, velocities and potential impact from foreign objects
- where there is a potential for overtopping of the defence, behaviour on overtopping or ability to safely raise protection during operation would be assessed
- where vandalism or exposure to activities that could lead to accidental are significant risks, then the susceptibility to damage from them and effect of damage on the system performance would be assessed
- where the underlying soil is weak or easily compressible, the bearing pressure on the underlying soil would be assessed, particularly where a temporary flood protection is concerned. Depending on the type of product used there may be the need to design and construct foundations for the temporary or demountable defence. Conversely the designated alignment of planned temporary defences may preferentially follow a sealed and flat surface and the issue would be whether that surface can deal with the anticipated loading.

Regarding operational compatibility, the specific product assessment will include the following:

- the speed with which the required operational requirements can be carried out with the resource at the disposal of the relevant organisation
- the ease with which the closure operation can be carried out and skill level required
- the resource requirement of the operation in terms of manpower, material and plant as compared to the capacity of the relevant operational organisation(s)
- the requirement for storage and whole life management and the ability of the relevant organisation to achieve this
- the requirements for preparation of the site before deployment and of clean-up post deployment.

The above should enable the removal of all specific products within the relevant generic groups that cannot deliver the requirements of the particular project. The selected product needs to form a flood protection system with any existing infrastructure, foundations and adjacent structures. Where systems are being designed for particular locations, full account of these and the constraints or performance issues they introduce needs to be taken into account fully to achieve an overall system that works for a particular solution.

As the actual performance during a flood event depends on the products being available and in place on time before inundation levels are reaches, there is a need for a clear operational plan and management to ensure this happens. This is addressed in Section 8.

7.3 How to Improve Operational Reliability

7.3.1 Summary of the operational reliability issues

The factors affecting the operational reliability of temporary and demountable flood protection systems have been discussed in Sections 4.2 to 4.5. As outlined in Section 4.1, a key objective of temporary and demountable systems is to make the operation as reliable as possible. This section describes how to improve the reliability of these systems, enabling as much benefits as possible to be derived from the intervention.

The key issues that affect reliability in relation to the forecasting, alert, mobilisation and closure processes can summarised as Lead Time (mobilisation and closure processes) and organisational and operational processes and systems (all four processes).

Where T_L is the available Lead Time, T_M and T_C represent the time required to carry out the mobilisation and closure processes respectively, and T_F is the Lead Time Float, the objective of improving the lead time is to maximise the Lead Time Float (T_F), where:

$T_F = T_L – (T_M + T_C)$

This is illustrated in Figure 7.2 below.

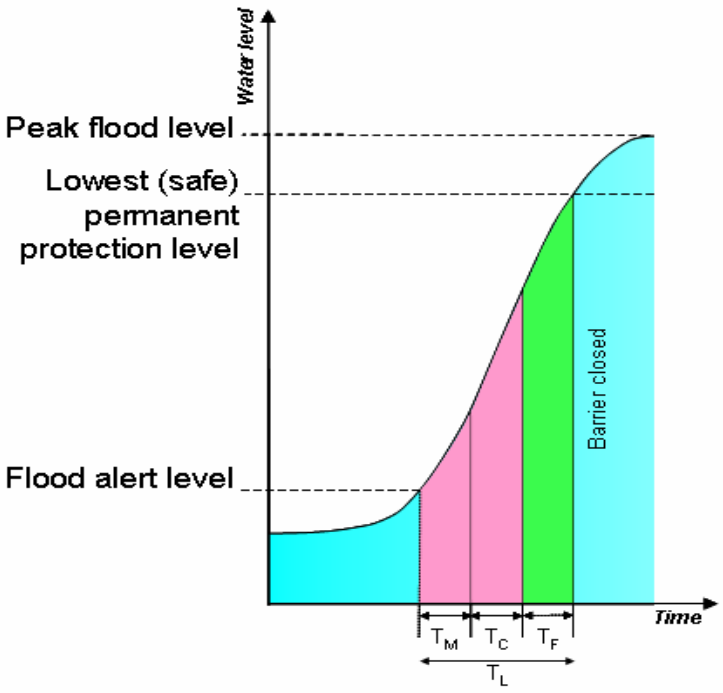


Figure 7.2 The lead time float

The level and readiness of organisational systems and the efficiency of the associated operational processes reliability of the above organisational and operational issues directly affect the reliability of the overall operation. In addition, they also have a knock on effect on the available lead time. Figure 7.3 below summarises how the above issues affect the reliabilities of each process

7.3.2 Improving operational reliability

In order to improve the reliabilities of each of the four operational processes, there will be a requirement to make changes that move the reliability upwards in line with the illustration in Figure 7.3. Some of the ways by which this can be achieved are outlined below.

Raising the lowest permanent protection level

Where it is possible, the lowest permanent protection level can be raised by constructing the lower parts of the defence as permanent sections up to the level that is acceptable. The temporary or removable part of the defence can then be installed when high water levels are expected. An example of this is shown in Figure 4.3, where the lower illustration has had its permanent protection level raised by a short wall. In the urban environment, this effect might be achieved by raising kerb levels. The benefits of raising the permanent flood protection level are as follows:

- Increase in the available Lead Time T_L due to the extra time that is created by the higher level of permanent protection
- Decrease in the time required to carry out the closure process due to the reduced amount of non-permanent part of the flood protection
- Increase in the Lead time Float T_F due to the combination of the increased available Lead Time T_L and the reduced required for closure T_C
- Reduction in operational requirement and whole life cost due to the higher permanent protection leading to less events where deployment of temporary or demountable parts are needed.

Earlier and more robust alert system

Provision of an earlier alert will result in an increase in available Lead Time T_L. It is therefore always beneficial to provide as much warning as possible. There are a number of ways by which reliable earlier flood alert can be achieved. If forecasting from upstream water level or flow, moving the forecast point further upstream would lead to earlier forecast. The available systems for generating forecasts of flood levels and flows from forecasts of precipitation using meteorological information is currently not yet reliable enough to base alerts for deployment of temporary and demountable systems on. They could however form part of an early alert service to be confirmed by actual precipitation or water levels or flows.

The earlier the trigger points for alerts, the more the potential for the alert to become unreliable. More robust alerts can be developed by improving the robustness of the forecasting system. This can be achieved by a number of measures including increasing the density of rain gauges or improving the detail of the hydrological and hydraulic analyses or hydraulic modelling. The use of real time modelling and forecasting systems also allows the alert and post alert processes to be based on the most up to date information.

The reliability of a flood alert system can be improved by ensuring that there is a clear communication feedback loop, such that all flood alert communication has a confirmation and feedback loop to ensure alerts are acted upon and non receipts are addressed through adequate back-up arrangements. Provision of 24 hour cover for the alert systems, with adequate standby arrangements to ensure receipt of alerts and availability of resources for the subsequent operational phases will further enhance the reliability of the processes.

More effective mobilisation operations and processes

Taking steps to improve the efficiency of the mobilisation process will improve reliability on its own, but in addition will reduce the time required for mobilisation T_M, which would lead to an increase of the Lead Time Float T_F and hence the reliability of the mobilisation and closure processes. The mobilisation process can be improved in a number of ways including:

- Keeping as much of the required materials (including non permanent defence sections) and plant on or very close to the deployment site
- Having a detailed mobilisation plan and increasing competence and readiness of the operations by regular training and exercises
- Having operators who live and work locally to the deployment site
- Utilising systems that require less mobilisation activities such as ones that do not need filling with other materials or a lot of plant which all need to be brought onto site.

More effective closure operations and processes

Taking steps to improve the efficiency of the closure process will also have a knock on effect on reducing the time required for closure T_C, which would lead to an increase of the Lead Time Float T_F. The closure process can be improved in a number of ways including:

- Maximising the extent of permanently installed parts of the defence system, leading to a reduction in the scale of the closure operations
- Utilising systems that are easier to install or operate and require less plant and heavy machinery
- Increasing the number of teams to reduce the total time required.
- Commencing installation of non permanent parts from area with the lowest permanent protection and working away towards higher areas
- Having designated impermeable and/or hard bedding surfaces for temporary defences
- Having a detailed mobilisation plan and increasing competence and readiness of the operations by regular training and exercise

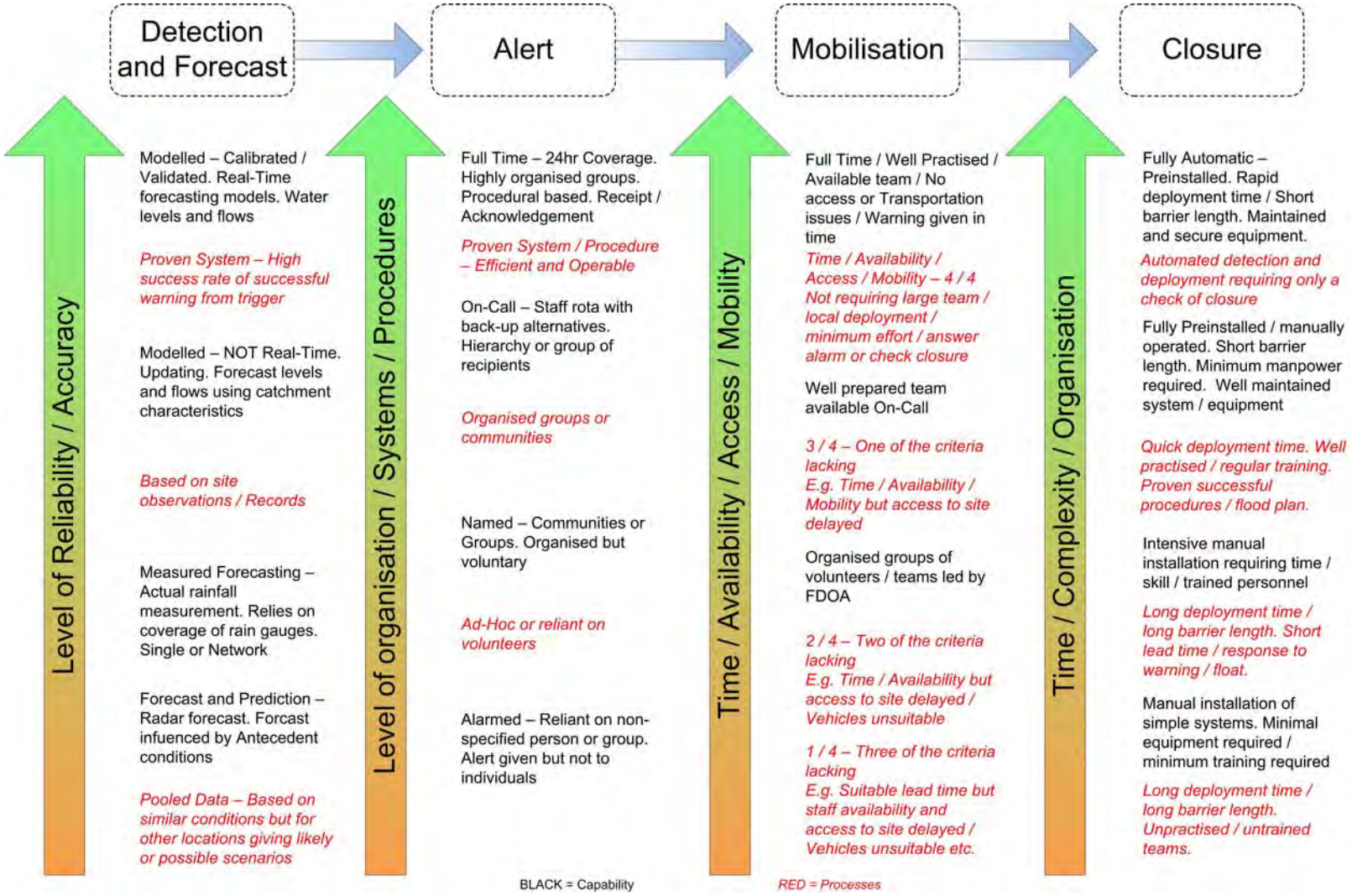


Figure 7.3 Improving levels of operational reliability

7.4 Assessment of whole life costs and benefits

7.4.1 Assessment principles

Decision making to carry out investment on interventions to reduce the risk of flooding often involves the need to build a business case showing the investment will offer a good return and to justify why the chosen approach or option is preferred over other possible alternatives. The requirement for justification and the level to which this is done will depend on the body providing the funds. Whatever the level of detail, information will normally be required about the whole life cost to ensure there is adequate funding available for the initial investment and for the subsequent whole life operational management activities required to ensure the expected performance is maintained. Some form of appraisal of the expected benefits from the investment is often required to enable an assessment of the expected returns on the investment.

Within the United Kingdom, government investment in flood risk management require appraisal in line with published guidance. The Flood and Coastal Erosion Risk Management Appraisal Guidance (Environment Agency 2010) is the relevant document covering England and Wales.

The appraisal period over which the whole life costs and benefits are appraised is very important and will need to be:

- The same for both cost and benefit to allow them to be compared;
- The same as that of the wider defence system, where the temporary or demountable protection forms part of a larger system, as the wider system performance will rely on the temporary or demountable protection being in place.

When comparing benefits and costs over an appraisal period, it is important that it is done using the same base date, with all investment and benefits discounted as necessary using official government discount rates to bring the future values into present day values to enable like for like comparison.

Guidance on the assessment of whole life costs and benefits are provided in Sections 7.4.2 and 7.4.3 below.

7.4.2 Assessment of whole life costs

It is important that the whole life cost of temporary and demountable flood protection is properly assessed to support wise investment decisions and to ensure there is sufficient funding available or to enable such funding to be secured.

The whole life cost includes two distinct components:

- the initial procurement cost
- ongoing maintenance, operation and replacement cost.

These are explored in more detail below.

Initial procurement cost

This is the cost associated with all initial stages of the project from its inception up to the point where the permanent parts of the flood protection are in place (where

applicable), the non permanent parts are procured and in their designated locations, and the operations plan is in place to enable closure of the systems when required and readiness when not in use.

Particular activities which need to be included within the cost where required are:

- Appraisal, design and any associated planning or consent approval processes
- Purchase of flood products and associated equipment, spares and materials
- Installation of permanent sections of the system including any associated structures
- Any additional works to limit leakage through underground voids below the defence line
- Land purchase or lease
- Any associated new or upgrade in forecasting or alert systems
- Establishment of storage location and plant
- Development of an operational plan, and associated training

Ongoing maintenance, operation and replacement cost

This is the cost associated with all the activities required to deploy the flood products and to ensure the readiness of the defence system and resources associated with their deployment, from the end of the initial procurement phase above to the end of the appraisal period.

Particular activities which need to be included within the cost are:

- Inspection and maintenance of the permanent and non permanent parts
- Mobilisation, including resources and the cost of ensuring these will be available (e.g. contracts and standby operations)
- Preparatory works to enable closure such as temporary closures of roads and paths and associated diversions, removal of obstructions along deployment path, preparation of bedding surface or receiving structure
- Flood protection erection or closure and associated processes e.g. pumping
- Removal, clean-up and storage of non permanent products following use
- Repair, replacement and disposal of damaged or expired parts
- Clean up and restoration of site and associated operations following deployment
- Regular training and exercises to build competence and ensure readiness
- Ongoing costs associated with storage and plant

7.4.3 Assessment of whole life benefits

The benefit derivable from an intervention to reduce flood risk can be defined as the damage avoided by the intervention. For permanent flood protection which is always in place, this is the difference between the residual damage following intervention and the damage that would occur if no intervention was carried out.

As discussed in Chapter 3, for temporary and demountable flood protection, there is an additional risk of the protection not actually being in place due to operational failure risk. As a result, the benefit derivable is dependent both on the potential benefit (assuming it was in place) and the reliability of the operational processes associated with ensure its closure. To achieve benefits as close as possible to that of a permanent

flood defence, a temporary or demountable flood protection system will need to have a very high level of operational reliability, where this is the probability that the system does not fail to achieve closure.

From the above discussion, the Benefit of a temporary or demountable flood protection can therefore be represented as:

$B_{TD} = R \times B_P$

Where B_{TD} Is the benefit of a temporary or demountable flood protection intervention;

R is the operational reliability function; and

B_P is the benefit of an equivalent permanent flood protection

Section 3.3 provides information on the reliabilities of each of the operational stages of flood forecasting, alerts, mobilisation and closure and Section 7.3 provides information on how the reliabilities can be improved.

Various methods of risk analyses have been used to date to assess the reliability of temporary and demountable defence schemes. These range from treating the defences as permanent systems (i.e. assuming R =100%), through to incorporation of all of the operational risk through risk and reliability based methods. A particular method which has been used successfully in a number of cases and which this guidance recommends for use is the Event Tree Analyses Methodology.

Event tree analyses involve assigning probabilities of success or reliabilities (R_1, R_2, R_3) to each of the operational activities, with the Reliability of the overall operation, R, being the product of the individual reliabilities.

The assessment of the reliabilities needs to be carried out by a team including operational staff experienced in the associated operations. A review of the use of this method to date for assessing the reliability of temporary and demountable systems showed inconsistencies in sub-division of the operational activities, leading to inconsistency and widely differing outcomes. The guidance provided by this document restricts the sub-division of operational activities to the four operational stages of forecasting, alerts, mobilisation and closure. This will ensure each of the process is given an equal level of importance within the assessment. Therefore, we have:

Reliability Function, $R = R_f \times R_a \times R_m \times R_c$,

where R_f, R_a, R_m and R_c are the reliability functions associated with the forecast, alert, mobilisation and closure processes respectively.

A worked example if shown below:

A risk assessment carried out for the operational processes required for part erection and closure of a demountable flood protection system shows that Rf = 0.95, Ra = 0.99, Rm = 0.98 and Rc = 0.90. The benefit of the defence if it was permanently in place without the need for any operation has been assessed as £2 million.

The Reliability Function R can therefore be assessed as follows:

$R = 0.95 \times 0.99 \times 0.98 \times 0.90$

$= 0.83$

The Benefit of the demountable flood protection, B_{TD} is therefore:

$B_{TD} = 0.83 \times 2{,}000{,}000$

$= £1{,}660{,}000$

Due to the ever present risk of failure no matter how small, the maximum reliability that is achievable for any of the four operational processes is 99%. In terms of the maximum overall reliability, it is recommended that this should never be taken as higher than 90% to recognise risks that cannot be designed out due to knowledge uncertainty.

It will sometimes be the case that the assessed reliability will be too low to be acceptable given the potential consequence in the defended area. It may also be the case that the reliability is too low for the scheme to be economically viable. In such situations, options to improve the reliability should be assessed. This is detailed in Section 7.3. The objective should be to move as high as possible towards the top of Figure 7.3.

7.5 Finalising the design

By this stage, the design and appraisal has been carried out in enough detail to be confident of the preferred flood protection product or short-list of products and their associated systems (including operational processes) that can provide a solution with an acceptable level of reliability. This final stage brings into consideration the other important attributes that affect the final choice of the solution.

The considerations at this stage could include:

- Confidence in associated product's ability to perform, For example availability of product certification of conformity to industry standards such as the BSI kitemark scheme and/or availability of information on successful application for flood conditions similar to that for which it is required;
- environmental issues such as potential for pollution, carbon consumption, bio-degradability of products or parts that require frequent replacement, impact on local habitats, sourcing of materials;
- Operational and resource considerations, which could include considerations of existing skills of the required operations team compared to that required for the proposed system(s);
- Aesthetics quality and in particular how it fits with the local landscape where the proposed location is known;
- Availability of after sales service such as product warranty, training and spares.
- durability, reusability and life expectancy;
- versatility of use, especially where flood protection products are proposed use is for multiple operations

The above or other important considerations should enable finalisation of the design. Once the design is complete, the plans to ensure the systems are in place and continue to be so throughout their intended life require to be developed around the organisational and resources available. This is discussed below in Chapter 8.

8 Operational Management

Once a system has been designed, permanently installed elements (where relevant) are in place and non permanent elements procured, the management of temporary and demountable flood protection systems required to ensure closure of the systems is addressed in this chapter. Four stages within the life cycle of the operational management of temporary and demountable flood protection are identified as follows:

- Logistics planning
- Flood plan development and operational readiness
- Operation during a flood event
- Post event operations

Each of these stages is discussed below in Sections 8.1 to 8.4.

8.1 Planning the logistics

Once the decision is made to use temporary or demountable defences consideration should also be given to the strategic planning of their use. The logistics to enable the operational management needs to be developed. For example they may be kept solely for use for a particular site or they may be managed as part of a pool of resource for wider management of the operational area. The level of fixity of the system will limit the choices in this regard. Whichever management approach is adopted, the logistical plns and arrangements for organisational and operational systems need to be clear to enable the detailed operational protocols to be developed. These plans need to consider a number of operational requirements as discussed in the following sub-sections.

8.1.1 Level of organisational resources

When selecting a temporary defence product for incident response or designing a temporary or demountable flood defence scheme, responsibility for the operational stages of the system before, during and after an event should be clear. The organisation or body responsible for each of the operational stages must be able to implement adequate procedures and provide sufficient resources to ensure the safe and successful operation of the protection system when required. This may either be provided by a single operator or as is more often the case, in association or partnership with others. Whatever the case, there must clearly be a single body responsible for the overall operations, with clear links and responsibilities. The level of organisational resources in terms of access to trained operatives, plant and materials needed is fundamental to the requirements for the other logistical issues outlined in the follwing sub-sections below.

8.1.2 Storage

For those systems that require installation as part of the emergency operations, the temporary or demountable parts require adequate storage when not in use. The following guidance relates to the storage of moveable components.

If possible, the storage area should be next to the required deployment area. For temporary flood products proposed to be used as a pool resource for wider area

operational management, it is important that the storage location(s) are sited to ensure easy accessibility during times of flood and to the likely sites where they would be required. It is also important to understand the likely lead times for operational use and ensure that there is sufficient time to obtain and transport the products to the required locations. Where this is not possible, multiple storage locations should be sourced as necessary. The probability of coincident need for the systems should also be assessed in determining how many systems to procure and their strategic location(s).

The storage area should be accessible at all times. Where the potential use is spread across a wide area, adequate storage location(s) need to be developed to ensure effective mobilisation to the required locations within the available lead times.

The type of storage provided should offer adequate protection from the environment for the type of system concerned.

Products should be laid and stacked in accordance with the manufacturer's instructions to ensure deterioration of the product is minimised. Common requirements are that products are stored undercover where possible and out of direct sunlight.

Storage facilities and loading areas should be well lit to allow for fast and safe deployment. They should be arranged in such a way as to facilitate adequate access for inspection and maintenance, and easy removal in an emergency.

If possible, dedicated storage should be provided for the temporary or demountable parts of the system to avoid both damage through other activities and loss of components. Some product manufacturers of temporary products have developed bespoke mobile storage systems such as trailers that can be attached to large cars and steel containers that can be transported by tractor and trailer units.

8.1.3 Transportation

Except for fully installed demountable systems only requiring closure, transportation of the products is a key factor in ensuring that a product or system reaches its required location in time to be deployed. When selecting a suitable storage facility, consideration of the transportation requirements of the system is vital.

The transportation requirement of products varies greatly from small trailers and 4WD pick up trucks through to large containers requiring fork lift access and lifting equipment. The storage facility therefore either needs to be located close to a transportation company or have the required transport available close to site.

Good transport links to the site are also required. Transport routes should be planned well to avoid locations which may become congested or blocked during severe weather. Alternative routes should also be considered. The access routes need to be assessed with regards to constraints such as widths, heights and load bearing capacities.

Whatever transportation methods are proposed, a clear strategy is required to ensure it is always available and able to be used successfully for the operations required during a flood event.

8.1.4 Maintenance

Maintenance of all moveable and permanent parts is essential to ensure the reliability of the flood protection system in service. These parts should be cleaned thoroughly and inspected after each use. All tears or damages should be repaired or parts replaced before the parts are stored for future use. All moving parts should be greased as necessary. Scheduled inspection and maintenance should also be carried out at

intervals defined by the manufacturer. A quick visual inspection should be carried out before use, with adequate provision made for spares.

Regular testing should be carried out as recommended by the manufacturer. Initial performance assessment and testing are discussed in Section 3.2.3.

If possible, a logbook containing the maintenance and inspection records should be kept with the defences. This will provide information on the state of the defences. Attention should be drawn to elements that have been removed for repairs or that are awaiting repairs to ensure they are not used in an emergency.

For demountable systems, regular maintenance and inspection of the pre installed components should also be undertaken. Permanent pre installed fixings, if not protected or covered, can suffer vandalism and unintentional damage due to their exposed position preventing the correct installation of a barrier.

8.1.5 Availability of appropriate resources

The knowledge and experience of the available personnel are crucial to the reliability of the protection system. The level of skill required depends on the type of system and its operational requirements.

In addition to the people carrying out operational processes, appropriately skilled personnel should be available to provide adequate supervision. Highly skilled supervisors are better able to develop safe creative solutions when things do not happen as planned. Someone should be available (preferably the supervisor) who can make emergency financial decisions without having to refer to others.

The right type of equipment and material for every stage of the mobilisation and operational phases must be available. The use of the wrong type of tool or equipment should be avoided as this can lead to unsafe installations or injury to personnel.

8.1.6 Training

Appropriate skills need to be refreshed as necessary with adequate training. Two forms of training are required:

- training in the basic skills required for the operations
- regular emergency exercises (drills).

These forms of training will help to:

- increase familiarisation and thus improve the reliability of those concerned
- verify the adequacy and condition of the flood barriers and emergency procedures.

Emergency drills should ideally be carried out at least once a year before the main flood season. Communication trials should also be undertaken at various times of the year to ensure that all of the lines of communication are active and that the correct individuals, organisations or groups are notified.

8.1.7 Public expectation

It is important to manage the public expectation of a scheme. This can be done through public meetings, leaflet campaigns and public involvement from early on in the planning and design stages of the scheme.

Due to the increased number of operational activities required for the deployment of temporary and demountable defences there is an associated risk of failure. Members of the public who are protected by temporary or demountable defences should still be considered as 'at risk'. Depending on the level of reliability that has been designed in, a clear strategy for actions which the defended public need to take should be clear and communicated. Whatever the level of reliability, personal evacuation plans should be promoted to residents within the risk area.

8.1.8 Health and safety

Operating authorities of temporary and demountable defences have a duty under the Health and Safety Work Act, 1974 to ensure the health and safety of both staff and members of the public. There is therefore a legal requirement to assess health and safety risks and also to develop procedures for deployment which are safe and without risk to people's health. The safe method of carrying out all operational processes should therefore be recorded clearly and all personnel given appropriate training.

Flood emergencies often occur in the middle of the night in dark, wet, cold and slippery conditions. Adequate safety work gear should be provided to reduce the risk of accidents. This should include the provision of portable spotlights to provide a safer working area.

In addition, the use of personnel who are already tired after a normal day's work for long lengths of emergency operations increases the risk of accidents. To avoid this, the emergency procedures should provide for proper staff management and shift work cover for the installation of systems requiring over six hours for the erection and supervision of systems when in use.

Constant monitoring of site conditions, river levels and methods of operation are essential if safe methods of working are to be maintained. Practitioner feedback has also highlighted the need for clear public safety signage and security fencing or safety barriers to maintain safety standards and reduce the risk of injury to the public.

8.1.9 Contingency and Back up

Due to the additional risk of failure from operational activities, it is vital that a contingency or back up plan is maintained for any temporary or demountable defence system. The plan should include procedures and activities which should be instigated if any of the following occur:

Non deployment of the defences

If a forecast indicated that the resulting peak water level was likely to exceed the defence systems design crest level, the decision may be taken to not deploy the barrier. This decision would prevent unnecessary damage to the system and remove the risk to staff and members of the public from rapid inundation or breach.

Overtopping of barriers

Following deployment of the system, if the resultant peak water level exceeds the forecast level, procedures should be in place to secure the barrier to try to reduce damage and evacuate the area behind the defence. This would include residents, operatives, plant, machinery and pumping equipment.

If following a successful deployment of the barrier a second peak water level is forecast to exceed the barrier design crest level, consideration should be given as to whether to remove the barrier before the second peak to prevent damage to the system. This

would be dependent on water levels falling to a safe operating level to remove the barrier.

Breach and rapid inundation

Temporary and demountable defences should be treated the same as permanent defences with regards to breach or failure. Procedures should be maintained as to the actions required following the breach of a defence.

8.2 Development of Flood Protocol and Keeping Prepared

The operational reliability of a flood barrier increases when all of the operational procedures required for its deployment are clearly set out within a flood protocol. The protocol should include all of the individual actions required, by whom and when to ensure that deployment and closure of the barrier can be achieved in the anticipated time. The interim guidance focused specifically on the protocol required for mobilisation and closure of the defence scheme. In addition to these, this section provides guidance on keeping prepared and the organisation required for maintaining readiness.

The protocol should be reviewed regularly following significant changes to key personnel, the catchment or flood protection structures, or any operation that may affect the emergency procedures.

For greater reliability, the protocol should provide for back-up and troubleshooting at all stages. Every process should also have a confirmation loop to ensure early detection of errors or mistakes. It should also be recognised that a flood protection system is only as good as its weakest point.

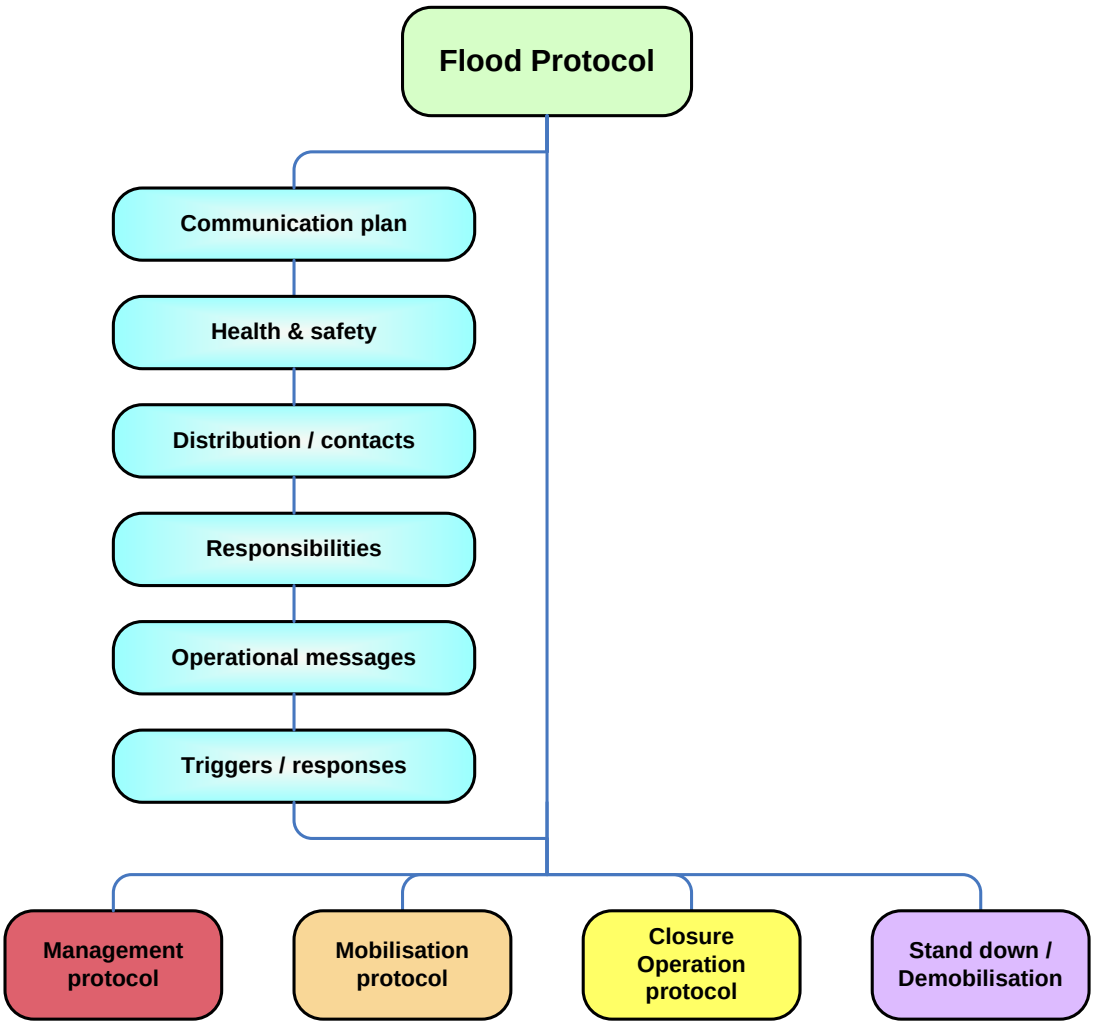


Figure 8.1 Key elements and requirements of a flood protocol

Key elements in a flood protocol are illustrated in Figure 8.1 above and should be considered within each of the operational protocols. They are:

- communication plan
- health and safety consideration
- contact list of all personnel, back-up personnel and relevant third parties
- clear responsibilities between all partners
- call-out procedure and operational messages
- trigger water levels and required action
- relationship with other emergency flood plans within the catchment

The flood protocol should also address the management, deployment and closure of the barrier by including separate procedures on each of the following:

- management protocol
- mobilisation protocol
- closure operation protocol
- demobilisation and clean-up procedure.

Management, mobilisation and closure operation protocols are discussed in more detail in Sections 8.2.1 to 8.2.3 below.

8.2.1 Management protocol

The management protocol considers all of the activities required for the maintenance and readiness of a defence system. It is important that each separate organisation or authority has clear and accountable procedures. The management protocol should also consider the operational requirements relating to the forecasting or detection of a flood event and the flood alert procedures which trigger the mobilisation phase of deployment.

In addition, the management protocol should also focus on the processes required for the improvement of system performance. This should include improvements identified from the performance evaluation of the barrier post event or from additional studies. Improvements to the flood protocol or processes should be fully tested before becoming operational. Any changes need to be communicated to all participating authorities.

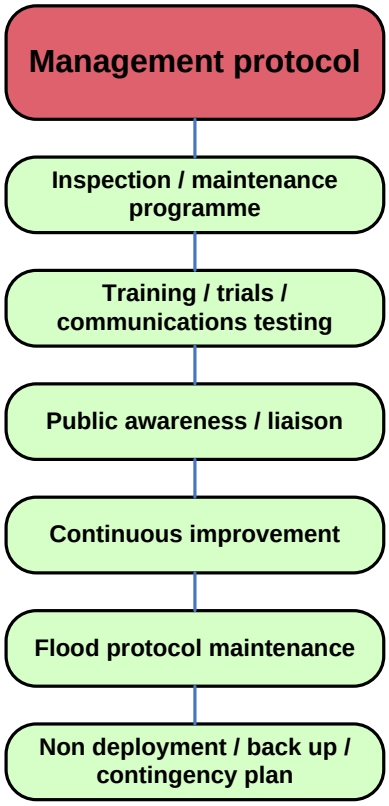


Figure 8.2 Requirements of a management protocol

The protocol should include:

- inspection and maintenance programme;
- schedule of trial deployments
- public awareness
- improvement processes, lessons learned
- maintenance of the flood protocol
- non deployment or operational failure plan.

Each activity within the management protocol should consider the key elements identified in Figure 8.1.

8.2.2 Mobilisation protocol

The mobilisation protocol is that part of the flood protocol that deals specifically with mobilisation issues and verification of the state of readiness of the organisation. The protocol should outline:

- monitoring and updates of the event
- all the processes involved in the mobilisation
- check procedures.

It is vital that continuous water level monitoring takes place during mobilisation to ensure that real-time information is available and to assist with decision-making. The mobilisation protocol should be clear on the link between mobilisation and closure operation. Based on the ongoing monitoring and the progress of mobilisation, decisions will need to be made before the closure period begins. The ability to make the decision to abort or commence closure will depend on the quality of the real-time forecasting information available. There should be clear responsibility for making such decisions and for their communication as appropriate. There should also be clear responsibility for checking the list of required resources to ensure their availability on site.

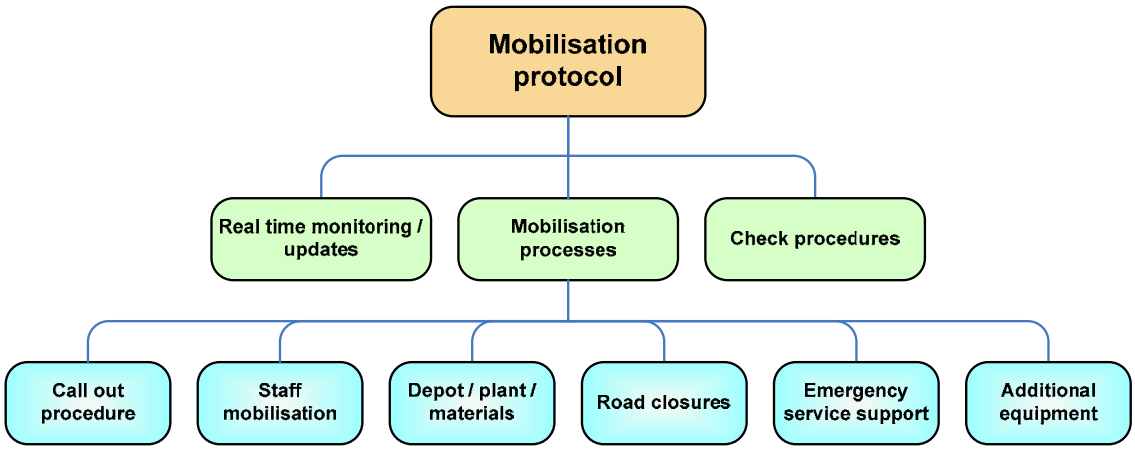


Figure 8.3 Requirements of a mobilisation protocol

8.2.3 Closure operation protocol

All aspects of the operational processes should be laid down within the closure operation protocol. This is part of the flood protocol and should include all requirements for:

- site preparation
- erection
- closure
- surveillance
- damage repair
- supervision
- emergency response following failure or exceedance of the barrier height.

Each process should be detailed clearly and responsibilities stated. The protocol should make clear:

- how the closure operation phase is commenced or triggered
- the checking procedure following closure or erection
- surveillance and monitoring activities
- the actions that lead towards beginning the removal of the temporary barrier or demountable sections at the end of the flood event.

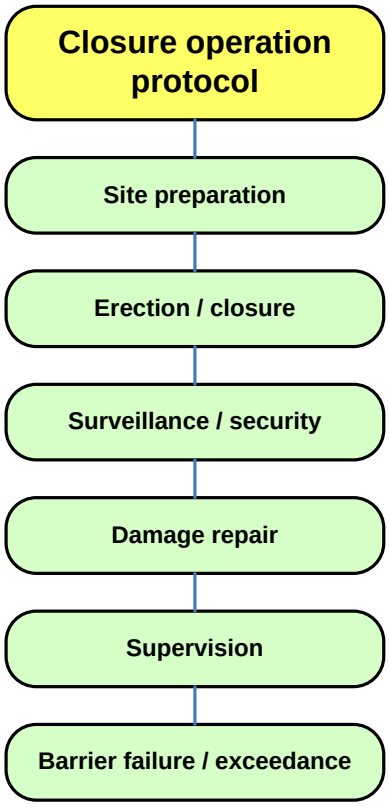


Figure 8.4 Requirements of a closure operation protocol

8.3 Operational management during an event

8.3.1 Mobilisation

The mobilisation phase begins with the receipt of the flood alert and continues until all personnel, material and plant required for to commence installation or closure of the defence are on site. The operational activities within it are outlined below.

Call-out

Call-out procedures should be well documented and practised. A reliable call-out system depends on dedicated, 24-hour availability of all personnel. To ensure this, a stand-by rota is required. All personnel on standby should be contactable and available at all times. Back-up lists should be available for unavoidable absences.

To support the call out process a suitable system of feedback or receipt acknowledgement should be in place. This will ensure that the correct message has reached the intended recipient and that the call out procedure does not fail.

The call-out system should be managed from a central point to:

- ensure a single point of information management
- identify and resolve mobilisation problems.

This management point can be passed to a dedicated site person or supervisor for the latter stages of the mobilisation. The key to a successful call-out exercise is good communication and feedback.

Access

Successful mobilisation requires accurate information about access. Reliable access during a flood scenario for all personnel and plant should be planned, available in the protocol and known by all members of the emergency team. Back-up information for key points of access should also be available in case of emergency blockages.

Reliability of access is critical where considerable transportation of defence elements and materials is required. The capacity of the access points should be checked beforehand for all vehicles (loaded weights) required for installing the flood protection system.

Shared use of space can occur where the alignment of the temporary or demountable protection system is also used for other purposes such as parking, access, mooring or as part of a domestic or industrial building. Regular inspection of these sites is required to ensure their availability during flood events. In addition, 24-hour contact information should be available for all other interested parties.

Responsibilities for obtaining access to all closed areas requiring keys or opening mechanisms should be clear. Such keys should always be held by more than one person to ensure back-up. There should be a check system for keys; lack of keys is a common delaying factor during mobilisation.

Equipment and materials

All equipment and materials required for the erection or closure of the system should be identified and recorded in the mobilisation protocol. It is essential that the right tools and equipment are available along with trained people to use them in an emergency.

The location of materials should be recorded and checked regularly to ensure their continued availability. Contact details for obtaining material or equipment should be set out in the flood protocol.

Back-up equipment and materials should always be available, as they are not normally dedicated for the sole use of the flood protection system.

8.3.2 Installation and system operation

The closure operation phase commences once the mobilisation phase is complete and a decision has been made to begin the erection or closure of the flood protection system. The operational activities within it are outlined below.

Site preparation

Site preparation refers to a number of activities required to enable the deployment to occur. The first activity within this is to secure the site to ensure activity can be carried

out safely. This may involve traffic and pedestrian prevention or management measures.

In all situations, it is important to ensure that the area where the flood barrier is to be erected is clear. This is particularly important where the sealing of the barrier depends on its interface with the soil. Large holes or protrusions can reduce water tightness.

Drainage pipes or systems that cut across the subsoil into the protected area should be blocked temporarily, as this is a common seepage route. Sharp objects should be removed from the bedding surface of flexible barriers to reduce the risk of a tear or puncture. The bedding surface should be prepared in line with the manufacturer's guidelines where uneven ground conditions exist.

Where sites share spatial uses, the need to tow or lift large objects away from the deployment area may arise. Access to suitable moving equipment should therefore be available.

All fittings, covers to underground housings, sockets and defence sections should be checked and made ready for use. A check should be made along the length of the protection to ensure there are no blockages, debris or access issues.

Site preparation sometimes occurs or begins during the mobilisation phase once some personnel are on site (especially for small sites). What is important is that it is carried out before the system is erected or the barrier is closed.

Once the site has been fully prepared and all of the barrier components, supporting equipment and materials have been delivered or distributed, commencement of the erection, closure or construction of the barrier can begin.

Closure and erection of the barrier

Continuous monitoring of the event and an assessment of the available time for closure should be undertaken to ensure that the barrier can still be deployed in time. This is vital to ensure that water levels will not exceed the level required for safe working or that the predicted water level will not exceed the barrier height.

Following a decision to continue closure, the barrier should be erected following clear instruction as laid out in the closure operation protocol. Instructions should follow manufacturer's recommendations to ensure the integrity of the product.

Erection of the barrier should commence from the location with the lowest permanent defence level. This location should be identified within the closure operation protocol. The number of processes or activities required in the erection or closure of a barrier is dependent on the type of product chosen. Multiple teams may be required to increase the efficiency and speed at which a barrier can be erected.

Supervision and quality control

A system of quality control is required within the closure operation protocol to ensure that adequate checks and supervision are carried out at all stages of the operational phase. Every part of the protection system should be checked by a competent person for correct fixing and adequate time allowed for dealing with errors or omissions.

Supervision should involve a review of the remaining time before the lowest safe permanent level (as defined in Section 5.3.2) is reached to ensure that the removable barrier or sections are installed, or the system is fully closed and checked in time. Any overrun in the preceding stages should be managed by using more resources (if practical) to achieve timely closure.

Defence surveillance

Once erected, the protection system must be kept under continuous surveillance until flood levels have receded below the opening level (Figure 4.4). This is particularly important for flexible protection systems, which are more susceptible to damage by vandalism or accidental impact. Responsibility for this surveillance and the actions to be taken if damage occurs should be made clear and written into the closure operation protocol.

Damage to flexible systems can normally be repaired by covering the damaged area with repair material. Rigid materials usually require other sections or objects to be placed behind the damaged section to reinforce the structure.

Whatever material the protection system is made of, the recommended damage repair method should always be recorded in the flood protocol, and adequate repair materials and equipment made available on site.

Evacuation of seepage

During the time in which the system is installed it may be necessary depending upon the type and performance if the system to pump out seepage from behind the line of defence. Therefore it is necessary to plan how this will be carried out to achieve the optimal result in terms of expenditure and performance. Where the sires are known, permanent sump areas should be considered.

The location of pumps needs to be determined along with suitable routes for the water to be evacuated back over the defences. It is not advisable for the pipes to be resting directly on the defence products as this places the system under additional load and in the case of flexible product types such as the filled tubes will reduce the effective crest height. The pumps also need to be monitored to ensure that they remain operational and are not the subject of vandalism, which both may compromise the effectiveness of the system as a whole.

8.4 Post event activities

8.4.1 Demobilisation

The demobilisation phase begins once the water level has receded below the opening level and the flood event is confirmed as over. The procedure for demobilisation, clean-up and storage of demountable or temporary sections of the protection system should be outlined in the flood protocol.

To avoid damage, the system should be dismantled, lifted and transported according to laid down procedures and manufacturers' guidelines.

Once all removable parts have been dismantled or the barrier opened, they should be properly cleaned, checked for damage and counted. Any recommended post-event oiling or coating should also be carried out.

All permanent and moveable parts should be inspected and all damage recorded. Damaged parts should then be separated and repaired or replaced as soon as possible after the event. Lifting, transportation and storage should be carried out in accordance with laid down procedures.

Some systems use materials such as aggregates or water as part of the protection system. These should be removed from the systems completely before cleaning. Disposal of aggregates should be carried out in accordance with current guidelines and

legal requirements. Aggregates that have been in contact with floodwater may be contaminated. They should be examined and disposed by a method appropriate to their post-event condition.

Once all temporary or demountable parts have been removed from the line of protection, the area should be cleaned up and returned to its pre-event state. This may involve:

- removal of debris
- levelling of the ground surface
- opening of access points
- securing all permanent parts of the system to discourage public access or tampering.

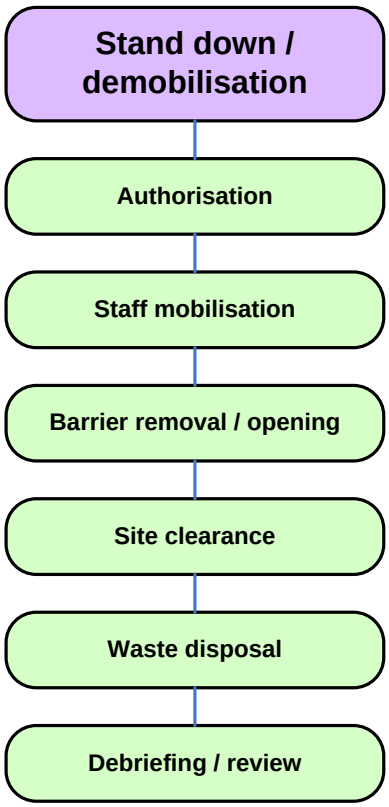


Figure 8.5 Procedures for ‘Stand down’ and demobilisation

8.4.2 Debriefing and performance evaluation

As soon as practical after demobilisation, all relevant information about the loading on the barrier and its response should be collated. Such information may include:

- the predicted and actual flood level hydrograph
- timing of the flood alert trigger or action level
- seepage and damage records
- the performance of the protection system under loading
- the effectiveness of the call-out system

- the time taken for all phases of mobilisation and operation
- the ease of erection, closure or damage repair
- resource deployment
- the adequacy of storage, access and communications
- demobilisation issues.

These and other relevant issues should be reviewed with the emergency team in a debriefing session. The aim of this session is to compare the predicted performance of the protection system and all operational procedures with the actual performance, and to identify improvements or, at the minimum, validate the performance of the existing protection system and flood protocol.

As temporary or demountable systems are seldom erected or closed, it is important to carry out emergency drills. During such exercises, the information highlighted above should be reviewed and the flood protocol amended as necessary.

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Glossary

Asset	In flood defence, any man-made or natural feature – such as a raised defence, retaining structure, channel, pumping station or culvert – that performs a flood defence or land drainage function
Asset Management	Systematic and coordinated activities through which an organisation manages its assets and asset systems for the purpose of achieving its strategic aims
Barrier closing level	The flood level at which the installation or closure of moveable parts of a temporary or demountable flood protection system commences.
Barrier opening level	The flood level at which the opening or dismantling of the moveable parts of a temporary or demountable flood protection system commences following a period of closure.
Benefits	In flood defence, land drainage or coast protection, the value placed on the reduced likelihood of flooding, waterlogging or coastal erosion provided by the asset, asset system or project.
Catchment	The land (and its area) which drains normally naturally) to a given point on a river, drainage system or other body of water
Closure	The process of installing or shutting the moveable parts of a temporary or demountable flood protection system following mobilisation of the resources required to begin the process.
Control Structure	Device constructed across a channel or between water bodies or water passages, used to control the discharge passing the device and/or the water level on either side of the device
Conveyance	Device constructed across a channel or between water bodies or water passages, used to control the discharge passing the device and/or the water level on either side of the device
Crest level	Highest part of an asset at a particular cross section above which overtopping could occur. Optional
Cut-off	That part of a floodwall, floodbank or other flood defence works, generally extending vertically below the general foundation level, which prevents or reduces the quantity of seepage passing through the foundation
Debris	Solid material (sediment or of vegetation or anthropogenic origin) transported in a watercourse, particularly during flood events. Debris can move

	intermittently and has the potential to cause blockages that impede the free flow of water.
Design Flood	Magnitude of the flood adopted for the design of the whole or part of a flood defence system, usually defined in relation to the severity of the flood in terms of its return period
Design Life	The service life of an asset intended by the designer. This assumes some rate of deterioration up to a point where the asset requires replacement or refurbishment.
Demountable flood protection system	A moveable flood protection system that is fully pre-installed and requires operation during a flood event or a system that requires part-installation into guides or sockets within a pre-constructed foundation. It is made up of demountable sections and permanent sections that act together to form a demountable flood protection system when fully installed.
Demountable section	A section of a demountable flood protection system that can be removed or opened when water levels are not in a flood condition.
Deployment	The process of mobilisation of all required resources and the installation or closure of the moveable parts of a temporary or demountable flood protection system. This process is triggered when the water level reaches a pre-determined flood alert level.
Deterioration	Decline in the material properties of some or all components of an asset caused by external agents (e.g. freeze/thaw) leading to a reduction in structural strength.
Discharge	Flow volume of a river, watercourse, drain or surface flood pathway as measured by volume per unit of time.
Element	A component of a system or asset
Embankment	An artificial, usually earthen, structure, constructed to prevent or control flooding, or for various other purposes including carrying roads and railways.
Erosion	Process by which particles are removed by the action of wind, flowing water or waves (opposite is accretion)
Event	Conditions which may lead to flooding. An event is, for example, the occurrence in source terms of critical variables such as flood water level being exceeded, or in receptor terms a particular flood depth.
Failure	Exceedence of a defined performance threshold or performance indicator.
Flood defence system	A collection of defence works for a river catchment and/or estuary and/or coastal region, in which the

	individual components (or assets) depend on each other for overall effectiveness.
Flood Plan	A flood plan details the operational & emergency response to a flood alert.
Flood protection system	A system for reducing the risks of flooding to people and property (receptor) by closing the pathway of flooding. It includes all parts that make up the system such as barriers, joints, foundations, end connections, interaction with the subsoil, and all operational activities required to close the systems (where applicable).
Flood protocol	Agreed procedures outlining all actions to be taken from the receipt of a flood alert through deployment and post-event clean-up operations. It includes mobilisation and closure operation protocols.
Flood alert level	The flood level at which the process of mobilisation or closure begins. It is normally measured upstream of the deployment area.
Flood alert mechanism	The process by which the flood alert level is detected and communicated to the relevant persons to initiate the process of mobilisation and/or closure of the temporary or demountable flood defence system.
Floodplain	Area of land bordering a river which is partly or wholly covered with water during floods
Floodwall	Wall, of any form of construction, built to prevent or control the extent of Flooding
Freeboard	The height at the top of a bank, floodwall or other flood defence structure, above the design water level (normally the water level that would occur disregarding any effects from wave action. Freeboard can be seen as a safety margin that makes allowance for uncertainties.
Function	The purpose that an asset fulfilled for those who benefit from or use it and the environment in which it exists. An asset will have a primary function for flood defence, land drainage or coast protection plus some secondary functions such as ecological, access, health & safety or amenity.
Groundwater	Water contained in the interstices of soil and rock, above and below the water table
Hazard	A situation (physical event, phenomenon or human activity) with the potential to result in harm. A hazard does not necessarily lead to harm – it can be managed.
Hydraulic loading	The product of the hydraulic pressures and the areas over which they apply

Hydraulic pressure	The pressure exerted by water (whether at rest or moving) on a surface or structure
Hydrograph	Graph that shows the variation with time of water level or discharge in a river, channel or other water body
Infrastructure	Collective term for a group of assets essential to normal life whose primary function is to provide a service to the community.
Intervention	A planned activity designed to effect an improvement in an existing natural or engineered system (particularly with asset management).
Limit state	The boundary between safety and failure for a structure. The limit state function Z=R-S is a function of the structure's strength (R) and loading (S) for a particular failure mode. Failure will not occur if the limit state function is positive.
Lowest permanent protection level	The lowest point within the permanent protection offered to a flood cell or area.
Lowest safe permanent protection level	The water level above which safe access to the permanent protection cannot be guaranteed. This level is lower than the lowest permanent protection level due to wave run-up and local requirements for safe working.
Maintenance	Work that sustains the desired condition and intended performance of an asset
Mobilisation	The process of communicating the alert level to the deployment team and the transportation of all resources required to begin erection or closure operations.
Operating Authority	An organisation (Environment Agency, local authority or Internal Drainage Board) having powers under the Land Drainage or Water Resources Act to operate, maintain or improve flood defence assets within its operational boundaries.
Overtopping	The passage of water over a component such as a floodbank or seawall, due to high water levels or wave action
Pathway	Route that enables a hazard to propagate from a 'source' to a 'receptor', as in the 'source–pathway–receptor' concept.
Performance	The creation or achievement of something that can be valued against some stated initial aim or objective, and also the degree to which a process succeeds when evaluated against some stated aim or objective.
Performance evaluation	The process of assessing past or future performance of a defence, policy or project against defined performance indicators.

Permanent flood protection System	A flood protection system that, once constructed, remains fully in place and requires no additional operational activity to provide protection from flooding up to its design flood level or range of levels.
Piping	The loss of integrity and strength of soil caused by water seepage (at a hydraulic gradient greater than unity) that results in movement of the soil particles.
Probability	Measure of chance that an event will occur. Typically defined as the relative frequency of occurrence of that event out of all possible events and expressed as a percentage with reference to time period e.g. 1% annual exceedance probability.
Progressive Failure	Failure process where, once a threshold is exceeded, some residual strength enables the asset to maintain restricted performance while further progressive loss of strength takes place.
Receptor	The entity (such as a person, property or habitat etc.) that may be harmed by an event via a source and pathway. The vulnerability of a receptor can be reduced by increasing its resilience.
Reliability	The probability that a flood defence asset will not fail during a given period of time
Resilience	In asset management, the ability of an asset or asset system to resist the damaging effect of extreme loading
Risk	Risk can be considered as having two components: • the probability that an event will occur • the consequence to receptors associated with that event Risk = probability x consequence
Risk Management	The systematic process of risk assessment, options appraisal and implementation of any risk management measures to control or mitigate risk.
Run-up	The upper level reached by a wave on a structure, relative to the Stillwater level
Stakeholder	An individual or group with an interest in, or having an influence over, the success of a proposed project or other course of action
Standard of Protection	In flood risk management, the annual probability of the design flood level being reached or exceeded
Temporary flood protection system	A removable flood protection system that is wholly installed during a flood event and removed completely when water levels have receded.
Uncertainty	Lack of precision that is due to (i) natural variability and (ii) knowledge uncertainty

Ultimate Limit State	Limiting condition beyond which a structure or element no longer fulfils its intended function(s) e.g. flood defence, amenity etc.
Watercourse	Defined natural or man-made channel for the conveyance of drainage flows and floods by gravity
Watershed	In usual British English usage, the boundary between catchments
Whole life costs	Total coat of managing an asset over its life, including cost of construction, use, operation, inspection, maintenance and refurbishment, replacement or disposal.

Temporary Product Manufacturers

Name of Product	Manufacturer	Contact Information	Description	Testing and accreditation
Tubes - Airfilled				
NOAQ TW Flood Fighting System *	NOAQ Flood Protection AB Forssa Industrial Estate 820 64 Nasviken Sweden	www.noaq.com info@noaq.com (+46) 650 30530	Interconnected air filled tubes with a skirt on water side. Weight/Pressure of the water keeps the tube secure.	No details of tests. Photos available on Internet. Website quotes 'various testing by independent institutions'
NOAQ TW Flood Fighting System (UK Supplier) *	Clan Tools and Plant Ltd. 3 Greenhill Avenue Giffnock Glasgow G46 6QX Scotland	clantools@btconnect.com www.clantools.com 0141 638 8040	As above	As above
Tubes - Water filled				
Aquadam Water Structures Unlimited (manufacturer) *	Water Structures 35 Church Lane / PO Box 206 Carlotta California 95528	www.waterstructures.com info@cofferdam.net info@waterstructures.com	Pressurised water filled tubes. 1 main tube and double "inner" tube. Available up to a height of 1.2m for flood control which can control a 0.9m depth of water.	Sutter Bypass levee north of Sacramento.1700 feet of water structure used in 1997 at Woodside Condominium, Sacramento.
Aquadam (Water Structures - supplier) *	Riverside Water Technologies Ltd. Morfa Road Swansea	ianhrees@riverside-water.co.uk sales@riverside-water.co.uk www.riverside-water.co.uk	As above	Fox River, Geneva Illinois, Clear Lake California, Salt River Canal Phoenix AZ
Tiger Dams (Manufacturer)*	US Flood Control Corp. 402 N. Division Street Carson City Nevada 89703 USA	info@usfloodcontrol.com www.usfloodcontrol.com 1 866 852 1118 (US Only)	Water filled vinyl coated polyester tubes. Two filling points. Tubes are stacked and strapped together to raise height of protection. Tubes are 15m in length and 0.48m high. Each tube takes approximately 3 minutes to fill.	R&D conducted at the University of British Columbia Ocean Engineering Test Center, Canada. Burst Tests undertaken to assess resistance to water pressure. Used extensively in the US.
Tiger Dams (UK Supplier)*	International Flood Control (UK) Ltd 103 Studdridge Street London SW6 3TD	andy.ritchie@northcliffemedia.co.uk Mr Andrew Ritchie 07500 999561	Water filled vinyl coated polyester tubes. Two filling points. Tubes are stacked and strapped together to raise height of protection. Tubes are 15m in length and 0.48m high. Each tube takes approximately 3 minutes to fill.	R&D conducted at the University of British Columbia Ocean Engineering Test Center, Canada. Burst Tests undertaken to assess resistance to water pressure. Used extensively in the US.
Waterwalls (manufacturer)	Waterwalls John Guiney Rescue Products Coquet Industrial Park Amble Northumberland NE65 0PE	Division of Holywell Enginering www.waterwalls.co.uk www.holywell.com eng@holywell.com 0166 571 0730	Water filled dam. With internal restraint baffles.	Unknown
Waterwalls (Eire supplier)	Argos (Fire and Safety) Ltd. Unit 16 Commercial Centre Kinsale Road	www.argosfire.com info@argosfire.com 0214319088 0872551946	As above	As above
WIPP / Aqua-Barrier (Manufacturer)	Hydrological-Solutions Inc. 41232 Park 290 Drive Building A Waller TX 77484 USA	ksullivan@hydrologicalsolutions.com www.aquabarrier.com www.wippsystem.com (+1) 936 372 1222	Water inflated coffer dam. 50 and 100 feet lengths available, from 2 to 7 feet high. Single or double diaphragm versions available.	Hydrological Solutions is BBBonline participant and BBB accreditation. This is a company standard not testing creditation.
WIPP / Aqua-Barrier (UK Supplier)	UK Flood Control Limited Unit 1, Dumyat Industrial Estate Tullibody Stirling FK10 2PB	www.ukfloodcontrol.com info@ukfloodcontrol.com UK Flood Control Limited 8 St Leonards Square Wallingford Oxfordshire OX10 0AR 08715 4727374 07969 340602	Water filled dam. With internal restraint baffles. Available up to a height of 2m. Lengths of 16m, 32m, up to 60m Can be joined by end to end butting or overlapping. 50mm Nylon Webbing strap connectors.	
Containers - Permeable				
Big Bag Harbeck *	Big Bag Harbeck GmBH Industriestrasse 11 D-84364 Bad Birnbach Germany	www.big-bag-harbeck.de info@big-bag-harbeck.de www.mobiler-hochwasserschutz.org (+49) 8563 91404	Aggregate filled geotextile joined bags. Filled on site or prefilled sections.	Simple impact tests undertaken.
Continuous Berm	MBW UK Limited Units 2 & 3 Cochrane Street, Bolton BL3 6BN	MBW@MBW.com www.mbw.com angelag@mbwuk.co.uk 0120 438 7784	Fabric encapsulated continuous berm of sand rock or soil. Material filled "wrapping " of geosynthetic fabric	Extensive testing in USA
Hesco Bastion Concertainer *	Hesco Bastion Ltd Unit 41 Knowsthorpe Way Cross Green Industrial Estate Leeds LS9 0SW	www.hesco.com www.hescobastion.com k.hardy@hescobastion.com 0113 248 6633 07802 221888	Aggregate filled geotextile concertinaed panels connected by joining pins. Fully collapsible and reusable.	Heavily used by the Armed Forces for barricades and bunkers. Tested by Environment Agency Midlands. Used in 2007 Floods in Gloucestershire.
Quick Dam Type E System	QUICK DAMM GmbH Rodheimer Straße 117 35452 Heuchelheim	www.quick-damm.de www.quick-systems.de info@quick-damm.de (+49) 641 96870	Aggregate filled geotextile bag with internal frame supports. To be machine filled with sand.	Unknown

Name of Product	Manufacturer	Contact Information	Description	Testing and accreditation
Sandbags (standard Hessian or Polypropylene)	Various	Various	Woven bags that are filled with sand to form a pillow-like shape and stacked to form a flood wall that directs water away from a protected area.	None. Significant experience of use across the world suggest they are unlikely to pass the PAS 1188 leakage tests.
Sandbags (self inflating)	Quick SandbagsTM S.G Baker Ltd Old Wharf Road Grantham Lincolnshire NG31 7AA Aqua-Sac self inflating bag A E T PO BOX 4706 SHEFFIELD S17 9BU Floodsax FloodSax Customer Service Protocol Communications Management Link 665 Business Centre A56 Rossendale	sales@sgbaker.co.uk www.sgbaker.co.uk/sandbags www.sandbagsuppliers.co.uk/ www.quicksandbags.co.uk/index.php 0800 612 9637 01476 565501 info@a-et.co.uk http://www.aqua-sac.com/ 0114 2621706 floods@protocol.uk.com http://www.floodsax.co.uk/ 0800 9534040	Semi-porous bags filled with absorbant materials to form a pillow-like shape which expand to full size when in contact with water	Unknown

Name of Product	Manufacturer	Contact Information	Description	Testing and accreditation
Containers - Impermeable				
Aqua-Levee *	Aqua-Levee Temporary Flood Control 501 N Roane Street Suite 202 Harriman TN 37748	www.aqua-levee.com inquiry@aqua-levee.com (+1) 8658 820 982	Stackable water filled triangular 'tubes' with solid frame. System has additional 'seam shields' protecting flexible joints from impacts.	Tested in 2002 by US Army Corps of Engineers.
Aqua-Levee (UK Supplier)	Independent Flood Defence Products (IFDP Ltd.) 2nd Floor Offices 16 Mere Street Diss IP22 4AD	http://ifdp.co.uk/index.html finlay.hunter@ifdp.co.uk enquiries@ifdp.co.uk 01379644033	Stackable water filled triangular 'tubes' with solid frame. System has additional 'seam shields' protecting flexible joints from impacts.	Tested in 2002 by US Army Corps of Engineers.
Barricades (ex DuraBull)	Creative Building Products 6409 Highview Drive Fort Wayne IN 46818	gerard@soacorp.com webmaster@soacorp.com www.soacorp.com (+1) 8000-860-2855 Gerrard Muegerl	Plastic ballast filled containers	Can withstand grenades detonated from 2 feet
Floodstop *	FLOODSTOP 21 Whitby Crescent Poole Dorset BH18 8HX	www.fluvial-innovations.co.uk info@fluvial-innovations.co.uk 07909 576127	Plastic units that are filled with rising flood water and give protection up to a height of 0.5m.	Unknown
MRP Modular Shielding *	MRP Systems Ltd 454 Carr Place, Walton Summit Centre, Bamber Bridge, Preston PR5 8AU	info@mrpsystemsuk.com www.ukmrp.com www.mrpsystemsuk.com 0161 427 8910 0177 262 7153	Hollow polyethylene box. To be filled by choice: sand, water, iron, lead shot, depending on requirements. Can be stacked 8 high.	Not yet used in flood situation.
Quick Dam Flood Safety System	QUICK DAMM GmbH Rodheimer Straße 117 35452 Heuchelheim	www.quick-damm.de www.quick-systems.de info@quick-damm.de (+49) 641 96870	Filled steel tube construction with either PVC covered polyester textile or geotextile fleece. Can be filled with water, sand, gravel, soil, stones or cinders.	Has been used in numerous flood prevention situations.
Frestanding Barriers - Flexible				
Alteau Flood Barrier *	Analox Environmental Technology Ltd 15 Ellerbeck Court Stokesley Industrial Park Stokesley North Yorkshire TS9 5PT	Fran Cleeton (Managing Director) fran.cleeton@a-et.co.uk www.aqua-sac.com info@analox-et.co.uk 0800 032 7404 0164 271 5926	By using the force of the water the Alteau Flood Barrier rises automatically up to a maximum height of 1.2 metres and lengths of several hundred metres.	The culmination of more than two years testing and development, the flood barrier is the third evolution of the flood defence principle that has been in use for seven years.
RAPIDAM *	Floodguard Systems Limited Brunninghams Farm Heath Ride Wokingham Berkshire RG40 3QJ	Sales@floodguards.com www.floodguards.com 0118 973 3535	Sectional Material panels with skirt. Heavy duty double sided industrial velcro. Can form linear barrier or box configuration. Non tear heavy duty material.	Rigorous testing by Hydroscience, HR Wallingford, Environment Agency and for Tomorrow's World.
RAPIDAM *	Revetment Limited North House 198 High Street Tonbridge Kent TN9 1BE	john.alexander@revetment.uk.com enquiries@revetment.uk.com www.revetment.uk.com 0844 804 4046	As above	As above
Water-Gate (Manufacturer) *	MegaSecure Inc Environmental Security 145 Jutras Boulevard East Suite 3 Victoriaville Quebec Canada G6P 4L8	h.lemay@megasecur.com info@megasecur.com www.megasecur.com (+1) 819 7510222	Portable, re-usable “self filling” water barrier for instant flood control. It is wedge shaped and as water enters over the front ‘apron’, the barrier forms a wedge shape therefore creating a barrier.	Tested in extreme climate conditions and at water pressures 3 to 4 times greater than would be encountered in the field
Water-Gate (Supplier) *	UK Flood Control Limited Unit 1, Dumyat Industrial Estate Tullibody Stirling FK10 2PB	www.ukfloodcontrol.com info@ukfloodcontrol.com UK Flood Control Limited 8 St Leonards Square Wallingford Oxfordshire OX10 0AR 08715 727374 07969 340602	As above	As above
Frestanding Barriers - Rigid				
Aqua Fence (Manufacturer) *	AquaFence Limited Industriveien 17 1890 Rakkestad Norway	www.aquafence.com info@aquafence.com (+47) 6920 7170	Each flood barrier module consists of two boards in compact flat packs. The construction is stabilised by water pressure when the flood arrives.	TUHH Performance Certificate 08/01 (Hamburg University Institute of River and Coastal Engineering)
Aqua Fence (Manufacturers UK Office) *	AquaFence Limited Minerva Mill Innovation Centre Station Road Alcester Warwickshire B49 5ET	www.aquafence.com info@aquafence.com 01789 761370	As Above	As Above
Aqua Fence (Supplier) *	Flood Defence Limited Unit 1 & 2 Pontarddulais Workshops Pontarddulais Swansea SA4 8SG	www.totalfloodsolutions.com info@totalfloodsolutions.com ron.whitehead@totalfloodsolutions.com 0179 288 1166 07825 541011	As Above	As Above

Name of Product	Manufacturer	Contact Information	Description	Testing and accreditation
NOAQ BW Box Wall System *	NOAQ Flood Protection AB Forssa Industrial Estate 820 64 Nasviken Sweden	www.noaq.com info@noaq.com (+46) 650 30530	Interconnecting rigid plastic panels	Unknown
Yewstop 'A' block *	Yewstop (Concrete) Ltd. Plumtree Farm Uppertown Ashover Chesterfield Derbyshire S45 0JF	www.yewstopablock.co.uk info@yewstopconcrete.co.uk yewstop@btconnect.com 0124 683 0002	Mass concrete block, stackable 'large interlocking bricks'. Available in variety of sizes. Largest weighing 1.5 tonnes (approx 3/4 m^3 of concrete per block)	Has been used in Chesterfield to provide flood defence to factory which flooded during 2007.
Frame Barrier - Flexible				
Portadam *	Onsite 89 Blackpole West Blackpole Worcester WR3 8TJ	portadam@btinternet.com solutions@onsite.co.uk www.portadam.co.uk 0190 534 0054	Welded steel "A" frames with impervious fabric membrane. Welded rectangular steel A frames, 600mm and 1250mm flumes, tailored impervious membrane causing hydrostatic	Longest used Portadam was to 250m in length
Frame Barrier - Rigid				
Beaver Barrier	ARTTEC Innovation Trade GMBH Franz-Abt-Str 10 D-65193 Wiesbaden	patente@transmit.de www.arttec.com (+49) 061199276-0	A steel 'A' framed pallet with sheet membrane sheet to cover the frame offering 1.5m protection	Tested by the Wiesbaden Institute of Technology and Frankfurt Fire Department. Constructed 10 metre dam in 15 minutes
Geodesign Barrier (Manufacturer) (Aquabarrier outside UK) *	Geodesign AB Teknikringen 1 S-583 30 Linkoping Sweden	kullberg@geodesign.se www.geodesign.se (+46) 13 211955 (+46) 705 515455	Galvanised steel support with slanted membrane covered pallets. Available to a height of 1.8m	PAS 1188 Part 2 accreditation . Tested by the Norwegian Water Authority, Glomma Valley and also in flooding events in France, UK and Australia. Used in 2007 at Walham Switching Station in UK.
Geodesign Barrier (UK) *	Geodesign Barrier UK 5 Fore Street Topsham Exeter Devon EX3 0HF	britt.warg@palletbarrier.com 0139 287 6100 07890983239	As Above	As Above
IBS Bauer K System (Manufacturer) *	IBS Zentrale Gemeindewald 4 86672 Thierhaupten Germany	sekretariat@ibs-technik.de weingartner@ibs-technik.de www.hochwasserschutz.de www.ibs-technik.de (+49) 82718176-0	K-trestles, dam beams and pressing tools. Maximum support height 1300mm	PAS 1188 Part 2 accreditation. Tested in various UK loctions. Used in 2007 at Walham Switching Station in UK
IBS Bauer K System (UK) *	IBS Engineered Products Ltd Dallam Lane Dallam House Warrington Cheshire WA2 7LT	info@ibsengineeredproducts.com www.ibsengineeredproducts.com 01925 428940 07734 878514	As Above	As Above
Mobile Flood Protection System * (Flood Protection SE)	Flood Protection Systems Sweden AB Malmo Sweden	www.floodprotection.se sahbi@floodprotection.se (+46) 708 306699	Frame mounted panels covered by impermeable membrane	Unknown

*** Fact Sheet Located in Appendix A5**

Demountable Product Manufacturers

Name of Product	Manufacturer	Email Address / Website	Description	Testing and accreditation
Free Standing Barrier (Part Preinstalled) - Flexible				
RAPIDAM *	Floodguard Systems Limited Brunninghams Farm Heath Ride Wokingham Berkshire RG40 3QJ	Sales@floodguards.com www.floodguards.com 0118 973 3535	Sectional Material panels with skirt fixed to the ground (demountable). Heavy duty double sided industrial velcro. Can form linear barrier or box configuration. Non tear heavy duty material. Also works as temporary	PAS 1188 accreditation. Rigorous testing by Hydroscience, HR Wallingford, EA and for Tomorrows World. Has Kitemark.
Free Standing Barrier (Part Preinstalled) - Rigid				
Aquabarrier *	AquaBarrier Systems Limited, 10 Cavalry Ride, Norwich NR3 1UA	www.aquabarrier-systems.com martinfrench.co@virgin.net 0160 362 5999	Modular demountable barrier, it self fills as the flood water rises and empties as the flood level recedes. These demountable barriers are connected to pre-installed ground works using lock down bolts and plates secured in the existing ground works.	Aquabarrier Systems hired a dry dock in Blyth and tested the product to an extreme flood event of 1.6 metres, the barrier successfully held back water up to 1.5 metres then overtopped without effecting the integrity of the barrier wall.
Aqua Fence (Manufacturer) *	AquaFence Limited Industriveien 17 1890 Rakkestad Norway	www.aquafence.com info@aquafence.com (+47) 6920 7170	Each flood barrier module consists of two boards in compact flat packs. The construction is stabilised by water pressure when the flood arrives.	TUHH Performance Certificate 08/01 (Hamburg University Institute of River and Coastal Engineering)
Aqua Fence (Manufacturers UK Office) *	AquaFence Limited Minerva Mill Innovation Centre Station Road Alcester Warwickshire B49 5ET	www.aquafence.com info@aquafence.com (+47) 6920 7170	As above	As above
Aqua Fence (Supplier) *	Flood Defence Limited Unit 1 & 2 Pontarddulais Workshops Pontarddulais Swansea SA4 8SG	www.totalfloodsolutions.com info@totalfloodsolutions.com ron.whitehead@totalfloodsolutions.com 01792 881166 07825 541011	As above	As above
Frame Barrier (Part Preinstalled)				
Alcan Aluminium Dam Log System *	Alusuisse Singen GmbH, D-78221 Singen/Hohentwiel	(+49) 7731/80-0	Removable aluminum beams that can be combined to form 5m high barriers.	Unknown
AQUA STOP 200AL AQUA STOP 200GL	AQUA-STOP Hochwasserschutz GmbH Hofgundchen 55 56564 Neuweid Germany	info@aquastop.net www.aquastop.de (+49) 2631 21631	Self supporting removable dams and supports. Glass Protection barrier used for flood protection.	Tested on a regular basis and used to successfully in Germany
BL/HDS High Water Defence System BL/HSW - (wall) BL/HAP-SB - (cover) (Manufacturer)	Blobel Umwelttechnik GmbH Friedberger Str. 4 86453 Dasing Germany	info@blobel.de www.blobel.de www.dammbalken.eu www.floodbarriers.eu (+49) 8205 9607 -0	Flood protection wall/barrier systems and smaller plates/barriers suitable for blocking doorways and other openings	Widely used in Europe
BL/HDS High Water Defence System BL/HSW - (wall) BL/HAP-SB - (cover) (UK Supplier)	Fluid System Technology Ltd. Unit 4/5 Bridge Road Business Park Brompton-on-Swale Richmond North Yorks DL10 7HB	rha@fluidsystemtechnology.com sales@fluidsystemtechnology.com 01748 810458	As above	As above
Caro Waterwall *	Caro Flood Defence Systems 11 Market Hill Royston Hertfordshire SG8 9JN	www.caro.co.uk info@carofds.co.uk 0176 324 4446	Modular demountable aluminium panels and locking posts	Unknown
Caro Waterwall (As above different supplier) *	Independent Flood Defence Products (IFDP Ltd.) 2nd Floor Offices 16 Mere Street Diss IP22 4AD	finlay.hunter@ifdp.co.uk enquiries@ifdp.co.uk 0137 964 4033	As above	As above
Coplasticx Stoplogs *	Ham-Baker Ltd. Garner Street Etruria Stoke on Trent Staffordshire ST4 7BH	www.hambaker.com.uk cdimmock@hambaker.co.uk rhaydon@hambaker.co.uk 0178 220 2300	Drop in synthetic, steel or stainless steel stoplogs. Can form barrier upto 2 metres high. Stoplog sizes either 300 or 400mm.	Unknown
DPS 2000 Hochwasserschutz *	G.O.H. Bonnstrasse 15 50226 Frechen (Koln West) Germany	info@goh.de www.goh.de (+49) 2234 276969 - 15 claudia.kusch@goh.de	Aluminium profiles slid between steel supports. Toothed aluminium profiles between galvanised steel supports, rubber edged with ties to keep in place.	Freestanding to 1.6m. Has been used in the Netherlands and is a capital purchase.
Flood Ark *	Flood Ark Limited Emmerson Industrial Estate Norwich Road Lenwade NR9 5SA	www.floodark.co.uk info@floodark.co.uk 0160 387 9977	Modular extendable barrier system. Bespoke aluminium and UPVC system comprising of 0.2m deep boards. Primarilly used as protection to doorways.	PAS1188:1 accreditation for building apertures, but would be also suitable for closures in defences or wall openings.

Name of Product	Manufacturer	Email Address / Website	Description	Testing and accreditation
IBS Demountable Frame Barrier (Manufacturer) *	IBS Zentrale Gemeindewald 4 86672 Thierhaupten Germany	sekretariat@ibs-technik.de weingartner@ibs-technik.de www.hochwasserschutz.de www.ibs-technik.de (+49) 82718176-0	Steel sunk bracket support with aluminium dam beams. Maximum support height 1.5m	PAS 1188 Part 4 acceditation
IBS Demountable Frame Barrier (UK) *	IBS Engineered Products Ltd Dallam Lane Dallam House Warrington Cheshire WA2 7LT	info@ibsengineeredproducts.com www.ibsengineeredproducts.com 01925 428940 07734 878514	As Above	PAS 1188 Part 4 acceditation
The Invisible Flood Control Wall	Flood Control America 29 Goodmans Hill Road Sudbury MA 01776	George Fryklund floodwall@floodcontrolam.com www.floodcontrolam.com 978 440 8902	Sill Plates mounted on intermediate and parting supports. Steel Aluminium Planks.	Permanent Demonstration wall. Scranton, P.A, USA.
L Series Modular Demountable Flood Barrier * (Flood control demountable system)	Flood Control Ltd Torrington House New Bridge Gunnislake Cornwall PL18 9LH	enquiries@floodcontrol.co.uk sales@floodcontrol.co.uk www.floodcontrol.co.uk John.scoot@floodcontrol.co.uk 0182 283 2385	Stackable barrier board system. Modular or single interlocking beams of Aluminium profile tubing with reinforced struts. To be installed in each property. Gates up to 1.8 m in 6m widths	Already installed by numerous private properties
L Series Modular Demountable Flood Barrier * (as above - different supplier)	Rs Stepanek OHG Limburger Strasse 78 65555 Limburg Offheim Germany	www.rs-stepanek.de vertrieb@rs-stepanek.de (+49) 6431 9582-0	As above	As above
Mobile Anti-flood Protection System	Eko-System s.r.o Na Koupaliste 10 103 00 Praha 10 - Benice Czech Republic	www.eko-system.cz info@eko-system.cz 00 42 267 090595,7	Aluminium profiles slid between steel supports. Stop log and gated system.	Extensive system protecting Prague succesfully built and tested.
Multi-Panel Flood Barrier (Model FP-M)	Walz & Krenzer, Inc 92 Willenbrook Road Unit 4B Oxford CT 06478	www.wk-mapeco.com sales@wkdoors.com 0141 638 8040	Removable multi panel lip seal flood barrier	Unknown
Presray Model CGSL Gasketed Aluminium Stop Log System	Presray Corporation 32 Nelson Hill Road, P.O. Box 200, Wassaic, New York 12592 USA	info@presray.com www.presray.com (845) 855 1120	Stackable barrier board system	Unknown
Ransfords	Charles Ransford & Son Ltd Station Street Bishops Castle Shropshire SY9 5AQ	info@ransfords.co.uk www.ransfords.co.uk 0158 863 8331	Timber tongue and groove barrier or polyplank made from 100% recycled material. To a height of 5.0m with sealed joints.	Not yet used in a flooding situation, no tests on water retention.
WasserWand Wibbeler	Wibbeler Hochwasserschutz Mühlenstraße 14 D-49549 Ladbergen	www.wibbeler.de kontakt@wibbeler.de (+49) 054 85 / 83 05 99	Demountable panel barrier with groundworks concealed below ground level.	Unknown
Sectional Barrier (Fully Preinstalled) - Manual				
Dutchdam Bold Dutchdam Cento Dutchdam Duplo *	Dutchdam BV B. Hosangweg 84 NL-2481 LA Woubrugge The Netherlands	info@dutchdam.nl www.dutchdam.nl 01792 881166 07825 541011	Collapsible flood barrier fencing stored under panels in the quay / riverbank. Available at heights of 55,75,95,125 and 150cm. Ist 3 height can be easily used in quay walls.	Wave and Impact testing at WL Delft Hydraulics for the Rijkswaterstaat. Fitted and Used on the River Liffey in Dublin
Tilt Dam and Spring Dam *	Tilt Dam Limited 3 Howe Drive Beaconsfield Bucks HP9 2BG	www.tiltdam.com jim@tiltdam.com 0149 467 2323	Gravity Powered permanent demountable flood defence	Installed in several locations in the UK. Tested at Building Research Establishment BRE at Garston, Herts.
Sectional Barrier (Fully Preinstalled) - Automatic				
Self Closing Flood Barrier (SCFB) (Manufacturer) *	Van Den Noort Innovations BV Zilverschaan 47 8265 HE Kampen The Netherlands	info@noort-innovations.nl www.noort-innovations.nl www.floodbarrier.nl (+31) 38 4204948	Fibreglass floating wall lifted by the hydrostatic pressure of the flood waters	Won many awards and installed and used in Dublin and Holland. Also installed worldwide."Intensively tested" but no details
Self Closing Flood Barrier (SCFB) (UK Supplier)*	UK Flood Barriers Ltd. Unit 4 West Stone Berry Hill Industrial Estate Droitwich Worcestershire WR9 9AS	info@ukfloodbarriers.co.uk www.ukfloodbarriers.co.uk 01905 773282	Fibreglass floating wall lifted by the hydrostatic pressure of the flood waters	Won many awards and installed and used in Dublin and Holland. Also installed worldwide."Intensively tested" but no details
Self Closing Waterdam (SCW) (Supplier)	Fydro BV Morsestraat 9-11 6716 AH Ede The Netherlands	www.fydro.com www.fydro.nl info@fydro.nl (+31) 318 648320	Fibreglass floating wall lifted by the hydrostatic pressure of the flood waters	Won many awards and installed and used in Dublin and Holland. Also installed worldwide."Intensively tested" but no details
Flood Gates (Fully Preinstalled) - Manual or Automatic				

Name of Product	Manufacturer	Email Address / Website	Description	Testing and accreditation
1. BL/BED (Manual) 2. BL/BDD-PM (Automatic) 3. BL/BST	Blobel Umwelttechnik GmbH Friedberger Str. 4 86453 Dasing Germany	www.blobel.de info@blobel.de (+49) 8205 9607 -0	1. Raising type barrier system, trapezoidal shaped with special rubber sealent. 2. Full pneumatic system electronically operated 3. Rectangular fill with rubber sealant inserted in a 'u' shaped mount	Unknown
Hydraulic Flip-Up * Pivot * Hinged *	Flood Control Ltd Torrington House New Bridge Gunnislake	enquiries@floodcontrol.co.uk sales@floodcontrol.co.uk www.floodcontrol.co.uk John.scoot@floodcontrol.co.uk	Watertight gates and barriers that are operated to close access points.	Unknown
Presray Models FB55 / FB44 / CG3S / CG11HA	Presray Corporation 32 Nelson Hill Road, P.O. Box 200, Wassaic, New York 12592 USA	info@presray.com www.presray.com (+1) 845 855 1120	Bottom hinged "flip-up" flood gate. Flood protection to over 8 feet. When not in use can be used for traffic passage. Available with side and bottom hinges or as sliding gate.	Unknown
Flood Gates and Stop Logs	Transglobal Engineering Beck Group of Companies	www.transglobalengineering.com stuart@transglobalengineering.com	Watertight gates that can block off walkways etc.	Unknown
Walz & Krenzer Hinged Flood Gates Water Tight doors and Hatches	Walz & Krenzer, Inc 92 Willenbrook Road Unit 4B Oxford CT 06478	www.wk-mapeco.com sales@wkdoors.com (+1) 203 267 5712	Water tight doors, flood barriers and hatches. Manual or Automatic. Compression, lip seal or Inflatable gaskets. Steel, Aluminium and Stainless Steel. Side hinged or lift off.	Unknown

*** Fact Sheet Located in Appendix A5**

Physical characteristics of temporary flood protection systems

Type	Product	Maximum head of water		Increase height during service	Product Dimensions		Adaptability to terrain and bedding conditions						Products adaptability to bends and corners	Product use as enclosure
		Unstacked	Stacked	Yes/No	Height Range	Width at base	Wall Extension	Soil / Grass	Concrete/ Tarmac	Sloping surface	2.5m wide bank	4.0m wide bank	Yes/No	Yes/No
Tubes														
Air Filled	**Tube wall**	1m	N/A	No	0.5 - 1.0 m	1.8 - 3.2m	No	Yes	Yes	No	Yes	Yes	Yes (units can be connected at any angle from 90° to 270°)	Yes
Water Filled	**Aquadam**	0.9m	N/A	No	0.3 - 1.2m	0.6 - 2.4m	No	Yes	Yes	No	Yes	Yes	Yes (can be laid in an arc)	Yes
Water Filled	**Tiger Dams**	0.48m	9.75m	Yes	0.48m	1.0m (for 0.9m height)	No	Yes	Yes	No	Yes	Yes	Yes (can be arced or angled)	Yes
Containers														
Permeable	**Hesco Bastion Concertina**	2m	3m	Yes	0.6 - 2.2m	0.3 - 2.1m	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Permeable	**Harbeck Big Bag**	0.75m	2.25m	Yes	0.75m	0.9m	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Permeable	**Sandbags**	0.1m	1.5m (suggested maximum height of a sandbag wall)	Yes	0.1m	3.0m (for 1.0m high sandbag wall)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Impermeable	**Aqua-Levee**	0.5m (for a 0.68m high barrier)	1.0m (for a 1.37m high barrier)	Yes	0.68m	0.81 - 1.68m	No	Yes	Yes	Yes	Yes	Yes	Yes (designed for 7° curve angle but can be engineered for tighter)	Yes
Impermeable	**Floodstop**	0.5 & 0.9m	N/A	No	0.5 - 0.9m	0.5 - 0.75m	No	Yes	Yes	Yes	Yes	Yes	Yes (90° corner units and 4° bend between 1m units)	Yes
Impermeable	**MRP**	0.75m	1.5m (can stack to 6m but not tested under flood conditions)	Yes	0.75m	0.5m	No	Yes	Yes	No	Yes	Yes	Yes (only 90° corners though)	Yes
Freestanding Barriers														
Flexible	**Alteau barrier**	0.96m (80% of design height)	N/A	No	0.5 - 1.2m	2.4m (for 0.7m barrier)	No	Yes	Yes	Yes	Yes	Yes	Yes (90° corner elements available and can be used in slight arcs)	Yes
Flexible	**Rapidam**	1.5m	N/A	No	1.5m	1.27 - 3.90m	No	Yes	Yes	Yes	Yes	Yes	Yes (can accommodate small curves and 90°/45° corner elements are available also)	Yes
Flexible	**Watergate**	2m	N/A	No	0.15 - 2.0m	2.7 - 3.8m	No	Yes	Yes	No	Yes	Yes	Yes (can adapt to corners and concave/convex angles)	Yes
Rigid	**Aquafence**	1.8m	N/A	No	0.75 - 1.8m	0.75 - 1.8m	No	Yes	Yes	No	Yes	Yes	Yes (standard elements can accommodate 5° curves, and corner elements are available for 30°, 60° and 90° angles)	Yes
Rigid	**NOAQ Boxwall**	0.5m	N/A	No	0.5m	0.68m	No	No	Yes	No	Yes	Yes	Yes (can accommodate convex and concave curves with radii of 12m)	Yes
Rigid	**Yewstop 'A' Block**	0.6m	2.4m	Yes	0.6m	0.6m	No	Yes	Yes	No	Yes	Yes	Yes (90° corners only)	Yes
Frame Barrier														
Flexible	**Portadam**	2.5m	N/A	No	1.5 - 2.5m	3.0 - 6.0m	No	Yes	Yes	Yes	Yes	Yes	Yes (can form corners and be arced)	Yes
Rigid	**Geodesign**	2.4m	N/A	Yes (can be extended if enough membrane is in place when the dam is initially installed)	0.45 - 2.4m	1.3 - 6.0m	No	Yes	Yes	Yes	Yes	Yes	Yes (corner elements are available and standard units can accommodate small changes in direction)	Yes
Rigid	**IBS K-system**	1.3m	N/A	Yes (by using additional dam beams)	1.5m	1.6m	No	Yes	Yes	No	Yes	Yes	Yes (corner elements available)	Yes
Rigid	**Mobile Flood Protection System**	1.2m	N/A	Yes	0.8 - 1.2m	0.9m	No	Yes	Yes	No	Yes	Yes	Yes (very flexible)	Yes

Operational characteristics of temporary flood protection systems

Type	Product	Approximate time and cost for installation of 100m long by 1m high barrier			Minimum resources required for installation			Storage and transportation			Site Preparation	Level of skill required for installation	Available for hire
		Time range	Cost	Training costs included	Labour	Plant	Materials	Storage area needed	Light van / 4WD	Heavy Lorry	Description	Low/Med/High	Yes/No
Tubes													
Air Filled	**Tube wall**	1 hour	£31,800	Yes	2-6 people	Compressor / electric blower and generator.	None	3m x 1m	Yes	No	Remove sharp objects and fill hollows	Medium	No
Water Filled	**Aquadam**	1.5 hours	Not supplied	No	4 people (30m of 1.2m high)	2 portable pumps and flexible fill hoses	Water supply	4.25m x 0.5m roll (30m of 1.2m high)	Yes	No	Remove sharp objects and fill hollows	Medium	No
Water Filled	**Tiger Dams**	1.5 hours	£29,000	No	2 people	1 pump and generator	Water supply	0.5m x 0.5m area required per roll	Yes	No	Remove sharp objects and fill hollows	Medium	Yes
Containers													
Permeable	**Hesco Bastion Concertina**	3.5 hours	£4,000	Yes	2 people	Aggregate filler	Sand/gravel	Stored on pallets of dimensions 1m x 1m x 1.8m to 1.3m x 1.4m x 1.8m holding 70m to 140m of containers	No	Yes	None	Low	No
Permeable	**Harbeck Big Bag**	1.5 hours	£3,600 for 0.75m height, £10,800 for 1.5m height	No	4 people	Aggregate filler	Sand/gravel	6 units on 1 palette 1.2m x 1m x 1.1m	Yes	Yes (for infill transport)	None	Low	No
Permeable	**Samdbags**	?	SG Baker Bags (Not filled unless stated, price approx): 1m height Hessian Bags - £21,000 1m height Woven Polypropylene Bags - £10,100 1m height UV Stabilised Woven Polypropylene Bags £13,200 1m height Filled Woven Polypropylene Bags - £54,600 1m height Hessian Sandless Bags - £115,600 Aqua-Sac 1m height - £112,000 FloodSax 1m height – £145,600	No	2 people (would take a long time)	None	Sand (for unfilled bags) Water (for self inflating bags)	Dependent on wheter fill is stored on site (sand) if so considerable area required. If not then bags alone are very compact.	Yes	Yes (for transport of large qualtities of sand)	None	Medium	No
Impermeable	**Aqua-Levee**	30 manhours	£100,260 for 91.2m long and 1.2m height	No	3 people	Water pumps	Water supply	0.06m^3 per unit	Yes	No	None	Medium	Yes
Impermeable	**Floodstop**	2 hours for 0.5m height	£15,000 for 0.5m barrier £35,000 for 0.9m barrier	No	1 person	None	None	10 units on 1.3m x 1.5m x 1m palette	Yes	No	None	Medium	Yes
Impermeable	**MRP**	4 hours for 0.75m height, 8 hours for 1.5m height	£40,000 for 0.75m high	Yes	2-4 people	2 water feed pipes	Water supply (sand can be used)	1m x 0.5m x 0.75m per unit	Yes	Yes (if using sand)	None	Medium	Yes
Freestanding Barriers													
Flexible	**Alteau barrier**	less than 1 hour	£20,000 for 0.7m height, £35,000 for 1.2m height	Yes	2 people	None	None	0.15m^2 (per unit)	Yes	No	Remove sharp objects and fill hollows	Medium	Yes
Flexible	**Rapidam**	45 minutes	Rapidam barrier, ground bolts/ ground anchors: £35,000 fully-installed	No	3-4 people	2 electric drills	None	2m x 3m x 2m (150m on a self contained handling system)	Yes	Yes (if long defence length)	Remove sharp objects and fill hollows	Medium	No
Flexible	**Watergate**	12 minutes	Price for 100 m long x 1 m high – excluding resources would be approximately £18,750	No	1 person (2 preferable)	Small pick-up truck required for larger barriers	None	0.71m high Water-Gate™ of 30.4m length will pack down to a 0. 62m diameter roll of 0.65m in height	Yes	No	Remove sharp objects and fill hollows	Medium	Yes
Rigid	**Aquafence**	1 hour	£47,000	Yes	6-8 people	Electric drills will speed installation on site.	None	2.1m x 1.2m x 0.15m (per unit), specially designed pallets for 7 units are 1.27m x 2.15m x 1.10m (high)	Yes	Yes (if larger volume is required)	Remove large objects and fill hollows	Medium	Yes
Rigid	**NOAQ Boxwall**	30 minutes for 0.5m height (which is the maximum)	£21,500	Yes	1 person	None	None	0.708m x 0.68m per unit. It is stackable also, and 26 units (16m of defence) will fit on a standard EUR pallet of dimensions 1.2m x 0.8m x 0.95m	Yes	No	Remove large objects and fill hollows	Low	No
Rigid	**Yewstop 'A' Block**	less than 8 hours	£14,500 for 1.2m height	No	3 people (1 plant driver and 2 operatives)	HGV / Telehandler / Block Grab	None	Dependent on unit size. Height and width are 0.6m, length varies from 0.6m to 1.8m	No	Yes	Remove large objects and fill hollows	Medium	Yes
Frame Barrier													
Flexible	**Portadam**	2 days	Installed by Portadam specialists and quoted on a site by site basis	Yes	2-3 people	None	None	A 10m length of the system requires a storage are of 2.4m x 2.4m to a height of 1.6m	Yes	No	None	High	Yes
Rigid	**Geodesign**	1-2 hours for 1.25m height	£29,800 to £52,300 for 1.25m height (dependent upon material, storage, delivery)	No	8 people (can be constructed by 1 over longer period)	Possibly forklift for movement of crates	None	For a 1.25m dam height, a 41m length of complete barrier is stored in three crates. The first crate with 33 supports (1.9m x 1.2m x 1.1m), the second crate with 66 aluminium sheets, 1,2m x 1,0m x 0,8m and the third crate with additional components (1,2m x 1.0m x 0.7m).	No	Yes	Remove sharp objects that may damage membrane	Medium	Yes
Rigid	**IBS K-system**	2 hours	There is no universal cost, as each scheme needs to be assessed on its own merits and is dependent on fluctuations in the cost of raw materials and currency exchange rates.	Yes (full commission of system and training of operatives included)	2 people	Light plant for deployment	None	1.31m x 0.84m	No	Yes	None	Medium	Yes
Rigid	**Mobile Flood Protection System**	30 minutes	The standard system with a protection height of 0.8m costs around £12,000 for 100m of defence; this can be extended to a 1.2m defence height for an additional £8000.	Yes	4 people	None	None	1.2m x 0.8m x 0.12m (per unit)	Yes	No	Remove sharp objects and fill hollows	Medium	No

Structural characteristics of temporary flood protection systems

Type	Product	Potential failure methods (extreme conditions)				Bearing pressure on bedding structure	Occurrence of seepage	Seepage greater than 40 l/m/h (on level ground)	Barrier resistance to damage			Repair during service	Likelihood of progressive system failure	Resistance to wind	BSI Kite mark	Manufacturers Warranty
									Low/Med/High							
		Sliding	Excessive seepage	Bearing capacity failure	Overturning and collapse	Low/Med/ High	Yes/No	Yes/No	Tear or puncture	Impact	Vandalism	Yes/No	Low/Med/ High	Low/Med/ High	Yes/No	Yes/No
Tubes																
Air filled	**Tube wall**	No	No	No	Yes	Medium	Yes	Yes	Medium (if not fixed, puncture will reduce air pressure and lead to collapse)	Medium (sharp debris could puncture tube on impact)	Medium (could be cut by sharp object)	Yes (for small punctures)	Medium (dependent on size of tear)	Medium	No	Yes (10 years, subject to correct storage)
Water filled	**Aquadam**	Yes	Yes	Yes	Yes	High	Yes	No	Medium (if punctured, product will deflate. Small punctures can be repaired)	Medium (sharp debris could puncture tube on impact)	Medium (could be cut by sharp object)	Yes (for small punctures)	Medium (dependent on size of tear)	High	No	No
	Tiger Dams	Yes	Yes	Yes	Yes	High	Yes	No	Medium (if punctured, product will deflate. Small punctures can be repaired)	Medium (sharp debris could puncture tube on impact)	Medium (could be cut by sharp object)	Yes (for small punctures)	Medium (dependent on size of tear)	High	No	Yes (5 Years)
Containers																
Permeable	**Hesco Bastion Concertina**	Yes	Yes	No	Yes	High	Yes	No	High	High	High	Yes	Med	High	No	Yes (1 year)
	Harbeck Big Bag	Yes	Yes	No	Yes	High	Yes	No	High	High	High	Yes	Med	High	No	No
	Sandbags	Yes	Yes	No	Yes	High	Yes	No	Medium	High	High	Yes	Med	High	No	No
Impermeable	**Aqua-Levee**	Yes	No	Yes	No	Med - High	Yes	No	Medium (can be repaired using standard industry practices)	High (hard shell protects against debris impacts)	Medium (intentional punctures to single units will not cause entire wall to fail and units can be replaced/reinforced in situ)	Yes	Low	High	No	Yes (5 years)
	Floodstop	Yes	Yes	Yes	No	Med - High	Yes	No	Medium (if foam gasket is damaged seepage will increase, however, can be replaced in the field)	Medium	Low	Yes	Low	High	No	Yes (1 year)
	MRP	No	Yes	Yes	Yes	Med - High	Yes	No	Medium (small holes could be repaired by plugging)	Medium (large impacts could cause cracks and require replacement of blocks)	High	Yes	Low	High	No	Yes (1 year warranty against defects)
Freestanding Barriers																
Flexible	**Alteau barrier**	Yes	Yes	No	No	Low	Yes	No	Medium	Medium	Low	No	Low	Medium (barrier is flat to the ground until there is a head of water)	No	No
	Rapidam	Yes	Yes	No	No	Low	Yes	No	Medium (tears will not result in major failure)	Medium	Low (proper usage would include security in public locations)	Yes	Low	Low	No	Yes (1 year standard, but extendable at extra cost to include maintenance programme)
	Watergate	Yes	Yes	No	No	Low	Yes	No	Medium	Medium	Low	No	Low	Medium (barrier is flat to the ground until there is a head of water)	No	Yes (for manufacturing defects)
Rigid	**Aquafence**	Yes	Yes	No	Yes	Low	Yes	No	High (no impact on system stability)	Medium - High	High (most parts that could be removed are under water and canvas is easily repaired)	Yes	Medium (only after damage)	High	No	Yes (1 year standard EU warranty)
	NOAQ Boxwall	Yes	No	No	No	Low	Yes	Yes	High	Medium	Medium	No	Low	Medium (may require ballast in high winds)	No	Yes (10 years, subject to correct storage)
	Yewstop 'A' Block	No	No	Yes	No	High	Yes	Yes	High	High	High	Yes	Low	High (each block weighs 1.2 tons)	No	No
Frame Barrier																
Flexible	**Portadam**	No	Yes	Yes	Yes	Low	Yes	No	Medium (can be damaged by heavy debris strikes which could tear fabric)	Medium (can be damaged by heavy debris strikes which could tear fabric of A bend frames)	Medium (damage can be repaired in situ)	Yes	Medium	Medium (until flooded, structure is vulnerable to high winds and sheeting up should be delayed as long as possible)	No	No
Rigid	**Geodesign**	Yes	Yes	Yes	No	Medium	Yes	No	Medium (membrane can be damaged but metal structure will limit water flow until repairs are made)	High - Medium (debris can puncture membrane)	Medium (possible threat, however, system needs surveillance to monitor pumps which lowers the risk, and the structure is hard to damage)	Yes	Low	High (system is weighed down by chain units)	Yes	Yes (2 years)
	IBS K-system	Yes	Yes	Yes	No	Medium	Yes	No	High	High	High	Yes	Low	High	Yes	Yes (5 years for metal parts and rubber seals)
	Mobile Flood Protection System	Yes	Yes	Yes	No	Medium	Yes	No	Medium - Low	Medium	Medium - Low	Yes	Medium	Medium	No	Yes (1 year)

Physical characteristics of demountable flood protection systems

Type	Product	Maximum head of water		Increase height during service	Product Dimensions		Adaptability to terrain and bedding conditions						Products adaptability to bends and corners	Product use as enclosure
		Unstacked	Stacked	Yes/No	Height Range	Width at base	Wall Extension	Soil / Grass	Concrete/ Tarmac	Sloping surface	2.5m wide bank	4.0m wide bank	Yes/No	Yes/No
Freestanding Barrier (Part Preinstalled)														
Flexible	**Rapidam**	1.5m	N/A	No	1.5m	0.83 - 2.60m	No	Yes	Yes	Yes	Yes	Yes	Yes (can accommodate small curves and 90°/45° corner elements are available also)	Yes
Rigid	**Aquabarrier**	1.5m	N/A	No	1.5m	2.2m	No	No	Yes	No	Yes	Yes	Yes (1-2° change in direction between units and corners accommodated through engineered concrete columns)	Yes
Rigid	**Aquafence**	1.8m	N/A	No	0.75 - 1.8m	0.75 - 1.8m	No	Yes	Yes	No	Yes	Yes	Yes (standard elements can accommodate 5° curves and corner elements are available for 30°, 60° and 90° angles)	Yes
Frame Barrier (Part Preinstalled)														
FrameBarrier	**Alcan Aluminium Dam Log System**	0.3m	5.0m	Yes	0.15 - 5.0m (possibly higher)	Varies depending on barrier height	Yes	Yes (soil only)	Yes	No[1]	Yes	Yes	Yes	Yes
FrameBarrier	**Caro Waterwall**	0.2m	1.2m	Yes	0.2 - 1.2m	0.3m	Yes	No	Yes	No[1]	Yes	Yes	Yes (highly adaptable)	Yes
FrameBarrier	**Coplastix Stoplogs**	0.4m	2.0m (larger sizes can be manufactured)	Yes	0.3 - 2.0m	Varies depending on barrier height	Yes	No	Yes	No[1]	Yes	Yes	Yes	Yes
FrameBarrier	**DPS 2000 Hochwasserschutz**	0.2m	5.0m	Yes	0.2 - 5.0m	0.27 - 0.9m	Yes	Yes	Yes	No[1]	Yes	Yes	Yes (standard units can accommodate 16° curves and corner supports are available for larger changes in direction)	Yes
FrameBarrier	**Flood Ark**	0.2m	1.0m	Yes	0.2 -1.0m	0.1m	Yes	No	Yes	No[1]	Yes	Yes	Yes	Yes
FrameBarrier	**IBS Mobile Wall Flood Protection System**	0.15	5.0m	Yes	0.15 - 5.0m	0.3 - 1.32m Possibly larger depending on barrier height	Yes	Yes (soil only)	Yes	No[1]	Yes	Yes	Yes (corner posts can be specially designed for individual projects to incorporate corners and arcs)	Yes
FrameBarrier	**L-Series Modular Demountable Flood Barrier**	0.3m	4.2m	Yes	0.3 - 4.2m	0.18 - 1.4m	Yes	No	Yes	No[1]	Yes	Yes	Yes (can be fabricated to accommodate virtually any configuration)	Yes
Sectional Barrier (Fully Preinstalled)														
Manual	**Dutchdam**	1.0m and 1.5m for the wall/quay and ground versions respectively	N/A	Yes - Bold & Cento No - Duplo	0.385m - 2.25m	0.4 - 1.0m	No	Yes	Yes	Yes	Yes	Yes	Yes (custom parts can be provided to allow this)	Yes
Manual	**Tilt/Spring Dam**	2.1m 'standard' (can be greater for special cases)	N/A	No	2.0m + 0.1m freeboard	2.5m (max)	No	Yes	Yes	No	Yes	Yes	Yes (can be designed to curves of radii 15m. Tilt dam can only run in straight lines with pillar features or short walls at direction changes)	Yes
Automatic	**SCFB Self Closing Flood Barrier**	2.5m	N/A	No	0.5m - 2.5m	0.6 - 1.1m	No	Yes	Yes	Yes	Yes	Yes	Yes (units can be coupled in arcs)	Yes
Flood Gates (Fully Preinstalled)														
Automatic or Manual	**Hinged Flood Gate**	1.5m	N/A	No	1.5m	0.08m	No	Yes (soil only, with concrete cill)	Yes	No	Yes	Yes	No	No
Automatic or Manual	**Hydraulic Flip-up Barrier**	2.4m (theoretically >4.0m is possible)	N/A	No	up to 2.4m	Varies depending on barrier height	No	No	Yes	Yes	Yes	Yes	Yes (multiple barriers can form arcs or angles)	Yes
Automatic or Manual	**Pivot Barrier**	0.6m	N/A	No	0.1m - 0.6m	Varies depending on barrier height	No	No	Yes	No	No	No	Yes (two barriers can be linked by a removable post to form corners)	No

[1] Small slopes and gradients may be possible

Operational characteristics of demountable flood protection systems

Type	Product	Approximate time and cost for installation of 100m long by 1m high barrier			Minimum resources required for deployment			Storage and transportation			Site Preparation	Level of skill required for installation	Available for hire
		Time range	Cost	Training costs included	Labour	Plant	Materials	Storage area needed	Light van / 4WD	Heavy Lorry	Description	Low/Medium/High	Yes/No
Freestanding Barrier (Part Preinstalled)													
Flexible	**Rapidam**	45 minutes	£60,000	No	3-4 people	Yes (2 electric drills)	None	2m x 3m x 2m (150m on a self contained handling system)	Yes	Yes (for 1-2km of defence)	Threaded sleeves are set into and left in the ground for the bolt-down barrier version	Medium	No
Rigid	**Aquabarrier**	5 hours	£1,000,000	Yes (two day training programme included)	4 people	Yes (hand tools)	None	2.2m x 1.75m (2 units)	No	Yes (for transport to site)	Ground works to provide for the use of lock down bolts and plates with the barriers	Low	No
Rigid	**Aquafence**	1 hour	£47,000	Yes	6-8 people	Yes (electric drills will hasten installation on site)	None	2.1m x 1.2m x 0.15m (per unit) 7 Units per pallet 1.27m x 2.15m x 1.10m	Yes	Yes (if larger volume required)	Pre-fabricated concrete elements with fastening rails	Medium	Yes
Frame Barrier (Part Preinstalled)													
FrameBarrier	**Alcan Aluminium Dam Log System**	1-2 hours	£12,500 - £21,000 inc. all seals (excluding vertical supports), (Log prices dependant on section lengths, but as example in 6.0m, actual prices at time of enquiry as subject to LME prices and f/x rates)	No	2 people	None	None	3 different sizes of 'Dam Logs'	Yes[1]	No	Support slots if necessary need to be preinstalled on site	Medium	No
FrameBarrier	**Caro Waterwall**	2 hours	Installation of a 3m x 1m barrier would be a "budget" price of £1,200 plus VAT. Pro-rata cost approx £40,000 per 100 m	No	1 person	None	None	2m x 0.2m x 0.25m	Yes[1]	No	Concrete or steel ground beam foundation required.	Medium	Yes
FrameBarrier	**Coplastix Stoplogs**	Unknown	As all systems are designed and manufactured to specific design requirements there is no universal cost for this system. Enquiries of cost for this system should be directed towards the manufacturers.	No	Not Supplied	Yes (Higher barriers require lifting equipment)	None	Not Supplied, depends on size of stop logs	Yes[1]	No	Needs pre-installation of support frame	Medium	No
FrameBarrier	**DPS 2000 Hochwasserschutz**	2 hours	£50,000	No	4 people	None	None	Stored on pallets 1.5m x 0.87m x 0.75m	Yes[1]	No	Ground connections with anchor plates	Medium	No
FrameBarrier	**Flood Ark**	Not Supplied	A 1m high system that spans 0.9m with the frame recessed into the ground and a removable, aluminium cover plate would be approximately £1200 Pro-rata cost approx £120,000 per 100 m	Yes	1 person	None	None	0.2m x 0.03m (per board unit)	Yes[1]	No	Pre-installation of supports required.	Medium	No
FrameBarrier	**IBS Mobile Wall Flood Protection System**	Not specifically supplied, but 3-4 hours estimated from video	A straight installation to a height of 1.05m would cost around £90,175 (ex vat). This includes all beam and post seals, fixtures, fittings and accessories, full design and design drawings, general risk assessment, generic method statement, site visits, training, delivery to site, storage system for posts and beams.	Yes (for first and possibly second installation)	Dependent on size of scheme	Yes (taller systems require lifting equipment)	None	Stored on specially designed pallets that are dependent on size of posts and beams	Yes[1]	Yes	Anchor plates in permanent ground beam	Medium	Yes
FrameBarrier	**L-Series Modular Demountable Flood Barrier**	4 hours (1 person) or 45 minutes (4 people)	£550 - £700 per metre depending on complexity (arcs, corners, angles gradients etc) Pro-rata cost approx £55,000 to £70,000 per 100 m	Yes	1-4 people	Yes (taller systems require lifting equipment)	None	Storage dimensions for a unit – 2 uprights and max 14 boards, assume 3m long beams. Storage unit will be approx 1m x 0.6m x 3m (HxWxL)	Yes[1]	Yes (if remote storage)	Fixed to a suitable existing concrete foundation or slab using chemically fixed anchors	Medium	No
Sectional Barrier (Fully Preinstalled)													
Manual	**Dutchdam**	3-4 hours	£60,000 for wall/quay version excluding works	No	2 people	None	None	None[2]	No	No	Preinstalled	Low	No
Manual	**Tilt/Spring Dam**	2 hours	£190,000 for 100m x 1m	Yes (each system has a specific operation, maintenance and inspection manual, which is explained to the operatives)	2 people	None	None	None[2]	No	No	Preinstalled	Low	No
Automatic	**SCFB Self Closing Flood Barrier**	30 seconds to a few minutes depending on flood characteristics	£260,000 for 1.0m height	Minimal training is only needed for a very small number of staff	N/A	N/A	N/A	None[2]	No	No	Preinstalled	N/A	No
Flood Gates (Fully Preinstalled)													
Automatic or Manual	**Hinged Flood Gate**	3 minutes	Supplier installation of a dual gate of maximum width 8m x 1m high = £21,000	Yes	1 person	None	None	None[2]	No	No	Preinstalled	Low	No
Automatic or Manual	**Hydraulic Flip-up Barrier**	2 minutes	Supplier installation of a single barrier of maximum width 12m x 1m high = £50,000	Yes	1 person	None	None	None[2]	No	No	Preinstalled	Low	No
Automatic or Manual	**Pivot Barrier**	15 seconds	For the standard unit which is 5m long x 0.6m high the automatic system costs £17,000 and the manual system costs £5,500	Yes	1 person	None	None	None[2]	No	No	Preinstalled	Low	No

[1] A light van or 4WD vehicle is only required if the storage of the defence is not local to site

[2] The defence remains in situ once installed

Structural characteristics of demountable flood protection systems

Type	Product	Potential failure methods (extreme conditions)				Bearing pressure on bedding structure	Occurrence of seepage	Seepage greater than 40 l/m/h	Barrier resistance to damage			Repair during service	Likelihood of progressive system failure	Resistance to wind	BSI Kite mark	Manufacturers Warranty
									Low/Med/High							
		Sliding	Excessive seepage	Bearing capacity failure	Overturning and collapse	Low/Med/High	Yes/No	Yes/No	Tear or puncture	Impact	Vandalism	Yes/No	Low/Med/ High	Low/Med/ High	Yes/No	Yes/No
Freestanding Barrier (Part Preinstalled)																
Flexible	**Rapidam**	No	No	No	No	Low	Yes	No	Medium	Medium	Low	Yes	Low	High	Yes	Yes (1 year, but extendable at extra cost to include maintenance programme)
Rigid	**Aquabarrier**	No	No	Yes	No	High	Yes	No	High	High	Medium	No	Low	High	No	Yes (10 years subject to proper usage)
Rigid	**Aquafence**	No	Yes	No	Yes	Low	Yes	No	High.	Medium - High	High	Yes	Medium	High	No	Yes (1 year standard EU warranty)
Frame Barrier (Part Preinstalled)																
FrameBarrier	**Alcan Aluminium Dam Log System**	No	No	Yes[1]	No	Medium	Yes	Yes	High	High	High (except seals and fixings)	Yes	Low	High	No	No
FrameBarrier	**Caro Waterwall**	No	No	Yes[1]	No	Medium	Yes	No	High	High	High (except seals and fixings)	Yes	Low	High	No	Yes (12 year warranty on all materials)
FrameBarrier	**Coplastix Stoplogs**	No	Yes	Yes[1]	No	Medium	Yes	No	High	High	High (except seals and fixings)	Yes	Low	High	No	No
FrameBarrier	**DPS 2000 Hochwasserschutz**	No	No	Yes[1]	No	Medium	Yes	No	High	High	High (except seals and fixings)	Yes	Low	High	No	No
FrameBarrier	**Flood Ark**	No	No	Yes[1]	No	Medium	Yes	No	High	High	High (except seals and fixings)	Yes	Low	High	Yes (PAS 1188-1:2003)	Yes (product failure insurance)
FrameBarrier	**IBS Mobile Wall Flood Protection System**	No	No	Yes[1]	No	Medium	No	No	High	High	High (except seals and fixings)	Yes	Low	High	No	No
FrameBarrier	**L-Series Modular Demountable Flood Barrier**	No	No	Yes[1]	No	Medium	Yes	No	High	High	High (except seals and fixings)	Yes	Low	High	No	Yes (2 years)
Sectional Barrier (Fully Preinstalled)																
Manual	**Dutchdam**	No	No	Yes	No	Medium	Yes	No	High	High	High	Yes	Low	High	No	Yes
Manual	**Tilt/Spring Dam**	No	No	No	No	Medium	Yes	No	High	High	High	No	Low	High	No	Yes (12 years product liability insurance)
Automatic	**SCFB Self Closing Flood Barrier**	No	No	No	No	Medium	Yes	No	High	High	High	No	Low	High	No	Yes (against installation, fabrication and leakage >0.1l/mtr/min)
Flood Gates (Fully Preinstalled)																
Automatic or Manual	**Hinged Flood Gate**	No	No	Yes	No	High	Yes	No	High	High	High	No	Low	High	No	Yes (2 years)
Automatic or Manual	**Hydraulic Flip-up Barrier**	No	No	Yes	No	High	Yes	No	High	High	High	No	Low	High	No	Yes (2 years)
Automatic or Manual	**Pivot Barrier**	No	No	Yes	No	High	Yes	No	High	High	High	No	Low	High	No	Yes (2 years)

[1] Dependant on foundation design and construction

TUBES – AIR FILLED

NOAQ-TW (TUBEWALL)

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1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

NOAQ – TW Tubewall

NOAQ Flood Protection AB (Manufacturer)
Forssa Industrial Estate, 820 64 Nasviken, Sweden
Tel: (+46) 650 30140
Fax: (+46) 650 30530
info@noaq.com
www.noaq.com
Contact: Mr Sigurd Melin

Clan Tools and Plant Ltd. (UK Supplier)
3 Greenhill Avenue, Giffnock, Glasgow, G46 6QX, Scotland
Tel: 0141 638 8040
Fax: 0141 638 8881
clantools@btconnect.com
www.clantools.com
Contact: Mr John Bell

1.1 Product availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☐

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Temporary (totally removable after use).

2.2 General description

The system is comprised of inflatable plastic tubes that interconnect to create a temporary barrier, a “Tube Wall”. Each tube has a skirt fused to the waterside face. As the floodwater rises, the increasing water pressure forces the skirt against the ground, securely anchoring the tube.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

Standard length is 10 metres, but other (customized) lengths are available to order. Minimum length of unit is 5 metres.

3.2 Maximum number of coupled units
No limitation.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
TW50 – 0.5m
TW75 – 0.75 m
TW100 – 1.0m

3.5 Maximum installable height
TW50 – 0.5m
TW75 – 0.75 m
TW100 – 1.0m

3.6 Design for or behaviour around curves/arcs/corners
Units may be connected to form 90° bends in either direction.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two per tube section (joining it with the preceding section and next one).

3.8 Number of horizontal joints/sealings (per unit / unit height)
One per tube (the skirt making a seal with the ground surface).

3.9 Width of structure at base (installed state)
TW50 - 1.8 m
TW75 - 2.4 m
TW100 - 3.2 m

3.10 Required storage area per unit (packed dimension)
TW50 - 1.6m x 0.5m
TW75 – 2.3m x 0.7m
TW100 – 3.0m x 1.0m

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☐	Rolling	☐	Sliding	☐	Collapse	☒
Breach	☒	Overturning	☐	Seepage	☐		

4.2 Maximum design head of water
TW50 – 0.5m
TW75 – 0.75 m
TW100 – 1.0m

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre).

4.4 Damage/Tear/Puncture. How does the product behave after damage?
If not addressed, an air leak will eventually lead to the collapse and breach of the barrier due to the air pressure being too low. The easiest way to avoid this risk is to connect the Tubewall to the pressure guard belonging to the system. The Pressure Guard is offered separately, but is recommended.

4.5 Does the product progressively worsen following damage/tear/puncture?
Yes, if unattended the performance of the barrier will progressively worsen (refer to above).

4.6 Can the defence height of the product be increased during service?
No.

4.7 Resistance to damage

(a) Wind
In strong winds the tube section may need to be secured by placing ballast on the skirt.

(b) Waves
As the system isn't rigid waves will cause minor movement of the barrier.

(c) Inertia forces
No information

(d) Overtopping (including maximum depth without failure if known)
Overtopping is allowed. As the anchoring ability of the skirt increases with the water depth the safety margins against sliding are unaffected.

(e) Floating debris
Small floating debris carried by the current parallel to the barrier will not cause damage to the Tubewall. Larger debris drifting perpendicular to the barrier could cause puncture of the Tubewall.

(f) Water pressure
Shown to withstand water pressure to full barrier height by theoretical calculations, practical tests and practise.

4.8 Repair during service conditions
Yes.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
1 hour.

5.2 Method of installation (including site preparation)
Manual, with air pumps/blowers included to inflate the tubes.

5.3 Likelihood of incorrect installation
The design is very simple, so there are not many ways to deploy it incorrectly. Once the tube section is placed in its intended location, inflate it and connect it with previous sections using ordinary zips. The supplied air pumps/blowers, and the special compressor-mounted pressure guard prevent over inflation of the tubes.

5.4 Storage requirements
The Tubewall should be stored in a dry location out of direct sunlight.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
Stackable plywood crates in customized sizes are offered.

5.6 Transportation requirements (including mobilisation)
No specific requirements. By truck, by car (on a trailer), by wheelbarrow or carried manually.

5.7 Access requirements
No specific requirements. If the site can be accessed by foot, then barrier sections can be carried there manually.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☒

2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other *(see below)*	☒

Uncovered gravel, sand or soil should be avoided. Soil may clog the drainage layer, and sand and gravel may become eroded by water seeping through it. On narrow banktops, the skirt may very well continue down the slope. The tubewall adapts easily to sloping ground, regardless of if the slope is parallel or perpendicular to the tube. If the inclination is steep enough that the tubes want to roll away, they must be secured by placing some ballast onto the skirt.

5.9 Provision of fixings / Susceptibility to damage or vandalism

The Tubewall could be punctured with a sharp object.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other *(see below)*	☒

Along roadsides, to keep roads open or to avoid cross-running currents.
On very weak soils (like saturated earthen embankments) because of its small ground pressure.

6. FINANCIAL ASPECTS

6.1 Installation resource requirements

The weight per unit may vary depending on the length and height of the barriers being used *(see Section 7.8)*, for lighter units (below 50 kg) two persons are needed for deployment. For heavier units (above 50 kg) four to six persons are needed. For inflating the tubes a compressor or a blower is needed. If an electric blower is used, accessibility to electricity is also needed (from the mains or from a generator).

6.2 Installation costs (100 m long x 1 m high – excluding resources)

10 - NOAQ Tubewall TW50 x 10m £24,700
10 - NOAQ Tubewall TW75 x 10m £26,200
10 - NOAQ Tubewall TW100 x 10m £31,800

6.3 Additional installation and removal costs (training/supervision)

We can provide familiarisation training free of charge on delivery of equipment.

6.4 Maintenance requirements

Product must be cleaned and dried after use, then stored in a dry area protected from direct sunlight.

6.5 Ease of cleaning (often use in muddy conditions)

May be washed clean with a water hose.

6.6 Reuse of the products

Yes

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
The product's functionality after ten years is guaranteed under the condition that the tubes are stored dry, away from direct sunlight, within a temperature range of -30°C to +40°C, and used according to the user instructions.

6.8 Deterioration with time
If cleaned after use and stored in accordance to manufacturers specification, the product will not deteriorate significantly over time.

7. OTHERS

7.1 Product trial or test information
The NOAQ Tubewall and its components have been thoroughly tested, both in field tests and by independent test laboratories, such as Vattenfall Research Laboratory, and SP, the Swedish National Testing and Research Institute.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003)?
No.

7.3 Performance under service conditions/ In use
The NOAQ Tubewall has performed well in tests and during real flood events.

7.4 New products or modifications under development.
Yes, the NOAQ Boxwall.
(A Fact Sheet for this product is included within the category 'Freestanding Barriers')

7.5 Environmental qualities
The Tubewall's main advantage is the speed at which it may be deployed, therefore giving the opportunity of saving the environment from the impact of the flooding.

7.6 Environmental Impact
The Tubewall has a very small impact on the environment. The barrier is air filled and therefore there is nothing to dispose of after the flood event. The Tubewall is fully removed after use and, because of its low ground pressure, it leaves no permanent damage to the deployed location.

7.7 Details of clients or locations where product is in service
The NOAQ Tubewall has been purchased and is in service in Austria, Germany, Italy, Netherlands, Poland, Denmark and Sweden.

7.8 Additional comments
The weight of the Tubewall is 3.5 kg (TW50), 5.0 kg (TW75) and 7.0 kg (TW100), per running metre. Weight per unit depends on length of section, and can vary.

TUBES – WATER FILLED

AQUADAM®

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Aquadam

Water Structures (Manufacturer)
35 Church Lane / PO Box 206, Carlotta, California, 95528
Tel: (+1) 800 682 9283 (Freephone US Only)
(+1) 707 768 3439
Fax: (+1) 707 768 2116
waterstructures@gotsky.com
www.waterstructures.com
Contact: David Doolaege

Albion Water Structures Ltd (UK supplier)
Pipehouse Warf, Morfa Road, Swansea, SA1 1TD
Tel: 01792 655968
Fax: 01792 644461
sales@albionwater.eu
www.albionwater.eu

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☐

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Temporary (totally removable after use).

2.2 General description

Aquadam is a flexible water filled barrier/dam/coffer structure comprising of an outer heavy duty geo-textile woven tube surrounding two watertight inner polyethylene tubes. These two inner tubes are separated by an anti-roll skirt/baffle with a triple seam sewn connecting top to bottom. It is available up to a height of 4.0 m, which can be used to hold back up to 3.0 m of water. Units can be coupled together using a connection collar to make any continuous length.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section
30.4m long units.

3.2 Maximum number of coupled units
Unlimited.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s)
0.3m, 0.46m, 0.61m, 0.76m, 0.9m and 1.2m

3.5 Maximum installable height
For flood defence – 1.2m dam which holds back up to 0.9m water depth.

3.6 Design for or behaviour around curves/arcs/corners
Can be laid in an arc and curves around obstacles, with no general limitations on radial size.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two joints per 30.4m length (joining to the preceding and next tubes, via water tight connection collars or attachment collars).

3.8 Number of horizontal joints/sealings (per unit / unit height)
One joint per tube (making a seal with the ground surface).

3.9 Width of structure at base (installed state)
Dependent upon the height of dam, width is approximately twice the height.

3.10 Required storage area per unit (packed dimension)
A 1.2m high and 30.4m long dam is stored as a 4.25m x 0.5m roll.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☒	Sliding	☒	Collapse	☒
Breach	☒	Overturning	☒	Seepage	☒		

4.2 Maximum design head of water
Is ¾ the inflated height e.g. the 1.2m high dam is suitable for 0.9m water depth.

4.3 Behaviour subject to seepage and water tightness
Some seepage along the bottom of the Aquadam, dependent on ground surface.

4.4 Damage/Tear/Puncture. How does the product behave after damage?
The product will deflate. If not repaired, then collapse and a breach of the defence may occur.

4.5 Does the product progressively worsen following damage/tear/puncture?
Depends on the size of the Aquadam and the size of the tear. Small tears (<~5cm) in the 1m high model will not tear further as there iss not enough internal pressure. Tears >~5cm are likely to worsen due to the volume of water causing the tube to tear further, although this is unlikely with the 0.9m model and below.

4.6 Can the defence height of the product be increased during service?
No.

4.7 Resistance to damage

(a) Wind
Water filled dam will resist wind.

(b) Waves

Will resist wave motion. Maximum depth plus wave action could cause the AquaDam to slide diminishing the overall retention capacity or water depth against the AquaDam..

(c) Inertia forces
When full, Aquadam can overcome slopes plus water pressure being exerted on one side of the AquaDam

(d) Overtopping (including maximum depth without failure if known)
No overtopping can occur except wave splash The AquaDam will not remain stable if the water depth being controlled exceeds the recommended height

(e) Floating debris
The geotextile outer casing is heavy duty but could be punctured by sharp floating debris.

(f) Water pressure
Will resist water pressure to maximum specified height for the dam.

4.8 Repair during service conditions
Small punctures can be repaired using patch tape, long 'knife type' slices cannot.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
Approx 1.5 hours if two 7.5cm pumps are used

5.2 Method of installation (including site preparation)
The ground surface where the barrier is to be deployed should be prepared by removing any sharp debris or filling any large ground depressions. Gravel must be cleared if used on top of embankments.

5.3 Likelihood of incorrect installation
Product installation is relatively straightforward, however, it requires the filling points to be elevated over inflated dam height and both inside tubes to be filled simultaneously.

5.4 Storage requirements
Store away from naked flames, sharp protrusions and out of direct sunlight. Can be stored stacked outside. Units store in temperatures as low as minus 60 degrees.

5.5 Are storage solutions supplied with/available for the product
No

5.6 Transportation requirements (including mobilisation)
Product can be moved by labourers, 4 wheel drive vehicle, tractor, car, van or flatbed truck to and around site.

5.7 Access requirements
Can be used in locations with restricted access.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☐
2.5m Wide Banktop	☒ (Aquadam type needs to be smaller than the 1 metre high model)
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☒ (almost anything that is water tight)

5.9 Provision of fixings / Susceptibility to damage or vandalism
The Aquadam could be punctured with a sharp object.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒how much is this?
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
Installing the 1.2m x 30.4m dam would require two people and two 7cm portable pumps with flexible fill hoses plus water. Time requirements are less than 1 hour. . A 300 ft. long AquaDam unit would fill in approximately 2 hours.

6.2 Installation costs (100 m long x 1 m high – excluding resources)
No information

6.3 Additional installation and removal costs (training/supervision)
Minor training, minimal cost.

6.4 Maintenance requirements
Product must be emptied, rerolled by using re-rolling brackets, cheater bars, and ratchets and stored properly after each use. Punctures repaired if necessary. The inner tubes can be replaced if required.

6.5 Ease of cleaning (often used in muddy conditions)
The product can be 'hosed down' after use. Alternatively, it can be inflated with an air blower with the dirt then drying and falling off.

6.6 Reuse of the products
AquaDams are reusable and if stored out of sunlight can be used multiple times over decades.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
New units are guaranteed against defect. This does not mean common carrier freight damage, installation failures, over filling, washouts due too much water depth, or vandalism. Minor seepage (pinholes) is not considered a defect.

6.8 Deterioration with time
The product will deteriorate slowly over time (10 years). The outer casing is UV treated for prolong usage.

7. OTHERS

7.1 Product trial or test information
See www.waterstructures.com

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003)?
No.

7.3 Performance under service conditions/ In use
The Aqudam product has been used successfully for over 20 years in civil engineering projects in both the USA and UK. These have included: canal, lake and river dewatering; Tidal Flood

Protection; dam topping; and slipway replacements. It is currently used by both home owners and US government agencies for flood defence response.

7.4 New products or modifications under development.
Presently offer many sizes.

7.5 Environmental qualities
Dam constructed from non polluting synthetic materials.

7.6 Environmental Impact
Low environmental impact as dam is filled with rising floodwater which can be released after use. In addition, the dam is fully removed after use, leaves no permanent damage to the deployment site, and can be reused.

7.7 Details of clients or locations where product is in service
In use for civil engineering purposes in UK, USA, Canada, Australia and is used by Army Corps of Engineers for flood defence along with USB of Reclamation. In Manitova Province Canada 5 miles of baffled AquaDams were deployed in the Red River Flood of 2009.

7.8 Additional comments
AquaDams are only part of a flood fighting plan. The recommended pumps are 3 inch (7-8cm) Honda volume discharge pumps, rated at 15,000 gallons per hour and weighing 58 pounds (26.3 kilos). Pumps are an essential part of the AquaDam project and are supplied separately.

TUBES – WATER FILLED

TIGER DAMS

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1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Tiger Dams

US Flood Control Corp. (Manufacturer)
402 N. Division Street, Carson City, Nevada 89703, USA
Tel: 1 866 852 1118 (US Only)
info@usfloodcontrol.com
www.usfloodcontrol.com

International Flood Control (UK) Ltd (UK Suppliers)
103 Studdridge Street, London, SW6 3TD
Mob: 0750 099 9561
andy.ritchie@northcliffemedia.co.uk
www.usfloodcontrol.com
Contact: Mr Andrew Ritchie

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☒	Supplier Assembly ?	☐

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Temporary (totally removable after use).

2.2 General description

The patented Tiger Dam flood system is a heavy duty water filled flood protection tube, made of heavy vinyl coated polyester. They are designed to be configured together in a wide variety of shapes and sizes, using a triangular stacking design. Each tube can be deployed and filled rapidly by two operatives. They are designed to be reusable for up to 17 years (if properly stored). After the flood, the equipment is simply drained, cleaned, rolled up and stored for future use. This product is designed to replace sandbags at a much cheaper cost.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

15.2m long units.

3.2 Maximum number of coupled units

Unlimited length.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
0.48m.

3.5 Maximum installable height
The 0.48m high tubes can be stacked to increase the height of the dam. Maximum installable height is restricted by the available surface width at the base of the structure. Manufacturers quote that the tubes can be stacked 'up to 9.75m'.

3.6 Design for or behaviour around curves/arcs/corners
When deployed the dam can be bent into arcs or constructed to form angles by overlapping the ends of the tubes.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two seals per tube. Each tube either butts up or overlaps or is staggered against another tube (or a hard defence) at either end forming a type of vertical seal.

3.8 Number of horizontal joints/sealings (per unit / unit height)
One seal per tube if on the ground surface, but if the product is stacked there are 2 seals as each tube will have a seal with the tube below and behind it.

3.9 Width of structure at base (installed state)
Dependent upon the height of dam, width is approximately twice the height.

3.10 Required storage area per unit (packed dimension)
15.2m long dam = 0.5m x 0.5m rolled.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☒	Sliding	☒	Collapse	☒
Breach	☒	Overturning	☒	Seepage	☒		

4.2 Maximum design head of water
No information

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre).

4.4 Damage/Tear/Puncture. How does the product behave after damage?
The product material is very tough but could be punctured. If punctured and not repaired the dam will deflate, leading to possible collapse and breach of the defence.

4.5 Does the product progressively worsen following damage/tear/puncture?
Small tears are repairable, larger tears are likely to worsen due to the volume of water causing the tube to tear further.

4.6 Can the defence height of the product be increased during service?
Yes, the product is designed to be modular and may be stacked higher during service conditions. The additional strapping needed to secure additional units must be in place before the onset of flooding to allow the system height to be increased and secured safely.

4.7 Resistance to damage

(a) Wind
Water filled Tiger Dam weighs approx 3 tonnes when filled with water.

(b) Waves
Water filled Tiger Dam is stable when subjected to wave action.

(c) Inertia forces
Triangular stacking provides additional stability.

(d) Overtopping (including maximum depth without failure if known)
Overtopping is a likely mode of failure, however, product may be stacked to increase height during service conditions to prevent it.

(e) Floating debris
The product is made of heavy duty material but could be punctured by fast moving sharp floating debris.

(f) Water pressure
Burst tests have been undertaken and demonstrated a maximum internal pressure of 17 p.s.i. The tube typically operates at 2 p.s.i.

4.8 Repair during service conditions
Small punctures can be temporarily repaired using duct tape or permanently repaired using an adhesive patch.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
Approx 1.5 hours, but can be further reduced with efficient team operation.

5.2 Method of installation (including site preparation)
Manual installation, requiring pumping of water and some transportation to site. The ground surface where the barrier is to be deployed should be prepared by removing any sharp debris or filling any large ground depressions.

5.3 Likelihood of incorrect installation
Research and development was conducted at the University of British Columbia Ocean Engineering test centre (the Oceanic Institute). The product is very simple to deploy.

5.4 Storage requirements
Each empty tube weighs 27kg and requires an area of 0.5m x 0.5m. The storage area should be covered, dry and out of the direct sunlight.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
Fully equipped standard emergency response trailers are available for purchase and include 60 individual tubes and all associated equipment.

5.6 Transportation requirements (including mobilisation)
No special requirements, each tube weighs 27kg and can be handled by two operatives.

5.7 Access requirements
Can be used in locations with restricted access.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism
The tiger dam could be punctured with a sharp object

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other *(see below)*	☒

This product can also be used for protection of buildings, roads and rail lines.

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
You do not need heavy equipment, two operatives with a pump and generator (if no power) with hoses and connections can deploy this equipment very rapidly. Each tube is 15.2m long and 0.48m high, so for 100m length you would need 7 tubes. To reach a height of 1m (0.96m) you would need to stack the tubes 2 high which requires 2 tubes width at the bottom (14 tubes) and one strapped on top (total tubes 21) each tube takes 2 minutes to fill (so with two operatives between an hour to an hour and a half)

6.2 Installation costs (100 m long x 1 m high – excluding resources)
Based on above, (21 tubes, 63 straps, pump and generator (if needed), 2 fill adapters, 1 chock, 2 quick hose connections, two hoses) Approximately £29,202.

6.3 Additional installation and removal costs (training/supervision)
Training can be arranged on request. Cost of training is not included within the product cost.

6.4 Maintenance requirements
The tubes must be emptied after use, washed, dried, rolled and stored correctly. If major repairs are required, they should be sent back to the authorised dealer.

6.5 Ease of cleaning (often use in muddy conditions)
The product should be cleaned by a water hose after use.

6.6 Reuse of the products
Yes.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
Yes, 5 year warranty.

6.8 Deterioration with time
If regularly used, maintained and stored in accordance with manufacturers specification the tubes will not significantly deteriorate over time, with the manufacturers quoting a shelf life of 17 years.

7. OTHERS

7.1 Product trial or test information
The product has been tested by the Oceanic Institute, Canada. Underwriters Laboratory certification Test, December 2002.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No.

7.3 Performance under service conditions/ In use

The product has been used in many flood situations in North America, most recently by the province of Manitoba Canada in March 2009. The product was a huge success and more products have since been ordered.

7.4 New products or modifications under development.

Always learning from use in the field.

7.5 Environmental qualities

Compared to sandbags and other systems requiring fill aggregates which need to be disposed of after a flood event, the Tiger Dams are environmentally friendly as there is only water to release after use.

7.6 Environmental Impact

Tiger dams are completely removable after a flood event and leave no permanent damage to the deployment site.

7.7 Details of clients or locations where product is in service

Mr Garry Doer- Premiere of Manitobia, Canada, many more can be provided on request.

7.8 Additional comments

This product is a very strong and flexible product that is not likely to puncture and has been used successfully in many situations. The diameter of the fully inflated tubes are 0.48m but, with the triangular stacking method required for increasing the height of the dam, a height of 0.45m per unit should be used.

CONTAINERS – PERMEABLE

HESCO BASTION CONCERTAINER

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

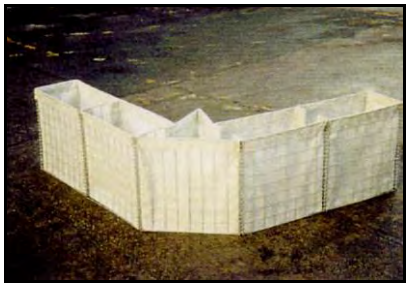
Hesco Bastion Concertainer

Hesco Bastion Ltd
Unit 41 Knowsthorpe Way, Cross Green Industrial Estate, Leeds, LS9 0SW
Tel: 0113 2486633
Mob: 07802 221888
k.hardy@hescobastion.com
www.hesco.com
www.hescobastion.com
Contact: Mr Kevin Hardy

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT



2.1 Type

Temporary (totally removable after use)

2.2 General description

The Concertainer defence barrier is a temporary barrier system and therefore there are no permanent fixings. The Concertainer comprises of a series of Galfan coated welded mesh panels connected vertically with wire coil spirals to form a series of fully collapsible multi-cellular units. These are lined with a non-woven 200g/m² robust re-usable liner geotextile available in sand or green. Units are joined quickly and easily with vertical steel pins. The units are then filled either manually, using a JCB or by a cement wagon, with sand or a sand/gravel mix.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

1.2m, 3m, 6m and 10m.

3.2 Maximum number of coupled units

Unlimited.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
0.6m, 1m, 1.4m and 2.2m.

3.5 Maximum installable height
3.0m when stacked.

3.6 Design for or behaviour around curves/arcs/corners
Units can be curved or joined at forty-five degrees or right angles. They are very flexible and strong.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two per unit section (joining it with the preceding and next units).

3.8 Number of horizontal joints/sealings (per unit / unit height)
One per unit (making a seal with the ground surface)

3.9 Width of structure at base (installed state)
0.3m, 0.6m, 1m and 2.1m (depending on single unit size).

3.10 Required storage area per unit (packed dimension)
The Concertainers can be stored on pallets. A pallet will contain between 70m to 140m of Concertainer units. Dependent on unit size, packed dimensions are 1.0m (l) x 1.0m (w) x 1.8m (h) to 1.3m (l) x 1.4m (w) x 1.8m (h).

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☒	Collapse	☒
Breach	☐	Overturning	☒	Seepage	☒		

4.2 Maximum design head of water
Tested up to 3.0m depth (stacked pyramid style).

4.3 Behaviour subject to seepage and water tightness
Minimal seepage will occur from the onset of water; this is expected to progressively worsen over time as the soil gets saturated. Pumping should only be required to keep the landward side dry in extreme conditions.

4.4 Damage/Tear/Puncture. How does the product behave after damage?
Damaged walls and structures are simple to repair by either removing or replacing damaged panels or by overlaying with new panels or by fitting of repair patches. All of the materials required for repairs can be taken from the storage location or taken from alternate units. Repair kits are available. These contain unit side panels, geotextile, coils, joining pins and a multi-tool. Once damage has been repaired the Concertainer units will again be as capable of meeting the requirements of the Performance Specifications as those that have not suffered any damage.

4.5 Does the product progressively worsen following damage/tear/puncture?
Due to the continuous construction of the Concertainer, Hesco Bastion believes that the Concertainer should not breach or progressively worsen during service conditions.

4.6 Can the defence height of the product be increased during service?
Additional units can be placed and filled, behind and on top of existing units to increase the width and height of the defence.

4.7 Resistance to damage
Resistant to waves and floating debris. Concertainers are made from heavy duty components and when filled are strong and resilient to impact.

4.8 Repair during service conditions
The system may be repaired during service conditions.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)

3 hours and 20 mins for a team of two people and a mechanical filling machine.

5.2 Method of installation (including site preparation)

Little or no site preparation is needed. Units can be erected and filled entirely by hand, without the use of any plant or mechanical handling equipment. Manpower is required to place and join units, and also to spread and compact the fill. Earthmoving equipment is ideal for placing the fill material in a fast and efficient manner. Compaction of the fill does not require any mechanical means, as compaction of the fill by foot is sufficient. All Concertainer units are freestanding, self supporting and stable during filling. An empty unit is collapsible and capable of being stored until required.

5.3 Likelihood of incorrect installation

The system is simple to construct. Hesco Bastion provides installation guides and will also provide training.

5.4 Storage requirements

The Concertainer units when stored on pallets in their original packaging can be stored in the open air for up to 12 months. The Concertainer units on the pallets will not deteriorate unless subjected to prolonged extreme weather condidtions. If stored under cover it will have an estimated storage life of no less than 10 years. No part of the Concertainer units will be degraded beyond use by storage or while dry. All parts of the system are resistant to the deteriorating effects of rot, fungus, mildew and corrosion. The components will remain fully functional when the Concertainer unit is stored under extreme high or low temperatures. If units are removed from their packaging, then they should be stored dry and in such a way that they are protected from direct sunlight.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.

Concertainer units are normally supplied on standard pallets. The complete package is wrapped in a weather-proof covering. .

5.6 Transportation requirements (including mobilisation)

Vehicle access will be needed for the larger units to be transported to site or for infill soil if not present on site.

5.7 Access requirements

Vehicle access to the site will be needed for deployment of larger units and for placement of infill.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☒
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☐

The units are capable of placement on all manner of terrain which is structurally able to support the resulting filled structure, whatever the nature of the chosen fill. Where sudden changes of level are encountered the Concertainer unit can be modified to suit the level changes.

5.9 Provision of fixings / Susceptibility to damage or vandalism

Vandalism has no serious effect on the Concertainer.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements

Construction of the Concertainer is done manually. Mechanical filling plant can be used to fill the Concertainer, which obviously reduces the time for deployment. In the construction of Concertainer unit structures the only specialist personnel required are plant operators if earthmoving equipment is used. The Concertainer units are designed to be filled with whatever locally obtained materials are available. For best performance, the Concertainer units should be filled with sand or crushed rock, or other suitable fills. Vehicles are needed to transport the unfilled units to site. Vehicle containing aggregate required for the filling of the containers. A team of 2 / 3 persons is required for the deployment

6.2 Installation costs (100 m long x 1 m high – excluding resources)

Dependent on the size of Concertainer used and excluding the cost of infill: typically £3896.00 for the units only.

6.3 Additional installation and removal costs (training/supervision)

Cost of infill and transportation to site. There is no cost for training.

6.4 Maintenance requirements

The units need to be hosed down after use before returning to storage.

6.5 Ease of cleaning (often use in muddy conditions)

Units can be hosed down to clean debris/mud.

6.6 Reuse of the products

The system is reusable.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)

The product is covered by a 1 year Manufacturers Warranty, subject to use and storage according to manufacturers specifications. Units can be reused subject to damage during use.

6.8 Deterioration with time

The Concertainer units have a minimum field life of two years without planned maintenance. In practice it has been found that the Concertainer units will generally not require planned maintenance for at least 3 to 5 years. The service life can be extended considerably beyond this by planned and routine maintenance. Life expectancy of the barriers may be increased by the application of UV CAM ™ to the geotextile. The application of UV CAM provides a protective layer for the geotextile and therefore prevents the geotextile from being weakened by sunlight. Another popular method is to apply cement slurry to the Concertainer unit. This is coated onto the Concertainer units and again provides a protective layer. By coating structures with UV CAM or cement slurry and by replacing or repairing damaged panels it is possible to extend the lives of structures for as long as they may reasonably be required. Periodic maintenance can increase the life of Concertainer units for as long as they are needed.

7. OTHERS

7.1 Product trial or test information

Successful trials have been carried out by the Environment Agency in 1998 on the River Ouse and at Lea Marston. In a comparative test, a wall of 10m long x 1m high x 1m wide was constructed using sandbags. This took a team of ten men seven hours to construct using approximately 1500 sandbags. The same wall using a Concertainer was constructed by two men in 20 mins. The Concertainer units were lined with a waterproof membrane and seepage was considerably less than the wall constructed of sandbags.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?

No.

7.3 Performance under service conditions/ In use

The Hesco Bastion Concertainer has been proven to perform well under service conditions. It has been used successfully at a number of locations during the Summer Flooding of 2007, where it was used for incident response. *(see Section 7.7)*

7.4 New products or modifications under development.

No

7.5 Environmental qualities

Environmental aspects are very good. Most units are fully reclaimable for re-use. Permanent units can be faced with stone or timber. Environmental impact is low. All units can be removed and/or reclaimed. Infill can be removed either manually or mechanically.

7.6 Environmental Impact

Little environmental impact as Concertainers are completely removed after the flood event leaving no permanent damage to the deployment site. Polluted or contaminated infill must be disposed of correctly.

7.7 Details of clients or locations where product is in service

Flood Barrier Projects undertaken by Hesco Bastion for the following organisations:

- Environment Agency – East Coast Railway Line, Doncaster
- Severn Trent Water Ltd – Mythe Water Treatment Plant
- National Grid UK – Walham Power Station, Gloucester
- Central Networks – Castle Meads Power Station, Gloucester
- Severn Trent Water Ltd - Ogston Reservoir - Derby
- Sheffield City Council - Kelham Museum - Sheffield
- Barhale Construction – Derby Projects
- Samtec NW – Chapeltown Sheffield Project
- Laing O'Rourke – Wakefield Waterfront Project
- Emergency Flood Barrier – New Orleans, USA
- Hurricane Protection Levee Closure – St. Bernard, USA
- Hurricane Flood Protection - Conoco Phillips – Belle Chase, USA
- Levee Breech Repair - Industrial Canal Levee – New Orleans, USA

In 2007, HESCO Bastion Ltd was approached to provide immediate defence from flooding by the emergency planners and utility companies to protect:

Walham Switching and Power Station, Gloucester – July 2007

HESCO Bastion was called in to assist the Royal Air Force and the Army with the installation of the Concertainer unit at the National Grid Facility at Walham. The barrier was approximately 800m long and was securely positioned in just 19 hours.

Castle Meads Sub Station, Gloucester – July 2007
Following flooding of the sub-station, HESCO Bastion conducted a site survey after the water levels had subsided and provided approximately 300 metres of Concertainer units to provide a longer term flood defence system against future flooding.

Mythe Water Treatment Plant – July 2007
HESCO Bastion provided emergency flood protection for the Mythe Water Treatment Plant. The units were ordered and delivered within 3hrs 30mins. Working with the Army and local companies, over 1000m of flood defence barriers greater than 1m high were erected around the perimeter in just 27 hours.

7.8 Additional comments
None

CONTAINERS – PERMEABLE

HARBECK BIG BAG

1. **PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS**

Harbeck Big Bag

Big Bag Harbeck GmBH
Industriestrasse 11, D-84364, Bad Birnbach, Germany
Tel: (+49) 8563 91404
Fax: (+49) 8563 2290
info@big-bag-harbeck.de
www.big-bag-harbeck.de
www.mobiler-hochwasserschutz.org
Contact: Rudolf Harbeck

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☒

2. **DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT**

2.1 Type

Temporary (totally removable after use).

2.2 General description

Mobile flood protection-system constructed using big sand filled bags. The bags are made from specially coated woven polypropylene-fabric and wooden frames. Each system unit is 0.9m wide, 0.9m high and 4.5 m long. The units are factory assembled and packed on palettes ready for use. Each palette holds 6 systems (27m defence line). Every unit has a wooden frame located in the first and last bag allowing the next unit to be positioned and fixed into place using four screws. The system has no limit to the length and can also follow curves and corners. The systems are stackable in form of a pyramid, up to 2.4m high. The waterside of the units are specially coated to prevent seepage of polluted water, oil or chemicals into the sand. This allows for the sand to be reused, without cleaning. Each bag unit has lifting hoops which allows them to be removed by lifting equipment and loaded onto a flat loader truck. The filling medium can be emptied and reused and the empty bags can be recycled. The system can be constructed in a short period of time and is not labour intensive. In practise, construction was 25 times quicker compared to standard sand-bags and only required 4 operatives. The Harbeck Big Bag system also costs less 50% less than normal sandbags.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section
4.5m.

3.2 Maximum number of coupled units
Unlimited.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
0.75m.

3.5 Maximum installable height
When stacked the maximum is 3 rows high = 2.25m.

3.6 Design for or behaviour around curves/arcs/corners
Curves and corners are possible.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two per unit section (joining it with the preceding and next units).

3.8 Number of horizontal joints/sealings (per unit / unit height)
One per unit (making a seal with the ground surface).

3.9 Width of structure at base (installed state)
0.9m.

3.10 Required storage area per unit (packed dimension)
6 units at one palette with 1.2m x 1m x 1.1m (It is possible to stack up to 4 palettes).

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☒	Collapse	☒
Breach	☐	Overturning	☒	Seepage	☒		

4.2 Maximum design head of water
Each unit = 0.75m, maximum stacked height is 2.25m.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre).

4.4 Damage/Tear/Puncture. How does the product behave after damage?
The product can withstand small punctures and tears. Large holes or tears can result in loss of infill and possible breach of the defence.

4.5 Does the product progressively worsen following damage/tear/puncture?
If not repaired infill material may be lost resulting in a weakness f the defence.

4.6 Can the defence height of the product be increased during service?
Yes, stacking in the form of a pyramid is possible to raise defence height during service.

4.7 Resistance to damage

(a) Wind
Withstands high winds.

(b) Waves
Secure against wave action.

(c) Inertia forces
Can withstand inertia forces.

(d) Overtopping (including maximum depth without failure if known)
Units are available with closable tops that can be secured after filling to prevent the fill material from being washed out.

(e) Floating debris
The loops of the bags should be bound to prevent being debris from being snagged. Large floating debris may puncture the material.

(f) Water pressure
Slight seepage but resistant to water pressure.

4.8 Repair during service conditions
Yes. A plastic film can be positioned in the bag and new sand placed in.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
4 people can deploy and fill the system in 1hr 30 mins using a truck to transport the sand to the site.

5.2 Method of installation (including site preparation)
Manual. Site requires minimal preparation. Ground surface should have any hollows filled to ensure a good seal is maintained below the units.

5.3 Likelihood of incorrect installation
The system is simple to install so likelihood of incorrect installation is low.

5.4 Storage requirements
System needs to be stored dry and away from direct sunlight.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
No storage solutions are provided.

5.6 Transportation requirements (including mobilisation)
Transportation of the units to site requires the use of vans or flat-back lorries. Earth moving vehicles are required for efficient filling of the units. The units can be pre-filled and moved into position by lifting equipment using the straps attached to the bags.

5.7 Access requirements
Access to the site is required by vehicles to ensure rapid filling of the system with sand.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☒
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism
The bags can be damaged with a sharp object.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒

Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
4 men/women, sand, electric screwdriver and screws.

6.2 Installation costs (100 m long x 1 m high – excluding resources)
Up to 0.75m = £3,875 (€4300)
Up to 1.5m = £11,625 (€12,900)
Up to 2.25m = £23,245 (€25,800)

6.3 Additional installation and removal costs (training/supervision)
Cost of infill and transportation to site. There is no cost for training.

6.4 Maintenance requirements
No maintenance requirements.

6.5 Ease of cleaning (often use in muddy conditions)
System is designed for single use.

6.6 Reuse of the products
No.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
No.

6.8 Deterioration with time
The pp-fabric is UV-resistant for 100 sunny days. The storage location should be protected against sunlight and wet conditions.

7. OTHERS

7.1 Product trial or test information
Expertise for standing safety, SWL Test, Safety factor 5:1.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No.

7.3 Performance under service conditions/ In use
System has been successfully used in mainland Europe in flood events.

7.4 New products or modifications under development.
Yes. (details not given)

7.5 Environmental qualities
No ground preparation required and product does not alter the environment.

7.6 Environmental Impact
Little environmental impact. The bags are completely removed following the flood event and the infill disposed of or reused, leaving no permanent damage to the deployment site. Polluted or contaminated infill must be disposed of correctly.

7.7 Details of clients or locations where product is in service

Germany: Dresden, Abensberg, Obersdorf, Chamerau, Immenstadt, Kempten, Mühldorf, Manching, Roßlau and more.
Austria: Linz, Kufstein, Gampern, Schwaz, Tulln and more.
Italy: Alessandria, Cuneo
Netherlands: Lelystad

7.8 Additional comments

More information on web site: www.mobiler-hochwasserschutz.org

CONTAINERS – PERMEABLE
SANDBAGS

1. **PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS**

Traditional Hessian and woven polypropylene sandbags
Various Suppliers

Self-inflating Sandbags
Quick Sandbags™
S.G Baker Ltd
Old Wharf Road
Grantham
Lincolnshire
NG31 7AA
0800 612 9637
+44 (0)1476 565501
sales@sgbaker.co.uk
http://www.sgbaker.co.uk/sandbags
http://www.sandbagsuppliers.co.uk/
http://www.quicksandbags.co.uk/index.php

Aqua-Sac self inflating bag
A E T
PO BOX 4706
SHEFFIELD
S17 9BU
Tel: +44 (0)114 2621706
Fax: +44 (0) 114 2621706
info@a-et.co.uk
http://www.aqua-sac.com/

Floodsax
FloodSax Customer Service
Protocol Communications Management
Link 665 Business Centre
A56 Rossendale
Lancashire
BB4 5HU
0800 953 40 40
floods@protocol.uk.com
http://www.floodsax.co.uk/

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☒	Supplier Assembly ?	☐

CONTAINERS – PERMEABLE
SANDBAGS

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Temporary (totally removable after use).

2.2 General description

Under the general title of sandbags there are several variations that are included in this fact sheet. The most basic product is the traditional hessian bag that is widely available from hardware stores and are usually filled with sharp sand. Both unfilled and filled bags are available on the market and can be built up to produce substantial walls. These bags are biodegradable and once used will rot and decompose. More recently woven polypropylene bags have been developed that are more resilient than the hessian bags. These are not biodegradable and will last longer submerged in water, however exposure to sunlight will cause these bags to degrade. To overcome this there are now bags that include a UV stabiliser which increases their resistance to sunlight.

Finally self inflating flood bags have been developed that 'inflate' when submerged in water. These bags are filled with absorbent materials that absorb water and then are used similar to standard sandbags. This has the advantage that they do not have to be filled with sand prior to use and are far easier to transport to site.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

SG Baker Hessian, Woven Polypropylene and UV Stabilised Polypropylene Bags: 0.76m
Aqua-Sac Self inflating bag: 0.54m
SG Baker Quick Sandbags™: 0.61m
Floodsax: 0.48m

3.2 Maximum number of coupled units

No limit.

3.3 Product height range

Fixed	☐	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)

Aqua-Sac Self inflating bag: 0.1m
SG Baker Quick Sandbags™: 0.1m

Floodsax: 0.1m

3.5 Maximum installable height
Unsure, depends upon stability of sandbag wall constructed. 1.5m high sandbag walls suggested by North Dakota State University guidance.

3.6 Design for or behaviour around curves/arcs/corners
Walls of sandbags can be built to accommodate curves, arcs and corners.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two per individual bag (joining it with the sandbags at either end).

3.8 Number of horizontal joints/sealings (per unit / unit height)
Two per unit (making a seal with the ground surface and the sandbag above).

3.9 Width of structure at base (installed state)
Varies depending upon height of the sandbag wall. For stability they should be three times as wide as they are tall, therefore a 1m high wall would be 3m wide. (EA 2009 use of sandbags guidance). North Dakota State University guidance suggests that width twice as much as height is required.

3.10 Required storage area per unit (packed dimension)
Unfilled sandbags alone require very small storage area, for pre-filled bags the storage areas required are much greater.
Aqua-Sac Self inflating bag; 100 can be stored on a single standard pallet.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☒	Collapse	☒
Breach	☒	Overturning	☐	Seepage	☒		

4.2 Maximum design head of water
Dependent upon space for construction of a stable sandbag wall, the main controlling factor is the maximum width of the structure that is possible.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre).

4.4 Damage/Tear/Puncture. How does the product behave after damage?
Small rips to the front of a sandbag wall are unlikely to lead to failure of the structure. If numerous bags are damaged this could compromise the structure leading to localised collapse and failure.

4.5 Does the product progressively worsen following damage/tear/puncture?
Yes, bags that are damaged will loose their fill contents weakening the overall sandbag wall.

4.6 Can the defence height of the product be increased during service?
Yes, add more sandbags to back face, increasing the overall height. This requires there to be additional space behind the wall.

4.7 Resistance to damage

(a) Wind
Wind unlikely to affect stability of a sandbag wall.

(b) Waves
Not known.

(c) Inertia forces
A well built sandbag pyramid wall is unlikely to move through sliding once constructed.

(d) Overtopping (including maximum depth without failure if known)
Can be overtopped without total collapse; however this may remove the bags at the top of the wall reducing the height of the barrier.

(e) Floating debris

Floating debris may cause tears to the bags on the front of the barrier and allowing sand to be washed out from the individual bags affecting the stability of the overall structure. Damage from larger impacts may punch holes in the barrier leading to its failure.

(f) Water pressure
The design of the barrier uses water pressure to seal the barrier to the ground surface. The water pressure also helps maintain its stability when in use.

4.8 Repair during service conditions
Wall may be repaired to some extent by replacing damaged sandbags or placing additional sandbags on the rear of the defence. Unlikely to be able to repair any damage to water facing side.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
EA 2009 estimates that it takes an hour to fill 12 standard sandbags; therefore installation is time consuming and requires large numbers of people to construct significant lengths. Time is reduced is sand bags are pre filled with material or specialised filling equipment.

The self inflating bags take between 3 and 5 minutes to 'inflate' once submerged in water. Then it is dependent upon resources available to construct the barrier.

5.2 Method of installation (including site preparation)
Manual.

5.3 Likelihood of incorrect installation
In building a sandbag wall the success of the installation depends upon how well the sandbags are placed to obtain the best possible seal between the bags and that they are not over filled, which also would compromise the seal. Stacjking sandbags without due car may lead to unstable and ineffective barriers that may leak excessively and be ineffective.

5.4 Storage requirements
Unfilled traditional sandbags alone require small amounts of storage space, however not storing fill in same location will introduce an operational risk of inability to deliver sand to require location. The fill material requires a considerably larger storage area. Pre-filled sandbags require large storage areas to have enough sand bags to produce an effective defence. The self inflating bags have far smaller storage requirements as no fill material is required.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
No

5.6 Transportation requirements (including mobilisation)
Unfilled bags are light and can be transported in a car, the fill material or filled bags require a van or truck for transportation to site. The self inflating bags have similar requirements to unfilled sandbags, assuming that a readily useable water supply is available at the deployment site.

5.7 Access requirements
Individual sandbags can be transported by hand, but if this is required over long distances this will significantly increase the time for installation. Transporting the fill and bags to the deployment site would increase the efficiency of deployment and reduce the risk of the barrier not being constructed in time. For the self inflating bags proximity of a water supply to the location which the defence will be built is important, if bags have to be inflated away from the deployment site then access requirements increase.

5.8 Adaptability to terrain conditions (Surface type)
Any Surface ☐

Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☒
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☒
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism

Yes, the barrier could be damaged with a sharp object which could tear sandbags.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☐
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☐
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other *(see below)*	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements

2 persons needed to fill a sandbag, while one person can deploy at self-inflating bag. However to construct significant sandbag walls in acceptable timescales a large number of people are required. If the site is accessible for small plant e.g. forklift truck then this would aid deployment as all types require considerable manual lifting.

6.2 Installation costs (100 m long x 1 m high – excluding resources)

Assuming that it takes 80 sand bags to build a barrier 60cm high by 1m wide (EA Guidance), therefore around 22400 bags are would be required for a 100m length of 1m height. Note all prices based on values quoted on websites, it is likely that for this number of bags discounts will be available and the price would be lower.

SG Baker Bags (Not filled unless stated, price approx):
1m height Hessian Bags - £21,000
1m height Woven Polypropylene Bags - £10,100
1m height UV Stabilised Woven Polypropylene Bags - £13,200
1m height Filled Woven Polypropylene Bags - £54,600
1m height Hessian Sandless Bags - £115,600

Aqua-Sac
1m height - £112,000

FloodSax
1m height – £145,600 (more for smaller scale I think)

6.3 Additional installation and removal costs (training/supervision)
The used bags usually must be disposed of after removal; biodegradable bags can be disposed of in landfill sites

6.4 Maintenance requirements
For most bags it is necessary to store them in dry conditions out of direct sunlight to prevent deterioration. The majority are supplied in sealed packaging to maximise their shelf life.

6.5 Ease of cleaning (often use in muddy conditions)
For the majority of sand bags they are single use, therefore cleaning is not necessary. For those that are reused assume cleaning using water would be sufficient.

6.6 Reuse of the products
Yes some types are, biodegradable hessian sand bags are not reusable, while the polypropylene ones are.
Aqua-Sac will deflate and dry out over 6-8 weeks, and then can be re-inflated as long as they have not been contaminated. FloodSax are biodegradable and therefore can't be reused

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
No.

6.8 Deterioration with time
Yes, basic sandbags are biodegradable and will rot over time, especially if wet. Woven polypropylene bags are more resilient but will still degrade overtime due to exposure to sunlight, they are not biodegradable. UV stabilised polypropylene bags are more resilient still but over time will still degrade trough exposure to sunlight, but far slower.

No information available on life of installed Aqua-Sac, but the bag is biodegradable and therefore will gradually deteriorate over time.

FloodSax self inflating bags are biodegradable and therefore will deteriorate over time, they are effective for 3 months once installed at a site.

7. OTHERS

7.1 Product trial or test information
No information.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003)?
No.

7.3 Performance under service conditions/ In use
No definitive information

7.4 New products or modifications under development.
No.

7.5 Environmental qualities
The majority of units are single use and therefore must be disposed of after use. Hessian and some self inflating bags are biodegradable so are suitable for landfill. Disposal of the polypropylene bags is more problematic as they only decompose slowly due to sunlight (UV).

7.6 Environmental Impact
No impact on the site if the fill material is contained, however if fill leaks from the sandbags then this may cause issues by releasing sand across the flooded area and potentially into the water course.

7.7 Details of clients or locations where product is in service

Various, sandbags have been widely used for flood protection over many years however the self-inflating bags are more recent in development.

7.8 Additional comments

None.

CONTAINERS – IMPERMEABLE

AQUA-LEVEE®

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Aqua-Levee ®

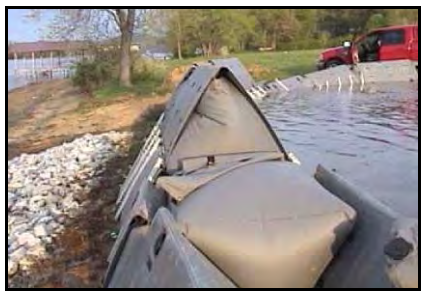
Aqua-Levee Temporary Flood Control (Manufacturer)
501 N Roane Street, Suite 202, Harriman, TN 37748
Tel: (+1) 865 882 0982
Fax: (+1) 865 882 0995
inquiry@aqua-levee.com
www.aqua-levee.com

Independent Flood Defence Products (IFDP Ltd.) (UK Supplier)
2nd Floor Offices, 16 Mere Street, Diss, IP22 4AD
Tel: 01379 644033
Fax: 01379 644073
finlay.hunter@ifdp.co.uk
enquiries@ifdp.co.uk
www.ifdp.co.uk
Contact: Finlay Hunter

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☒	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT



2.1 Type

Temporary (totally removable after use)

2.2 General description

Aqua Levee is a modular water-filled artificial barrier that requires no heavy machinery to place, no specialist tools to construct and causes no disturbance to the environment during preparation, installation and removal. The Aqua Levee System configured in a two-tier construction has retained water to a depth of approximately 1.15m. In addition, soil anchors are designed to secure the wall further in the event of overtopping.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

1.9m

3.2 Maximum number of coupled units
Unlimited linearly. Vertically, a 2-tier “stacked height” is constructed as 2 standard rows in parallel, one inverted row at the base elevation, and 1 standard row installed on top of inverted row.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
0.68m.

3.5 Maximum installable height
Current maximum is a 4-unit, 2-tier "stacked height" of 1.37m designed for 1.0m flood level.

3.6 Design for or behaviour around curves/arcs/corners
Designed to accommodate a 7° angle.

3.7 Number of vertical joints/sealings (per unit / unit width)
2 vertical joints, one at each end of the 1.9m unit.

3.8 Number of horizontal joints/sealings (per unit / unit height)
1 seal for a single unit (making seal with the ground surface), 2 horizontal joints if constructing 2-tier stacked system.

3.9 Width of structure at base (installed state)
For 0.68m high single units, base width = 0.81m.
For 1.37m stacked height, base width = 1.68m

3.10 Required storage area per unit (packed dimension)
Compresses to approximately 0.06 cubic metres during storage (average 0.1m depth by 1.9m length).

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☒	Collapse	☐
Breach	☐	Overturning	☐	Seepage	☐		

4.2 Maximum design head of water
1.0m.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre).

4.4 Damage/Tear/Puncture. How does the product behave after damage?
Material can be repaired using standard industry practices, or a component of standard unit can be easily replaced.

4.5 Does the product progressively worsen following damage/tear/puncture?
No, propagation of material damage does not occur.

4.6 Can the defence height of the product be increased during service?
Yes.

4.7 Resistance to damage

(a) Wind
Is not affected by wind due to ballast and hard-shell cover.

(b) Waves
Nominally impacted and, in fact, the flood wall releases wave energy due to run-up on the side of the walls on the 60 degree slope.

(c) Inertia forces
Dynamic forces tend to be absorbed and/or deflected.

(d) Overtopping (including maximum depth without failure if known)
Aqua Levee has been demonstrated in real-world situations as capable of resisting overtopping. The system has been shown to withstand 0.2m of overtopping on a spillway dam installation, with concrete expansion anchorage to the surface.

(e) Floating debris
Hard shell covers protect against debris impact punctures of ballast bladders.

(f) Water pressure
Flood wall is documented to be resistant with proper ground anchoring.

4.8 Repair during service conditions
Yes.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
Approximately 30 man hours.

5.2 Method of installation (including site preparation)
Manual installation requiring pumps (or hydrant) and hoses. Ground anchors are recommended to provide increased stability. Minimal site preparation needed.

5.3 Likelihood of incorrect installation
Simplicity of design and minimal components reduce incorrect installation.

5.4 Storage requirements
Units must be stored in cool, dry location, protected from ultraviolet light, in the upright position, and with either base or tip to the ground. Protect water bags from puncture by placing away from any sharp objects.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
Standard units are nominally 1.9m long by 0.68m high equilateral triangles when installed, but fold into a space of approximately 1.9m long x 0.81m wide x 0.1m high. Rack systems are intended for optimization of storage, transportation and handling, and can easily be manufactured on request.

5.6 Transportation requirements (including mobilisation)
Each unit is approximately 23 kg, and can be transported by hand or by vehicle.

5.7 Access requirements
No heavy equipment or machinery is required, and units can be installed anywhere there is personnel access.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☒
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other (river bed)	☒

5.9 Provision of fixings / Susceptibility to damage or vandalism
Extensive damage to flood wall can cause major leakage. In case of single unit damage such as intentional punctures, the entire defence will not fail and the damaged unit can be replaced or reinforced in situ.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other *(see below)*	☒

Product can be deployed in active flowing water to redirect flow routes.

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
4 people (filling, handling & placement). The entire Aqua-Levee System can be installed by a single person. However under actual flood conditions; a team of at least 3 individuals is optimum to permit 2 persons to carry and position the unit, and the third person to fill the unit while the other 2 persons position the next unit in line.

6.2 Installation costs (100 m long x 1 m high – excluding resources)
A 30.4m length of 1.2m height can be installed for £33,420 (app. $54,250)
Therefore 91.2m length of 1.2m height can be installed for £100,260 (app. $162,750)

6.3 Additional installation and removal costs (training/supervision)
Product cost does not include training.

6.4 Maintenance requirements
No regular maintenance is necessary if storage as per manufacturers specification is maintained.

6.5 Ease of cleaning (often use in muddy conditions)
Units are easily rinsed with water.

6.6 Reuse of the products
Yes, the system is reusable.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
Material is warranted for 5 years, however, useful life may be 20-25 years based on similar applications of component material.

6.8 Deterioration with time
Product is protected by UV inhibitors, but life expectancy is increased with correct storage in dry space and not in direct sunlight. Similar PVC membranes in geotechnical and roofing applications validate useful product lifespan.

7. OTHERS

7.1 Product trial or test information
Aqua Levee was tested at the US Army Corps of Engineers Vicksburg research facility in 2002. Based on test results, product was enhanced and has subsequently been validated through actual field deployments.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
Product has not been tested to PAS 1188-2:2003.

7.3 Performance under service conditions/ In use
The Aqua Levee has been used in service conditions for temporary flood protection and channel diversion, and has been installed in actively flowing water.

7.4 New products or modifications under development.
Upon interest in larger scale units (such as single unit height for 1m flood heights), product redesign and manufacturing will proceed.

7.5 Environmental qualities
No disturbance to the environment during preparation, installation and removal. Constructed of environmentally acceptable materials, plastic materials of the standard Aqua Levee units are recyclable.

7.6 Environmental Impact
There is minimal intrusion to the environment during deployments due to no requirement for heavy equipment and no alteration of the mounting surfaces. In addition, water used for ballast can be chemically treated within the system and be released back to the environment cleaner than when captured. Finally, primary components of Aqua Levee are recyclable.

7.7 Details of clients or locations where product is in service
US municipalities have used Aqua Levee during federally declared disasters, and have received FEMA funding for use. Government agencies have purchased and leased Aqua Levee for temporary water diversion and dewatering applications, as well as flood control. Private contractors have rented Aqua Levee for water diversion applications. Private homeowners have purchased Aqua Levee for personal property protection.

7.8 Additional comments
Case Study descriptions and photographs of a representative number of projects are available to view at www.aqua-levee.com. Website video links are being developed, and are currently available on Youtube.com
Discounting to government agencies is available, based on volume and current raw material market conditions

CONTAINERS – IMPERMEABLE

FLOODSTOP (MODULAR FLOOD BARRIER)

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

FLOODSTOP Modular Flood Barrier

Fluvial Innovations Ltd.
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info@fluvial-innovations.co.uk
www.fluvial-innovations.co.uk
Contact: Simon Phelps

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☒	Supplier Assembly ?	☐

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Temporary (totally removable after use).

2.2 General description

The FLOODSTOP product uses (recyclable) Medium Density Polyethelene, PVC/Nitrile foam gasket, concrete ballast and stainless steel eye bolts in its construction. Modular units fill with the rising flood waters. When this function is combined with the 'weighted' connection keys, the barrier becomes permanently denser than the flood waters, thus holding the water back.

Key Design Features:

- Cheaper than sandbagging
- Superior to sandbags in terms of function
- No bolting to the ground required
- Recyclable
- Repeatable
- Can be rapidly assembled by one person
- Units nest to minimise storage
- Multi-functional, also functions as a road traffic delineator barrier and reservoir
- Units when assembled, are flexible and can be laid around corners and obstructions

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section
1.0m.

3.2 Maximum number of coupled units
No limit.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
0.5m or 0.9m depending on selected system.

3.5 Maximum installable height
0.5m or 0.9m.

3.6 Design for or behaviour around curves/arcs/corners
Each unit can have a curvature of +/- 4 degrees applied at joints i.e. every 1m along the barrier assembly. 60 to 90º corners can be applied using the FLOODSTOP multi-hub unit.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two joints every 1m securing to the preceding and next units using the locking key. When securing an assembled barrier to an in-situ object (such as a wall) the FLOODSTOP Multi-Hub creates a seal using a foam gasket under pressure.

3.8 Number of horizontal joints/sealings (per unit / unit height)
Each modular unit incorporates a single foam gasket base. When the modular unit is self-filling with the rising flood water this foam base is placed under pressure – creating a seal.

3.9 Width of structure at base (installed state)
0.5m (0.5m high system) or 0.75m (0.9m high system)

3.10 Required storage area per unit (packed dimension)
10 FLOODSTOP units (i.e. 10 metres of barrier excluding universal keys) can be packed onto a single pallet with the overall dimensions - 1.3m x 1.5m x 1m. 150 FS units (150 metres) can be stored in a single 6.7m freight container. Alternatively the product can be used as a road traffic delineator barrier when not in use.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☒	Collapse	☐
Breach	☐	Overturning	☐	Seepage	☒		

4.2 Maximum design head of water
0.5m or 0.9m depending on selected system.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre)
This is dependent on the ground surface, e.g. Hard standings such as tarmac, drive ways and other road/pedestrian surfaces.

4.4 Damage/Tear/Puncture. How does the product behave after damage?
If a foam gasket is damaged the amount of leakage at that section will increase. However, gaskets can be easily replaced in field.

4.5 Does the product progressively worsen following damage/tear/puncture?
No.

4.6 Can the defence height of the product be increased during service?
No.

4.7 Resistance to damage

(a) Wind
Will not move; FLOODSTOP units are very similar to the plastic road traffic barriers currently seen on road networks in the UK. If required every 4 to 6 units in the assembly can be pre-filled, thus increasing the weight of the overall assembly when no flood waters are present.

(b) Waves
If wave action is predicted every 5 units (minimum) in the assembly must be pre-filled (rather being than self-filled by the incoming flood waters). Product may slide on excessive wave action.

(c) Inertia forces
When a unit has fully self-filled with the rising flood water, each modular unit can weigh in excess of 100kg. Once flood waters have receded the barrier can be packed away by a single person.

(d) Overtopping (including maximum depth without failure if known)
Overtopping is a likely mode of failure if flood waters exceed unit height.

(e) Floating debris
Units constructed of medium density Polyethelene. Units are heavy duty and very robust, however, damage from impact has not yet been tested.

(f) Water pressure
Only tested and used on static load & moving flow of water at 0.5m head.

4.8 Repair during service conditions
Yes.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
One person can assemble a 100m length in under 2 hours. If you increase the number of people involved, assembly time will be reduced significantly. The EA can assemble 180 metres in 90 minutes.

5.2 Method of installation (including site preparation)
Manual, no in-situ preparation is required, modular units are simply placed on the ground and connected using slide-in keys. Minimal, ground surface preparation required if at all.

5.3 Likelihood of incorrect installation
Design has been rationalised during 3 years of R&D. Easy to assemble, even in poor conditions.

5.4 Storage requirements
When stored for long periods of time, product is best stored in a dry location.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
150m length of FLOODSTOP can be stored within the volume of a 6.7m cargo container. Storage solutions (i.e. freight containers) are available for the FLOODSTOP barrier.

5.6 Transportation requirements (including mobilisation)
Dependent upon quantity requiring movement, units can be moved by car, van or lorry. Individual units can be moved by hand.

5.7 Access requirements
Dependent on the quantity, however each empty unit can be handled manually.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☐
Sloping Surface	☒
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism

Product has been designed to be robust when in field. We supply the product with anti-vandalism (removable) handles making it difficult to disband the barrier when in the field.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☐
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☐
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other *(see below)*	☒

Road networks, pathways, quaysides and any other hard-standings.

6. FINANCIAL ASPECTS

6.1 Installation resource requirements

1 person & a method for filling a handful of modular units when a length is assembled.

6.2 Installation costs (100 m long x 1 m high – excluding resources)

0.5m high system at 100 metres in length - £15,000
0.9m high system at 100 metres in length - £35,000

6.3 Additional installation and removal costs (training/supervision)

None.

6.4 Maintenance requirements

Check foam gaskets periodically.

6.5 Ease of cleaning (often use in muddy conditions)

If required, simply wash units down after use. This can be easily done with a hose.

6.6 Reuse of the products

Yes.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)

Product manufactured in accordance with ISO9001 accreditation.

6.8 Deterioration with time

MDPE units do not deteriorate significantly; foam gasket will last for 3+ years (depending on usage)

7. OTHERS

7.1 Product trial or test information

Fluvial Innovations Ltd was initially formed to carry out a 9-month feasibility study into the FLOODSTOP modular flood barrier. The study application was supported by the Environment Agency and awarded and part-funded by the Department of Trade of Industry. The study included numerous prototypes, testing and evaluation stages. Documentation can be provided on request. The technology has been successfully deployed in a number of flood scenarios.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003)?

No.

7.3 Performance under service conditions/ In use

Minimal leakage can begin to pool over time, it is recommended to use the product in conjunction with a small pump.

7.4 New products or modifications under development.

0.9m high system and the multi-hub units have been recently developed. The Multi-hub unit (which is available for both the 0.5m & 0.9m high system) allows cornering and connection to in-situ objects.

7.5 Environmental qualities

Modular units are manufactured from recyclable medium density polyethylene. The product can be supplied in varying colours - allowing the client to select if they wish it to conform or standout from its surroundings.

7.6 Environmental Impact

Little environmental impact. FLOODSTOP barriers are totally removed after use leaving no permanent damage to the deployment location.

7.7 Details of clients or locations where product is in service

Clients include:
Environment Agency (South), 180 metres for rapid protection at Sandwich Quay, Kent
Scottish Border (Melrose), traffic barrier colours for quay-side protection
Hampshire Highways, traffic barrier colours for rapid response to flood incidents
Worthing Borough Council, rapid response tool for flood incidents
Kings Lynn & West Norfolk Council
Private Households, including Worcester where it has been successfully deployed.

7.8 Additional comments

For comprehensive product details, including a product demonstration please visit our website at www.fluvial-innovations.co.uk. FLOODSTOP won The Emergency Planning Society's Most Innovative Product of 2009 Award. This accolade honours products with a real practical emergency planning application.

FLOODSTOP & Fluvial Innovations Ltd has appeared in:

- The Financial Times
- The Independent
- The Sunday Times
- The Sunday Telegraph
- BBC & ITV television broadcast
- Local news and radio

CONTAINERS – IMPERMEABLE

MRP MODULAR SHIELDING

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1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

MRP Systems Modular Shielding

MRP Systems Limited
Unit 454, Carr Place, Walton Summit Centre, Bamber Bridge, Preston, Lancashire
Tel: 01772 627153
info@mrpsystemsuk.com
Contact: Mr Malcolm L Thomson

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☒	Supplier Assembly ?	☐

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Temporary (totally removable after use).
Demountable (part permanently installed).

2.2 General description

The MRP system is a modular, hollow, polyethylene barrier system. The protective walls are constructed by manually fitting each block into place and securing them with plastic plates and bolts. Seals to the ground and in between the blocks can be added to reduce leaks. The barrier can then be filled with water and /or sand to provide the fixing weight. After use the barriers can then be disassembled and stored for reuse.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

1.0m or 5.0m.

3.2 Maximum number of coupled units

Unlimited.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)

0.75m.

3.5 Maximum installable height
6.0m (tested).

3.6 Design for or behaviour around curves/arcs/corners
Has been designed to provide left hand and right hand corners and cross pieces for multiple options.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two (one joint at each vertical upright)

3.8 Number of horizontal joints/sealings (per unit / unit height)
One joint for every unit (sealing it with either the ground surface or if stacked, the unit below.)

3.9 Width of structure at base (installed state)
0.5m, wider if supporting T-walls are required.

3.10 Required storage area per unit (packed dimension)
Standard unit 1.0m x 0.5m x 0.75m.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☒	Collapse	☐
Breach	☐	Overturning	☒	Seepage	☒		

4.2 Maximum design head of water
Final details for this information are not available; 1.5m has been suggested as the maximum height of the system under flood conditions.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre).

4.4 Damage/Tear/Puncture. How does the product behave after damage?
Minor holes can be repaired by drilling, tapping and plugging. Large heavy impacts could cause cracks which would require the individual damaged block to be replaced.

4.5 Does the product progressively worsen following damage/tear/puncture?
No.

4.6 Can the defence height of the product be increased during service?
Yes, it is possible to increase the height of the MRP system during service conditions although this may require an increase to the vertical stability of system by the addition of cruciform support walls (buttresses).

4.7 Resistance to damage

(a) Wind
Wind loading trials and calculations have been completed by BRE and we can provide walls designed to suit wind applications using the building blocks. The use of the blocks and the designs depend on the applications. We use buttresses to strengthen the walls.

(b) Waves
Using the information from the wind loading and inertia trails it is possible to infer levels of wave energies that could be resisted

(c) Inertia forces
Damage due to physical impact from objects has been tested and the blocks will absorb energies of up to 1 KJ with no damage. Minor damage occurs above this energy level which could crack the barrier and release the protective water infill. (sand filling may be more stable)

(d) Overtopping (including maximum depth without failure if known)
Product not yet tested against maximum head of water or overtopping.

(e) Floating debris
The wall is impact resistant. Although large impacts could cause damage to the units.
(f) Water pressure
No Data.

4.8 Repair during service conditions
Yes.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
0.75m high wall, 1 block 100 units and 100m long would take 2 men approx 8 hours using one hose pipe (or pump at 100 litres/min) to fill the barriers. 2 hose pipes would achieve this in half the time or complete a wall 1.5m high 100m long in the 8 hours.

5.2 Method of installation (including site preparation)
Manual, for sand filling a supply of sand can be delivered from a lorry or can be filled with water.

5.3 Likelihood of incorrect installation
Due to the block system's interlocking features, the risk of incorrect installation is low.

5.4 Storage requirements
Most users store outside or in a container. Robust weather protection is inherent in the design. Therefore product has no specific storage requirements.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
ISO Containers or Trailers could be made available to suit customer requirements

5.6 Transportation requirements (including mobilisation)
4 standard units can be transported on a pallet 1.0m x 1.1m x 1.8m high or stacked 150 units in a 13.4m container.

5.7 Access requirements
Blocks are 1.0m x 0.5m x 0.75m and weigh 33kg (empty) and are easily managed by 2 people. Access by vehicles will make deployment easier.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☐

MRP advise that the floor on which the modular shielding is to be installed must be level and flat, preferably with a smooth finish. The wall is probably best installed in a small engineered trench to stop slippage, particularly for the temporary closure and protection of access breaks in permanent flood barriers.

5.9 Provision of fixings / Susceptibility to damage or vandalism
Blocks are very robust however may be damaged by a large impact from a heavy weight or sharp object. Resistance to impact is improved if the blocks are sand filled.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
2 operatives and a water or sand supply for filling the blocks.

6.2 Installation costs (100 m long x 1 m high – excluding resources)
A simple wall 100m long 1 row, 0.75m high would cost be approx £40,000 ex VAT with all the fittings and instructions delivered to any site on the UK Mainland.

6.3 Additional installation and removal costs (training/supervision)
Assembly instructions and tools (speed drive and cap spanner) are included. Training can be provided (takes 15minutes).

6.4 Maintenance requirements
None.

6.5 Ease of cleaning (often use in muddy conditions)
Cleaning can be undertaken with a water hose.

6.6 Reuse of the products
Yes.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
There is a 12 month manufacturing warranty against defects. Not warranted in service as there is no control.

6.8 Deterioration with time
No, blocks have a usable life of at least 20 years.

7. OTHERS

7.1 Product trial or test information
Flood trials to be arranged.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No.

7.3 Performance under service conditions/ In use
Trials and in service use for other applications show the wall units to be robust, easily constructed and weather proof.

7.4 New products or modifications under development.
Seals, and flood trials are progressing using the basic building MRP blocks. Closed cell adhesive seals have been found to suit the polyethylene and are now under trial.

7.5 Environmental qualities
Although the product is currently made in black it can be manufactured in other colours to suit any environment requests.

7.6 Environmental Impact

There is no environmental Impact. Any used /failed units can be returned to MRP for recycling. The MRP units can be completely removed leaving no permanent damage to the deployment site. As the blocks are impermeable there is no risk of pollution or contamination of the infill therefore sand can be reused and water can emptied in situ.

7.7 Details of clients or locations where product is in service

No flood uses, but currently in use by Nuclear Industry at Hunterston Power Station, Sizewell B and others. Also in use by MOD, RAF and USAF, particularly at Culdrose, Devonport and in Afghanistan.

7.8 Additional comments

Due to the rigidity of the structure, the end jointing details and seepage control at the connections of units to each other and the underlying surface, are potential issues with this product. Note that the current trials on the seals is very positive. Seepage at the base joint with the underlying surface maybe resolved by using 'Protek' Flood bags.

FREESTANDING BARRIERS – FLEXIBLE

ALTEAU BARRIER

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Alteau Barrier

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www.aqua-sac.com
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1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☒	Supplier Assembly ?	☐

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Temporary (totally removable after use).

2.2 General description

Alteau Barrier is manufactured from 600g polyethylene fabric. By using the force of the water, the Alteau Flood Barrier rises automatically up to a maximum height of 1.2 metres and lengths of several hundred metres. Particularly designed for and used by rapid response emergency services it is a portable, self-inflating, reusable water barrier. It can be installed in minutes with one to two people and easily packed and reused for a different application by hosing down and rolling up.

The portable barrier can be transported by small vehicles to the intended site, smaller ones being able to be carried by hand. Available in 5m or 10m lengths to protect against water heights of 0.5m, 0.7m or 1.2 metres, multiple sections can be quickly joined using the Velcro fastening system.

Alteau barrier is used for flood control, creating water reservoirs, damming streams and chemical spill containment.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

5m or 10m.

3.2 Maximum number of coupled units

No limit.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
0.5m, 0.7m and 1.2m.

3.5 Maximum installable height
1.20m.

3.6 Design for or behaviour around curves/arcs/corners
Can be used in slight arcs with 90° corner sections available.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two per unit section (joining it with the units at either end).

3.8 Number of horizontal joints/sealings (per unit / unit height)
One per unit (making a seal with the ground surface).

3.9 Width of structure at base (installed state)
2.4m (0.7m water retention).

3.10 Required storage area per unit (packed dimension)
0.15m^2

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☒	Collapse	☒
Breach	☐	Overturning	☐	Seepage	☒		

4.2 Maximum design head of water
80% of design height.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre).

4.4 Damage/Tear/Puncture. How does the product behave after damage?
Performance impaired. Punctures and rips may be repaired at an approved UK repair site.

4.5 Does the product progressively worsen following damage/tear/puncture?
No.

4.6 Can the defence height of the product be increased during service?
No.

4.7 Resistance to damage

(a) Wind
The Alteau Barrier is flat to the ground with no head of water and unaffected by wind.

(b) Waves
Not known.

(c) Inertia forces
May cause the barrier to slide if the seal to the ground surface is poor with excessive seepage.

(d) Overtopping (including maximum depth without failure if known)
Can be overtopped without collapse.

(e) Floating debris
Floating debris may cause tears to the material. Damage from larger impacts is unknown.

(f) Water pressure
The design of the barrier uses water pressure to seal the barrier to the ground surface. The water pressure also helps maintain its stability when in use.

4.8 Repair during service conditions
No.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
Less than 1 hour for a 1.2m high system.

5.2 Method of installation (including site preparation)
Manual.

5.3 Likelihood of incorrect installation
The Alteau Barrier is designed with no attachments or construction needed in deployment. Therefore incorrect installation can only occur with the joining of units together.

5.4 Storage requirements
Each section rolled up to store

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
Sections can be supplied with bags.

5.6 Transportation requirements (including mobilisation)
Sections are able to be manually handled, transported in a car boot or van.

5.7 Access requirements
No restrictions as the units can be manually transported.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☒
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism
Yes, the barrier could be damaged with a sharp object.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☐
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☐
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☐
Other *(see below)*	☒

Damming streams, chemical spill containment and creating reservoirs.

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
2 persons.

6.2 Installation costs (100 m long x 1 m high – excluding resources)
0.5m height- £18,700 + VAT and delivery
0.7m height- £20,000 + VAT and delivery
1.2m height- £35,000 + VAT and delivery

6.3 Additional installation and removal costs (training/supervision)
For a 100m length, training would be included.

6.4 Maintenance requirements
Clean, dry and pack after use.

6.5 Ease of cleaning (often use in muddy conditions)
Simply hose down with water.

6.6 Reuse of the products
Yes the product is reusable.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
No.

6.8 Deterioration with time
No.

7. OTHERS

7.1 Product trial or test information
No information.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003)?
No.

7.3 Performance under service conditions/ In use
Alteau Barrier has been used over the last three years by many French Fire Services.

7.4 New products or modifications under development.
No.

7.5 Environmental qualities
Alteau Barrier is a neat design, can be supplied in several colours and is non-polluting.

7.6 Environmental Impact
No environmental impact. After use the barrier is totally removable and leaves no permanent damage to the deployment site.

7.7 Details of clients or locations where product is in service
SDIS 13 (Bouches du Rhone)
SDIS 24 (Dordogne)
SDIS 30 (Gard)
SDIS 44 (Loire Atlantique)
COPR Nantes Métropole
Ecole des Mines d'Ales
Pompiers de Tournai (Belgique)
Tao Group France

7.8 Additional comments
None.

FREESTANDING BARRIERS – FLEXIBLE

RAPIDAM

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Rapidam

Flood Guards Systems Ltd
Unit D, Bridge Farm, Reading Road, Arborfield, Reading, RG2 9HT, UK
Tel: 0118 976 1160
Fax: 0118 976 1598
Sales@floodguards.com
www.floodguards.com
Contacts: Alan Wall and Gavin George

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Temporary (totally removable after use) (referred to as free-standing (FS)).
Demountable (part permanently installed) (referred to as bolt-down (BD)).

2.2 General description

Rapidam is a single component flexible membrane system which uses the floodwater itself to provide friction with the ground and system stability. Its modular design means that unlimited number of lengths can be joined together to form one large barrier.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

150m maximum.
10m minimum.

3.2 Maximum number of coupled units

Unlimited.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)

0.5m, 1m or 1.5m dependent on desired size.

3.5 Maximum installable height
1.5m.

3.6 Design for or behaviour around curves/arcs/corners
As a flexible system it will accommodate small curves/arcs/corners. Internal/external corners at 90/45 degrees can be provided.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two continuous seals (one at each end).

3.8 Number of horizontal joints/sealings (per unit / unit height)
One seal (making a seal with the ground surface).

3.9 Width of structure at base (installed state)

HEIGHT	BD (STAND-UP)	BD (TIP FORWARD)	FREE-STANDING (ANCHORED)
0.5m	0.83m	1.27m	1.27m
1.0m	1.56m	2.60m	3.90m

1.5m high barriers will be engineered according to site-specifics such as ground conditions, with base width one of the variables. Minimum of 2.074m.

3.10 Required storage area per unit (packed dimension)
Approx. 2m long x 3m wide x 2m high (150m on self-contained handling system).

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☒	Collapse	☒
Breach	☒	Overturning	☐	Seepage	☒		

4.2 Maximum design head of water
1.5m.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre).

4.4 Damage/Tear/Puncture. How does the product behave after damage?
Rapidam could be punctured by a sharp object. Puncture would result in limited seepage but structural stability would remain.

4.5 Does the product progressively worsen following damage/tear/puncture?
Rapidam is manufactured from a 'rip-stop' material and, therefore, even puncturing with a knife will not cause a catastrophic failure.

4.6 Can the defence height of the product be increased during service?
No.

4.7 Resistance to damage

(a) Wind
Strong wind on back of barrier will mean that the D-rings provided should be used to secure system to ground to provide added stability.

(b) Waves
Barrier acts as a wave re-curve wall reducing over-topping. Not to be used in areas of breaking waves where there is no steady load providing necessary ground friction.

(c) Inertia forces
Rapidam should be securely bolted to the ground or anchored to fixed structures to deal with inertia forces, otherwise sliding may occur.

(d) Overtopping (including maximum depth without failure if known)
Wave re-curve wall reduces over-topping compared with conventionally configured systems.

(e) Floating debris
Wave re-curve wall reduces risk and light debris would not be a problem. Where a high risk of large debris exists then consideration should be made of the exact position/angle of the barrier to minimise risk including the use of optional debris screen.

(f) Water pressure
Water pressure is an element upon which the system relies and is therefore not a problem. The system is engineered with a safety factor of 200-300%

4.8 Repair during service conditions
Yes. An emergency repair can be carried out by applying a patch to the pressurised side of the barrier.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
Deployment time for 100m from handling system is typically 45mins.

5.2 Method of installation (including site preparation)
Manual handling-system or smaller sections man-handled.

5.3 Likelihood of incorrect installation
Single component system.

5.4 Storage requirements
Approximately 2m long x 3m wide x 2m high (150m on self-contained handling system) typically a shed/garage/barn/purpose built storage unit.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
Yes, numerous options are available.

5.6 Transportation requirements (including mobilisation)
Car/van for smaller systems, vehicle with tow bar for self contained handling-systems, flat-bed lorry where larger handling systems for 1km -2km are required.

5.7 Access requirements
Access to site would be needed to deploy the system from the self contained handling system 'roll'.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☒
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism
Not as attractive to vandals or thieves as aluminium systems, however, proper usage in public areas would include adequate security. Rapidam systems could be damaged by sharp objects.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒

As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
Manpower requirement 3-4 people, with 2 electric drills required.

6.2 Installation costs (100 m long x 1 m high – excluding resources)
Rapidam barrier, aluminium angle (if bolt-down version), ground bolts/ ground anchors: from £35,000 FS or £60,000 BD fully-installed

6.3 Additional installation and removal costs (training/supervision)
Bespoke training guide and DVD provided.

6.4 Maintenance requirements
There are no special storage requirements other than out of direct sunlight, in the dry and away from harmful chemicals. These considerations will increase the longevity of the system. Due to the compact nature of the Rapidam System the required storage area can be very small. Annual inspections and repairs/replacements can be included in a maintenance contract at extra cost. Client inspection to check for build up of any damp etc or damage to any components is recommended.

6.5 Ease of cleaning (often use in muddy conditions)
Straightforward process of disconnecting shackles, hosing down and wiping off.

6.6 Reuse of the products
Yes, many times.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
1 year warranty, extendable at extra cost to include a maintenance programme.

6.8 Deterioration with time
Treated for ultra-violet and fungi protection. Deterioration is insignificant if used in accordance with User Guide and with typically limited usage in flood conditions.

7. OTHERS

7.1 Product trial or test information
3 months of independent testing at HR Wallingford prior to Kitemark existing. Details available upon request.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003)
Yes (for the bolt down system), and PAS 1188:4 (2009) pending.

7.3 Performance under service conditions/ In use
The Rapidam has shown in tests and field trials to perform well under service conditions.

7.4 New products or modifications under development.
Yes. New ground fixing methods, new joining methods, higher barriers.

7.5 Environmental qualities
Produced in a variety of colours to suit environment/usage.

7.6 Environmental Impact
The Rapidam system has been designed to have as little environmental impact as possible. Outside of the threaded sleeves being set into and left in the ground for the bolt-down barrier

Rapidam has no environmental impact. The Rapidam system is available in a range of colours and it is planned that the back wall of the barrier will be printed with important information such as emergency contact numbers or instruction. The FS Rapidam system is totally removable after an event and leaves no permanent damage to the deployment site.

7.7 Details of clients or locations where product is in service

Government Departments, mobile communications hubs, military establishments, Royal Mail, Scottish Borders Council, Edinburgh City Council etc.

7.8 Additional comments

None.

FREESTANDING BARRIERS – FLEXIBLE

WATER-GATE

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Water Gate™

MegaSecur Inc. Environmental Security
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Tel: (819) 751-0222
Fax: (819) 751-5550
Info@megasecur.com
h.lemay@measecur.com
www.megasecur.com
www.water-gate.com
Contact: Ms. Helene Lemay

Distributors reference on website.

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☒	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Temporary (totally removable after use).

2.2 General description

The Water-Gate™ is a portable, re-usable “self filling” water barrier for instant flood control. Made of PVC and/or polyethylene fabric, the wedge or ‘‘V’’ shaped barrier with top and bottom membrane (apron) is joined by inner walls. Top membrane has a small integrated floater and the bottom membrane that is longer has integrated ballast plates. The barriers are joined together using a double hook and loop fastener joints. The barrier is delivered in a rolled bundle or set pre-attached folded up like an accordion in a fast deployment crate. The base of the Water-Gate™ is approximately 4 times wider than the maximum height. When water enters the Water-Gate™, it unfolds and deploys to contain it as a parachute and create a seals, moulding to the surface and using the water weight and pressure to stabilize the contained water. (Note: ballast rolls are added to the edge of bottom bib when models without ballasting are used).

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section
Standard sizes are 9.1 m and 15.2 m, however it can be manufactured to client specifications.

3.2 Maximum number of coupled units
Unlimited.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
The barriers can retain a water level as high as its retention height so a 1m high barrier can retain 1m of water. A 2m high barrier will retain 2m of water.

3.5 Maximum installable height
2m.

3.6 Design for or behaviour around curves/arcs/corners
The Water-Gate™ barriers are very flexible and can be deployed in arcs so no corner joints are necessary. The barriers can adopt a concave or convex angle.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two per unit, joining it with the next unit. Barriers all attach together regardless of retention height.

3.8 Number of horizontal joints/sealings (per unit / unit height)
One making a seal with the ground surface.

3.9 Width of structure at base (installed state)
The base or "apron" is 3½ to 4 times the retention height.
For the 0.71m high Water-Gate™ the base width is 2.7m.
For the 1.0m high Water-Gate™ the base is 3.8m.

3.10 Required storage area per unit (packed dimension)
The 0.71m high Water-Gate™, 30.4m length will pack down to a 0.62m diameter roll of 0.65m in height with a total weight of 163kg.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☒	Collapse	☒
Breach	☐	Overturning	☐	Seepage	☒		

A perceived form of failure would be sliding due to excessive seepage underneath the barrier. Overtopping could result in sliding of the barrier if water height accumulation behind it is more than 1/3 of the barriers maximum retention height.

4.2 Maximum design head of water
The Maximum product height is 2.0m – the barriers can retain a water level as high as its retention height.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre)

4.4 Damage/Tear/Puncture. How does the product behave after damage?
If punctured by a sharp object, seepage would occur but structural stability would remain. Tearing is unlikely but would result in seepage if the top membrane (apron) was punctured. If more than 2 out of 3 inner walls were torn, the barrier could locally collapse or allow more seepage.

4.5 Does the product progressively worsen following damage/tear/puncture?
No

4.6 Can the defence height of the product be increased during service?
No.

4.7 Resistance to damage

(a) Wind
When the barrier is deployed, it lays flat and therefore is not exposed to wind. Before the barrier is weighed down by flood water it is recommended that the barrier is held in place by using sand bags to prevent movement and damage from wind. When water fills the barrier, the bags can be removed from the barrier.

(b) Waves
The Water-Gate is manufactured with flexible materials allowing the barrier to stabilise itself to the ground and resist wave action. If the wave forms crests, there is a risk that water will flow over the barrier and accumulate at the rear. Pumps should be used to return the water into the watercourse. The barrier will not collapse because the water inside the barrier will pressurise the barrier to regain its original state and retain the water level up to its retention capacity.

(c) Inertia forces
The Water-Gate is designed at least 3 times stronger than it should be to assure a stable and secure flood protection system.

(d) Overtopping (including maximum depth without failure if known)
Overtopping could result in sliding of the barrier if water height accumulation behind it is more than 1/3 of the barriers maximum retention height. Pumping of water from the dry side of the barrier would reduce the risk of sliding.

(e) Floating debris
Openings at each end of the partitions inside the barrier allow the water to circulate freely preventing excessive whirlpools or suction. In cases where there is a lot of floating debris, it may accumulate at the edge of the barrier and be pushed over. Debris landing on top of the barrier can be removed. The barrier will retain its original shape due to the pressure of the water. The debris will then pile up behind the barrier and you can just remove it.

(f) Water pressure
The barrier is designed at a ratio of 4 to 1 which means that the water pressure is 4 times greater on the bottom membrane than it is on the top membrane.

4.8 Repair during service conditions
The barrier can be temporarily repaired using boards or any flat material placed over a tear or puncture inside the barrier to stop seepage.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
Installation time for a 1m high Water-Gate™ x 100m is about 12 minutes.

5.2 Method of installation (including site preparation)
Manual installation with little or no site preparation. The removal of large boulders will improve the seal of the Water-Gate™ against the ground surface. Unroll the barrier and apply a uniformed weight on the entire front edge of the barrier's apron. For long distance installations, a Rapid Deployment Crate is available to facilitate the installation. This method allows for an even quicker installation time: 1m high barrier x 1000m is about 25 minutes. While one person drives the vehicle, one or two persons unfurl the front apron uncovering the integrated steel plate ballasting. The crate sizes may vary with the choice of the barrier but are designed for easy access with its palletised bottom and can be stacked one on top of the other.

5.3 Likelihood of incorrect installation

The product is simple to install and easily rolls out. The Water-Gate is designed to avoid the use of additional equipment and machinery for its installation and all the components needed for its installation is either sewn directly onto the barrier or can be found on site such as the weights. There are also prints on the barrier that demonstrate how to correctly use the product and what not to do. The Water-Gate's concept assures an easy and simple deployment. Each barrier is sold with a User Guide to ensure that the consumer masters all the steps to using the product correctly.

5.4 Storage requirements

Storage volume for 152m of 0.53m Water-Gate™ barrier in a crate is a 1.40m^3.Storage volume for a 1.0m high X 15.2m long is approximately 0.40m^3. Storage is minimal as the Water-Gate™ can be rolled up and piled up one on top of the other without affecting their future deployment. However, it is recommended to store them upright to preserve the shape of the roll.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.

A Rapid Deployment Crate is available: A crate holding 107m of the 0.67m high Water-Gate™ is 1.32m x 1.98m x 1.07m and weighs approximately 657kg.

5.6 Transportation requirements (including mobilisation)

A vehicle is required when the barriers are set in a fast deployment crate for rapid deployment of many sections of pre attached barriers.

5.7 Access requirements

Vehicle access is required to transport the larger units to the deployment site.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☐

The Water-Gate™ system would not be suitable for narrow bank tops (due to the 'bib' length) and sloping surfaces.

5.9 Provision of fixings / Susceptibility to damage or vandalism

The Water-Gate™ is a temporary defence and therefore has no fixings. The barriers do not need to be fixed or pegged down since it's the weight of the water that stops the water. Thus, it is not recommended to fix the barrier in place because the pull in the material may cause water infiltrations and water will accumulate underneath the barrier, and eventually be susceptible to sliding.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
The Water-Gate™ may be deployed by just one person although two may be preferable with the larger defences. The larger Water-Gate™ may need to be transported to the deployment site by small pick-up truck or similar.

6.2 Installation costs (100 m long x 1 m high – excluding resources)
Price for 100 m long x 1 m high – excluding resources would be approximately £18,750 ($30,000 USD), this is subject to fluctuations in the currency exchange rates.

6.3 Additional installation and removal costs (training/supervision)
Training is not included in the product price, however Megasecur do provide a 'water barrier' users guide and video on its installation. A detailed User Guide is supplied to the client when purchasing.

6.4 Maintenance requirements
Washing of dirt and debris with regular or high pressured water, proper drying and inspecting is recommended. Proper folding back in the correct order is necessary for proper reuse in subsequent flood event.

6.5 Ease of cleaning (often use in muddy conditions)
Rinse with water after each use

6.6 Reuse of the products
The Water-Gate™ is reusable, lifespan of 15 years for the economy barriers and 20 years for the heavy duty barriers.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
Warranty on all manufacturing defects.

6.8 Deterioration with time
The Water-Gate has a life expectancy of 15 years (minimum). Deterioration of the barrier may increase due to wet leaves, chemicals, certain food acids, Ultra-Violet rays and organic matters such as fish, frogs and algae.

7. OTHERS

7.1 Product trial or test information
The materials have undergone laboratory strength tests.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No.

7.3 Performance under service conditions/ In use
The Water-Gate™ performs well under service conditions. It has won various awards in Canada including 3 international awards. These were in the Fire Services and Emergency Response and in the Environment categories. The Ministry of the Environment in Quebec Canada has, in the spring of 2000, issued a document stating that all forms of dikes should be done using the Water-Gate™ barriers.

7.4 New products or modifications under development.
Yes, new barriers are undergoing research for other applications.

7.5 Environmental qualities
The Water-Gate™ is simple and easy to install. It is reliable and user-friendly. It is self-contained and does not unduly affect affect the watercourse in which it is deployed. The Heavy-Duty Water-Gate™ (WL series) barriers are only available in a distinctive yellow colour but the economic barriers (WP & WPL series) are available in green, orange and/or black.

7.6 Environmental Impact

It does not cause contamination to the environment and has no environmental impact on the sites and surrounding areas. Safety procedures and useful tips are printed on all the water barriers for correct use of the product.

7.7 Details of clients or locations where product is in service

The Water-Gate barriers have been sold across the world in many countries such as Canada, the United States, Australia, Japan, Korea, Switzerland, France, Germany, the UK, Belgium, Turkey, New Zealand and many more.

7.8 Additional comments

None.

FREESTANDING BARRIERS - RIGID

AQUAFENCE

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Aquafence

AquaFence AS (Manufacturer)
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info@aquafence.com
www.aquafence.com
Contact: Helge Krogenes

AquaFence Limited (UK Office)
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Tel: 01789 761370
info@aquafence.com
www.aquafence.com
Contact: Helge Krogenes

Flood Defence Limited (UK Supplier)
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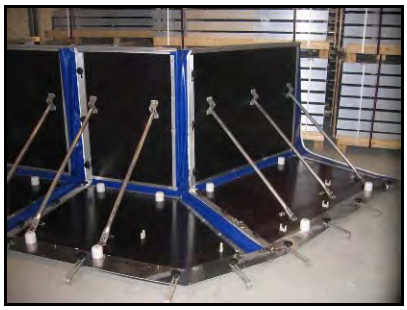
Tel: 01792 881166
Mob: 07825 541011
info@totalfloodsolutions.com
ron.whitehead@totalfloodsolutions.com
www.totalfloodsolutions.com
Contact: Mr Ron Whitehead

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission * ?	☒	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT



2.1 Type

Temporary (totally removable after use).
Demountable (part permanently installed).

2.2 General description

Semi-mobile or mobile flood protection system.

FREESTANDING BARRIERS - RIGID

AQUAFENCE

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section
Standard length is 2.10m.

3.2 Maximum number of coupled units
No limit.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
0.75m, 1.20m and 1.80m are available.

3.5 Maximum installable height
1.80m.

3.6 Design for or behaviour around curves/arcs/corners
The standard straight elements can be moved 5 degrees up/down and back/forward. There are also corner elements to accommodate 30°, 60° and 90° corners.
New corner elements have 45° inner or outer corner. Inner length:1.77 metre, outer length:1 metre

3.7 Number of vertical joints/sealings (per unit / unit width)
Two per unit, joining with the next unit or end support fixing.

3.8 Number of horizontal joints/sealings (per unit / unit height)
Two per unit. One which makes a seal with the ground surface, and one joining the lower panel with the upright panel.

3.9 Width of structure at base (installed state)
Available in 0.75, 1.20 (standard) and 1.8 metres.

3.10 Required storage area per unit (packed dimension)
1 standard unit: 2.10m (l) x 1.20m (w) x 0.15m (h)
Recommend to store the elements on special pallets: 1 pallet + 7 standard elements:
2.15m (l) x 1.27m (w) x 1.10m (h)
Weighing a total of: 500kg

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☒	Collapse	☐
Breach	☐	Overturning	☒	Seepage	☒		

4.2 Maximum design head of water
Same as height of each element, i.e. 0.75m, 1.20m and 1.80m.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre).

4.4 Damage/Tear/Puncture. How does the product behave after damage?
Almost all parts can be exchanged. Minor damages from impact have no effect on the stability of the system during an operation.

4.5 Does the product progressively worsen following damage/tear/puncture?
No.

4.6 Can the defence height of the product be increased during service?
No.

4.7 Resistance to damage

(a) Wind
Fixation to the ground in the front and extra available "wind-prevention" supports to the back allows the Aqua Fence to withstand storms of 9 Beaufort or more.

(b) Waves
Aqua Fence behaves very well in inland-water, even in wild-water and can withstand waves. This has been confirmed in the certification process - TU Hamburg-Harburg, where it can withstand waves up to 0.5m.

(c) Inertia forces
None, water stabilizes the system and 0.2m of flood water makes the additional fixation obsolete.

(d) Overtopping (including maximum depth without failure if known)
System is fixed, so overtopping is not a problem.

(e) Floating debris
A front fixing shield can be added to prevent impact from debris, e.g. logs of greater than 1 ton.

(f) Water pressure
As the elements are filled with water and have a rigid frame they are resistant to water pressure.

4.8 Repair during service conditions
Yes.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
We recommend a team of 10 persons (or less) to assembly 100 m, and 8 to 10 persons will assemble 100 metres in 1 hour.

5.2 Method of installation (including site preparation)
Manual. Installation is by man-power, however battery drills are preferable.

5.3 Likelihood of incorrect installation
The design is prepared to prevent incorrect assembly. It is self-explaining and the "Step-by-Step" guide will easily instruct the workers how to install this properly.

5.4 Storage requirements
We recommend storing the elements on pallets within a container or warehouse. The elements can stand both very high and low temperature. The main material is wood, thus it should be not stored for too long in direct sunlight. It does not need to be absolutely dry, but animals (mice and rats) and vermin might be a threat.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
One 13.4m container can transport/store 18 pallets. 2 pallets can be placed on top of each other during transport or storage.

5.6 Transportation requirements (including mobilisation)
Can be transported on pallets in containers, trucks, boats or planes.

5.7 Access requirements
Each element can be transported by hand, but also by front-loader, lorry, quad or else. AquaFence has developed carrier handles.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other (*)	☒

(*) A mobile solution with an extra gasket is available to put up AquaFence on limited sloping surface, or e.g. cobblestones.

5.9 Provision of fixings / Susceptibility to damage or vandalism

Relatively secure; although most parts that can be stolen or disconnected are located in or under water. Canvas can be easily repaired even under operation if it is damaged by vandalism.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements

For 1000m we recommend 3-4 teams of 6-8 persons. All installation can be done by man power after the system has been delivered to site (by e.g. truck, ATV or lorry etc). It is recommended to use battery powered drills for faster tightening of the wheels and bolts.

6.2 Installation costs (100 m long x 1 m high – excluding resources)

£475/m (2008 prices) with all elements included. If foundation is required, pre-fabricated concrete elements with fastening rails are available for £8/m.

6.3 Additional installation and removal costs (training/supervision)

Yes, if requested.

6.4 Maintenance requirements

Elements must be rinsed and checked for any damage. Replace any damaged components or repair the plywood if damages to the wood. Inspection should be around once a year.

6.5 Ease of cleaning (often use in muddy conditions)

Rinse with clean water after use.

6.6 Reuse of the products

Yes, when properly maintained and stored, Aqua Fence can be re-used for approx. 12-15 years.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)

Standard EU-warranty of 1 year.

6.8 Deterioration with time

Only when damaged. If stored to manufacturers specification then the system will not deteriorate significantly.

7. OTHERS

7.1 Product trial or test information

Aqua Fence has received the BWK and FM-Global certificate - October 2008.
Currently no certification for BSI Kitemark (PAS 1188-2-2003) has been undertaken, however, the tests undertaken for the BWK and FM-Global certificate by Prof. Pasche from Technical University Hamburg also included the standards and requirements of BSI Kitemark (PAS 1188-2-2003) in their test procedures.

7.2 Awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003)?

No.

7.3 Performance under service conditions/ In use

The Aqua Fence has been demonstrated to withstand actively flowing water when anchored to the ground surface.

7.4 New products or modifications under development.

Yes, will be specified at a later point in time.

7.5 Environmental qualities

No toxic waste is absorbed in the elements and the plywood used by Aqua Fence is certified and comes from cultivated forestry.

7.6 Environmental Impact

No environmental impact. The system is completely removable after the event leaving no permanent damage to the deployment site.

7.7 Details of clients or locations where product is in service

Mount Vernon, (Seattle USA). 460m long, 1.20m high, by riverbank in City of Mount Vernon Contact persons: Fred A. Buckenmeyer, Engineering Services Manager, City of Mount Vernon.
A video news feed is available from Mt. Vernon.
Adony, (Hungary) Entrance to corn-storage facility, 1.80m high. Contact person: Kőszegi László.

7.8 Additional comments

None

FREESTANDING BARRIERS - RIGID

NOAQ BOXWALL

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

NOAQ Boxwall

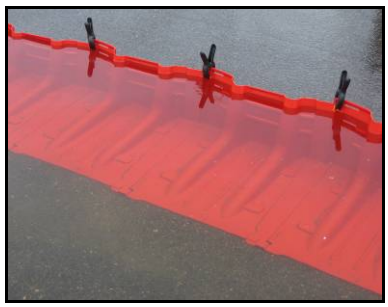
NOAQ Flood Protection AB (Manufacturer)
Forssa Industrial Estate, 820 64 Nasviken, Sweden
Tel: (+46) 650 30140
Fax: (+46) 650 30530
www.noaq.com
info@noaq.com
Contact: Sigurd Melin

Clan Tools and Plant Ltd. (UK Supplier)
3 Greenhill Avenue, Giffnock, Glasgow, G46 6QX, Scotland
Tel: 0141 638 8040
Fax: 0141 638 8881
clantools@btconnect.com
www.clantools.com
Contact: Mr John Bell

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☐

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT



2.1 Type

Temporary (totally removable after use).

2.2 General description

The NOAQ Boxwall is a freestanding flood barrier designed for use in urban environments that feature hard and even surfaces like asphalt streets and concrete floors. The NOAQ Boxwall is anchored using the weight of the floodwater alone, and is assembled by simply snapping boxes together to the desired length and fixing them to each other using clamps.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

0.705 m (effective length 0.625 m)

3.2 Maximum number of coupled units
No limitation.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
0.5m.

3.5 Maximum installable height
0.5m.

3.6 Design for or behaviour around curves/arcs/corners
Units may be connected at an angle of up to 3° in both directions, this makes it possible to create curves with a minimum radius of 12m. Corner elements are offered on demand.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two per unit (joining one unit with the next).

3.8 Number of horizontal joints/sealings (per unit / unit height)
One per unit (making a seal with the ground surface)

3.9 Width of structure at base (installed state)
0.68m.

3.10 Required storage area per unit (packed dimension)
0.705m x 0.68m for a single unit, however, being stackable, 26 units (corresponding to 16 meters of wall length) fit on a standard EUR pallet with dimensions 1.2m x 0.8m x 0.95m

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☒	Collapse	☐
Breach	☐	Overturning	☒	Seepage	☒		

4.2 Maximum design head of water
0.5m.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre)
Some seepage (greater than 40 litres per hour per metre)
This is dependent on the roughness of the ground surface.

4.4 Damage/Tear/Puncture. How does the product behave after damage?
To date, no damage has been experienced.

4.5 Does the product progressively worsen following damage/tear/puncture?
No.

4.6 Can the defence height of the product be increased during service?
No.

4.7 Resistance to damage

(a) Wind
In hard winds the wall may need to be secured by putting some ballast on the leading edge.

(b) Waves
Withstands regular overtopping scale waves.

(c) Inertia forces
Unaffected by inertia forces

(d) Overtopping (including maximum depth without failure if known)

The system can tolerate small overtopping volumes as the anchoring ability of the wall increases with the water depth.

(e) Floating debris
The system can withstand small floating debris.

(f) Water pressure
Resistant to water pressure, according to both theoretical calculations and practical tests.

4.8 Repair during service conditions
The product is robust and does not damage easily.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
30 minutes for a 100m long and 0.5m high wall.

5.2 Method of installation (including site preparation)
Manual.

5.3 Likelihood of incorrect installation
The design is very simple, so incorrect installation is unlikely. The only foreseen incorrect installation is when used on uneven or erosive surfaces, or without prior removal of loose sand on top of hard surfaces.

5.4 Storage requirements
Dry and away from direct sunlight.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
Yes, stackable pallet units, each containing 26 boxes (16 meters), are supplied. Also containers containing a number of pallet units, are offered.

5.6 Transportation requirements (including mobilisation)
No specific requirements. By truck, by estate car and/or trailer, by wheelbarrow or carried manually.

5.7 Access requirements
No specific requirements. Access to the site by foot is also possible.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☐
Grassed Surface	☐
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☒
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism
Before the system becomes stable under the weight of the water, the units are removable.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☐
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☐
As second line defences (away from watercourse)	☒

Enclosures (around property/properties) ☒
Access locations (permanent breaks in defences (not breaches)) ☒
Other *(see below)* ☒
Along roadsides, to keep roads open or to avoid cross-running currents, in front of entrances.

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
The wall can be easily deployed by a single person. No extra resources are needed.

6.2 Installation costs (100 m long x 0.5 m high – excluding resources)
160 - NOAQ Boxwall BW50 x 0.625m £120.50 per unit.
Total installation cost of £19,280 (cost based on price at August 2009).

6.3 Additional installation and removal costs (training/supervision)
Familiarisation training is provided free of charge on delivery of equipment.

6.4 Maintenance requirements
Clean and let dry after use. Then store dry and away from direct sunlight.

6.5 Ease of cleaning (often use in muddy conditions)
May be washed clean with a garden hose.

6.6 Reuse of the products
Yes.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
The product's functionality after ten years in storage is guaranteed under the condition that the boxes are stored dry, away from direct sunlight, and within a temperature range of -30°C to +40°C.

6.8 Deterioration with time
No.

7. OTHERS

7.1 Product trial or test information
The NOAQ Boxwall has been thoroughly tested, both in field tests and in hydraulic laboratories.

7.2 Awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003)
No.

7.3 Performance under service conditions/ In use
The NOAQ Boxwall has performed well in tests, and is awaiting use in a flood event.

7.4 New products or modifications under development.
No.

7.5 Environmental qualities
The Boxwall's main advantage is the speed at which it may be deployed, hereby giving the opportunity of saving the environment from the vast environmental impact from the flooding.

7.6 Environmental Impact
The Boxwall has a very small impact on the environment. If scrapped, the ABS plastic boxes will be shredded, melted down and recycled into new boxes.

7.7 Details of clients or locations where product is in service
Not yet available as it is a brand new product.

7.8 Additional comments
The weight of the Boxwall is 3.4kg per unit and 5.5kg per running metre.

FREESTANDING BARRIERS - RIGID

YEWSTOP 'A' BLOCK

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Yewstop (Concrete) Ltd.
Plumtree Farm, Uppertown, Ashover, Chesterfield, Derbyshire, S45
Tel: 01246 830002
info@yewstopconcrete.co.uk
yewstop@btconnect.com
www.yewstopablock.co.uk
Contact: Adrian Buxton

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☒	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type
Temporary (totally removable after use).

2.2 General description
Yewstop "A" Block, mass concrete blocks.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section
0.6m, 0.9m, 1.2m, 1.5m and 1.8m.

3.2 Maximum number of coupled units
Unlimited.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
0.6m.

3.5 Maximum installable height
2.40m.

3.6 Design for or behaviour around curves/arcs/corners
Able to form 90 deg corners

3.7 Number of vertical joints/sealings (per unit / unit width)
Two per unit joining each end of the unit with the next

3.8 Number of horizontal joints/sealings (per unit / unit height)
One

3.9 Width of structure at base (installed state)
All blocks are 0.6m wide.

3.10 Required storage area per unit (packed dimension)
1.8m x 1m stacked 4 high
As units are of a fixed dimension, the required storage for each unit is based on each blocks dimensions. Allowance need to be made for excess for grab down each side.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☐	Rolling	☐	Sliding	☐	Collapse	☐
Breach	☐	Overturning	☐	Seepage	☒		

4.2 Maximum design head of water
Untested.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre).

4.4 Damage/Tear/Puncture. How does the product behave after damage?
Difficult to damage due to total mass.

4.5 Does the product progressively worsen following damage/tear/puncture?
No.

4.6 Can the defence height of the product be increased during service?
Yes, height increased 0.6m at a time to a recommended max of 2.4m.

4.7 Resistance to damage

(a) Wind
Ok, each 1.8m block weighs 1.2ton.

(b) Waves
Untested, but due to the mass of each block, damage from fluvial waves is not considered possible.

(c) Inertia forces
Untested, but due to the mass of each block and interlocking design, damage from inertia forces is not considered possible.

(d) Overtopping (including maximum depth without failure if known)
Untested, but due to the mass of each block, damage from overtopping is not considered significant.

(e) Floating debris
Untested, but indications due to block mass would appear ok.

(f) Water pressure
Interlocking design of the blocks provides greater stability to water pressure.

4.8 Repair during service conditions
No, repair of the blocks is not possible however the wall could be reinforced with additional units.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
Assuming all materials are available less than 8 hours

5.2 Method of installation (including site preparation)
Manual - Plant driver + 2 Operatives.
Plant - HGV/Telehandler/Block Grab.

5.3 Likelihood of incorrect installation
Interlocking system of fitting will only fit male/female indentations.

5.4 Storage requirements
Yard/compound area.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
No.

5.6 Transportation requirements (including mobilisation)
HGV with crane, block grab.

5.7 Access requirements
The site needs to be accessible by HGV to deliver the blocks.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other *(see below)*	☒

The Yewstop 'A' Block can be deployed on any level surface wider than 0.6m

5.9 Provision of fixings / Susceptibility to damage or vandalism
Minor

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
Labour, Telehandler with scissor grab, lorry for transport

6.2 Installation costs (100 m long x 1 m high – excluding resources)
0.6m height £7250 (approx)
1.2m height £14500 (approx)
1.8m height £21750 (approx)
2.4m height £29000 (approx)

6.3 Additional installation and removal costs (training/supervision)
No.

6.4 Maintenance requirements
Minor visual inspection for damage.

6.5 Ease of cleaning (often use in muddy conditions)
Pressure washer.

6.6 Reuse of the products
Yes.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
No.

6.8 Deterioration with time
Solid concrete, so deteriation would be slow.

7. OTHERS

7.1 Product trial or test information
Untested.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No.

7.3 Performance under service conditions/ In use
In use but untested in flood conditions.

7.4 New products or modifications under development.
Ongoing.

7.5 Environmental qualities
Solid concrete block with little or no potential for contamination.

7.6 Environmental Impact
Limited, Blocks can be removed after an event.

7.7 Details of clients or locations where product is in service
United Cast Bar (UK) Ltd Spital Lane Chesterfield Derbyshire

7.8 Additional comments
The product is yet to be tested in flood conditions however it has been installed at a number of sites. However due to its construction and form seepage may occur at the joints between the blocks.

FREESTANDING BARRIERS – RIGID

AQUABARRIER

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

AquaBarrier

AquaBarrier Systems Limited (Manufacturer)
10 Cavalry Ride, Norwich, NR3 1UA
Tel: 01603 625999
Fax: 01603 763256
martinfrench.co@virgin.net
www.aquabarrier-systems.com
Contact Martin French

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Demountable (part permanently installed).

2.2 General description

The Aquabarrier System is designed around a basic barrier module comprising of hollow, rigid, polyethylene sections of 7mm wall thickness, manufactured using a rota moulding process. Once deployed, holes in the front face of each barrier enable the ingress of water into the unit, hence, it self fills as the flood water rises and empties as the flood level recedes. The fully loaded weight is 3.2 tons with a weight of 85kg when empty. Multiples of units are linked together with a unique rubber seal on the vertical and horizontal axis to form a continuous barrier chain of any chosen length. These demountable barriers are connected to pre-installed ground works using lock down bolts and plates already secured in the existing ground works. The barrier can be erected at a rate of 20 metres per hour by four non skilled personal. No heavy machinery/plant is required to deploy the barriers once delivered to location.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

1.0m modular width.

3.2 Maximum number of coupled units

No maximum.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
1.5m standard unit height.

3.5 Maximum installable height
2.5m units can be produced.

3.6 Design for or behaviour around curves/arcs/corners
There is a 35mm gap to accommodate the seal between the units at the same time allowing for a 1° - 2° curve. Ends and corners are currently fixed by using engineered concrete or steel channel-section columns. Units can be integrated into permanent hard landscape features to enable a significant change in direction. .

3.7 Number of vertical joints/sealings (per unit / unit width)
Two per unit (joining each unit to the next one or to the upright engineered columns).

3.8 Number of horizontal joints/sealings (per unit / unit height)
One per unit (making a seal with the engineered ground works)

3.9 Width of structure at base (installed state)
2.2m per unit.

3.10 Required storage area per unit (packed dimension)
2.2m x 1.75m space per 2 units with 1 metre stacking ability up to 5 metres, hence 10 barriers can be stored on the 2.2m x 1.75m floor area.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☐
Breach	☐	Overturning	☐	Seepage	☒		

4.2 Maximum design head of water
1.5m for the 1.5m barrier, 2.5m for the 2.5m barrier.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre).

4.4 Damage/Tear/Puncture. How does the product behave after damage?
The unit is made from extremely robust Medium Density Polyethylene plastic (MDPE). The system is sealed at the rear of the barrier, furthest from the water. The front curved face not only allows water to fill and empty the internal void, it also acts as a wave return and an impact face. As the material used in these barriers allows for a certain amount of flex, most flotsam can not damage the front face. In the event that this should occur by any of the mentioned methods, it does not affect the rear seal as the barrier is or would be full of water. All that would occur would be the impact face would be damaged therefore the individual unit would require replacement before the next deployment.

4.5 Does the product progressively worsen following damage/tear/puncture?
No.

4.6 Can the defence height of the product be increased during service?
No.

4.7 Resistance to damage
(a) Wind
The units are resistant to wind damage.

(b) Waves
1) Significant wave height up to 100mm+/- 10mm
2) Mean wave period 1.0-1.5s.

(c) Inertia forces
As the units are bolted down into designed and engineered ground works, the units are designed to resist inertia and dynamic forces.

(d) Overtopping (including maximum depth without failure if known)
1.8m for the 1.5m barrier

(e) Floating debris
Will not affect rear face and therefore would not significantly affect the barrier.

(f) Water pressure
Designed to withstand water pressure, with a significant factor of safety applied.

4.8 Repair during service conditions
No, once it has a head of water against the barrier then it can not be repaired.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
For the 1.5m high system: 5 hours by one team of 4 people or 2.5 hours by two teams of 4 people.

5.2 Method of installation (including site preparation)
Manual. Each unit is fixed in place by simple nut and bolt fixings.

5.3 Likelihood of incorrect installation
The requirement of technical operation has been avoided to allow easy deployment by an unskilled work force.

5.4 Storage requirements
Barriers are currently stored on their transport trailers with a cover. If stored in the open the barriers need to be covered to avoid UV light.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
Storage solutions are at the client's request. In York, two purpose built trailers have been provided which contain all the equipment and tools required to deploy the barriers at their location. Trailer dimensions are; length 3.8m, width 2.0m and gross weight loaded under 1000kg.

5.6 Transportation requirements (including mobilisation)
For York two purpose built trailers were supplied which are moved using a standard vehicle with a towing hitch. No heavy vehicles are required.

5.7 Access requirements
Prearranged and pre-planned storage areas are preferred, with access to the flood site within easy reach by road or track to allow timely deployments of the barrier. The locations and deployment logistics are agreed with the Client and details entered into the deployment plan.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☐
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☒

Concrete ☒
Other ☐

5.9 Provision of fixings / Susceptibility to damage or vandalism
The barriers could be vulnerable to vandalism when first deployed if the lock-down bolts are deliberately slackened. This is resolved by re-tightening the bolts, which can be done whether the barriers are full or empty. Another possible concern would be arson, when empty.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other *(see below)*	☒

Between urban structures
Creation of a lined reservoir for deployment into drought areas

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
4 man team.

6.2 Installation costs (100 m long x 1 m high – excluding resources)
£1,000,000 for all surface equipment for a 1.5m high system excluding ground works.

6.3 Additional installation and removal costs (training/supervision)
Aquabarrier provide skilled staff to complete a two day training programme to personnel for the installation and operation of the system.

6.4 Maintenance requirements
Cleaning and disinfecting after each deployment. When stored in the open they need to be covered to mitigate against UV degradation.

6.5 Ease of cleaning (often use in muddy conditions)
A simply power wash gun is used to clean and disinfect after demounting.

6.6 Reuse of the products
Yes.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
10 years subject to proper usage. Automatic replacement if faulty material or manufacturing fault is discovered.

6.8 Deterioration with time
If stored correctly there will be little UV degradation, however, if stored continually in direct sunlight MDPE will degrade over many years.

7. OTHERS

7.1 Product trial or test information
There is no provision for BSI Kite for a product designed to a flood height of 1.5 metres. At present PAS 1188-2:2003 only allow for testing up to 0.9m, this is 0.6m below our current height. Using the criteria provided by the aforementioned, Aquabarrier Systems hired a dry dock in Blyth and tested the product to an extreme flood event of 1.6m, the barrier successfully held back water up to 1.5m

then overtopped without affecting the integrity of the barrier wall. Prior to this testing, HR Wallingford conducted desk top analysis on the product resulting in changes to the original design.

7.2 Awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003)

No.

7.3 Performance under service conditions/ In use

The Aquabarrier system was successfully deployed in York in September 2008. Minor seepage was experienced due to some incorrect installation, however, the system held 0.6m depth of flood water effectively.

7.4 New products or modifications under development.

Using the same 2.2m x 1.0m footprint we intend to produce barriers up to 2.5m height, in addition we are looking at producing corner units in MDPE. We are currently carrying out an R&D programme for Blast Ballistic walls up to a height of 4.5 m.

7.5 Environmental qualities

The product is demountable therefore circumventing the complaint from the general public and local residents that many permanent works create a great deal of visual blight. Once manufactured the barriers are reusable, damaged barriers can be returned to the manufacturer, and the material can be recycled.

7.6 Environmental Impact

These units can be manufactured using a variety of colours to blend in with the surrounding areas, and they are demountable allowing for a return to the natural configuration of the area when not in use.

7.7 Details of clients or locations where product is in service

With our construction partners Birse Civils, the barriers were deployed in the Clementhorpe area of the City of York on September 8th 2008. This is part of an Environment Agency Pilot study, latest report number Product code SCHO1008TU-E-P.The end user of this flood alleviation system is the City of York Council.

7.8 Additional comments

It is important to note that this is an engineered system, and requires a bespoke design which we offer. Every flood event or deployment attracts differing ground conditions, it is therefore not feasible to price below ground engineering without having a full Ground Investigation report, or a Geotechnical Interpretive report.

Video footage of the Aquabarrier Trials may be viewed at
http://www.youtube.com/user/bootquin
The three Aquabarrier videos show

- the trials undertaken at Blyth dry dock,
- dry run deployment at Clementhorpe City of York,
- a demonstration of how strong the material MDPE is when live fire testing was conducted on the barriers.

FRAME BARRIERS - FLEXIBLE

PORTADAM

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Portadam

OnSite Central Ltd
89 Blackpole West, Blackpole, Worcester, WR3 8TJ
Tel: 01905 340054
Fax: 01905 751571
solutions@onsite.co.uk
davidwedgdury@onsite.co.uk
www.onsite.co.uk
Contact: Mr David Wedgbury

1.1 Product Availability

Buying / Purchase ?	☐	Client Assembly ?	☐
Hire / Commission ?	☒	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Temporary (totally removable after use)

2.2 General description

The Portadam system comprises of welded rectangular steel “A” frames, which are placed at pre-calculated intervals. A tailored membrane is then suspended from the frames and lies along the “A” frame and the underlying surface to create a hydrostatic seal.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

Portadam has a unique system in joining the tailored fabric. The standard sheets are 6m or 10m.

3.2 Maximum number of coupled units

Theoretically unlimited

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)

1.5m to 2.5m for standard equipment (dams greater than 2.5m in height are possible by special arrangement)

3.5 Maximum installable height
Usually 2.5m (greater than 2.5m by special arrangement).

3.6 Design for or behaviour around curves/arcs/corners
Portadam can be constructed to account for curves arcs and corners.

3.7 Number of vertical joints/sealings (per unit / unit width)
The interlocking steel "A" frames form a continuous structure. The sealing fabrics are connected together every 6-10 metres

3.8 Number of horizontal joints/sealings (per unit / unit height)
One (where the skirt makes a seal with the ground surface)

3.9 Width of structure at base (installed state)
Between 3 and 6 metres dependant on height of dam

3.10 Required storage area per unit (packed dimension)
10 linear metres of dam requires a storage area of 2.4 m x 2.4m at a height of 1.6m

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☒
Breach	☒	Overturning	☒	Seepage	☒		

The likely mode of failure is overtopping, in addition until the dam is flooded Portadam can be vulnerable in high winds, in exposed areas it is recommended to delay sheeting up the structure as long as possible. In fast flowing applications the dam can be damaged by heavy debris strike, which could bend the "A" frames or rip the fabric.

4.2 Maximum design head of water
2.5m for standard dam (dams greater than 2.5m in height are possible by special arrangement)

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre)
System can leak against low water pressures, however the longer the Portadam is installed, the better the seal becomes. Pumping may be required to keep the landward side of the defence dry.

4.4 Damage/Tear/Puncture. How does the product behave after damage?
The Portadam should remain intact if damaged, however a breach under the dam could cause scour and may undermine the bearing capacity of the ground on which the dam is stood. If this was not attended to it could lead to failure

4.5 Does the product progressively worsen following damage/tear/puncture?
Generally no, though substantial leakage under the dam can worsen if not attended too.

4.6 Can the defence height of the product be increased during service?
No

4.7 Resistance to damage

(a) Wind
Until the dam is flooded Portadam can be vulnerable in high winds, in exposed areas it is recommended to delay sheeting up the structure as long as possible.

(b) Waves
System is unaffected by small waves

(c) Inertia forces
Because the A Frame framework is a rigid structure when erect, there are unlikely to be any inertial forces unless the surface upon which the frames are stood moves itself

(d) Overtopping (including maximum depth without failure if known)
Overtopping is not likely to lead to failure, no specific information in depth of water required.

(e) Floating debris
The frames can generally withstand damage from floating debris other than very heavy objects; the membrane could be punctured by sharp floating objects

(f) Water pressure
System can leak at low pressure and as this increases the seal becomes more effective and seepage is reduced.

4.8 Repair during service conditions
Portadam is susceptible to vandalism; however damage to the membrane can be repaired under service conditions.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
The Portadam would take 2 days with up to 6 operatives, although it could be quicker with a larger team of operatives.

5.2 Method of installation (including site preparation)
Manual, standard dams can be installed manually no need for heavy equipment or site preparation.

5.3 Likelihood of incorrect installation
Incorrect installation unlikely, all operatives require full training

5.4 Storage requirements
Portadam may be stored in open-air site.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
10 linear metres of dam requires a storage area of 2.4 m x 2.4m at a height of 1.6m.

5.6 Transportation requirements (including mobilisation)
Transportation requirement is dependant on Dam dimensions. Individual component parts can be carried on a 3 ton van or Land Rover and trailer.

5.7 Access requirements
All the dam components can be carried to the location.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☒
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☒
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☐

In some cases stone may be required to increase the surface width to allow the base of the frames to be adequately supported so that the load can be well distributed

5.9 Provision of fixings / Susceptibility to damage or vandalism
The Portadam system requires no fixings; the fabric could be susceptible to vandalism.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒

As second line defences (away from watercourse) ☒
Enclosures (around property/properties) ☒
Access locations (permanent breaks in defences (not breaches)) ☒
Other *(see below)* ☒
Product may be deployed within a flooded area and pumps used to remove the flood waters.

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
Minimum requirement 2 or 3 operatives and a van to transport to site

6.2 Installation costs (100 m long x 1 m high – excluding resources)
Portadam is available on a hire basis only; installation is carried out by on site specialist teams. The work is quoted on a job-by-job basis.

6.3 Additional installation and removal costs (training/supervision)
N/A, Portadam is available on a hire basis only; installation is carried out by on site specialist teams.

6.4 Maintenance requirements
Not applicable as the system is maintained by the supplier.

6.5 Ease of cleaning (often use in muddy conditions)
Portadam is easily cleaned using a hosepipe either at site or on return to depot after use

6.6 Reuse of the products
Portadam is reusable.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
No.

6.8 Deterioration with time
Portadam does not deteriorate with time and is easily maintained.

7. OTHERS

7.1 Product trial or test information
Tested in 1972 at the National Physics Laboratory at Teddington, UK in tanks and concrete bases. Test data not published. The Portadam system has also undergone laboratory and field testing by the United States Army Corps of Engineers (Engineer Research and Development Centre) and they have produced a very comprehensive report, which can be downloaded at their website, www.erdc.usace.army.mil . Of the U.S. systems tested, Portadam was regarded as the all round best performing system.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No.

7.3 Performance under service conditions/ In use
Performs well and has a long history of use for canal and river engineering projects sine the early 1970's.

7.4 New products or modifications under development.
No.

7.5 Environmental qualities
Portadam has been used in a number of riverbed restoration projects, maintaining river channels and banks, improving habitats; does not require heavy equipment; does not cause damage to the ground.

7.6 Environmental Impact

Does not pollute the watercourse, with little or no damage to the bed and the surrounding area. Portadam is totally removed following use and leaves no permanent damage to the deployment site.

7.7 Details of clients or locations where product is in service

1. Gary Mackie
Project Manager
Kier Southern, St Andrews House, West Street, Havant, Hampshire
2. Harry Patel
Project Manager
BW Morrison, Unit 7, The Priory, London Road, Canwell, Sutton Coldfield, B75 5SH
3. Charles Baker
Assets & Operations Engineer:
North & South Stratford Canal
Trent & Mersey Canal (Gt. Haywood - Fradley - Burton on Trent)
Project Manager of Culvert Inspections
West Midlands Region, British Waterways, Peel's Wharf, Fazeley, Tamworth, B78 3QZ

Product trials and testing
Contact: Mr Fred Pinkard, USAC ERDC. – Tel: 001 601 634-3086
E-Mail Fred.Pinkard@usac.army.mil

7.8 Additional comments

Flumes are available to allow the continual flow of water between two dams reducing the need for over pumping.

FRAME BARRIERS - RIGID

GEODESIGN BARRIER

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1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Geodesign Barrier

Geodesign AB
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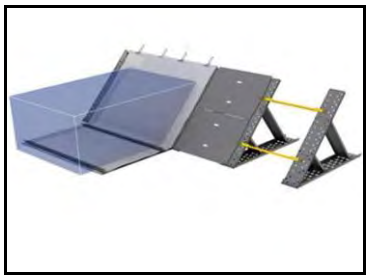
Tel: (+46) 13 21 19 55
Mob: (+46) 70 551 54 55
kullberg@geodesign.se
www.geodesign.se
Contact :Mr Sten-Magnus Kullberg

Geodesign Barriers Ltd
3 Fore Street, Topsham, Exeter, Devon, EX3 0HF
Tel: 01392 876100
Mob: 07890 983239
britt.warg@palletbarrier.com
www.geodesignbarriers.com
Contact: Ms Britt Warg

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☒	Supplier Assembly ?	☐

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT



2.1 Type

Temporary (totally removable after use)

2.2 General description

Collapsible, flat-packed galvanised steel supports, which hold either a standard wooden Euro pallet or a waterproof plywood board or an aluminium sheet. Each panel spans between two supports. Each support has various number of supporting diagonal beams, depending on the dam height type. Horizontal connection rods form a 'brace' through the whole metal structure. The pallets, boards or aluminium sheets are fixed to the supports from the front and from behind with simple, easy-to-use lock-pins. The metal 'skeleton' is then covered with a waterproof, reinforced - polypropylene membrane. Clips hold the membrane in place on the top of the barrier, while 5m long units of iron chain are used to hold down the leading edge of the membrane on the waterside. The chains are all linked together with karabiners and can also be (intermittently) fastened by clip-on 'clac pacs', to prevent the chain from rolling off the membrane. Another line of chain units are

placed across the front of the sloping barrier. The role of the chain is to weigh down the plastic membrane initially - before the water pressure takes over. Corner elements are available to create various inner or outer corners. For irregularities and very undulating ground (i.e. fences, lamp-posts, trees, kerbs, slopes etc), adjustable connection rods are used instead of those of fixed length. These, together with the slightly conical corner elements are used to improvise and adjust to any obstacles or to create a shorter than normal section. Special 'adjustable kit crates', containing a set of 'adjustables' are also available for this purpose. The barrier can be free standing or attached at the end(s), if needed.
As the barrier system has developed from the original Pallet Barrier but now comprises of the Pallet Barrier, the Board Barrier and the Steel Barrier, the overall name of the flood barrier system has been changed to Geodesign Barriers in the UK. The metal structure remains the same but the 'panels' applied to the structure differ.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section
1.23m between supports

3.2 Maximum number of coupled units
Unlimited

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☒	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
Heights of 0.45m, 0.65m, 0.85m, 1.25m, 1.50m, 1.80m and 2.40m are available.

3.5 Maximum installable height
2.40m

3.6 Design for or behaviour around curves/arcs/corners
By using corner elements the system can be erected around corners. The system can adapt to smaller changes in direction. The corner elements can also be used for any irregularities as described above, in the general description. It is also possible to create pools and basins of various shapes.

3.7 Number of vertical joints/sealings (per unit / unit width)
For the metal structure: 1 joint per section. (For the membrane, typically at every 100m length.)

3.8 Number of horizontal joints/sealings (per unit / unit height)
No joints needed up to the dam height of 1.8m, for the 2.4m dam height there is one joint, where the extension is slotted in to the 1.8m support. If preferred, extensions are still available for dam heights lower than 1.8m.

3.9 Width of structure at base (installed state)
The maximum width / footprint (i.e. the length of the support and the part of the plastic membrane lying on the ground) varies depending with the chosen dam height, as follows.

0.45m dam height - 1.3m,	0.65m dam height - 1.8m
0.85m dam height - 2.4m,	1.25m dam height - 3.7m
1.50m dam height - 4.5m,	1.80m dam height - 6.0m
2.40m dam height - 6.0m	

3.10 Required storage area per unit (packed dimension)

The metal supports are flat-packed and stored in crates of wood or metal.
For the 0.45m dam height system, a total length of complete 50m barrier is stored in one crate (1.3m x 1.4m x 0.85m).
For the 1.25m dam height system a total length of 41m complete barrier is stored in three crates. The first crate with 33 supports (1.9m x 1.2m x 1.1m), the second crate with 66 aluminium sheets, 1.2m x 1.0m x 0.8m and the third crate with additional components (1.2m x 1.0m x 0.7m).

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☐	Rolling	☐	Sliding	☒	Collapse	☒
Breach	☐	Overturning	☐	Seepage	☒		

The likely modes of failure are sliding and seepage. To avoid sliding on cohesive soil and grass, the system should be pinned down with anchor pins to a depth of 100mm. (One per support) For friction soils like sand, gravel, moraine or asphalt, the friction is sufficient and no anchor pin is needed. For concrete, the system should be bolted to the ground. (One per support). The seepage through the barrier membrane is almost none. Even the seepage through the soil is comparatively low and of no great significance. However, the seepage through drains and gullies can be significant and could potentially cause failure to the emergency operation. Pumps are always necessary.

4.2 Maximum design head of water

2.4m

4.3 Behaviour subject to seepage and water tightness

Some seepage (less than 40 litres per hour per metre)
The leakage of water is due to ground water seepage and leakage between the plastic membrane and the ground. The seepage will decrease with time due to clogging with suspended materials but also due to consolidation of the ground surface and the leading edge of the membrane loaded with the iron chain. One 3-5hp-water pump, working intermittently, is sufficient to keep the landward side dry per 150m of defence. The pumps provided by Geodesign Barrier pump 3,000 LPM.
One can expect slightly increased leakage wherever there is a ‘weak’ area along the barrier. For example, this can occur at membrane joints or where the membrane is unable to reach out to its maximum length due to obstacles (such as trees or lamp-posts etc). But because these locations are generally known beforehand, extra pumping can be carried out to neutralise the seepage.

4.4 Damage/Tear/Puncture. How does the product behave after damage?

A breach of the defence at one point is not likely to progressively worsen, as there is a strong metal structure underneath the membrane, with horizontal connection rods holding everything together. Flow of water should be reduced even if a tear develops in the membrane. Although the metal structure is not watertight on its own, it will sufficiently slow the flow of water until a new membrane can be applied to the rupture.

4.5 Does the product progressively worsen following damage/tear/puncture?

No

4.6 Can the defence height of the product be increased during service?

Yes; during service the system height can be increased in two different ways, depending on what is preferable. One way is to add an extension to the first support. If a one-piece support is used instead, the number of layers/rows of panels can then be added to the support, in order to increase the dam height as the water rises. In both cases, enough membrane should be gathered and rolled up at the top of the barrier beforehand - to be able to cover any future extensions.

4.7 Resistance to damage

(a) Wind
Because the barrier is weighed down by chain units, it can withstand windy conditions. If the wind increases, simply add chain - or / and sandbags. The panels are secured from the front and from behind so they will not become loose. When deploying the barrier, with plastic membrane in very windy conditions, it is recommendable to deploy one section completely at the time, making sure every section is weighed down and clips applied before moving on.

(b) Waves
Tests and real flooding situations have proven the barrier withstands waves.

(c) Inertia forces
Erosion can occur when the barrier is erected on erosion sensitive soil like silt. To avoid this force the membrane has to be deployed correctly.

(d) Overtopping (including maximum depth without failure if known)
The barrier has full stability when overtopped by flood water. It is tested for overtopping up to 2.40m by the DNV (Det Norske Veritas).

(e) Floating debris
The membrane is susceptible to puncture from floating debris however this can be repaired easily in service conditions by applying a piece of spare membrane or similar on top of the puncture, like a ‘plaster’. The water pressure will then create suction and make it adhere to the barrier. This ‘gluing’-effect makes it rather difficult to cut a hole in the membrane on the barrier - even when doing it deliberately.

(f) Water pressure
The test by Wallingford Hydraulic Laboratory (BSI Kitemark) proved the system to withstand corresponding water pressure.

4.8 Repair during service conditions
Yes, see above in section 4.7(e).

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
The time required to deploy 100m of defence to a height of 1.25m is 1-2 hrs, with a team of 8 operatives, provided there is a motorised fork-lift on site, to help distributing the barrier material. The more trained the operatives are, the quicker the installation will be carried out. The deployment time is significantly reduced with lower dam heights, as only one layer/row of panels are needed.

5.2 Method of installation (including site preparation)
Manual; installation is manual although transport and access to the site will be needed for the provision the barrier material. Normally, no preparation of the site is needed part from possible removal of sharp objects which can cause unnecessary damage to the plastic membrane.

5.3 Likelihood of incorrect installation
The barrier is easy to understand and deploy, training of key staff is recommended to reduce the chance of incorrect installation. There is a metal 'tray' at the back of each support. It contains the exact number of ring-locks needed for that section and also a security rod. Provided this tray is always filled up after dismantling, an empty tray means that the security rod and the correct number of pins have all been used. There is also a sticker with safety instructions on each support and on the aluminium sheets. We also have a manual with a risk assessment and instructions. The horizontal connection rods will only fit into the supports in one way, which facilitates a correct installation. The plastic membrane is marked with the words "chain line" and "folding line" as a

guidance indicating where the loading chain should be placed and how much overlap of membrane there should be at the back - respectively.

5.4 Storage requirements

There are no special storage requirements other than storing under cover and kept reasonably dry. The barrier can be stored outside, if covered with a tarpaulin or similar. The metal supports are flat-packed.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.

Yes, for large scale use, durable metal crates are available - for supports, aluminium sheets, connection rods, chain, membrane, pumps, corners, adjustable sections and various clips and pins. The crates can be lifted by a fork-lift, are all stackable and can be labelled and colour coded, for easy usage. Each crate will contain enough material of a certain kind (supports, aluminium sheets, connection rods etc) for a certain length. For the 1.25m dam height, this length is typically 40m. If one crate of each type is distributed evenly every 40m, this will facilitate and speed up the deployment.

5.6 Transportation requirements (including mobilisation)

The crates can be transported from a central depot to the site - on trailers or lorries. Alternatively, when there is little lead time, the crates can be stored in a locked container close to, or on site - complete with pumps and everything needed. As the barrier can be deployed in water, this means it is possible to deploy even in flash flood conditions – provided it is planned for.

5.7 Access requirements

Access for trailers or lorries to get system to the site.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☒
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☒

The barriers are suitable for use on rough concrete (not smooth and hard). Sloping surfaces should be positive not negative slopes. For friction soils (asphalt, sand, silt, moraine, gravel,) no extra anchor is needed. For cohesion soils (clay, mud, thick grass) an anchor pin is needed to secure the system. The anchor pin is placed through the 45mm holes on the bottom beam. (One per support.)

5.9 Provision of fixings / Susceptibility to damage or vandalism

The pallet barrier system is a temporary defence and therefore has no permanent fixings to consider. As the barrier needs surveillance in any case (to make sure the pumps are working etc), this means a less risk of vandalism. As the barrier consists of a strong metal structure underneath the plastic membrane, this also means less likelihood of attempts to damage the barrier.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒

Enclosures (around property/properties) ☒
Access locations (permanent breaks in defences (not breaches)) ☒
Other *(see below)* ☒

It can also function as a way of diverting water away from vulnerable areas. It can also be used as a coffer dam in already flooded areas, to speed up the recovery process or for civil engineering purposes in rivers, lakes and canals. The system can be built as a pool or basin, to be used for temporary storage of various kinds (i.e. polluted water or oil spillage etc.).

6. FINANCIAL ASPECTS

6.1 Installation resource requirements

Access is needed for lorries to transport the system to site. Alternatively, an Emergency Flood Container can be placed close to, or on site – for a speedier deployment. A 20ft container can typically contain 300m of barrier, to a dam height of 1.25m, 2 x 3,000 LPM pumps and everything else needed. The number of operatives depends on the warning lead-time, as the barrier can be assembled by one person only, if needed. If wooden pallets are used, a pallet supplier should be arranged prior to its use.

6.2 Installation costs (100 m long x 1 m high – excluding resources)

For a length of 100m to 1.25m dam height, the cost would therefore be between £29,800 - £52,300 depending on barrier material (Pallet, Board or Steel) and storage system (Wooden or Steel Crates). This cost includes freight costs for the delivery.

6.3 Additional installation and removal costs (training/supervision)

We do not include the training cost in the actual product cost, but provide it separately. Typically, we do not include deployment cost as this is - normally - a client assembly product.

6.4 Maintenance requirements

The estimated lifespan of the barrier is 60-90 years, apart from the plastic membrane, which is to be checked and renewed every 10-12 years even if never used. The supports are galvanised and in use for only a few weeks each year. If wooden pallets are used the transport companies maintain the quality of the EUR pallets. Pumps should be regularly serviced and maintained.

6.5 Ease of cleaning (often use in muddy conditions)

The supports are easily cleaned off with a water hose

6.6 Reuse of the products

Yes - Depending on its state, the plastic membrane can be reused after a flood event, provided it is washed off and re-rolled. The system is totally re-usable.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)

2 years

6.8 Deterioration with time

The steel structure has a lifespan of 60-90 yrs but the plastic membrane needs replacing every 10-12 yrs, even if never used.

7. OTHERS

7.1 Product trial or test information

Independent stability reports and tests have been carried out on the barrier system. The system was tested for slip safety (by DNV - Det Norske Veritas – 13619000) in 2004. The test showed the system fulfilled the duty to withstand water (including overtopping) to a height of 2.4m, without being anchored down, on tarmac. There is also a long history of its successful use, across the

world – including the UK. In 2005, VUVH in Bratislava carried out static and dynamic tests during installation failure, to a dam height of 1.25m.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?

Yes.

7.3 Performance under service conditions/ In use

The barrier system has been deployed successfully since the mid 1990s across the world, even though the barrier had been used in Sweden and other European countries since 1995. The longest barrier deployed to date has been in Arvika, Sweden in Nov – Dec 2000 where 1.2km of Geodesign Barrier was used. In the UK, the barrier was part of a DEFRA-funded trial of temporary barriers, carried out by the EA Midlands Region in 2003. It has been used frequently in the Severn Valley in Shrewsbury, Ironbridge, Bewdley, Worcester and Upton-upon-Severn. The barrier was also used to safeguard vital infrastructure during the 2007 summer floods. At National Grid's switching station Walham in Gloucester, around 1km of barrier (dam height 1.25m) was erected in water in 5 hrs. At the nearby Central Network-owned Castlemead substation, the barrier was used to speed up recovery after the site had been flooded. The system was also used by CE Electric the same summer, to protect vital assets in Leeds, Rotherham and Hull. During the North Sea storm surge and threat of flooding in the autumn of 2007, the barrier was deployed around an EDF Energy substation in Great Yarmouth. This barrier was a loan from the EA Midlands region. From the initial call, it took 12 hrs for the EA staff to organise and transport the barrier across the country and finalise the erection of the barrier, with the assistance of local EDF staff. EDF Energy has since invested in their own barriers for emergency use.

7.4 New products or modifications under development.

Yes, we have the new 0.45 dam height barrier. Geodesign Barriers have also replaced previously used tube sandbags with lengths of iron chains, in order to avoid the handling of (often polluted) sand. Durable metal crates, which can be stacked whilst in storage, have been introduced, as an alternative to wooden boxes, which do not last as long as the metal variety.

7.5 Environmental qualities

The Pallet barrier system does not pollute and has high environmental qualities and low environmental impact. All components in the barrier system can be recycled.

7.6 Environmental Impact

Using a temporary barrier instead of sandbag walls is of course in itself environmental friendly and provides a more sustainable alternative.

7.7 Details of clients or locations where product is in service

Environment Agency
National Grid
EDF Energy

In 2003, the barrier was placed just a few metres out in the sea water, off a sandy beach in Sweden. An oil tanker was letting out oil offshore and the idea was to collect oil spillage on a geotextile which had been placed on top – instead of the plastic membrane. The test result was positive as it meant avoiding having to collect the oil on the actual beach.

7.8 Additional comments

Geodesign Barriers can also be deployed in water. This can be done for civil engineering purposes in rivers, lakes or canals (i.e. bridge or wall building, degraveling, scouring repair work etc). It also means the barrier can be deployed even if the flood has already happened. Vital properties and sites can be dewatered and take up normal activities earlier than what would otherwise be possible.

In 2003, the barrier was placed just a few metres out in the sea, off a sandy beach in Sweden. An oil tanker was spilling oil offshore and the idea was to collect oil spillage on a geotextile which had been placed on top – instead of the plastic membrane. The test result was positive as it meant avoiding having to collect the oil on the actual beach.

Geodesign would like to test how the barrier can be used for erosion control along eroding coastlines and in meandering rivers, but no such test has yet been carried out. This would be done without plastic membrane and by allowing nature to 'bury' the metal structure into the ground for a long period of time.

FRAME BARRIERS - RIGID

IBS K SYSTEM

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

IBS K System

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IBS Engineered Products Ltd. (UK Office)
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Tel: 01925 428940
Fax: 01925 244133
Mob: 07734 878514
www.ibsengineeredproducts.com
info@ibsengineeredproducts.com
Contacts: Mr Howard Crouch

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☒	Supplier Assembly ?	☐

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Temporary (totally removable after use)

2.2 General description

The K-System is a mobile temporary flood defence barrier, aimed at both the domestic and community defence sectors. This lightweight aluminium System achieves the benefits of reduced capital cost, rapid deployment prior to a flood event, and a 'flat-pack' design concept that improves on alternative temporary flood defence provision when it comes to removal from site and storing. Additional covering membranes are not required with the K-System design, further reducing installation time and storage space requirements.

FRAME BARRIERS - RIGID

IBS K SYSTEM

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section
Range of lengths available from 0.5m – 2.5m

3.2 Maximum number of coupled units
Unlimited

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
Each panel is 262mm in height

3.5 Maximum installable height
1.3m

3.6 Design for or behaviour around curves/arcs/corners
Special corner elements are available

3.7 Number of vertical joints/sealings (per unit / unit width)
Two, one at each end of the profiles joining with the upright supports.

3.8 Number of horizontal joints/sealings (per unit / unit height)
Total no of joints depends on the installed height, each beam is 262mm in height, there are 2 seals per beam, the beams are designed to interlock to effect the seal

3.9 Width of structure at base (installed state)
Dependant on defence height - max height of 1.3m requires a footprint of 1.6m

3.10 Required storage area per unit (packed dimension)
A 550mm flood height requires 1.16m x 1.31m, a 900mm flood height requires 1.95m x 1.31m, a 1.3m flood height 2.02m x 1.31m, the beams require 2.5m x 1.07m.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☒	Collapse	☐
Breach	☐	Overturning	☒	Seepage	☒		

4.2 Maximum design head of water
1.3m

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre)

4.4 Damage/Tear/Puncture. How does the product behave after damage?
Damage to the metal parts of the barrier would not necessarily affect performance- damage to seals could affect performance.

4.5 Does the product progressively worsen following damage/tear/puncture?
No

4.6 Can the defence height of the product be increased during service?
Yes, by means of additional dam beams.

4.7 Resistance to damage

(a) Wind
Resistant to wind.

(b) Waves
In accordance with PAS 1188-2

(c) Inertia forces
No information
(d) Overtopping (including maximum depth without failure if known)
No information
(e) Floating debris
No information
(f) Water pressure
The system is designed for hydrostatic water pressure with a safety factor of 1.35 according to the following D I N Standards – 19704; 4113;18800;1055; The design calculations were checked and verified when tested by the B S I for the Kitemark and also the L G A in Germany

4.8 Repair during service conditions
Yes. Panels can be removed during an event to change damaged seals assuming the part of the barrier in question is not under water.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
2 operatives require approximately 3 hrs once the system has been delivered to site

5.2 Method of installation (including site preparation)
Manual deployment. Light plant may be required to move the components to site.

5.3 Likelihood of incorrect installation
'The system has been designed with a very limited number of components that are symmetrical, which results in the probability of incorrect installation being low. Also any of the dam beams can accommodate a ground seal'

5.4 Storage requirements
Storage should be in a secure, dry location away from direct sunlight as the U V can affect the seals over long periods of time.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
Storage systems are provided, palletised racks are available for the back supports and beams, bespoke container storage is available on request.

5.6 Transportation requirements (including mobilisation)
Varies per system
Trailer units, flatbeds and lorries are required for transport depending on the size of the scheme.

5.7 Access requirements
Dependant on size and location of scheme, and hence transport requirements.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism
Dependant on location, the panels are lockable by means of lockable pressing tools being used once the panels are in place

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☐
Banks - Up to 400mm waves	☐
Banks - Reservoir banks	☐
Banks - Up to 400mm waves	☐
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
Lifting devices, trailers, manpower are all dependant on size of system

6.2 Installation costs (100 m long x 1 m high – excluding resources)
There is no universal cost, as each scheme needs to be assessed on its own merits and is dependant on fluctuations in the cost of raw materials and currency exchange rates.

6.3 Additional installation and removal costs (training/supervision)
Full commissioning of system - and training of operatives is inclusive in price

6.4 Maintenance requirements
The system should be checked for seal / beam damage after each event or annually

6.5 Ease of cleaning (often use in muddy conditions)
After an event the system would be put away into the storage system and jet washed down with clean water - no chemicals or detergents required

6.6 Reuse of the products
Yes the product is reusable.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
5 years on metal parts 5 years on rubber seals

6.8 Deterioration with time
All metal construction is Aluminium with an estimated service life of 50 years.

7. OTHERS

7.1 Product trial or test information
The product has been trial tested by the E A at Coton Hill Shrewsbury and also by the L G A in Germany to test the integrity of the system

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
Yes

7.3 Performance under service conditions/ In use
Has been used by the Environment Agency and private clients and performed well during service conditions; however there is no specific information on performance.

7.4 New products or modifications under development.
Yes - but commercially sensitive at present

7.5 Environmental qualities
The system does not pollute and all components can be recycled.

7.6 Environmental Impact
The components of the system are essentially inert, comprising of aluminium profiles made from 70% recycled aluminium. As the system is temporary and not permanent feature; any visual impact is minimal. The system is completely removable after use and leaves no permanent damage to the deployment site.

7.7 Details of clients or locations where product is in service
Environment Agency - Coton Hill Shrewsbury
Environment Agency, Romsey -,various locations
Environment Agency, Exeter
Severn Trent Water - various locations
Sequania (private client)
Newsquest International (private client)
Also outside the U K ;
Germany ; Regensberg,Magdeberg,Bad Kreuzbach
France ; Coubon
Australia ; Nathalia
Austria ; Bregenz
Poland ; Stobrawa

7.8 Additional comments
None

FRAME BARRIERS - RIGID

MOBILE FLOOD PROTECTION SYSTEM

1. **PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS**

Mobile Flood Protection System

Flood Protection Systems Sweden AB
Malmo, Sweden
Tel: (+46) 708 306699
www.floodprotection.se
sahbi@floodprotection.se
Contact: Sahbi Belarbi

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☐

2. **DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT**

2.1 Type

Temporary (totally removable after use)

2.2 General description

Demountable Flood Defence Protection comprising of a foldable frame of galvanised metal which encloses a plywood disc. The unit is attached with a hook to the other unit and covered with plastic membrane.

3. **AVAILABLE SIZES / DIMENSIONS**

3.1 Length of unit or section

1.2m

3.2 Maximum number of coupled units

No limit.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☒	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)

0.8m

3.5 Maximum installable height

1.2m

3.6 Design for or behaviour around curves/arcs/corners

Units are flexible are it is possible to create arcs or corners.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two, one at each edge of a unit.

3.8 Number of horizontal joints/sealings (per unit / unit height)
One joint per unit

3.9 Width of structure at base (installed state)
0.9m

3.10 Required storage area per unit (packed dimension)
1.2m x 0.8m x 0.12m per unit, stored with 12 units on special pallets.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☒	Collapse	☒
Breach	☐	Overturning	☒	Seepage	☒		

4.2 Maximum design head of water
The standard unit has a design head of water of 0.8m; this can be increased to 1.2m by an extension.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre)

4.4 Damage/Tear/Puncture. How does the product behave after damage?
The only problem is seepage if the membrane is torn

4.5 Does the product progressively worsen following damage/tear/puncture?
No, however repairs to the membrane should be undertaken to ensure system stability.

4.6 Can the defence height of the product be increased during service?
Yes, by lifting the plastic membrane and attaching an extension panel.

4.7 Resistance to damage

(a) Wind
It can endure wind under normal conditions.

(b) Waves
Waves up to 400 mm

(c) Inertia forces
Very strong construction, not easy moved.

(d) Overtopping (including maximum depth without failure if known)
It maintains its position with low volume of overtopping. Maximum depth not known.

(e) Floating debris
Smaller debris does not damage the system. Damage from larger debris is not known.

(f) Water pressure
Can withstand water pressure to full height of defence.

4.8 Repair during service conditions
Yes, although dependant on nature of damage.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
4 people takes approximately 30 minutes (Standard 1.2m height).

5.2 Method of installation (including site preparation)
Manual, deployment only requires manpower without tools.

5.3 Likelihood of incorrect installation
The system is relatively simple to deploy. All components are attached to a single unit and easily installed.

5.4 Storage requirements
Easy and economic to store on special pallets.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
Racking systems / pallet; 1.2m x 0.8m x 0.12m with 12 units on each pallet.

5.6 Transportation requirements (including mobilisation)
Transport with standard transport systems, such as trailer / container.

5.7 Access requirements
None, as units can be transported by hand to deployment site.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☒
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism
Yes, the membrane can be damaged with a sharp object. Deployed systems may need supervision to prevent vandalism.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
Manpower only.

6.2 Installation costs (100 m long x 1 m high – excluding resources)
The standard system with a protection height of 0.8m costs around £12,000 for 100m of defence; this can be extended to a 1.2m defence height for an additional £8000.

6.3 Additional installation and removal costs (training/supervision)
Yes training is provided on use of the system.

6.4 Maintenance requirements
Periodic inspection of the system whilst in storage should be undertaken.

6.5 Ease of cleaning (often use in muddy conditions)
Easy to clean and wash with water.

6.6 Reuse of the products
Yes, product is reusable

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
Product comes with a 1 year Manufacturers warranty, the steel is galvanized and the plywood is very easy to replace in case of damage.

6.8 Deterioration with time
No significant deterioration, Polythene membrane should be inspected and replaced after use or damage.

7. OTHERS

7.1 Product trial or test information
Co-operation with Lund University. Mathematical Calculations undertaken by Professor Tord Isakson regarding the durability of components.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No

7.3 Performance under service conditions/ In use
Has been used by the Swedish Rescue Department and has performed well in trials and tests.

7.4 New products or modifications under development.
No.

7.5 Environmental qualities
Environmentally friendly. The system does not pollute the deployment site.

7.6 Environmental Impact
The system is totally removable after use and leaves no permanent damage to the deployment site.

7.7 Details of clients or locations where product is in service
Used by the Swedish Rescue Department.
Can you provide us with details of locations or events where your product has been used in a flooding scenario?

7.8 Additional comments
The plastic membrane is commonly disposed of after use and replaced due to contamination from polluted flood waters.

FRAME BARRIERS - RIGID

ALCAN ALUMINIUM DAM LOG SYSTEM

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Alcan Aluminium Dam Log System

Alcan Singen GmbH
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Tel: (+49) 7731 80 0
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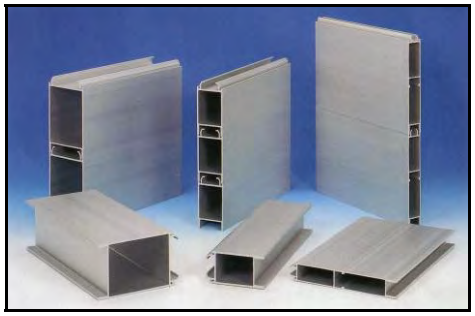
info@alcan-singen.de
www.alcan-singen.de
www.alcan.com

UK Sales
Alcan International Network UK Ltd, Pechiney House, The Grove, Slough, SL1 1 QF
Tel: 01753 555622
Fax: 01753 522800
andrew.weaver@alcan.com
Contact: Mr Andrew Weaver – Sales Manager

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☐

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT



2.1 Type

Demountable (part permanently installed)

2.2 General description

Alcan Aluminium extruded section, 3 sizes of beams: 50 mm wide x 300 mm high, 90 mm wide x 150 mm high, 150 mm wide x 225mm high. All available in lengths up to 7.5m, (longer possible on request). Beams are stacked within upright stanchions. Accessories: Sealing gaskets for horizontal joints, for support slots and for ground seal. Site pre-conditions to be checked by user, support slots to be installed separately on site. Best application: high pressure achievements (high water depth), short distances, but relatively long support-to-support span, single installations without middle support; height up to 5m. Authorised static verification provided, based on this calculation it is easy to calculate possibility for every individual case. Aluminium Alloy EN AW 6063 T6 and gaskets provide good corrosion resistance against aggressive water or sewage, Technical support provided if required.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section
Individual up to 7.5m, longer on request

3.2 Maximum number of coupled units
Limited only by system load limit

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
150 mm, 225 mm and 300 mm

3.5 Maximum installable height
5.0m

3.6 Design for or behaviour around curves/arcs/corners
No

3.7 Number of vertical joints/sealings (per unit / unit width)
Two, where the beams fit into the upright supports.

3.8 Number of horizontal joints/sealings (per unit / unit height)
One per beam joining with either the ground surface or the beam below. Total number of joints is variable depending on installed height and beam widths used.

3.9 Width of structure at base (installed state)
Beams are a maximum of 150 mm wide.
The beams fit into upright stanchions or guides for support.
The width from the front of the beams to the rear of the supports depend on the support used, concrete, steel, wood or aluminium .

3.10 Required storage area per unit (packed dimension)
Storage requirements depend on the number of beams and their dimensions. These are the sizes outlined in section 2.2.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☒
Breach	☐	Overturning	☐	Seepage	☐		

4.2 Maximum design head of water
5.0m, stress curves are available for up to this height. Greater heights are possible with use of internal stiffeners but it is not normally recommended by the manufacturer.

4.3 Behaviour subject to seepage and water tightness
Some seepage (greater than 40 litres per hour per metre)

4.4 Damage/Tear/Puncture. How does the product behave after damage?
Large impacts could influence the load resistance of the system. Smaller impacts can be withstood by the system with no significant effect to stability.

4.5 Does the product progressively worsen following damage/tear/puncture?
No

4.6 Can the defence height of the product be increased during service?
Yes, placing one upon the other, until calculated load limit

4.7 Resistance to damage

(a) Wind
Alcan Dam Logs are not affected by wind.

(b) Waves
Resistant to damage from small waves.

(c) Inertia forces
Force is included in installation calculations and therefore not an issue.

(d) Overtopping (including maximum depth without failure if known)
No influence

(e) Floating debris
In regular use they are resistant against smaller impacts. Can be dented by impacts although material property allows repairs to be undertaken.

(f) Water pressure
Resistant up to calculated height.

4.8 Repair during service conditions
Temporary repairs can be carried out, however replacement of beams during flood conditions are not possible

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
Dependent on support-slots being preinstalled or not. Single beams of 5m length (as an example) -> 100 beams required. Two operatives would take between 1- 2hrs.

5.2 Method of installation (including site preparation)
Manual, single beam per operative; small lifting equipment is useful where there are wider spans to deploy.

5.3 Likelihood of incorrect installation
Geometry makes elements fit easily together.

5.4 Storage requirements
Ventilation is needed to prevent surface corrosion..

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
No.

5.6 Transportation requirements (including mobilisation)
No special requirements. Vans or flat trucks would be needed to transport beams to site if not stored adjacent to the deployment site.

5.7 Access requirements
Access to the site can be as limited to on foot, depending on the number of beams to deploy and the method of mounting.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☐
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☒
Concrete	☒

Other *(see below)* ☒
Alcan aluminium dam log system can also be deployed on steel surfaces.

5.9 Provision of fixings / Susceptibility to damage or vandalism
The geometry and weight of the beams lock together and rely on gravity. The logs do not require fixing at the top of the supports to prevent vertical movement and seepage between the beams

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
Depending from enclosure width: single beam can be lifted into position by two persons manually

6.2 Installation costs (100 m long x 1 m high – excluding resources)
Log prices dependant on section lengths, but as example in 6.0m. lengths (excluding vertical supports), actual prices at time of enquiry as subject to LME prices and f/x rates.
Using 50 x 300 mm cost approximately £12,500 incl. all intermediate and ground seals.
Using 90 x 150 mm cost approximately £20,000 incl. all intermediate and ground seals
Using 150 x 225 mm cost approximately £21,000 incl. all intermediate and ground seals

6.3 Additional installation and removal costs (training/supervision)
No

6.4 Maintenance requirements
No real maintenance required. Inspection of units for damage after use required.

6.5 Ease of cleaning (often use in muddy conditions)
Yes, easy to clean with a water hose.

6.6 Reuse of the products
Yes.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
No.

6.8 Deterioration with time
No.

7. OTHERS

7.1 Product trial or test information
Tested and proved over more than 20 years of sales and application.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No.

7.3 Performance under service conditions/ In use
No specific information. Dam Log system has been used widely within Europe in flood situations.

7.4 New products or modifications under development.
No.

7.5 Environmental qualities
Aluminium is stable, not sensitive or harmful to the environment.

7.6 Environmental Impact
The Dam Log system is removed following an event.

7.7 Details of clients or locations where product is in service
Many installed in smaller facilities; mostly enclosure for maintenance periods: public installations as sluices, sewage plants, rain storage basin / dike openings, channels, water power plants; also as building protection.

7.8 Additional comments
None.

FRAME BARRIERS - RIGID

CARO WATERWALL & WATERDOOR FLOOD PROTECTION PRODUCTS

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Caro WaterWall & WaterDoor Flood Protection Products

Caro Flood Defence Systems
11 Market Hill, Royston, Hertfordshire, SG8 9JN
Tel: 01763 244446
Fax: 01763 244111
info@caro.co.uk
www.caro.co.uk
Contact: Technical Department

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☒	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Demountable (part permanently installed).

2.2 General description

Caro Flood Defence Systems WaterWall and WaterDoor demountable flood protection barrier, uses aluminium extruded panels and posts to BS6063 and EPDM rubber seals. Its key design features are rapid deployment in flooding events and bespoke manufacture to suit any potential problem.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

Between the demountable uprights 0.2m to 1.2m. WaterDoor will span openings up to 2.1m wide, whilst WaterWall will span any subsequent length required.

3.2 Maximum number of coupled units

System can span infinite length with upright supports at a maximum spacing of 1.2m.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
Standard panels are 0.2m in height, or bespoke heights, panels can be fabricated together to make larger sections.

3.5 Maximum installable height
1.2m.

3.6 Design for or behaviour around curves/arcs/corners
The Caro WaterWall & WaterDoor can be designed to fit most scenarios. Caro offer 90 degree posts as standard and can manufacture others to any angle required.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two vertical seals down the inside of the two demountable posts at each end of a section.

3.8 Number of horizontal joints/sealings (per unit / unit height)
One joint per 0.2m board width up to the maximum of 6 boards high.

3.9 Width of structure at base (installed state)
Width of concrete or steel ground beam to be 0.3m with demountable barrier being 0.15m maximum at post receiver/ground insert.

3.10 Required storage area per unit (packed dimension)
Approx 2.0m in length by 0.2m x 0.016m square

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☒
Breach	☐	Overturning	☐	Seepage	☐		

4.2 Maximum design head of water
1.2m

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre)

4.4 Damage/Tear/Puncture. How does the product behave after damage?
Large impacts could influence the load resistance of the system. Smaller impacts can be withstood by the system with no significant effect to stability.

4.5 Does the product progressively worsen following damage/tear/puncture?
No, however damage should be repaired to ensure system integrity.

4.6 Can the defence height of the product be increased during service?
No.

4.7 Resistance to damage

(a) Wind
Structure remains stable

(b) Waves
Structure remains stable

(c) Inertia forces
Structure remains stable

(d) Overtopping (including maximum depth without failure if known)
Not known

(e) Floating debris
Not known

(f) Water pressure
Not known

4.8 Repair during service conditions
Yes, temporary repairs can be carried out; however replacement of panels during flood conditions would not be possible.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
1 person can deploy the system in 2 hours.

5.2 Method of installation (including site preparation)
Manual deployment during event. Pre-installation of concrete or steel ground beam foundation required.

5.3 Likelihood of incorrect installation
Panels and demountable posts are standard dimensions and therefore interchangeable reducing the risk of incorrect installation. However incorrect fitting of the panels is possible.

5.4 Storage requirements
Storage unit can be manufactured to client's request. Manufacturers recommend dry storage away from direct sunlight to prevent rubber from deteriorating.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
Containers, racking systems and trailers are all available on request. Product length 2.0m maximum.

5.6 Transportation requirements (including mobilisation)
No specific vehicle required, the components can be transported by vehicle or manually.

5.7 Access requirements
As components can be manually transported, access to the deployment site can be by foot.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☐
Grassed Surface	☐
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☒
Concrete	☒
Other *(see below)*	☒

Caro can provide ground beams in any stable surface

5.9 Provision of fixings / Susceptibility to damage or vandalism
Yes, additional locking mechanisms available on request.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
Single person required, plant and material not required for deployment. Installation of ground beam may require light plant.

6.2 Installation costs (100 m long x 1 m high – excluding resources)
Installation of a 3m x 1m barrier would be a "budget" price of £1,200 plus VAT. The installation cost is assuming perfect ground conditions exist. Any remedial/proprietary work would be subject to a surcharge. Based on these figures, a pro rata cost for 100m x 1m would be approximately £40,000

6.3 Additional installation and removal costs (training/supervision)
Training included when installed by Caro. If supply only, installation sheets are supplied.

6.4 Maintenance requirements
Maintenance of rubber seals to be annually undertaken

6.5 Ease of cleaning (often use in muddy conditions)
Yes panels and post can be cleaned down easily with water.

6.6 Reuse of the products
Yes

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
12 warranty on all materials

6.8 Deterioration with time
EPDM rubber seals will deteriorate in time due to excessive sunlight

7. OTHERS

7.1 Product trial or test information
Test facility available at our manufacturing plant at request of our clients

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No

7.3 Performance under service conditions/ In use
There are a number of WaterDoor and WaterWall systems in use at one of the Dover Port Authority's Ferry Terminals installed in 2007. During the winter months, the barriers have provided protection to Transit and Office Buildings.

7.4 New products or modifications under development.
Following the recent successful allocation of EU Funding, Caro FDS are currently working to develop flood defences that use recycled plastics. Research is ongoing, with costs and modifications in design still to be determined.

7.5 Environmental qualities
Totally recyclable and manufactured in the UK.

7.6 Environmental Impact
No excessive impact on the environment.

7.7 Details of clients or locations where product is in service
Dover Cruise Terminal Kent
Gloucester Quayside
Haycock Hotel Wansford
Nelson Thorne 27 Bath Street Cheltenham

7.8 Additional comments
None

FRAME BARRIERS - RIGID

COPLASTIX STOP LOGS

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

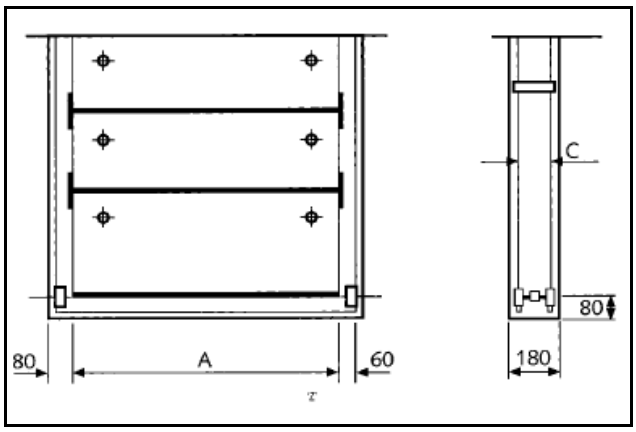
Coplastix Stop Logs

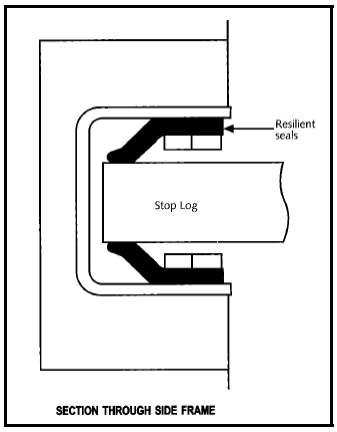
Ham-Baker Ltd
Garner Street, Etruria, Stoke on Trent, Staffordshire, ST4 7BH
Tel: 01782 202300
Fax: 01782 260534
cdimmock@hambaker.co.uk
rhaydon@hambaker.co.uk
www.hambaker.co.uk
Contacts: Colin Dimmock and Ray Haydon

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT





Stainless steel frame.

Stoplog frame:

- Channel mounted into pre-formed rebates
- To span 10m in three frame sections, fixing to 2no. removable centre posts, demountable
- Height split into sections for transport
- Material Stainless Steel Gr316
- EPDM seals, mechanically fixed

Stoplogs:

- Hambaker Coplastix sandwich construction, with a white skin
- Mechanically fixed EPDM seals, pressure sensitive, interlog
- 1no. 300 deep, 2no. 400 deep
- 4no. stainless steel lifting pins per log

2.1 Type

Demountable (part permanently installed).

2.2 General description – Product Range
Standard scope of supply includes:
- Penstocks: Cast Iron; Coplastix and Stainless Steel
- Stoplogs: Aluminium, GRP, Coplastix
- Handstops
- Bellmouths
- Pipes and fittings to suit all your needs

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section
Lengths range between a minimum of 0.4m, up to a maximum of 5.0m.

3.2 Maximum number of coupled units
Designed to suit your requirements, centre posts join multiple units.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
0.4m – 5.0m.

3.5 Maximum installable height
5.0m is standard, can be higher if required.

3.6 Design for or behaviour around curves/arcs/corners
Yes
Corners de-burred

3.7 Number of vertical joints/sealings (per unit / unit width)
Two (one at either end of the logs).

3.8 Number of horizontal joints/sealings (per unit / unit height)
One joint every 0.4m between individual Stoplogs.

3.9 Width of structure at base (installed state)
0.18m

3.10 Required storage area per unit (packed dimension)
Individual logs are 0.4m x 0.18m x width which varies between 1.0m and 2.0m
Up to 5.0m

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☒
Breach	☐	Overturning	☐	Seepage	☒		

4.2 Maximum design head of water
Currently up to 2.0m on logs quoted

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre)

4.4 Damage/Tear/Puncture. How does the product behave after damage?
Dependent on scale of damage!

4.5 Does the product progressively worsen following damage/tear/puncture?
Damage should be repaired to ensure system integrity.

4.6 Can the defence height of the product be increased during service?
Yes, additional logs can be installed provided the frame supports can accommodate them

4.7 Resistance to damage

(a) Wind
Structure remains stable - yes

(b) Waves
Dependent on location

(c) Inertia forces
Structure remains stable

(d) Overtopping (including maximum depth without failure if known)
Stoplogs are designed for a TWL within the log stack. Overtopping can be accommodated, but must be specified.

(e) Floating debris
Would not lead to catastrophic failure

(f) Water pressure
As per design requirement

4.8 Repair during service conditions
Not possible

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
No information

5.2 Method of installation (including site preparation)
Pre-formed rebates required for product quoted
Full details included in our Installation, Operation & Maintenance Manual supplied with the penstock.

5.3 Likelihood of incorrect installation
No information

5.4 Storage requirements
Individual logs are 0.4m x 0.18m x width, which varies dependent on requirement

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
Solution may be provided on requested.

5.6 Transportation requirements (including mobilisation)
For quotation supplied – 300mm logs 143kg (dry); 400mm logs 191kg (dry)

5.7 Access requirements
Require transportation dependent on weight

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☐
Grassed Surface	☐
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☒
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism
Lockable if specified by customer

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other *(see below)*	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
Full Installations, Operation & Maintenance manual provided

6.2 Installation costs (100 m long x 1 m high – excluding resources)
As all systems are designed and manufactured to specific design requirements there is no universal cost for this system. Enquiries of cost for this system should be directed towards the manufacturer.

6.3 Additional installation and removal costs (training/supervision)
No information.

6.4 Maintenance requirements
Full details in IOMs – though normally every 3 months.
Hosing down, checking civil structure integrity, etc.

6.5 Ease of cleaning (often use in muddy conditions)
Hose down with water.

6.6 Reuse of the products
Yes.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
Yes.

6.8 Deterioration with time
No.

7. OTHERS

7.1 Product trial or test information
Product has not been tested or trialled but product is used extensively.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003)?
No.

7.3 Performance under service conditions/ In use
There are numerous schemes where this product is in place.

7.4 New products or modifications under development.
None.

7.5 Environmental qualities
No information.

7.6 Environmental Impact

Coplastix Stoplogs are removable after an event and leave no permanent damage to the deployment site.

7.7 Details of clients or locations where product is in service

- Stublach
- Browney STW
- Silk Stream

7.8 Additional comments

None

FRAME BARRIERS - RIGID

DPS 2000 HOCHWASSERSCHUTZ

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

DPS 2000 Hochwasserschutz

GOH Gesellschaft für operativen Hochwasserschutz mbH
Wiesenweg 32, D-51147 Köln, Germany
Tel: (+49) 2203 / 20 22 3-0
Fax: (+49) 2203 / 20 22 3-11
info@goh.de
claudia.kusch@goh.de
www.goh.de
Contact: Claudia Kusch

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Demountable (part permanently installed)

2.2 General description

DPS 2000 patented flood protection system is constructed from lightweight aluminium dam beams, which are stacked between aluminium support beams. When the water level rises, the interlocking aluminium profiles fill up with water and therefore increase the stability of the wall. Length of protection wall is unlimited and individual solutions can be designed to adapt to local situations. The new "DPS2000-TDB" is available in addition to the standard-system. It contains bigger dam beams and stronger supports. The system was chosen for installation in Nijmegen, (NL) / length 970m and height up to 3.50 m. It was also placed in Switzerland with a total length of 545m and height up to 1.75m

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

Usually 3.0m however up to 6.0m possible. When only water pressure is considered a 1.0m high barrier can have 4.4m long beams and a 2.0m high barrier can have 3.4m long beams. When additional forces need to be taken into consideration (storm, ice-floes or driftwood), the beams will be shorter in order to make them stronger.

3.2 Maximum number of coupled units
No limitation of coupled units, distance between upright supports depends on design requirements of the scheme.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
Standard-beams are 0.2m high, TDB-beams are 0.25m high and Light-beams are 0.15m high.

3.5 Maximum installable height
Usually up to 3.0m, but 4.0m and 5.0m have been designed and installed.

3.6 Design for or behaviour around curves/arcs/corners
The supports can accommodate angles up to 16° each without changes to the system. For bigger angles "corner"-supports are used which are available in different designs.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two

3.8 Number of horizontal joints/sealings (per unit / unit height)
Individual panels are 0.2m high with joints between them so dependent upon height of the installed barrier.

3.9 Width of structure at base (installed state)
Permanently installed ground connections are the widest elements. Each support requires an anchoring plate which is usually 0.27m wide. (But depending on the project and its requirement larger anchoring plates can be necessary; up to 0.4m). If the aluminium supports need to be strengthened by a back brace of steel this needs approx. 0.5m additional space on the dry side.

3.10 Required storage area per unit (packed dimension)
The dam beams and support beams are stored on post pallets. The dimensions of the empty pallets are 1.5m x 0.87m x 0.75m, and the pallets are available in galvanised or painted finish. The dam beams are stored horizontally whereby the individual layers are separated by e.g. thin wooden or PVC battens to prevent galling. The support beams can be stored horizontally or vertically. For vertical storage holes will be incorporated into the base plate of the pallet to accommodate the screw joints of the support beams.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☒
Breach	☐	Overturning	☐	Seepage	☐		

4.2 Maximum design head of water
Assumed up to maximum height of barrier (5.0m). A barrier of 4.6m height was installed fourteen years ago which has functioned successfully.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre)

4.4 Damage/Tear/Puncture. How does the product behave after damage?
Damaged elements can be exchanged separately.

4.5 Does the product progressively worsen following damage/tear/puncture?
No

4.6 Can the defence height of the product be increased during service?
Yes, it is necessary to build up to the complete protection height immediately. The protection wall can be heightened during rising flood levels by inserting more dam beams.

4.7 Resistance to damage

(a) Wind
Each project is designed for the special demands. The statistical calculations determine the section width and support-designs

(b) Waves
Each project is designed for the special demands. The statistical calculations determine the section width and support-designs

(c) Inertia forces
Each project is designed for the special demands. The statistical calculations determine the section width and support-designs

(d) Overtopping (including maximum depth without failure if known)
Each project is designed for the special demands. The statistical calculations determine the section width and support-designs

(e) Floating debris
Each project is designed for the special demands. The statistical calculations determine the section width and support-designs

(f) Water pressure
Each project is designed for the special demands. The statistical calculations determine the section width and support-designs

4.8 Repair during service conditions
Depends on the element which is damaged - mobile elements can be changed.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
4 people would require two hours if the mobile elements are available. The mobile elements are stored on pallets which need to be transported from storage room to the site, which would add additional time. In June 2009 a wall 300m long and 2.25m high was erected in 2.5 hours with 10 people.

5.2 Method of installation (including site preparation)
Manual.

5.3 Likelihood of incorrect installation
Low likelihood of incorrect installation. It is easier if all the aluminium beams and supports are of the same size and dimension.

5.4 Storage requirements
Elements can be stored on pallets - these can be stored in containers or any storeroom.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
The dimensions of the empty pallets are 1.5m x 0.87m x 0.75m, and the pallets are available in galvanised or painted finish.

5.6 Transportation requirements (including mobilisation)
Elements/ pallets can be moved by a forklift and single elements can be transported by hand, for larger projects trucks would be required for transport.

5.7 Access requirements
Depending of the size of the system, single elements can be transported by hand however this will impact on installation time.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☒
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism
Permanent elements can be protected/ mobile elements can be locked

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
A 2.0m high wall which is 100 m long can be erected by 5 persons in three hours. This is for untrained persons and training will reduce this.

6.2 Installation costs (100 m long x 1 m high – excluding resources)
Approximately £51,600 (€60,000).

6.3 Additional installation and removal costs (training/supervision)
No.

6.4 Maintenance requirements
Check the aluminium and the gaskets e.g. annually or after every use.

6.5 Ease of cleaning (often use in muddy conditions)
The elements are cleaned with clear water after use. This usually takes place during dismounting the system. The holes in the anchoring plates are filled with grease before putting in the screws.

6.6 Reuse of the products
Yes, designed for multiple reuses.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
No.

6.8 Deterioration with time
The gaskets need to be exchanged over time depending on the storage and the frequency of use

7. OTHERS

7.1 Product trial or test information
Inspected by the American corps of engineers (see www.floodcontrolam.com), checked by the German TÜV, accepted by Austrian civil engineers, accepted by Italian civil defence, European insurances , patented in Europe, USA and Canada, listed in "BWK-Merkblatt 6/BWK".

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No.

7.3 Performance under service conditions/ In use
Is currently installed and has been deployed successfully in a wide variety of locations worldwide.

7.4 New products or modifications under development.
Since 2008 new system "DPS2000-TDB" is available in addition to the standard system. It contains bigger dam beams and stronger supports.

7.5 Environmental qualities
Individual special solutions adapt to every local situation.

7.6 Environmental Impact
The DPS 2000 system is removable after use. The system only leaves the demountable supports at the deployment site.

7.7 Details of clients or locations where product is in service
The system is already installed in Germany, Switzerland, Austria, Scotland, GB, Ireland, Luxembourg, USA, Canada, Poland, Czech Republic, Netherlands, Italy, Belgium, and ordered in Russia.

7.8 Additional comments
None

FRAME BARRIERS - RIGID

FLOOD ARK

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1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Flood Ark

Flood Ark Limited
Emmerson Industrial Estate, Norwich Road, Lenwade, NR9 5SA
Tel: 01603 879977
Fax: 01603 879964
info@floodark.co.uk
www.floodark.co.uk

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Demountable (part permanently installed).

2.2 General description

Bespoke aluminium and UPVC system comprising of 0.2m deep boards which can be made to suit customer requirements.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

Up to 2.5 metres in one span in compliance with our British Standards Kitemark, all frames are bespoke.

3.2 Maximum number of coupled units

We can provide barriers with a multiple span of up to 2.5 metres.

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)

Each board is 0.2m high.

3.5 Maximum installable height
Can go to full door height but has been tested to 1.0m.

3.6 Design for or behaviour around curves/arcs/corners
No, but can usually be engineered to fit around any configuration.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two (One at each end of the boards)

3.8 Number of horizontal joints/sealings (per unit / unit height)
Up to 5 in 1.0m high barrier (Every 0.2m including seal with the ground surface)

3.9 Width of structure at base (installed state)
100 mm

3.10 Required storage area per unit (packed dimension)
Length of boards x 0.2m x 0.03m (boards sections only)

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☒
Breach	☐	Overturning	☐	Seepage	☒		

4.2 Maximum design head of water
Up to 1.0m.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre)

4.4 Damage/Tear/Puncture. How does the product behave after damage?
No data of this has not arisen to date

4.5 Does the product progressively worsen following damage/tear/puncture?
No

4.6 Can the defence height of the product be increased during service?
Yes
Each individual 0.2m board can be added to frame as and if required

4.7 Resistance to damage

(a) Wind
Hurricane resilience tested in the USA

(b) Waves
Passed BSI PAS 1188

(c) Inertia forces
Not known

(d) Overtopping (including maximum depth without failure if known)
Not known

(e) Floating debris
Not known

(f) Water pressure
One metre head of water BSI PAS 1188

4.8 Repair during service conditions
Yes, temporary repairs can be carried out; however replacement of boards during flood conditions would not be possible

FRAME BARRIERS - RIGID

FLOOD ARK

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
Less than 5 minutes, for a normal system spanning up to a couple of metres.

5.2 Method of installation (including site preparation)
Deployment is manual. Pre-installation of supports required.

5.3 Likelihood of incorrect installation
Low

5.4 Storage requirements
None but storage brackets can be provided

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
Yes wall mounted brackets supplied if requested

5.6 Transportation requirements (including mobilisation)
None

5.7 Access requirements
None apart from access to location where installed

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☒
Flat Soil	☐
Grassed Surface	☐
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☒
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism
No recorded incidents

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
1 person can install the system

6.2 Installation costs (100 m long x 1 m high – excluding resources)
A 1m high system that spans 0.9m with the frame recessed into the ground and a removable, aluminium cover plate would be approximately £1200. Based on these figures, a pro rata cost for 100 m x 1 m would be approximately £120,000

6.3 Additional installation and removal costs (training/supervision)
Yes, training costs included.

6.4 Maintenance requirements
No maintenance just visual checks for signs of damage and distress. The frames are made of aluminium and require no maintenance, but should be kept clean and free from debris. The foam seals should be inspected at regular intervals and replaced if damaged. The UPVC boards should be kept clean, but providing they sustain no damage, no further maintenance is required. The locks may require oil.

6.5 Ease of cleaning (often use in muddy conditions)
Easy to clean, hose down with clean water

6.6 Reuse of the products
Yes

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
Product Failure Insurance

6.8 Deterioration with time
The only element that could deteriorate are the silicone seals, however the manufacturer specifies a 20 year life cycle

7. OTHERS

7.1 Product trial or test information
BSI PAS1188/SCHEDULE OF ACCREDITATION ISSUED BY UNITED KINGDOM ACCREDITATION SERVICE UKAS 1472/ FLORIDA STATUTE 9B-72,SECTION 72.110 (HURRICANE RESILIANCE)

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No, however product has been awarded (BSI) Kitemark for Building Apertures (PAS 1188-1:2003)

7.3 Performance under service conditions/ In use
The system has been tested in the UK British Standards Institute (BSI) and Aston University. And no leakage was found with a 1.1m head of water. In addition the barriers have been tested in the United States for flood and hurricane resilience

7.4 New products or modifications under development.
No

7.5 Environmental qualities
The UPVC and aluminium are recyclable.

7.6 Environmental Impact
The system is removable after use. The system only leaves the demountable supports at the deployment site

7.7 Details of clients or locations where product is in service
Barclays Bank Plc – St Austell
Cash Converters – Dunstable
Nottinghamshire Council
Sheffield Council Offices
Stirlingshire Council
Lincolnshire Police
Environment Agency – Heritage properties in Norwich
Thames Water – Sewer Flooding Mitigation
Anglian Water

Various Schools

7.8 Additional comments

None

FRAME BARRIERS - RIGID

IBS MOBILE WALL FLOOD PROTECTION SYSTEM

1. PRODUCT NAME, SUPPLIER AND MANUFACTURER DETAILS

IBS Mobile Wall Flood Protection System

IBS – Zentrale (Manufacturer)
Gemeindewald 4 - 6, D-86672, Thierhaupten, Germany
Tel: (+49) 8271 8176-00
Fax: (+49) 8271 8176-76
www.hochwassershutz.de
info@ibs-technik.de

IBS Engineered Products Ltd. (UK Office)
Dallam Lane, Dallam House, Warrington, Cheshire, WA2 7LT
Tel: 01925 428940
Fax: 01925 244133
Mob: 07734 878514
www.ibsengineeredproducts.com
info@ibsengineeredproducts.com
Contacts: Mr Howard Crouch

7.9 Product availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☒

8. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

8.1 Type

Demountable (part permanently installed).

8.2 General Description

The IBS Mobile Wall demountable flood defence system is a well-engineered system comprising of lightweight extruded aluminium profiles including supporting posts and dam beams, which can be quickly erected in the event of a flood warning and subsequently dismantled and placed in storage when not in use. When in service the supporting posts are fixed into anchor plates which are cast into a suitably constructed permanent ground beam. The system has a compressible base / ground seal, which negates the need for a ground rail.

2. AVAILABLE SIZES / DIMENSIONS

8.3 Length of unit or section

Variable depending on defence requirement, but typically 2.0 to 4.5m

8.4 Maximum number of coupled units
Unlimited

8.5 Product height range:
Fixed ☒
Extendable ☐
Multiple Unit ☒

8.6 Installed unit height(s) (to apex)
Various profile sizes are available from 150mm – 300mm heights.

8.7 Maximum installable height
5.0m.

8.8 Design for or behaviour around curves/arcs/corners.
Corner posts can be specially designed for individual projects allowing the system to incorporate corners and arcs. Curves can also be achieved by using standard posts and anchor plates depending on the curvature.

8.9 Number of vertical joints/sealings (per unit / unit width)
Two, one at each end of the profiles joining with the upright supports

8.10 Number of horizontal joints/sealings (per unit / unit height)
Two per profile joining it to the profile below. Total number of joints depends on the installed height.

8.11 Width of structure at base (installed state)
Variable depending on load criteria / flood height and axis distance. Width of supporting posts is 0.3m. With back support this can be up to 1.32m. Larger support beams are available depending on the installed height. Generally back supports are provided for heights above 1.5–1.6m.

8.12 Required storage area per unit (packed dimension)
Dependent on the size of the scheme, however an individual storage pallet for beams is 840mm wide but the length is determined by the beam length

3. STRUCTURAL ASPECTS

8.13 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☒
Breach	☐	Overturning	☐	Seepage	☐		

No failures of the IBS system have ever been reported and the system has been used for many years in Germany and worldwide Overtopping could occur if the flood height protection is not adequately specified by client. Overturning and collapse could be a form of failure but this is reliant on the failure of the foundations and not the IBS system itself.

8.14 Maximum design head of water
5.0m

8.15 Behaviour subject to seepage and water tightness.
The IBS system is watertight above the formation level as soon as it is erected. Furthermore the system height can be increased during service without seepage occurring. The IBS system will ensure water-tightness above ground level. IBS recommend a full geotechnical assessment of ground conditions. If significant seepage laterally through the soil is likely this would need to be cut off using a sheet piled wall or similar on which the ground beams and demountables would fit.

8.16 Damage/Tear/Puncture. How does the product behave after damage?
The seals on the dam beams are deliberately kept to a small volume such that in the event of any small damage or leakage occurring this would not compromise the integrity of the system.

8.17 Does the product progressively worsen following damage/tear/puncture?
No

8.18 Can the defence height of the product be increased during service?
Yes, it is possible to carry out a partial erection of the system and increase its height during service. The pressing tool, which locks the upper dam beam in place, can be released and further dam beams added since the hydrostatic pressure in and around the lower hollow beam profile compresses the seals and locks the system firmly in place with no risk of leak or breach.

8.19 Resistance to damage
The extruded aluminium beams are tough and will be difficult to damage. The system is designed to withstand impacts of 20KN/M².

8.20 Repair during service conditions
Repairs could be carried out during service conditions, however due to the size of the seals; small damage to the system could be repaired after the flood event without fear of the system failing whilst in service.

4. OPERATIONAL ASPECTS

8.21 Time required for installation (100 m long x 1 m high)
Once the system is delivered to site a team of 5 men should take 1.5 hours to install. In a trial installation in Linz, Austria, 20 men erected 940m x 2.4m high in 5.5 hours.

8.22 Method of installation (including site preparation)
Defence heights of less than 2.4 m could be installed manually. After this height lifting equipment would be necessary. The site would initially need the construction of the foundations and ground beams. Transport of the system to the site would require forklifts and large lorries.

8.23 Likelihood of incorrect installation
The system has been designed with a very limited number of components that are symmetrical, which results in the probability of incorrect installation being low. Also any of the dam beams can accommodate a ground seal.

8.24 Storage requirements
Storage should be under cover in a shed or warehouse, away from direct sunlight to protect the seals from UV light.

8.25 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
The system is stored on specially designed pallets to accommodate the supporting posts and dam beams respectively for ease of storage and recovery when required for use. Contact between the components on the pallet system is prevented using rubber separators. This obviates unnecessary compression on the seals and avoids contact corrosion.

8.26 Transportation requirements (including mobilisation)
Trailer units, flatbeds and lorries are required for transport depending on the size of the scheme. Forklifts or other lifting equipment will be required for defence heights over 2.4m in height.

8.27 Access requirements
See above

8.28 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☐
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☒

Concrete ☒
Other ☐

IBS state that the system is suitable for most ground types providing that the ground is suitable for a permanent foundation to be constructed and plant can reach the site in times of deployment. IBS do not recommend its use on grassed or sloped surfaces. Although the system can accommodate changes in level and direction.

8.29 Provision of fixings / Susceptibility to damage or vandalism

Lockable pressing tools are available

8.30 Possible locations of use

Banks - Fluvial watercourse flood bank/levee ☒
Banks - Up to 400mm waves ☒
Banks - Reservoir banks ☒
Banks - Up to 400mm waves ☒
As second line defences (away from watercourse) ☒
Enclosures (around property/properties) ☒
Access locations (permanent breaks in defences (not breaches)) ☒
Other ☐

The IBS system is suitable for all locations except the specific openings such as pipes and airbricks.

5. FINANCIAL ASPECTS

8.31 Installation resource requirements

Transport to the site is required; lifting equipment is required for defences over 1.5m in height. Manpower depends wholly on the size of scheme and lead-time available for erection.

8.32 Installation costs (100 m long x 1 m high – excluding resources)

There is no universal cost, as each scheme needs to be assessed on its own merits. A standard straight installation of 100m to a height of 1.05m would cost around £90,175 (ex vat). This includes all beam and post seals, fixtures, fittings and accessories, full design and design drawings, general risk assessment, generic method statement, site visits, training, delivery to site, storage system for posts and beams. The GBP cost is approximate due to fluctuations in the exchange rate with the Euro and the cost of the raw materials as each system is made to order.

8.33 Additional installation and removal costs (training/supervision)

No additional cost as the price of the system includes training and deployment costs. Assistance / supervision with the first and possibly second erection if required can be offered, which would not necessarily be charged for separately.

8.34 Maintenance requirements

The extruded aluminium profiles would not be expected to deteriorate with time provided they are properly maintained and stored away from direct sunlight not in use

8.35 Ease of cleaning (often use in muddy conditions)

The system is easily cleaned with high-pressure hoses but not detergents.

8.36 Reuse of the products

The system is totally reusable.

8.37 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)

5 yrs on metal components and 5 yrs on seals

8.38 Deterioration with time

The components are stored in specially designed pallets, which prevent contact between them. This also provides sufficient air circulation, which facilitates quick drying and contributes to a good

life span. Seals should be inspected after each event for damage or annually along with all system components

6. OTHERS

8.39 Product trial or test information
IBS have their own test bed facility where the behaviour of the materials in continuous use can be monitored and tested. Ice tests and crash tests have also been undertaken.

8.40 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No

8.41 Performance under service conditions/ In use
The IBS system has been in use in Germany and worldwide for several years on rivers such as the Rhine and Mosel, which experience annual flooding. During this time no 'in-service' breaches or failures have been experienced.

8.42 New products or modifications under development.
A "pull up" post has been developed (post stored on site under ground) also Glass walls and a lightweight post which can be manually handled up to 2.4m in height.

8.43 Environmental qualities
The system is quite pleasant in appearance when erected. The system does not pollute and all components can be recycled.

8.44 Environmental Impact
The components of the system are essentially inert, comprising of aluminium extruded profiles made from 70% recycled aluminium. As the system is demountable it is only a temporary and not permanent feature; therefore any visual impact is minimal and only temporary.

8.45 Details of clients or locations where product is in service
For the Environment Agency, a 680m barrier of height 2.1m was installed at Bewdley in 2003 and a 180m barrier of height 3.3m was installed at Shrewsbury in 2002. In addition the system has been installed at 20 locations in Germany, 3 in Austria, 1 in the USA and 1 in Slovakia.

8.46 Additional comments
None

FRAME BARRIERS - RIGID

L SERIES MODULAR DEMOUNTABLE FLOOD BARRIER SYSTEM

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

L Series Modular Demountable Flood Barrier System

Flood Control Ltd
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Fax: 01822 833401
enquiries@floodcontrol.co.uk
sales@floodcontrol.co.uk
John.scoot@floodcontrol.co.uk
www.floodcontrol.co.uk
Contact: Mr John Scoot

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☐

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Demountable (part permanently installed)

2.2 General description

This modular demountable flood barrier system builds up in 0.3m increments and can be used to defend against flood depths up to 4.2m. The system can be retrospectively fixed to any suitable existing concrete foundation or slab using load rated Hilti chemically fixed anchors - the system also has an optional "All Terrain" seal that will take up uneven surfaces and anomalies of +/- 25mm.

The system has a relatively narrow profile; beams 57mm wide and intermediate supports 0.12m x 0.12m making it ideal for mounting on top of RC walls.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

Any length up to 6.5m, spans over 3 metres may need additional bracing depending on barrier height and flood conditions. The section lengths are normalised across the entire span of the system so that all beams are identical sizes and interchangeable.

3.2 Maximum number of coupled units

Unlimited

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
0.3m

3.5 Maximum installable height
4.22m

3.6 Design for or behaviour around curves/arcs/corners
The system can be fabricated to accommodate virtually any configuration including arcs and angles of any degree, the system can also be made to take up slopes of any gradient without the need to step the supports.

3.7 Number of vertical joints/sealings (per unit / unit width)
Two, one at each end of the profiles joining with the upright supports

3.8 Number of horizontal joints/sealings (per unit / unit height)
Two horizontal seals on each beam

3.9 Width of structure at base (installed state)
Beams 57mm Supports 0.24m x 0.24m
The width of the brace varies according to height of barrier and load requirements. For example a 1.5m system not exposed to impact only needs an upright brace with a 180mm footprint. A 3m high barrier subject to wave impact will require 45 degree bracing with a 1.4m footprint.

3.10 Required storage area per unit (packed dimension)
Variable - various storage options available. Storage dimensions for a unit – 2 uprights and max 14 boards, assume 3m long beams. Storage unit will be approx 1m x 0.6m x 3m (HxWxL)

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☒
Breach	☐	Overturning	☐	Seepage	☒		

4.2 Maximum design head of water
The system can be designed for any head of water up to 4.2m, additional loads such as impact and wind load are taken into account. Full specific load calculations are available for every system

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre)

4.4 Damage/Tear/Puncture. How does the product behave after damage?
Localised seepage

4.5 Does the product progressively worsen following damage/tear/puncture?
Not unless structural damage to foundations

4.6 Can the defence height of the product be increased during service?
Yes, the system can be supplied with intermediate compression points at 0.3m increments up to the maximum height of the system. For example a 2.1m high barrier can be built to 0.3m initially and extended up to 2.1m in 0.3m increments as required.

4.7 Resistance to damage

(a) Wind
Can be designed for any wind factor

(b) Waves
Can be designed for any wave impact

(c) Inertia forces
Can be designed for any inertia forces - load calculations provided.
(d) Overtopping (including maximum depth without failure if known)
Will withstand water load up to maximum storage height
(e) Floating debris
Standard calculation is for 10KN impact at 80° at any point along top of barrier.
(f) Water pressure
Static and dynamic loads are included in design calculations

4.8 Repair during service conditions
Yes, although dependant on nature of damage.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
1 person in 4 hours. 4 people in 45 minutes

5.2 Method of installation (including site preparation)
Manual for systems up to 2.1m high, however taller systems require lifting equipment and mobile platforms.

5.3 Likelihood of incorrect installation
On standard systems all beams and intermediate supports are interchangeable – corner and angled supports are specific. Where systems are installed directly onto an uneven surface (e.g. cobbles) the bottom beam has a 50mm seal and must be inserted first. High systems have an option for front loading the beams (rather than top loading) and the intermediate supports must all face in one direction.

5.4 Storage requirements
Various storage options available including local secure GRP housings, Secure local racking systems, palletised storage

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
See above. Storage length depends on beam length & number of components.

5.6 Transportation requirements (including mobilisation)
If stored locally, no transportation required
Remote storage would require the use of a forklift.

5.7 Access requirements
Access to the site would be needed by forklifts, or crane if components stored away from deployment site.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☐
Grassed Surface	☐
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☒
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism
Provided with vandal proof covers and lockable security clamps

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other *(see below)*	☒
Doorways and entrances	

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
Depending on length and height of system - smaller systems can be erected by one person

6.2 Installation costs (100 m long x 1 m high – excluding resources)
£550 - £700 per metre depending on complexity (arcs, corners, angles gradients etc) Based on these figures, a pro rata cost for 100 m x 1m would be approximately £55,000 to £70,000

6.3 Additional installation and removal costs (training/supervision)
Training included – Deployment costs not included as this product is for client assembly.

6.4 Maintenance requirements
Check seals for damage after use and regularly when in storage

6.5 Ease of cleaning (often use in muddy conditions)
Hose down components with clean water

6.6 Reuse of the products
Yes

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
2 Years Warranty on all components

6.8 Deterioration with time
Steel & Aluminium Components 50+ year design life. EPDM Seals 15 - 20 years design life.

7. OTHERS

7.1 Product trial or test information
The factory has a static water test facility – impact and wind loads are calculated on a project by project basis. Generic load calculations are independently certified as per German Government Regulations. TuV (or equivalent) Certification can be provided for individual systems at a cost.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No

7.3 Performance under service conditions/ In use
Designed for most adverse flood conditions – has been installed at various locations in the UK.

7.4 New products or modifications under development.
We have introduced a front loading option to allow the beams of tall systems to be loaded from the front rather than the top of the supports.

7.5 Environmental qualities
All components can be recycled.

7.6 Environmental Impact
System can be powder coated to suite location.

7.7 Details of clients or locations where product is in service
John Lewis Partnership – 180m on banks of Thames
Environment Agency, Wales - Framework agreement - Various sites in South Wales.
Environment Agency - Colne Valley FAS
River Ogmore FAS
Over 2km installed in UK

7.8 Additional comments
None

SECTIONAL BARRIERS - MANUAL

DUTCHDAM

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

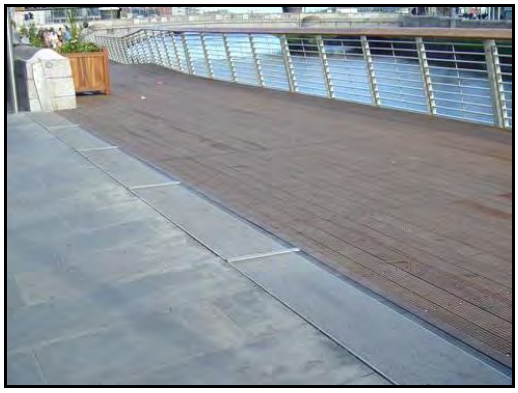
Dutchdam ©

Dutchdam BV
Boddens Hosangweg 84, NL 2481 LA, Woubrugge, The Netherlands
Tel: (+31) (0)172 51 8088
info@dutchdam.nl
corne.rijlaarsdam@kpnplanet.nl
www.dutchdam.nl
Contact: Mr Corné Rijlaarsdam

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☐

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT



2.1 Type

Demountable (fully preinstalled)

2.2 General description

Dutchdam is a folding flood defence system which can be stored on site by folding down into its own case/foundation. Four different types of Dutchdam are in production,

1. The Dutchdam-Bold, equipped with a high load capacity panels (50 kN/m2, depending on defence height and over 400 kN of impact capacity.
2. The Dutchdam-Cento, equipped with mid load capacity panels (20 kN/m2), storage on site or in cabins, panels are extreme compact, during use all parts are locked internally.
3. The Dutchdam-Duplo, foldable into its own casing on site. Available as 0.8m defence height only,
4. The Guard (handrail) version is a custom application of the –Cento, The hand rail is installed permanently, the panels are demountable.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

2.40 metres standard pitch, custom dimensions on request.

3.2 Maximum number of coupled units
Unlimited or as needed

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☒	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
Dutchdam-Bold; multiple sections of 0.25m or 0.385m up to a height of 2.25m.
Dutchdam-Duplo 0.8m (fixed height only)

3.5 Maximum installable height
2.25m

3.6 Design for or behaviour around curves/arcs/corners
Curves can be produced as custom parts on request.

3.7 Number of vertical joints/sealings (per unit / unit width)
One per 2.4m length

3.8 Number of horizontal joints/sealings (per unit / unit height)
Depending on panel heights, e.g. 0.385m or 0.25m.
Maximum of 10 horizontal joints for a 2.25m barrier.

3.9 Width of structure at base (installed state)
Depending on applied height, type and the use of storage on site or elsewhere.

3.10 Required storage area per unit (packed dimension)
Dutchdam Duplo folds down into the foundation.
17cm depth 40cm width 240cm length

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☐
Breach	☐	Overturning	☐	Seepage	☒		

Overtopping is the likely mode as the defence cannot be increased in height during service conditions.

4.2 Maximum design head of water
Cento (wall/quay versions) - 1.0m and 1.5m
Bold (ground version) - 2.25m

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre)

4.4 Damage/Tear/Puncture. How does the product behave after damage?
The Dutchdam systems will not progressively worsen if damaged as the construction is very durable (made of steel or aluminium) and stable due to its design.

4.5 Does the product progressively worsen following damage/tear/puncture?
No

4.6 Can the defence height of the product be increased during service?
The Dutchdam Bold and Cento systems can be increased in height during service to their maximum design height. The Dutchdam Duplo can not be increased in height during service.

4.7 Resistance to damage
The Dutchdam system is not susceptible to vandalism, as the whole system is self contained and stored underground. The strong materials used in its construction limit the possible damage that

may occur. Each panel is locked from the inside by slide bars going from one panel –through the stanchion- into the next section. During storage the cover plates are internally locked.

4.8 Repair during service conditions

If damage does occur, repairs during service conditions may be undertaken.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)

A team of two operatives can set up the Dutchdam in approximately 3-4 hours.

5.2 Method of installation (including site preparation)

Once the Dutchdam is fully installed, which will require plant and machinery for its construction, the operation of the Dutchdam is manual. There is no site preparation apart from the initial construction of the installation.

5.3 Likelihood of incorrect installation

Incorrect deployment is not likely due to its simple design. Construction of the installation will be monitored and checked throughout.

5.4 Storage requirements

None; once the defence is in place there are no transport, mobilisation or storage requirements.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.

Not applicable for the Dutchdam systems.

5.6 Transportation requirements (including mobilisation)

Not applicable for the Dutchdam systems.

5.7 Access requirements

It is important that the top cover of the Dutchdam systems is kept free from obstructions to ensure access to the barrier is possible.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☐
Grassed Surface	☐
Sloping Surface	☒
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism

The Dutchdam systems are completely stored in-situ there are no fixings to be considered. The system is protected from tampering and vandalism by being contained within its own housing and internally installed locking system.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒

Other *(see below)* ☒
Wave environments as the Dutchdam has designed the top 0.4m section to cope with 10x the hydrostatic pressure.

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
Engineering plant and machinery required for the initial installation construction. For deployment, the only requirement is a hand tool for unlocking the cover to the defence housing.

6.2 Installation costs (100 m long x 1 m high – excluding resources)
For the Duplo version excluding the cost of works, the cost would be approximately £602/m (€700/m) therefore = approximately £60,200 for the 100m total length (€70,000)

6.3 Additional installation and removal costs (training/supervision)
Limited, depending on type, training is not required due to its simplicity.

6.4 Maintenance requirements
Physical inspection must be carried out frequently.

6.5 Ease of cleaning (often use in muddy conditions)
The Dutchdam system is durable and can be cleaned easily with water and detergents if necessary

6.6 Reuse of the products
Yes

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
Yes the products are covered by both warranty and according to standard delivery terms by the Dutch metal industry.

6.8 Deterioration with time
It has a long service life of up to 20 years or more. And can be used as often as necessary. Inspection for damage should be undertaken after a flood event has subsided. Rubber seals should be checked and replaced as necessary.

7. OTHERS

7.1 Product trial or test information
Extensive testing of the Dutchdam is currently being carried out at WL Delft Hydraulics commissioned by the Dutch National Water board., including extreme water levels (up to the top) in combination with relative heavy collisions by objects of 600 kg - 2m/sec. A full test report is available in Dutch. Development tests and stress calculations have been carried out. Calculations for inertia forces and water pressure have been undertaken.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No

7.3 Performance under service conditions/ In use
Water pressure up to the top of the barrier (2.25 m)

7.4 New products or modifications under development.
Yes various new products are currently in development.

7.5 Environmental qualities
The Dutchdam-Cento is available without any permanently installed constructive post aside.

7.6 Environmental Impact
Minimal environmental impact, no pollution or cosmetic damage to the environment.

7.7 Details of clients or locations where product is in service

Dublin – Ireland: Dutchdam-Duplo and Dutchdam-Cento built at 9 locations, ordered by the Dublin City Council / Office of Public Works and private companies.
Lismore – Australia: Dutchdam-Bold installed over 50 metres, ordered by the City Council.
Llanwrst / Wales, UK, ordered by the Environment Agency (Dutchdam-Cento-150 and the Dutchdam-Cento-100)
Weston-super-Mare / North Somerset Council, UK, ordered by the Environment Agency; Dutchdam-Bold, for the sea defence splash wall.
Municipality Alblasserdam / The Netherlands: Dutchdam-Cover for the City Cultural Centre "Landvast".

7.8 Additional comments

If stored on site the cover plate is can withstand traffic weight up to 100 kN/0.3x0.3 m (margin up to 165 kN/0.3mx0.3m)

All of the Dutchdam flood barriers are (patented) designs under Copyright
Corné Rijlaarsdam © 2000 – 2009

SECTIONAL BARRIERS - MANUAL

TILT DAM / SPRING DAM

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1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Tilt Dam and Spring Dam

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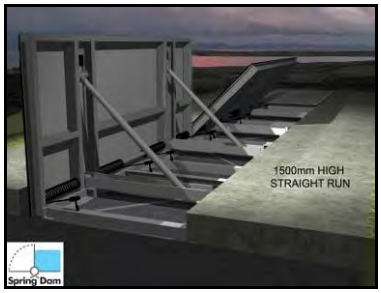
jerry@tiltdam.co.uk
jim@tiltdam.co.uk
www.tiltdam.com
Contacts:-John Forrest, Bill Tustin, Jerry Forrest, Jim Barrack

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☐
Hire / Commission ?	☐	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT



2.1 Type

Demountable (fully preinstalled)

2.2 General description

The primary "product", called Spring Dam, is a permanent in-situ flood defence system deployed by manual rotation which when dormant is a path, roadway or equivalent. This may be a single unit at an opening or a series to form a continuous wall. When unlocked, the slab is manually raised through 90 degrees assisted by the energy stored in the torsion springs (re-energised each time the slab is lowered) to become a flood defence wall. Props are installed to support the vertical slab against subsequent flood water pressure and vertical seals installed between units or end walls and units. A continuous horizontal seal is permanently in place. The slab rests on a concrete base and may be made of galvanised steel or other equally robust materials to suit loading and matching surroundings. The props and seals are stored on the underside of the slab and the only "equipment" required on arrival to mobilise is a key to unlock. Anti-vandal measures are taken into account. Two people can mobilise the system at a rate of one metre a minute.

The system, with a design life of 50 years, is installed initially by casting the concrete base on to which is placed the integral unit of slab (with support frame and inbuilt springs) in the vertical position. All is then lined and levelled to specified tolerances. Lowering the installed slab from the vertical to the horizontal energises the torsion springs.

The system is based on the following design principles - simplicity, robustness, and completeness, speed of mobilisation, longevity and easy maintenance. It has the benefits of being permanently in situ in its entirety, no offsite storage/costs, no transportation risks/costs, no damage risks in handling, matches surroundings, environmentally acceptable and non labour intensive.
There is also Tilt-Dam which is a trench with a counterbalanced tilting lid. The principles are the same. Where Tilt-Dam varies from Spring Dam this is noted in this response.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section
Units can vary in length dependent on size and weight; typical length 3m

3.2 Maximum number of coupled units
Unlimited

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
Flexible depending on flood depth plus any freeboard or wave height allowance.
2.1m "standard" including 0.1m freeboard. The minimum is circa 0.5m and the maximum tested is 1.5m (see 7.1), based on proven design which will effectively apply at greater heights.

3.5 Maximum installable height
2.1m "standard" including 0.1m freeboard with greater heights as special design cases. In theory there is no maximum design head but practically, insertion of the seals into the top of the raised slab limits the height to a maximum of 2.1m. Greater heights can be achieved by inserting the seals from within the “mating” sides of the adjacent slabs.

3.6 Design for or behaviour around curves/arcs/corners
Spring Dam can be designed for curves with a minimum radius of 15m.
Tilt-Dam can only run in straight lines and typically has a feature pillar, or short wall, at direction change.

3.7 Number of vertical joints/sealings (per unit / unit width)
One vertical joint between each unit

3.8 Number of horizontal joints/sealings (per unit / unit height)
Single joint along the length

3.9 Width of structure at base (installed state)
Varies with the flood depth designed for. Width of structure at the base is generally 20% greater than the height of the barrier, stored flat insitu.

3.10 Required storage area per unit (packed dimension)
No storage required - permanent in situ

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☐
Breach	☐	Overturning	☐	Seepage	☐		

4.2 Maximum design head of water
Generally 2.0m plus 0.1m freeboard but greater head can be considered as a special case. This has not been tested.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre)

4.4 Damage/Tear/Puncture. How does the product behave after damage?
There is no potential tear or puncture. Any other form of damage will entail appropriate repair of robust materials (e.g. steel and concrete). Should structural damage occur in operation, it will impair the system but will not result in collapse.

4.5 Does the product progressively worsen following damage/tear/puncture?
No, provided that it is inspected and maintained.

4.6 Can the defence height of the product be increased during service?
No

4.7 Resistance to damage

(a) Wind
Will resist any design wind loading

(b) Waves
Can resist small waves - in relation to flood depth - by added freeboard in fluvial flood defence - not suitable for front line coastal defence but can be used there to cater for overtopping as a second line of defence.

(c) Inertia forces
Dead load plus ground resistance of the base slab (ground trench with Tilt-Dam) provides adequate resistance

(d) Overtopping (including maximum depth without failure if known)
The props provide adequate resistance to deal with general overtopping with pumping from designed sumps on the "dry" side as may be appropriate for the location - (e.g. protection around a building)

(e) Floating debris
Once again the factor of safety in the props design will deal with this

(f) Water pressure
The props are designed for the head of water plus allowance for debris and overtopping as above.

4.8 Repair during service conditions
Not during a flood unless minor and temporary.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
A team of two people can deploy one metre per minute for Tilt-Dam and less time for Spring Dam (for any height up to 2.0m). So for 100m say two hours for Tilt-Dam and one and a half hours for Spring Dam. For two teams of two persons each then these times would be halved and so on, making the systems rapid to deploy and non labour intensive.

5.2 Method of installation (including site preparation)

Manual

Relating to mobilisation, not original installation, the work proceeds progressively and can start at any point (or points for more than one team) in the system run. The lid of each unit is unlocked by special key and rotated by hand through 90 degrees from the horizontal dormant position to the vertical mobilised state. The props and the vertical seals for the joint between units, which are clipped to the back of the lid, are then placed in position, props first followed by seals.

5.3 Likelihood of incorrect installation

Each installation is purpose designed based on standard units for that particular application and as such it would not be possible to install incorrectly. Where non standard lengths may be required then these would be marked accordingly along with complementary marks on the relevant part of the foundation slab.

5.4 Storage requirements

No storage required - system permanent in-situ

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.

Not required

5.6 Transportation requirements (including mobilisation)

None

5.7 Access requirements

It is important that the barriers in their dormant position are kept free from obstructions to ensure that the barrier can be raised. As the barriers are permanently in-situ the only access required is on foot by the operatives.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other *(see below)*	☒

The system can be placed on a whole range of flat surfaces and made to match surroundings (e.g. with Astroturf on a river bank). Where level differences occur or are required, then a pillar can be designed in as a stop end to one height with a different height thereafter.

5.9 Provision of fixings / Susceptibility to damage or vandalism

Not susceptible to vandalism due to appropriate consideration in design

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other – Secondary defences to coastal property	☒

6. FINANCIAL ASPECTS

6.1 Installation resource requirements

There is only one installation process when the system is delivered new, the resources required are those appropriate to the particular site and scale of the project for ground preparation, concrete base formation, lifting and positioning the assembled system followed by commissioning.

6.2 Installation costs (100 m long x 1 m high – excluding resources)

The following are budget costs (for design, manufacture and installation) and in view of the systems being purpose designed for specific sites with specific loading then specific quotations should be obtained -

Flood 0.6m £150,000
Flood 0.8m £170,000
Flood 1.0m £190,000
Flood 1.2m £210,000
Flood 1.4m £230,000
Flood 1.6m £250,000
Flood 1.8m £270,000
Flood 2.0m £290,000

6.3 Additional installation and removal costs (training/supervision)

Each delivered system is provided with an operation, inspection and maintenance manual. This is explained to the appropriate people in the organisation responsible for the system along with any back up teams. System mobilisation and restoration is then undertaken along with those responsible. Tilt-Dam Ltd staff may be contacted if changes occur and there has been no overlap.

6.4 Maintenance requirements

Recommended inspection and any required maintenance every 6-12 months and following action in a flood, principally locks, bearings, seals and props.

6.5 Ease of cleaning (often use in muddy conditions)

Simple hose and brush action working at ground level plus in the trench for Tilt-Dam.

6.6 Reuse of the products

The system is permanently in-situ, designed for repetitive use over the full 50 year design life.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)

Product liability insurance for 12 years

6.8 Deterioration with time

The overall system has a 50 year life with 15-20 years for the seals, all provided that the system is inspected and maintained to manufacturer's recommendations.

7. OTHERS

7.1 Product trial or test information

Each application of the Spring Dam (or Tilt-Dam) system is a bespoke purpose designed installation backed by appropriate warranties. It is therefore considered inappropriate for the BSI Kitemark. A full scale system for a 1.5m flood depth and 3m wide has been designed, manufactured and fully wet tested at the works of our licensed contractor Littlehampton Welding. This has demonstrated performance wholly in accordance with requirements of PAS 1188-4:2009 and there has been virtually no leakage. This installation is available for inspection and demonstration.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No

7.3 Performance under service conditions/ In use
For performance to date please refer to *Section 7.1* above.

7.4 New products or modifications under development.
At Tilt-Dam Ltd continuous innovation and improvement of systems such as Spring Dam (a development from the original Tilt-Dam) and variations on gravity based insitu flood defence is ongoing.

7.5 Environmental qualities
The materials used in manufacture (concrete, steel, timber, recycled PVC) can all be recycled. The surface of Spring Dam can be finished in many forms to match or contrast with surroundings (e.g. roadway, paving, Astroturf, boarding etc) and in city areas illumination through portholes can be incorporated as a special feature.

7.6 Environmental Impact
The system design accompanied by appropriate finishes means that it can blend with its surroundings and become completely unobtrusive. Alternatively, it can become a path or boarded walkway alongside say a river bank. The choice and range is open.

7.7 Details of clients or locations where product is in service
Tilt-Dam insitu flood defence deployed by manual rotation has been installed in early 2008 for Wilson Bowden Developments (reference available) around Vulcan House Iron at Riverside Exchange, Sheffield. This was designed, manufactured and installed successfully under a contract with Littlehampton Welding. Spring Dam is the successor to this Tilt-Dam flood defence, based on the same design principles and with the same benefits plus certain additions such as no ground trench, lighter lids, easier cleaning and maintenance and reduced cost.

7.8 Additional comments
Tilt-Dam Ltd (with Spring Dam and Tilt-Dam as permanent insitu flood defences deployed by rotation) has nevertheless participated in the development of PAS 1188-4:2009 which relates to demountable flood defences.

Spring Dam (and Tilt-Dam), once installed, are permanently in place and ready for service, quick and easy to mobilise by manual rotation and non labour intensive. Spring Dam (and Tilt-Dam) remove the risk of mobilisation and transportation to site of a barrier system and therefore are to be considered as wholly viable solutions where the detriment of a complete wall or bund permanently in sight is unwanted or not possible.

SECTIONAL BARRIERS - AUTOMATIC

SELF CLOSING FLOOD BARRIER (SCFB)

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Self Closing Flood Barrier (SCFB)

Van Den Noort Innovations BV
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Mob: (+31) 65 3193883
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Contact: Johann H.R. van den Noort

UK Flood Barriers (UK Supplier)
Unit 4, West Stone Berry Hill Industrial Estate, Droitwich, Worcestershire, WR9 9AS, UK
Tel: 01905 773282
Fax: 01905 775037
info@ukfloodbarriers.co.uk
www.ukfloodbarriers.co.uk

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type
Demountable (fully preinstalled)

2.2 General description
Self Closing Flood Barrier (SCFB) is a fully preinstalled system automatically powered by floodwater. It consists of a prefabricated steel or concrete chamber containing a polyester floating wall which is installed below the surface of the ground. When not in use it is hidden by a top cover over the structure. Once the floodwater reaches the trigger level of the SCFB the concrete basin of the structure fills with water, causing the polyester wall to rise and float within the chamber, defending the risk area. As soon as the chamber is totally filled, the closing surface will lock the barrier in a watertight position. When floodwaters subside, the basin is drained through a drainage line with one way check valves. The wall returns to its resting position within the chamber. The cover on top of the wall then seals to prevent the inflow of waste or debris. Under normal conditions when the SCFB is not in operation, the system is not visible and does not cause an obstruction to traffic.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section
From 1m to 6m (Units can be joined up to a maximum recommended length of 100m)

3.2 Maximum number of coupled units
Unlimited

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)
0.5m, 1.0m, 1.5m, 2.0m and 2.5m, with alternate heights available upon request.

3.5 Maximum installable height
2.5m

3.6 Design for or behaviour around curves/arcs/corners
The units can be coupled in arcs or coupled to make corners.

3.7 Number of vertical joints/sealings (per unit / unit width)
Each wall element has one vertical joint (joining it with the next wall element)
1.0m and 2.0m elements are coupled by means of a rubber bib within each unit up to 6m. Two rubber elements seal the wall within the frame at each end.

3.8 Number of horizontal joints/sealings (per unit / unit height)
One joint for the full protection height

3.9 Width of structure at base (installed state)
0.6m for the SCFB 500,
0.75m for the CFSB 1000,
1.0m for the SCFB 1500,
1.2m for the SCFB 2000
1.1m for the SCFB 2500.
The widths of the lids on top of the systems are
0.6m for the SCFB 500, SCFB 1000 and SCFB 1500
0.72m for the SCFB 2000
0.86m for the SCFB 2500

3.10 Required storage area per unit (packed dimension)
No storage required

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☐
Breach	☐	Overturning	☐	Seepage	☒		

The SCFB is designed to allow activation by flood waters from three different flow routes minimising the risk of failure of operation caused by blockage of the filling access pipes. The automated activation of the barrier can also be overridden manually by having the barrier connected to the mains water supply.

4.2 Maximum design head of water
The SCFB is designed to withstand water depths to its full defence height for each of the available unit heights.

4.3 Behaviour subject to seepage and water tightness
Some seepage (less than 40 litres per hour per metre)

4.4 Damage/Tear/Puncture. How does the product behave after damage?
The wall is constructed with a PUR-foam core in a very strong sandwich construction and reinforced by laminated steel strips. The wall does not absorb water and will retain its buoyancy even if damaged.

4.5 Does the product progressively worsen following damage/tear/puncture?
No, the SCFB is made from durable materials and will not significantly worsen following damage.

4.6 Can the defence height of the product be increased during service?
No

4.7 Resistance to damage

(a) Wind
No influence

(b) Waves
No influence

(c) Inertia forces
No influence

(d) Overtopping (including maximum depth without failure if known)
The wall can tolerate overtopping without failure. Overtopping tests have been undertaken with no damage .also structure of wall assists

(e) Floating debris
In order to minimize collision damage floating debris, exposed areas in the floating wall are protected by Kevlar.

(f) Water pressure
The design of the wall is calculated to withstand a minimum of 10 times the sideways water pressure.

4.8 Repair during service conditions
Due to wall construction likelihood of minor damage is not needed to be repaired.

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
The SCFB takes between 30 seconds to a few minutes to become fully closed. The speed of closure will depend on the flood characteristics e.g. the speed at which the water is rising.

5.2 Method of installation (including site preparation)
Operation of the barrier is Automatic (however the barrier can also be operated manually if needed.)

5.3 Likelihood of incorrect installation
Support is provided by the manufacturer in the construction/installation of the SCFB. This includes extensive "Instructions on the Construction of the Self Closing Flood Barrier".

5.4 Storage requirements
Storage is not needed as the barrier is self contained underground.

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
The system does not require storage solutions as it is fully preinstalled.

5.6 Transportation requirements (including mobilisation)
Transportation is not needed

5.7 Access requirements
It is important that the top of the wall is kept free from obstructions to ensure closure is possible

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☒
Sloping Surface	☒
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☐

The SCFB system is suitable in any type of surface with a good foundation

5.9 Provision of fixings / Susceptibility to damage or vandalism
The SCFB when not in operation is stored within the ground under a protective cover. When the SCFB is in operation, the materials and construction methods make it difficult to damage.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☒
Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
No resources are needed to operate the SCFB

6.2 Installation costs (100 m long x 1 m high – excluding resources)
0.5m high (SCFB500) = approximately £2,150 per metre (€ 2,500/m)
1.0m high (SCFB1000) = approximately £2,580 per metre (€ 3,000/m)
2.5m high (SCFB2500) = approximately £5,160 per metre (€ 6,000/m)

6.3 Additional installation and removal costs (training/supervision)
There is no need for service staff to operate the barrier as the system is fully self operating. Minimal training is only needed for a very small number of staff

6.4 Maintenance requirements
Due to the automated operation of the SCFB. It is essential to have a Maintenance Plan in place. The Maintenance Plan should include the following as a minimum requirement:
Annually
- Hydrostatic testing of each complete system from intake structure to the SCFB unit(s) by filling with a water hose.
- Checking for leakage of seals at the base of the rising wall during the hydrostatic test. Replace seals that show signs of leakage.
- Visual inspection of seals at the ends of the flood wall. Replace seals that have perished or cracked.

Every 6 months
- Testing of the submersible pump.
- Testing and cleaning of the non-return flap valves in the Service Pit.
- Testing of alarms to the building Manager's office and off-site monitoring station.
- Testing of alarms linked to the evacuation system.
- Cleaning of debris from intake structure gratings.
- Cleaning of silt from control pits.

The frequency of testing may be modified based on experience of the system operation.

6.5 Ease of cleaning (often use in muddy conditions)
The SCFB is very easy to clean. Can be cleaned with a water hose.

6.6 Reuse of the products
The SCFB is a permanent system which can be operated regularly.

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
Each SCFB installed system carries a warranty on its manufacture of 1 year as well as installation faults including any incurring leakages of more than 0.1 l/m/min. Product to be checked annually

6.8 Deterioration with time
The SCFB system remains virtually maintenance free and will not deteriorate significantly over time. The steel elements are protected by a two-compound coating (Redox EP Ferroflake) and a Cathodic Protection (PC) other parts can be manufactured in stainless steel

7. OTHERS

7.1 Product trial or test information
Assessed against the criteria of the Dutch Water Board, which it passed.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No

7.3 Performance under service conditions/ In use
The SCFB has been installed in a number of locations worldwide. Carrick on sure operates at least 3 times per year successfully without damage or operating failure

7.4 New products or modifications under development.
The SCFB recently has been redeveloped. Allowing for easier maintenance and closing operation easier.

7.5 Environmental qualities
The SCFB operates automatically using the flood water and requires no power. It is also noise free.

7.6 Environmental Impact
When the SCFB is not in use, it is flush to the ground and hidden from view therefore has no visual impact or causes an obstruction.

7.7 Details of clients or locations where product is in service
1 Yamanouchi, Meppel the Netherlands 2 SCFB 1000 barriers of 6 metres
2. Carrick on Sure, Ireland 2 SCFB 1000 barriers of 3 metres
3. Boulder,Colorada, USA 2 SCFB 1250 barriers of 1,5 metre
4. Yamanouchi, Meppel the Netherlands 1 SCFB 1000 barrier of 11 metres
5 Narabeen, Australia SCFB 1500 barrier of 5 metres
6. New York, USA 2 SCFB 1500 barriers of 7 metres
7. Colorado USA 2 barriers 1500 of 8 metres
8 Marrickville Australia SCFB 1500 of 5 metres
9 2 barriers have been installed at the national; archive in Washington DC

7.8 Additional comments
Developed by Van den Noort Innovations BV, The Netherlands, the SCFB was judged the best Civil Technical Invention in the world by the 24th Salon International des Inventions.
For more see website www.floodbarrier.nl

FLOOD GATES – MANUAL

LIFT HINGED FLOOD GATES

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Lift Hinged Flood Gates

Flood Control Ltd
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enquiries@floodcontrol.co.uk
sales@floodcontrol.co.uk
John.scoot@floodcontrol.co.uk
www.floodcontrol.co.uk
Contact: Mr John Scoot

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☒
Hire / Commission ?	☐	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Demountable (part permanently installed)

2.2 General description

The lift hinged flood gate can be used on a completely flush threshold. A lifting mechanism enables the flood gate to rise up to 0.2m on opening. Installation therefore requires no humps, raised sills or steps thus eliminating all trip hazards. The gates are fabricated in stainless steel and aluminium and are 70% lighter than equivalent steel flood gates. They feature a patented single lever locking mechanism and can be safely and easily operated by any able bodied person. Unlike steel gates these do not need cast-in frames and can be retrospectively fixed to any suitable structure. Gates can be designed to open inward or outward up to 180°.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

Designed to requirements up to 4.5m.

Double gates designed to requirements up to 8m.

3.2 Maximum number of coupled units

2

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)

Any Height up to 1.5m in 100mm increments

3.5 Maximum installable height

1.5m

3.6 Design for or behaviour around curves/arcs/corners

N/A

3.7 Number of vertical joints/sealing's (per unit / unit width)

Two per gate (on the vertical upright sides)

3.8 Number of horizontal joints/sealing's (per unit / unit height)

One per gate (making a seal with the ground surface)

3.9 Width of structure at base (installed state)

0.08m

3.10 Required storage area per unit (packed dimension)

No storage required - Gate is permanently installed.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☐
Breach	☒	Overturning	☐	Seepage	☒		

4.2 Maximum design head of water

Individually designed to withstand maximum head of water to the height of the gate.

4.3 Behaviour subject to seepage and water tightness

Heavy duty EPDM seals ensure gates remain water tight with no seepage. The EPDM seals are extremely durable, reforming after prolonged periods of compression.

4.4 Damage/Tear/Puncture. How does the product behave after damage?

Damage to the seals or gate components would result in some seepage.

4.5 Does the product progressively worsen following damage/tear/puncture?

The gates would not progressively worsen after damage to the seals. Impact to the gates would have to exceed the design rating to cause damage. Gates are individually designed / rated to withstand 10KN at 80° along the top of the gate.

4.6 Can the defence height of the product be increased during service?

No

4.7 Resistance to damage

(a) Wind
Load Rated as applicable

(b) Waves
Load Rated as applicable

(c) Inertia forces
Load Rated as applicable

(d) Overtopping (including maximum depth without failure if known)
Extensive overtopping may be a likely mode of failure.

(e) Floating debris
Rated for 10kN at 80° along top of system

(f) Water pressure
Load rated for full head of water

4.8 Repair during service conditions
No

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
Gates can be manually closed within 2 minutes.

5.2 Method of installation (including site preparation)
Manual operation. Threshold should be free from debris to ensure water tight seal can be made with the surface.

5.3 Likelihood of incorrect installation
Permanent fixture - cannot be incorrectly deployed

5.4 Storage requirements
None - Gate is permanently in place

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
Not Applicable - Gate is permanently in place.

5.6 Transportation requirements (including mobilisation)
None

5.7 Access requirements
Gate entrance must be kept clear of obstructions to ensure closure is possible

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☒
Grassed Surface	☐
Sloping Surface	☐
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other *(see below)*	☒

Gates must be mounted directly onto level watertight surface. Banks and soil would require the construction of a concrete sill to ensure water tight seal.

5.9 Provision of fixings / Susceptibility to damage or vandalism
Vandal Resistant Covers to protect seals and hinges. Gates can be padlocked in both open and closed position.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☐
Banks - Up to 400mm waves	☐
Banks - Reservoir banks	☐
Banks - Up to 400mm waves	☐
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☐
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
One operative.
6.2 Installation costs (100 m long x 1 m high – excluding resources)
Supplier installation of a dual gate of maximum width 8m x 1m high = £21,000
6.3 Additional installation and removal costs (training/supervision)
Training is included within the cost. Deployment can be undertaken within 2 minutes.
6.4 Maintenance requirements
Bearings are lifetime lubricated. All steel components are 316 grade stainless, all aluminium parts are T6 grade aluminium powder coat finished so no ongoing maintenance required. Spindles and winding mechanisms benefit from periodic (annual) lubricating.
6.5 Ease of cleaning (often use in muddy conditions)
Hose with clean water
6.6 Reuse of the products
Gates are designed for daily use
6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
Two Years Warranty covers all components & seals – excludes misuse and accidental damage.
6.8 Deterioration with time
All steel & aluminium gate components have 50 Year design life. EPDM seals do not deteriorate significantly and can be expected to last 15 to 20 years before replacement.

7. OTHERS

7.1 Product trial or test information
Each gate is factory tested before shipping. All fixings are load rated. Heat treated aluminium extrusions to BS1474. Stainless steel sections manufactured to EN10088.
7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No
7.3 Performance under service conditions/ in use
Has been effectively used in full height floods at Deerhurst and in several YEDL sub-stations.
7.4 New products or modifications under development.
We have recently designed a range of steel floodgates suitable for floods up to 2.1 metres
7.5 Environmental qualities
All components can be recycled
7.6 Environmental Impact
No environmental impact once installed. Gates can be powder coated to match surroundings
7.7 Details of clients or locations where product is in service
River Rother FAS - 15 gates installed. Environment Agency
Deerhurst - Tewksbury 2 gates installed. EA Norwich 2 gates installed
Tewksbury Council/Environment Agency
Over 40 flood gates installed in electricity sub-stations throughout Yorkshire & the North. Yorkshire Electricity Distribution Ltd. Northern Electricity Distribution Ltd.
7.8 Additional comments
None

FLOOD GATES – AUTOMATIC OR MANUAL

HYDRAULIC FLIP UP BARRIER

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Hydraulic Flip-Up Barrier

Flood Control Ltd
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enquiries@floodcontrol.co.uk
sales@floodcontrol.co.uk
John.scoot@floodcontrol.co.uk
Contact: Mr John Scoot

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	x
Hire / Commission ?	☐	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Demountable (part permanently installed)

2.2 General description

This system is available in a wide range of configurations from a manually operated system raised with a portable hydraulic pump through to a computer controlled and monitored fully automated barrier. Automated systems can be supplied with UPS back-up and mission critical systems fitted with a full set of independent back-up operating mechanisms which automatically take over in the event of primary system failure. In the event of a catastrophic failure the systems also have an independent manually operated mode, making this the most reliable and dependable automatic flood barrier system available. Individual barriers can be anything up to 15m long and multiple barriers can be joined via intermediate supports to protect openings of virtually any size.

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

Designed to order up to 2.4m

3.2 Maximum number of coupled units

Multiple units may be joined by intermediate supports

3.3 Product height range

Fixed ☒ (single unit height)
Extendable ☐ (single unit plus extension)
Multiple Unit ☐ (stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)

Dependant on the width required, barrier heights up to 2.4m are available as standard

3.5 Maximum installable height

Subject to design considerations, barriers in excess of the standard height 2.4m can be manufactured up to 4.0m

3.6 Design for or behaviour around curves/arcs/corners

Multiple linked barriers can form arcs or angles.

3.7 Number of vertical joints/sealing's (per unit / unit width)

Standard system has one continuous pneumatic seal
Option to have two independent pneumatic seals for mission critical systems

3.8 Number of horizontal joints/sealing's (per unit / unit height)

Seal is with barrier – continuous pneumatic seal

3.9 Width of structure at base (installed state)

Dependant on height of barrier required.

3.10 Required storage area per unit (packed dimension)

No storage required - Gate is permanently installed.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☐
Breach	☐	Overturning	☐	Seepage	☒		

Design of system is such that it is virtually impossible for barrier to collapse
Barrier is 10mm plate steel

4.2 Maximum design head of water

Fully load rated for design height

4.3 Behaviour subject to seepage and water tightness

Some seepage (less than 40 litres per hour per metre)

4.4 Damage/Tear/Puncture. How does the product behave after damage?

Seepage may occur after damage to the barrier or seals
Standard seals are EPDM with an additional nylon fabric reinforcing mesh for puncture resistance.
Alternative Nitrile seals are available for locations where oil resistance is required.
Kevlar reinforcing is also available for explosive environments.

4.5 Does the product progressively worsen following damage/tear/puncture?

The barrier would not progressively worsen after damage to the seals. Impact to the barrier would have to exceed the design rating to cause damage. Barriers are individually designed / rated to withstand 10KN at 80° along the top of the gate.

4.6 Can the defence height of the product be increased during service?

No

4.7 Resistance to damage

(a) Wind
Load Rated as applicable

(b) Waves
Load Rated as applicable

(c) Inertia forces
Load Rated as applicable
(d) Overtopping (including maximum depth without failure if known)
Extensive overtopping may be a likely mode of failure
(e) Floating debris
Rated for 10kN at 80° along top of system
(f) Water pressure
Load rated for full head of water

4.8 Repair during service conditions

No

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)

Automatic hydraulic closing – 60 seconds.
Manual hydraulic closing - 2 minutes.
Manual winch closing – 5 minutes.

5.2 Method of installation (including site preparation)

Barrier is automated but also fitted with a separate manual pump to allow manual operation should the automated systems fail. Ultimate failsafe operation is provided by a winch system. All operating modes are standard.

5.3 Likelihood of incorrect installation

Permanent fixture - cannot be incorrectly deployed

5.4 Storage requirements

None - Gate is permanently in place

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.

Not Applicable - Gate is permanently in place.

5.6 Transportation requirements (including mobilisation)

None

5.7 Access requirements

Barrier in open position must be kept clear of obstructions to ensure closure is possible.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☐
Grassed Surface	☐
Sloping Surface	☒
2.5m Wide Banktop	☒
4.0m Wide Banktop	☒
Wall	☐
Concrete	☒
Other	☐

5.9 Provision of fixings / Susceptibility to damage or vandalism

Very robust steel unit so low susceptibility to vandalism

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee ☒

Banks - Up to 400mm waves	☒
Banks - Reservoir banks	☒
Banks - Up to 400mm waves	☒
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☒
Access locations (permanent breaks in defences (not breaches))	☒
Other	☐

6. FINANCIAL ASPECTS

6.1 Installation resource requirements

Automatic operation – unmanned.
Manual operation – 1 operative.

6.2 Installation costs (100 m long x 1 m high – excluding resources)

Supplier installation of a single barrier of maximum width 12m x 1m high = £50,000

6.3 Additional installation and removal costs (training/supervision)

Training is included in price.

6.4 Maintenance requirements

Bearings are lifetime lubricated

6.5 Ease of cleaning (often use in muddy conditions)

Hose with clean water.

6.6 Reuse of the products

Gates are designed for daily use

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)

Two Years – warranty covers all components including electronics.

6.8 Deterioration with time

All steel & aluminium gate components have 50 year design life. EPDM seals do not deteriorate significantly and can be expected to last 15 to 20 years before replacement.

7. OTHERS

7.1 Product trial or test information

Factory & Commission Tested.

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?

No.

7.3 Performance under service conditions/ in use

No Information.

7.4 New products or modifications under development.

None.

7.5 Environmental qualities

All components can be recycled.

7.6 Environmental Impact

No environmental impact once installed.

7.7 Details of clients or locations where product is in service

Wakefield Waterfront Regeneration Scheme - 6 hydraulic barriers providing 50 metres flood protection to 1.9m storage. All controlled by central computer system.
Barratt Homes - Wandsworth - fully automated system

AIB Credit Card Centre - Dublin - 6 flip-up barriers

7.8 Additional comments

Dual independent hydraulic systems are now fitted on critical systems with automatic switch over if one unit fails. There is also a separate manual pump option as a further level of failsafe.
Ultimate failsafe is provided by manual winch operation.

FLOOD GATES – MANUAL OR AUTOMATIC

PIVOT BARRIER

1. PRODUCT NAME, MANUFACTURER AND SUPPLIER DETAILS

Pivot Barrier

Flood Control Ltd
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John.scoot@floodcontrol.co.uk
Contact: Mr John Scoot

1.1 Product Availability

Buying / Purchase ?	☒	Client Assembly ?	☐
Hire / Commission ?	☐	Supplier Assembly ?	☒

2. DIAGRAM AND (GENERAL) DESCRIPTION OF PRODUCT

2.1 Type

Demountable (part permanently installed)

2.2 General description

This system is specifically designed to be installed in access locations; it can be fitted either internally or externally. When not in use the barrier beam stands vertically to one side of the opening leaving a totally clear access. The barrier is fitted with powerful gas assist mechanisms which enable the barrier to be effortlessly raised and lowered by one person, making it ideal for immediate deployment in flash flood situations. We also provide an automated version of this barrier which can be linked to alarm systems and sensors for unattended operation

3. AVAILABLE SIZES / DIMENSIONS

3.1 Length of unit or section

Designed to order up to 6m

3.2 Maximum number of coupled units

Two with a removable intermediate post

3.3 Product height range

Fixed	☒	(single unit height)
Extendable	☐	(single unit plus extension)
Multiple Unit	☐	(stackable unit of fixed height)

3.4 Installed unit height(s) (to apex)

0.1m to 0.6m

3.5 Maximum installable height

0.6m

3.6 Design for or behaviour around curves/arcs/corners

Can form corner with two barriers linked by removable post

3.7 Number of vertical joints/sealing's (per unit / unit width)

Two per gate (on the vertical upright sides)

3.8 Number of horizontal joints/sealing's (per unit / unit height)

One per gate (making a seal with the ground surface)

3.9 Width of structure at base (installed state)

Dependant on the height of the barrier

3.10 Required storage area per unit (packed dimension)

No storage required - Gate is permanently installed.

4. STRUCTURAL ASPECTS

4.1 Likely modes of failure

Overtopping	☒	Rolling	☐	Sliding	☐	Collapse	☐
Breach	☒	Overturning	☐	Seepage	☒		

4.2 Maximum design head of water

Fully load rated for design height

4.3 Behaviour subject to seepage and water tightness

No seepage

4.4 Damage/Tear/Puncture. How does the product behave after damage?

Seepage may occur after damage to the barrier or seals

4.5 Does the product progressively worsen following damage/tear/puncture?

The barrier would not progressively worsen after damage to the seals. Impact to the barrier would have to exceed the design rating to cause damage. Barriers are individually designed / rated to withstand 10KN at 80° along the top of the gate.

4.6 Can the defence height of the product be increased during service?

No

4.7 Resistance to damage

(a) Wind
Load Rated as applicable

(b) Waves
Load Rated as applicable

(c) Inertia forces
Load Rated as applicable

(d) Overtopping (including maximum depth without failure if known)
Extensive overtopping may be a likely mode of failure

(e) Floating debris
Rated for 10kN at 80° along top of system

(f) Water pressure
Load rated for full head of water

4.8 Repair during service conditions
No

5. OPERATIONAL ASPECTS

5.1 Time required for installation (100 m long x 1 m high)
Automatically closing – 1 minute
Manual closing – 1 minute.

5.2 Method of installation (including site preparation)
Barrier can be automatically or manually operated.

5.3 Likelihood of incorrect installation
Permanent fixture - cannot be incorrectly deployed

5.4 Storage requirements
None - Gate is permanently in place

5.5 Are storage solutions supplied with/available for the product e.g. containers/ racking systems/ trailers.
Not Applicable - Gate is permanently in place.

5.6 Transportation requirements (including mobilisation)
None

5.7 Access requirements
System is fully preinstalled so there are no access requirements.

5.8 Adaptability to terrain conditions (Surface type)

Any Surface	☐
Flat Soil	☐
Grassed Surface	☐
Sloping Surface	☐
2.5m Wide Banktop	☐
4.0m Wide Banktop	☐
Wall	☐
Concrete	☒
Other *(see below)*	☒

Can be mounted directly onto any level watertight surface.

5.9 Provision of fixings / Susceptibility to damage or vandalism
Barrier is lockable in both open and closed positions.

5.10 Possible locations of use

Banks - Fluvial watercourse flood bank/levee	☐
Banks - Up to 400mm waves	☐
Banks - Reservoir banks	☐
Banks - Up to 400mm waves	☐
As second line defences (away from watercourse)	☒
Enclosures (around property/properties)	☐
Access locations (permanent breaks in defences (not breaches))	☒
Other *(see below)*	☒

Roller and security shutter entrances

6. FINANCIAL ASPECTS

6.1 Installation resource requirements
Automatic – unmanned
Manual – 1 operative

6.2 Installation costs (100m long x 1.0m high – excluding resources)
For the standard unit which is 5m long x 0.6m high the automatic system costs £17,000.00 and the manual system costs £5,500

6.3 Additional installation and removal costs (training/supervision)
Training is included in the price.

6.4 Maintenance requirements
Bearings are lifetime lubricated. All steel components are 316 grade stainless, all aluminium parts are T6 grade aluminium powder coat finished so no ongoing maintenance required. Spindles and winding mechanisms benefit from periodic (annual) lubricating.

6.5 Ease of cleaning (often use in muddy conditions)
Hose with clean water

6.6 Reuse of the products
Gates are designed for daily use

6.7 Product covered by manufacturer's warranty. (Length, type and limitation of warranty)
Two Years
Warranty covers all components

6.8 Deterioration with time
All steel & aluminium gate components have 50 Year design life. EPDM seals do not deteriorate significantly and can be expected to last 15 to 20 years before replacement.

7. OTHERS

7.1 Product trial or test information
Factory & Commission Tested

7.2 Has the product been awarded (BSI) Kitemark for Temporary and Demountable Flood protection products (PAS 1188-2:2003) ?
No

7.3 Performance under service conditions/ in use
Over 200 systems installed no specific information on performance.

7.4 New products or modifications under development.
No

7.5 Environmental qualities
All components can be recycled

7.6 Environmental Impact
No environmental impact once installed

7.7 Details of clients or locations where product is in service
Over 200 systems installed, clients include ICI and Coca Cola

7.8 Additional comments
Slot in manual systems are also available.

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Published by:

Environment Agency
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Waterside Drive, Aztec West
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