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

Digital Good Practice Manual: Identifying mitigation measures for good and maximum ecological potential

Science Report: SC060065/SR2



Product code: SCHO0809 BQWL-E-P

Environment Agency

defra
Department for Environment Food and Rural Affairs

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Steve Killeen

Head of Science

Executive summary

This report covers an important task in Phase 1 of the development of a Digital Good Practice Manual, namely the production of a technical report proposing a checklist and guidance for assessing whether a flood risk or land drainage scheme represents good environmental practice and, if not, what further mitigation measures/techniques could be undertaken without significant adverse effects on the flood defence or land drainage objectives. This involves activities on rivers, lakes, estuaries and coastal waters with a view to complying with the requirements of the Water Framework Directive (WFD) but without having adverse impacts on their use (and taking into account costs).

Phase 1 of the Digital Good Practice Manual is reported in a parallel report. This report describes a series of flood risk management (FRM) trials on heavily modified water bodies (HMWBs). The results of these trials (and iterative development of checklists) has fed back into the broader work of UKTAG, which has coordinated trials in all water sectors, including ports, navigation, water resources and hydropower. This report has also drawn on other initiatives, principally the Environment Agency project *Managing Hydromorphological Pressures in Rivers*.

This report covers four trials conducted primarily for FRM, namely:

- Hogsmill Stream (FRM - Rivers)
- Lower Thames (FRM – Rivers and Navigation)
- River Irwell (FRM – Rivers)
- Pagham (FRM - Transitional and Coastal (TRAC))

For the trialling, UKTAG initially prescribed testing three approaches (or proformas) to determine whether a water body is below, close to, or at good ecological potential (GEP). The main finding of this report is that GEP cannot be determined per se by the UKTAG decision-making tool alone (whichever of the suggested approaches (or proformas) is adopted). Whilst from an FRM perspective UKTAG Approach B is the most user-friendly, even this process does not allow a conclusion to be drawn on whether the water body is at, below, or above GEP. Conclusions from the FRM trials are that expert judgment is needed and UKTAG Approach B is recommended as a means of transparent recording of the audit trail. Equally important are the comments that are likely to arise and these should be recorded by the scribe. It is very probable, for example, that a water body might be judged to be close to or at GEP from an FRM perspective but to be degraded by activities unrelated to one of the recognised sectors (for example, on the Lower Thames extensive piecemeal bank protection by riparian landowners).

In addition to reporting the outcomes of the trials, this report makes recommendations on the classification process of all HMWBs which needs to be completed by the Environment Agency and others as soon as possible. It is suggested that the process of classification will take place as facilitated meetings, probably at area level of the Environment Agency, with the help of nationally-trained facilitators to ensure consistency across all areas. Time constraints (the need to classify a large number of water bodies in a short period of time) and the views of experts with “knowledge of their patch” may force grouping of water bodies together (for example, based on similar characteristics of adjacent water bodies) or similar river, transitional water, coastal or lake “types”. Thus if a template (proforma) is developed for one water body, this might be extended (with appropriate tailoring and recording of differences) fairly rapidly to similar types in the area, region, or indeed nationally. Some early and tentative guiding principles for grouping water bodies are given in this report.

Acknowledgements

The assistance of area staff within the Environment Agency who made themselves available at short notice is gratefully acknowledged. Select members of the Steering Group have also provided constructive comments during compilation of this report.

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1 Introduction

1.1 Purpose of overall project

This work forms part of a wider project to develop guidance (a Digital Good Practice Manual) on mitigation for flood risk management (FRM) and land drainage activities on rivers, lakes, estuaries and coastal waters to help comply with the requirements of the Water Framework Directive (WFD) but without adversely impacting their use (and taking into account costs). A specific aim is for the guidance to be in digital form, to enable selection of cost-effective combinations of mitigation measures. This guidance will be applicable to Scotland and Northern Ireland as well as England and Wales. The entire project will take until early 2009 to complete.

Phase 1 of this work is summarised in a parallel report (Jacobs, 2008). Phase 1 involved review of national and international best practice (including interviews and questionnaires); review of effectiveness of measures/techniques to improve biological quality and the development of a rapid assessment tool for existing schemes to identify scope to reduce adverse impacts. Phase 1 also involved the production of a checklist and guidance for assessing whether a flood risk management or land drainage scheme represents good environmental practice.

Future phases of the work include Phase 2 which will specifically address prioritisation of measures, produce a technical report identifying the cost-effectiveness of measures/ techniques and author more detailed guidance sheets. Phase 3 will involve designing the digital aspects of the manual (to be placed on the Environment Agency's website) and trialling the product using case studies and operational staff from across the UK.

1.2 Purpose of this report

This report concerns a specific aspect of Phase 1, namely the production of a technical report proposing a checklist and guidance for assessing whether a flood risk or land drainage scheme represents good environmental practice and, if not, what further mitigation measures could be undertaken without significant adverse effects on the flood defence or land drainage objectives.

This purpose of this report is to provide information for classifying good ecological potential (GEP) of water bodies, in particular to see which measures/techniques could be used to assess whether a water body is reaching GEP. The report describes a series of flood risk management (FRM) trials to glean this information and to trial a process for eventual classification.

This part of project also feeds directly into the production of UKTAG guidance on the classification of ecological potential for heavily modified water bodies (HMWBs) and artificial water bodies. This wider UKTAG guidance covers all water sectors (flood risk management, land drainage, ports, navigation, water resources and hydropower). UKTAG has been supported by Royal Haskoning as consultants. As part of the trialling UKTAG has prescribed for testing a series of approaches (or proformas) intended to determine whether a water body is below, close to or at GEP.

In addition to reporting the outcomes of the trials, this makes tentative recommendations on the classification process of all HMWBs which needs to be

completed by the Environment Agency and others early in 2008. Please note that subsequent to the drafting of this report (in December 2007), UKTAG produced a final report with guidance on the classification of ecological potential for heavily modified water bodies (HMWBs) and artificial water bodies (AWBs). Jacobs also produced for the Environment Agency some further guidance in April 2008 entitled *Outlining the Process for Establishing if a Candidate A/HMWB is at GEP*.

1.3 Approach to trialling

The trials described in this report concerned heavily modified water bodies (HMWBs) from a flood risk management perspective. The land drainage sector was not included in the scope of these trials and neither were AWBs. In any HMWB and in any sector, it will be difficult to achieve good ecological status, a state where the biological quality elements (for example benthic invertebrates and fish) of a water body deviate only slightly from conditions that would be present if the water body was undisturbed by human activity. For these water bodies, an alternative objective of good ecological potential (GEP) can be set in relation to reference conditions; for HMWBs the reference condition is defined as the maximum ecological potential (MEP). MEP is the maximum ecological quality that could be achieved once all mitigation measures have been applied. GEP is the state where biological, hydromorphological and physicochemical quality elements deviate only slightly from the MEP that is obtainable for the water body without having significant adverse effects.

By definition, HMWBs may have undergone a wide range of physical alterations (such as widening, deepening, straightening, embanking and lining with artificial materials) and therefore have an ecological state that is far from natural. An alternative has therefore been made available to EU Member States (and adopted by UKTAG for the UK), in particular estimating MEP and GEP based on those mitigation measures that could be taken to potentially improve the ecology of the water body without having a significant adverse impact. This alternative is outlined in Figure 1.1.

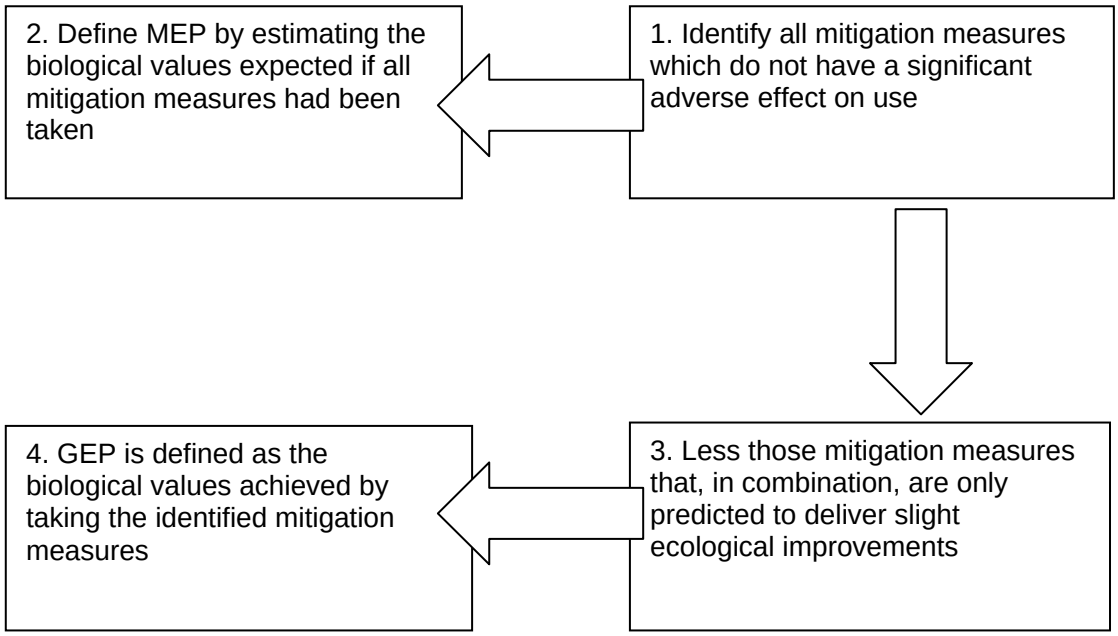


Figure 1.1 Alternative process (after UKTAG November 2007 and based on a WFD Seminar in Prague in 2005).

The alternative in Figure 1.1 has been prescribed by UKTAG to deal with pressures in all water sectors (ports, navigation, water resources, hydropower, FRM and land drainage). Its purpose (through trialling) is to assess which measures could be applied to a water body to classify whether it is attaining GEP. Where GEP is not being met, mitigation measures that will help to improve hydromorphology and support achievement of GEP need to be defined. The timescale for classifying water bodies is tight. Just as the WFD aims for all inland and coastal waters to achieve good status (including good ecological status and good chemical status) by 2015, so HMWBs have to achieve the objective of GEP in the same timeframe.

Based on the alternative process illustrated in Figure 1.1, UKTAG asked for a series of approaches (or proformas) to be trialled by the water sectors. Initially (and prior to the FRM trials) an Approach A and an Approach B were recommended for trialling, whilst for the later trials a further approach was devised (herein called Approach A modified).

These three approaches are all intended to determine which measures could be applied to a water body to classify whether it is attaining GEP. Where GEP is not being met, the approaches aim to elicit those mitigation measures which would help to improve hydromorphology and support achievement of GEP. All three approaches rely on assessing individual mitigation measures by asking a series of sequential questions. The example shown in Table 1.1 includes the questions (numbered sequentially from (1) to (7)) proposed in Approach B for a water body. Note that the ordering of columns and precise wording of the questions varies according to the approach prescribed for a particular trial (initially A and B, then a modified Approach A).

Table 1.1 Example questions taken from UKTAG Approach B.

(1) Is the pressure present? If so , If not, X.	(2) Is there an impact as result of the pressure? If so ( ), if not, document evidence.	(3) Is the measure to deal with legacy issues or ongoing activities? If so , if not, X.	(4) Is the measure applicable to local characteristics of the water body? If so , If not, document reasons why the measure has been discounted.	(5) Can the measure be taken forward without having significant adverse impact on use or wider environment? If yes , if no document why not.	(6) Does the measure (alone or in combination with others) offer more than a slight ecological benefit? If so , if not document the reasons why only a slight ecological benefit.	(7) For remaining measures check if the measure is already in place. Where measure is not in place please , where the measure is already in place please document.

Moving sequentially from left to right, each question is answered with a 'Yes' or a 'No'. Effectively each mitigation measure is considered valid for a water body unless a question screens it out. Where a measure is screened out, an appropriate explanation/justification is required (for transparency purposes and the audit trail).

The questions are important as they capture wording in the WFD legislation. There are differences in the ordering of questions in Approach A and Approach A (modified). These differences are made apparent in the individual trials which conclude with a preferred approach.

The key elements to the decision-making process are:

- identification of where pressures and impacts are present at a given site;
- identification of whether proposed measures (to mitigate any pressures or impacts) are appropriate given the existing use of the system (for example, if there will be a significant negative impact on flood risk);
- identification of where measures are already in place and whether they adequately mitigate for the impacts.

Where measures only apply to a particular sector, but there are mutliple uses, the potential impact of the mitigation measure should also be considered in relation to those uses/users.

For any approach UKTAG has provided general principles and would not wish to see, for example, any measures ruled out at an early stage by a question relating to 'impact on use and the wider environment'. UKTAG has also stipulated that none of the measures be dismissed prematurely, although if any measure is proven to be disproportionately expensive it is possible to set a longer timeframe to achieve GEP (by 2021 or 2027). Alternatively if achieving GEP is disproportionately expensive, in absolute terms, a less stringent ecological objective can be set. The FRM trialling examined all three approaches.

UKTAG produced a draft report in December 2007 on *Guidance on the Definition of Ecological Potential for HMWBs and AWBs*. This has since been made into a final report (UKTAG, 2008). This report supports the process of identifying which mitigation measures are required to meet GEP, and assessing whether those measures are in place. The classification of being below, at, or above GEP will need to take account of the original reasons for designation as a HMWB (or AWB) and consider the particular mitigation measures that could be taken for use. This guidance does not identify the precise mitigation needed at a local site, nor does it provide any design guidance. The alternative default objective setting process for HMWB/AWB (summarised in Figure 1.1 above) only serves as a starting point to identify where measures are actually needed to help the water body achieve GEP and where the water body does not require measures as it is already at (or above) GEP. This guidance will be reviewed and updated for each of the river basin planning cycles as method and understanding improves. The reviews will take into account experience, application of the guidance, information from environmental monitoring programmes, research projects on impacts resulting from physical modification and new practical measures and techniques.

1.4 Links with science initiatives

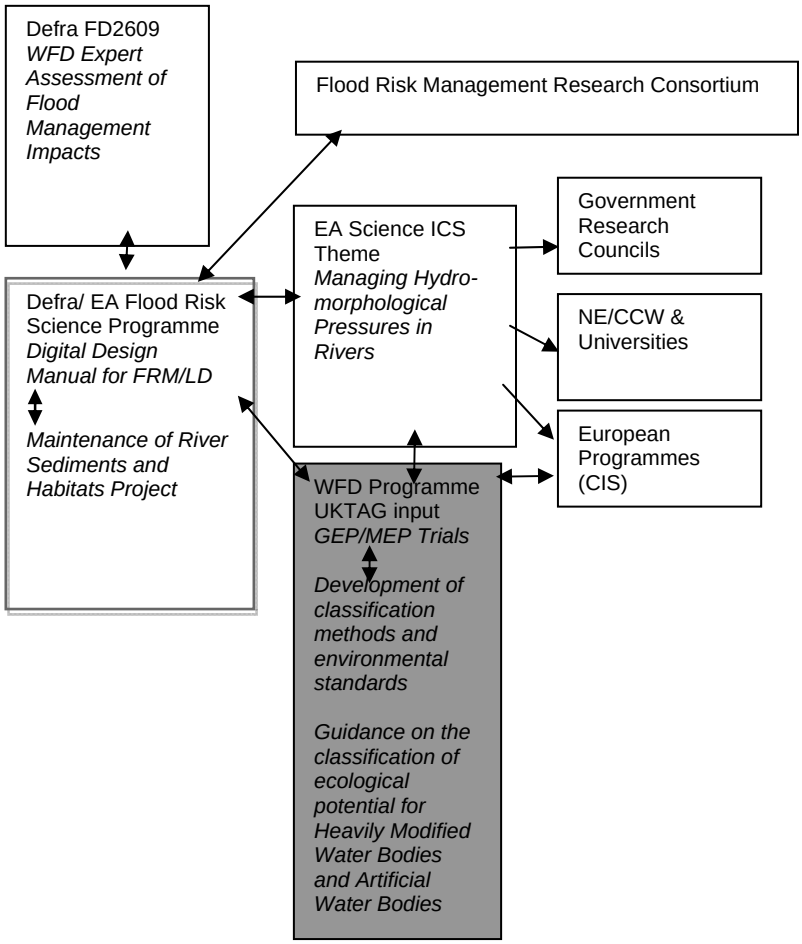
The link between this Digital Good Practice Manual and other key science initiatives is shown in Figure 1.2 below. The Digital Good Practice Manual is under one theme of the joint Defra/Environment Agency Flood Risk Science Programme. It has a key link with the *Maintenance of River Sediments and Habitats* Project. This theme in turn links to several other projects, one of which is the Defra FD2609 project on *Expert*

Assessment of Flood Management Impacts under the Strategy and Policy Development Theme. The Digital Good Practice Manual also links to the Environment Agency's Integrated Catchment Science (ICS) Theme, of which a sub-strategy is hydromorphology. The *Managing Hydromorphological Pressures in Rivers* Project is part of a toolkit for river management addressing hydromorphological pressures affecting good ecological status/ potential. This project involves a better understanding of pressure-impact responses, improved use of existing data and information and science in support of restoration and mitigation programmes. It is envisaged that in the short term (2009-2015) quick-win proven measures will be adopted, whilst in the medium term piloting and monitoring will lead to the development of new measures and good practice. Wider measures will be delivered between 2015 and 2021.

Both the Digital Good Practice Manual and the hydromorphology sub-strategy of the ICS Theme link to the UKTAG work. Two important links are with the GEP/MEP trialling work which included identification of mitigation measures and the development of the UK-wide classification methods and environmental standards that aim to meet the requirements of the Water Framework Directive (such as WFD SNIFFER 49 concerning *Trialling of MImAS and proposed Environmental Standards*). This provides a direct link to the work in developing the MImAS tool. Since the drafting of this Report UKTAG has produced a final report (31 March 2008*) – Guidance on the classification of ecological potential for Heavily Modified Water Bodies and Artificial Water Bodies.*

The Flood Risk Management Research Consortium (www.floodrisk.org.uk) aims to undertake an integrated programme of research to support flood risk management.

Figure 1.2 Linking science initiatives.



2 Flood risk management measures

This section outlines the development of the proforma, the listing of measures for rivers, lakes and TRAC waters, and the initial checklist which was developed as part of Phase 1 of the Digital Good Practice Manual. It also outlines the consultation that has enabled iteration of the measures/techniques.

2.1 Development of checklist

Task 1 of the Digital Good Practice Manual (Jacobs 2008) developed the checklist of measures from an extensive review whilst the trials described in this report used (and further developed) those checklists. Feedback from the trials has been invaluable in strengthening Phase 1 (and subsequent phases) of this project.

The navigation sector (for example) has already evolved its checklist of measures (Association of Inland Navigation Authorities June 2007). Therefore whilst derived from an extensive review (Task 1), as far as practicable the FRM checklists were consistent with that already produced by the navigation sector. Although used in the trials, these checklists of measures are open to further development subject to consultation in Phase 2 of the Digital Good Practice Manual.

The checklist of measures was inevitably simplified and "lumped" rather than "split" into a large number of measures and sub-measures. Development of the checklists (for rivers, lakes and Transitional and Coastal (TraC) water bodies) is described in more detail in Jacobs (2008). Each measure is related to a potential impact, which in turn is derived from a pressure or sub-pressure and reflected in the headings of Table 1.2.

Table 2.1 Development of checklist.

Pressure	Sub-pressure	Impact	No.	Mitigation measures

The checklist of measures (see Section 2.1 above) was combined with the questions in the respective UKTAG approaches (see Section 1.3 above) to provide single proformas for trialling purposes.

2.2 List of measures

Table 2.2 (below) provides a summary of the measures/techniques reviewed. These have all been used at one or more locations around the world. Each measure may apply to more than one pressure/sub-pressure. Some apply generically across all environments (rivers, lakes, transitional waters and coasts). Several river mitigation measures apply to FRM and land drainage activities. Please note that this is the latest version as it appears in the Digital Good Practice Manual Phase 1 Report.

Table 2.2 Summary of measures/techniques covered.

Reference Number Rivers	Reference Number Lakes	Reference Number TRAC	Measure/technique
1, 4	1, 6		Removal of existing hard bank reinforcement/ revetment or replacement with soft engineering scheme
2, 5	2		Protect and enhance ecological value of marginal aquatic habitat, banks and riparian zone
3, 6			Protect and restore aquatic habitats (through river restoration)
7			Operational and structural changes to dams, sluice and weirs
8	5	16	Install fish passes
9	6	14, 18	Removal of structure
10			Retain marginal aquatic and riparian habitats
11		12	Increase in-channel morphological diversity e.g. install in-stream features; two-stage channels and geometric variation
12, 14			Re-opening existing culverts
13, 15			Alteration of channel bed
16			Flood bunds
17	8		Set-back embankments
18, 19			Improve floodplain connectivity
20			Enhance aquatic and riparian habitats
21	9		Sediment management strategies
22			Appropriate channel maintenance strategies and techniques (minimise disturbance to channel bed and margins)
23			Appropriate channel maintenance strategies and techniques (remove wood only when in vicinity of urban area)
24			Appropriate vegetation control regime

Reference Number Rivers	Reference Number Lakes	Reference Number TRAC	Measure/technique
25			Appropriate techniques to prevent transfer of invasive species
26			Appropriate techniques to align and attenuate flow to limit detrimental effects of these features
27			Water level management
28	11		Land management strategies (develop and revise)
3, 10, 11	3		Amend design (re-naturalise) bed and banks
	4		Undertake operational and structural changes to control structures
16	7		Remove flood banks/walls
	10		Adopt an appropriate release strategy (e.g phased de-watering, small frequent release cycles)
		1	Removal of hard engineering (e.g. naturalisation)
		2	Modify existing structures
		3	Replacement with soft engineering solution
		4	Bank re-profiling
		5	Managed realignment of flood defence
		6, 11, 20	Restore/create/enhance aquatic and marginal habitats
		7, 9, 13, 17, 21	Indirect/offsite mitigation (offsetting measures)
		8	Sediment management strategies (develop and/or revise)
		10	Material emplacement strategies (develop and/or revise)
		15	Operational and structural changes to locks, sluices and tidal barrages
		19	Modify structure design

2.3 Initial checklist

The following checklist is taken directly from Phase 1 Report of the Digital Good Practice Manual (Jacobs 2008). This is intended (at this stage) to be a rapid assessment tool and is shown in Table 2.3 below. This is developed for each of the measures/techniques described in Section 2.2 above in Section 5 of the Phase 1 Report (Jacobs 2008).

Table 2.3 Proposed screening tool for rapid assessment.

Where has it been applied (geographically)?	
At what scale (reach, individual river, catchment)?	
To what type of environment has it been applied?	
What is the basis for its use?	
Was it successful? What criteria used?	
What were the potential environmental risks/benefits?	
What ecological impacts/improvements?	
Are there any other non-physical impacts?	
What monitoring is in place?	
What are the general learning lessons?	
What is the scientific evidence to demonstrate an ecological benefit?	Are there any papers published on this measure in scientific journals? Has a digest of results been produced? Does a systematic review of the literature exist? Overall, what is the quality of the scientific evidence base?
Indication of order of costs	
Is there an impact on the key use?	

2.4 Consultation to date

The process of developing the checklist of measures for FRM activities and the specific UKTAG approach was iterative in the trials which were held during November and December 2007. In addition to consulting members of the Digital Good Practice Manual Steering Group, Table 2.4 (below) lists consultations with UKTAG for this task.

Table 2.4 Consultation undertaken for this task.

Consultation	Description
11 September 2007 Meeting in Birmingham, with a limited number of stakeholders (attended by all sector representatives).	At this meeting a MS PowerPoint Presentation was given for FRM depicting progress to date on the Digital Good Practice Manual. Whilst some semblance of a checklist of measures was presented, following this meeting an intense period of development of the checklists (for rivers, lakes, transitional waters and coasts) took place.
22 October 2007 Internal Meeting in London with UKTAG Coordinator.	This involved a discussion of progress on FRM checklists and provisional programme for trialling. The FRM checklists were initially released at this meeting but marked "provisional" as they had not been road-tested at that stage.
20 November 2007 Internal Progress Meeting with UKTAG in London (attended by representatives from ports, navigation and water resources sectors).	Two FRM trials (Hogsmill and Lower Thames) had taken place prior to this meeting and a report-back was made on the effectiveness of the two different approaches (A and B) available at that time.
23 November 2007 Workshop in Birmingham with a wider range of stakeholders (and attended by all sector representatives).	FRM MS PowerPoint Presentation given to UKTAG and stakeholders. This presentation has been placed on the UKTAG website.

3 Flood risk management trials

FRM trialling took place in November and December 2007 for all sectors. The general findings from the FRM trialling were fed back to UKTAG to assist development of generic guidance (UKTAG December 2007). This was subsequently fed into a final report produced for UKTAG on 31 March 2008 entitled *Guidance on the classification of ecological potential for Heavily Modified Water Bodies and Artificial Water Bodies.*

Because of their infrequent use for FRM purposes, 'natural' lakes were not trialled.

Given the timescale and other constraints, a limited number of trial sites were selected for FRM. Initially a total of seven were allowed for, with four being predominantly FRM pressures (with one also involving navigation) (see (i) to (iv) below):

(i) Hogsmill Stream (FRM - Rivers)

(ii) Lower Thames (FRM – Rivers and Navigation)

(iii) River Irwell (FRM – Rivers)

(iv) Pagham (FRM - TRAC)

(v) Portsmouth Harbour (Ports and Navigation and FRM Ports)

(vi) Yorkshire (Water Resources and FRM Rivers)

(vii) Any Other Site

The remaining three (v, vi and vii) were for "other sector" trials where FRM (as a use) would make an input. To date, only one of these has been completed (Portsmouth Harbour) and is reported more fully as part of the ports sector trials. The UKTAG Coordinator had proposed a trial involving an Internal Drainage Board, although the results of this are still pending and not referenced in this report.

To ensure consistency in developing the approach (outlined in Section 1.3 above), the UKTAG Coordinator attended the initial FRM Hogsmill Stream trial.

3.1 Selection of sites for trialling

For the four FRM-led trials, this section considers the reasons for their selection.

3.1.1 Hogsmill Stream (FRM - Rivers)

The Hogsmill Stream is approximately six miles long and is located in South West London. It flows in a northerly direction mainly as a concrete channel through the urban areas of Epsom and Kingston upon Thames. The catchment is a highly urbanised area of approximately 73 km^2 and there is limited scope for typical strategic flood risk measures such as storage. The stream has been affected by industrial, commercial and residential property development. Historically a series of mills has operated along its length and it was also widened and deepened in the 1930s and 1940s. Extensive installation of wooden toe-boards has also been undertaken in the more recent past. The stream is a tributary of the River Thames and has its confluence at Kingston. The water body was also chosen partly because of Jacobs' prior knowledge of the catchment from their involvement in the Department for Environment,

Food and Rural Affairs (Defra) project concerning integrated urban drainage pilot study of which the Hogsmill is one of the 15 case studies. It is representative of a highly urbanised catchment in England and Wales. This Defra project is currently testing new approaches to reduce the impact of urban drainage flooding, so that towns and cities across the country are better prepared for the impacts of climate change.

The Hogsmill Stream was provisionally designated as heavily modified for FRM. It was also selected as part of the GEP/MEP trials as the entire catchment is within one water body (Number 45) and thus the trial avoided any upstream or downstream impacts that could potentially be associated with catchments containing multiple water bodies. In addition, the water body is not complicated by the involvement of other water sectors. It was therefore selected as a simple water body for the first FRM trial, as all the pressures and potential mitigation measures are contained. The Hogsmill Stream trial was undertaken on 8 November 2007 at the Environment Agency office in Frimley. The trial involved two representatives from the Environment Agency, one from asset management (representing the 'developer') and one from conservation (representing the 'regulator'), as well as a senior consultant from Jacobs with expert knowledge of the Hogsmill Stream. Facilitator and note taker (scribe) roles were sourced by Jacobs.

River Hogsmill: Water body summary	
Location:	South West London
Area:	Thames Region
Component water bodies:	45
Pressures:	
Bank and bed reinforcement and in-channel structures	Hard protection; dams, sluices and weirs
Channel alteration	Realignment/re-profiling/regrading; culverts
Operations and maintenance	Sediment management; removal/clearance of urban trash and woody debris; vegetation control
Floodplain alteration	Flood banks and flood walls
Land use	Intensive land use
Wider pressures (at risk or probably at risk):	Point source pollution; diffuse source pollution; physical or 'morphological' alteration; alien species

3.1.2 Lower Thames (FRM – Rivers and Navigation)

In contrast to the Hogsmill Stream trial, the Lower Thames was selected for a FRM trial since it is significantly more complex. The water body selected (Number 651) forms part of the Lower Thames stretching from the tidal limit at Teddington upstream to Staines, a distance of about 20 km. It was provisionally designated as heavily modified for FRM. The water body was selected partly because it is covered by the Lower Thames FRM Strategy Study currently looking at potential mitigation for flooding in the Datchet to Teddington reaches (a total distance of 40 km). For water bodies covered

by FRM strategies, considerable information and knowledge may be available which would help speed up the GEP/MEP trialling process.

As this water body is part of the Lower Thames, it is directly connected to other water bodies upstream and downstream (and tributaries) within the Thames Catchment. As a result, pressures and potential mitigation measures for the water body could arise from outside the water body. In addition to FRM activities, the water body has other sector interest since this part of the Thames is also used for navigation (the Navigation Authority in this instance being the Environment Agency). The Lower Thames trial was undertaken on 15 November 2007 at the Environment Agency area office in Frimley. The trial involved two representatives from the Environment Agency, one from asset management (representing the 'developer') and one from conservation (representing the 'regulator'). In addition, a representative from the Environment Agency navigation sector was present, together with a senior consultant from Jacobs with expert knowledge of the Lower Thames FRM Strategy. Facilitator and note taker (scribe) roles were again sourced by Jacobs.

Lower Thames: Water body summary	
Location:	Staines to Teddington, West London
Area:	Thames Region
Component water bodies:	651
Pressures:	
Bank and bed reinforcement and in-channel structures	*Not FRM or navigation*
Channel alteration	Realignment/re-profiling/regrading
Floodplain modification	Flood banks and flood walls
Operations and maintenance	Sediment management; removal/clearance of urban trash and woody debris; vegetation control; pipes, inlets, outlets and off-takes
Land use	Intensive land use
Navigation	Boat movement
Wider pressures (at risk or probably at risk):	Point source pollution; diffuse source pollution; water abstraction and flow regulation; physical or 'morphological' alteration; alien species

3.1.3 The Upper Irwell (Rivers)

The Upper Irwell is an upland gravel bed river that flows in a westerly direction from Bacup to Rawtenstall in Lancashire and then heads south to Bury where the River Roch converges. The River Irwell, known as the Lower Irwell, continues in a southerly direction into Salford and the City of Manchester and onto the Manchester Ship Canal.

The Upper Irwell is a typical river in upland Britain exhibiting an industrial legacy. The river is channelised and culverted in parts with development in the narrow valley up to the bank top. Other characteristics along the river corridor include mills and weirs, many of which are derelict and in disrepair. Some of the mills and old industrial buildings adjacent to the channel have been redeveloped and culverts opened up as part of the regeneration initiatives in the area. However, there is still relatively little investment in the Rossendale area and many of the old industrial features have been left to deteriorate.

The Upper Irwell is currently the focus of a flood risk viability strategy, part of which includes consideration of more environmentally/ecologically acceptable management (such as only dredging where necessary) and the wider Water Framework Directive objectives. This was a key reason for its selection.

The Upper Irwell comprises eight water bodies. The main river is split into four water bodies and the tributaries (Limy Water, Whitewell Brook, River Ogden and Kirklees Brook) make up the remaining water bodies in the Irwell catchment. The most downstream water body encompassing the Upper Irwell and the largest of the eight is considered low risk and was not provisionally designated heavily modified. The majority of the other water bodies were designated high risk and heavily modified with urbanisation and water storage identified as the main pressures (rather than FRM).

The lack of a FRM HMWB designation for the water body became apparent from information supplied after the Upper Irwell had been selected and planned for trialling purposes. Whilst FRM had not been formally recognised as a pressure in any of the eight water bodies, there was a known flood risk and the Environment Agency was already engaged in meetings on the strategy. This apparent anomaly was due to de facto (or informal) assets in the water body and the Environment Agency agreed that it was a water body worthy of trialling. This trial water body also provided a contrast to the two Thames Region FRM HMWBs where lack of dredging sediment removal had proved to be important to increase GEP.

The three water bodies considered in the trial were identified by the numbers 206, 203 and 204 (working in a downstream direction). Water body numbers 206 and 203 included the Bacup and Rawtenstall areas respectively and were very similar in character. Therefore the assessment for identifying mitigation measures to achieve GEP could be treated in a similar manner. Water body 204 was slightly more rural and the channel less constrained in some reaches. However, the modifications and management were broadly the same, especially in the upper half of the water body. One proforma only is presented as part of this trialling.

Table 3.1 Designation of water body numbers 203, 204 and 206.

Water body	Name	Urbanisation	Wider environment	Water storage	Flood risk management	Navigation	Result
No.203	River Irwell Whitewell Brook to Limy Water	Yes	No	Water body specific	No	No	HMWB
No. 204	River Irwell Limy Water to River Ogden	Yes	No	No	No	No	HMWB
No. 206	River Irwell upstream of Whitwell Brook	Yes	No	Yes	No	No	HMWB

The Upper Irwell trial was undertaken on the 30 November 2007 at the Jacobs Office in Sale. The trial involved four representatives from the Environment Agency, one from asset management, one from conservation, one technical specialist (geomorphologist/river modeller) and one from the National Environmental Assessment Service. Jacobs representatives included a facilitator (consistent with the other trials), a geomorphologist who had undertaken a fluvial audit of the Upper Irwell and a member of staff who could advise on the flood risk aspects. These staff were also involved in the flood risk strategy viability study. A note taker (scribe) role was again sourced by Jacobs.

Upper River Irwell: Water body summary	
Location:	Bacup to Bury, Lancashire
Area:	North West Region
Component water bodies:	Three water bodies along the main river (206; 203; 204); and the following tributaries: Limy Water (208), Whitewell Brook (207), River Ogden (205), Kirklees Brook (202) Water bodies trialled: 206 (Irwell upstream of Whitewell Brook), 203 (Irwell between Whitewell Brook and Limy Water), 204 (Irwell between Limy Water and River Ogden)
Pressures:	
Bank and bed reinforcement and in-channel structures	Hard protection; dams, sluices and weirs (*but not FRM assets*)
Channel alteration	Realignment/re-profiling/regrading; culverts (*but not FRM assets*)
Floodplain modification	Flood banks and flood walls (*but not FRM assets*)
Operations and maintenance	Sediment management; removal/clearance of urban trash and woody debris; vegetation control
Land use	Intensive land use
Wider Pressures (at risk or probably at risk):	Urbanisation and water storage Point source pollution; diffuse source pollution; physical or 'morphological' alteration

3.1.4 Pagham (FRM – Coastal)

Pagham Harbour is located on the south coast of England in West Sussex. The water body was selected for trialling because it is a coastal water body and was designated as a candidate heavily modified water body for coastal protection. The coastline of Pagham Harbour is approximately 13 km in length, the majority of which has some form of coast and flood protection. The entirety of the 257 ha of Pagham Harbour is designated as a Special Protection Area (SPA) under the Habitats Directive. The Harbour also has RAMSAR and Site of Special Scientific Interest (SSSI) designation.

The Pagham Harbour trial was undertaken on the 20 December 2007 at the Environment Agency area office in Worthing, Sussex. The trial involved three representatives from the Environment Agency, a technical lead from asset management, a technical lead from conservation and biodiversity and an area lead for the Water Framework Directive. In addition a principal geomorphologist from Jacobs with knowledge of the Pagham Harbour attended. Facilitator and note taker (scribe) roles were sourced by Jacobs.

Pagham Harbour: Water body summary	
Location:	West Sussex
Area:	Southern Region
Component water bodies:	Pagham Harbour
Pressures:	
Bank reinforcement	*No sub-pressures identified*
Impounding	*No sub-pressures identified*
Operations and maintenance	Removal/clearance of urban trash and woody debris; vegetation control
Land use	Intensive land use
Manipulation of sediment transport	*No sub-pressures identified*
Wider pressures (at risk or probably at risk):	Physical or 'morphological' alteration; alien species

4 Findings

4.1 Outcome of trialling

For the four FRM-led trials, this section of the report considers the outcome of each.

4.1.1 Hogsmill Stream (FRM - Rivers)

(a) Trial details

The Hogsmill Stream trial was the first to be undertaken for the FRM aector. The results of trialling are illustrated in Figures A1 and A2 in Appendix A. In the Hogsmill trial, both Approaches A and B were run and appropriate forms completed (illustrated in Figures A1 and A2 respectively). These were the most up-to-date versions of the proformas provided by UKTAG at the date of trialling. Standardised proformas provided by UKTAG were intended to allow consistent write-up across all sectors. The checklist of measures for FRM activities used for the trial was developed (in draft form) by Jacobs prior to the meeting, following as closely as practicable a format prescribed for the navigation sector.

The results are discussed with respect to the questions detailed in the various columns (provided by UKTAG) within Approaches A and B. Column headings for Approaches A and B proformas are detailed in Table 4.1. The original question *Is the measure to deal with legacy issues or ongoing activities? If so ✔ if not ✗* – (Column 3) was disregarded in the results analysis, as it became clear that the trial was addressing legacy FRM issues and not planned FRM activities which would be covered by current policies and procedures (likely to be at or close to WFD-proofing).

Table 4.1 Hogsmill Trial.

Column	Approach A	Approach B
Column 1	1) Is the pressure present? If so , if not ✕.	1) Is the pressure present? If so , if not ✕.
Column 2	2) Is there an impact as a result of the pressure? If so ( ), if not document evidence.	2) Is there an impact as a result of the pressure? If so ( ), if not document evidence.
Column 4	4) Is the measure applicable to the local characteristics of the water body? If so , if not document why the measures have been discounted.	4) Is the measure applicable to the local characteristics of the water body? If so , if not document why the measures have been discounted.
Column 5	5) Is the measure already in place? Where the measure is not in place please , where the measure is already in place please document.	5) Can the measure be taken forward without having a significant adverse impact on use or the wider environment? If yes , if no document why not.
Column 6	6) Can the measure be taken forward without having a significant adverse impact on use or the wider environment? If yes , if no document why not.	6) Does the measure (alone or in combination with other measures) offer more than a slight ecological benefit? If so , if not document the reasons why only a slight ecological benefit.
Column 7	7) Does the measure (alone or in combination with other measures) offer more than a slight ecological benefit? If so , if not document the reasons why only a slight ecological benefit.	7) For those remaining measures check if the measure is already in place. Where the measure is not in place please , where the measure is already in place please document.

The trial itself took three and a half hours to complete. It was found important to emphasise that this was a trial rather than actual classification of the water body. An introduction to the trial took 30 minutes using a series of Microsoft PowerPoint slides. A discussion followed on the main issues within the water body using a flipchart. This was initiated by drawing an approximate rough map of the water body (in this case the entire catchment) which detailed the principal issues in the various parts (20 minutes). Subsequent to this, the two approaches were run through in detail using A0 plots of the spreadsheets outlining the pressures, impacts and proposed mitigation measures. Completing the spreadsheets took up the remainder of the time.

(b) Trial Results

Approach A (Figure A1)

Column 1 – Identifying pressures

For the river trials for FRM, five generic pressures were identified beforehand, namely: i) bank and bed reinforcement and in-channel structures, ii) channel alteration, iii) operations and maintenance, iv) floodplain alteration and v) land use. A series of sub-pressures and impacts was also identified for each of these generic measures. Column 1 was analysed by examining whether impacts of the various sub-pressures were present in the Hogsmill Stream water body. Of the ten sub-pressures identified prior to the trial only one, namely, *pipes, inlets, outlets and off-takes* was deemed not to be in the water body. This meant that nine of the ten sub-pressures were identified as occurring within the water body.

Column 2 – Identifying where there is no significant impact

Prior to the trial, 16 impacts were identified as applicable to the ten sub-pressures. In identifying whether any impacts occurred as a result of the sub-pressure, a further ten impacts were screened out at this stage (one having already been screened out in Column 1). Only five impacts were identified in the water body, namely:

i) Hard bank protection – loss of riparian zone/marginal habitat/loss of connectivity/loss of sediment input

ii) Dams, sluices and weirs – loss of biological continuity

iii) Dams, sluices and weirs – loss of sediment continuity

iv) Realignment/reprofiling/regrading – loss of morphological habitat

v) Intensive land use – changes to vegetation, hydrology and sediment management

Column 4 – Measures which are not practicable given the site-specific characteristics

Of the five impacts carried through to this stage (column) there were nine potential mitigation measures. These were all deemed to be applicable to the local characteristics of the water body. It was felt that none of these measures could be ruled out at this broad scale. It might be different at a reach (local) scale but it was determined that all of these mitigation measures could be possible within the Hogsmill Stream water body as a whole.

Column 5 – Assessing whether the measure is in place and adequate

At this stage (column) a further four mitigation measures were screened out by the UKTAG Approach A as already existing within the water body. Approach A meant that these measures were ruled out regardless of whether they could still be suitable, as they were already in place at some location. In practice these measures would need to be continued in addition to any new mitigation measures identified. This left five mitigation measures to be taken forward, namely:

i) Removal of hard reinforcement/revetment, or replacement with soft engineering solution where possible (Measure A1)

ii) Operational/structural changes to dams, sluices and weirs (Measure A4)

iii) Install fish passes (Measure A5)

iv) Removal of structure (Measure A6)

v) Land management strategies (develop and revise), including Sustainable Urban Drainage Systems (SUDS) and changes in farming practices and forest management (Measure A18)

Column 6 – Where significant adverse impact on use or the wider environment might apply

None of the five measures could be screened out at this stage, since this question was largely considered redundant in FRM for the Hogsmill.

If the measures had been identified as valid then generally speaking they would not, by definition, have wider environmental impacts. However, at this level of analysis there was insufficient detail to decide whether there would be a wider environmental impact. Many wider environmental impacts could be adequately dealt with in the design. As a result, all five mitigation measures were carried forward to Column 7.

Column 7 – Does the measure (or combination of measures) offer only a slight ecological benefit?

It was not possible to screen out any measures since they all could, under certain situations, be used alone or as part of a combination of measures to bring more than a slight ecological benefit. Thus, at the end of the trial five measures were left, namely:

i) Removal of hard reinforcement/revetment, or replacement with soft engineering solution where possible (Measure A1)

ii) Operational/structural changes to dams, sluices and weirs (Measure A4)

iii) Install fish passes (Measure A5)

iv) Removal of structure (Measure A6)

v) Land management strategies (develop and revise), including SUDS and changes in farming practices and forest management (Measure A18)

Approach B (Figure A2)

Approach B is exactly the same as Approach A up to and including Column 4. Thus, at this stage nine mitigation measures were identified associated with five sub-pressures. These were all deemed to be applicable to the local characteristics of the water body. It was felt that none of these measures could be ruled out at this broad scale. As a result, nine mitigation measures were taken through to Column 5.

Column 5 – Where significant adverse impact on use or the wider environment might apply

In Approach B, Column 5 relates to whether measures could be taken without causing a significant adverse impact on use or a wider impact on the environment. The advantage of Approach B is that it retains a variety of measures to a later stage of the decision-making process and does not rule them out just because they are already in place (as does Approach A). It was decided that it would be impossible to screen out any mitigation measures at this stage (column) since all measures could be taken forward without having an adverse impact on use or the wider environment.

Column 6 – Does the measure (or combination of measures) offer only a slight ecological benefit?

Of the nine measures taken forward to Column 6, none could be ruled out at this stage (column) as they were all able to individually, or in combination, offer more than slight ecological benefit. As a result, the nine mitigation measures taken forward to the last stage were:

i) Removal of hard reinforcement/revetment, or replacement with soft engineering solution where possible (Measure A1)

ii) Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone (Measure A2)

iii) Preserve and where possible restore historic aquatic habitats (Measure A3)

iv) Operational/structural changes to dams, sluices and weirs (Measure A4)

v) Install fish passes (Measure A5)

vi) Removal of structure (Measure A6)

vii) Retain marginal aquatic and riparian habitats (Measure A7)

viii) Increase in-channel morphological diversity, e.g. install in-stream features; two-stage channels (Measure A8)

ix) Land management strategies (develop and revise), including SUDS and changes in farming practices and forest management (Measure A18)

Column 7 – Assessing whether the measure is in place and adequate

Of the nine measures taken forward to this stage, four were deemed to already exist in the water body and thus the remaining measures were:

i) Removal of hard reinforcement/revetment, or replacement with soft engineering solution where possible (Measure A1)

ii) Operational/structural changes to dams, sluices and weirs (Measure A4)

iii) Install fish passes (Measure A5)

iv) Removal of structure (Measure A6)

v) Land management strategies (develop and revise), including SUDS and changes in farming practices and forest management (Measure A18)

(c) Trial Summary

Using the two Approaches (A and B) helped to tease out some of the issues associated with the Hogsmill Stream water body. However, it was not clear from the trial how following this structured approach offered any improvement to assembling experts at a meeting with the pressure, sub-pressure and mitigation measure checklist to determine whether the water body was at, near, or below GEP. During the classification process, there was no alternative to using experts with local knowledge when defining GEP. A UKTAG proforma would, however, provide an important record for the audit trail.

An important component of such a meeting is that consensus of diverse views on GEP status can be achieved (through capturing professional judgment). It was felt by the participants of the trial that this process could not be undertaken by contacting the "developer" (such as an asset manager) and "regulator" (such as a fisheries, recreation and biology officer) separately or in any automated way. The two approaches adopted for this trial screened out most of the good practice within the water body at an early stage (at Column 2) which asked whether an impact had resulted from a pressure within a water body. Discussions with Environment Agency staff revealed that some mitigation measures were already in place on the Hogsmill Stream, such as sediment and vegetation management. As a result, good practice was screened out in the early phase of the spreadsheet. The only measures left reflected those that were likely to be more difficult or costly to undertake and thus were not in place despite being suitable alternatives. Thus, it was not possible to determine GEP based on the checklist of

measures left at the end of the process since this, in effect, hid the variety of good practice already in place within the water body.

As a result, a more prescriptive method needs to be developed to enable a decision to be made on practices already undertaken in each water body. A key finding of this trial is that it was not possible to define GEP or MEP at the end of this process using the spreadsheets developed.

Most of the mitigation measures were thought to be appropriate and logical with respect to generic pressures and sub-pressures. It was concluded that some measures could be repeated for different sub-pressures, so this was considered for alteration in future trials. It was generally considered that a combination of mitigation measures would be the best way forward to reached GEP.

An interesting outcome of the trial is that (through expert judgment of those present) the Hogsmill Stream water body was considered to be not quite at GEP but close to it. One remaining issue was with the (intensive) land use pressures for which there are land management strategies for mitigation. Whilst not in itself a flood risk management pressure, land use does affect flood risk. It was concluded that there needs to be some way of accounting for this measure within the definition of GEP and MEP.

One of the main concerns of Environment Agency staff at the trial was that it was quite difficult to answer some of the questions, since much of the decision on whether a mitigation measure was appropriate could only be made on a reach (local) basis. Thus it was difficult at the water body scale to rule out any measure. One staff member raised a particularly good point on activity footprint versus activity impact and how this could be mitigated for within the process of GEP definition. For example, a weir would have a small footprint but, potentially, a large impact. Thus by removing this feature, or installing a fish pass around the feature, a significant level of mitigation could be achieved. There needs to be some prescription to enable the issue of activity footprint versus impact to be accounted for in the determination of GEP.

4.1.2 Lower Thames (FRM – Rivers and Navigation)

(a) Trial Details (Figure A3)

The Lower Thames trial was the second to be undertaken for the FRM sector. Results are illustrated in Figure A3 in Appendix A. In the Lower Thames trial, only Approach B was completed (Figure A3) since from the Hogsmill Stream water body trial (described previously in this report) this proved to be the most effective approach. The results are discussed with respect to questions in the various columns within Approach B. This was undertaken following guidance provided by UKTAG so that the write up of the trials could be standardised across the various sectors. The column headings for Approach B are detailed in Table 4.2. The original question (Column 3) – *Is the measure to deal with legacy issues or ongoing activities? If so ✔ if not ✘* – was disregarded in the results analysis, as during the previous trial on the Hogsmill Stream, it became clear that the trial was addressing all legacy issues and not planned activities which would be covered by current policies and procedures.

Table 4.2 Lower Thames Trial.

Column	Approach B
Column 1	1) Is the pressure present? If so , if not ✕.
Column 2	2) Is there an impact as a result of the pressure? If so ( ), if not document evidence.
Column 4	4) Is the measure applicable to the local characteristics of the water body? If so , If not, document reasons why the measure has been discounted.
Column 5	5) Can the measure be taken forward without having a significant adverse impact on use or the wider environment? If yes , if no document why not.
Column 6	6) Does the measure (alone or in combination with other measures) offer more than a slight ecological benefit? If so , if not document the reasons why only a slight ecological benefit.
Column 7	7) For those remaining measures, check if the measure is already in place. Where the measure is not in place please , where the measure is already in place please document.

The Lower Thames trial itself took three hours to complete. An initial introduction to the trial using Microsoft PowerPoint slides lasted 30 minutes. A discussion followed on the main issues within the water body. This was initiated by drawing an approximate map of the water body detailing the key FRM and navigation issues (20 minutes). In contrast to the Hogsmill trial, a detailed discussion was then held with the Environment Agency representatives on whether they believed that the water body was at, or close to, GEP (for FRM and navigation sectors). It was made clear that any early judgment could be iterated throughout the trial. The discussion centred on the main generic pressures likely to exist in the water body. This lasted for about one hour. It was noted that for the classification proper, Thames Water should be present as water abstraction (from the major London reservoirs) is a key issue.

Once this discussion was finished the notetaker from Jacobs completed the spreadsheet (for the audit trail) which was then pinned up on the wall (on an A0 sheet) for all present to discuss. This incorporated information from both the FRM and navigation sectors. However, since the original spreadsheet only detailed FRM activities the additional navigation information was added during the trial (by the navigation expert present). Any additional observations were noted and the spreadsheet completed. This proved to be a more effective method of running the trial.

(b) Trial Results

Approach B

Column 1 – Identifying pressures

In the river trials for FRM, five generic pressures were identified namely, i) bank and bed reinforcement and in-channel structures, ii) channel alteration, iii) operations and maintenance, iv) floodplain alteration and v) land use. An additional generic pressure (navigation) was identified by the navigation sector. A series of sub-pressures and impacts were then identified for each of these generic measures. Column 1 was analysed by examining whether the impacts of the various sub-pressures were present in the Lower Thames water body. Of all ten sub-pressures identified for FRM prior to the trial only one, namely 'culverts', was deemed not to be in the water body. The additional three sub-pressures for the navigation sector were also present. The FRM sector led this trial, so sub-pressures noted as being present for both sectors were detailed under FRM (unless it was not screened out for navigation at the same stage (column) as FRM).

An interesting difference in this trial was that three sub-pressures, namely, i) hard protection; ii) dams and sluices and weirs; and iii) pipes, inlets, outlets and off-takes, were present within the water body but were not necessarily FRM or navigation activities. For example, individual riparian landowners have been solely responsible for substantial (and when combined extensive) lengths of bank protection. A number of off-takes exist in the water body but these are for abstraction purposes, not FRM or navigation. As a result, these three sub-pressures were not taken forward to the next stage. However, it was considered important to record such observations (especially during the actual classification). This meant that seven of ten sub-pressures were identified as occurring within the water body for FRM activities and an additional one for navigation.

Column 2 – Identifying where there is no significant impact

Prior to the Hogsmill Stream trial 18 impacts were identified as applicable for the ten different sub-pressures for FRM. The trials enabled slight iteration and refinement of the checklists developed for FRM. A revision was undertaken subsequent to the Hogsmill Stream trial, where a further impact was identified. In identifying whether any impacts occurred as a result of the sub-pressure, a further 13 impacts were screened out at this stage (four having being screened out in Column 1). Only one impact was identified as being present in the Lower Thames water body under FRM, namely:

i) Intensive land use

The additional impacts for navigation were also found not to occur in the water body and thus were screened out at this stage (column).

Column 4 – Measures which are not practicable given the site-specific characteristics

Only one mitigation measure was identified for the impact that was carried through to this stage (column). The measure of land management was deemed applicable to the local characteristics of the water body and thus could not be ruled out at this stage.

Column 5 – Where significant adverse impact on use or the wider environment might apply

Column 5 relates to whether measures can be taken without causing a wider impact on use or on the wider environment. It was not possible to screen out the surviving measure at this stage since it could be taken forward without having an adverse impact on the wider environment.

Column 6 – Does the measure (or combination of measures) offer only a slight ecological benefit?

The only mitigation measure taken forward to Column 6 could not be ruled out at this stage as it was possible that this measure could offer more than a slight ecological benefit. As a result, the measure taken forward to the last stage (Column 7) was:

i) Land management strategies

Column 7 – Assessing whether the measure is in place and adequate

Effective land management strategies were not present in the Lower Thames water body and thus this measure was considered one that could be employed.

(c) Trial Summary

Using Approach B helped determine the issues associated with the Lower Thames water body. As with the Hogsmill Stream trial, it was not clear how following this structured approach would enable GEP to be determined. Assembling a small group of experts with knowledge of the water body to discuss GEP was still considered to be the most appropriate way forward. The structured approach adopted in this trial again enabled the various issues to be teased out, but most of the good practice was screened out at an early stage. Indeed, the only mitigation measure left after Column 2 was land management. Environment Agency staff considered that FRM measures were already being undertaken within the water body. For example, there is a national policy on gravel removal within the Environment Agency and localised policies on dredging. However, a number of sub-pressures were identified within the Lower Thames water body that had no FRM or navigation function. Off-takes were a good case in point. Hard bank protection was also common, having been installed mainly by riparian landowners on a piecemeal basis. Encroachment into the channel was a key concern for the Environment Agency. The length of bank protection required for FRM or navigation was regarded as negligible in terms of overall length. The concerns of landowners would, however, need to be addressed if, to reach GEP, ad-hoc measures needed to be mitigated against. The general consensus of the Environment Agency staff was that the water body was at GEP for FRM and navigation.

Again, it was concluded that the proforma (Figure A3 in Appendix A) was useful as a recording tool for the audit trail. However, the proforma itself did not enable a decision on GEP to be reached. The decision was effectively reached because there were virtually no impacts from the various sub-pressures identified under FRM. The Environment Agency navigation representative largely concurred with FRM with respect to lack of pressures and impacts and (consequently) no requirement for mitigation measures at the water body scale. However, a number of activities carried out on the Lower Thames (not captured by any of the sectors) could affect the definition of GEP (principally hard bank protection by individual riparian landowners).

At the Lower Thames trial the proforma detailing generic pressures, sub-pressures and mitigation measures was felt to be appropriate and logical and did not require amending. As with the Hogsmill Stream trial, the issue of intensive land use did not fit readily into the proforma. Whilst not an FRM activity, a land management activity does affect flood risk and thus needs to be examined in this process. This would be more pronounced in water bodies such as the Lower Thames due to its connectivity to other water bodies upstream and downstream. There needs to be some prescription of accounting for this measure within the definition of GEP and MEP.

As with the Hogsmill Stream trial, one of the main concerns of Environment Agency staff was that it was quite difficult to answer some questions on the proforma (5 in Appendix A). Much of the decision on whether a mitigation measure was appropriate could only be made on a reach basis. Thus it was difficult at a water body scale to rule

out any mitigation measure. It is therefore questionable as to whether the approach (proforma) is appropriate in defining GEP. Those present felt that the alternative of using expert judgment might be the best way to define GEP/MEP (whilst accepting that the proforma should be used as a recording tool for the audit trail).

4.1.3 Upper Irwell trial

(a) Trial Details

The results of the Upper Irwell trial are illustrated in Figure A4 in Appendix A. The approach used for this trial and prescribed by UKTAG differed from the Hogsmill Stream and the Lower Thames trials. Whilst there had been some slight iteration of the checklist of pressures, sub-pressures, impacts and mitigation measures (for FRM) following feedback at the earlier trials, Approach A (modified) was the most up-to-date one prescribed by the UKTAG trial coordinator after consultation with all sectors at a progress meeting in London on 20 November 2007. This involved a re-ordering of the columns, together with clearer questions and explanations (and is akin to the original Approach A).

Approach A (modified) avoided the legacy issue (see Hogsmill Stream trial discussed earlier). However, the Upper Irwell trial subsequently found genuine industrial legacy issues on the Upper Irwell.

The results are discussed with respect to questions in the various columns within Approach A (modified). This was undertaken following the guidance provided by UKTAG so that the write up of the trials could be standardised across the various sectors. Column headings for the modified Approach A are detailed in Table 4.3.

Table 4.3 Upper Irwell Trial.

Column	Approach
Column A	1) Is the pressure present? If so , proceed to Column B, if no ✕.
Column B	Is there a significant impact (in the absence of any mitigation already in place would there be a significant impact?) as a result of the pressure? If so ( ), proceed to Column C, if no (✕), document.
Column C	Is the measure practical given the site-specific considerations? If so ( ), proceed to Column D, if no, (✕) document.
Column D	Is the measure in place and adequate? If so ( ), document, if no (✕) proceed to Column E.
Column E	Can the measure be taken forward without having an adverse impact on use or the wider environment? If so ( ), proceed to Column F, if no (✕), document.
Column F	Will the mitigation measure provide more than slight ecological benefit when considered in combination with other measures?
Column G	Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, and likelihood of measure being disproportionately costly.

The trial itself took two hours to complete, with the introduction taking 30 minutes at the start of the meeting. The outset of the trial differed from the previous two in that an initial brainstorming of positive and negative features of the water body was stimulated using a series of photographs and an annotated Ordinance Survey map as a prompt. These features are listed in Table 4.4. This led to an initial assessment of whether the Upper Irwell was at GEP. The consensus was no and it was concluded that in general the water body (river and corridors) could be managed more sustainability and continuity and connectivity improved. The question of *'How do we define slight ecological benefit?'* was raised. Again, this shows the importance of providing guidance before a method is rolled out for Environment Agency staff to undertake national classification. Also with a view to the practicalities of rapid classification, the following question was asked at the outset: *Are the adjacent water bodies so similar in characteristics that they could be treated using the same template derived from Approach A (modified)?* The answer was that the three contiguous water bodies could be grouped and also tentatively that the template might be applied to similar river types in the North West.

For the Upper Irwell trial, the method was followed with more detailed discussion of pressures, impacts and proposed measures using A0 plots (affixed to a board) of the spreadsheets. The spreadsheets took approximately 90 minutes to complete.

Table 4.4 Features recorded for Upper Irwell.

Positive Features	Negative Features
Noticeable improvement in water quality (although recognised that this was more to do with good chemical status)	Channelized (artificial banks and bed). Collapsing walls supplying a high volume of coarse sediment.
Natural recovery evident in some sections (laid stone bed allowed to break up and improve flow and substrate diversity)	Weirs and mill races (some in disrepair). Recognised that part of the industrial heritage (but few listed in-channel structures)
Relatively good conveyor of sediment	High number of culverts
	Extensive dredging

(b) Trial Results

Approach A (modified)

Column A – Identifying pressures

As for the FRM trials five generic pressures and ten sub-pressures were presented. Although the majority of these exist in the water body, they were considered not necessarily to be flood risk induced. Bank and bed reinforcement, channel alteration and floodplain modifications are common in the Upper Irwell catchment due to mill and factory development in the nineteenth century, but there are no formal FRM asset schemes as such. The Environment Agency refers to these channel walls, weirs, culverts and embankments as "de facto structures". They are not owned nor routinely

maintained by the Environment Agency. However, flood modelling has shown in some cases that some structures provide a flood risk benefit and it is within the jurisdiction of the Environment Agency to provide reactive maintenance if, for example, the wall or weir fails. For the purposes of the Upper Irwell trial, these pressures are identified as present although they are not exclusively FRM pressures despite locally acting to defend against flooding.

All but one of the 'operations and maintenance' sub-pressures were assessed as being present in the water body. Sediment management, specifically dredging, is one of the main pressures in the Upper Irwell as it is undertaken wherever there is a perceived flood risk (not necessarily a real flood risk). 'Pipes, inlet, outlets and off-takes' were not regarded as significant pressure for the water body.

The sub-pressure relating to urban trash and woody debris could be separated, as the management practices differ notably in the water body. Vegetation control could be linked to sediment management measures. Land use, as in the other trials, is not a direct FRM pressure but should be taken forward to the next stage (Column B). Experts stated that the flood risk would not be significantly reduced if the headwaters were afforested. However, sediment supply was seen as a key issue for this water body type and therefore it is important to involve holistic thinking to improve land use management practices. The Catchment Sensitive Farming Delivery Initiative aims to do this, the driver also being the Water Framework Directive.

Column B – Identifying where there is no significant impact

All of the sub-pressures carried through were identified as imposing impacts on the water body (although to reiterate, many were identified as "de facto structures", not formal flood defence assets). No impacts were screened out at this stage (Column B), although some were only regarded as short-term impacts, for example, the transfer of fine sediment downstream during and after dredging operations.

Column C – Measures which are not practicable given the site-specific characteristics

On a water body scale, only 10 to 20 per cent of the river length could be mitigated against the potential impacts related to "de facto structures" because of the lack of space to restore, or at least encourage, natural recovery. Removal of hard bank protection or opening up of culverts, for example, could only be considered if an opportunity arose. Any opportunities would be likely to be part of a riverside regeneration scheme when the Environment Agency and local authority could liaise with each other and a prospective developer to reduce flood risk and improve the ecological value of the river corridor. The Environment Agency is already working hard to integrate best practice into new development plans, but does not have the power to make these practices a statutory requirement. The need to consider and implement such mitigation measures should be written into the Local Development Frameworks (currently being rewritten).

As with other "de facto structures" such as weirs, Environment Agency staff did not feel it would be practical to remove or lower weirs or construct a fish pass, unless there was a natural collapse and a flood risk associated with that failure. The Environment Agency conservation representative at the trial wanted to see improved continuity in the Upper Irwell, but conceded that this might not be feasible in the steep upland environment and could not be conducted as a flood risk management activity. It was concluded that mitigation measures C1 to C18 (Figure A4) could be undertaken at a local scale if opportunities arose in the future. These opportunities would probably be local and undertaken by private developers. However it would be impractical for these local initiatives to be implemented at the water body scale and therefore be effective in WFD terms of improving GEP.

With regards to ‘operations and maintenance’ pressures and impacts it was determined that all those carried through to this stage (Column C) could be mitigated. In terms of sediment management, mitigation associated with dredging (C19) was judged to involve reducing all but necessary FRM in flood risk areas to allow natural recovery. Appropriate channel maintenance for woody debris and urban trash (C20) was deemed practical and therefore carried forward to the next stage (Column D), as were measures associated with vegetation control (C21, 22). A strong link between sediment management (allowing bars to form) and vegetation management on those bars was determined for the Upper Irwell water body. Experience has shown that it is acceptable to allow vegetation to colonise the channel bed, but growth must be controlled to ensure flood risk is not enhanced though increased roughness. Vegetation and sediment can also cause potential blockages if carried downstream to a culvert or bridge during high flows. Land use management strategies (C24) were also carried forward to the next Stage (Column D).

Column D – Assessing whether the measure is in place and adequate

The only measures currently in place and deemed adequate were those related to the management of urban trash and woody debris (D20). Other measures such as minimising dredging operations (D19), in-channel and riparian vegetation management (D21) and control of invasive species (D22) had been previously discussed as part of the strategy study but not agreed for implementation on the Upper Irwell. Land management practices could also be improved (D24). These four measures were taken forward to the next stage (Column E) as part of the trial.

Column E – Where significant adverse impact on use or the wider environment might apply

For the Upper Irwell, further investigation would be required to ascertain whether sedimentation was exacerbating flood risk in certain areas (and therefore in need of removal) or whether it could remain in the channel. Some Environment Agency staff noted that there is a perceived rather than actual increase in flood risk in many locations. Hence the sediment management mitigation measure was carried forward to the next stage (Column F). Likewise, since provision of vegetation control measures would not increase flood risk in the vicinity (or upstream or downstream), these measures were not screened out. Land management measures were also carried forward to the next stage (Column F).

Column F – Does the measure (or combination of measures) offer only a slight ecological benefit?

Since it was determined at the trial that the remaining measures would offer more than a slight ecological benefit individually and in combination, these were not screened out.

Column G – Comments on implementation, cost and so on

It was stated that hydraulic modelling would be required to test the sensitivity of bed levels and flood levels but should not be disproportionately costly. The only measure that could be prohibitively costly would be the control of invasive species (G22).

(c) Trial Summary

The trial again demonstrated the need to have a group of experts present with good working knowledge of the water body to determine GEP. The approach (proforma) prescribed by UKTAG for this trial was relatively easy to complete (for the audit trail) although the facilitator commented that the original method used for the previous Lower Thames trial (Approach B) would have provided a smoother, more logical process. It was suggested by Environment Agency staff that a representative from operations delivery would make a useful contribution at future meetings convened to classify water

bodies. This could be a field team leader or a technical specialist. A representative from the local authority could also be valuable if pluvial flooding was regarded as a potential issue, as it is in the Upper Irwell. However, discussions would still need to be held to decide whether this flooding mechanism would be considered at all.

The main complicating factor highlighted by this trial involves “de facto structures” that provide flood defence but are not listed as formal FRM assets. Channelization and structures such as weirs and mill races on the Upper Irwell are largely attributed to the industrial era, although some bank protection has been replaced in subsequent floodplain development. Although these modifications exert a hydromorphological pressure, it is difficult to explicitly declare that the in-channel and floodplain structures are for FRM purposes. Whilst it would be impractical to mitigate for these pressures, it is important to recognise them and their associated impacts. Thus, mitigation measures C1 to C18 were screened out in Column C.

Opportunities to modify or remove these structures and improve the river corridor (alongside reduction of flood risk) should be taken when there are plans for adjacent land to be redeveloped. This highlights the role of the Environment Agency as a regulator (as on the Lower Thames trial). It is therefore important that good practice measures are made statutory requirements in these circumstances, perhaps as part of the Local Development Frameworks. Although it may appear to be a piecemeal approach, it is the only practical and cost-effective way of improving rivers like the Upper Irwell that are considered to be below GEP. The Environment Agency must capture these WFD objectives as a regulator as well as a developer.

The issue of scale was also highlighted by the Upper Irwell trial. Guidance needs to be developed for the classification process. It was difficult in the trial to know whether to incorporate catchment scale issues such as land management (see the Lower Thames and Hogsmill) or to consider the Manchester Ship Canal (located far downstream) in terms of potential fish migration and effectiveness of weir removal, for example.

Assessing whether measures can be implemented on a water body scale when there are more localised issues was also raised in the trial. It would be useful to have broad thresholds for guidance; for example, if more than half of the water body river length could be restored with softer or no bank protection, it could be considered ecologically beneficial. Whilst appreciating that thresholds are difficult to determine, the need to define thresholds is implicit in the questions: *How do we define slight ecological benefit?* and *What is the “significant” adverse impact on use or the wider environment?*

Lastly, it is clear that there are flood risk pressures on the Upper Irwell as the Irwell has been the focus of a CFMP and now a flood risk strategy viability study. This was a key factor in choosing the Upper Irwell for trialling. Extensive and frequent dredging occurs in the Upper Irwell but this is not sustainable or environmentally acceptable. Although the initial high level designation process of HMWB for FRM involved different data, it was felt that this knowledge of dredging should be adequate to assign an FRM pressure to the Upper Irwell, whether it be a maintenance operation carried out because of an actual increase in flood risk or just a perceived risk.

4.1.4 Pagham Harbour (FRM – Coastal)

(a) Trial Details

The Pagham Harbour trial was the fourth to be undertaken for the FRM sector. The results are illustrated in Figure A5 in Appendix A. For the Pagham Harbour trial Approach A (modified) was used (Figure A4). The results are discussed with respect to the questions in the various columns in Approach A (modified). This was undertaken following guidance provided by UKTAG so that the write up of the trials could be

standardised across the various sectors. Column headings for Approach A (modified) are detailed in Table 4.5. The original question, *Is the measure to deal with legacy issues or ongoing activities? If so ✔ if not ✘*, was disregarded in the results analysis as during the previous trial on the Hogsmill Stream it became clear that the trial was addressing legacy issues and not planned activities, which would be covered by current policies and procedures.

Table 4.5 Column headings for Approach A.

Column	Approach
Column 1	1) Is the pressure present? If so , proceed to Column 2, if no ✘.
Column 2	Is there a significant impact (in the absence of any mitigation already in place would there be a significant impact?) as a result of the pressure? If so ( ), proceed to Column 3, if no (✘), document.
Column 3	Is the measure practical given the site-specific considerations? If so ( ), proceed to Column 4, if no, (✘) document.
Column 4	Is the measure in place and adequate? If so ( ), document, if no (✘) proceed to Column 5.
Column 5	Can the measure be taken forward without having an adverse impact on use or the wider environment? If so ( ), proceed to Column 6, if no (✘), document.
Column 6	Will the mitigation measure provide more than slight ecological benefit when considered in combination with other measures?
Column 7	Add comments on implementation, for example, reasons for time exemption, prioritization in combination with other measures, cost, likelihood of measure being disproportionately costly.

People present at the Trial:

- Tony Davison – Environment Agency (asset management - technical lead)
- Sean Ashworth - Environment Agency (WFD - area lead)
- Charlotte Murray – Environment Agency (biodiversity - technical lead)
- Dr Andrew Brookes - Jacobs
- Dr Matthew Wright - Jacobs

The Pagham Harbour trial itself took three hours to complete. The introduction to the trial using Microsoft PowerPoint slides lasted 30 minutes. A discussion followed on the main issues within the water body. This was initiated using a map of the water body provided by Tony Davison showing the key FRM structures and issues. In contrast to

the Hogsmill trial, a detailed discussion was then held with the Environment Agency representatives on whether they believed that the water body was at, or close to, GEP (for FRM sector); the consensus was no. It was made clear that any early judgment could be iterated throughout the trial. The discussion centred on the main pressures likely to exist in the water body. This lasted for about one hour.

Once this discussion was finished the notetaker from Jacobs completed the spreadsheet (for the audit trail) which was then pinned up on the wall for all present to discuss. This proved to be effective for running the trial.

(b) Trial Results

Approach A (modified) (Figure A5)

Column A – Identifying Pressures

In the coastal waters trial for FRM, six generic pressures were identified namely, i) bank reinforcement, ii) channel dredging, iii) deposition of material, iv) tidal river alteration, v) impounding and vi) manipulation of sediment transport. A series of sub-pressures and impacts were then identified for each of these generic pressures. Column A was analysed by examining whether the impacts were present in the Pagham Harbour water body. Of the six pressures identified for FRM prior to the trial three, namely 'channel dredging', 'deposition of material' and 'tidal river alteration', were not deemed to be present in the water body.

Column B – Identifying where there is no significant impact

The three remaining pressures not screened out in Column A, 'bank reinforcement' 'impounding' and 'manipulation of sediment transport' were considered to be present in the water body. These pressures were considered to have a significant impact.

Column C – Measures which are not practicable given the site-specific considerations

Measure 17 'indirect/offsite mitigation (offsetting measures)' was not considered relevant or practical in relation to 'impounding' pressures in this water body. Similarly Measures 20 and 21 (restore/create/enhance aquatic and marginal habitats and indirect/offsite mitigation (offsetting measures) respectively) were also not considered relevant to this water body. All other mitigation measures were considered practical.

Column D – Is the measure in place and adequate?

None of the mitigation measures taken forward to this point were considered to be in place and adequate so all remaining measures were taken forward to Column E.

Column E – Where there may be a significant adverse impact on use or the wider environment

Column E relates to whether measures can be adopted without causing a wider impact on use and the environment. It was only possible to screen out one of the surviving mitigation measures ('removal of structure' in pressure 'manipulation of sediment transport') at this stage, since it could not be taken forward without having an adverse impact on the wider environment. Removal of the training wall which helps to prevent the closing off of Pagham Harbour from the outer Pagham Beach would have a significant impact on use and possible major implications for the wider environment. Possible impacts would be erosion of Pagham Spit (endangering local properties) and complete enclosure of Pagham Harbour, cutting it off from the sea and changing the nature of the system from intertidal to freshwater-dominated.

The rest of the measures carried forward to this stage were all considered to be practical without having an adverse impact, provided that they were implemented in the appropriate locations within the water body.

Column F – Does the measure (or combination of measures) provide more than a slight ecological benefit?

Nearly all the remaining mitigation measures would provide more than slight ecological benefit when considered in combination with others. However, Measures 3 and 4 ('replacement with soft engineering solution' and 'bank re-profiling') within pressure 'bank reinforcement' were considered to provide only slight benefit.

Column G – Comments

In concluding comments and discussions of the Pagham Harbour trial, it was agreed that 'quick win' measures to improve the ecological potential of Pagham Harbour should concentrate on impounding structures (flap valves) present in the water body; this could be achieved by implementing one or a combination of Measures 14, 15 and 16 ('removal of structure', operational and structural changes to impoundments' and 'installation of fish passes').

(c) Trial Summary

Using Approach A (modified) helped determine the issues associated with the Pagham Harbour coastal water body. As with the Hogsmill Stream trial, it was not clear how following this structured approach would enable GEP to be determined. As with previous trials, it demonstrated the need to have a group of experts with good working knowledge of the water body to determine GEP. The structured approach adopted in this trial again enabled the various issues to be teased out.

The proforma (Figure A5 in Appendix A) was useful as a recording tool for the audit trail. However, the proforma itself did not enable the decision on GEP to be reached. At the Pagham Harbour trial, the proforma detailing generic pressures, impacts and mitigation measures was felt to be adequate and did not require amending.

One of the main concerns of Environment Agency staff was that it was difficult to answer some questions on the proforma. Thus it was difficult at a water body scale to rule out many measures, since they might work in different situations within the water body. It was therefore questioned as to whether the approach (proforma) was helpful in defining GEP. Those present felt that expert judgment might be the best way to define GEP/MEP (whilst accepting that the proforma should be used as a recording tool for the audit trail).

4.2 Observations from trials where FRM contributed

4.2.1 Portsmouth Harbour

Staff from Jacobs also attended the trial of Portsmouth Harbour, another water body designated as heavily modified for coastal protection. Portsmouth is also designated as heavily modified for navigation purposes and the trial was led by Jan Brooke from the navigations sector.

The trial was conducted on the 11 December at the Continental Ferry Port in Portsmouth, with the following people:

- Commander Stephen Harper – Queens Harbour Master (Royal Navy)
- Roger Davies – Assistant Queens Harbour Master (Royal Navy)
- John Saunders – Deputy Queens Harbour Master (Royal Navy)
- Rupert Taylor – Commercial Port Harbour Master, Portsmouth
- Brett Davies – Coastal engineer, Portsmouth City Council
- Jan Brooke – Independent consultant, ports and navigation sector
- Matthew Wright – Coastal Geomorphologist, Jacobs

Unfortunately the trial had to be hastily organised owing to the limited availability of Royal Navy staff. Representatives from the Environment Agency and two of the three local councils responsible for coastal protection works were unable to attend at such short notice. The representative from Portsmouth City council had only been employed for a short time and was unable to provide a great deal of insight as to the nature of coastal protection works in the harbour and any measures that might have been implemented to improve the ecological potential of the harbour. Discussions were much more tailored towards port and navigation-related pressures and mitigation measures and very little FRM and coastal protection information could be obtained.

A key lesson from this trial is the need for sufficient lead time (in the final classification process) to gather all the necessary participants for a workshop.

The brainstorming session conducted during the trial identified two potentially significant impacts, both in the southern/eastern part of the harbour:

- physical disturbance and associated direct and indirect loss of seabed habitat due to ongoing maintenance dredging and vessel movement;
- historic loss of inter-tidal and sub-tidal habitats due to structures (quay lines, coastal defences, reclamation and so on).

The second of the above impacts may relate to FRM and coastal protection activity and mitigating for these impacts by removing the structures would probably not be practicable as many are used as roosts for local bird populations. Modification of structures would not be practical in such a busy port.

The main outcome of this trial is that it is essential to have all relevant staff from the Environment Agency, and other authorities/bodies, present at the trial to properly assess whether a water body is at GEP.

5 Provisional recommendations for national classification

The purpose of this report is to summarise the outcomes of trials undertaken for UKTAG, concerning FRM HMWBs alone or in combination with other sectors. The main finding is that GEP/MEP cannot be determined per se using the UKTAG Approach A, Approach B or Approach A (modified). Whilst from an FRM perspective Approach B is more user-friendly, even this process does not allow a conclusion to be drawn on whether the water body is at, below, or above GEP. This has to rely on expert judgment and in effect the UKTAG proforma is recommended as a means of transparently recording the audit trail. Equally important are the comments likely to arise during the classification process and these should be recorded by the scribe. It is probable, for example, that a water body might be judged to be close to, or at, GEP from an FRM perspective but to be degraded by activities not arising from any of the defined sectors (for example, on the Lower Thames extensive piecemeal bank protection by riparian landowners). Experts are also needed with detailed knowledge of a water body so that assumptions can be made and applied strategically to the entire water body.

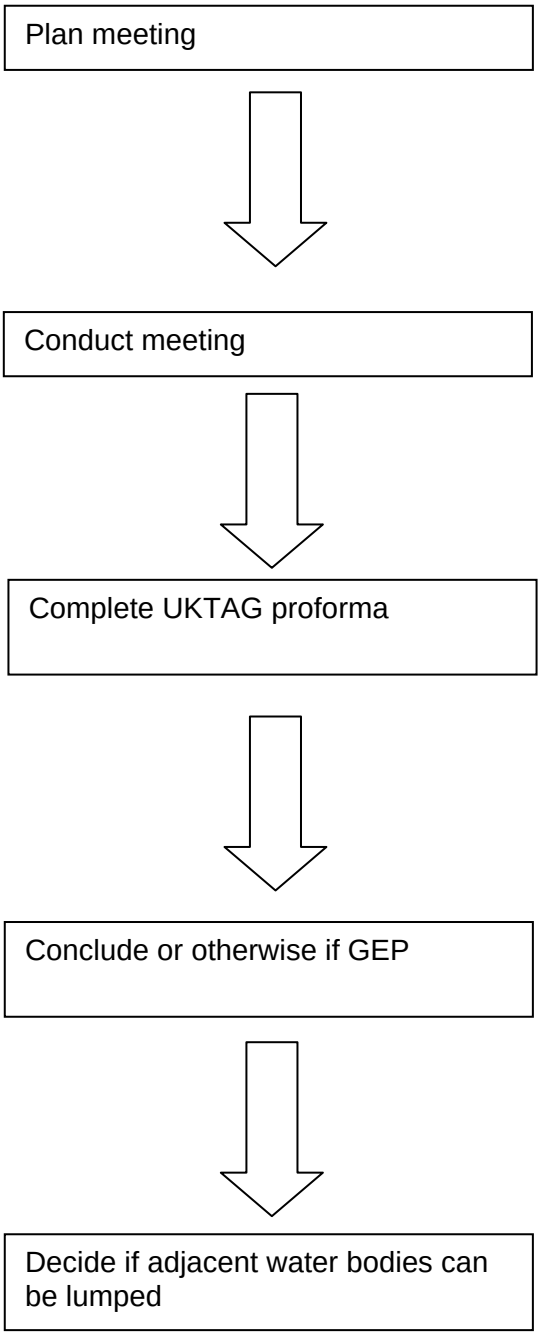
In terms of the imminent national classification, it is difficult to develop guidance based on so few trials. Any advice given here is fairly tentative although further work could be done. The process of classifying more than 2,000 HMWBs nationally is likely to take place in facilitated meetings, probably at area level of the Environment Agency. Time constraints (the need to classify a large number of water bodies in a short period of time) and the views of experts with knowledge of their patch may force grouping of water bodies (for example, based on similar characteristics of adjacent water bodies) or similar river, transitional water, coastal or lake types. Thus, if a template is developed for one water body this might be extended (with tailoring and recording of differences) fairly rapidly to similar types in the area, region, or indeed nationally.

Initial recommendations are made here on the processes to be followed in facilitated meeting and guiding principles for experts who may have to group similar water bodies. The guidance is written from an Environment Agency perspective but could be used by local authorities and Internal Drainage Boards (IDBs) concerned with FRM.

For the purposes of national consistency, training materials should be developed and led nationally but with further training of regional WFD leads who in turn cascade to (and attend) area meetings.

5.1 Facilitated meetings

Figure 5.1 below shows the steps that have proven successful in these trials. The premise is that a group of experts needs to be assembled to undertake classification.



1. Decide on who should attend (which sectors)
2. Decide on approximate number of water bodies
3. Arrange meeting at least a month in advance to ensure key people attend (send agenda and information)
4. Decide on suitable venue

5. Chair/ facilitator introduces meeting (and outlines process for meeting)
6. Powerpoint presentation
7. 30 minute brainstorm using a flipchart of issues with the water body (use a scribe)
8. Ask whether water body is at or close to GEP

9. Complete a wall version of the proforma step-by-step (moving from left to right)
10. Decide on pressures, sub-pressures and measures
11. Scribe records process (including assumptions)

12. As the proforma does not conclude GEP/MEP use experts in room to provide professional judgement
13. Decide what needs to be done
14. Again, record for the audit trail

15. Decide if any of the adjacent water bodies can be grouped/lumped
16. Record any differences between these
17. Final output (after meeting) is a written record of the process and results.

Figure 5.1 Flow chart illustrating recommended steps.

5.1.1 Plan meeting

The key steps suggested are:

1. Decide on how many water bodies might be covered in one meeting. Although it could take between two and three hours for one 'run through' of a water body, the trials showed that grouping adjacent water bodies (to a similar template) might only take a matter of a few minutes per additional water body. It is probable that more than one meeting would be required to tackle all water bodies in an Environment Agency area (for example).

2. Decide on the experts to invite to cover the water bodies listed on the agenda. The types of expertise required are individuals with detailed knowledge of the characteristics and use of their HMWBs, not necessarily people with expertise in WFD. In the trials, a minimum of one "regulator" (such as area fisheries, recreation and biology representative) and one "developer" (such as area asset system management representative) was required. However, in at least two of the trials an operations delivery person was also recommended. The organiser of the meeting must decide on representatives to cover additional sectors affecting an FRM HMWB (such as ports, navigation, water company). It may also be necessary to invite experts from operating authorities other than the Environment Agency. Experts from local authorities could be invited to deal with pluvial and groundwater flooding aspects. IDBs may also be useful.

3. A facilitator for the meeting and scribe should be elected. It might be useful to have a scribe with a technical FRM background. For a much larger meeting, a member of the national hydromorphology team and/or an area manager may be present to given an overall introduction and emphasise the importance and urgency of the classification process.

4. Information needs to be collected on each water body beforehand, including:

   a. A tailored Microsoft PowerPoint presentation (an example from the trials is attached in Appendix B). It is useful to include one or more images of the water body. Subject to copyright, Google Images may provide a useful source. Print the MS PowerPoint Presentation for distribution to attendees. The presentation can be given by the chair or facilitator but is only needed where the audience needs an introduction to the background of the classification process.

   b. One or two plans or maps taken from an Environment Agency document such as a strategy or CFMP encompassing the water body.

   c. A clear definition of the start and end of the water body being classified.

   d. A clear understanding of FRM assets for the water body (whether legacy or current) as opposed to 'legacy issues' such as "de facto defences". The National Flood and Coastal Defence Database is a good start (for the Environment Agency) but does not necessarily list structures that are not a FRM responsibility.

   e. Research prior to the meeting. For example, if a conservation officer is leading the environmental aspects he/she might like to elicit the views of their fisheries office beforehand.

   f. Photocopy the two UKTAG handouts to accompany the presentation (these are appended in Appendix C).

5.1.2 Conduct meeting

5. The facilitator gives a 20-minute PowerPoint Presentation as an introduction to the meeting. The contents of this presentation will vary depending on how up to speed the experts are with the WFD and the GEP classification process.

6. Brainstorm the first water body using a flipchart. On one page of the flip chart draw a crude outline/boundaries of the water body and ask "what is good" and "what is bad" about this water body in terms of modification and GEP. Annotate responses as lists on the flipchart. Check that the experts present are comfortable with a HMWB designation and then ask if the water body is well below, close to or at GEP. This is important as the trials have thrown up some discrepancies whereby an area person may rightly or wrongly contend that a water body is wrongly designated as HMWB from an FRM perspective. Any such anomalies should be reported back to the national hydromorphology team after the meeting. Feedback is important to ensure consistency across the trials. In asking about GEP at this stage, the facilitator should make it clear that this will be revisited at the end of the meeting. Note that in the trials, this process (30 minutes maximum) led to a fairly accurate and final determination of GEP.

7. Throughout all of this, the scribe should keep careful notes as a record for the audit trail is very important.

5.1.3 Complete UKTAG proforma

8. The UKTAG proforma should now be completed for the audit trail using the guidance provided (see Appendix C). Approach B (as used for the Hogsmill and Lower Thames) is recommended. It is important that additional issues teased out in compiling this proforma should be recorded by the scribe. The facilitator may need to reach a consensus between the "developer" and "regulator" on occasions where there is a diversity of views/conflicts. It is important also to record other pressures that do not fall within any sector (for example, riparian landowner bank protection was an issue on the Lower Thames detracting from GEP) (guide time taken: 60 to 90 minutes).

5.1.4 Conclude or otherwise GEP

9. The proforma alone will not allow a decision to be made on whether a water body is at, close to or below GEP. Revisit initial determination of GEP and then confirm with experts whether it is well below, close to or at GEP from the perspective of the FRM and other sectors present. Record this final decision.

5.1.5 Decide if adjacent water bodies can be grouped

10. Initially see whether any adjoining water bodies (upstream or downstream) have similar characteristics/issues and ask if the proforma (perhaps with a few modifications for differences) could be applied to those water bodies (including the same GEP classification). Scribe to record any differences for the audit trail (estimated time taken: 5 to 10 minutes (or less) per relevant water body).

11. Ask if by virtue of the type of water body (for example, an over-wide concrete lined channel) this can be extrapolated to other water bodies in the area/ region (estimated time taken: 5 to 10 minutes per relevant water body).

Please note that the times given above are approximate. More time may be required if the experts are new to the subject of classification. This should speed up with experience of individuals.

For national consistency, training materials should be developed and led nationally and this lead (for example, one person from the national hydromorphology team) should then train regional WFD contacts who in turn cascade to (and attend) area meetings. Regional WFD contacts could be the facilitators at area meetings.

Regional WFD contacts would be responsible for taking the training material and tailoring it to their areas. These trainers could also adopt a suitable 'sales pitch' for the initiative. Clearly the WFD is a powerful driver for the work but it might also be useful to put the work in the context of ongoing initiatives such as System Asset Management Plans (currently at the pilot stage) which have been successful in many areas. These plans assess the need for maintenance across 97 systems in England and Wales and have involved FRM, operations, navigation, fisheries, recreation and biology staff. There are potentially 3,000 systems for which a SAMP may be required, half of which have a high flood risk consequence. The virtue of this initiative has been to encourage area staff to think more broadly and ask questions such as: "Can maintenance be reduced?"

Once complete, it may be useful to place training materials as an e-learning package on the Environment Agency's intranet.

5.2 Grouping of water bodies

Assuming over 2,300 HMWBs need to be classified from an FRM perspective in England and Wales, (taking 20 Environment Agency areas) on average there would be about 115 water bodies per area. This is quite a large task. Once training was given to a group of experts, the process of grouping (adjacent water bodies, for example) should speed up considerably. However it is important to avoid complacency amongst the experts, who might be tempted to rapidly classify water bodies given the inevitable time constraint of this process. Grouping should be less of an issue for local authorities and IDBs who may have a much smaller number of HMWBs on their patch.

The following are suggestions to help the process of grouping water bodies. This guidance is for rivers only; so few TraC water bodies have been designated as HMWB that these can probably be dealt with on a singular basis. Also, we are not aware of any 'natural' lakes designated as HWMB from an FRM perspective.

Precisely how water bodies are grouped in an area is down to expert judgment. The trials have provided some early examples of potential grouping. For example, the Hogsmill Stream water body is an example of a concrete-lined over-enlarged urban river and this template might be extended to other rivers in South London (with tailoring). Some of the adjacent water bodies, although similar, have more extensive lengths of culverting. Also, the Upper Irwell trial suggested that the template might be extended to other water bodies in the North West Region. The expert group at that trial immediately grouped three contiguous water bodies together.

Literature on channelized rivers (Brookes, 1988) and channel modification (see Davenport *et al*., 2001) was examined. The following may be useful guiding principles for grouping of FRM channels for rivers:

Initial screening:

- heavily maintained channels which might appear natural;
- resectioned (widened and deepened) earth channels (example would be the River Tame through Birmingham);
- embanked channels;
- channels with flood walls;
- urban concrete-lined channels with or without culverted lengths;
- channels impounded by weirs and sluices (physical barriers).

These categories may not be mutually exclusive within a particular water body.

Going beyond this initial screening would probably be too complex for this level of water body grouping. If more complexity was required, screening on criteria such as low/high energy and substrate should be considered, as follows:

Table 5.1 Suggested further criteria for grouping of water bodies.

Possible criteria	Example	Example
River energy	High energy river systems (generally affecting areas north of a line joining the River Tees and the River Exe). These rivers include self-forming gravel bed alluvial rivers which actively migrate through erosion. In asset management terms these may be synonymous with “rapid response watercourses”.	Low energy rivers systems (generally affecting areas south of a line joining the River Tees and the River Exe). These rivers are not generally self-formed but include rivers which have such low energy that they do not have a tendency to erode their bed and banks.
Substrate	Mobile gravel bed substrate	Cohesive bed and banks (such as clay or chalk rivers)
Planform	Meandering planform (with a tendency to form asymmetrical/ symmetrical features)	Straight planform with less tendency to form natural depositional features (such as point bars on the inside of a bend)
Channel shape	High width:depth ratio (such as over-widened channel)	Low width:depth ratio (such as over-deepened and dredged)
Vegetation	Presence of riparian vegetation (such astree roots binding the banks)	Absence of riparian vegetation

It might be possible to prescribe a more complex hydromorphology classification for rivers but this would require more research of the literature on river channel typology in the UK. For example, the size, sedimentology and morphology of rivers vary as they

flow from their source to the sea and from region to region in response to catchment inputs of water and sediment and underlying topography and geology. This variability has led to a desire amongst scientists to classify rivers into morphological types with similar physical attributes and to determine how individual river types are controlled by flow, sediment transport, slope and bed bank resistance. Biologists are also interested in how morphological attributes of channels control biota. This scientific understanding is necessary because classifying rivers into geomorphologically-defined types is seen as the way forward by a number of environmental protection agencies across Europe in determining favourable status under the Water Framework Directive.

5.3 Subsequent developments

This report has helped inform and develop the UKTAG national guidance (UKTAG, 2008) subsequently produced in final form (31 March 2008). A copy can be found in Appendix C. However, the ordering and wording of the columns in this report is revised for compatibility across all sectors (and with generic guidance) such that (reading from left to right):

Column A. Identifying pressures

Column B. Identifying whether there is no significant adverse ecological impact

Column C. Measures which may not be practicable given site-specific characteristics

Column D. Assessing whether the measure is in place and adequate

Column E. Where significant adverse impact on use might apply

Column F. Where there may be a significant adverse impact on the wider environment

Column G. Document **(x)** for measures not in place and **( )** for those already in place and **(–)** for those screened out

Column H. Will the mitigation measure provide more than a slight ecological benefit when considered alone or in combination with other measures?

Column I. Document any reasons which could affect inclusion of measure in RBMP.

This approach is most similar to Approach A (modified) described in this report.

The UKTAG (2008) guidance should be updated to accommodate issues not included in this report, which is primarily aimed at Environment Agency staff. Also Annex 4 needs two new pressures (identified and developed in the final Phase 1 report of the Digital Good Practice Manual) added. These concern water levels and flood diversion channels. Reviewers from the Digital Good Practice Steering Group have also made comments directly to UKTAG on how the national guidance could be improved.

Subsequent to this report, Jacobs have also produced for the Environment Agency a training guide: *Outlining the Process for Establishing if a Candidate A/HMWB is at GEP* (Environment Agency 2008) for use in area and regional meetings.

6 References

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Appendix A Trial Proformas

Sector: FRM rivers (A): Trial Hogsmill - Figure A1

Pressure	Sub- pressure	Impact	No.	Mitigation Measures	(1) Is the pressure present? If so □, If not, X.	(2) Is there an impact as result of the pressure? If so (□), if not, document evidence.	(3) Is the measure to deal with legacy issues or ongoing activities? If so □, if not, X.	(4) Is the measure applicable to the local characteristics of the water body? If so □, If not, document reasons why the measure has been discounted.	(5) Is the measure already in place? Where the measure is not in place please □, where the measure is already in place please document.	(6) Can the measure be taken forward without having a significant adverse impact on use or the wider environment? If yes □, if no document why not.	(7) Does the measure (alone or in combination with other measures) offer more than a slight ecological benefit? If so □, if not document the reasons why only a slight ecological benefit.
Bank and bed reinforcement and in channel structures	**Hard protection** E.g. Steel piling, vertical walls and gabion baskets. Includes hard bank protection in a state of disrepair.	Loss of riparian zone/ marginal habitat/loss of connectivity/loss of sediment input	**1**	Removal of hard reinforcement/revetment, or replacement with soft engineering solution where possible	✓	✓	n/a	✓	✓	✓	✓
			2	Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone				✓	In place	·	·
			3	Restore, enhance and create aquatic habitats				✓	In place	·	·
	Dams, sluices and weirs	Loss of biological continuity - interference with fish population movements	**4**	Operational and structural changes to dams, sluices and weirs	✓	✓		✓	✓	✓	✓
			5	Install fish passes				✓	✓	✓	✓
		Loss of sediment continuity - build up of sediment upstream, reduced bedload downstream	**6**	Removal of structure		✓		✓	✓	✓	✓
Channel alteration	**Realignment/ re-profiling/ regrading**	Loss of morphological diversity and habitat	**7**	Restore, enhance and create aquatic habitats	✓	✓		✓	In place	·	·

			8	Increase in-channel morphological diversity, e.g. install instream features; multi-stage channels				✓	In place	·	·
	Culverts	Loss of morphological diversity and habitat	**9**	Removal of existing culverts	✓	×		×	×	×	×
		Hard protection and associated impacts	**10**	Alteration of channel bed		×		×	×	×	×
Operations and Maintenance	**Sediment management (including dredging)**	Direct loss of/impact on aquatic habitats/ hydromorphology	**11**	Sediment management strategies (develop and revise) which could include substrate reinstatement or sediment traps	✓	×		×	×	×	×
		Transfer of fine sediment downstream				×					
		Bankside erosion and impacts on riparian habitats				×					
		Source of fine sediment (disposal of dredgings on banks)				×					
	Removal/clearance of urban trash and woody debris	Loss of aquatic habitats	**12**	Appropriate channel maintenance strategies and techniques	✓	×		×	×	×	×
		Transfer of fine sediment downstream				×					
	Vegetation control	Physical disturbance of bed and or bank- increased sediment input; sediment mobilisation and loss of marginal/riparian vegetation	**13**	Appropriate vegetation control regime	✓	×		×	×	×	×
		Transfer and establishment of alien invasive species	**14**	Appropriate techniques to prevent transfer of invasive species		×		×	×	×	×
	Pipes, inlets, outlets and off-takes	Hydromorphological alterations of water and sediment inputs through artificial means	**15**	Appropriate techniques to align and attenuate flow to limit detrimental effects of these features	×	×		×	×	×	×

Floodplain Alteration	**Flood banks and flood walls**	Loss of riparian zone/ marginal habitat/loss of connectivity/loss of sediment input	**16**	Flood bunds	✓	×		×	×	×	×
			17	Set-back embankments				×	×	×	×
Land Use (not in itself a sustainable flood management pressure)	**Intensive land use**	Changes to vegetation, hydrology and sediment supply	**18**	Land management strategies (develop and revise), including SUDS and changes in farming practices and forest management	✓	✓		✓	✓	✓	✓

Sector: FRM rivers (B): Trial Hogsmill - Figure A2

Pressure	Sub – pressure	Impact	No.	Mitigation Measures	(1) Is the pressure present? If so □, If not, X.	(2) Is there an impact as result of the pressure? If so (□), if not, document evidence.	(3) Is the measure to deal with legacy issues or ongoing activities? If so □, if not, X.	(4) Is the measure applicable to the local characteristics of the water body? If so □, If not, document reasons why the measure has been discounted.	(5) Can the measure be taken forward without having a significant adverse impact on use or the wider environment? If yes □, if no document why not.	(6) Does the measure (alone or in combination with other measures) offer more than a slight ecological benefit? If so □, if not document the reasons why only a slight ecological benefit.	(7) For those remaining measures check if the measure is already in place. Where the measure is not in place please □, where the measure is already in place please document.
Bank and bed reinforcement and In Channel Structures	**Hard protection** E.g. Steel piling, vertical walls and gabion baskets. Includes hard bank protection in a state of disrepair.	Loss of riparian zone/ marginal habitat/loss of connectivity/loss of sediment input	**1**	Removal of hard bank reinforcement/revetment, or replacement with soft engineering solution	✓	✓	n/a	✓	✓	✓	✓
			2	Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone				✓	✓	✓	In place
			3	Preserve and, where possible, restore historic aquatic habitats				✓	✓	✓	In place

Pressure	Sub – pressure	Impact	No.	Mitigation Measures	(1) Is the pressure present? If so □, If not, X.	(2) Is there an impact as result of the pressure? If so (□), if not, document evidence.	(3) Is the measure to deal with legacy issues or ongoing activities? If so □, if not, X.	(4) Is the measure applicable to the local characteristics of the water body? If so □, If not, document reasons why the measure has been discounted.	(5) Can the measure be taken forward without having a significant adverse impact on use or the wider environment? If yes □, if no document why not.	(6) Does the measure (alone or in combination with other measures) offer more than a slight ecological benefit? If so □, if not document the reasons why only a slight ecological benefit.	(7) For those remaining measures check if the measure is already in place. Where the measure is not in place please □, where the measure is already in place please document.
	Dams, sluices and weirs	Loss of biological continuity - interference with fish population movements	**4**	Operational and structural changes to sluices and weirs	✓	✓		✓	✓	✓	✓
			5	Install fish passes				✓	✓	✓	✓
		Loss of sediment continuity - build up of sediment upstream, reduced bedload downstream	**6**	Removal of structure		✓		✓	✓	✓	✓
								✓	✓	✓	✓
Channel alteration	**Realignment/ re-profiling/ regrading**	Loss of morphological diversity and habitat	**7**	Retain marginal aquatic and riparian habitats	✓	✓		✓	✓	✓	In place
			8	Increase in-channel morphological diversity, e.g. install instream features; two- stage channels				✓	✓	✓	In place
	Culverts	Loss of morphological diversity and habitat	**9**	Re-opening existing culverts	✓	×		×	×	×	×
			10	Alteration of channel bed				×	×	×	×

Pressure	Sub – pressure	Impact	No.	Mitigation Measures	(1) Is the pressure present? If so □, If not, X.	(2) Is there an impact as result of the pressure? If so (□), if not, document evidence.	(3) Is the measure to deal with legacy issues or ongoing activities? If so □, if not, X.	(4) Is the measure applicable to the local characteristics of the water body? If so □, If not, document reasons why the measure has been discounted.	(5) Can the measure be taken forward without having a significant adverse impact on use or the wider environment? If yes □, if no document why not.	(6) Does the measure (alone or in combination with other measures) offer more than a slight ecological benefit? If so □, if not document the reasons why only a slight ecological benefit.	(7) For those remaining measures check if the measure is already in place. Where the measure is not in place please □, where the measure is already in place please document.
Operations and Maintenance	**Sediment management (including dredging)**	Direct loss of/impact on aquatic habitats/ hydromorphology	**11**	Sediment management strategies (develop and revise) which could include substrate reinstatement or sediment traps	✓	×		×	×	×	×
		Transfer of fine sediment downstream				×		×	×	×	×
		Bankside erosion and impacts on riparian habitats				×		×	×	×	×
		Source of fine sediment (disposal of dredgings on banks)				×		×	×	×	×
	Removal/clearance of urban trash and woody debris	Loss of aquatic habitats	**12**	Appropriate channel maintenance strategies and techniques	✓	×		×	×	×	×
		Transfer of fine sediment downstream									
	Vegetation control	Physical disturbance of bed and or bank- increased sediment input; sediment mobilisation and loss of marginal/ riparian vegetation	**13**	Appropriate vegetation control regime	✓	×		×	×	×	×

Pressure	Sub – pressure	Impact	No.	Mitigation Measures	(1) Is the pressure present? If so □, If not, X.	(2) Is there an impact as result of the pressure? If so (□), if not, document evidence.	(3) Is the measure to deal with legacy issues or ongoing activities? If so □, if not, X.	(4) Is the measure applicable to the local characteristics of the water body? If so □, If not, document reasons why the measure has been discounted.	(5) Can the measure be taken forward without having a significant adverse impact on use or the wider environment? If yes □, if no document why not.	(6) Does the measure (alone or in combination with other measures) offer more than a slight ecological benefit? If so □, if not document the reasons why only a slight ecological benefit.	(7) For those remaining measures check if the measure is already in place. Where the measure is not in place please □, where the measure is already in place please document.
		Transfer and establishment of alien invasive species	**14**	Appropriate techniques to prevent transfer of invasive species		×		×	×	×	×
	Pipes, inlets, outlets and off-takes	Hydromorphological alterations of water and sediment inputs through artificial means	**15**	Appropriate techniques to align and attenuate flow to limit detrimental effects of these features	×	×		×	×	×	×
Floodplain Alteration	**Flood banks and flood walls**	Loss of riparian zone/ marginal habitat/loss of connectivity/loss of sediment input	**16**	Flood bunds	✓	×		×	×	×	×
			17	Set-back embankments				×	×	×	×
Land Use (not in itself a sustainable flood management pressure)	**Intensive land use**	Changes to vegetation, hydrology and sediment supply	**18**	Land management strategies (develop and revise), including SUDS and changes in farming practices and forest management	✓	✓		✓	✓	✓	✓

Sector: FRM rivers (B): Lower Thames - Figure A3

Pressure	Sub – pressure	Impact	No.	Mitigation Measures	(1) Is the pressure present? If so □, If not, X.	(2) Is there an impact as result of the pressure? If so (□), if not, document evidence.	(3) Is the measure to deal with legacy issues or ongoing activities? If so □, if not, X.	(4) Is the measure applicable to the local characteristics of the water body? If so □, If not, document reasons why the measure has been discounted.	(5) Can the measure be taken forward without having a significant adverse impact on use or the wider environment? If yes □, if no document why not.	(6) Does the measure (alone or in combination with other measures) offer more than a slight ecological benefit? If so □, if not document the reasons why only a slight ecological benefit.	(7) For those remaining measures check if the measure is already in place. Where the measure is not in place please □, where the measure is already in place please document.
Bank and bed reinforcement and In Channel Structures	**Hard protection** E.g. Steel piling, vertical walls and gabion baskets. Includes hard bank protection in a state of disrepair.	Loss of riparian zone/ marginal habitat/loss of lateral connectivity/loss of sediment input	**1**	Removal of hard bank reinforcement/revetment, or replacement with soft engineering solution	Not FRM or Navigation	Not FRM or Navigation					
			2	Protect and enhance ecological value of marginal aquatic habitat, banks and riparian zone							
			3	Protect and restore historic aquatic habitats							
		Loss of sediment continuity (lateral) - build up of sediment in the channel	**4**	Removal of hard bank reinforcement/revetment, or replacement with soft engineering solution		Not FRM or Navigation					
			5	Protect and enhance ecological value of marginal aquatic habitat, banks and riparian zone							
			6	Protect and restore historic aquatic habitats							
	Dams, sluices and weirs	Loss of biological continuity - interference with fish population movements	**7**	Operational and structural changes to sluices and weirs	Not FRM or Navigation	Not FRM or Navigation					
			8	Install fish passes							

Pressure	Sub – pressure	Impact	No.	Mitigation Measures	(1) Is the pressure present? If so □, If not, X.	(2) Is there an impact as result of the pressure? If so (□), if not, document evidence.	(3) Is the measure to deal with legacy issues or ongoing activities? If so □, if not, X.	(4) Is the measure applicable to the local characteristics of the water body? If so □, If not, document reasons why the measure has been discounted.	(5) Can the measure be taken forward without having a significant adverse impact on use or the wider environment? If yes □, if no document why not.	(6) Does the measure (alone or in combination with other measures) offer more than a slight ecological benefit? If so □, if not document the reasons why only a slight ecological benefit.	(7) For those remaining measures check if the measure is already in place. Where the measure is not in place please □, where the measure is already in place please document.
		Loss of sediment continuity (longitudinal) - build up of sediment upstream, reduced bedload downstream	**9**	Removal of structure		Not FRM or Navigation					
Channel alteration	**Realignment/re-profiling/ regrading**	Loss of morphological diversity and habitat	**10**	Retain marginal aquatic and riparian habitats	✓	×		×	×	×	×
			11	Increase in-channel morphological diversity, e.g. install instream features; two-stage channels				×	×	×	×
	Culverts	Loss of morphological diversity and habitat	**12**	Re-opening existing culverts	×	×		×	×	×	×
			13	Alteration of channel bed				×	×	×	×
		Continuity	**14**	Re-opening existing culverts		×		×	×	×	×

Pressure	Sub – pressure	Impact	No.	Mitigation Measures	(1) Is the pressure present? If so □, If not, X.	(2) Is there an impact as result of the pressure? If so (□), if not, document evidence.	(3) Is the measure to deal with legacy issues or ongoing activities? If so □, if not, X.	(4) Is the measure applicable to the local characteristics of the water body? If so □, If not, document reasons why the measure has been discounted.	(5) Can the measure be taken forward without having a significant adverse impact on use or the wider environment? If yes □, if no document why not.	(6) Does the measure (alone or in combination with other measures) offer more than a slight ecological benefit? If so □, if not document the reasons why only a slight ecological benefit.	(7) For those remaining measures check if the measure is already in place. Where the measure is not in place please □, where the measure is already in place please document.
			15	Alteration of channel bed				×	×	×	×
Floodplain Modification	**Flood banks and flood walls**	Loss of riparian zone/ marginal habitat/loss of lateral connectivity/loss of sediment input	**16**	Flood bunds	✓	×		×	×	×	×
			17	Set-back embankments				×	×	×	×
			18	Improve floodplain connectivity				×	×	×	×
Operations and Maintenance	**Sediment management (including dredging)**	Direct loss of/impact on aquatic habitats/ hydromorphology	**19**	Sediment management strategies (develop and revise) which could include a) substrate reinstatement, b) sediment traps, c) allow natural recovery minimising maintenance, d) riffle construction, e) reduce all bar necessary management in flood risk areas	✓	×		×	×	×	×
		Transfer of fine sediment downstream				×					
		Bankside erosion and impacts on riparian habitats				×					

Pressure	Sub – pressure	Impact	No.	Mitigation Measures	(1) Is the pressure present? If so □, If not, X.	(2) Is there an impact as result of the pressure? If so (□), if not, document evidence.	(3) Is the measure to deal with legacy issues or ongoing activities? If so □, if not, X.	(4) Is the measure applicable to the local characteristics of the water body? If so □, If not, document reasons why the measure has been discounted.	(5) Can the measure be taken forward without having a significant adverse impact on use or the wider environment? If yes □, if no document why not.	(6) Does the measure (alone or in combination with other measures) offer more than a slight ecological benefit? If so □, if not document the reasons why only a slight ecological benefit.	(7) For those remaining measures check if the measure is already in place. Where the measure is not in place please □, where the measure is already in place please document.
		Source of fine sediment (disposal of dredgings on banks)				×					
	Removal/clearance of urban trash and woody debris	Loss of aquatic habitats Transfer of fine sediment downstream	**20**	Appropriate channel maintenance strategies and techniques eg a) minimise disturbance to channel bed and margins, b) remove woody debris only in the vicinity of an urban area	✓	×		×	×	×	×
	Vegetation control	Physical disturbance of bed and or bank- increased sediment input; sediment mobilisation and loss of marginal/riparian vegetation	**21**	Appropriate vegetation control regime eg a) minimise disturbance to channel bed and margins, b) selective vegetation management for example only cutting from one side of the channel, c) providing/reducing shade	✓	×		×	×	×	×
		Transfer and establishment of alien invasive species	**22**	Appropriate techniques to prevent transfer of invasive species eg appropriate training of operational staff		×		×	×	×	×

Pressure	Sub – pressure	Impact	No.	Mitigation Measures	(1) Is the pressure present? If so □, If not, X.	(2) Is there an impact as result of the pressure? If so (□), if not, document evidence.	(3) Is the measure to deal with legacy issues or ongoing activities? If so □, if not, X.	(4) Is the measure applicable to the local characteristics of the water body? If so □, If not, document reasons why the measure has been discounted.	(5) Can the measure be taken forward without having a significant adverse impact on use or the wider environment? If yes □, if no document why not.	(6) Does the measure (alone or in combination with other measures) offer more than a slight ecological benefit? If so □, if not document the reasons why only a slight ecological benefit.	(7) For those remaining measures check if the measure is already in place. Where the measure is not in place please □, where the measure is already in place please document.
	Pipes, inlets, outlets and off-takes	Hydromorphological alterations of water and sediment inputs through artificial means	**23**	Appropriate techniques to align and attenuate flow to limit detrimental effects of these features	✓	×		×	×	×	×
Land Use (not, in itself, a sustainable flood management pressure)	**Intensive land use**	Changes to vegetation, hydrology and sediment supply	**24**	Land management strategies (develop and revise), including SUDS and changes in farming practices and forest management	✓	✓		✓	✓	✓	✓
Navigation	**Boat Movement**	Bank erosion/loss of marginal, riparian vegetation (boat wash)	**25**	Encourage reduction of boat wash impacts through traffic management in sensitive areas	✓	×		×	×	×	×
			26	Bank rehabilitation		×		×	×	×	×
		Bed scour/sediment mobilisation/macrophyte disturbance (propeller action)	**27**	Encourage use of environmentally friendly vessel design		×		×	×	×	×
		Transfer and establishment of alien invasive species	**28**	Lateral zoning to concentrate boats within a central track		×		×	×	×	×

Sector: FRM rivers (A): River Irwell - Figure A4

Sector:

Water body Information:	Water body Name	River Irwell - upstream of Whitewell Brook		Easting		Northing
	Water body ID	206	Downstream NGR Water body			
	Water body Type		Upstream NGR Water body			

		A		**B**			**C**	**D**	**E**	**F**	**G**
Pressure (physical modification or ongoing activity)	**Sub-pressure**	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
Bank and bed reinforcement and in channel structures	**Hard protection** E.g. Steel piling, vertical walls and gabion baskets. Includes hard bank protection in a state of disrepair.	Y - de facto structures (not FRM asset but reactive maintenance)	Loss of riparian zone/ marginal habitat/loss of connectivity/loss of sediment input	Y	**1**	Removal of hard reinforcement/ revetment, or replacement with soft engineering solution where possible	N - very little space to restore/re-naturalise				Could be impossible to develop links with Local Authority and create opportunities Redevelopment - if remove floodplain storage (site specific)

		A		B			C	D	E	F	G
Pressure (physical modification or ongoing activity)	**Sub-pressure**	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
					2	Preserve and enhance ecological value of marginal aquatic habitat, banks and riparian zone	N				
					3	Protect and restore historic aquatic habitats	N			.	.

		A		B			C	D	E	F	G
Pressure (physical modification or ongoing activity)	**Sub-pressure**	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
					4	Removal of hard bank reinforcement/ revetment, or replacement with soft engineering solution	N			.	.
					5	Protect and enhance ecological value of marginal aquatic habitat, banks and riparian zone	N			.	.
					6	Restore, enhance and create aquatic habitats	N			.	.

		A		B			C	D	E	F	G
Pressure (physical modification or ongoing activity)	**Sub-pressure**	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
	Dams, sluices and weirs	Y - de facto structures (not FRM asset but reactive maintenance)	Loss of biological continuity - interference with fish population movements	Y	**7**	Operational and structural changes to dams, sluices and weirs	N			.	.
					8	Install fish passes	N			.	.
			Loss of sediment continuity - build up of sediment upstream, reduced bedload downstream	Y	**9**	Removal of structure	N			.	.
Channel alteration	**Realignment/ re-profiling/ regrading**	Y – de facto structures (not FRM asset but reactive maintenance)	Loss of morphological diversity and habitat	Y	**10**	Restore, enhance and create aquatic habitats	N			.	.

		A		B			C	D	E	F	G
Pressure (physical modification or ongoing activity)	**Sub-pressure**	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
					11	Increase in-channel morphological diversity, e.g. install instream features; multi-stage channels	N			.	.
	Culverts	Y – de facto structures (not FRM asset but reactive maintenance)	Loss of morphological diversity and habitat	Y	**12**	Removal of existing culverts	N			.	.
					13	Alteration of channel bed	N			.	.
			Continuity	Y	**14**	Re-opening existing culverts	N			.	.

		A		B			C	D	E	F	G
Pressure (physical modification or ongoing activity)	**Sub-pressure**	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
					15	Alteration of channel bed	N			.	.
Floodplain Modification	**Flood banks and flood walls**	Y - de facto structures (not FRM asset but reactive maintenance)	Loss of riparian zone/ marginal habitat/loss of connectivity/loss of sediment input	Y	**16**	Flood bunds	N			.	.
					17	Set-back embankments	N			.	.
					18	Improve floodplain connectivity	N			.	.
Operations and Maintenance	**Sediment management (including dredging)**	Y - perceived as FRM	Direct loss of/impact on aquatic habitats/ hydromorphology	Y	**19**	Sediment management strategies (develop and revise) which could include a) substrate reinstatement, b) sediment	Y - aim for (c) and (e)	N - talked about but not agreed or implemented	Y - need further investigation	Y	Hydraulic models required to ascertain flood risk in certain areas.

		A		B			C	D	E	F	G
Pressure (physical modification or ongoing activity)	**Sub-pressure**	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
			Transfer of fine sediment downstream	Y - short term							
			Bankside erosion and impacts on riparian habitats	Y - decreasing connectivity							
			Source of fine sediment (disposal of dredgings on banks)	Y							
	Removal/clearance of urban trash and woody debris	Y	Loss of aquatic habitats	Y	**20**	Appropriate channel maintenance strategies and techniques eg a) minimise disturbance to channel bed and margins, b) remove woody debris only in the vicinity of an urban area	Y	Y			
			Transfer of fine sediment downstream	Y			Y	Y			

		A		B			C	D	E	F	G
Pressure (physical modification or ongoing activity)	**Sub-pressure**	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
	Vegetation control	Y	Physical disturbance of bed and or bank- increased sediment input; sediment mobilisation and loss of marginal/riparian vegetation	Y	**21**	Appropriate vegetation control regime eg a) minimise disturbance to channel bed and margins, b) selective vegetation management for example only cutting from one side of the channel, c) providing/ redcing shade	Y - linked to sediment management	N	Y	Y	
			Transfer and establishment of alien invasive species	Y	**22**	Appropriate techniques to prevent transfer of invasive species eg appropriate training of operational staff	Y	N	Y	Y	Controlling invasive species could be dispropostionately costly

		A		B			C	D	E	F	G
Pressure (physical modification or ongoing activity)	**Sub-pressure**	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
	Pipes, inlets, outlets and off-takes	N	Hydromorphological alterations of water and sediment inputs through artificial means		**23**	Appropriate techniques to align and attenuate flow to limit detrimental effects of these features eg adequate alignment of feature to limit disturbance to the channel				.	.
Land Use (not in itself a sustainable flood management pressure)	**Intensive land use**	Y	Changes to vegetation, hydrology and sediment supply	Y	**24**	Land management strategies (develop and revise), including SUDS and changes in farming practices and forest management	Y	Y		.	.

Sector: FRM TRaC Waters: Pagham Harbour - Figure A5

Water body Information:	Water body Name	Pagham Harbour		Easting		Northing
	Water body ID		Downstream NGR Water body			
	Water body Type	Coastal	Upstream NGR Water body			

	A		B			C	D	E	F	G
Pressure (physical modification or ongoing activity)	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
Bank reinforcement	**Yes**	Coastal squeeze; disruption of tidal flow and channel interaction; disruption/alteration of estuarine process dynamics; modification of sediment dynamics; disruption of natural habitats; loss of faunal nursery, refuge and feeding areas	**Yes**	**1**	Removal of hard engineering structures (e.g.naturalisation)	**Yes**	**No**	**Yes** in appropriate locations	**Yes**	
				2	Modify existing structures	**Yes**	**No**	**Yes** in appropriate locations	**Yes**	
				3	Replacement with soft engineering solution	**Yes**	**No**	**Yes** in appropriate locations	**Yes**	would probably provide least benefit
				4	Bank reprofiling	**Yes**	**No**	**Yes** in appropriate	**Yes**	would probably provide

	A		B			C	D	E	F	G
Pressure (physical modification or ongoing activity)	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
								locations		least benefit
				5	Managed realignment of flood defence	**Yes**	**No**	**Yes** in appropriate locations	**Yes**	
				6	Restore/create/enhance aquatic and marginal habitats	**Yes**	**No**	**Yes** in appropriate locations	**Yes**	
				7	Indirect/offsite mitigation (offsetting measures)	**Yes**	**No**	**Yes**	**Yes**	
Channel dredging	**No**	Alteration of bathymetry; disruption/alteration		**8**	Sediment management strategies (develop and/or revise)					

	A		B			C	D	E	F	G
Pressure (physical modification or ongoing activity)	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
		of natural tidal and sediment dynamics; destruction and alteration of benthic habitats; mobilisation of contaminants; increased turbidity (periodically)		**9**	Indirect/offsite mitigation (offsetting measures)					
Deposition of material	**No**	Smothering of existing floral and faunal and habitats; alteration of estuarine processes; alteration of natural sediment dynamics; alteration of bathymetry		**10**	Material emplacement strategies (develop and/or revise)					
Tidal river alteration e.g. channelisation /realignment/ straightening	**No** possibly an issue but considered to be minor	Disruption of tidal flow and interaction; alteration of estuarine processes; alteration of natural sediment dynamics; alteration of		**11**	Restore/create/enhance aquatic and marginal habitats					
				12	Increase in-channel					

	A		B			C	D	E	F	G
Pressure (physical modification or ongoing activity)	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
		bathymetry; loss of morphological diversity and habitat			morphological diversity					
				13	Indirect/off-site mitigation (offsetting measures)					
Impounding	**Yes**	Alteration of bathymetry; disruption of tidal flow and interaction; alteration of natural sediment dynamics - loss of continuity; destruction and alteration of benthic habitats; mobilisation of contaminants; increased turbidity;	**Yes**	**14**	Removal of structure	**Yes**	**No**	**Yes**	**Yes**	Could provide quick win if implemented
				15	Operational and structural changes to locks, sluices and tidal barrages	**Yes**	**No**	**Yes**	**Yes**	Could provide quick win if implemented

	A		B			C	D	E	F	G
Pressure (physical modification or ongoing activity)	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
		loss of faunal nursery, refuge and feeding areas; disruption of habitat connectivity/continuity - interference with fish population movements		**16**	Install fish passes	**Yes**	**No**	**Yes**	**Yes**	Could provide quick win if implemented
				17	Indirect/off-site mitigation (offsetting measures)	**No** not considered relevant to this water body				
Manipulation of sediment transport	**Yes** Training harbour wall	Disruption of tidal flow and interaction; alteration of estuarine processes; alteration of natural sediment dynamics; alteration of bathymetry; direct/indirect habitat loss	**Yes**	**18**	Removal of structure	**Yes**	**No**	**Yes**	**No** removing training wall could cause closure of harbour inlet and/or erosion of Pagham Spit	.
				19	Modify structure design	**Yes**	**No**	**Yes**	**Yes**	.

	A		B			C	D	E	F	G
Pressure (physical modification or ongoing activity)	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant impact? (In the absence of any mitigation already in place would there be a significant impact?) (Y/N) If yes, proceed to column C, if no document.**	**No.**	**Mitigation Measures**	**Is the measure practical given the site specific considerations? If yes, proceed to column D, if no document.**	**Is the measure in place and adequate? If so document here. If not proceed to column E.**	**Can the measure be implemented without having an adverse impact on use or the wider environment? If yes, proceed to column F, if no document.**	**Will the mitigation measure provide more than a slight ecological benefit when considered in combination with other measures?**	**Add comments on implementation, for example, reasons for time exemption, prioritisation in combination with other measures, cost, likelihood of measure being disproportionately costly.**
				20	Restore/create/enhance aquatic and marginal habitats	**No** not considered relevant to this water body			.	.
				21	Indirect/offsite mitigation (offsetting measures)	**No** not considered relevant to this water body			.	.

Appendix B Example Presentation

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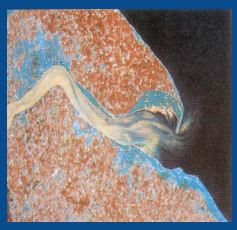
Digital Good Practice Manual

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Specific Objectives of Project

- To develop guidance on mitigation for FRM and Land Drainage activities on rivers, estuaries, lakes and coasts with a view to complying with the requirements of the WFD ***but*** *without having adverse impacts on the Use (and taking into account cost)*
- The manual to be in a digital format that enables selection of cost-effective combinations of mitigation measures (combinations = technical + costs and intangibles)

Applicable to NI, Scotland, England and Wales
(Immediate Client is the Environment Agency)

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Objectives for this afternoon

- As part of this project Jacobs have been tasked with undertaking trials for the FRM component of a UK-wide trial covering all Sectors (eg Navigation, Ports, Impoundments etc). This is for UK TAG (the Technical Advisory Group Water Framework Directive Implementation).
- Royal Haskoning (Helen Dangerfield) are coordinating the trails overall for UKTAG, a key milestone being a Stakeholder Workshop in Birmingham on 23 November 2007 Jacobs were specifically tasked with reporting back on the initial trials for FRM at this workshop
- Other trials have been taking place up to and beyond 23 November to cover all sectors and cross-sector water bodies (eg those which are classed as HMWB for both impoundments and FRM (also known as in combination)).

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Background

- The Water Framework Directive is the most substantial piece of EC water legislation to date.
- Will be implemented through River Basin Management Plans
- Aim is for all inland and coastal waters to achieve good ecological and good chemical status by 2015
- Good Ecological Status is a state close to being undisturbed by human activity. GES is supported by hydromorphological quality elements.
- Hydromorphology is concerned with hydrological and geomorphological forms and processes (eg flow, sediment, structure of a channel and riparian zone). Also concerned with connectivity (to allow upstream/downstream movement and migration of fauna and flora)

Background (Continued)

- **Heavily Modified and Artificial Water Bodies – a water body having a defined use eg a flood defence or a navigation. Difficult to attain GES as hydromorphological quality has been reduced, such that ecology is poor and the physical alterations cannot be reversed without major impact on use or on the wider environment.**
- **Good Ecological Potential. An alternative objective used for HMWB and AWBs. GEP is set in relation to reference conditions (Maximum Ecological Potential for HMWBs). GEP does not have an adverse impact on use or the wider environment**

The Alternative Approach

- Difficult to set reference conditions for HMWBs without having a natural ecological state, Therefore an alternative method which estimates GEP and MEP based on those mitigation measures that could be taken to enhance the water body without having a significant impact on use.
- Need now to trial the method to see which measures could be applied to water bodies to classify whether the water body is reaching GEP or not. Where GEP is not being met then mitigation measures will be identified.

FRM Trails

- Hogsmill (FRM Rivers only)
- Lower Thames (FRM Rivers and Navigation)
- Irwell (FRM Rivers only)
- Pagham (FRM Coastal)
- Portsmouth Harbour (FRM TRAC and Ports)
- AN Other
- AN Other

Why Pagham?


Environment Agency
Pagham
• Is it at GEP already?
• Where does it sit?

Appendix C UKTAG Guidance and Proforma

Annex IV Flood Risk Management

How should this Annex be used?

The purpose of this Annex is to provide specific guidance on using the checklist of mitigation measures for water bodies designated as heavily modified as a result of Flood Risk Management. Two separate checklists of measures have been provided for FRM for rivers and TRaC water bodies. The information contained within this Annex covers both, distinguishing where necessary, and the information should be read in conjunction with the forms.

Guidance is provided where specific guiding principles have been identified by the sector to help the decision making process. Where specific guidance has not been identified the user should refer to the generic guidance.

It is anticipated that this Annex will be updated and improved in subsequent river basin management planning cycles.

How is the Annex Guidance Structured?

The Annex Guidance is structured in the same way as the main document with guidance under each column (A-F).

Filling in the forms

During trialling of the process, it was found that decisions on the answers to the questions within the forms must rely on expert judgement. Experts are also needed to temporarily drill down into the detailed knowledge of a water body to glean relevant information so that assumptions can be made and applied strategically for the entire water body. The comments that are likely to arise during the classification process are likely to be important to these should be recorded into the form at the meeting.

In order to maximise the effectiveness of the expert group meeting, it is suggested that the representatives attending should be asked to bring with them the following:

- Information on physical modification (function, maintenance of structures, residual life etc from the National Flood and Coastal Defence Database where possible).
- Information on ongoing maintenance regimes (likely to be anecdotal derived from locals).
- Information on any existing Flood and Coastal Defence Database mitigation measures and the impacts they are intended to mitigate.

ANNEX IV: FLOOD RISK MANAGEMENT

ROYAL HASKONING

Sector: FRM Transitional and Coastal Waters

Waterbody Information:

Waterbody Name			Easting	Northing
Waterbody ID		NGR Waterbody Boundary		
Waterbody Type		NGR Waterbody Boundary		

List the pressures identified within the HMWB/AWB designation for this waterbody	
Record other water uses appearing to cause signficant pressure not identified within the HMWB/AWB designation	

		A		B			C	D	E	F	G	H	I
Pressure (physical modification)	Sub-pressure	Is the pressure present? (Y/N) If Yes, proceed to column B.	Potential Impacts	Is there a significant adverse ecological impact or, in the absence of any mitigation already in place, could there be a significant adverse impact? (Y/N) If yes, proceed to column C, if no document and proceed to Column G.	Mitigation Measures	No.	Is the measure practicable given the characteristics of the water body? (Yes/No) If yes, proceed to Column D. If no, document and proceed to column G.	Is the mitigation measure in place and adequate? (Yes/No) If No, proceed to Column E. If Yes document the mitigation measure and proceed to Column G.	Can the measure be implemented without having a significant adverse impact on use? (Yes/No) If yes, proceed to column F, If no document and proceed to Column G.	Can the measure be implemented without having a significant adverse impact on the wider environment? (Yes/No) If yes, proceed to Column G, If no document and proceed to Column G.	Document: x : For measures not in place (proceed to Column H) ✓: For those already in place and adequate - : For those screened out	Will the mitigation measure provide more than a slight ecological benefit when considered alone or in combination with other measures? If yes, proceed to Column I; if no, document	Document any reasons which could affect the inclusion of the measure in the RBMP (e.g. prioritisation in combination with other measures, disproportionate cost, other reasons why an extended deadline or less stringent target might be justified)
Shoreline reinforcement / elevation	Bank reinforcement		Coastal squeeze; Disruption of tidal flow and channel interaction; Disruption / alteration of estuarine process dynamics; Modification of sediment dynamics; Disruption of natural habitats; Loss of faunal nursery, refuge and feeding areas			1							
					Modify existing structures	2							
					Replacement with soft engineering solution	3							
					Bank reprofiling	4							
					Managed realignment of flood defence	5							
					Restore / create / enhance aquatic and marginal habitats	6							
					Indirect / offsite mitigation (offsetting measures)	7							
Operations and maintenance	Channel dredging		Alteration of bathymetry; Disruption / alteration of natural tidal and sediment dynamics; Destruction and alteration of benthic habitats; Mobilisation of contaminants; Increased turbidity (periodically)		Sediment management strategies (develop and/or revise)	8							
					Indirect / offsite mitigation (offsetting measures)	9							
	Deposition of material		Smothering of existing floral and faunal and habitats; Alteration of estuarine processes; Alteration of natural sediment dynamics; Alteration of bathymetry		Material emplacement strategies (develop and/or revise)	10							
Channel alteration	Tidal river alteration e.g. channelisation / realignment / straightening		Disruption of tidal flow and interaction; Alteration of estuarine processes; Alteration of natural sediment dynamics; Alteration of bathymetry; Loss of morphological diversity and habitat		Restore / create / enhance aquatic and marginal habitats	11							
					Increase in-channel morphological diversity	12							
					Indirect / offsite mitigation (offsetting measures)	13							
Impoundment	Locks, sluices and tidal barrages		Alteration of bathymetry; Disruption of tidal flow and interaction; Alteration of natural sediment dynamics - loss of continuity; Destruction and alteration of benthic habitats; Mobilisation of contaminants; Increased turbidity; Loss of faunal nursery, refuge and feeding areas; Disruption of habitat connectivity/continuity - interference with fish population movements		Removal of structure	14							
					Operational and structural changes to locks, sluices and tidal barrages	15							
					Install fish passes	16							
					Indirect / offsite mitigation (offsetting measures)	17							
Manipulation of sediment transport	Installation of beach control structures		Disruption of tidal flow and interaction; Alteration of estuarine processes; Alteration of natural sediment dynamics; Alteration of bathymetry; Direct / indirect habitat loss		Removal of structure	18							
					Modify structure design	19							
					Restore / create / enhance aquatic and marginal habitats	20							
					Indirect / offsite mitigation (offsetting measures)	21							

Hydromorphological assessment for classification	

ANNEX IV: FLOOD RISK MANAGEMENT

ROYAL HASKONING

Sector:
Waterbody Information:

FRM River and Drainage Watercourses

Waterbody Name				Easting	Northing
Waterbody ID		Downstream NGR Waterbody			
Waterbody Type		Upstream NGR Waterbody			

List the pressures identified within the HMWB/AWB designation for this waterbody	
Record other water uses appearing to cause significant pressure not identified within the HMWB/AWB designation	

		A		B			C	D	E	F	G	H	I
Pressure (physical modification)	Sub-pressure	Is the pressure present? (Y/N) If Yes, proceed to column B.	Potential Impacts	Is there a significant adverse ecological impact or, in the absence of any mitigation already in place, could there be a significant adverse impact? (Y/N) If yes, proceed to column C, if no document and proceed to Column G.	Mitigation Measures	No.	Is the measure practicable given the characteristics of the water body? (Yes/No) If yes, proceed to Column D. If no, document and proceed to column G.	Is the mitigation measure in place and adequate? (Yes/No) If No, proceed to Column E. If Yes document the mitigation measure and proceed to Column G.	Can the measure be implemented without having a significant adverse impact on use? (Yes/No) If yes, proceed to column F, if no document and proceed to Column G.	Can the measure be implemented without having a significant adverse impact on the wider environment? (Yes/No) If yes, proceed to Column G, If no document and proceed to Column G.	Document: x : For measures not in place (proceed to Column H) ✓: For those already in place and adequate - : For those screened out	Will the mitigation measure provide more than a slight ecological benefit when considered alone or in combination with other measures? If yes, proceed to Column I, if no, document	Document any reasons which could affect the inclusion of the measure in the RBMP (e.g. prioritisation in combination with other measures, disproportionate cost, other reasons why an extended deadline or less stringent target might be justified)
Bank and bed reinforcement and in-channel structures	Hard protection (e.g. Steel piling, vertical walls and gabion baskets. Includes hard bank protection in a state of disrepair.		Loss of riparian zone / marginal habitat / loss of lateral connectivity / loss of sediment input		Removal of hard bank reinforcement / revetment, or replacement with soft engineering solution	1							
					Protect and enhance ecological value of marginal aquatic habitat, banks and riparian zone	2							
					Protect and restore historic aquatic habitats	3							
			Loss of sediment continuity (lateral) - build up of sediment in the channel		Removal of hard bank reinforcement / revetment, or replacement with soft engineering solution	4							
					Protect and enhance ecological value of marginal aquatic habitat, banks and riparian zone	5							
					Protect and restore historic aquatic habitats	6							
	Dams, sluices, weirs and gravel traps		Loss of biological continuity - interference with fish population movements		Operational and structural changes to sluices and weirs	7							
					Install fish passes	8							
			Loss of sediment continuity (longitudinal) - build up of sediment upstream, reduced bedload downstream		Removal of structure	9							
Channel alteration	Realignment / re-profiling / regrading		Loss of morphological diversity and habitat		Retain marginal aquatic and riparian habitats	10							
					Increase in-channel morphological diversity, e.g. install instream features; 2 stage channels	11							
	Culverts		Loss of morphological diversity and habitat		Re-opening existing culverts	12							
					Alteration of channel bed	13							
			Continuity		Re-opening existing culverts	14							
					Alteration of channel bed	15							
Floodplain modification	Flood banks and flood walls		Loss of riparian zone / marginal habitat / loss of lateral connectivity / loss of sediment input		Flood bunds (earth banks)	16							
					Set-back embankments (a type of managed retreat)	17							
					Improve floodplain connectivity	18							
Operations and maintenance	Sediment management (including dredging)		Direct loss of / impact on aquatic habitats / hydromorphology		Sediment management strategies (develop and revise) which could include a) substrate reinstatement, b) sediment traps, c) allow natural recovery minimising maintenance, d) riffle construction, e) reduce all bar necessary management in flood risk areas	19							
			Transfer of fine sediment downstream										
			Bankside erosion and impacts on riparian habitats										
			Source of fine sediment (disposal of dredgings on banks)										
	Removal/clearance of urban trash and woody debris		Loss of aquatic habitats		Appropriate channel maintenance strategies and techniques e.g. minimise disturbance to channel bed and margins	20							
			Transfer of fine sediment downstream		Appropriate channel maintenance strategies and techniques e.g. remove woody debris only upstream of, or within, areas of urban flood risk	21							
	Vegetation control		Physical disturbance of bed and or bank - increased sediment input, sediment mobilisation and loss of marginal / riparian vegetation		Appropriate vegetation control regime e.g. a) minimise disturbance to channel bed and margins, b) selective vegetation management for example only cutting from one side of the channel, c) providing/reducing shade, d) seasonal maintenance	22							
			Transfer and establishment of alien invasive species		Appropriate techniques to prevent transfer of invasive species e.g. appropriate training of operational staff	23							
	Pipes, inlets, outlets and off-takes		Hydromorphological alterations of water and sediment inputs through artificial means		Appropriate techniques to align and attenuate flow to limit detrimental effects of these features	24							
								Hydromorphological assessment for classification					

Identifying pressures (Column A)

It is sometimes the case that historic physical alteration of the channel has been undertaken for reasons other than Flood Risk Management, for example, bank and bed reinforcement, channel alteration and floodplain modifications are common in industrial catchments. Although these assets are not part of formal FRM schemes and are not routinely maintained by the regulatory authority, in some cases flood modelling may show that the structures provide a flood risk benefit and it is within the jurisdiction of the regulatory authority to provide reactive maintenance if for example the wall or weir fails. These are known as 'defacto structures' and should be included as pressures.

Identifying where there is no significant adverse ecological impact (Column B)

The impacts identified within the spreadsheet are related to those hydromorphological quality elements listed within the Water Framework Directive itself (Annex V). In order to determine whether an impact is significant within specific water bodies, it may help to refer back to those quality elements. These are as follows:

- Hydrological regime
  - Quantity and dynamics of water flow
  - Connection to ground water bodies
- Morphological conditions
  - Depth and width variation
  - Quantity, structure and substrate of the bed
  - Structure of the riparian zone or inter-tidal zone
- River continuity
- Tidal regime
  - Freshwater flow
  - Wave exposure

The hydromorphological quality elements listed above are considered to (in part) support the biological quality elements of the Water Framework Directive. For reference the biological quality elements are as follows:

- Composition and abundance of phytoplankton
- Composition and abundance of other aquatic flora
  - Macrophytes and phytobenthos
  - Macroalgae
  - Angiosperms
- Composition and abundance of benthic invertebrate fauna
- Composition, abundance and age structure of fish fauna

Measures which may not be practicable given site specific characteristics (Column C)

As water bodies in many cases are large (for example encompassing entire catchments), it may be the case that certain mitigation measures may be practicable in one location (for example where a policy may be to increase flood risk through removing flood defence infrastructure it may be possible to reconnect river and floodplain) but not practicable elsewhere (for example, where defences are required to protect urban areas). Where it is practicable to implement measures in certain locations the measure should be retained. Lack of space to restore may change into the future thus any potential for regeneration, identified in Local Development Frameworks or other strategic plans, particularly in urban areas, might be flagged up for future consideration in revision to RBMP plans.

Assessing whether the measure is in place and adequate (Column D)

Where a measure is already 'in place and adequate', this should be documented and the delivery mechanism for the measure should be explained.

The measure may be considered to be adequately implemented if, for example:-

- The measure is being undertaken in accordance with the regulators policy and or process guidance.
- The measure is being delivered through established good/best practice.
- The measure has been implemented in all locations where practicable.

For spatially variable measures, where the measure could be further applied within the water body towards improving hydromorphological quality elements then the measure is not fully in place or adequate as the ecological potential has not been achieved.

Where the measure has been achieved through suspension of an existing practice (such as maintenance dredging) for reasons other than ecological enhancement (for example, to reduce costs) but ecological benefit has been achieved, note should be made of this as an indirect measure. Although the maintenance activity may not have occurred for sometime, it may not have formally ceased and as such could recommence. Works should follow the regulators policy (where available) on gravel removal, however, by noting this as a mitigation measure, any recommencement of works would need to demonstrate the benefit to flood risk management before being undertaken.

Where significant adverse impact on use might apply (Column E)

Significant adverse impact on use would be determined in the case of Flood Risk Management where:

- Flood defence infrastructure or activity is still required and active and undertaking the measure would either compromise the function and integrity of the asset or activity and/or reduce the residual life of the asset.
- Any change in the infrastructure or activity would result in a change in flood risk at upstream, downstream or alongshore which would be against the policy set out within large scale plans or policies.

Where there may be a significant adverse impact on the wider environment (Column F)

See generic guidance.

Glossary

It is assumed that readers of this report have a firm grounding in Flood Risk Management (FRM) and Land Drainage (LD) terminology, so unless considered peculiar or unique the terms which appear in the report are not defined in this glossary.

Artificial water body (AWB)

A specific WFD term which refers to a water body which is totally artificial (man-made) rather than with natural origins. Examples could include lakes and canals.

Asset management

The management of systems for flood defence assets over their whole life. Flood defence assets are recorded on the National Flood and Coastal Defence Database. Many of these assets are maintained by the Environment Agency, although a considerable number are the responsibility of others such as local authorities and private landowners. “System Asset Management Plans” is a specific term relating to an ongoing project within the Environment Agency to assess the maintenance needs of discrete systems of assets.

De facto structure

A structure which has been judged or proven to be a flood defence benefit but which is not within the specific ownership or responsibility of the FRM organisation. This is term only used in this report and is not an accepted Environment Agency term. The Environment Agency has recently (Operating Instruction 028_08) produced guidance on what is and what is not a flood defence asset. Structures (like garden walls) which provide an incidental level of protection (but are not designed to hold water back) are now not flood defence assets unless they are integral to a wider scheme.

Developer

A person or organisation (public or private) responsible for proposing modification to water bodies.

Facilitated meeting

A meeting conducted (usually by a facilitator) to attain a consensus of professional views and judgement.

Fisheries, Recreation and Biology (FRB)

A specific Environment Agency term encompassing those disciplines responsible for the protection and conservation of water bodies.

Flood defence structure

This is a structure that provides reduced risk of flooding and by its failure would increase the likelihood of flooding.

Good chemical status (GCS)

One of the two components of good status (the other being good ecological status). GCS is defined in terms of compliance with all the quality standards established for chemical substances at the European level.

Good ecological potential (GEP)

By 2015 all artificial water bodies have to reach good ecological potential (GEP). GEP is set in relation to reference conditions. For HMWBs this reference condition is the MEP (maximum ecological potential).

Good ecological status (GES)

An expression of the quality of the structure and functioning of aquatic ecosystems associated with surface waters, classified in accordance with Annex V of the Water Framework Directive. GES is defined as: a state where the biological quality elements (for example benthic invertebrates or fish) of a water body deviate only slightly from conditions that would be present if the water body was undisturbed by human activity. To achieve GES in a HMWB would result in a significant adverse impact on use.

Heavily modified water body (HMWB)

In some cases, substantial alterations made for activities like navigation, water storage, flood defence and land drainage may mean that a surface water body cannot reach 'good' ecological status. Where certain criteria are met, the WFD allows such water bodies to be designated as heavily modified water bodies.

Hydromorphology

Used to describe in combination the hydrological and geomorphological forms and processes of rivers, lakes, estuaries and coastal waters. This includes the quantity and dynamics of flow or the tidal regime, associated sediment regime and size, shape and structure of the channel or foreshore. For rivers, hydromorphology not only includes the forma and function of the channel but also its connectivity (such as the allowance of sediment movement or the migration/movement of organisms.

Impact

The environmental effect of a pressure (such as fish killed; ecosystems modified).

Maximum ecological potential (MEP)

Hydromorphological conditions mean the only impacts on the water body result from the artificial or heavily modified characteristics of the water body once all mitigation measures have been taken to ensure the best approximation to ecological continuum, in particular with respect to migration of fauna and spawning and breeding grounds.

Measure

Measures that can potentially be deployed to mitigate adverse impacts, thereby improving the ecological potential of a water body.

Pressure (sub-pressure)

The direct effect of a driver (an anthropogenic activity). For example, an effect that causes a change in flow.

Regulator

The organisation (or departments within an organisation) responsible for ‘regulating’ the works proposed by developers.

Third party asset

An asset maintained by a third party (note: this does not simply relate to ownership as the Environment Agency maintains many assets that it doesn’t own).

Transitional and coastal waters (TraC)

A specific term coined to cover estuarine as well as coastal environments. In this report both have been confined.

UK Technical Advisory Group (UKTAG)

The advisory group set up in the UK to implement the EU Water Framework Directive.

Use

The specific pressure which results in the water body being designated as “heavily modified”. Uses may be singular (FRM, LD, navigation, water resources, HEP) or a combination of pressures.

Water body

A specific term used to define (for example) a length of watercourse or coastline. A river basin (catchment) may contain several water bodies.

Water Framework Directive (WFD)

Directive 2006/60/EC establishing a framework for EU community action in the field of water policy.

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