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Environment Agency

delivering benefits through science

Mechanical, Electrical, Instrumentation, Control and Automation (MEICA) scoping programme

Science project SC070040/SR1

Flood and Coastal Erosion Risk Management Research and Development Programme

The Environment Agency is the leading public body protecting and improving the environment in England and Wales.

It's our job to make sure that air, land and water are looked after by everyone in today's society, so that tomorrow's generations inherit a cleaner, healthier world.

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

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

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Science at the Environment Agency

Science underpins the work of the Environment Agency. It provides an up-to-date understanding of the world about us and helps us to develop monitoring tools and techniques to manage our environment as efficiently and effectively as possible.

The work of the Environment Agency's Science Department is a key ingredient in the partnership between research, policy and operations that enables the Environment Agency to protect and restore our environment.

The science programme focuses on five main areas of activity:

- **Setting the agenda**, by identifying where strategic science can inform our evidence-based policies, advisory and regulatory roles;
- **Funding science**, by supporting programmes, projects and people in response to long-term strategic needs, medium-term policy priorities and shorter-term operational requirements;
- **Managing science**, by ensuring that our programmes and projects are fit for purpose and executed according to international scientific standards;
- **Carrying out science**, by undertaking research – either by contracting it out to research organisations and consultancies or by doing it ourselves;
- **Delivering information, advice, tools and techniques**, by making appropriate products available to our policy and operations staff.

Steve Killeen

Head of Science

Executive summary

In response to business needs, the Environment Agency has become more focused on research & development/science over recent years, and this has led to a study to investigate areas where MEICA science and research investment could most effectively be deployed. This project focuses particularly on the mechanical and electrical areas where strategic investment could bring benefits, setting aside such areas as civil structures or major construction projects, which are addressed separately in other projects.

Early on in the study, interviews were conducted with staff from the Environment Agency and other related organisations such as internal drainage boards, and from their comments a list of possible projects for MEICA research & development was drawn up. Core members of the project team then assessed this list and divided projects into 'science', 'collation and best practice', 'scoping', 'park' and 'initially ruled out'. They also, in some cases, combined suggested projects where they were very similar, or grouped projects together under a more general project title.

This 'shortlist' of projects was then taken forward to a workshop held on 25 February 2009, where projects were introduced by the project 'sponsors' and the attendees were then asked to score the projects in three ways:

- importance or benefit to the Environment Agency;
- perceived difficulty;
- expected cost.

The data was collated for analysis, and in chapter 4 of the report a series of figures present the results graphically, while the text elaborates and comments on some of the results. In the light of this data, the shortlist was cut down to nine chosen projects, which the project team recommended that the Environment Agency should consider taking forward. The nine projects are listed below.

'Science' projects:

1. Improving the efficiency and best practice for pumps. (Project 19, 22 and 49).
2. Use of biodegradable oils as opposed to conventional mineral oil products. (Project 50).
3. Non-intrusive methods for corrosion between jointing plates and I-beams (critically relating to the Thames Barrier). (Project 14).
4. Alternatives to bespoke stop logs for gate structures. (Project 41).

'Collation and best practice' projects

1. Devices and methods for inspecting wire ropes. (Project 30 and 29).
2. Best practice for use of remote camera surveillance or CCTV. (Project 48).
3. Paint finishes for gates and structures. (Project 31 and 45).
4. Identifying common signs indicating gate failure. (Project 32).
5. Research into the use of alternative materials for flap valves, penstocks etc. (Project 20, 25 and 26).

The project team provided some guidance on prioritisation of these projects, and also some comments on possible sources of funding . A very brief literature search on the chosen projects was also undertaken to get some idea of what information was already available.

The final chapter of the report summarises the recommendations, and this is followed by appendices, which give more detailed information on the comments made during the survey consultations and the voting results from the workshop, as well as project summary tables for the recommended projects.

It must be emphasised that there is a degree of flexibility over the actual level of importance each project should be assigned. The choice of project priority should be made qualitatively following further consultation with the Environment Agency. Also, where projects are listed as being of limited value (such as 'Investigating the cost of vandalism and related topics', as well as 'Robotic devices for inspection in confined areas' this does not mean that they are of no value to the Environment Agency, only that from the above workshop and analysis of information provided, expenditure on these projects is considered to have a lower priority.

The priority of projects may also be affected to some degree by events outside the Environment Agency's control, and it may be that at some point in the near future an unexpected event or possibly even a change in legislation will force a new direction to be undertaken.

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1 Introduction

1.1 Background

The Environment Agency has a supervisory role for all watercourses in England and Wales. Along with other operating authorities, it builds and maintains a wide and varied collection of assets including guillotine and mitre-type lock gates, pumping stations and river level maintenance weirs, and a large array of flow and level measurement systems.

In order to ensure the continuing safe and reliable operation of these assets, the Environment Agency has a programme to carry out regular maintenance and replacement of its assets as and when needed. However, over time the cost of this annual maintenance has generally increased due to a combination of factors, and the Environment Agency has found that in many areas the cost of carrying out the work has become prohibitive. In other related industries such as the water and waste water industry, there have been numerous demonstrated benefits from a sustained programme of investment in research & development, both in terms of reduced manpower costs and also in enhanced reliability and asset operability.

In response to business needs, the Environment Agency has become more focused on research & development and science over recent years, and one result of this has been the implementation of a programme to investigate areas where research investment could most effectively be deployed. This project will focus particularly on the mechanical, electrical, instrumentation, control and automation (MEICA) areas where strategic investment could bring benefits, setting aside such areas as civil structures or major construction projects, which are addressed elsewhere as a separate issue.

1.2 Objectives

The primary objective of this project was to consult with the Environment Agency and other interested parties to better understand their MEICA needs, and from this information create a list of specific areas for targeted research investment. End-users were consulted in the early stages of the project in order to avoid wasted effort resulting from development of solutions which do not necessarily solve identified problems.

1.3 Guiding principles

The methods used in this project are described in more detail later on, but basically stem from the knowledge that within the Environment Agency's operation and maintenance teams there are many people who have a good understanding of the day-to-day problems associated with various pumping stations, lock gates, weir structures and other related equipment. The project team was guided by the underlying principle that the project must focus on their needs so that these needs are met with targeted research.

While research & development projects often lead to other, unexpected benefits, either in the form of innovative uses for existing technology, or from the transfer of best operating practices from one application to another, the key point of the project is to ensure that the initial problems are addressed. Any coincidental benefits arising from the research will, of course, be captured in order to gain maximum advantage from the investment.

1.4 Project scope

The following operations are considered to be relevant to the project scope:

- pumps and pumping stations, plus associated equipment;
- controls and instrumentation equipment;
- pipeline ancillaries;
- steel mechanical structures;

while the following are not considered to be relevant to the project scope:

- civil structures;
- fixed steelwork;
- personnel and related manpower issues.

2 Drivers for MEICA

2.1 Short-term drivers

There are two main short-term drivers for the kind of work described in this project. The first is the requirement to trim back day-to-day expenditure on maintenance and operational costs, through improved efficiency. The second is avoidance of any kind of safety concerns through improvements to health and safety procedures and elimination (or significant reduction) of hazards. This may result in an overall improvement in the working environment and a reduction in working time lost through accidents. The projects described within this document will have impacts in both areas, providing clear financial benefits and also improving health and safety.

2.2 Long-term drivers

Other drivers for this kind of work tend to centre more on the long-term application of new operating practices and operational procedures as well as the longer-term implementation of new products or processes derived from the scientific studies. It is often difficult to adequately describe benefits of longer-term changes in advance as they may only become apparent long after the initial investment has taken place. However, there are expected to be major savings due to improved working practices and the implementation of better and safer procedures, as described in more detail later within this report.

3 Methodology

3.1 Brief summary

The project team was as follows:

Nigel Bulmer	Environment Agency	Regional MEICA Manager (North East)
Martin Earlham	Environment Agency	Asset System Management Team Leader
Neil Terry	Environment Agency	Regional MEICA Engineer
Martin Hayes	Environment Agency	Regional MEICA Manager (Midlands)
Darsha Gill	Environment Agency	Regional MEICA Manager (Thames)
Martin Lee	Environment Agency	Regional MEICA Manager (Anglian)
Edward Morris	Environment Agency	Technical Director (Thames Barrier)
Geoff Baxter	Environment Agency	Theme Manager (Flood Risk Science)
Gary Tustin	Environment Agency	Principal Scientist (Flood Risk Science)
Neville White	Environment Agency	Senior Scientist (Flood Risk Science)
Keith Solts	Environment Agency	National MEICA Technical Advisor
Andy Fitton	Environment Agency	Technical Manager – MEICA and Systems
John Hunt	Environment Agency	Regional MEICA Manager (North West)
David Thomas	Middle Level Commissioners	Chief Engineer
Malcolm Downes	Middle Level Commissioners	MEICA Manager
John Sheppard	Atkins Consultants	Principal Mechanical Engineer
Martin Ward	Atkins Consultants	Senior Mechanical Engineer
Colin Lee	Atkins Consultants	Review Engineer
Anne-Marie Eldred	Atkins Consultants	Administrator

3.2 MEICA staff interviews

In order to ensure end-user interest in the project from the start, a series of interviews were conducted with various operations MEICA managers and interested other parties such as MEICA engineers in Internal Drainage Boards (IDB's). In order to maximise the benefit from this round of research, as many interviews as practically possible were carried out in a number of different regions.

3.3 Collation of ideas and shortlisting

The ideas and problems identified were collated into a list, which is described later. As expected, there was some repetition of comments within the interviews, and in cases where two or more identified projects were apparently the same, these were combined. In cases where projects were similar, but not necessarily identical, they were combined into a project with wider scope.

3.4 Information review

The next stage in the investigation was to conduct a brief overview of existing technologies, methodologies and products. The key aim was to establish if there could be any 'quick fixes' using key technologies which had already been developed by other industries elsewhere, or products which may have been developed only recently.

In some cases solutions may already exist to the problems identified, but for reasons of commercial secrecy or the 'newness' of the product or methodology, few people are aware of the solution. In cases where it was obvious that a new solution does appear to address a specific question, this was discussed at the workshop, but no further investigation was conducted.

The literature search included a survey of available technologies for the problems identified from staff interviews. It did not seek to identify solutions to problems that the project team did not feel were sufficiently relevant. During the survey, some information which could help in other areas of the Environment Agency's daily operations was likely to come to light. Any such information was recorded and kept for discussion at the workshop.

3.5 Workshop and voting

A key part of the project was the scoring and discussion workshop held at Atkins' Peterborough office on Wednesday 25th February 2009. The aims of the workshop were to discuss in relative detail the key problems identified by the staff interviews, and to give each a score in terms of level of perceived difficulty, importance to the client body, and estimate of the expected cost to the client.

The workshop was a good opportunity for staff members from different regions of the Environment Agency to share their collective experiences and, in some cases, offer solutions which may already have been trialled within a different region. It was also an opportunity for key members to discuss and make decisions on projects which were irrelevant or of such minimal value that they were not worth pursuing in any detail. The reasons for this decision were recorded for any such projects identified for elimination from the scope.

If research completed elsewhere indicated that a project had been rendered obsolete or was not financially viable, this was also recorded to help prevent a repetition of the work. Each of the projects was introduced by the relevant 'sponsor' for the benefit of the overall project team. Bearing in mind the number of projects and the depth to which these could be discussed, the time for each discussion was limited to approximately 20 minutes. A free discussion then took place, followed by scoring.

The voting process was based on a simple scoring sheet, on which people were asked to record their personal feelings on the relative importance, level of perceived difficulty and cost of each project.

The scores were retained at the end of the workshop session and the results were collated for further dissemination. Using these results a list of priorities was created and presented for further discussion.

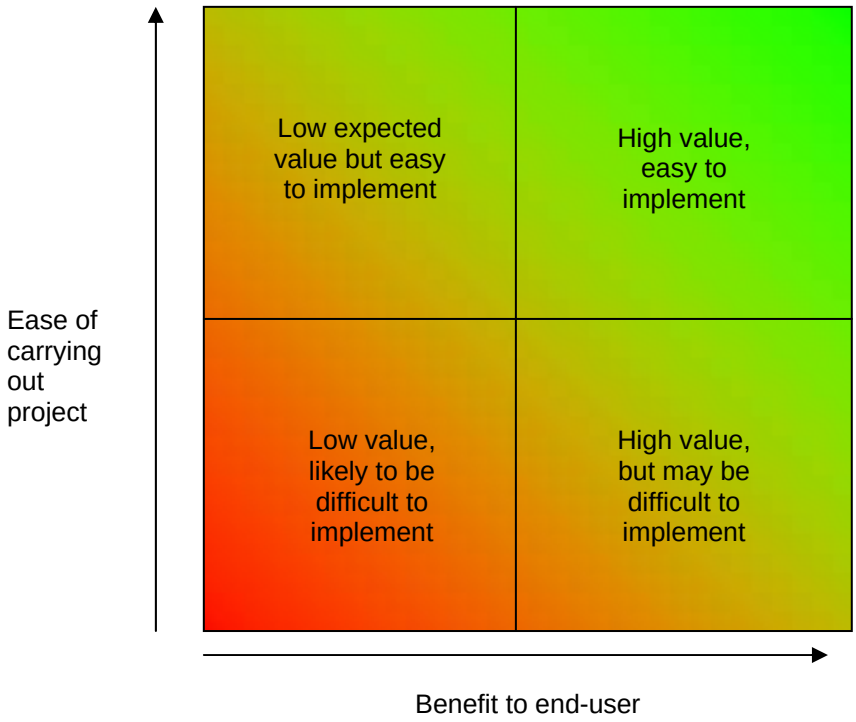

Figure 3.1 Schematic cost/benefit strategy.

It can be seen from Figure 3.1 that the key drivers are cost, as measured by relative difficulty and/or financial requirements, and benefit to the end-user. It is recommended that projects which are found in the red areas of low benefit and expected high difficulty to the lower left should not be taken any further than initial consideration at this time. Suggestions which upon first inspection can provide good, tangible benefits for reduced cost and minimal perceived difficulty would be the preferred projects to be taken forward for further consideration.

4 Results

4.1 Environment Agency interviews

A series of interviews were carried out as follows:

Nigel Bulmer	29 January 2009	Viking Close, Kingston-upon-Hull
Martin Earlham	4 September 2008	Thames Barrier, London
Neil Terry	23 December 2008	Environment Agency, Worthing
Martin Hayes	3 September 2008	Sentinel House, Litchfield
Darsha Gill	22 December 2008	Bishops Square, Hatfield
Martin Lee	18 September 2008	Riverside House, Lincoln
Edward Morris	4 September 2008	Thames Barrier, London
Andy Fitton	8 September 2008	Richard Fairclough House, Warrington
John Hunt	8 September 2008	Richard Fairclough House, Warrington
David Thomas	18 December 2008	Broadoak (Atkins), Peterborough
Malcolm Downes	18 December 2008	Broadoak (Atkins), Peterborough

As each project was identified it was given a project number in the order that it was collected. These interviews identified specific ideas for projects that are recorded in Appendix B. Appendix B1 summarises dates of the interviews, the engineers involved, the project ideas, and associated designated project numbers.

4.2 Shortlisting, science, collation and best practice

As some 55 projects were identified it was necessary to initially shortlist those that would be taken forward to the whole project team at the workshop. To do this a meeting was held at Atkins, Birmingham, on 3rd February 2009, and attended by core team members Gary Tustin, Andy Fitton, Keith Solts and John Sheppard. This identified the following groups of projects:

- Science projects. Research & development projects to prototype new tools/devices.
- Collation and best practice projects. Research & development of existing systems and procedures to produce best practice guides.
- Scoping. Projects that are an investigation into the business case (e.g. the cost of vandalism to the Environment Agency).
- Park. Projects that are not considered to be worth taking forward at present but which should perhaps be considered at a later date.
- Initially ruled out. Projects that overlap with existing Environment Agency initiatives or are variations of management or maintenance systems that are already readily available.

Appendix B2 lists all the projects grouped as above. From this the shortlist taken forward to the workshop was all projects listed as ‘science’ or ‘collation and best practice’.

4.3 Workshop results and analysis

The scoring workshop was held on 25th February 2009. The attendees were as described in 3.1 above, drawn from a range of Environment Agency and IDB backgrounds. The projects were introduced in their respective groups of 'science' and 'collation and best practice' by the relevant project sponsors, and a brief discussion followed, culminating in a scoring session. As the meeting progressed, the delegates were asked to score the projects in three ways, as follows:

- Importance, or benefit to the Environment Agency (score 1–10);
- Perceived difficulty (score 1–3);
- Expected cost, an estimate based on instinctive feel from previous experience (in thousands of pounds, £k).

The data was gathered at the end of the meeting and collated for analysis as described in the following figures. In some cases, it was felt that the projects could be combined; hence sometimes a project is described as a group (for example 19, 22 & 49) rather than as a single number. A summary of the scores is given in Appendix C.

This combination usually occurred when a 'science' project contained elements that were already described in a 'collation and best practice' project and which technically, therefore, was a combination of the two. In these cases it was agreed that these should be considered as 'science'-based projects, since any best practice work would necessarily need to take second place to the scientific work, even if it were the larger proportion of the overall scope.

4.3.1 Benefit scores

Figures 4.1 (science projects) and 4.2 (collation and best practice) show the variation in 'benefit' score, with more 'useful' projects to the left and 'less useful' projects to the right. The arithmetic average is shown for comparison, and it could therefore be used as a baseline against which to judge the usefulness of any particular project.

From the graphs it can be seen that project 30 & 29 (devices and methods for inspecting wire ropes) and project 50 (biodegradable hydraulic oil) score very highly. It is also clear, however, that the projects fall into two distinct groups with very little differentiation in between. Project 30 & 29, project 50, project 14 (non-intrusive methods of investigating corrosion between jointing plates and I-beams) and project 41 (alternatives to bespoke stop logs for gate structures) actually score very much the same, implying that there is little perceived difference in the benefit achieved from these.

Also, it can be seen that project 19, 22 & 49 (improving the efficiency and best practice for pumps) emerges as a clear front-runner with perceived high benefit to the end user, while project 13 (identify best sealer or filler between plates and I-beam joints) appears to be considered of lower importance, with the lowest score.

Projects such as 48 (investigation into appropriate remote camera surveillance) and 32 (identification of common signs leading to gate and plant failure) also score well, indicating a high perceived benefit. For the purpose of deciding priorities, it should be emphasised that high benefit projects offer the best chance of successful resolution even if they are considered to be more difficult to carry out.

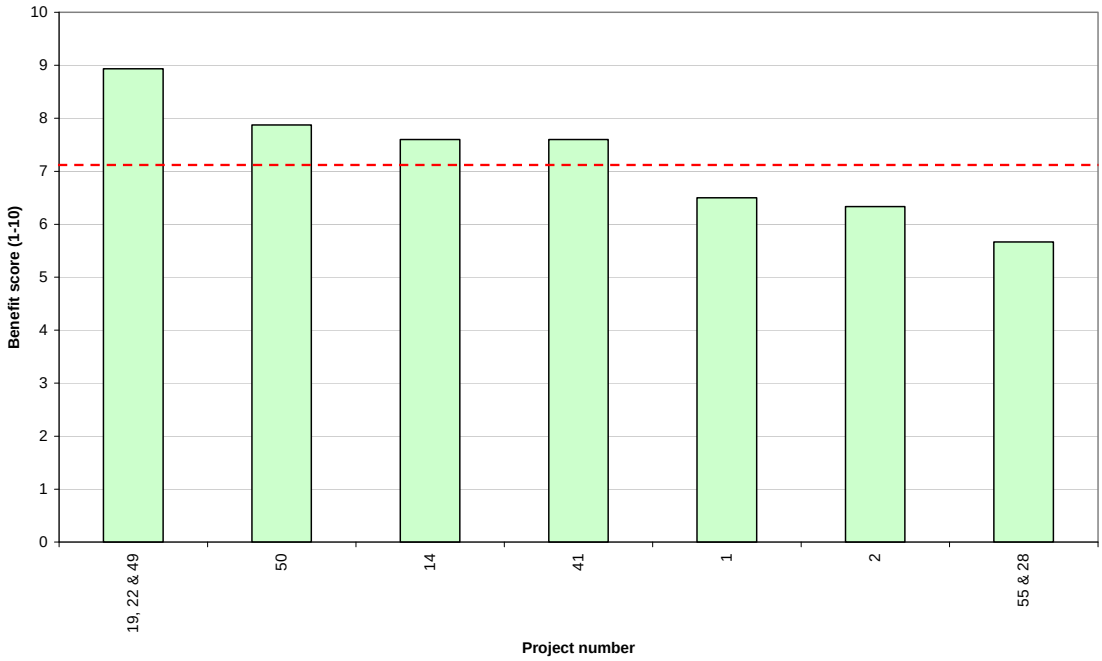

Figure 4.1 Descending 'benefit' scores for 'science' projects.

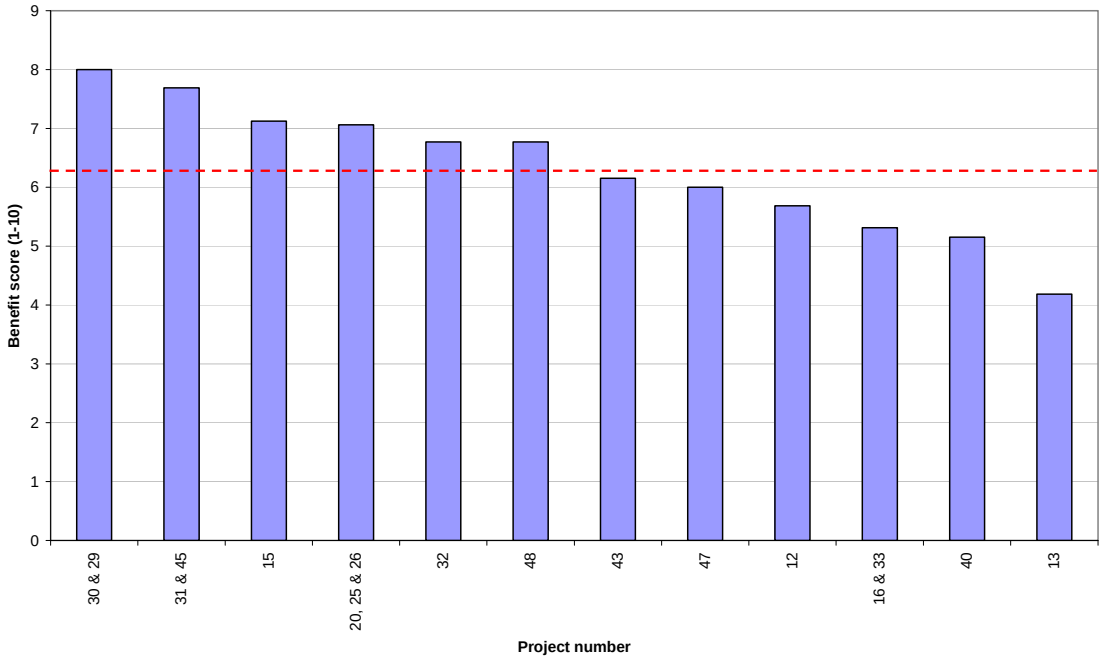

Figure 4.2 Descending 'benefit' scores for 'collation and best practice' projects.

4.3.2 Difficulty scores

Figures 4.3 (science projects) and 4.4 (collation and best practice projects) show the perceived difficulty scores by project number, with 'easy' projects being to the left. The arithmetic average is again shown for comparison.

Project 2 (vandal proof barrel locks) and project 30 & 29 (Devices and methods for testing wire ropes) are considered to be 'easy' projects. This possibly reflects the discussion that much of this work could be carried out externally from the Environment Agency and would therefore involve little or no input from staff other than project management.

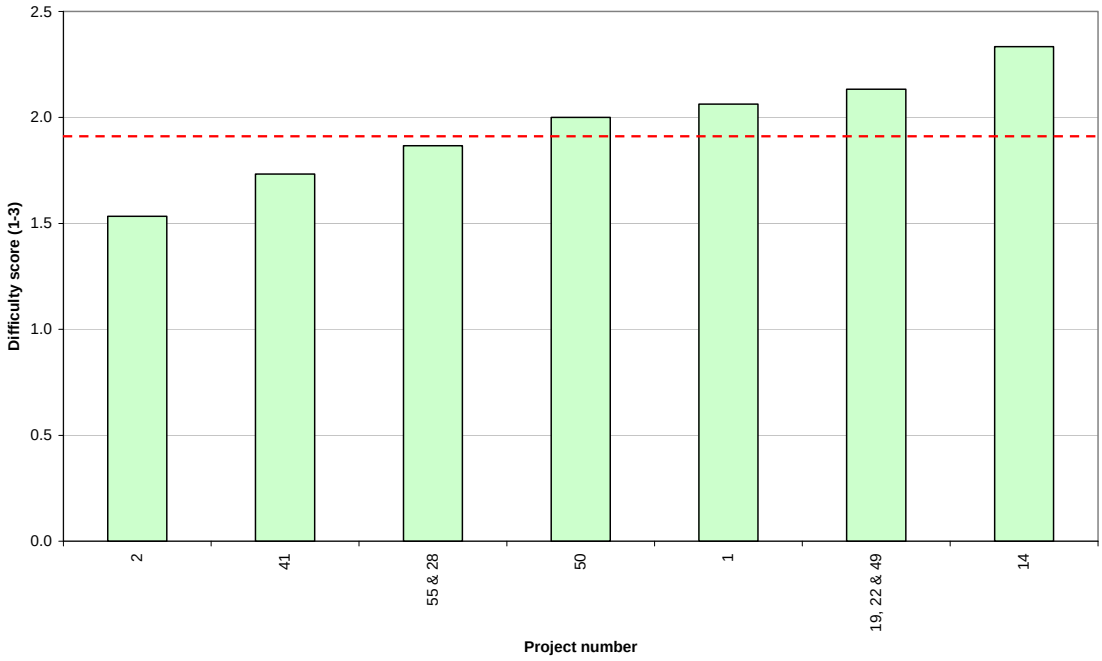

Figure 4.3 Ascending perceived difficulty scores for 'science' projects.

Project 14 (non-intrusive methods of investigating corrosion between jointing plates and I-beams) was considered to be extremely 'difficult' as it would involve employing a specialist R&D company and access around the gates of the Thames Barrier would be challenging.

It is also worth noting from Figure 4.4 that project 19, 22 & 49 (improving the efficiency and best practice for pumps) which was the apparent clear winner from the benefit score, is considered to be one of the more difficult projects to undertake. This is generally felt to be due to the difficulty of suitable measurement, rather than due to any particular difficulty of the actual methodology involved and should not be taken as a reason to discount this project. If, for example, at a later date, an investigation reveals that the perceived difficulties are in fact not likely to be realised then this may make the project score 'easy' using the above methodology.

In addition, it can be seen that project 31 & 45 (paint finishes for gates and structures) is considered to be extremely easy to undertake, while apparently delivering one of the highest benefits. The expected ease of this project is most likely due to the nature of the work, and the fact that a lot of this can be done by external parties, therefore requiring little involvement from the Environment Agency's own staff.

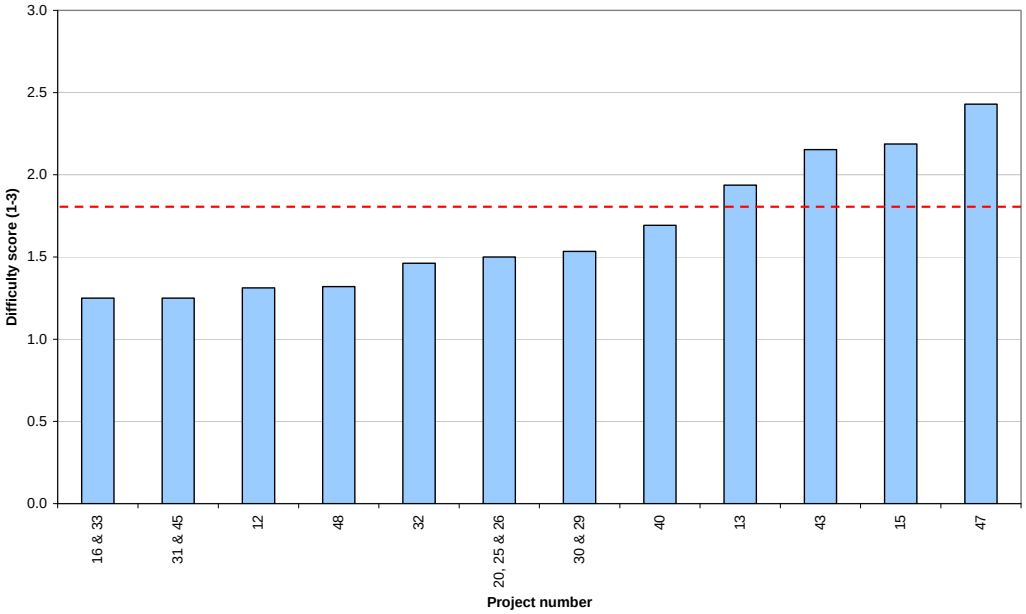

Figure 4.4 Ascending perceived difficulty scores for 'collation and best practice' projects.

4.3.3 Cost scores

Perceived cost was an area where there was a significant variety of scores, reflecting both the attendees' past experiences of research projects, and a general feeling that at this stage the cost would be hard to define without a more rigid scope of work. From Figure 4.5 (science projects) it is clear that projects 14, and 19, 22 & 49 were considered to be very expensive as well as very difficult (see above).

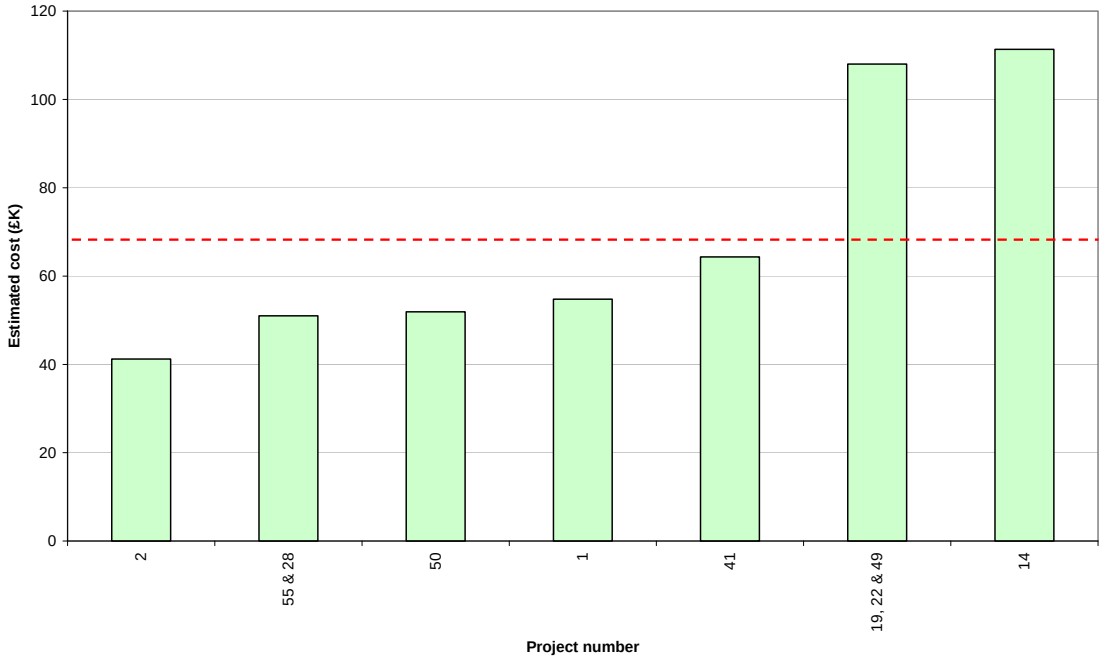

Figure 4.5 Expected cost scores for 'science' projects.

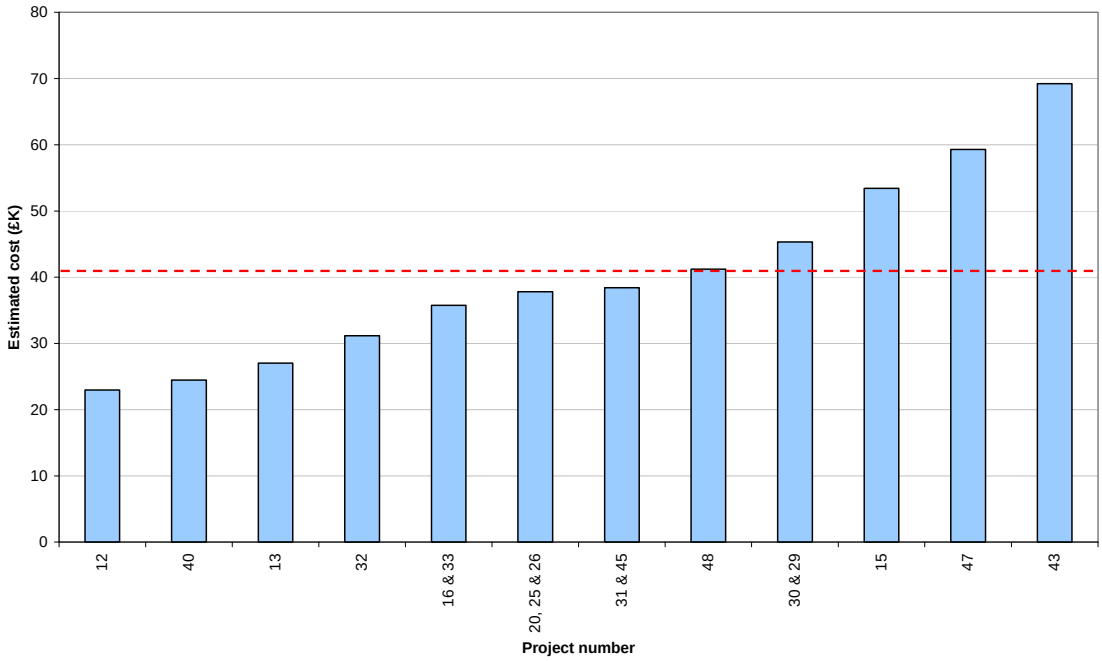

Figure 4.6 Expected cost scores for 'collation and best practice' projects.

From Figure 4.5 it can be seen that project 19, 22 & 49 (improving the efficiency and best practice for pumps) is particularly expensive, which probably reflects the high degree of manpower and time invested by the Environment Agency. This kind of work could not easily be passed on to third parties, and would therefore require a substantial investment. It is, however, important to note that the costs indicated are so indistinct at this stage that greater emphasis should be placed on other aspects.

4.3.4 Benefit vs. cost scores

An alternative method of analysing the data would be to consider how the relative benefit varies with the predicted cost of the project. Since the delegates were asked to give an expected project cost, it is relatively easy to present expected benefit vs. cost by a simple division, as shown in Figures 4.7 (science projects) and 4.8 (collation and best practice projects).

As described later, one major difficulty with this approach is that, while the delegates were asked to provide a relative costing estimate, there were few baseline costs against which to assess the likely requirements for each project, and so there was a significant variation between delegates. Also, without a more definitive scope of work the expected cost information could vary significantly when compared with the actual final estimate.

Using this method of analysis a project suitable for consideration would be one which appears to the left of the graph, delivering a high benefit with apparently minimal cost. From this analysis the best projects for 'Collation and Best Practice' Science' appear to be 30 & 29 (devices for testing wire rope) and 2 (vandal proof barrel locks) and the best for collation and best practice appear to be number 12 (elastomeric seals resilience) and 32 (identification of common signs leading to gate and plant failure).

It should be noted, however, that this method could easily be influenced by the fact that the figure represents the ratio of benefit to cost, and may simply be responding to a very low expected cost.

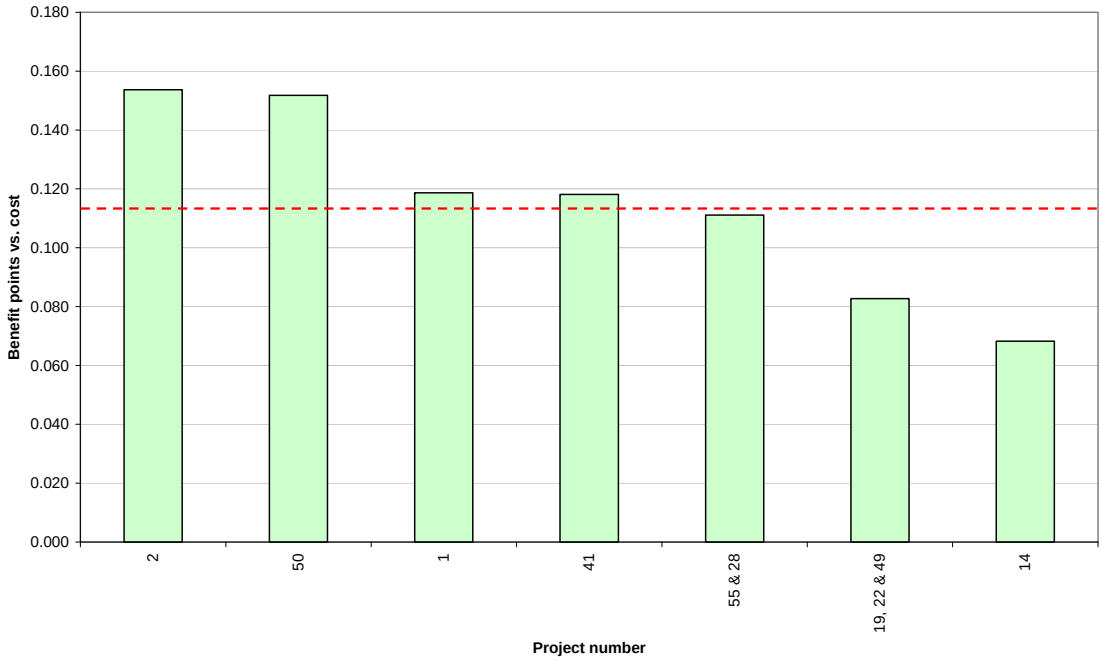

Figure 4.7 Benefit vs. expected project cost for 'science' projects.

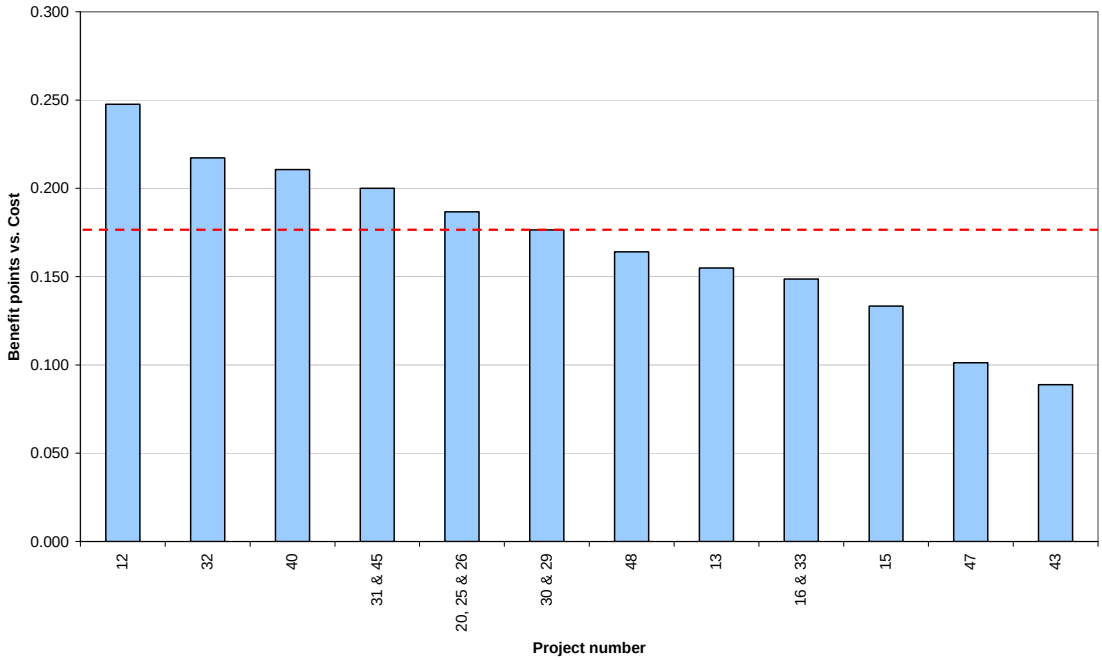

Figure 4.8 Benefit vs. expected project cost for 'collation and best practice' projects.

4.3.5 Benefit vs. difficulty scores

Another way to show the data is to compare the apparent benefit with the expected level of difficulty, as illustrated in Figures 4.9 (science projects) and 4.10 (collation and best practice), again with the arithmetic average shown for comparison.

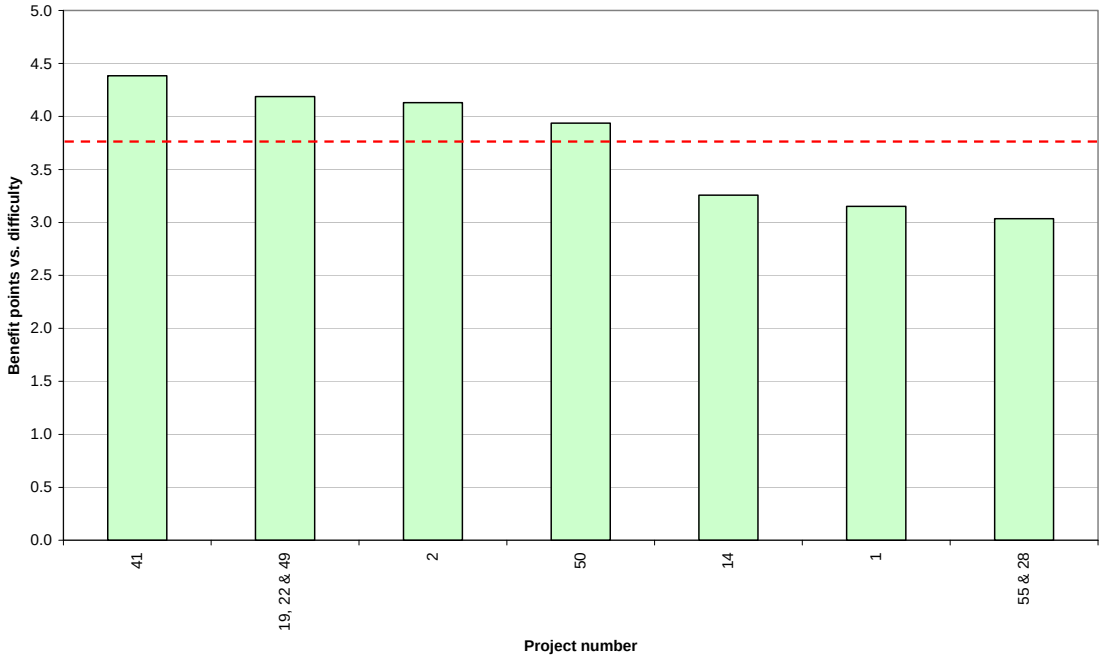

Figure 4.9 Benefit points vs. difficulty for 'science' projects.

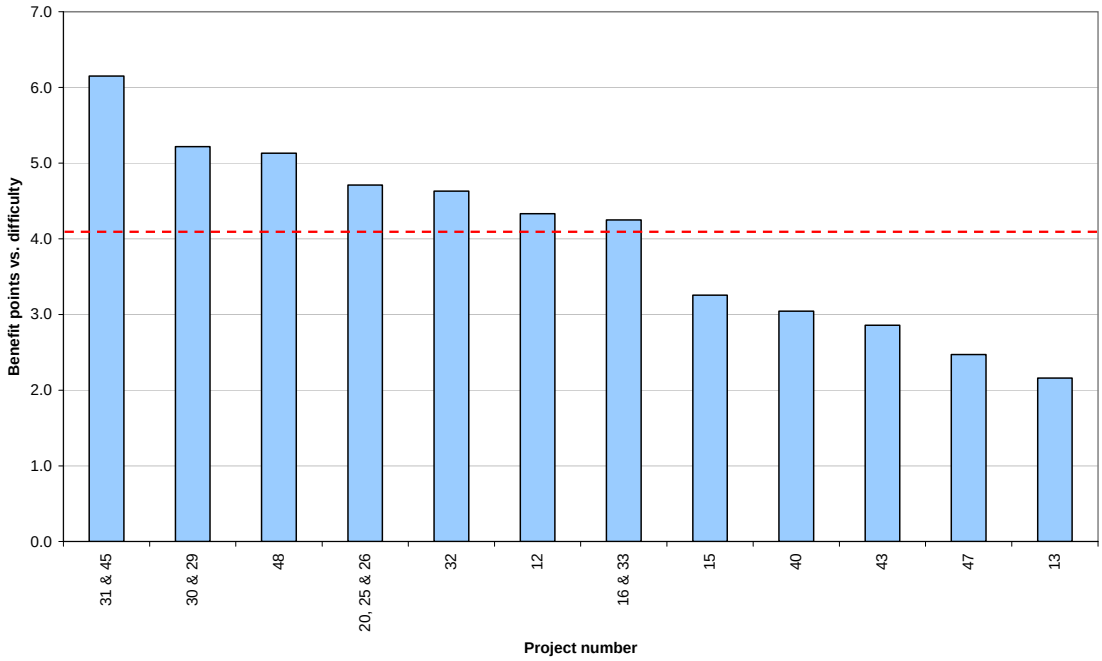

Figure 4.10 Benefit points vs. difficulty for 'collation and best practice' projects.

As may be expected, project 30 & 29 (devices and methods for inspecting wire ropes) scores highly in this particular analysis, although project 2 (vandal proof barrel locks) is now found in third place. This would still be considered to be a very useful project, however. For collation and best practice, the best project in this instance is likely to be 31 & 45 (paint finishes for gates and structures) although this is generally thought to represent an extremely 'easy' project, rather than a good investment.

Conversely, projects such as 19, 22 & 49 (improving efficiency and best practice for pumps) and to a lesser extent, project 50 (biodegradable oils) generally score better. Project 14 (non-intrusive measurement of corrosion) generally scores well but is considered to be extremely expensive and also project 15, relating to the standardised method for predicting failures of large gate structures, generally scores well. This high score is almost certainly due to the perception that gate failure would be catastrophic and hence any kind of failure prevention would be a high value return. From this analysis, it can be seen that project 31 & 45 (paint finishes for gates and structures) and 48 (remote camera surveillance) score highest.

Figure 4.11 shows the proportion of an ideal overall budget allocated for the projects. This figure, and the information obtained from the delegates, does not necessarily relate to any potential budget actually available for research within the Environment Agency; it merely reflects what the delegates would like to see spent on a scheme if the funds were available.

When presented as a proportion of overall budgets, the scores are shown to be relatively evenly spread, and even the two most 'expensive' projects described above will only account for less than a quarter of the overall cost when combined.

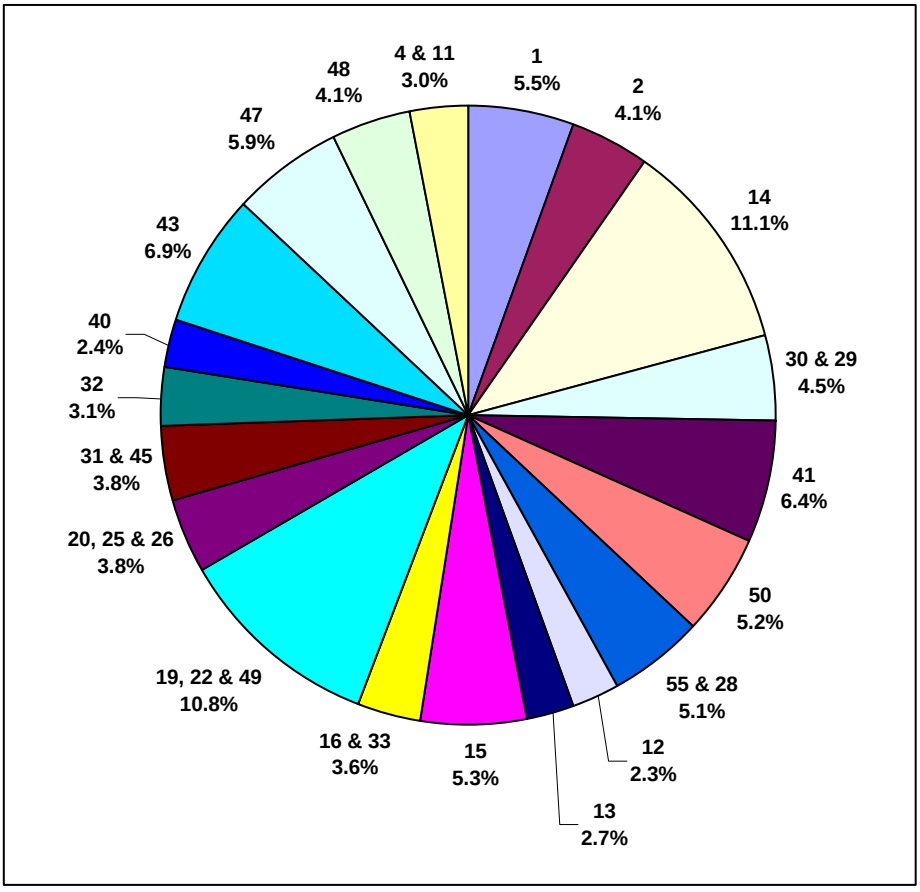

Figure 4.11 Proportion of expected spend by project.

Having considered the main findings of the staff interviews, workshop and literature survey, the projects were reviewed for their suitability for research funding in order to draw up a list of projects which could then progress to the next stages.

4.3.6 Summary diagram

Figures 4.12 (science projects) and 4.13 (collation and best practice) show how the projects appear within the simple benefit vs. cost matrix as described earlier. While this by itself does not justify a single project, it can be used as the basis of a decision-making process in order to create the final shortlist of projects.

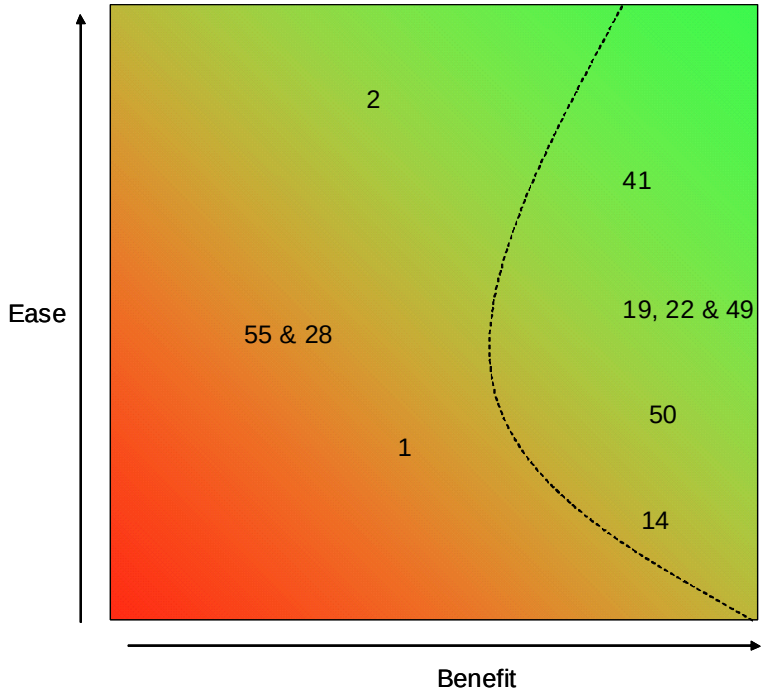

Figure 4.12 Benefit/ease matrix for 'science' projects.

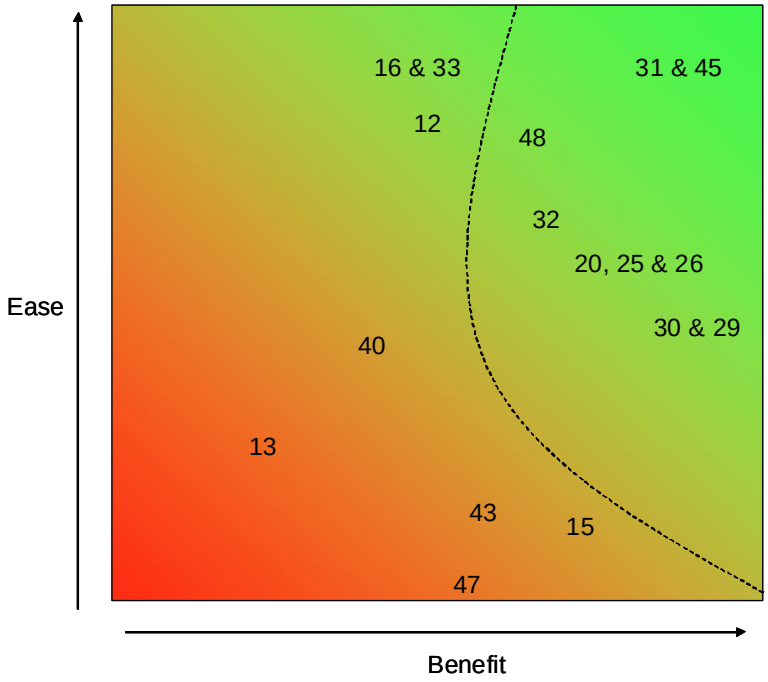

Figure 4.13 Benefit/ease matrix for 'collation and best practice' projects.

4.3.7 Discussion of prioritisation

Figures 4.12 and 4.13 are derived from an analysis of the benefit vs. ease, where 'ease' is very much a qualitative measure based on cost and difficulty. A project that is likely to involve lengthy periods of inactivity will also attract a difficulty score. The principal reason this method may yield a distorted picture of the relative importance of different projects is that the scoring system for potential benefit only yields a relative number for comparison purposes; it does not take into account the significant difference between high benefit and low benefit in actual terms.

For example, the benefit from improving pump efficiency across the entire Environment Agency may be measured in hundreds of thousands of pounds per year and may well be worth the investment, whereas inspecting wire ropes may save a significantly smaller amount of annual maintenance, even though the difference in the 'benefit' scores is negligible. Of course, a method of preventing accidents through inspection of assets such as wire ropes can have a significant benefit in terms of avoided cost and improved health and safety rather than direct income.

It is not an easy task to assess the likely benefit from the research projects, as because of the very nature of research and development, the benefit of the project is almost impossible to define until the bulk of the work is completed. It is, however, possible to state approximate figures for the estimated benefit in terms of both capital and operational savings.

As the expected project cost in each case is very much an educated guess based on past experience, and because there may be some difference in expectation between delegates, it must be understood that the actual project cost may be significantly different once a more comprehensive scope of work has been produced.

Research & development often takes unexpected turns during the lifetime of an individual project and a definitive scope is sometimes difficult to produce at the project outset. It is also common to find that alternative benefits come from a particular project and that the new benefit is worthy of as much investment as the original aim. It is therefore worth considering the possibility that the scope of work should be a loosely defined set of aims which are sufficiently flexible to allow for new ideas to be noted and explored if considered of value as the project progresses.

Another area where project prioritisation could be affected is when considering timescales and publicity. For example, a project which produces quick results that are perceived to be beneficial to the general public might be considered to be well worth undertaking while a project which has a longer timescale and only produces 'invisible' benefits may be less desirable even if the actual benefits of the latter project are greater.

An investigation into biodegradable hydraulic oils, which in the public consciousness will deliver a distinct benefit to the environment, could be seen as a project which will help to raise the Environment Agency's general profile, especially if such a project can be delivered quickly and to a relatively defined plan. Similarly, the putting in place of photovoltaic cells which are not immediately vandalised or stolen could also be highly visible.

Another example would be improving the efficiency of pumping stations, where a significant saving in power costs and reduction in emissions would be improvements that could be delivered relatively quickly. Conversely, it could be argued that investigating standardised failure probabilities will deliver a very important benefit to a community affected by a particular flood barrier, but unless it is highly publicised it is unlikely that this will ever be seen as a great success by the general public, who will not necessarily see a tangible benefit from the work even if the benefit does actually exist.

If an event being guarded against by low visibility preventative measures does not occur, people may think that this is because the event would never have happened in the first place rather than because the preventative measures were successful. High-cost preventative measures are therefore sometimes seen as a waste of money, especially if guarding against low probability events, however extreme the consequences of failure. Guarding against high frequency events is generally considered to be more visible.

Similarly, helping to prevent corrosion of existing structures is almost certain to be a complex, lengthy and protracted project which will not yield an immediate or highly visible end result, even if the actual benefit can be measured in savings many times the original project costs. The benefit from this kind of work may be real, significant and easy to measure, but if the benefit does not readily appear until (for example) ten years after the work was done, the general public may consider the project to be a waste of resources.

It may also be prudent for the Environment Agency to consider to what extent the project work could be done in-house as opposed to being sourced from external suppliers. Obviously some of the projects involving specialist skills and equipment would have to be carried out in connection with a contractor, but in many cases Environment Agency staff could be used for field trials or for data collection and manipulation.

Using Environment Agency staff would help to keep costs down as well as ensuring 'buy-in' from the end-users, so there would be distinct benefits from allowing the interested parties to help in the process of the research project. This would also be beneficial in the case of projects which require a degree of commercial confidentiality.

The priority of projects may also be affected to some degree by events outside the Environment Agency's control, and it may be that at some point in the near future an unexpected event will force a new direction to be taken. If for example an event which results in major vandalism of a high-profile asset triggers a renewed investigation into the causes and costs associated with this aspect of the public behaviour, then this may cause a currently low-priority project to be re-examined.

As with all research projects, the work and results will be wasted unless they are put in place where needed. In order to ensure that the maximum benefit is derived from any project it is essential to keep all interested parties involved and informed, and when results are available they should be disseminated and distributed across the UK to as many end-users as possible.

4.3.8 Recommended shortlist of projects

From the above reasoning, the projects which appear to show the most promise were selected and are listed below. They are in no particular order of preference, although, if needed, the order could be inferred from the summary graphs.

'Science' projects:

1. Improving the efficiency and best practice for pumps (Project 19, 22 and 49).
2. Use of biodegradable oil as opposed to conventional products (Project 50).
3. Non-intrusive methods for detecting corrosion between jointing plates and I-beams, initially specifically relating to the Thames Barrier (Project 14).
4. Alternatives to bespoke stop logs for gate structures (Project 41).

'Collation and best practice' projects:

1. Devices and methods for inspecting wire ropes (Project 30 and 29).
2. Best practice for use of remote camera surveillance or CCTV (Project 48).
3. Paint finishes for gates and structures (Project 31 and 45).
4. Identifying common signs leading to of gate and plant failure (Project 32)
5. Research into the use of alternative materials for flap valves, penstocks etc (Project 20, 25 and 26).

It must be emphasised that there is a degree of flexibility over the actual level of significance each project should be assigned. The choice of project priority should be made qualitatively following further consultation with the Environment Agency.

Projects which are considered to be of limited value are projects such as 4 (evaluate cost of vandalism) and project 11 (vandal proof gauging stations) relating to investigating the cost of vandalism and related topics, as well as 16 and 33 which both relate to robotic devices. Again, this does not imply that these projects are of no value to the Environment Agency, only that from the above workshop and analysis of information provided, expenditure on these projects is not justified at the current time.

4.4 Literature search on chosen projects

4.4.1 Project 19, 22 & 49 – Pump efficiency and general pumping station improvements

The area of pump efficiency is one particular topic where major savings could, in theory, be realised. There is little in the way of actual research opportunities, as much of the equipment likely to be used in field trials such as clamp-on flow meters and power measurement already exist. This is largely due to a rapid expansion in the awareness of waste within industry generally (PE Davis, 2001).

There are a number of suppliers already in the market for these products; hence there is little opportunity for any new advances in the technology employed.

Detailed fluid modelling systems using CFD software to predict the optimum pump layout and design are usually employed prior to station construction (World Pumps, 2002) and hence offer little opportunity for engineering solutions following completion.

Various manufacturers provide a range of pump designs, but it is only for the significantly larger applications that choice of pump type becomes more important (Ingersoll-Dresser, 1995). Some manufacturers provide a full service across a range of designs (Orbit, 2009), although the full range of pump suppliers is too large to describe in detail here.

It is not practicable to rely on information provided by suppliers for making comparisons between pump types because of commercial considerations and so any direct comparison would need to be carried out independently of, but perhaps with reference to, the suppliers themselves.

The project also aims to investigate pump reliability as well as operational cost. This could be incorporated in the scope, although it could be argued that this information is already readily available from manufacturers.

Pump starting is also a subject which could be investigated, although it is generally felt that this is well covered by the manufacturers of starting equipment such as star/delta starting, inverter drives or electronic soft starting devices. A side-by-side trial of the various systems could form the basis of a branch of the main project scope.

Figure 4.14 Pumping arrangement at St Germans Pumping Station.

4.4.2 Project 50 – Biodegradable hydraulic oils

There is much information available regarding the use of hydraulic oils that are vegetable rather than mineral based (Insidersecrets, 2009). The central assumption that these oils are more environmentally benign has been challenged with the observation that these oils apparently cause a degree of pollution should they be spilled, and that they appear to increase the likelihood of failure in certain applications. The literature appears to suggest that the problems with these new hydraulic systems are recognised by the industry and that there are some cases where the end-user has reverted to non-biodegradable oils following an unsuccessful trial.

The general conclusions are that, while it is recognised that there may be problems with these new products, the full benefits can only be realised if the hydraulic system is designed from the start with these new fluids in mind (Schaeffer, 2009) and with lower pressures and mechanical shear forces. In effect, the various authors are stating that it is not possible to simply replace the oils on existing machinery and expect to receive the same degree of reliability.

The research investigated the claimed biodegradability of these new products. The work does not relate directly to spills into a watercourse (the failure mode which was implied in the project description) and tends to only concentrate on degradation within soils and groundwater. The research also describes work which has taken place on composting the oils as an alternative to potentially costly disposal methods.

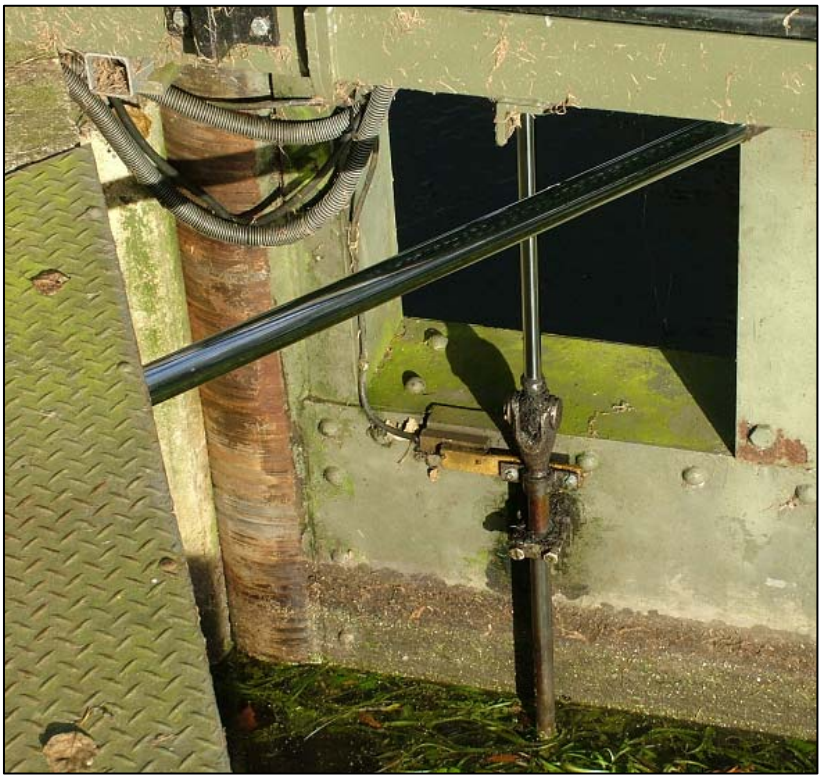

Figure 4.15 Example of hydraulic installation on the Great Ouse.

It is also not accepted by the Environment Agency that there is a clear legal advantage to using the new biodegradable products, as the perception is that a spill can still result in a prosecution regardless of the environmental consequence.

There is little information directly relating to this, implying that there may not be any current test cases of this kind. However, this is likely to change as the new products are more widely adopted by the industry. The counter-argument to this could be that the technology is relatively immature and research is ongoing, and it is likely that vegetable-based oils will one day completely replace the traditional mineral-based oils in all applications.

It would appear that there are in fact three sides aspects to this particular problem: the precise modifications needed to ensure that replacement oils operate as effectively as mineral-based products; the need to investigate the actual biodegradability as applied to effects on a watercourse rather than to effects on compost, groundwater or soils; and the need to better understand the implications of accidental spills.

It is also possible that research could be directed towards a comprehensive evaluation of all products on the market, with a view to using the data from the study to upgrade or modify Environment Agency hydraulic installations nationwide.

4.4.3 Project 14 – Non-intrusive methods of investigating for corrosion between jointing plates and I-beams

There are a number of different processes and technologies for inspecting paint and corrosion protection methods as applied to larger structures such as the Thames Barrier, although the same principles apply to all structures, large or small (Vijayan & Pae, 2008). There are not many new research opportunities in this area, as most of the

existing processes including ultrasound or electromagnetic devices are already optimised and readily available for hire or purchase.

Any project in this area would therefore need to focus more on the application of these technologies rather than the development of the technologies themselves. A good approach to the problem would be to develop a methodology for inspection and more centralised and accessible record keeping.

In some cases including, for example, submerged pins on flap valves, the larger problem is the need to test a particular device *in situ*, which may be under water or buried in the ground. In this case there may not be a technological solution available and the project should focus purely on the application side.

Figure 4.16 Example of failed paint finish on the Great Ouse.

4.4.4 Project 41 – Alternatives to bespoke stop logs

The use of alternative designs for stop logs is something with little or no commonly available information in the public domain. However, there are many areas (FWR, 2004; Obermeyer Hydro, 2009) where air or water inflatable designs do exist and are used regularly (FWR, 2004; Obermeyerhydro, 2009; EA, 2008). In Europe, if not in the UK, the technology for creating inflatable weirs is readily available and has a long track record (InCom, 2006), while not in the UK, definitely more in Europe (MBW, 2007). Such technology is not identical but would be relatively straightforward to transfer.

The use of mechanically adjustable stop logs is not something which is widely publicised, although it would be relatively undemanding to design and build a mechanism suitable for this purpose using existing designs.

4.4.5 Project 30 & 29 – Devices and methods for inspecting wire rope

As indicated above, in connection with project 14 (non-intrusive corrosion investigation), there are a number of different processes and technologies for inspecting paint and corrosion protection methods (DeFelsko, 2009). There are few new research opportunities in the area for wire rope inspection as most of the existing

processes including ultrasound or electromagnetic devices are already optimised and readily available.

Any project resulting from this would therefore need to focus more on the application of these technologies rather than the development of the technologies themselves, although there appears to be some scope for development of a more robust and portable inspection device, which could be used in 'wet' environments.

In some cases including, for example, wire ropes or chains on submerged equipment, the greater problem is the need to test a particular device *in situ*, which may be under water or buried in the ground. In this case there may not be a technological solution available. There is a wealth of information relating to the use of a variety of methods for failure prediction for other areas. In addition, the Environment Agency has in the past conducted studies such as the 'TE2100' study to establish the failure probability of its lock gates, flood defence gates and pumping stations along the existing Thames Estuary over the coming century (Environment Agency, 2007). In the instance described by the team member, the specific problem relates to the need to predict failure of movable flood defences, with some reference to chains or wire ropes.

The research project would therefore need to focus on the application of existing methodologies rather than trying to invent a new one. For standardisation it would also be advantageous to try to convey the importance of adopting the same values for different rope failures throughout the Environment Agency.

4.4.6 Project 48 – Appropriate remote CCTV surveillance

Closed Circuit Television (CCTV) Systems are one area where there appears to be little which can be done in the way of research into the devices themselves as most of the major advances have already been made. As with other projects, the research would more likely focus on the application of the existing technology within the Environment Agency rather than development of new technology.

Most of the available literature does not go into detail about the operation of the products, and focuses more on sales of CCTV systems. This may indicate that there is little work remaining to be done on the installation and placement of the devices.

4.4.7 Project 31 and 45 – Paint finishes for gates and structures

There are a number of different processes and technologies for inspecting paint and corrosion protection methods (DeFelsko, 2009). There are few new research opportunities in this area as most of the existing processes including ultrasound or electromagnetic devices are already optimised and readily available. Any project resulting from this work would therefore need to focus on the application of these technologies to existing problems rather than the development of the technologies themselves, where much of the work has already been carried out.

In some cases such as submerged pins on flap valves, the need may be to test a particular piece of equipment in place, which may not always be possible if the device is immersed in water or buried. In such a case new hardware may not actually be the answer and the solution may be more methodological rather than technological in nature.

One of the projects submitted aimed to address one of the more fundamental problems associated with damaged or corroded equipment, namely that the owner does not necessarily know how much money and effort are spent each year on repairs and replacement.

There is little or no direct information on this, but it is assumed that the Environment Agency would be able to generate accurate figures following a detailed study of all its ongoing maintenance costs. This would be an area of study where no existing methodology would be available and a dedicated programme of work would need to be generated by the project team to ensure consistency across a number of regions. An alternative approach would be to investigate in detail one particular region and find the actual true cost to the client each year, and then find a way to extrapolate this to the country as a whole.

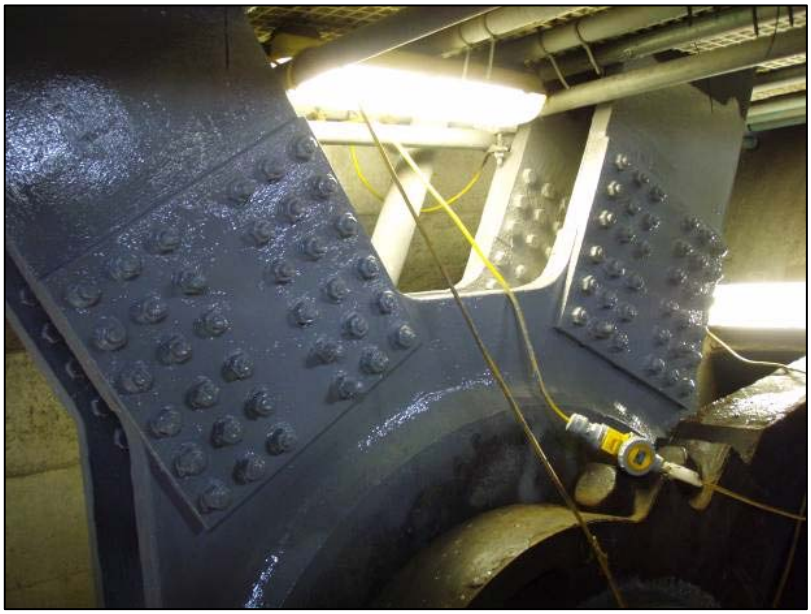

Figure 4.17 Example of steel plates and joints (Thames).

4.4.8 Project 32 – Identifying common signs leading to gate and plant failure

One area where extensive research in failure mode analysis has already been carried out and which is mostly in the public domain is the nuclear industry. Although this cannot be directly related to the Environment Agency's work, there are some shared characteristics in the sense of large, motorised equipment such as flood barriers or surge protection equipment which has to remain idle for long stretches and then operate with as close to guaranteed success as possible.

There is no information specifically relating to the application of the various methods to moving flood barriers. However, an important finding was that in addition to the 'fault tree' methods used in TE2100 there is, worldwide, a significant wealth of information on failure statistics and likely causes on a range of engineering applications from aviation to automobiles (Turnbull and Alldrin, 2008).

By gaining a detailed understanding of the methods and systems used in the water industry (Endress + Hauser, 1992) it is possible to apply the principles described to assess the likely failure methods of any mechanical or electrical system regardless of actual application (AEAT Hunter, 1975). While the probability of failure is generally possible to assess and predict largely regardless of application, the consequence of failure is clearly something which is very specific to the nature of the equipment being used and would therefore require a detailed understanding by the operational staff.

However, most of the work so far carried out appears to focus on switchgear, motors and mechanical plant such as gearboxes. There is little which is directly relevant to the wire rope, gate, plant or electrical plant investigation problems, there would need to be a degree of transfer between the different disciplines with consequent problems caused by differences in format, research methods and translation of results. A recent development is the formation of the WASIG, the Water industry Alarm Systems Improvement Group, which aims to coordinate knowledge in the field of alarm technology and presumably help to standardise approaches across the industry (WET, 2009) and therefore eliminate much of the wasted effort which goes into replicating results across disciplines.

Figure 4.18 Example of failed lock gate system (Great Ouse).

4.4.9 Project 20, 25 & 26 – Research into different modern materials for penstocks and flap valves and comparison with more traditional materials

Many products exist on the open market which contain a number of different materials for both flap valves and penstocks, but there is little in the way of definitive comparison between them, and manufacturers' information is naturally biased toward their particular product, rather than being an independent review.

4.5 Sources of funding

There are a number of funding opportunities for the projects described above. It is apparent from the workshop that there are a wide range of views regarding the level of funding needed, both in terms of overall funding and funding for individual projects. In order to allocate funds to individual projects, it is necessary to divide the projects into different categories based on their content. The major categories identified are as follows:

1. Individual research of academic interest
2. Major collaborative research
3. In-house research

4.5.1 Individual research of academic interest

This kind of work is most suited to small-scale projects. While the level of funding does not directly relate to the size of project, the nature of the work must be tailored to the needs of a single individual having to do the majority of the work. There is clearly little benefit to assigning to an individual a project with tasks at numerous different sites around the UK or overseas as, even if funding is available, the individual will have little opportunity to carry out work across the breadth of the project scope. The most obvious method for providing funding for this kind of work is via university degrees, either as a small-scale undergraduate degree project, or as a larger-scale project for a masters or doctorate degree depending on size.

There are numerous universities around the UK that could manage, organise and provide the technical back-up and expertise for students, making the task of managing the project significantly easier from the Environment Agency's perspective.

NERC, the Natural Environment Research Council, offers significant opportunities for funding in areas as diverse as biodiversity, marine and terrestrial ecology. NERC invests many millions of pounds each year in projects such as carbon offset or alternative energy. It must be noted, however, that most of the projects described in this study would not readily fit into the categories identified, although NERC does state that it does not wish to be seen as being too prescriptive regarding the nature of the work it undertakes.

Awards can be made to any eligible institution to enable individuals or universities to conduct research, and applications can generally be made at any time. Eligibility is not defined closely although, again, NERC is keen to be seen as promoting research across a range of topics and will therefore not wish to be restricted should an interesting and potentially beneficial topic be presented to the council.

4.5.2 Major collaborative research

The Environment Agency and the government's Department for Environment, Food and Rural Affairs (Defra) are known to fund various projects relating to, for example, flood risk management and flood defence assessment. In addition, EPSRC, the Engineering and Physical Sciences Research Council, is one of the UK's foremost government agencies providing funding for research projects which can bring positive

benefits to industry and science. Critically, for skills transfer, EPSRC operates to a large extent with the universities to provide funding and support for individual students.

The method of operation is sufficiently flexible to allow for larger groups or even companies to conduct work with little or no upper limit on the number of people who can be employed in this way.

EPSRC funding is considered to be extremely flexible and provides opportunities for industry to work with universities via partnerships or directly via masters degrees or doctorates. The nature of the work proposed in order to meet the requirement of EPSRC funding is not clearly defined although there is a tendency to concentrate more on cutting edge science projects rather than operational and maintenance strategies.

Joint projects, formed by cooperation between EPSRC and another organisation (e.g. an interested industrial client), provide an alternative method of funding in such a way that the council does not fund the entire project. In this way it is possible for EPSRC to fund more projects.

Crucially, this also provides a degree of involvement with the other funding parties and helps to ensure a smooth transition into service once the results of the project become available. The Environment Agency would need to approach EPSRC directly in order to make first contact regarding possible funding opportunities.

It is generally considered unlikely that any one single external organisation would provide the kind of funding or support needed for a project to be undertaken. Bearing in mind the relatively specialist nature of the work, there is little that could realistically be transferred from the research described into the normal operation and maintenance practices of any large industrial partner.

One obvious example of this would be anything relating to lock gates in the UK, where very few other industrial organisations would be able to benefit directly from research. It is possible that other external interested parties would benefit from the research once the findings become known and are in the public domain, but this would be extremely difficult to identify before the work was commenced. It is, however, suggested that it is worth the Environment Agency contacting other industrial clients who operate in similar areas to establish whether this approach is a feasible option.

There would also be a case to suggest that manufacturers of equipment, such as (for example) wire ropes, would have an interest in the results of the project as this could help them to improve their product. It was mentioned during the workshop, however, that some manufacturers would not be willing to participate in such activities because of the reduced sales that would inevitably result. This is an argument which could only be resolved by discussion with the manufacturers themselves to convince them that this would not be the case.

4.5.3 Internal (in-house) funding

Comments from the scoping interviews and workshop suggested that there is only limited funding available within the Environment Agency for research projects of this type. The actual figure varies between £75,000 and £150,000 depending on department. It is inferred from this that there is no central funding body within the organisation, and that projects of this type are funded as and when needed.

Due to the nature of research, this is a likely scenario, as funding predictions for research are notoriously difficult to set beforehand, and tend to vary significantly throughout the lifetime of the project despite the best intentions of the project manager, the project team and the majority of the parties involved with the delivery of the project on a daily basis.

Project costs can either increase greatly when it is apparent that a project is more difficult or may take longer than originally planned, or can suddenly decrease when it becomes apparent that a project cannot actually achieve its stated deliverables.

There is a significant incentive for bodies such as the Environment Agency to keep the work in-house as this can make for easier control over personnel and resources and can also help with confidentiality. In this instance, however, it could be argued that few of the projects are likely to contain material of a confidential nature.

5 Recommendations

It is recommended that a more in-depth investigation is conducted to refine the scope of work for the above projects and to better understand the likely costs and implications of success or failure.

The suggested order of work for the research projects is described below, based on this investigation.

'Science' projects priority 1 for consideration:

- Improving the efficiency and best practice for pumps. (Project 19, 22 & 49)
- Use of biodegradable oils as opposed to conventional products. (Project 50)

'Science' projects priority 2 for consideration:

- Alternative stop logs for gate structures. (Project 41)
- Non-intrusive methods for corrosion between jointing plates and I-beams. (Project 14)

'Collation and best practice' projects priority 1 for consideration:

- Devices and methods for inspecting wire ropes. (Project 30 & 29)
- Best practice for use of remote camera surveillance or CCTV. (Project 48)
- Paint finishes for gates and structures. (Project 31 & 45)

'Collation and best practice' projects priority 2 for consideration:

- Research into the use of alternative materials for flap valves, penstocks etc. (Project 20, 25 & 26)
- Identifying common signs leading to of gate and plant failure (project 32)

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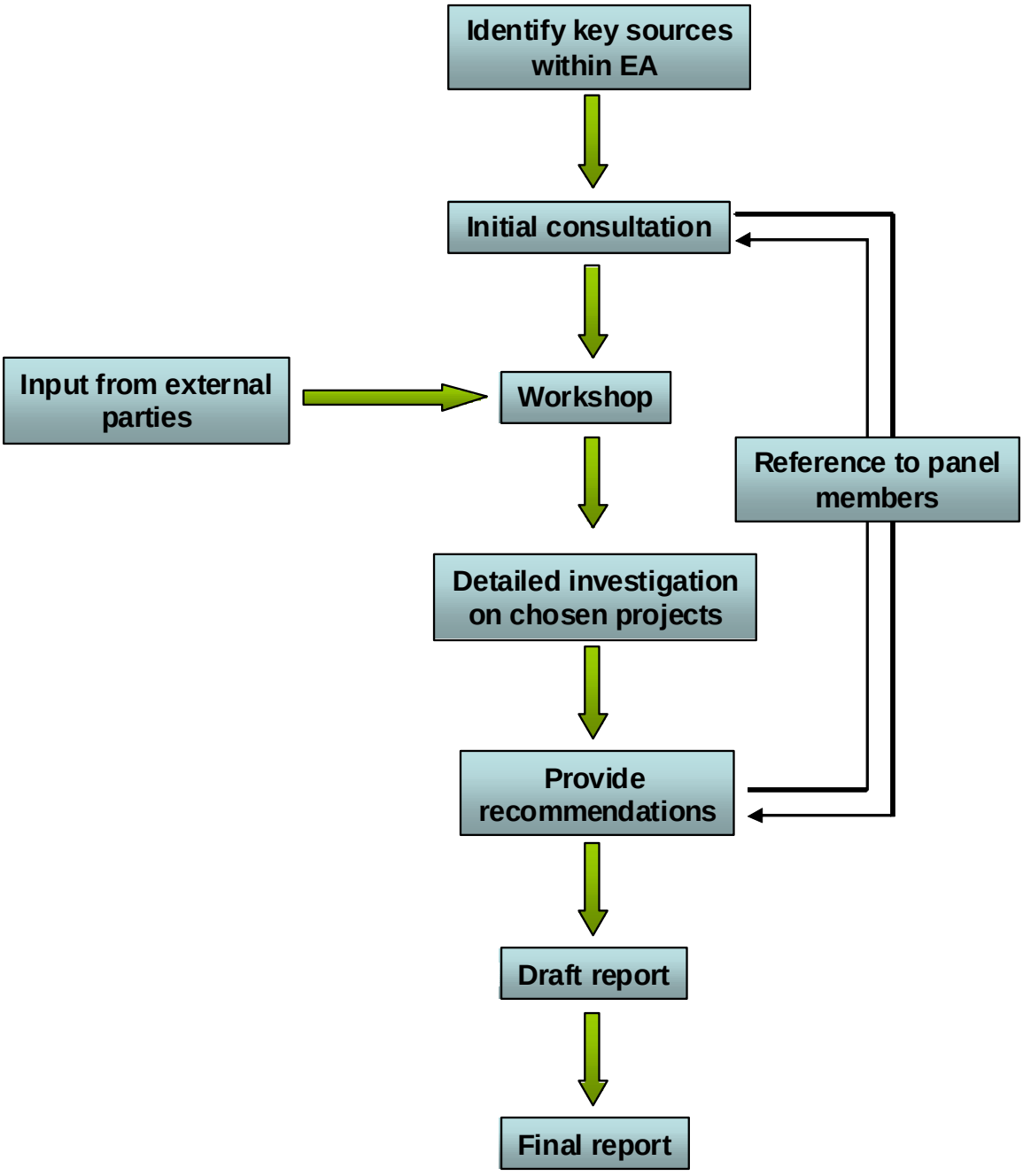
Appendix A – Strategy process diagram



Appendix B – Record of consultations

B.1 Reference of initial consultation items (in brief)

Item	Meeting details	Idea/requirement
1	Regional manager (Midlands Region): Martin Hayes Date of meeting: 03/09/2008 Place of meeting: Sentinel House, Lichfield	Resilient photovoltaic cell, i.e. vandal proof. For low power sites such as rain gauges and monitoring.
2	Regional manager (Midlands Region): Martin Hayes Date of meeting: 03/09/2008 Place of meeting: Sentinel House, Lichfield	Vandal proof barrel locks.
3	Regional manager (Midlands Region): Martin Hayes Date of meeting: 03/09/2008 Place of meeting: Sentinel House, Lichfield	Understand better the psychology of vandalism.
4	Regional manager (Midlands Region): Martin Hayes Date of meeting: 03/09/2008 Place of meeting: Sentinel House, Lichfield	Evaluate the cost of vandalism and theft to the Environment Agency.
5	Regional manager (Midlands Region): Martin Hayes Date of meeting: 03/09/2008 Place of meeting: Sentinel House, Lichfield	Simpler ultrasonic.
6	Regional manager (Midlands Region): Martin Hayes Date of meeting: 03/09/2008 Place of meeting: Sentinel House, Litchfield	'Bluetooth' access to data and change instrumentation parameters from outside installations that negate the need to get out of the car, unlock the building and go into the building.
7	Regional manager (Midlands Region): Martin Hayes Date of meeting: 03/09/2008 Place of meeting: Sentinel House, Lichfield	Remote control device to operate installations where they have been isolated by flood water.
8	Regional manager (Midlands Region): Martin Hayes Date of meeting: 03/09/2008 Place of meeting: Sentinel House, Lichfield	Centralised and easily accessed MEICA library including specifications and O&M information. Probably via Easinet.
9	Regional manager (Midlands Region): Martin Hayes Date of meeting: 03/09/2008 Place of meeting: Sentinel House Midlands Region, Lichfield	Develop standard format of O&M information for manufacturers to provide and for manufacturers to licence access via the intranet to their libraries of O&M information.
10	Regional manager (Midlands Region): Martin Hayes Date of meeting: 03/09/2008 Place of meeting: Sentinel House, Lichfield	Develop standard of reporting for maintenance contractors so that the reports are accessed via the intranet.
11	Regional manager: Martin Earlham and Ed Morris Date of meeting: 04/09/2008 Place of meeting: Thames Barrier	Vandal proof gauging post huts.
12	Regional manager: Martin Earlham and Ed Morris Date of meeting: 04/09/2008 Place of meeting: Thames Barrier	How can the Environment Agency best test elastomerics, e.g. can we build up a statistical database of experience on the ageing of elastomerics (seals).

Item	Meeting details	Idea/requirement
13	Regional manager: Martin Earlham and Ed Morris Date of meeting: 04/09/2008 Place of meeting: Thames Barrier	Identify best sealant/filler between plates and I-beam at I-beam joints. The mating surfaces are coated with sealant/filler before being bolted together.
14	Regional manager: Martin Earlham and Ed Morris Date of meeting: 04/09/2008 Place of meeting: Thames Barrier	Non-intrusive method of investigating for corrosion between the jointing plates and I-beams at I-beam joints. Variation solution for Item 13.
15	Regional manager: Martin Earlham and Ed Morris Date of meeting: 04/09/2008 Place of meeting: Thames Barrier	Standardised method of measuring probability of failure for moving flood barriers that protect against catastrophic failures.
16	Regional manager: Martin Earlham and Ed Morris Date of meeting: 04/09/2008 Place of meeting: Thames Barrier	Robotic device for inspection of remote/confined space areas.
17	Regional manager North West Region: Andy Fitton. John Hunt Date of meeting: 08/09/2008 Place of meeting: Richard Fairclough House, Warrington	Optimise the term contracts for M&E maintenance and incorporate an incentive to the contractors to improve the installations.
18	Regional manager North West Region: Andy Fitton. John Hunt Date of meeting: 08/09/2008 Place of meeting: Richard Fairclough House, Warrington	A suitable method for how the Environment Agency can measure value for money of its operation and maintenance teams. See item 17.
19	Regional manager North West Region: Andy Fitton. John Hunt Date of meeting: 08/09/2008 Place of meeting: Richard Fairclough House, Warrington .	To identify the efficiency improvements that can be made to pumps and plant and to collect the evidence to demonstrate that these improvements will work.
21	Regional manager North West Region: Andy Fitton. John Hunt Date of meeting: 08/09/2008 Place of meeting: Richard Fairclough House, Warrington	What is an appropriate Project Management toolkit for regional MEICA engineers?
22	Regional manager Anglian Region: Martin Lee Date of meeting: 18/09/2008 Place of meeting: Riverside House, Lincoln	Research into best guidance on best practice for pumping station design: Pumping station type for best efficiency verses value for money; Pump starting; Configuration; and Discharge.
23	Regional manager Anglian Region: Martin Lee Date of meeting: 18/09/2008 Place of meeting: Riverside House, Lincoln	Investigation into the refurbishment of old installations. Is this really the best solution for the UK?
24	Regional manager Anglian Region: Martin Lee Date of meeting: 18/09/2008 Place of meeting: Riverside House, Lincoln	Project management tool for projects with capital value of less than £250k.
25	Regional manager: Darsha Gill Date of meeting: 22/12/2008 Place of meeting: Environment Agency Hatfield, Bishops Square	Research into whether it is better to refurbish flap valves or replace them?
26	Regional manager: Darsha Gill Date of meeting: 22/12/2008 Place of meeting: Environment Agency Hatfield, Bishops Square	Research into the use of HDPE and also stainless steel for flap valves and penstocks and to their track record as opposed to the more traditional materials of cast steel, cast iron and mild steel.
27	Regional manager: Darsha Gill Date of meeting: 22/12/2008 Place of meeting: Environment Agency Hatfield, Bishops Square	Research into standardisation of software for flood defence (moving) gate control.

Item	Meeting details	Idea/requirement
28	Regional manager: Darsha Gill Date of meeting: 22/12/2008 Place of meeting: Environment Agency Hatfield, Bishops Square	Research into how best to inspect tidal flaps and specifically hinge pieces.
29	Regional manager: Darsha Gill Date of meeting: 22/12/2008 Place of meeting: Environment Agency Hatfield, Bishops Square	Research into the best method to inspect a wire rope.
30	Regional manager: Darsha Gill Date of meeting: 22/12/2008 Place of meeting: Environment Agency Hatfield, Bishops Square	Develop a device to test the integrity of wire ropes and specifically to determine if there is internal corrosion.
31	Regional manager: Darsha Gill Date of meeting: 22/12/2008 Place of meeting: Environment Agency Hatfield, Bishops Square	Research into paint finishes for gates and structures.
32	Regional manager: Darsha Gill Date of meeting: 22/12/2008 Place of meeting: Environment Agency Hatfield, Bishops Square	Identification of common signs that lead up to gate and plant failure.
33	Regional manager: Darsha Gill Date of meeting: 22/12/2008 Place of meeting: Environment Agency Hatfield, Bishops Square	Coupled with 32, difficult to undertake inspections in confined spaces.
34	Regional manager: Neil Terry Date of meeting: 23/12/2008 Place of meeting: Environment Agency Worthing	Change in control set point parameters by telemetry.
35	Regional manager: Neil Terry Date of meeting: 23/12/2008 Place of meeting: Environment Agency Worthing	What is the best PDA system to tie in with the ID Hammer maintenance system.
36	Regional manager: Neil Terry Date of meeting: 23/12/2008 Place of meeting: Environment Agency Worthing	More Web hosting of Environment Agency information on: Best practice, Lessons learned and Specs and designs.
37	Regional manager: Neil Terry Date of meeting: 23/12/2008 Place of meeting: Environment Agency Worthing	External Web-based platform to host data/information.
38	Regional manager: Neil Terry Date of meeting: 23/12/2008 Place of meeting: Environment Agency Worthing .	Project management system for MEICA. See items 21 and 24.
39	Regional manager: Neil Terry Date of meeting: 23/12/2008 Place of meeting: Environment Agency Worthing	Automated meter readings (AMR).
40	Regional manager: Neil Terry Date of meeting: 23/12/2008 Place of meeting: Environment Agency Worthing	Auto lubrication system for large chains on large gates.
41	Regional manager: Neil Terry Date of meeting: 23/12/2008 Place of meeting: Environment Agency Worthing	Alternatives to bespoke stop logs for each installation.
42	Regional manager: Neil Terry Date of meeting: 23/12/2008 Place of meeting: Environment Agency Worthing	Standardisation of drawings for motor control centres, starter cubicles Direct-on-line, Star-Delta, Auto Transformer and inverter.

Item	Meeting details	Idea/requirement
43	Regional manager: Nigel Bulmer Date of meeting: 29/01/2009 Place of meeting: Environment Agency Hull, 1 Vikings Close, Kingston-upon-Hull	Supports idea to question is it better to replace gates than refurbish them. See item 25.
44	Regional manager: Nigel Bulmer Date of meeting: 29/01/2009 Place of meeting: Environment Agency Hull, 1 Vikings Close, Kingston-upon-Hull	Methods to reflect on projects for lessons learned.
45	Regional manager: Nigel Bulmer Date of meeting: 29/01/2009 Place of meeting: Environment Agency Hull, 1 Vikings Close, Kingston-upon-Hull	Good guidance on paint use. See Item 31.
46	Regional manager: Nigel Bulmer Date of meeting: 29/01/2009 Place of meeting: Environment Agency Hull, 1 Vikings Close, Kingston-upon-Hull	Meters for energy management at sites.
47	Regional manager: Nigel Bulmer Date of meeting: 29/01/2009 Place of meeting: Environment Agency Hull, 1 Vikings Close, Kingston-upon-Hull	Flow measurement for high volume pumps.
48	Regional manager North West Region: Andy Fitton. John Hunt Date of meeting: 08/09/2008. Place of meeting: Richard Fairclough House, Warrington.	Best practice for remote camera surveillance.
49	Regional manager: David Thomas and Malcolm Downs of MLC Date of meeting: 18/12/2008 Place of meeting: Atkins, Peterborough	Pump reliability between different pump types.
50	Regional manager: David Thomas and Malcolm Downs of MLC Date of meeting: 18/12/2008 Place of meeting: Atkins, Peterborough	Investigation into the pros and cons of the use of biodegradable oils versus mineral oils.
51	Regional manager: David Thomas and Malcolm Downs of MLC Date of meeting: 18/12/2008 Place of meeting: Atkins, Peterborough	Put small power generators on weirs.
52	Regional manager: David Thomas and Malcolm Downs of MLC Date of meeting: 18/12/2008 Place of meeting: Atkins, Peterborough	USB stick configured on ultrasonics to be able to copy the set up from one ultrasonic unit and load it onto another unit.
53	Regional manager: David Thomas and Malcolm Downs of MLC Date of meeting: 18/12/2008 Place of meeting: Atkins, Peterborough	Enable the IDBs to be able to access the Environment Agency information.
54	Regional manager: David Thomas and Malcolm Downs of MLC Date of meeting: 18/12/2008 Place of meeting: Atkins, Peterborough	PAR document that is accessed through the internet that is based on filling in the boxes.
55	Regional manager: Darsha Gill Date of meeting: 22/12/2008 Place of meeting: Environment Agency Hatfield, Bishops Square	Develop a non-intrusive device to check the condition of flap valve hinge pin (in situation).

B.2 Reference of initial consultation items (in full)

Item	Meeting details	Idea/requirement	What is the problem	What is the improvement	What is the effect	Business case	Comment	Research & development already identified	Summary of conclusions from research & development carried out	Device/system that is already available that fulfils the need
Science projects										
1	**Regional manager (Midlands Region):** Martin Hayes **Date of meeting:** 03/09/2008 **Place of meeting:** Sentinel House, Litchfield	Resilient photovoltaic cell (i.e. vandal proof). For low power sites such as rain gauges and monitoring.	Far too often the cells and instrumentation are stolen or vandalised.	• Improve ease of installation. • Reduce civil cost. • Ideal is 'you pick up a unit slap it in with the instrument you are powering'. No need for external power supply.	• Cost reduction for installation. • Resilient installations and hence more reliable data record.	Cost saving for: • replacement; • installation; • power supply installation and standing charge; • time delays for new power.	Recently a camera installation in Long Eaton, park and library grounds lasted 3 weeks before being stolen.	There is lack of data about vandal proof photovoltaic cells.	Suitable for R&D project.	N/A
2	**Regional manager (Midlands Region):** Martin Hayes **Date of meeting:** 03/09/2008 **Place of meeting:** Sentinel House, Litchfield	Vandal proof barrel locks.	Vandals put 'superglue' into the barrel or where the lock is behind a cover, vandals will put needles that will hurt personnel accessing the lock.	Vandal proof lock ideally keyless.	• Reduction in unnecessary operational time. • More confidence from the staff.	Cost saving for: • standing time associated with dealing with locks that have been vandalised; • H&S costs of staff being injured, i.e. time off work and potential for compensation.		There is lack of data about barrel locks which are vandal proof. However, several designs of keyless locks are available. None suitable in their current form as all have delicate exposed components. Designs for keyless radio operated lock unavailable.	Suitable for R&D project. Some locks that may be suitable at following websites http://gokeyless.com/remote-door-locks.php http://keylessdoor.com/interconnected-ir-remote-control-deadbolt-levers-locks-p-29.html?zenid=ra24c1f0rdopo3hodkrph80rf5	N/A

Item	Meeting details	Idea/requirement	What is the problem	What is the improvement	What is the effect	Business case	Comment	Research & development already identified	Summary of conclusions from research & development carried out	Device/system that is already available that fulfils the need
14	**Regional manager:** Martin Earlham and Ed Morris **Date of meeting:** 04/09/2008 **Place of meeting:** Thames Barrier	Non-intrusive method of investigating for corrosion between the jointing plates and I-beams at I-beam joints.	On the barrage for each gate there are 16 I-beam joining plates adjacent to the main pivots. The contact surfaces between the plates and the I-beams need to be inspected for corrosion.	A device that can measure/indicate if corrosion is occurring between the mating surfaces of the jointing plates and I-beams.	• Easy operation that does not involve having a gate unavailable for flood operation.	To remove one plate for inspection costs £30k, which is £480k per gate.	Contact has been made with a research & development organisation in Cambridge that has a number of ideas of how this can be done, i.e. it would appear to be a reasonably realistic proposition.	There is available information about non-intrusive methods of corrosion measuring, e.g. US Patent 6861853 – Investigating corrosion. Also some specialist companies like 'Metacor External Corrosion Management Ltd' provide wide range of information.	Additional research about investigation of corrosion between jointing plates and I-beams at I-beam joints may be useful. In our case we need to cope with unusual circumstances and a specific method should be chosen, moreover cooperation with Cambridge may be helpful.	There are available devices, e.g. from 'Metacor External Corrosion Management Ltd' http://www.metacor.co.uk
30	**Regional manager:** Darsha Gill **Date of meeting:** 22/12/2008 **Place of meeting:** Environment Agency Hatfield, Bishops Square	Develop a device to test the integrity of wire ropes and specifically to determine if there is internal corrosion.	As item 29.	Easy method to assess the condition of a wire rope which would: • prevent failure by early identification of problem allowing replacement; • prevent unnecessary replacement of wire ropes.	As item 29.	As item 29.	There is significant expertise within the Environment Agency on this subject. To contact Colin Barker.			

Item	Meeting details	Idea/requirement	What is the problem	What is the improvement	What is the effect	Business case	Comment	Research & development already identified	Summary of conclusions from research & development carried out	Device/system that is already available that fulfils the need
41	**Regional manager:** Neil Terry **Date of meeting:** 23/12/2008 **Place of meeting:** Environment Agency Worthing	Alternatives to bespoke stop logs for each installation.	Every installation requires its own bespoke stop logs to suit the particular width and depth.	Research into: • Identifying the range of sizes that the Environment Agency has a requirement for and any installations that do not have stop logs. • Alternative methods such as the inflatable air bag system. This is available and some trials should be carried out. • Research into designs of stop logs that allow adjustment in width.	Ultimately cost saving in the provision of stop logs.	Potential reduction in the storage of stop logs, hence may free up space for storage of other equipment or allowing land to be freed up for other purposes.	Do we know the condition of the existing logs? It may be that the logs are in some cases soon to be replaced anyway.	Research into 3 distinct groups of lock i.e.: • must use bespoke logs, no alternative; • suitable for mechanical adjustable log; • suitable for inflating balloon-type device.	Suitable for R&D project.	No proprietary log for adjustable lock width available, but inflatable weir or inflatable rubber devices for spillways and flood control are common. Little reported history in UK, most in France or USA.
50	**Regional manager:** David Thomas and Malcolm Downs of MLC **Date of meeting**: 18/12/2008 **Place of meeting:** Atkins, Peterborough	Investigation into the pros and cons of the use of biodegradable oils versus mineral oils.	All IBD and Environment Agency plant sited on flood defences has to use biodegradable oils (Bio Oils) as opposed to mineral oils. The Bio Oils cause seals to go more quickly (causing spillage), do not appear to be up to heavy duties and cause additional wear of components. Also the impression is that when Bio Oils leak they sit on the bottom of a watercourse potentially doing ecological damage.	Confirmation is sought as to whether Bio Oils are proving to be better for the environment than mineral oils. Also confirmation is required as to whether there are situations where it is better to use mineral-based oils instead of Bio Oils.	Potentially less damage to the environment. Potentially longer plant life and reduced maintenance.	Environmental improvement and reduction in maintenance.	More important owing to general tendency to replace existing systems with newer products to avoid adverse effect on watercourses. Bio Oils cannot always be retro-fitted without extensive modification to the overall system. (e.g. pressure reduction).	Research already carried out by USDA confirms that synthetic oil is better than vegetable-derived oil. Most existing research is based on composting and soil biodegradability, and does not relate to oil contaminants in watercourses. In USA research covers soil and groundwater effects, also use of composting as method of disposal. No direct research on impact of Bio Oils on hydraulic seals or pumps etc.	Suitable for R&D project, but not relating to hydraulic performance – the existing ISO 32 and 46 already cover this and in some cases manufacturers already describe methods for reducing operating pressures. Research should focus specifically on biodegradability.	Few existing products have extensive testing on impact of spillage on watercourses.

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55	**Regional manager:** Darsha Gill **Date of meeting:** 22/12/2008 **Place of meeting:** Environment Agency Hatfield, Bishops Square	Develop a non-intrusive device to check the condition of flap valve hinge pin (*in situ*).	Often visual inspections do not reveal that a hinge pin is close to failure and failures then occur.	A simple device that an inspector can use to determine if a pin has started to fail, even at a very early stage.	Maximising flap valve pin life and reduce costs of the effects of and dealing with flap valve failures.	Cost savings in reducing the effects of hinge pin failures.	Contact has been made with a specialist R&D company who believe the development of such a device is relatively simple.	There is a significant amount of research & development into non-destructive methods of testing structures. There is no evidence that can easily be found for a device to do this particular application.	The science is readily available but it will be necessary to develop the science and a device to do the *in situ* testing.	
Collation and best practice										
12	**Regional manager:** Martin Earlham and Ed Morris **Date of meeting:** 04/09/2008 **Place of meeting:** Thames Barrier	How can the Environment Agency best test elastomerics, e.g. can we build up a statistical database of experience of the ageing of elastomerics (seals).	Elastomerics have a limited life and over time they age harden and are all likely to fail at the same time in an installation's life. It is difficult to optimise the life of elastomerics (seals, hoses etc).	Method that determines the application life of elastomerics to optimise use.	Optimise life of elastomerics (seals and hoses).	Need to assess wasted cost of changing elastomerics too early and costs of elastomeric failure.		There is some information about research which has been done in this area, e.g. 'Thermal, UV- and sunlight ageing of thermoplastic elastomeric natural rubber-polyethylene blends' from *Journal of Materials Science*; 'Effect of Physical Ageing on Mechanical Behaviour of an Elastomerics Glass under Combined Pressure and Temperature' by Vijayan, K.; Pae, K.D, 'Elastomers and aging'	There are a lot of materials about elastomeric ageing. The project would initially be to do desk study and research undertaken to date to collate statistics and conclusions particular to the Environment Agency's requirements.	No data about statistical database for ageing of elastomerics.

Item	Meeting details	Idea/requirement	What is the problem	What is the improvement	What is the effect	Business case	Comment	Research & development already identified	Summary of conclusions from research & development carried out	Device/system that is already available that fulfils the need
13	**Regional manager:** Martin Earlham and Ed Morris **Date of meeting:** 04/09/2008 **Place of meeting:** Thames Barrier	Identify best sealant/filler between plates and I-beam at I-beam joints. The mating surfaces are coated with sealant/filler before being bolted together.	On the barrage for each gate there are 16 I-beam joining plates adjacent to the main pivots (4 plates per joint). These plates need to be removed to check for corrosion of the adjacent faces. A replacement sealant is required. The current mastic used is not guaranteed by the manufacturer for this application.	Identify a new sealant/filler that can easily be removed in the future.	Allows inspection of surfaces for corrosion.	To remove one plate costs £30k. If the wrong mastic is chosen this cost will increase for future inspections. Since the commissioning of the barrage these plates have not been removed.	When first installed a mastic (Choc Fast Orange) was used to seal between the plates and I-beams, followed by the plates being bolted on. The removal of one plate costs £30k. A new sealant/filler has been identified which is applied in a liquid metal form. However, its future removal will necessitate heating the joint to 100°C and the sealant being chiselled off.	There is lack of information about the best replacement sealant for plates and I-beam at I-beam joints.	Additional research or contact with manufacturers may be useful; however, the cheapest solution is to focus on non-intrusive method of investigating of corrosion.	The best sealant/filter was not found.

Item	Meeting details	Idea/requirement	What is the problem	What is the improvement	What is the effect	Business case	Comment	Research & development already identified	Summary of conclusions from research & development carried out	Device/system that is already available that fulfils the need
15	**Regional manager:** Martin Earlham and Ed Morris **Date of meeting:** 04/09/2008 **Place of meeting:** Thames Barrier	International standardised method of measuring probability of failure for moving flood barriers that protect against catastrophic failures.	Everyone on the barrage team has contact with either international or UK counterparts. It is clear from the contact that the method of measure of probability of failure all differ.	A standard measuring technique for moving flood barriers would: • uncover inadequacies in existing assumptions; • save unnecessary efforts where it will be shown they concentrate in the wrong area; • reinforce or change the maintenance priority list; • help develop specifications for performance requirements for new or replacement plant.	• To improve the probability of failure from the 10^{-3} that is the present achievement. • Improve efficiency of maintenance.	A reduction in the probability of failure for the Thames Barrier should have a significant cost benefit. To improve efficiency of maintenance procedures will have a cost saving, but this cannot be calculated unless the standardisation is carried out.	The Thames Barrier team periodically attend international meetings with their counterparts from other countries. This has brought to light that it does not appear that any country has a standard method, even between regions within their own country.	Lack of information about standardised methods of measuring probability of failure. Much work already carried out regarding 'Black Swan theory', i.e. high impact and low probability events. Also work on TE2100 Environment Agency project for assessing reliability of pumping stations, in particular the probability of allowing backflow during high tide events. UKAEA have done much research on standardised reliability approach with standard figures being assigned to individual components. Atkins has access to specialist fault tree software FT100 and FT+ which allows for fault tree analysis to be conducted. NOTE – much of this research is considered to be confidential and may not be available in the public domain.	Suitable for R&D project. Three-prong approach – incorporating use of standard tables for reliability of components, incorporating personnel experience information and specialist experience for high consequence events. Various regulations to ensure compliance with, NUREG, DO-178 and 254, SAE 4761 and 4754.	There is no available standardised method although most methods all employ basically similar approaches.

Item	Meeting details	Idea/requirement	What is the problem	What is the improvement	What is the effect	Business case	Comment	Research & development already identified	Summary of conclusions from research & development carried out	Device/system that is already available that fulfils the need
16 and 33	**Regional manager:** Martin Earlham and Ed Morris **Date of meeting:** 04/09/2008 **Place of meeting:** Thames Barrier **Regional manager:** Darsha Gill **Date of meeting:** 22/12/2008 **Place of meeting:** Environment Agency Hatfield, Bishops Square	Robotic device for inspection of remote/confined space areas.	Access in confined spaces is a significant H&S risk and expensive to carry out.	A robotic device that allowed inspection without the need for human entry.	• Improvement in health and safety because there will be a reduction in the need for persons to go into confined spaces for maintenance.	Improved H&S. Potential to reduce cost of confined space entry (training, time and equipment).	There are difficult places to access, typically by ladder to a volume 1 m by 2 m by 1 m deep which are confined spaces up to 30 m from a safe area. The inspections can cover paintwork (paint adhesion test) and visual inspection, visual inspection of corrosion, welds. A robot should be able to do all of this. At the barrier they have a Scorpion robot that can inspect the flood gates which are reasonably flat surfaces, but this is no good in a tight space. Simple remote controlled devices are getting cheaper and consideration could be given to a lighter than air robot with cameras for inspection (confined spaces are not usually windy).	There do appear to be a number of affordable robotic devices already on the market that could be modified for Environment Agency tasks. There is a lot information available online especially on the websites of manufacturers, e.g. UL Robotics provide wide range of robotic devices or Resources – Working Safely in Confined Spaces from http://www.worksafebc.com http://www.active-robots.com/products/robots/bugbrain.shtml	Initially research in devices and discussions with manufacturers necessary.	Appropriate robots are available on the market e.g. Micro VGTV provided by American Standard Robotics http://www.asrobotics.com/products/spectrum45.html

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19	**Regional manager North West Region:** Andy Flitton. John Hunt **Date of meeting: 0**8/09/2008 **Place of meeting:** Richard Fairclough House, Warrington	To identify the efficiency improvements that can be made to pumps and plant and to collect the evidence to demonstrate that these improvements will work.	The Environment Agency are charged with reducing their carbon footprint. Pumping systems are responsible for a significant portion of the Environment Agency's power consumption (66 to 70%). There are methods of improving efficiency by, for example, Belzone coatings on pump impellors.	Improved efficiency of pumping and other plant.	• Reduce power cost. • Reduced carbon footprint.	Reduce power cost. Reduced carbon footprint.		A lot of research has been done. This includes e.g. component replacements, system optimisation – 'Test for pumping system efficiency ' and 'Matching pumps to system requirements' from World Pumps, 2008, or polymer coatings – 'Polymer Coating of Pumps Boosts Efficiency Performance' by William Xia. A lot of information may be found, e.g. in magazine 'Pump World'.	Additional promotion of pump efficiency may be useful. The research is really to identify what existing installations require improvement.	New solutions have already been implemented. For instance, polymer coating in TVA Colbast Steam Plant, Alabama, and Fayetteville, NC.

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20, 25, 26 [1]	**Regional manager North West Region:** Andy Flitton. John Hunt **Date of meeting:** 08/09/2008 **Place of meeting:** Richard Fairclough House, Warrington **Regional manager:** Darsha Gill **Date of meeting:** 22/12/2008 **Place of meeting:** Environment Agency Hatfield, Bishops Square	Research into the use of HDPE and also stainless steel for flap valves and penstocks and their track record as opposed to the more traditional materials of cast steel, cast iron and mild steel. Research to include: • cost; • differing environments; • reliability; • ease of maintenance; • efficiency; • design life; • replace or refurbish.	The Environment Agency regularly install new flap valves manufactured in HDPE and the assumption is that it is an improvement over the older cast iron, cast steel and mild steel flap valves. However, is this in reality an improvement? It would be helpful to have research into the reported track record of: • HDPE flap valves; • stainless steel flap valves; • combinations of HDPE and stainless steel. It may be that HDPE is very good in some environments, but not so good in other environments. The same can be true for stainless steel. The hidden cost of refurbishment of flap valves often results in the feeling that it would have been cost-effective to have replaced them. There are numerous old iron flap valves that are heavy and it is believed that their weight adds to the head loss. This must have a poorer efficiency than lighter weight modern equivalents.	The Environment Agency would benefit from some research, primarily within the Environment Agency, into the track record of these more modern materials, and whether they are providing better value for money. Research/case studies on a range of schemes over the past 20 years should give an indication of under what circumstances/conditions flap valves and penstocks should be replaced rather than refurbished. Improved efficiency of water transfer.	Up to date guidance based on Environment Agency experience to demonstrate what the life-cycle costing of the use of these materials is. Better decision making for best value for money regarding replacement/ refurbishment of flap valves and penstocks.	Optimised value for money for appropriate material selections will reduce life-cycle costs. This would need to be linked to a demonstration of a reduced flood risk for which a benefit cost can be applied. Life-cycle cost saving on flap valve and penstock replacement/ refurbishment.		There are new types of valves which installation can improve efficiency and sort problems with maintenance. For instance 'Tideflex' Check Valves company provides new type of valves –unique all-rubber check valves which improve system efficiency. Hambaker provides ductile iron flap valves, which are lighter than cast iron. More information about advantages of installation of new types of valve is available on manufacturers' websites.	There is a lot of research done by manufacturers.	New types of valves are available on market, e.g. from Tideflex, Hambaker etc.

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22 and 49	**Regional manager Anglian Region:** Martin Lee **Date of meeting:** 18/09/2008 **Place of meeting:** Riverside House, Lincoln **Regional manager:** David Thomas and Malcolm Downs of MLC **Date of meeting:** 18/12/2008 **Place of meeting:** Atkins, Peterborough	Research into best guidance on best practice for land drainage and flood alleviation pumping station design: • Pumping station type for best efficiency vs. value for money. • Pump reliability between different pump types • Pump starting. • Configuration. • Discharge.	For each project people's preferences can cause argument and delay. In addition, outdated technology is installed. IDBs do not have a database of case histories on how reliable different pump types have proved to be in the field.	Clear guidance should enable design getting through the SAR and PAR procedures. Defined minimum efficiency performance and control. By researching into the IDBs and the Environment Agency track records, information could be built up on the reliability of the differing pump types and particular issues that relate to certain pump types. This would provide guidance to the IDBs and Environment Agency when considering new pumping plant for either refurbishment of stations or for new stations.	• Improved standardised design solutions. • Perhaps determine best pump station configuration e.g.: o if bowl pump then this type (bearing lube, materials, speed, flow through etc); o if canister then this type (as above); o if diesel driven then this type (natural level of turbo boost, transmission, availability rating). • Possibly flow chart to derive solution. • Better informed selection of pump types.	Saving in design time. Saving in capital cost. Reduce power cost. Reduced carbon footprint.	In the past Anglian Northern Area employed consultants to produce a standard landowner access bridge in a range of sizes. For each new job the nearest design was pulled off the shelf, made site specific and built. Contractors knew what they were doing and outturn costs were better known. Need to involve pump manufacturers.	This problem has already been discussed during various water conferences, e.g. Third International Conference on Water and Wastewater Pumping Stations, Cranfield, 2005. Papers and books with state of art design of pumping stations are available. Many designs of proprietary pumping systems available through (for example) Grundfos. These are not commonly used by water companies, however. A lot of research has been done. This includes, for example, component replacements, system optimisation – 'Test for pumping system efficiency' and 'Matching pumps to system requirements' from World Pumps, 2008, or polymer coatings – 'Polymer Coating of Pumps Boosts Efficiency Performance' by William Xia. A lot of information may be found, e.g. in magazine 'Pump World'. Many statistics already exist from (for example) SRD – Safety & Reliability Directorate of British Nuclear industry. This covers all types of mechanical and electrical equipment. (e.g. KGV gate, London).	It would be useful to run series of workshops with the Environment Agency and IDBs to develop a best practice guide for land drainage.	Some materials from the water and wastewater pumping conferences were produced. Also European Water Association created a guidance. Additionally, a lot of books about pumping station design can be found, e.g. 'Pumping station design' by Robert Sanks, July 2008. New solutions have already been implemented. For instance, polymer coating in TVA Colbast Steam Plant, Alabama and Fayetteville, NC.

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28 [1]	**Regional manager:** Darsha Gill **Date of meeting:** 22/12/2008 **Place of meeting:** Environment Agency Hatfield, Bishops Square	Research into how best to inspect tidal flaps and specifically hinge pieces.	Often it is difficult to inspect tidal sluices and flap valves (due to confined spaces). Often for example a hinge piece can be inspected and appear to be good, but you later find out it has failed. How else can the Environment Agency inspect or know that a failure is imminent, and are there any telltale signs from experience.							
29 [2]	**Regional manager:** Darsha Gill **Date of meeting:** 22/12/2008 **Place of meeting:** Environment Agency Hatfield, Bishops Square	Research into the best method to inspect a wire rope.	There have been a number of failures and now in some areas the maintenance teams just change wire ropes every 2 to 3 years as this is the safe option.	Research into methods of testing of wire ropes should give better guidance as to when replacement is necessary. It may be unnecessary expenditure with frequent replacement of wires. It may be the local environment, frequency of use and differing maintenance practices have a very significant effect on the life of the wire ropes.	• Prevent failures of wire ropes. • Prevent unnecessary replacement of wire ropes.	Reduced costs in emergency repair and potentially flooding that result from a gate failure. Reduced maintenance costs for unnecessarily frequent wire rope replacement.		TCK weak magnetic inspection technology related wire rope http://en.tck-cn.com		

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31 and 45[3]	**Regional manager:** Darsha Gill **Date of meeting:** 22/12/2008 **Place of meeting:** Environment Agency Hatfield, Bishops Square **Regional manager:** Nigel Bulmer **Date of meeting:** 29/01/2009 **Place of meeting:** Environment Agency Hull, 1 Vikings Close, Kingston-upon-Hull	Research into paint finishes for gates and structures.	Paint technology has moved forward quite significantly in the last 10 or 15 years, but the standard specifications for paint finishes have not. Up to date guidance is needed and also research across the Environment Agency as to what is proven to be good and what is proven not to be so good. The existing specification could well no longer be best practice. When painting structures the problem is often that one cannot get into the nooks and crannies, joints, webs where the worst problems are. A major problem is that you can only paint the structures *in situ*.	Good research into: • What paint improvements have been made. • What the Environment Agency is finding with case study results. • Best protection (marine) and paints to overcome difficult access (paints to be environmentally acceptable). • Best practice for *in situ* painting. • Can you paint underwater? • Best practice for grit blasting. Or: Do you let it corrode away with a calculated design life and replace once structural failure becomes a measured risk.	Up to date guidance that would potentially increase the time between maintenance paintings. Best value for money by reduced maintenance.	Extended life of paint protection will significantly increase installation life and reduce the cost of maintenance re-painting. Value for money.	The Hull Barrier was painted in 1995 with a 2-pack epoxy with a 40 year design life. In practice it has only lasted 14 years before protection has started to fail.			
32[4]	**Regional manager:** Darsha Gill **Date of meeting:** 22/12/2008 **Place of meeting:** Environment Agency Hatfield, Bishops Square	Identification of common signs that lead up to gate and plant failure.	Where inspections are difficult failures can occur. This is because, for example, the hinge piece on a flap valve looks good but, not long after inspection it has failed.	By researching the Environment Agency experience and that of similar bodies around the world it may be possible to build up good guidance on telltale signs for gate/plan failure.	Prevention of failures by earlier identification.	Reduced costs in emergency repair and potentially flooding that result from a gate failure.				

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40	**Regional manager:** Neil Terry **Date of meeting:** 23/12/2008 **Place of meeting:** Environment Agency Worthing	Auto lubrication system for large chains on large gates.	The Dartford Creek Barrier has large chains that are manually lubricated. This is very time consuming and difficult to do.	Research into what automatic chain lubrications are available on the market and if none are suitable developing a new system. Also sealed for life bearings can be considered.	Significant saving in manpower and lubricant and also more certainty in the system.	Saving in time and lubrication costs.	For Dartford Creek Barrier the chain supplier, Reynolds Chain, have looked at the issue but not come up with anything that can be taken forward.			
43	**Regional manager:** Nigel Bulmer **Date of meeting:** 29/01/2009 **Place of meeting:** Environment Agency Hull, 1 Vikings Close, Kingston-upon-Hull	Similar to items 20, 25 and 26 but for gates. Supports idea to question is it better to replace gates than refurbish them.	Often when the refurbishment option is followed the depth of checking of the existing structure and additional works that result can sometimes seem never ending. Consequently it is often felt it would have been cheaper to replace the gate.	Research/case studies on a range of schemes over the past 20 years should give an indication of under what circumstances/conditions gates should be replaced rather than refurbished.	Better decision making for best value for money regarding replacement/refurbishment of gates.	Life-cycle cost saving on gate replacement/refurbishment.				
47	**Regional manager:** Nigel Bulmer **Date of meeting:** 29/01/2009 **Place of meeting:** Environment Agency Hull, 1 Vikings Close, Kingston-upon-Hull	Research into best method of flow measurement for high volume pumps.	In order to measure the performance of a pump you need to measure power consumed and flow and head. For large stations the measure of flow is very difficult to do sufficiently accurately. The issue is compounded in that the head of the pumps is constantly changing so the use of time-consuming methods becomes nonsense.	Research & development into a new method to measure flow sufficiently accurately to determine if pumps are operating at the design efficiencies.	Massive improvements in pumping efficiency and hence savings in power costs.	Saving in energy bills.				

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48	**Regional manager North West Region:** Andy Fitton. **Date of meeting:** 03/02/2009 **Place of meeting:** Atkins, The Axis, Birmingham	Investigation into the appropriate type of remote camera surveillance.	There are many different types of CCTV technologies and systems supporting them. Guidance is needed to the: • operational constraints; • benefits of differing types • costs; • environmental impacts.	Clear guidance on the selection of CCTV camera and associated systems so that they can be related to specific environmental and site needs.	Clear guidance.	Reduced time in specification and procurement.				
Scoping										
4 [5]	**Regional manager (Midlands Region):** Martin Hayes **Date of meeting:** 03/09/2008 **Place of meeting:** Sentinel House, Litchfield	Evaluate the cost of vandalism and theft to the Environment Agency.	Vandalism is a constant issue with installations.	A better understanding of the real cost of vandalism and theft to justify future mitigation measures.	• Efficiency in design for longer life.	Business can only be made if linked with actual design changes that would follow.	There are lots of opinions regarding the causes of vandalism, from boating seen as 'elite' to perceived ease of high-value scrap metal.	There is lack of data about cost of vandalism to the Environment Agency.	Suitable for R&D project.	N/A
11 [5]		Vandal proof gauging post huts.	Instrumentation gets stolen or vandalised.	Have a vandal proof hut.	• Resilient installations. • Hence more reliable data record.	Cost saving for: • replacement; • installation.		There are a lot of available data, especially on the websites of manufacturers, e.g. B2B.	See item 3.	CCTV products.

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Park										
3	**Regional manager (Midlands Region):** Martin Hayes **Date of meeting:** 03/09/2008 **Place of meeting:** Sentinel House, Litchfield	Understand better the psychology of vandalism.	The Environment Agency is constantly dealing with vandalism (and theft) to installations.	Design guides on how to best consider vandalism during design and installation.	• Resilient installations. • Less down time for failure to start.	Cost saving for: • replacement of damaged/stolen plant.	Even when the installations are in the middle of nowhere and seem secure they get vandalised. Often the better the security the more determined the vandals are because they think there is something valuable inside.	The Home Office has published a series of short practical guides to help practitioners address vandalism and criminal damage (http://www.crimereduction.homeoffice.gov.uk/vandalism01.htm). More information and assistance in tackling vandalism is also available from 'British Crime Survey', http://www.respect.gov.uk/, http://www.crime-prevention-intl.org/index.php, http://www.popcenter.org/	There is available information, solution and best practice to help tackle vandalism. Need to collate research available especially to the Environment Agency's needs.	Available documents are listed in Research & development column. There are also books available, e.g. *The Psychology of Vandalism* (Goldstein 1996).
17	**Regional manager North West Region:** Andy Flitton. John Hunt **Date of meeting:** 08/09/2008 **Place of meeting:** Richard Fairclough House, Warrington	Optimise the term contracts for M&E maintenance and to incorporate an incentive to the contractors to improve the installations.	Currently the contracts are based on time and materials and/or prices for maintenance tasks. There is no incentive for the contractors to improve asset or improve the service. The Environment Agency currently have price surety with standard maintenance costs. However, this does not relate to overall reliability. Also the Environment Agency cannot predict and do not know the cost to the Environment Agency of a breakdown.	If some sort of service deliverables with Key Performance Indicators (KPIs) for a lump sum contract can be developed. This should include for the contractors to actively improve the asset and hence reduce the probability of failure.	It will improve service by maintenance contracts by giving the contractors the appropriate type of incentive to improve the availability of plant.	Ultimately it should reduce maintenance expenditure by targeting the money to the critical aspects to reduce failure to operate and improve H&S.	They have four Contractors; 2 for M&E, 1 for HV and 1 for diesel engines and generators. An example idea is to work with the contractors to achieve an acceptable level of availability for a reduced cost and then the contractor to share in the cost saving.	There is relatively little data about this topic.	Suitable for R&D project.	N/A

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18	**Regional manager North West Region:** Andy Flitton. John Hunt **Date of meeting:** 08/09/2008 **Place of meeting:** Richard Fairclough House, Warrington	A suitable method for how the Environment Agency can measure value for money of its operation and maintenance teams. This is linked to 17.	The Environment Agency does not have any means of measuring the non-availability of assets and hence the value for money that each region is giving for the budget allocation. The Environment Agency does not have a standard way of assessing 'availability of plant'. There is no target deliverable from money given out to measure of performance level. To know how much a breakdown of plant costs (e.g. John Hunt used to work in a foundry where the cost to the business of breakdown of plant was known and maintenance was better targeted. For each breakdown a route cause analysis was carried out which fed back into the procedures). Environment Agency assets are often not operating for long periods.	Provision of a standard performance measure that can be used between the regions. This will help the individual region's business case for budget and demonstrate optimum value for money.	It should improve maintenance by giving clear performance targets to the regional MEICA teams.	Improved value for money and improved availability of plant.	Improvements in H&S should be a measure for determining value for money. Consideration should be given to how often failed signals are generated. Some sites are more critical than others.	There is relatively little data about this topic.	Additional research may be useful.	N/A

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54	**Regional manager:** David Thomas and Malcolm Downs of MLC **Date of meeting**: 18/12/2008 **Place of meeting:** Atkins, Peterborough	PAR document that is accessed through the internet that is based on filling in the boxes.	IDBs are finding it increasingly difficult to complete PAR documents that satisfy the Environment Agency's requirements. It is felt that a PAR could be a box filling exercise with the addition of technical and environmental reports.	Easier more prescriptive system for the IDBs to follow.	Reduced time and cost and improved understanding of the main drivers for PARs to the IDBs.	Saving in time and cost and paper.				
Initially Ruled out										
5	**Regional manager (Midlands Region):** Martin Hayes **Date of meeting:** 03/09/2008 **Place of meeting:** Sentinel House, Litchfield	Simpler ultrasonic.	Modern ultrasonic units are too sophisticated, taking a lot of time to set up and if a field is changed it is time-consuming and mistakes with other fields can unwittingly occur.	Modern but simpler ultrasonic unit with: • 4–20 mA output; • 4 relays for control. (for the basic 2 pump station control).	• Operational time saving. • Simpler to understand ultrasonic control. • No need for complicated manual.	Cost saving for: • design time; • operational time; • potentially less expensive ultrasonic unit and less expensive installation.	The average ultrasonic unit (Hydroranger) has more than 100 functions to set.	There are a lot of manufacturers which provide simpler ultrasonic units, e.g. Zenit or Control Electronics.	Discussion with manufacturers necessary.	Model PSM-660U Ultrasonic Pump Station Flow Monitor Controller from Control Electronics, Inc. or Commander 20 from Zenit.
6	**Regional manager (Midlands Region):** Martin Hayes **Date of meeting:** 03/09/2008 **Place of meeting:** Sentinel House, Litchfield	'Bluetooth' access to data and change instrumentation parameters from outside installations that negate the need to get out of the car, unlock the building and go into the building.		Reduce time in getting information from installations and changing instrumentation set points. Improvement in H&S.	• Reduced operational time. • Potential improved H&S.	Cost saving for reduced operational time.		There is available information, e.g. 'Bluetooth gets a filling' from In Tech or from Agilent Solutions for Bluetooth Technology.	Discussion with manufacturers necessary.	Industrial instrumentation manufacturers started to build Bluetooth-enabled devices, e.g. Wilcoxon company or Oceana Sensor.

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7	**Regional manager (Midlands Region):** Martin Hayes **Date of meeting:** 03/09/2008 **Place of meeting:** Sentinel House, Litchfield	Remote control device to operate installations where they have been isolated by flood water.	Where flooding has damaged the automatic control instrumentation and manual control still works the station cannot be operated because it cannot be accessed due to flood waters.	From a distance of up to say 100m pumps and gates can be remotely manually operated.	• Potential improved flood protection when serious flooding is occurring.	Need to document and assess incidents of where this would have helped and what potential reduction in flood damage would have resulted. Also potential to reduce H&S risk to personnel trying to access station that is cut off by flood water.	There have been incidents where station instrumentation was under water but the MCC was above water level and the manual function was operable. A good example is a new station Burton Joyce.	There are a lot of available data about remote control via Bluetooth technology, e.g. Bluetooth I/O module for industrial remote control from Instrumentation and Control News, for more info see point 6.	Discussion with MCC manufacturers necessary.	See item 6. Global Spec offers a variety of Bluetooth remote control related products.
8	**Regional manager (Midlands Region):** Martin Hayes **Date of meeting:** 03/09/2008 **Place of meeting:** Sentinel House, Litchfield	Centralised and easily accessed MEICA library including specifications and O&M information. Probably via Easinet.	Design and investigation work is often duplicated because information is not easily shared, i.e. the wheel is continually reinvented.	Good library with powerful search engine of designs, specifications, O&M information, operational procedures, maintenance improvements.	• Reduced design time. • Improved MEICA standardisation across the regions. • Intangible cost savings in cross-fertilisation of ideas.	Reduced design time and savings in standardisation.	This should be linked with other R&D projects below. Believe this may be covered by the AMIT (asset management IT solutions) project under Jim Barlow.	There are no data about centralised MEICA library.	Project would be discussed with Environment Agency's Systems Integration and/or Atkins systems integration to specify user requirement specification for development in functional design specification	There is no MEICA library.
9	**Regional manager (Midlands Region):** Martin Hayes **Date of meeting:** 03/09/2008 **Place of meeting:** Sentinel House, Litchfield	Develop standard format of O&M information for manufacturers to provide and for manufacturers to licence access via the intranet to their libraries of O&M information.	O&M information can be difficult to access and maintenance staff can sometimes turn up at site without the correct information. Paper manuals can be bulky and often a waste of paper.	Reduction in paper manuals. Potential via mobile links to access manufacturers' O&M information from site.	• More efficient access to O&M information.	Cost saving for: • reduced maintenance operatives' time in searching out O&M data; • potential reduction of paper O&M manuals; • offices less cluttered (with O&M manuals).	Anything that reduces paper usage is bettering the environment.	There are no data about a standard format of O&M information.	Project would be discussed with Environment Agency's Systems integrated and/or Atkins systems integration to specify URS for development in FDS. Also review with contractors.	There is no standard format of O&M information.

Item	Meeting details	Idea/requirement	What is the problem	What is the improvement	What is the effect	Business case	Comment	Research & development already identified	Summary of conclusions from research & development carried out	Device/system that is already available that fulfils the need
10	**Regional manager (Midlands Region):** Martin Hayes **Date of meeting:** 03/09/2008 **Place of meeting:** Sentinel House, Litchfield	Develop standard of reporting for maintenance contractors so that the reports are accessed via the intranet.	Maintenance contractors' reports can be bulky.	General efficiency of management of maintenance contracts and more green approach to information storage.	• Reports would be stored by the maintenance contractors on their servers and the Environment Agency would access these for appropriate information.	Reduce management time.		There is no standard of reporting for maintenance contractors.	Project would be discussed with Environment Agency's Systems integrated and/or Atkins systems integration to specify URS for development in FDS. Also review with contractors.	No reports accessed via internet.
21	**Regional manager North West Region:** Andy Flitton. John Hunt **Date of meeting:** 08/09/2008 **Place of meeting:** Richard Fairclough House, Warrington	What is an appropriate project management toolkit for regional MEICA engineers?	The regional MEICA engineers do not have a standard method and set of procedures for project management. One is needed as the regional engineers are constantly involved in project delivery for new and refurbishment works.	Standard project management procedures. Security of knowledge that engineers are performing their project management duties fully and correctly.	• Unification of procedures. • Easier transfer of duties where a project manager is replaced on a scheme (illness, leaving etc).	Reduced cost for more efficient working. Reduced risk of over-expenditure on projects where aspects have been missed.	NCPMS and other parts of the Agency use a project management system called (PRINCE 2).	There are a lot of articles, papers, books and media provided by Project Management Institute http://www.pmi.org/Pages/default.aspx	Most of the available materials contain general guides about project management. Research for project management for the regional MEICA engineers may be useful.	One of the available books:' Project Management Tool Kit' by Tom Kendrich or 'Project Procurement Management: Contracting, subcontracting , Teaming' by Q. Fleming.

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24	**Regional manager Anglian Region:** Martin Lee **Date of meeting:** 18/09/2008 **Place of meeting:** Riverside House, Lincoln	Project management tool for projects with capital value of less than £250k. (See 21 as it is effectively the same point).	NCPMS have standard procedures for large projects. Region needs less protracted standard that meets all internal requirements (e.g. environmental and finance). Need a decision process that can complete a project in one year.	See item 21.	See item 21.	See item 21.	NCPMS have a project management system.	There are some guidance and case studies for management of the small projects, e.g. article: 'Implementing Project Management Best Practices on Small Projects' by Simon Buehring, or book 'Project Management for Small Projects (paperback)'by Sandra Rowe. There are also a lot of articles, papers, books and media provided by Project Management Institute (http://www.pmi.org/Pages/default.aspx)	It seems that there is available information about small project management. It could be useful to create a new project management tool for the small project with case studies for MEICA.	Good source of information is Project Management Institute. They have a lot of documents for project management. E.g. Managing and leading small projects [electronic resource] / Sandra Rowe from PMI Global Congress 2007—North America.
27	**Regional manager:** Darsha Gill **Date of meeting:** 22/12/2008 **Place of meeting:** Environment Agency Hatfield, Bishops Square	Research into standardisation of software for flood defence (moving) gate control.	It would appear that with each new gate project there is new logic and software for the gate control. This means that the maintenance can be hampered by each system being different.	By discussion throughout the Environment Agency it is felt some common logic paths can be developed and hence standard elements of software developed.	Reduced maintenance time due to fitters not being familiar with the logic controls for each new installation.	Reduction in time spent by maintenance staff coming up to speed on each control system's logic.				
34	**Regional manager**: Neil Terry **Date of meeting:** 23/12/2008 **Place of meeting:** Environment Agency Worthing	Change in control set point parameters by telemetry.	Need to understand within the Environment Agency what is the best practice for changing control set point parameters via telemetry.	Unified approach within the Environment Agency.	Clear guidance within the Environment Agency on all new schemes that involve telemetry.					

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35	**Regional manager:** Neil Terry **Date of meeting:** 23/12/2008 **Place of meeting:** Environment Agency Worthing	What is the best PDA system to tie in with the ID Hammer maintenance system?	The Environment Agency is implementing a computerised maintenance management system called ID Hammer.	Research into the best PDA system that can be used by maintenance personnel to be able to interrogate and interact with ID Hammer.	This will assist with frequent maintenance checks and historical data collection, e.g. recording winding resistance straight to the records.	Help to increase the maintenance database that will ultimately help to streamline maintenance system and reduce cost.				
36	**Regional manager:** Neil Terry **Date of meeting:** 23/12/2008 **Place of meeting:** Environment Agency Worthing	More Web hosting of Environment Agency information on: • best practice; • lessons learned; • specifications and designs.	See item 8.	See item 8.	See item 8.	See item 8.				
37	**Regional manager:** Neil Terry **Date of meeting:** 23/12/2008 **Place of meeting:** Environment Agency Worthing	External Web-based platform to host data/information.	The perception of the Environment Agency's internal system is that: • it has size limitations; • it is very slow for the Environment Agency to access; • it is very difficult for contractors to get permission and onto the Environment Agency system.	It would be better if contractors and suppliers would host information that the Environment Agency would have access to.	Improve data communication.	Saving in time for both Environment Agency personnel and contractors.				

Item	Meeting details	Idea/requirement	What is the problem	What is the improvement	What is the effect	Business case	Comment	Research & development already identified	Summary of conclusions from research & development carried out	Device/system that is already available that fulfils the need
38	**Regional manager:** Neil Terry **Date of meeting:** 23/12/2008 **Place of meeting:** Environment Agency Worthing	Project management system for MEICA. See items 21 and 24.	They have a system 'One Business One Solution' which is used for procurement, training, expenses and sickness, but they do not have anything for project management.	They need a system for each job that allows the job to progress through its life cycle, highlighting forms, information standards, process, legislation, timescales etc. The important aspect is that it will not let you progress (within reason) unless each step has been completed and authorised.	Improvement in project management capability which will reduce time and regularise MEICA jobs that are not done under NCPMS.	See item 21.	NCPMS have a project management system.			
42	**Regional manager:** Neil Terry **Date of meeting:** 23/12/2008 **Place of meeting:** Environment Agency Worthing	Standardisation of drawings for motor control centres for starter cubicles Direct-On-Line, Star-Delta, Auto Transformer and inverter.	All cubicles are different.	Standardisation.	Standardisation of starter cubicles.	Easier maintenance because the electricians do not require a learning curve for each new panel.				
51	**Regional manager:** David Thomas and Malcolm Downs of MLC **Date of meeting:** 18/12/2008 **Place of meeting:** Atkins, Peterborough	Put small power generators on weirs.	A reasonable amount of power could be generated from weirs.	Research into are there any cost effective methods of power generation from relatively small weirs.	Carbon footprint saving.	Potential payback of power generated.				

Item	Meeting details	Idea/requirement	What is the problem	What is the improvement	What is the effect	Business case	Comment	Research & development already identified	Summary of conclusions from research & development carried out	Device/system that is already available that fulfils the need
52	**Regional manager:** David Thomas and Malcolm Downs of MLC **Date of meeting:** 18/12/2008 **Place of meeting:** Atkins, Peterborough	USB stick configured on ultrasonics to be able to copy the set up from one ultrasonic unit and load it onto another unit.	Considerable time is spent setting up ultrasonic level recorders/controllers.	Making the setting up of ultrasonic controllers easier.	Reduced maintenance time.	Reduction in maintenance time costs.				
53	**Regional manager:** David Thomas and Malcolm Downs of MLC **Date of meeting:** 18/12/2008 **Place of meeting:** Atkins, Peterborough	Enable the IDBs to be able to access the Environment Agency's information.	If the IDBs had direct access to the Environment Agency's flood data and operational control, it would greatly assist the IDBs in responding to the same flood event. Knowledge is critical and water transfers between Environment Agency and IDB systems. Currently the IDB have to ring the Environment Agency and request the information. Also if the IDBs could access the Environment Agency's OS map data this would be a significant cost saving to the IDBs.	Greater sharing of knowledge and data between the Environment Agency and IDBs.	Improved flood control and reduction in IDB costs.					

Appendix C – Voting results

Table C.1 Averaged scores by project number.

Project no.	Benefit score	Difficulty score	Estimated cost score
1	6.50	2.06	54.75
2	6.33	1.53	41.20
14	7.60	2.33	111.33
30 and 29	8.00	1.53	45.33
41	7.60	1.73	64.33
50	7.88	2.00	51.88
55 and 28	5.67	1.87	51.00
12	5.69	1.31	22.97
13	4.19	1.94	27.03
15	7.13	2.19	53.44
16 and 33	5.31	1.25	35.75
19, 22 and 49	8.93	2.13	108.00
20, 25 and 26	7.06	1.50	37.81
31 and 45	7.69	1.25	38.44
32	6.77	1.46	31.15
40	5.15	1.69	24.46
43	6.15	2.15	69.23
47	6.00	2.43	59.29
48	6.77	1.32	41.21
4 and 11	3.50	1.86	30.43

Appendix D – Final prioritised list of research projects

‘Science’ projects:

1. Improving the efficiency and best practice for pumps. (Project 19, 22 & 49)
2. The use of biodegradable oils as opposed to normal products. (Project 50)
3. Non-intrusive methods for corrosion between plates and I-beams on the Thames Barrier. (Project 14)
4. The use of alternative stop logs for gate structures. (Project 41)

‘Collation and best practice’ projects

1. Devices and methods for inspecting wire ropes. (Project 30 & 29)
2. Best practice for use of remote camera surveillance or CCTV. (Project 48)
3. Paint finishes for gates and structures. (Project 31 & 45)
4. Identifying common signs indicating gate failure. (Project 32)
5. Research into the use of alternative materials for flap valves, penstocks etc. (Project 20, 25 & 26)

Appendix E – Project summary tables

Summary tables are present for each of the projects recommended for further research as follows:

Project Title – Where projects have been merged from the original list on the voting forms this has been indicated in the project title.

Project Scope – A brief description of the main aims of the project. It should be noted that this is an outline scope only, and it is expected that a full scope will be developed when the project is carried forward.

Environment Agency Theme – The relevant Environment Agency Flood Risk Science Theme that the project will fall under.

Output – Project outcome or product (report, guide, tool etc).

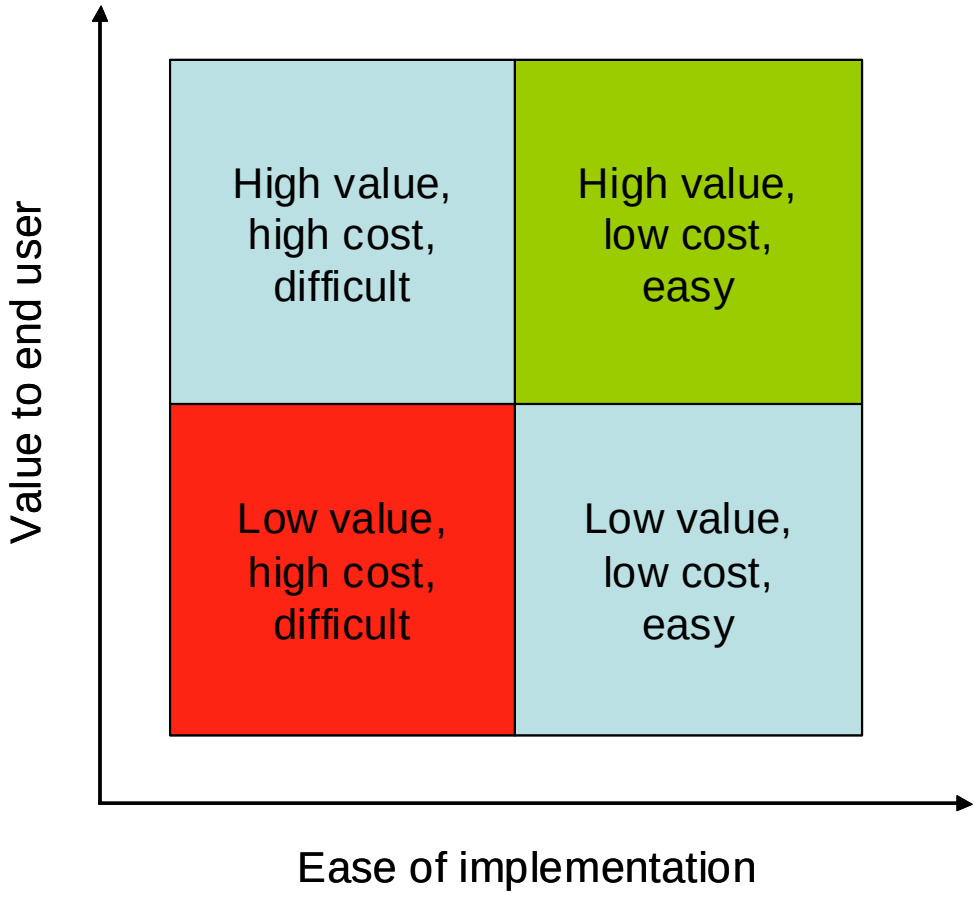
Estimated Cost.

Duration.

Beneficiaries of the project.

Outcome if not done.

Project Type – HV/HC/D, HV/LC/E, LV/HC/D and LV/LC/E as below.



Preferred options for 'science' projects

Item No:	19, 22 and 49	**Benefit Score:**	8.93	**Benefit vs. Ease Score**	4.19
Project Title: Improving the efficiency and best practices for pumping stations (large flow, low head)					
Project Scope: 1. Data review of all existing literature and previous studies within the Environment Agency. 2. Link up with selected pump manufacturers, flow measuring device manufacturers and specialist pump efficiency measurement equipment providers and undertake an initial shortlisting of methods/devices.✶ 3. Identify a series of sites which could be used for the study with a range of typical flow rates and heads, suction and discharge arrangements and operating regimes (number to be agreed prior to start). 4. Production of scope for the given sites, obtain permissions and site inductions as needed. 5. Site trials comparing effectiveness of differing methods/equipment to determine equipment and methods that give what is considered to be sufficiently accurate and usable data. 6. Produce reports as needed with recommendations. **As a follow-on under a separate budget that is not recorded here:** 7. Select quick-win sites and programme to implement changes to reduce power costs. 8. Following commissioning and for a reasonable time, record power usage to demonstrate or otherwise that the initial reports on potential pumping efficiency improvements have been verified.					
Environment Agency Theme: Sustainable Asset Management			**Output:** Report and guidance		
Cost: (estimated figure)			£125k (1 to 6, excluding costs of hire or purchase of specialist equipment)		
Duration:			12 months from start		
Beneficiaries: Environment Agency Operations Management			**Additional Sources of Funding:** To be identified on project commencement		
Outcome if not done: Inefficient practices will continue unmonitored throughout Environment Agency					
Project Type: HV/HC/D					

✶ It is understood the Environment Agency is already undertaking studies into pump efficiency in one or two regions (Environment Agency Lincoln under Martin Lee is one good example) and that contact with pump manufacturers is already under way i.e. item 2 onwards above. There is an opportunity, if funding is available, to enlarge/develop the existing study(s).

Item No:	50	Benefit Score:	7.88	Benefit Vs Ease Score	3.94

Project Title:
Use of biodegradable oils as opposed to normal products

Project Scope:

1. Conduct thorough literature review to consider previous information, in conjunction with manufacturers and end-users to review effectiveness of biodegradable oils.
2. Research thoroughly through Environment Agency and IDBs to obtain good case history data on the perceived pros and cons of biodegradable oils and specifically relating to:
    a) effect of spillage on watercourses and wildlife for both biodegradable and mineral-based oils;
    b) comparison of perceived reliability of biodegradable oil hydraulic systems when compared with mineral-based oil hydraulic systems in hydraulic systems:
        I. originally designed for mineral-based oils; and,
        II. originally designed for biodegradable oils;
    c) comparison of perceived life cycle costs of biodegradable oil hydraulic systems when compared with mineral-based oil hydraulic systems as b) above;
    d) persistence of spillages with biodegradable oils in the water environment.
3. Report and make recommendations as needed.

If the above information in 2a) is not sufficiently conclusive with regard to the effects of spillage site trials/studies will be necessary. Obviously it is unlikely that a controlled spillage for study in an existing watercourse will be permissible. Therefore, it would be necessary to undertake laboratory tests in simulated environments to compare the effects of spillage of biodegradable and mineral-based oils on a watercourse. The costs of such a laboratory study are not included in the estimated costs below.

Environment Agency Theme: Sustainable Asset Management	**Output:** Report and guidance
Cost: (estimated figure)	£65k, 1, 2 and 3 above only
Duration:	6–9 months from start – depending on nature of biological degradability
Beneficiaries: Environment Agency Operations Management	**Additional Sources of Funding:** To be identified on project commencement
Outcome if not done: Inefficient practices relating to use of biodegradable oils will continue throughout Environment Agency	
Project Type: HV/HC/D	

Item No:	14	Benefit Score:	7.6	Benefit vs. Ease Score	3.26

Project Title:
Investigation into non-intrusive methods of detecting corrosion (primarily for Thames Barrier)

Project Scope:

1. Review the scope of joints on the Thames Barrier that this relates to and identify with the operations team the methods of access to the joints and any experience of costs to get access to the joints.
2. Produce a specification of requirement detailing which methods of access to the joints will form a important aspect.
3. Conduct literature review of existing information in conjunction with manufacturers of leading products.
4. If there are devices already available that can do the detection, arrange for testing of the devices and report accordingly.
5. If there are no devices, select an R&D company to develop a working prototype to detect corrosion between two clamped plates.
6. Test prototype(s) at site.
7. Report and make recommendations as needed.

Environment Agency Theme: Sustainable Asset Management	**Output:** Prototype device for detecting corrosion between two plates
Cost: (estimated figure)	£70 to 140k
Duration:	12 months from start
Beneficiaries: Primarily Thames Barrier Operations and Maintenance. Potential spin-off for Environment Agency Operations Management	**Additional Sources of Funding:** To be identified on project commencement

Outcome if not done:
Inefficient practices relating to fragmented use of bespoke items will continue throughout Environment Agency

Project Type:
HV/HC/D

Item No:	41	Benefit Score:	7.6	Benefit vs. Ease Score	4.38

Project Title:
Alternatives to bespoke stop logs for each application

Project Scope:

1. Research through Environment Agency and IDBs to establish a database of sites requiring stop logs and sites that already have stop logs. For each site record the key dimensions (size of slot, width, depth, opening restraints) and place on central database for future Environment Agency and IDB reference. This may reveal that there is already a level of compatibility that the Environment Agency and IDBs can exploit.
2. If there is a suitable range of sizes, undertake trials with suppliers of the adjustable or inflatable stop logs and report on findings.
3. Following 2, if there is still a need identified, produce a design of adjustable or inflatable stop log that will fit the greatest range of sizes practicable (in partnership with local manufacturer as needed).
4. Report and make recommendations as needed.

Environment Agency Theme: Sustainable Asset Management	**Output:** Report and guidance and new design
Cost: (estimated figure)	£75k
Duration:	6 to 9 months from start
Beneficiaries: Environment Agency and IDB Operations Management	**Additional Sources of Funding:** To be identified on project commencement

Outcome if not done:
Inefficient practices relating to fragmented use of bespoke items will continue throughout Environment Agency

Project Type:
HV/HC/E

Preferred options for 'collation and best practice projects'

Item No:	30 and 29	**Benefit Score:**	8.0	**Benefit vs. Ease Score**	5.22
Project Title: Investigating rope integrity devices and methods of inspection					
Project Scope: 1. Conduct thorough literature review of all existing information, including liaison with manufacturers. 2. Select a series of equipment and methodologies currently available on the marketplace. 3. Select a series of sites which could be used as test subjects. 4. Conduct a series of tests using proprietary equipment. 5. Report and make recommendations as needed.					
Environment Agency Theme: Sustainable Asset Management			**Output:** Report and guidance		
Cost: (estimated figure)			£55k (excluding any purchase costs of equipment)		
Duration:			6 months from start		
Beneficiaries: Environment Agency Operations Management			**Additional Sources of Funding:** To be identified on project commencement		
Outcome if not done: Inefficient practices will continue unmonitored throughout Environment Agency					
Project Type: HV/LC/E					

Item No:	48	Benefit Score:	6.77	Benefit vs. Ease Score	5.13

Project Title:
Best practice for use of remote camera surveillance CCTV

Project Scope:

1. Confirm scope, which is currently to identify for differing CCTV technologies and systems supporting them:
    a. operational constraints;
    b. benefits of differing types;
    c. costs;
    d. environmental impacts.
2. Review all studies and CCTV implementations undertaken by the Environment Agency to see if the above scope can be answered from the data already available, and if so:
    a. check on updates of technology readily available in the marketplace;
    b. update findings of previous studies, collating the previous conclusions;
    c. if there is insufficient study data within the Environment Agency, review other non-Environment Agency and available studies to achieve the same.
3. Report and make recommendations as needed.

Currently the scope excludes new site trials of equipment and it is understood a number of trials have already been carried out by the Environment Agency.

Environment Agency Theme: Sustainable Asset Management	**Output:** Report and guidance
Cost: (estimated figure)	£45k
Duration:	6 to 9 months from start
Beneficiaries: Environment Agency Operations Management	**Additional Sources of Funding:** To be identified on project commencement
Outcome if not done: Inefficient practices will continue unmonitored throughout Environment Agency	
Project Type: HV/LC/E	

Item No:	31 and 45	Benefit Score:	7.69	Benefit vs. Ease Score	6.15

Project Title:
Paint finishes for gates and structures

Project Scope:

1. Conduct literature review of market information and employ paint and corrosion specialist (probably from within NECCA consultant).
2. Identify case studies from within and outside the Environment Agency. For example:
    a. Forth rail bridge;
    b. ship builders;
    c. roll-on roll-off ferry companies;
    d. known projects in the Environment Agency where design life has not matched actual life.
3. From the above report and collate expertise to develop an up to date paint selection, preparation and application specification for and accounting for:
    a. new build factory applied;
    b. refurbishment (with particular attention applied to Environment Agency experiences of difficulty to prepare and apply paints in steel areas difficult to access);
    c. local environment.

Environment Agency Theme: Sustainable Asset Management	**Output:** Report and guidance
Cost: (estimated figure)	£45k
Duration:	6 to 9 months from start, depending on extent of scope
Beneficiaries: Environment Agency Operations Management	**Additional Sources of Funding:** To be identified on project commencement

Outcome if not done:
Inefficient practices will continue unmonitored throughout Environment Agency

Project Type:
HV/LC/E

Item No:	32	Benefit Score:	6.77	Benefit vs. Ease Score	4.63

Project Title: Identifying common signs leading to of gate and plant failure

Project Scope:

1. Conduct literature review of publicly available information including liaison with manufacturers and suppliers.
2. Identify experienced individuals within the Environment Agency and IDBs to interview.
3. Carry out interviews to collect:
    a. methods of gate inspection;
    b. anecdotal and documented evidence of failures that have occurred;
    c. failure modes and signs identified prior to failure.
4. Consultation with suppliers and manufacturers in the form of questionnaires and interviews.
5. Reporting and recommendations as needed.

Environment Agency Theme: Sustainable Asset Management	**Output:** Report and guidance
Cost: (estimated figure)	£45k
Duration:	3 to 6 months from start
Beneficiaries: Environment Agency Operations Management	**Additional Sources of Funding:** To be identified on project commencement
Outcome if not done: Inefficient practices will continue unmonitored throughout Environment Agency	
Project Type: HV/LC/E	

Item No:	20, 25 and 26	Benefit Score:	7.06	Benefit vs. Ease Score	4.71

Project Title:
Alternative materials for flap valves and hinge pins

Project Scope:

1. Interview key personnel within the Environment Agency and IDBs to record the known track record of modern materials for penstocks and flap valves such as HDPE and stainless steel when compared with the more traditional and more expensive materials of cast iron, cast steel and carbon steels.
2. The above research is to specifically focus on:
    a. cost;
    b. performance and reliability in differing environments;
    c. ease of maintenance;
    d. efficiency;
    e. design life;
    f. whether it is better to replace an old flap valve or penstock with one using modern materials or refurbish the unit with the original materials.
3. Item 2 above is to include review and collation of manufacturers' guidance and recommendations.
4. Reporting and recommendations as needed.

Environment Agency Theme: Sustainable Asset Management	**Output:** Report and guidance
Cost: (estimated figure)	£45k
Duration:	3 to 6 months from start
Beneficiaries: Environment Agency Operations Management	**Additional Sources of Funding:** To be identified on project commencement
Outcome if not done: Inefficient practices will continue unmonitored throughout Environment Agency	
Project Type: HV/LC/E	

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