

NATIONAL RIVERS AUTHORITY



PROGRAMMING & PRIORITISATION OF RIVER WORK

PART 1: STRATEGY & EXPERIENCE

Proposals for Consultancy Services by
LAURENCE GOULD CONSULTANTS LIMITED

MAY 1990

NRA Thames 194



ENVIRONMENT AGENCY

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24 May 1990

KT/JMS

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NRA - PRO
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Dear Mr Llewellyn

**Programming and Prioritisation of River Work
Project No. C4/10**

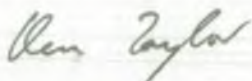
In response to your letter of invitation dated 25th April 1990, we have please in submitting our proposal for the above project. The document has been prepared in two sections as requested and four copies of each are enclosed.

We have formulated our proposals in the light of our existing knowledge of the work done on this and related subjects and preliminary discussions with two organisations faced with similar decisions on programming and prioritisation - the Department of Transport and British Waterways Board. Our work on Levels of Service for most of the regions is well-known to the NRA's project management team and we would be able to deploy most of the same staff on this project. Our understanding of the subject, the requirements of the study and how the output needs to be integrated into the flood defence function's planning and strategies is probably unmatched by any other consultancy organisation.

We would be happy to discuss any aspects of these proposals and to revise them if necessary.

I look forward to hearing the outcome of the tender evaluation process.

Yours sincerely



Ken Taylor
Director
Consultancy Services

ENVIRONMENT AGENCY



052600

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1. Introduction

1. Introduction

1.1 General Introduction

The National Rivers Authority (NRA) - Thames Region, has invited Laurence Gould Consultants Limited (LGC) to submit a tender for a Research Project. This document presents our proposed strategy for undertaking the project, and the experience of the staff who would be deployed on it. A separate document has been prepared which sets out our expected expenditure.

This project in effect asks two fundamental questions about flood defence work:

- how should one decide what needs to be done?
- how should one decide in what order it should be done?

The first of these questions requires expertise in river engineering, both of a revenue and capital nature. For this expertise, LGC would associate with Sir William Halcrow and Partners Ltd (SWHP). SWHP is amongst the leading UK-based consulting engineers with an extensive range of experience including river engineering work in the UK.

The second is dependent on an understanding, knowledge and appreciation of:

- benefit:cost analyses;
- levels of service (LOS) strategies;
- the de facto operating procedures within the NRA;
- other factors which influence the spending of the flood defence budget.

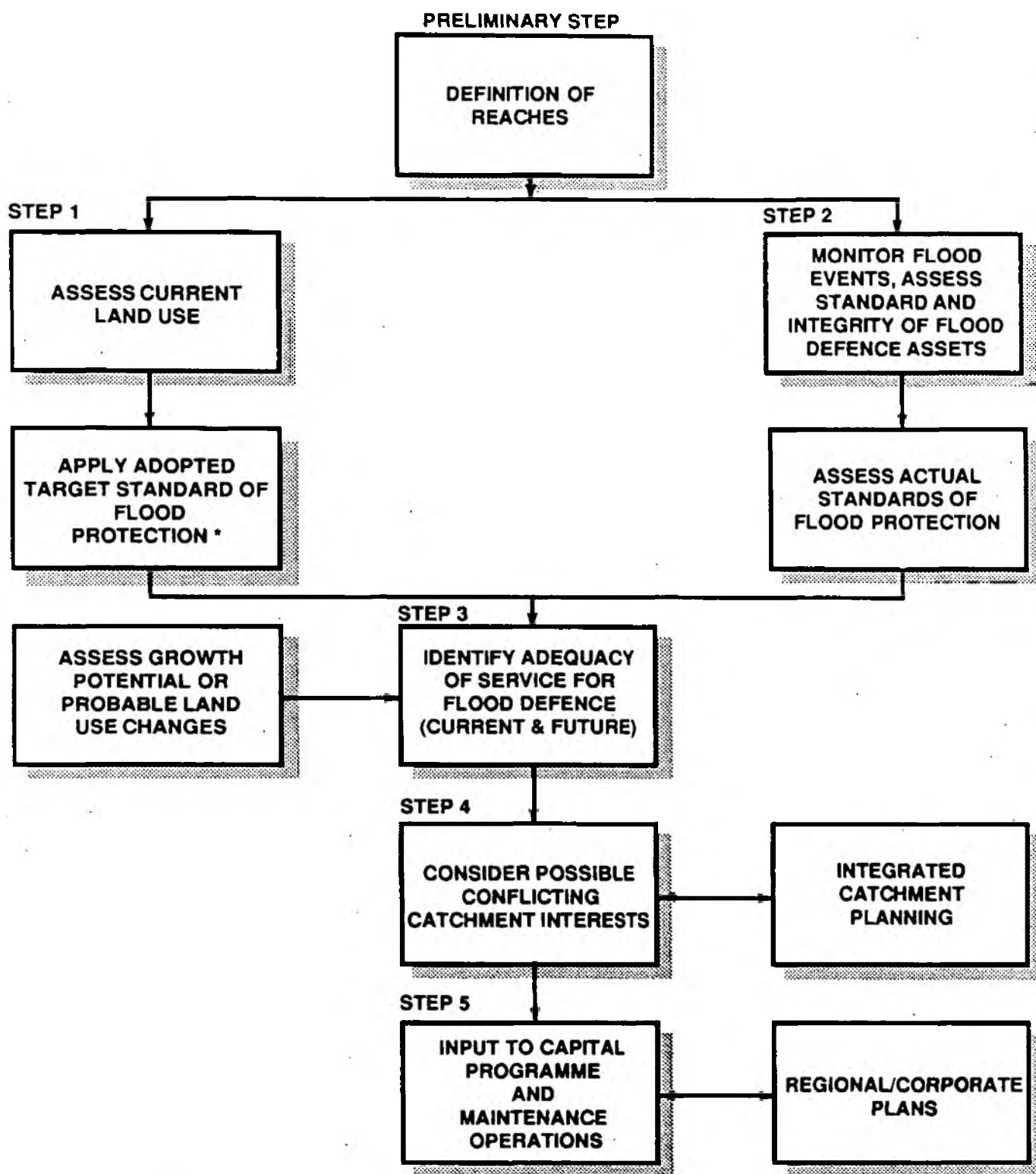
For over three years, LGC have been developing flood defence LOS strategies, often in association with SWHP, and so are able to meet these requirements from within. The experience available from within each company is described more fully in Section 8, and that of the nominated individuals in Section 7.

1.2 Appreciation

The formation of the NRA, brought into effect by the Water Act 1989, established for the first time a single organisation charged with caring for the aqueous environment. Being part of a national body, with nationally agreed aims and objectives, has created the opportunity for harmonising processes and procedures. For example, initiatives are underway to adopt standard Information Technology systems and River Corridor surveying techniques.

There are numerous opportunities to adopt a similarly consistent and more corporate approach to flood defence work. The responsibilities of the flood defence function cover a much wider scope than just river work, and include:

Figure 1.1: LEVELS OF SERVICE FRAMEWORK



** Targets will be set by the NRA for each land use band, based on recommendations from the consultants.*

- research and development;
- flood warning and forecasting;
- maintenance of plant and machinery;
- undertaking feasibility studies;
- river and coastal defence work;
- capital and revenue.

The flood defence functional and regional managers are required to produce plans for incorporation into the NRA's overall corporate plan. Within these functional plans, aims, objectives and targets will need to be defined; inputs and anticipated outputs will need to be assessed and performance measures defined.

It is difficult to accomplish this without clear statements of levels of service for each aspect of the function's activity as these give direction to programming and prioritisation. At present only the flood alleviation/protection levels of service have been researched in depth. Much of the work done in this area over the last few years has involved LGC, often in association with SWHP, and has centred around the development of techniques which allow the NRA to set consistent target standards for flood alleviation and assess, uniformly and objectively, what is being provided. This work is now reaching completion, and we are on schedule to produce the first draft report on what we hope will be adopted as a national system.

Previous work has concentrated on Steps 1 to 3 (see **Figure 1.1**); this new project now moves the focus of development a stage further, to Steps 4 and 5, but also widens the scope of the budgetary allocations embraced.

Programming of river work means the identification of tasks that needs to be done to achieve and/or maintain an adequate levels of service for flood defence activities of all forms. It can include both revenue and capital works; the maintenance of man-made structures and machines as well as control of natural processes; design of alternative engineering options for capital schemes and recognition of most cost:effective practices. Consequently, this work will need to interface with other projects also being let under the topic of Operational Management. It also must include provision for emergency or unplanned works which inevitably arise throughout the course of the year.

Having identified the work that needs to be done, the limit that is placed on resource availability imposes a requirement that these works be prioritised. Current practice throughout the regions in prioritising capital schemes is relatively consistent, but the approach to revenue work varies both between regions and within. Much work is based on historical precedence, without a significant regard to levels of service provision, and is often influenced by other catchment management considerations such as fisheries, conservation, navigation, etc.

At the time of increasing demands for public accountability and the wish to trim budgets as tightly as possible, an objective and consistent approach is needed which clearly links resource demands with desired levels of service. It is only in this way that all can be assured that the best value for money is being achieved, that is - getting the biggest impact for the least cost.

2. Objectives

2. Objectives

2.1 Project Objectives

The overall objective for the study is "to review current practice and then develop methods for programming and prioritisation of Flood Defence work".

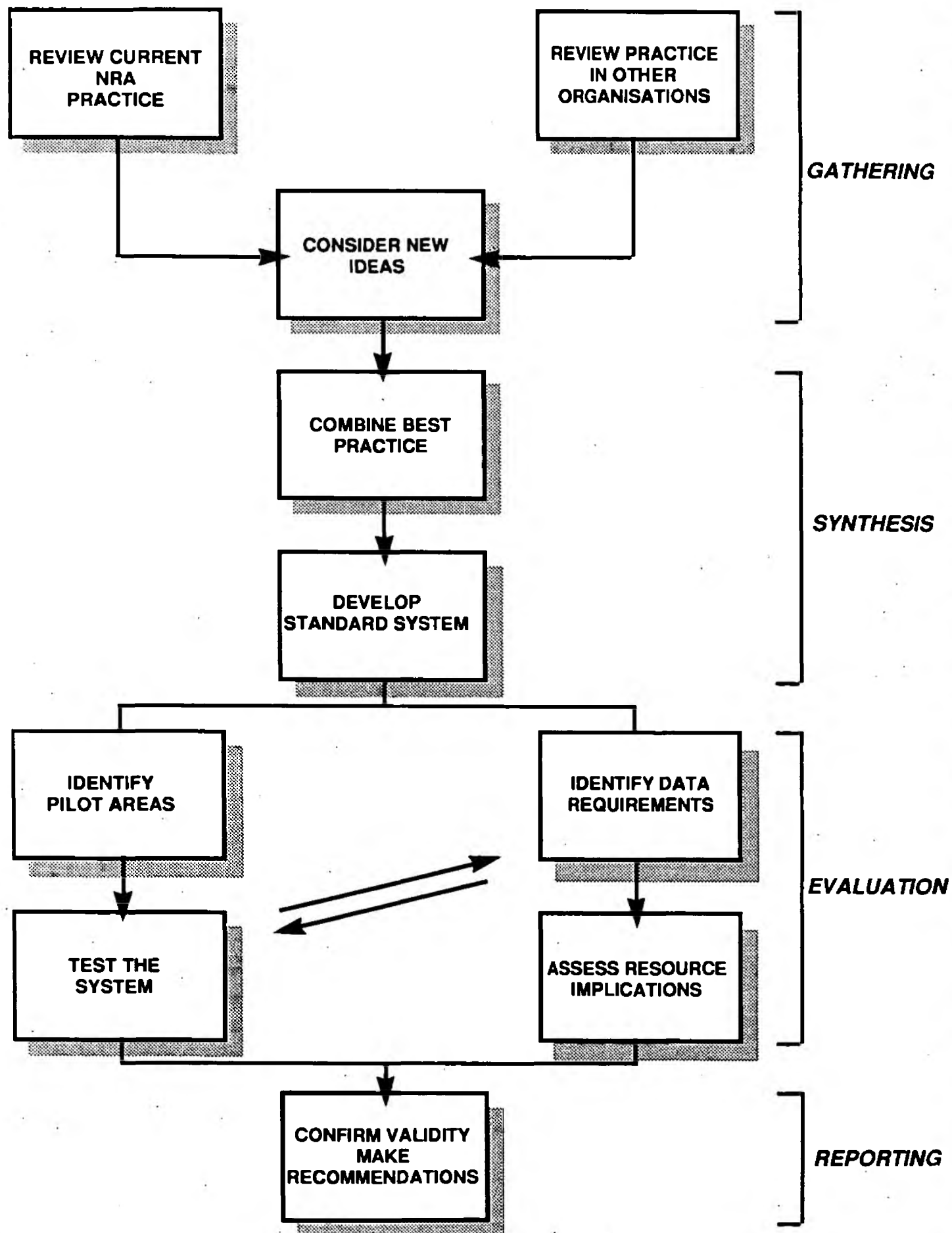
To achieve this overall objective, we would be conscious of the need to achieve a number of sub-objectives:

- to ensure that regional decision-makers are able to contribute to the development process as fully as possible;
- close liaison is maintained with project management and regional staff;
- to maintain the momentum of development of a study with which we have been intimately involved in the past;
- to define a workable system within the timescale of the project.

However, attention is drawn to the caveats and constraint noted in Section 5.2.

3. Strategy

Figure 3.1: OVERALL FRAMEWORK



3. Strategy

3.1 Introduction

It is important in an innovative study of this kind to operate within an overall framework which embodies the strategic approach. **Figure 3.1** provides our view of the appropriate framework. The study would thus have four phases:

- collection of data
- synthesis and assimilation
- testing and evaluation
- reporting and discussion

3.2 Collection of Data

There are two sources of data on current practice:

- NRA regions
- other organisations

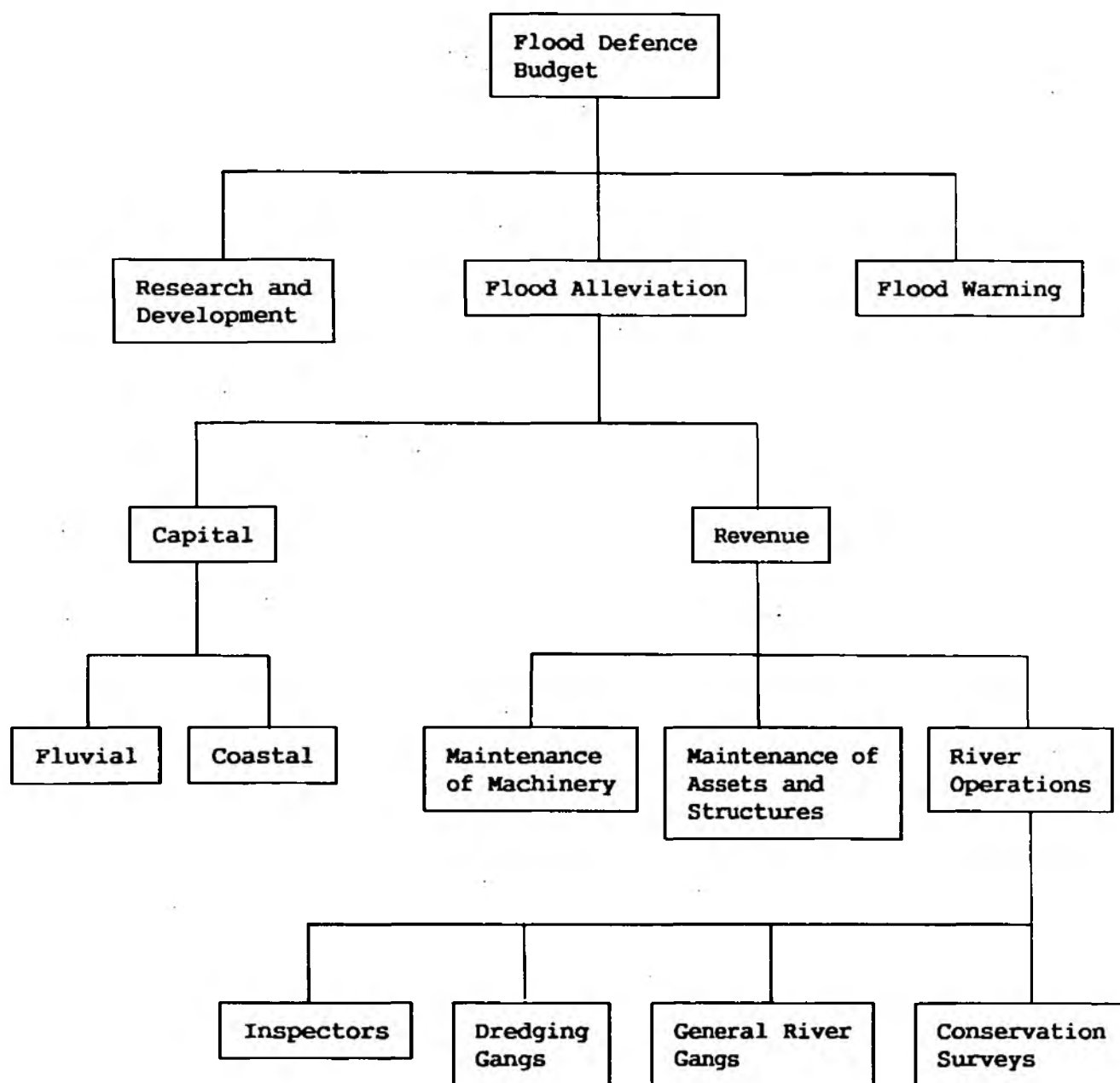
We would place particular emphasis on current practice in the regions for a number of reasons:

- it should, in most cases, represent a status quo reached between levels of service provision, whether defined or not, and work undertaken;
- the new system should ultimately involve fine tuning rather than a radical re-think for most areas;
- acceptance of a new system is easier if those expected to implement it believe they have contributed to its development;
- there is a vast store of knowledge and experience that one would be foolish to ignore.

It is not intended that current practice should entirely dominate the research, but we would reflect its importance in the care and depth with which this would be reviewed. We would therefore:

- obtain information from central sources on the breakdown of spending within the NRA's budget;
- ask the regional contacts to describe their flood defence management structure;
- identify the persons who actually take the decisions on programming and prioritisation;

Figure 3.2: HIERARCHY OF FLOOD DEFENCE SPENDING



- identify those persons who feed the information on work items to the decision-makers;
- ask for copies of recent work programmes, together with the actual out-turn;
- prepare a list of questions designed to obtain a clear understanding of their current approach to programming and prioritisation;
- interview the decision-makers.

It is important to recognise that other organisations have been faced with similar circumstances. At a high level in the NRA, decisions will need to be taken on how the budget should be allocated. This mirrors the difficulties faced by many other government departments, particularly The Treasury. If appropriate, and if access was possible, there would be merit in investigating their procedures. For a more specific example the Department of Transport was subjected to a review by Sir Derek Rayner who found a wide spectrum of approaches to road maintenance and capital spending. He initiated the development of a code of practice which is now used nationally and sets standard inspection and maintenance requirements for different types of roads, and sets procedures for evaluating capital schemes.

Planners in the Department of Transport enjoy the luxury of being able to produce relatively easily the rate of deterioration of their roadways. At the other extreme, the fire, ambulance and police services have to be able to respond to emergency situations. Between these two extremes lie the public utilities such as gas, electric and suppliers of drinking water and sewerage services. It is proposed that a rapid review of a number of these organisations would be conducted and the three most appropriate ones selected for more detailed investigation, adopting a similar approach to the NRA regional interviews. Flood defence agencies in other developed countries will be faced with very similar issues, and it is proposed to undertake an overview of their activities and, if appropriate, contact key individuals and consider their methods.

3.3 Synthesis and Assimilation

It is anticipated that this research will reveal a hierarchy of priorities and within each layer of the hierarchy a series of budget headings will exist (see Figure 3.2). More detailed programming and prioritisation will be necessary as one descends the hierarchy as this represents the transition from stated policy to tasks carried out.

The degree of detail to which the research can be carried out will depend on the existing availability of information within the NRA. It is unlikely to be available with equal quality across the whole range of activities. It is anticipated that the areas most well-developed will be capital and, to a lesser extent, revenue spending on flood alleviation works. As this accounts for the majority of the budget this is hardly surprising and it is in this area that we would anticipate progressing development the farthest.

Conflicts will arise where the budget of intended activities built up from the lower tiers meets the realities of the budget limits imposed from above, together with any primary allocation of budget (eg between R&D and others). It is not intended to enter into what is essentially a political argument, but to identify how this balance is achieved in other organisations.

Within each of these main budget headings it is assumed that programmes will be built up from the lower tiers.

3.3.1 Programming

In order to create a coherent system for programming, we would organise the work into the following four steps:

- *Define objective:* In this case the objective is a method of defining tasks required to meet specified levels of services for flood defence and specified requirements for flood forecasting and warning, research and development and the other elements which make up flood defence spending.
- *Define requirements:* For each aspect of flood defence expenditure the information and techniques necessary to fulfil the objectives must be set out. Information from organisations outside the NRA will be used at this stage.
- *Review existing situation:* The results of the surveys of current practice within the NRA will be reviewed to correlate present data availability and use of techniques with the requirements, and identify significant shortcomings in the existing situation.
- *Recommend new procedure* The three preceding steps will enable the best of existing NRA practice to be combined with new methods from external sources to give a practical and comprehensive methodology for programming.

In each case the investigations would be aimed at identifying:

- Methods of assessing flood defence condition such as: monitoring of embankment crest levels and past maintenance requirements; inspection of structures and measurements of particular parameters such as metal corrosion concrete deterioration; monitoring of river bank and beach erosion;
- Methods of assessing channel conveyance capacity and monitoring restrictions caused by sediment build-up, weed growth and accumulation of debris;
- Maintenance work undertaken specifically to allow condition monitoring of assets or to provide access;
- Existing methods of programming works including estimation of residual life of structures and assessment of the benefits of maintenance work in terms of levels of services or direct economic or financial risk;

- Details of information held on the assets and on past maintenance practice especially where the effects of changes to maintenance techniques or frequency has been assessed
- Details on the format in which information is held and experience of successful and unsuccessful practice. This topic would include an investigation as to the extent of progress or plans for the adoption of Geographical Information Systems (GIS).

3.3.2 Prioritisation

Within each of the main areas of work, a method for assessing priorities will need to be developed. In doing so, the key factors which influence priorities would be identified. These will include:

- levels of service assessments;
- degrees of deviation from adequate service provision;
- size of benefit, cost and their ratio estimated for the proposed task(s);
- social/political pressure;
- aesthetic considerations (environment, fisheries, navigation, etc);
- nature of the work to be carried out.

It is essential that those which should influence priorities are separated from those that do. For each factor which must be considered, methods would be developed as far as possible which allow their influence to be quantified objectively. Wherever possible this would draw on existing categorisation procedures (eg Land Use Banding technique developed by Thames Water/Thames NRA). The relative importance of each factor would then be assessed. Initially, this may need to include some subjective assessments which may lead to recommendations for future developments. One such area is environmental economics which would be required to assess aesthetic considerations. It is anticipated that, at this stage, few regions will take into account output data from the levels of service system but this would be incorporated into the procedure where possible, along with any other appropriate innovations that become apparent.

Our preliminary view is that these factors will need to be considered through a matrix approach, the output from which would be a numerical assessment of each task which would be a priority ranking. A similar approach is often adopted when considering alternative capital scheme options.

Ideally, the same factors should be used in each category, so that a consistent approach is in place. However, it is possible that the precision with which particular factors are assessed would vary. For example, the benefit:cost ratio of a £33 million flood alleviation scheme should be assessed in more detail than the same index for the construction and installation of a gauge board, costing only a few hundred pounds.

It will be necessary to define at which stage of the prioritisation procedure the matrix evaluation process is introduced. There may be factors which need to be given overriding importance, such as sea defence work. The system may also need to respond to rapidly changed circumstances, for example after a major flood event.

3.4 Testing and Evaluation

It is vital that the proposed options be tested in a 'live' example. Subject to agreement with the project team, the two most suitable options or combination of options, would be tested in pilot areas. Selection would be made to provide, inter alia:

- an area for which appropriate levels of service have been assessed or for which information is immediately available to allow them to be assessed;
- a mix of regional representations;
- coastal and fluvial situations;
- urban and rural situations;
- a variety of capital and revenue works;
- a mix of morphological, hydraulic, hydrological, vegetative and geological features.

The scope and size of the pilot areas would be agreed with the project officer but should be of sufficient size to encompass as closely as possible the smallest budgetary unit.

The pilot testing procedure would reveal:

- the data requirements;
- an indication of likely availability;
- by difference, those which would need to be collected.

Accordingly, it would give an indication of the resource implications for implementing the proposed options.

The specification of data needs for programming river work may be constrained to a great extent by what is already held by the various regions of the NRA. Clearly there can be some encouragement given to all regions to emulate the best current practice and some new forms of data capture and management might be suggested and certainly it would be necessary to specify the ideal data requirements before making concessions to practical considerations dictated by present practice. In particular, it is clear that the adoption of Geographical Information Systems is seen as a desirable medium-term objective in many regions.

In respect of prioritisation, consideration will need to be given to the continual gathering and analysis of data, including:

- benefits or avoidance of disbenefits;
- unit costs;
- land use banding;
- adequacy of service;
- nature of flooding or risk of flooding;
- political/social pressure;
- other catchment management considerations;
- historical work practices.

3.5 Reporting and Discussions

The results of the interview programme and the pilot studies would be presented in a written report. Strategies for the implementation of the recommended programming and prioritisation options would be developed in discussions with the NRA project management, together with indications of appropriate timescales.

To operate the selected option, a computer-based management system is likely to offer the best solution. Recommendations will be made on the most appropriate system to use, giving particular regard to the decisions taken at national level about information systems.

It is likely to take a number of years before a system is completely implemented. During this development and implementation process, further research is likely to be required. We would clearly indicate where this is considered necessary.

4. Timescale

Figure 4.1: Timescale for the Components of the Project

Task	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Review of Current Practice							
- preparation	■						
- interviews (NRA and non-NRA)	■	■					
- reporting		■					
Determination of Options		■	■				
Undertake Pilot Studies			■	■	■		
Analyse and Assess Results					■		
Draft Report							*
Final Report							*
Liaison	*	*	*	*	*	*	*

4. Timescale

We would adhere to the overall timescale as set out in the terms of reference. However, within this we believe that inadequate time is allowed for the initial review of current practice. If the contract is awarded on 1st June 1990 the design of a suitable questionnaire, identification of appropriate staff, briefing them on our needs and fixing appointments would delay the start of visits until about 11th June. An elapsed time of 3 weeks is likely to be needed to visit all 10 regions, bearing in mind the onset of the holiday season, followed by a further elapsed time of 1 to 2 weeks to analyse and record the results. It is proposed that the approved timescale for the first items of work is extended to mid-July.

With this exception, all other components of the study would be completed within the timescale laid down, subject to all information available within the NRA and other organisations needed to complete the work, is made available within a reasonable timescale.

5. Outputs

5. Outputs

5.1 Outputs

Outputs from the study would be as requested, namely:

- review of current practice;
- report on options;
- results of pilot studies;
- draft and final project reports;
- recommendations for further research.

The outputs in terms of the system developed and tested would be:

- a method for programming river work which employs as objective an approach as possible to achieve and maintain appropriate levels of service;
- a method for prioritising the capital and revenue work programmed.

5.2 Caveats and Constraints

The proposed timescale and budget for the study relative to the wide scope of activities under consideration precludes the achievement of detailed analysis of every issue. The lack of clearly defined levels of service for many of the flood defence function's activities also limits the ability to define comprehensive programming and prioritisation procedures; these can be defined in general terms only or limited to a small number of factors (eg benefit:cost).

The remit of the brief is taken to mean flood defence activities only; whilst recognition of other factors' influence can be accommodated, merging their levels of service objectives with those of flood defence are seen as being outside the brief. Such combining of interests is, nevertheless, vitally important and is now referred to as integrated catchment planning.

The system developed is unlikely to be able to easily assess the resource implications of changes to a levels of service.

The timescale is insufficient to allow adequate testing of the system's effectiveness - changes to levels of service brought about by a change in management activity may take years to emerge - and permits only a testing of the process by which the decision to change is made.

Also, it has been found that the effectiveness and accuracy of the techniques advocated and tested are only able to be assessed by reference to the NRA's local engineers. However, their opinion may be influenced by the implications of the test results and therefore such comparisons may not be valid.

6. Variations

6. Variations

At this stage we do not anticipate or recommend any variations from the objectives, strategies and outputs as described in the terms of reference. Our recommended variation in timescale for the first component of the study has been discussed above.

7. Staff

7. Staff

The approach taken in selecting a team who would conduct this study is to exploit the wide range of skills available within LGC and SWHP staff. The bulk of the work would be conducted by four key individuals, each with specific relevant experience. They would also be able to draw on other expertise to cover all of the subject matter areas envisaged in the Terms of Reference.

The proposed team is set out below; a brief outline CV is provided with a description of the individual's intended role. The anticipated inputs of each are described in the detailed costs. Full CVs are provided in Appendix 2.

The staff inputs, particularly during June and July 1990, have been carefully arranged to suit other commitments of the staff concerned. Any alterations to the programme for this project might require reorganisation of staff inputs.

Unforeseen circumstances may lead to changes in this team and the Consultants reserve the right to substitute other suitably qualified staff if this proves necessary. Such changes would be agreed with the NRA in advance.

**Position: Project Director/
Levels of Service Specialist**

K TAYLOR, CV No. 1

Mr Taylor is a Director of LGC and head of the Consultancy Services Division. He has been closely involved in all the company's work on levels of service since 1986 and has gained considerable knowledge of the practical operation of flood defence maintenance work in the NRA as a result. He has also been involved in efforts to explain and define the framework within which the NRA must now define its corporate plans. He would assume responsibility for the management of the project and would also act as the specialist on levels of service outputs.

Position: Consultant

P A REASTON, CV No. 2

Mr Reaston is an LGC Consultant who has been very actively involved in much of the field work, pilot testing and analysis of results undertaken as part of recent projects related to levels of service. He would be responsible for investigating current organisations other than NRA, procedures, undertaking pilot testing and investigating alternative prioritisation options.

**Position: Specialist in
Flood Defence Procedures**

J TINKLER, CV No. 3

Mr Tinkler is a well-known figure within the water industry and worked for many years in what is now the Wessex Region of the NRA, eventually as land drainage manager before taking early retirement in 1988 and establishing a freelance consultancy business. He has an intimate and detailed understanding of all aspects of flood defence budget spending, including capital and revenue work, programming and prioritisation, as currently practised. He would undertake the initial review of current practice and act as consultant to the team on matters relating to maintenance practices.

Position: Benefit Assessment Specialist

J B CHATTERTON, CV No. 4

Dr John Chatterton is one of Middlesex Polytechnic's Flood Hazard Research Associates and is well known for his contribution to the methodology of benefit assessment techniques. He was also closely involved in the development of Severn-Trent's RIMS. He has worked with LGC on a number of past projects, including ones relating to levels of service. His recent work with Severn Trent Water Authority plc is also of particular relevance. He has been responsible for the development of the TEROMAN system which allows the scheduling of maintenance activities, linked to an asset inventory, and provides a consistent basis for management reporting. He would be available for consultation on any matters arising in respect of benefit assessment techniques, particularly those of an intangible nature, and the use of computer systems in work scheduling.

Position: Engineering Director

A P G RUSSELL, CV No. 5

Mr Andrew Russell is head of the Irrigation and Drainage Division of SWHP and is a director of their joint venture with LGC's sister company, ULG Consultants. He has many years' experience of engineering studies, both at home and abroad. He has wide experience of coordinating multi-disciplinary projects and has particular interest in catchment planning and C.A.D. Mr Russell would be responsible for the engineering components of the study.

Position: Senior Engineer

J E BEDWELL, CV No. 6

Mr John Bedwell is a senior engineer with SWHP with a wide experience of engineering projects in the UK and overseas. He is now UK-based would be responsible for undertaking the bulk of the investigations relating to engineering studies, including setting up of questionnaires, field work in pilot study areas and testing.

**Position: Coastal Engineer and
Computer Specialist**

I H TOWNEND, CV No. 7

Mr Ian Townend has worked with SWHP for 14 years and is now closely involved in the Anglian Sea Defence Management Study. He has gained considerable experience of the demands and priorities of sea defence work. He would be available for consultation on aspects of the study relating to coastal issues.

Position: Senior Engineer

A R KEY, CV No. 8

Mr Tony Key is a senior engineer with particular expertise in soil and water engineering. He has been involved in other research projects including the original work done by LGC on rural land drainage levels of service.

8. Experience

8. Experience

8.1 Laurence Gould Consultants Limited

LGC is Britain's largest and best-known independent consultancy specialising in agriculture and the rural environment. Founded nearly 30 years ago, it has maintained continuing involvement with farmers and landowners now numbering over 250 regular clients. It has also achieved a world-wide reputation working for international agencies, governments, public authorities and private sector clients both large and small.

This expertise has proved to be of great value to the Water Industry, initially for the assessment of the benefits of rural and urban flood alleviation schemes. However, LGC has responded to the industry's environmental assessments of capital projects and investigations into the pollution of surface and groundwater by nitrate, pesticides and farm effluent. At a time when public accountability and services to customers are receiving closer scrutiny, LGC has been instrumental in developing a new flood defence levels of service strategy for a number of the Water Authorities. The Company has therefore remained at the forefront of development where the water and agricultural industries overlap.

For our work in the water industry, we have formed close links with consulting engineers, Sir William Halcrow and Partners Ltd, and Middlesex Polytechnic. Together we form a strong team, well accustomed to working together, to the advantage of our clients.

In 1987 LGC became part of the Robertson Group plc, which is UK based and operates internationally. It provides research and consultancy services in the development and conservation of natural resources, including oil, gas, minerals, water and soils. Many of the component companies have worked within the Water Industry in their own right on projects ranging from soils analysis to barrage design. With over 1100 professionals the Robertson Group provides a formidable range of expertise in depth. This, together with our close links with other leading firms involved in the water industry, gives us an enviable base from which to undertake a wide range of work. Examples of recent relevant projects undertaken by LGC are listed in Appendix 3.

In particular, we wish to give special emphasis to the unique and intimate involvement of LGC in the bulk of the work done on the levels of service work to which this current project is a closely related and logical extension. The stimulation and interest generated by being at the leading edge of developments of such national significance militates against any danger of staleness, lack of new ideas or complacency. The reverse is more the case. Our understanding of the context within which this work is being done is probably unparalleled outside the NRA itself, and enables us to provide a clearer context for the engineering aspects of the study, rather than the narrower perspective that might otherwise be adopted.

8.2 Sir William Halcrow & Partners Limited

SWHP is the principal company in the firm of professional engineering, architectural and surveying practices led by the Halcrow Partnership. The original partnership was formed in 1868 and it built up a particularly strong reputation in port, maritime and railway development worldwide. These remain important sectors of activity, but more recently the firm has diversified into fields of consultancy which have a direct impact on basic human needs for food and water supplies, shelter and income.

SWHP is structured on two main Operating Divisions, supported by a comprehensive range of technical and administrative service departments.

Halcrow Water and Maritime covering irrigation, water resource development, hydrology, hydrogeology, mathematical models, reclamation, river works, land drainage, dams and barrages, hydro-electric projects, pipelines, water supply, sewage treatment and urban drainage, major harbours, dry docks, dockyards, shore works, dredging, reclamation, thermal power stations, desalination plants, heavy foundations and structures, cooling water systems and alternative energy.

Halcrow Geotechnics, Transportation and Tunnels covering bridges, roads, tunnels, airports, structures, underground construction rapid transit systems, traffic studies, urban development, railways, site investigations, geology for waste disposal and land stability.

SWHP has worked in over 100 countries, on schemes ranging from small-scale projects to large multi-disciplinary assignments. Over half of the Group's work is undertaken within the UK. Clients include international funding agencies, government departments, public sector authorities and utilities, industrial and commercial firms, financial institutions and private individuals. The Group has gained a particular capability in the effective transfer of engineering technology and project management skills to the counterpart staff of client authorities.

The resources of the SWHP group are its personnel, skills and experience. These include over 1000 professional and technical staff who form highly qualified, specialist teams to meet the precise requirements of the client on each project. These skills integrate advanced with proven techniques to secure the best practical response to a problem reflecting over 100 years' experience in consultancy.

Emphasis has been placed on training and technology transfer. Over many years, SWHP has built up a tradition of training its own very large staff, and on most overseas projects is now actively engaged in transferring knowledge and skills to the staff of its clients.

The consultancy services offered by SWHP are available at every stage of a project from conceptual planning to implementation, and include:

- strategic and master planning
- project definition
- site investigations
- studies and feasibility reports
- preparation of tender and contract documents
- contract administration and measurement
- supervision of construction quality assurance
- training and technology transfer
- operation and maintenance facilities
- project management

Each assignment undertaken by the company is under the direct supervision of a Director, designated the Project Director, who will normally be chosen by reason of his special knowledge of either the nature of the work or the geographical area concerned. The project Director may draw upon the resources of any, or all, of the technical and/or specialist departments to build up a team most appropriate to the work in hand and, of course, will draw upon the special experience and special knowledge of his colleagues whenever required. This procedure, developed over many years, ensures that the full resources and expertise of the company are available for any difficulty or problem that may arise, while ensuring that the client has direct and continuing access to a Project Director to discuss or deal with any matter concerning the project.

A selection of projects, which demonstrate the wide range of experience available within the company, is included in Appendix 3.

9. Literature

9. Literature

9.1 Laurence Gould Consultants Ltd

Programming and Prioritisation of River Maintenance Work, June 1989. Laurence Gould Consultants Limited. Unpublished report for NRA Thames Region.

Flood Defence Levels of Service, Stage 1 Report - A preview of the Current Regional Situation and Data Availability, March 1990, Laurence Gould Consultants Ltd. Internal report for NRA Anglian Region.

Levels of Service for Urban and Rural Flood Defence, 1989. NRA Thames Region.

Land Drainage Levels of Service, 1986 to 1989, Laurence Gould Consultants Ltd. A series of unpublished reports for Thames Water Authority:

- Review of Agricultural Land Drainage Standards (Oct 1986)
- Review of Rural Land Drainage Levels of Service (July 1987)
- Review of Rural Land Drainage Levels of Service Stage 3 Final Report (July 1988)
- Revision of The Land Use Assessment Techniques and Weightings (September 1988)
- Theoretical Basis of the Land Drainage Levels of Service Strategy and Its Link with Work Scheduling (December 1988)

Land Drainage Levels of Service Pilot Study, June 3 1989, unpublished, NRA South West Region.

Land Drainage Levels of Service Pilot Study, July 1989, unpublished, NRA North West Region.

Land Drainage Levels of Service Pilot Study, August 1989, unpublished, NRA Wessex Region.

9.2 Sir William Halcrow and Partners

The output of literature from SWHP is mainly in the form of written technical reports which are not widely circulated. Recent work which has received wider press coverage includes the Alleviation of Low Flows Study undertaken for Thames Water Authority. Details of this and other work is included in Appendix 3.

9.3 Middlesex Polytechnic Flood Research Associates

The publications in which Dr Chatterton has been involved are listed in his CV in Appendix 2. Many of these are relevant to this subject.

10. Appendices

Appendix 1

Terms of Reference

PROJECT INVESTMENT APPRAISAL

- 1) R & D Commission C - Flood Defence

Topic: C4 Operational Management

Project Title: Prioritisation and Programming of River Work

Proposed No:

Project No. C4/10

Classification of R&D: Applied Research with Specific Aims.

- 2) Project Leader - Colin Candish Tel. 0734-535210
Flood Defence Planning Manager Fax 0734-500388
NRA Thames Region
Kings Meadow House
Kings Meadow Road
Reading
Berks RG1 8DQ

- 3) Research Contractor - To be appointed on competitive tender basis from the following select list:

Howard Humphreys
Laurence Gould Consultants Ltd
Mott Macdonald
Ove Arup

- 4) Contract Details

Start Date 01/06/90

End Date 31/12/90

Contract type: Competitive tender

5) Objectives

Overall Project Objective

To review current practice and then develop methods for prioritisation and programming of Flood Defence Work.

Specific Objectives

- a) To review current practices and document them for each NRA region including data requirements.
- b) To have regard to prioritisation and programming techniques in other organisations which may be applicable.
- c) To combine the most appropriate elements of current practice with any new ideas to develop a national acceptable systems.
- d) To assess existing and required data requirements in each region to determine a likely timescale for implementation.
- e) To carry out pilot testing of recommended system in a number of NRA regions to confirm validity of proposals.
- f) To make specific recommendations on further research in this area particularly in relation to work planning and computer systems.

6) Background

The annual Flood Defence expenditure for the NRA is in excess of £100 million per annum. The programme of work in Topic C4 - Operational Management is aimed at developing the framework for effective management of flood defence work. This project aims at developing methods to provide a consistent and robust approach which the NRA can adopt. It builds upon work already carried out in a number of NRA Regions and MAFF.

The trust of this work has been:-

- (i) To develop techniques to justify, in economic terms, flood defence work by quantifying benefits and costs.
- (ii) To assess land use and thus target levels of service and to develop systems to determine actual (current) levels of service for comparison.
- (iii) To improve methods of assessing the condition of flood defence assets and thus develop asset management plans.

This project should combine and build upon the essential elements of this work and reference will need to be made to the continuing research projects in these areas.

7) Strategy

Method

- (i) Review and document current practice in each of the areas of prioritisation and programming within the NRA (NOTE: it is not intended at this stage to research methods of work planning ie. programming refers to the determination of appropriate capital works and maintenance regimes on a year by year basis whereas work planning is the scheduling of particular activities, tasks and resources for work planned within the financial year).
- (ii) Agree suitable external organisations where the techniques employed may be applicable, investigate and document.
- (iii) Develop suitable options for prioritisation and programming, documenting advantages and disadvantages, constraints on opportunities and make recommendations.
- (iv) Recommend scope and size of pilot areas to be used for trials.
- (v) Carry out pilot studies, document and assess results.

- (vi) Assess data requirements for recommended methods and compare with existing data availability.
- (vii) Recommend strategy for implementation of recommended approach to prioritisation and programming, including timing, bearing in mind data availability needs.
- (viii) Make specific recommendations for further research particularly in the areas of work planning and computer systems.
- (ix) Produce draft Project Report.
- (x) Finalise Project Report following review by NRA.

Timing

This project is programmed to meet the following timescale:-

Draft Investment Appraisal. Complete by	end March '90
Tender Documents and Tender List. Prepared by	mid April '90
Tender Period to	mid May '90
Tender evaluation (inc presentations) and Contract Award	end May '90
Contract Award	beg Jun '90
Contract	Jun '90 - Dec '90

Monitoring

The project will be monitored by the Project Leader who will require a monthly meeting (half day) with a brief progress report. Monthly invoicing will be required with supporting documentation. Contacts will be established by the Project Leader in each Region for reference/review. At specific review points (see below) progress reports and meetings will be set up.

8) Targets and Timescales

<u>Item No</u>	<u>Description</u>	<u>Output</u>	<u>Date Complete</u>
(i)x(ii)	Review current practice	Report	End Jun '90
(iii)x(iv)	Develop options and recommend pilot areas	Report/Review	Mid Aug '90
(v)	Pilot Studies	Report Review	End Oct '90
(vi)(vii)(viii)(ix)	Draft Project Report	Report	End Nov '90
(x)	Final Report	Report/ Presentation	End Dec '90

9) Outputs

(i)	Review of current practice	: End June	(25 copies)
(ii)	Report on options	: Mid Aug	(25 ")
(iii)	Results of Pilot Studies	: End Oct	(30 ")
(iv)	Draft Project Report	: End Nov	(25 ")
(v)	Final Report	: End Dec	(80 ")

10) Costs

R&D Budget Provision for 1990/91 £45,000.

No internal costs have been identified other than time spent in each Region providing base data.

11) Benefits

Project outputs will be used to provide the framework for prioritisation flood defence work with specific methods for programming that work on a year by year basis.

Benefits will include:-

- (i) Consistent national approach for the NRA.

- (ii) Identification of resource requirements to achieve specified Levels of Service.
- (iii) Optimum use of resources focusing on the highest priorities.
- (iv) Likely financial savings resulting from clear policies, methods and procedures.
- (v) Greater ability to demonstrate accountability to Government, RFDCs and customers.

12) Assumptions and Risks

It is assumed that the work currently being carried out on Levels of Service and Asset Management will conclude within the specified timescales. Minimal risk is involved in the results of this work throwing up anything which will materially effect this project brief.

The work already carried out demonstrates that the desirable output is feasible. There are no perceived risks of a technical nature, risk being limited to the research contractors performance. It is however essential that the contractor receives regional support.

13) Overall Appraisal

This project is an integral part of the framework currently being developed for management of flood defence work. It links past and current levels of service and asset planning and will provide the essential links for bringing the financial and management benefits of this work to fruition.

Appendix 2

Curricula Vitae

Ken Taylor

<i>Nationality</i>	British
<i>Year of Birth</i>	1955
<i>Years with Firm</i>	4
<i>Position</i>	Director

Qualifications and Affiliations

BSc (Reading University) Agric. Hons
Member of British Trust for Conservation Volunteers
Member of Warwickshire Nature Conservation Trust
Member of the Institution of Water and Environmental Management
Member of a NRA National Working Group investigating Flood Defence Levels of Service

Computer Literacy : Lotus 1-2-3 Spreadsheets
Limited experience in Dbase III

Career

1986 -

Laurence Gould Consultants Limited. After one year with the Farm Appraisals Division, during which time farm business appraisals, insurance investigations and other on-farm work was undertaken, Mr Taylor joined the Consultancy Services Division as Senior Consultant. As Project Manager, a number of major projects have been undertaken, including work on Environmental Impact, Levels of Service for Land Drainage, and investigations into Farm Diversification. Appointed as Director and Head of Division in 1989.

1984-85

A sabbatical year spent travelling around the world. Opportunities were made in each country visited to study agricultural systems.

1976-84

Initially as trainee then full Consulting Officer with Farm Management Services of the MMB. After training for one year in the South West, work continued in Dorset and subsequently Cheshire. Duties involved specific technical, financial and managerial advice to farmers of all types. In addition, several training programmes were compiled with the ATB and presented to groups in these areas. A study tour was organised to Republic of Ireland.

Key Specialities

- Levels of Service Specialist
- Water Industry
- Agricultural Adviser on Environmental Impact Assessments

Specific Relevant Experience

1990 National Rivers Authority (Anglian Region and National Head Office) and Water Research Centre

Flood Defence Level of Service.

Project Director of a major study to define a national system for levels of service determination and monitoring. Personal responsibilities included client liaison, project management and participating in the steering group meetings.

1989 Wessex Region of the National Rivers Authority

Flood Defence Levels of Service Update.

Project Leader of an update of an earlier study.

1989 Severn Trent Region of the National Rivers Authority

Flood Defence Levels of Service Concept Report.

Personally involved in a series of discussions and production of a report to investigate the most practical means of adopting existing data and procedures for use in a levels of service system.

1989 Thames Water Authority

Analysis of Maintenance Histories.

Responsible for co-ordinating the establishment of a computer database to contain information about past river maintenance practices. This included development of data input and output, content and format and management of the project to complete the inputting.

1986-89 Thames Water Authority

Land Drainage Levels of Service.

Leader, and subsequently Director, of a major series of projects to develop, test and implement a land drainage levels of service system. The work was done in five stages.

Stage 1 : Review of Existing Levels of Service

Review of existing levels of service system (as at October 1986) as set out in the Thames Water publication - "Setting the Standards". The study concluded that they could not be applied or operated with the current state of knowledge.

Stage 2 : Development

Personally responsible for the development of a system to assist in determining and monitoring land drainage levels of service based on land use. Initially working on two rivers and subsequently on a number of watercourses totalling over 500 km, a land use assessment technique was devised using financial data provided by Middlesex Polytechnic Flood Hazard Research Centre.

Stage 3 : Implementation

Having developed a system which could be implemented, was responsible for assessing the resource implications of implementing the system and, subsequently, for leading the surveying and collating of land use and flood event data for the whole of the Thames Water catchment of over 5100 km of main river.

Stage 4 : Work Programming and Prioritisation

The levels of service system has major implications for the programming and prioritisation of maintenance and capital works. Responsible for identifying the priority options which the levels of service system made available and how these could be used to build up annual work programmes.

Stage 5 : Post-implementation

LGC assisted Thames Water in training staff, applying the system to a Geographical Information System, drawing up action programmes and developing internal and external reporting procedures. Responsibilities included co-ordinating these diverse activities, devising training programmes and liaising with the client.

1988-89 Thames Water Authority

Land Use Survey of the Floodplains in the TW catchment area.

Project Leader of a land use assessment survey of all the floodplains of rivers in the TW region. Responsibilities included the setting up of survey operating and monitoring procedures to effectively control the team of 11 Surveyors, the appointment of Surveyors and regular reporting of progress to the client.

1988 Thames Water Authority

Cotswold Monitoring Stations.

Project Leader on a study to assess the environmental impact of installing river-flow monitoring devices in two rivers in the Cotswold. Personal responsibility included project management and advice on report content.

1988 Halcrow/Thames Water Authority

Study of the alleviation of low river flows resulting from groundwater abstraction.

Agricultural Adviser on a multi-disciplinary team investigating means of alleviating low flows caused by groundwater abstraction from six chalk streams. Input included examination of several options for each stream and making recommendations to minimise the impact on local agriculture whilst achieving the objectives of the schemes.

1988 Wessex Water Authority

Land Drainage Levels of Service Study.

Project Leader on a study to investigate the potential to transfer the Levels of Service system developed for Thames Water to the Wessex Water area. Responsibilities included undertaking field surveys, analysis of flood data and gathering of other necessary data.

1988 North West Water

Levels of Service Pilot Study.

Project Leader of a study of three rivers in the North West Water region to pilot test the suitability of the levels of service system developed by LGC with Thames Water Authority. In addition to co-ordinating in-house and associated staff, responsibilities included report preparation and presentation, and high level discussions leading to the implementation of some of the report recommendations.

1988 South West Water

Levels of Service Pilot Scheme.

Project Leader of a pilot study of two rivers in the South West region to assess the suitability of the levels of service system developed by LGC.

1987 Halcrow/South West Water Authority

River Dart Resources Project.

Agricultural Adviser on a multi-disciplinary team to assess the impact of a proposed scheme to transfer water from Burrator Reservoir to the River Dart. Responsibilities included advice to the consulting engineers on pipeline routing, liaison with farmers and landowners, advice on procedures in relation to commoners and assessment of the impact of the scheme on agriculture.

1987 Halcrow/Wessex Water Authority

Avalon Lakes. Design studies - land use investigations.

Agricultural and land use adviser on a major project to assess the feasibility of using shallow lakes in old peat works for water supply. Advice was given on pipeline routing, taking into account the agricultural aspects of each option. Work included assessment of the short and long term impacts of setting up and maintaining the scheme on farms and other land holdings.

1987 Wessex Water Authority

Avonmouth Sewage Sludge.

As agricultural adviser on a multi-disciplinary team, assisted in the evaluation of a series of disposal options. Responsibilities included the identification of areas suitable for disposal to agricultural land, assessment of the volume and timing available for disposal in each area, an outline assessment of farmer attitudes and a review of the legal and environmental constraints to disposal on agricultural land.

Paul Reaston

<i>Nationality</i>	British
<i>Year of Birth</i>	1964
<i>Years with Firm</i>	3
<i>Position</i>	Consultant

Qualifications and Affiliations

BSc (commen) (Harper Adams) Agricultural Technology.

Computer Literacy : Lotus 1-2-3 Spreadsheets
Wordstar 5.5
Dbase III

Career

Before joining Laurence Gould Consultants Limited gained extensive practical farming experience of a wide variety of farming systems in the UK. Following completion of A levels, worked for a year on an intensive sheep and arable farm prior to commencing BSc. Following several vacation jobs on intensive arable and both intensive and extensive sheep farms, spent a further 15 months working on a large arable and dairy estate in Northumberland before completing degree.

Key Specialities

- Water industry levels of service
- Interview surveys

Specific Relevant Experience

1990 National Rivers Authority (Anglian region and National head office) and Water Research Centre

Flood Defence Levels of Service.

Data gathering and analysis supervisor of a major study to define a national system for levels of service determination and monitoring. Personal responsibilities included co-ordination of land use surveys and development of assessment methodology.

1990 Ministry of Agriculture, Fisheries and Food

ESA low level evaluation.

Principle interviewer in a 400 farm survey on 7 ESA's to evaluate the cost effectiveness of the scheme to the exchequer and landowner. Responsible for ensuring consistency of approach by all interviewers involved.

1989 Wessex Region of the National Rivers Authority

Flood Defence Levels of Service Update.

Responsible of reassessing the information and methodology of an earlier study into Flood Defence Levels of Service.

1989 Halcrow/South West Water Authority

Wimbleball pump storage scheme.

Part of an integrated study group undertaking an environmental impact assessment of a proposed pumped storage scheme. Personal responsibility included a survey of all farmers and landowners along several alternative pipeline routes to determine the most favourable route option. Discussions involved identifying areas of main contention and ascertaining how opposition could be overcome and disruption to agricultural activities minimised.

1989 Thames Water Authority

Land drainage Levels of Service.

A major series of projects to develop, test and implement a land drainage levels of service system. Responsibilities following the initial stage 1 review were:

Stage 2: Development

Completion of field testing of the new land use assessment technique on watercourses totalling 500 km including an assessment of adaptability of the rural system to urban situations and identification of required modifications to finalise the system. Development of an efficient surveying methodology for stage 3 of the project was an essential aspect of stage 2.

Stage 3: Implementation

Manager of the project to collect and analyse the land use assessment data necessary to implement the system throughout the Thames Water region. This included liaison with client on the development and field testing of a computerised data handling and analysis system.

Stage 4: Work Programming and Prioritisation

The levels of service system provides a key methodology by which maintenance and capital works can be programmed and prioritised. After providing assistance in devising the appropriate technique was responsible for presenting and promoting the technique to the future operators of the system.

Stage 5: Post Implementation

LGC assisted Thames Water in the integration of the new system into existing operations. Responsibilities included advice to computer consultants on applying levels of service to a Geographic Information System and providing briefing and training documents for the users of the LOS system.

1989 Thames Water Authority

Analysis of maintenance histories.

Responsible for day to day co-ordination of an analysis of Thames Waters' past river maintenance records. This included client liaison to resolve mapping and information availability problems.

1989 Thames Water Authority

Land Use survey of floodplain areas.

Project manager of a land use assessment survey of all the floodplains of rivers in the Thames Water region. Responsibilities included day to day management of the 11 surveyors covering such activities as allocation of survey areas, ensuring consistency of data collection, checking accuracy of surveyed information and liaising with planning authorities on new developments.

1988 North West Water

Levels of Service pilot study.

Responsible for the pilot testing of the levels of service system, developed by LGC with Thames Water, on one of three rivers being studied in the North West Region.

1988 Manders Raikes Marshall/South West Water

Water quality catchment study on the River Otter.

Responsible for surveying agricultural practices in a river catchment as part of a ground water and surface water resources study. Investigations, by over 30 personal interviews and visual appraisal, were undertaken into current and future land use, fertiliser and pesticide usage, together with a risk assessment of pollution.

1988

Halcrow/Thames Water

Cotswold Monitoring Stations.

Responsible for liaison between landowners, engineers and Water Authority Officers and report production for an assessment of acceptable locations, design, impact and acquisition of land for a series of river flow monitoring stations in the Cotswolds.

John Ashton Tinkler

Nationality British

Year of Birth 1926

Qualifications and Affiliations

Articles served with Black Sluice Internal Drainage Board, Boston, Lincs.

Fellow of the Institution of Civil Engineers (also an Examiner).

Fellow of the Institution of Water and Environmental Management (past Chairman of its River Engineering Section).

Career

Early career in summary:

1941-45

Articled pupil and subsequently Assistant Engineer, Black Sluice IDB, Boston, Lincs.

1945-52

Assistant Engineer, River Ouse (Yorks) Catchment Board.

1952-56

Senior Assistant Engineer, Wear & Tees River Board.

1956-60

Irrigation Engineer, Ministry of Agriculture, Northern Nigeria.

1960-62

Senior Assistant Engineer, Yorkshire Ouse River Board.

Career at management level:

1962-73

Divisional Engineer, Home Division, Yorkshire River Authority.

First Divisional Engineer of this newly-formed Division which was one of five covering the Authority area.

The Division, under his management, was responsible for design and execution of all capital maintenance river works in the catchments of the Rivers Aire and Calder, by direct labour and by contract, including estimating, budgeting and cost control.

Also responsible for the exercise of land drainage regulatory powers, together with a large volume of advice to planning authorities and developers and for devising and operating a flood warning service.

1973-74

Principal Assistant Engineer, Yorkshire River Authority.
The main duties of this post were:

- the coordination of the capital and maintenance river works designed and executed by the five Divisions of the Authority;
- supervision of cost-benefit analysis of capital projects, preparation of forward works programmes, budgets and plant allocations;
- monitoring of expenditure and liaison with MAFF.

1974-78

Land Drainage Engineering Manager, Wessex Water Authority.

In this post reported to the Director of Operations and was responsible for dealing with all land drainage matters at Regional Headquarters.

These included capital works planning and monitoring, coordination of practice and standards in the Authority's three operating divisions and advice to divisions on land drainage problems and scheme design.

Reported on flood defence matters to three Local and the Regional Land Drainage Committees, guiding them on principles and policies.

Supervised the data gathering and publication of the Wessex Water's Section 24(5) Land Drainage Survey (Water Act, 1973).

Participated in many national working groups aimed at achieving a uniform approach on river and sea defence operations and their planning and management.

1978-88

Regional Operations and Land Drainage Manager, Wessex Water Authority.

This promotion added to my previous duties certain RHQ aspects of management of the engineering operations of the Authority. Specifically - emergencies, operational research, transport, health and safety at work, farming/land-owning liaison and the determination and introduction of policies on nature conservation.

1988-present

Consultant in river engineering and related topics.

Since retirement from Wessex Water in September 1988, has practised as a self-employed consultant. Principal clients have been:

Severn Tidal Power Group - report on the impact of the Severn Barrage on tidal outfalls with proposals for remedial works and their costs.

Wessex Water plc - three trunk water mains - route-finding, negotiations with land interests, nature conservation interests and archaeology interests.

Lewin, Fryer and Partners - river restoration after opencast mining and literature survey.

Water Research Centre - adviser on study into sea defence raising costs.

Experience of particular relevance to NRA Project C4/10

The whole 46 years of his career has been closely involved with the engineering of rivers and drainage channels as practised by arterial drainage authorities and internal drainage boards in England and Wales. This covered both maintenance and capital work.

Has practised and supervised the financial and economic evaluation of flood defence benefits since its inception in the late sixties (when increase in property value arising from flood alleviation, as perceived by a 'prudent investor' was used as a proxy for the benefit): through Middlesex Polytechnic's developing methodologies, MAFF Guidelines, application to agricultural benefits and, in recent years, the attempts to apply evaluation of benefits (and disbenefits) to impact upon wildlife conservation and to river maintenance works.

Since the mid-seventies has advocated the importance of nature conservation interests being given full weight during the execution of river works (and their planning).

In Wessex Water was responsible for the introduction of 'Conservation Guidelines' in 1975 (the first in the country); the introduction of conservation budgets to fund conservation enhancements during rivers operations; the engagement of a full-time Conservation Officer in 1983 (the first fully-dedicated one in the country) and the introduction of river corridor wildlife surveys in 1985.

In the 1980s, served on a national working group to develop a harmonised procedure for planning maintenance on rivers and on another MAFF-led group to codify river maintenance practices and frequencies as a forerunner to the introduction of a 'levels of service' maintenance philosophy.

JOHN BRANT CHATTERTON

Nationality British

Year of Birth 1948

Qualifications and Affiliations

University of London
Undergraduate 1966 - 1969 (BSc Special Honours)
Postgraduate 1969 - 1973 (PhD)

Career

1973/77 Middlesex Polytechnic, Research Fellow

Severn Trent Water :

1977/85 Assistant Regional Engineer, Rivers and Land Drainage
1985/date Senior Information Analyst, Operational and Technical Support

Specific Relevant Experience

1988

Project Manager for Middlesex Polytechnic/LGC/Thames Water work on Revision of Rural Land Drainage Levels of Service Assessment Matrix.

In addition, has had an ongoing co-ordinating role with projects commissioned by STWA R. & D., including research on the assessment of agricultural take-up following the implementation of land drainage schemes; and the effective dissemination of flood warning.

1988/date

Member of Severn Trent-International team in Madras, India on ODA funded project 'Environmental Improvement of the Waterways of Greater Madras'.

1989/date

Project Manager, Teroman.

1987/88

Organisation of training and implementation programme for the Teroman project (Computer Aided Maintenance management).

1987

Revision of Flood Damage computer database for MAFF.

1986/date

Development of the Severn Trent Asset Register and an asset/plant management system to permit the economic and effective control of maintenance, operating and whole life costs of plant and enable optimum standards and performance of assets to be achieved.

1985

Commissioned by IWES to produce the economics and project appraisal chapter for Water Practice Manual River Engineering 1 - Design Principles.

1985/date

Development of user requirement specifications for priorities identified by the Business Plan (eg. Asset Management) within the Technical Services function.

1985

BIS Senior Systems Analysis Course, Northwich, Cheshire.

1984/85

Development of cost/benefit techniques in river maintenance project at STWA and production of computer model to assess maintenance priorities (RIMS).

1984/85

Implementation of benefit/cost techniques for river projects in the Federal Republic of Germany. Research project based in Munich with the Bavarian State Bureau for Water Resource Management.

1983/86

Member of MAFF Steering Committee to oversee research in the indirect consequence of flooding.

1984/85

Co-opted onto the MAFF Flood Protection R. & D. Committee Chaired by Professor P.D. Wolf for consideration of MAFF's 5-year R. & D. strategy.

1983

Witness for STWA at the House of Lords Select Committee Inquiry into the Soar Valley Improvement Scheme.

1983

Invited guest at conference organised by Centre National de la Recherche Scientifique, Ecole Polytechnique, Paris.

1982

Chaired session of American Society of Civil Engineers, Water Resource Conference in San Francisco.

1979/82

Four visits to USA to United States Army Corps of Engineers presentation of three papers to the Water Resource Management Division of the American Society of Civil Engineers. The 1982 visit to Fort Belvoir, Washington and the Hydrologic Engineering Centre, California was sponsored by the US Army.

1978/date

Course lecturer on NWC/WITA project appraisal course MSM 13. (Some 50 courses at Tadley Court, Hampshire, Melvin House, Scotland and Millis House, Derby).

1978/85

Benefit/cost analysis on all STWA capital land drainage and selected sewer schemes.

1978/85

Assistant Engineer in preparation of STWA Section 24(5) Land Drainage Strategy document.

1978/date

Lecturer on annual course at Middlesex Polytechnic on the benefits of land drainage, sewer rehabilitation and the social costs of watercourse pollution (to RWA engineers).

1978/date

Research Associate with Middlesex Polytechnic's Flood Hazard Research Centre. Consultant on cost-benefit techniques on all aspects of water resource management including current WRC/DoE sponsored work on the benefits of sewer rehabilitation and the social costs of watercourse pollution.

1977/78

Co-ordination of Central Water Planning Unit Research contract on the damage reducing effects of flood warning.

1977

Project Leader on the assessment of the benefits of flood warning for Nottingham under contract STWA.

1977/78

Data handling for Ministry of Agriculture, Fisheries and Food research grant on assessing damage by sea water flooding.

1976/78

Assistant Project Leader for Southern Water Authority research contract on benefit assessment procedures for flood alleviation and land drainage schemes.

1974/77

Research Fellow on National Environment Research Council research grant - Economic appraisal of flood alleviation schemes. Development of computer software (ESTDAM) and database for evaluation of flood alleviation benefits.

1971

Leader of London University Speleological Expedition to Julian Alps, Yugoslavia.

1969/73

Preparation of Doctoral Thesis at University of London: "Environmental Controls on the Components of Stream Discharge : an example from the Waller's Haven Catchment, E. Sussex". (NERC Studentship).

PUBLICATIONS

1. Books

1987

Urban Flood Protection Benefits : A Project Appraisal Guide. (Contributions to) Gower Press, Farnborough.

1987

Cost/benefit analysis and project appraisal. Chapter 8 of IWEM, River Engineering - Part I, design principles.

1986

Evaluation de la rentabilite economique des projets de drainage en Angleterre et an Pays de Galles. Chapitres X of "Milieux Naturel", illustration de quelques reussites, press de l'Ecole Polytechnique, Paris.

1985

The use of benefit/cost techniques in developing objective land drainage maintenance programmes. Proceedings of 2nd International Conference on the Hydraulics of Floods and Flood Control. University of Cambridge.

1978

The benefits of urban storm drainage : computer modelling and standard assessment techniques. In Proceedings of the International Conference on Storm Drainage. Southampton.

1978

The effect of flood warning on flood damage reduction. HMSO, London.

1977

The benefits of flood alleviation : a manual of assessment techniques. Gower Press, Farnborough.

2. Journal Publications (*referred)

1987*

Comparative aspects of computerised floodplain data management. Journal of the Water Resources Planning and Management Division, Proceedings of the American Society of Civil Engineers, Vol. 113(6).

1984*

Gauging the economic viability of agricultural land drainage schemes. Journal of the Institution of Water Engineers and Scientists, Vol. 38(2).

1981*

Computer modelling of flood alleviation benefits. Journal of the Water Resources Planning and Management Division, Proceedings of the American Society of Civil Engineers, Vol. 197.

1980*

Assessing the benefits of flood alleviation and land drainage schemes. Proceedings of the Institution of Civil Engineers, Part II, Vol. 69.

1979*

The benefits of flood forecasting. Journal of the Institution of Water Engineers and Scientists, Vol. 33(3).

1978

The benefits of flood alleviation : an evaluation of assessment techniques in the UK. Water Services, Vol. 82, No. 984.

1977

Constraints on environmental planning: the example of flood alleviation, Area Vol. 8(2).

3. Conference Papers

1987

The Teroman Implementation Plan: STW view. Meeting of the Teroman User Group at Castle Ashby, Northants, October.

1985

The use of benefit/cost techniques in developing objective land drainage maintenance programmes. British Hydrological Society/IAHR National Meeting in Flood Plain Planning, University of Birmingham.

1983

Gauging the economic viability of agricultural land drainage schemes in England and Wales. Round Table at Centre National de la Recherche Scientifique, Ecole Polytechnique, Paris.

1982

Comparative aspects of floodplain data management in Australia, UK and USA. Water Resource Management Division of American Society of Civil Engineers, San Francisco.

1980

Assessing wetland values : economic and conservation impacts of land drainage. Water Resource Management Division of American Society of Civil Engineers, Green Bay, Wisconsin.

1979

Flood alleviation benefit assessment in UK : Computer modelling and standard assessment techniques. Water Resources Management Division of American Society of Civil Engineers, Houston, Texas.

1977

The benefits of flood alleviation schemes. The 139th annual meeting of the British Association for the Advancement of Science, University of Aston.

1977

Benefit assessment computer models. Conference of River Engineers, Cranfield.

1976

Methods of forecasting flood damage potential. Association of British Climatologists, University of Strathclyde.

1975

Discharge characteristics of three adjacent catchments in East Sussex : The effect of land use management on components of flow. Conference of University and Polytechnic Teachers of Hydrology UWIST, Cardiff.

1974

The development of flood damage information : a preliminary analysis. Conference of River Engineers, Cranfield.

4. Consultancy Reports

1989

Environmental Improvement of the Waterways of Greater Madras (Chapter 9 : Watercourse Management and Flood Control); Commissioned by the Overseas Development Administration of the British Government for the Government of Tamil Nadu.

1988

Rural Land Drainage Levels of Service : Revision of Assessment Matrix. Prepared for Thames Water (Rivers Division) and Laurence Gould Consultants Ltd.

1984

Overview Benefits of Flood Alleviation in the Thames Valley from Oxford to Reading. Prepared for TWA.

1977

Nottingham flood warning scheme : Benefit assessment. Prepared for Severn Trent Water Authority.

1976

Proposed embankment and drainage scheme, Middle Arun : Benefit assessment. Prepared for Southern Water Authority.

1975

Proposed flood alleviation scheme for Pulborough : Benefit assessment. Prepared for Southern Water Authority.

ANDREW P G RUSSELL

Personal Details

Nationality	British
Profession	Chartered Civil Engineer
Specialisation	Land and Water Resources planning and development
Position in Firm	Head of Irrigation and Drainage, Director Halcrow ULG Ltd
Year of Birth	1945
Years with Firm	17

**Key
Qualifications**

- Chartered Civil Engineer with more than 20 years experience of planning, design and implementation of water resource and agricultural development projects in arid, semi-arid and tropical climates.
- Chief Engineer responsible for technical review of UK land drainage projects including river engineering, tidal outfalls and flood defences.
- Wide experience of co-ordinating multi-disciplinary activities involving a number of agencies.
- Particular interests include: total water resources development, catchment planning, rehabilitation and computer aided design and management.

**Education and
Professional
Status**

MA, Mechanical Sciences, Cambridge University, England

Member of the Institution of Civil Engineers, UK

Member British National Committee, ICID

Language Ability

English	Mother tongue
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**Experience
Record**

1972-present

Sir William Halcrow & Partners Limited

1988

Head of Irrigation and Land Drainage

Responsible for technical quality of the firms practice in the fields of irrigation, flood control, drainage, river engineering and rural water supplies.

Responsible for overseeing both technical and financial performance of a number of projects including:

UK:

Berkeley Tidal Outfall Refurbishment, NRA Severn-Trent: Condition survey of existing river-outfall including survey and ground investigation followed by refurbishment works design and supervision.

Keadby Pumping Station, NRA Severn-Trent: River and drainage system modelling to determine pumping requirements.

Horton Mill Refurbishment, NRA Thames Region. Refurbishment of an existing river sluice and construction of a bypass channel.

Aylesbury Flood Alleviation; NRA Thames Region Study and design of a flood alleviation scheme including channel improvements and provision of flood detention storage.

River Neath Diversion: West Glamorgan CC. Design of river diversion works in connection with the realignment of the A465 Aberdulais-Glynneath road. This design makes maximum use of morphological principles to avoid the need for "hard" defences.

Overseas:

Pat Feeder Canal, Pakistan: US\$200M project for the upgrading of the main canal and introduction of the new secondary and tertiary level drainage and irrigation system for 185,000 ha.

Mahakali Irrigation Project, Nepal. US\$20m project for river training and irrigation development.

Low cost water supply and sanitation project, Pakistan involving the preparation of standard design modules for UNICEF.

Baluchistan Minor Irrigation Project, Pakistan. US\$35m development of 50 small scale irrigation schemes.

- 1986-88 **Cyprus: Southern Conveyor Project**
Design Team Leader responsible for the design review of the 110km long pipeline, which varies in diameter from 1400mm to 800mm, and supervised the completion of detailed design and contract documentation for the first phase irrigation development comprising an on-demand distribution system serving 9,000 ha. Resident Engineer for the Akhna balancing dam and the irrigation development which involved three civil contracts and twenty supply contracts in addition to direct labour works amounting to US\$30m.
- 1985 **UK: Ribble Weir Feasibility**
Prepared a report on the feasibility of constructing one or more weirs on the tidal portion of the River Ribble at Preston for amenity purposes. Aspects covered were: channel sedimentation, water quality control, fisheries, navigation, flood control, amenity value and engineering and financial feasibility.
- 1983-1984 **Pakistan: Baluchistan Minor Irrigation and Agricultural Development Project**
Team Leader of the multi-disciplinary Technical Assistance Team providing guidance and on-the-job training to the Project Management Cell on this World Bank and KFW funded project, comprising a large number of schemes ranging in size from 400 to 2,500 ha.
- 1980-1983 **India: Kandi Watershed and Agricultural Development Project**
Water Resources Engineer and acting team leader of a team of specialists advising and assisting the Government of Punjab to select representative watersheds in the Himalayan foothills and to prepare integrated watershed development plans for ten pilot schemes, covering about 24,000ha, for immediate implementation.
- 1980 **Somalia: Northern Rangeland Development Project**
Leading a team developing designs for utilisation of sporadic runoff for increasing fodder production: involving both water harvesting techniques and diversion and distribution of spate flows.
- 1977-1980 **Guyana: Abary River Control Project and Tapakuma Irrigation Project**
Chief Planning Engineer heading the planning unit responsible for all aspects of physical and financial planning, co-ordinating implementation and monitoring of progress for these two schemes comprising flood control, irrigation and drainage works serving more than 125,000ha.
- 1976-1977 **Guyana: Tapakuma Irrigation Project**
Design Team Leader responsible for preliminary and detailed design of flood control, drainage and irrigation works for an existing rice farming area. Including preparation of contract drawings and documents.

- 1975-1976 **Guyana: Mahaica Mahaicony Abary Water Control Project**
Member of a team of experts carrying out the reappraisal of this major scheme for the provision of flood control, irrigation, drainage, infrastructure and agroindustry for an area of 423,000ha.
- 1975 **UK: Wadi Jizan Irrigation Project, Saudi Arabia**
Supervising a design team preparing working drawings for control and diversion structures for this flood irrigation scheme.
- 1974-1975 **Oman: Waterwell Drilling Programme and Pilot Irrigation Scheme**
Responsible for overall management of a waterwell drilling programme in the Jebel area of Dhofar Province, involving severe logistic problems, including the design and construction of water distribution systems for domestic and livestock purposes and an associated pilot overhead irrigation scheme incorporating an intensive beef cattle feedlot.
- 1972-1974 **UK: Craig Goch Dam Feasibility Study and Wadi Jizan Feasibility Study**
Responsible for elements of the field investigations and report preparation.
- 1967-1972 **Zimbabwe (Rhodesia): Ministry of Water Development**
Initially responsible at the District level for investigating, preparing, designing and supervising construction of small irrigation schemes, including dams, weirs, lift arrangements, sprinkler and flood irrigation layouts, in close association with the agricultural extension service. Also Resident Engineer for a medium sized irrigation development and latterly responsible for preparing preliminary designs for several medium-sized schemes.

JOHN E BEDWELL

Personal Details

Nationality	British
Profession	Chartered Civil Engineer
Specialisation	Water Resources, Barrages, Engineering Hydrology
Position in Firm	Senior Engineer
Year of Birth	1954
Years with Firm	1

**Key
Qualifications**

- Study, construction and rehabilitation of river barrages in UK, Indonesia, Pakistan and Sudan
- Refurbishment of tidal flood alleviation schemes in UK
- Flood studies in UK and Mozambique
- Hydraulic structures design for projects in Chile, Indonesia, Pakistan and UK.
- Reservoir operation studies in Indonesia and Mozambique

**Education and
Professional
Status**

BSc (Hons), Civil Engineering, The City University, London, 1980

Member of The Institution of Civil Engineers, London, 1983

Member of The Institution of Water and Environmental Management
1989

Member of the British Section of ICOLD

Language Ability

English

Mother tongue

**Experience
Record**

1989-present

Sir William Halcrow & Partners

1989-present

UK: Senior Engineer, Water Resources Engineering

UK: Kenwith Valley Flood Alleviation Scheme

Project Manager responsible for the study and design of improvements to an existing flood alleviation scheme with a tidal outfall. Aspects considered included hydrological analysis, pumping station design and the development of new operating rules for an existing flood detention reservoir.

UK: Berkeley Tidal Outfall Refurbishment

Project Engineer managing investigations and design work for the refurbishment of the Little Avon outfall to the tidal River Severn. Aspects considered included under-seepage analysis, leakage prevention, corrosion protection and the provision of new penstock gates and flap gates (3m x 3m).

UK: Waterloo Bridge, Inverness.

Project Engineer responsible for scour estimates and remedial river bed protection to an existing bridge.

Yemen: Taiz Upgrading

Taiz Storm Drainage Hydraulic analysis and detailed design of a branched channelised and culverted drainage system carrying up to 268 m³/s at super critical velocity up to 15 m/s.

1987-1989

Coode Blizard Ltd

1987-1989

Pakistan: Senior Engineer, Kotri Barrage Rehabilitation Project

Responsible for site supervision of borehole investigations and structural surveys. Major contributions to a report detailing options for remedial works to increase security against uplift and foundation erosion, river training works and gate replacement. Design of piezometer and trial relief well installation including novel de-airable vibrating wire piezometers with full in-situ calibration facilities. Additional visits for flood monitoring and study of canal rehabilitation works.

1987-1989

UK: Senior Engineer, Purley Head Office

Sudan: Sennar Dam Renovations

Project administration including design work relating to methods of isolating existing sluiceways and provision of new workshop facilities and a slipway.

UK: Carlyon Bay River Training.

Detailed design of river channel stabilisation work to protect beach deposits and allow leisure development.

UK High Warren Dam, Essex

Project engineer responsible for the design of an 11m high earthfill dam on London Clay including site investigation.

JOHN E BEDWELL

1975-1987

Rendel Palmer & Tritton

1987

UK: Senior Engineer, London Head Office

UK: River Usk barrage study, Newport, Wales

Computer simulation and outline design of a tidal exclusion barrage to improve the attractiveness of Newport town centre to commercial development.

UK: Mersey barrage study, Liverpool

Supervision and analysis of hydraulic model studies to investigate the environmental consequences of a tidal power barrage on the River Mersey.

UK: Queen's Valley Reservoir, Jersey

Coordination of the independent review panel's reports including review of flood hydrology and spillway hydraulics, and editing of their report.

UK: Exeter Skypart Development

Outline design for an ornamental flood detention lake forming the centrepiece of a proposed commercial park.

1986-1987

Indonesia: Project Advisor, Arakundo - Jambu Aye Irrigation Project

Supervision of remedial work and new construction to complete the headworks for a project to irrigate 20,000 ha of paddy. The headworks will divert 30 cumecs and are designed to pass the 100 year flood of 3000 cumecs over a 100m long weir.

1986

Solomon Islands: Project Engineer, Lee's Lake Emergency Spillway

Design and direction of construction of a temporary spillway for a 6 million cubic metre lake formed by a very large cyclone induced landslip. Construction was part of a disaster relief operation and used large nylon sandbags and Reno mattresses placed by a specially recruited labour force of 100 local villagers.

1985-1986

UK: Civil Engineer, London Head Office

UK: Oldbury nuclear power station

Inspection of cooling water system to assess service life.

UK: Salisbury by-pass flood study

Studies of 10 proposed river crossing sites to assess waterway opening requirements including the establishment of 30 river gauging stations on the Wyle, Nadder, Bourne and Avon rivers.

UK: Devil's Dingle ash disposal scheme

Flood routing studies and design to achieve completion of an on-going scheme which includes an impounding reservoir.

UK: Small reservoirs

Flood estimation and routing calculations for several existing reservoirs in connection with their inspection under the 1975 Reservoir Act.

- 1985
- UK: Civil Engineer Seconded to James Williamson and Partners' Glasgow Office**
- UK: Edinburgh Castle**
Feasibility study of the provision of infrastructure, including a road access tunnel through the castle rock, to allow development of new tourist facilities.
- UK: Wyndford Road housing estate, Glasgow**
Site supervision of cladding repairs to multi-storey system-built housing.
- UK: Nuclear Submarine bases**
Infrastructure studies in connection with the development of MoD facilities at Faslane and Coulport.
- 1984-1985
- Civil Engineer, Jambu Ave Multipurpose Reservoir Project, Indonesia**
Reservoir operation studies, site investigation supervision and field reconnaissance for hydrological and demand studies for a project including a 4000 MCM reservoir supplying a 160 MW power station and 18 000 ha of double-cropped rice. This work included the development of a new computer model of multipurpose reservoirs and responsibility for study team logistics in Indonesia.
- 1983-1984
- UK: Civil Engineer, London Head Office**
- Sines Ash Disposal Project, Portugal**
Outline designs for the disposal of conditioned ash from a large coal-fired power station, including proposals for a water supply reservoir.
- Arakundo-Jambu Aye Irrigation Project, Indonesia**
Study and design of an end-tipped closure dam to divert The Arakundo river through new headworks against a head of 5 metres with flows of up to 400 cumecs.
- 1981-1982
- UK: Site Engineer, Thames Barrier Project**
Site supervision of the construction of onshore civil works including precast concrete driven piles, steel sheet piling, in-situ and precast concrete works, structural steelwork, architectural works, roads, drainage, landscaping and interface with separate services contracts.
- 1980-1981
- UK: Graduate Engineer, London Head Office**
- Rio Blanco Hydro-electric Project, Chile.**
Design of a 6 cumec headworks structure and also the power station superstructure steelwork for a 20 MW run-of-river power station. Project economics and financing calculations.

Zambesi flood study, Mozambique

Reassessment of the design flood for the Cabora Bassa catchment including the development of a simple reservoir routing model which was applied to the upstream reservoirs at Kariba, Itzehitezhi and Kafue Gorge.

UK: Shoreham harbour

Assessment of the capability of an existing anchored sheetpile quay structures to withstand exceptional superimposed loads from mobile cranes.

Nigerian dams

Stability analyses of existing earthfill dams at Gari, Marke and Challawa Gorge.

1975-1980

UK and Saudi Arabia: Student Engineer

Yare and Blyth Flood Studies

Hydrographic survey to provide information for river modelling.

Jeddah Marine Terminal, Saudi Arabia

Site supervision of the construction of a new berth for 100 000 dwt oil tankers.

Zambesi Flood Study

Outline design of a telemetred hydrometry network and flood warning system and the formulation of new operating rules for the Cabora Bassa reservoir (spillway capacity 16 000 cumecs).

1974-1975

Johnston Construction Limited

1974-1975

UK: Site Engineer, Horsham Sewage Treatment Works

Contractor's setting out engineer for a new works to serve a population of 47 000.

IAN H TOWNEND

Personal Details

Nationality	British
Profession	Chartered Civil Engineer
Specialisation	Design and engineering of coastal engineering works
Position in Firm	Principal Engineer
Year of Birth	1954
Years with Firm	14

**Key
Qualifications**

- Fourteen years experience of civil engineering principally in design and engineering of coastal protection, port and harbour facilities
- International participation in the development of coastal management techniques
- Specialist understanding of mathematical modelling and numerical analysis techniques as applied to coastal engineering problems
- Experienced in the preparation of feasibility reports, design studies, contract documentation and supervision of construction

**Education and
Professional
Status**

BSc (1st Class Honours), Engineering Science, Exeter University, 1975
Member of the Institution of Civil Engineers

Language Ability

English	Mother tongue
French	Fair

**Experience
Record**

1975-1989

Sir William Halcrow & Partners

1989-present

UK: Principal Engineer, Maritime Department, Wiltshire Office
Working on the development of coastal management and responsible for research and development within the Maritime Department. Continuing involvement in coastal management projects, most notably Stage III of the Anglian Sea Defence Management Study. This involves extensive field and model studies, together with the development of a highly sophisticated computer based management system.

1987-1989

UK: Project Manager, Anglian Sea Defence Management Study - Stage I & II, Peterborough Office

The Anglian coastal project is probably the largest coastal study ever launched in Europe. It involves the collection of all data types related to a coastline and coastal processes along 1000 km of shoreline. This data, which amounts to a massive volume of information, was used to establish a novel relational database and associated mapping system. The system provided spatial and temporal analysis of variables for any region or sub-region and was the foundation for an extremely powerful management system.

1982-1987

UK: Project Engineer, Maritime Department, Wiltshire Office
Responsible for supervision of team dealing with solution of coastal engineering problems using mathematical modelling and numerical analysis techniques. Projects have included design work, reporting, tender and contract documents, supervision of construction and the development of numerical models. Projects undertaken to-date include

- CEEB Flood Studies (1987), extreme flood conditions examined for two sites and joint probability analysis technique for waves and water level developed for use in this study
- Channel Tunnel (1987), reviewed wave analysis aspects of marine design
- WRC Long Sea Outfall Design Guide (1986), produced draft guidance notes on the use of rock backfill for pipelines and long sea outfalls.
- North European Storm Study, UK (1985-), major hindcast study being undertaken by a consortium of European Institutes for oil industry. Drafted specification and now provides technical advice during project as part of overall supervisory role
- Holderness Coastal Protection, UK (1985-), nearshore environmental studies and the evaluation of tyre reef and minestone shoal schemes

- Kadiky Coastal Reclamation Study, Turkey (1986), environmental studies and detailed design of beaches and associated coastal structures
- Current Profile Sensitivity Study, UK (1986), an evaluation of possible wave-current profiles and the resultant sensitivity of a jacket structure for variations in vertical velocity profile
- Map Ta Phut Port, Thailand (1985), numerical and physical modelling of waves and sediments to optimise port layout
- Porlock Bay Sea Defences, UK (1985), evaluate range of coastal protection options and prepare a cost benefit analysis
- 3-Dimensional Flow Modelling, UK (1984-5), a feasibility study for the Dept of Energy to evaluate the use of mathematical models for predicting the structure of extreme currents on the North European continental shelf
- Das Island Coastal Protection, UAE (1984), wave and hydraulic studies
- Kaltim Fertiliser Plant, Indonesia (1984), a re-circulation study of heat transport in a tidal basin
- Hamriyah Deep Water Harbour, UAE (1984), numerical and physical modelling of wave agitation within the approach channel and harbour basin
- Plymouth Marina Breakwater, UK (1984), wave and hydraulic studies for the design of a perforated breakwater
- Longman Quay Dredging Study, UK (1984), evaluation of dredging proposals
- Maui Platform Development, New Zealand (1983-), advice on oceanographic studies relating to platform and pipeline design.
- Dungeness Coast Protection, UK (1983-), a numerical study of long term beach stability and annual reports on beach nourishment requirements
- Barton-on-Sea, UK (1982-), preparation of contracts and supervision of work relating to under cliff drainage and the construction of strongpoints. Bi-annual inspections of the works and advice on the long term coastal management policy
- Preesall Embankment Coastal Defences, UK (1983), environmental and hydraulic studies
- Tripoli Breakwater Design Review, Libya (1983), numerical and physical model studies to derive alternative designs

Essequibo Sea Defences, Guyana (1983), design review

- Port of Plymouth, Montserrat (1983), revetment design for hurricane conditions
- Portland Bill Coastal Protection, UK (1983), design of coastal revetment
- Benghazi North Lakes, Libya (1982), design of sea entrances to lake
- West Sole Wave Studies, UK (1982-3), detailed analysis of wave climate for the West Sole platforms
- Hurst Castle Coast Protection, UK (1982), review of design options and cost benefit analysis
- Minehead Coastal Defence Study, UK (1982), review of design options, cost benefit analysis, preparation of drawings and specification, and supervision of construction

In addition, has acted as adviser on coastal processes and hydrodynamic loading for various other projects.

1981-1982

Malaysia: Coastal Design Engineer, Nonok Sub-Project, Sarawak
Responsible for collection of maritime data to determine cause of erosion and production of suitable design, drawings and report. Also supervised design and preparation of drawings for 16 composite deck bridges and responsible for overall programming during the design stage of the project.

1981

UK: Design Engineer, Maritime Department, Wiltshire Division
Responsible for engineering design input to Saudi Minor Ports Study. Carried out work for proposal for fishing harbour in Saudi Arabia.

1980

Malaysia: Engineer, Bintulu Water Supply Project, Sarawak
Preparation of final design and tender documents.

1979-1980

UK: Design Engineer, Maritime and Transportation Depts, Wiltshire Division
Responsible for design input for report on Mokha Port Development, Yemen Arab Republic and other port development and coastal remedial works. Also compiled catalogue of information relevant to bridge maintenance on trunk roads and motorway bridges in Wales and South West England, for the Department of Environment.

1978-1979

UK: Site Engineer, A34, Chieveley-By-Pass and A10, Downham Market
Seconded to Mears Construction Limited. Responsible for supervision, setting out, programming and planning for road and bridge works including both precast and in-situ concrete bridge construction methods.

IAN H TOWNEND

1975-1978

UK: Engineer, Maritime Department, Wiltshire

Responsible for design and drawings for Sharjah Deep Water Harbour, including work on quay walls, breakwaters, oil tanker jetty and port infrastructure. Later carried out structural design and drawings for port administration building using limit state design with an allowance for seismic loads. Also involved in design checks and proposals for Port of Yanbu and scheme in Gulf of Carpentaria, Australia.

Publications

Joint author with P. McLaren, Postulated Model for the coastal genesis of East Anglia, In Press.

A regional study of Coastal Morphology, ICCE, In Press

Frameworks for Shoreline Management, Gustav Willems Prize, PIANC, 1989.

Joint author with C A Fleming, "Beach Nourishment and Socio-economic Aspects", Coastal Engineering. In Press.

"Engineering implications of sea level rise", MAFF River and Coastal Engineers Conference, Loughborough, 1989 and M1 Press.

Joint author with C A Fleming, "A coastal management database for East Anglia, ASCE, Coastal Zone '89", 1989.

Joint author with P McLaren, "Anglian Coastal Management Atlas", Sir William Halcrow & Partners, 1989.

"Wave prediction and hindcasting", IAHR British Section one day meeting on Coastal Hydraulics Research, 1988.

"The development of coastal management procedures" Beach Management Seminar, Hydraulics Research Ltd, 1988 and 1989.

The design of five beaches in Istanbul, Talk to the ICE South West Region, Bristol, 1988.

The use of numerical models in coastal engineering, Talk to the ICE Scottish Region, Glasgow, 1988.

Editorial comment on the development of coastal management, Journal of Shoreline Management, 3, 4, 1987.

Joint author with J D Gardner, Slotted Vertical Screen Breakwaters, ICE Breakwater 87 Conference, Thomas Telford, 1987.

Joint author with J W Eastwood and C J H Watson, "The modelling of wave-current velocity profiles in the offshore design process". SUT Conference on Modelling the Offshore Environment, 1987.

Joint author with P S Godfrey and M Wenger, "Study of sensitivity of a jacket design to sea current profile". HMSO publication OTH 87 267, 1987.

Joint author with J D Gardner and C A Fleming, "The design of a slotted vertical screen breakwater" 20th Coastal Engineering Conference Proceedings, ASCE, 1986.

"Coastal Studies to establish coastal management procedures", Jnl of Shoreline Management, No 2, Vol 1, 1986.

"Wave-current sensitivity study", Seminar on wave-current interaction held at IOS Bidston, 1986.

Joint author with I A Savell "The application of ray methods to wave refraction studies". Lecture

IAN H TOWNEND

Notes on Coastal and Estuarine Studies No 12, "Offshore and Coastal Modelling", Ed P P G Dyke et al, Springer-Verlag, 1985.

Joint author with L Summers "Engineering on sandy coasts, Part II", 26th PIANC Congress, Brussels, 1985.

Participated in the ICE Working Party looking at research requirements for "Siltation, Dredging and Dispersion".

ANTHONY R KEY

Personal Details

Nationality	British
Profession	Civil Engineer
Specialisation	Design of soil conservation, irrigation and drainage works
Position in Firm	Senior Engineer
Year of Birth	1946
Years with Firm	16

**Key
Qualifications**

- Wide experience in the design engineering and implementation of irrigation drainage and flood alleviation works
- Supervision of design and investigation teams in developing countries including on-the-job training
- Specialist understanding of soil conservation techniques, on-farm irrigation trials, hydraulic design of irrigation canals and structures, and deep subsoil drainage.

**Education and
Professional
Status**

BSc, National College of Agricultural Engineering

MSc, Soil and Water Engineering, University of Reading

Member of the Institution of Civil Engineers

Member of the Institution of Agricultural Engineers

Language Ability

English	Mother tongue
French	Fair
Indonesian	Working knowledge

Experience Record

- 1973-present **Sir William Halcrow & Partners Ltd**
- 1990 **UK: Senior Design Engineer, River Neath and Aylesbury Flood Diversion Schemes.**
Prepared design drawings for diverting the River Neath at five locations using sympathetic geomorphological and environmental criteria. Prepared drawings and necessary documentation for Planning Applications for flood storage ponds along two rivers upstream of Aylesbury.
- 1989-1990 **Nepal: Water Management Consultant, Mahakali Irrigation Project**
Undertook two assignments as Consultant to the Project Water Management Unit. Established farmer demonstration plots and trained farmers in proper on-farm water distribution techniques associated with a rotational water supply system. Advised on a water measurement programme to calibrate all canal water control structures.
- 1989 **Pakistan: Senior Irrigation Engineer, Baluchistan Minor Irrigation Project**
Advisor to the Project on all technical and contractual matters relating to the construction of some 40 on-going small irrigation schemes throughout Baluchistan. Responsible for checking all design and contract documents prepared by two local sub-consultants.
- 1988 **UK: Flood Defence Specialist**
Assisted Associated Consultants with the development of a methodology for assessing deficiencies in the levels of service of flood embankments and other assets owned and operated by the National Rivers Authority (Thames Region).
- 1988 **Tanzania: Team Leader, Bugwema and Kahe Project Studies**
Headed a multi-disciplinary team responsible for preparing feasibility reports, re-appraising the potential of two irrigation projects. The Bugwema project studied alternative crops and engineering options for a partially completed pumped irrigation scheme covering 1600 ha, utilizing water raised through 5 pump stations from Lake Victoria. The Kahe project studied alternative cropping and livestock regimes and methods of rehabilitation for a 1500 ha scheme which was badly affected by high groundwater tables and soil salinity.
- 1988 **UK: Senior Irrigation Design Engineer, Kapunga Rice Project, Tanzania.**
Responsible for leading a team preparing contract drawings and documents for a 3800 ha rice scheme and the rehabilitation of a 1200 ha smallholder rice scheme.

- 1987-1988 **Pakistan: Irrigation Engineer, Baluchistan Minor Irrigation Project**
Prepared designs and contract documents for conjunctive water use schemes which included the design of small earth flood retention dams, diversion bunds, aqueducts and lined channels. Advised on the implementation of command area works for irrigating steeply sloping lands.
- 1987 **South Yemen: Irrigation Engineer, Eastern Region Agricultural Development Project**
On attachment to FAO as member of a multi-disciplinary team preparing a feasibility report for the development of spate irrigation and groundwater development projects for 12 agricultural co-operatives throughout the southern coastal region.
- 1986-1987 **Nepal: Design Supervisor, Mahakali Irrigation Project**
Responsible for the supervision and implementation of the detailed re-design of distribution canals, drains and associated structures for this 2500 ha rice irrigation project. The original design for an on-demand system being changed during the construction phase to a rotational water supply system. Subsequently up-dated the feasibility study for Stage II covering some 6000 ha. which involved preparing alternative scheme layouts, preliminary engineering designs and cost estimates.
- 1986 **UK: Design Engineer, Lower Colne and Monmouth Flood Alleviation Studies**
Assisted in feasibility studies, costing and preparation of contract documents for hydraulic and associated works required to control flooding alongside the Monnow and Lower Colne Rivers.
- 1985-1986 **UK: Design Engineer, Asajaya Sub-Project Malaysia**
Responsible for detailed design checks and modifications to hydraulic structures for a tidal drainage project on the North Coast of Sarawak. Advised on design queries during the implementation of the project.
- 1984-1985 **Ethiopia: Design Engineer, Master Drainage Plan for Melka Sadi and Amibara Areas**
Responsible on site in Ethiopia and in Head Office for the development of open and deep subsoil drainage systems for those areas suffering from or immediately threatened by salinisation. Work included assessment of water table fluctuations, review of irrigation scheduling, co-ordination with agriculturalist, analysis of optimum drainage requirements and preparation of detailed cost estimates.
- 1984 **Tanzania: Design Engineer, Kapunga Madibira Rice Projects**
Undertook designs and responsibility for the preparation of contract documents for two rice irrigation projects covering 8,800 ha in the Mbeya district. The works included rockfill weirs, flood dykes, irrigation canals, drains and hydraulic control structures.

- 1982-1983 **Ethiopia: Irrigation Engineer, Amibara Irrigation Project, Siltation Studies**
Responsible for establishing and implementing a monitoring programme to measure and record the extent of the siltation problems affecting the irrigation canal system throughout the project area. Undertook flushing trials to confirm the effectiveness of removing deposited sediment.
- 1981-1982 **Guyana: Team Leader, Abary Irrigation Project Secondary Works Design**
Responsible for the management and technical supervision of a large multi-national team undertaking the detailed design and preparation of working drawings for all secondary canals, drains and hydraulic structures over an area of 18,000 ha of proposed irrigated rice lands.
- 1980-1981 **Ethiopia: Design Engineer, Dabus Irrigation Project Feasibility Study**
As a member of a multi-disciplinary team, responsible for analysing the most cost effective system of irrigation and power supply for the Dabus Project Area. Undertook designs for the preferred sprinkler irrigation option and responsible for preparing a report on all aspects of civil engineering for the Project, including capital and future recurrent cost estimates.
- 1979-1980 **Egypt: Irrigation Engineer, West Nubariya Crop Trials Programme**
Responsible for supervising a local team engaged in the implementation of irrigation trials including land levelling and the field layouts for furrow, border strip, basin and sprinkler irrigation systems. Undertook leaching and irrigation regime studies. Set up programmes to monitor the efficiency of each irrigation system.
- 1977-1979 **Indonesia: Irrigation Design Engineer, West Sumatra Design Unit**
Member of a technical assistance team engaged to provide expert advice and in-service training to the newly established Design Unit of the Government's Irrigation Department in the province of West Sumatra. The Unit's function covered all aspects of the water resource development sector. Specifically responsible for skills development and technical supervision of Indonesian engineers engaged in the implementation of irrigation and drainage schemes. Established standard designs and procedures for hydraulic structures and provided on-the-job training and guidance in their widespread adoption. The structures included a weir, main canal offtakes, secondary and tertiary canal structures and an aqueduct.
- 1975-1977 **UK: Design Engineer; Wadi Dhamad Irrigation Project**
Engaged on designs of the irrigation system for this spate irrigation project in Saudi Arabia. Responsible for the hydraulic and structural design of two major concrete weirs across the wadi and associated canal headworks and scour sluices.

ANTHONY R KEY

1974-1975

UK: Design Engineer, Angelele and Bolhamo Feasibility Study and Amibara Irrigation Project

Assisted in the preparation of the final report for the Angelele and Bolhamo feasibility study in Ethiopia. Assisted in preliminary designs for a low rock-fill weir at Amibara and completed a cost comparison exercise between pumped and gravity fed irrigation options.

1973-1974

UK: Assistant Resident Engineer, Remedial Works to Coal Spoil Heaps

Supervised the 120,000 cu m Marine Tip earth-moving contract in South Wales. Undertook the final measure and assisted with the claims associated with the Penhriw Baffled Drop Structure Contract.

1969-1973

Ministry of Agriculture and Natural Resources, Malawi

1969-1973

Malawi: Soil Conservation and Planning Officer, Lilongwe

A member of a three man team responsible for all soil conservation measures and land use planning for the Central Region. Undertook a large scale resources planning exercise over some 72,000 hectares. Supervised the development of 30 tobacco estates from the soil conservation point of view, planning access and in-farm roads, the siting of waterways and the planning of in-field conservation measures.

Undertook the site investigation design and supervision of construction of small earth dams for water conservation. Responsible for a programme to control gully erosion in dam spillways.

Appendix 3

Relevant Company Experience

1. **Laurence Gould Consultants Ltd**
2. **Sir William Halcrow & Partners Ltd**

Company

Experience

Laurence Gould Consultants Ltd

1. Levels of Service Projects

1990 NRA ANGLIAN REGION

National Flood Defence Levels of Service

Building on work done in other regions, LGC were commissioned by Anglian NRA to develop a national framework for applying a flood defence levels of service strategy. The project is co-funded by Anglian NRA, NRA head office and the Water Research Centre.

1990 NRA HEAD OFFICE

Corporate Planning Process and Framework

Preparation of a written guide to aid NRA staff in the understanding of the corporate planning process and the framework within which it will operate. Examples were drawn from flood defence and conservation functions.

1986-1989 THAMES WATER

Land Drainage Levels of Service

A major series of projects to develop, test and implement a land drainage levels of service system. The work can be described in 5 stages:

Stage 1: Review of Existing Levels of Service

Review of existing levels of service system (as at October 1986) as set out in the Thames Water publication - "Setting the Standards". The study concluded that they could not be applied or operated with the current state of knowledge.

Stage 2 : Development

Initially working on 2 rivers and subsequently on a number of water courses totalling over 500 km, a system for determining and monitoring land drainage levels of service was developed based on land use. A land use assessment technique was devised using financial data provided by Middlesex Polytechnic Flood Hazard Research Centre.

Stage 3 : Implementation

Having developed a system which could be implemented, LGC were commissioned to assess the resource implications of implementing the system and, subsequently, to survey and collate land use and flood event data for the whole of the Thames Water catchment of over 5100 km of main river.

Stage 4 : Work Programming and Prioritisation

The levels of service system has major implications for the programming and prioritisation of maintenance and capital works. LGC identified the priority options which the levels of service system made available and how these could be used to build up annual work plans.

Stage 5 : Post-Implementation

LGC assisted NRA Thames Region in training staff, applying the system to a Geographical Information System, drawing up action programmes and developing internal and external reporting procedures.

1987-

1989 **WESSEX WATER/WESSEX RIVERS**

Land Drainage Levels of Service

A pilot study on approximately 80 km of main river to assess the suitability of introducing a land drainage levels of service system to Wessex Water. An initial study was conducted using an early version of the land use matrix. This was updated using the latest data. The catchments selected included sections of the Somerset Levels within Internal Drainage Board areas.

1989 **SOUTH WEST WATER NRA/NORTH WEST WATER NRA**

Land Drainage Levels of Service

A pilot study was conducted for each of these NRA units to assess the suitability of introducing a land drainage levels of service system and indicating the potential implications in terms of resources and management procedures. The selected catchments included areas at risk from tidal as well as fluvial flooding.

1989 **SEVERN TRENT NRA**

Flood Defence Levels of Service - Concept Report

A comparison of Severn Trent's River Information and Maintenance System (RIMS) with Thames and Anglian NRA's LOS systems with a view to modifying RIMS to fulfil a role as an LOS system.

2. Flood Alleviation Schemes

1981 SEVERN TRENT WATER AUTHORITY

Soar Valley Improvement Scheme, Assessment of Agricultural Costs and Benefits

A full financial feasibility study of the agricultural costs and benefits of a flood alleviation scheme in the Soar Valley. Investigations were carried out through extensive personal interviews into the existing land use and farming practices to determine possible direct and indirect agricultural benefits and costs. The study was subsequently updated and a parallel analysis undertaken in economic terms for presentation at a House of Lords Inquiry.

1983 SEVERN TRENT WATER AUTHORITY

River Blithe Benefit Study

Assessment of the financial benefits and costs of implementing a proposed flood alleviation scheme in the River Blithe Valley. Work included a farmer attitude survey, assessment of agriculture, soil types and land use within the catchment area and a full financial benefit:cost analysis.

1983 SEVERN TRENT WATER AUTHORITY

Lower Severn Benefit Assessment

Full feasibility study to assess the potential to improve land drainage and sea defences of the Lower Severn. The study components included an interview survey to assess the likely uptake of agricultural benefits, an assessment of urban benefits, investigation of environmental aspects, engineering and a detailed benefit:cost analysis. The study area covered 24,300 ha.

1985 WESSEX WATER AUTHORITY

Brue Flood Alleviation Scheme : Agricultural Benefits Study

An assessment of the potential value of changes in agricultural production which would result from a reduction of flooding and waterlogging and improved drainage if a flood alleviation scheme were implemented. All farmers (approximately 100) who were affected by the scheme were interviewed personally.

1982 ANGLIAN WATER AUTHORITY

Flood Alleviation Scheme

An urban benefit study to provide a preliminary estimate of the various levels of protection required for a flood relief scheme for the city of Lincoln. Work included estimating flood level extent and frequency for the city and preparation of a computerised flood damage model to obtain the benefits for the various levels of protection. LGC also represented these findings at a Public Inquiry.

1984 THAMES WATER AUTHORITY

River Ray (Oxon) Land Drainage Scheme

In-depth study of the River Ray Catchment Area to investigate land use and review alternative engineering strategies to improve land drainage. The work included collection of agricultural, conservation and engineering data through field work, farm inspection and interview.

1984 THAMES WATER AUTHORITY

Survey of Thameside Drainage

Preliminary assessment of the drainage problems of land adjacent to a 138 km stretch of the River Thames. The study included conservation, amenity, urban flooding, navigation, land use and agricultural productivity.

3. Capital Scheme Evaluations

1990 WEST GLAMORGAN COUNTY COUNCIL/HALCROWS

River Neath Diversions

Evaluation of the impact of proposed diversions of the river Neath as part of a major road scheme.

1990 A WATER COMPANY

Environmental Impact Assessment

Update and extension of an earlier environmental impact assessment of a large number of potential reservoir sites. Apart from engineering, the study included conservation and environmental aspects, landscape, land use, and agriculture, the impact on transport and local communities, both in the short and long-term. A short list of sites was recommended prior to public announcement.

1988 THAMES WATER AUTHORITY/HALCROWS

Study of the alleviation of low river flows resulting from groundwater abstraction.

Part of a multi-disciplinary team investigating means of alleviating low flows caused by groundwater abstraction from six chalk streams. Input included examination of several options for each stream and making recommendations to minimise the impact on local agriculture whilst achieving the objectives of the schemes.

1988 THAMES WATER AUTHORITY/HALCROWS

Environmental impact assessment for the Lower Colne Valley

Responsible for the rural land use aspects within a multi-disciplinary team assessing the environmental impact of a proposed flood alleviation scheme in the Lower Colne Valley. This included extensive interviews with land occupiers, local agricultural bodies and sand and gravel extraction companies and the preparation of an environmental balance sheet summarising the net environmental impact of the scheme throughout the study area.

1987 SOUTH WEST WATER AUTHORITY/HALCROWS

River Dart Resources Project

Part of a multi-disciplinary team to assess the impact of a proposed scheme to transfer water from Burrator Reservoir to the River Dart. LGC's responsibilities included advice to the consulting engineers on pipeline routing, liaison with farmers and landowners, advice relating to procedure in relation to commoners and assessment of the impact of the scheme on agriculture.

1987 WESSEX WATER AUTHORITY/HALCROWS

Avalon Lakes - design studies, land use investigations

Agricultural land use advisers on a major project to assess the feasibility of using shallow lakes in old peat works for water supply. Work included assessment of the short and long term impacts of setting up and maintaining the scheme on farms and other land holdings. A programme of personal interviews with organisations and individuals affected was undertaken.

Company Experience

Sir William Halcrow & Partners

RIVER RAY (OXON) LAND DRAINAGE SCHEME

COUNTRY: United Kingdom

CLIENT: Thames Water Authority

SCOPE OF SERVICES: Scheme, identification, feasibility study and preliminary designs

PERIOD OF SERVICES: 1983 - ongoing

CAPITAL COST: £ 1.5 million (estimated)

PROJECT DESCRIPTION:

The firm was engaged, in association with Lawrence Gould and Associates, to identify, study and produce preliminary designs for proposed drainage improvement works necessary for agricultural improvements to be obtained for a benefit area of 4000 ha within a total catchment area of 285 square km. The agricultural benefits were to be achieved by means of channel improvements to the arterial drainage network and by the removal or modification of a number of existing weirs and other obstructions to the flow. Modifications to, and in some cases, replacement of existing road bridges were also proposed and provision in the works was made to safeguard amenity and conservation interests in the area. In addition, the recommendations also included the lowering of weirs on the River Cherwell at Oxford. In particular, care was taken to ensure the continuation of the high aesthetic and amenity value of the river and its environment.